FARMINGTON BAY PROJECT REPORT

By Paul A. Sturm

Written - June 1983
Edited and Submitted - January 1986

Utah Geological and Mineral Survey
Open-File Report 86

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INTRODUCTION

History

The southeastern portion of the Great Salt Lake known as Farmington Bay has long held the imagination and interest of local individuals. Since approximately 1940, various individuals have made formal proposals to reclaim the Farmington Bay area for agricultural use and/or to freshen its waters for use as a freshwater multipurpose recreation area.

During the 1960's, construction of two causeways connecting the eastern shore of the lake with the north and south ends of Antelope Island virtually isolated this area from the rest of the Great Salt Lake and gave physical boundaries to Farmington Bay. The southern causeway was constructed by a ranching company to provide access to their grazing lands on the island. The road surface of this causeway is approximately 4202 ft msl and during average GSL elevations (which are lower than 4202) permits virtually no interchange of waters between the bay and the GSL. The northern causeway, called the Antelope Island-Syracuse causeway, was constructed to connect the approximately 2,000-acre State park to the mainland. The road surface elevation of this causeway is 4207 ft msl. This causeway does have an opening that, depending on the lake and bay elevations, is either a maximum of 72 or 82 feet wide. This opening permits a dual interchange of waters from the bay to the lake and a return flow from the lake to the bay. This bidirectional flow of waters through the same opening is a very rare occurrence in the world. The upper, less dense water flows in a northerly direction from Farmington Bay into the south arm of the Great Salt Lake, while the more dense lake water flows in a southerly direction from the GSL into the bay, where it mixes with inflow waters to the the bay.

Only one individual has continued to be a vocal proponent of alternate uses of Farmington Bay since the bay was isolated from the rest of the lake. This individual is Major Glen O. Fleek, USAF retired. For approximately the past 10 to 15 years, Mr. Fleek has made numerous proposals to the governors, elected officals and other officials of the State of Utah concerning his desire to make Farmington Bay a freshwater multipurpose reservoir. He had been answered in each case either by letter or by a meeting held to respond to his proposals.

In early 1980 such a meeting was held at the direction of then Governor Scott Matheson to investigate and comment on Mr. Fleek's proposal. (Note: No minutes were taken at the meeting, so the names of the participants and the outcome of their findings are from the memories of some of those attending.)

Participants	Representing
Glen O. Fleek	Himself
Havan Barlow	State Senator
Marv Maxell	Dept. of Health - Meeting Chairman
Ross Elliot	Parks and Recreation - Director
Doug Day	Wildlife Resources - Director
Ed Rawley	Wildlife Resources - Nongame
Don Adriano	Wildlife Resources - Fisheries
Al Regenthal	Wildlife Resources - Waterfowl
Doug Stewart	GSL Division - Director
Stan Elmer	State Lands
Gordon Harmston	Natural Resources
Norm Stauffer (?)	Water Resources - Engineer
A. Z. Richards (?)	Consultant

During this meeting Mr. Fleek presented a report by Mr. A. Z. Richards entitled "Preliminary Report - Water Control Possibilities for Farmington Bay." This report contained information regarding estimates of costs, equipment, and a time frame necessary to make the bay a freshwater reservoir. (See Appendix A)

The result of the meeting was that Mr. Fleek's proposal to freshen Farmington Bay was determined to be infeasible because:

1. Farmington Bay has no potential as a fishery since it is too shallow and turbid.

2. Farmington Bay has no potential for boating recreation because of the extreme shallowness of approximately three-fourths of its area.

3. Farmington Bay has no potential for water contact sports (i.e. swimming) because of bottom conditions (mud) and the high nutrient and bacterial content of the water.

Thus, it was determined that insufficient benefits existed to justify State expenditure of funds.

One thing that was determined during this meeting was that no definitive study had been made on Farmington Bay that could sufficiently answer some of the questions posed.

BACKGROUND OF STUDY

A great need for a study on Farmington Bay did exist because the proposal to make the bay a fresh-water reservoir has many ramifications. A fresh water lake such as Farmington Bay would be available for public uses such as swimming and boating. Such parameters as water quantity and quality of both inflows and the bay itself had not been studied in sufficient detail to permit the evaluation of the consequences of freshening Farmington Bay. Another public use of the areas surrounding and influenced by Farmington Bay is the waterfowl habitat that is used for birdwatching, hunting, etc. The entire area, water and land, must be considered jointly when a study on the bay is conducted because what may be optimum for wildlife may seriously hinder other recreation. Optimization of the bay elevation for waterfowl would require a much lower surface elevation than would be optimum for other recreational uses.

The water quality of Farmington Bay is affected by past and present quality of the inflow waters. Prior to 1965, raw sewage from Salt Lake City was dumped directly into the bay by way of the Jordan River. Since that time the pollution entering Farmington Bay through the Jordan River inflows has been reduced somewhat. Additional sources of potential pollution exist from the five sewage treatment plants that now discharge effluent into the bay. The water quality aspects of these "new" inflows and their influence on Farmington Bay had never been studied.

Following is a chronology of how the project developed and UGMS involvement in the Farmington Bay Project.

During a meeting held in June of 1980 between Dr. Marv Maxell of the State Department of Health and Dr. J. Paul Riley of Utah State University Water Research Laboratory on prospective 208 projects (Federal Clean Water Act), Dr. Riley mentioned the possibility of a student cooperative project on Farmington Bay.

Dr. Riley then presented the idea of a study on Farmington Bay at a meeting of the Great Salt Lake Technical Team. Agencies interested in participating in the project met after the Technical Team meeting to decide how the project could be implemented. Soon after, a meeting was held at UGMS to decide upon an initial course of action for the project. Preliminary discussions were held to determine: a) what parameters needed to be measured, b) what methods were to be used (i.e. flow rates, chemistry, etc.), and c) how the work was to be assigned.

It was decided, after the approval of the various division directors, that the Division of Water Pollution Control, Utah Geological and Mineral Survey, and the Division of Water Resources would cooperate with Dr. Riley and his students at USU in conducting the Farmington Bay study. Water Pollution Control and UGMS collected the water quality samples (nutrients and chemical components) and measured water flow rates for all sites with measureable surficial inflows and outflows relating to the Farmington Bay area. Water Resources worked with USU in the acquisition and evaluation of historical inflow information. Because no funds were available for this project, other than a modest amount for data processing, Water Pollution Control and UGMS absorbed the costs (manpower, equipment, chemical and nutrient analyses, etc.) of collecting the project data within respective GSL sampling programs.

UGMS Participation in Farmington Bay Study

A. Initial Project Work

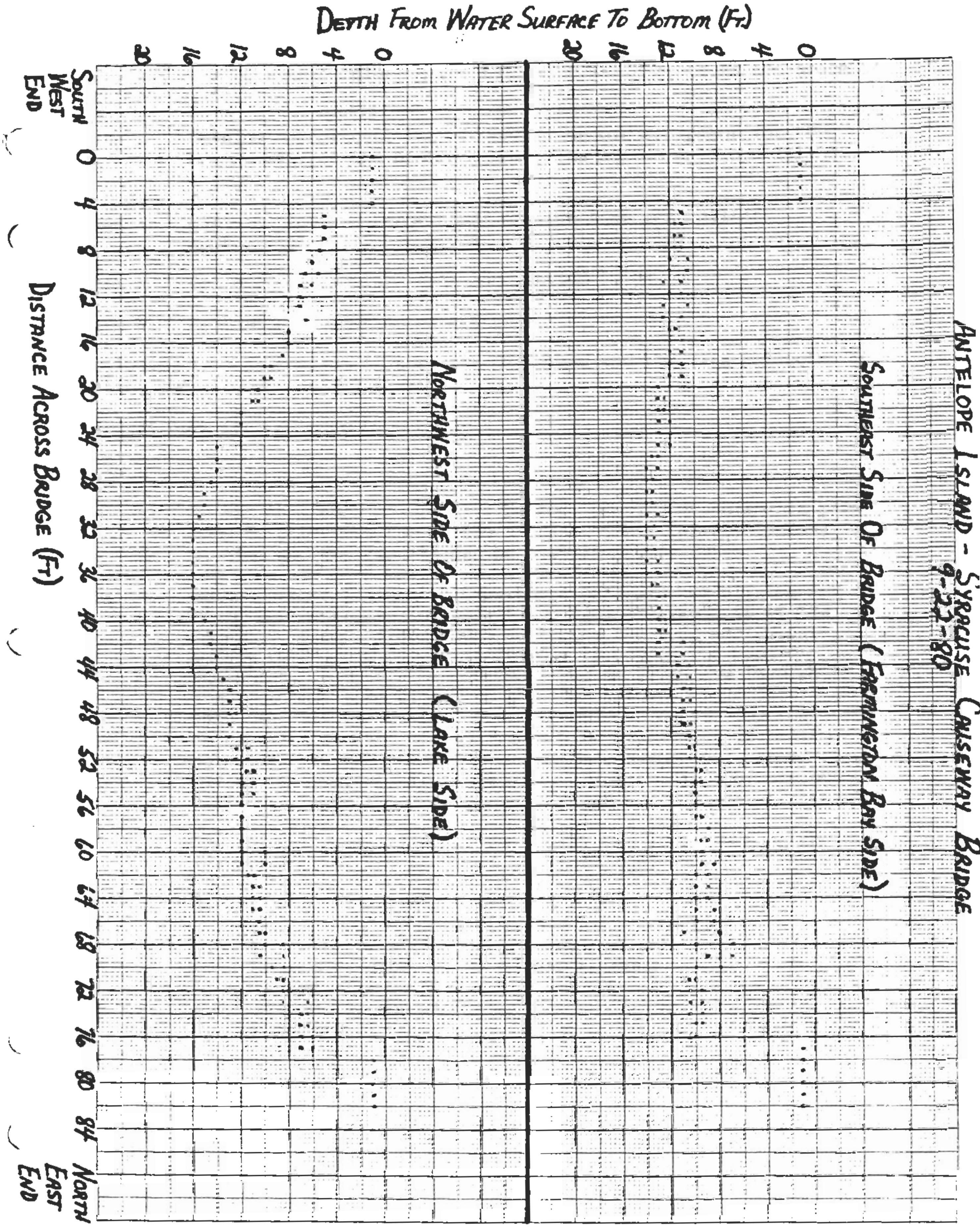
UGMS performed the first actual work on Farmington Bay when on 9-22-80 cross-section measurements of the Antelope Island-Syracuse causeway bridge opening were made to determine the bottom profile. This measurement was critical because, as mentioned before, the bridge opening is typically the only outflow from the bay. This is the location where a bidirectional flow is observed, i.e. outflow from the bay, and inflow to the bay of GSL waters occurs simultaneously. The measurements were performed with a segmented 30-foot length of one-inch aluminum pipe marked at one-foot intervals. The bottom was probed at one-foot intervals across both faces of the bridge because of the irregularly shaped bottom comprised of boulders washed into the opening during bridge and causeway construction. Both maximum and minimum water depth readings were taken from a directly vertical point to five feet out from the bridge face (see figure 1). This is the typical area where water flow measurements are made. It was decided that the causeway bridge's bidirectional flow could best be measured on the bay side, because the bottom was more regular.

On September 30, 1980 the first measurements at the causeway bridge were performed using equipment borrowed from the U.S. Geological Survey. The initial measurements were quite time consuming and means to simplify the flow measurements were considered. The first measurement was terminated without being completed because additional inflow measurement sites had to be located and measured that day. On October 1 the project participants completed locating and measuring the additional inflow sites to Farmington Bay. The first complete set of measurements and samplings was made on October 2, 1980 at all bay sampling sites. The project was continued, as is described in the following section, until December 1982.

After this initial work was performed, and the manpower, level of effort, and time requirements were known, a meeting was held to develop a detailed operations plan for the project. It was decided by all participants that the sampling frequency interval should coincide with the flow rates to the bay in order to optimize the reliability of the data gathered. During periods of typically high inflow measurements were taken more frequently than during periods of low inflow. The sampling schedule was set as follows: October to March - monthly; April to June - weekly; and July to September - biweekly.

Two data sets were collected during the course of this study. These were field and laboratory measurements. The field measurements consisted of flow rate (in cfs) and temperature of the samples taken at each site whenever it was sampled. Additional field measurements of pH, conductivity, and dissolved oxygen were taken whenever possible. The laboratory measurements were performed by the State Health laboratory on all samples collected. The following parameters were tested: complete chemical analysis, ammonia (NH_3), nitrite (NO_2) plus nitrate (NO_3) as total nitrogen (N), total phosphorous (P), TKN, COD, total dissolved solids (TDS), major anions, major cations, and TOC. Heavy metals were tested bimonthly. Starting in early 1982 the major cations and anions portion of the investigation was discontinued because the information it provided did not justify the laboratory costs. In addition, the sampling frequency was reduced from being taken at each flow rate measurement to every other measurement, with a minimum sampling frequency of once a month.

FIGURE 1



DEPTH FROM WATER SURFACE TO BOTTOM (FT.)
20 16 12 8 4 0
20 16 12 8 4 0
SOUTH WEST END
NORTH EAST END
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84
DISTANCE ACROSS BRIDGE (FT)
NORTHWEST SIDE OF BRIDGE (LAKE SIDE)
SOUTHEAST SIDE OF BRIDGE (FARMINGTON BAY SIDE)
ANTELOPE ISLAND - SYRACUSE CAUSEWAY BRIDGE
9-27-80

B. Project Work Assigned to UGMS

UGMS was charged with completing the following assignments as its share of the project tasks:

Task 1 Develop measurement techniques and secure equipment for the measurement of the bidirectional flow at the Antelope Island bridge.

Task 2 Perform flow and temperature measurements and collect appropriate water samples at all assigned flow locations.

Task 3 Collect and tabulate data and provide to USU.

Task 4 Perform other duties as assigned.

Following is a discussion of the work performed and the data collected in completing the various project tasks:

C. Project Work Accomplished by UGMS

Task 1

a) As was mentioned previously, bottom sounding measurements were made to determine the bottom profile. This information was plotted and the results can be seen in figure 1.

b) Since neither the Health Department nor UGMS had all the equipment necessary to conduct the flow measurements at the Antelope Island bridge, UGMS contacted the U.S. Geological Survey (USGS) and made arrangements to borrow the needed equipment. Some of the equipment was on temporary loan while the rest had to be picked up and then returned immediately after each use. It was decided that it would be better for the State to have its own set of equipment. The Department of Health agreed to provide the funds to purchase a complete set of flow measuring equipment from the USGS. As each piece of equipment arrived, the corresponding loaned piece was returned to the USGS.

The following is a list of equipment used in conducting the flow measurements at the Antelope Island bridge.

1. Type AA Price Meter - clicker type
2. Type A sounding reel with wire and connectors
3. Bridge crane with counterbalance weights
4. Torpedo weights, 30 pound and 50 pound
5. Headset with battery
6. Hanging bar and pen
7. Stopwatch

c) The measurement technique used at the Antelope Island bridge was basically the same as was used by the USGS while measuring bidirectional flows in the Southern Pacific Railroad causeway culverts. Prior to the beginning of the Farmington Bay study, UGMS had accompanied, observed and assisted the USGS in making the flow measurements at the SPRR culverts. The flow measurement technique used for this study required approximately two to three months samplings to fully develop. The initial procedure used, along with the modifications finally made, are included in the following text. Flow Measurements were made on the Farmington Bay side of the bridge.

1. Set up bridge crane and weights
2. Attach Type A reel and wire
3. Attach hanging bar and pin to wire
4. Attach 30-pound torpedo weight to the hanging bar with the pin
5. Lower weight over bridge until the bottom of the weight just touches the water.
6. Reset the depth dial on the Type A reel to 0
7. Determine the interface by lowering the weight to a specified depth (5 feet for example), permit it to stabilize for approximately one minute, and then raise the weight rapidly. If the weight swings in an arc then the interface has been encountered, if it doesn't, then the interface is lower. Proceed likewise at other depths to zero in on the interface location.
8. The weight was then recovered, the Price meter attached to the hanging bar, and the contact wire attached.
9. The meter was then lowered to the bottom of the opening and the total depth was recorded.
10. Readings of revolutions per x seconds were taken at one-foot invervals from the bottom to the top of the water.
11. Step 10 was then repeated every three feet across the bridge face, except on each five-foot end of the opening where the distance moved was 2.5 feet.
12. The readings were recorded on a standard USGS form (See Appendix B). The flow velocity was then located on a revolutions versus time chart.
13. Calculations were then performed to determine cross-sectional area at each bridge location for both above and below the interface.
14. The flow velocities are then averaged for each bridge location, also for the areas above and below the interface.
15. The respective flow velocities and cross-sectional areas are multiplied to determine flow volume per unit of time, i.e. cubic feet per second (cfs).
16. All of the upper flows are then added to determine the total flow from Farmington Bay into the Great Salt Lake, and all of the lower flows are totaled to give the Great Salt Lake to Farmington Bay flow.

Modifications were made to this procedure based on mathematical computations. It was determined that more than one half of the readings could be eliminated without affecting the results within 3 percent. This variation is well within the 5 percent accuracy standard that the USGS classifies as good. Step 10 was modified by only taking a reading at .2 and .8 of the depth from the surface to the interface. Step 11 was modified by increasing the sampling distance across the bridge face from three to six feet. Even with this reduction in sampling, approximately 142 calculations were required to reduce the data to the two flow values.

Only one other change occurred to the flow measurement procedure during the rest of the study. After having been rebuilt, the Price meter was recalibrated on February 4, 1982. The new calibration changed the flow rate constant from 2.20 feet per revolution to 2.18 feet per revolution. A new chart to determine flow velocity was made (see Table 1). Flow rates were then read as a function of revolutions per sixty seconds.

Task 2

The flow locations assigned to UGMS were collectively called the north run of the Farmington Bay study. The following is a location-by-location description of the assigned sites and the flow measurement, temperature, and water sampling, etc. techniques used during this study. See figure 2 for sampling site locations. See Appendix B for the field forms used to record the data collected.

Site 1 Great Salt Lake - Farmington Bay at Antelope Island causeway bridge.

a) The upper flow under the Antelope Island bridge was measured as previously described. The water was sampled using a bucket and line. The water temperature was taken and a density reading was made using a 1.0-1.2 g/cc range hydrometer. The samples were taken in standard Department of Health sampling bottles, one-half gallon for chemical, acid stabilized one quart for nutrients, and acid stabilized one-half pint for metals analyses.

b) The lower flow likewise was measured as before. The water was sampled using a horizontal Van Dorn bottle. The temperature, density, and samples were taken as in a) above.

Site 2 Unnamed ditch below North Davis Waste Water Treatment plant (WWTP).

a) The flow from an unnamed ditch is measured just above its confluence with the North Davis WWTP outfall at the debris gate. This stream varied from 0 to 5.25 feet wide and from 0 to .5 feet deep. Flow rates were determined using a pygmy meter and depth was measured with a wading rod. A pygmy meter measures flow at the rate of one revolution per one foot of water movement.

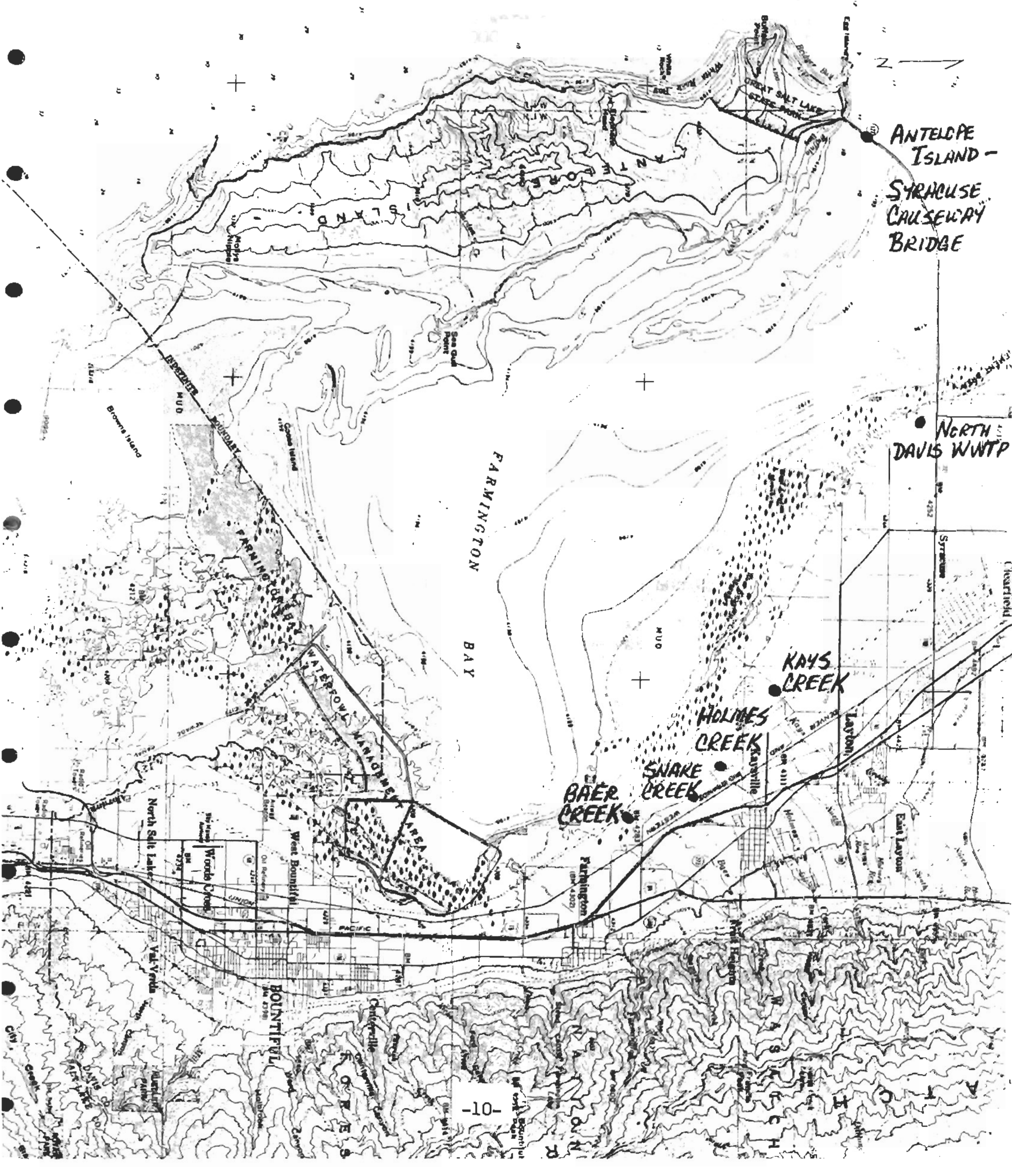
TABLE 1

FLOW DATA TABLE*
Column A - Number of Counts Per 60 Seconds
Column B - Velocity (feet per second)

A	B	A	B	A	B	A	B
1	.04	26	.94	51	1.85	76	2.76
2	.07	27	.98	52	1.88	77	2.79
3	.11	28	1.02	53	1.92	78	2.83
4	.14	29	1.05	54	1.96	79	2.86
5	.18	30	1.09	55	1.99	80	2.90
6	.22	31	1.12	56	2.03	81	2.94
7	.25	32	1.16	57	2.07	82	2.97
8	.29	33	1.20	58	2.10	83	3.01
9	.33	34	1.23	59	2.14	84	3.04
10	.36	35	1.27	60	2.18	85	3.08
11	.40	36	1.30	61	2.21	86	3.12
12	.44	37	1.34	62	2.25	87	3.15
13	.47	38	1.38	63	2.28	88	3.19
14	.51	39	1.41	64	2.32	89	3.23
15	.54	40	1.45	65	2.36	90	3.26
16	.58	41	1.49	66	2.39	91	3.30
17	.62	42	1.52	67	2.43	92	3.34
18	.65	43	1.56	68	2.46	93	3.37
19	.69	44	1.60	69	2.50	94	3.41
20	.72	45	1.63	70	2.54	95	3.44
21	.76	46	1.67	71	2.57	96	3.48
22	.79	47	1.70	72	2.61	97	3.52
23	.83	48	1.74	73	2.65	98	3.55
24	.87	49	1.78	74	2.68	99	3.59
25	.91	50	1.81	75	2.72	100	3.62

* TABLE FOR PRICE METER #R-640 SAH-05-17-042
CALIBRATED FEBRUARY 4, 1982

FIGURE 2
SAMPLING SITES - NORTH RUN



b) The flow rate from the North Davis WWTP was read from a flowmeter in the plant.

c) The site samples were collected in the unnamed ditch approximately 1000 feet below the confluence of the two streams. The samples were collected with a bucket and line and split into the various Health Department sample bottles. The sample temperature was also read.

Site 3 Kays Creek below Angel Street

The initial readings were taken at the dirt road bridge that passes over Kays Creek. This was soon determined to be unsuitable because of debris and irregular flow patterns at that site. The sampling site was then moved approximately 200 yards upstream to a pasture bridge. Flows were measured with a pygmy meter and depths with a wading rod. The width was constant at fifteen feet while the depth varied from .1 to 2.6 feet during the study period. The standard chemical, nutrient and metals samples and the water temperature were taken at the original dirt road bridge. The samples were collected with a bucket and line.

Site 4 Holmes Creek at Angel Street

Initially flow readings and samples were taken at the mouth of the Holmes Creek culvert as it passed under Angel Street. During late April 1981 a diversion dam was located about 100 feet upstream from the initial site. These flow sites were measured independently and called Holmes Creek and Holmes Creek Diversion. Water samples and temperature measurements were collected from the upstream side of the diversion structure. Flows were measured with a pygmy meter and wading rod assembly.

a) Holmes Creek's flow measuring site is a concrete opening 5 feet wide. The depth of flow varied from .15 to 2.1 feet during the study period.

b) Holmes Creek diversion's flow measuring site is also a concrete opening but it is only 3.4 feet wide. The depth of flow during the study period varied from 0 to 3.0 feet.

Site 5 Snake Creek and Snake Creek Diversion

These were both very minor inflows to Farmington Bay. Snake Creek Diversion was first located in late Aril 1981 and Snake Creek itself not until the first of June 1981. Snake Creek was covered by a willow tree that obstructed its view from the road and the diversion ditch was overgrown with weeds. Flows were measured with a pygmy meter and wading rod assembly. No water samples or temperatures were taken.

a) Snake Creek was originally a smashed 16-inch culvert. This was replaced by a new approximately 3-1/2 foot elongated culvert in December 1981. The flow depths varied from 0 to 1.25 feet during the project.

b) Snake Creek Diversion was measured at the discharge end of 3.2 foot elongated culvert. The flow depths varied from 0 to 1.25 feet during the study period.

Site 6 Baer Creek Below Central Davis WWTP

This site has nearly the same configuration as Site 2.

a) The flow from Baer Creek was measured in a concrete-lined canal just above its confluence with the Central Davis WWTP outfall waters. The concrete culvert has a base one foot wide with sides sloping upward at a 50^{0} angle. The depth of this site varied from .29 to 1.7 feet during the study period. A pygmy meter with wading rod was used to measure flows.

b) The flow rate from the Central Davis WWTP was a combination of two readings from the plant's control panel.

c) The sampling location for this site was approximately 3/8 of a mile below the confluence of the two waters. Once again chemical, nutrient, and metals sample bottles were filled and the water temperature read.

The tables following are summaries of the flowrate field data collected (Tables 2 through 5), and of the laboratory determinations of TDS, Nitrogen, and phosphorous content of the six sample sites analyzed (Tables 6 through 11). Some of these data are not complete. If and when they are located they will be added to this report. In addition some samples were not taken to reduce laboratory costs.

TABLE 2

FARMINGTON BAY PROJECT
ANTELOPE ISLAND - SYRACUSE CAUSEWAY BRIDGE BIDIRECTIONAL FLOWS IN CFS (1980-1981)

Date	Farmington Bay To Great Salt Lake (Surface Flow)	Great Salt Lake To Farmington Bay (Subsurface Flow)	Interface Depth(ft)	Weather Conditions
9/30/80	454.4	285.3	5.25	
10/2/80	230.1	624.7	4.25	
10/29/80	1197.0	159.0	7.75	Moderately strong south wind
11/26/80	1110.2	13.6	10.5	South wind preceding 24 hours
12/18/80	622.0	120.3	4.75	Calm
1/28/81	651.2	479.9	5.0	Shifting winds
2/25/81	821.8	258.9	5.5	Relatively calm
3/25/81	1109.0	113.7	6.5-9.5	Winds increasing from south
4/15/81	1576.6	20.2	10.5	Extremely strong south wind
4/22/81	806.5	100.3	6.5	Relatively calm, slight south wind
4/29/81	642.4	457.1	5.0	Slight south wind (?)
5/6/81	87.9	2519.9	5.0-0.0	Extremely strong north wind
5/13/81	1217.1	34.2	10.0	Southeast wind 10-15 mph
5/20/81	2554.2	0.0	Bottom(15)	Gale wind from south
5/27/81	771.2	305.8	5.75	Storm with shifting winds
6/3/81	242.2	1063.7	4.75	Strong wind from north
6/24/81	749.1	223.8	5.75	Wind from east
7/7/81	178.2	910.4	3.75	North wind 10-15 mph
7/23/81	396.4	597.7	4.5	Slight north wind
8/11/81	276.3	585.9	4.75	No. wind increasing during reading
8/26/81	205.8	684.9	4.0	South wind 5-10 mph (?)
9/23/81	696.3	8.6	9.25	Calm (?)
10/14/81	303.5	374.0	4.0	No. wind decreasing during reading
11/17/81	306.0	420.0	4.25	Slight north wind
12/15/81	261.5	487.5	4.25-3.5	Strong So. wind whipping around Antelope Island
Averages	698.7	434.7	6.2	No perceptible pattern
DOH #	498513 Top	498513 Bottom		
Average Acre Feet Per Day [1]	1385.9	862.2		
Average Acre Feet Per Year [2]	505,843	314,710		

Notes: 1. 1 cfs (cubic feet per second) equals 1.9835 af/day (acre feet per day).
2. 365 days/year.

TABLE 3

FARMINGTON BAY PROJECT
ANTELOPE ISLAND - SYRACUSE CAUSEWAY BRIDGE BIDIRECTIONAL FLOWS IN CFS (1982)

Date	Farmington Bay To Great Salt Lake (Surface Flow)	Great Salt Lake To Farmington Bay (Subsurface Flow)	Interface Depth(ft)	Weather Conditions	Gage Height
1/19/82	726.2	120.0	4.75	Calm	1.95
2/17/82	687.2	238.5	9.5-5.0	Wind from south then west	(2.05) es
3/16/82	114.0	2106.8	3.5-0.0	NW wind changed surface flow	(2.65) es
4/13/82	716.1	573.7	5.25	Calm	3.29
4/22/82	509.7	1010.0	4.75	Slight wind from north	3.36
4/29/82	115.4	1466.6	3.75-3.5	Wind from north 15-20 mph	3.38
5/5/82	21.0	1884.5	2.5-0.0	Wind from north 20-30 mph	3.40
5/12/82	157.0	1301.9	4.25-3.0	Wind from north Dec. flows	3.62
5/19/82	176.5	1452.5	4.0	Wind from north	3.80
5/26/82	1840.6	66.5	9.0	Winc from south	4.10
6/3/82	810.9	431.6	6.25	Calm	3.95
6/8/82	738.2	147.4	5.5	Wind from north 10-15 mph	3.92
6/17/82	793.5	438.8	6.0	Wind from east 10-15 mph	3.95
7/2/82	765.0	383.7	5.75	Calm	3.66
7/12/82	790.3	348.2	6.75-5.75	Wind from north retarded flow	3.64
7/28/82	638.5	560.8	5.25	Calm	3.45
8/11/82	1898.3	53.1	9.75-Bottom	Steady wind from west 20-25 mph	3.4+ .1
8/25/82	756.4	55.7	8.0	Steady wind from south	2.95
9/10/82	1008.1	73.1	10.5-8.0	Strong south wind	2.90
9/24/82	763.3	40.5	8.5	Steady wind from south	2.85
10/7/82	0.0	2602.6	0.0	Wind from north 25-30 mph	3.0
11/10/82 3.85	555.2	864.0	4.5	Relatively calm - possible siech	
12/9/82	657.8	818.3	5.0	Slight wind from north/calm	4.47
Averages	662.6	740.8	5.5	Spring winds from north are in excess of fall winds from south	
DoH#	498513 Top	498513 Bottom			
Average acre/feet per day	1314.3	1469.4			
Average acre/feet per year	479,720	536,322			

TABLE 4

FLOW DATA IN CFS - NORTH RUN OF FARMINGTON BAY PROJECT (1980-1981)

Date	N. Davis WWTP	Unnamed Ditch	Kays Creek	Holmes Creek	Holmes Cr Diversion	Snake Creek	Snake Ck. Diversion	Cent. Davis WWTP	Baer Creek
10/2/80	NDT*	NDT	8.5	5.0	?*	?	?	NDT	NDT
10/29/80	24.6		2.4	1.0	?	?	?	3.7	5.0
11/26/80	14.3		7.5	.8	?	?	?	7.3	
12/18/80	23.1		15.9	.3	?	?	?	10.1	
1/28/81	17.8		10.5	1.9	?	?	?	6.8	
2/25/81	23.9		5.3	1.2	?	?	?	8.4	
3/25/81	22.9		4.1	2.1	?	?	?	6.9	
4/15/81	22.9		7.3	3.1	?	?	?	15.2	
4/22/81	22.2		5.2	5.5	?	?	?	13.5	
4/29/81	21.1	1.3	18.2	4.6	3.1	?	.2	4.6	3.2
5/6/81	22.1	9.0	16.1	3.8	2.9	?	.2	2.0	13.0
5/13/81	22.8	6.8	26.2	1.1	2.8	?	.1	4.6	3.3
5/20/81	23.2	.7	28.7	9.1	5.3	?	.3	2.7	8.5
5/27/81	41.0	7.8	323.7	63.0	30.6	?	8.7	13.2	68.5
6/3/81	27.9	5.2	56.9	29.6	6.2	2.0	1.0	5.2	25.2
6/24/81	22.8	.2	1.7	1.3	3.5	.0	.0	5.5	.3
7/7/81	21.7	1.5	15.3	2.1	2.0	.0	.0	5.7	1.1
7/23/81	19.4	7.9	12.9	1.1	1.8	2.5	.9	5.1	.6
8/11/81	16.6	4.4	29.2	2.3	.0	2.1	1.3	4.8	1.0
8/26/81	23.2	.3	4.9	5.8	.0	1.7	1.3	4.8	1.1
9/23/81	23.2	2.0	13.7	2.1	4.8	.5	.6	3.6	4.2
10/14/81	27.1	3.2	12.4	8.1	.0	.5	.4	4.5	1.9
11/17/81	12.8	.2	6.1	3.8	.0	.0	.0	4.0	3.3
12/15/81	22.1	.2	18.6	7.8	.0	.3	.1	3.9	4.6
Averages	23.1	3.4	27.1	6.9	4.2	1.0	1.0	4.9	9.0
Combined	24.8			11.1				12.6	
DoH#	491273		491267	491265				491269	

* Notes NDT - No data taken
? - Location was not known

TABLE 5

FLOW DATA IN CFS - NORTH RUN OF FARMINGTON BAY PROJECT
(1982)

Date	Location								
	N. Davis WWTP	Unnamed Ditch	Kays Creek	Holmes Creek	Holmes Cr Diversion	Snake Creek	Snake Ck. Diversion	Cent. Davis WWTP	Baer Creek
1/19/82	21.7	.8	7.0	4.9	.0	.1	.6	6.4	3.1
2/17/82	26.3	5.1	27.8	11.2	.1	1.0	1.8	12.5	9.6
3/16/82	41.6	5.4	30.1	16.7	2.3	2.5	.7	12.7	13.3
4/13/82	29.4	.0	25.9	15.0	2.6	.6	1.3	12.7	18.9
4/22/82	23.2	.2	10.8	12.4	1.3	.6	.2	5.0	5.8
4/29/82	21.3	.6	30.2	18.0	3.4	.3	.6	5.7	27.7
5/5/82	29.4	.2	66.8	34.8	7.5	.6	1.0	4.5	21.5
5/12/82	29.4	6.5	95.2	27.0	5.7	1.0	1.4	6.6	17.0
5/19/82	21.7	10.2	67.4	26.6	9.9	3.7	.0	7.0	23.0
5/26/82	30.2	.5	24.9	19.2	3.5	.6	2.0	3.9	15.0
6/3/82	20.9	.4	16.0	10.7	3.2	.0	2.1	3.5	11.3
6/8/82	21.7	2.8	13.5	9.4	6.3	1.0	.2	5.7	6.9
6/17/82	22.0	6.4	43.8	11.1	2.1	.0	.5	5.4	12.5
7/2/82	30.2	4.7	32.5	12.8	4.7	2.2	2.4	5.3	4.7
7/12/82	21.7	4.2	7.8	10.6	2.0	.0	.0	5.7	.7
7/28/82	27.5	4.9	54.2	25.5	11.8	.5	3.5	4.7	4.7
8/11/82	21.7	8.8	6.7	7.7	5.2	.0	.5	3.0	3.4
8/25/82	29.8	4.5	16.5	11.2	2.4	.0	2.1	5.0	3.1
9/10/82	21.7	9.0	18.5	6.8	1.8	.0	.6	5.0	1.3
9/24/82	18.6	1.5	16.2	13.4	8.2	.0	.3	3.9	4.4
10/7/82	26.3	4.6	17.5	16.7	9.6	.6	.6	4.5	8.1
11/10/82	30.2	.4	16.0	2.9	2.7	.4	.1	3.6	5.6
12/9/82	31.0	.9	13.2	2.9	3.6	.0	.0	5.1	8.1
Averages	26.0	3.6	28.6	14.2	4.3	.7	1.0	6.0	10.0
	29.6				1.85			1.60	
DoH#	491273		491267	491265				491269	

TABLE 6

CHEMICAL AND NUTRIENT ANALYSES FOR
ANTELOPE ISLAND-SYRACUSE CAUSEWAY BRIDGE
SURFACE FLOW SAMPLES

Date	mg/l TDS	N	P
10/2/80			
10/29/80			
11/25/80	68000	.50	1.50
12/17/80	64160		.70
1/27/81	36700	1.70	1.30
2/24/81	53200		.95
3/25/81	54600	.80	.85
4/15/81	60000	1.30	.80
4/22/81	59000	.30	.10
4/29/81	59100	.50	.75
5/6/81	54500	.05	1.15
5/13/81	68100	.50	.95
5/19/81	59400	.50	
5/29/81	55200	.50	.80
6/4/81	55500	.50	.80
6/23/81	63900	.20	1.00
7/7/81	68600	.50	.90
7/22/81	68200	.50	.90
8/11/81	77700	9.95	
8/25/81	85000	5.30	
9/22/81	101400	1.20	
10/20/81			
11/18/81	65240	.50	.80
12/15/81	52480	.50	1.15
1/19/82	54680	.05	1.00
2/17/82	29178	.05	.50
3/17/82	44320	.05	.85
4/15/82			
5/7/82	58554	.05	.70
5/13/82			
5/20/82	52130	.05	.82
5/25/82			
6/2/82	58520	.05	.70
6/8/82			
6/18/82			
7/2/82			
7/15/82			
7/29/82			
8/10/82			
8/26/82			
9/9/82			
9/23/82	72600	.10	.96
10/7/82	65400	.10	.80
11/10/82	44200	.10	.74
12/18/82			

TABLE 7

CHEMICAL AND NUTRIENT ANALYSES FOR
ANTELOPE ISLAND-SYRACUSE CAUSEWAY BRIDGE
BOTTOM FLOW SAMPLES

Date	TDS (mg/l)	N (mg/l)	P (mg/l)
10/2/80			
10/29/ 80			
11/25/80	141700	.50	1.00
12/17/80	13800		.80
1/27/81	140000		1.10
2/24/81	134000		.90
3/25/81	134600	.40	.70
4/15/81	133800	.05	.80
4/22/81	12500	1.00	.10
4/29/81	125400	1.70	.80
5/6/81	127000	.05	.75
5/13/81	127800	.50	.90
5/19/81			
5/29/81	132600	,59	.85
6/4/81	122500	.50	.80
6/23/81	12500	.50	.95
7/7/81	125200	.50	.70
7/22/81	128800	1.10	.80
8/11/81	138400	1.00	
8/25/81	142400	1.20	
9/22/81	145800	2.50	
10/20/81			
11/18/81	145000	5.75	.60
12/15/81	142900	.05	.90
1/19/82	146100	.05	.85
2/17/82	141200	.35	.75
3/17/82	131800	.05	.80
4/15/82			
5/7/82	122875	.05	.70
5/13/82			
5/20/82	12700	.05	.50
5/25/82			
6/2/82	124030	.05	.50
6/8/82			
6/18/82			
7/2/82			
7/15/82			
7/29/82			
8/10/82			
8/26/82			
9/9/82			
9/23/82	130200	.10	.60
10/7 82	120200	.10	.66
11/10/82	108000	.10	.64
12/10/82			

TABLE 8

CHEMICAL AND NUTRIENT ANALYSES FOR UNNAMED DITCH BELOW NORTH DAVIS WWTP

Date	mg/l		
	TDS	N	P
10/2/80			
10/29/80			
11/25/80	792	19.50	4.80
12/17/80			
1/27/81	838	20.75	6.20
2/24/81	818	14.40	5.00
3/25/81			
4/15/81	728	9.30	5.90
4/22/81	776	19.94	5.40
4/29/81	690		5.70
5/6/81	536	8.25	1.15
5/13/81	624	8.50	4.45
5/19/81	722	12.70	6.05
5/29/81	628	7.25	3.20
6/4/81	566	7.55	2.90
6/23/81	692	12.25	4.30
7/7/81	752	9.20	3.10
7/22/81	692	6.90	2.65
8/11/81	610	8.30	6.75
8/25/81	654	10.15	4.85
9/22/81			
10/20/81	692	13.60	4.60
11/18/81	812	8.90	4.50
12/15/81	854	3.25	3.70
1/19/82	874	3.95	4.05
2/17/82	962	3.85	2.45
3/17/82	1166	3.90	2.75
4/15/82			
5/7/82	688	4.05	5.15
5/13/81			
5/20/82	660	4.00	3.20
5/25/82			
6/2/82	728	5.10	4.00
6/8/82			
6/18/82	644	1.15	4.60
7/2/82	752	2.35	3.05
7/15/82	572	2.30	4.50
7/29/82			
8/10/82			
8/26/82	746	4.20	3.15
9/9/82	672	10.30	2.95
9/23/82	694	11.25	4.75
10/7/82	838	4.0	6.10
11/10/82	820	5.70	4.55
12/10/82			

TABLE 9

CHEMICAL AND NUTRIENT ANALYSES FOR
KAYS CREEK

Date	mg/1 TDS	N	P
10/2/80			
10/29/80			
11/25/80	538	3.60	.10
12/17/80	532	3.75	.05
1/27/81	510	3/75	.10
2/24/81	576	4.50	.05
3/25/81			
4/15/81	6.04	4.60	.06
4/22/81	556	4.60	.10
4/29/81	344	2.20	.15
5/6/81	332	1.75	3.65
5/13/81	326	1.00	.10
5/19/81	302	1.05	.07
5/29/81	76	.90	.75
6/4/81	272	1.10	.10
6/23/81	688	24.30	.40
7/7/81	406	3.75	.20
7/22/81	400	3.10	.08
8/11/81	376	2.50	.65
8/25/81	490	5.70	.25
9/22/81	392	2.60	.15
10/20/81	482	4.70	.05
11/18/81	554	4.50	.40
12/15/81	308	1.65	.60
1/19/82	718	5.05	.50
2/17/82		5.80	.45
3/17/82	552	4.20	.90
4/15/82			
5/7/82	238	.95	.35
5/13/82			
5/20/82	250	1.10	.45
5/25/82			
6/2/82	364	2.05	.20
6/8/82			
6/18/82	257	.75	.05
7/2/82	330	1.65	.05
7/15/82	416	4.10	.15
7/29/82			
8/10/82			
8/26/82			
9/9/82			
9/23/82	396	2.20	.10
10/7/82	400	3.70	.15
11/10/82	407	3.10	.12
12/10/82			

TABLE 10

CHEMICAL AND NUTRIENT ANALYSES FOR HOLMES CREEK

Date	TDS (mg/l)	N (mg/l)	P (mg/l)
10/2/80			
10/29/80			
11/25/80	492	1.05	.10
12/17/80	510	1.45	.05
1/27/81	528	1.25	.15
2/24/81	564	1.40	.10
3/25/81			
4/15/81	284	.80	.25
4/22/81	254	1.10	.10
4/29/81	242	1.75	.20
5/6/81	310	.90	.06
5/13/81	324	1.05	.20
5/19/81	280	.95	.10
5/29/81	176	1.20	.55
6/4/81	178	.90	.30
6/23/81	378	2.20	.15
7/7/81	336	135	.15
7/22/81	374	1.60	.32
8/11/81	364	.90	.17
8/25/81	344	.50	.08
9/22/81	322	.65	.15
10/20/81	460	1.00	2.05
11/18/81	870	1.25	.20
12/15/81	326	.70	.35
1/19/82	620	1.90	.30
2/17/82	583	3.80	.30
3/17/82	414	1.85	.35
4/15/82			
5/7/82	138	.50	.30
5/13/82			
5/20/82	192	.45	.30
5/25/82			
6/2/82	194	.40	.20
6/8/82			
6/18/82	232	.65	.05
7/2/82	244	.65	.15
7/15/82	256	.30	.10
7/29/82			
8/10/82			
8/26/82	309	.55	.40
9/9/82	298	.72	.30
9/23/82	258	.35	.10
10/7/82	298	.65	.15
11/10/82	496	1.40	.15
12/10/82			

TABLE 11

CHEMICAL AND NUTRIENT ANALYSES FOR BAER CREEK BELOW CENTRAL DAVIS WWTP

	mg/l		
Date	TDS	N	P
10/2/80			
10/29/80			
11/25/80	604	11.30	3.00
12/17/80			
1/27/81	608	14.95	4.65
2/24/81	606	11.85	2.85
3/25/81			
4/15/81	376	5.55	1.90
4/22/81	398	7.80	2.05
4/29/81	894	7.60	3.05
5/6/81	227	3.10	.15
5/13/81	520	15.50	3.65
5/19/81	366	7.15	2.55
5/29/81	272	1.40	1.25
6/4/81	244	3.00	1.10
6/23/81	470	15.30	3.70
7/7/81	672	11.25	3.45
7/22/81	700	4.10	.28
8/11/81	621	8.60	4.55
8/25/81	626	10.05	3.35
9/22/81			
10/20/81	712	12.35	3.25
11/18/81	690	8.45	4.25
12/15/81	632	5.70	3.95
1/19/82	706	6.00	3.80
2/17/82	544	4.75	1.40
3/16/82	522	4.60	1.30
4/15/82			
5/7/82	208	2.15	.95
5/13/82			
5/20/82	346	4.50	1.70
5/25/82			
6/2/82	300	4.30	1.50
6/8/82			
6/18/82	678	7.70	3.35
7/2/82			
7/15/82	556	5.50	1.90
7/29/82			
8/10/82			
8/			

FIGURE 3

Task 4 Three miscellaneous projects were also completed as part of this Farmington Bay study. These were:

a) Cross-sectional measurement of the Salt Lake City sewer canal.

b) Airboat sampling trip on Farmington Bay.

c) Installation of staff gage at Antelope Island bridge.

The following sections describe the work performed for these projects:

a) The first project completed was measuring the flow of the SLC sewer canal at the concrete bridge located near the southwest corner of the Turpin unit of the Farmington Bay Waterfowl Management area. The cross-sectional area and flow velocity data were collected by using the bridge crane assembly as described in the Antelope Island Bridge section. Figure 3 shows a typical cross section of the opening. As can be seen, the opening was 27 feet wide with a maximum depth of 4.3 feet. This flow measurement was conducted on two occasions: October 29 and November 26, 1980. In conjunction with the flow readings, a measurement of the distance from the top of the bridge to the water surface was also made. A staff gage was installed directly beneath the edge of the bridge in order to correlate the staff gage reading of water surface elevation with measured flows. Future flow readings were then taken by others and correlated with the staff gage readings. UGMS had no other dealings with this sampling site.

b) The next project conducted was an airboat sampling of Farmington Bay itself. On July 21, 1981, salinity and depth measurements were made along two sampling lines and five sampling points (see figure 4). An attempt was made to accurately locate each of these sampling sites by taking a series of compass bearings directly from the airboat. This did not prove to be a good method as was evidenced when triangulation plots were made, after having returned to the office. Each successive triangle plotted encompassed the preceeding triangle. It was discovered later that an inconsistent deflection in the compass reading was being caused by the magnets in the airboat engine. These deflections thus caused the erroneous plots. Figure 4 is an approximation of the sampling site locations as derived from memory, interpretation of the depth data taken during the samplings, and the transect endpoints used.

Tables 12 and 13 present the depth and conductivity data collected during the July 21, 1981 airboat trip. The field conductivity readings taken were read with a Hydrolab conductivity sensor. Conductivity is a direct, but not

FIGURE 3

SALT LAKE CITY SEWER CANAL CROSS SECTION

SEE FIGURE 4 FOR LOCATION

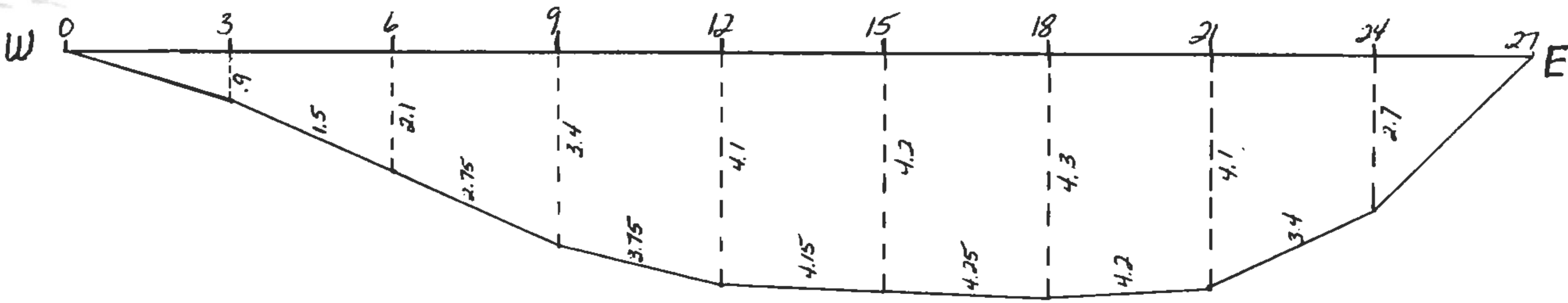
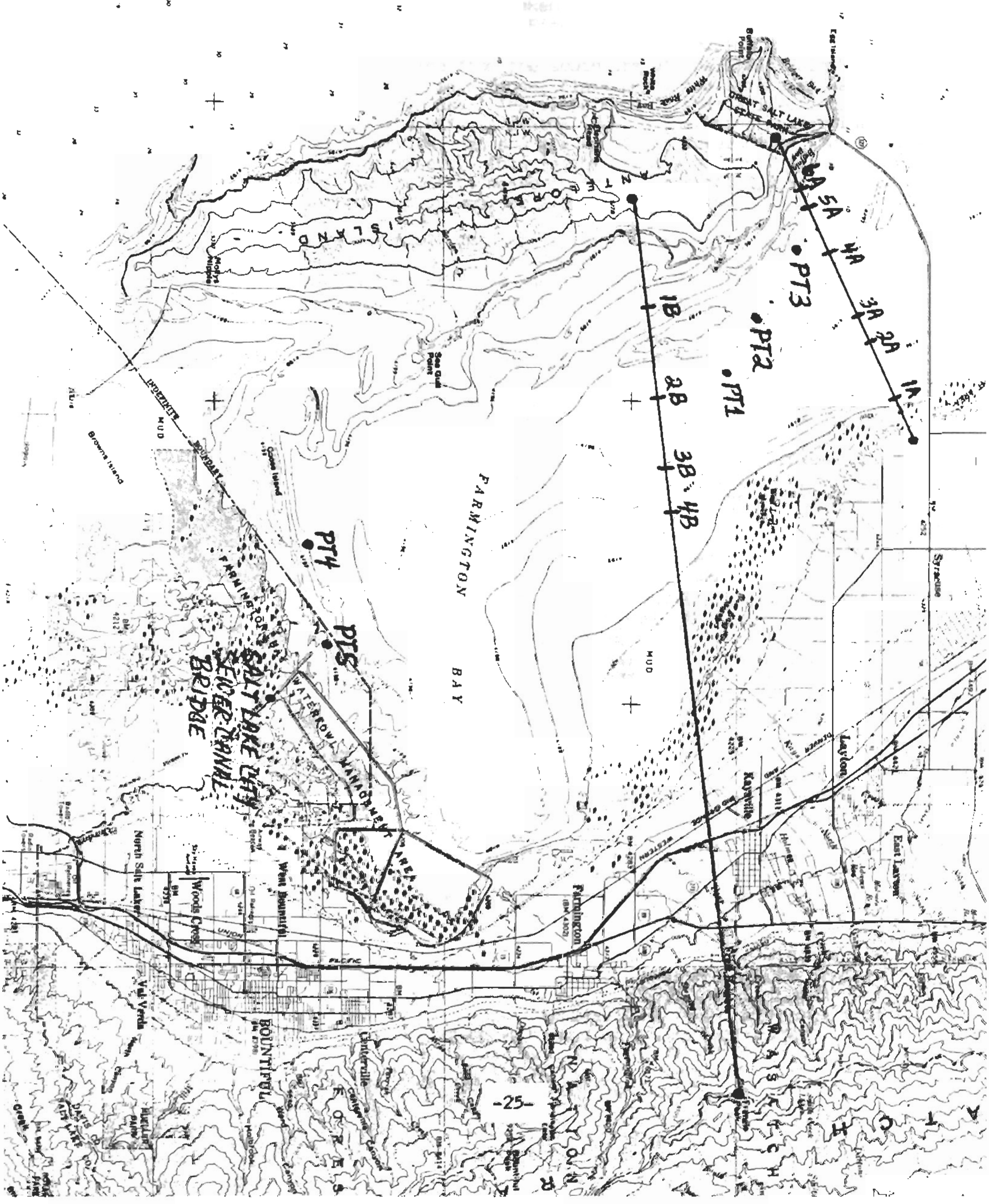


FIGURE 4
FARMINGTON BAY AIRBOAT TR
7-21-81



definitive indicator of the salinity of high TDS water. The compass readings taken during the trip are not recorded in this presentation. Figure 5 is a rough schematic representation of the pycnocline found during this project. Brine from the south arm of the Great Salt Lake, because it is more dense, flows under the surficial waters of Farmington Bay. The turbulence of the bidirectional flow and the effects of the lower brine being pushed into shallow depths, cause a mixing of the lower brine and surficial waters. This is the primary source for the increased salinity noted in the bay's surficial waters that cannot be accounted for from inflow waters.

Table 14 shows UGMS and Department of Health readings for specific conductance (conductivity) and total dissolved solids (TDS) of those samples selected during the airboat trip samplings. A comparison of the data shows:

1) The conductivity values measured in the field vary significantly from those in the lab. This variation could be attributed to several things such as change in sample composition after equilibration, or differences in sensitivity of conductivity meters used.

2) The TDS values determined by UGMS were approximately 5 to 20 percent higher than those determined by the Health laboratory. The relative ratios of the sample values compare well with each other.

c) The final miscellaneous project conducted as part of this study was the installation of a staff gage in Farmington Bay itself to monitor flows. The first attempt made was to drive a highway type steel post into the bottom sediments. The location selected was approximately 50 yards south of the Antelope Island causeway pumphouse. The post was driven through the gravel and cobble until it struck a hard cemented oolitic sand layer. The post could be driven no further and the point of the post began to bend and curl.

It was then decided to install the staff gage at the Antelope Island bridge. The staff gage and post were nailed to the wooden wingwalls during October/November 1981. A transit to be operated by USU was supposed to determine the base height of the staff gage. This was not accomplished because of lack of availability of equipment, and because the nearest benchmark was more than one-half mile east of the Antelope Island causeway entrance station. This would have been approximately a seven mile run

Staff gage readings were then taken each time the bridge flows were measured. These are the values that are recorded in Table 3. They provide information concerning the relative change in elevation of the bay surface.

TABLE 12

FARMINGTON BAY CONDUCTIVITY TRANSECTS
AIRBOAT TRIP JULY 21, 1981

* Means samples were taken for laboratory conductivity and TDS measurements.
Sampling locations can be found on figure 4

Location	Depth(ft)	Conductivity(Umho)
1A	0*	36,900
	2	85,700
2A	0	39,000
	3.75	
3A	0	39,000
	1	78,000
	2	85,000
	3	87,000
	4	86,500
	4.5	87,000
4A	0*	39,000
	1	42,000
	2	42,000
	3	59,000
	4	71,000
	5	76,000
	6	117,000
	7	134,000
	7.5*	138,000
5A	0	38,000
	1	86,000
	2	86,000
	3	86,500
	4	86,700
	5	86,500
	6	128,000
	7	135,500
	8	139,500
	8.5	139,500

Location	Depth(ft)	Conductivity(Umho)
6A	0	39,000
	1	63,000
	2	70,000
	3	74,000
	4	72,000
	5	73,000
	6	123,000
1B	0	39,000
	1	41,000
	2	53,000
	3	56,000
	4	81,000
2B	0	39,000
	1	52,000
	2	65,000
	3	70,000
	4	80,000
	5	85,000
	6	96,000
3B	0	41,000
	5.25	88,500
4B	0	39,000
	4.2	87,300

TABLE 13

FARMINGTON BAY CONDUCTIVITY POINT SITES
AIRBOAT TRIP JULY 21, 1981

* Means samples were taken for laboratory conductivity and TDS measurements.
Sampling locations can be found on figure 4

Location	Depth (ft)	Conductivity (umho)
PT1	0	40,000
	6	88,200
PT2	0	40,000
	1	80,000
	2	78,000
	3	84,000
	4	86,000
	5	87,000
	6	124,000
PT3	0*	40,000
	1	58,500
	2	71,000
	3	73,000
	4	79,000
	5	81,000
	6	130,000
	7	134,000
	8*	137,000
PT4	0*	38,000
	2.25*	62,000
PT5	0	33,000

TABLE 14

FARMINGTON BAY AIRBOAT TRIP JULY 21, 1981
COMPARISON OF DOH LAB AND UGMS FIELD AND LAB READINGS

Location	Depth (ft.)	Specific Conductance		TDS (mg/l)	
		UGMS Field	DOH Lab	UGMS Lab	DOH Lab
1A	0.0	36,900	75,000	69,388	60,040
4A Surface	0.0	39,000	75,000	74,184	69,200
Bottom	7+'	138,000	105,000	109,367	100,120
Pt3 Surface	0.0	40,000	77,000	73,694	69,520
Bottom	8'	137,500	85,000	78,837	75,120
Pt4 Surface	0.0	38,000	76,000	70,796	67,600
Bottom	2.25	62,000	76,000	70,714	67,640

SUMMARY

The culmination of all of this work is contained in two reports. The first report, A Hydrologic Model to Determine Water Quantity Management of the Farmington Bay and Farmington Bay Bird Refuge by David E. Hansen was completed in 1981 as a Masters thesis from Utah State University. This thesis produced a preliminary computer model for simulating inflow, outflow, and other parameters that relate to the Farmington Bay system.

The second report, A Hydroquality Management Model of the Farmington Bay Area, Great Salt Lake, Utah by D. George Chadwick, David E. Hansen, J. Paul Riley, Russel Hinshaw, and Paul Sturm, was presented at the American Water Resources Association meeting in October 1983, and published in their proceedings. This paper represented the assimilation of all data collected during the Farmington Bay Project into a more dynamic computer model that can be used to predict future scenarios for Farmington Bay including scenarios with and without manmade control structures.

APPENDIX A

A. Z. RICHARDS REPORT

PRELIMINARY REPORT
WATER CONTROL POSSIBILITIES FOR FARMINGTON BAY

By
A. Z. Richards, Jr., P.E.
May 12, 1980

PRELIMINARY REPORT

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WATER CONTROL POSSIBILITIES FOR FARMINGTON BAY

By A. Z. Richards, Jr., P.E.

General

For the purpose of this presentation, Farmington Bay is defined as that part of the bed of Great Salt Lake lying below the 4205 U.S.G.S. contour line and bounded by the following:

On the North by the Syracuse Causeway;

On the West by Antelope Island;

On the South by the Island Dike Road;

On the East by the mainland and the Farmington Bird Refuge.

The primary sources of water feeding Farmington Bay are:

(a) Residue from Jordan River

(b) Residue from Surplus Canal

(c) Combined S.L.C. Sewer Outfall

(d) Inflow from miscellaneous small streams

(e) North Davis Waste Treatment Effluent

(f) Central Davis Waste Treatment Effluent

(g) South Davis (North Plant) Effluent

(h) South Davis (South Plant) Effluent

(i) Infiltration directly into Farmington Bay from artesian pressure under bed of Lake.

(j) Estimated precipitation falling directly into the Farmington Bay area.

In estimating the present condition of Farmington Bay and its sources of water, we have used 1978 water year data, which is the latest U.S.G.S. information conveniently available, and other estimated data.

You will observe from the hydrograph that the water surface of the Great Salt Lake was at Elev. 4200 during the year 1978. Therefore, we have used Elev. 4200 as the basis for determining approximate water surface area and volume of Farmington Bay for this preliminary study.

Other Basic Assumed Data

(a) Farmington Bay Total Area = 100,000 acres
    Water Surface @ Elev 4200 = 68,000 acres
    Mud Flats Up to Elev 4205 = 32,000 acres

(b) Annual Net Evaporation from Farmington Bay:
    62.9"/12" x 0.7 = 3.7 Ft./year

(c) Present Salinity:

Great Salt Lake at Bridge Bay	108,300 p.p.m.
Farmington Bay 1 mile E. of Bridge	55,000 p.p.m.
Farmington Bay 1/8 mile W. of Bridge	56,400 p.p.m.
State Park Well on Causeway	800 p.p.m.

Purpose

The purpose of this presentation is to demonstrate that it is possible to improve the general quality of Farmington Bay water approximately 20-fold (from its present 55,000 p.p.m. salinity to 3,000 p.p.m.) by the simple expediency of installing a control gate which will not let salt water from the Great Salt Lake come back into Farmington Bay, and then giving nature the necessary time to carry out this transformation.

Regarding the desirability of permanently raising the water level in Farmington Bay above the present 4200 ft. level in order to increase the size of the lake to improve its use as a recreational facility, our preliminary calculations show that this will have to wait for some time if water quality is the primary consideration. This is because the "flushing out" of the existing salts can only be accomplished in the shortest time by employing maximum out-flow from Farmington Bay into the Great Salt Lake and not by raising the water level in the Bay and thus holding in the existing salts.

Our preliminary calculations show that if the surface water in the Bay is maintained at 4200, it will still take at least 12 years to freshen the water in the Bay to the high quality of 3,000 p.p.m. salinity. See table below: (Note: Use of Goggin Drain water would reduce this time schedule. See Page 7.)

Preliminary Estimate of Possible Saline Reduction in Farmington Bay

Beginning Salinity	55,000 p.p.m.	17,428,400 Tons in Bay
		8,876,280 Tons Removed 1st year
After 1 year	27,000 p.p.m.	
		5,545,959 " "
After 2 years	9,500 p.p.m.	
		1,014,432 " "
After 3 years	6,300 p.p.m.	
		412,113 " "
After 4 years	5,000 p.p.m.	
		253,608 " "
After 5 years	4,200 p.p.m.	
		126,804 " "
After 6 years	3,800 p.p.m.	
		95,103 " "
After 7 years	3,500 p.p.m.	
		79,252 " "
After 8 years	3,250 p.p.m.	
		42,162 " "
After 9 years	3,117 p.p.m.	
		21,240 " "
After 10 years	3,050 p.p.m.	
		10,780 " "
After 11 years	3,016 p.p.m.	
		5,072 " "
After 12 years	3,000 p.p.m.	
		945,595 Tons Remaining

$$\frac{945{,}595 \text{ Tons}}{233{,}000 \text{ Acres}} = 4.06 \text{ T/Ac} = 3{,}000 \text{ p.p.m. (Final Salinity)}$$

Stratified Brine Salinity

It is generally known that uniform salinity does not exist in vertical cross section of the Great Salt Lake water nor in Farmington Bay. Higher salinity brine is found in the depths of the Lake rather than near the surface. Rain and inflow water apparently spreads out over the surface of the lake and reduces the salinity of the upper strata brine rather than diffusing evenly throughout the depth of the Lake. This is called "stratification" and the weaker brine is near the surface while the heavier brine remains at the bottom.

Minimum Control Structure Required

In preliminary concept, we are suggesting a simple pipe and flood gate type control structure to be installed directly under the present bridge, or if it is decided not to distrub the present bridge, then the control pipes can easily be constructed in a coffer-dam some distance from the bridge on the ~~Lake~~ BAY side. This auxiliary dam circling the bridge can be rip-rapped with rock and will be a protection against wave action from the open part of the Great Salt Lake.

Presently, we are thinking of about 8 - 48" dia concrete pipes laid parallel to each other with the inlet flowline depth about Elevation 4190. Each pipeline would be equipped with an Armco flap-gate on the G.S.L. end. This would only allow flow in one direction--from the Bay to the open Lake, and the top of the pipe at the outlet end would be set at about Elevation 4200.

Each pipeline, with about 1 ft. differential in height of water in the Bay and the Lake, should be designed to carry about 75 cfs giving a total capacity for the system of about 600 cfs. The vast expanse of Farmington Bay reservoir would provide the necessary detention period for incoming water surges and the surface would always remain at near 4200 even when the G.S.L. drops substantially.

The proposed control pipelines must be located and positioned so as to pick up brine from the lower strata in Farmington Bay, carry it and evacuate it directly into the Lake, thus leaving the upper strata water (best quality water) in the Bay area reservoir. The elevation of the discharge end of the pipelines in this system will determine the final operating level of the water in the Bay. The pipelines can be calibrated as to velocity and flow so that accurate measurements for record purposes can be made and kept.

Foundations and apron walls should be provided to both the inlet and the outlet ends of the pipelines. At the outlet end a narrow concrete distribution channel, with slotted pilasters designed for removable flash-boards, should be provided over which the discharge waters will flow. This wier arrangement will enable the discharge water to be accurately measured, and will enable the surface elevation of Farmington Bay to be controlled by the operators.

Explanation of Chart I

The basic information on Chart I, which follows, was obtained from USGS records with some estimated data, for the purpose of determining typical annual inflow into Farmington Bay for all source water.

Discussion of Factors Involved in the Freshening of Farmington Bay

The inflow figures given in this presentation are thought to be conservative. The year 1978 was not a high water year. Never-the-less, the 168,450 acre ft. of surplus water (see Chart I) available during that year would have raised the surface level of the Bay at least 2 feet (to Elev. 4202) if no water had been released.

In 1952 and in 1976 the flow of the Surplus Canal through Salt Lake City was more than double its 1978 figure of 175,290 acre ft. Such an increase would have raised Farmington Bay an additional 2 more feet in height (to Elev. 4204) in one year if no water was released.

Neither can 1978 be considered a low water year. The hydrograph of the Lake indicates that peak heights were leveling--not dropping or raising substantially. In a low water year the hydrograph will show a receding level, and during a drouth period the inflow to Farmington Bay would be much less favorable than the 1978 figures.

CHART 1

ADJUSTED QUANTITY & QUALITY OF WATER INFLOW TO FARMINGTON BAY -- WATER YEAR 1978

SOURCE	STREAM MEASUREMENT Acre Feet	NET REACHING BAY Acre Feet	SALINITY P.P.M.	SALINITY Tons/Ac.Ft.	SALT CONTENT Tons
Jordan River Record	128,850	78,852	1100	1.50	118,278
Surplus Canal Record	175,290	134,528	1000	1.36	182,958
Combined SLC Sewer	43,025	43,025	2000	2.72	117,028
Misc. Measured Small Stream, Kays Cr., etc.		6,521	1200	1.63	10,629
N. Davis Effluent	12,072	12,072	655	0.89	10,744
Central Davis Effluent	2,483	2,483	610	0.83	2,061
S. Davis, North Plant	5,255	5,255	751	1.02	5,360
S. Davis, South Plant	1,988	1,988	1665	2.27	4,512
Assumed Infiltration Directly into Bottom of Farmington Bay	(Estimated)	136,000**	1000*	1.36	185,000
TOTALS (Before Subtracting 1 Year Evaporation)		420,730 Ac.Ft.			636,570 Tons
One Year's Evaporation From Bay		252,280 Ac.Ft.			
TOTALS (After Subtracting 1 Year Evaporation)		168,450 Ac.Ft.	(Surplus Water)		636,570 Tons

Resulting Salinit
= 3.78 Tons/Ac.Ft
= 2780 P.P.M.

(**) Quantity estimated by Ward & Marsell
(*) Quality estimated slightly higher than 800 PPM (State Park Well)

Chart I indicates that about 168,450 acre ft. of new water (with an average salinity of about 2780 p.p.m.) is added to Farmington Bay annually--enough to raise its water level to about Elev. 4202 in one year if no water was released. This preliminary study shows, however, that for the first few years the level should remain at about Elev. 4200 and said 168,450 acre ft. of brine should be allowed to pass into the Great Salt Lake in order to remove about 8,876,280 tons of the existing salt content (168,450 x 74.8 T/Ac. x 70%) in the first year. During the same first time period, however, there will be added approx. 636,500 tons of new salt from the annual incoming water. This makes a net reduction of about 8,239,780 tons of salt the first operational year.

With an initial salt content of 17,428,400 tons in Farmington Bay waters and estimating that about 47% of this amount can be flushed out the first year, (See tabulation on page 3), the continuing preliminary calculations show that the salinity in the Bay will reduce at a decelerating rate as time goes on if the level is consistently held at about the 4200 ft. level. Further calculations show that the salinity in the Bay may reach some stable figure between 2780 p.p.m. and 3,000 p.p.m. (3.78 to 4.00 T/Ac. Ft. salinity) in about twelve (12) years--provided that all of the excess water is released and the present water surface near the 4200 ft. level remains. However, after the desired low salinity is obtained, the water surface could likely be raised rapidly--up to Elev. 4203 in one or two years depending upon favorable meteorological conditions.

<u>Further Improving the Farmington Bay Picture Would Involve Goggin Drain</u>

Goggin Drain enters the Great Salt Lake about 1 mile south of the south end of Farmington Bay. A new 1½ mile long canal running northerly from the existing location of Goggin Drain in Section 13 (near the meander line of G.S.L.) could easily divert the flow of this relatively good water into the Bay during the 3 month optimum period (April 1 thru June 30) each year.

This would likely bring 56,720 ac. ft. of 900 p.p.m. (low salinity) water directly into Farmington Bay, which heretofore has been running directly into the Great Salt Lake. This amount of additional water could annually raise Farmington Bay about 7" (see Chart II below), and it would also have an important impact on the quality of the resulting Bay water. We have not taken advantage of this alternative in any of our figures herewith, because the project of relocating Goggin Drain has not been dealt with, but we certainly recommend its consideration.

CHART II

MEASUREMENTS OF GOGGIN DRAIN WATER - DEC. 1977 to AUG. 1978

MONTH	MEASURED FLOW Acre Ft./Month	SALINITY Tons/Acre Ft.	SALINITY P.P.M.	T. D. S. Tons	Calculated Average Salinity T/Ac. Ft.
December	1,020	4.24	5766	4,325	
January	614	3.51	4774	2,155	
February	248	10.8	14688	2,678	
March	1,340	9.82	13355	13,150	
April	10,050	1.10	1496	11,055	
May	18,550	0.83	1129	15,397	
June	28,120	0.87	1182	24,464	
July	3,550	2.64	3588	9,372	
August	2,110	2.91	3955	6,140	
9 Month Totals	65,602 (6,000 SEPT. OCT; NOV) (71,602 ANNUAL)			88,744	1.35
114 3 Month Totals (May, June, July)	56,720			50,915	0.90

Conclusions & Recommendations

(1) No records of consequence have been kept on the flow of brine in and out of Farmington Bay and with the great potential for recreational development, it seems most important to construct a control facility at the Antelope Island

bridge which will eliminate any back-flow of brine from the Great Salt Lake into the Bay and will enable accurate measurements to be made of the varying flow from the Bay into the Lake, the primary purpose being to freshen the Bay waters.

(2) It has been determined that during a median-inflow year there appears to be about 168,000 acre ft. of average 4.0 T/Ac. Ft. salinity water available for freshening the Bay, flushing it out, and in due time providing a very large body of high quality water for aquatic life, boating and recreation. A higher than normal inflow year (when the Great Salt Lake is on the ascending curve of the hydrograph) will provide substantially more good quality water than is needed. Further studies (after a control structure is operating and measurements of out-flow can be obtained) will likely show that adequate water is available to Farmington Bay to enable the maintenance of satisfactory quality even during low-water years.

(3) It appears that, with present available data, the improvement of the quality of the Bay water can best be accomplished by leaving its elevation near the 4200 level for several years, rather than considering an early date for raising the level.

(4) There are many ways by which the necessary control structure could be designed and constructed. In the accompanying preliminary sketches we suggest one economical way to accomplish it. This would involve the installation of about 8 - 48" dia. concrete culvert pipes parallel to each other between the bottom strata in Farmington Bay (Elev. 4190) and sloping up to a submerged flap-gate discharge elevation of 4200. The 48" Armco flap-gates would be installed at the end of each pipeline to prevent any back-flow salt water from the Lake returning to the Bay area. These flap-gates would discharge into a narrow concrete control basin from which the water is released into the main body of the Great Salt Lake via 8 adjustable flash-board weirs. By adding or

subtracting flash-boards, the surface water elevation can be controlled in Farmington Bay, and may be adjusted from time-to-time as the needs dictate. The structure, under normal circumstances, should handle a flow of up to 600 cfs.

With this control facility located on the Farmington Bay side of the causway bridge, it will be protected from the vicissitude of the main body of the Lake. Also during the construction period there should be little or no disturbance of regular traffic to and from the Island.

Although the above preliminary over-view of Farmington Bay does not deal with its many ecological aspects, we trust that it will encourage the planning for the construction of a needed control structure which, in turn, will lead to the more complete utilization of Farmington Bay for recreational purposes and to its great potential for improvement of aquatic life.

A. Z. Richards, Jr.

RULE OF THUMB - CLASSIFICATION OF SALINE WATER & LIMITATIONS OF USE

	Total Dissolved Salts Parts/Million	Tons/Acre Ft.
FOR IRRIGATION PURPOSES:		
Very Good Irrigation Water	0 to 1000	- 1.36
Good Irrigation Water	1000 to 2000	- 2.72
Fair Irrigation Water	2000 to 2750	- 3.74
Poor Irrigation Water	above 2750	+ 3.74
FOR LIVESTOCK FEED WATER		
Maximum Recommended for Chickens	3,000*	4.08
Maximum Recommended for Horses	6,500*	8.84
Maximum Recommended for Dairy Cattle	7,000*	9.51
Maximum Recommended for Beef Cattle	10,000*	13.60
Maximum Recommended for Sheep	13,000*	17.68
Maximum for Sea-Water Fish	35,000	48.96
COMPARABLE KNOWN SOURCES OF WATER		
Salt Lake City Drinking Water	300	0.41
Antalope Island State Park Well Water	800	1.09
Jordan River at Salt Lake City	500 to 1000	- 1.36
Surplus Canal at Salt Lake City	500 to 1000	- 1.36
Salt Lake City Sewage Canal	1600 to 2500	- 3.40
South Davis (South Plant)	1500 to 1800	- 2.45
Kennecott C-7 Ditch (from tailings)	5616 to 5682	- 7.72
Goggin Drain (Average April 1 to June 30)	900	1.22
Sea Water	35,000	47.60
Apr.1980 - Farmington Bay Salinity at causeway	55,000	74.30

(*) Reference: National Academy of Science booklet: Nutrients and Toxic Substances in Water for Livestock & Poultry - 1974

PRELIMINARY GENERAL INFORMATION USED IN ESTIMATING

FARMINGTON BAY - SOUTH OF SYRACUSE ROAD

WATER SURFACE ELEVATION	WATER AREA	MUD FLATS AREA	VOLUME OF WATER IN BAY	
4205	100,000 Acres	0 Acres	652,500 Acre-Feet	
4204	94,000	6,000	555,500	
4203	87,100	12,900	465,000	
4202	80,800	19,200	381,000	
4201	73,700	26,300	304,000	
4200	68,000	32,000	233,000	
- - - -	- - - -	- - - -	- - - -	Year 1978
4199	55,700	44,300	171,000	
4198	46,100	43,900	120,000	
4197	29,900	70,100	82,000	
4196	26,570	73,430	54,000	
4195	22,140	77,860	29,500	
4194	13,280	86,720	11,800	
4193	5,900	94,100	2,200	
4192	1,475	98,525	1,550	
4191	590	99,410	500	
4190	440	99,560	0	

EVAPORATION DATA FROM BEAR RIVER

BIRD REFUGE . . . J. Vern Hales

January	0.8
February	0.7
March	1.6
April	5.7
May	8.8
June	9.6
July	11.8
August	9.3
September	6.6
October	4.2
November	2.5
December	1.3
	62.9" Annual net evaporation from open pan.

62.9" x 0.7 (open lake) = 44.4"

$\frac{44.4"}{12"}$ = 3.7 ft. (estimated annual net evaporation from Farmington Bay)

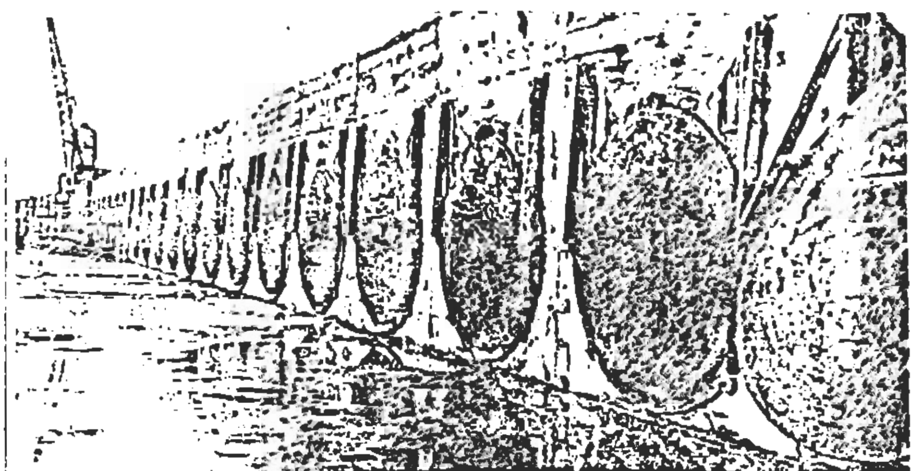
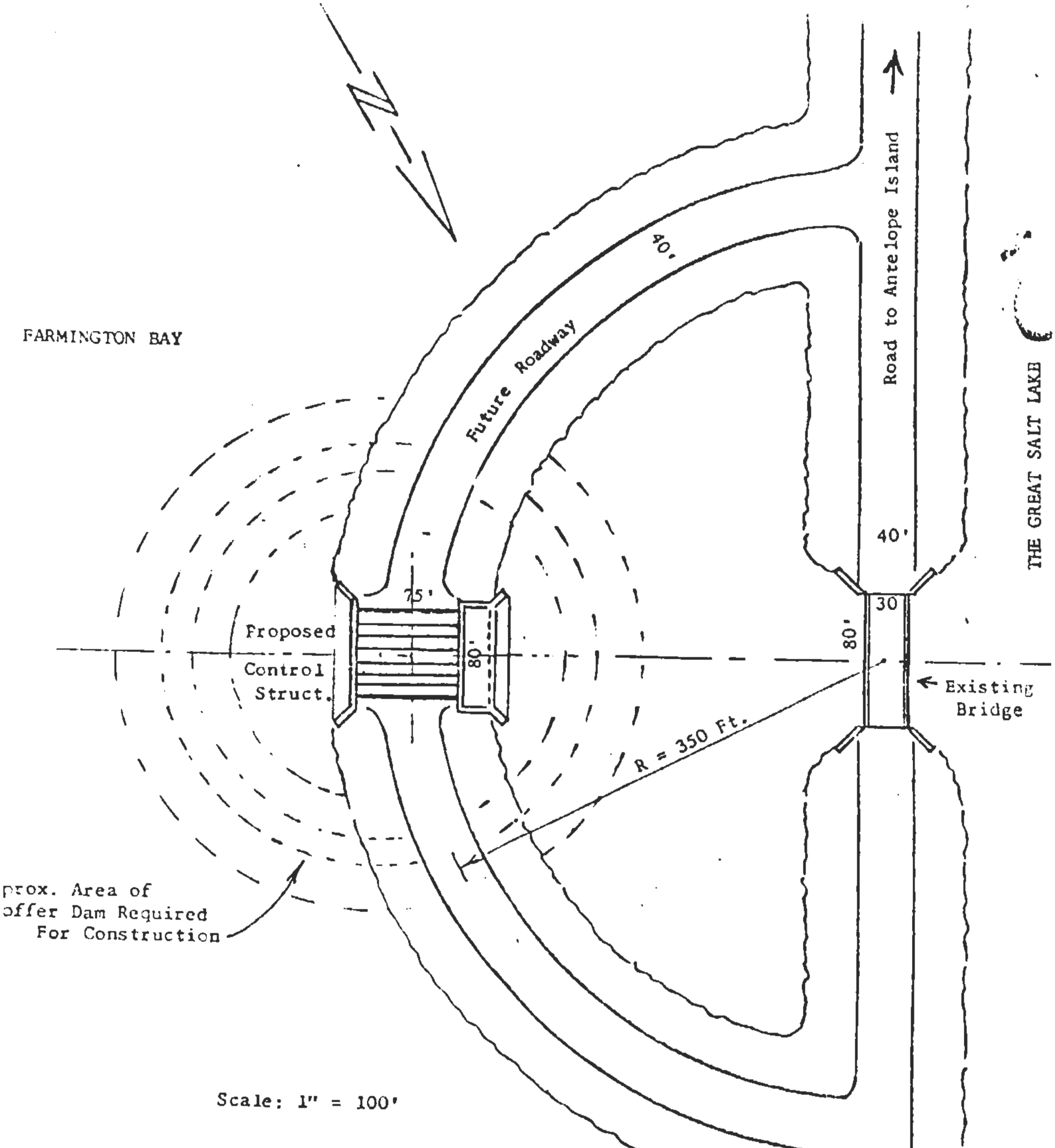


Fig. 265. Series of twenty-eight Armco flap gates Model 100 attached to corrugated pipe culverts through low levee in Texas.

A TYPICAL FLAP-GATE INSTALLATION



SUGGESTED LOCATION
FOR
CONTROL STRUCTURE

APPENDIX B

Figures 1A & 1B — Blank field data sheets for measuring flows at the Antelope Island - Syracuse causeway bridge.

Figures 2A & 2B — Completed field data sheets for measuring flows at the Antelope Island - Syracuse causeway bridge.

Figure 3 — Blank field data sheet for other inflows into Farmington Bay for the north run of the project.

Figure 4 — Completed field data sheet for other inflows into Farmington Bay for the north run of the project.

Figure 5 — Blank field data sheet for time and temperature readings while collecting water samples for chemical, nutrient, and metals analyses.

Figure 6 — Completed field data sheet for time and temperature readings while collecting water samples for chemical, nutrient, and metals analyses.

FIGURE 1A

9-275-F
(May 1971)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. ....
Comp. by ....
Checked by ....

Sta. No. ....

....

Date ...., 19...... Party ....

Width .... Area .... Vel. .... G. H. .... Disch. ....

Method .... No. secs. .... G. H. change .... in .... hrs. Susp. ....

Method coef. .... Hor. angle coef. .... Susp. coef. .... Meter No. ....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter ....
Date rated .... for rod, other.
Meter .... ft. above bottom of weight.
Spin before meas. .... after ....
Meas. plots .... % diff. from rating ....
Wading, cable, ice, boat, upstr., downstr., side bridge .... feet, mile, above, below gage, and ....
Check-bar, found ....
changed to .... at ....
Correct ....
Levels obtained ....

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%). Based on following conditions: Cross section ....

Flow .... Weather ....

Other .... Air ....°F@ ....

Gage .... Water ....°F@ ....

.... Record removed .... Intake flushed ....

Observer ....

....

Control ....

....

Remarks ....

....

....

G. H. of zero flow .... ft.

River at—

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY At point	VELOCITY Mean in vertical	Adjusted for hor. angle or	Area	Discharge

FIGURE 1B

River at—

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY At point	VELOCITY Mean in vertical	Adjusted for hor. angle or	Area	Discharge

River at—

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY At point	VELOCITY Mean in vertical	Adjusted for hor. angle or	Area	Discharge

FIGURE 2A

12-18-80

9-275-F
(May 1971)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Meas. No. ....
Comp. by ....
Checked by ....

DISCHARGE MEASUREMENT NOTES

Sta. No. .... ANTELOPE ISLAND – SYRACUSE CAUSEWAY BRIDGE

Date 12-18, 1980 Party FBAM → SA 622 cfs

Width 82 Area .... Vel. .... G. H. .... Disch. 120 cfs SA → FBAM

Method .... No. secs. .... G. H. change .... in .... hrs. Susp. ....

Method coef. .... Hor. angle coef. .... Susp. coef. .... Meter No. 204877

GAGE READINGS			
Time	Recorder	Inside	Outside
Weighted M. G. H.			
G. H. correction			
Correct M. G. H.			

Type of meter AA

Date rated .... for rod, other.

Meter 1.0 ft. above bottom of weight.

Spin before meas. .... after ....

Meas. plots .... % diff. from rating ....

Wading, cable, ice, boat, upstr., downstr., SOUTH side bridge .... feet, mile, above, below gage, and ....

Check-bar, found .... changed to .... at ....

Correct ....

Levels obtained ....

Measurement rated excellent (2%), **good (5%)** [circled], fair (8%), poor (over 8%). Based on following conditions: Cross section ....

Flow .... Weather CALM –

Other .... Air .... °F @ ....

Gage .... Water .... °F @ ....

.... Record removed .... Intake flushed ....

Observer ....

Control ....

Remarks ....

G. H. of zero flow .... ft.

	DENSITY
S → N	1.046
N → S	1.094

River at –

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	Velocity At point	Velocity Mean in vertical	Adjusted for hor. angle or ...	Area	Discharge	
	2.5	5.0	1.0	.6	35	42	1.83	1.83		5.0	9.15	
	8.0	6.0	11.0	9.0	3	55	.14	.20		37.5	7.50	NS
			6.25	6.0	5	48	.25					
				4.75	0	0	—					
				3.5	35	45	1.71	1.76		28.5	50.16	
				1.0	40	49	1.80					
	14.0	[illegible]	12.0	9.5	10	60	.38	.38		43.5	16.53	NS
			7.25	6.5	10	[illegible]	.38					
				4.75	0	0	—					
				3.5	35	42	1.83	1.82		28.5	51.87	
				1.0	40	49	1.80					
	20.0	6.0	11.5	9.5	5	44	.27	.26		40.5	10.53	NS
			6.75	6.5	5	46	.26					
				4.75	0	0	—					
⊙				3.5	35	42	1.83	1.83		28.5	52.16	
				1	35	42	1.83					
	26.0	6.0	13.5	10.5	5	50	.24	.24		52.5	12.60	NS
			8.75	7.0	5	48	.25					
				4.75	0	0	—					
				3.5	35	43	1.79	1.79		28.5	51.02	
				1.0	35	43	1.79					
	32.0	6.0	14.0	11.0	5	66	.18	.20		55.5	11.10	NS
			9.25	7.0	5	56	.22					
				4.75	0	0	—					
				3.5	35	44	1.75	1.73		28.5	49.30	
				1.0	35	45	1.71					
	38.0	6.0	13.0	10.5	3	45	.16	.17		49.5	8.42	NS
			8.25	7.0	5	67	.18					
				4.75	0	0	—					
				3.5	35	44	1.75	1.77		28.5	50.45	
				1.0	35	43	1.79					

FIGURE 2B

River at— ANT IS BRIDGE

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	Velocity: At point	Velocity: Mean in vertical	Adjusted for hor. angle or	Area	Discharge	
	44.0	1.0	11.5	9.5	3	56	.14	.15		40.5	6.08	NS
			6.75	6.[illegible]	3	48	.16					
				4.75	0	0	—					
				3.5	35	45	1.71	1.73		28.5	[illegible]	
				1.0	35	44	1.75					
	50.0	6.0	10.5	8.5	5	50	.24	.27		34.5	9.32	NS
			5.75	6.0	7	55	.30					
				4.75	0	0	—					
				3.5	35	45	1.71	1.73		28.5	49.30	
				1.0	35	44	1.75					
	56.0	6.0	9.5	7.5	7	49	.33	.36		28.5	10.26	NS
			4.75	5.5	7	42	.38					
				4.75	0	0	—					
				3.5	35	45	1.71	1.73		28.5	49.30	
				1.0	35	44	1.75					
	62.0	6.0	9.5	7.5	10	53	.43	.48		28.5	13.68	NS
			4.75	5.5	10	44	.52					
				4.75	0	0	—					
				3.5	35	44	1.75	1.77		28.5	50.45	
				1.0	35	43	1.79					
	68.0	6.0	8.0	7.0	10	56	.41	.44		19.5	8.58	NS
			3.25	5.5	10	48	.47					
				4.75	0	0	—					
				3.5	35	43	1.79	1.91		28.5	51.58	
				1.0	35	42	1.83					
	74.0	6.0	10.0	8.5	5	63	.19	.18		31.5	5.67	NS
			5.25	6.0	3	43	.17					
				4.75	0	0	—					
				3.5	35	42	1.83	1.81		28.5	51.58	
				1.0	35	43	1.79					
	79.5	5.0	1.0	.6	25	46	1.20	1.20		5.0	6.0	

River at—

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	Velocity: At point	Velocity: Mean in vertical	Adjusted for hor. angle or	Area	Discharge
	TOTALS		FB →		SA			(SN)		352	621.62
				SA →		FB		(NS)		462	120.27

FIGURE 3

DATE ____________ NORTH RUN FARMINGTON BAY PROJECT
FLOWS DATA SHEET

NORTH DAVIS WWTP ______ MGD ÷ .646 = Q_{ND} Q_{ND} = ______ cfs

UNNAMED DITCH WIDTH ___.___ FT
AVG DEPTH ___.___ FT

RE	SEC	VEL

Q_{UN} = W X AVG DEPTH X AVG VEL

AVG VEL ______

Q_{UN} = ______ cfs

Q_T = ______ cfs

KAYS CREEK

DISTANCE	DEPTH	AREA	REV	SEC	VEL	Q

Q_T = ______

Q_T = ______ cfs

HOLMES CREEK

MAIN - WIDTH 5'

DEPTH	REV	SEC	VEL

DIVERSION - WIDTH 3.4'

DEPTH	REV	SEC	VEL

AVG DEPTH$_m$ ______ AVG VEL$_m$ ______ AVG DEPTH$_D$ ______ AVG VEL$_D$ ______

Q_m = ______ cfs
Q_D = ______ cfs

Q_m = 5 X AVG DEPTH$_m$ X AVG VEL$_m$ Q_D = 3.4 X AVG DEPTH$_D$ X AVG VEL$_D$

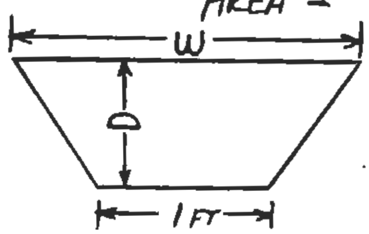
Q_T = ______ cfs

CENTRAL DAVIS WWTP

______ MGD$_{(PRIMARY)}$ + ______ MGD$_{SECONDARY}$ = ______ MGD$_T$ ÷ .646 = Q_{CD} = ______ cfs

BAER CREEK WIDTH ___.___ FT
DEPTH ___.___ FT
AREA = $(W + 1/2) \times D$

REV	SEC	VEL



AVG VEL ______
AREA X AVG VEL = Q_B

Q_B = ______ cfs

Q_T = ______ cfs

FIGURE 4

DATE 9-22,23-81 NORTH RUN FARMINGTON BAY PROJECT
FLOWS DATA SHEET

NORTH DAVIS WWTP 15.0 MGD ÷ .646 = Q_{ND} Q_{ND} = 23

UNNAMED DITCH WIDTH 5.25 FT
3.75
3.5 3.0
2.0 3.0
AVG DEPTH .24 FT

REV	SEC	VEL
33	30	
58		
98		
37		
32		

Q_{UN} = W X AVG DEPTH X AVG VEL

AVG VEL 1.63

Q_{UN} = 2

Q_T = 25.

KAYS CREEK

DISTANCE	DEPTH	AREA	REV	SEC	VEL	Q
3.0	.3	.9	38	15	2.53	2.28
↓	.35	1.05	41	↓	2.73	2.87
	.35	1.05	40		2.67	2.80
	.38	1.14	40		2.67	3.04
	.35	1.05	39		2.60	2.73

Q_T = 13.72

.61 cfs SN CK DIV 21/30 2
2.7' ← 2.7 .6 .4
SN CK 12/30
.45 ← 1.8 → .8
.6 .49
.53

Q_T = 15

HOLMES CREEK

MAIN - WIDTH 5'

DEPTH	REV	SEC	VEL
.3	74	30	2.47
.2	60	↓	2.00
.15	40		1.33

AVG $DEPTH_m$ .22 AVG VEL_m 1.93

DIVERSION - WIDTH 3.4'

DEPTH	REV	SEC	VEL
1.15	20	15	1.33
↓	18	↓	1.20
	18		1.20

AVG $DEPTH_D$ 1.15 AVG VEL_D 1.24

Q_m = 2.1
Q_D = 4.8

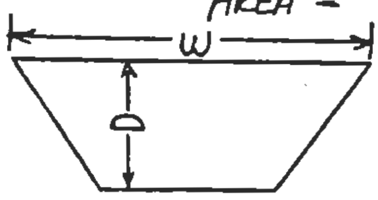
Q_m = 5 X AVG $DEPTH_m$ X AVG VEL_m Q_D = 3.4 X AVG $DEPTH_D$ X AVG VEL_D Q_T = 7.

CENTRAL DAVIS WWTP
1.2 $MGD_{(PRIMARY)}$ + 1.1 $MGD_{SECONDARY}$ = 2.3 MGD_T ÷ .646 = Q_{CD} = 3.

BAER CREEK WIDTH 2.1 FT
DEPTH .6 FT
AREA = (W + 1/2) X D

REV	SEC	VEL
51	15	3.40
50	15	3.33

AVG VEL 3.36
AREA X AVG VEL = Q_B



Q_B = 4.
7.
Q_T =

FIGURE 5

FARMINGTON BAY SAMPLING PROGRAM

BUDGET CODE # 748

STORET	DESCRIPTION	DATE	TIME	TEMP	DO	COND	pH	COL	BOD	NUT	CHEM	T.M	O&G	PHEN	H2S	CN	NH3			
498513 04) (06)	GSL FARMINGTON BAY A I ANTLPE IS-SYRCSE C SWY BDG SURFACE O1							F Q		Z	P C									
498513 04) (06)	GSL FARMINGTON BAY A I ANTLPE IS-SYRCSE C SWY BDG BOTTOM 03							F Q		Z	•									
491273 03 (06)	UNNAMED DITCH 300M B L N DAVIS WWTP AT FE NCE							F Q		Z	•									
491267 03 (06)	KAYS CK AT LOWER BRI DGE BL ANGEL ST							F Q		Z	•									
491265 03 (06)	HOLMES CK AT ANGEL C K XING							F Q		Z	•									
491269 03 (06)	BAER CK BL CENTRAL D AVIS WWTP							F Q		Z	•									

PC = Ca, Mg, K, Na, HCO_3, CO_2, CO_3, Cl^-, OH^-, SO_4, TDS, TSS, Sp Cond, Sp. Grav.

FIGURE 6

FARMINGTON BAY
SAMPLING PROGRAM

BUDGET CODE # 748

PC = Ca, Mg, K, Na, HCO_3, CO_2, CO_3, Cl^-, OH^-, SO_4, TDS, TSS, Sp.Cond., Sp.Grav.

STORET	DESCRIPTION	DATE	TIME	TEMP	DO	COND	pH	COL	BOD	NUT	CHEM	[illegible]	[illegible]	[illegible]	H2S	CN	[illegible]			
498513 04) (06)	GSL FARMINGTON BAY A T ANTLPE IS-SYRCSE C SW4 BDG SURFACE 01	8-10-82	0930	68°F				F Q		Z	P C									
498513 04) (06)	GSL FARMINGTON BAY A T ANTLPE IS-SYRCSE C SW4 BDG BOTTOM 03	8-10-82	0945	64°F				F Q		Z	•									
491273 03 (06)	UNNAMED DITCH 300M B L N DAVIS WWTP AT FE NCE	8-10-82	1030	56°F				F Q		Z	•									
491267 03 (06)	KAYS CK AT LOWER BRI DGE BL ANGEL ST	8-10-82	1200	58°F				F Q		Z	•									
491265 03 (06)	HOLMES CK AT ANGEL C K XING	8-10-82	1345	52°F				F Q		Z	•									
491269 03 (06)	BAER CK BL CENTRAL D AVIS WWTP	8-10-82	1530	60°F				F Q		Z	•									