ERDC/CHL LAB

Coastal and Hydraulics Laboratory

US Army Corps
of Engineers®
Engineer Research and
Development Center

John Day General Model

John Day Model Validation Data Report

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Executive Summary

The U.S. Army Corps of Engineers, Portland District is preparing for upcoming feasibility work on the John Day Lock and Dam project. In support of this work, the district intends on using the 1:80 scale physical hydraulic general model of the John Day project located at the U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi for much of the work. However, before using the model, the district requested that the model be validated to insure that the results of experiments were accurate. To accomplish this, a series of tests were conducted to validate the model. First, the inflow into the model was verified by removing the venturi meter and calibrating it in the ERDC's calibration facility. After the inflow was validated, measurements were made at the downstream end of the model to verify that the flow rate was correct at the lower end. Once the inflow to the model was validated, the model powerhouse and spillway were calibrated and rating curves were developed for each. Next the model was validated by comparing data collected in the prototype to data collected in the model with the model set up to match the prototype conditions. This was done with two different flow scenarios and data collected throughout the John Day tailrace. The comparison generally showed good agreement between the model and the prototype but revealed that some areas, epecially near the model structures, are not reproducing prototype conditions perfectly. These areas were identified and the information from this report will be used to provide confidence in data collected in these areas.

1. ***Task 1*** was to verify that the correct discharge was being input into the model. To verify this, the 10 inch by 5 inch venturi meter used to measure the John Day General Model inflow was checked for accuracy. This was accomplished by removing the venturi meter from the model inflow pipe and installing it in the U.S. Army Engineer Research and Development Center, (ERDC) Coastal and Hydraulic Laboratory's (CHL) calibration flume. The Calibration Flume is a 37.6 ft long by 8 ft wide by 4.0 ft deep concrete flume. Water is supplied to the flume by a constant head tank so inflow is constant and the flume can accept various size venturi meters and other types of flow measuring devices and velocity meters. A volumetric calibration was accomplished by setting an inflow to the flume and measuring the differential pressure in the venturi with a U-tube mercury manometer. After the flow stabilized, the time it took to fill a known volume in the flume was measured so a flow rate could be calculated. To check past performance of the venturi meter, it was taken from the model to the flume without being refurbished or disturbed in any way. It was installed in the flume and was tested extensively through its' full range of measurement. Ten data points were obtained by running at least three tests per data point. Traditionally, only 5 or 6 data points are collected for calibration but 10 were collected because the flume operator (author) had not operated the calibration flume before. Table 1 shows the data collected during the calibration check. The data was then plotted and compared to the calibration curve that was being used previously to operate the model (Figure 1). The comparison revealed that with the theoretical curve, discharge error increased with increase in discharge. This is because a single discharge coefficient was assumed and in reality the coeffiecient changes with velocity in the venturi meter throat. However, the maximum error found was 4.3% which is well below the stated accuracy of 10%. Percent differences between the discharges found during the calibration check and the theoretical curve are presented in Table 2. After the venturi meter calibration was checked, the venturi meter was removed from the calibration flume and taken to the ERDC's, Department of Public Works' (DPW) Welding/Pipe Shop to be refurbished. The venturi meter was thoroughly cleaned and painted and new pressure tabs were installed. The venturi meter was then taken back to the calibration flume and reinstalled so a new calibration curve could be developed for the refurbished venturi meter. The calibration was executed as previously described and the data from the calibration is shown in Table 3. Only six data points were recorded with the refurbished venturi because this is standard operating procedure when calibrating a venturi in the calibration facility. Figure 2 shows the new calibration curve for the John Day General Model 10 inch by 5 inch venturi meter and Figure 3 shows a comparison of the Theoretical Venturi Meter Discharge curve, the curve developed for the venturi meter before it was refurbished and the new calibration curve of the refurbished venturi meter. Since the venturi has just been refurbished and calibrated, it is safe to say that inflow accuracy into the model is less than +/- 5%.

2. ***Task 2*** was to verify that the correct discharge flows through the entire model. This was accomplished by taking velocity measurements with an Accoustic Doppler Velocimeter (ADV) at a cross section near the end of the model. The selected cross section was located approximately 33 feet (4080 feet prototype) from the end of the model. Velocities were taken at 1 foot intervals (80 feet prototype) across the model at 2

tenths and 8 tenths depth for 2 minutes (17.9 minutes prototype) at each depth. The average velocity at the two depths was averaged and multiplied by the cross sectional area contained by lines drawn 40 feet on each side of the location where the velocity was taken. Figure 4 shows the cross section, where the velocities were taken and lines used to calculate the area for each velocity measurement. The velocity measurements were made two times on different days to ensure repeatability. Tables 4 and 5 show the data and the calculated discharge for each data set. The discharge being introduced into the model (as measured by the recently calibrated venturi meter) was 210,000 cfs. Table 4 shows the first data set yielded a measured discharge of 170,073 cfs (23% error) and Table 5 shows the second data set yielded a measured discharge of 165,623 cfs (27% error). This suggested that approximately 42,000 cfs (0.7 cfs model) was leaking from the model between the headbay and the lower end of the model. Figure 5 shows a comparison of the lateral velocity profiles of the two data sets and demonstrates the model's consistency from day-to-day. At this point, we assumed the transect discharge measurements were correct and questioned the inflow into the model. After discussing these data with Mr. Sean Askelson of your office, it was decided to verify the proper discharge was actually getting from the Venturi to the model. This was accomplished by taking ADV data at template number 5 which approximately 18 ft. (1440 ft prototype) from the model headbay. Figure 6 shows the cross section, where the velocities were taken and lines used to calculate the area for each velocity measurement. The data was collected and processed in the same manner as the data collected at the lower end of the model except that data was only collected at 6 tenths depth. This was done because the model is so deep there that the ADV could not reach the 8 tenths depth without submerging the connection on the probe or altering the testing setup.. Tables 6 and 7 show the data and the calculated discharge for the two data sets collected at template 5. The first data set (Table 6) yielded a discharge of 203,058 cfs (3.4% error) and the second data set (Table 7) yielded a discharge of 203,196 cfs (3.3% error). This amount of error is well within the stated 10% accuracy of the model and confirmed that the correct amount of water was entering the model. Again, the data was discussed with Mr. Askelson and it was decided to perform a leak test on the model to see if the water deficiency between the upper end and lower end was a result of leakage. The leak test was performed by pooling the model to the proper upper and lower pool elevations, then closing the model structures, raising the tailgate and turning off the water supply pump. Staff gages were placed in the sumps and were monitored to determine how much the sump volume changed with time. Table 8 shows the data collected during the leak test and the results which were that the model is leaking approximately 0.15 cfs. This is far from the amount indicated by the data sets taken at the upper and lower ends of the model. Again, the results were discussed with Mr. Askelson and it was decided that the ADV being used for data collection should be tested to make sure it was operating properly. Sontek corporation was contacted and a beam check was performed as per their directions. The beam check was satisfactory. Since the ERDC has many models and meters, it was decided to compare the ADV (#A1352) to other meters. A meter check was performed by taking the ADV and a magnetic meter to the 1:60 scale Olmsted Locks and Dam model where test were being performed with the lock open and operating as a floodway. The 20 ft (model) long lock provided an acceptable "flume" for the test. Data was collected for 5 minutes with each of 3 meters, the A1356 ADV, the magnetic meter, and another ADV (one being used by

Mr. Glenn Davis of CHL). The results of the tests are shown in Table 9. The data indicates that there is some variability between meters but did not provide any evidence that the meter was faulty. The differences between the readings was attributed to not precisely locating the meters in the exact spot in the "flume". Because of the convex shape of the lateral velocity profile in the "flume" a small lateral change is position could cause a change in the velocity measured. Since we were looking for a gross meter error, and we wanted to minimize disruption of testing on the Olmsted model, extreme care in locating the meters was not taken. Therefore, based on the factory beam check and the comparison with other meters, it was decided to keep using the #A1356 ADV. While the meter comparisons were being made, Mr. Askelson reviewed all the available data. In his review, he noticed that at both ends of the template 94 data (downstream cross section), the 8 tenths depth velocity seemed extremely low. He questioned whether the 8 tenths depth was near the boundary layer in the model and made some idealized CFD runs to test his theory. As a result, he suggested we go back and retake both ends of the data. This was accomplished and the data is shown (with the new data in red) on Tables 10 and 11. This improved the discharge comparison only slightly, bringing the percent errors for the two data sets to 16 and 19%. After much discussion with Mr. Askelson, he suggested that we check the vertical velocity distribution at the lower transect. His theory was that the distribution was not typical and averaging the 2 tenths and 8 tenths measurements may not be valid to give the true average velocity at a point. Data was collected at 3 points on the transect (320, 1200, and 2080 ft from the left descending bank) at 10, 20, 30, 40, 50, 60, 70, 80, and 90 percent depths. These data are shown in Table 12 and the vertical velocity profiles at the 3 points are shown in Figures 7, 8, and 9. Review of the vertical velocity profiles suggested that taking the average of the 2 tenths and 8 tenths measurements may not yield a good average velocity. It was decided to take the data again at 6 tenths depth and to take the data with both the ADV and the magnetic meter. This was accomplished by taking data simultaneously with the magnetic meter and the ADV with the magnetic meter taking data at the previous ADV location. The data taken with the magnetic meter is shown in Table 13 and yielded a measured discharge of 234,154 cfs. The discharge being measured by the Venturi was 210,000 cfs so the percent error was 9.9% which is barely within the stated 10% accuracy of the model. However, this is consistent with the data collected during the meter comparison which showed that the magnetic meter reading is higher than the ADV. The data collected from the ADV is shown in Table 14 and yields a discharge o f 210,004 cfs which is only a 0.5% error. Figure 10 shows a comparison of the later velocity profiles measured with the two meters. After discussing all of the above with Mr. Askelson, it was determined that the proper discharge was being introduced into the model and that it was progressing satisfactorily to the end of the model. The decision was made to proceed to the next task.

3. ***Task 3*** was to "spot check" calibration of the powerhouse and the spillway. Because of the differences found in Task 1, it was decided that the powerhouse and spillway structures should be recalibrated so this task was omitted from the SOW.

4. ***Task 4*** was to recalibrate the model powerhouse. This was accomplished by introducing a known discharge into the model and only allowing the flow to pass through the powerhouse. A known number of powerhouse gates were opened the same amount

until the upper pool stabilized at elevation 264.0 ft NGVD. For example, the inflow was set to 200,000 cfs (prototype) and 10 gates were opened and manipulated until the upper pool stabilized at 264.0 ft NGVD. This meant that 20,000 cfs was passing through each gate. This provided one data point in the calibration. This procedure was repeated four more times with different numbers of gates open and at different settings until the rating curve was developed. Table 15 shows the data collected for the calibration and Figure 11 shows the new rating curve for the John Day Powerhouse. Considering possible errors in measuring discharge into the model, pool elevation and gate openings, accuracy of discharge through the powerhouse units is +/- 10%.

5. ***Task 5*** was to recalibrate the model spillway. The spillway was calibrated just like the powerhouse. The data collected during the calibration is shown in Table 16 and the new rating curve for the John Day Spillway is shown in Figure 12. For the same reasons as stated regarding the powerhouse calibration, accuracy of discharge through the spillway bays is +/- 10%.

6. ***Task 6*** was to collect velocity data in the model and compare it to data collected in the prototype. This was accomplished for two different conditions. The first prototype data used was collected in April 2003 and the second was collected in February 2005. The model was set up to match the conditions that existed during collection of each of the data sets and ADV data was collected for comparison to the prototype data. Table 17 and Figures 13 -17 show a comparison between model data and the April 2003 prototype data and Table 18 and Figures 18 - 21 show a comparison between model data and the February 2005 prototype data. Mr. Sean Askelson of your office was present during collection of the model data and assisted with processing the data. During the data collection, it was obvious from viewing the flow and the ADV time series, that flow in the John Day General model is variable and transient. Since the model is operated in controlled laboratory conditions, it is reasonable to assume that this variability is only more pronounced in the prototype. Therefore, one should not expect a direct one-to-one comparison of velocitites and angles but should look to verify that the model is reproducing trends. In general, the model did a good job of reproducing prototype conditions. As expected in a 1:80 scale general model, the further downstream of the dam, the better the comparison. There are two areas that have been a concern since the first prototype data set was collected. The first is the area downstream of the powerhouse skeleton bays and the second is riverward of the lock guide wall near point 3-10 on Figure 13 and B3 on Figure 18. In the area downstream of the skeleton bays, the model does an acceptable job of reproducing velocity magnitudes but does poorly reproducing the direction. It seems that the model is not reproducing the spillway entrainment flow. However, during the data collection, the authors and Mr. Askelson used dye to visualize the flow in that area and found that if you moved approximately 100 ft (prototype) toward the spillway, the model seemed to pick up the entrainment. In the area near the guide wall, the prototype velocity is much higher than the model velocity. This area was also investigated with dye during the data collection and again it was observed that the model was picking up the high velocity if you moved about 80 ft north. To better describe the performance of the model, the tailrace was divided into four zones which are shown on Figure 22. The data collected in each zone was analyzed so that confidence

levels could be determined for each zone. Table 19 shows the reduced data for each zone. Zone 1 is the zone immediately downstream of the powerhouse skeleton bays. Comparison of prototype and model data in this zone indicates that the Average Angle Difference in this zone is 58 degrees and the Average Velocity Difference is 0.1 fps. Because of the large angle difference, caution should be used in using model data from this zone. However, it should be noted, that the flow conditions in this zone are so transient and variable that there is a strong possibility that the model and prototype data are out of phase and the model is most likely performing better that this data comparison indicates. Zone 2 is the area immediately downstream of powerhouse units 1 – 16. Comparison of prototype and model data in this zone indicates that the Average Angle Difference is 18 degrees and the Average Velocity Difference is -0.5 fps. This comparison indicates that the model can be used in this zone but, as with any 1:80 scale general model, caution should be used when using data taken within 200 ft (prototype) of the model powerhouse because the flow exiting the draft tubes is not reproduced exactly. Zone 3 is the area downstream of Zones 1 and 2 and upstream of the end of the lock guide wall. Comparison of prototype and model data in this zone indicates that the Average Angle Difference is 13 degrees and the Average Velocity Difference is 0.4 fps. This comparison indicates that the model can be used with confidence in this zone. Zone 4 is the area downstream of the end of the lock guide wall. Comparison of prototype and model data in this zone indicates that the Average Angle Difference is 3 degrees and the Average Velocity Difference is 0.3 fps. This comparison indicates that the model can be used with confidence in this zone.

7. ***Conclusions and recommendations***. Based on the above model experiments and comparison of model data to prototype data the following conclusions and recommendations are submitted.

a. The venturi meter measuring discharge into the model has been calibrated and inflow into the model is accurate within +/- 5%.

b. Velocity data taken at the upstream and downstream ends of the model verify that the proper discharge is being input into the model and is reaching the end of the model.

c. The model powerhouse and spillway have been calibrated and the discharge being passed by each powerhouse unit and each spillway bay is accurate within +/- 10%.

d. The model has been validated against two prototype data sets and, considering the turbulent and transient nature of the flow in the John Day tailrace, is doing a very good job of reproducing prototype conditions. The two areas of concern were looked at and it was verified that the model is adequately reproducing conditions in those areas. Furthermore, the model was divided into four zones and the Average Angle and Velocity Differences between the model and prototype data sets were documented. The result was that the model can be used with confidence except in the area immediately downstream of the powerhouse skeleton bays where caution in using model data should be taken.

e. It is recommended that this model be used as the primary tool for investigating general flow patterns within the reach covered by the model. However, it is also recommended that the two model to prototype comparisons be available to all using the model so they can determine for themselves the degree of confidence in the model data in different areas.

Table 1: Data collected during Calibration Check

Manometer Reading (Inches of Hg)	Volume (ft^3)	Elapsed Time (Seconds)	Average Time (Seconds)	Model Discharge (cfs)	Prototype Discharge (cfs)
2.0	300.7	185.19			
2.0	300.7	186.04			
2.0	300.7	191.23	187.49	1.60	91810
4.0	300.7	136.46			
4.0	300.7	136.18			
4.0	300.7	138.81	137.15	2.19	125505
6.0	300.7	108.49			
6.0	300.7	108.57			
6.0	300.7	110.35	109.14	2.76	157720
8.0	300.7	96.18			
8.0	300.7	95.24			
8.0	300.7	97.37	96.26	3.12	178812
10.0	300.7	86.59			
10.0	300.7	87.46			
10.0	300.7	86.91	86.99	3.46	197882
12.0	300.7	79.06			
12.0	300.7	80.92			
12.0	300.7	80.68	80.22	3.75	214573
14.0	300.7	72.51			
14.0	300.7	73.87			
14.0	300.7	73.63	73.34	4.10	234713
16.0	300.7	67.46			
16.0	300.7	67.58			
16.0	300.7	68.40	67.81	4.43	253830
18.0	300.7	64.05			
18.0	300.7	65.31			
18.0	300.7	64.50	64.62	4.65	266374
20.0	300.7	61.26			
20.0	300.7	61.40			
20.0	300.7	60.04	60.90	4.94	282645

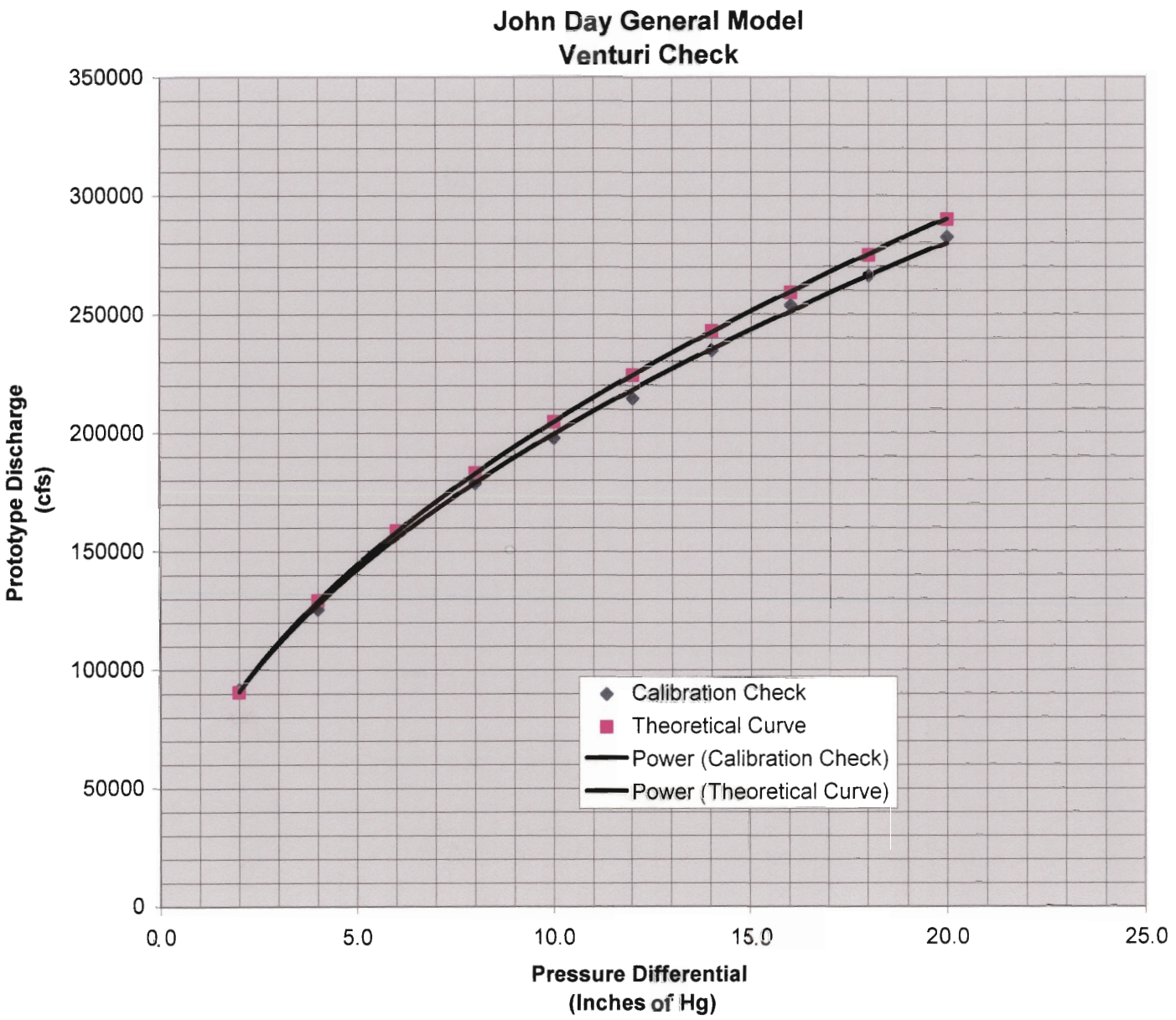

John Day General Model
Venturi Check
Prototype Discharge (cfs)
350000
300000
250000
200000
150000
100000
50000
0
0.0
5.0
10.0
15.0
20.0
25.0
Pressure Differential (Inches of Hg)
Calibration Check
Theoretical Curve
Power (Calibration Check)
Power (Theoretical Curve)

Figure 1

Table 2: Results of venturi calibration check.

Manometer Reading (Inches of Hg)	Measured Discharge (cfs)	Theoretical Discharge (cfs)	Percent Difference
2.0	91,810	90,624	1.3
4.0	125,505	129,293	-2.9
6.0	157,720	158,660	-0.6
8.0	178,812	183,143	-2.4
10.0	197,882	204,651	-3.3
12.0	214,573	224,326	-4.3
14.0	234,713	242,971	-3.4
16.0	253,830	259,152	-2.1
18.0	266,374	274,991	-3.1
20.0	282,645	290,082	-2.6

Table 3: Calibration Data for Refurbished Venturi

Manometer Reading (Inches of Hg)	Volume (ft^3)	Elapsed Time (Seconds)	Average Time (Seconds)	Model Discharge (cfs)	Prototype Discharge (cfs)
2.0	300.7	199.85			
2.0	300.7	199.58			
2.0	300.7	204.11	201.18	1.49	85,560
6.0	300.7	113.00			
6.0	300.7	113.06			
6.0	300.7	112.35	112.80	2.67	152,594
10.0	300.7	87.34			
10.0	300.7	88.57			
10.0	300.7	88.17	88.03	3.42	195,544
14.0	300.7	74.73			
14.0	300.7	73.85			
14.0	300.7	74.52	74.37	4.04	231,462
18.0	300.7	64.76			
18.0	300.7	64.80			
18.0	300.7	65.71	65.09	4.62	264,450
20.0	300.7	62.08			
20.0	300.7	59.25			
20.0	300.7	61.47	60.93	4.93	282,490

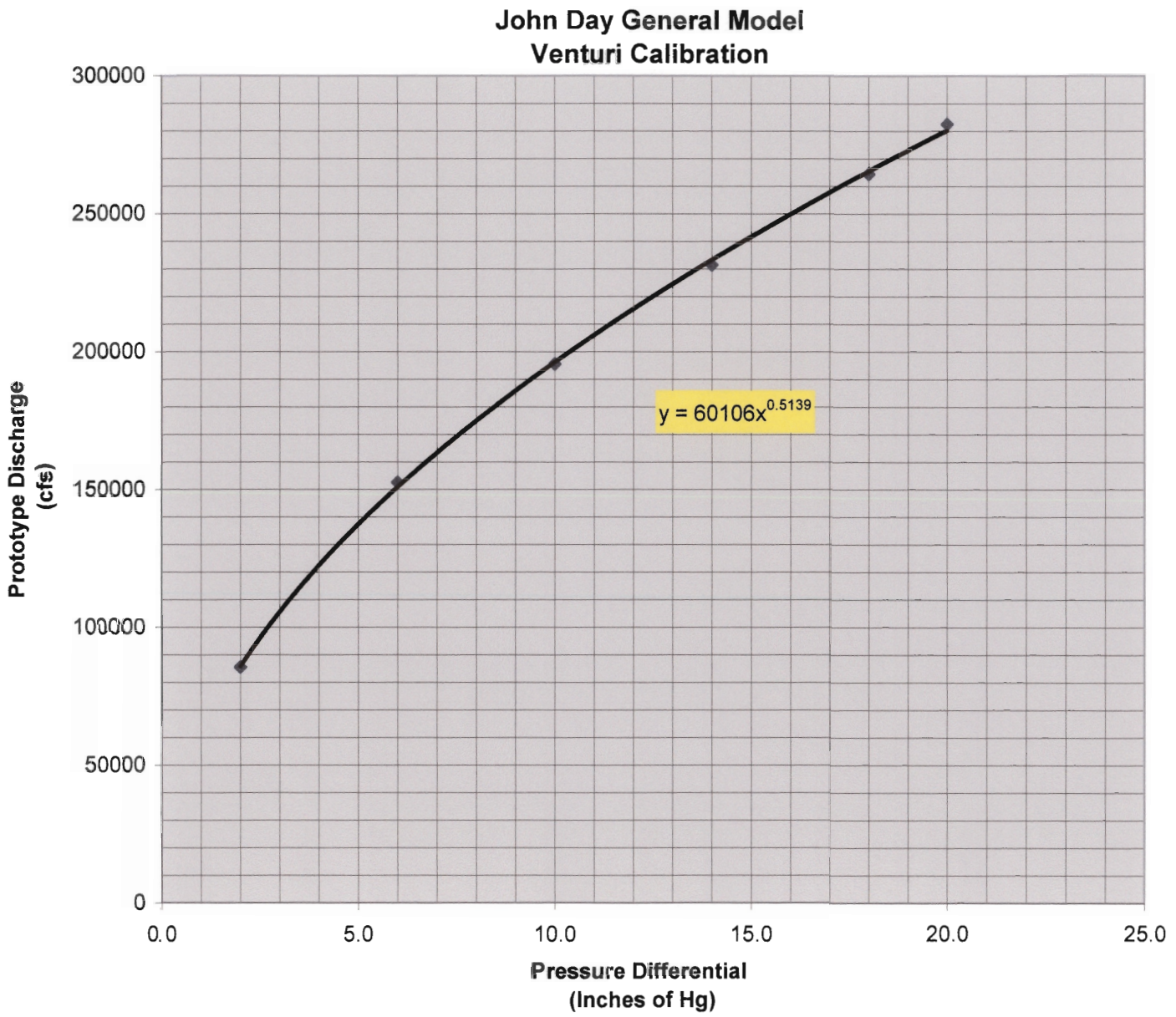

John Day General Model
Venturi Calibration
Prototype Discharge (cfs)
300000
250000
200000
150000
100000
50000
0
y = 60106x^0.5139
0.0
5.0
10.0
15.0
20.0
25.0
Pressure Differential (Inches of Hg)

Figure 2

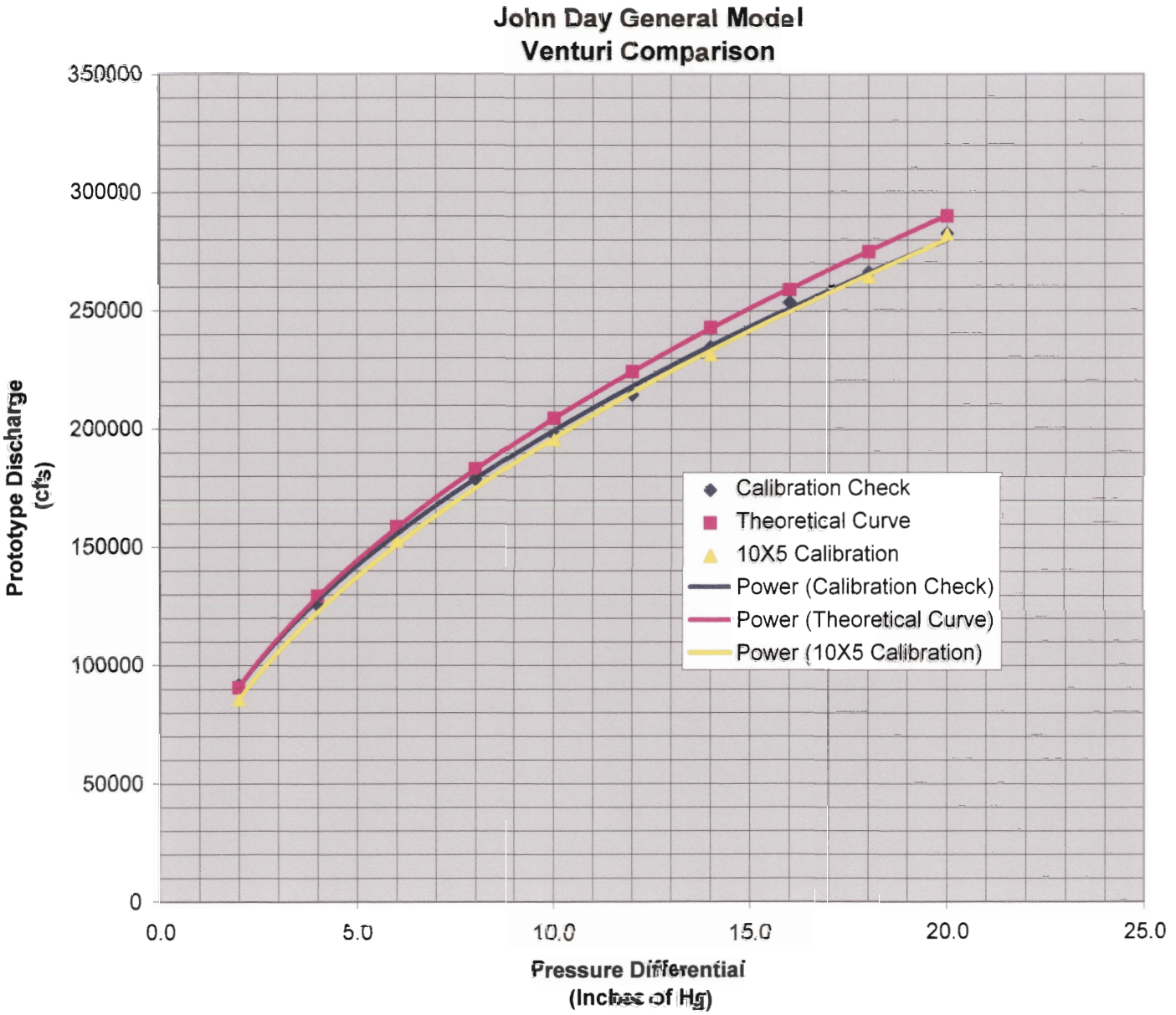
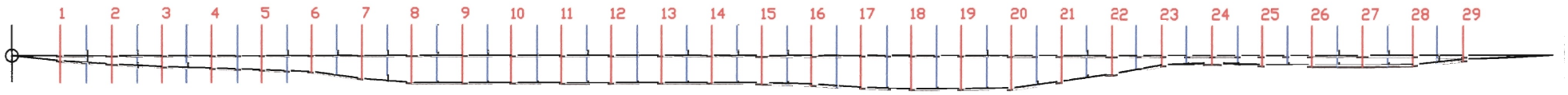

John Day General Model
Venturi Comparison
Prototype Discharge (cfs)
350000
300000
250000
200000
150000
100000
50000
0
0.0
5.0
10.0
15.0
20.0
25.0
Pressure Differential (Inches of Hg)
Calibration Check
Theoretical Curve
10X5 Calibration
Power (Calibration Check)
Power (Theoretical Curve)
Power (10X5 Calibration)

Figure 3



Cross Section of Model at Template 94
Looking Downstream

Figure 4

Table 4: Discharge Check at Template 94 (First Data Set)

Prototype Distance (feet)	Depth (%)	Prototype Velocity (fps)	Avg. Proto. Velocity (fps)	Prototype Area (sqft)	Prototype Discharge (cfs)
80	60	0.19	0.19	660	125.4
160	20	1.36			
160	80	0.16	0.76	1060	803.44
240	20	1.59			
240	80	0.15	0.87	1370	1196.6
320	20	2.42			
320	80	0.85	1.63	1600	2615.81
400	20	2.57			
400	80	0.50	1.53	1820	2787.07
480	20	3.18			
480	80	0.52	1.85	2155	3990.59
560	20	3.29			
560	80	1.76	2.52	2960	7468.86
640	20	3.23			
640	80	3.92	3.58	3381.6	12096.25
720	20	3.05			
720	80	2.58	2.81	3460	9735.67
800	20	3.25			
800	80	2.63	2.94	3460	10170.03
880	20	3.03			
880	80	2.39	2.71	3470	9407.87
960	20	3.10			
960	80	2.50	2.80	3470	9712.90
1040	20	2.94			
1040	80	2.41	2.68	3450	9231.05
1120	20	2.84			
1120	80	2.45	2.65	3450	9131.89
1200	20	3.03			
1200	80	2.21	2.62	3510	9205.93
1280	20	2.92			
1280	80	2.25	2.58	3670	9478.2
1360	20	2.96			
1360	80	2.41	2.69	3990	10720.4
1440	20	2.85			
1440	80	2.26	2.56	4160	10639.55
1520	20	2.86			
1520	80	1.56	2.21	4195	9282.81
1600	20	2.76			
1600	80	2.38	2.57	4020	10327.02
1680	20	2.64			
1680	80	2.12	2.38	3230	7680.4
1760	20	2.25			
1760	80	1.89	2.07	2290	4742.13
1840	20	2.19			
1840	80	1.27	1.73	1275	2208.45
1920	20	1.72			
1920	80	4.07	2.90	980	2841.62
2000	20	1.61			
2000	80	0.93	1.27	1130	1435.44
2080	20	1.53			
2080	80	0.06	0.80	1240	989.43
2160	20	1.47			
2160	80	0.38	0.93	1260	1169.74
2240	20	1.10			
2240	80	0.27	0.68	1090	746.42
2320	60	0.17	0.17	7750	132.18
		Totals		***72584.10***	***170073.13***

Table 5: Discharge Check at Template 94 (Second Data Set)

Prototype Distance (feet)	Depth (%)	Prototype Velocity (fps)	Avg. Proto. Velocity (fps)	Prototype Area (sqft)	Prototype Discharge (cfs)
80	60	0.30	0.30	660	198.00
160	20	1.50			
160	80	0.30	0.90	1060	954.00
240	20	1.40			
240	80	1.30	1.35	1370	1849.50
320	20	2.20			
320	80	0.10	1.15	1600	1840.00
400	20	2.80			
400	80	0.10	1.45	1820	2639.00
480	20	3.10			
480	80	0.30	1.70	2155	3663.50
560	20	3.20			
560	80	3.85	3.53	2960	10434.00
640	20	2.90			
640	80	2.60	2.75	3381.6	9299.40
720	20	2.90			
720	80	2.10	2.50	3460	8650.00
800	20	3.20			
800	80	2.60	2.90	3460	10034.00
880	20	2.90			
880	80	2.50	2.70	3470	9369.00
960	20	2.80			
960	80	2.30	2.55	3470	8848.50
1040	20	2.80			
1040	80	1.90	2.35	3450	8107.50
1120	20	2.90			
1120	80	2.40	2.65	3450	9142.50
1200	20	2.80			
1200	80	2.50	2.65	3510	9301.50
1280	20	2.70			
1280	80	2.30	2.50	3670	9175.00
1360	20	2.90			
1360	80	2.20	2.55	3990	10174.50
1440	20	2.70			
1440	80	2.50	2.60	4160	10816.00
1520	20	2.70			
1520	80	2.40	2.55	4195	10697.25
1600	20	2.60			
1600	80	2.20	2.40	4020	9648.00
1680	20	2.50			
1680	80	2.00	2.25	3230	7267.50
1760	20	2.40			
1760	80	1.90	2.15	2290	4923.50
1840	20	2.10			
1840	80	1.80	1.95	1275	2486.25
1920	20	1.90			
1920	80	1.00	1.45	980	1421.00
2000	20	1.70			
2000	80	1.55	1.63	1130	1836.25
2080	20	1.30			
2080	80	0.20	0.75	1240	930.00
2160	20	1.40			
2160	80	0.10	0.75	1260	945.00
2240	20	1.10			
2240	80	0.40	0.75	1090	817.50
2320	60	0.20	0.20	7750	155.50
		Totals		***72584.10***	***165,623.65***

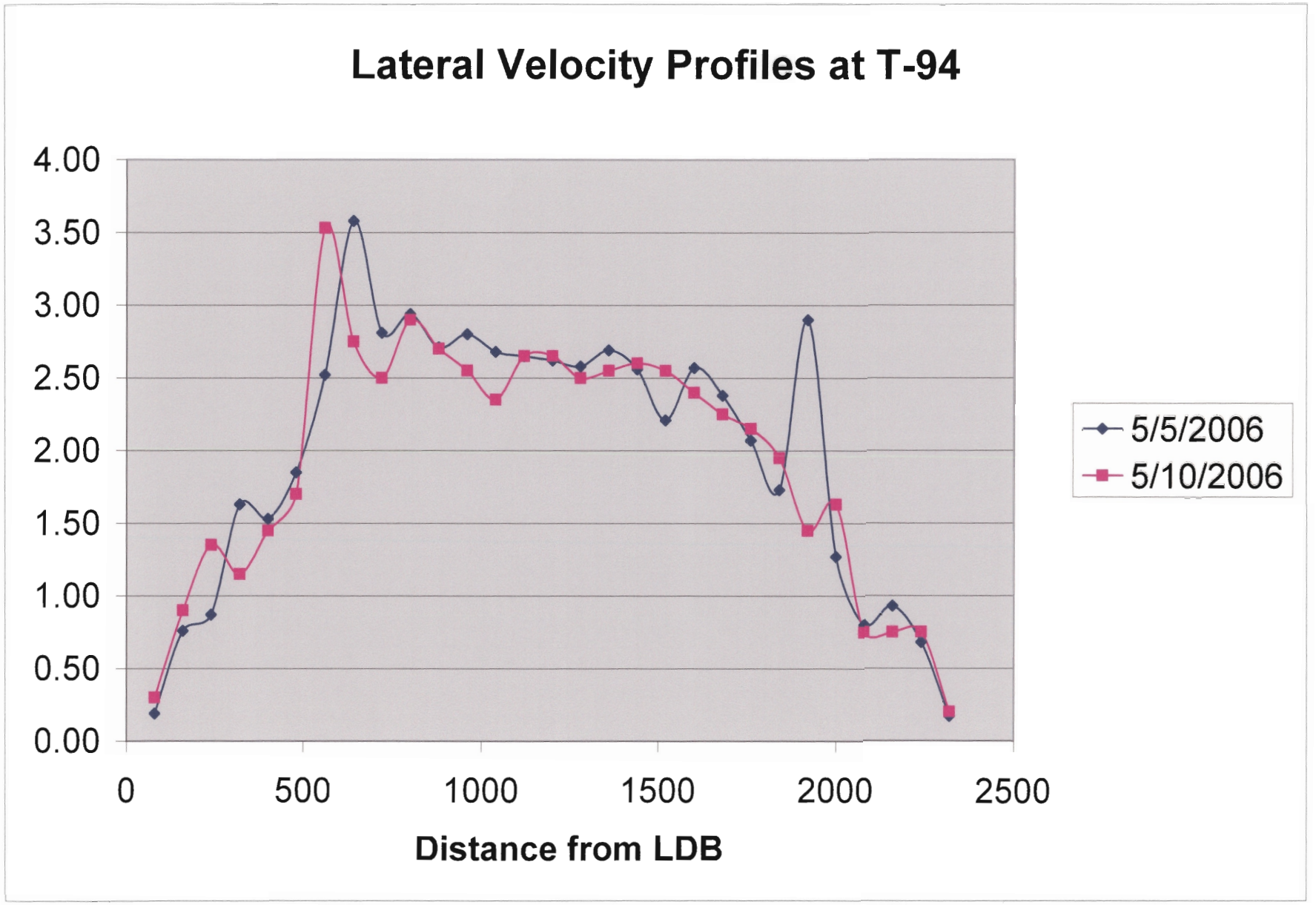
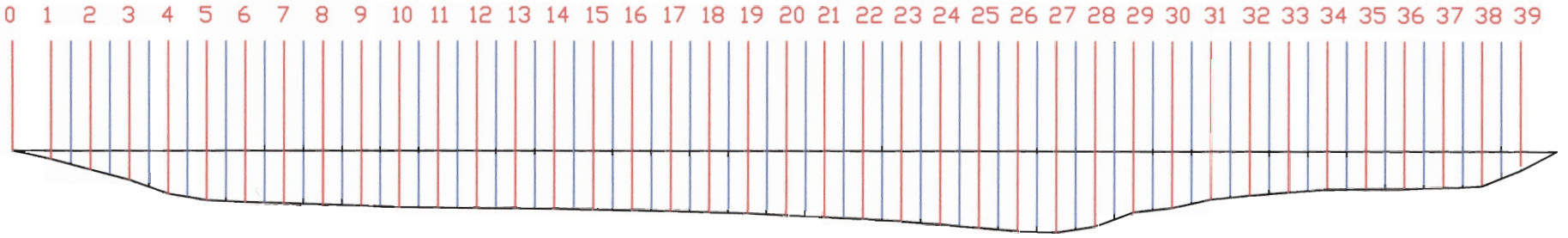

Lateral Velocity Profiles at T-94
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
500
1000
1500
2000
2500
Distance from LDB
5/5/2006
5/10/2006

Figure 5



Cross Section of Model at Template 5
Looking Downstream

Figure 6

Table 6: Discharge Check at Template 5 (First Data Set)

Prototype Distance (feet)	Depth (%)	Avg. Proto. Velocity (fps)	Prototype Area (sqft)	Prototype Discharge (cfs)
80	60	0.40	1610	649.19
160	60	0.63	3080	1947.09
240	60	0.58	4835	2797.20
320	60	0.52	6890	3611.84
400	60	0.48	8020	3834.94
480	60	0.28	8390	2384.47
560	60	0.26	8605	2231.44
640	60	0.22	8830	1926.51
720	60	0.36	9010	3213.73
800	60	0.26	9220	2376.04
880	60	0.28	9320	2563.45
960	60	0.37	9390	3458.11
1040	60	0.43	9415	4082.60
1120	60	0.39	9520	3682.27
1200	60	0.33	9635	3149.12
1280	60	0.32	9730	3088.51
1360	60	0.35	9880	3500.57
1440	60	0.42	10045	4205.75
1520	60	0.33	10255	3360.49
1600	60	0.41	10555	4347.42
1680	60	0.36	10840	3948.54
1760	60	0.47	11135	5252.24
1840	60	0.59	11535	6775.92
1920	60	0.51	12040	6140.18
2000	60	0.49	12560	6134.47
2080	60	0.54	13040	7057.69
2160	60	0.47	13130	6186.70
2240	60	0.60	12115	7221.15
2320	60	0.68	10160	6951.49
2400	60	0.90	9155	8273.37
2480	60	1.09	7935	8616.40
2560	60	1.20	7215	8635.30
2640	60	1.36	6685	9074.60
2720	60	1.52	6250	9473.03
2800	60	1.55	6130	9528.05
2880	60	1.28	6100	7782.33
2960	60	1.26	5945	7478.86
3040	60	1.71	5390	9203.64
3120	60	2.69	3309	8913.26
			Total	***203,057.96***

Table 7: Discharge Check at Template 5 (Second Data Set)

Prototype Distance (feet)	Depth (%)	Avg. Proto. Velocity (fps)	Prototype Area (sqft)	Prototype Discharge (cfs)
80	60	0.02	1610	36.90
160	60	0.09	3080	264.01
240	60	0.10	4835	500.70
320	60	0.28	6890	1915.30
400	60	0.34	8020	2766.24
480	60	0.33	8390	2744.66
560	60	0.15	8605	1252.20
640	60	0.38	8830	3317.69
720	60	0.24	9010	2189.20
800	60	0.20	9220	1829.52
880	60	0.26	9320	2432.99
960	60	0.22	9390	2101.60
1040	60	0.27	9415	2524.10
1120	60	0.31	9520	2928.83
1200	60	0.28	9635	2743.39
1280	60	0.30	9730	2928.62
1360	60	0.34	9880	3341.98
1440	60	0.45	10045	4501.40
1520	60	0.41	10255	4219.04
1600	60	0.40	10555	4242.42
1680	60	0.46	10840	4946.09
1760	60	0.58	11135	6413.84
1840	60	0.62	11535	7178.05
1920	60	0.67	12040	8047.71
2000	60	0.73	12560	9170.75
2080	60	0.71	13040	9194.82
2160	60	0.65	13130	8521.21
2240	60	0.64	12115	7785.70
2320	60	0.69	10160	7004.56
2400	60	0.87	9155	7932.73
2480	60	1.09	7935	8613.83
2560	60	1.19	7215	8585.33
2640	60	1.26	6685	8420.57
2720	60	1.41	6250	8835.33
2800	60	1.53	6130	9359.32
2880	60	1.47	6100	8990.42
2960	60	1.27	5945	7564.69
3040	60	1.65	5390	8892.68
3120	60	2.71	3309	8957.92
			Total	***203,196.35***

Table 8: Leak Test Data

Date	Clock Time	Time (min)	East Sump (Rod Readin	East Sump (ft)	South Sump (Rod Reading	South Sump (ft)
5/16/2006	11:45	0	855	5.70	700	4.67
	12:20	35	900	6.00	695	4.63
	12:45	60	910	6.07	680	4.53
	13:15	90	925	6.17	680	4.53
	13:45	120	950	6.33	680	4.53
	16:00	255	965	6.43	685	4.57
	16:45	300	995	6.63	720	4.80
5/17/2006	6:45	735	1060	7.07	800	5.33
	7:15	765	1060	7.07	800	5.33

From 12:45 on 5/16/06 until 7:15 AM on 5/17/06 (705 minutes), both sumps were filling.

The East Sump filled 1.0 ft and the South Sump filled 0.8 ft

The East Sump is 90 ft long by 35 ft wide. There is a 12 ft by 12 ft area in the corner that does not contribute so the area is: (90X35)-(144)=3006 sqft

The South Sump is 136 ft long by 30 ft wide. The area is 136X30=4080 sqft

East Sump

Time (min)	Area (sqft)	Depth Change (ft)	Discharge (cfs)
705	3006	1	0.07

South Sump

Time (min)	Area (sqft)	Depth Change (ft)	Discharge (cfs)
705	4080	0.8	0.08

***Table 9* : Velocity Meter Check**

Processed data from ADV - A1352 taken in Lock on 1:60 Scale Olmsted model

Processed by: WinADV32 - Version 2.012

Sample Rate	Velocity Range	Time Span	No. of Samples	Number Good	%Good	WinADV Units	Avg Vx	Avg Vy	Mag V-Avg	Avg Vmag	RMS[Vx']	RMS[Vy']	|RMS[V']|	RMS[Vmag']	Skew-x	Skew-y	Kurt-x	Kurt-y	Avg COR	Avg SNR
10	30 cm/s	0.05-300.85	3009	2975	98.87	cm/s,cm	-12.1438	-0.3796	12.1497	12.2085	1.9193	1.1882	2.2573	1.9138	0.2161	-0.0383	-0.2109	0.1371	81.67	6.23
10	30 cm/s	0.05-299.65	2997	2956	98.63	cm/s,cm	-12.3715	-0.3017	12.3751	12.436	1.9014	1.2143	2.2561	1.892	0.1645	-0.0705	-0.3626	-0.0084	81.57	6.56
10	30 cm/s	0.05-310.35	3104	3043	98.03	cm/s,cm	-11.9543	-0.1473	11.9552	12.0151	1.9021	1.1892	2.2433	1.8959	-0.0142	0.0684	-0.2309	0.1754	82.09	6.6

Average = 12.16 (cm/s)

Processed data from Glenn's ADV in Lock on 1:60 Scale Olmsted model

Processed by: WinADV32 - Version 2.012

Sample Rate	Velocity Range	Time Span	No. of Samples	Number Good	%Good	WinADV Units	Avg Vx	Avg Vy	Mag V-Avg	Avg Vmag	RMS[Vx']	RMS[Vy']	|RMS[V']|	RMS[Vmag']	Skew-x	Skew-y	Kurt-x	Kurt-y	Avg COR	Avg SNR
10	250 cm/s	0.05-363.65	3637	3520	96.78	cm/s,cm	-13.1365	0.4096	**13.143**	13.2127	2.1438	1.3234	2.5194	2.1224	0.2886	-0.0528	-0.0816	-0.0406	92.36	10.06

Average = 13.143 (cm/s)

Data from Magnetic Meter in Lock on 1:60 Scale Olmsted Model

Vx (fps)	Vy (fps)	Vr (fps)	Vr (cm/s)	Vr Prototype (fps)	A1352 (cm/s)	A1352 (fps)	A1352 Prototype (fps)	Glenn's ADV (cm/s)	Glenn's ADV (fps)	Glenn's ADV Prototype (fps)
-0.450	0.112	0.464	14.134	4.148	12.150	0.399	3.565			
-0.454	0.106	0.466	14.210	4.170	12.375	0.406	3.631			
					11.955	0.392	3.508			
		Average =	**14.172 (cm/s)**	**4.2**	**12.160**	**0.399**	**3.6**	**13.143**	**0.431**	**3.9**

Prototype Velocity Comparison

ADV #A1352 = 3.6 fps
Glenn's ADV = 3.9 fps
Magnetic Meter = 4.2 fps

Table 10: Discharge Recheck at Template 94 (First Data Set)

Prototype Distance (feet)	Depth (%)	Prototype Velocity (fps)	Avg. Proto. Velocity (fps)	Prototype Area (sqft)	Prototype Discharge (cfs)
80	60	1.54	1.54	660	1016.40
160	20	2.12			
160	80	0.55	0.76	1060	1415.10
240	20	2.21			
240	80	1.02	0.87	1370	2212.55
320	20	2.70			
320	80	2.12	1.63	1600	3856.00
400	20	3.28			
400	80	2.70	1.53	1820	5441.80
480	20	3.94			
480	80	2.87	1.85	2155	7337.78
560	20	3.29			
560	80	1.76	2.52	2960	7468.86
640	20	3.23			
640	80	3.92	3.58	3381.6	12096.25
720	20	3.05			
720	80	2.58	2.81	3460	9735.67
800	20	3.25			
800	80	2.63	2.94	3460	10170.03
880	20	3.03			
880	80	2.39	2.71	3470	9407.87
960	20	3.10			
960	80	2.50	2.80	3470	9712.90
1040	20	2.94			
1040	80	2.41	2.68	3450	9231.05
1120	20	2.84			
1120	80	2.45	2.65	3450	9131.89
1200	20	3.03			
1200	80	2.21	2.62	3510	9205.93
1280	20	2.92			
1280	80	2.25	2.58	3670	9478.2
1360	20	2.96			
1360	80	2.41	2.69	3990	10720.4
1440	20	2.85			
1440	80	2.26	2.56	4160	10639.55
1520	20	2.86			
1520	80	1.56	2.21	4195	9282.81
1600	20	2.76			
1600	80	2.38	2.57	4020	10327.02
1680	20	2.64			
1680	80	2.12	2.38	3230	7680.4
1760	20	2.25			
1760	80	1.89	2.07	2290	4742.13
1840	20	2.19			
1840	80	1.27	1.73	1275	2208.45
1920	20	1.72			
1920	80	4.07	2.90	980	2841.62
2000	20	1.88			
2000	80	1.28	1.58	1130	1785.40
2080	20	1.69			
2080	80	1.24	1.47	1240	1816.60
2160	20	1.59			
2160	80	1.11	1.35	1260	1701.00
2240	20	0.64			
2240	80	0.74	0.69	1090	752.10
2320	60	0.06	0.06	7750	46.65
		Totals		***72584.10***	***181,462.39***

Table 11: Discharge Recheck at Template 94 (Second Data Set)

Prototype Distance (feet)	Depth (%)	Prototype Velocity (fps)	Avg. Proto. Velocity (fps)	Prototype Area (sqft)	Prototype Discharge (cfs)
80	60	1.54	1.54	660	1016.40
160	20	2.12			
160	80	0.55	0.76	1060	1415.10
240	20	2.21			
240	80	1.02	0.87	1370	2212.55
320	20	2.70			
320	80	2.12	1.63	1600	3856.00
400	20	3.28			
400	80	2.70	1.53	1820	5441.80
480	20	3.94			
480	80	2.87	1.85	2155	7337.78
560	20	3.20			
560	80	3.85	3.53	2960	10434.00
640	20	2.90			
640	80	2.60	2.75	3381.6	9299.40
720	20	2.90			
720	80	2.10	2.50	3460	8650.00
800	20	3.20			
800	80	2.60	2.90	3460	10034.00
880	20	2.90			
880	80	2.50	2.70	3470	9369.00
960	20	2.80			
960	80	2.30	2.55	3470	8848.50
1040	20	2.80			
1040	80	1.90	2.35	3450	8107.50
1120	20	2.90			
1120	80	2.40	2.65	3450	9142.50
1200	20	2.80			
1200	80	2.50	2.65	3510	9301.50
1280	20	2.70			
1280	80	2.30	2.50	3670	9175.00
1360	20	2.90			
1360	80	2.20	2.55	3990	10174.50
1440	20	2.70			
1440	80	2.50	2.60	4160	10816.00
1520	20	2.70			
1520	80	2.40	2.55	4195	10697.25
1600	20	2.60			
1600	80	2.20	2.40	4020	9648.00
1680	20	2.50			
1680	80	2.00	2.25	3230	7267.50
1760	20	2.40			
1760	80	1.90	2.15	2290	4923.50
1840	20	2.10			
1840	80	1.80	1.95	1275	2486.25
1920	20	1.90			
1920	80	1.00	1.45	980	1421.00
2000	20	1.88			
2000	80	1.28	1.58	1130	1785.40
2080	20	1.69			
2080	80	1.24	1.47	1240	1816.60
2160	20	1.59			
2160	80	1.11	1.35	1260	1701.00
2240	20	0.64			
2240	80	0.74	0.69	1090	752.10
2320	60	0.06	0.06	7750	46.65
		Totals		***72584.10***	***177,176.78***

Table 12

	Model V-Avg (cm/sec)	Prototype V-Avg (fps)	Percent Depth (%)	Prototype Depth (ft)	Prototype Distance from Bottom (ft)	Description
t-94 1200 0	12.4184	3.64	10	4.32	38.88	T-94 Dist=1200 0.1 depth - vertical vel profle
t-94 1200 0	12.1095	3.55	20	8.64	34.56	T-94 Dist=1200 0.2 depth - vertical vel profle
t-94 1200 0	11.9606	3.51	30	12.96	30.24	T-94 Dist=1200 0.3 depth - vertical vel profle
t-94 1200 0	11.1693	3.28	40	17.28	25.92	T-94 Dist=1200 0.4 depth - vertical vel profle
t-94 1200 0	11.2158	3.29	50	21.6	21.6	T-94 Dist=1200 0.5 depth - vertical vel profle
t-94 1200 0	11.2508	3.30	60	25.92	17.28	T-94 Dist=1200 0.6 depth - vertical vel profle
t-94 1200 0	11.1031	3.26	70	30.24	12.96	T-94 Dist=1200 0.7 depth - vertical vel profle
t-94 1200 0	9.795	2.87	80	34.56	8.64	T-94 Dist=1200 0.8 depth - vertical vel profle
t-94 1200 0	3.4842	1.02	90	38.88	4.32	T-94 Dist=1200 0.9 depth - vertical vel profle
t-94 2080 0	5.9632	1.75	10	1.576	14.184	T-94 Dist=2080 0.1 depth - vertical vel profle
t-94 2080 0	5.849	1.72	20	3.152	12.608	T-94 Dist=2080 0.2 depth - vertical vel profle
t-94 2080 0	5.9919	1.76	30	4.728	11.032	T-94 Dist=2080 0.3 depth - vertical vel profle
t-94 2080 0	5.6453	1.66	40	6.304	9.456	T-94 Dist=2080 0.4 depth - vertical vel profle
t-94 2080 0	5.3385	1.57	50	7.88	7.88	T-94 Dist=2080 0.5 depth - vertical vel profle
t-94 2080 0	4.7825	1.40	60	9.456	6.304	T-94 Dist=2080 0.6 depth - vertical vel profle
t-94 2080 0	4.5897	1.35	70	11.032	4.728	T-94 Dist=2080 0.7 depth - vertical vel profle
t-94 2080 0	4.0902	1.20	80	12.608	3.152	T-94 Dist=2080 0.8 depth - vertical vel profle
t-94 320 0	8.7591	2.57	20	3.904	15.616	T-94 Dist=320 0.2 depth - vertical vel profle
t-94 320 0	9.1095	2.67	30	5.856	13.664	T-94 Dist=320 0.3 depth - vertical vel profle
t-94 320 0	9.0009	2.64	40	7.808	11.712	T-94 Dist=320 0.4 depth - vertical vel profle
t-94 320 0	9.6354	2.83	50	9.76	9.76	T-94 Dist=320 0.5 depth - vertical vel profle
t-94 320 0	8.7032	2.55	60	11.712	7.808	T-94 Dist=320 0.6 depth - vertical vel profle
t-94 320 0	8.8569	2.60	70	13.664	5.856	T-94 Dist=320 0.7 depth - vertical vel profle
t-94 320 0	7.3797	2.17	80	15.616	3.904	T-94 Dist=320 0.8 depth - vertical vel profle
t-94 320 0	3.2769	0.96	90	17.568	1.952	T-94 Dist=320 0.9 depth - vertical vel profle

Prototype Dist from LDB (ft)	Prototype Depth (ft)
320	19.52
1200	43.2
2080	15.76

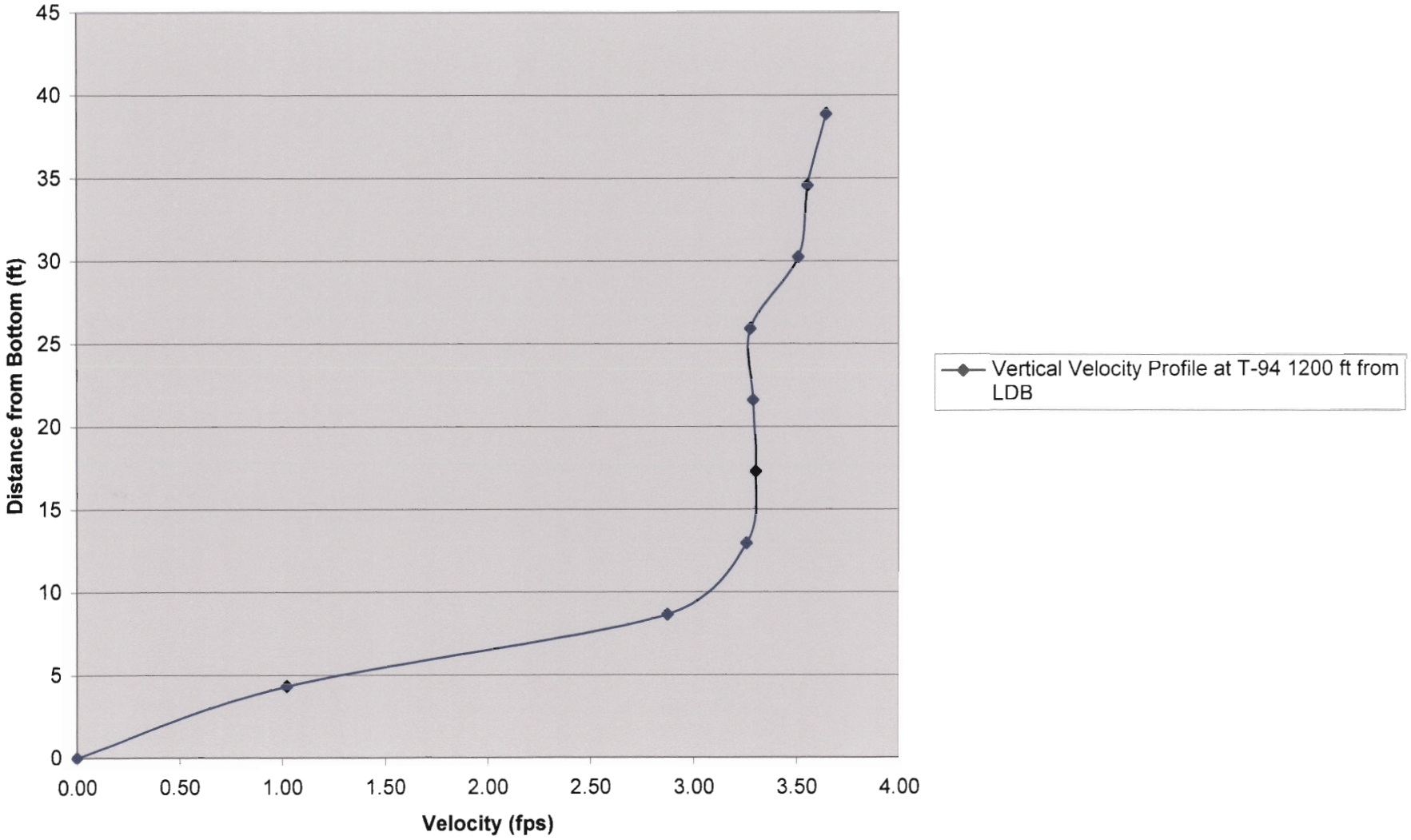

Vertical Velocity Profile at T-94 1200 ft from LDB
Distance from Bottom (ft)
45
40
35
30
25
20
15
10
5
0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Velocity (fps)
Vertical Velocity Profile at T-94 1200 ft from LDB

Figure 7

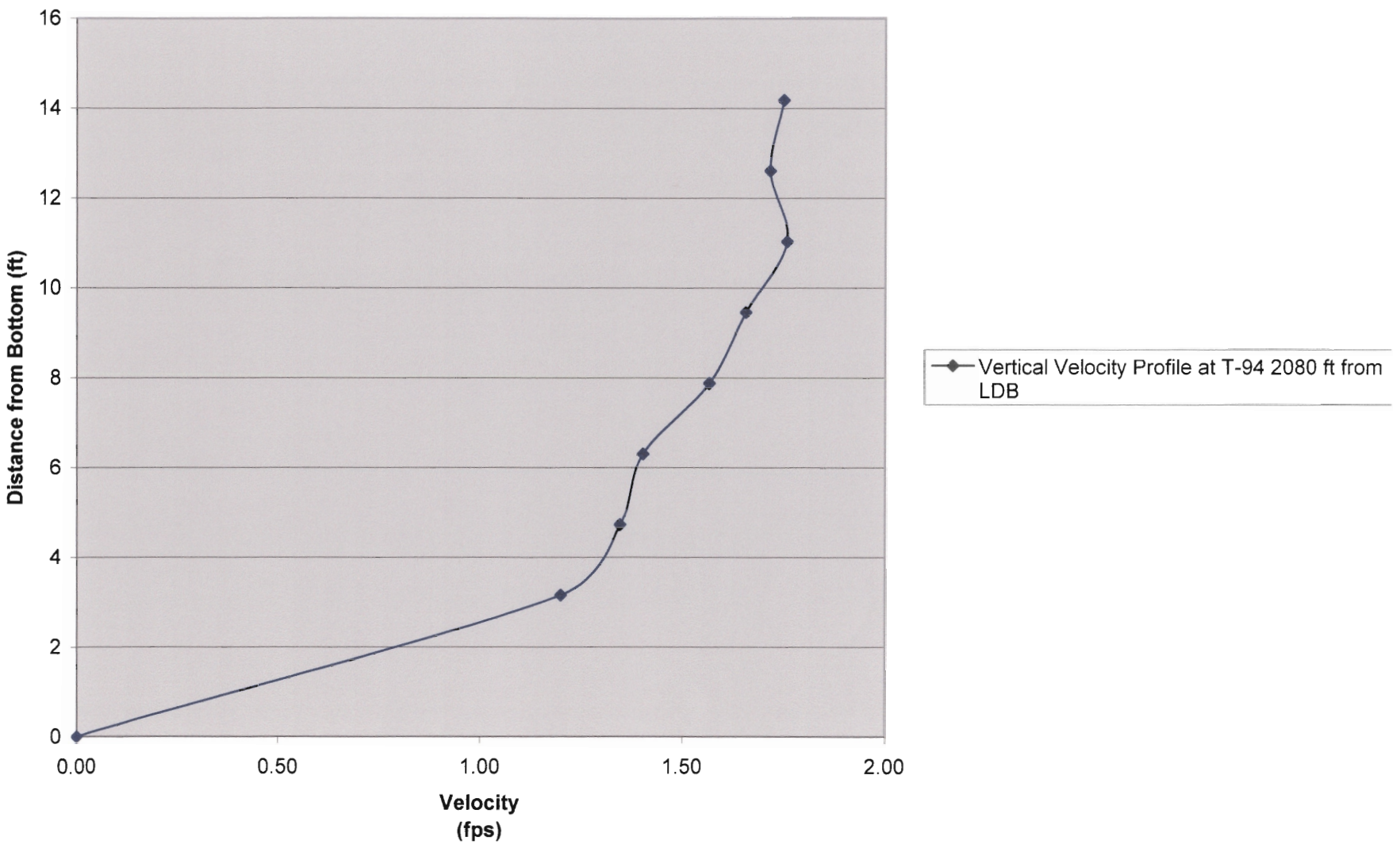

Vertical Velocity Profile at T-94 2080 ft from LDB
Distance from Bottom (ft)
16
14
12
10
8
6
4
2
0
0.00
0.50
1.00
1.50
2.00
Velocity (fps)
Vertical Velocity Profile at T-94 2080 ft from LDB

Figure 8

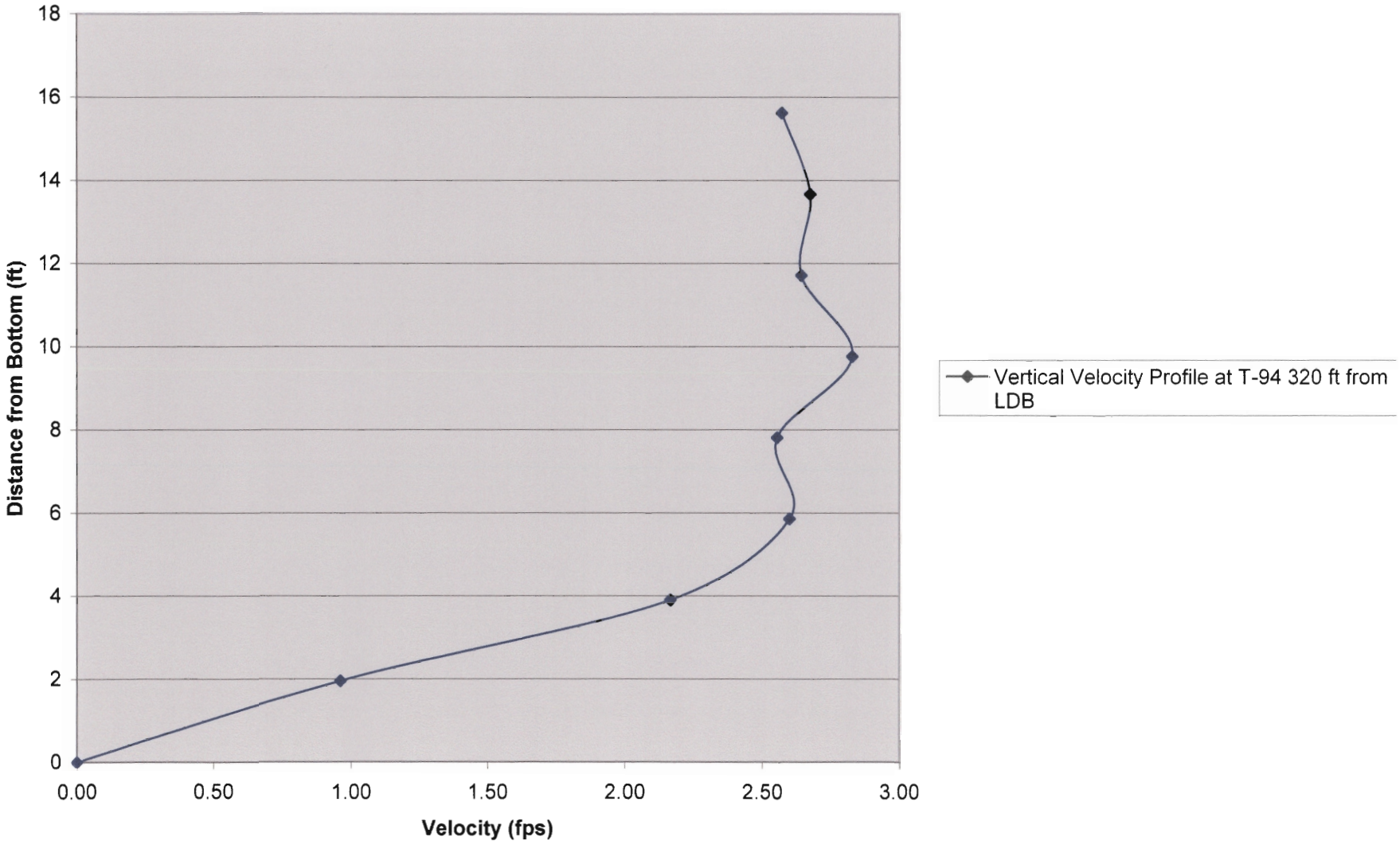

Vertical Velocity Profile at T-94 320 ft from LDB
Distance from Bottom (ft)
18
16
14
12
10
8
6
4
2
0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Velocity (fps)
Vertical Velocity Profile at T-94 320 ft from LDB

Figure 9

Table 13

Filename = 5-26-06 t-94 Qcalc
5/26/2006
Data collected on T-94 at 0.6 depth with Magnetic Meter

Distance Number	Proto Dist from LDB (ft)	Avg Vel	area	Discharge
1	80	2.30	660.00	1518
2	160	1.90	1060.00	2014
3	240	2.50	1370.00	3425
4	320	2.70	1600.00	4320
5	400	3.60	1820.00	6552
6	480	3.70	2155.00	7973.5
7	560	3.90	2960.00	11544
8	640	3.70	3381.60	12511.92
9	720	3.70	3460.00	12802
10	800	3.70	3460.00	12802
11	880	3.60	3470.00	12492
12	960	3.70	3470.00	12839
13	1040	3.60	3450.00	12420
14	1120	3.60	3450.00	12420
15	1200	3.60	3510.00	12636
16	1280	3.40	3670.00	12478
17	1360	3.40	3990.00	13566
18	1440	3.40	4160.00	14144
19	1520	3.30	4195.00	13843.5
20	1600	3.00	4020.00	12060
21	1680	2.90	3230.00	9367
22	1760	2.60	2290.00	5954
23	1840	2.30	1275.00	2932.5
24	1920	2.20	980.00	2156
25	2000	2.30	1130.00	2599
26	2080	1.80	1240.00	2232
27	2160	1.60	1260.00	2016
28	2240	1.40	1090.00	1526
29	2320	1.30	777.50	1010.75
		Totals	***72584.10***	***234154***

Q Venturi =	***211,000***
%error =	***9.9***

Table 14

Filename = 5-26-06 t-94 Qcalc
5/26/2006
Data collected on T-94 at 0.6 depth with ADV A1352

Distance Number	Proto Dist from LDB (ft)	Avg Vel	area	Discharge
1	80	1.60	660.00	1056
2	160	1.70	1060.00	1802
3	240	2.20	1370.00	3014
4	320	3.00	1600.00	4800
5	400	3.10	1820.00	5642
6	480	3.50	2155.00	7542.5
7	560	3.40	2960.00	10064
8	640	3.40	3381.60	11497.44
9	720	3.40	3460.00	11764
10	800	3.30	3460.00	11418
11	880	3.10	3470.00	10757
12	960	3.10	3470.00	10757
13	1040	3.30	3450.00	11385
14	1120	3.20	3450.00	11040
15	1200	3.20	3510.00	11232
16	1280	3.30	3670.00	12111
17	1360	3.00	3990.00	11970
18	1440	3.20	4160.00	13312
19	1520	3.20	4195.00	13424
20	1600	3.00	4020.00	12060
21	1680	2.70	3230.00	8721
22	1760	2.30	2290.00	5267
23	1840	2.00	1275.00	2550
24	1920	1.30	980.00	1274
25	2000	1.40	1130.00	1582
26	2080	1.30	1240.00	1612
27	2160	1.00	1260.00	1260
28	2240	1.00	1090.00	1090
29	2320	0.00	777.50	0
		Totals	***72584.10***	***210004***

Q Venturi =	***211,000***
%error =	***0.5***

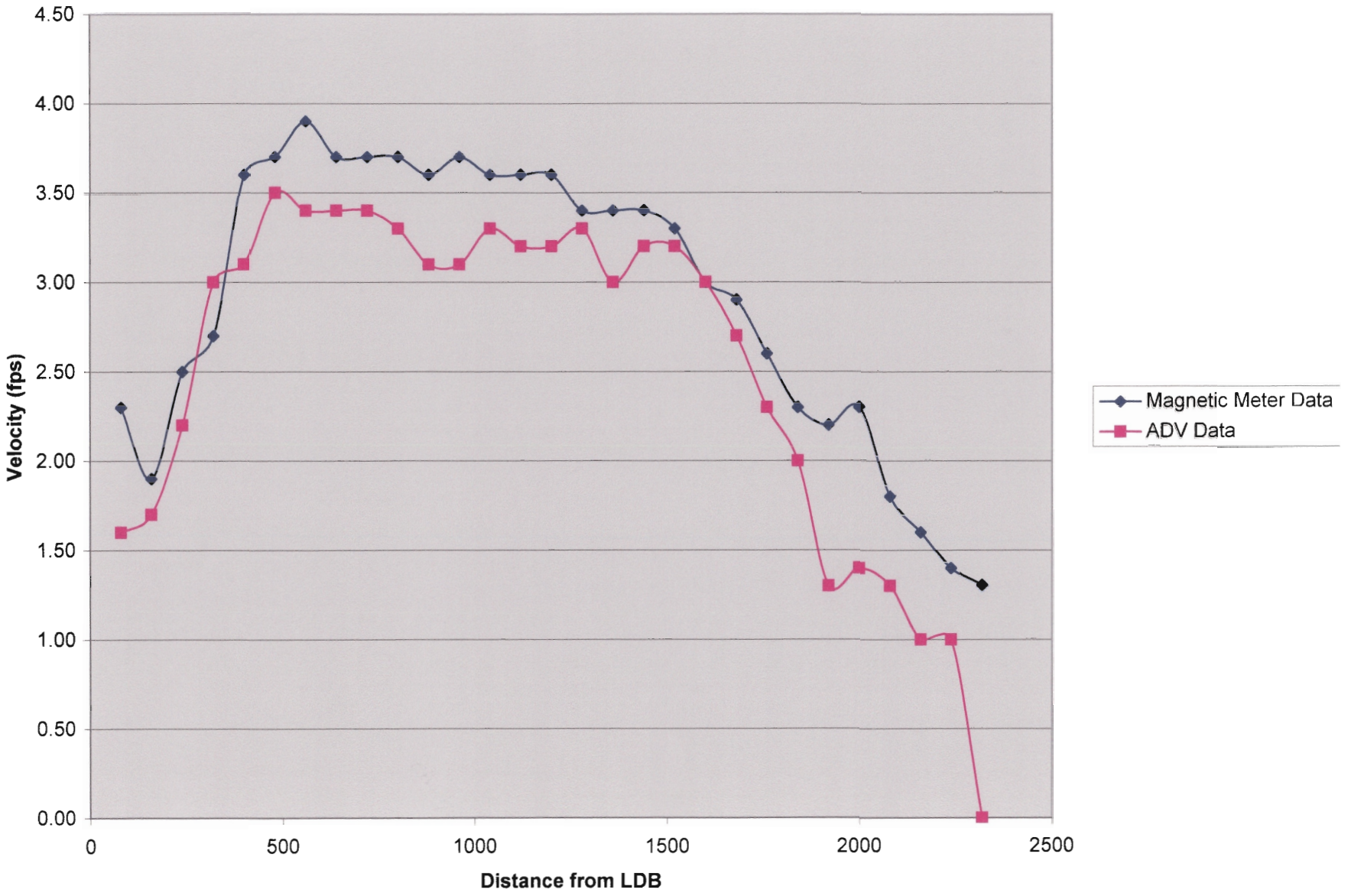

4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Velocity (fps)
0
500
1000
1500
2000
2500
Distance from LDB
Magnetic Meter Data
ADV Data

Figure 10

Table 15

John Day General Powerhouse
Calibrated, June 2006

Discharge per Unit (cfs)	*Gate Setting (inches)*
12500	4.65
14286	5.12
15385	5.4025
16666	5.7255
20000	6.669

Input value for "Unit Discharge" below and "Gate Setting" will be calculated.

Unit Discharge =	20000
Gate Setting =	6.6668

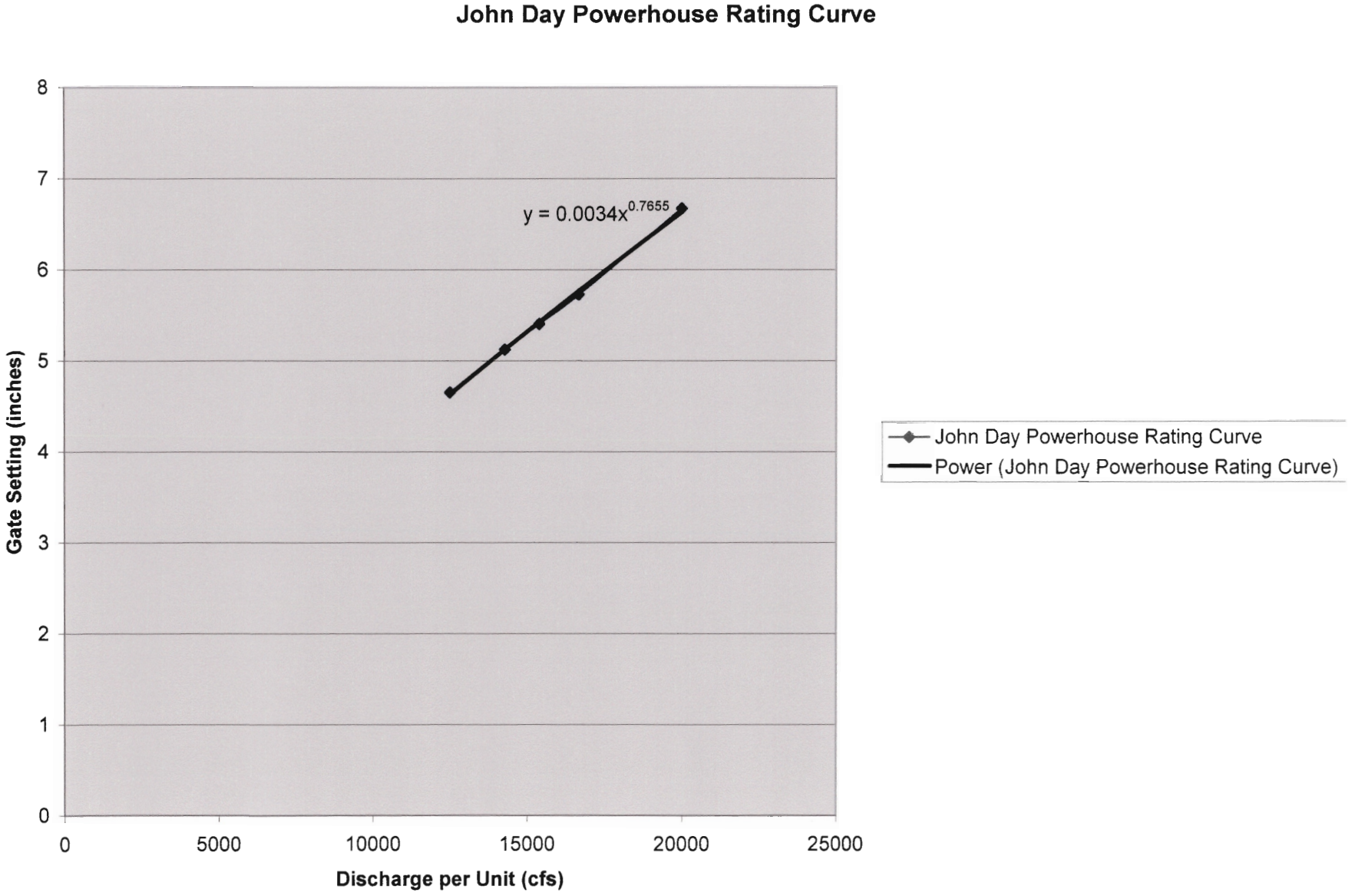

John Day Powerhouse Rating Curve
Gate Setting (inches)
Discharge per Unit (cfs)
y = 0.0034x^0.7655
0
1
2
3
4
5
6
7
8
0
5000
10000
15000
20000
25000
John Day Powerhouse Rating Curve
Power (John Day Powerhouse Rating Curve)

Figure 11

Table 16

John Day General Spillway
Calibrated June 2006

Discharge per gate	Gate Setting (ft)
3200	0.007
4000	0.0105
5333	0.0175
6400	0.025
8000	0.0355
10000	0.05

Input value for "Gate Discharge" and "Gate Setting" will be calculated.

Gate Discharge =	2100
Gate Setting =	0.0036

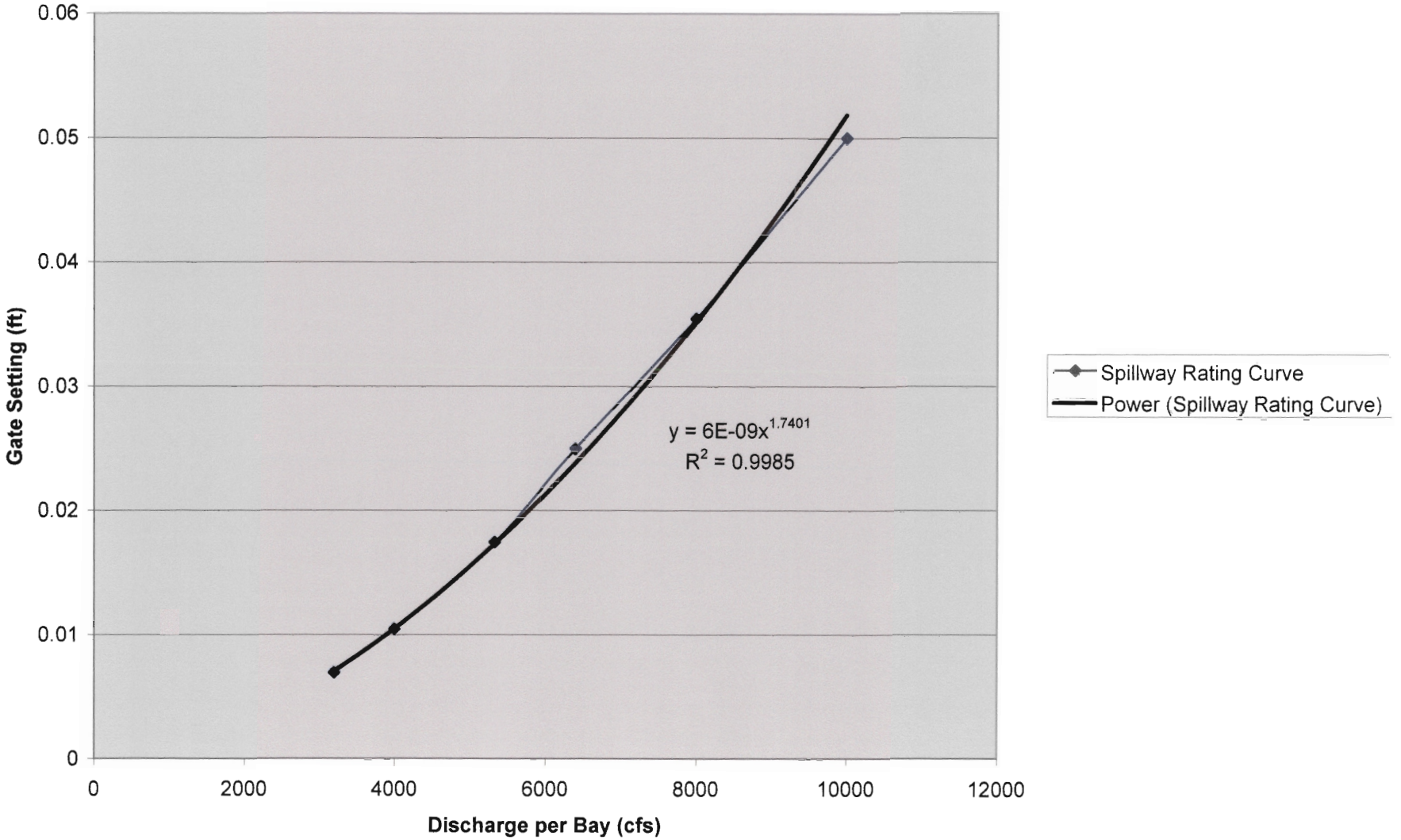

John Day General Spillway Rating Curve
Gate Setting (ft)
0.06
0.05
0.04
0.03
0.02
0.01
0
0
2000
4000
6000
8000
10000
12000
Discharge per Bay (cfs)
y = 6E-09x^1.7401
R^2 = 0.9985
Spillway Rating Curve
Power (Spillway Rating Curve)

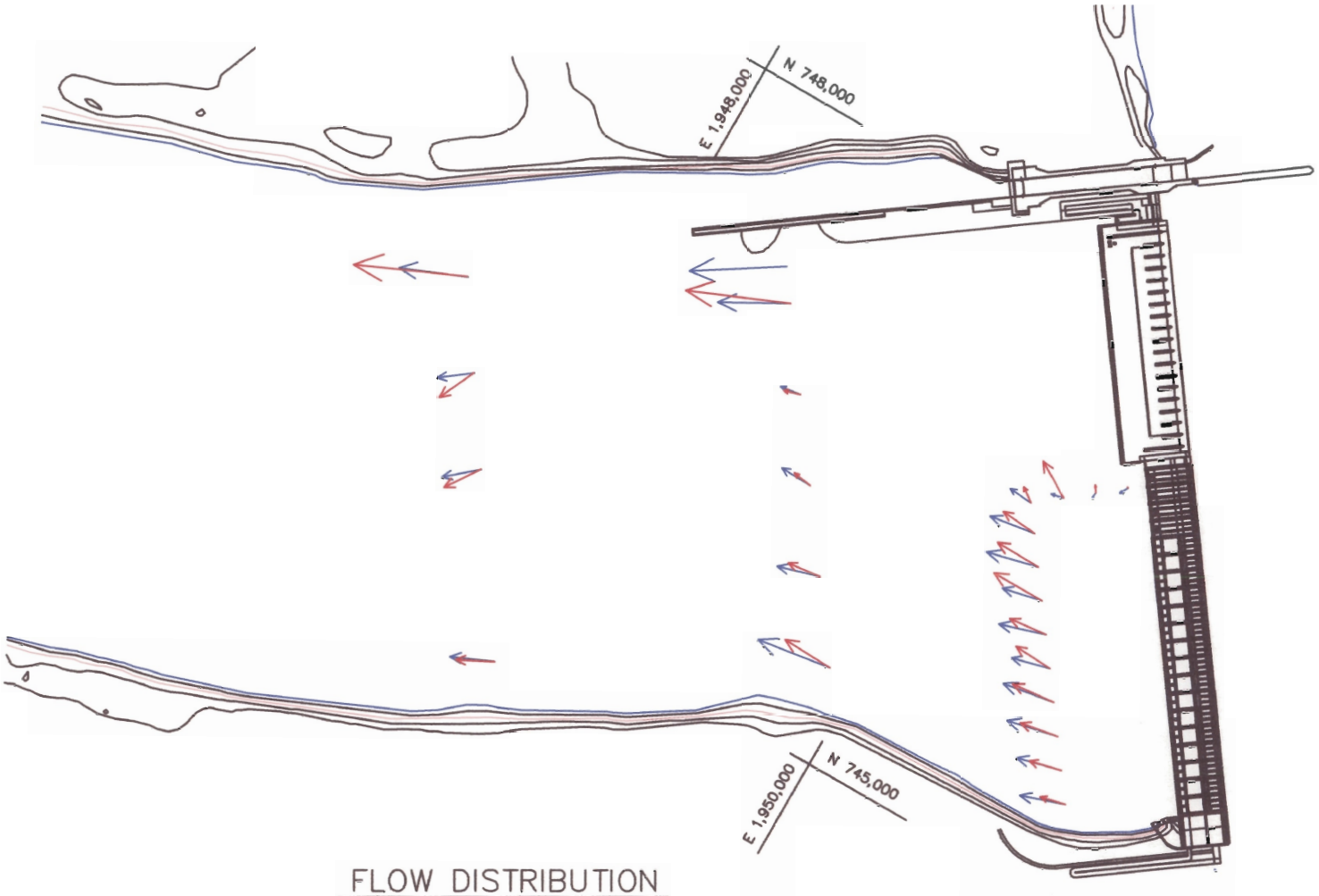
Figure 12

Table 17 **205,200 cfs Model - Prototype Comparison**

Point	Depth (ft)	Prototype Angle (deg)	Model Angle (deg)	Angle Difference (deg)	Avg Angle Difference (deg)	Prototype Velocity (fps)	Model Velocity (fps)	Velocity Difference (fps)	Avg Vel Difference (fps)
1 - 1	10	305	237	68		0.1	0.7	-0.6	
1 - 2	10	356	61	65		0.5	0.1	0.4	
1 - 3	10	331	287	44		2.9	0.9	2	
1 - 4	10	337	305	32	52	1.2	1.8	-0.5	0.3
2 - 1	10	286	281	5		1.8	3.2	-1.4	
2 - 2	10	286	286	0		2.3	3.2	-0.9	
2 - 3	10	290	288	2		2.7	3.7	-0.9	
2 - 4	10	294	291	3		3.1	3.7	-0.6	
2 - 5	10	303	286	17		2.8	2.7	0	
2 - 6	10	294	283	11		2.7	3.3	-0.6	
2 - 7	10	300	288	12		3.8	2.9	1	
2 - 8	10	301	286	15		3.3	3.7	-0.4	
2 - 9	10	305	291	14	9	2.6	3.3	-0.6	-0.5
3 - 1	10	302	291	11		3.6	5.3	-1.7	
3 - 3	10	293	283	10		1.4	3	-1.6	
3 - 5	10	308	302	6		1.4	2.3	-0.9	
3 - 6									
3 - 7	10	283	291	-8		1.2	1.5	-0.3	
3 - 8									
3 - 9	10	277	271	6		7.3	5.1	2.2	
3 - 9.8	10	277	268	9	6	7.3	6.7	0.6	-0.3
4 - 1	10	273	276	-3		2.7	3.1	-0.4	
4 - 5	10	244	259	-15		2.8	2.8	0	
4 - 7	10	235	263	-28		2.9	2.6	0.3	
4 - 9	10	276	277	-1	-12	7.8	4.8	3	0.7
1 - 1	20	12	196	176		4	0.5	-0.1	
1 - 2	20	25	67	-42		0.8	0.1	0.6	
1 - 3	20	341	286	55		2.7	0.9	1.8	
1 - 4	20	355	304	51	60	0.9	1.9	-1	0.3
2 - 1	20	291	285	6		1.5	2.9	-1.4	
2 - 2	20	290	288	2		2.2	3.2	-1	
2 - 3	20	291	290	1		2.6	3.4	-0.8	
2 - 4	20	293	290	3		2.8	3.4	-0.6	
2 - 5	20	301	287	14		2.4	2.3	0.1	
2 - 6	20	303	285	18		2.5	3.2	-0.7	
2 - 7	20	303	291	12		3.7	3	0.6	
2 - 8	20	305	290	15		3.4	3.2	0.2	
2 - 9	20	301	295	6	9	2.2	3.1	-0.9	-0.5
3 - 1	20	301	291	10		3.3	5.2	-1.9	
3 - 3	20	290	281	9		2.1	2.5	-0.4	
3 - 7	20	279	285	-6		1.2	1.6	-0.4	
3 - 9	20	279	272	7		6.6	5.1	1.5	
3.9.8	20	279	270	9	6	6.6	6.5	0.1	-0.2
1 - 1	30	63	311	112		0.4	0.9	-0.5	
1 - 2	30	27	210	177		0.5	0.5	0	
1 - 3	30	355	292	63		1	0.9	0.1	
1 - 4	30	16	310	66	105	1.1	1.8	-0.6	-0.3
2 - 9	30	316	292	24	24	2.6	2.8	-0.2	-0.2
3 - 3	30	286	279	7		1.5	2.1	-0.6	
3 - 9	30	282	273	9	8	6.1	4.8	1.3	0.4
1 - 1	40	89	314	45		0.5	1.3	-0.8	
1 - 3	40	24	278	74	60	1.4	0.6	0.8	0.0
3 - 9	40	284	276	8	8	4.7	4.2	0.5	0.5


E 1,948,000
N 748,000
E 1,950,000
N 745,000
TRANSECT 5
TRANSECT 4
TRANSECT 3
TRANSECT 7
TRANSECT 1
TRANSECT 2
5-10
5-9
5-8
5-7
5-6
5-5
5-4
5-3
5-2
5-1
4-10
4-9
4-8
4-7
4-6
4-5
4-4
4-3
4-2
4-1
3-10
3-9
3-8
3-7
3-6
3-5
3-4
3-3
3-2
3-1
3-0
7-10
7-9
7-8
7-7
7-6
7-5
7-4
7-3
7-2
7-1
1-4
1-3
1-2
1-1
2-9
2-8
2-7
2-6
2-5
2-4
2-3
2-2
2-1
SCALES IN FEET
0
500
1000
1500
JOHN DAY LOCK AND DAM
COLUMBIA RIVER
MODEL VS. PROTOTYPE
VELOCITIES
April 2003 Prototype Data
Data Collection Points
DISCHARGE: 205,200 CFS
LOWER POOL EL: 161.1 FT

Figure 13



FLOW DISTRIBUTION

LEGEND

← MODEL VELOCITY
← PROTOTYPE VELOCITY

SCALES IN FEET

0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	13.8	12.3	12.1	12.1	12.8	13.1	0	0	0	12.3	12.6	12.1	0	20.0	0	12.1

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	5.9	5.5	4.0	4.0	4.6	4.9	3.3	3.3	3.5	3.4	2.8	3.3	3.3	3.2	3.3	1.6	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

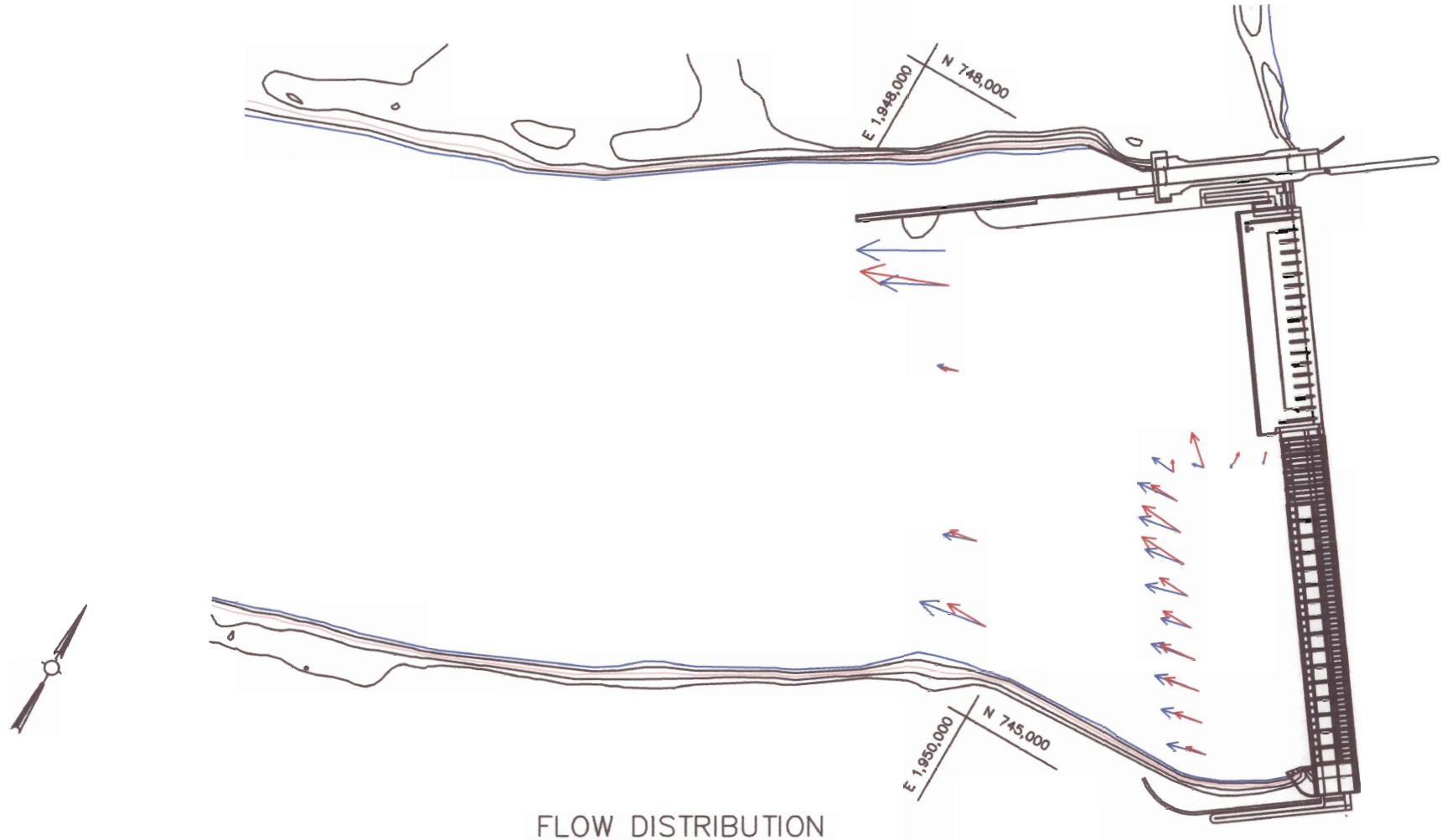
April 2003 Prototype Data

10 FT. DEPTH

DISCHARGE: 205,200 CFS

LOWER POOL EL: 161.1 FT

Figure 14



FLOW DISTRIBUTION

LEGEND

← MODEL VELOCITY
← PROTOTYPE VELOCITY

SCALES IN FEET

0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	13.8	12.3	12.1	12.1	12.8	13.1	0	0	0	12.3	12.6	12.1	0	20.0	0	12.1

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	5.9	5.5	4.0	4.0	4.6	4.9	3.3	3.3	3.5	3.4	2.8	3.3	3.3	3.2	3.3	1.6	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

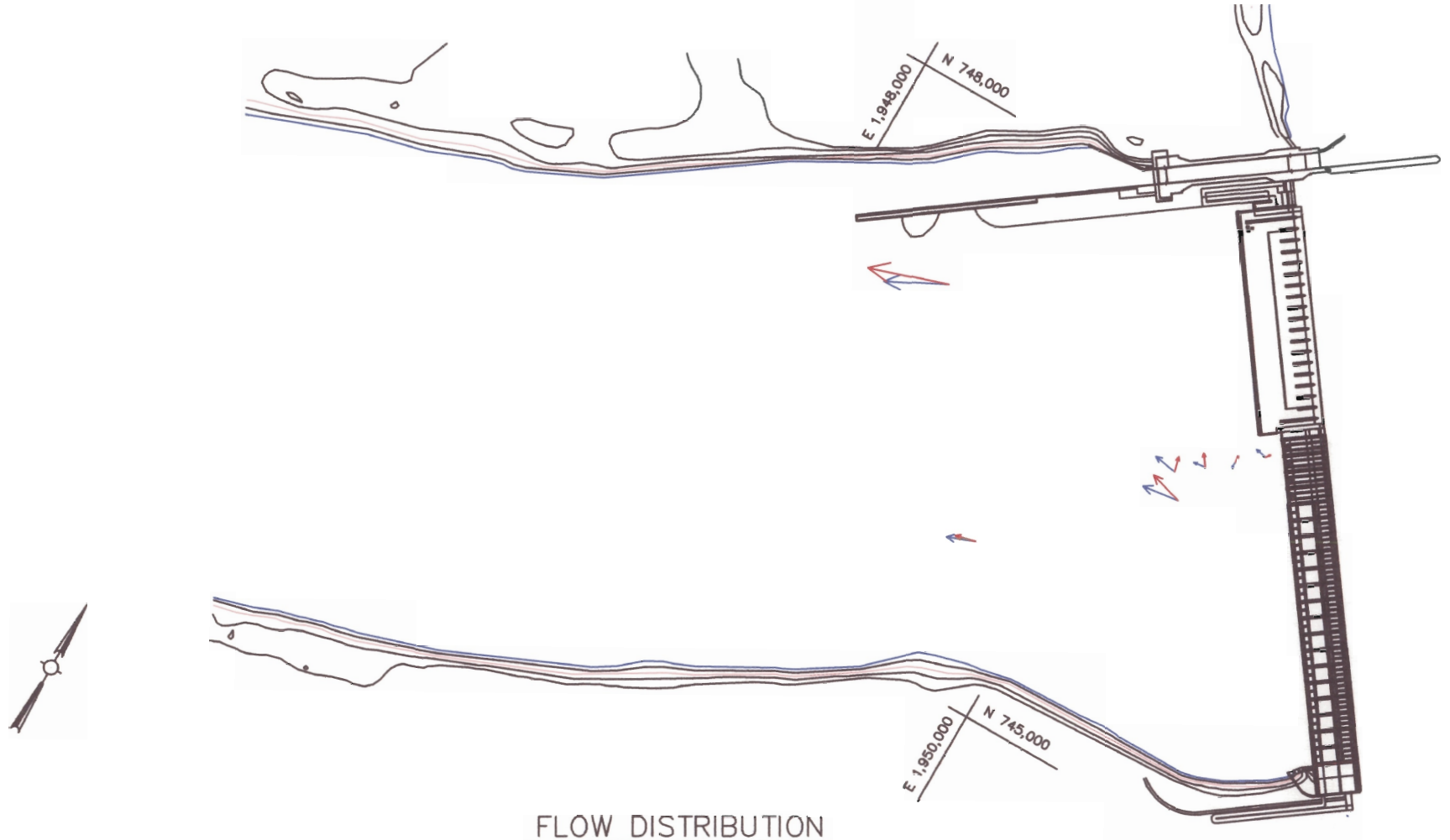
April 2003 Prototype Data

20 FT. DEPTH

DISCHARGE: 205,200 CFS

LOWER POOL EL: 161.1 FT

Figure 15



FLOW DISTRIBUTION

LEGEND

← MODEL VELOCITY
← PROTOTYPE VELOCITY

SCALES IN FEET

0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	13.8	12.3	12.1	12.1	12.8	13.1	0	0	0	12.3	12.6	12.1	0	20.0	0	12.1

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	5.9	5.5	4.0	4.0	4.6	4.9	3.3	3.3	3.5	3.4	2.8	3.3	3.3	3.2	3.3	1.6	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

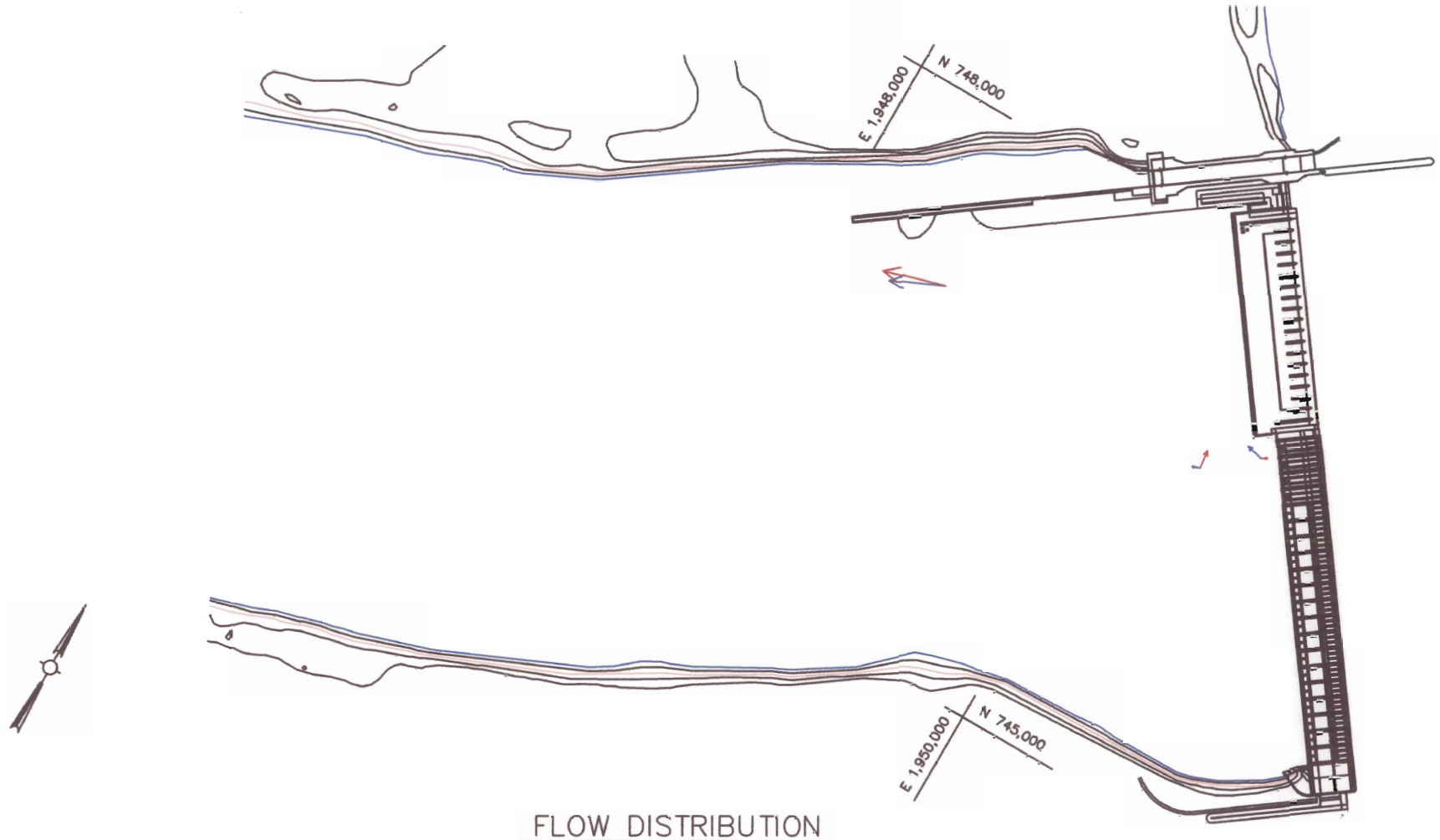
April 2003 Prototype Data

30 FT. DEPTH

DISCHARGE: 205,200 CFS

LOWER POOL EL: 161.1 FT

Figure 16



FLOW DISTRIBUTION

LEGEND

MODEL VELOCITY
PROTOTYPE VELOCITY

SCALES IN FEET

0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	13.8	12.3	12.1	12.1	12.8	13.1	0	0	0	12.3	12.6	12.1	0	20.0	0	12.1

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	5.9	5.5	4.0	4.0	4.6	4.9	3.3	3.3	3.5	3.4	2.8	3.3	3.3	3.2	3.3	1.6	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

April 2003 Prototype Data

40 FT. DEPTH

DISCHARGE: 205,200 CFS

LOWER POOL EL: 161.1 FT

Figure 17

Table 18 **152,000 cfs Model - Prototype Comparison**

Point	Depth (ft)	Prototype Angle (deg)	Model Angle (deg)	Angle Difference (deg)	Avg Angle Difference (deg)	Prototype Velocity (fps)	Model Velocity (fps)	Velocity Difference (fps)	Avg Vel Difference (fps)
A - 1	10	286	268	18		3.1	2.8	0.2	
A - 2	10	298	278	20		3.8	3.9	-0.1	
A - 3	10	313	286	27		3.8	3.3	0.4	
A - 4	10	305	281	24	22	2.9	3.9	-1.0	-0.1
A - 5	10	304	277	27		1.7	0.9	0.8	
A - 6	10	318	260	58		1.9	0.7	0.6	
A - 7	10	290	216	82	56	0.9	0.8	0.1	0.5
B - 1	10	304	287	17		2.3	3.8	-1.5	
B - 2	10	331	315	16		2.1	2.7	-0.6	
B - 3	10	285	265	20	18	5.5	2.6	2.8	0.2
C - 1	10	272	259	13		2.9	4.2	-1.3	
C - 2	10	283	279	4		1.4	1.3	0.1	
D - 1	10	276	281	-5		4.9	2.9	2.0	
D - 2	10	280	275	5		4.5	3.4	1.0	
E - 1	10	289	281	8		2.6	2.9	-0.3	
E - 2	10	283	275	8		4.5	3.9	0.6	
F - 1	10	296	290	6		3.1	3.6	-0.5	
F - 2	10	278	271	7	6	3.7	3.3	0.4	0.3
A - 1	20	287	267	20		2.9	2.6	0.3	
A - 2	20	298	281	17		3.6	3.4	0.2	
A - 3	20	313	273	40		3.6	3.0	0.5	
A - 4	20	308	285	23	25	3	7.8	-4.9	-1.0
A - 5	20	290	268	22		1.5	1.3	0.2	
A - 6	20	300	250	50		0.8	1.2	-0.4	
A - 7	20	267	215	52	41	0.4	1.6	-1.2	-0.5
B - 1	20	304	286	18		1.7	3.5	-1.8	
B - 2	20	336	317	19		1.6	2.3	-0.7	
B - 3	20	285	274	11	16	4.9	2.0	2.9	0.1
C - 1	20	272	257	15		2	4.1	-2.1	
C - 2	20	278	274	4		1.2	1.1	0.0	
D - 1	20	275	273	2		4.1	3.7	0.3	
D - 2	20	280	275	5		4	3.1	0.8	
E - 1	20	293	282	11		2.7	2.9	-0.2	
E - 2	20								
F - 1	20	298	292	6		3	3.3	-0.3	
F - 2	20				7				-0.3
A - 1									
A - 2									
A - 3									
A - 4									
A - 5	30	294	294	30		1	0.6	0.4	
A - 6	30								
A - 7	30				30				0.4
B - 1	30								
B - 2	30								
B - 3	30	285	255	30	30	4	1.7	2.3	2.3
C - 1	30	275	252	23		1.3	3.3	-2.0	
C - 2	30	273	271	2		1.1	1.0	0.0	
D - 1	30	274	273	1		3.4	3.3	0.0	
D - 2	30								
E - 1	30	299	283	16		2.7	2.8	-0.1	
E - 2	30								
F - 1	30	299	293	6		2.9	3.1	-0.2	
F - 2	30				10				-0.5
E - 1	40								
F -1	40								

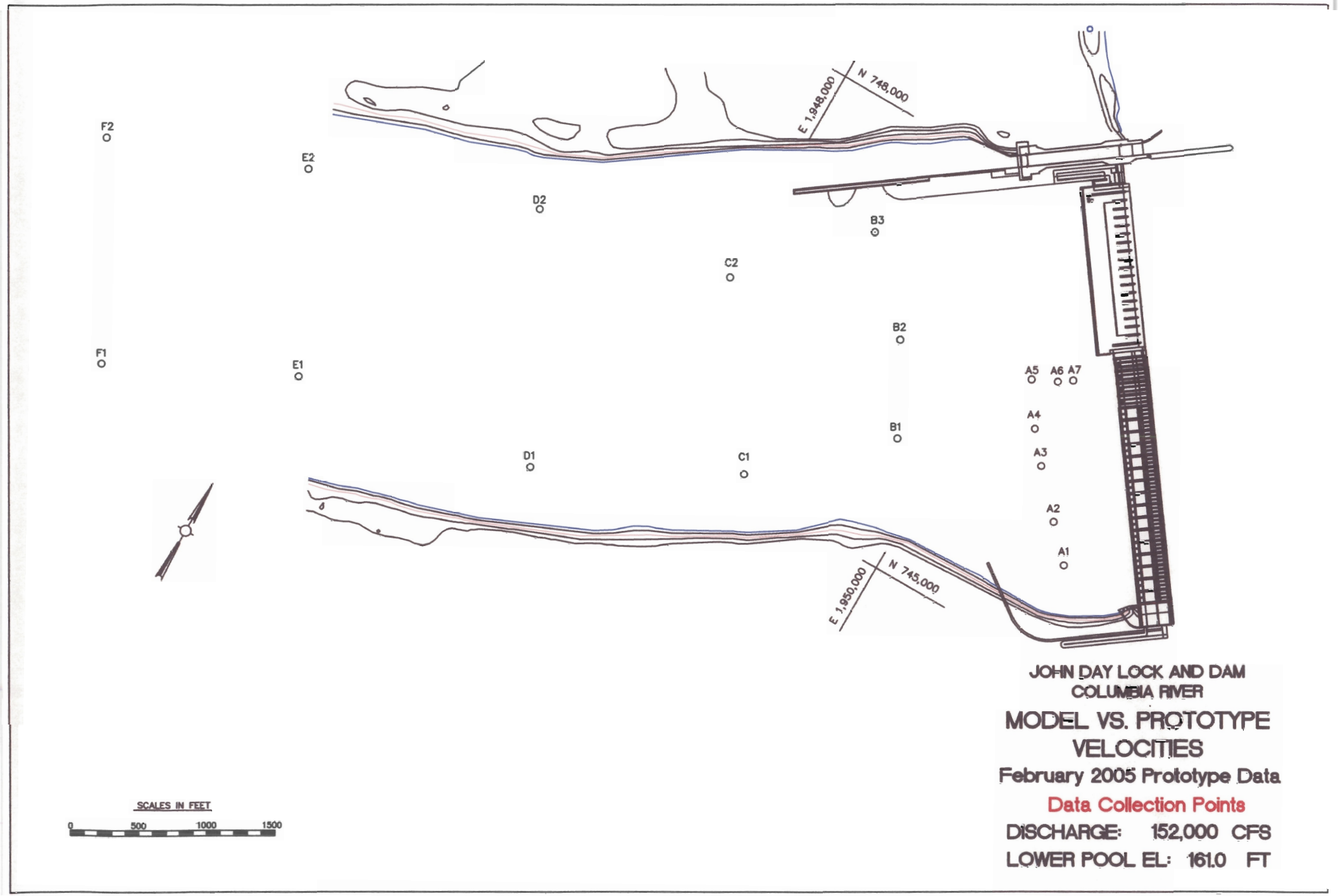

F2
E2
D2
B3
C2
B2
F1
E1
A5
A6
A7
A4
B1
D1
C1
A3
A2
A1
E 1,948,000
N 748,000
E 1,950,000
N 745,000
SCALES IN FEET
0
500
1000
1500
JOHN DAY LOCK AND DAM
COLUMBIA RIVER
MODEL VS. PROTOTYPE
VELOCITIES
February 2005 Prototype Data
Data Collection Points
DISCHARGE: 152,000 CFS
LOWER POOL EL: 161.0 FT

Figure 18

FLOW DISTRIBUTION

LEGEND

MODEL VELOCITY
PROTOTYPE VELOCITY

SCALES IN FEET

0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	0	0	15.4	14.8	15.2	15.2	15.2	15.2	15.2	0	15.5	0	0	14.9	0	15.4

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	4.9	4.9	3.1	2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

February 2005 Prototype Data

10 FT. DEPTH

DISCHARGE: 152,000 CFS

LOWER POOL EL: 161.0 FT

Figure 19

FLOW DISTRIBUTION

LEGEND

← MODEL VELOCITY
← PROTOTYPE VELOCITY

SCALES IN FEET

0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	0	0	15.4	14.8	15.2	15.2	15.2	15.2	15.2	0	15.5	0	0	14.9	0	15.4

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	4.9	4.9	3.1	2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

February 2005 Prototype Data

20 FT. DEPTH

DISCHARGE: 152,000 CFS

LOWER POOL EL: 161.0 FT

Figure 20

FLOW DISTRIBUTION

LEGEND

MODEL VELOCITY
PROTOTYPE VELOCITY

SCALES IN FEET
0 500 1000 1500

POWERHOUSE OPERATION

UNIT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discharge (1000 cfs)	0	0	15.4	14.8	15.2	15.2	15.2	15.2	15.2	0	15.5	0	0	14.9	0	15.4

SPILLWAY GATE PATTERN

BAY NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Discharge (1000 cfs)	0	4.9	4.9	3.1	2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

JOHN DAY LOCK AND DAM
COLUMBIA RIVER

MODEL VS. PROTOTYPE VELOCITIES

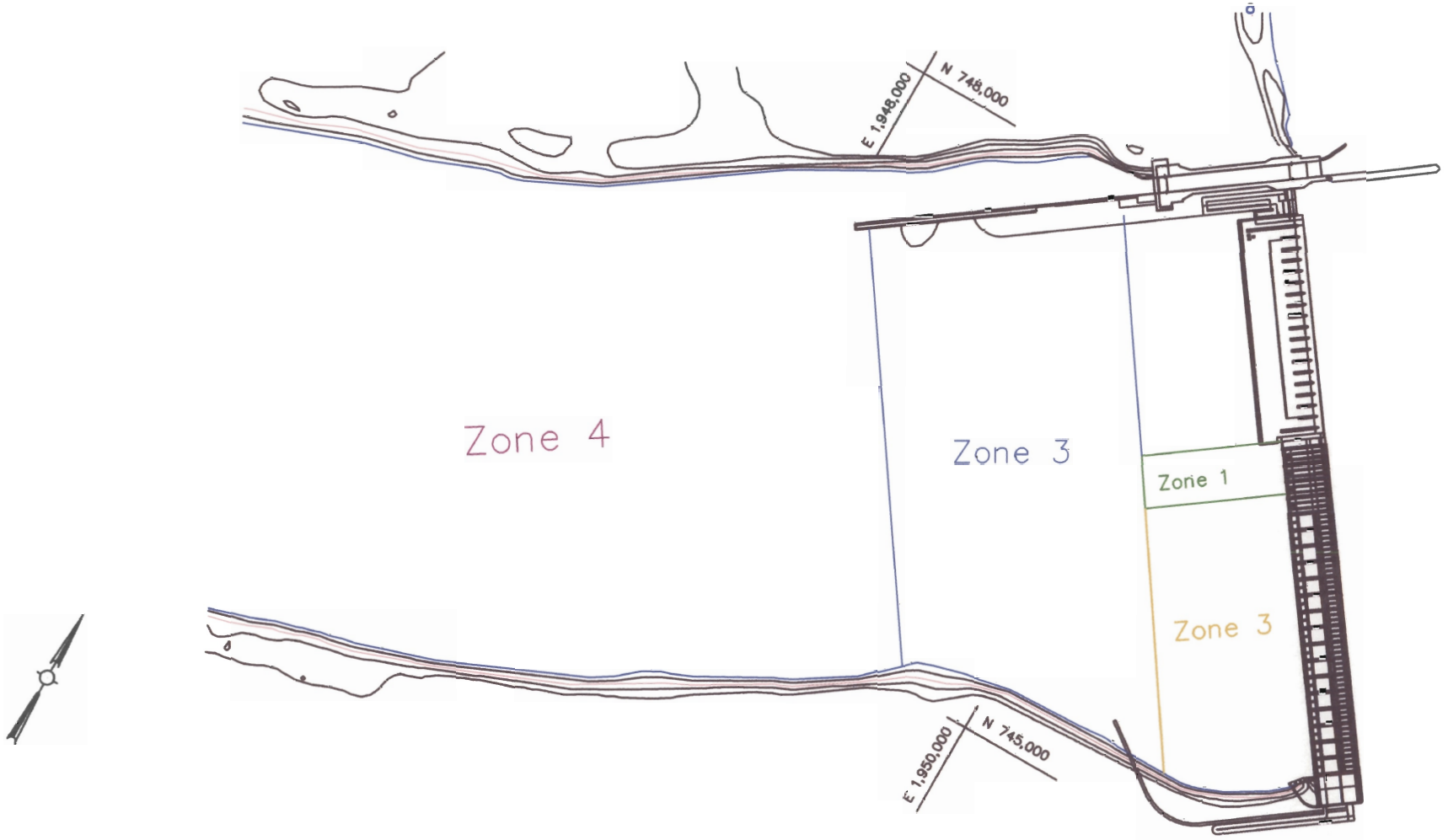
February 2005 Prototype Data

30 FT. DEPTH

DISCHARGE: 152,000 CFS

LOWER POOL EL: 161.0 FT

Figure 21



JOHN DAY LOCK AND DAM
COLUMBIA RIVER

Data Collection Zones

Figure 22

Table 19 **Average Angle and Velocity Differences, Zones 1 - 4**

Point	Depth (ft)	Avg Angle Difference (deg)	Avg Vel Difference (fps)
1 - 1	10		
1 - 2	10		
1 - 3	10		
1 - 4	10	52	0.3
1 - 1	20		
1 - 2	20		
1 - 3	20		
1 - 4	20	60	0.3
1 - 1	30		
1 - 2	30		
1 - 3	30		
1 - 4	30	105	-0.3
1 - 1	40		
1 - 3	40	60	0.0
A - 5	10		
A - 6	10		
A - 7	10	56	0.5
A - 5	20		
A - 6	20		
A - 7	20	41	-0.5
A - 5	30		
A - 6	30		
A - 7	30	30	0.4

Point	Depth (ft)	Avg Angle Difference (deg)	Avg Vel Difference (fps)
2 - 1	10		
2 - 2	10		
2 - 3	10		
2 - 4	10		
2 - 5	10		
2 - 6	10		
2 - 7	10		
2 - 8	10		
2 - 9	10	9	-0.5
2 - 1	20		
2 - 2	20		
2 - 3	20		
2 - 4	20		
2 - 5	20		
2 - 6	20		
2 - 7	20		
2 - 8	20		
2 - 9	20	9	-0.5
2 - 9	30	24	-0.2
A - 1	10		
A - 2	10		
A - 3	10		
A - 4	10	22	-0.1
A - 1	20		
A - 2	20		
A - 3	20		
A - 4	20	25	-1.0
A - 1	30		
A - 2	30		
A - 3	30		
A - 4	30		

Point	Depth (ft)	Avg Angle Difference (deg)	Avg Vel Difference (fps)
3 - 1	10		
3 - 3	10		
3 - 5	10		
3 - 6			
3 - 7	10		
3 - 8			
3 - 9	10		
3 - 9.8	10	6	-0.3
3 - 1	20		
3 - 3	20		
3 - 7	20		
3 - 9	20		
3.9.8	20	6	-0.2
3 - 3	30		
3 - 9	30	8	0.4
3 - 9	40	8	0.5
B - 1	10		
B - 2	10		
B - 3	10	18	0.2
B - 1	20		
B - 2	20		
B - 3	20	16	0.1
B - 1	30		
B - 2	30		
B - 3	30	30	2.3

Point	Depth (ft)	Avg Angle Difference (deg)	Avg Vel Difference (fps)
4 - 1	10		
4 - 5	10		
4 - 7	10		
4 - 9	10	-12	0.7
C - 1	10		
C - 2	10		
D - 1	10		
D - 2	10		
E - 1	10		
E - 2	10		
F - 1	10		
F - 2	10	6	0.3
C - 1	20		
C - 2	20		
D - 1	20		
D - 2	20		
E - 1	20		
E - 2	20		
F - 1	20		
F - 2	20	7	-0.3
C - 1	30		
C - 2	30		
D - 1	30		
D - 2	30		
E - 1	30		
E - 2	30		
F - 1	30		
F - 2	30	10	0.5
E - 1	40		
F - 1	40		

Zone 1	Average Angle Difference (deg)	Average Velocity Difference (fps)
	58	0.1

Zone 2	Average Angle Difference (deg)	Average Velocity Difference (fps)
	18	-0.5

Zone 3	Average Angle Difference (deg)	Average Velocity Difference (fps)
	13	0.4

Zone 4	Average Angle Difference (deg)	Average Velocity Difference (fps)
	3	0.3