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Monitoring Groundwater and River Interaction Along the Hanford Reach of the Columbia River

M. D. Campbell

April 1994

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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Pacific Northwest Laboratory
Richland, Washington 99352

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Executive Summary

As an adjunct to efficient Hanford Site characterization and remediation of groundwater contamination, an automatic monitor network has been used to measure Columbia River and adjacent groundwater levels in several areas of the Hanford Site since 1991. Water levels, temperatures, and electrical conductivity measured by the automatic monitor network provided an initial database with which to calibrate models and from which to infer ground and river water interactions for site characterization and remediation activities. Measurements of the dynamic river/aquifer system have been simultaneous at 1-hr intervals, with a quality suitable for hydrologic modeling and for computer model calibration and testing. This report describes the equipment, procedures, and results from measurements done in 1993.

During 1993, Columbia River and groundwater elevations were measured hourly at 50 locations in seven areas of the Hanford Site in southcentral Washington State. Water temperature was measured at 10 of these locations; electrical conductivity was measured at five.

Water level accuracy is unknown, but is believed to be within ±0.1 ft. Factors affecting accuracy are topographic surveys, instrument calibrations, and steel tape measurements. Measurement precision appears to be within ±0.02 ft for wells and ±0.2 ft for river stage. Repeated steel tape measurements vary within ±0.01 ft. Survey errors vary with distance between sites, but most appear to be less than ±0.07 ft.

Visual inspection and graphic review of data confirmed its continuity. Comparisons between simultaneous steel tape and datalogger readings were used as periodic data quality checks. River elevations varied up to 15 ft during the year and up to 9 ft during a single day. The 300 Area river elevation varied about 60% as much as the other stations because of the influence of the McNary Dam forebay. Ice Harbor Dam tailwater also influenced the fluctuation of the river in the 300 Area. Groundwater elevations varied up to about 3 ft per day in a few wells nearest the river and up to about 6 ft over the season in some wells.

Electrical conductivity of water in wells was influenced by river intrusion to a small degree. Riverbank seep conductivity varied between river and well values. Each of these factors is important in more efficient site characterization and remediation.

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1.0 Introduction

Aquifer hydraulic properties and head gradients control contaminant migration to the Columbia River. Contaminant migration also depends on concentration and thermal gradients operating in the aquifer/river system. Properly calibrated computer models can process such data to simulate interactions between the unconfined aquifer and the Columbia River to show likely consequences of remediation. Measurement variety, frequency, and accuracy must satisfy model requirements for acceptable predictive reliability.

The monitor network is a feasible and economical system of collecting the simultaneous and frequent data required for remedial investigation of river and groundwater interaction. Monitors collect the data automatically and transmit it by radio telemetry to a computer for storage and processing.

During 1993, river and groundwater levels were measured by an automatic monitor network at 50 locations in seven areas along the Columbia River on the Hanford Site. Water temperatures at 10 locations and electrical conductivity at five locations were also measured. Pacific Northwest Laboratory (PNL)[a] personnel, under contract to Westinghouse Hanford Company (WHC), initiated network installation early in FY 1991 at 35 sites in the 300 Area, with nine sites added later that year in 100-F, -H, and -B Areas.

Emphasis and equipment were shifted from the 300-FF-5 Operable Unit to the 100 Aggregate Area Operable Unit during the spring of 1993. Monitors removed from the 300 Area were installed in 100-D, -N, and -K Areas and added to the number in the -F, -H, and -B Areas. Eleven wells and one river station are still monitored in the 300-FF-5 boundary while the others are spread about evenly among the 100 Areas. The monitor network currently consists of 44 radio transceivers and 42 automatic dataloggers, with one station in each area, except 100-N, serving two wells. The seven areas currently monitored are shown in Figure 1.

This report summarizes conductivity, temperature, and water level data obtained by the network. Equipment and procedures are detailed. The monitor stations are discussed. Quality and calibration are discussed, followed by measurements and the programs used to make them. Electrical conductivity, temperatures, and water levels are presented and discussed. Finally, measurements and their frequency and precision are presented and discussed, and conclusions are presented. Network programming and other information are presented in the appendixes.

(a) Operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

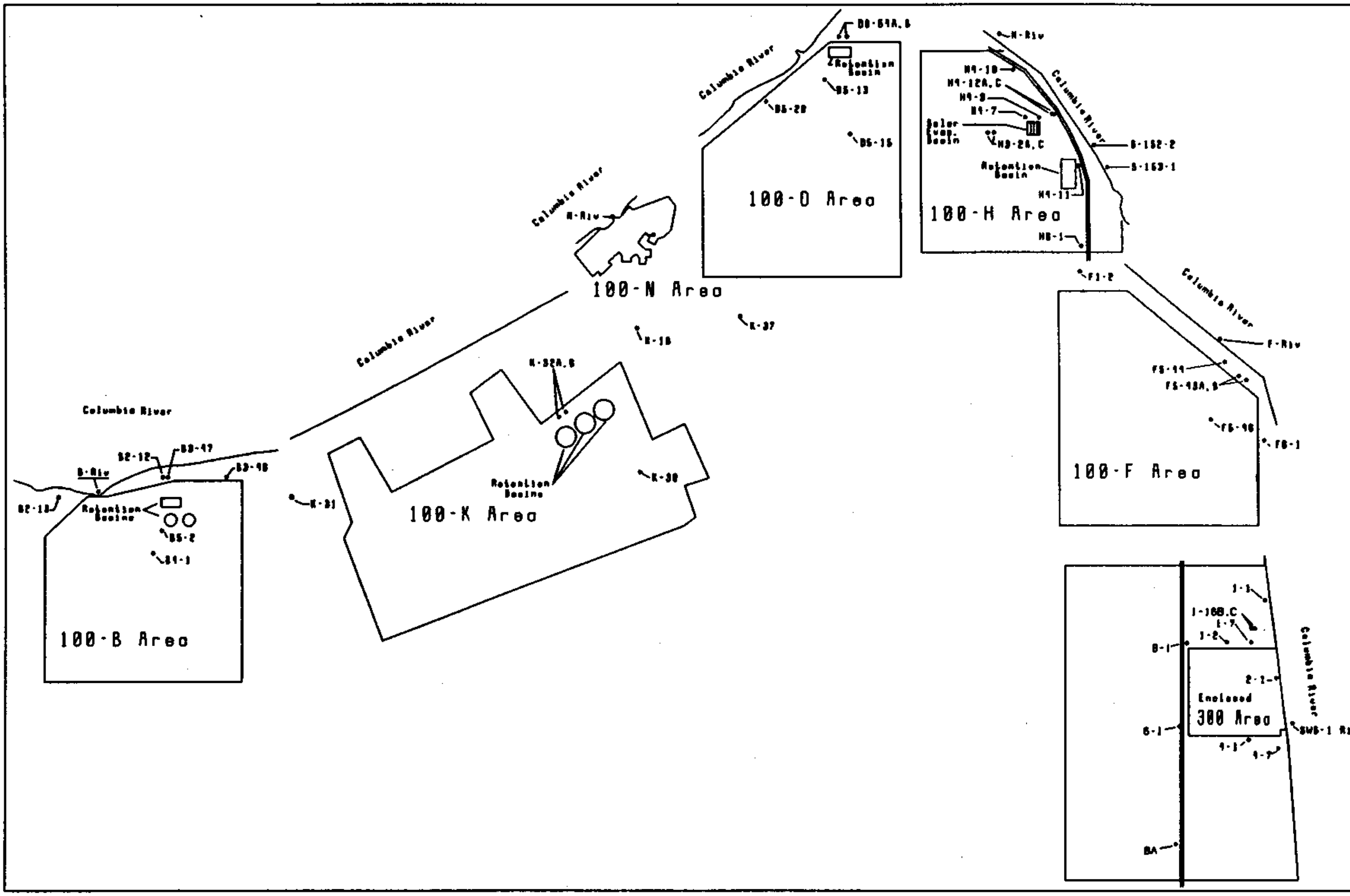

Figure 1. Network Monitor Station Locations During 1993

2.0 Equipment

Monitor network stations have a datalogger, a frequency modulated (FM) radio transceiver with a radio frequency (RF) modem connected to the datalogger, an FM antenna, and a 12-volt battery with a solar recharging panel. The datalogger, modem, and transceiver are installed in a weather enclosure. The entire assembly is mounted on a tripod or a well post pipe. Forty-eight of the 50 sites have pressure transducers to measure water depth. Ten sites have thermocouples to measure water temperatures. Five sites have probes to sense electrical conductivity and water temperature. The electrical conductivity measurements, corrected for temperature, reflect the concentration of dissolved ions.

2.1 River Stations

Two of the five river stations have the transducer retainer pipe extending down the river bank slope into the water at an angle. One station is staked to the bank and is likely to move with time. These two stations, located at 100-F and 100-H, require adjustments to the steel tape measurements taken along the pipe to compensate for their non-vertical angle. The 100-F correction is 0.2425 x tape reading. The 100-H correction was 0.4395 x tape reading up to January 25, 1994 and 0.4417 x tape reading thereafter. The other three stations, 100-B, 100-N, and SWS-1 in the 300 Area, have vertically mounted transducer retainer pipes. SWS-1 in the 300 Area has a river stage scale mounted on the concrete wall next to the retainer pipe. Although river stage can be read directly from the scale, survey indicated the need for a 0.4 ft adjustment. The 100-N and 100-B stations require steel tape measurements from the top of the top pipe coupling to the water surface.

All river station elevations were surveyed. The SWS-1 scale was reported to be 0.4 ft lower than its indicated value. Thus, the 345-ft stage scale mark is actually 344.6 ft above mean sea level (MSL). The 100-F river station surveyed as 373.33 ft above MSL at the top, south corner of the channel iron. The bottom south corner of the channel was 368.48 ft above MSL. The 100-H river station was originally surveyed as 386.47 ft above MSL at the top of the 2-in. pipe coupling; resurvey on January 25, 1994 set the elevation at 386.83 ft above MSL. The 100-N river station surveyed as 426.09 ft above MSL at the top of the pipe coupling. The 100-B river station surveyed as 448.32 ft above MSL at the top of the pipe coupling.

The 100-H river station has an electrical conductivity cell as well as a pressure transducer attached. This station measured depth, electrical conductivity, and temperature of the water. Water depth was recorded as a feet-per-volt ratio, ranging between 0. and 15.xxxx. Electrical conductivity was recorded as milliSiemens, ranging from 0.0000 to 0.5xxx. Electrical conductivity before October 5, 1993 required temperature compensation during data processing, but it was compensated in the datalogger after that date. Temperature ranged from 0 to 30°C.

2.2 Single-Well Stations

Single-well stations have transducers connected to channels 1 and 2 of the current dataloggers, with orange, black, yellow, and blue wires connected to 1H, 1L, 2H, and 2L, respectively. The red wire is connected to the E1 excitation channel and the white wire connected to any AG. The silver wire is not connected because of its tendency to create a ground loop.

2.3 Multiple-Well Stations

Multiple-well stations have transducers connected sequentially. The transducer from the first well, numerically or alphabetically, is connected as described for the single well station. The second transducer is connected with orange, black, yellow, and blue going to 3H, 3L, 4H, and 4L, respectively. The red wire is connected to E1 with the first transducer, and the white wire is connected to any AG terminal.

The readout from multiple-well stations is in the sequence wired. Early in the monitor project, some well numbers were unknown when we began monitoring them. In some cases, the sequence was reversed, causing difficulty in quality control. This problem required help from the Database Manager in the Geosciences Department of WHC or reference to the Laboratory Record Book to avoid errors in data interpretation.

2.4 Multiple Sensor Stations

Pressure, temperature, and electrical conductivity of water were measured in some locations. Stations that measured all three were wired to measure pressure, electrical conductivity, and temperature, in that order. The electrical conductivity cell has six wires. Either the blue or the black wire can be used, but not both. The black wire is used when high resolution is required. The connections used were red-6L, white-6H, green-E3, black-E2, purple-AG, and clear-G. This configuration avoids interference and allows for use of two pressure transducers on a single datalogger.

Where electrical conductivity is measured, temperature is also measured by the same transducer and used to compensate for thermal changes in the river or groundwater solution.

2.5 Datalogger Programs

The transducers used in our monitor systems require precise, selectable excitation, and simultaneous measurements of transducer excitation and output. The datalogger programs to accomplish this task are shown in Appendix A.

3.0 Procedures

Periodic maintenance and tests were required to assure quality data through proper equipment operation. Tape and datalogger readings recorded simultaneously were compared with previously recorded sets to detect changes. Errors and problems were addressed. Initial calibration and recalibration determined the factors for data reduction. Battery voltage was measured periodically, and desiccant packages were replaced to help ensure proper equipment operation.

3.1 Paired Tape and Datalogger Tests

Water levels at a site were simultaneously measured by steel tape and by a datalogger. Readings were repeated when paired reading sets disagreed with previously paired reading sets.

An equivalent change in water level is required by the tape and the datalogger. The following equation was used to deal with errors:

$$T_1 - T_2 = f(DL_1 - DL_2) \tag{1}$$

where T_1 and T_2 are steel tape readings 1 and 2, "f" is the calibration factor for the transducer, and DL_1 and DL_2 are the paired datalogger readings 1 and 2.

Dataloggers measured volt ratios as transducer voltage output/input. The following equation converts the datalogger reading into elevation relative to MSL elevation:

$$E_{MSL} = E_{ToC} - T + (DL - DL_T) \times F \tag{2}$$

where E_{MSL} = elevation above Mean Sea Level
E_{ToC} = surveyed elevation at top of the well casing
T = steel tape measurement
DL = ambient datalogger reading
DL_T = datalogger reading taken with the tape reading
F = the calibration factor for the transducer.

All pressure transducer readings were preserved as volt ratios. Calibration factors were not stored with raw data. Raw data were preserved in computers in two separate locations, readily accessible for processing.

Datalogger resolution is 0.33μV on its most sensitive range, which corresponds with 0.000123 ft of water elevation change. Both voltage and depth resolution are displayed in Table 1.

Table 1. Datalogger Range and System Resolution, Assuming Calibration Factor of 0.93 ft/volt-ratio

Datalogger			
Range		Sensitivity	System Resolution
Code	(mv)	(mv)	(ft)
21	2.5	0.00033	0.0001
22	7.5	0.00100	0.0003
23	25.	0.00333	0.0012
24	250.	0.0333	0.012
25	2500.	0.333	0.12

3.2 Calibration Checks

Cross-checking the datalogger readings with the steel tape measurements helped identify errors. Errors have been traced to well casing extension, misread tape, transducer movement, transducer failure, and datalogger wiring panel failure. Table 2 shows examples of correct and erroneous tape and datalogger reading sets. (See Appendix B for all reading sets.) Some well casings were extended upward approximately 1 ft when some of the older wells were renovated. When the work was done, a time lag occurred before resurvey records were available, so the water elevations appeared incorrect until resurvey.

Steel tape measurements are commonly accepted as the standard, but tape reading accuracy depends on technique, individual observation, and weather conditions. For example, tape may be lodged on an obstacle rather than suspended straight into the water. Detection of this problem depends on the observer's skill and judgment. Also, the wet line across the tape scale may result from either normal water submergence or from contact with a condensing surface and may also require the observer's judgment. Repeated tape measurements revealed observer errors ranging up to 10 ft. Errors were more difficult to detect and resolve in wells with other equipment. Large amounts of condensation near the top of the well casing made accurate measurement more difficult. However, we repeated measurements to verify the steel tape readings within 0.01 ft. Disagreement between steel tape and transducer readings required repeat readings to achieve consistency. Steel tape readings should be questioned and proven by replicated remeasurement.

3.3 Precautions and Sources of Error

Errors in Table 2 and Appendix B include those that are positive because a steel tape or datalogger reading was too small. Errors that are negative result from a steel tape or datalogger reading that is too large. Condensate wetting of a steel tape causes a positive error. Transducer cable slippage and steel tape hangup cause a negative error. Aquifer changes from wind cause both positive and negative

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Table 2. Paired Sets of Tape and Datalogger Readings (see Appendix B)

T&D for Jan, Feb, and Mar 1993.

(-,TorD large) (+,TorD small)

Well/ Date	Time	Tape	DL Rdg.	Change (ft)
1-1				
1-29-92	917	34.33	4.4550	-0.07
2-5-92	1137	34.85	3.9525	-0.12
3-5-92	1408	34.49	4.3510	-0.13
4-8-92	804	34.28	4.5720	-0.13
5-6-92	736	33.39	5.3094	0.00
6-3-92	724	32.98	5.8256	0.00
7-2-92	711	33.22	5.5568	0.01
8-7-92	739	34.97	3.6517	0.04
9-9-92	810	35.43	3.4042	-0.19
10-8-92	808	35.29	3.6406	-0.27
11-10-92	840	35.14	3.8468	-0.32
12-8-92	945	33.12	6.0288	-0.32
1-7-93	925	32.32	6.8431	-0.28
2-9-93	908	35.19	3.7187	-0.25
3-9-93	838	35.92	2.9122	-0.23
1-2				(ft)
5-1-92	1130	44.42	4.7465	0.03
5-6-92	806	44.12	5.0986	0.00
6-3-92	736	43.57	5.7202	-0.03
7-2-92	726	43.44	5.8715	-0.04
8-7-92	658	45.3	3.6305	0.19
9-9-92	732	46.04	3.0894	-0.00
10-8-92	737	45.82	3.2789	-0.01
11-10-92	802	45.73	3.3457	0.02
12-8-92	859	43.86	5.8361	-0.43
1-7-93	849	43.18	6.7032	-0.55
2-9-93	822	45.75	4.013	-0.62
3-9-93	800	46.2	3.3547	-0.46
2-1				
1-29-92	1030	33.41	5.0283	0.07
2-5-92	1145	33.78	4.6196	0.08
3-5-92	1413	33.52	4.9622	0.02
4-8-92	749	33.27	5.2568	0.00
5-6-92	742	32.32	6.2786	0.00
6-3-92*	720	31.94	6.7143	-0.03
7-2-94	704	32.27	4.2827	1.91
7-8-92	1255	34.48	1.9634	0.48
8-7-92	745	33.95	3.0511	0.00
9-9-92	810	34.35	2.6865	-0.06
10-8-92	813	34.19	2.8055	-0.01
11-10-92	908	33.91	3.3632	-0.25
12-8-92	952	32	5.6197	-0.44
1-7-93	933	31.14	6.7382	-0.62
2-9-93	911	34.07	3.633	-0.66
3-9-93	844	34.81	2.9014	-0.72
2-2				
9-16-92	1145	36.35	4.9659	0.00
10-8-92	746	36.41	5.0153	-0.11
11-10-92	817	36.24	5.2036	-0.11
12-8-92	925	34.3	7.3153	-0.13
1-7-93	904	33.46	8.2109	-0.13
2-9-93	835	36.35	5.1672	-0.19
3-9-93	826	36.97	4.28	0.02
SWS-1				
11-15-91	1020	343.42	10.9960	0.00
12-5-91	1441	341.35	8.6580	-0.10
12-13-91	1217	341.62	9.3522	0.27
12-13-91*	1354	341.89	7.7273	Adj.
1-24-92	1443	341.43	7.2292	0.00
2-5-92	1243	341.30	7.0972	0.01
3-5-92	1422	341.30	7.0906	0.00
4-8-92	738	342.65	8.5316	-0.01
5-5-92	1115	342.8	8.7018	0.00
6-2-92	1116	343.52	9.4853	0.01
6-30-92	1046	343.32	9.2495	-0.01
8-7-92	811	341.50	7.1636	-0.13
9-9-92	1249	341.53	7.1981	-0.13
10-8-92	819	341.25	6.898	-0.13
11-10-92	855	343.72	8.5221	-1.09
12-8-92	1001	344.05	9.9512	-0.09
1-7-93	939	344.18	11.185	0.93
1-15-93	1615	342.33	8.0788	-0.11
2-9-93	920	341.2	7.0989	0.11
3-9-93	853	340.41	6.0137	-0.11

Well/ Date	Time	Tape	DL Rdg.	Change (ft)
1-7				
1-9-92	1450	42.48	3.4295	0.05
2-5-92	1038	43.95	1.9163	-0.01
3-5-92	1433	43.68	2.1911	0.00
4-8-92* b	904	43.59	9.7679	-6.96
4-21-92*	1335	44.45	4.792	
6-3-92	742	42.23	7.2562	0.01
7-2-92	740	42.37	7.1209	0.00
8-7-92	713	44.21	5.1349	0.01
9-9-92	743	44.67	4.6284	0.02
10-8-92	725	44.47	4.8486	0.01
11-10-92	937	44.3	5.0319	0.01
12-8-92	911	42.4	7.0938	-0.00
1-7-93	908	41.62	7.9452	-0.02
2-9-93	838	44.38	4.927	0.03
3-9-93	815	44.99	4.2652	0.04
1-8				
7-12-91	1008	40.89	5.0464	-0.07
8-15-91	935	40.34	5.6381	-0.07
8-22-91	1126	41.88	3.9608	-0.05
9-5-91	738	42.59	3.1963	-0.05
12-5-91	1536	43.13	2.5909	-0.03
1-9-92	1456	41.74	4.0986	-0.04
2-5-92	1038	43.17	2.3150	0.00
3-5-92	1433	42.9	2.8026	0.00
4-8-92	904	42.85	2.8605	0.00
5-6-92	820	41.99	3.8092	-0.02
6-3-92	742	41.51	4.3166	-0.01
7-2-92	740	41.56	4.2609	-0.01
8-7-92	713	43.51	2.2003	-0.05
9-9-92	748	43.94	1.6871	0.00
10-8-92	725	43.74	1.9088	-0.00
11-10-92	820	43.63	2.0242	-0.00
12-8-92	911	41.71	4.1171	-0.03
1-7-93	908	40.96	4.928	-0.03
2-9-93	838	43.68	1.9818	-0.01
3-9-93	815	44.25	1.3499	0.00
1-9				
7-12-91	1020	19.97	3.3714	0.03
8-15-91	931	19.85	3.9275	-0.36
8-22-91	1127	20.60	2.6837	0.04
9-5-91	739	20.83	2.4347	0.04
12-5-91	1533	19.84	3.4848	0.06
1-9-92	1454	19.26	4.1263	0.04
2-5-92	1300	22.14	1.1029	-0.03
3-5-92	1433	22.49	0.6965	0.00
4-8-92	904	22.78	0.3848	0.00
5-6-92* L	815	15.33	13.706	Adj
6-3-92	742	22.92	5.5095	0.00
7-2-92	740	23.83	4.5432	-0.01
8-7-92	713	24.38	3.9611	-0.02
9-9-92	743	25	3.5196	-0.23
10-8-92	725	23.03	5.9199	-0.49
11-10-92	824	26.58	2.0512	-0.44
12-8-92	911	25.94	2.7283	-0.43
1-7-93	908	25.84	2.8088	-0.41
2-9-93	838	26.75	1.8072	-0.39
3-9-93	815	27.03	1.5115	-0.39
1-10B				
1-24-92	1351	32.97	5.2823	0.11
2-5-92	1219	33.70	4.5796	0.04
3-5-92	1310	33.35	4.9636	0.03
4-8-92	811	32.95	5.4254	-0.00
5-6-92	756	31.94	6.5104	0.00
6-3-92	728	31.67	6.815	-0.01
7-2-92	716	32.17	6.2674	-0.00
8-7-92	733	43.73	4.4183	-9.84
9-9-92	1236	34.09	4.1024	0.09
10-8-92	805	34.11	4.1021	0.07
11-10-92	836	33.61	4.6649	0.05
12-8-92	933	31.72	6.7429	0.00
1-7-93	922	30.84	7.6954	-0.00
2-9-93	903	33.99	4.2441	0.06
3-9-93	837	34.79	3.3879	0.05

Well/ Date	Time	Tape	DL Rdg.	Change (ft)
3-9				
8-15-91	1028	43.07	6.2603	0.00
8-22-91	1217	44.80	4.3962	0.00
9-5-91	756	45.29	3.8632	0.01
12-9-91	1011	46.31	3.1102	-0.31
1-9-92*	1421	44.33	4.8742	0.03
2-5-92	1430	46.72	3.1705	Adj.
3-6-92	1125	46.46	3.4672	0.02
4-8-92	950	46.25	3.7143	0.00
5-5-92	1238	45.69	4.6332	-0.29
6-2-92	1219	45.05	5.0023	0.00
6-30-92	1155	44.91	5.5683	-0.38
7-8-92	850	47.38	2.4510	0.04
8-6-92	756	46.95	2.9204	0.04
9-9-92	1208	47.37	2.4657	0.04
10-8-92	1320	47.28	2.395	0.20
11-10-92	1122	46.96	2.4900	0.43
12-9-92	1011	45.03	4.3578	0.62
1-7-93	1131	44.22	5.5635	0.31
2-10-93	806	47.16	2.1974	0.50
3-9-93	944	47.74	1.5149	0.56
3-12				
2-13-92*	1200	46.82	4.4304	0.05
3-6-92	1130	46.32	4.9093	0.03
4-8-92	940	46.2	5.1354	0.02
5-5-92	1247	45.64	5.7568	0.00
6-2-92	1226	44.97	6.4741	0.00
6-30-92	1203	44.31	7.1886	-0.00
8-6-92	749	46.82	4.4507	0.03
9-9-92	1214	47.34	3.7228	0.19
10-8-92	1327	47.15	3.9409	0.18
11-10-92	1130	46.97	4.1463	0.17
12-9-92*	1023	44.97	4.9106	1.46
1-7-93* B	1124	44.48	5.026	1.84
2-10-93*	813	47.06	1.9745	2.10
3-9-93* B	948	47.59	1.6063	1.91
4-1				
12-9-91	1059	53.73	1.8634	0.00
1-9-92*	1347	52.02	3.8699	-0.16
2-13-92	1034	54.49	5.1808	Adj.
3-6-92	1055	54.03	5.7782	0.08
4-8-92	1013	53.87	5.9803	0.05
5-5-92	1223	53.32	6.5762	0.05
6-2-92	1159	52.75	7.2338	0.01
6-30-92	1136	52.14	7.8995	0.00
8-6-92	818	54.63	5.2990	-0.07
9-9-92	1148	55.05	4.8446	-0.07
10-8-92	1300	54.83	5.0701	-0.06
11-10-92	1104	54.68	5.2667	-0.09
12-9-92	950	52.62	7.4909	-0.10
1-7-93	1116	51.96	8.2371	-0.13
2-10-93	749	54.79	5.1338	-0.08
3-9-93	740	55.3	4.5741	-0.07
4-7				
12-9-91	1045	35.84	1.8009	0.00
1-9-92*	1438	34.22	3.9718	-0.40
2-12-92	1533	37.82	5.6859	Adj.
3-6-92	1107	37.24	6.4773	0.14
4-8-92	1006	36.8	7.0846	0.01
5-5-92	1229	36.3	7.6377	0.00
6-2-92* B	1206	35.75	7.0368	1.11
6-10-92	930	36.48	6.2914	1.07
6-25-92*	1020	34.18	4.9947	
6-30-92	1141	35.39	3.7434	0.00
8-6-92	809	37.69	1.2466	0.02
9-9-92	1155	37.97	0.9521	0.02
10-8-92	1310	38	0.9199	0.02
11-10-92	1113	37.50	1.4640	0.01
12-9-92	959	35.65	3.4608	0.00
1-7-93	1140	34.74	4.4565	-0.01
2-10-93	758	37.75	1.177	0.03
3-9-93	934	38.4	0.4597	0.04

Well/ Date	Time	Tape	DL Rdg.	Change (ft)
4-9				
8-15-91	1042	37.25	7.5159	0.00
8-22-91	1231	39.04	5.5584	0.03
9-5-91	801	39.42	5.1879	-0.00
12-9-91	1027	40.12	4.4008	0.03
1-9-92	1404	38.50	6.2134	-0.04
2-5-92*	1436	40.90	4.5442	Adj.
3-6-92	1115	40.65	4.8268	-0.05
4-8-92	957	40.34	5.1521	-0.04
5-5-92	1232	39.79	5.7006	0.00
6-2-92	1213	39.21	6.3509	-0.02
6-30-92	1147	38.75	6.8365	-0.02
8-6-92	801	41.77	4.2626	-0.64
9-9-92	1200	41.47	3.5204	0.35
10-8-92	1316	41.45	3.3007	0.57
11-10-92	1118	41.03	3.8631	0.47
12-9-92	1005	39.14	5.9277	0.44
1-7-93	1136	38.29	6.8871	0.40
2-10-93	802	41.25	3.752	0.35
3-9-93	938	41.88	3.0148	0.41
5-1				
8-13-92	808	53.91	4.8994	0.00
9-9-92	605	54.55	4.2434	-0.03
10-8-92	654	54.41	4.4125	-0.05
11-10-92	1138	54.3	4.5452	-0.06
12-9-92	940	52.53	6.4519	-0.06
1-7-93	1146	52.13	6.8838	-0.07
2-10-93	739	54.24	4.6183	-0.07
3-9-93	749	54.64	4.1751	-0.06
6-1				
1-28-92		46.24	5.826	0.13
2-5-92	1412	46.61	5.5082	0.06
3-5-92	1541	46.65	5.5016	0.02
4-7-92	1043	47	5.186	-0.03
5-5-92	1323	46.17	6.0429	0.00
6-2-92	1151	45.24	7.0736	-0.03
6-30-92	1130	44.3	8.055	-0.00
8-6-92	917	46.67	5.5028	0.00
9-9-92	1140	47.34	4.7781	0.01
10-8-92	1253	47.38	4.7414	0.00
11-10-92	1145	47.24	4.8921	0.00
12-9-92	1130	45.71	6.4593	0.07
1-7-93	1044	45.36	6.7876	0.12
2-10-93	854	47.11	4.9047	0.12
3-9-93	958	47.46	4.5194	0.13
8-1				
5-1-92	930	53.49	4.6068	0.03
5-6-92	837	53.32	4.8258	0.00
6-2-92	1143	52.52	5.6933	-0.01
6-30-92	1010	51.59	6.7013	-0.01
8-6-92	1002	54.04	4.0826	-0.04
9-9-92	610	54.77	3.9083	-0.60
10-8-92	700	54.71	3.976	-0.60
11-10-92	754	54.6	3.5238	-0.07
12-9-92	828	53.12	5.2652	-0.21
1-7-93	1017	52.56	5.8061	-0.23
2-9-93	805	54.5	3.801	-0.23
3-9-93	759	54.89	3.367	-0.21

errors. Survey or well casing modifications may cause either type of error. Survey errors usually affect accuracy, not precision. Gradual relaxation of the transducer cable causes errors, but they are usually small. Temporary hang-up of a transducer on a pump or other obstruction in the well causes error. Samplers and well maintenance crews frequently remove or adjust pumps; this cause of error is relatively common. Error detection is done by plotting normalized differences between simultaneous water elevations in similar wells. Differences are cause for system calibration recheck.

Errors increase with datalogger range because resolution decreases, as shown in Table 1. Since it is necessary to use a greater range in river stations than in wells, the errors in river measurements are greater in the river data. Errors from topographic survey should be less than ± 0.06 ft, for most wells.

Transducers produce errors as a result of plugged ports or vent tubes. Water, debris, or a compressed cable cause this type of error. The vent tubes are checked, and a dry desiccant is placed in the vented enclosure to keep air vents clean and dry. Small animals, most likely porcupines, have chewed through three transducer cables during 1993. Larger animals, such as coyotes, have not been able to bite through the cover, however.

If monitor system battery voltage drops too low, directly measured voltages increase. This type error is most likely where solar panels fail to recharge the lead-acid battery, especially during winter time. The pressure transducer and other readings will gradually go too high and will finally be recorded as -99999 when overrange conditions exist.

Errors in the data were detected by listing each file after data download and by field observation. Slipped fittings or observed well pumping or renovation called for error checks.

3.4 Desiccant and Battery Service

Battery voltages were measured monthly to detect potential power supply problems without data loss. During December of both 1992 and 1993, battery power proved inadequate on several stations. Low voltages were detected and batteries were replaced without significant data loss. However, the causal problems differed between years. During cold winter weather in 1992, the large, 80-Ah, liquid, lead-acid batteries discharged by parallel connection to the small gel-cell, lead-acid batteries and the sulfate hardened to prevent recharge. The liquid and gel cells should not be connected in parallel unless the solar charger and regulator are capable of voltage output great enough to recharge the liquid cell under low temperatures.

During December of 1993, the systems were operated without the large batteries, and the small gel cells lacked capacity to withstand the prolonged cloudy weather. Solar radiation was inadequate to recharge batteries during November, December, and January. Solar insolation during December 1993 was less than 10% of typical June radiation. Thus, it was necessary to replace and recharge batteries each week. Solar panel enlargement proved incapable of resolving the problem. Investigation of the power supply issue caused us to decide to do two things in the future: Install 40- to 60-Ah, sealed, lead-acid battery with a 2-yr shelf life, and set voltage regulators to output 14.1 V, with over-voltage supply with temperature drop. This will be done during early 1994.

The desiccant packs have been replaced when the 30% indicator button in each datalogger enclosure began to turn pink or when there was other evidence of humidity. When the packs were dried in the oven at the specified 250°F, they exploded. After securing new packs, we poked two small tack holes in the clear side of each pack to allow outgassing of the water vapor. We had no further problems. In each enclosure, all entrances except the breather vent were sealed. During cold, wet weather, replacement may be required each month. Desiccant replacement is not usually necessary during warm weather.

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4.0 Results and Conclusions

A year's data, from the earliest measured in 1993 up to day 340 (December 6), have been processed and plotted for representative sites in each of the seven areas (see Appendix B). We began by processing and plotting river data to show the potential driving forces for the Columbia River/aquifer interactions. Then data from selected wells in each area were processed and plotted to demonstrate the relative magnitude of interaction among the wells and between each well and the river. While all of the wells showed long-term change with the river, some wells showed no short-term interaction.

Electrical conductivity and temperature were measured in the river and in some wells. Examples and comparisons of seep conductivity and temperature changes were also prepared.

4.1 Data and Interpretations

River water elevation measurements for 1993 are shown in Figure 2. Note that time is displayed in Figure 2 and subsequent figures as day of year to match the database values. The range of fluctuation in Figure 2 is most notable, with the maximum just above 400 ft and the minimum just above 384 ft at the 100-B river station. The single-day fluctuation at 100-B was about 13 ft. Also notable in Figure 2 is the attenuation of the daily cycle as the water reaches the 300 Area. The cause of fluctuation in the 300 Area river between days 84 and 115 is evidently influenced by something other than the upstream river (e.g., the influences from McNary forebay and Ice Harbor tailwater).

Figure 3 depicts detail more than Figure 2 for four of the five river stations and more clearly displays the dependence of the downstream stations on the upstream water fluctuation. Again, the attenuation is apparent in the 300 Area. Figure 4 shows a still shorter and different interval for all five river stations. The attenuation in the 300 Area appears to be about 60% of the amplitude of the 100-B station, while all of the other stations demonstrate less than 20%. Figure 5 shows a nearly constant flow period for 10 days. However, the 300 Area river shows more than a foot of variation. The cause of this variation is the composite influence of the Ice Harbor Dam and McNary Dam releases. In short, the 300 Area is in the McNary forebay and responds to the releases from the Ice Harbor Dam.

Figure 6 shows the fluctuation of three wells and the river in the 300 Area, with the river data from station SWS-1. As expected, the river fluctuates most, and the well farthest from the river fluctuates least. Notably, the maximum river variation depicted is about 10 ft, whereas the 100-B river fluctuation for the same period was about 15 ft. Figure 7 shows a 3-day interval in which hourly elevations are visible. Clearly, the river appears to drive the variation. Well 2-1 is nearest the river, well 8-1 is farthest from the river, with well 1-2 midway between. It is somewhat surprising that fluctuations in well 2-1 are not larger because the well is within about a hundred feet of the river bank.

Figure 8 shows the 100-F river elevations, with variations from three wells. Measurements started in these wells in late May 1994. There is a clear pattern of related variation among the water levels. Figure 9 shows 10 days of water levels measured hourly. Wells F5-43A and F5-43B differ in that they access different horizons within the aquifer. It is surprising, however, that F5-43B responds to river

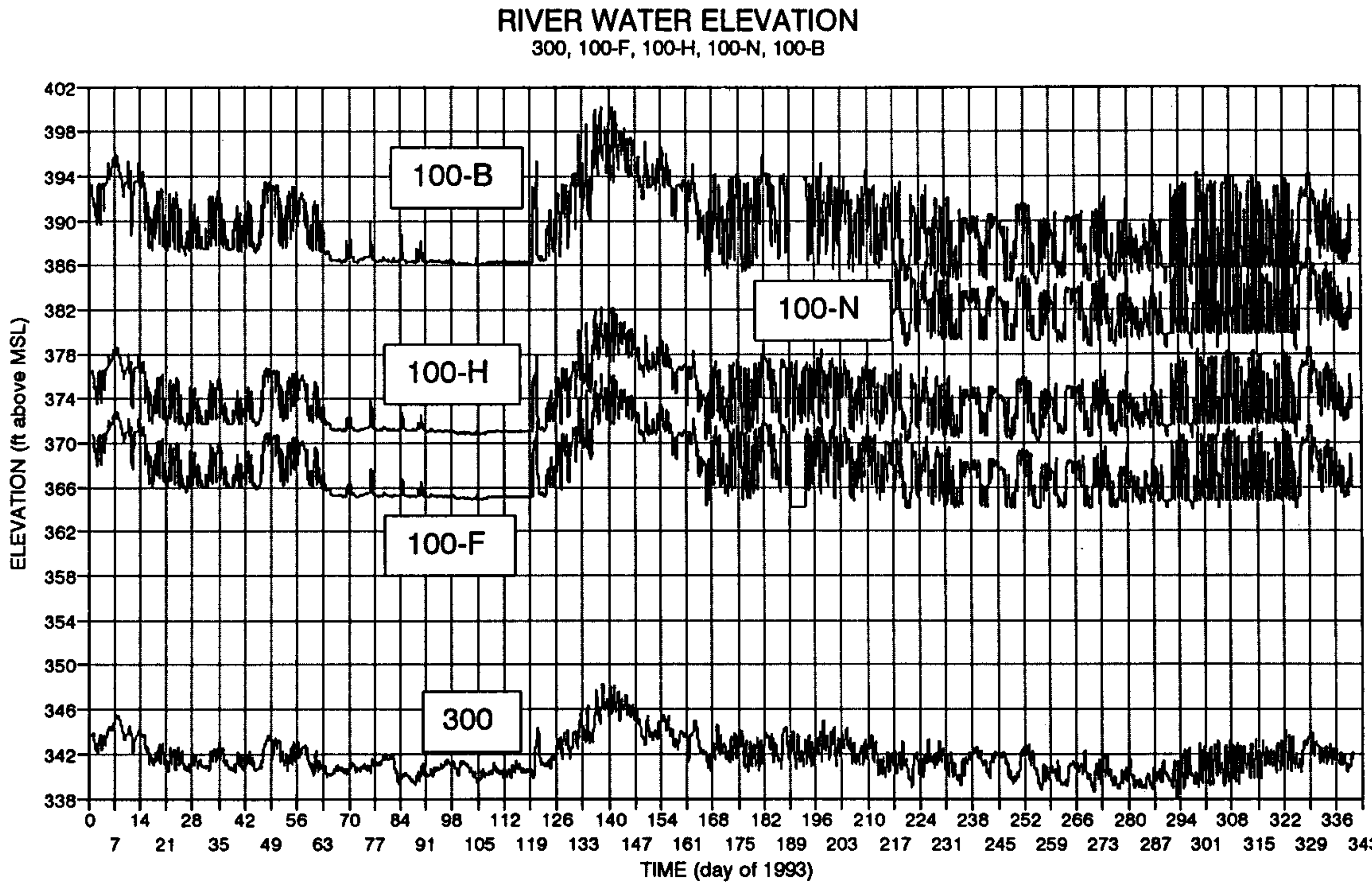

Figure 2. Columbia River Stage at Five Stations

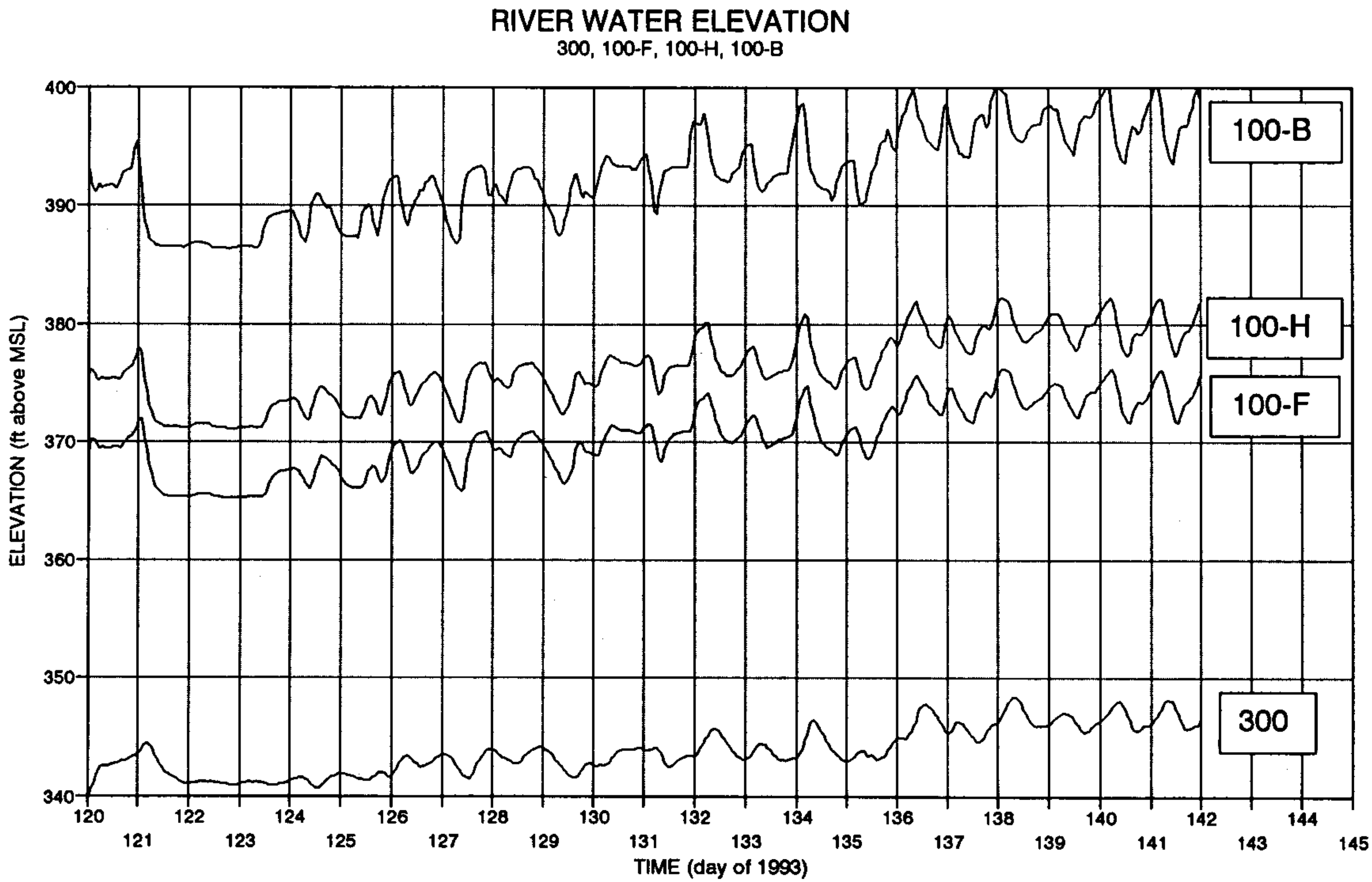

Figure 3. Columbia River Stage at Four Stations for 25 Days

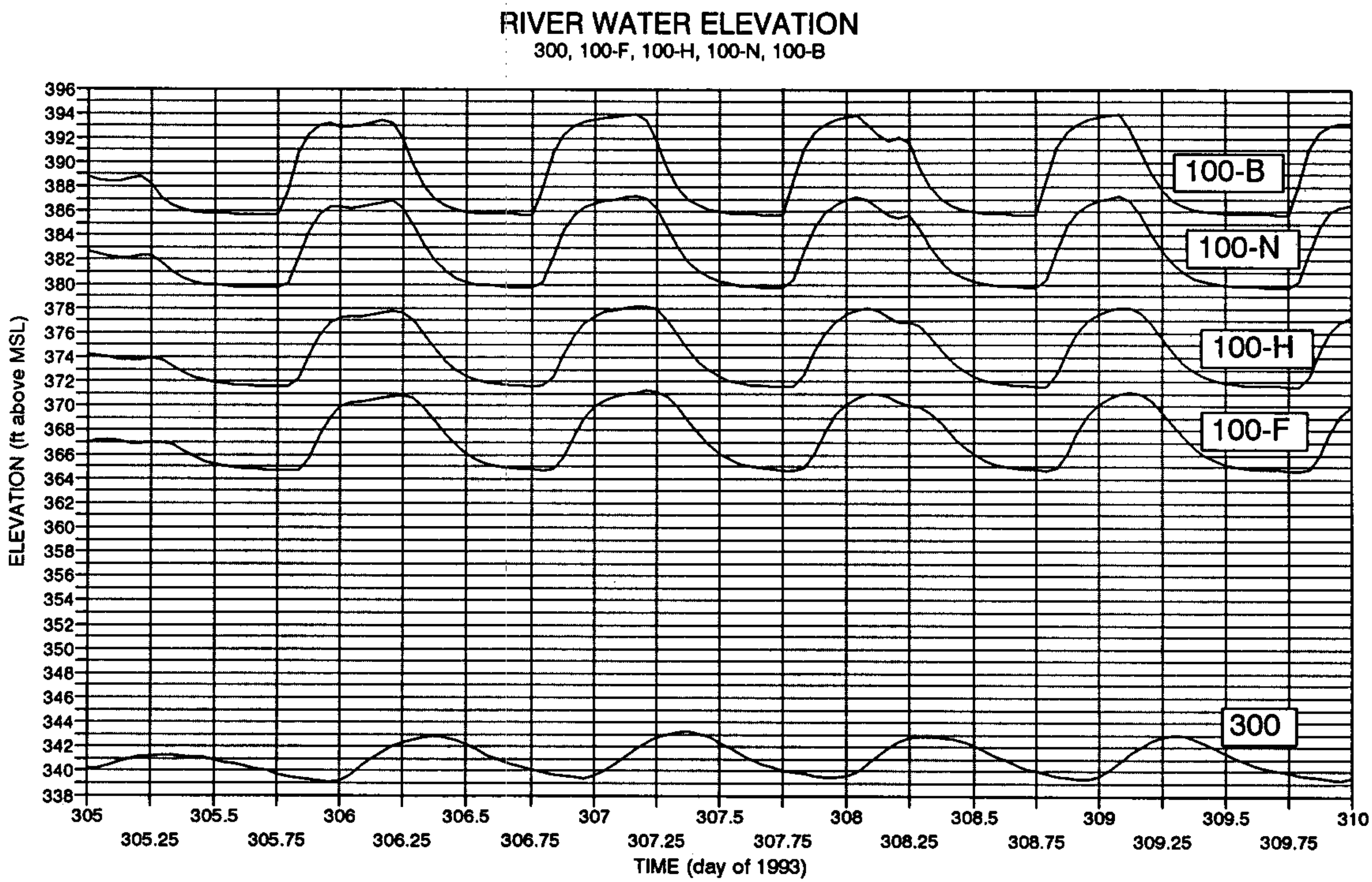

Figure 4. Columbia River Stage at Five Stations for Five Days, Showing Time Lag and Attenuation

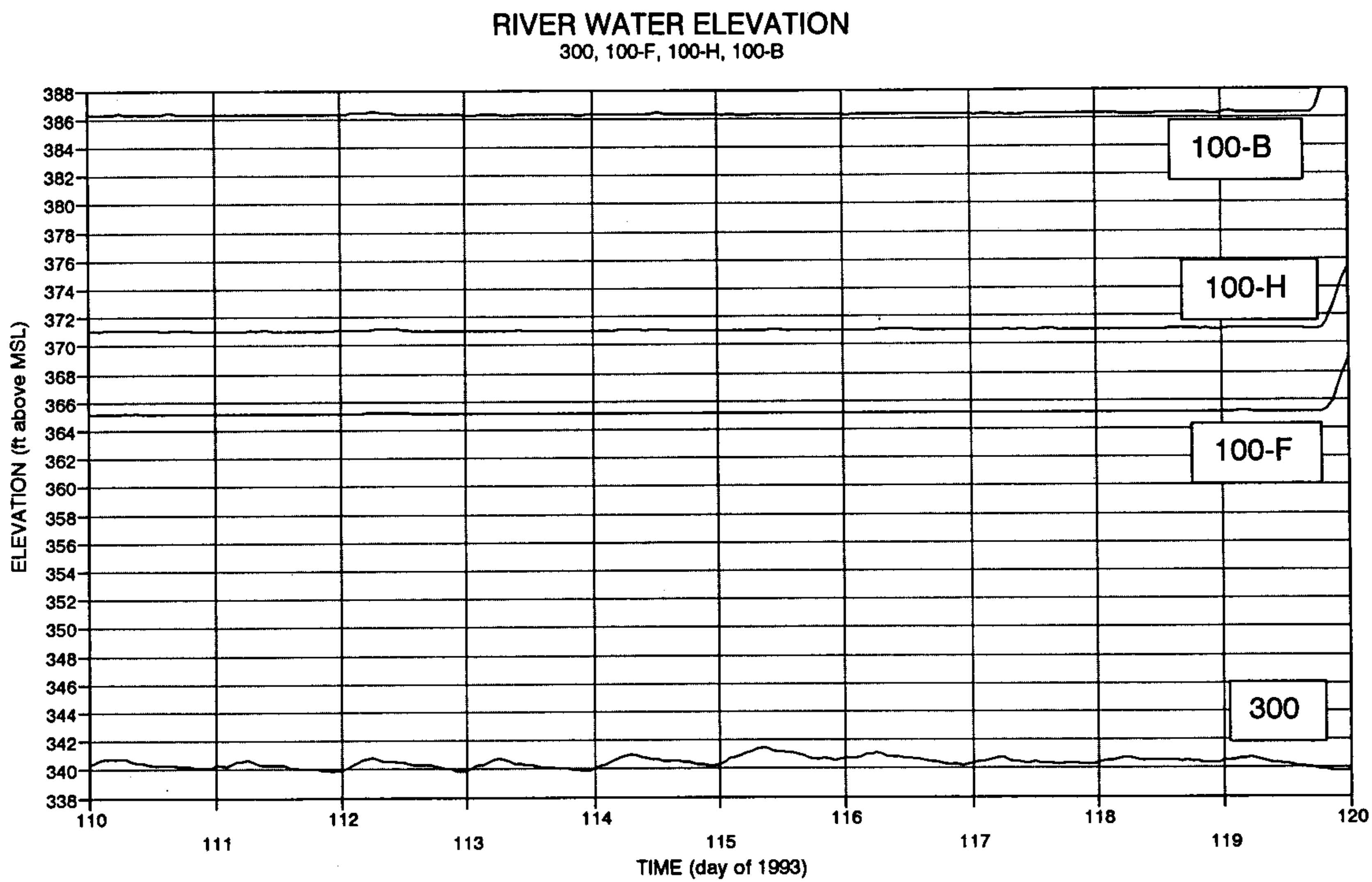

Figure 5. Columbia River Stage at Four Stations During 10 Days of Low Flow

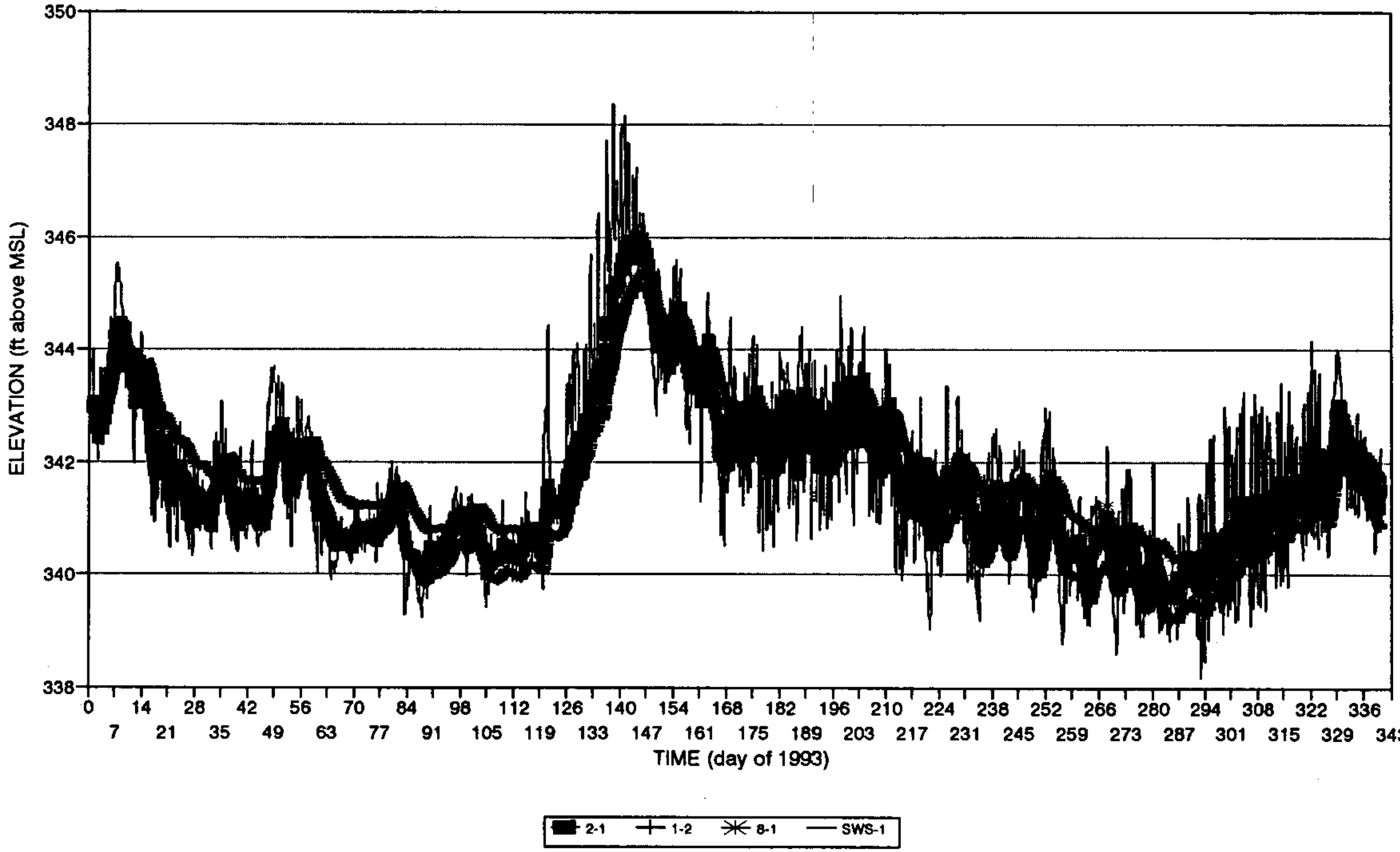

Figure 6. Water Elevations in Three Wells and The River in The 300 Area

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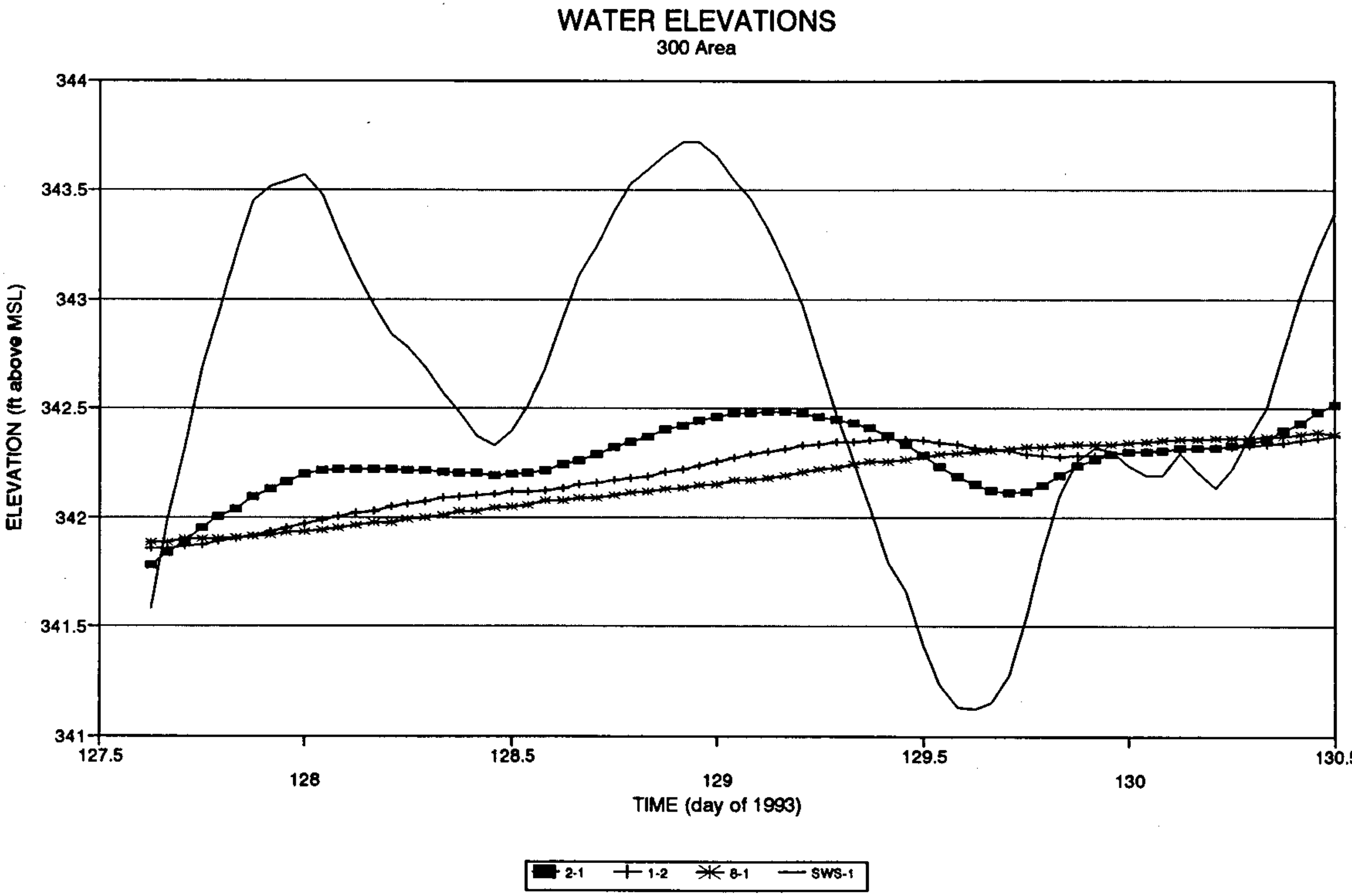

Figure 7. Detailed Variations in Water Elevations in The 300 Area

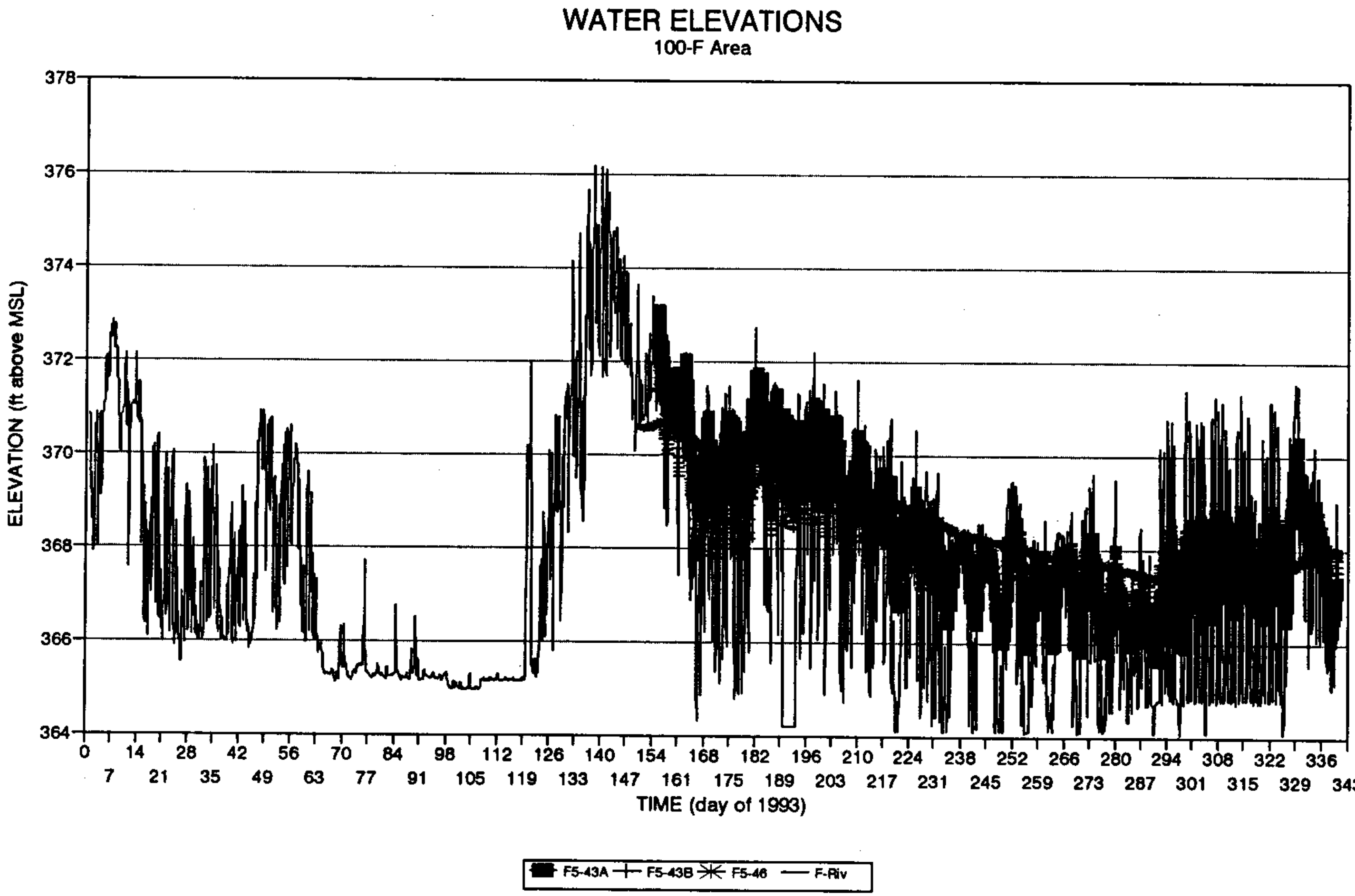

Figure 8. Water Elevations in Three Wells and The River at 100-F Area

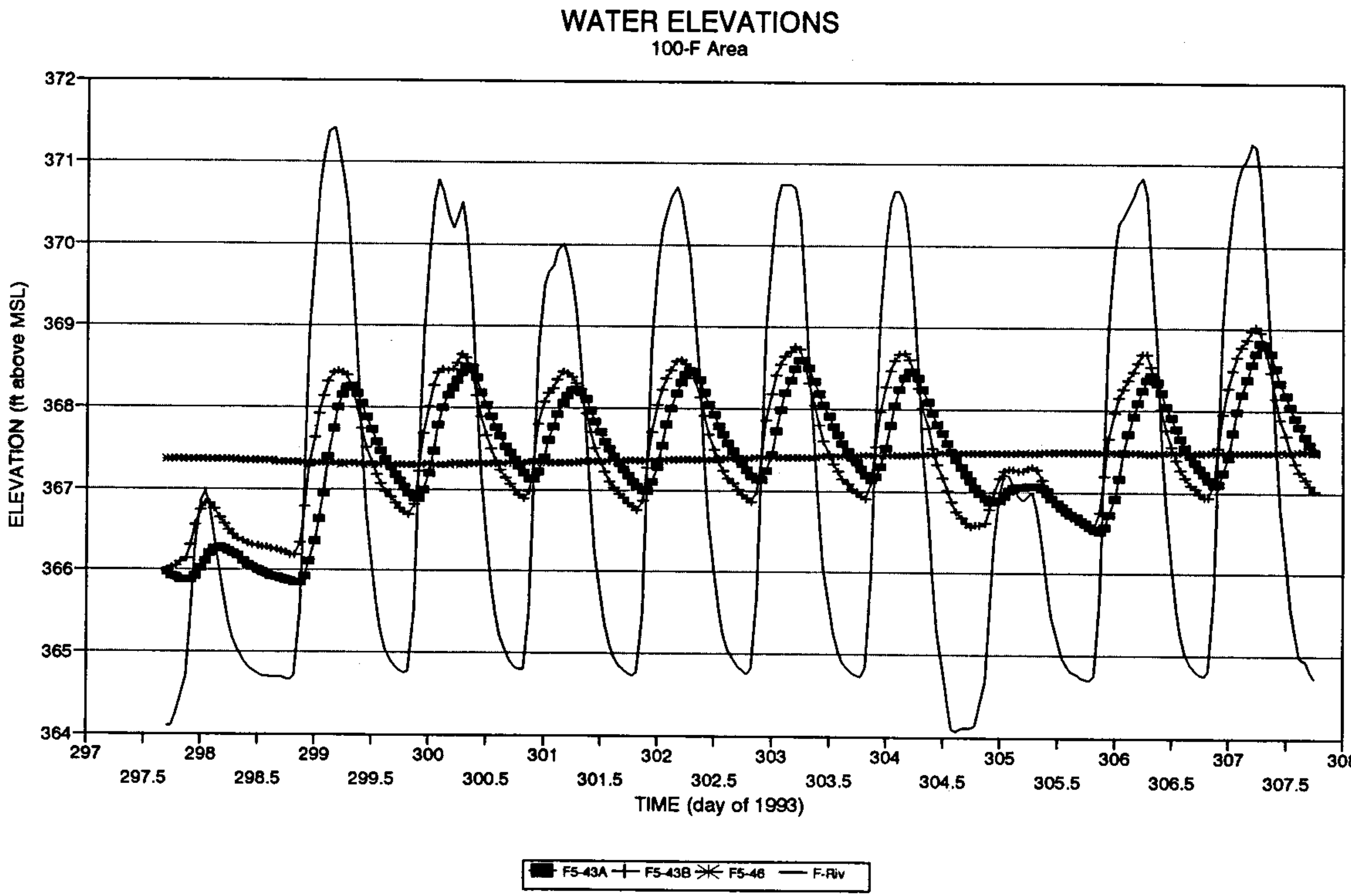

Figure 9. Detailed Variations in Water Elevations in 100-F Area

influence more rapidly and to a greater extent than F5-43A. Evidently, better hydraulic connection to or partial confinement of the lower phreatic aquifer accounts for the observed behavior in the 100-F Area. While there is long-term influence from the river on well F5-46, there appears to be essentially no influence within the 10-day time interval.

Figure 10 shows water elevations from the river and three wells in the 100-H Area. Here again, the river seems to influence all three wells. Well H4-11 is nearest the river and shows the greatest river influence. However, there appears to be an error in surveyed elevations. This appears to be why well H4-11 elevation is consistently higher than the river water elevation. There may, of course, be another cause for this phenomenon. There may be considerable water flow from up gradient toward the river past well H4-11. While this seems unlikely, it could justify the higher elevation observed in well H4-11. Another possibility is that the 100-H river station survey was incorrect. Resurvey revealed that there was an error of 0.45 ft. Also, transducer shift of about 1 ft was logged during tape and datalogger paired tests. The remaining possibility considered was that the top of casing survey for well H4-11 is in error. This has not been resurveyed. Even so, the relation of groundwater elevation to river elevation is unquestionable, in all three wells.

Figure 11 shows a data plot for a 5-day period, with data adjusted to display the relationships between river and groundwater changes. Well H4-11 clearly follows the river, even in fairly minor detail. While wells H3-2A and H3-2C are shown to follow the river in Figure 10, Figure 11 shows very limited response of H3-2C and no response from H3-2A. This also indicates either better hydraulic contact with the river or the existence of a partial confining layer between the upper and lower levels of the aquifer, as was the case in the 100-F area in well F5-43B.

Figure 12 shows a composite of wells in the 100-D and -K Areas with the 100-B river data superimposed. The 100-N river station was not installed until about day 217. Again, there appears to be a long-term trend for most wells to follow river fluctuation, with a greatly attenuated amplitude. Well D5-20 shows significant short-term fluctuation, with only token response from well K32A. Well D5-15 data remains unexplainable, though transducer error was a factor, and the transducer was replaced. Still, well behavior seemed independent of river fluctuation. Figure 13 demonstrates the short-term independence between the 100-D and -K Area wells and the river fluctuation. While Figure 4 showed the common pattern of fluctuation among all four 100-Area river stations, none of the 100-D or -K wells varied with this short-term pattern. Only well D5-20 shows cyclic response as short as 7 days.

Figure 14 shows water elevations in four wells in the 100-B Area, along with that in the river. Water levels in all four wells seem to vary with that in the river. Although all well water levels shown appear to be above the river level, it is helpful to recall from Figure 2 that 100-B river water elevations were more than 400 ft above MSL for a short period preceding the data interval shown. Figure 15 shows how well the well and river water elevations coincide. It would be more comfortable to explain the fluctuations in Figure 15 if well B2-12 were exactly 2 ft lower. However, well B2-12 is right next to well B3-47, and the tops of casings appear to be about the same, which survey has confirmed. Perhaps tape records were in error; but that is unlikely, based on seven separate sets of paired measurements without significant computed error. We would like to adjust the river level up, but the data from well B3-47 confirms a good match between it and the river. The only remaining explanation we have considered is the possibility that well B2-12 is upstream from the river in a close-coupled

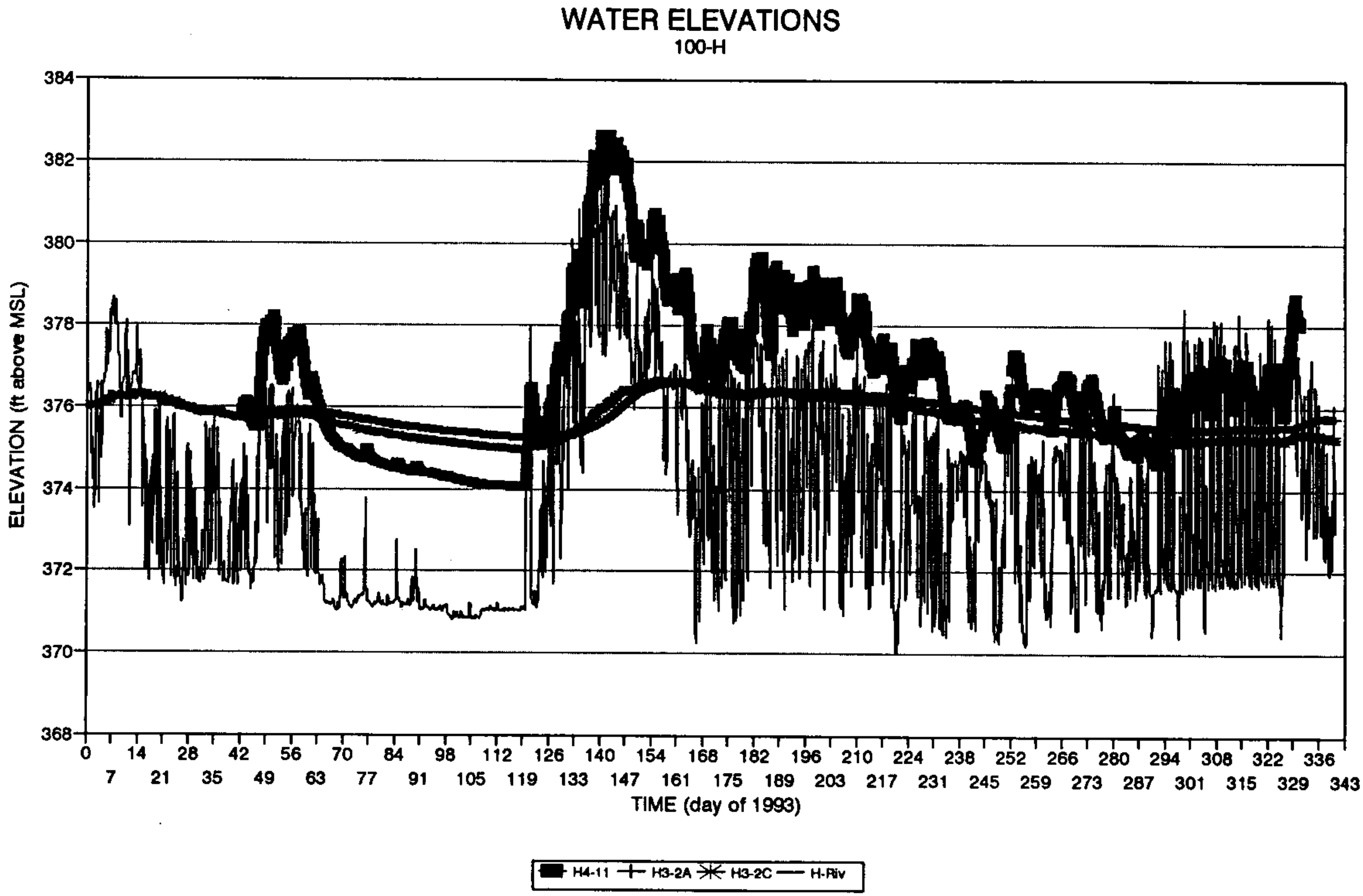

Figure 10. Water Elevations in Three Wells and The River in 100-H Area

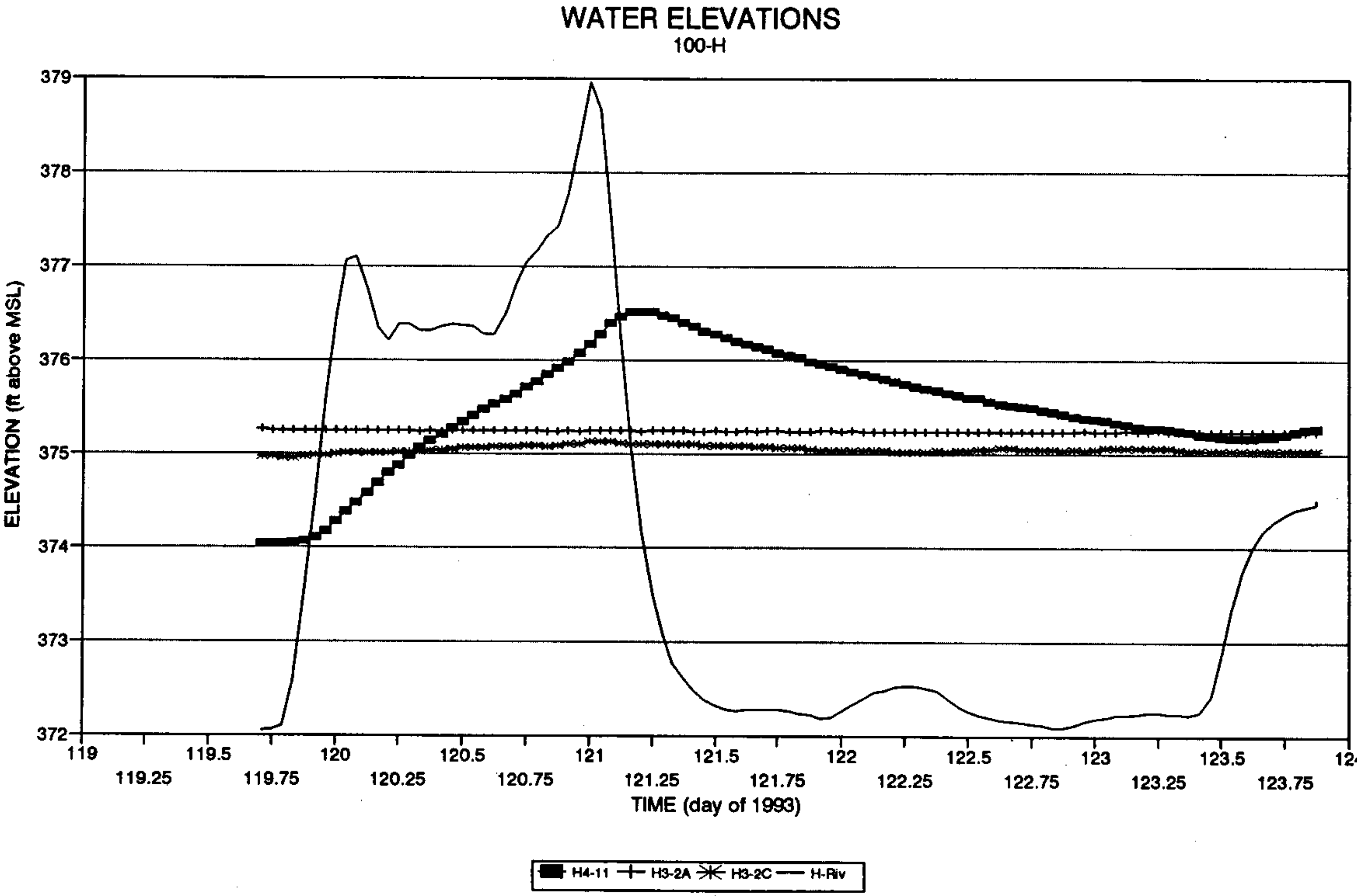

Figure 11. Detailed Variations in Water Elevations in 100-H Area

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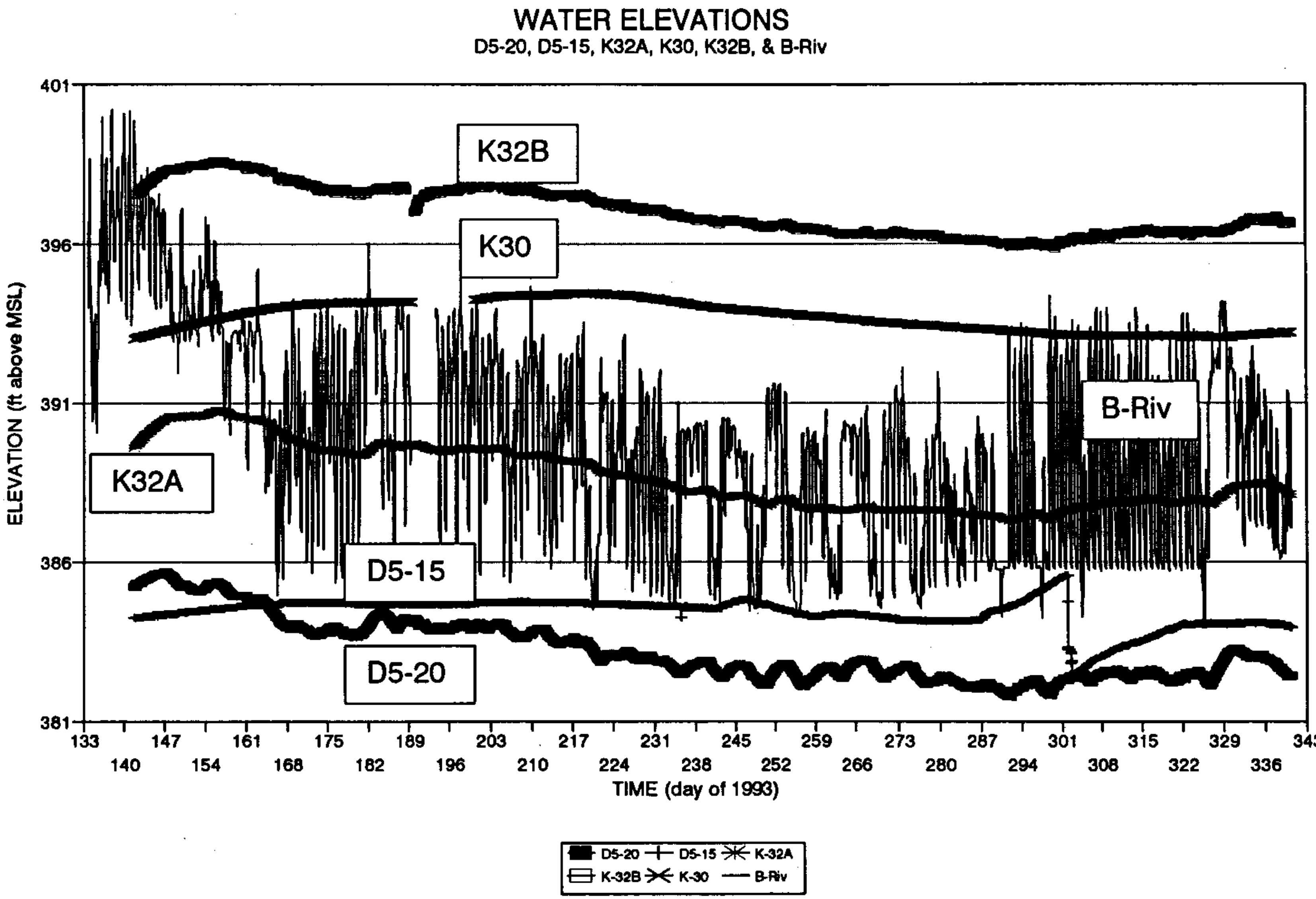

Figure 12. Water Elevations in 100-D and 100-K Wells and The 100-B River

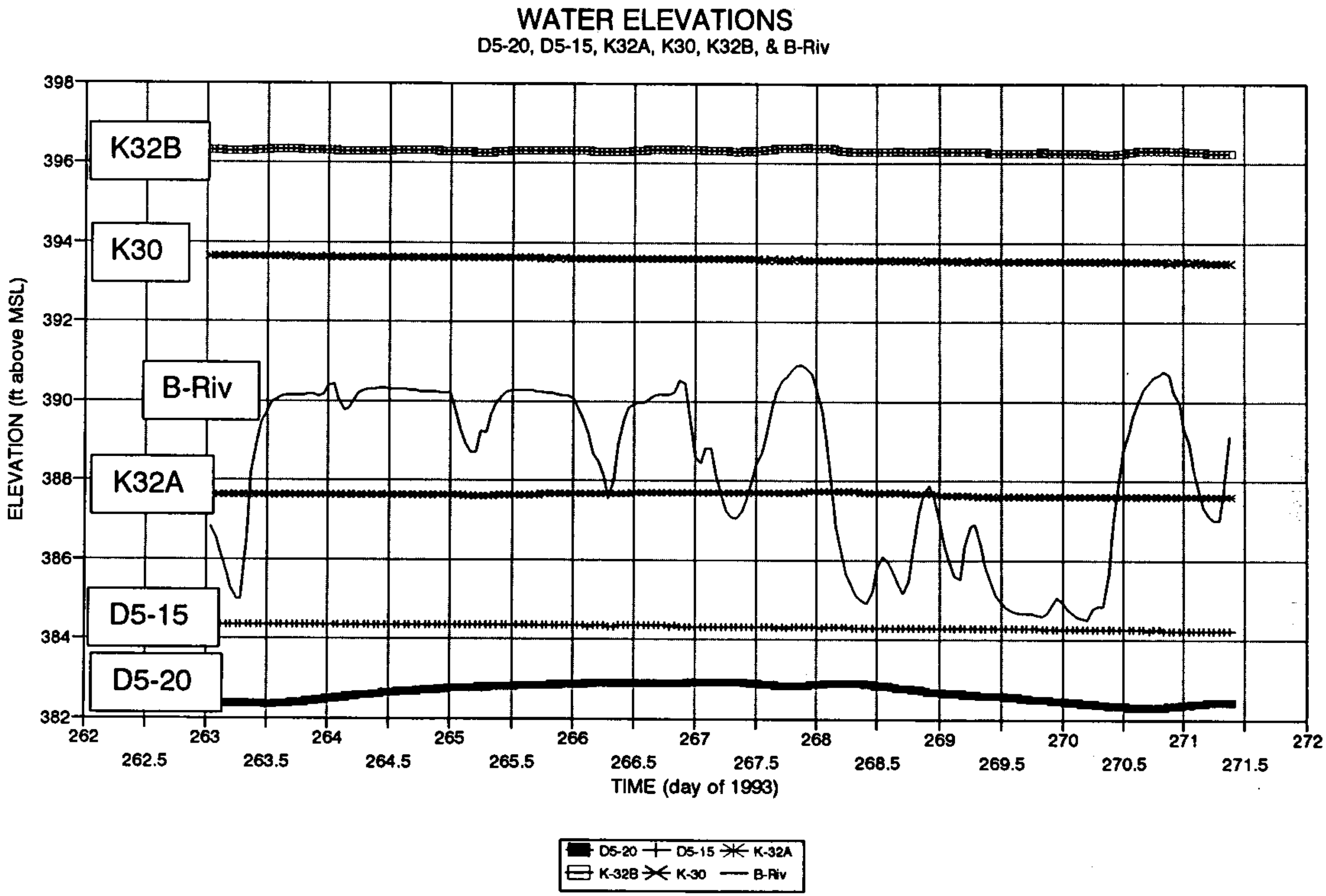

Figure 13. Detailed Variations of 100-D and 100-K Wells and The 100-B River

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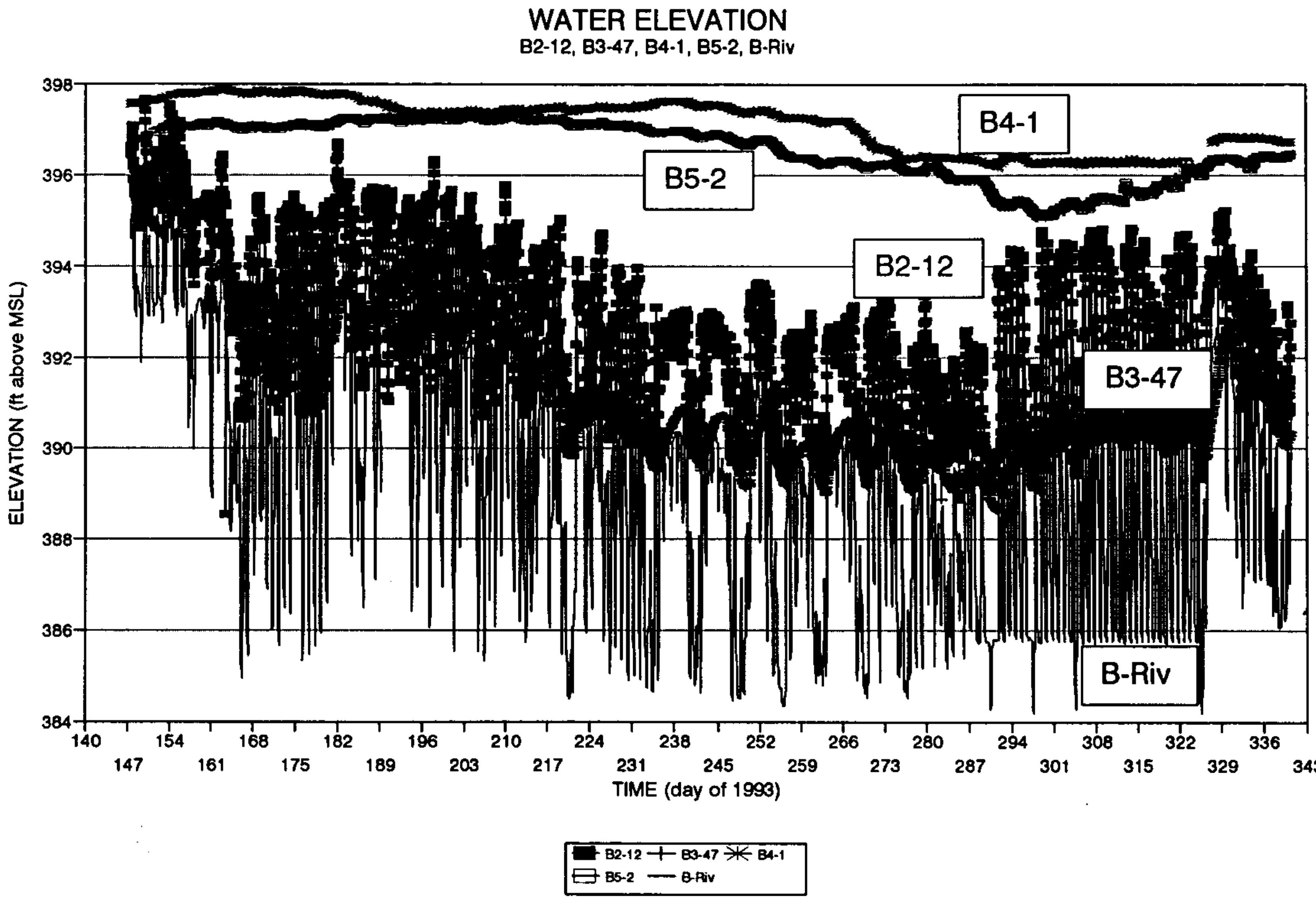

Figure 14. Water Elevations at 100-B Area

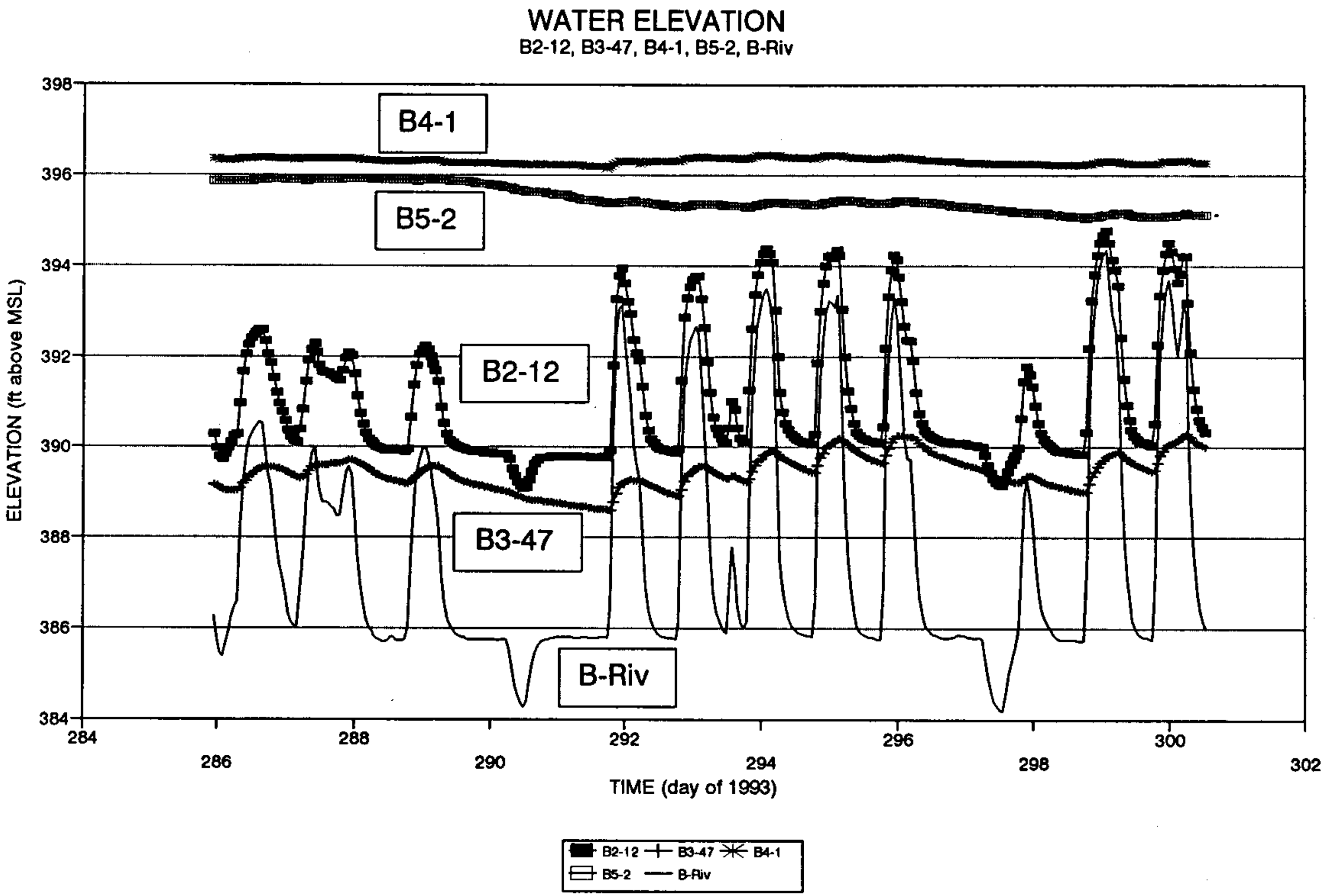

Figure 15. Detailed Variations in Water Elevations in 100-B Area

aquifer channel. This close-couple status is apparent from the detail with which the river level is duplicated in well B2-12. Wells B4-1 and B5-2 are distant from the river and are expected to have slow response, with B4-1 being the more distant.

Electrical conductivity (EC) was measured in the 100-H Area by sensors located in the river, well H4-11, and two nearby river-bank seeps, S-152-2 and S-153-1. Figure 16 shows well H4-11 EC as relatively constant at 0.35 mS. The river EC is even more constant at about 0.1 mS. While neither of these values is temperature compensated during the interval shown, their relative magnitude remains unaltered after compensation. Temperature compensation and individual calibration followed this interval when the transducer had to be replaced because a porcupine destroyed it. The EC at seep S-153-1 varied from the river value up toward the well value when the river flow dropped below the elevation of the seep, only to decline again as the river water covered the transducer. Just after day 180, the transducer reading dropped to zero for several hours. The same phenomenon occurred on day 184 and again about day 186. This drop to zero was caused by a reduction in bank storage and failure of the seep to yield drainage water. It is likely that the seep EC never would rise to the level of well H4-11 because bank storage represents a zone of river intrusion and influence. The evidence for this conclusion is shown at about day 172, where the river is not directly influencing the conductivity of the seep and yet the seep EC does not rise. On the other hand, well H4-11 clearly shows the influence of intruding river water, especially when the river level fluctuates strongly above the 375-ft elevation.

Figure 17 shows temperature compensated EC for the stations displayed in Figure 16 and for seep S-152-2 at the outfall. Here, the seep EC does exceed that of well H4-11 for a short interval when the river drops below the 375-ft elevation. Again, seep S-153-1 ran low on water when the river dropped below the 375-ft elevation. At no time did seep S-152-2 appear dry. Instead, it seeped up through the cracks in the concrete outfall apron and formed a significant stream that flowed off the apron and into the river.

Figure 18 shows some water temperatures measured by the EC probes. The large fluctuations near day 182 resulted from drying of the seep, leaving the transducer exposed to the atmosphere. The low temperatures shown near day 325 also represent periods of transducer exposure to air because of seep dry-down. The temperature in well H4-11 remained nearly constant near 20°C, while the river varied from about 4 to 22°C. With these relative temperatures, river water would be expected to intrude beneath the groundwater during cold periods and over the top during warm periods. It would be useful to find a long, screened section of well near the river where EC could be measured to distinguish river water intrusion level.

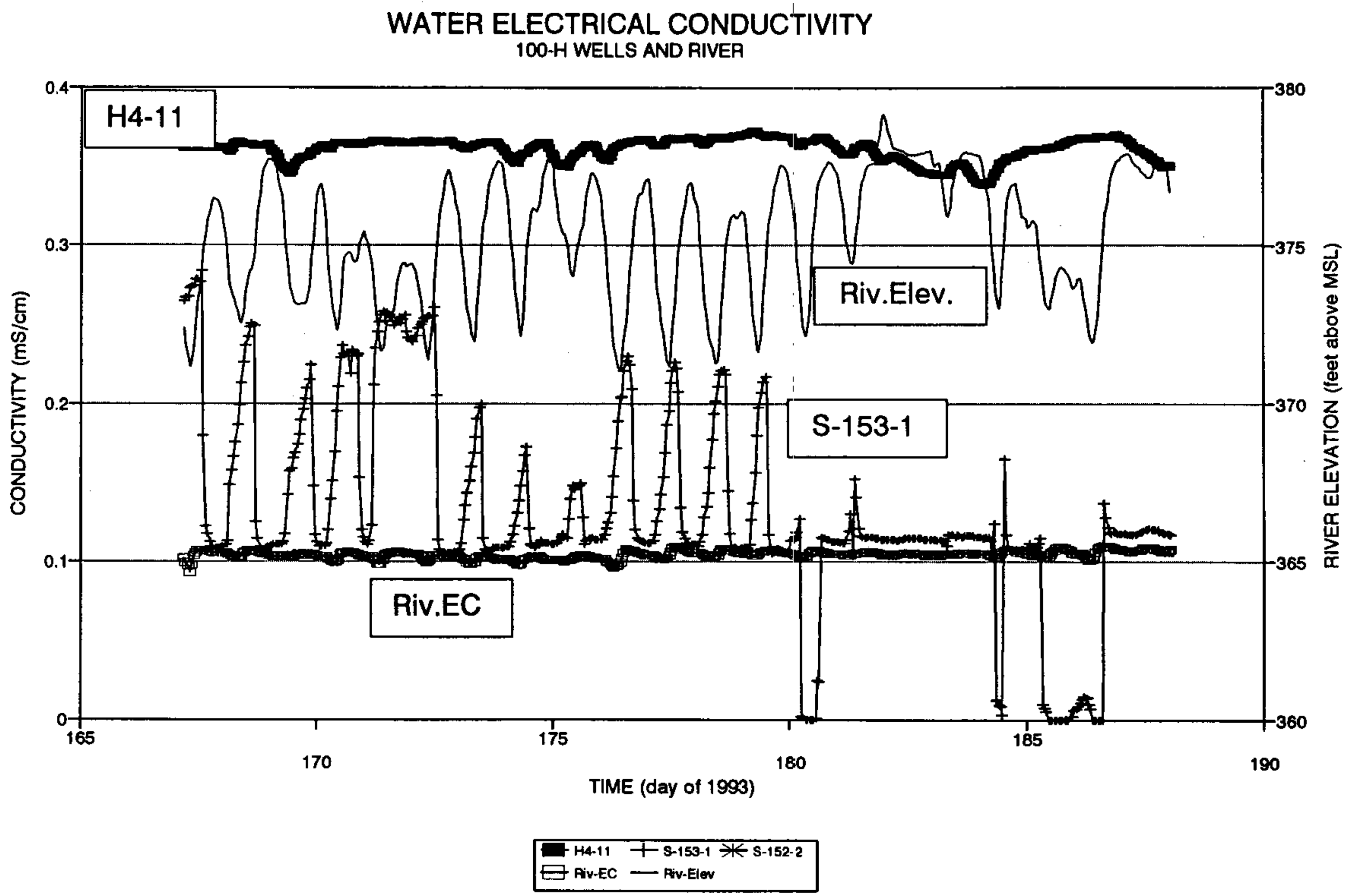

Figure 16. Electrical Conductivity of 100-H Seeps, Well, and River

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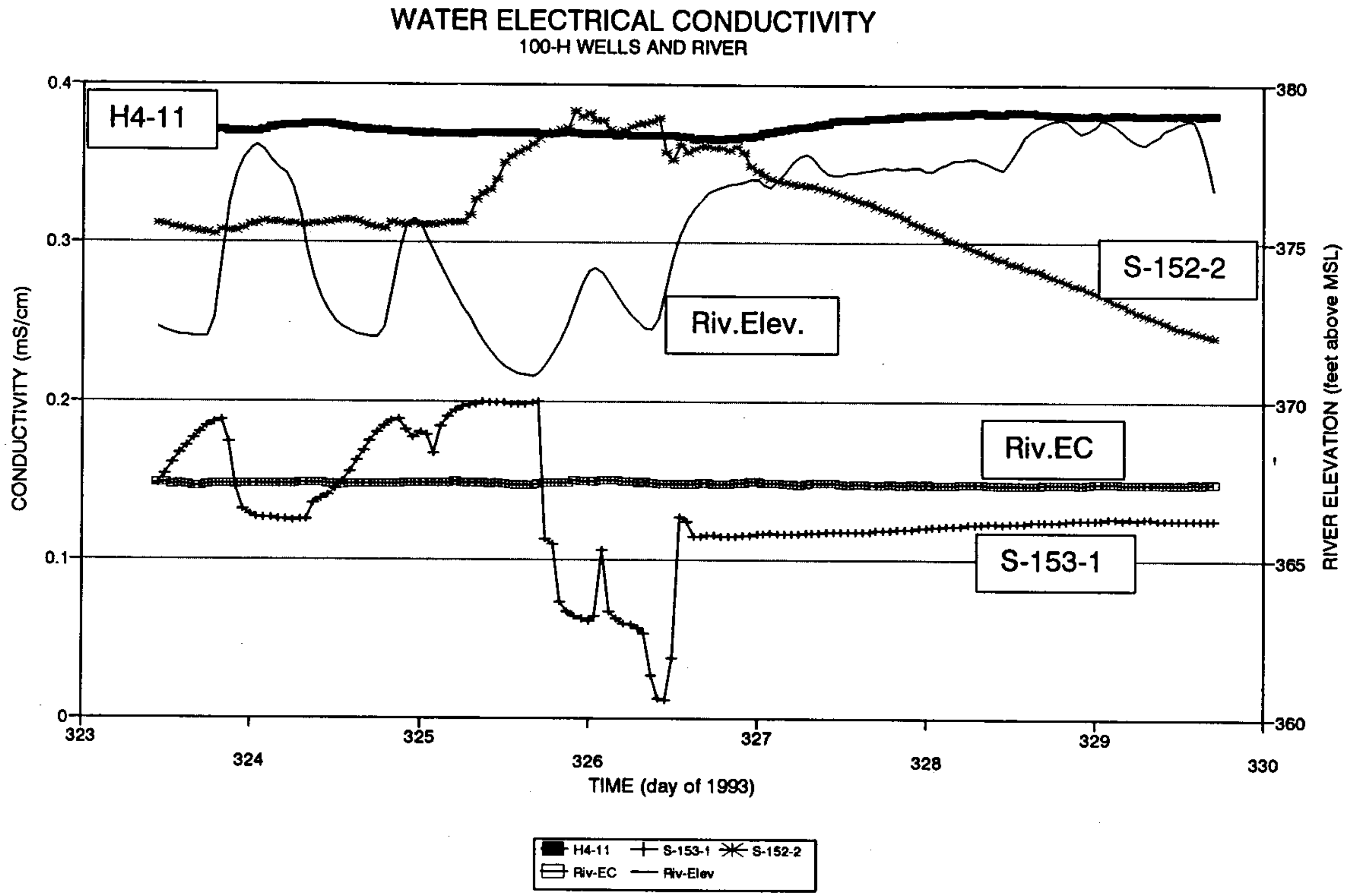

Figure 17. Detailed Variation of Electrical Conductivity at 100-H Area

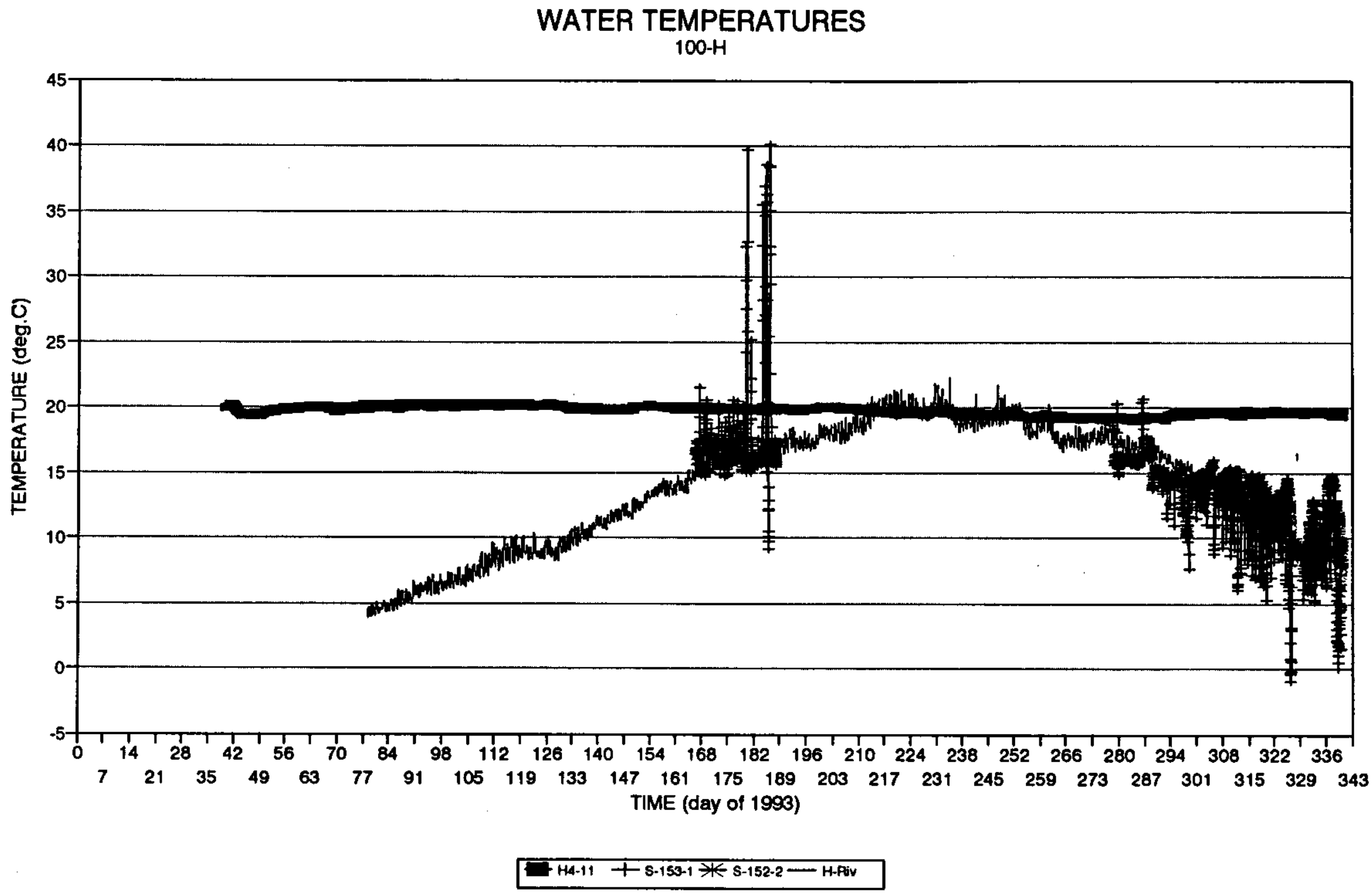

Figure 18. Thermal Variations of River and Groundwater at 100-H Area

4.2 Conclusions

Emphasis and equipment shifted from the 300-FF-5 Operable Unit to the 100 Aggregate Area Operable Unit during spring 1993. Monitors removed from the 300 Area were installed in 100-D, -N, and -K Areas and added to the number in the -F, -H, and -B Areas. Eleven wells and one river station are still monitored in the 300-FF-5 boundary while the others were spread about evenly among the 100 Areas. The monitor network currently consists of 44 radiotransceivers and 42 automatic dataloggers, with one station in each area, except 100-N, serving two wells.

Electrical conductivity and temperature, measured at well, seep, and river locations, showed the influence of intruding river water in both seep and well water. Measurement frequency remained at 1-hr intervals.

Elevation accuracy is believed to be within ±0.1 ft. Topographic surveys, instrument calibrations, and steel tape measurements all contribute error. Short-term network precision appeared to be within ±0.02 ft. Steel tape measurements were read within ±0.01 ft. Survey error varied with distance from the reference, but was probably less than ±0.07 ft. Periodic tape and datalogger tests helped ensure precision and accuracy by including the entire measurement system in the tests. Accuracy of survey errors or ground shift approached 0.5 ft at SWS-1 and 100-H river stations.

Examples of conductivity, temperature, and water levels were presented for each area monitored. River water levels at all five river stations were shown to fluctuate together, with a phase shift and amplitude change to adjust for river mile and channel cross section. Only in the 300 Area was the river amplitude attenuated significantly because of the McNary Dam forebay. Ice Harbor influence on the water level in the 300 Area is apparent when water elevations drop to 340 ft above MSL.

Some equipment problems were reported, such as transducer drift and battery discharge. Transducer drift was resolved by replacement or compensated by periodic manual measurements using steel tape coupled with datalogger readings. Questionable data were tested by comparison with similar stations. For example, 100-H and 100-F river stations were compared by subtracting the mean and dividing by the standard deviation. This normalized the data about a common zero. It did not correct for data divergence due to time lag. Where data drift was apparent, linear adjustment was used from the last known correct point to the measured divergent point. Long-term drift of transducers was accommodated in this manner. Key factors in data reliability were in situ calibration of pressure transducers, periodic steel tape and datalogger paired readings, difference tests of data, and visual data checking. Solar radiation at Hanford was inadequate to recharge batteries during November, December, and January. Experience demonstrated the necessity to use batteries with at least 40-Ah capacity to operate the network remote stations reliably during this period.

Water levels, temperatures, and electrical conductivity measured by the automatic monitor network provide an initial database with which to calibrate models and from which to infer ground and river water interactions for site characterization and remediation activities.

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Appendix A

Datalogger Programs

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Appendix A

Datalogger Programs

Several datalogger programs were used to gather the required data. Each program combination is shown separately for reference. All programs begin with instructions to measure battery voltage and store it for display. Also, an instruction is included to measure with high resolution.

The widest use was made of the program to measure pressure. This program appears first. The second program adds thermocouple temperature to pressure. The third program replaces thermocouple temperature with a combination of solution electrical conductivity (EC) and temperature. The fourth program is for EC and temperature.

Pressure Measurement Only

```
Program:

*      1        Table 1 Programs
  01: 3600      Sec. Execution Interval

01:  P78        Resolution
  01: 1         High Resolution

02:  P10        Battery Voltage
  01: 5         Loc :

03:  P9         Full BR w/Compensation
  01: 1         Rep
  02: 25        2500 mV 60 Hz rejection EX Range
  03: 24        250 mV 60 Hz rejection BR Range
  04: 1         IN Chan
  05: 1         Excite all reps w/EXchan 1
  06: 2500      mV Excitation
  07: 1         Loc :
  08: 1         Mult
  09: 0         Offset

04:  P86        Do
  01: 10        Set high Flag 0 (output)

05:  P77        Real Time
  01: 110       Day,Hour-Minute

06:  P70        Sample
  01: 1         Reps
  02: 1         Loc

07:  P          End Table 1
```

Pressure and Thermocouple Temperature Measurement

```
Program: mc112

*      1       Table 1 Programs
  01: 3600     Sec. Execution Interval

01:   P10      Battery Voltage
  01: 5        Loc :

02:   P78      Resolution
  01: 1        High Resolution

03:   P9       Full BR w/Compensation
  01: 1        Rep
  02: 25       2500 mV 60 Hz rejection EX Range
  03: 24       250 mV 60 Hz rejection BR Range
  04: 1        IN Chan
  05: 1        Excite all reps w/EXchan 1
  06: 2500     mV Excitation
  07: 1        Loc :
  08: 1        Mult
  09: 0        Offset

04:   P86      Do
  01: 10       Set high Flag 0 (output)

05:   P77      Real Time
  01: 110      Day,Hour-Minute

06:   P70      Sample
  01: 1        Reps
  02: 1        Loc

07:   P17      Module Temperature
  01: 2        Loc :

08:   P14      Thermocouple Temp (DIFF)
  01: 1        Rep
  02: 21       2.5 mV 60 Hz rejection Range
  03: 3        IN Chan
  04: 1        Type T (Copper-Constantan)
  05: 2        Ref Temp Loc
  06: 3        Loc :
  07: 1.8      Mult
  08: 32       Offset

09:   P86      Do
  01: 10       Set high Flag 0 (output)

10:   P70      Sample
  01: 1        Reps
  02: 3        Loc

11:   P        End Table 1
```

```
Program:  mc125

*      1         Table 1 Programs
  01: 3600       Sec. Execution Interval

01:  P10         Battery Voltage
  01: 5          Loc :

02:  P78         Resolution
  01: 1          High Resolution

03:  P9          Full BR w/Compensation
  01: 1          Rep
  02: 25         2500 mV 60 Hz rejection EX Range
  03: 24         250 mV 60 Hz rejection BR Range
  04: 1          IN Chan
  05: 1          Excite all reps w/EXchan 1
  06: 1000       mV Excitation
  07: 1          Loc :
  08: 1          Mult
  09: 0          Offset

04:  P86         Do
  01: 10         Set high Flag 0 (output)

05:  P77         Real Time
  01: 110        Day,Hour-Minute

06:  P70         Sample
  01: 1          Reps
  02: 1          Loc

07:  P5          AC Half Bridge
  01: 1          Rep
  02: 15         2500 mV fast Range
  03: 11         IN Chan
  04: 2          Excite all reps w/EXchan 2
  05: 2500       mV Excitation
  06: 6          Loc :
  07: 1          Mult
  08: 0          Offset

08:  P59         BR Transform Rf[X/(1-X)]
  01: 1          Rep
  02: 6          Loc :
  03: .7042      Multiplier (Rf)

09:  P42         Z=1/X
  01: 6          X Loc
  02: 6          Z Loc :
```

```
Page 2   Table 1

10:  P11        Temp 107 Probe
  01: 1         Rep
  02: 12        IN Chan
  03: 3         Excite all reps w/EXchan 3
  04: 7         Loc :
  05: 1         Mult
  06: 0         Offset

11:  P34        Z=X+F
  01: 7         X Loc
  02: -25       F
  03: 8         Z Loc :

12:  P37        Z=X*F
  01: 8         X Loc
  02: .01       F
  03: 8         Z Loc :

13:  P55        Polynomial
  01: 1         Rep
  02: 8         X Loc
  03: 9         F(X) Loc :
  04: 1         C0
  05: -2.021    C1
  06: 4.0445    C2
  07: -6.3483   C3
  08: 0         C4
  09: 0         C5

14:  P36        Z=X*Y
  01: 6         X Loc
  02: 9         Y Loc
  03: 10        Z Loc :

15:  P86        Do
  01: 10        Set high Flag 0 (output)

16:  P70        Sample
  01: 1         Reps
  02: 10        Loc

17:  P70        Sample
  01: 1         Reps
  02: 7         Loc

18:  P          End Table 1
```

Electrical Conductivity and Temperature Measurements Only

```
Program: mc139

*      1        Table 1 Programs
  01: 3600      Sec. Execution Interval

01:  P10        Battery Voltage
  01: 5         Loc :

02:  P78        Resolution
  01: 1         High Resolution

03:  P5         AC Half Bridge
  01: 1         Rep
  02: 15        2500 mV fast Range
  03: 11        IN Chan
  04: 2         Excite all reps w/EXchan 2
  05: 2500      mV Excitation
  06: 6         Loc :
  07: 1         Mult
  08: 0         Offset

04:  P59        BR Transform Rf[X/(1-X)]
  01: 1         Rep
  02: 6         Loc :
  03: .7148     Multiplier (Rf)

05:  P42        Z=1/X
  01: 6         X Loc
  02: 6         Z Loc :

06:  P11        Temp 107 Probe
  01: 1         Rep
  02: 12        IN Chan
  03: 3         Excite all reps w/EXchan 3
  04: 7         Loc :
  05: 1         Mult
  06: 0         Offset

07:  P34        Z=X+F
  01: 7         X Loc
  02: -25       F
  03: 8         Z Loc :

08:  P37        Z=X*F
  01: 8         X Loc
  02: .01       F
  03: 8         Z Loc :
```

Electrical Conductivity and Temperature Measurements Only (contd)

```
Page 2   Table 1

09:  P55         Polynomial
  01: 1          Rep
  02: 8          X Loc
  03: 9          F(X) Loc :
  04: 1          C0
  05: -2.021     C1
  06: 4.0445     C2
  07: -6.3483    C3
  08: 0          C4
  09: 0          C5

10:  P36         Z=X*Y
  01: 6          X Loc
  02: 9          Y Loc
  03: 10         Z Loc :

11:  P86         Do
  01: 10         Set high Flag 0 (output)

12:  P77         Real Time
  01: 110        Day,Hour-Minute

13:  P70         Sample
  01: 1          Reps
  02: 10         Loc

14:  P70         Sample
  01: 1          Reps
  02: 7          Loc

15:  P           End Table 1
```

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Appendix B

Steel Tape and Datalogger Paired Sets

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Appendix B

Steel Tape and Datalogger Paired Sets

Appendix B shows steel tape and datalogger paired sets that were used as data quality checks on the monitor system. Data from the initial sets in 1991 through December 1993 are included.

Tape and Datalogger Reading Pairs

Composite File: 91-3T&DLWQ1
Main T&DL file (77 SITES)
from start to end of '93
Tape and Datalogger readings

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
SWS-1				
11-15-91	1020	343.42	10.9960	0.00
12-5-91	1441	341.35	8.6580	-0.11
12-13-91	1217	341.62	9.3522	0.26
	1354	341.89	7.7273	Adj.
1-24-92	1443	341.43	7.2292	-0.01
2-5-92	1243	341.30	7.0972	0.00
3-5-92	1422	341.30	7.0906	-0.01
4-8-92	738	342.65	8.5316	-0.01
5-5-92	1115	342.8	8.7018	0.00
6-2-92	1116	343.52	9.4853	0.01
6-30-92	1046	343.32	9.2495	-0.01
8-7-92	811	341.50	7.1636	-0.14
9-9-92	1249	341.53	7.1981	-0.13
10-8-92	819	341.25	6.898	-0.14
11-10-92	855	343.72	8.5221	-1.09
12-8-92	1001	344.05	9.9512	-0.08
1-7-93	939	344.18	11.185	0.94
1-15-93	1615	342.33	8.0788	-0.11
2-9-93	920	341.2	7.0989	0.10
3-9-93	853	340.41	6.0137	-0.12
4-6-93	750	341	6.6296	-0.14
6-8-93	753	341.61	7.3075	-0.11
7-9-93	1332	340.6	6.2163	-0.12
8-2-93	752	341.6	7.1961	-0.21
9-14-93	924	340	5.7076	0.00
10-15-93	655	340.65	5.9852	-0.39
11-19-93	1444	340.90	6.6694	0.00
12-21-93	1535	342.00	7.7537	-0.09
1A				
12-9-91	1300	38.65	1.9362	0.18
1-9-92*	1320	37.22	3.8282	-0.15
2-5-92	1517	38.66	2.1188	-0.00
3-5-92	1029	38.39	2.4014	0.00
4-8-92	648	37.95	2.8945	-0.01
5-5-92	1428	37.46	3.4066	0.00
6-2-92	1250	36.99	3.9249	-0.01
6-30-92*	1231	36.82	3.8166	0.26
7-8-92*	928	39.47	1.1292	0.00
8-6-92*	932	38.99	1.5066	0.13
9-9-92	549	39.09	20.7060	bad xd
9-17-92	907	38.44	4.9407	0.00
10-8-92	635	38.81	4.5293	0.01
11-10-92	1052	38.54	4.8137	0.02
12-9-92	921	36.82	6.6863	-0.00
1-7-93	1102	35.66	7.9377	-0.01
2-9-93	744	38.79	4.4922	0.07
3-9-93	730	39.5	3.75	0.05
1B				
12-9-91	1301	38.82	2.5376	0.16
1-9-92*	1320	37.10	4.4456	0.11
2-5-92	1517	38.78	2.7406	0.02
3-5-92	1029	38.51	3.0164	0.03
4-8-92	648	38.08	3.4994	0.01
5-5-92	1428	37.61	4.0152	0.00
6-2-92	1250	37.13	4.5299	0.00
6-30-92*	1231	36.95	4.7245	0.00
8-6-92	932	39.14	2.7351	-0.34
9-9-92*	549	39.22	2.7215	-0.41
10-8-92	635	38.90	2.5548	0.07
11-10-9	1052	38.67	2.6395	0.22
12-9-92	921	36.95	4.4587	0.25
1-7-93	1102	35.81	5.7021	0.23
2-9-93	744	38.95	2.2828	0.27
3-9-93	730	39.62	1.5474	0.29

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
1C				
12-9-91	1302	4.57	3.4048	0.17
1-9-92*	1320	4.26	3.8340	0.08
2-5-92	1517	4.32	3.8317	0.02
3-5-92	1029	4.11	4.0620	0.02
4-8-92	648	3.70	4.4928	0.03
5-5-92	1428	3.45	4.7916	0.00
6-2-92	1250	3.64	4.5748	0.01
6-30-92*	1001	3.15	5.1139	0.00
8-6-92	932	2.22	6.1151	-0.00
9-9-92	549	2.45	5.8647	0.00
10-8-92	635	2.97	5.3095	-0.00
11-10-92	1052	3.07	5.1405	0.06
12-9-92	921	2.86	5.3658	0.06
1-7-93	1102	2.19	6.0879	0.05
2-9-93	744	2.7	5.5669	0.03
3-9-93	730	3.13	5.0756	0.06
1-1				
1-29-92	917	34.33	4.4550	-0.07
2-5-92	1137	34.85	3.9525	-0.12
3-5-92	1408	34.49	4.3510	-0.13
4-8-92	804	34.28	4.5720	-0.13
5-6-92	736	33.39	5.3894	0.00
6-3-92	724	32.98	5.8256	0.00
7-2-92	711	33.22	5.5568	0.01
8-7-92	739	34.97	3.6517	0.04
9-9-92	810	35.43	3.4042	-0.19
10-8-92	808	35.29	3.6406	-0.27
11-10-92	840	35.14	3.8468	-0.32
12-8-92	945	33.12	6.0288	-0.32
1-7-93	925	32.32	6.8431	-0.28
2-9-93	908	35.19	3.7187	-0.25
3-9-93	838	35.92	2.9122	-0.23
4-6-93	736	35.89	2.9477	-0.23
5-6-93	735	34.96	3.4164	0.26
6-8-93	735	33.13	5.7829	-0.11
7-9-93	802	33.56	5.3809	-0.16
8-2-93	722	34.83	4.0374	-0.18
9-14-93	852	36.05	2.7198	-0.18
10-15-93	638	36.52	2.2351	-0.20
11-19-93	1418	34.81	4.0753	-0.20
12-21-93	1519	34.56	4.3911	-0.24
1-2				(ft)
5-1-92	1130	44.42	4.7465	0.03
5-6-92	806	44.12	5.0986	0.00
6-3-92	736	43.57	5.7202	-0.03
7-2-92	726	43.44	5.8715	-0.05
8-7-92*	658	45.3	3.6305	0.20
9-9-92	732	46.04	3.0394	0.02
10-8-92	737	45.82	3.2789	0.01
11-10-9	802	45.73	3.3457	0.04
12-8-92	859	43.86	5.8361	-0.43
1-7-93	849	43.18	6.7032	-0.57
2-9-93	822	45.75	4.013	-0.61
3-9-93	800	46.2	3.3547	-0.44
4-6-93	712	46.33	3.0163	-0.25
5-6-93	727	45.91	3.3895	-0.18
7-9-93	752	44.06	5.281	-0.11
8-2-93	714	45.3	3.9201	-0.07
9-14-93	839	46.39	2.7557	-0.07
10-15-93	729	47.07	2.0456	-0.08
11-19-93	1401	45.26	4.0608	-0.16
12-21-93	1511	44.95	4.4104	-0.18

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
1-7				
1-9-92	1450	42.48	3.4295	0.05
2-5-92	1038	43.95	1.9163	-0.01
3-5-92	1433	43.68	2.1911	0.00
4-8-92	904	43.59	9.7679	-6.96
4-21-92*	1335	44.45	4.792	0.00
6-3-92	742	42.23	7.2562	-0.06
7-2-92	740	42.37	7.1209	-0.07
8-7-92	713	44.21	5.1349	-0.08
9-9-92	743	44.67	4.6284	-0.07
10-8-92	725	44.47	4.8486	-0.07
11-10-92	937	44.3	5.0319	-0.07
12-8-92	911	42.4	7.0938	-0.08
1-7-93	908	41.62	7.9452	-0.09
2-9-93	838	44.38	4.927	-0.05
3-9-93	815	44.99	4.2652	-0.05
4-6-93	722	44.97	4.2814	-0.05
5-6-93	725	44.58	4.7286	-0.07
6-8-93	723	42.23	7.2705	-0.07
7-9-93	733	42	6.7031	0.68
8-2-93	706	43.90	5.3094	0.07
9-14-93	833	45.18	4.0938	-0.08
10-15-93	720	45.50	3.7023	-0.04
11-19-93	1527	43.99	5.7019	-0.38
12-22-93	1145	43.27	6.5266	-0.42
1-8				
7-12-91	1008	40.89	5.0464	-0.07
8-15-91	935	40.34	5.6381	-0.07
8-22-91	1126	41.88	3.9608	-0.05
9-5-91	738	42.59	3.1963	-0.05
12-5-91	1536	43.13	2.5909	-0.03
1-9-92	1456	41.74	4.0986	-0.04
2-5-92	1038	43.17	2.5150	0.00
3-5-92	1433	42.9	2.8026	0.00
4-8-92	904	42.85	2.8605	0.00
5-6-92	820	41.99	3.8092	-0.02
6-3-92	742	41.51	4.3166	-0.01
7-2-92	740	41.56	4.2609	-0.01
8-7-92	713	43.51	2.2003	-0.05
9-9-92	748	43.94	1.6871	0.00
10-8-92	725	43.74	1.9088	-0.00
11-10-9	820	43.63	2.0242	-0.00
12-8-92	911	41.71	4.1171	-0.03
1-7-93	908	40.96	4.928	-0.03
2-9-93	838	43.68	1.9818	-0.01
3-9-93	815	44.25	1.3499	0.00
1-9				
7-12-91	1020	19.97	3.3714	0.03
8-15-91	931	19.85	3.9275	-0.36
8-22-91	1127	20.60	2.6837	0.04
9-5-91	739	20.83	2.4347	0.04
12-5-91	1533	19.84	3.4848	0.06
1-9-92	1454	19.26	4.1263	0.04
2-5-92	1300	22.14	1.1029	-0.03
3-5-92	1433	22.49	0.6965	0.00
4-8-92	904	22.78	0.3848	0.00
5-6-92*	815	15.33	13.706	Adj
6-3-92	742	22.92	5.5095	0.00
7-2-92	740	23.83	4.5432	-0.01
8-7-92	713	24.38	3.9611	-0.02
9-9-92	743	25	3.5196	-0.23
10-8-92	725	23.03	5.9199	-0.49
11-10-9	824	26.58	2.0512	-0.44
12-8-92	911	25.94	2.7283	-0.43
1-7-93	908	25.84	2.8088	-0.41
2-9-93	838	26.75	1.8072	-0.39
3-9-93	815	27.03	1.5115	-0.39

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Tape and Datalogger Reading Pairs (contd)

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
1-10B				
1-24-92	1351	32.97	5.2823	0.11
2-5-92	1219	33.70	4.5796	0.04
3-5-92	1310	33.35	4.9636	0.03
4-8-92	811	32.95	5.4254	-0.00
5-6-92	756	31.94	6.5104	0.00
6-3-92*	728	31.67	6.815	-0.01
7-2-92	716	32.17	6.2674	-0.00
8-7-92*	733	43.73	4.4183	-9.84
9-9-92	1236	34.09	4.1024	0.09
10-8-92	805	34.11	4.1021	0.07
11-10-9	836	33.61	4.6649	0.05
12-8-92	933	31.72	6.7429	0.00
1-7-93	922	30.84	7.6954	-0.00
2-9-93	903	33.99	4.2441	0.06
3-9-93	837	34.79	3.3879	0.05
1-16B				
7-23-91	1037	36.80	6.7517	-0.06
8-15-91	1003	36.57	7.1367	-0.18
8-22-91	1146	38.11	5.3128	-0.03
9-5-91	743	38.63	4.7563	-0.03
12-5-91	1520	36.35	3.9832	2.97
1-9-92	1506	37.87	5.5572	-0.01
2-5-92	1030	39.38	3.9364	-0.02
3-5-92	1442	39.07	4.2565	-0.01
4-8-92	917	38.9	4.4339	0.00
5-6-92	827	37.98	5.4168	0.01
6-3-92	750	37.58	5.8618	-0.01
7-2-92	730	37.81	5.6138	-0.01
8-7-92*	705	39.45	3.6826	0.15
9-9-92	739	40.05	3.2004	-0.00
10-8-92	731	39.86	3.3976	0.00
11-10-9	810	39.73	3.5833	-0.04
12-8-92	918	37.73	5.7082	-0.02
1-7-93	856	36.92	6.5691	-0.01
2-9-93	827	39.8	3.4723	-0.01
3-9-93	821	40.46	2.7598	-0.00
4-6-93	729	40.43	2.7952	-0.01
5-6-93	727	40.01	3.2363	0.00
6-8-93	725	37.69	5.7689	-0.03
7-9-93	739	38.14	5.2566	-0.01
8-2-93	708	39.39	3.8564	0.05
9-14-93	817	40.63	2.5712	0.00
10-15-93	712	41.19	2.0574	-0.08
11-19-93	1511	39.44	3.9097	-0.05
12-22-93	1129	38.78	4.7638	-0.19
1-16C				
9-28-93*	1230	8.82	6.2864	0.00
10-15-93	712	8.44	6.7537	-0.05
11-19-93	1511	8.69	6.4924	-0.06
12-22-93	1129	8.25	6.929	-0.03
1-18A				
7-23-91	1103	45.23	5.9405	-0.05
8-15-91	905	44.97	6.2738	-0.10
8-22-91	1055	46.03	5.0414	-0.01
9-5-91	726	46.90	4.1335	-0.04
12-5-91	1504	47.65	3.2559	0.03
1-9-92	1535	46.68	4.3624	-0.03
2-5-92	1012	47.68	3.2686	-0.01
3-5-92	1251	47.57	3.3714	-0.00
4-8-92	835	47.59	3.3406	0.01
5-5-92	1141	47.15	3.8226	0.00
6-2-92	1014	46.3	4.7436	-0.01
6-30-92	1020	45.51	5.5982	-0.01
8-6-92	1027	47.72	3.2265	-0.02
9-9-92	627	48.43	2.4699	-0.02
10-8-92	841	48.4	2.4904	-0.01
11-10-9	927	48.41	2.4393	0.03
12-8-92	1031	46.86	3.9787	0.14
1-7-93	1003	46.28	4.5366	0.21
2-9-93	945	48.17	2.3999	0.30
3-9-93	912	48.61	1.7931	0.43

Well/Da	Time	St.Ta	DLRdg.	Abs.Ch
1-18B				
7-23-91	1110	44.03	4.8157	0.00
8-15-91	908	43.87	4.9892	-0.00
8-22-91	1058	44.94	3.8226	0.01
9-5-91	727	45.70	3.0024	0.02
11-19-91*new rd		46.00	3.629	-0.01
12-5-91	1500	46.54	3.0378	0.01
1-9-92	1535	45.54	4.1063	0.01
2-5-92	1012	46.57	3.0259	-0.01
3-5-92	1251	46.44	3.1473	0.00
4-8-92	835	46.44	3.164	-0.01
5-5-92	1141	46.01	3.6125	0.00
6-2-92	1014	45.17	4.5192	-0.00
6-30-92	1020	44.52	5.2391	-0.03
8-6-92	1027	46.69	2.9184	-0.03
9-9-92*	627	47.26	2.283	-0.01
10-8-92	841	47.27	2.3301	-0.07
11-10-9	927	47.23	2.6176	-0.29
12-8-92	1031	45.7	4.1919	-0.23
1-7-93	1003	45.12	4.7982	-0.21
2-9-93	945	47.02	2.715	-0.17
3-9-93	912	47.5	2.1773	-0.15
1-18C				
7-23-91	1112	41.70	4.2031	
8-15-91	909	41.45	2.9275	Adj.
8-22-91	1100	42.49	1.7859	0.02
9-5-91	728	43.30	0.9025	0.03
11-19-91* adj.11-6		43.61	2.112	Adj.
12-5-91	1506	47.00	1.6866	-3.19
1-9-92	1535	43.08	2.6649	-0.18
2-5-92	1012	44.03	1.6424	-0.18
3-5-92	1251	43.97	1.5547	-0.04
4-8-92	835	43.98	1.4869	0.02
5-5-92	1141	43.65	1.8579	0.00
6-2-92	1014	42.79	2.7937	-0.01
6-30-92	1020	42.26	3.3822	-0.03
8-6-92	1027	44.22	1.2428	0.00
9-9-92	627	44.87	0.5457	0.00
10-8-92	841	44.88	0.6109	-0.07
11-10-9	927	44.85	0.8827	-0.29
12-8-92	1031	43.37	2.7803	-0.58
1-7-93	1003	42.83	3.5732	-0.78
2-9-93	945	44.58	1.6392	-0.73
3-9-93	912	44.97	1.1142	-0.63
2-1				
1-29-92	1030	33.41	5.0283	0.07
2-5-92	1145	33.78	4.6196	0.08
3-5-92	1413	33.52	4.9622	0.02
4-8-92	749	33.27	5.2568	0.00
5-6-92	742	32.32	6.2786	0.00
6-3-92*	720	31.94	6.7143	-0.03
7-2-94	704	32.27	4.2827	1.91
7-8-92	1255	34.48	1.9634	0.48
8-7-92	745	33.95	3.0511	0.00
9-9-92	810	34.35	2.6865	-0.06
10-8-92	813	34.19	2.8055	-0.01
11-10-9	908	33.91	3.3632	-0.25
12-8-92	952	32	5.6197	-0.44
1-7-93	933	31.14	6.7382	-0.62
2-9-93	911	34.07	3.633	-0.66
3-9-93	844	34.81	2.9014	-0.72
4-6-93	742	34.69	3.1085	-0.79
5-6-93	744	34.28	3.5407	-0.79
6-8-93	745	32.27	5.7931	-0.87
7-9-93	816	32.63	5.4005	-0.86
8-2-93	729	33.4	4.1147	-0.44
9-14-93	906	35.03	2.7857	-0.83
10-15-93	644	35.47	2.3498	-0.87
11-19-93	1429	33.75	4.2156	-0.88
12-21-93	1527	33.48	4.5544	-0.93
10-15-93	644	35.47	2.3498	-0.87
11-19-93	1429	33.75	4.2156	-0.88
12-21-93	1527	33.48	4.5544	-0.93

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
2-2				
9-16-92	1145	36.35	4.9659	0.00
10-8-92	746	36.41	5.0153	-0.11
11-10-9	817	36.24	5.2036	-0.11
12-8-92	925	34.3	7.3153	-0.13
1-7-93	904	33.46	8.2109	-0.13
2-9-93	835	36.35	5.1672	-0.19
3-9-93	826	36.97	4.28	0.02
3A				
1-9-92	1524	29.52	4.6721	-0.63
2-5-92	1059	30.59	3.5262	-0.63
3-5-92	1248	30.41	3.7111	-0.62
4-8-92	820	30.29	3.0946	0.07
5-5-92	1131	29.89	3.6001	0.00
6-2-92	1025	29.00	4.5552	0.00
6-30-92	1029	28.46	5.1709	-0.03
8-6-92	1015	30.61	3.0287	-0.19
9-9-92*	620	31.12	2.5745	-0.28
10-8-92	832	31.19	2.5321	-0.31
11-10-9	918	31.02	2.7419	-0.33
12-8-92	1019	29.46	4.4522	-0.36
1-7-93	955	28.82	5.1562	-0.38
2-9-93	936	30.95	2.8425	-0.36
3-9-93	906	31.54	2.2239	-0.37
3-9				
8-15-91	1028	43.07	6.2603	0.00
8-22-91	1217	44.80	4.3962	0.00
9-5-91	756	45.29	3.8632	0.01
12-9-91	1011	46.31	3.1102	-0.31
1-9-92*	1421	44.33	4.8742	0.03
2-5-92	1430	46.72	3.1705	Adj.
3-6-92	1125	46.46	3.4672	0.02
4-8-92	950	46.25	3.7143	0.00
5-5-92	1238	45.69	4.6332	-0.29
6-2-92	1219	45.05	5.0023	0.00
6-30-92	1155	44.91	5.5683	-0.38
7-8-92	850	47.38	2.4510	0.04
8-6-92	756	46.95	2.9204	0.04
9-9-92	1208	47.37	2.4657	0.04
10-8-92	1320	47.28	2.395	0.20
11-10-9	1122	46.96	2.4900	0.43
12-9-92	1011	45.03	4.3578	0.62
1-7-93	1131	44.22	5.5635	0.31
2-10-93	806	47.16	2.1974	0.50
3-9-93	944	47.74	1.5149	0.56
3-12				
2-13-92	1200	46.82	4.4304	0.05
3-6-92	1130	46.32	4.9893	0.03
4-8-92	940	46.2	5.1354	0.02
5-5-92	1247	45.64	5.7568	0.00
6-2-92	1226	44.97	6.4741	0.00
6-30-92	1203	44.31	7.1896	-0.00
8-6-92	749	46.82	4.4507	0.03
9-9-92	1214	47.34	3.7228	0.19
10-8-92	1327	47.15	3.9409	0.18
11-10-9	1130	46.97	4.1463	0.17
12-9-92	1023	44.97	4.9106	1.46
1-7-93	1124	44.48	5.026	1.84
2-10-93	813	47.06	1.9745	2.10
3-9-93	948	47.59	1.6063	1.91

Tape and Datalogger Reading Pairs (contd)

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
4A				
12-9-91	NOT INSTALLED YET			
1-29-92	1054	29.17	3.5784	0.00
2-5-92	1334	29.32	3.4280	-0.01
3-5-92	1525	29.62	3.0898	0.00
4-7-92	1010	29.61	3.1133	-0.01
5-5-92	1330	29.55	3.1768	-0.01
6-2-92*	1320	28.81	1.6843	Bad xd
6-10-92	900	28.91	1.8054	Bad xd
6-25-92*	730	28.65	5.0411	0.00
6-30-92	946	28.44	5.2863	-0.02
8-6-92	848	29.24	4.4287	-0.02
9-9-92	652	29.63	3.9928	0.00
10-8-92	1222	29.86	3.7531	-0.01
11-10-9	1004	29.95	3.655	-0.00
12-9-92	1050	29.65	3.9774	-0.00
1-7-93	825	29.32	4.3384	-0.01
2-10-93	829	29.57	4.0705	-0.01
3-9-93	1017	29.71	3.9142	-0.01
4B				
12-9-91	1124	28.18	3.1681	0.09
1-29-92	1054	28.02	3.4402	0.00
2-5-92	1334	28.14	3.3094	0.00
3-5-92	1525	28.41	3.0435	-0.02
4-7-92	1010	28.43	3.017	-0.01
5-5-92	1330	28.33	3.1089	0.00
6-2-92	1320	27.69	3.8251	-0.03
6-30-92	946	27.34	4.2066	-0.03
8-6-92	848	28.15	3.4685	-0.15
9-9-92	652	28.56	3.0891	-0.21
10-8-92	1222	28.69	2.9696	-0.23
11-10-9	1004	28.8	2.6386	-0.03
12-9-92	1050	28.47	2.9984	-0.04
1-7-93	825	28.09	3.4113	-0.04
2-10-93	829	28.45	2.9998	-0.02
3-9-93	1017	28.6	2.8301	-0.01
4C				
12-9-91	NOT INSTALLED YET			
2-7-92	1334	379.02	7.0965	-0.03
3-5-92	1525	378.99	7.0917	-0.00
4-7-92	1010	378.7	6.7511	-0.03
5-5-92	1330	379.89	8.0645	0.00
6-2-92	1320	378.43	6.4807	-0.01
6-10-92	900	377.96	5.9559	-0.03
6-25-92*	908	377.54	5.4861	-0.05
6-30-92	946	378.83	6.8919	0.00
8-6-92	848	378.40	6.4811	0.05
9-9-92	652	377.54	5.5608	0.05
10-8-92	1222	378.64	6.7543	0.06
11-10-9	1004	377.46	5.4709	0.05
12-9-92	1050	frozen	frozen	frozen
1-7-93	**	**	**	**
2-10-93	829	378.52	XD bad	**
3-9-93	1017	378.46	XD bad	**

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
4-1				
12-9-91	1059	53.73	1.8634	0.00
1-9-92	1347	52.02	3.8699	-0.16
2-13-92	1034	54.49	5.1808	Adj.
3-6-92	1055	54.03	5.7782	0.08
4-8-92	1013	53.87	5.9803	0.06
5-5-92	1223	53.32	6.5762	0.05
6-2-92	1159	52.75	7.2338	0.01
6-30-92	1136	52.14	7.8995	0.00
8-6-92	818	54.63	5.2993	-0.07
9-9-92	1148	55.05	4.8446	-0.07
10-8-92	1300	54.83	5.0701	-0.06
11-10-92	1104	54.68	5.2667	-0.09
12-9-92	950	52.62	7.4909	-0.10
1-7-93	1116	51.96	8.2371	-0.13
2-10-93	749	54.79	5.1338	-0.08
3-9-93	740	55.3	4.5741	-0.06
4-6-93	647	55.26	4.6377	-0.08
5-6-93	1337	54.4	5.5448	-0.07
6-8-93	827	52.58	7.5510	-0.12
7-9-93	857	53.05	7.0004	-0.07
8-2-93	841	54.54	5.4097	-0.08
9-14-93	706	55.66	4.1847	-0.06
10-15-93	616	56.41	3.7402	-0.40
11-19-93	1322	54.09	5.9032	-0.09
12-22-93	1234	53.54	6.5085	-0.11
4-7				
12-9-91	1045	35.84	1.8009	0.00
1-9-92	1438	34.22	3.9718	-0.40
2-12-92	1533	37.82	5.6859	Adj.
3-6-92	1107	37.24	6.4773	0.14
4-8-92	1006	36.8	7.0846	0.01
5-5-92	1229	36.3	7.6377	0.00
6-2-92	1206	35.75	7.0368	1.11
6-10-92	930	36.48	6.2914	1.07
6-25-92	1020	34.18	4.9947	Adj.
6-30-92	1141	35.39	3.7434	0.00
8-6-92	809	37.69	1.2466	0.02
9-9-92	1155	37.97	0.9521	0.02
10-8-92	1310	38	0.9199	0.02
11-10-92	1113	37.50	1.4640	0.01
12-9-92	959	35.65	3.4608	0.00
1-7-93	1140	34.74	4.4565	-0.01
2-10-93	758	37.75	1.177	0.03
3-9-93	934	38.4	0.4597	0.05
4-6-93	651	38.18	0.7065	0.04
5-6-93	1330	37.32	1.6626	0.01
6-8-93	831	36.88	3.0017	-0.80
7-9-93	904	36.33	2.729	0.00
8-2-93	851	37.63	1.3366	0.00
9-14-93*	729	38.66	0.2071	0.02
10-15-93	622	39.00	0.9524	-0.01
11-19-93	1331	37.20	2.8852	-0.01
12-22-93	1239	36.60	3.5783	-0.06

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
4-9				
8-15-91	1042	37.25	7.5159	0.00
8-22-91	1231	39.04	5.5584	0.03
9-5-91	801	39.42	5.1879	-0.00
12-9-91	1027	40.12	4.4008	0.03
1-9-92	1404	38.50	6.2134	-0.04
2-5-92*	1436	40.90	4.5442	Adj.
3-6-92	1115	40.65	4.8268	-0.05
4-8-92	957	40.34	5.1521	-0.04
5-5-92	1232	39.79	5.7006	0.00
6-2-92	1213	39.21	6.3509	-0.02
6-30-92	1147	38.75	6.8365	-0.02
8-6-92	801	41.77	4.2626	-0.64
9-9-92	1200	41.47	3.5204	0.35
10-8-92	1316	41.45	3.3007	0.57
11-10-9	1118	41.03	3.8631	0.47
12-9-92	1005	39.14	5.9277	0.44
1-7-93	1136	38.29	6.8871	0.40
2-10-93	802	41.25	3.752	0.35
3-9-93	938	41.88	3.0148	0.41
5A				
1-23-92	1600	56.65	5.4636	0.12
2-5-92	1312	57.41	4.7629	0.01
3-5-92	1452	57.66	4.5194	-0.01
4-7-92	955	57.8	4.3635	-0.00
5-5-92	1355	57.19	5.0151	0.00
6-2-92	922	56.13	6.1974	-0.04
6-30-92	933	55.32	7.0912	-0.06
8-6-92	831	57.41	4.8139	-0.03
9-9-92	640	58.07	4.1002	-0.03
10-8-92	1149	58.25	3.8518	0.02
11-10-9	953	58.28	4.0291	-0.17
12-8-92	843	57.08	5.185	-0.05
1-7-93	815	56.65	5.6458	-0.05
2-9-93	809	57.85	4.3295	-0.02
3-9-93	1005	58.19	3.9978	-0.05
5B				
1-23-92	1600	55.8	4.5909	0.07
2-5-92	1312	56.33	4.0544	0.04
3-5-92	1452	56.59	3.7835	0.03
4-7-92	955	56.71	3.6460	0.04
5-5-92	1355	56.26	4.1677	0.00
6-2-92	922	55.3	5.2156	-0.01
6-30-92	933	54.65	6.0543	-0.14
8-6-92	831	56.42	3.7129	0.26
9-9-92	640	57.01	3.0232	0.31
10-8-92	1149	57.12	2.9465	0.28
11-10-9	954	57.11	2.9469	0.29
12-8-92	843	56.17	3.9964	0.25
1-7-93	815	55.77	4.4528	0.22
2-9-93	809	56.76	3.3709	0.24
3-9-93	1005	57.09	3.0192	0.24
5C				
1-23-92	1600	28.56	5.2896	0.12
2-5-92	1312	28.94	4.9602	0.04
3-5-92	1452	29	4.9268	0.02
4-7-92	955	29.24	4.6721	0.01
5-5-92	1355	28.74	5.2233	0.00
6-2-92	922	29.65	4.2217	0.02
6-30-92	933	28.87	5.0968	-0.01
8-6-92	831	28.05	6.0061	-0.04
9-9-92	640	26.79	7.3704	-0.05
10-8-92	1149	27.81	6.1938	0.03
11-10-9	9.55	28.12	5.899	-0.01
12-9-92	843	27.77	6.3967	-0.12
1-7-93	815	27.34	6.9063	-0.17
2-9-93	809	28.03	6.1379	-0.14
3-9-93	1005	28.61	5.5039	-0.13

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Tape and Datalogger Reading Pairs (contd)

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
5-1				
8-13-92	808	53.91	4.8994	0.00
9-9-92	605	54.55	4.2434	-0.03
10-8-92	654	54.41	4.4125	-0.05
11-10-9	1138	54.3	4.5452	-0.06
12-9-92	940	52.53	6.4519	-0.06
1-7-93	1146	52.13	6.8838	-0.07
2-10-93	739	54.24	4.6183	-0.07
3-9-93	749	54.64	4.1751	-0.06
6-1				
1-28-92		46.24	5.826	0.13
2-5-92	1412	46.61	5.5082	0.06
3-5-92	1541	46.65	5.5016	0.02
4-7-92	1043	47	5.186	-0.03
5-5-92	1323	46.17	6.0429	0.00
6-2-92	1151	45.24	7.0736	-0.03
6-30-92	1130	44.3	8.055	-0.00
8-6-92	917	46.67	5.5028	0.00
9-9-92	1140	47.34	4.7781	0.01
10-8-92	1253	47.38	4.7414	0.00
11-10-92	1145	47.24	4.8921	0.00
12-9-92	1130	45.71	6.4593	0.07
1-7-93	1044	45.36	6.7876	0.12
2-10-93	854	47.11	4.9047	0.12
3-9-93	958	47.46	4.5194	0.13
4-6-93	658	47.87	4.0652	0.14
5-6-93	1323	47.45	4.5533	0.11
6-8-93	819	44.89	7.3122	0.10
7-9-93	848	45.88	6.2654	0.08
8-2-93	833	46.49	5.6179	0.08
9-14-93	1039	47.4	4.5942	0.12
10-15-93	743	48.32	3.638	0.09
11-19-93	1542	47.09	4.9371	0.11
12-21-93	1553	46.64	5.4563	0.08
7A				
12-9-91	1154	42.31	3.4800	0.07
2-5-92*	1352	42.42	3.4664	-0.02
3-5-92	1508	42.48	3.3476	0.03
4-7-92	1027	42.67	3.2126	-0.04
5-5-92	1343	42.74	3.0973	0.00
6-2-92	955	42.64	3.2018	0.00
6-30-92*	1001	42.5	4.5183	-1.08
7-8-92*	755	42.46	3.4773	-0.07
8-6-92	858	42.46	3.4721	-0.07
9-9-92	711	42.61	3.2849	-0.04
10-8-92	1238	42.68	3.1596	0.00
11-10-9	1015	42.76	3.0818	-0.01
12-9-92	1120	42.76	3.0633	0.01
1-7-93	1027	42.69	3.1406	0.01
2-10-93	840	42.68	3.1354	0.02
3-9-93	1030	42.75	3.0241	0.06
7B				
12-9-91	1157	40.98	3.0112	-0.03
2-5-92*	1352	41.04	3.0108	-0.09
3-5-92	1508	41.18	2.8640	-0.09
4-7-92	1104	41.30	2.6382	-0.00
5-5-92	1347	41.24	2.7005	0.00
6-2-92	959	41.03	2.9369	-0.01
6-30-92	1001	40.93	3.0479	-0.01
8-6-92	858	41.24	2.7012	-0.00
9-9-92	717	41.44	2.504	-0.02
10-8-92	1238	41.35	2.6046	-0.02
11-10-9	1017	41.50	2.4626	-0.04
12-9-92	1120	41.2	2.6815	0.06
1-7-93	1027	41.19	2.9149	-0.15
2-10-93	840	41.35	2.6395	-0.05
3-9-93	1030	41.44	2.5174	-0.03

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
7C				
12-9-91	1200	6.24	3.8467	0.16
2-5-92	1352	5.76	4.5225	0.01
3-5-92*	1508	5.54	4.7808	-0.01
4-7-92	1027	5.90	4.3735	0.01
5-5-92	1347	5.76	4.5385	0.00
6-2-92	959	6.53	3.709	0.00
6-30-92	1001	6.46	3.7437	0.04
8-6-92	858	6.38	3.8248	0.04
9-9-92	717	7.16	2.9691	0.06
10-8-92	12.38	6.81	3.3634	0.04
11-10-9	1017	6.55	3.6445	0.04
12-9-92	1120	5.97	4.2842	0.03
1-7-93	1027	5.69	4.5782	0.03
2-10-93	840	5.49	4.7897	0.04
3-9-93	1030	5.52	4.787	0.01
8A (S28-E12)				
1-9-92	1600	45.31	3.4644	-0.05
2-5-92	1504	45.42	3.3462	-0.05
3-5-92	1545	45.75	2.9829	-0.04
4-7-92	1047	45.83	2.8734	-0.02
5-5-92	1410	45.71	2.9777	0.00
6-2-92	1239	44.98	3.7427	0.02
6-30-92	1215	44.59	4.1226	0.06
8-6-92	922	45.28	3.3759	0.06
9-9-92	1225	45.60	3.1477	-0.05
10-8-92	1339	45.71	3.0548	-0.07
11-10-9	1032	45.77	2.9512	-0.04
12-8-92	1135	45.58	3.1427	-0.02
1-7-93	1050	45.42	3.3272	-0.04
2-10-93	859	45.73	2.9892	-0.03
3-9-93	1357	45.9	2.7798	-0.01
Apr-Jun No Log				
7-9-93	922	45.04	3.6498	0.00
8-2-93	904	44.87	3.871	-0.04
9-14-93	1029	45.09	3.6714	-0.07
10-15-93	750	45.12	3.6459	-0.08
11-19-93	1550	44.96	3.8049	-0.06
12-21-93	1603	44.90	3.8998	-0.09
8-1				
5-1-92	930	53.49	4.6068	0.03
5-6-92	837	53.32	4.8258	0.00
6-2-92	1143	52.52	5.6933	-0.01
6-30-92	1010	51.59	6.7013	-0.01
8-6-92	1002	54.04	4.0926	-0.04
9-9-92	610	54.77	3.9083	-0.60
10-8-92	700	54.71	3.976	-0.60
11-10-9	754	54.6	3.5238	-0.07
12-9-92	828	53.12	5.2652	-0.21
1-7-93	1017	52.56	5.8861	-0.23
2-9-93	805	54.5	3.801	-0.23
3-9-93	759	54.89	3.367	-0.21
4-6-93	702	55.19	2.9572	-0.13
5-6-93	1316	54.74	3.5099	-0.20
6-8-93	811	52.17	6.2662	-0.19
7-9-93	839	53.18	5.2342	-0.24
8-2-93	823	53.88	4.3902	-0.15
9-14-93	753	54.87	3.3145	-0.14
10-15-93	629	55.79	2.2943	-0.12
11-19-93	1347	54.41	3.7155	-0.06
12-21-93	1506	53.98	4.2488	-0.12

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
F-Riv Surv.Elev.-0.2425T				
11-19-92	936	26.74	2.4189	0.00
12-8-92	1148	6.10	7.3216	-0.15
1-6-93	1357	11.94	7.3372	-1.58
2-9-93	1150	27.58	2.2657	-0.04
3-9-93	1116	32.37	0.9163	0.21
4-6-93	844	33.04	0.9683	-0.00
5-6-93	1046	24.64	3.0769	-0.18
7-14-93	1410	20.35	3.9641	-0.07
8-2-93	1310	26.76	2.5189	-0.11
9-16-93	824	27.18	2.5009	-0.19
10-14-93	1325	23.94	3.2476	-0.19
11-18-93	1515	33.57	0.8604	-0.02
12-21-93	1409	14.63	5.5055	-0.30
F1-2				
6-4-93	1340	25.38	8.8833	0.18
7-8-93	1338	27.48	6.8209	0.00
7-12-93	1223	27.93	6.3299	0.01
8-2-93	1307	28.65	5.5342	0.02
9-16-93	833	29.82	4.2628	0.04
10-14-93	1315	30.32	3.7418	0.02
11-18-93	1506	29.26	4.8614	0.04
12-21-93	1402	28.58	5.6293	0.01
F5-1				
9-12-91	1415	36.00	no DL	
9-25-91	1355	36.68	5.2967	-0.00
12-5-91	1322	37.04	4.9032	0.00
1-9-92	1325	35.89	6.2669	-0.11
2-4-92	1255	36.90	5.0482	0.01
3-6-92	1250	36.62	7.4882	-1.97
4-7-92	745	36.71	6.9423	-1.56
5-5-92	758	36.30	6.9285	-1.14
5-21-92	***	***	***	***
6-24-92	955	32.99	5.1947	0.03
6-30-92	852	33.50	4.7384	0.00
8-5-92	1240	36.5	1.9008	0.01
9-9-92	855	37.64	0.8251	0.01
10-8-92	924	37.84	0.6425	0.00
11-10-92	1237	38	0.476	0.02
12-8-92	1156	35.85	2.512	0.01
1-6-93	1402	35.44	2.8991	0.01
2-9-93	1154	37.31	1.0775	0.07
3-9-93	1117	37.74	0.6936	0.05
3-24-93	1527	38.49	4.4372	0.00
4-6-93	848	38.75	4.1908	0.00
F5-4				
9-12-91	1315	39.73		
11-11-91	1144	41.04	2.044	-0.01
12-5-91	1347	41.27	1.7905	0.00
1-9-92	1300	41.52	1.4985	0.02
2-4-92	1203	41.55	1.4777	0.01
3-6-92	1239	41.71	1.2355	0.08
4-7-92	736	41.85	1.1715	-0.00
5-5-92	750	41.96	1.0478	0.00
6-2-92	725	41.69	1.3384	0.00
6-30-92	844	41.34	1.72	-0.00
8-6-92	1232	41.46	1.6115	-0.02
9-9-92	849	41.79	1.2336	-0.00
10-8-92	919	42.11	0.8806	0.01
11-10-92	1253	42.4	0.5681	0.01
12-8-92	1134	42.3	0.4994	0.17
1-6-93	1343	42.22	0.7851	-0.02
2-9-93	1144	42.09	0.9433	-0.03
3-9-93	1105	42.18	0.8355	-0.02
4-6-93	831	42.46	0.5317	-0.02

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Tape and Datalogger Reading Pairs (contd)

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
FS-6				
9-12-91	1348	44.50	no DL	
11-11-91	1303	44.18	2.9385	0.01
12-5-91	1335	44.46	2.6153	0.03
1-9-92	1311	43.10	4.1478	-0.04
2-4-92	1244	44.43	2.6845	0.00
3-6-92	1245	44.01	3.1364	-0.00
4-7-92	741	43.91	3.2248	0.01
5-5-92	754	43.49	3.6579	0.03
6-2-92	730	42.26	5.0023	-0.01
6-30-92	848	41.48	5.8726	-0.04
8-5-92	1235	44.23	2.9048	-0.01
9-9-92	850	44.97	2.0827	0.03
10-8-92	921	45.29	1.7315	0.03
11-10-92	1235	45.25	1.7362	0.07
12-8-92	1139	42.99	4.2056	0.01
1-6-93	1346	42.67	4.5204	0.04
2-9-93	1145	44.88	2.1303	0.07
3-9-93	1110	45.69	1.249	0.09
4-6-93	834	46.34	0.5131	0.13
FS-43A				
6-4-93	1029	23.38	7.8075	-0.30
7-8-93	1400	25.58	5.1306	0.00
7-12-93	1153	26.48	4.1109	0.05
8-2-93	1331	27.37	2.9684	0.23
8-3-93	1235	26.9	3.4895	0.21
9-16-93	753	27.9	2.1383	0.47
10-14-93	1339	28.28	1.6671	0.53
11-18-93	1538	27.20	2.7052	0.64
12-21-93	1427	26.28	3.6707	0.66
FS-43B				
6-4-93	1029	23.13	11.381	0.29
7-8-93	1402	24.94	9.7428	0.00
7-12-93	1152	25.91	8.6553	0.04
8-2-93	1332	26.59	8.0018	-0.04
9-16-93	754	27.32	7.0307	0.13
10-14-93	1339	27.45	6.9393	0.09
11-18-93	1538	27.54	6.8205	0.11
12-21-93	1427	25.80	8.7096	0.10
FS-44				
7-8-93	1353	32.91	2.9967	0.00
7-12-93	1142	34.3	1.3917	0.10
8-2-93	1327	35.23	0.11196	0.36
8-3-93	1232	34.48	0.9178	0.36
9-16-93	815	35.28	0.5071	-0.06
9-28-93*	1420	35.06	4.7646	0.00
10-14-93	1334	35.25	4.7207	-0.15
11-18-93	1524	35.13	4.7283	-0.04
12-21-93	1426	33.18	6.139	0.60
FS-46				
5-20-93	823	47.72	5.1912	0.07
7-8-93	1330	46.87	6.1678	0.01
7-12-93	1230	47.02	6.0171	0.00
7-14-93	1423	47.09	5.9709	-0.03
8-2-93	1257	47.29	5.7447	-0.02
8-3-93	1224	47.33	5.7019	-0.02
9-16-93	745	48.56	4.3629	-0.00
10-14-93	1305	49.03	3.8976	-0.04
11-18-93	1455	48.84	4.0729	-0.02
12-22-93	1420	48.51	4.4629	-0.05
F6-1				
6-4-93	906	33.27	10.09	0.00
7-8-93	1410	35.75	7.5071	-0.09
8-2-93	1339	36.44	6.7852	-0.11
9-16-93	804	37.93	5.212	-0.14
10-14-93	1347	38.45	4.6934	-0.18
11-18-93	1553	38.05	5.0808	-0.14
12-21-93	1437	37.74	5.5159	-0.23

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
H-Riv 0.4395T				
12-5-91	1150	no tape	5.7357	
1-9-92	1420	22.20	10.2590	-0.02
2-4-92	1423	26.99	7.8775	0.09
3-6-92	1311	25.07	8.8555	0.02
4-7-92	815	30.28	6.4188	-0.00
5-5-92	837	28.40	7.3059	0.00
6-2-92	748	25.67	8.6190	-0.02
6-30-92	820	27.10	7.8854	0.03
8-5-92	1314	32.18	5.4775	0.04
9-9-92	917	28.99	7.051	-0.02
10-8-92	954	35.08	4.0866	0.06
11-10-92	1330	36.25	3.5064	0.08
12-8-92	1300	22.28	10.118	0.07
1-6-93	1441	20.15	11.331	-0.12
2-9-93	1125	33.5	5.4631	-0.53
3-9-93	1148	36.19	4.0046	-0.35
4-6-93	932	36.2	4.0084	-0.36
5-6-93	1006	31.3	6.4315	-0.46
6-14-93	1101	31.6	6.5034	-0.66
7-8-93	1251	25.6	9.144	-0.48
7-14-93	1348	28.64	8.1512	-0.89
8-2-93	1215	32.51	6.1918	-0.77
9-16-93	852	31.93	7.1303	-1.39
10-14-93	1213	30.51	7.7558	-1.35
11-16-93	1423	36.84	4.7291	-1.31
12-21-93	1329	24.95	10.6020	-1.55
H3-2A				
3-9-93	1141	42.51	5.9839	0.00
4-6-93	923	42.87	5.583	0.01
5-6-93	955	43.07	5.3612	0.02
6-14-83	1055	41.74	6.8466	-0.03
7-8-93	1237	41.9	6.624	0.02
8-2-93	1202	42.02	6.5153	-0.00
9-15-93	1444	43.13	5.3722	-0.06
10-14-93	1154	42.8	5.7055	-0.03
11-16-93	1557	42.85	5.6633	-0.04
12-21-93	1310	42.61	5.7652	0.10
H3-2C				
11-10-92	1317	43.21	5.3715	0.00
12-8-92	1343	42.78	5.8512	-0.02
1-6-93	1437	42.59	6.08	-0.04
2-9-93	1131	42.98	5.6132	0.00
3-9-93	1141	43.17	5.4149	-0.00
4-6-93	923	43.6	4.9779	-0.02
Disconnected XD				
8-2-93	1203	42.59	6.0148	0.02
9-15-93	1443	42.52	5.9914	0.11
10-14-93	1154	43.43	5.0640	0.07
11-16-93	1557	43.38	5.0472	0.13
12-21-93	1310	43.32	5.0851	0.16

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
H4-7				
9-27-91	944	44.95	2.1125	-0.06
12-5-91	1208	45.37	1.6320	-0.04
1-9-92	1408	45.33	1.6443	-0.01
2-4-92	1358	45.45	1.5047	-0.00
3-6-92	1305	45.70	1.2388	-0.01
4-7-92	809	45.79	1.1565	-0.02
5-5-92	825	45.65	1.2869	0.00
6-2-92	745	44.68	2.3441	-0.01
6-30-92	815	43.81	3.2816	-0.00
8-5-92	1304	45.40	1.569	-0.01
9-9-92	917	45.93	1.0015	-0.02
10-8-92	946	46.25	0.6679	-0.03
11-10-92	1307	46.47	0.4073	-0.01
12-8-92	1327	45.85	1.1022	-0.03
1-6-93	1430	45.57	1.3913	-0.02
2-9-93	1110	46.13	0.8158	-0.04
3-9-93	1224	46.25	0.6378	0.00
4-6-93	915	46.83	0.046	-0.03
5-6-93	950	46.85	0.0279	-0.04
6-14-93	1046	44.78	2.2591	-0.03
7-8-93	1229	45.17	1.758	0.04
8-2-93	1154	45.49	1.4714	-0.01
9-15-93	1433	46.32	0.5649	-0.00
10-14-93	1201	46.68	0.2491	-0.07
11-16-93	1545	46.46	0.4605	-0.05
12-21-93	1316	46.35	0.5301	-0.00
H4-9				
9-26-91	1410	43.90	1.6211	-0.04
12-5-91	1219	44.00	1.4820	-0.01
1-9-92	1354	43.49	2.0366	-0.02
2-4-92	1345	43.93	1.5453	0.00
3-6-92	1315	44.02	1.4372	0.01
4-7-92	804	44.15	1.2885	0.02
5-5-92	820	43.75	1.7417	0.00
6-2-92	740	42.43	3.1667	-0.01
6-30-92	810	41.20	4.5037	-0.03
8-5-92	1300	43.83	1.6489	0.01
9-9-92	913	44.66	0.7769	-0.01
10-8-92	943	44.86	0.5245	0.03
11-10-92	1302	44.95	0.4351	0.02
12-8-92	1321	43.5	1.9959	0.01
1-6-93	1425	43.33	2.1774	0.01
2-9-93	1105	44.59	0.8144	0.03
3-9-93	1227	44.7	0.6832	0.04
3-19-93	1722	45.36	1.0913	0.00
4-6-93	910	45.85	0.7045	-0.08
5-6-93	944	45.56	1.0166	-0.12
6-14-93	1042	42.53	3.832	-0.08
7-8-93	1222	43.11	3.2587	-0.06
8-2-93	1148	43.67	2.7426	-0.07
9-15-93	1428	44.99	1.4928	-0.06
10-14-93	1205	45.35	1.1771	-0.08
11-16-93	1534	44.61	1.8770	-0.09
12-21-93	1318	44.5	1.9986	-0.10
H4-10				
5-26-93*	1059	26.26	8.6749	0.00
6-14-93	1113	30.03	4.6504	-0.03
7-8-93	1247	29.83	4.8555	-0.02
8-2-93	1212	30.78	3.858	-0.04
9-15-93	1457	31.99	2.6361	-0.12
10-14-93	1223	32.28	2.3870	-0.18
11-16-93	1439	31.17	3.5918	-0.19
12-21-93	1329	30.79	4.0059	-0.19

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Tape and Datalogger Reading Pairs (contd)

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
H4-11				
2-11-93	1104	44.94	4.4503	0.00
3-9-93	1241	45.64	3.7168	-0.02
4-6-93	939	46.4	2.8989	-0.02
5-6-93	1021	44.71	4.7182	0.00
6-14-93	1129	43.48	6.0029	0.04
7-8-93	1307	42.88	7.5322	0.00
7-12-93	1248	43.49	6.8169	0.06
8-2-93	1237	44.30	5.8680	0.13
9-15-93	1523	45.24	11.3900	-5.95
10-7-93*	1420	45.08	3.0890	0.00
10-14-93	1230	45.48	2.7518	-0.04
11-16-93	1500	44.58	3.5934	-0.03
12-21-93* Porcupine bit cable in two.				
H4-12A				
9-16-91	1255	40.60	no DL	
9-26-91	1132	40.43	1.3129	0.00
12-5-91	1230	40.51	1.2297	0.00
1-9-92	1347	38.50	3.3915	0.00
2-4-92*	1325	40.43	-0.9800	2.14
2-19-92	1330	40.21	-0.4849	1.90
3-6-92*	1322	39.82	1.7259	0.23
5-5-92*	846	39.33	0.6929	1.68
5-21-92	***	***	***	***
6-24-92*	1035	35.76	5.4257	0.06
6-30-92	829	37.66	3.6872	0.00
8-5-92	1319	40.02	1.4849	-0.03
9-9-92	920	40.89	0.6672	-0.04
10-8-92	1001	41.02	0.5467	-0.04
11-10-9	1342	40.67	0.8856	-0.05
12-8-92	1315	38.05	3.3313	-0.01
1-6-93	1452	37.84	3.5254	-0.01
2-9-93	1059	39.45	0.7356	1.33
2-11-93	1349	40.91	0.6477	-0.04
3-9-93	1235	41.15	0.4204	-0.04
4-6-93*	954	42.28	0.3009	-0.01
5-6-93	1015	41.07	1.4419	-0.01
6-14-93	1119	39.42	2.9949	0.00
7-8-93	1300	39.15	3.2205	0.03
8-2-93	1228	40.15	2.2755	0.03
9-15-93	1514	41.25	1.2488	0.02
10-14-93	1232	41.54	0.9778	0.01
11-16-93	1523	40.5	1.9362	0.04
12-21-93	1323	40.03	2.3864	0.03
H4-12C				
2-11-93	1349	40.6	4.2904	0.00
3-9-93	1235	41.42	3.4401	-0.03
4-6-93	954	42.21	2.5217	0.04
5-6-93	1015	41	3.839	0.02
6-14-93	1120	39.44	5.2642	0.25
7-8-93	1301	39	5.9852	0.02
8-2-93	1230	40.53	4.3589	0.01
9-15-93	1516	40.95	3.8743	0.04
10-14-98	1232	41.22	3.6229	0.00
11-16-93	1523	41.07	3.7672	0.02
12-21-93	1323	39.71	5.2501	-0.00
H6-1				
5-28-93	1204	43.44	7.979	-0.94
7-8-93	1316	42.95	7.497	0.00
7-12-93	1256	43.01	7.4656	-0.03
8-2-93	1244	43.14	7.2907	0.00
9-15-93	1539	43.97	6.3513	0.05
10-14-93	1246	44.40	5.8528	0.08
11-16-93	1515	44.39	5.7557	0.15
12-21-93	1335	44.33	5.8106	0.19

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
D5-13				
5-21-93	730	87.58	3.3303	1.47
7-8-93	1136	86.94	5.6015	0.00
7-14-93	1318	87.02	5.5395	-0.02
8-2-93	1101	87.08	5.4657	-0.01
9-15-93	1343	86.66	5.9532	-0.05
10-14-93	1100	87.75	4.7881	-0.06
11-18-93	1339	88.86	4.4029	-0.81
12-21-93	1234	87.65	4.9514	-0.11
D5-15				
5-19-93	1420	87.32	4.7424	0.00
7-8-93	1145	86.78	5.2326	0.09
8-2-93	1111	86.88	5.2811	-0.06
9-15-93	1333	87.25	5.7411	-0.85
10-14-93	1053	87.32	5.4973	-0.70
11-18-90	1323	87.5	3.9044	0.60
12-21-93	1228	87.51	4.7308	-0.18
D5-20				
5-19-93	1440	83.27	5.1221	0.00
7-8-93	1158	84.05	4.3358	-0.05
8-2-93	1126	84.7	3.6303	-0.04
9-15-93	1404	85.86	2.4345	-0.09
10-14-93	1108	86.11	2.1899	-0.11
11-18-93	1414	85.7	2.6183	-0.10
12-21-93	1255	85.02	3.2796	-0.03
D8-54A				
5-19-93	1212	57.78	4.4748	0.00
7-8-93	1209	59.7	3.1908	0.00
7-14-93	1333	60.76	2.4008	-0.32
8-2-93	1131	61.39	1.8179	-0.41
9-15-93*	1354	62.62	0.526	-0.43
10-14-93	1136	62.95	2.1225	0.00
11-18-93	1357	61.35	3.3796	0.43
12-21-93	1248	60.92	4.1532	0.13
D8-54B				
5-19-93	1212	57.98	5.07925	0.00
7-8-93	1205	60.39	2.7482	-0.23
7-14-93	1335	60.14	2.7176	0.05
8-2-93	1133	60.86	1.9474	0.04
9-15-93	1355	61.62	1.1283	0.05
10-14-93	1136	61.81	2.887	0.00
11-18-93	1357	61.35	3.3796	-0.00
12-21-93	1248	60.53	4.2698	-0.01
N-RIV				
8-6-93	929	42.49	7.1338	0.00
9-15-93	SIT CA	42.77	4.3326	2.34
9-15-93	1309	42.77	6.8847	-0.05
10-14-93	1023	42.69	6.9937	-0.07
11-18-93	1301	45.92	3.4718	-0.01
12-21-93	1210	39.99	9.5316	0.26
K18				
5-21-93	953	22.2	7.5265	0.00
7-8-93	1027	21.76	8.0216	-0.02
8-2-93	958	22.28	7.4205	0.02
9-15-93	1206	23.89	5.5805	0.10
10-14-93	942	24.43	5.0045	0.09
11-18-93	1102	23.93	5.5148	0.12
12-21-93	1122	23.41	6.1022	0.10
K30				
5-21-93	1119	73.2	6.5663	0.00
7-8-93	1008	72	7.8429	0.02
8-2-93	921	71.88	8.0817	-0.08
9-15-93	938	72.56	7.3388	-0.08
10-14-93	836	73.03	6.8896	-0.13
11-18-93	1037	73.24	6.6224	-0.09
12-21-93	1021	73.21	6.6934	-0.13

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
K-31				
5-21-93	833	20.57	7.2519	0.00
7-8-93	946	24.86	2.6784	-0.06
8-2-93	901	26.94	0.3672	0.00
9-15-93*	1129	27.73	0.0176	0.55
10-14-93	814	28.11	1.8014	0.06
11-18-93	1515	27.73	2.1888	0.08
12-21-93	1001	25.48	4.4159	0.27
K-32A				
5-21-93	1239	54.51	1.9686	0.00
9-15-93*	1042	56.43	-0.0564	-0.03
10-14-93	918	56.92	1.0859	-0.06
11-18-93	1124	56.44	1.5761	-0.04
K32-B				
5-21-93	1239	47.85	8.0720	0.00
9-15-93	1039	48.92	6.9999	-0.07
10-14-93	918	49.28	6.6560	-0.11
11-18-93	1124	49.09	6.8229	-0.07
K-37				
5-27-93	832	52.94	8.3298	0.00
7-8-93	1114	53.61	7.0585	0.00
7-14-93	1258	53.95	6.8896	-0.18
8-2-93	1012	53.92	6.6303	0.09
9-15-93	1154	55.5	5.6358	-0.57
10-14-93	956	55.85	5.3192	-0.62
11-18-93	1200	55.72	5.6874	-0.83
12-21-93	1135	55.41	5.7577	-0.59
B-Riv				
3-11-92	1437	56.53	8.1304	0.02
4-7-92	858	57.08	7.5461	0.01
5-5-92	924	56.38	8.3103	0.00
6-2-92	834	58.63	5.7769	0.10
6-30-92	748	58.38	6.0991	0.05
8-6-92	1358	58.04	6.5357	-0.01
9-9-92	1013	57.43	7.2085	-0.03
10-8-92	1037	60.75	3.5618	0.03
11-10-92	1427	62.63	1.725	-0.15
12-8-92	1430	56.12	8.964	-0.35
1-6-93	1519	52.83	12.601	-0.43
2-9-93	1237	58.04	6.9193	-0.37
3-9-93	1311	61.79	2.719	-0.23
4-6-93	1025	61.84	2.6285	-0.19
5-6-93	914	58.69	6.0798	-0.05
6-15-93	737	63.22	1.1721	-0.03
7-8-93	804	57.7	6.2969	0.74
7-14-93	1200	57.71	7.2214	-0.13
8-2-93	756	61.95	2.6571	-0.14
9-15-93	837	60.38	4.2892	-0.08
10-14-93	728	59.18	5.577	-0.07
11-17-93	1359	62.5	1.9989	-0.08
12-21-93	923	57.04	7.8711	-0.06
B2-12				
5-27-93	1147	42.55	8.5929	0.00
7-8-93	834	45.63	5.2278	0.04
8-2-93	814	48.07	2.7324	-0.08
9-15-93	737	48.17	2.5833	-0.05
10-14-93	746	47.33	3.5052	-0.06
11-17-93	1422	48.87	1.8233	-0.04
12-21-93	941	45.62	5.2653	0.02
B2-13				
5-29-93	0.774	21.84	7.7902	0.00
7-8-93	920	23.32	6.3631	0.03
8-2-93	838	23.85	5.9025	-0.01
9-15-93	902	25.33	4.496	0.00
10-14-93	659	25.82	4.0972	-0.07
11-17-93	1334	25.2	4.6228	-0.00
12-21-93	902	24.79	5.0279	-0.02

Tape and Datalogger Reading Pairs (contd)

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
B3-1				
9-27-91	1237	46.79	2.7586	-0.04
12-5-91	1030	47.06	2.4401	-0.01
1-9-92	1516	45.30	4.3026	0.00
2-4-92	1520	46.83	2.6705	0.00
3-6-92	1357	46.25	3.2911	0.00
4-7-92*	910	46.54	-0.2865	3.06
5-5-92*	935	46.01	4.9500	-1.32
5-21-92	***	***	***	***
7-2-92	********	********	********	********
7-28-92*	1142	46.65	2.6544	0.00
8-5-92	1406	46.90	2.4125	0.01
9-9-92	1004	48.08	1.2926	0.01
10-8-92	1044	48.42	0.955	0.03
11-10-92	1436	48.63	0.7541	0.03
12-8-92	1444	45.46	3.6704	0.12
1-6-93	1540	45.22	4.0144	-0.01
2-9-93	1244	47.9	0.9188	0.58
3-9-93	1318	48.87	0.1601	0.41
3-23-93	1532	49.63	4.6987	0.00
4-6-93	1035	48.78	4.4504	1.11
B3-46				
5-28-93	1230	46.05	8.489	0.11
7-8-93	857	48.63	5.8379	0.00
7-14-93	1222	48.94	5.4307	0.07
8-2-93	825	49.74	4.5124	0.13
9-15-93	801	51.31	2.8968	0.06
10-14-93	750	51.43	2.6889	0.14
11-17-93	1445	51.12	3.1281	0.04
12-21-93	947	49.72	4.6379	0.03
B3-47				
5-28-93	1050	43.04	8.3201	0.00
7-8-93	838	46.1	5.1022	-0.08
8-2-93	815	47.61	3.5053	-0.10
9-15-93	747	49.27	1.7057	-0.09
10-14-93	746	49.48	1.5425	-0.15
11-17-93	1422	48.77	2.2444	-0.09
12-21-93	941	45.94	3.8654	1.23
B4-4				
9-27-91	1346	73.92	3.4563	-0.04
12-5-91	1115	74.93	2.3084	0.02
1-9-92	1448	75.12	2.0962	0.02
2-4-92	1449	75.15	2.0675	0.02
3-6-92	1346	75.80	1.7948	-0.38
4-7-92	847	75.86	1.7174	-0.36
5-5-92	910	75.63	1.5748	0.00
6-2-92	813	75.24	1.9500	0.04
7-2-92*	********	********	********	********
7-28-92*	759	75.43	2.1547	0.00
8-5-92*	1342	75.36	2.0651	0.15
9-9-92	949	75.96	1.5866	-0.00
10-8-92	1020	76.00	1.1793	0.34
11-10-92	1401	76.35	0.7727	0.37
12-8-92	1406	76.35	0.7728	0.37
1-6-93	1525	76.06	1.0903	0.36
2-9-93	1218	75.96	1.1928	0.37
3-9-93	1259	76.13	1.0011	0.38
4-6-93	1011	76.57	0.5219	0.38

Well/Da	Time	St.Tape	DLRdg.	Abs.Ch
B4-1				
9-23-91	1355	61.91	1.7979	-0.11
12-5-91	1050	62.98	0.5319	-0.00
1-9-92	1458	63.06	0.4435	0.00
1-21-92*	Replace	63.10	5.9525	
2-4-92	1510	63.20	5.8207	-0.12
3-6-92	1353	63.39	5.5804	-0.08
4-7-92	853	63.53	5.4742	-0.13
5-5-92	915	63.59	5.2738	0.00
6-2-92	821	63.19	5.6286	0.07
7-2-92*	********	********	********	********
7-28-92*	842	63.14	5.8577	0.00
8-5-92	1348	63.27	5.7775	-0.06
9-9-92*	955	63.72	5.3417	-0.10
10-8-92	1030	64.13	4.7133	0.07
11-10-92	1417	64.57	3.9033	0.39
12-8-92	1418	64.3	4.1218	0.45
1-6-93	1535	64.01	4.5143	0.38
2-9-93	1231	64.06	4.4078	0.43
3-9-93	1304	64.34	4.206	0.33
4-6-93	1017	64.85	3.6061	0.38
5-27-93	1021	64.25	4.6367	0.02
7-14-93	1203	63.91	4.4111	0.57
8-2-93	737	63.95	4.468	0.48
9-15-93	700	64.58	4.3185	-0.01
10-14-93	713	64.97	3.3586	0.49
11-17-93	1346	65.20	3.2796	0.33
12-21-93	912	64.95	3.5066	0.37
B5-2				
5-31-93	1100	61.98	8.2133	0.00
7-14-93	1214	61.78	8.4549	-0.05
8-2-93	804	61.84	8.4491	-0.11
9-15-93	713	62.55	7.8876	-0.23
10-14-93	737	63.04	7.5173	-0.33
11-17-93	1409	63.16	5.8401	1.31
12-21-93	931	61.55	7.7241	0.94

Appendix C

Location and Calibration Data

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Appendix C

Location and Calibration Data

Appendix C contains information about the locations of the wells and river stations, their assigned station number, and the transducers used there. Next is the initial calibration data pertaining to each transducer.

Installation Data

SN_LISTS. 110 Gable Butte Relay
Rev.2/94 130 High Bay, 300 Area Relay

ELEV.MS ToC	STA.	WELL	XD SN & Date In		
	(300AREA)				
381.40	129	4-9	409783		removed
			7/16/91		
345.00	128	300-RIV	400814		
Scale slipped down 0.4ft			11/6/91		
374.19	127	4A	409780	409779	removed
			10/4/91	6/25/92	
373.69		4B	425860		removed
			10/4/91		
372.24	(371.10')	4C	409774	400927	removed
	base angl		1/24/92	6/25/92	
373.86	126	3A	400615		removed
			12/13/91		
379.74	121	1A	410070	409776	removed
			11/23/91	9/17/92	
379.88		1B	400613		removed
			11/23/91		
379.48		1C	409773		removed
			11/23/91		
394.88	120	8-1	425876		
			5/1/92		
387.31	119	3-9	400808		removed
			7/17/91		
390.83	118	18A	395108		removed
			7/2/91		
389.94		18B	410075	410067	removed
			7/2/91	11/6/91	
388.05		18C	400806		removed
			7/2/91		
375.87	117	1-10B	425877		removed
			1/24/92		
381.14	116	16B	409782		
			7/15/91		
382.29		16C	507401		
			9-28-93		
400.61	115	5A	426118		removed
			1/23/92		
400.14		5B	426120		removed
			1/23/92		
400.20		5C	390084		removed
			1/23/92		
386.38	113	3-12	390088?		removed
			2/13/92		
376.99	112	4-7	390466	400928	
			11/22/91	6/25/92	
395.00	111	4-1	409775		
			11/22/91		
385.63	109	1-7	409779	425873	507392
			12/18/91	4/21/92	1/20/94
384.91		1-8	404587		removed
			7/15/91		
384.80		1-9	410071	425874	removed
			7/15/91	2/13/92	
389.76	108	8A	400930		
			12/18/91		
390.26	107	7A	426122		removed
			11/20/91		
390.43		7B	425871		removed
			11/20/91		
390.58		7C	425865		removed
			11/20/91		
386.93	106	6-1	409778		
			1/28/92		
395.60	105	5-1	394990		removed
			8/13/92		
384.52	104	1-2	394096		
			1/29/92		
375.53	103	2-2	410071		removed
			9/16/92		
375.26	102	2-1	425872		
			1/29/92		
375.90	101	1-1	425864		
			1/29/92		

ELEV.MS ToC	STA.	WELL	XD SN & Date In					
	(100-F AREA)							
412.12	054	F5-4	400921		removed			
			9/24/91					
412.95	056	F5-6	400925		removed			
			9/24/91					
406.56	051	F5-1	400927	501375	removed			
			9/24/91	6/24/92				
373.33	140	F-RIV	501357					
Chann.top -0.2425 x Tape			9/19/92					
397.95	132	F1-2	409783					
			6-4-93					
395.35	151	F5-43A	390088	482452				
			6-4-93	1/19/94				
394.87	151	F5-43B	400615					
			6-4-93					
402.65	144	F5-44	395108	409780				
			5-28-93	9-28-93				
416.95	154	F5-46	400921					
			5-20-93					
405.15	150	F6-1	426120					
			6-4-93					
	(100-H AREA)							
386.47	125	H-RIV	404333					
Top 2"Pipe - 0.4395 x Tape			9/26/91					
	EC probe		SN1033	k=1.42				
			11/15/93					
420.59	124	H4-7	426125					
			9/26/91					
418.08	123	H4-9	395112	501395				
			9/26/91					
413.50	122	H4-12A	394990	501362				
			9/26/91	6/24/92				
413.52	122	H4-12C	390089					
			2-11-93					
417.83	138	H3-2A	425875					
			11-7-92					
418.22	138	H3-2C	390092					
			11-7-92					
404.44	160	H4-10	410071					
			5-26-93					
416.84	137	H4-11	386999	481177	503403			
			2-8-93	10/5/93	12-29-93			
	EC probe		SN ???	k=1.42				
418.10	161	H6-1	410067					
			5-26-93					
	136	O.f.152-2	SN1086	k=1.371				
	EC probe		11/12/93					
	139	Seep153-1	SN1087	k=1.399				
	EC probe							
	(100-B AREA)							
472.14	044	B4-4	404586	GEOLOG	404586	removed		
			9/27/91	4/21/92	7/28/92	sprg.93		
461.80	041	B4-1	400928	426127	GEOLOG	426127	400925	507400
			9/23/91	1/21/92	4/21/92	7/28/92	5-27-93	11/23/93
439.79	031	B3-1	400929	GEOLOG	501356	removed		
			9/27/91	4/21/92	7/28/92	sprg.93		
439.06	191	B2-12	425874					
			5-27-93					
448.31	114	B-Riv	425863					
			3/11/92					
418.53	143	B2-13	501375					
			5-29-93					
441.62	192	B3-46	404586					
			5-29-93					
438.78	191	B3-47	404587					
			5-28-93					
458.91	141	B5-2	501370	409774				
			5-31-93	1/19/94				

ELEV.MS ToC	STA.	WELL	XD SN & Date In	
	(100-D AREA)			
471.49	171	D5-13	426122	
470.88 ??			5-21-93	
471.53	170	D5-15	400806	507389
			5-19-93	1/19/94
468.11	172	D5-20	425865	
			5-19-93	
442.78	173	D8-54A	409773	
442.75 ??			5-19-93	
442.51	173	D8-54B	409776	
			5-19-93	
	(100-N AREA)			
426.09	133	N-Riv	395112	
			8/6/93	
	(100-K AREA)			
409.85	183	K-18	426118	
			5-21-93	
466.09	180	K-30	425860	
			5-21-93	
	EC probe		SN ???	k=1.42
			11/15/93	
412.30	181	K-31	390084	
			5-21-93	
444.02	182	K32-A	409779	
			5-21-93	
445.27	182	K32-B	394990	
			5-21-93	
441.80	184	K-37	425871	
			5-27-93	

Initial Calibration Data

CALIBRATION FROM LRB54110

XD SN	Factor	Original Order	Page Listed IN 54110	XD SN	Factor	Original Order	Page Listed IN 54110
386999	0.930129	49	57	425871	0.930162	34	55
390008	0.929759	45	57	425872	0.925998	46	57
390084	0.925817	44	56	425873	0.924778	53	58
390088	0.921753			425874	0.927466	52	58
390089	0.930984	50	57	425875	0.923511	55	58
390092	0.933043	48	57	425876	0.933277	38	55
390466	0.931572	32	43	425877	0.924719 recal	54	58
394096	0.940487	10	38	426118	0.919618	40	56
394990	0.934299	2	38	426120	0.927198	41	56
395108	0.928344	23	42	426122	0.927131	33	55
395112	0.934208	5	38	426123	0.928045	43	56
400613	0.928318 r	25	42	426125	0.924634	39	56
400615	0.926237	30	43	426127	0.92888 recal	42	56
400806	0.925422	22	41	REPAIRED XD's added 9-4-92			
400808	0.924320	26	42	394990	0.924224	3	108
400814	0.934277	24	42	400927	0.919469	1	108
400921	0.928259	6	38	400928	0.924320	4	108
400925	0.938906	4	38	409779	0.930646	5	108
400927	0.925948	3	38	410071	0.929051	2	108
400928	0.930894	9	38	NEW XD's added 9-4-92			
400929	0.937396	7	38	501356	1.056266	3	108
400930	0.928236	11	40	501357	1.050504	4	108
404333	0.934862	1	38	501359	1.063546	2	108
404586	0.932610	8	38	501362	1.056783	5	108
404587	0.927600	12	40	501370	1.049866	1	108
409773	0.933826	17	41	501375	1.059638	6	108
409774	0.9307 rec	15	40	NEW XD's added ----			
409775	0.930978	28	42	481177	1.053189		147
409776	0.933341	27	42	482452	1.05196 recal		146
409778	0.931615	16	40	495533	1.051341		146
409779	0.935513	13	40	500042	1.051024 recal		146
409780	0.927762	29	43	501379	1.05512 recal		146
409782	0.930449	31	43	503403	1.052781		147
409783	0.928530	14	40	503546	1.058283		146
410067	0.931645	20	41	507381	1.067479 recal		146
410070	0.931287	18	41	507384	1.047854 recal		147
410071	0.931156	19	41	507389	1.038989 recal		147
410075	0.923157	21	41	507392	1.068226 recal		147
425860	0.925743	36	55	507394	1.055505 recal		146
425863	0.926984	51	58	507396	1.062276 recal		147
425864	0.929513	47	57	507397	1.055673 recal		146
425865	0.932000	35	55	507400	1.051118		147
425871	0.930162	34	55	507401	1.053642		146

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