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JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

M E M O R A N D U M
June 3, 1983

To: Clar Pratt

From: Art Johnson and Al Newman

Subject: Water Quality in the Gap-to-Gap Reach of the Yakima River, June - October, 1982

Introduction

In response to your request of March 5, 1982, the Water Quality Investigations Section, in cooperation with Al Newman of your office, conducted a series of field investigations during the summer and fall of 1982 to assess the impact of municipal/industrial effluents, irrigation returns, and tributaries discharging to the Yakima River between Selah and Parker. The objectives of this work were as follows:

1. Determine existing water quality conditions throughout this reach;

2. Quantify pollutant loads to the reach;

3. Assess the capacity of the river to assimilate these loads; and

4. Screen selected discharges for the presence of toxic organic chemicals and metals.

The results of our surveys are reported below.

Study Area Description

Figure 1 is a map of the study area. Class A criteria apply to this portion of the Yakima River system. WDOE's 1982 Water Quality Index analysis (*1*) for the Yakima River was as follows:

Station Number and Name	River Mile	Water Quality Index Categories: Temp.	Oxygen	pH	Bacteria	Trophic	Aesthetics	Susp. Solids	Ammonia Toxicity	Overall Index Rating
39A090 Yakima River near Cle Elum	191.0	7.0	7.3	4.4	7.3	4.1	3.8	*	0.2	4.4
39A070 Yakima River near Thorp	165.4	8.7	6.1	3.3	5.3	7.1	11.7	*	0.9	4.1
37A200 Yakima River above Ahtanum Creek	107.3	17.3	6.4	10.1	43.1	22.6	9.7	17.2	7.9	28.5
37A190 Yakima River at Parker	104.6	14.4	6.1	10.5	25.9	21.5	12.2	8.0	4.6	13.9
37A090 Yakima River at Kiona	29.9	41.7	6.9	21.0	27.2	30.4	19.2	24.8	3.2	33.9
38A070 Naches River at Yakima	116.3	14.3	5.7	10.1	11.2	7.0	9.7	*	3.7	8.7
39C070 Wilson Creek at Thrall	147.0	13.3	6.8	8.0	68.5	39.9	12.8	*	10.7	61.1

*Insufficient data.

Scores between 0 and 20 meet goals of the Federal Water Pollution Control Act. Scores between 20 and 60 are considered marginal in meeting these goals. Values greater than 60 indicate unacceptable water quality problems exist. The index uses WDOE routine monitoring data from the past five years.

This analysis indicates that Yakima River water quality becomes marginal with respect to bacteria and nutrients between Thorp and Ahtanum Creek. Wilson Creek and its tributaries are the first major sources of low-quality water below Thorp (overall index rating 61.1 as shown above). A second group of sources with a potential for significant adverse effects on river water quality are in the Selah gap to Union gap reach of the river -- the object of this study.

Survey Methods

The portion of the Yakima River surveyed was the 12-mile reach between Selah and Parker bridges (r.m. 117.1 - 104.6). The schematic diagram in Figure 2 shows the relative position of each river station, municipal or industrial effluent, irrigation return, and tributary monitored. Diversion canals are not shown.

There were three parts to the study: (1) weekly water quality monitoring in the river from June through October; (2) intensive surveys on August 31-September 1 and October 19-20, measuring the water quality and quantity of point and non-point sources and resulting river quality; and (3) collection of water and sediment samples on July 7 for priority pollutant analysis. The hydrograph in Figure 3 shows the changes in river flow during the study period and timing of the routine monitoring and intensive survey activities. Flows are regulated by the Bureau of Reclamation.

Al Newman conducted the weekly monitoring program. Samples were collected above and below the Selah STP, above and below the Yakima STP, and at Parker bridge (YKM-1, 2, 4, 6, and 8 in Figure 2). Temperature and dissolved oxygen (Winkler - azide modification) were measured twice a week. Chemical oxygen demand, pH, specific conductivity, fecal coliform, nutrients, total suspended solids, and turbidity were determined on weekly samples returned to the WDOE Tumwater laboratory and analyzed according to EPA's *Methods for Chemical Analysis of Water and Wastes*. All samples were collected from bridges using a Van Dorn bottle except at stations YKM-1 and YKM-6 which were waded and sampled by hand.

The two intensive surveys were cooperative efforts between staff of the Water Quality Investigations Section and the Central Regional Office. The larger of the two surveys was done August 31 - September 1 during warm, dry weather. A follow-up survey was conducted on October 19-20 during low-flow conditions (see hydrograph in Figure 3). Eight river stations and 13 discharges to the river were monitored. The plan of each survey is outlined in Table 1 which shows when and where each sample was collected, the number of samples per station, and the parameters measured. River water quality was characterized by taking large numbers of individual samples at each station. About 100 individual water quality measurements were made for each of the four major river stations in the August 31 - September 1 survey; about half that number were made for the October 19-20 survey. Concomittant with the river sampling, 24-hour automatic composites (250 to 300 ml aliquots at 30-minute intervals) were taken of municipal and industrial effluents. Manual composites of shorter duration were taken from irrigation returns and tributaries. Flow data were provided by the Bureau of Reclamation, recorded from municipal and industrial measuring devices or gaged in the field by WDOE personnel. All samples were analyzed at the WDOE Tumwater laboratory as described above. Nitrification was inhibited in all BOD samples (Hach Nitrification Inhibitor Formula 2533™); the results of this analysis, therefore, represent carbonaceous oxygen demand only. Long-term, multiple-day BOD was determined for the Selah STP and Yakima STP effluent samples of August 31 - September 1 for use in D.O. modeling efforts, if undertaken at a later date. These data are in Appendix I.

Organic compounds and trace metals classified as "priority pollutants" by EPA were measured in water samples (grabs) collected July 7 from nine of the discharges monitored in the intensive surveys. A sediment sample was also collected from the mouth of Birchfield Drain (also called Moxee Drain). The fact that creek and river sediments in other parts of the study area were largely gravel or rock prevented additional sediment samples from being collected, as had been planned. Sample containers for organics analysis were cleaned with sequential rinses of soap and water, 15% HNO_3, 50% HCl, distilled water, deionized water, nannograde acetone, and nannograde methylene chloride. The procedure for trace metal sample bottles omitted the solvent rinses. Samples were analyzed for organic priority pollutants at the EPA Region X laboratory in Manchester, Washington, according to EPA's "Guidelines establishing test procedures for the analysis of pollutants; and proposed regulations" (*Federal Register*, 1979, vol. 44, no. 233). Trace metal analyses were done by atomic absorbtion spectroscopy at the WDOE Tumwater laboratory.

Results

Routine Monitoring Program

All data generated through the Central Region's June-October 1982 monitoring program in the river are tabulated in Appendix II. Figures 4 through 10 were constructed from these data and show how D.O., fecal coliform, turbidity, suspended solids, specific conductivity, and nutrient concentrations changed with time and with distance downstream. Results for adjacent stations are plotted separately (YKM-1 with YKM-2; YKM-2 with YKM-4, etc.). At the bottom of each figure the data from the beginning and end of the Selah-Parker reach (YKM-1 and YKM-8) are also plotted together. Our observations on inspecting these figures are as follows:

D.O. (Figure 4) - River D.O. was always well above the Class A standard of 8.0 mg/L and near or above saturation values. The only portion of this reach with a consistent between-station drop in D.O. was between Selah and the Naches confluence, probably due to Golf Creek which contains Selah STP effluent and irrigation return flows.

The normal decrease in D.O. between the Selah discharge and the Naches River was about 0.2 to 0.3 mg/L over the summer with the largest decreases occurring after September 9 when the main water supply for the Sunnyside and Wapato irrigation systems came from the reservoirs on the Naches River rather than those on the Yakima River. With this shift in flow to the Naches, decreases in the D.O. level of the Yakima River below Selah ranged from 0.3 to 1.5 mg/L.

The other parts of the river monitored did not show substantial changes in D.O. On the average, the river contained 0.5 mg/L less D.O. at Parker bridge than at Selah bridge 12 miles upstream. D.O. began to increase at all stations in the fall because of lower water temperatures.

Temperature (not figured; see Appendix II) - Water temperatures were never in excess of the 21°C allowed this reach of the Yakima as a special condition of the Class A standards. The general Class A criterion of 18°C was rarely exceeded.

pH (not figured; see Appendix II) - pH was usually within the 6.5 to 8.5 range specified in the Class A standard. Values of 8.5 - 9.1 were measured occasionally. pH was determined on iced samples within 24 hours of collection rather than in the field and, therefore, may have varied somewhat from actual in-stream values.

Fecal coliform (Figure 5) - During most of the monitoring period, the Yakima River exceeded Class A fecal coliform standards prior to entering the Selah-Parker reach. The maximum concentration measured was 1000 col/100 ml. Fecal coliform concentrations did not increase below the Selah STP/Golf Creek discharge, based on results from the monitoring station above the Naches confluence 0.6 mile downstream.

The bacterial quality of the river was much improved from below the Naches confluence to the end of the reach at Parker bridge, probably largely due to dilution with Naches River and Rosa Power Return water. The river was generally within Class A standards except in September when a peak in fecal coliform concentrations occurred. The source(s) of contamination is not known but appeared to be between monitoring stations YKM-5 and -6 (r.m. 111.4 - 108.0) which bracket the Yakima STP and Chano Ditch. A cattle ranch on the east bank of the river is one potential source of fecal contamination here. If the Yakima STP discharge monitoring reports for June through October 1982 are accurate, the STP was probably not responsible for the September fecal coliform peak. Fecal coliform counts in the final effluent ranged from 20 to 300 colonies/100 ml in September (daily samples). Results of Chano Ditch bacterial samples collected during the intensive surveys of August 31 - September 1 and October 19-20 (discussed later in this report) showed this was also a source of minor significance.

Turbidity (Figure 6) - The only substantial increase in turbidity occurred in the lower river and probably reflects the influence of agricultural return flows, Birchfield (Moxee) Drain being the largest. Turbidity was highest in all parts of the river in June and July and then decreased in the fall as river and irrigation return flow dropped. The Class A turbidity standard allowing no more than a 5 NTU increase over background was exceeded during July and August below the Birchfield Drain/Wide Hollow Creek/Ahtanum Creek complex. During fall, turbidity did not change appreciably between Selah and Parker.

Total suspended solids (Figure 7) - The seasonal and downstream patterns for suspended solids were the same as described above for turbidity. Suspended solids concentrations in the range observed in these samples (1 to 50 mg/L) are considered to afford a high-to-moderate level of protection for aquatic life (2).

Specific conductivity (Figure 8) - Dissolved solids (indirectly measured by conductivity) gradually increased over the course of the summer and fall. The sudden increase seen above the Naches confluence in September coincided with the reduced Yakima River flow mentioned previously. A consistent increase in conductivity of about 10 percent occurred at the end of the reach due to the influence of Ahtanum and Wide Hollow creeks and Birchfield Drain.

Nitrogen (Figure 9) - Total inorganic nitrogen (NH_3-N + NO_2-N + NO_3-N) typically increased between successive downstream stations, except below the Naches River and Rosa Power Return where nitrogen concentrations decreased, again probably due to dilution. Concentrations in the lower river were generally higher in late summer and fall than earlier in the year. The average net increase over the course of the Selah-Parker reach was .07 mg/L, or about 50 percent, during the monitoring period. Neither ammonia nor nitrite were measured at concentrations toxic to aquatic life.

Phosphorus (Figure 10) - Phosphate concentrations did not change appreciably along this reach except between stations bracketing the Yakima STP where an increase of .01 to .03 mg/L T-PO_4-P typically occurred. Phosphate concentrations, like inorganic nitrogen and conductivity, tended to increase slightly over the course of the summer and fall in the lower river. On the average, T-PO_4-P concentrations were about 35 percent higher at Parker than at Selah.

Intensive Surveys

Quality of Point and Non-point Discharges - Tables 2 and 3 summarize the water quality data collected on August 31 - September 1 and October 19-20 on municipal/industrial effluents, irrigation returns, and tributaries discharging to the Yakima River between Selah and Parker. Major characteristics of each discharge are briefly described below, based on these data.

Selah STP and Golf Creek - Selah STP is subject to periodic upsets due to variable BOD loads from Tree Top, Inc., as documented in WDOE's most recent Class II inspection (*3*). On August 31 - September 1, the plant was operating within its NPDES permit limits. Golf Creek downstream of the outfall was clear but low in D.O. (4.2 to 5.2 mg/L), of marginal bacterial quality (140 - 500 col/100 ml), and contained relatively large amounts of nitrate (0.57 mg/L NO_3-N) and phosphate (.25 mg/L T-PO_4-P). The creek was not sampled upstream of the STP outfall so background water quality data for the creek is lacking.

During the October 19-20 survey, the plant was not operating properly. Its discharge violated flow, BOD, TSS, and fecal coliform limits by large margins and appeared to be causing substantial D.O., coliform, solids, and turbidity problems in Golf Creek. The creek was severely degraded aesthetically. Golf Creek:Selah STP dilution ratios were only 14:1 and 10:1 on August 31 - September 1 and October 19-20, respectively. This is well below the 20:1 ratio recommended by WDOE (*4*).

Naches River - Both surveys showed the Naches to be a source of good quality water to the Yakima system.

Boise Cascade Pond and Canal - Boise Cascade Pond collects log sort yard runoff and has a small discharge to the river. The most noteworthy survey finding was high fecal coliform counts (2,400 to 12,000 col/100 ml) in samples collected August 31 - September 1. During the October 19-20 follow-up survey, counts were only 33 to 80 col/100 ml. *Klebsiella pneumoniae*, a bacterium often associated with wood waste and other organic substrates and a positive interference in the fecal coliform analysis, accounted for 8 percent and 13 percent of the fecal coliform colonies in the two October samples so analyzed. *Klebsiella* analysis was not done for the first survey. This discharge was within its NPDES permit during both surveys.

Boise Cascade Canal (also called the PP&L Canal) contains excess irrigation flow, discharges from the mill, cooling water from two food processors, and urban runoff. Water quality problems noted here were elevated fecal coliform bacteria (160 - 760 col/100 ml) on August 31 - September 1 and low D.O. (4.1 mg/L, average), and high BOD (10 mg/L) on October 19-20. Samples of Boise Cascade's discharge into the canal were not collected so permit compliance and receiving water impacts cannot be assessed for the intensive surveys. Boise Cascade's discharge monitoring reports show their discharge into the canal was generally within permit limits during the summer and fall of 1982.

Rosa Power Return - This return and the Naches River at times account for a large fraction of the flow in the Selah-Parker reach of the Yakima River. During the August 31 - September 1 survey, their combined flows were equal to between 60 and 100 percent of that in the Yakima at Selah. Like the Naches, Rosa Power Return had good water quality. Judging by its low conductivity, it apparently changes very little after diversion from the Yakima 14.5 miles upstream.

Snokist - Both surveys showed the Snokist effluent to be within permit limits. Fecal coliform counts of 4,500 to 9,200 col/100 ml were found in the August 31 - September 1 samples of the clarifier effluent. It was later discovered that this effluent is mixed with an intermittent flow of recycled, chlorinated process water prior to discharge into the river. The October 19-20 bacterial samples were collected from the outfall on the river's bank rather than at the clarifier. This final effluent had 95 to 680 col/100 ml, 13 to 24 percent of which were *Klebsiella pneumoniae*.

The Snokist effluent had the highest nitrate and phosphate concentrations of all discharges monitored in these surveys. 8.3 mg/L NO_3-N and 31 mg/L T-PO_4-P were measured August 31 - September 1 and October 19-20, respectively. Ammonia and ammonium phosphate are added to the wastewater treatment system influent to balance the nutrient deficiency of the cannery waste.

Yakima STP - Yakima STP was meeting permit limits during both surveys, with the exception of very high fecal coliform concentrations on August 31 - September 1. Six samples collected at the end of the chlorine contact chamber averaged 14,000 col/100 ml with a range of 930 to 48,000 col/100 ml compared to the 234 and 210 col/100 ml reported by the plant operators on those two days. This discrepancy may be because the operators were switching from one basin of the chlorine contact chamber to the other during the time some of these samples were collected. Fecal coliform concentrations during the October 19-20 survey were in agreement with the consistently low levels reported in the plant's 1982 monitoring reports. Based on the intensive survey data, the STP discharge would not have resulted in toxic concentrations of un-ionized ammonia or total residual chlorine below the outfall after mixing.

Chano Ditch - Irrigation overflow water, non-contact cooling water from warehouses, and urban runoff enter the Yakima River via Chano Ditch. The ditch was low in bacterial quality and had a NO_3-N content of 2 to 2.1 mg/L - among the highest of the non-point sources monitored. The relatively high levels of NO_3-N may be partly due to oxidation of ammonia escaping from leaks in the warehouse cooling system. Under the dry-weather conditions that existed during both intensive surveys, this ditch ran clear and contained less than 1 mg/L suspended solids.

Birchfield (Moxee) Drain and Postma Ditch - Birchfield Drain is the major irrigation return and third largest discharge to this reach of the Yakima. Postma Ditch receives effluent from the Moxee STP in addition to irrigation return flows. Both Birchfield and its tributary, Postma Ditch, showed evidence of fecal contamination and had high nitrate concentrations. Postma Ditch had the highest concentrations (4.9 to 5.3 mg/L NO_3-N) of all non-point sources sampled. Lower concentrations (.68 to 2.2 mg/L NO_3-N) were measured at the mouth of Birchfield Drain. Suspended solids concentrations were high (88 mg/L) in Birchfield Drain during the August 31 - September 1 survey. Postma Ditch was not an important source of solids. It should be noted that these solids data are based on surface grabs and, although appropriate for comparisons between different discharges, may not be an accurate measurement of the average suspended solids concentrations in the water column.

Wide Hollow and Ahtanum Creeks - These creeks were similar in quality, each being a relatively clear, well-oxygenated stream. They met Class A standards except for fecal coliform. Wide Hollow Creek had 1.2 to 1.7 mg/L NO_3-N -- twice the concentration found in Ahtanum Creek.

Pollutant Loads and River Water Quality

Point and non-point loads in pounds per day of BOD, fecal coliform (col/day), NH_3-N, NO_3-N, T-PO_4-P, and TSS calculated from the August 31 - September 1 and October 19-20 data discussed above are shown in Table 4. Tables 5 and 6 contain corresponding water quality data for the river. This information was used to construct Figures 11 through 14 which locate each load by river mile and compare load distribution in this reach to the changes observed in river water quality. Reference to routine monitoring data, discussed earlier in this report, indicates that the intensive surveys coincided with periods of maximum river impacts for D.O., fecal coliform, and nutrients, but minimum impacts due to suspended solids and turbidity.

D.O./BOD (Figure 11) - There was ample D.O. in the river during both intensive surveys, as already documented in the routine monitoring results. On August 31 - September 1, point and non-point BOD loads were having little, if any, effect on river D.O. Larger effects were observed October 20 when river flow was half that of the previous survey. Small D.O. sags averaging 1.5 and 1.9 mg/L occurred in the river immediately below the Yakima STP and at Wapato Diversion Dam below the Birchfield Drain/Wide Hollow Creek/Ahtanum Creek complex, two sites not included in the routine monitoring program. At no time was the Class A 8.0 mg/L standard violated. A single low measurement of 9.3 mg/L in the early morning below the STP may overestimate the sag there. All river stations during both surveys showed a gradual rise in D.O. over the course of a day, presumably in response to photosynthesis. This effect was greatest on the October 19-20 survey during which time mid-afternoon D.O.s ranged from 1.4 to 2.9 mg/L higher than in the early morning, depending on sampling station.

The largest BOD loads were from the Naches River and Rosa Power Return, but this was by virtue of their volume and had no adverse effect on the river. Relative BOD loads are ranked below for the remaining discharges. Loads contributing more than 10 percent of the total load (an arbitrary cut-off) are highlighted.

Source	Percent of Total BOD Load to Selah-Parker Reach of Yakima River	
	August 31 - September 1	October 19-20
Golf Creek	9	/30/
Boise Cascade Pond	1	<1
Boise Cascade Canal	9	4
Snokist Effluent	<1	4
Yakima STP Effluent	/58/	/43/
Chano Ditch	1	3
Birchfield Drain	/14/	9
Wide Hollow Creek	4	3
Ahtanum Creek	3	5

The Yakima STP effluent represented the largest BOD load to this reach of the river. Birchfield Drain was a source of secondary importance. During periods of upset at the Selah STP, Golf Creek's BOD load to the river was greatly increased. BOD loads from the other discharges were not significant.

Fecal coliform (Figure 12) - Fecal coliform concentrations had a wide range at each of the four river stations monitored during the intensive surveys. The highest concentrations occurred at the beginning and end of the Selah-Parker reach, with Class A standards being met in mid-reach. The figure suggests that Birchfield Drain, Wide Hollow Creek, and Ahtanum Creek bear some responsibility for the lower bacterial quality of the river at Parker. The October data probably aren't sufficient to accurately describe the river's bacterial quality.

Fecal coliform loads are ranked below, exclusive of the Naches River and Rosa Power Return for reasons previously explained.

Source	Percent of Total Fecal Coliform Load to Selah-Parker Reach of Yakima River	
	August 31 - September 1	October 19-20
Golf Creek	1	/91/
Boise Cascade Pond	2	<1
Boise Cascade Canal	2	<1
Snokist Effluent	2	<1
Yakima STP Effluent	/62/	<1
Chano Ditch	1	1
Birchfield Drain	/14/	3
Wide Hollow Creek	/14/	4
Ahtanum Creek	3	<1

The high Yakima STP load measured August 31 - September 1 apparently does not reflect typical disinfection practices. This atypical result aside, Birchfield Drain and Wide Hollow Creek were the most prominent sources. Golf Creek's load was very large during upset conditions at the Selah STP in October. Water samples were not taken at a point in the river that would reflect the impact of the October 19-20 coliform load. As previously mentioned, the Central Region's routine monitoring data did not show an increase in fecal coliform concentrations .6 mile downriver of the Selah STP/Golf Creek discharge during the period of mid-June to mid-October.

Nitrogen (Figure 13) - Both intensive surveys demonstrated that a substantial increase in inorganic nitrogen concentration occurred downstream of the Yakima STP. This was also seen in the routine monitoring data.

The calculations below demonstrate that the total inorganic nitrogen (TIN) load from the Yakima STP and the Birchfield Drain/ Wide Hollow Creek/Ahtanum Creek complex was potentially sufficient to account for the 250 percent increase observed in the lower river on October 19-20 when the largest effects were observed.

1. Yakima STP Effluent + Yakima R. above STP:

$$\frac{(7.05\ \text{mg/L*} \times 13.2\ \text{cfs}) + (.08\ \text{mg/L} \times 1148\ \text{cfs})}{13.2\ \text{cfs} + 1148\ \text{cfs}} =$$

Calculated TIN conc. after mixing	Observed TIN conc. downstream of STP
.16 mg/L	.17 mg/L

2. Birchfield Drain + Wide Hollow Creek + Ahtanum Creek + Yakima River above Birchfield Drain:

$$\frac{(1.60\ \text{mg/L} \times 77.6\ \text{cfs}) + (.17\ \text{mg/L} \times 1170\ \text{cfs})}{77.6\ \text{cfs} + 1170\ \text{cfs}} =$$

Calculated TIN conc. after mixing	Observed TIN conc. downstream of drain & creeks
.26 mg/L	.28 mg/L

*This calculation uses inorganic nitrogen data from the August 31 - September 1 survey. Because of a mechanical failure in the automatic compositor, the October 19-20 data for the STP effluent are from a composite of three 2-liter grabs collected 1205 to 1730 hours, October 20 rather than the usual 24-hour composite and therefore not a representative sample. If the high inorganic nitrogen concentration (14.6 mg/L) measured in the grab composite is used in the above calculation, the calculated TIN value after mixing is .25 mg/L.

The relative source loadings for NH_3-N, NO_3-N, and TIN are ranked below.

Source	Percent of Total NH3-N, NO3-N, and TIN Loads to Selah-Parker Reach of Yakima River					
	August 31 - September 1			October 19-20		
	NH_3-N	NO_3-N	TIN	NH_3-N	NO_3-N	TIN
Golf Creek	<1	5	4	2	/10/	6
Boise Cascade Pond	<1	<1	<1	<1	<1	<1
Boise Cascade Canal	1	4	2	<1	<1	<1
Snokist Effluent	<1	6	3	<1	<1	<1
Yakima STP Effluent	/93/	9	/49/	/96/	5	/54/
Chano Ditch	<1	/10/	5	<1	/11/	5
Birchfield Drain	3	/31/	/18/	<1	/38/	/18/
Wide Hollow Creek	<1	/30/	/16/	<1	/27/	/13/
Ahtanum Creek	<1	5	3	<1	9	4

The Yakima STP accounted for 93 to 96 percent of the NH_3-N load to the river. Birchfield Drain and Wide Hollow Creek were the major NO_3-N sources. Loads of NH_3-N and NO_3-N upstream of the Yakima STP were not significant, with the possible exception of Golf Creek on October 19-20 which, theoretically, could cause an increase in the river's NO_3-N concentration from .07 to .10 mg/L. The Yakima STP was responsible for about half the inorganic nitrogen load to the river.

Phosphorus (Figure 14) - As already seen in the routine monitoring data, the major increase in the river's phosphorus content occurred between stations bracketing the Yakima STP. Figure 14 also shows that a substantial increase occurred on October 20 in the upper river, apparently due to the Snokist discharge.

The theoretical change in the river's T-PO_4-P concentration after mixing with the Snokist and Yakima STP effluents of October 19-20 was calculated below.

1. Snokist Effluent / Yakima R. above Snokist

$$\frac{(31\ \text{mg/L} \times 1.87\ \text{cfs}) + (.03\ \text{mg/L} \times 1148\ \text{cfs})}{1.87\ \text{cfs} + 1148\ \text{cfs}} =$$

Calculated T-PO_4-P conc. after mixing	Observed T-PO_4-P conc. downstream
.08	.06 mg/L

2. Yakima STP Effluent / Yakima River above STP

$$\frac{(2.6\ \text{mg/L}^* \times 13.2\ \text{cfs}) + (.06\ \text{mg/L} \times 1148\ \text{cfs})}{13.2\ \text{cfs} + 1148\ \text{cfs}} =$$

Calculated T-PO_4-P conc. after mixing	Observed T-PO_4-P conc. downstream
.09	.12 mg/L

*August 31 - September 1 data, see footnote for nitrogen calculation.

Although both effluents were capable of substantially increasing T-PO_4-P concentrations in the river, agreement between calculated and observed T-PO_4-P concentrations is not very good. Mass balance often does not work well with phosphorus because it tends to associate with particulate matter and, as a consequence, not act conservatively.

T-PO_4-P loads to the river are ranked on the following page.

Source	Percent of Total T-PO_4-P Load to Selah-Parker Reach of Yakima River	
	August 31 - September 1	October 19-20
Golf Creek	5	/11/
Boise Cascade Pond	<1	<1
Boise Cascade Canal	2	<1
Snokist Effluent	6	/40/
Yakima STP Effluent	/64/	/40/
Chano Ditch	1	<1
Birchfield Drain	/11/	4
Wide Hollow Creek	6	3
Ahtanum Creek	3	2

During the August 31 - September 1 survey, Yakima STP accounted for 64 percent of the T-PO_4-P load to the river. Other T-PO_4-P sources had a uniformly low load. On October 19-20, the load from Snokist equaled that of the STP. Together these two sources contributed 80 percent of the load to the river. Monitoring reports from Snokist show that phosphorus concentrations are highest in the fall. Total phosphorus concentrations of up to 40 mg/L, higher than measured in the present survey, were reported for November 1981. As noted previously, phosphate is added in the Snokist treatment process.

<u>Suspended solids (not figured)</u> - Total suspended solids loads are ranked below.

Source	Percent of Total Suspended Solids Load to Selah-Parker Reach of Yakima River	
	August 31 - September 1	October 19-20
Golf Creek	<1	/28/
Boise Cascade Pond	<1	<1
Boise Cascade Canal	3	2
Snokist Effluent	<1	2
Yakima STP Effluent	<1	/12/
Chano Ditch	<1	<1
Birchfield Drain	/88/	/50/
Wide Hollow Creek	4	2
Ahtanum Creek	2	4

Birchfield Drain contributed most of the suspended solids load to the river during August 31 - September 1. Its relative importance was less in the fall with lower return flows. These data do not reflect conditions when maximum impacts to the river occur. Suspended solids concentrations in the river were essentially unchanged between Selah and Parker during the intensive surveys. It is probable that the load from Birchfield Drain and, perhaps, Ahtanum and Wide Hollow creeks, is much larger in June and July when turbidity problems are encountered in the lower river.

Priority Pollutant Screening Survey

The results from priority pollutant analysis of grab samples taken from nine of the point- and non-point sources in this reach are shown in Tables 7 (organics) and 8 (metals). Sixteen organic priority pollutants were present in detectable concentrations - primarily aromatic hydrocarbons, phthalate acid esters, haloforms, and chlorinated ethylenes in effluents from the Selah STP, Yakima STP, and Snokist and in Boise Cascade Canal. Concentrations were low in these samples; i.e., several parts per billion or less, and well within EPA criteria for protection of aquatic life. DDT and its metabolites, DDE and DDD, were found in Birchfield Drain, Wide Hollow Creek, and Boise Cascade Canal (DDE only). The creek and canal samples contained concentrations slightly in excess of levels considered by EPA to be protective of aquatic life. Larger amounts of DDT compounds, .01 to .04 μg/L, were present in Birchfield Drain -- an order of magnitude greater than the EPA 24-hour average criterion of .001 μg/L. High concentrations of DDT, DDE, and DDD (31, 170, and 60 μg/Kg, dry, respectively) were also measured in a single sediment sample collected from the mouth of Birchfield Drain at the same time as the water sample. These concentrations are higher than those measured by EPA in 51 water and 36 sediment samples recently collected at 42 sites throughout Washington State (5). A preliminary review of the literature on hand reporting DDT levels in other parts of the United States suggests DDT compounds in the Birchfield Drain samples may be in the upper end of the concentration ranges reported by other investigators.

Trace metals concentrations were low in most discharges sampled and in the Birchfield Drain sediment sample. The Yakima STP effluent sample contained 20 μg/L copper which is slightly above the EPA protection criteria of 5.6 μg/L (24-hour average) and 12 μg/L (maximum). Zinc concentrations in the Yakima STP effluent, Boise Cascade Canal, Wide Hollow Creek, and Birchfield Drain were intermediate between the 24-hour average and maximum criteria.

Discussion

In these surveys, the adverse effects on water quality observed in the Yakima River during its transit from Selah to Parker were: (1) D.O. sags of .3 to 1.5 mg/L below the Selah STP/Golf Creek discharge during the month of September; (2) D.O. sags averaging 1.5 and 1.9 mg/L, respectively, immediately below the Yakima STP and at the Wapato Diversion Dam during low flow on October 20; (3) violations of the Class A fecal coliform standard in the lower parts of the reach in September; (4) increases in total inorganic nitrogen and total phosphate concentrations averaging 50 percent and 35 percent, respectively, during the period June - October; and (5) violations of the Class A turbidity standard in the lower parts of the reach during July and August. In addition, water quality problems were identified in Golf Creek due to the Selah STP discharge.

Because of the Yakima River's large dilution capacity, only minor changes in the river's D.O. content were observed and these were associated with low flow. The colder water temperatures and resulting higher D.O. experienced during the September - October low-flow period provided an additional buffer against D.O. problems occurring in the reach.

A simple and conservative method for determining if significant BOD levels exist in receiving waters is to assume that BOD does not decay, and calculate a BOD mass balance. If BOD remains low, the inclusion of decay rates and reaeration coefficients would only serve to further lower in-stream BOD. River velocities in this reach are too high for sludges to deposit, so this demand can be ignored. A net positive change in D.O. due to plant photosynthesis and respiration would be likely in the Selah-Parker reach during September - October.

A mass balance of this type was calculated below using data from the October 19-20 low-flow survey in the first case and projected* BOD loads (supplied by Al Newman, Central Region) for Selah STP, Snokist and Yakima STP in the second case. The influence of Moxee, Hubbard, Union Gap, Richartz, and Blue Slough diversions on river flow were ignored since the sum of their average flows in October is only 36 cfs (Bureau of Reclamation).

Case I. Low-flow conditions of October 20, 1982, and existing loads.

Location	Point/non-point Source BOD Load, W (pounds/day)	Point/non-point Source Flow, Qw (cfs)	Yakima R. Upstream BOD Conc. Su (mg/L)	Yakima R. Upstream Flow, Qu (cfs)	Yakima R. Downstream Resulting BOD Conc. = $\frac{SuQu + W/5.38}{Qu + Qw}$ (mg/L)	Percent Change in BOD
Selah STP	520	1.92	2.0	673	2.1	+5
Naches River	4,500	381	2.1	675	2.1	0
Boise Cascade Pond + Canal	158	3.6	2.1	1,056	2.1	0
Rosa Power Return	1,000	194	2.1	1,060	1.9	-10
Snokist	150	1.87	1.9	1,148	1.9	0
Yakima STP	1,700	13.2	1.9	1,150	2.2	+15
Chano + Birchfield + Wide Hollow + Ahtanum	1,260	86	2.2	1,163	2.2	0
					Net percent change	+11

*These projected industrial and municipal loads are expected to occur in 5-10 years and 10-15 years, respectively.

Case II. Low-flow conditions of October 20, 1982, and projected STP and fruit processor loads.

Selah STP	3,146*	3.87	2.0	673	2.9		+45
Naches River	4,500	381	2.9	677	2.7		-7
Boise Cascade Pond + Canal	158	3.6	2.7	1,058	27		0
Rosa Power Return	1,000	194	2.7	1,062	2.4		-11
Snokist	1,228	3.87	2.4	1,148	2.6		+8
Yakima STP	4,779	29.6	2.6	1,152	3.3		+27
Chano + Birchfield + Wide Hollow + Ahtanum	1,260	86	3.3	1,182	3.3		0
						Net percent change	+62

*3,146 lbs/day = 525 lbs/day Selah STP + 2,421 lbs/day Tree Top + 200 lbs/day Hi-Country.

Based on the above calculations and underlying conservative assumptions, significant increases in BOD and resulting D.O. problems would not be expected during low flow with the projected wasteloads. This assessment is doubly conservative in that it uses the 1148 cfs flow at Terrace Heights on October 20 which is less than half the 7-day, 10-year low flow of 2640 cfs during the April-October irrigation season* (Al Newman, Central Region). These conclusions do not apply to Golf Creek which has insufficient flow to assimilate a BOD load of 3146 pounds/day as projected for Selah STP.

The potential for D.O. sags due to nitrogenous demand from the ammonia in the Yakima STP effluent is expected to decline in the future because of the capacity for operation in a nitrification mode (Al Newman, Central Region). Under the October 19-20 low-flow conditions, the 14 mg/L NH_3-N measured in the effluent had the potential for decreasing river D.O. by .78 mg/L (assuming 4.57 mg/L D.O. are required in the oxidation of 1 mg/L NH_3-N to NO_3-N). In-stream nitrification may have contributed to the small sag in D.O. observed immediately below the treatment plant. The depth, velocity, substrate, and pH conditions below the STP are well suited to establishment of nitrifying bacteria. The lower velocity and increased turbidity and depth of the river above the Wapato diversion are likely to have contributed to the second D.O. sag observed here by reducing aeration and photosynthesis. Although the term "sag" is used here, it should be noted that D.O. was near 100 percent saturation in both instances.

While fecal contamination was evident in most discharges to the reach, the bacterial quality of the river improved in passing from Selah to Parker. The river typically met Class A standards from Moxee Bridge (and probably Terrace Heights bridge) to Parker. Dilution with Naches River and Rosa Power Return water appeared to be the major reason for this. Although an unidentified source(s) between Moxee Bridge and

*In water year 1977, the driest on record, a minimum discharge of 565 cfs was measured March 27, 1977, in the Yakima River above Ahtanum Creek. This would result in a worst-case dilution ratio of 19:1 using the Central Region's projected flow for the Yakima STP.

Birchfield Drain caused violations of the Class A criterion in September, the overall results of our surveys indicate the bacterial quality of this reach is not a significant problem. The bacterial quality of Golf, Wide Hollow, and Ahtanum creeks, however, was insufficient for contact recreation.

Substantial increases in nutrient concentrations occur in this reach due to ammonia and phosphate in the Yakima STP effluent, nitrate in irrigation returns, and phosphate in Snokist effluent (during peak fruit processing in the fall). Based on the intensive survey results, 50 percent of the inorganic nitrogen load and 70 to 90 percent of the phosphate load to this reach of the Yakima were from municipal and industrial point sources.

The concentrations of $T\text{-}PO_4\text{-}P$ and $O\text{-}PO_4\text{-}P$ measured in the river exceed the .05 mg/L and .01 mg/L levels considered thresholds for algal blooms, other conditions being favorable (*6*). $NO_3\text{-}N$ was always below its .3 mg/L threshold concentration (*6*). These bloom criteria apply to lakes and sluggish rivers and streams. Nuisance growths of algae are not commonly a problem in fast-flowing stretches of river like this reach of the Yakima. Total inorganic nitrogen:orthophosphate ratios in the range observed in most of our samples from the river, 3:1 to 6:1, indicate these waters are nitrogen- rather than phosphorus-limited (*7, 8*). Under present conditions, there does not appear to be sufficient nitrogen in this reach to produce excessive algae growth regardless of the physical characteristics of the river. The importance of the eutrophication taking place between Selah and Parker lies chiefly in its contribution to algal growth problems that exist downstream in the lower Yakima River.

The major source of suspended solids (and turbidity problems) in this reach is Birchfield Drain. No data on solids inputs to the river were collected during the July and August period when violations of the Class A turbidity standard occurred so the relative importance of Wide Hollow Creek, Ahtanum Creek, and Birchfield Drain cannot be assessed. Adverse impacts on the river's aquatic life due to high suspended solids concentrations would be expected below Birchfield Drain. Judging from the routine monitoring data, this effect did not extend beyond Parker Bridge where suspended solids concentrations were within protective levels. Turbidity impaired the aesthetic qualities of the river from the mouth of Birchfield Drain to Parker Bridge and beyond.

CONCLUSIONS

Yakima River water quality between Selah and Parker was generally good. The river has the capacity to assimilate the increase in BOD load projected for this reach in the near future. Based on the studies reported here, a wasteload allocation does not need to be performed for this reach of the river.

Two water quality concerns identified in the river were turbidity and eutrophication. A major soil conservation effort, primarily on agricultural lands served by Birchfield Drain, would be required to mitigate the turbidity problems in the lower reach. The eutrophication that occurs between Selah and Parker is more amenable to control, being largely the result of municipal and industrial discharges. A comprehensive nutrient load allocation study for the Yakima River system would be needed to determine the relative importance of the incremental increase in nutrient concentrations between Selah and Parker and the costs and benefits of controlling nutrient addition.

Additional, localized problems documented in these surveys were poor water quality in Golf Creek due to the Selah STP discharge and high DDT concentrations at the mouth of Birchfield Drain. At low flow, the creek is not large enough to assimilate the treatment plant effluent and periodically becomes severely degraded during plant upsets caused by Tree Top's discharge. Further water quality degradation is to be expected with the increased wasteload projected. The Central Region should continue in its efforts to alleviate this problem. It is recommended that additional samples be collected in Birchfield Drain and in the Yakima River above and below the drain to better assess DDT levels there. Sediment and fish tissue would be the most useful types of samples to collect.

AJ:cp

Attachments

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3. Chase, S., 1981. Selah Sewage Treatment Plant Class II Inspection, WDOE memorandum.

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Figure 1. Study area for the WDOE water quality survey in the gap-to-gap reach of the Yakima River, June - October, 1982.

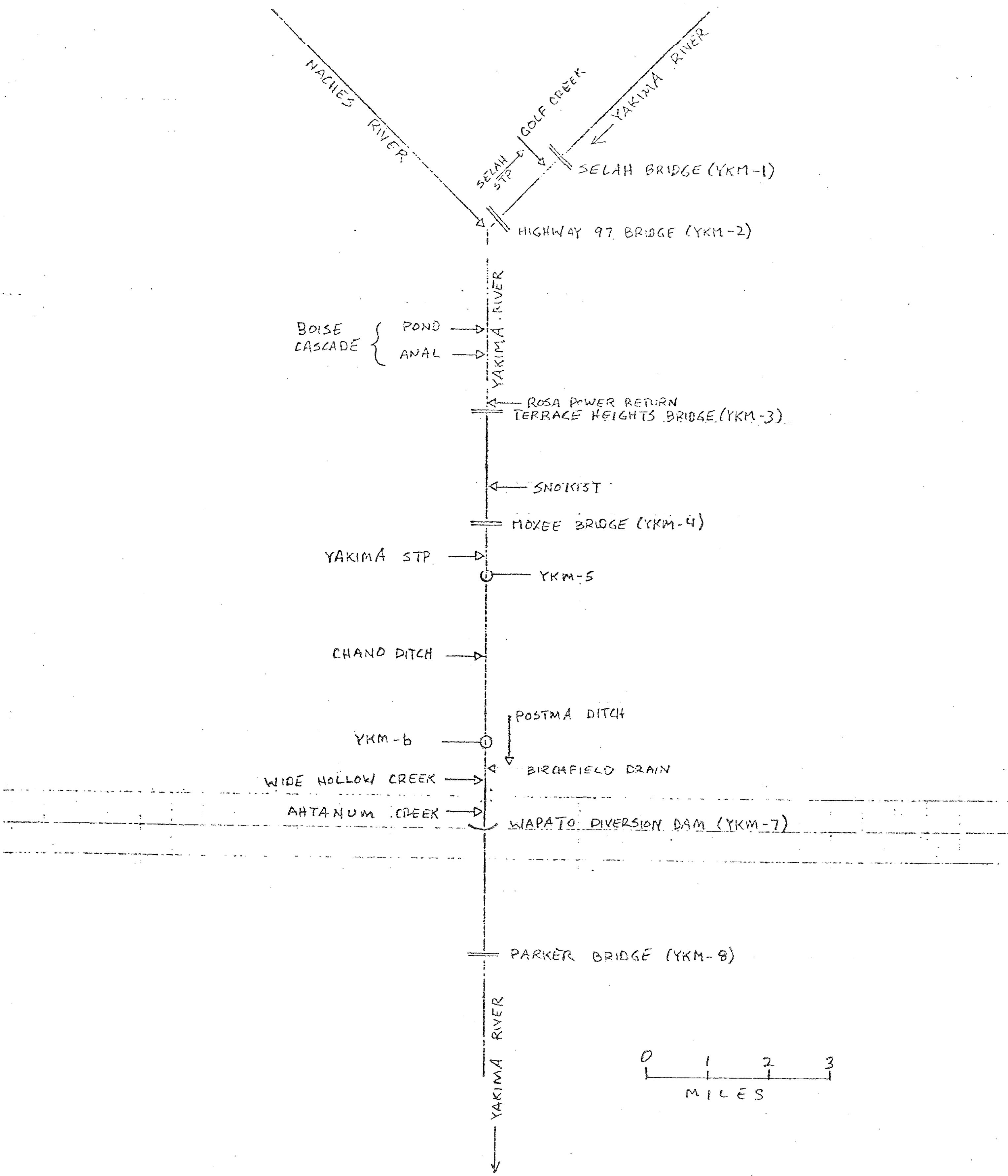
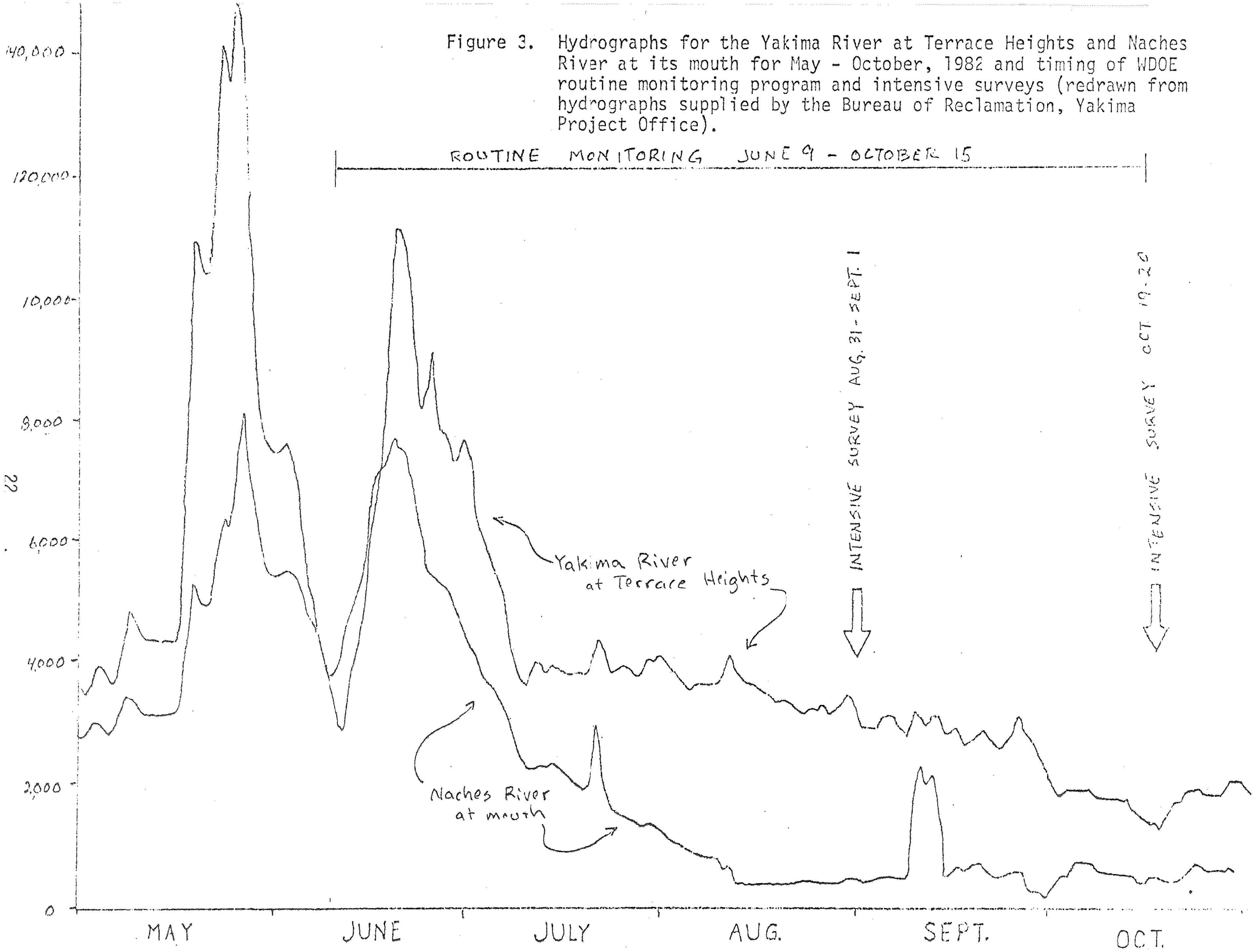


Figure 2. Schematic diagram of Yakima River system between Selah and Parker showing river stations (YKM-1, etc.) and point/non-point discharges (⟶) sampled by WDOE July - October, 1982.

Figure 3. Hydrographs for the Yakima River at Terrace Heights and Naches River at its mouth for May - October, 1982 and timing of WDOE routine monitoring program and intensive surveys (redrawn from hydrographs supplied by the Bureau of Reclamation, Yakima Project Office).



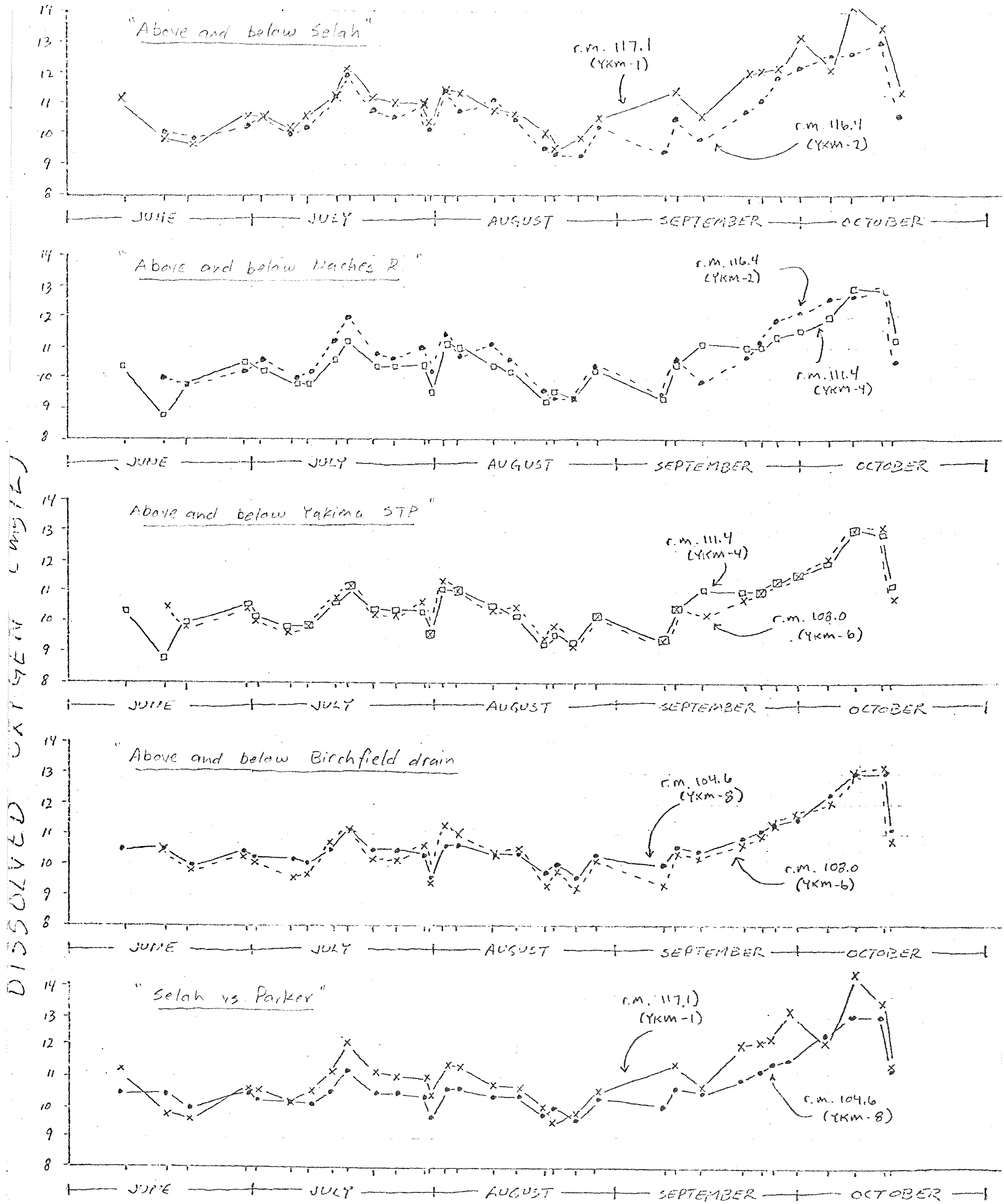


Figure 4. Changes in D.O. concentration with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October, 1982.

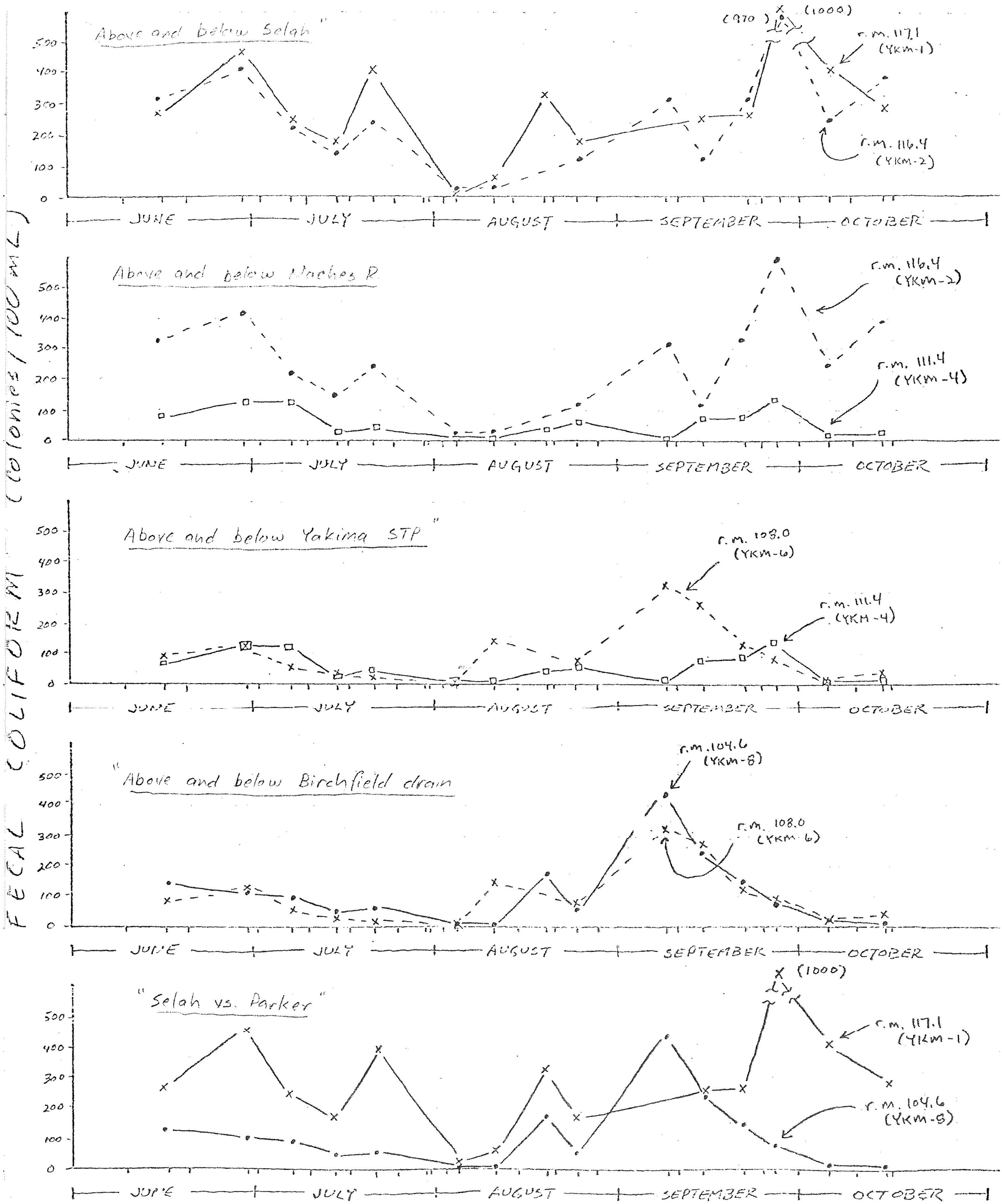


Figure 5. Changes in fecal coliform concentration with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October, 1982.

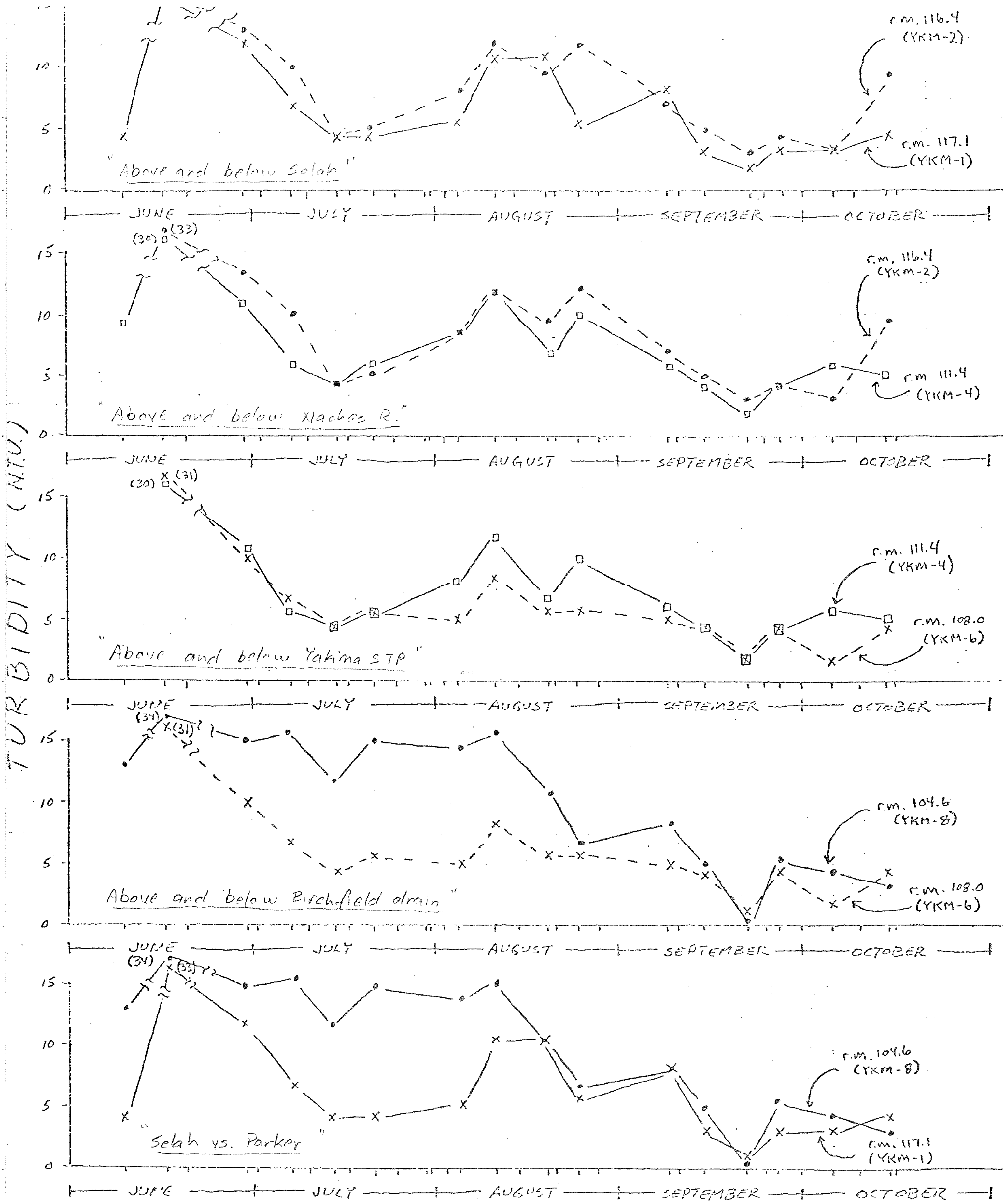


Figure 6. Changes in turbidity with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October, 1982.

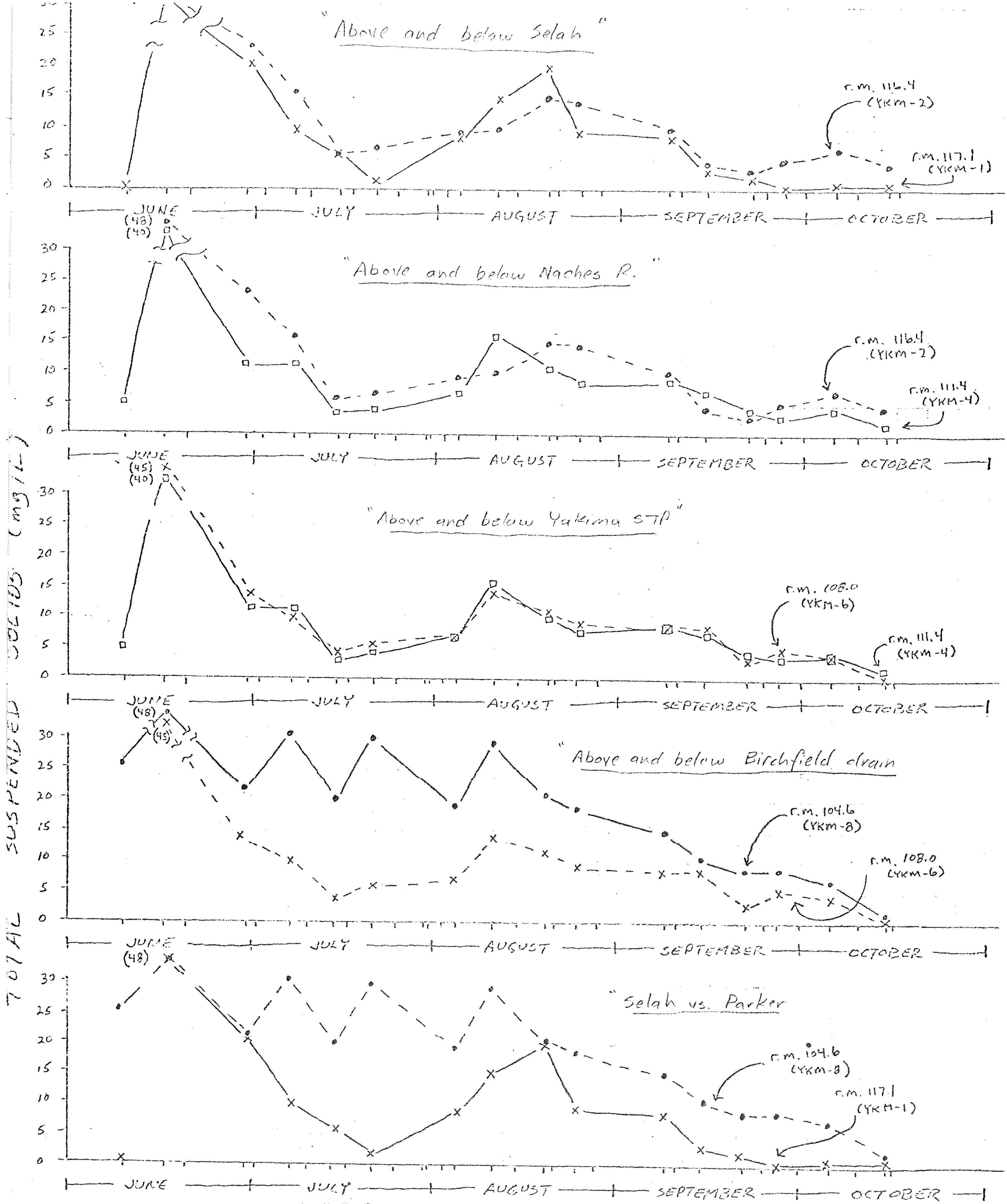


Figure 7. Changes in total suspended solids concentration with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October, 1982.

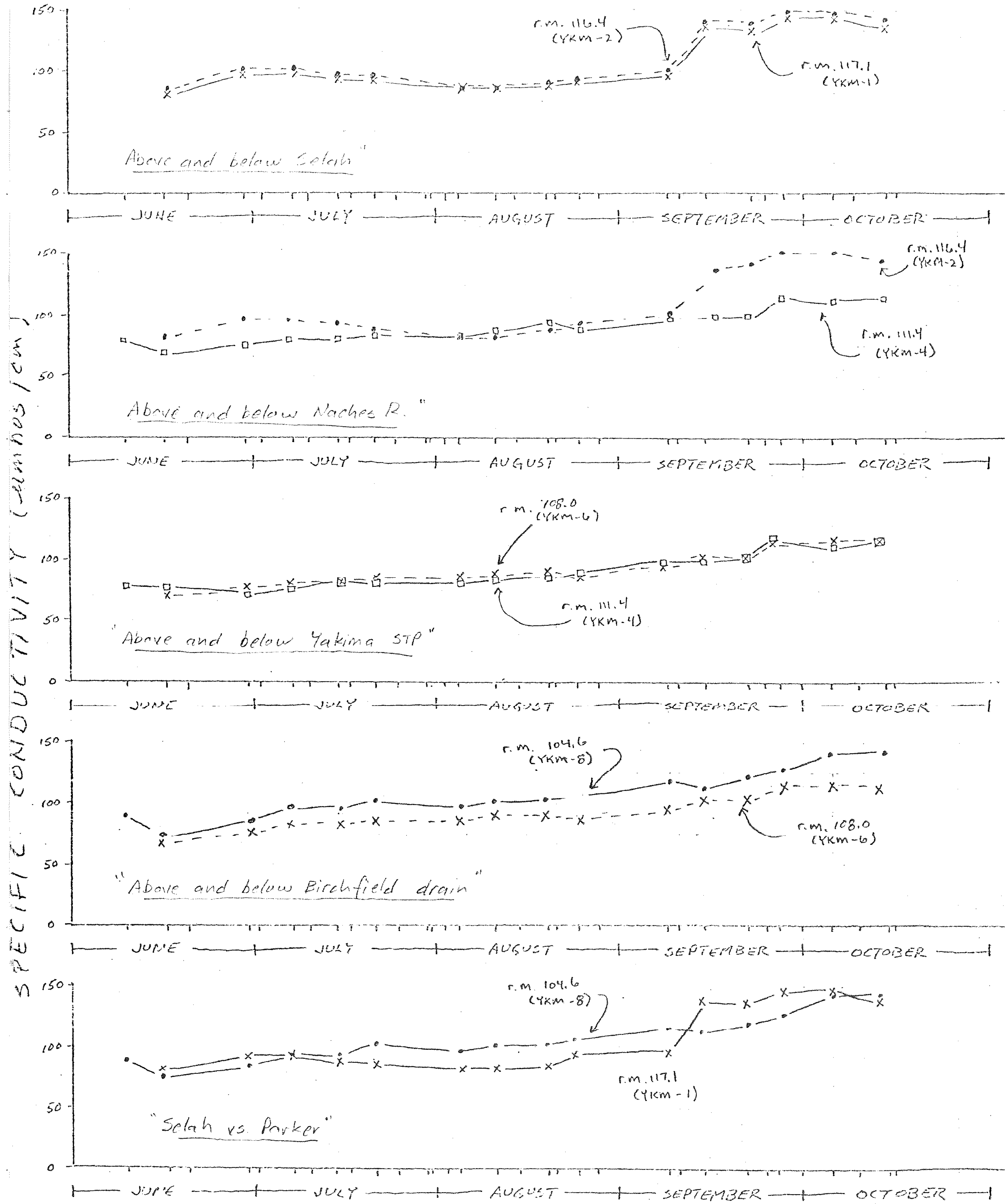


Figure 8. Changes in specific conductivity with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October, 1982.

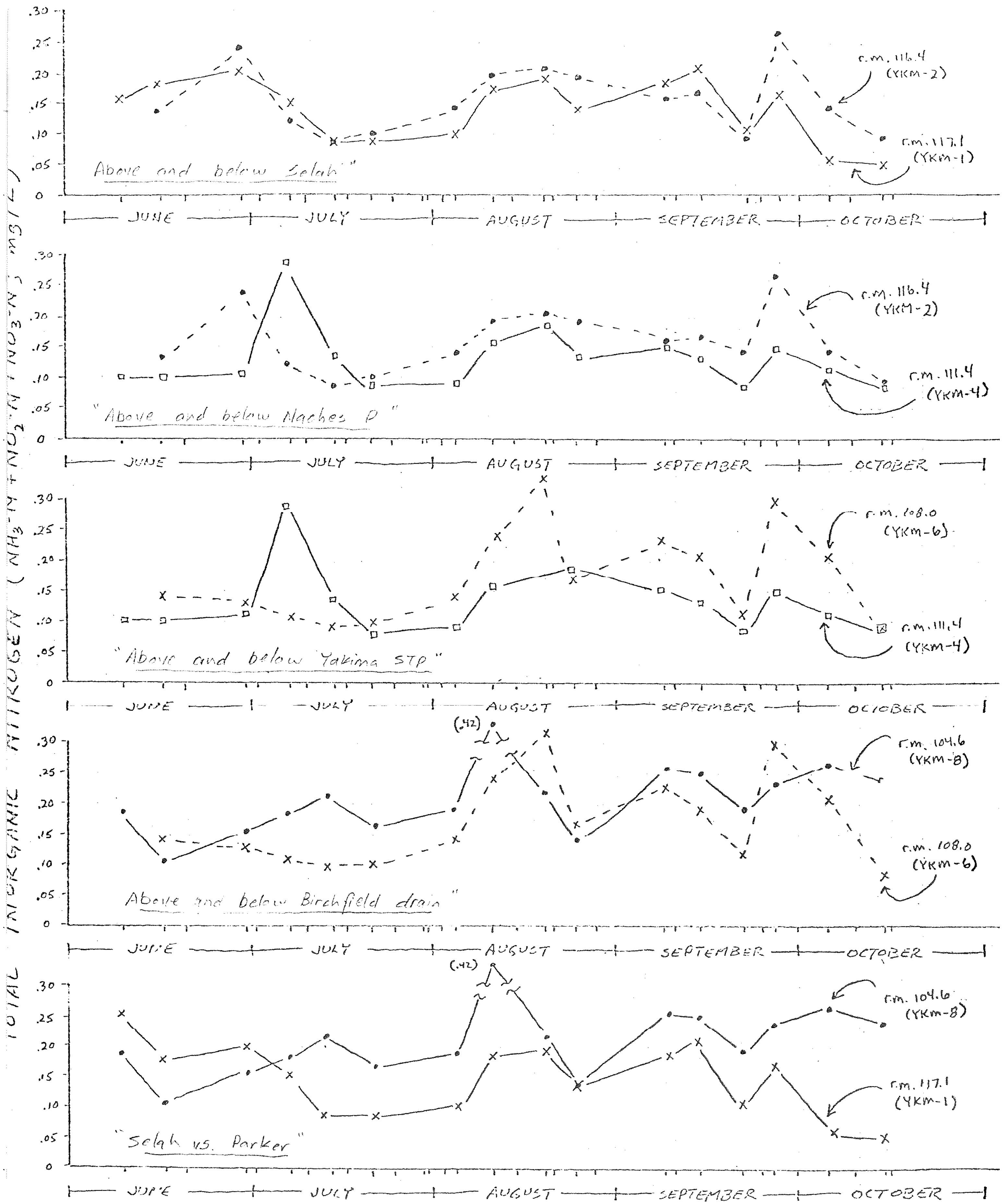


Figure 9. Changes in total inorganic nitrogen concentration with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October, 1982.

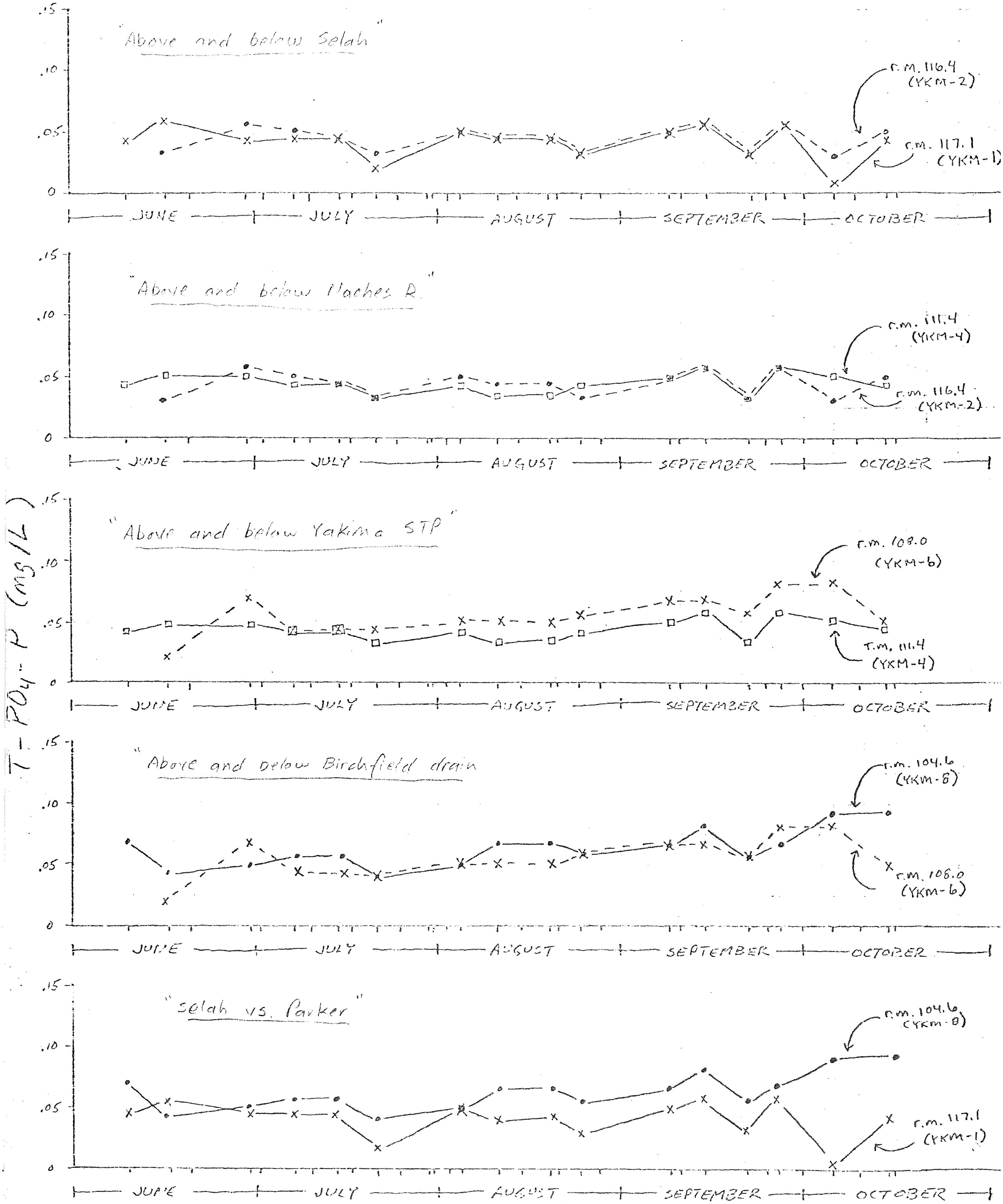


Figure 10. Changes in total phosphate phosphorus concentration with time at five locations in the Selah-to-Parker reach of the Yakima River (r.m. 117.1 - 104.6), June - October. 1982.

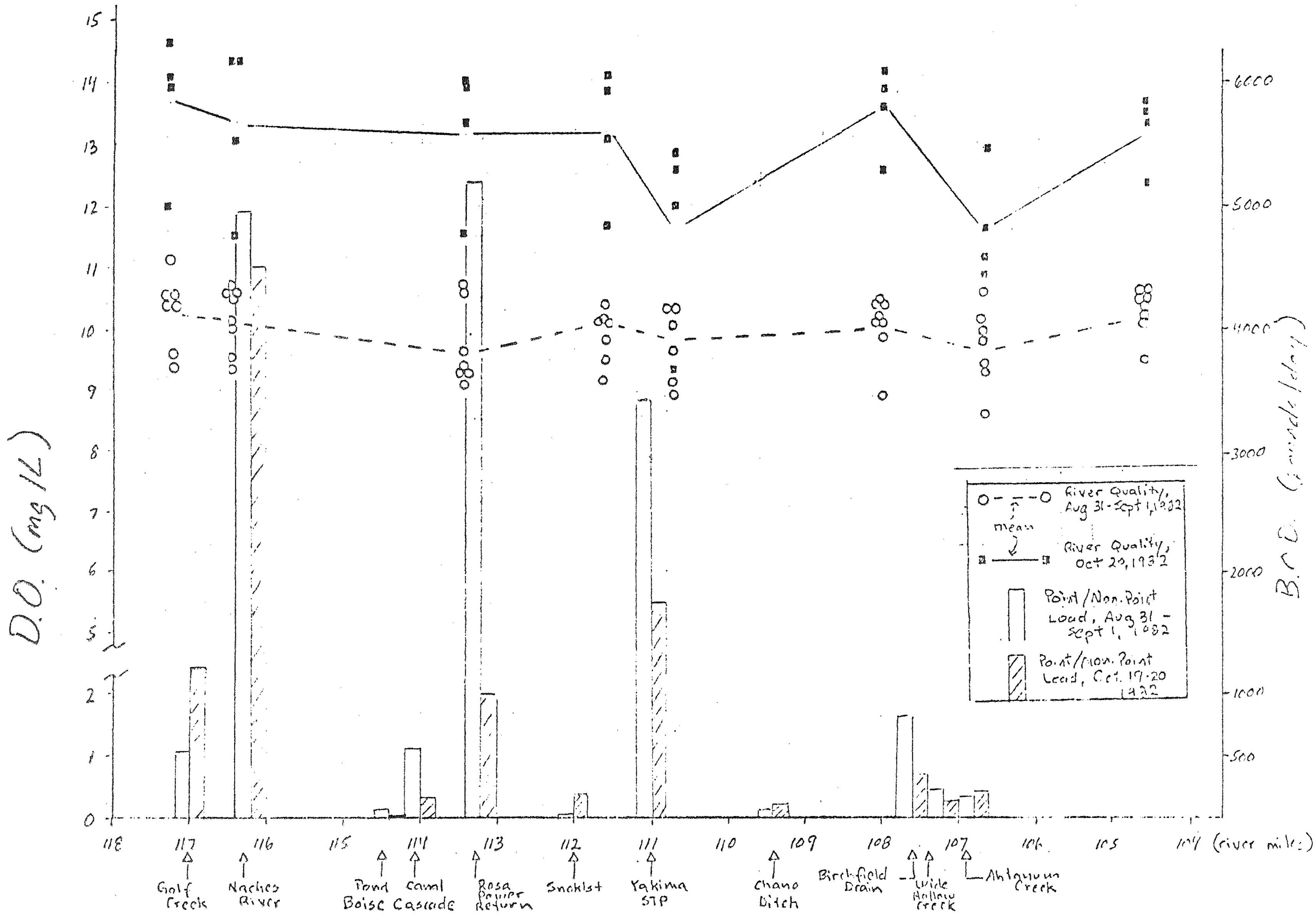


Figure 11. D.O. concentrations in the Selah-to-Parker reach of the Yakima River and associated BOD loads, August 31-September 1 and October 19-20, 1982.

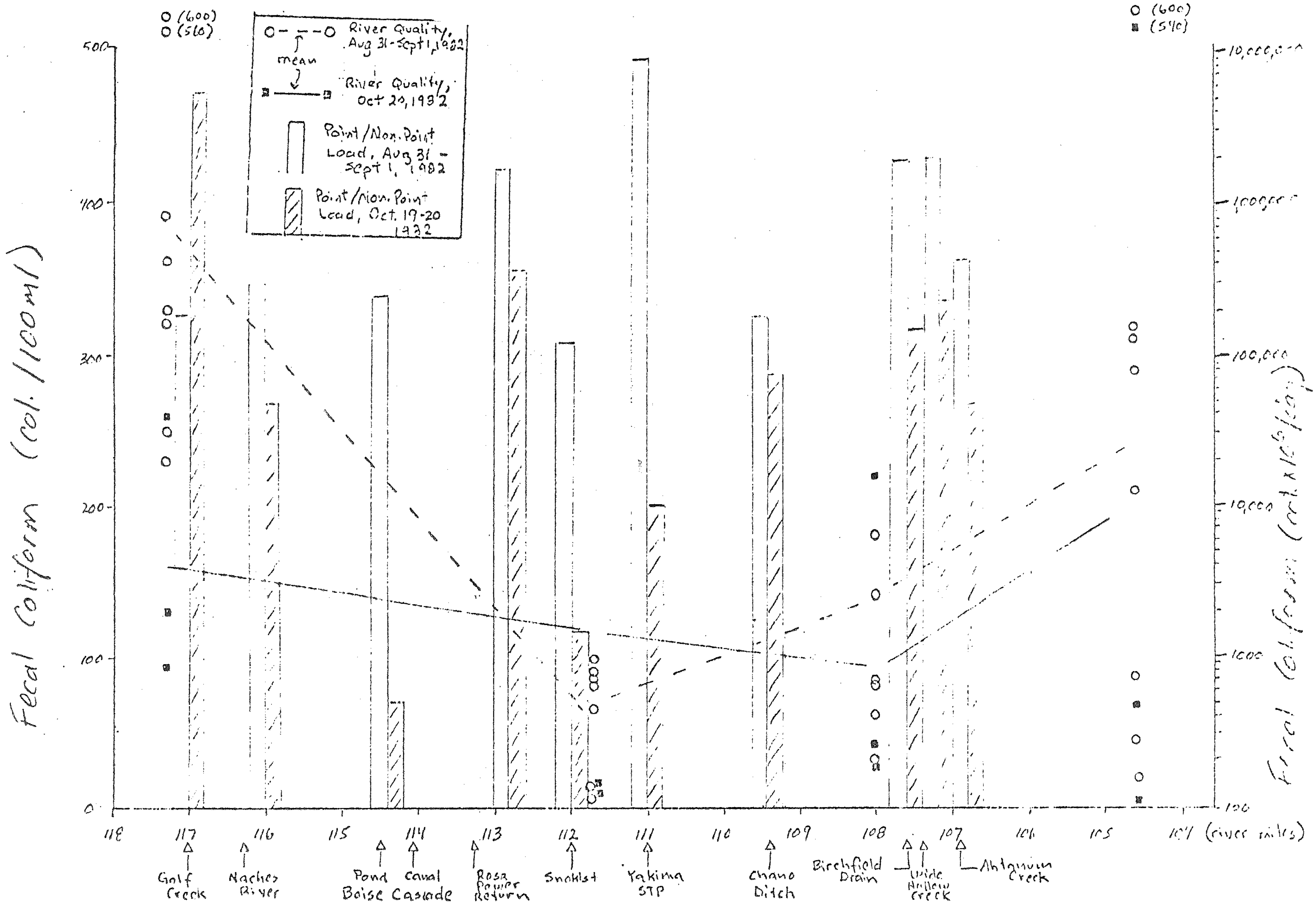


Figure 12. Fecal coliform concentrations in the Selah-to-Parker reach of the Yakima River and associated fecal coliform loads, August 31-September 1 and October 19-20, 1982.

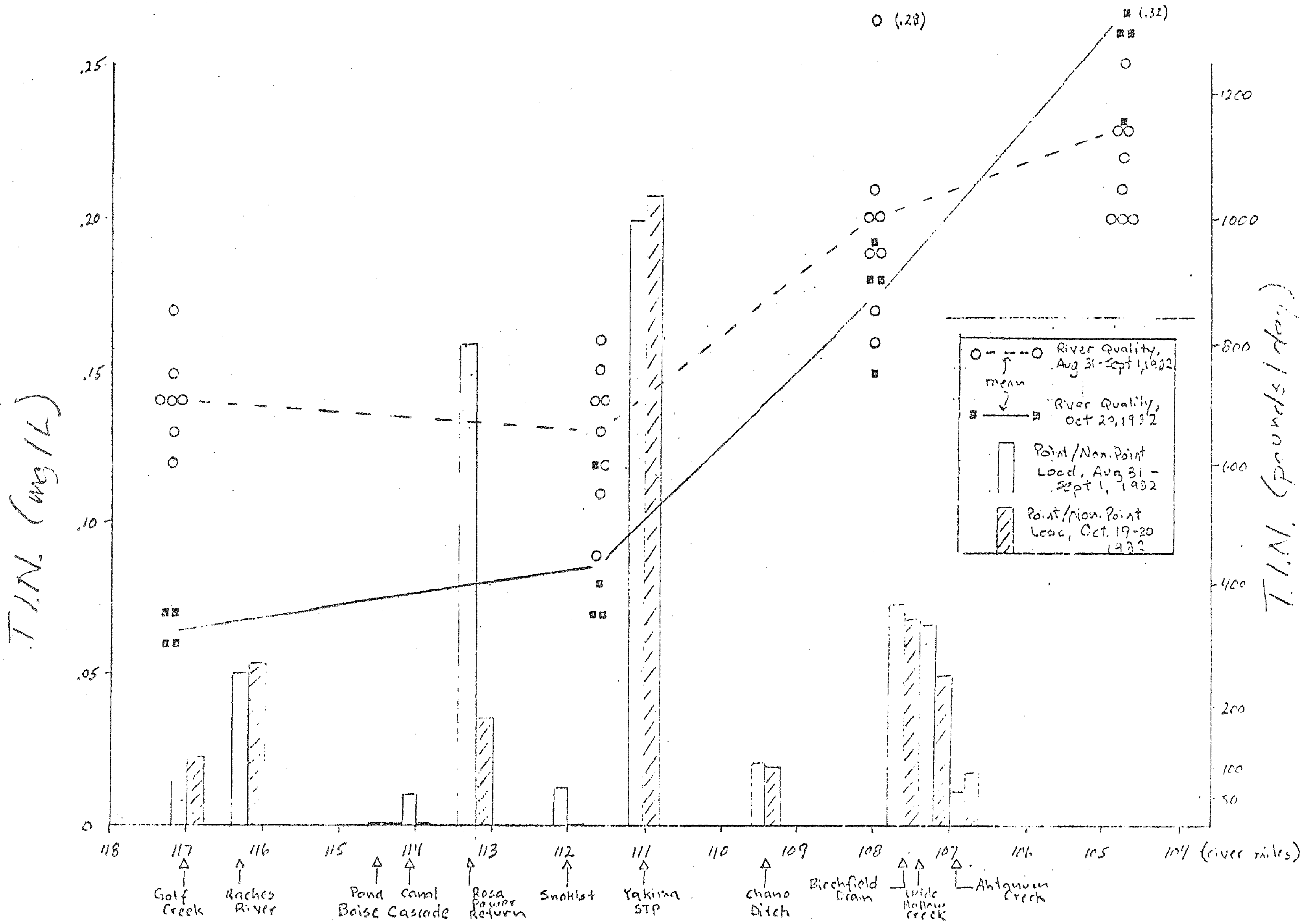


Figure 13. Total inorganic nitrogen (TIN) concentrations in the Selah-to-Parker reach of the Yakima River and associated TIN loads, August 31-September 1 and October 19-20, 1982.

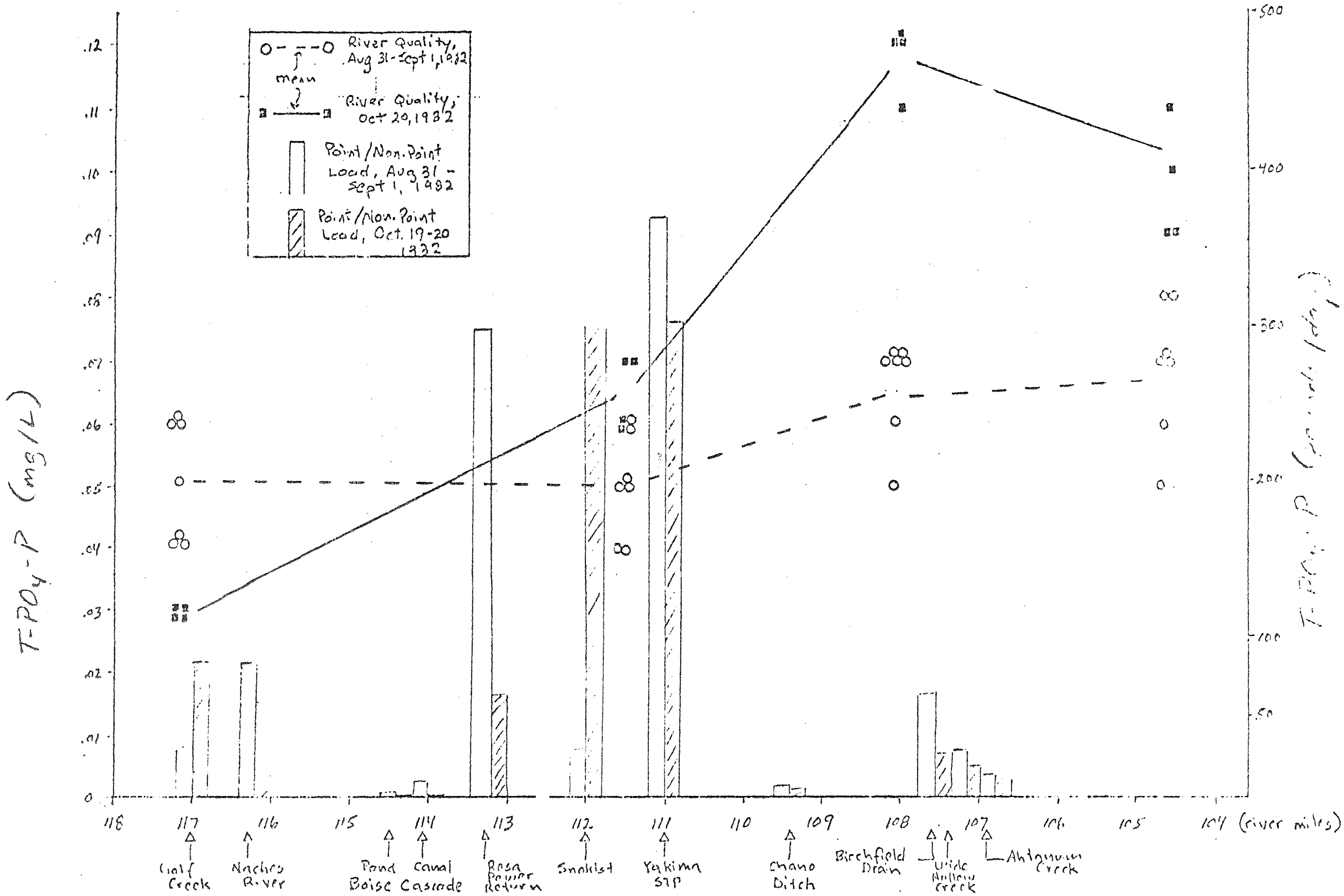


Figure 14. Total phosphate phosphorus concentrations in the Selah-to-Parker reach of the Yakima River and associated phosphate phosphorus loads, August 31-September 1 and October 19-20, 1982.

Table 1. Sampling schedule for WDOE intensive surveys in the Selah-Parker reach of the Yakima River, August 31 - September 1 and October 19-20, 1982.

Sampling Station	Parameter	Date and Time	Sampling Method	Number of Samples per Station
	1. August 31 - September 1 Survey			
A. River				
all stations	temperature, D.O.	0820, Aug. 31 - 1435, Sept. 1	grabs	8
YKM-1, 4, 6, 8	pH, conductivity, NH_3-N, NO_2-N, NO_3-N, T-PO_4-P, O-PO_4-P, TSS, turbidity, fecal coliform	0820, Aug. 31 - 1435, Sept. 1	grabs	8
YKM-1, 4, 6, 8	BOD_5	0820-1745, Aug. 31	grabs	3
B. Point and Non-Point Sources				
all sources	temperature, D.O.	0630-2020, Aug. 31	grabs	4
all sources	fecal coliform	1130, Aug. 30 - 1235, Sept. 1	grabs	6
Selah STP, Yakima STP, Boise Cascade canal, Snokist	pH, conductivity, NH_3-N, NO_2-N, NO_3-N, T-PO_4-P, O-PO_4-P, TSS, turbidity, BOD_5, BOD_{20} (STPs only)	Aug. 31 - Sept. 1	24-hour composites using Manning automatic compositor	1
Golf Creek, Naches River, Boise Cascade Pond, Rosa Power Return, Chano Ditch, Wide Hollow Creek, Ahtanum Creek, Birchfield Drain, Postma Ditch	as above	0630-2020, Aug. 31	manual composite of (4) 2-liter aliquots	1
	2. October 19-20 Survey			
A. River				
all stations	temperature, D.O.	0800-1720, Oct. 20	grabs	4
YKM-1, 4, 6, 8	pH, conductivity, NH_3-N, NO_2-N, NO_3-N, T-PO_4-P, O-PO_4-P, TSS, turbidity	0800-1720, Oct. 20	grabs	4
YKM-1, 4, 6, 8	fecal coliform	1500, Oct. 19 - 1510, Oct. 20	grabs	3
YKM-1	BOD_5	0900-1720, Oct. 20	manual composite of (4) 2-liter grabs	1
B. Point and Non-Point Sources (Rosa Power Return not sampled)				
all sources	temperature, D.O.	08'0-1730, Oct. 20	grabs	3
all sources	fecal coliform	15'0, Oct. 19 - 1545, Oct. 20	grabs	3
Selah STP, Snokist	pH, conductivity, NH_3-N, NO_2-N, NO_3-N, T-PO_4-P, O-PO_4-P, TSS, turbidity, BOD_5	Oct. 19-20	24-hour composite using Manning automatic compositor	1
Yakima STP	as above	1205-1730, Oct. 20	manual composite	1
Golf Creek, Naches River, Boise Cascade Canal, Boise Cascade Pond, Chano Ditch, Wide Hollow Creek, Ahtanum Creek, Birchfield Drain, Postma Ditch	as above (except no BOD_5 on creeks)	0825-1700, Oct. 20	manual composite of (3) 2-liter grabs	1

Table 2. Water quality of municipal/industrial effluents, irrigation returns, and tributaries discharging to the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.6), August 31 - September 1, 1982.

Source	River Mile	Flow (cfs)	Temperature (°C)	Diss. Oxygen (mg/L)	BOD_5 (mg/L)	pH (units)	Spec. Cond. (µmhos/cm)	Fecal Coli.[a/] (col/100 mL)
Selah STP Effluent	b/	1.53	20.0(19.1-20.9)[c/]$_4$	5.3(5.1-5.5)$_4$	4 est.	7.8	586	4(<1-6)$_6$
Golf Creek	117.0	20.9(20.8-21.1)$_2$	18.3(16.9-19.8)$_4$	4.8(4.2-5.2)$_4$	4.8	7.6	376	370(140-500)$_6$
Naches River	116.3	393(379-406)	17.9(14.7-20.0)$_8$	10.7(9.6-11.3)$_8$	2.3	8.2	98	34(15-66)$_6$
Boise Cascade Pond	114.5	1.64(.77-2.92)$_5$	19.6(16.4-21.1)$_4$	2.5(2.0-3.1)$_4$	8.4	7.0	158	6300(2400-12,000)$_6$
Boise Cascade Canal	114.1	27.8(25.2-33.1)$_5$	16.9(16.1-18.5)$_4$	9.1(8.3-9.8)$_4$	3.6	7.8	141	460(160-760)$_6$
Rosa Power Return	113.3	911(913-908)$_2$	16.7(16.4-17.2)$_4$	9.5(8.9-10.2)$_4$	1.0	7.6	82	75(52-97)$_6$
Snokist Effluent[d/]	112.0	1.49	18.7(18.4-19.2)$_4$	5.4(5.0-5.9)$_3$	2.8	7.7	545	6200(4500-9200)$_6$
Yakima STP Effluent	111.0	26.1(24.1-27.9)$_2$	21.0(20.4-21.5)$_4$	3.1(2.2-3.9)$_4$	24	7.3	486	14,000(930-48,000)$_6$
Chano Ditch	109.4	10.4	16.7(16.0-17.3)$_4$	6.4(4.3-7.6)$_4$	1.4	7.1	206	730(380-1700)$_6$
Birchfield Drain	107.6	91(88-93)$_2$	17.5(14.6-19.3)$_4$	9.4(9.2-9.8)$_4$	1.6	8.2	226	910(400-2400)$_6$
Postma Ditch	e/	6.7(6.4-7)$_2$	15.0(13.5-16.2)$_4$	7.1(5.6-8.4)$_4$	1.0	7.6	476	240(110-480)$_6$
Wide Hollow Creek	107.4	50.0	16.4(15.0-17.3)$_4$	9.2(8.2-9.8)$_4$	.9	7.3	302	1600(800-2100)$_6$
Ahtanum Creek	106.9	19.3	17.2(14.8-19.2)$_2$	9.6(8.3-11.0)$_4$	1.4	7.5	331	970(620-1600)$_4$

a/ Fecal coliform data for each station includes two samples collected on August 30

b/ Selah STP effluent discharges into Golf Creek

c/ Mean(range)number of samples

d/ Clarifier effluent, prior to mixing with chlorinated, recycled process water

e/ Postma Ditch flows into Birchfield Drain

Table 2 - Continued.

Source	River Mile	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	Total Chlorine Residual (mg/L)
Selah STP Effluent	b/	.20	<.05	.05	2.1	2.1	11	6	$.7(.6-.8)_5$
Golf Creek	117.0	.06	.06	.57	.25	.21	4	2	--
Naches River	116.3	.03	<.01	.09	.04	.02	6	2	--
Boise Cascade Pond	114.5	.04	.01	<.01	.34	.30	13	11	--
Boise Cascade Canal	114.1	.08	.01	.25	.06	.06	11	9	--
Rosa Power Return	113.3	.04	<.01	.12	.06	.04	10	5	--
Snokist Effluent d/	112.0	.05	.02	8.3	4.6	4.6	6	2	--
Yakima STP Effluent	111.0	6.3	.10	.65	2.6	2.4	3	14	$.4(.1-1.0)_7$
Chano Ditch	109.4	.02	.02	2.0	.13	.11	<1	1	--
Birchfield Drain	107.6	.06	.02	.68	.13	.13	88	32	--
Postma Ditch	e/	.05	.03	4.9	.17	.19	14	14	--
Wide Hollow Creek	107.4	.03	.02	1.2	.12	.09	7	4	--
Ahtanum Creek	106.9	.05	.02	.48	.15	.11	10	6	--

b/ Selah STP effluent discharges into Golf Creek

d/ Clarifier effluent, prior to mixing with chlorinated, recycled process water

e/ Postma Ditch flows into Birchfield Drain

Table 3. Water quality of municipal/industrial effluents, irrigation returns, and tributaries discharging to the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.6), October 19-20, 1982.

Source	River Mile	Flow (cfs)	Temperature (°C)	Diss. Oxygen (mg/L)	BOD_5 (mg/L)	pH (units)	Spec. Cond. (µmhos/cm)	Fecal Coli. (col/100 mL)
Selah STP Effluent	a/	1.92	14.6(13.9-15.3)$_2$ [b/]	1.7(1.2-2.1)$_2$	50	7.4	669	26,000(680-78,000)$_3$
Golf Creek	117.0	18.8	14.9(14.0-15.3)$_3$	4.1(3.5-4.9)$_3$	12	7.7	493	13,000(5500-28,000)$_3$
Naches River	116.3	381	7.0(5.6-8.2)$_4$	13.4(12.6-14.2)$_4$	2.2	7.6	103	6(3-11)$_3$
Boise Cascade Pond	114.5	.77	8.2(7.7-8.7)$_2$	7.4(7.1-7.7)$_2$	1.8	7.4	180	<54(33-80)$_3$
Boise Cascade Canal	114.1	2.82	13.7(13.1-14.2)$_2$	4.1(3.9-4.3)$_2$	10	7.2	143	56(12-100)$_2$
Rosa Power Return	113.3	194	(Not sampled) --	--	--	--	--	--
Snokist Effluent [c/]	112.0	1.87	14.8(14.8-14.9)$_2$	9.3(9.3-9.4)$_2$	15	6.9	439	370(96-680)$_3$
Yakima STP Effluent	111.0	13.2	17.4(16.9-17.7)$_3$	2.4(.7-3.8)$_3$	24	7.5	650	<62(38-<100)$_3$
Chano Ditch	109.4	8.3	15.9(15.5-16.2)$_3$	7.0(6.3-7.9)$_3$	2.4	7.2	243	390(230-640)$_3$
Birchfield Drain	107.6	25-30	8.3(6.7-9.9)$_3$	11.1(10.9-11.4)$_3$	2.4	8.1	494	250(220-290)$_3$
Postma Ditch	d/	3.7	11.6(10.2-12.7)$_3$	8.2(8.0-8.6)$_3$	2.0	7.9	609	89(73-100)$_3$
Wide Hollow Creek	107.4	25.7	11.2(10.1-12.2)$_3$	10.2(9.6-10.7)$_3$	--	e/	e/	370(260-530)$_3$
Ahtanum Creek	106.9	24.4	8.1(7.0-9.2)$_3$	12.1(11.0-12.9)$_3$	--	8.1	340	<160(<20-280)$_3$

a/ Selah STP effluent discharges into Golf Creek
b/ Mean(range)number of samples
c/ Final effluent
d/ Postma Ditch flows into Birchfield Drain
e/ Samples lost

Table 3 - Continued.

Source	River Mile	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	Total Chlorine Residual (mg/L)
Selah STP Effluent	a/	1.0	<.10	<.10	10	.80	700	240	.5(.3-.7)$_2$
Golf Creek	117.0	.25	.05	.85	.84	.30	37	16	--
Naches River	116.3	.02	<.01	.11	.03	.02	1	2	--
Boise Cascade Pond	114.5	.07	<.01	.09	.14	.13	8	8	--
Boise Cascade Canal	114.1	.03	<.01	<.01	.12	.04	16	16	--
Rosa Power Return	113.3	--	--	--	--	--	--	--	--
Snokist Effluent c/	112.0	.10	<.10	<.10	31	30	33	11	.7(.6-.8)$_2$
Yakima STP Effluent	111.0	14	<.10	.60	4.4	3.8	23	16	1.2(.6-1.5)$_3$
Chano Ditch	109.4	.06	.02	2.1	.12	.11	<1	1	--
Birchfield Drain	107.6	.06	.03	2.2	.19	.18	46	22	--
Postma Ditch	d/	.04	.03	5.3	.18	.18	40	25	--
Wide Hollow Creek	107.4	.02	.03	1.7	.15	.14	2	2	--
Ahtanum Creek	106.9	.02	.02	.62	.10	.09	4	3	--

a/ Selah STP effluent discharges into Golf Creek

c/ Final effluent

d/ Postma Ditch flows into Birchfield Drain

Table 4. BOD, fecal coliform, nutrient, and suspended solids loads in municipal/industrial effluents, irrigation returns, and tributaries discharging to the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.6), August 31 - September 1 and October 20, 1982 (pounds/day unless otherwise noted).

	River Mile	Flow (cfs)		BOD_5		Fecal Coliform (col x 10^6/day)		NH_3-N		NO_3-N		T-PO_4-P		TSS	
Date		8/31-9/1	10/20	8/31-9/1	10/20	8/31-9/1	10/20	8/31-9/1	10/20	8/31-9/1	10/20	8/31-9/1	10/20	8/31-9/1	10/20
Source															
Selah STP Effluent	a/	1.53	1.92	33	520	150	1,200,000	1.7	10	.41	.52[b/]	17	100	91	7,300
Golf Creek	117.0	20.9	18.8	540	1,200	190,000	6,000,000	6.8	25	64	86	23	85	450	3,800
Naches River	116.3	393	381	4,900	4,500	333,000	56,000	64	41	190	230	85	61	13,000	2,100
Boise Cascade Pond	114.5	1.64	.77	74	7.5	250,000	510[b/]	.35	.29	.04[b/]	.37	3.0	.58	120	33
Boise Cascade Pond	114.1	27.8	2.82	540	150	310,000	3,900	12	.46	38	.08[b/]	9.0	1.8	1,700	240
Rosa Power Return	113.3	911	194	4,900	1,000[c/]	1,700,000	360,000[c/]	200	42[c/]	590	130[c/]	300	63[c/]	49,000	10,000[c/]
Snokist Effluent	112.0	1.49	1.87	23	150	230,000	17,000	.40	1.0	67	.50	37	310	48	330
Yakima STP Effluent	111.0	26.1	13.2	3,400	1,700	9,000,000	10,000[b/]	890	1,000	92	43	370	310	420	1,600
Chano Ditch	109.4	10.4	8.3	79	110	190,000	80,000	1.1	2.7	110	94	7.3	5.4	28[b/]	22[b/]
Postma Ditch	d/	6.7	3.7	36	40	40,000	8,100	1.8	.80	180	106	6.2	3.6	510	800
Birchfield Drain	107.6	91	25-30	790	360	2,000,000	170,000	29	8.9	330	330	64	28	43,000	6,800
Wide Hollow Creek	107.4	50.0	25.7	240	125[c/]	2,000,000	230,000	8.1	2.8	320	240	32	21	1,900	280
Ahtanum Creek	106.9	19.3	24.4	150	180[c/]	460,000	48,000[b/]	5.2	2.6	50	82	16	13	1,000	530

[a/]Selah STP discharges into Golf Creek

[b/]Load calculated using 1/2 of values reported as "less than" concentrations

[c/]Load calculated using water quality data from 8/31-9/1 survey

[d/]Postma Drain flows into Birchfield Drain

Table 5. Water quality in the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.6), August 31 - September 1, 1982 (mean and range of 7-8 samples each).

Station Number	Location	River Mile	Flow (cfs)	Temperature (°C)	Dissolved Oxygen (mg/L)	D.O. % Sat. (mean)	BOD_5[b] (mg/L)	pH (units)	Specific Cond. (μmhos/cm)	Fecal Coliform (col/100 mL)
YKM-1	Yakima River at Selah Bridge	117.1	1164-1999[a]	17.8(16.7-19.2)	10.3(9.4-11.1)	108	1.0(.8-1.2)	8.4(7.9-8.8)	93(87-100)	380(230-600)
YKM-2	Yakima River at US Highway 97 Bridge above Naches confluence	116.4	--	17.8(16.6-19.2)	10.2(9.3-10.7)	107	--	--	--	--
YKM-3	Yakima River at Terrace Heights Bridge	113.2	2856-3213	17.0(16.7-17.3)	9.7(9.1-10.7)	100	--	--	--	--
YKM-4	Yakima River at Moxee Bridge	111.4	--	17.6(16.6-18.8)	10.1(9.2-11.0)	105	1.5(1.3-1.6)	8.5(7.9-8.9)	97(90-103)	74(8-150)
YKM-5	Yakima River below Yakima STP	110.7	--	17.7(16.2-18.4)	9.8(8.9-10.3)	102	--	--	--	--
YKM-6	Yakima River above Birchfield Drain	108.0	--	17.8(16.6-18.9)	10.0(8.9-10.4)	105	1.5(1.0-1.8)	8.4(7.8-8.8)	100(93-106)	140(30-490)
YKM-7	Yakima River at Wapato Diversion Dam	106.6	2840-3300[c]	17.8(16.4-19.4)	9.7(8.6-10.6)	102	--	--	--	--
YKM-8	Yakima River at Parker Bridge	104.6	388-730	18.0(16.4-19.4)	10.3(9.5-10.6)	108	1.4(1.1-1.7)	8.3(7.9-8.7)	114(108-119)	240(20-600)

a/ Estimated by Bureau of Reclamation personnel
b/ Mean and range of 3 samples per station
c/ Union Gap gage

Table 5 - Continued.

Station Number	Location	River Mile	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	Total Susp. Solids (mg/L)	Turbidity (NTU)
YKM-1	Yakima River at Selah Bridge	117.1	.04(.02-.07)	<.01 (all samples)	.10(.09-.11)	.05(.04-.06)	.02(.02-.03)	10(7-15)	6(4-8)
YKM-2	Yakima River at US Highway 97 Bridge above Naches confluence	116.4	--	--	--	--	--	--	--
YKM-3	Yakima River at Terrace Heights Bridge	113.2	--	--	--	--	--	--	--
YKM-4	Yakima River at Moxee Bridge	111.4	.04(.02-.05)	<.01 (all samples)	.09(.05-.12)	.05(.04-.06)	.03(.02-.05)	7(2-10)	5(4-7)
YKM-5	Yakima River below Yakima STP	110.7	--	--	--	--	--	--	--
YKM-6	Yakima River above Birchfield Drain	108.0	.09(.05-.17)	<.01 (all samples)	.11(.10-.12)	.07(.05-.07)	.04(.03-.05)	9(7-11)	4(3-6)
YKM-7	Yakima River at Wapato Diversion Dam	106.6	--	--	--	--	--	--	--
YKM-8	Yakima River at Parker Bridge	104.6	.06(.03-.10)	.01 (all samples)	.15(.14-.17)	.07(.05-.08)	.04(.03-.05)	11(5-16)	6(5-12)

Table 6. Water quality in the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.6), October 20, 1982 (mean and range of four samples each).

Station Number	Location	River Mile	Flow (cfs)	Temperature (°C)	Dissolved Oxygen (mg/L)	D.O. % Sat. (mean)	BOD_5 (mg/L)	pH (units)	Specific Cond. (μmhos/cm)	Fecal Coliform[c] (col/100 mL)
YKM-1	Yakima River at Selah Bridge	117.1	673[a]	7.3(6.2-8.2)	13.6(12.0-14.6)	112	2.0[b]	8.6(8.4-9.0)	138(135-142)	160(93-260)
YKM-2	Yakima River at US Highway 97 Bridge above Naches confluence	116.4	--	7.1(5.5-8.5)	13.3(11.4-14.3)	109	--	--	--	--
YKM-3	Yakima River at Terrace Heights Bridge	113.2	1148	6.9(5.7-8.1)	13.2(11.6-14.0)	108	--	--	--	--
YKM-4	Yakima River at Moxee Bridge	111.4	--	6.8(5.3-8.2)	13.2(11.7-14.1)	108	--	8.5(7.9-9.0)	130(125-132)	119(9-330)
YKM-5	Yakima River below Yakima STP	110.7	--	7.0(6.0-8.1)	11.7(9.3-12.8)	96	--	--	--	--
YKM-6	Yakima River above Birchfield Drain	108.0	--	7.1(6.2-8.1)	13.6(12.6-14.2)	111	--	8.4(7.9-8.9)	138(133-141)	95(24-220)
YKM-7	Yakima River at Wapato Diversion Dam	106.6	1430[d]	7.3(6.5-8.3)	11.7(10.8-12.9)	97	--	--	--	--
YKM-8	Yakima River at Parker Bridge	104.6	1417	7.2(6.5-8.1)	13.2(12.3-13.7)	108	--	8.3(8.0-8.6)	164(158-166)	200(<10-540)

[a] Estimated by Bureau of Reclamation personnel
[b] BOD_5 determined from one composite sample
[c] Mean and range of 3 samples per station
[d] Union Gap gage

Table 6 - Continued.

Station Number	Location	River Mile	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	Total Susp. Solids (mg/L)	Turbidity (NTU)
YKM-1	Yakima River at Selah Bridge	117.1	.02*	<.01*	.05(.04-.05)	.03*	.02(.01-.02)	5(2-8)	2(1-3)
YKM-2	Yakima River at US Highway 97 Bridge above Naches confluence	116.4	--	--	--	--	--	--	--
YKM-3	Yakima River at Terrace Heights Bridge	113.2	--	--	--	--	--	--	--
YKM-4	Yakima River at Moxee Bridge	111.4	.01*	<.01*	.07(.05-.11)	.06(.06-.07)	.05(.05-.06)	3(2-4)	3(2-3)
YKM-5	Yakima River below Yakima STP	110.7	--	--	--	--	--	--	--
YKM-6	Yakima River above Birchfield Drain	108.0	.09(.06-.11)	<.01*	.08(.07-.10)	.12(.11-.12)	.09(.08-.10)	3(2-4)	3(2-4)
YKM-7	Yakima River at Wapato Diversion Dam	106.6	--	--	--	--	--	--	--
YKM-8	Yakima River at Parker Bridge	104.6	.04(.03-.05)	.01*	.23(.20-.26)	.10(.09-.11)	.08(.06-.10)	5*	3(2-3)

*All samples

Table 7. Organic priority pollutants in selected discharges to the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.6), July 7, 1982 (concentrations in µg/L).

	Selah STP Effluent	Yakima STP Effluent	Boise Cascade Canal	Boise Cascade Pond	Snokist Effluent	Wide Hollow Creek	Ahtanum Creek	Birch-field Drain	Chano Ditch	EPA criteria* for protection of aquatic life	
										Acute	Chronic
Base/Neutral Compounds											
1,4-dichlorobenzene	--	T	--	--	--	--	--	--	**	1,120	763
flouranthene	--	0.31	--	--	--	--	--	--	**	3,980	--
napthalene	--	T	--	--	--	--	--	--	**	2,300	620
bis(2-ethylhexyl) phthalate	†	†	†	†	†	†	†	†	**	940	3
di-n-butyl phthalate	--	--	0.08	--	T	0.12	--	--	**	940	3
diethyl phthalate	--	0.2	--	--	--	--	--	--	**	940	3
Acid Compounds											
(none detected)	--	--	--	--	--	--	--	--	**		
Volatile Compounds											
1,1,1-trichloroethane	--	T	--	--	--	--	--	--	--	--	--
chloroform	2.2	T	T	--	T	--	--	--	T	11,000(halomethanes)	
1,2-trans-dichloroethylene	T	--	--	--	--	--	--	--	--	11,600	--
dichlorobromomethane	T	--	--	--	T	--	--	--	--	11,000	--
tetrachloroethylene	T	T	T	--	T	--	--	--	--	5,280	840
toluene	3.5	2.3	--	--	T	--	--	--	--	17,500	--
trichloroethylene	T	--	--	--	--	--	--	--	T	45,000	--
										Maximum	24-hour average
Pesticides											
4,4' DDT	--	--	--	--	--	0.002	--	0.024	**	1.1	.001
4,4' DDE	--	--	0.005	--	--	0.008	--	0.04	**	(DDT & metabolites)	
4,4' DDD	--	--	--	--	--	0.005	--	0.01	**		

*EPA, 1980. Water quality criteria documents; availability. *Fed. Reg.*, Vol. 45 No. 231
-- = Not detected
**sample lost
T = trace; value is greater than the limit of detection, but less than the limit of quantification
† = detected in samples and in blanks

Table 8. Trace metal concentrations in selected discharges to the Yakima river between Selah (r.m. 117.1) and Parker (r.m. 104.6), July 7, 1982 (total metal in µg/L).

	Copper	Zinc	Nickel	Chromium	Cadmium	Lead	Mercury	Arsenic	Selenium
Selah STP Effluent	<10	23	<20	<10	<2	<20	<.2	15	
Yakima STP Effluent	20	91	<20	<10	<2	<20	<.2	8	
Boise Cascade Pond	<10	25	<20	<10	<2	<20	<.2	<1	
Boise Cascade Canal	<10	65	<20	<10	<2	<20	<.2	<1	
Snokist Effluent	<10	17	<20	<10	<2	<20	<.2	4	
Wide Hollow Creek	<10	80	<20	<10	<2	<20	<.2	2	
Birchfield Drain	<10	57	<20	<10	<2	<20	<.2	19	<5
Chano Ditch	<10	38	<20	<10	<2	<20	<.2	<1	
Birchfield Drain (sediment, mg/Kg dry)	19	54	19	9.7	.38	12	<.0002	11	8.2
EPA water quality criteria for protection of aquatic life* (at 50 mg/L hardness)									
Maximum (or acute)	12	180	1100	2200**	1.5	74	4.1	440***	260
24-hr. average (or chronic)	5.6	47	56	44**	.012	.75	.2	--	35

*EPA, 1980. Water quality criteria documents; availability *Fed. Reg.*, Vol. 45 No. 231

**Cr^{+3}

***As^{+3}

APPENDIX

Appendix I. Long-term BOD of Selah STP and Yakima STP effluents.

The long-term BOD data shown below are based on analysis of 24-hour effluent composites collected by WDOE August 31 - September 1, 1982. Nitrification was inhibited in both samples (Hach Nitrification Inhibitor Formula 2533™). Analysis was by the WDOE Tumwater laboratory using EPA's *Methods for Chemical Analysis of Water and Wastes*.

Sample Name	Selah STP effluent	Yakima STP effluent
Laboratory number	4443	4445
BOD, 2-hour	0.6	1.0
4-hour	0.4	1.4
6-hour	1.0	1.9
1-day	1 Est.	6
5-day	4 Est.	24
9-day	4 Est.	26
15-day	6	36
20-day	10	38

Appendix II. Results of the WDOE Central Regional Office water quality monitoring program in the Yakima River between Selah (r.m. 117.1) and Parker (r.m. 104.7), June 9 to October 15, 1982.

Date	Time	Temp. (°C)	D.O. (mg/L)	D.O. (% Sat.)	COD (mg/L)	pH (S.U.)	Sp. Cond. (µmhos/cm)	F. Coliform (col/100 mL)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	TSS (mg/L)	Turb. (NTU)
							Yakima River at Selah Bridge - r.m. 117.1 (YKM-1)								
06/09	1550	--	11.2	--	15	9.0	134	--	.03	<.01	.13	.04	.03	<1	4
06/21	1140	15.8	9.3	98	4	7.8	83	270	.05	.01	.12	.06	.05	48	33
06/24	1450	16.8	9.7	99	--	--	--	--	--	--	--	--	--	--	--
06/28	1155	--	10.6	--	4	8.0	95	470	.08	<.01	.13	.04	.04	21	12
07/02	1455	16.2	10.6	107	--	--	--	--	--	--	--	--	--	--	--
07/07	0935	15.9	10.2	104	13	8.0	96	240	.04	<.01	.11	.04	.03	10	7
07/09	0955	16.5	10.6	107	--	--	--	--	--	--	--	--	--	--	--
07/14	1550	16.5	11.2	113	8	8.9	89	180	.03	<.01	.05	.04	.02	6	4
07/16	1435	14.9	12.1	119	--	--	--	--	--	--	--	--	--	--	--
07/20	1245	18.1	11.2	118	9	8.8	85	400	.04	<.01	.04	.02	<.01	2	4
07/23	0950	14.7	11.0	108	--	--	--	--	--	--	--	--	--	--	--
07/28	1320	--	11.0	--	--	--	--	--	--	--	--	--	--	--	--
07/29	1005	18.5	10.4	111	--	--	--	--	--	--	--	--	--	--	--
08/02	1640	18.0	11.4	120	--	--	--	--	--	--	--	--	--	--	--
08/04	1650	16.7	11.3	115	4	9.0	82	6 est.	.03	<.01	.07	.05	.01	8	6
08/10	1510	16.1	10.8	109	4	8.3	83	67	.09	<.01	.09	.04	.03	15	11
08/13	1450	15.3	10.7	106	--	--	--	--	--	--	--	--	--	--	--
08/18	1000	16.5	10.0	101	4	8.0	86	330 est.	.09	<.01	.10	.04	.02	20	11
08/20	1015	17.7	9.6	100	--	--	--	--	--	--	--	--	--	--	--
08/23	1005	17.6	9.9	103	8	7.9	90	180	.05	<.01	.09	.03	.03	9	6
08/27	1440	19.1	10.6	114	--	--	--	--	--	--	--	--	--	--	--
09/08	1055	18.6	--	--	9	8.3	96	--	.07	<.01	.11	.05	.03	8	8
09/10	1545	17.5	11.4	119	--	--	--	--	--	--	--	--	--	--	--
09/14	1000	13.6	10.7	102	5	8.0	139	260 est.	.05	<.01	.16	.06	.03	3	3
09/22	1145	15.8	12.0	120	9	8.5	136	270 est.	.02	<.01	.09	.03	.02	2	2
09/24	1515	17.5	12.1	126	--	--	--	--	--	--	--	--	--	--	--
09/27	1540	15.8	12.2	122	4	8.9	146	1000 est.	.02	<.01	.15	.06	.04	<1	3
09/30	1545	15.9	13.2	132	--	--	--	--	--	--	--	--	--	--	--
10/05	1720	13.8	12.1	116	8	9.1	147	410	.01	<.01	.05	.01	<.01	1	3
10/08	1505	12.1	14.3	132	--	--	--	--	--	--	--	--	--	--	--
10/13	1520	14.0	13.5	130	8	9.0	138	290	.02	<.01	.03	.04	.01	1	4
10/15	1045	11.7	11.3	104	--	--	--	--	--	--	--	--	--	--	--

Appendix II. Continued.

Date	Time	Temp. (°C)	D.O. (mg/L)	D.O. (% Sat.)	COD (mg/L)	pH (S.U.)	Sp. Cond. (μmhos/cm)	F. Coliform (col/100 mL)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	TSS (mg/L)	Turb. (NTU)
							Yakima River below Selah - r.m. 116.4 (YKM-2)								
06/09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/21	1200	16.1	10.0	--	22	7.8	85	320	.05	.01	.07	.03	--	48	33
06/24	1430	16.2	9.8	99	--	--	--	--	--	--	--	--	--	--	--
06/28	1140	--	10.2	--	4	8.0	98	410	.08	<.01	.16	.06	.04	23	13
07/02	1445	16.4	10.6	107	--	--	--	--	--	--	--	--	--	--	--
07/07	0920	15.9	10.0	102	9	8.0	97	220	.02	<.01	.10	.05	.03	16	10
07/09	0945	16.4	10.2	103	--	--	--	--	--	--	--	--	--	--	--
07/14	1530	16.8	11.2	114	8	8.8	90	140	.02	<.01	.06	.04	.02	6	4
07/16	1425	15.6	12.0	120	--	--	--	--	--	--	--	--	--	--	--
07/20	1230	18.3	10.8	114	9	8.7	86	230	.06	<.01	.04	.03	<.01	7	5
07/23	0945	14.6	10.6	104	--	--	--	--	--	--	--	--	--	--	--
07/28	1315	--	11.0	--	--	--	--	--	--	--	--	--	--	--	--
07/29	0955	17.0	10.2	105	--	--	--	--	--	--	--	--	--	--	--
08/02	1625	18.2	11.4	120	--	--	--	--	--	--	--	--	--	--	--
08/04	1630	17.2	10.8	111	4	9.0	82	11 est.	.03	<.01	.11	.05	.03	9	8
08/10	1450	16.2	11.1	112	4	8.4	83	37	.08	<.01	.11	.04	.02	10	12
08/13	1440	15.8	10.6	106	--	--	--	--	--	--	--	--	--	--	--
08/18	0945	16.3	9.5	97	4	8.0	87	--	.11	<.01	.10	.04	.02	15	9
08/20	1020	17.6	9.4	98	--	--	--	--	--	--	--	--	--	--	--
08/23	0950	17.5	9.3	97	4	7.9	91	120	.09	<.01	.10	.03	.03	14	12
08/27	1435	19.7	10.3	112	--	--	--	--	--	--	--	--	--	--	--
09/08	1045	18.3	9.4	99	9	8.1	102	310 est.	.05	<.01	.11	.05	.03	10	7
09/10	1535	17.1	10.6	109	--	--	--	--	--	--	--	--	--	--	--
09/14	0950	13.3	9.9	94	5	8.0	138	120	.02	<.01	.15	.06	.04	4	5
09/22	1135	15.2	10.8	107	4	8.3	143	320 est.	.02	<.01	.07	.03	.03	3	3
09/24	1505	17.3	11.1	114	--	--	--	--	--	--	--	--	--	--	--
09/27	1530	15.6	11.9	119	4	8.8	151	970 est.	.09	<.01	.18	.06	.06	5	4
09/30	1530	15.1	12.2	111	--	--	--	--	--	--	--	--	--	--	--
10/05	1715	14.0	12.7	122	8	8.9	151	250	.08	<.01	.06	.03	.02	7	3
10/08	1455	11.8	12.8	117	--	--	--	--	--	--	--	--	--	--	--
10/13	1510	13.6	13.0	124	12	8.9	145	390	.03	<.01	.06	.05	.02	4	9
10/15	1035	11.6	10.6	97	--	--	--	--	--	--	--	--	--	--	--

Appendix II. Continued.

Date	Time	Temp. (°C)	D.O. (mg/L)	D.O. (% Sat.)	COD (mg/L)	pH (S.U.)	Sp. Cond. (μmhos/cm)	F. Coliform (col/100 mL)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	TSS (mg/L)	Turb. (NTU)
							Yakima River above Yakima STP - r.m. 111.4 (YKM-4)								
06/09	1820	15.4	10.3	103	19	8.1	78	--	.02	<.01	.08	.04	.03	5	9
06/21	1215	15.0	8.8	86	4	7.8	69	84	.04	.01	.05	.05	.05	40	30
06/24	1415	16.4	9.8	99	--	--	--	--	--	--	--	--	--	--	--
06/28	1120	--	10.5	--	4	7.9	75	120	.03	<.01	.08	.05	.03	12	11
07/02	1430	15.3	10.2	101	--	--	--	--	--	--	--	--	--	--	--
07/07	0900	14.8	9.8	95	9	7.9	80	120	.22	<.01	.06	.04	.03	12	6
07/09	0920	15.3	9.8	97	--	--	--	--	--	--	--	--	--	--	--
07/14	1510	16.2	10.7	108	8	8.5	81	37 est.	.08	<.01	.05	.04	.02	3	4
07/16	1350	14.6	11.2	110	--	--	--	--	--	--	--	--	--	--	--
07/20	1205	18.2	10.3	108	13	8.4	84	49	.04	<.01	.04	.03	<.01	4	6
07/23	0930	14.8	10.3	101	--	--	--	--	--	--	--	--	--	--	--
07/28	1345	--	10.4	--	--	--	--	--	--	--	--	--	--	--	--
07/29	0920	18.5	9.6	102	--	--	--	--	--	--	--	--	--	--	--
08/02	1610	18.5	11.1	118	--	--	--	--	--	--	--	--	--	--	--
08/04	1610	17.6	11.0	115	4	9.1	83	<1	.02	<.01	.07	.04	.02	7	8
08/10	1540	17.1	10.4	107	4	8.5	87	1 est.	.05	<.01	.11	.03	.02	16	12
08/13	1410	16.6	10.2	104	--	--	--	--	--	--	--	--	--	--	--
08/18	0805	16.2	9.2	93	4	7.9	90	42	.09	<.01	.09	.03	.02	11	7
08/20	1040	17.9	9.6	100	--	--	--	--	--	--	--	--	--	--	--
08/23	0930	17.6	9.3	97	4	8.0	87	64	.04	<.01	.09	.04	.02	8	10
08/27	1505	19.7	10.2	111	--	--	--	--	--	--	--	--	--	--	--
09/08	1020	18.0	9.3	98	14	8.7	98	2 est.	.04	<.01	.11	.05	.03	8	6
09/10	15.5	15.5	10.5	104	--	--	--	--	--	--	--	--	--	--	--
09/14	0925	13.3	11.1	106	5	7.9	100	84	.02	<.01	.11	.06	.03	7	4
09/22	1115	15.0	11.0	108	4	8.2	103	92	.01	<.01	.07	.03	.02	4	2
09/24	1430	16.0	11.0	110	--	--	--	--	--	--	--	--	--	--	--
09/27	1515	14.6	11.3	111	4	8.6	117	130	.03	<.01	.12	.06	.04	3	4
09/30	1520	14.2	11.6	113	--	--	--	--	--	--	--	--	--	--	--
10/05	1645	12.6	12.0	112	4	8.8	113	12 est.	.02	<.01	.10	.05	.05	4	6
10/08	1440	11.1	13.0	117	--	--	--	--	--	--	--	--	--	--	--
10/13	1445	13.4	12.9	124	8	8.8	115	13 est.	.02	<.01	.06	.04	.03	2	5
10/15	1010	11.2	11.2	102	--	--	--	--	--	--	--	--	--	--	--

Appendix II. Continued.

Date	Time	Temp. (°C)	D.O. (mg/L)	D.O. (% Sat.)	COD (mg/L)	pH (S.U.)	Sp. Cond. (µmhos/cm)	F. Coliform (col/100 mL)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	TSS (mg/L)	Turb. (NTU)
							Yakima River below Yakima STP - r.m. 108.6 (YKM-6)								
06/09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/21	1300	14.4	10.5	102	4	7.7	67	96	.03	<.01	.11	.02	--	45	31
06/24	1400	15.6	9.9	99	--	--	--	--	--	--	--	--	--	--	--
06/28	1100	--	10.4	--	4	7.8	77	120	.05	<.01	.08	.07	.04	14	10
07/02	1410	15.0	10.1	99	--	--	--	--	--	--	--	--	--	--	--
07/07	0845	14.8	9.7	95	4	7.9	82	63	.04	<.01	.07	.04	.04	10	7
07/09	0900	15.2	9.8	97	--	--	--	--	--	--	--	--	--	--	--
07/14	1450	15.9	10.8	108	8	8.4	82	40 est.	.04	<.01	.05	.04	.03	4	4
07/16	1335	14.1	11.2	108	--	--	--	--	--	--	--	--	--	--	--
07/20	1150	17.7	10.2	106	4	8.4	87	24	.04	<.01	.06	.04	.01	6	6
07/23	0915	14.6	10.2	100	--	--	--	--	--	--	--	--	--	--	--
07/28	1425	--	10.7	--	--	--	--	--	--	--	--	--	--	--	--
07/29	0905	18.5	9.6	102	--	--	--	--	--	--	--	--	--	--	--
08/02	1545	18.5	11.3	120	--	--	--	--	--	--	--	--	--	--	--
08/04	1545	17.7	11.0	115	4	9.0	86	<1	.07	<.01	.07	.05	.03	7	5
08/10	1635	17.2	10.3	106	4	8.4	90	150	.12	<.01	.12	.05	.04	14	8
08/13	1400	16.8	10.4	106	--	--	--	--	--	--	--	--	--	--	--
08/18	0845	16.3	9.3	94	4	7.9	92	--	.22	<.01	.11	.05	.03	12	6
08/20	1120	18.5	9.9	105	--	--	--	--	--	--	--	--	--	--	--
08/23	0905	17.4	9.2	95	4	8.0	85	80	.07	<.01	.10	.06	.04	9	6
08/27	1540	19.6	10.2	111	--	--	--	--	--	--	--	--	--	--	--
09/08	1005	17.9	9.3	97	9	8.1	96	320 est.	.11	<.01	.12	.07	.04	8	5
09/10	1500	15.5	10.5	104	--	--	--	--	--	--	--	--	--	--	--
09/14	0910	13.3	10.3	98	5	7.9	103	270 est.	.07	<.01	.14	.07	.06	8	4
09/22	1055	14.7	10.8	106	9	8.2	103	120	.04	<.01	.08	.06	.04	3	2
09/24	1425	16.0	11.0	110	--	--	--	--	--	--	--	--	--	--	--
09/27	1500	14.6	11.3	111	4	8.6	115	92	.15	<.01	.15	.08	.05	5	4
09/30	1510	14.3	11.6	113	--	--	--	--	--	--	--	--	--	--	--
10/05	1635	12.8	12.1	113	8	8.8	117	19 est.	.10	<.01	.11	.08	.07	4	2
10/08	1430	11.4	13.0	118	--	--	--	--	--	--	--	--	--	--	--
10/13	1435	12.7	13.1	122	12	8.8	114	47	.02	<.01	.06	.05	.03	<1	4
10/15	1005	11.4	10.8	98	--	--	--	--	--	--	--	--	--	--	--

Appendix II. Continued.

Date	Time	Temp. (°C)	D.O. (mg/L)	D.O. (% Sat.)	COD (mg/L)	pH (S.U.)	Sp. Cond. (μmhos/cm)	F. Coliform (col/100 mL)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-PO_4-P (mg/L)	O-PO_4-P (mg/L)	TSS (mg/L)	Turb. (NTU)
							Yakima River at Parker Bridge - r.m. 104.6 (YKM-8)								
06/09	1743	16.3	10.5	106	8	8.1	89	--	.06	.01	.11	.07	.07	26	13
06/21	1245	15.2	10.5	104	4	7.8	74	130	.04	.01	.06	.04	--	48	34
06/24	1340	16.0	10.0	100	--	--	--	--	--	--	--	--	--	--	--
06/28	1040	--	10.5	--	4	7.8	84	110	.05	<.01	.11	.05	.04	22	15
07/02	1350	15.8	10.3	103	--	--	--	--	--	--	--	--	--	--	--
07/07	0830	15.1	10.2	101	9	7.9	95	100	.06	<.01	.12	.06	.05	31	16
07/09	0845	15.2	10.1	100	--	--	--	--	--	--	--	--	--	--	--
07/14	1430	16.5	10.6	107	13	8.3	96	64 est.	.12	<.01	.10	.06	.05	20	12
07/16	1320	15.3	11.2	111	--	--	--	--	--	--	--	--	--	--	--
07/20	1140	18.4	10.5	111	17	8.2	101	74	.06	<.01	.11	.04	.04	30	15
07/23	0905	15.2	10.5	104	--	--	--	--	--	--	--	--	--	--	--
07/28	1415	--	10.3	--	--	--	--	--	--	--	--	--	--	--	--
07/29	0855	19.0	9.7	103	--	--	--	--	--	--	--	--	--	--	--
08/02	1530	19.2	10.7	115	--	--	--	--	--	--	--	--	--	--	--
08/04	1530	19.3	10.7	115	4	8.9	99	<1	.05	.01	.13	.05	.04	19	14
08/10	1600	18.0	10.3	108	4	8.4	102	1 est.	.13	.01	.28	.07	.05	29	16
08/13	1350	16.9	10.3	106	--	--	--	--	--	--	--	--	--	--	--
08/18	0830	16.2	9.8	99	4	7.9	104	180 est.	.07	.01	.16	.07	.04	21	11
08/20	1110	18.6	10.0	106	--	--	--	--	--	--	--	--	--	--	--
08/23	0855	17.4	9.7	100	4	7.9	109	65	.08	<.01	.16	.05	.05	18	7
08/27	1525	20.3	10.3	113	--	--	--	--	--	--	--	--	--	--	--
09/08	0955	17.8	10.0	104	14	8.1	121	430 est.	.06	<.01	.20	.07	.05	15	8
09/10	1450	15.5	10.7	106	--	--	--	--	--	--	--	--	--	--	--
09/14	0855	13.6	10.6	101	5	7.9	114	240	.05	.01	.19	.08	.06	11	5
09/22	1035	14.9	10.9	107	9	8.1	123	150	.04	<.01	.15	.06	.04	8	1
09/24	1415	16.1	11.1	112	--	--	--	--	--	--	--	--	--	--	--
09/27	1445	15.1	11.3	112	4	8.5	128	88	.02	.02	.19	.07	.07	8	6
09/30	1500	15.0	11.5	113	--	--	--	--	--	--	--	--	--	--	--
10/05	1615	13.5	12.3	117	4	8.8	141	19 est.	.05	.01	.21	.09	.07	7	4
10/08	1410	11.9	13.0	119	--	--	--	--	--	--	--	--	--	--	--
10/13	1420	13.2	13.0	123	8	8.8	141	8 est.	.04	.01	.19	.09	.06	2	3
10/15	0950	11.4	11.1	101	--	--	--	--	--	--	--	--	--	--	--