MI/DEQ/SWQ-97/022

Michigan Department of Natural Resources
Surface Water Quality Division

November 17, 1994

Continuous Dissolved Oxygen Monitoring of the Rouge River at Greenfield Road (September 14 - October 10, 1994)

Significant Findings

1. The MDNR successfully monitored the dissolved oxygen (D.O.) and temperature of the Rouge River at Greenfield Road from September 14, 1994 through October 10, 1994, using a YSI Model 56 Continuously Recording D.O. meter. Approximately **two (2) calibration visits per week** were necessary in order to gather reliable data. Using a criterion of reading river water which was made saturated at the end of each calibration period, approximately 25.4% of the total D.O. data verified within 0.1 mg/l, 78.5% of the data verified within 0.6 mg/l, and 97.2% of the data verified within 1.1 mg/l. Approximately 2.8% of the data was not usable.

2. During the dry and warm period from September 14, 1994 through September 24, 1994, the D.O. was super-saturated during each afternoon. The diurnal D.O. variation (the difference between daily average D.O. and daily minimum D.O.) during this period ranged from 1.6 mg/l to 4.5 mg/l. Daily minimum D.O. ranged from 4.3 mg/l to 7.1 mg/l. Daily maximum D.O. ranged from 8.0 mg/l to 16.0 mg/l.

3. Rain which began at about 11:30 pm on September 24 was followed by severely depressed D.O. in the river on September 25. After an initial rise in D.O. after the start of rain (from 7.6 mg/l at 12:44 am, to 10.7 mg/l at 4:45 am, on 9/25), the D.O. fell rapidly to 1.1 mg/l in about 3.5 hours (sag at 8:22 am). The D.O. did not recover to the warmwater standard (5.0 mg/l minimum) until noon on September 26, 1994.

4. Additional rain events on September 27, and September 30/October 1, were followed by moderately depressed river D.O.

5. The warmwater D.O. standard (5.0 mg/l, minimum) was not met at this location during approximately 9% of the monitoring period.

Introduction

The Rouge River at Greenfield Road is one of the continuous monitoring sites maintained by the Wayne County Rouge Program Office (RPO), as part of the Rouge River National Wet Weather Demonstration Program. Based on comments made during some Sampling TAG meetings held during the 1994 sampling season, and on a preliminary review of spring 1994 data, it became apparent that reliable continuous data was not being obtained at this location (as well as some others). The MDNR - Surface Water Quality Division (SWQD) decided to set up a continuously recording YSI Model 56 D.O. meter at this location with the goals of: 1) obtaining reliable data, and 2) making observations about river D.O. The meter probe was suspended from the downstream side of the Greenfield Bridge, approximately 1 foot under the water surface.

Presentation and Brief Discussion of Results

Figures 1 through 5 present the results of the continuous D.O. and temperature monitoring of the Rouge River at Greenfield Road, from approximately noon on September 14, 1994 to approximately noon on October 10, 1994. Results are presented from Sunday to Saturday to ease comparison with RPO's data.

Figures 1 and 2 show high diurnal D.O. variations (with supersaturated D.O. conditions during each afternoon) from September 14 through September 24. Supersaturated conditions probably occurred because algae and instream plants were photosynthesizing during these dry and warm afternoons. The river appeared to be nearly stagnant and relatively clear during this period. Such clarity could allow for the sunlight to penetrate into the water column. The last rain before this period was on September 6, according to the Dearborn DPW. Note that light rains were recorded at Metro Airport on September 8 and 14 (see Attachment 1).

Figure 3 presents results which appear to show effects on river D.O. due to rain. As previously discussed, there was a significant dry period prior to late September 24. On September 24/25, the Dearborn DPW recorded 0.35" of rain at Telegraph Road and 0.4" of rain at Greenfield Road (0.7" was recorded at Metro Airport). Dearborn has an excellent system for recording when their CSO's discharge, and they recorded CSOs starting to discharge just after midnight. Following this, there was an initial rise in D.O. followed by a sharp decline to 1.1 mg/l. If Dearborn's CSOs discharged, it is our opinion that other jurisdiction's CSOs may have discharged as well (i.e. Wayne County, Detroit, Oakland County). The sharp decline of D.O. due to this rain could have been due to a combination of causes;

including CSOs (from various jurisdictions), storm water, and/or resuspension into the water column of previously deposited oxidizable material. The sharp and deep decline in D.O. may have been due to the dry period preceding this rain. Other rains on September 27 and September 30/October 1 resulted in more moderate depressions of D.O. (see Figure 3). The possible causes for these depressions are probably similar to those of the September 25 event.

Figures 4 and 5 present the remainder of the monitoring results. Note that the stream temperatures for the October 2-10 period are below those of the September 14-24 period, and the corresponding diurnal D.O. variations are greatly reduced. The increase in stream temperature from October 5 to October 6 is consistent with a rise in air temperature (see Attachment 1). Also note that near noon on October 10, there was no appreciable difference in D.O. and temperature between 1 foot below the water surface and approximately 6 feet below the water surface. The sharp rise in D.O. during late October 3 and early October 4 is unexplained.

Attachment 1 contains daily weather observations and rain amounts at Metro Airport during the monitoring period. Metro Airport is not in the watershed, but weather observations there are provided for information.

Quality Assurance/Quality Control

Meter calibration was performed using saturated air. Meter accuracy was verified during field visits, before and after calibration, by saturating river water and comparing the D.O. recorded by the meter with the saturation value at the ambient water temperature and an elevation of 542 feet above sea level (see Table 1 below). In addition, the river D.O. recorded by the meter was compared to river D.O. determined by the Winkler method during field visits (see the Winkler results on Figures 1-5). Winklers were analyzed by MDNR-SWQD staff, except as analyzed by the MDNR Environmental Protection Bureau Lab (Lansing) on September 14 and the upper value on October 10.

The procedures for field calibrating the meter are reproduced in Attachment 2. These procedures were followed, except that the check of reading river water which was made anaerobic was not done. Any additional changes from procedures are described in the field notes for each calibration visit (see Attachment 3).

Based on these procedures, D.O. data shown on Figures 1-5 were verified as accurate.

Table 1: Field Verification of D.O. Data

	..Initial Verification..			..After Calibration..		
Date	Satur. Temp. (C)	Meter D.O. Sat. Water (mg/l)	Satur. D.O. (mg/l)	Satur. Temp. (C)	Meter D.O. Sat. Water (mg/l)	Sat. D.O. (mg/l)
9-14	Equipment set-up			27	7.7	7.8
9-15*	28	7.6	7.7	29	7.3	7.5
9-19	23	7.8	8.4	22	8.2	8.5
9-22	27.5	7.3	7.75	26.5	7.8	7.85
9-27*	16	8.6	9.7	NA	NA	NA
9-30*	18.5	8.8	9.2	NA	NA	NA
10-3	13	10.4	10.3	12.5	10.1	10.4
10-6*	18.5	9.3	9.2	NA	NA	NA
10-10	12	10.0	10.5	Equipment removal		

* Please read field notes for this date for explanation. (see Attachment 3)

Staff Report By:

Phil Argiroff, SE Michigan District
Mike Mulcrone, Water Quality Studies Unit

Field Work By:

Phil Argiroff, SE Michigan District
Alec Malvetis, SE Michigan District
Mike Mulcrone, Water Quality Studies Unit
Erik Sunday, SE Michigan District
Bahram Zamani, Water Quality Studies Unit

D.O. Titrations (Winklers) By:

Phil Argiroff, SE Michigan District (except as indicated as being analyzed by the Environmental Protection Bureau Lab, Lansing)

Acknowledgments:

1) Dearborn DPW for allowing our canoe to be stored at their yard, and especially Steve Sienkiewicz for providing rain and CSO data.
2) U.S. Weather Service for Detroit Metro Airport Weather Data.

FIG.1: Rouge at Greenfield (Week 1)

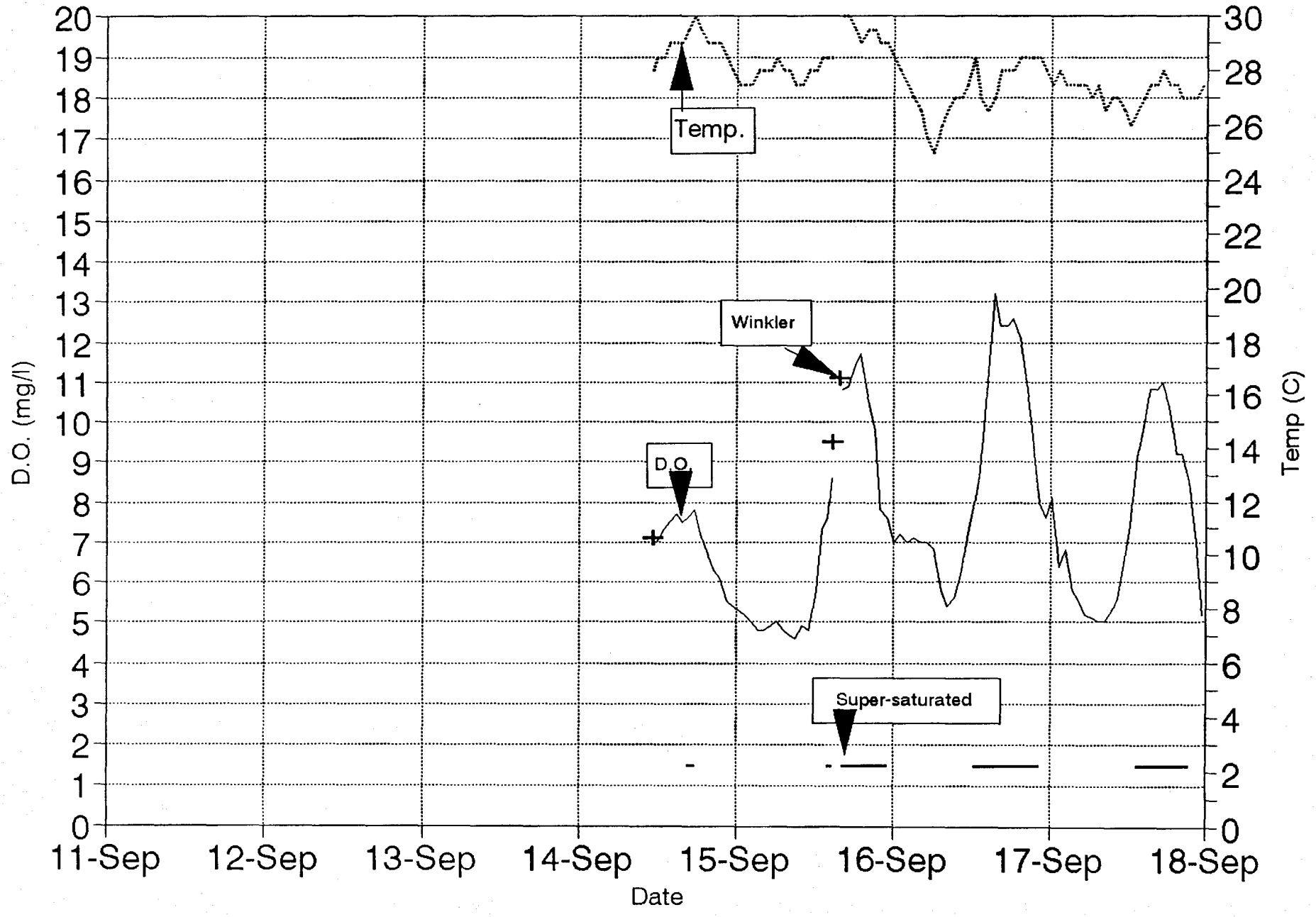


FIG.2: Rouge at Greenfield (Week 2)

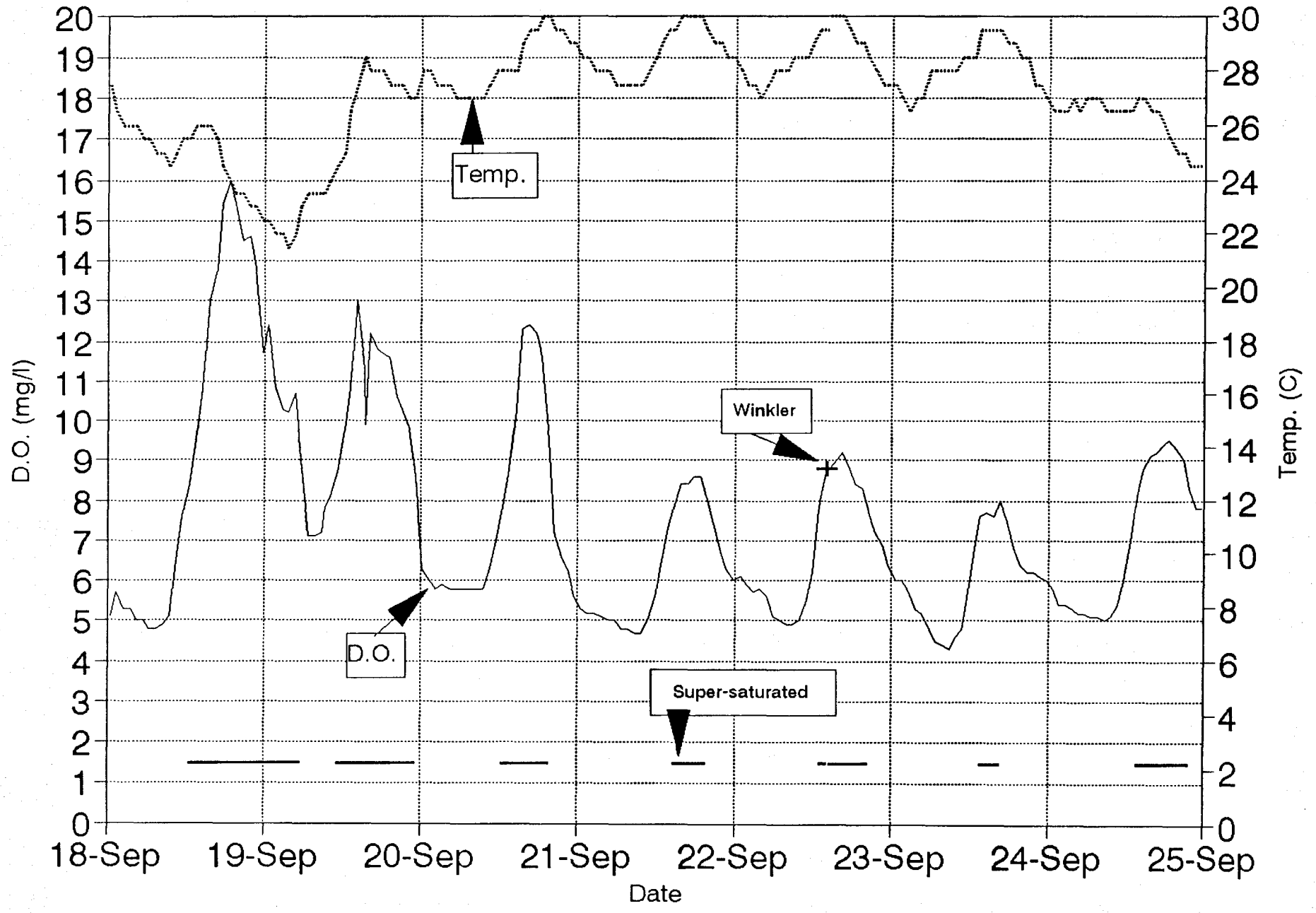


FIG.3: Rouge at Greenfield (Week 3)

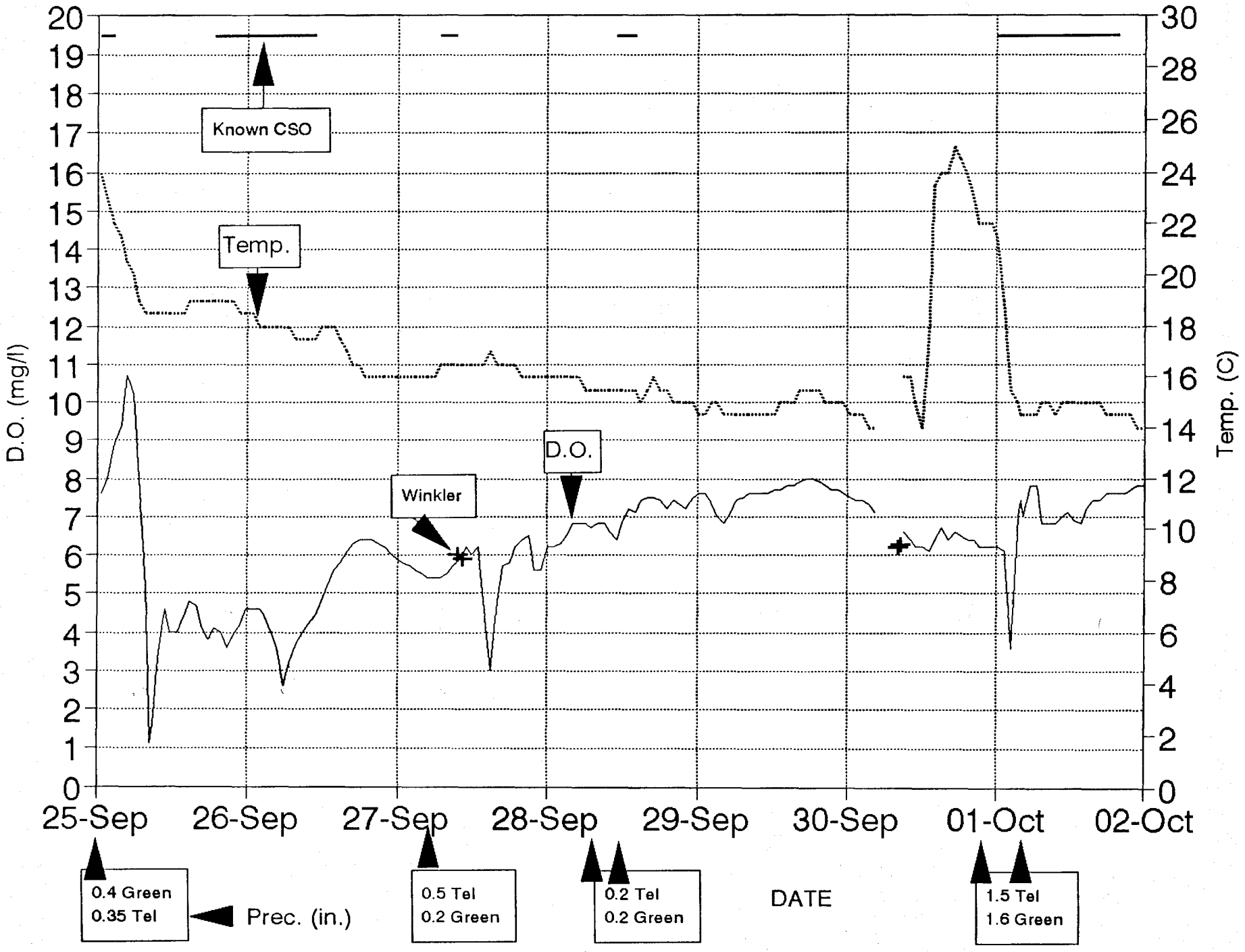


FIG.4: Rouge at Greenfield (Week 4)

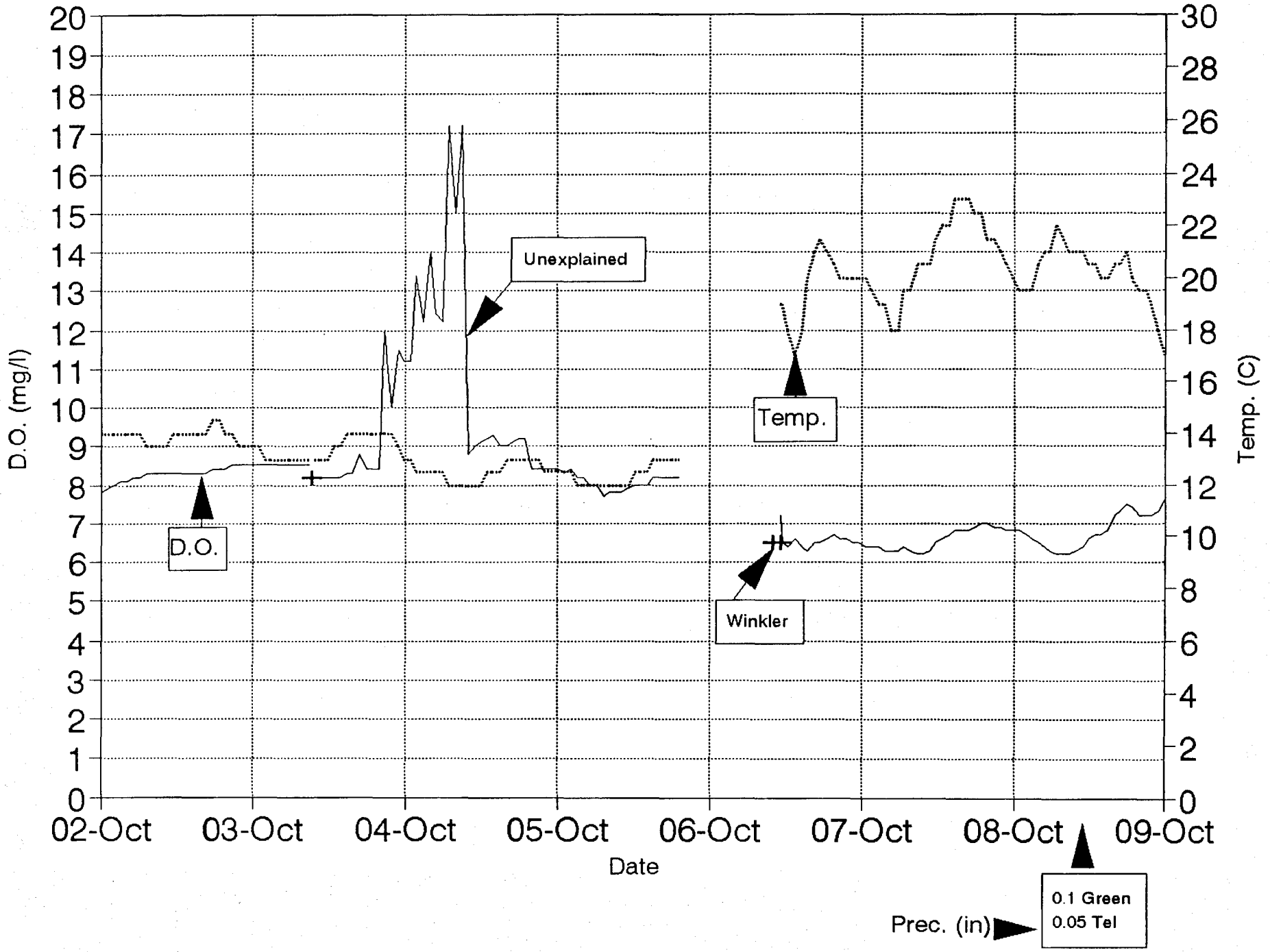
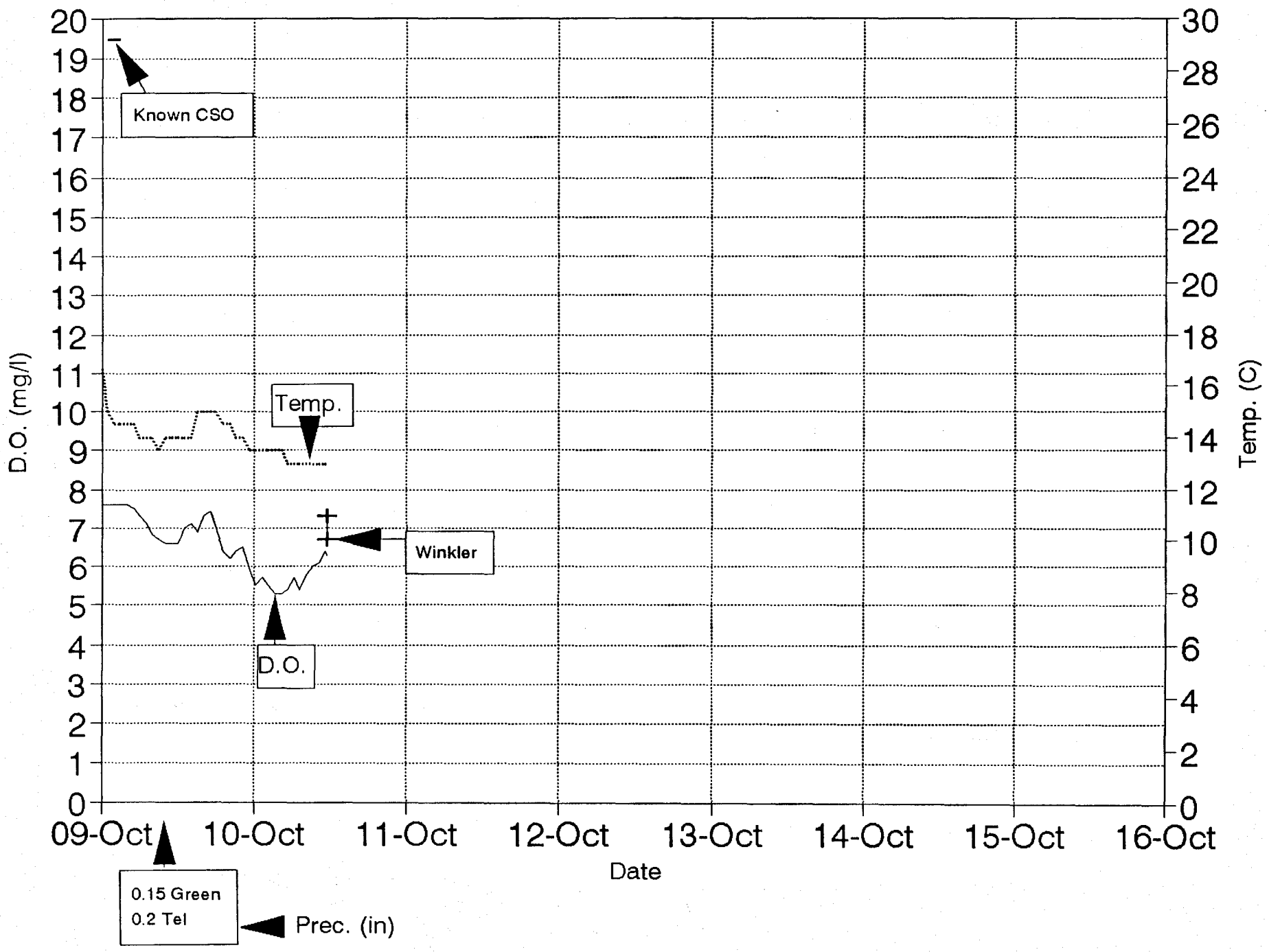


FIG.5: Rouge at Greenfield (Week 5)



Attachment 1

Preliminary Local Climatological Data (WS Form: F-6)

Station: DETROIT, MI (DTW)
Month: SEP
Year: 1994

Latitude +4214 Longitude +8320 Gnd Elev. 633 ft. Std Time: EST

	Temperature in Fahrenheit							Precipitn.	Snow	Wind	Fastest 1-Min:		Sunshine	Sky		Peak Wind	
	Columns →																
-1- Day	-2- Max	-3- Min	-4- Avg	-5- Dep.	-6a- HDD	-6b- CDD	-7- Water	-8- Snow	-9- Depth	-10- Avg.	-11- Speed	-12- Dir	-13- Mins.	-14- %PSBL	-15- SR-SS	-16- Weather	-17- Speed	-18- Dir
1	68	50	59	-8	6	0	0.00	0.0	0	11.3	18	36	689	87	5		24	NW
2	71	50	61	-6	4	0	0.00	0.0	0	5.7	10	36	617	78	5		16	N
3	73	51	62	-5	3	0	0.00	0.0	0	5.8	12	02	595	76	4		17	N
4	72	51	62	-5	3	0	0.00	0.0	0	8.9	15	09	396	51	6		23	E
5	75	54	65	-1	0	0	0.00	0.0	0	7.9	13	15	645	83	3		18	SE
6	77	59	68	2	0	3	T	0.0	0	9.0	17	30	260	34	7	8	26	NW
7	78	54	66	0	0	1	0.00	0.0	0	10.4	17	25	687	89	2	1	25	NW
8	83	53	68	2	0	3	0.13	0.0	0	9.6	17	24	509	66	4	3	36	N
9	80	58	69	3	0	4	0.00	0.0	0	8.3	15	32	767	100	0	1	21	NW
10	73	54	64	-1	1	0	0.00	0.0	0	6.5	12	11	764	100	0		15	E
11	78	51	65	0	0	0	0.00	0.0	0	4.8	14	17	761	100	1		16	ESE
12	84	52	68	3	0	3	0.00	0.0	0	6.8	16	18	745	98	4		16	SW
13	87	63	75	11	0	10	0.00	0.0	0	11.8	21	25	420	56	9	1,8	29	W
14	89	69	79	15	0	14	0.28	0.0	0	7.6	16	29	335	45	9	1,8	35	E
15	91	67	79	16	0	14	0.00	0.0	0	8.2	18	22	473	63	7	2,8	23	SW
16	89	64	77	14	0	12	0.00	0.0	0	13.5	23	23	498	67	3	1,8	31	SW
17	78	59	69	6	0	4	T	0.0	0	11.4	18	36	380	51	7		26	NW
18	77	53	65	2	0	0	0.00	0.0	0	8.7	14	31	716	97	1		24	NW
19	82	54	68	6	0	3	0.00	0.0	0	6.4	13	31	739	100	0		21	W
20	85	53	69	7	0	4	0.00	0.0	0	4.4	13	25	702	95	4	1	18	SW
21	81	58	70	9	0	5	0.00	0.0	0	8.3	14	14	635	87	6	1,8	20	SE
22	79	61	70	9	0	5	0.00	0.0	0	9.3	14	15	620	85	4	1,8	21	SE
23	76	58	67	6	0	2	0.00	0.0	0	6.5	12	15	400	55	.9	1	17	E
24	78	62	70	9	0	5	0.64	0.0	0	9.8	16	11	315	43	8	3	20	E
25	76	62	69	9	0	4	0.05	0.0	0	6.7	13	12	95	13	9	1,3,8	32	SW
26	65	51	58	-2	7	0	0.01	0.0	0	9.4	16	16	185	26	8	1	22	S
27	61	54	58	-1	7	0	0.42	0.0	0	12.4	21	24	10	1	10	1	30	SW
28	63	51	57	-2	8	0	0.28	0.0	0	16.6	23	29	195	27	9	1,5	37	NW
29	65	49	57	-2	8	0	0.00	0.0	0	12.9	18	29	560	79	4		30	NW
30	71	42	57	-1	8	0	0.57	0.0	0	7.0	13	20	549	78	5	3	17	S
Sum	2305	1667			55	96	2.38	0.0		265.9			15262		153			
Avg	76.8	55.6								9.9	Fast	Dir.	Psbl	%	5.1		Max (mph)	
										Misc --------→	23#	29	22458	68			037	NW

Notes:
Last of several occurrences
Column 9 readings are taken at 0700
Column 17 Peak Wind in M.P.H.

MONITORING

Preliminary Local Climatological Data (WS Form: F-6)

Station: DETROIT, MI (DTW)
Month: OCT
Year: 1994

Latitude +4214 Longitude +8320 Gnd Elev. 633 ft. Std Time: EST

MONITORING

	Temperature in Fahrenheit							: Precip(in.):	Snow :	Wind : Fastest 1-Min:			Sunshine :	Sky		: Peak Wind	
	Columns																
-1- Day	-2- Max	-3- Min	-4- Avg	-5- Dep.	-6a- HDD	-6b- CDD	-7- Water	-8- Snow	-9- Depth	-10- Avg.	-11- Speed	-12- Dir	-13- Mins.	-14- %PSBL	-15- SR-SS	-16- Weather	-17- Speed	-18- Dir
1	61	47	54	-3	11	0	0.36	0.0	0	9.0	14	35	15	2	10	1,3	25	N
2	65	41	53	-4	12	0	0.00	0.0	0	8.5	14	05	701	100	1		18	NE
3	61	41	51	-5	14	0	0.00	0.0	0	9.4	14	36	633	90	3		22	NE
4	58	42	50	-6	15	0	0.00	0.0	0	9.1	16	31	135	19	10		21	N
5	57	42	50	-6	15	0	0.00	0.0	0	6.1	12	28	290	42	9		17	W
6	68	39	54	-1	11	0	0.00	0.0	0	8.8	15	20	691	100	0		18	SW
7	76	48	62	7	3	0	0.00	0.0	0	11.0	15	18	593	86	5		21	SE
8	78	55	67	13	0	2	0.18	0.0	0	15.0	21	29	370	54	10	1,8	30	S
9	60	43	52	-2	13	0	0.09	0.0	0	13.9	25	27	301	44	6	1	31	W
10	57	36	47	-6	18	0	0.00	0.0	0	7.8	16	36	680	100	0		20	N
11	61	35	48	-5	17	0	0.00	0.0	0	5.4	12	09	676	100	0		15	E
12	68	41	55	2	10	0	0.00	0.0	0	8.0	14	09	662	98	1	1	20	E
13	65	47	56	4	9	0	0.00	0.0	0	5.0	09	12	295	44	10		12	E
14	67	50	59	7	6	0	0.00	0.0	0	8.7	16	08	623	93	2	1,8	21	E
15	66	46	56	5	9	0	0.00	0.0	0	8.5	13	06	480	72	6	1	17	E
16	71	46	59	8	6	0	0.00	0.0	0	7.2	13	06	663	100	2		16	E
17	74	44	59	8	6	0	0.00	0.0	0	5.7	13	16	508	77	5	1	16	S
18	76	50	63	13	2	0	T	0.0	0	11.7	23	22	260	40	8	1	30	SW
19	64	58	61	11	4	0	0.35	0.0	0	11.6	16	24	0	0	10	1	22	SW
20	62	47	55	5	10	0	0.00	0.0	0	9.6	14	28	115	18	9	1	18	W
21	64	43	54	5	11	0	0.00	0.0	0	4.3	09	15	112	17	9	1	14	SW
22	67	46	57	8	8	0	0.00	0.0	0	5.0	09	12	545	84	2	2,8	15	S
23	65	42	54	6	11	0	0.01	0.0	0	13.3	21	27	610	95	1		35	W
24	57	39	48	0	17	0	0.01	0.0	0	13.0	18	25	91	14	10		32	W
25	47	38	43	-5	22	0	T	0.0	0	12.9	21	26	0	0	10		25	W
26	50	36	43	-4	22	0	0.00	0.0	0	9.3	16	29	285	45	6		31	W
27	56	38	47	0	18	0	0.00	0.0	0	9.1	18	22	364	57	6		20	SW
28	63	35	49	2	16	0	0.00	0.0	0	14.6	23	21	509	81	7		29	SW
29	69	51	60	14	5	0	0.00	0.0	0	16.5	23	23	410	65	8		32	SW
30	64	48	56	10	9	0	0.00	0.0	0	5.6	13	18	295	47	7	1	14	S
31	54	46	50	4	15	0	0.35	0.0	0	11.4	21	04	0	0	10	1	33	NE
Sum	1971	1360			345	2	1.35	0.0		295.0			11912		183			
Avg	63.6	43.9								9.5	Fast	Dir.	Psbl	%	5.9		Max	(mph)
										Misc ------>	25	27	20561	58			035	W

Notes:
Column 9 readings are taken at 0700
Column 17 Peak Wind in M.P.H.

Attachment 2: D.O. Meter Procedures

D. YSI Dissolved Oxygen Meters

1. Operation of YSI Model 56 Continuous Dissolved Oxygen Meter

a. Locating the meter

The meter should be located in a secure location well above the likely high water mark. It should be hidden from view as much as possible to prevent vandalism. An ideal location is upstream of a sewage treatment plant, industry or other private property where owner can keep an eye on meter for you. The meter should be placed outside the chlorine plume of a wastewater treatment plant since chlorine can interfere.

The probe should be located where there is good flow. It should be secured to a metal fence post that is pounded into the streambed or to a bridge abutment or pilings. The probe cable should be secured in such a way as to prevent violent oscillations in the current. Ideally, the probe should be in shade to minimize fouling with algae. The probe should also be located away from the plume of discharges or tributaries in order to get representative measurements. Be sure probe is well below the potential low water mark.

b. Maintenance

Replace the membrane if any of the following is observed:

-membrane is damaged or wrinkled
-bubbles have formed under the membrane
-erratic readings
-calibration is not stable

Membrane will normally need to be replaced every 2-4 weeks. Always store the probe in a humid environment such as in a plastic whirl-pac. Batteries should be removed when the instrument is stored for more than two months. The rechargeable battery pack should be replaced with a fully charged battery pack each time the meter is serviced and at least every 10 days.

c. Instrument preparation

1) check for sufficient paper supply and replace if necessary

2) Replace desiccant pack if it is not blue

3) Turn power on and pen input to zero. Adjust pen zero to read zero on 0-10 red scale on chart paper.

4) Turn pen input switch to battery check. A reading of 10 is fully charged. Recharge batteries if reading is ñ9.0.

5) Allow 15 minutes warm-up time for optimum probe stabilization.

d. Initial Calibration

1) Place a moist piece of tissue paper in the bottom of the small plastic calibration bottle. (The calibration bottle is a small plastic bottle with the bottom cut out. The calibration bottle ensures a 100% humidity during calibration). Fasten protective collar to probe and slide the probe into the calibration bottle. The probe membrane must be completely dry but in a humid environment. The probe should also be placed where the temperature will not be changing rapidly.

2) Wait ten minutes for temperature stabilization. This may be done simultaneously while the probe is stabilizing.

3) Set chart speed to 10 cm/hr, pen input to O2 & C, O2 range to 0-10 mg/l, O2 filter to off. After 1 minute, adjust the calib knob to give a full scale dissolved oxygen reading. Wait for the pen to draw a straight line on the paper. This verifies that the probe has stabilized.

4) Switch pen input to zero, set chart speed to rapid, and adjust pen zero control to indicate zero on the chart.

5) Switch to temperature and read the temperature. Switch pen input to O2 and adjust the O2 Calib control until the pen traces at the appropriate reading for that temperature and elevation. Switch Chart Speed control back to 1 cm/hr.

e. Dissolved Oxygen Measurement

1) With the instrument prepared for use and calibrated, remove protective collar from probe and thread probe onto stirrer. Place the probe in the water to be measured and turn on the automatic stirrer.

2) When called for by the quality assurance plan, measure the DO of River water that has been saturated by pouring between two containers. Saturation should be verified by tracing DO on the chart until there is no further change with time. When called for by the quality assurance plan measure the DO of river water that has been made

anaerobic through the addition of excess sodium sulfite (1 gram/liter) and a trace of cobalt chloride. The measurement of DO by the probe should be ± 0.8 mg/l of the theoretical value. If not, then re-check all maintenance and calibration procedures, if error is still greater than 0.8 mg/l then replace membrane, if error is still greater than 0.8 mg/l then replace probe.

3) Place the probe back in the stream.

4) Set chart speed to 1 cm/hr.

5) Set pen input to O2 & C (dashed line is temperature and solid line is DO).

6) Set Range to appropriate range.

7) Mark the chart paper with date, time of day, location, chart speed and O2 range in use. Turn on filter.

8) Always fill out the use log after each visit.

9) Collect a winkler sample and note meter DO and temperature on the lab analysis request form. Measure stream temperature with a glass thermometer.

10) Double check all settings

11) Secure the meter in a locked steel drum.

f. Field Maintenance

1) The meter should have a maintenance visit at least once every 7 days, more frequently at the beginning of a monitoring period.
2) The continuous DO meter log should be filled out during each visit.

3) Check the probe and the meter for signs of vandalism, damage or other disruption that could affect data quality.

4) Note the River DO as measured by the continuous meter. Note date, time, location on chart.

5) Check stirrer, membrane condition and battery and turn off filter.

6) Before making any adjustments, check the meter accuracy by measuring the DO of river water that has been saturated and that has been made anaerobic.

7) Replace membrane and clean probe if necessary and calibrate the meter as described above.

8) Again measure the DO of air saturated River water and water that has been made anaerobic by the addition of excess sodium sulfite and a trace of cobalt chloride.

9) Place the probe back in the river and read the DO.

10) Note date, time, scale and location on chart.

11) Turn filter on and double check all settings.

12) When called for by the quality assurance plan, collect a sample of river water for DO analysis by the winkler method. Note the corresponding meter temperature and DO on the lab analysis request form. Measure the stream temperature with a glass thermometer and record the reading on the field sheets.

Attachment 3: Field Visit Notes

9/14/94

Initial D.O. meter installation (between piers). Following calibration, saturated river D.O. read 7.7 mg/l at 27 C(p) (good - 7.8 mg/l). A Winkler was taken and sent to the lab. Results were 7.0 mg/l (7.2 mg/l upon re-analysis). The probe D.O reading was 7.0 mg/l at 28 C(p).

(MM, BZ, PA)

9/15/94 (14:32)

Did not recalibrate. The purpose of this visit was to move the probe out further into the river (at a pier) from its original location. At 14:32, the probe D.O. was 8.6 mg/l at 28.5 C(p), and was rapidly rising. A Winkler taken at 14:45 read 9.6 mg/l (9.4 mg/l upon re-analysis). A check of saturated river water read 7.6 mg/l at 28 C(p) (good, 7.7 mg/l). Battery was at 86% and was not replaced. Once the probe was moved, the probe read 11.2 mg/l at 30 C(p). A Winkler taken at 15:39 read 11.0 mg/l (11.2 mg/l upon re-analysis). Saturated river water was again checked. The water read 7.3 mg/l at 29 C(p) (28 C(t)) (good, 7.5 mg/l).

Status: Meter functioning well. Data good.

(MM, PA)

9/19/94 (9:15)

Prior to recalibration, saturated river water at 23 C(p) (22 C(t)) read 7.8 mg/l. At 23 C, 100% saturation should read 8.4 mg/l. This was 0.6 mg/l low and is acceptable. Note that no Winklers were analyzed because I forgot the D.O. preservatives. The membrane looked good and the battery was replaced. The probe in saturated air read 7.6 mg/l at 26 C(p), and was adjusted to appropriately read 7.9 mg/l after recalibration. A check with saturated river water read 8.2 mg/l at 22 C(p) (good - 8.5 mg/l).

Status: Data from 9/14/94 to 9/19/94 checked.

(PA, ES)

9/22/94 (13:57)

Between the last visit and this one, the meter can was disturbed, but it was not -because it could not be - pulled off the bridge. Prior to recalibration, saturated river water at 27.5 C(p) read 7.3 mg/l. At 27.5 C, 100% saturation should read 7.75 mg/l. This was 0.45 mg/l low and is acceptable. The probe was reading

about 8.6 mg/l at 13:57, and a Winkler taken at 14:10 read 9.2 mg/l - however this did not titrate well due to my error - (8.8 mg/l upon re-analysis). The membrane looked good. The battery was replaced (60% before, 100% after). The probe in saturated air read 7.8 mg/l at 23.5 C(p) (22 C(t)), and was adjusted to appropriately read 8.3 mg/l after recalibration. A check with saturated river water read 7.8 mg/l at 26.5 C(p) (good - 7.85 mg/l).

Status: Data from 9/19/94 to 9/22/94 checked.

(PA, ES)

9/27/94 (9:35)

There was significant rain since the last visit. Water clarity was down, turbidity up. River velocity was much higher, and there was noticeable sanitary trash in the river. Prior to recalibration, saturated river water at 16 C(p) and 15 C(t) read 8.6 mg/l. At 16 C, 100% saturation should read 9.7 mg/l. This was 1.1 mg/l low but under the situation, is acceptable. The probe was reading about 5.8 mg/l at 9:35, and a Winkler taken at 9:45 read 5.8 mg/l (6.2 mg/l upon re-analysis). The membrane was covered with a significant amount of slime. Therefore, I removed it lightly with a towel, and allowed the membrane to dry. The membrane had an extremely slight wrinkle but was not replaced on this visit due to adverse conditions. The battery was replaced (35% prior, 95% after). The probe read 8.8 mg/l at 16 C(p) under air calibration, and was adjusted to appropriately read 9.7 mg/l at this temperature. The probe was placed in the river, but no check with saturated river water was done due to rainy, high river velocity, and windy conditions. However, another Winkler was taken at 10:30. With the probe reading 6.0 mg/l (16 C(p)) after calibration, the Winkler was analyzed at 5.8 mg/l (6.0 mg/l upon re-analysis).

Status: Data from 9/22/94 through 9/27/94 checked.

(PA)

9/30/94 (7:47)

The meter was recording fairly erratically for approximately 3 hours prior to this visit. However, saturated river water at 18.5 C(p) read 8.8 mg/l, and 100% saturation at this temperature should read 9.2 mg/l. Our hand-held thermometer was no longer functioning, so it was not possible to determine if this reading of 18.5 C was accurate. However, it seemed that the saturated water temperature could be high based on the river temperature on the chart prior to the erratic readings, and an air temperature of approximately 11 C based on a radio report. Using the river

temperature measured by the probe about 1 hour later (14.5 C), saturated water would be 10.0. So, if the temperature was off, the saturated river water would have been reading approximately 1.2 mg/l low. The membrane looked O.K, but the battery at 60% power was replaced with a charged battery. Air calibration at 18.5 C(p) read 9.1 mg/l prior to cleaning and drying the membrane, and was slightly adjusted to read 9.2 mg/l after being cleaned and dried. Since only one person was present at this visit, a re-check with saturated river water was not preformed. However, a Winkler read 6.2 mg/l (6.4 mg/l upon re-analysis) while the probe was reading 6.4 mg/l at 14.5 C.

Status: Air calibration checked well. Saturated river water checked within 0.4 mg/l if the temperature was recording correctly - which we cannot confirm that it was not. In fact, we can only assume that 18.5 C was accurate because the container was in the sunlight. If the temperature probe was reading high, the worst saturated water could have been off was 1.2 mg/l. Therefore, based on this information and the Winkler results, the data from 9/27/92 through 9/30/94 checked absent the last 3 hours.

(PA)

10/3/94 (8:52)

Prior to recalibration, saturated river water read 10.4 mg/l at 13 C(p) (good, 10.3 mg/l at 100%). The battery - at 52% power - was replaced. Prior to adjusting the calibration, saturated air at 15 C(p) read 10.3 mg/l. It was adjusted with a clean and dry membrane to appropriately read 9.9 mg/l. After recalibration, saturated river water read 10.1 mg/l at 12.5 C(p) (good, 10.4 mg/l at 100%). The saturated water was poured 5 more times to see if the D.O. would increase. It remained at 10.1 mg/l. A Winkler taken at 9:25 read 8.4 mg/l (8.0 mg/l upon re-analysis) while the probe was reading 8.5 mg/l. Note that at 8:52 the probe D.O. was 8.5 mg/l, and at 9:47 the probe D.O. was 8.3 mg/l. (Note: a new hand-held thermometer was obtained, and it checked within .5 C of the probe thermometer.)

Status: Data from 9/30/94 to 10/3/94 checked.

(PA, ES)

10/6/94 (9:30)

The meter was recording somewhat erratically for about 17 hours preceding this visit (based on the chart). Upon pulling the probe out of the water to check with saturated river water, it was discovered that the stirrer was detached from the probe. This could account for the erratic readings (the point where the erratic behavior started is dramatic). Prior to recalibration,

saturated river water read 9.3 mg/l at 18.5 C(p) (good, 9.2 mg/l at 100% saturation). A Winkler at 9:48 read 6.4 mg/l (6.6 mg/l upon re-analysis). The battery was replaced. Because the membrane was to be replaced at this visit, air calibration was checked prior to cleaning the membrane. At 20.5 C(p), the reading was 9.4 mg/l (0.6 mg/l high, but within range). The membrane was replaced. At a temperature of 23 C(p) within the calibration cup, the reading was adjusted to 8.4 mg/l. A recheck of saturated river water read 8.7 mg/l at 18.5 C(p). This was 0.5 mg/l below the 100% saturation value of 9.2 mg/l, so I decided to recalibrate the probe one more time. This time, the probe with calibration cup was placed in the shade. At 15.5 C(p), the calibration was adjusted upwards 0.3 mg/l to appropriately read 9.8 mg/l. A Winkler at 11:10 read 6.6 mg/l (6.4 mg/l upon re-analysis) while the probe reading was approximately 7.2 mg/l.

Status: Data from 10/3/94 through 10/6/94 checked absent the erratic data the final 17 hours (attributed to a detached stirrer). Also note that an additional 12 hours of data within this period seemed strangely high, but there is no reason to discount these data at this point.

(PA, AM)

10/10/94 (11:29)

The meter is to be pulled this visit. The battery was approximately at 40% power. Saturated river water read 10.0 mg/l at 12 C(p) (good, 10.5 mg/l at 100% saturation). With the probe reading 6.4 mg/l at 13 C, a Winkler was analyzed at 6.8 mg/l (6.6 mg/l upon re-analysis). With the calibration cup on, saturated air read 11.4 mg/l at 8 C(p) (good, 100% saturation is 11.6 mg/l). Note that we lowered the probe deeper into the channel to see if D.O. varied with depth. At about 1 foot deep, D.O. was 6.4 mg/l at 13 C. At about 6 feet deep, D.O. was 6.3 mg/l at 13 C.

Status: Data checked from 10/6/94 to 10/10/94.

(PA, MM)

Phil Argiroff, SWQD, MDNR