MISSOURI STREAM TEAM
VOLUNTEER WATER QUALITY MONITORING PROGRAM
Standard Operating Procedure

ORIGINAL EFFECTIVE DATE: January 30, 2018
RECERTIFICATION DATE:
SOP TITLE: MoST-VWQM-SOP: Dissolved Oxygen Measurement of Streams
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APPLICABILITY:	Applies to all Level 1, Level 2, Level 3 and CSI trained Missouri Stream Team, Volunteer Water Quality Monitoring Program Participants

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) provides MoST, VWQM Program participants with guidance on the operation of the Hach Modified Winkler Dissolved Oxygen kit and how to conduct field analysis of dissolved oxygen in streams. Dissolved oxygen enters water through diffusion from the atmosphere, aeration and photosynthesis. Cooler water has the capacity to hold more dissolved oxygen; while warmer water has less capacity. Since temperature has an effect on the capacity of water to hold dissolved oxygen, it is also important to measure temperature when measuring dissolved oxygen to determine oxygen saturation. The Missouri Water Quality Standards (MoDNR 2014) specify a minimum criterion of 5.0 mg/L for warm water and cool water streams, and 6.0 mg/L for cold water streams.

2.0 DEFINITIONS AND ABBREVIATIONS

CSI – Cooperative Stream Investigation
D.O. – Dissolved Oxygen
MDC – Missouri Department of Conservation
mg/L – milligrams per liter
MoDNR – Missouri Department of Natural Resources
MoST – Missouri Stream Team
SOP – Standard Operating Procedure
VWQM – Volunteer Water Quality Monitoring
QAPP – Quality Assurance Project Plan
QA/QC – Quality Assurance/Quality Control

3.0 SUMMARY OF METHOD

The dissolved oxygen method described in this SOP is used by the MoST, VWQM Program participants that have received Level 1, Level 2, Level 3 or CSI Program training. Further background information can be found in the MoST, VWQM Level 1 Notebook and PowerPoint Presentation on water chemistry (see Section 11.0).

4.0 HEALTH AND SAFETY REQUIREMENTS

Appropriate protective gear, such as gloves and water proof boots, should be worn to protect against encountering potential water-borne illnesses during sampling. It is also advisable to frequently wash hands with soap and water, especially before eating or drinking.

Those participants that monitor near wastewater outfalls should be vaccinated for Hepatitis A. Please contact your county health department or your personal physician for this vaccination.

5.0 PERSONNEL QUALIFICATIONS

Participants will be knowledgeable of this SOP and will have, at a minimum, attended an Introductory and Level 1 VWQM workshop.

6.0 SUPPLIES AND EQUIPMENT

The following equipment is needed to measure dissolved oxygen:

- Program-provided Hach Dissolved Oxygen kit
- Program-provided alcohol-type thermometer measured in degrees Celsius to allow oxygen saturation calculation

7.0 DISSOLVED OXYGEN PROCEDURE

1. Rinse the Dissolved Oxygen bottle (round bottle with glass stopper) three times with stream water.

2. Fill the Dissolved Oxygen bottle with sample water by submerging the sample bottle under water. Avoid turbulence and air bubbles in the sample while filling.

3. Remove the bottle from the water and pour off water until it is in the frosted area of the bottle neck.

4. Add the contents of one Dissolved Oxygen Reagent 1 Powder Pillow and one Dissolved Oxygen 2 Reagent Powder Pillow. Stopper the bottle while making sure to avoid trapping air bubbles. If air bubbles become trapped, remove the stopper and add a few drops of sample water to increase the sample volume. Replace the stopper so no air bubbles are present.

5. While holding the stopper firmly in place, shake the bottle vigorously to mix. Flocculent (floc) precipitate will form. Brownish-orange precipitate indicates oxygen is present. White precipitate may be present on the bottom of the bottle, due to excess reagent. This will not affect result.

6. Wait for floc to settle to approximately half the bottle volume (below white line on bottle). Floc will not settle if high concentrations of chloride are present or if performing test in very cold conditions. In this case wait 4-5 minutes before proceeding.

7. Shake the bottle vigorously again.

8. Wait for the floc to settle halfway.

9. Remove the stopper and add the contents of one Dissolved Oxygen 3 Reagent Powder Pillow. Stopper the bottle carefully to avoid trapping air bubbles.

10. Shake the bottle vigorously to mix. Floc will dissolve and the sample will turn orange if oxygen is present.

11. Fill the plastic tube with prepared sample so that liquid is even with the top of the tube.

12. Pour the contents of the tube into the square-mixing bottle. A simple method for transferring the solution from the measuring tube into the mixing bottle is to place the mixing bottle upside down on the measuring tube and invert.

13. Add Sodium Thiosulfate Standard Solution one drop at a time to the mixing bottle. Each drop will be counted. To insure adequate drops, hold the dropper vertically and use firm pressure for each drop. Release pressure on the bulb between drops. Swirl to mix after each drop. Add drops until the sample becomes colorless.

14. The total number of drops of titrant used in step 13 equals the total mg/L dissolved oxygen.

8.0 DISSOLVED OXYGEN SATURATION

1. Find stream temperature in °C on the left side vertical column of the D.O. Percent Saturation Sheet (page 6 of this document).

2. Find the dissolved oxygen concentration in mg/L on the top horizontal row of the D.O. Percent Saturation Sheet (page 6 of this document).

3. Follow across from the appropriate temperature and down from the appropriate dissolved oxygen concentration on the D.O. Percent Saturation Sheet until the intersection point is reached.

4. Report the appropriate dissolved oxygen saturation percentage listed at the intersection point (Example: 10 °C and 11 mg/L dissolved oxygen = 98% dissolved oxygen saturation).

9.0 SPECIAL CONSIDERATIONS

- Do not dispose of the orange solution in the stoppered bottle until after titration is complete. If a mistake is made during titration; repeat the analysis beginning at step 10.

- Do not wear sunglasses or other colored lenses when determining color change. Hold a white background a few inches from the square mixing bottle when determining color change.

- If the water temperature exceeds 39 °C; use the formula at the bottom of the D.O. Percent Saturation Sheet along with the actual dissolved oxygen value, and the maximum oxygen concentration at a specific temperature to calculate the dissolved oxygen percent saturation.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

As part of attending a Level 2 QA/QC workshop, dissolved oxygen kits will be checked against a reference optical dissolved oxygen meter. Kits that cannot measure ± 1.0 mg/L of the reference meter will be replaced.

Level 2 and Level 3 workshop QA/QC is covered under a MoDNR QAPP (see Section 10.0).

11.0 REFERENCES

Missouri Department of Natural Resources. 2014. Code of State Regulations, Rules of Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 7 – Water Quality. Pg. 23.

Missouri Department of Natural Resources. Quality Assurance Project Plan for Level 2 and Level 3 Volunteer Water Quality Monitoring.

Missouri Stream Team – Volunteer Water Quality Monitoring Program; Level 1 Volunteer Water Quality Monitoring Training Notebook, Chapter 2, Water Chemistry http://www.mostreamteam.org/Documents/VWQM/Level1_Notebook/04_Chapter2_Chemistry.pdf

Missouri Stream Team – Volunteer Water Quality Monitoring Program; Level 1 Volunteer Water Quality Monitoring Workshop PowerPoint Presentation, Water Chemistry http://www.mostreamteam.org/Documents/VWQM/Level1_PPT/Chapter%202%20–%20Water%20Chemistry.pdf

D.O. Percent (%) Saturation Sheet

Temp (C)	D.O. (mg/L) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15*
0	7%	14%	21%	27%	34%	41%	48%	55%	62%	68%	75%	82%	89%	96%	103%
1	7%	14%	21%	28%	35%	42%	49%	56%	63%	70%	78%	85%	92%	99%	106%
2	7%	14%	22%	29%	36%	43%	51%	58%	65%	72%	80%	87%	94%	101%	109%
3	7%	15%	22%	30%	37%	45%	52%	60%	67%	74%	82%	89%	97%	104%	112%
4	8%	15%	23%	31%	38%	46%	53%	61%	69%	76%	84%	92%	99%	107%	115%
5	8%	16%	24%	31%	39%	47%	55%	63%	71%	78%	86%	94%	102%	110%	118%
6	8%	16%	24%	32%	40%	48%	56%	64%	72%	80%	88%	97%	105%	113%	121%
7	8%	17%	25%	33%	41%	50%	58%	66%	74%	83%	91%	99%	107%	116%	124%
8	8%	17%	25%	34%	42%	51%	59%	68%	76%	85%	93%	101%	110%	118%	127%
9	9%	17%	26%	35%	43%	52%	61%	69%	78%	87%	95%	104%	113%	121%	130%
10	9%	18%	27%	35%	44%	53%	62%	71%	80%	89%	98%	106%	115%	124%	133%
11	9%	18%	27%	36%	45%	54%	64%	73%	82%	91%	100%	109%	118%	127%	136%
12	9%	19%	28%	37%	46%	56%	65%	74%	84%	93%	102%	112%	121%	130%	139%
13	10%	19%	29%	38%	48%	57%	67%	76%	86%	95%	105%	114%	124%	133%	143%
14	10%	19%	29%	39%	49%	58%	68%	78%	87%	97%	107%	117%	126%	136%	146%
15	10%	20%	30%	40%	50%	60%	70%	79%	89%	99%	109%	119%	129%	139%	149%
16	10%	20%	30%	41%	51%	61%	71%	81%	91%	102%	112%	122%	132%	142%	152%
17	10%	21%	31%	41%	52%	62%	73%	83%	93%	104%	114%	124%	135%	145%	155%
18	11%	21%	32%	42%	53%	63%	74%	85%	95%	106%	116%	127%	138%	148%	159%
19	11%	22%	32%	43%	54%	65%	76%	86%	97%	108%	119%	130%	140%	151%	162%
20	11%	22%	33%	44%	55%	66%	77%	88%	99%	110%	121%	132%	143%	154%	165%
21	11%	22%	34%	45%	56%	67%	79%	90%	101%	112%	124%	135%	146%	157%	169%
22	11%	23%	34%	46%	57%	69%	80%	92%	103%	115%	126%	138%	149%	161%	172%
23	12%	23%	35%	47%	58%	70%	82%	93%	105%	117%	129%	140%	152%	164%	175%
24	12%	24%	36%	48%	60%	71%	83%	95%	107%	119%	131%	143%	155%	167%	179%
25	12%	24%	36%	49%	61%	73%	85%	97%	109%	121%	133%	146%	158%	170%	182%
26	12%	25%	37%	49%	62%	74%	87%	99%	111%	124%	136%	148%	161%	173%	185%
27	13%	25%	38%	50%	63%	75%	88%	101%	113%	126%	138%	151%	164%	176%	189%
28	13%	26%	38%	51%	64%	77%	90%	102%	115%	128%	141%	154%	166%	179%	192%
29	13%	26%	39%	52%	65%	78%	91%	104%	117%	130%	143%	156%	169%	183%	196%
30	13%	27%	40%	53%	66%	80%	93%	106%	119%	133%	146%	159%	172%	186%	199%
31	13%	27%	40%	54%	67%	81%	94%	108%	121%	135%	148%	162%	175%	189%	202%
32	14%	27%	41%	55%	69%	82%	96%	110%	124%	137%	151%	165%	179%	192%	206%
33	14%	28%	42%	56%	70%	84%	98%	112%	126%	140%	154%	168%	182%	196%	209%
34	14%	28%	43%	57%	71%	85%	99%	113%	128%	142%	156%	170%	184%	199%	213%
35	14%	29%	43%	58%	72%	87%	101%	115%	130%	144%	159%	173%	188%	202%	216%
36	15%	29%	44%	59%	73%	88%	103%	117%	132%	147%	161%	176%	191%	205%	220%
37	15%	30%	45%	60%	75%	89%	104%	119%	134%	149%	164%	179%	194%	209%	224%
38	15%	30%	45%	61%	76%	91%	106%	121%	136%	151%	166%	182%	197%	212%	227%
39	15%	31%	46%	61%	77%	92%	108%	123%	138%	154%	169%	184%	200%	215%	230%

*** If D.O. is greater than 15 mg/L then use the formula on page. 175 in your Stream Keepers Field Guide:**

$$\frac{\text{Actual Dissolved Oxygen (mg/L)}}{\text{Max Oxygen Concentration at Water Temp}}$$