M e m o r a n d u m

Date: June 5, 2020

To: DWR Program Managers

From: **North Central Region Office, Water Quality Evaluation Section**

Subject: DWR YSI Turbidity Sensor Measurement Units

Purpose:

This memorandum serves as the official notice from North Central Region Office (NCRO) Water Quality Evaluation Section to all Department of Water Resources (DWR) program managers that all turbidity measurement units reported on the departments California Data Exchange Center (CDEC) by Yellow Springs Instruments (YSI) turbidity sensors will be changed from **N**ephelometric **T**urbidity **U**nits (**NTU**) to **F**ormazin **N**ephelometric **U**nits (**FNU**). The reported sensor values will not be changing only the displayed units on the website will be changing to reflect the appropriate units measured by the sensor type that YSI manufactures and the sensors deployed by DWR NCRO staff.

Background:

Since 1995, YSI has been manufacturing in-situ turbidity sensors and DWR has been using these sensors since the late 1990s on YSI 6-series multi-parameter water quality instrumentation (Note: Multi-parameter water quality instruments are also commonly referred to as ‘sondes’). In Technical Note T627 (1) provided by the manufacturer, YSI informed product users that their company has been incorrectly reporting turbidity units for all 6-series sensors as NTU, even though the method used by the sensors was ISO7027 and should instead be reported as FNU (1). YSI explained that they were following the common practice of NTU as the measurement unit of turbidity rather than the actual method used by the sensor to collect the data.

YSI 6-Series sondes did not allow the user the option of reporting in FNU, but current YSI instrumentation platforms (i.e. EXO sondes and ProDSS Handhelds that are currently used by DWR) provide the ability to report in FNU units. It is important to note that switching the reporting units between NTU and FNU on the YSI EXO or ProDSS Handheld does not change the value or affect the comparability of the recorded measurement. No difference in internal or post-processing is applied to turbidity measurements recorded by YSI equipment. Therefore, all historical turbidity data collected with YSI turbidity sensors by DWR NCRO should be and should have always been reported as FNU (see Table 1).

Turbidity units represented as NTU are captured by sensors using a white light with a frequency between 400-680 nm at a 90-degree detection angle (EPA 180.1 method compliant) (2). This contrasts with turbidity units represented as FNU, which are captured by sensors using an infrared, monochromatic light with a wavelength between 780-900 nm at a 90- degree angle. ISO’s recommendation for in-situ turbidity measurements is to use turbidity sensors with an infrared, monochromatic light source

between 830-890 nm. These options help to eliminate color interferences inherent in environmental water samples collected in aquatic environments. Following that recommendation, YSI turbidity sensors, for all their instrument platforms, have always used an infrared sensor at a frequency greater than 800nm and therefore should be reported in FNU.

Although, no unit conversions of historical turbidity data collected by DWR YSI 6-series or EXO sensors are necessary when comparing between in-brand instrumentation across years, the data comparison is not direct when collecting with other instrumentation with turbidity sensors actually measuring NTU (using US EPA 180.1 Method). Important to note, there is a numerical equivalence between sensors reporting NTU (US EPA 180.1 Method) and FNU (ISO7027) when measuring in prepared formazin standards (used for sensor calibration), but this is not true with these different sensor types and units when measuring in environmental water.

Station	WDL StationID	CDEC	Funding Program	Station Turbidity Data Record w/ Incorrectly Reported NTU Units	CDEC Update to FNU	Station Upgrade to YSI EXO2
Old River near Franks Tract	B9510800	OSJ	SWPAO	10/20/2005-02/24/2019	2/25/2019	03/16/2016
Turner Cut near Holt	B9561600	TRN	SWPAO	06/18/2009-02/24/2019	2/25/2019	03/26/2015
Miner Slough near Sacramento River	B9147000	MIR	O&M-South Delta Branch	06/12/2015-02/20/2020	2/21/2020	04/11/2017
Steamboat Slough near Sacramento River	B9145000	SXS	O&M-South Delta Branch	06/12/2015-02/20/2020	2/21/2020	10/05/2018
Sacramento R Downstream of Isleton	B9125000	SOI	O&M-South Delta Branch	06/12/2015-02/20/2020	2/21/2020	07/03/2019
Fisherman's Cut	B9505000	FCT	O&M-South Delta Branch	10/07/2014-02/20/2020	2/21/2020	02/04/2015
Bethel Island @ Piper Slough	B9504500	BET	O&M-South Delta Branch	05/12/2014-02/21/2020	2/21/2020	10/03/2019
Middle River near Holt	B9545800	HLT	O&M-South Delta Branch	06/23/2006-02/24/2019	2/25/2019	06/05/2019
Grant Line Canal near Clifton Court Forebay	B9529500	GLC	O&M-South Delta Branch	02/02/2007-02/24/2019	2/25/2019	05/24/2018
Grant Line Canal East	B9532000	GLE	O&M-South Delta Branch	02/26/2013-02/20/2020	2/21/2020	06/23/2017
Middle River near Tracy Blvd	B9550600	MRX	O&M-South Delta Branch	01/01/2003-02/20/2020	2/21/2020	10/03/2018
Middle River at Howard Road	B9553100	MHO	O&M-South Delta Branch	10/01/2019-02/20/2020	2/21/2020	10/03/2018
Middle River at Undine Road	B9554100	MRU	O&M-South Delta Branch	06/04/2002-02/20/2020	2/21/2020	05/11/2017
Old River below DMC barrier	B9536500	ODM	O&M-South Delta Branch	01/18/2006-02/20/2020	2/21/2020	06/29/2017
Old River at TWA	B9537800	TWA	O&M-South Delta Branch	07/14/1999-02/20/2020	2/21/2020	05/23/2019
Old River near Head	B9540000	OH1	O&M-South Delta Branch	07/10/2001-02/20/2020	2/21/2020	04/24/2018
Grant Line Canal at Tracy Blvd	B9530000	GCT	O&M-South Delta Branch	03/06/2006-08/03/2018	N/A	N/A
Doughty Cut above GLC	B9532500	DGL	O&M-South Delta Branch	06/19/2006-08/08/2018	N/A	N/A
Middle River at Union Point	B9550000	MUP	O&M-South Delta Branch	02/23/2006-08/14/2018	N/A	N/A
Old River above DMC barrier	B9536600	OAD	O&M-South Delta Branch	04/28/2000-11/28/2017	N/A	N/A
Victoria Canal	B9528500	VCU	O&M-South Delta Branch	03/30/2007-02/24/2019	2/25/2019	06/23/2016
Three Mile Slough near SJR	B9506100	TSL	O&M	04/10/2008-02/24/2019	2/25/2019	03/26/2015
Mokelumne River near Hwy 12	B9409500	MOK	O&M	04/04/2008-02/24/2019	2/25/2019	03/16/2016
Old River near Bacon Island at USGS Pile	B9525100	OBI	O&M	01/09/2008-02/24/2019	2/25/2019	01/10/2019
False River near Oakley	B9504400	FAL	O&M	10/20/2005-02/24/2019	2/25/2019	03/16/2016
Holland Cut near Bethel Island	B9512000	HOL	O&M	10/20/2005-02/24/2019	2/25/2019	03/26/2015
Old River at Quimby Island	B9520000	ORQ	O&M	10/20/2005-02/24/2019	2/25/2019	05/15/2019
Old River above Doughty Cut	B9539000	ORX	O&M	03/21/2013-02/20/2020	2/21/2020	05/01/2018
Old River above Mountain House Creek	B9537000	ORM	O&M	02/25/2015-02/20/2020	2/21/2020	06/13/2017
Truckee River at Bridge 8	G7166310	N/A	CalNEVA	02/07/2000-02/20/2020	2/21/2020	06/13/2019
Truckee River above TTSA	G7151310	N/A	CalNEVA	05/24/2006-02/20/2020	2/21/2020	06/13/2019
Little Truckee above Boca	G7216000	LAB	CalNEVA	03/07/2007-02/20/2020	2/21/2020	06/13/2019
Truckee River at Farad	G7119500	FAR	CalNEVA	10/16/1998-02/20/2020	2/21/2020	06/13/2019
San Joaquin River at Blind Point	B9502900	BLP	DES	02/03/2010-02/20/2020	2/21/2020	02/04/2020
Old River at Clifton Court Intake	B9534100	ORI	DES	04/10/2018-02/20/2020	2/21/2020	02/06/2020
West Canal at Clifton Court Intake	B9533800	WCI	DES	04/10/2018-02/20/2020	2/21/2020	02/06/2020

Table 1. List of DWR NCRO water quality stations that report turbidity data on California Data Exchange Center (CDEC) that have had measured turbidity units updated from NTU to FNU.

Data Reporting and Management:

In response to YSI's Technical Note T627 (1) and documentation research (2-4), NCRO Water Quality Evaluation Section has recently updated the reporting turbidity units from NTU to FNU for all telemetered real-time stations on CDEC (Table 1). This is to ensure that we are representing the YSI sensor method used (ISO7027) with the correct turbidity units and properly comparing turbidity values between instruments that use equivalent methods.

Reported turbidity units in all future report and presentation deliverables to program/project managers will be updated to the proper FNU unit measure for YSI turbidity data. In addition, the next steps in NCRO data management will include updating both units in the internal DWR Hydstra database and the public accessible Water Data Library.

Thank you for your attention to this matter. If you have questions or concerns, please contact Jared Frantzich (916) 376-9823 and/or Paul Larson (916) 376-9658.

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1. YSI (2017). Technical Note T627: Turbidity and Calibration Solutions. Released: February 2, 2017. https://www.ysi.com/File%20Library/Documents/Technical%20Notes/T627_Turbidity_Units_and_Calibration_Solutions.pdf
2. Anderson, C.W. (2005). Turbidity: U.S. Geological Survey Techniques of Water-Resources Investigations. Book 9 Chap. A6.7. https://pubs.er.usgs.gov/publication/twri09A6.7
3. Graham, J.L. et al. (2018). Water Quality Conditions with an Emphasis on Cyanobacteria and Associated Toxins and Taste-and-Odor Compounds in the Kansas River, Kansas, Jul. 2012-Sept. 2016. USGS Investigations Report 2018-5089, 55 p., https://pubs.er.usgs.gov/publication/sir20185089
4. Etheridge, A.B. et al. (2014). Water-quality and Biological Conditions in Selected Tributaries of the Lower Boise River, Southwestern Idaho, water years 2009-12: USGS 2014-5132, 58 p. http://dx.doi.org/10.3133/sir20145132