

# Appendix 13. Field Comparison between YSI EXO and YSI 6136 Turbidity Sensors at Cheney Reservoir near Cheney, Kansas (U.S. Geological Survey [USGS] Station Number 07144790), October 1, 2014 to March 12, 2015

## Comparison Description

**Station name:** Cheney Reservoir near Cheney, Kansas (U.S. Geological Survey [USGS] station number 07144790).

**Equipment:** A Yellow Springs Instrument (YSI) EXO water-quality monitor equipped with a YSI EXO turbidity sensor and a YSI 6 series equipped with a YSI 6136 turbidity sensor were deployed at the site for comparison between the sensors. The monitors were set to log data every 15 minutes. The distance between the two sensors was less than 10 feet. No datum corrections were applied to either dataset. All of the turbidity data was less than 100 FNU, therefore the data could not be separated into low- and high-turbidity conditions.

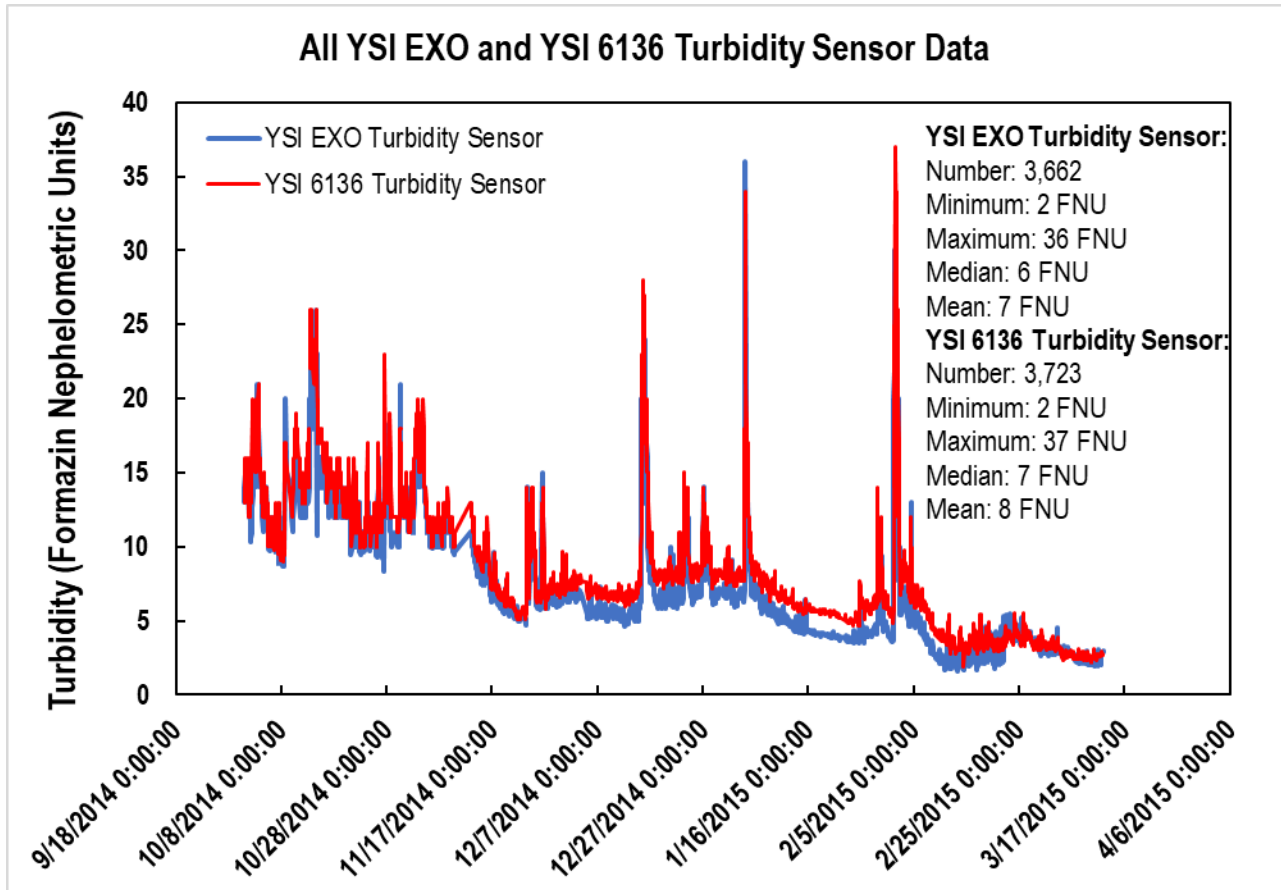
**Calibration standard used:** YSI polymer standard.

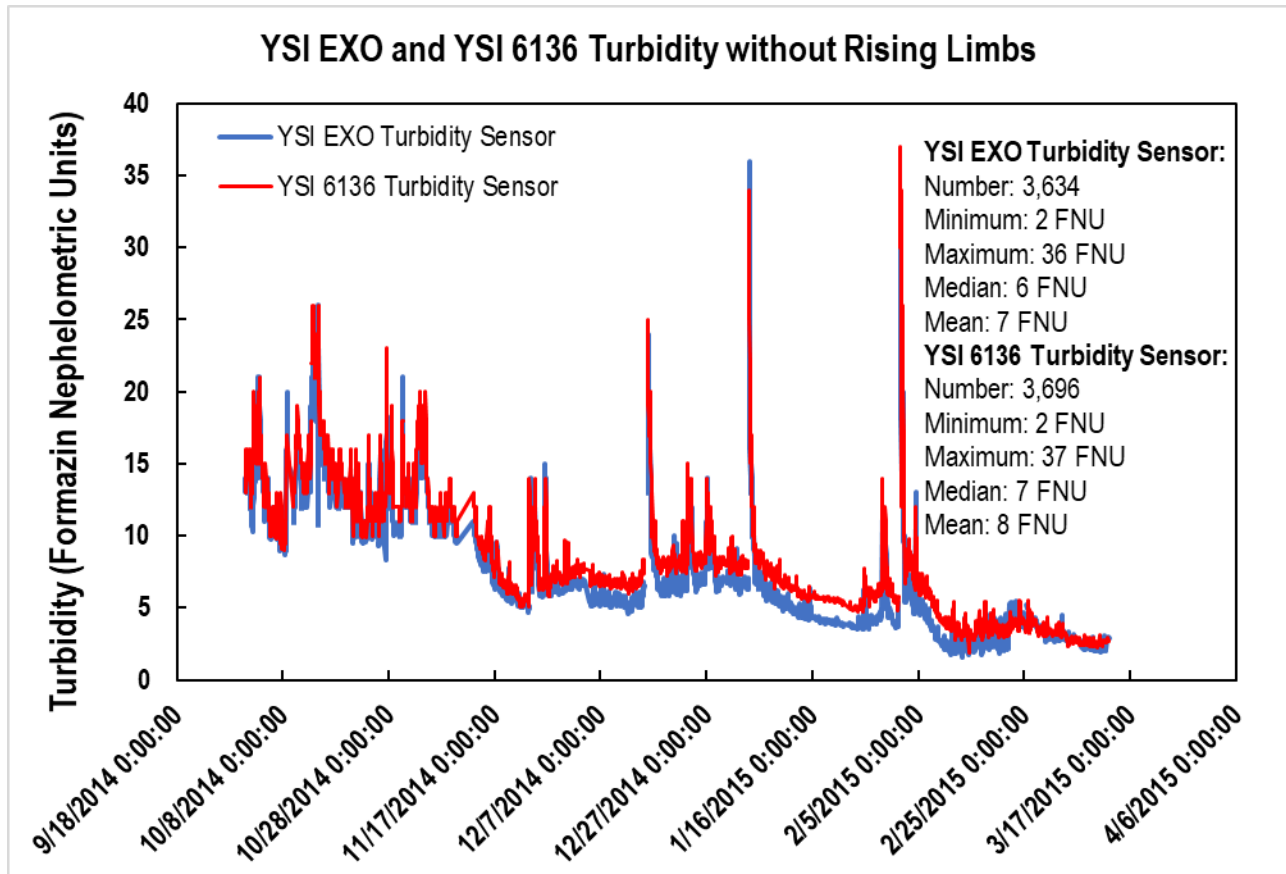
**Side-by-side comparison data period:** October 1, 2014 to March 12, 2015.

## Datasets

All data were collected using USGS protocols (U.S. Geological Survey, variously dated) and are published in King (2021). Data were analyzed in three ways: (1) the entire dataset (0–1,000 formazin nephelometric units [FNU]) with only clearly erroneous data edited out, (2) 0–99 FNU with the rising limbs removed, and (3) 100–1,000 FNU with the rising limbs removed. Rising limbs were removed (on the basis of visual inspection, when the hydrograph became vertical to near vertical) to eliminate the effect of the highly variable turbidity readings commonly observed during this part of the hydrograph.

# Time Series





## Statistical Analyses – All Data

Slope comparison

The following is a summary of final regression analysis for sensor-measured turbidity from a YSI EXO turbidity sensor and a YSI 6136 turbidity sensor at Cheney Reservoir near Cheney, Kansas, October 1, 2014 to March 12, 2015.

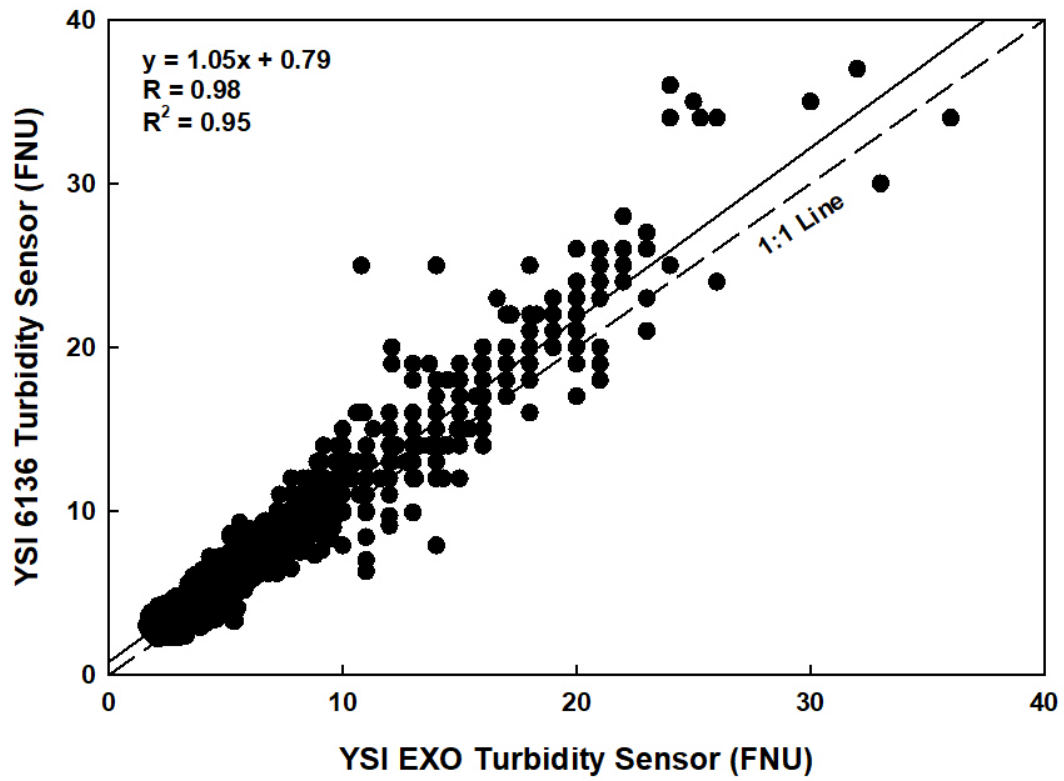
$$y = 1.05x + 0.79$$

where

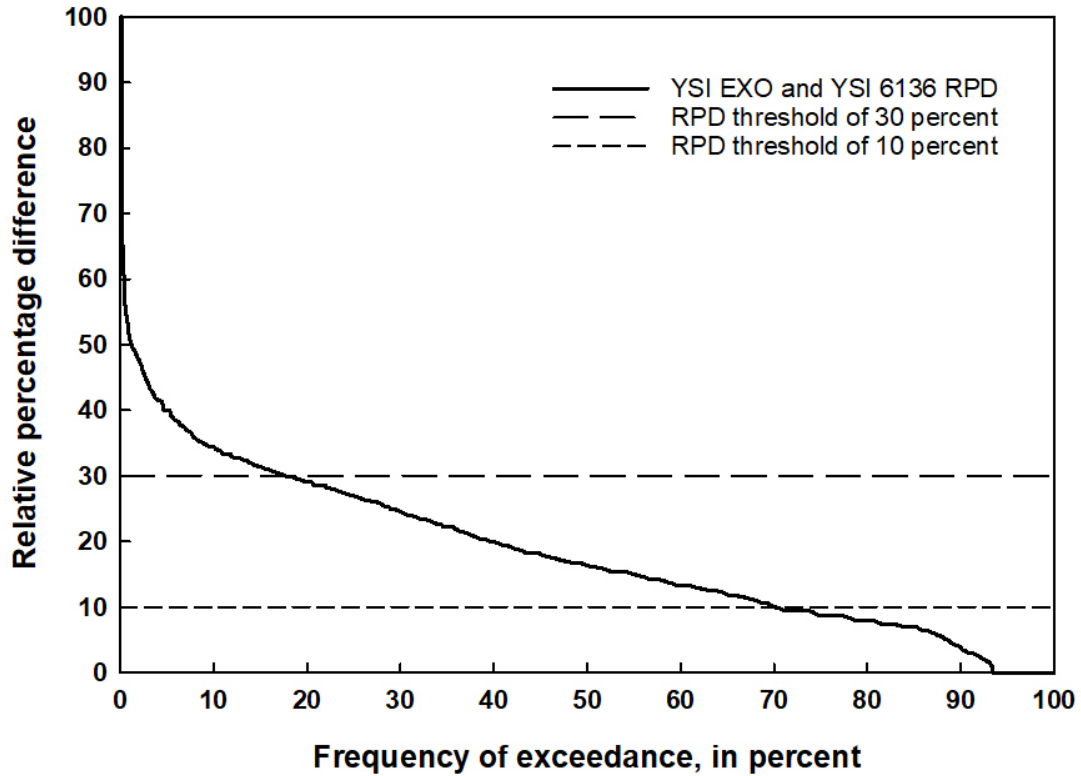
y = turbidity measured with YSI 6136 turbidity sensor (FNU)

x = turbidity measured with YSI EXO turbidity sensor (FNU).

### Linear Association of All YSI EXO and YSI 6136 Turbidity Data



## Relative Percentage Difference (RPD) of YSI EXO and YSI 6136 Turbidity Sensors



Wilcoxon Signed-Rank Test for All Data

SigmaPlot Statistical Output:

**Normality Test (Shapiro-Wilk):** Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
YSI EXO	3658	4	6.200	4.200	10.000
YSI 6136	3658	0	7.400	5.600	11.000

W= 5456334.000 T+ = 5642869.500 T- = -186535.500

Z-Statistic (based on positive ranks) = 47.393

(P = <0.001)

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

R Statistical Output:

wilcoxon signed-rank test with continuity correction

```
data: YSI 6136 and YSI EXO
V = 5642870, p-value < 2.2e-16
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
 1.199922 1.249965
sample estimates:
(pseudo)median
 1.200021
```

## Summary of Results

There is a strong linear association between measurements made with the two sensors ( $R = 0.98$ ). Seventeen percent of the time, the relative percentage difference in turbidity values measured with the two sensors was greater than 30 percent. The data did not pass the Shapiro-Wilk test for normality ( $P < 0.05$ ); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the YSI EXO and YSI 6136 turbidity sensors was statistically significant ( $P < 0.05$ ).

## Selected References

Cleveland, W.S., 1979, Robust locally weighted regression and smoothing scatterplots: Journal of the American Statistical Association, v. 74, no. 368, p. 829–836.

Helsel, D.R., and Hirsch, R.M., 2002, Statistical methods in water resources—Hydrologic analysis and interpretation: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. A3, 522 p. [Also available at <https://doi.org/10.3133/twri04A3>.]

King, L.R., 2021, Laboratory and field data for selected turbidity standard and sensor comparisons, October 2014 to September 2017: U.S. Geological Survey Data Release, <https://doi.org/10.5066/P9EVSDHH>.

U.S. Geological Survey, variously dated, The national field manual for the collection of water-quality data: U.S. Geological Survey Techniques and Methods, book 9, chaps A1–A10. [Also available at <https://water.usgs.gov/owq/FieldManual/>.]