



Conversion of Fecal coliform to *Escherichia coli* Bacteria in Austin, TX

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Abstract

Escherichia coli (*E. coli*) is the current bacteria monitored in water quality samples to examine the potential presence of pathogenic microorganisms. Fecal coliform was used in the past for similar purposes, but the current science suggests that the use of *E. coli* bacteria is a better marker for water contaminated by human fecal waste. The City of Austin has required that stormwater runoff meet compliance for fecal coliform, but wishes to match current science by switching to compliance for *E. coli* bacteria. Not enough *E. coli* data has been collected in stormwater by the City of Austin to accurately suggest a compliance level for stormwater. Thus a conversion equation was formed using side by side monitoring of fecal coliform and *E. coli* bacteria.

Fecal coliform and *Escherichia coli* (*E. coli*) data collected in side-by-side samples in Austin, TX, from 1993 until 2009 were used to create a conversion equation from *Fecal coliform* to *E. coli*. Prior to analysis, data was screened to remove any sample event where the value of either bacteria was less than or greater than the detection/reporting limit and counts of each type of bacteria were log transformed. Two separate analyses were run to create the conversion equation. One equation used only bacteria data from baseflow conditions while the other analysis used baseflow and stormwater bacteria data. The analysis that used only baseflow data contained 2,241 data points with *fecal coliform* counts less than 14,000 MPN/100 mL and *E. coli* counts less than 8,000 MPN/100 mL. The mixed dataset added 180 data points that contained *fecal coliform* counts less than 160,000 MPN/100 mL and *E. coli* counts less than 60,000 MPN/100 mL. A summary of each data set can be seen in Table 1.

Table 1: Summary statistics for *Fecal coliform* and *E.coli* for baseflow and stormwater conditions.

Statistic	Baseflow Counts (MPN/100 mL)		Mixed Data Counts (MPN/100 mL)	
	Fecal coliform	E. coli	Fecal coliform	E. coli
Sample size	2,241	2,241	2,421	2,421
Mean	142	97	887	552
Median	30	20	36	23
Mode	2	2	2	2
Standard Deviation	626	412	6,210	3,353
Min. – Max.	0 – 12,200	0 - 7600	0 – 157,000	0 – 60,000

Least square regression was then used to create the two conversion equations. Little difference existed between the two resulting equations, partially because the relatively small addition of stormwater data points compared to the large number of baseflow condition data points (Figure 1):

$$\text{Baseflow Equation: } E. coli = 0.834252 * (\text{Fecal Coliform}^{0.94107})$$
$$\text{Mixed Equation: } E. coli = 0.81325546 * (\text{Fecal Coliform}^{0.95761})$$

The adjusted R^2 value for the baseflow condition equation was 0.8893, while the mixed equation adjusted R^2 was 0.9055. Both models showed that data was slightly skewed but residual plots did not indicate any particular patterns (Figures 2 and 3). The residuals for the mixed data model showed a higher standard deviation, meaning that more actual *E. coli* data points were further away from the *E. coli* data points predicted by the mixed equation than in the baseflow model. This is not surprising since the variance in the stormwater data was high. Even though the adjusted R^2 was higher in the mixed model, the equation chosen to represent the conversion from *fecal coliform* to *E. coli* bacteria for the City of Austin was the baseflow model because of the lower variability in the data and in the residuals.

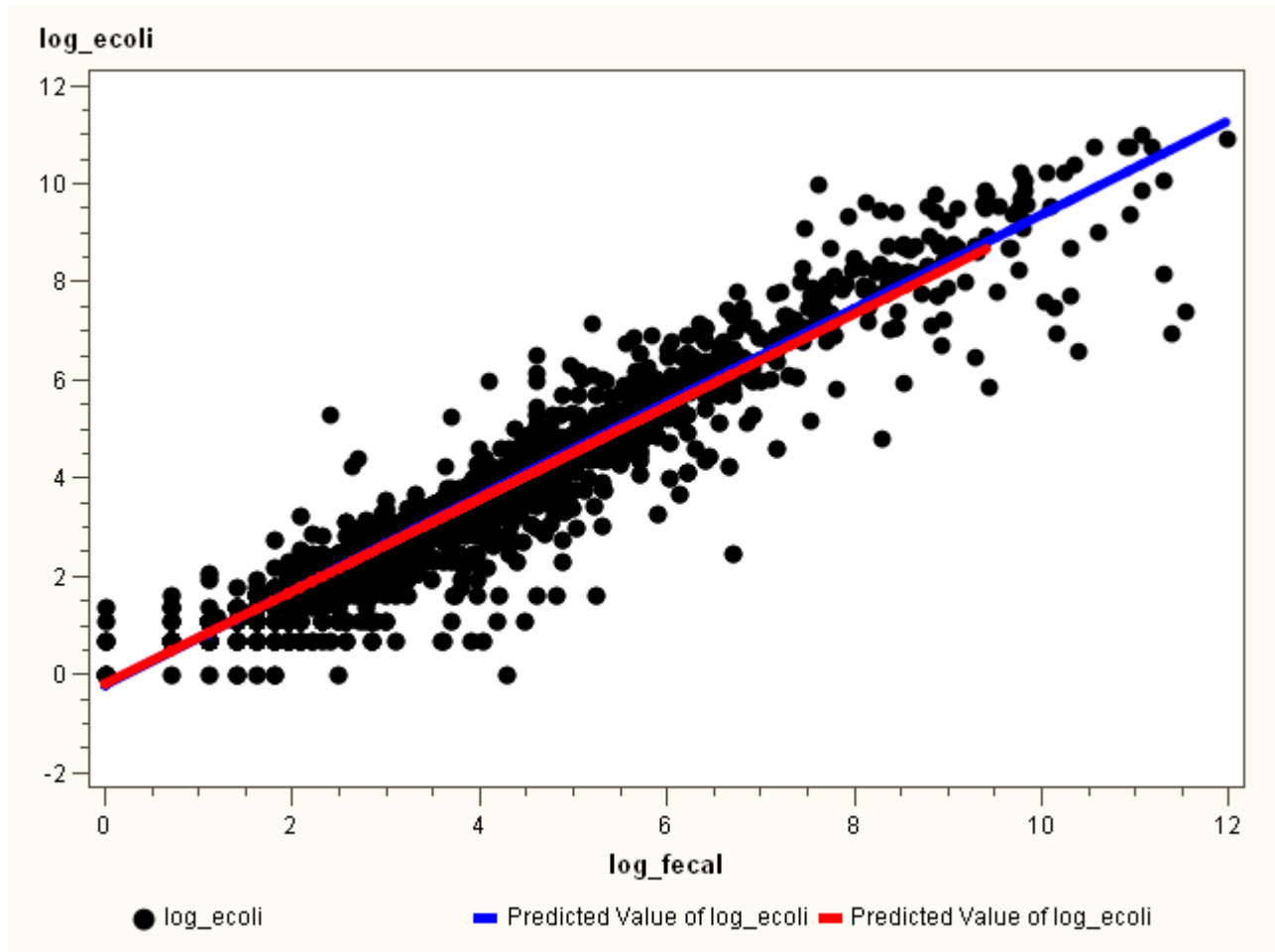


Figure 1: Ln(*fecal coliform*) by Ln(*E. coli*) and the regression equations with storm values (blue) and without stormwater (red).

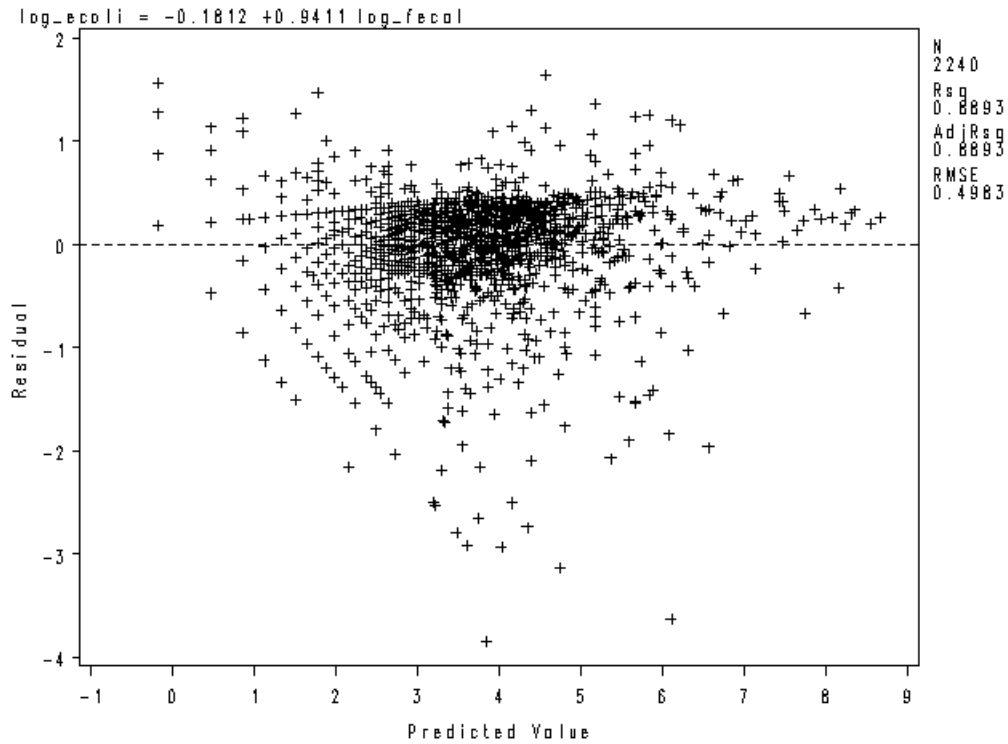


Figure 2: Residual plot of the *fecal coliform* and *E. coli* bacteria regression for baseflow conditions.

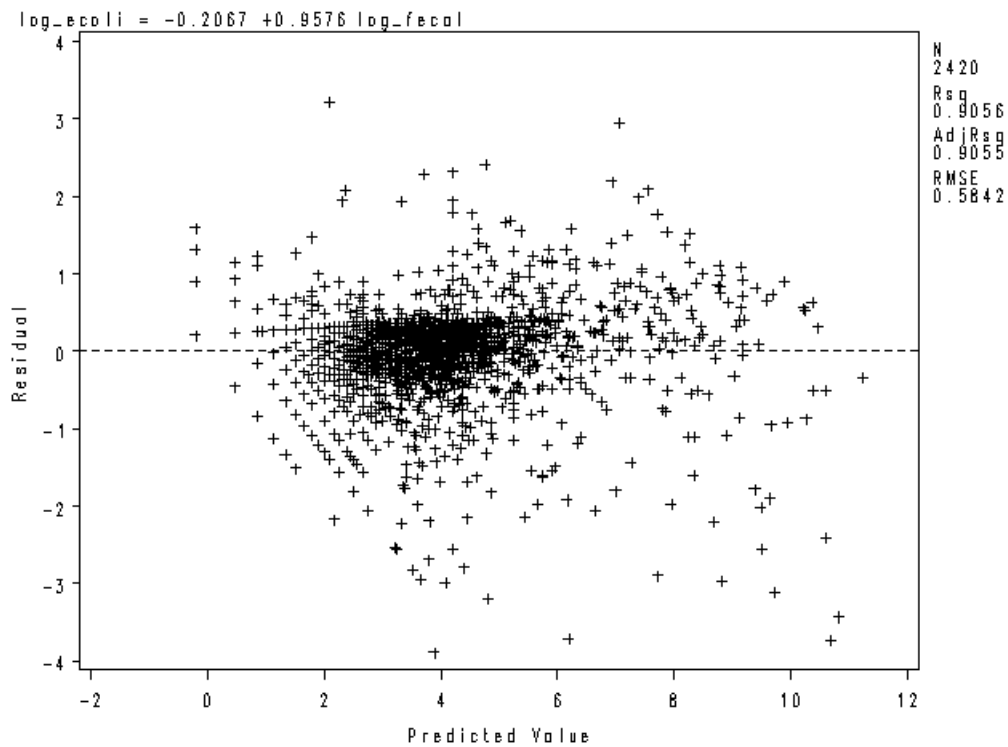


Figure 3: Residual plot of *fecal coliform* and *E. coli* bacteria regression for baseflow and stormwater conditions.