Problem 2: Sample size for trend estimation

Use the following P concentration summary data for these two examples:

Mean	= 0.89 mg/L
Std Dev.	= 0.62 mg/L
n	= 165

a. Step trend

Calculate the change in (or difference between the pre- and post-) mean values that can be detected if 52 biweekly samples are collected in both the pre- and post-BMP periods. The change can be compared to the actual change anticipated with BMP implementation. Sample size can be iteratively changed to obtain the desired detectable change.

Results:

With 52 samples for each of the pre- and post- (e.g., biweekly over 2 years for each of the pre- and post-BMP periods), the change in post- vs pre- BMP means that could be statistically verified where (See section 3.4.2), total sample size is 104 and total of 4 years:

> $d=t_{102}$* sqrt ((0.62 * .062 * 2)/52)), using a 2-sided t-test with t_{102} =1.98
> d=0.24 mg/l or 27% change in post- vs pre- BMP means

With 4 years pre- and 4-years post (n_{per} and n_{post} = 104, total sample size is 208),

> $d=t_{206}$ * sqrt ((0.62 * .062 * 2)/104)), using a 2-sided t-test with t_{206} =1.97
> d=0.17 mg/l or 19% change in post- vs pre- BMP means

Note that this does not account for potential autocorrelation. See section 3.4.2 for a discussion of correction for autocorrelation which will result in requirement for a higher percent change to be realized for the same sample size without autocorrelation.

b. Linear trend

Calculate the change that can be detected in a linear trend. Assume that the MSE is the same as the variance of the water quality data (i.e., no trend in data). Use the values of $\sum(Xi - \overline{X})^2$ from Table 3-11 in section 3.4.1.2.

$$d = (N) * t_{(n*N-2)df} * 365 * s_{b1} \quad \text{where } s_{b1} = 0.62/4{,}224$$

For 104 samples, biweekly over a 4-years period:

> $d=2 * t_{(102)}$ * 365 * 0.62/4,224
> d=2*1.98*365*0.62/4,224, two-sided t
> d=0.21mg/l or 24%

For 208 samples, biweekly over a 8-years period:

> $d=2 * t_{(206)}$ * 365 * 0.62/15,955
> d=2*1.97*365*0.62/15,955, two-sided t
> d=0.06 mg/l or 6%

The d would actually be smaller due to autocorrelation. See Section 3.4.2 for correction to standard deviation.