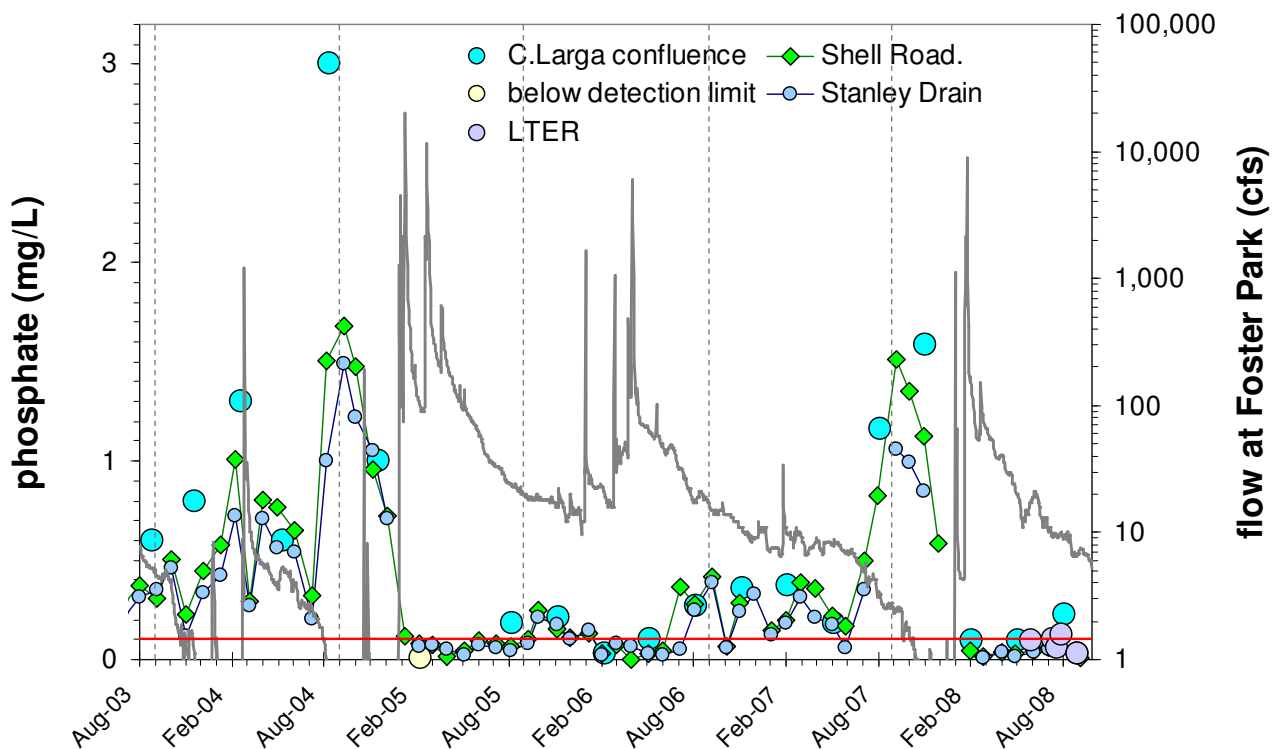


I've prepared graphs for phosphate in the same format as I did for nitrate: in files named Phosphate.VR.I, Phosphate.VR.II and Phosphate.VR.III. I'm not going to bother showing them. Instead, I want to concentrate on comparing data from the Ojai Treatment Plant (OVSD) with the Channelkeeper dataset. Unfortunately, the sanitary district only began analyzing samples for phosphate beginning in August 2003, and this date, also unfortunately, marks the beginning of a reduced sampling program; sampling only 3 locations: above the WWTP (R-3), just below the outfall (R-4) and just above the Canada Larga confluence (R-5). As a result only a limited amount of OVSD phosphate data is available. The above graph shows data from their above the WWTP sampling point (R-3). These results should be compatible with Channelkeeper's Foster Park data. Unfortunately they are not; phosphate concentrations above the plant appear to be much higher above the WWTP than they are even further above at Foster Park. The expectation is that differences between these two sampling locations, if any, should show a decrease in phosphate, not an increase.

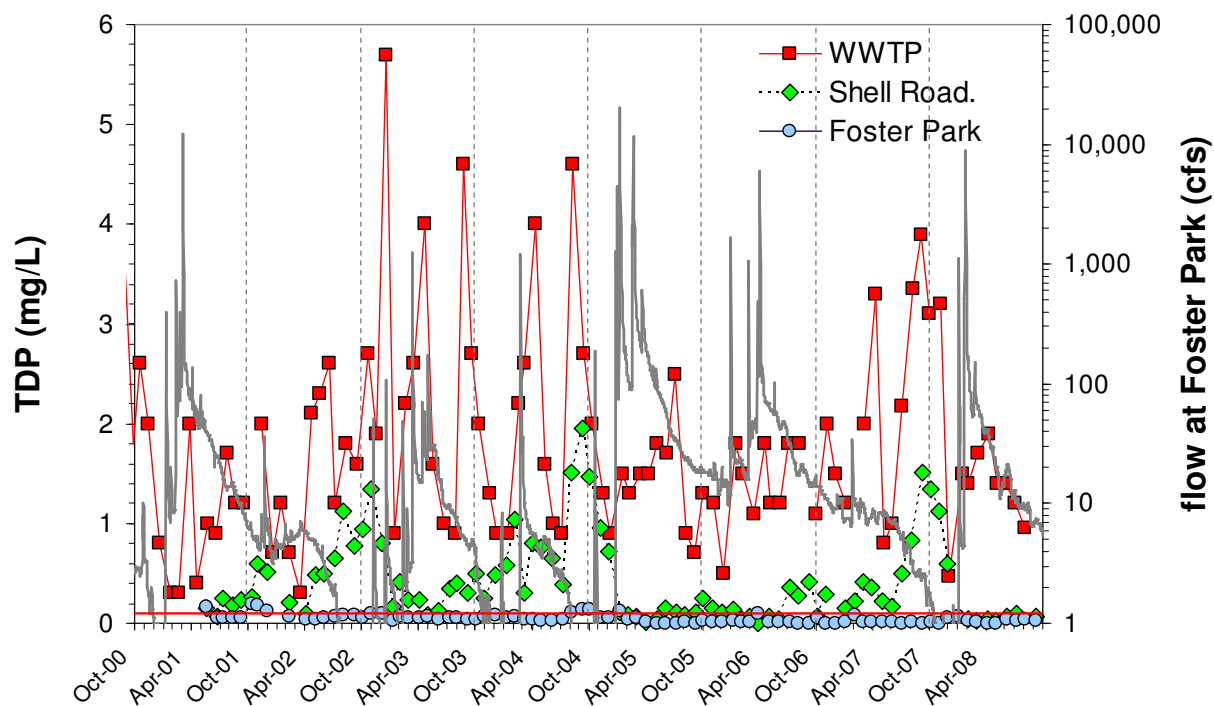
There are (I need to quit saying unfortunately) a number of "non-detects" in the OVSD dataset. I've assigned these samples a value of 0.009 mg/L – this being half the detection limit given in the most recent results. Detection limits were not given for earlier results and I've assumed that this value is also applicable to them. This is probably not accurate and to compensate, all non-detect samples are shown in a different color on the graph. I have also decided not to apply the same rule to Channelkeeper results (as Emerson said "a foolish consistency being the hobgoblin of little minds"). The LTER lab gives the phosphate and total dissolved phosphorus (TDP) detection limit as 0.3  $\mu\text{M}$ , i.e., 0.0093 mg/L. I probably should have begun assigning half this value, 0.005 mg/L, to all phosphorus samples below 0.3  $\mu\text{M}$  back in 2001. Since I didn't, and never have, I've also left the values in these graphs unchanged. However the dashed blue line marks the < 0.01 mg/L TP limit for "good quality" waters (from the 305b SWAMP Report) (the red line marks the > 0.1 mg/L limit defining "poor quality") and results below this line are usually below the stated LTER detection limit.



This graph shows phosphate data from the site just above the Canada Larga confluence (R-5). Again, I've indicated any samples below the detection limit (only one since this location, below the plant, is almost always high in phosphate). I've also included, from the early summer of 2008 on, LTER analyzed samples collected at approximately the same location. All are shown against a background of Foster Park flow, and Shell Road and Stanley Drain monthly phosphate. The Canada Larga confluence is approximately 0.6 km below the WWTP, Shell Road 2.4 km further downriver, and Stanley Drain another 1.5 km below. The expected pattern between the confluence and Shell Road should be similar to that between Shell and Stanley Drain: very little difference during winter and periods of high flow, but a noticeable decrease during low-flow, dry-season uptake.

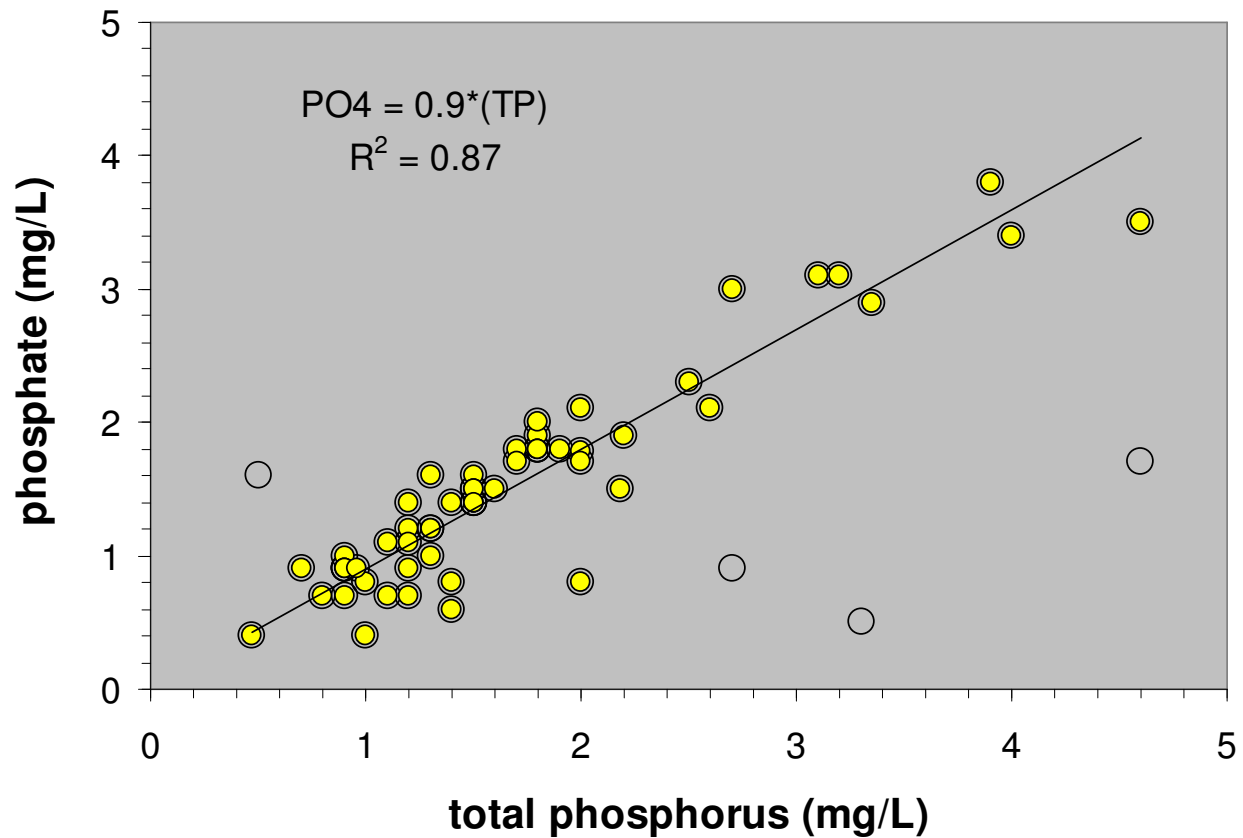
The actual pattern, unlike that seen in the first graph, shows the expected similarity during the most recent years, but higher than expected OVSD concentrations during the earlier period. Part of the similarity, of course, is due to scale differences between the two graphs (roughly 10:1), but it is reassuring that the patterns here do resemble one another. What is a little upsetting is that the OVSD concentrations are noticeably higher – especially the earlier ones. LTER (Channelkeeper) phosphorus concentrations show a “step” between pre- and post-2005 data (visible in Foster Park data shown on the first graph), due, most probably, to some kind of analysis or calibration problem. My general feeling has been that the post-2005 data is the more accurate, i.e., that pre-2005 concentrations are too high. That the OVSD concentrations are higher still is not reassuring.

However, this is not to say that part of the problem might not lie with OVSD data. Although I don't know for sure, it seems like at least 3 labs have been used over the years for analysis (2 since August 2003) and these earlier samples may have been analyzed by a different lab, with different detection limits, than the later. As a final note, as of September 2008 Channelkeeper has abandoned sampling at Shell Road and Stanley Drain, and, instead, will sample at the confluence. So in the future we will have a better chance of comparing phosphorus concentrations. Keep in mind, however, that, because of variations in WWTP output, different sampling dates and times may make exact comparisons problematic.

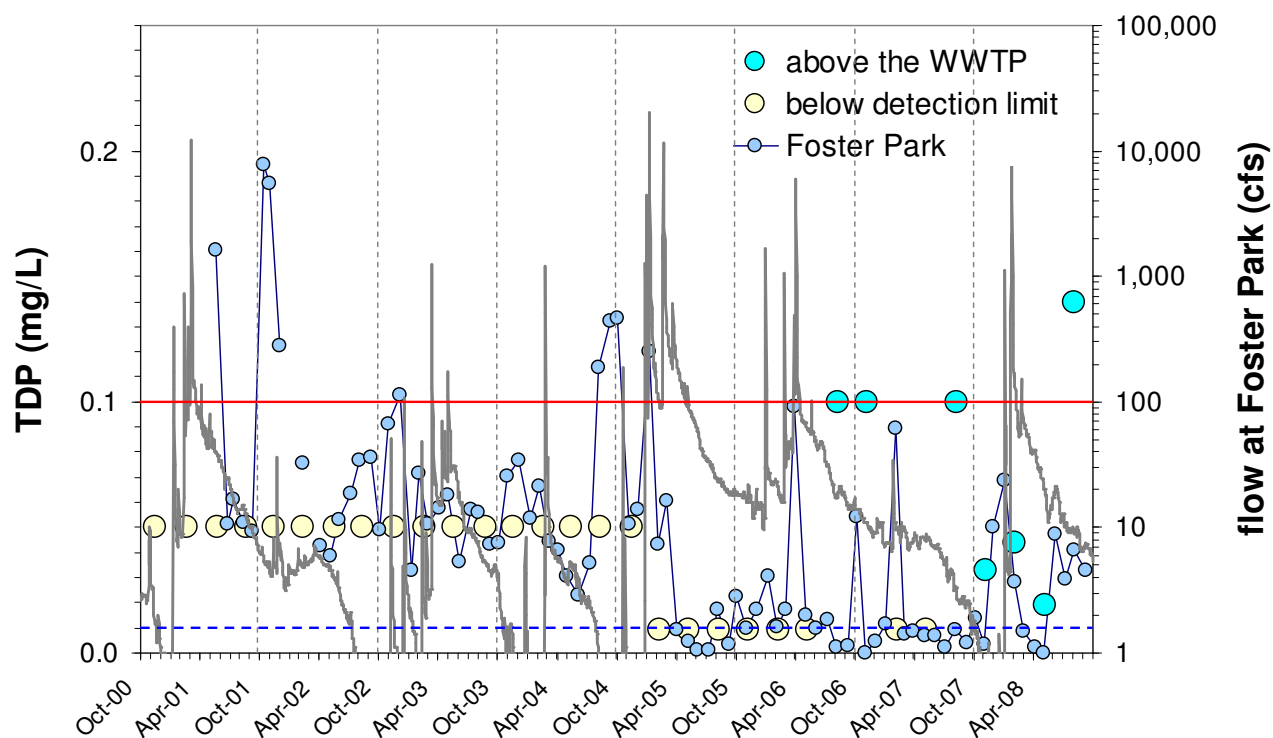


On to total dissolved phosphorus (TDP): This graph shows monthly total phosphorus (TP) concentrations in WWTP effluent along with Channelkeeper TDP concentrations at Shell Road and Foster Park. While WWTP output is quite variable, river flow (i.e., the amount of dilution) is the principal determinant of downriver concentrations. I need to make two points. The first is that there is typically very little difference between TP and TDP concentrations in river and streamflow. The main exception occurs during, and shortly after, storms when the river carries an appreciable sediment load – normally sediment concentrations can be considered negligible (turbidity readings usually meet drinking water standards).

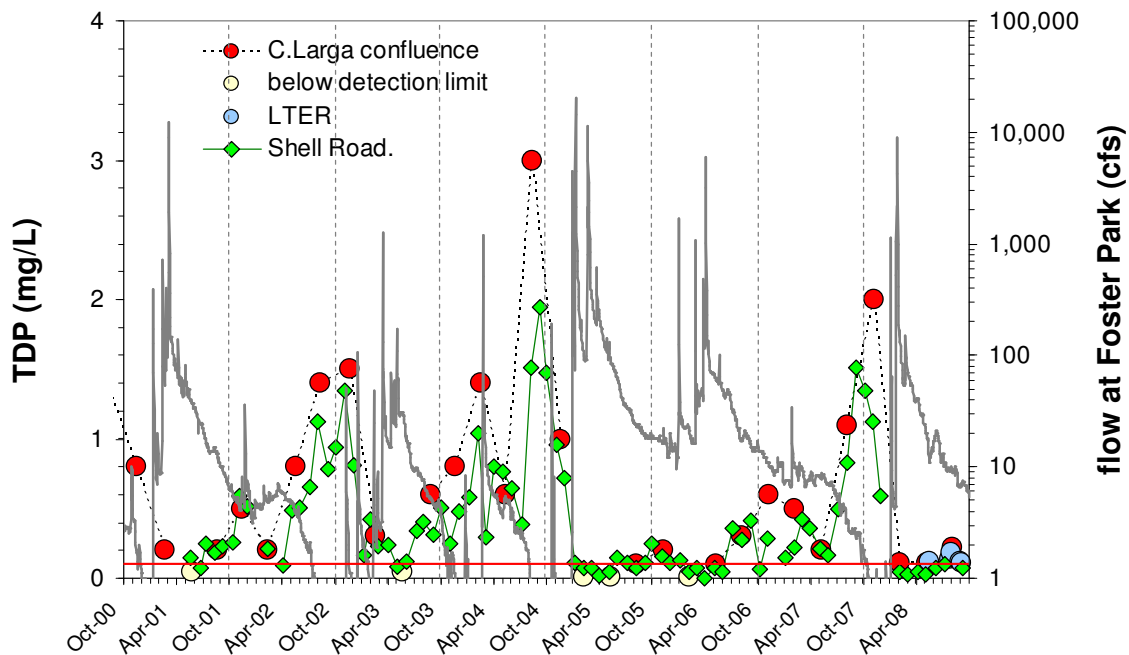
The second is that Channelkeeper TDP concentrations are what I've termed in the past "modified TDP," which I often express as TDP\*. There has been, and still is, a major problem with the LTER TDP analysis: TDP concentrations are often lower than those for phosphate in the same sample. Obviously, this cannot be true: TDP may equal phosphate, but can never be lower. But this is not a uncommon occurrence if phosphorus concentrations are low and if dissolved organic phosphorus, DOP, makes up a very small percentage of the phosphorus total (the LTER doesn't actually measure phosphate, or what is often called ortho-phosphate, it measures soluble reactive phosphorus, SRP, which may include some small amount of low molecular-weight organic phosphorus; either way, phosphate + DOP, or SRP + DOP equals TDP). Unfortunately, this is not an occasional problem with the LTER analysis; it occurs in 42 % of the samples included in the Channelkeeper dataset. Modified TDP partially corrects for this problem by substituting phosphate concentrations for TDP whenever a TDP result is lower than phosphate. All Channelkeeper data in the above graph, and in all the graphs that follow, show modified TDP or TDP\*. While I believe this doesn't introduce appreciable error (the majority of "modified" samples containing low concentrations of DOP) I have no way of proving it, so when looking at Channelkeeper TDP concentrations the words "at a minimum" should be kept in the back of your mind.



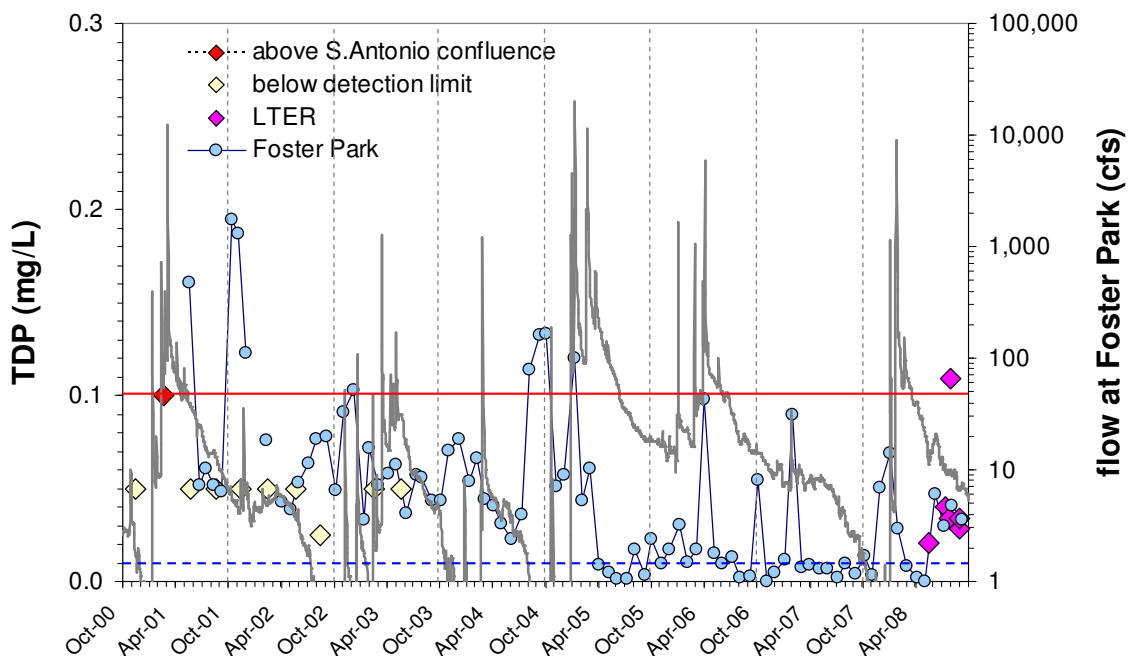
The discussion on the previous page lends itself to the question of how much of the phosphorus coming out of the WWTP is phosphate? Fortunately, since August 2003 effluent analysis has included both TP and phosphate. The above graph shows these results. There is a consistent correlation between the two; phosphate typically makes up 90 % of the total phosphorus found in effluent (r-square = 0.87; the plain circles represent data considered outliers and were left out of the regression).



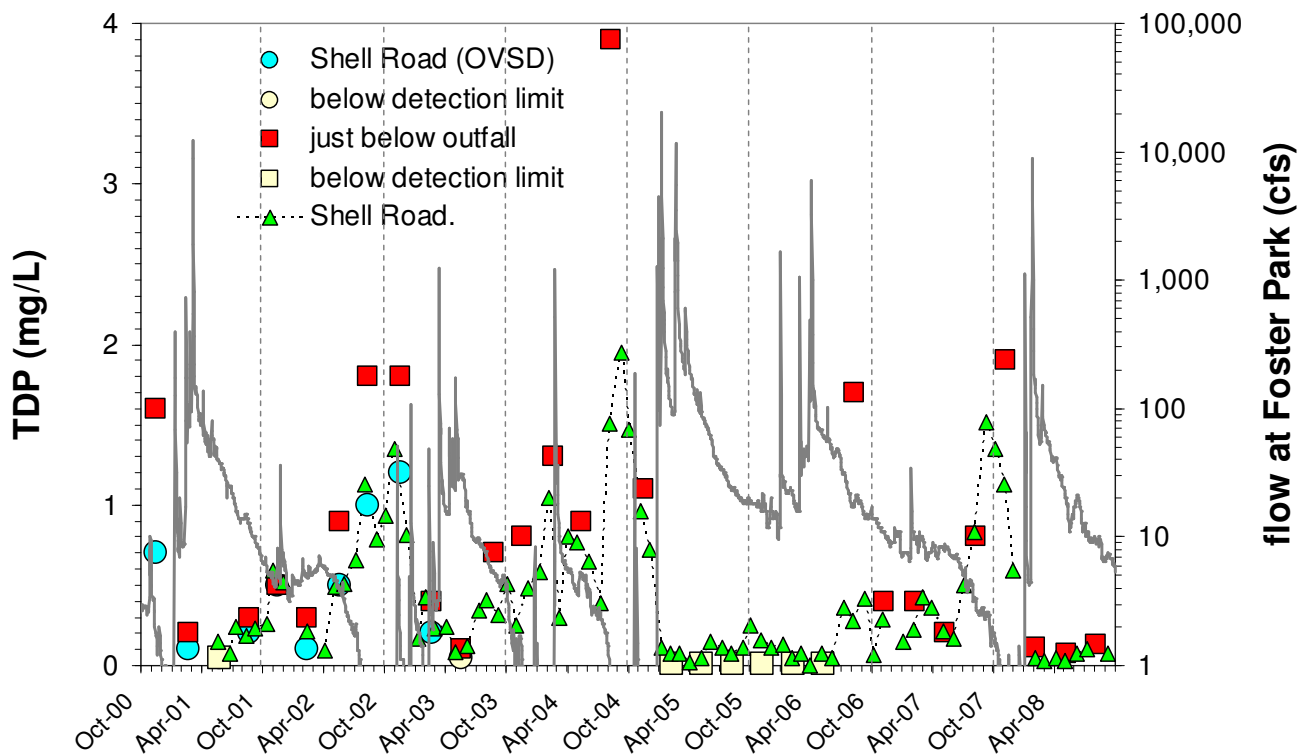
In this graph OVSD TP data from samples collected above the treatment plant (R-3) are plotted along with flow and TDP from Foster Park. Again, there is no joy. Most of the OVSD samples were below the detection limit ( $< 1$  mg/L up to 2005,  $< 0.018$  from late 2006, and “your guess is as good as mine” for the period in-between). Although the “non-detects” look like they fit the Channelkeeper pattern, this is pure coincidence based on my arbitrary choice on assigning concentrations to these samples. Again, as for phosphate, the light-blue circles show concentrations appreciably higher than the Channelkeeper Foster Park results.



Looking at OVSD TP concentrations just above the Canada Larga confluence (R-5) (and a few taken this summer, marked LTER) compared with Channelkeeper Shell Road TDP results. The patterns are similar although the actual concentrations are noticeably higher (with a few exceptions).

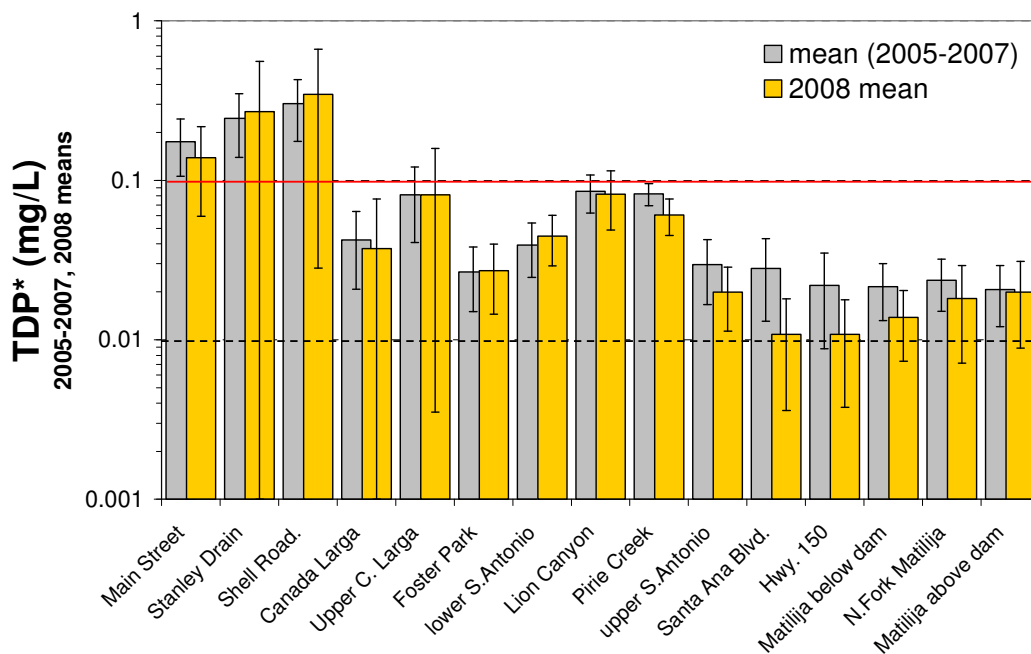
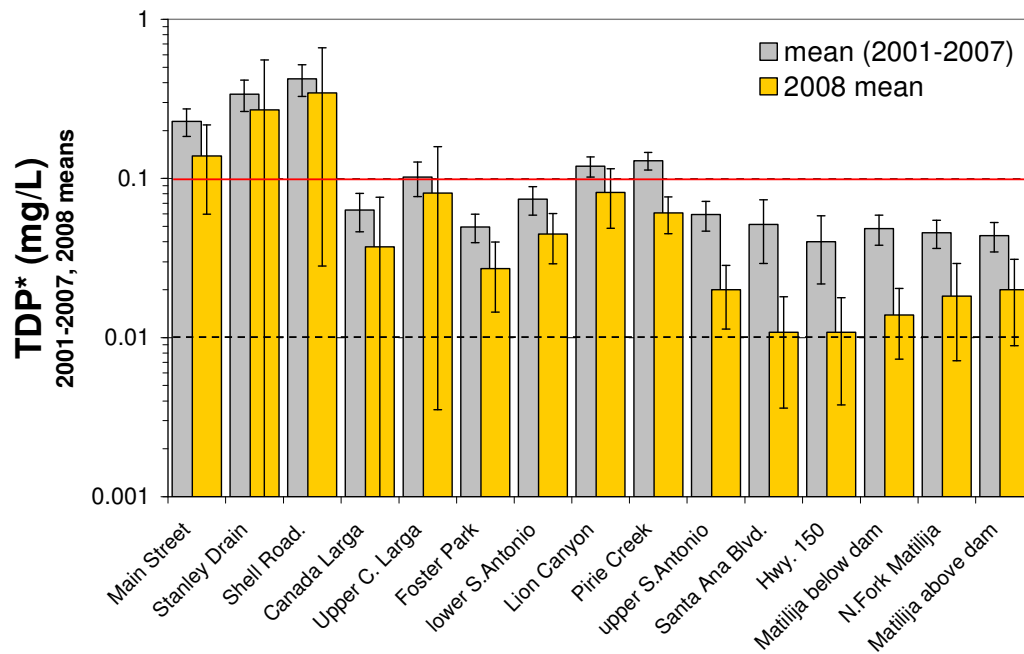


TP concentrations measured just above the San Antonio confluence in earlier years (R-1, when the OVSD had an expanded sampling program) turn out to be relatively useless, as all but one fell below the detection limit and that one was collected prior to the Channelkeeper program. Recent samples collected at this location (LTER) show a great similarity to those from Foster Park (3.4 km downstream)(a result we might profitably spend some effort contemplating). The one high value is most likely in error, having anomalously high DOP.



Finally, here's a plot of OVSD TP concentrations from samples collected just below the WWTP outfall (R-4) – about 0.5 km above the Canada Larga confluence. Also shown are Shell Road TP concentrations from the early series of OVSD samples (R-6) and Channelkeeper Shell Road TDP results. I've used a pale-yellow color to indicate non-detect results for both OVSD series. This graph probably displays the most encouraging results: the TP patterns are similar and the actual concentrations not far removed from each other. Shell Road values are usually lower than those right below the outfall – as they should be. I've assigned a value of 0.009 mg/L to the long series of 2005-06 (R-4) non-detects (based on the minimum detection limit of later samples); they could just as easily be given a value of 0.05 mg/L, in which case they would fit right in with the Channelkeeper results. High flows kept TP concentrations low at all points below the WWTP during this extended period, reinforcing my point that it's river flow and not treatment plant output that determines lower reach phosphorus concentrations.

As to my overall thoughts? As long as we are dealing with relatively high phosphorus concentrations all the datasets are compatible and in rough agreement with each other, and I'm confident that they express reality. However, low concentrations are a problem, and one that is currently irresolvable.



Because of the “step” down in all LTER analyzed phosphate and TDP values after 2004 I’ve decided to show 2008 data in two different ways: first in comparison with averages of 2001 through 2007 concentrations be they for individual months or for all years; and then in comparison with averages using only 2005 through 2007 data – thus avoiding problems with the phosphorus dichotomy and presenting a more balanced picture of what happened in 2008. These graphs, showing mean monthly TDP concentrations, are an example of how including, or excluding, the first 4 years of data changes the comparison. The TDP files, which show both of these alternatives along with TDP and phosphate comparisons, are especially complicated. There are 3 of them: TDP & phosphate.VR.I, TDP & phosphate.VR.II, and TDP & phosphate.VR.III. The third is organized similarly to the “III” files for nitrate and phosphate, but the first two are somewhat different.