Chapter 3. DSM2 Version 8.1 Time Step Sensitivity Test

3.1 Introduction

This chapter gives the update on DSM2 version 8.1.2 time step sensitivity test results. The sensitivity tests are important because relatively small changes in time steps should not result in large changes in water quality results. If there are large differences in results due to differences in time step size, this reflects a problem in the model's ability to converge. Time steps for Hydro (the DSM2 hydrodynamic module), the tidefile (output from Hydro), and Qual (the DSM2 water quality module) have been tested. Sensitivity tests were done to evaluate the effects of different time steps on simulated EC. These results suggest DSM2 converges well. Time steps for the v8.1 calibration were chosen based on these results.

3.2 Testing Scenarios and Result Analysis

The historical run setup was used for all the test runs. The simulation period was from June 1, 2006, to June 1, 2008. The two-year time period is long enough to provide representative data for comparing the results.

3.3 Test for Qual Time Step Sensitivity

For Qual, four time steps of 15, 5, 3 and 1 minutes were tested. In all these simulations, Hydro was run at a 5-minute time step and the tidefile was output at 15-minute time steps. The EC results were tidally filtered and compared. Results at a few representative key stations are shown here in the following figures. The key stations are Clifton Court Forebay (CLIFTON_COURT), Old River at Bacon Island (ROLD024), San Joaquin River at Jersey Point (RSAN018), and Stockton Ship Channel (RSAN058) (Figures 3-1 to 3-4).

The output results show that the model converges well. The difference between time steps of 15 minutes and 5 minutes is around 1% for Clifton Court Forebay and Old River at Bacon Island (Figures 3-5 and 3-6). In each of these two figures, the top part shows comparison and the difference in values, and the bottom part shows the difference in percentage. The difference in simulated results between time steps of 5 minutes and 3 minutes is less than 1% (Figures 3-7 and 3-8). The difference between time steps of 3 minutes and 1 minute is less than 0.4% (Figures 3-9 and 3-10).

Figure 3-1 Qual Time Step Sensitivity at Clifton Court Forebay

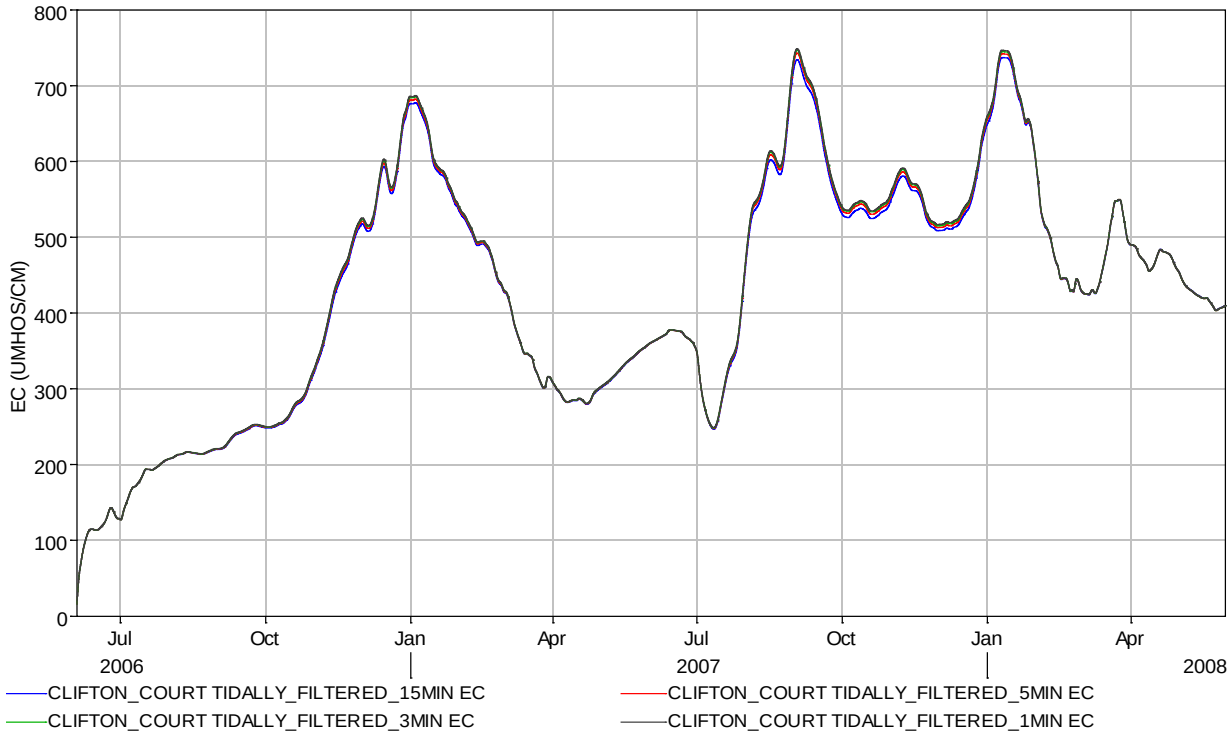


Figure 3-2 Qual Time Step Sensitivity at Bacon Island (ROLD024)

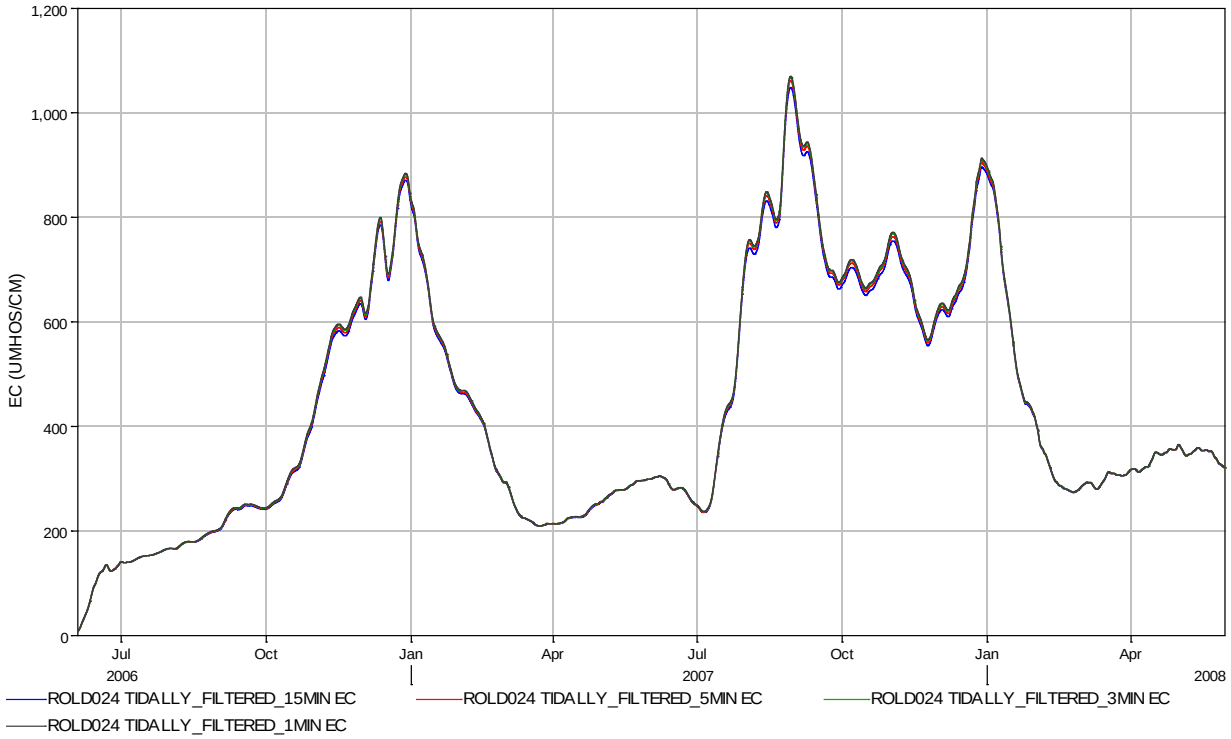


Figure 3-3 Qual Time Step Sensitivity at Jersey Point (RSAN018)

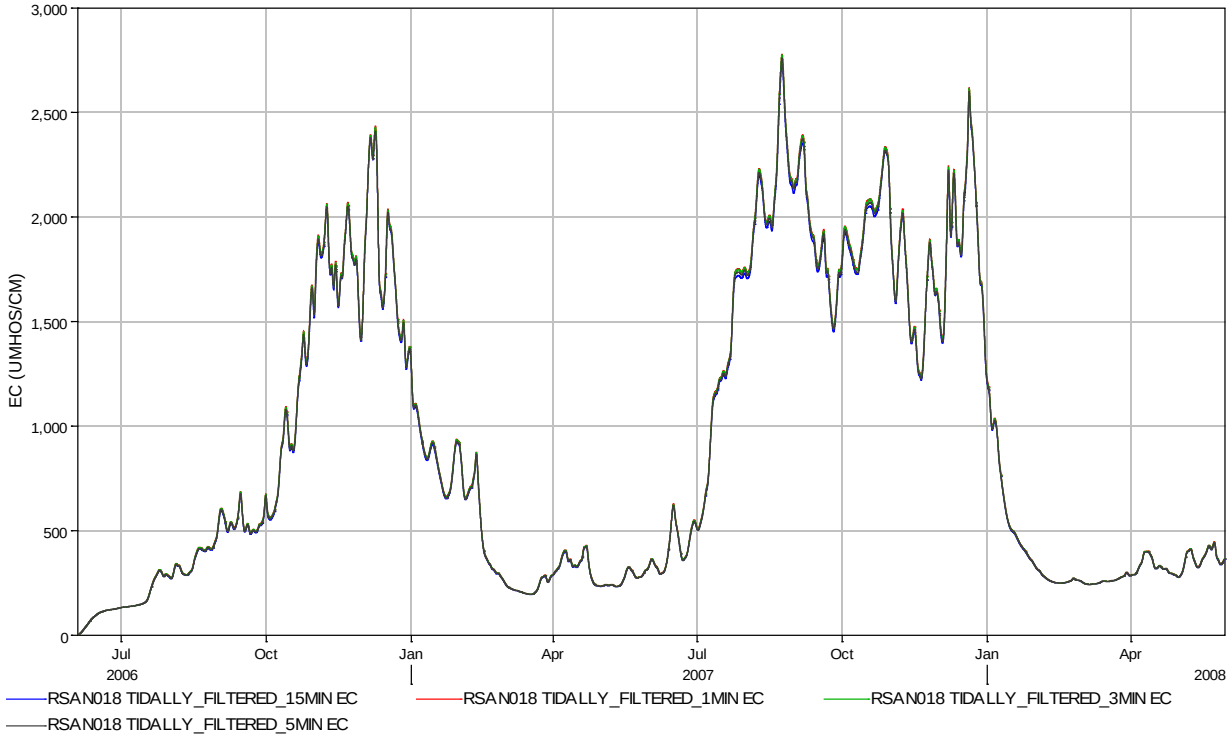


Figure 3-4 Qual Time Step Sensitivity at Stockton Ship Canal (RSAN058)

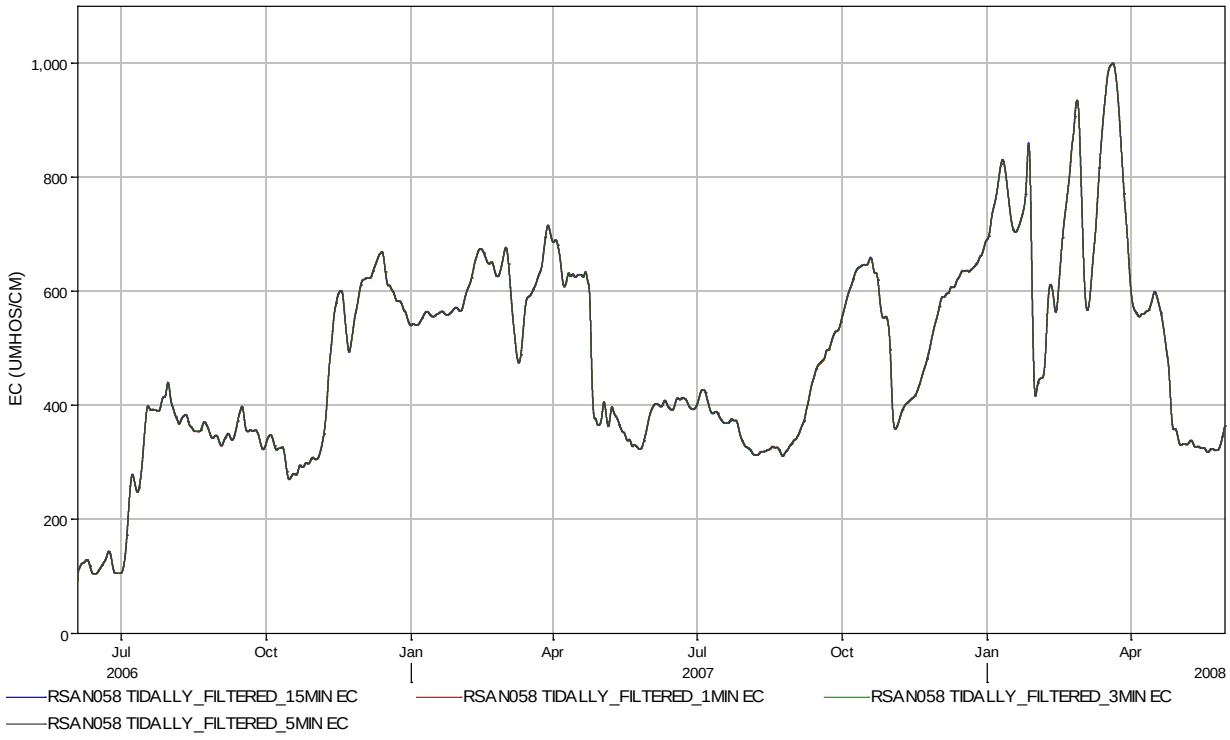


Figure 3-5 Comparison of Simulated EC with Time Steps of 15 Minutes and 5 Minutes at Clifton Court Forebay

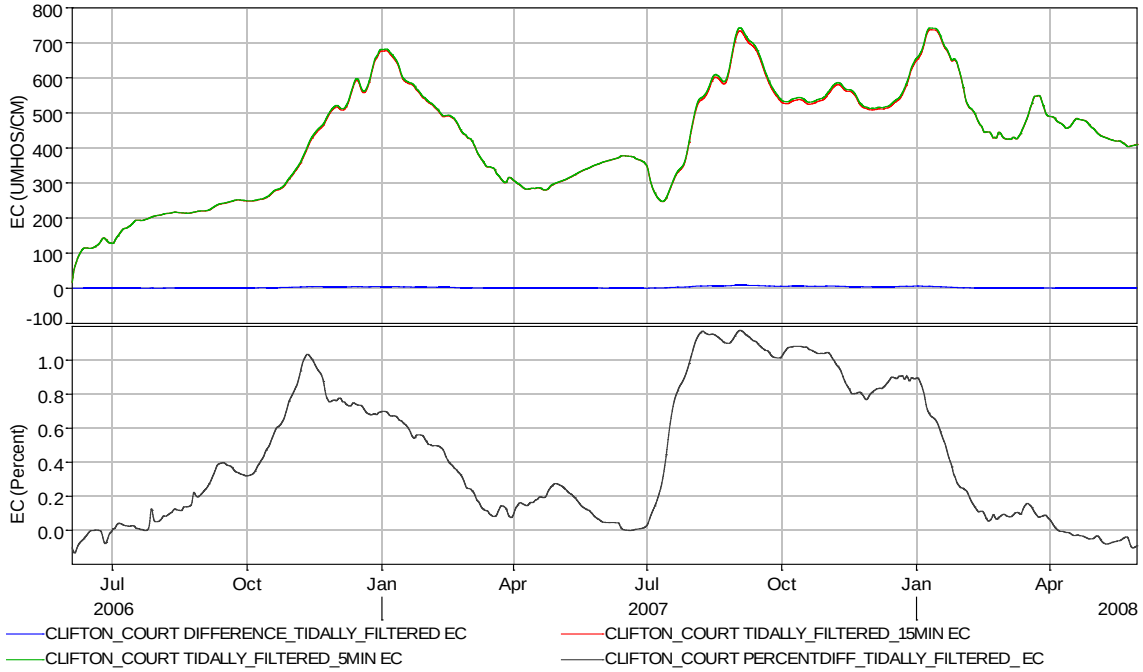


Figure 3-6 Comparison of Simulated EC with Time Steps of 15 Minutes and 5 Minutes at Bacon Island

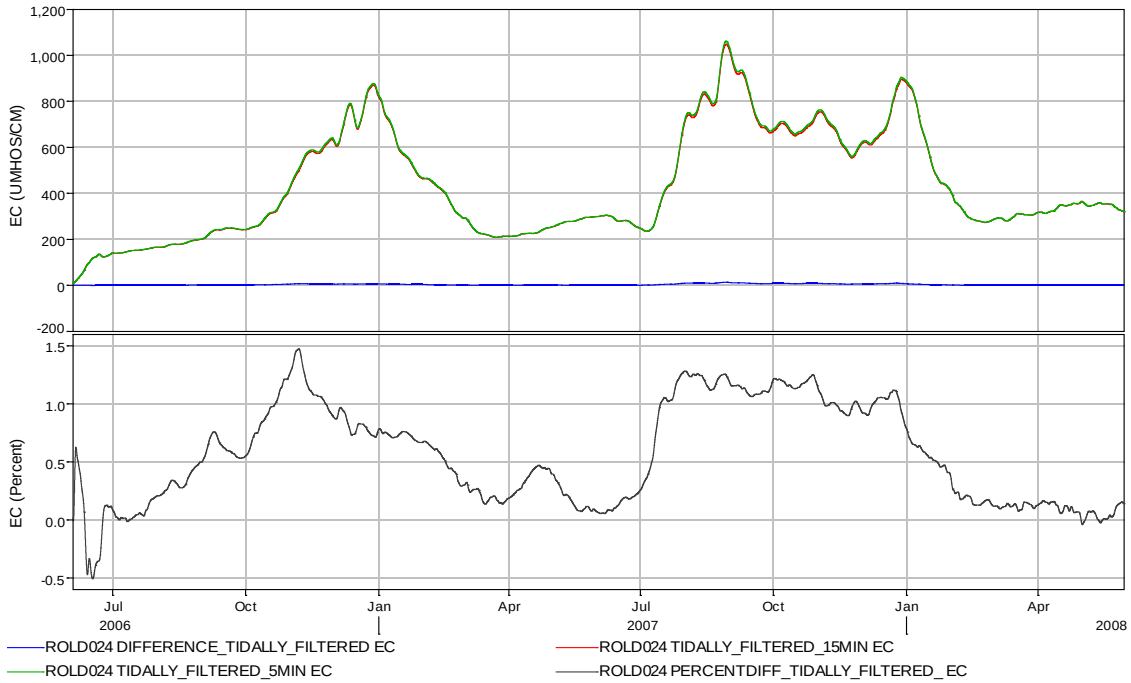


Figure 3-7 Comparison of Simulated EC with Time Steps of 5 Minutes and 3 Minutes at Clifton Court Forebay

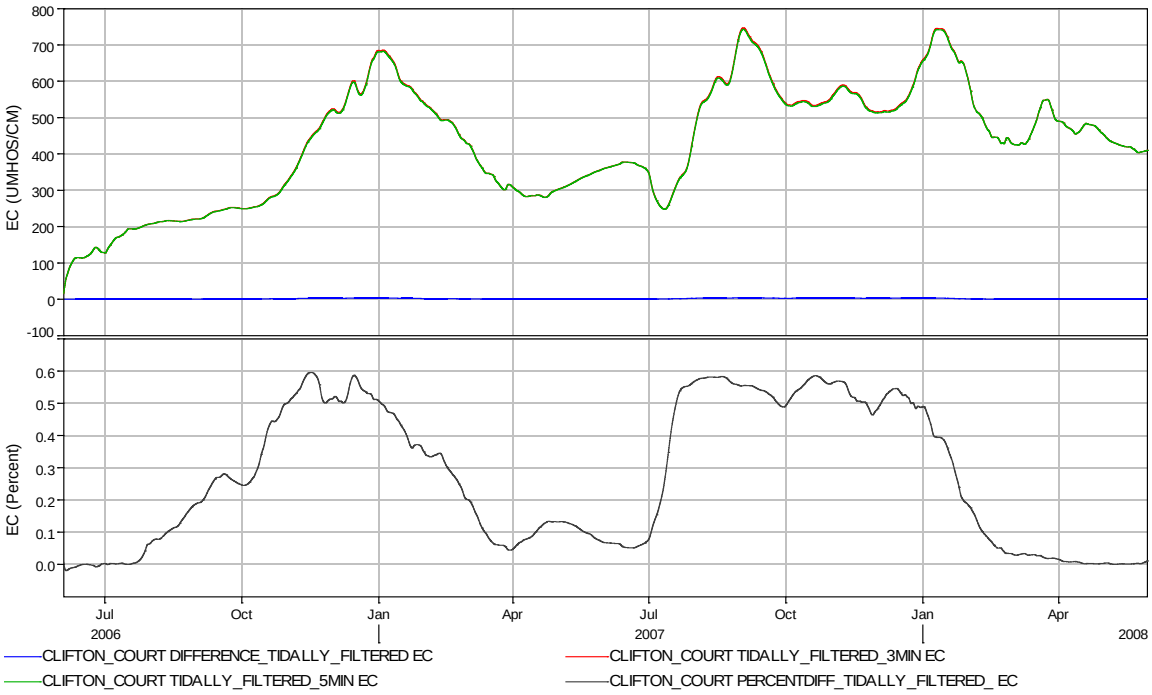


Figure 3-8 Comparison of Simulated EC with Time Steps of 5 Minutes and 3 Minutes at Bacon Island

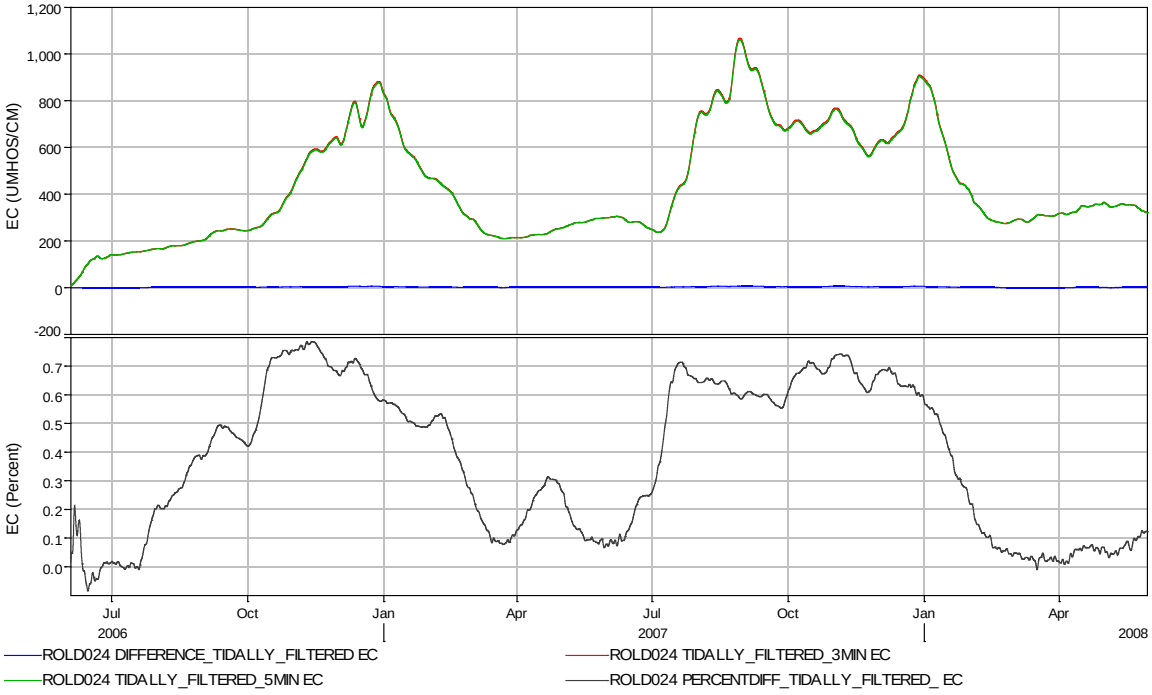


Figure 3-9 Comparison of Simulated EC with Time Steps of 3 Minutes and 1 Minute at Clifton Court Forebay

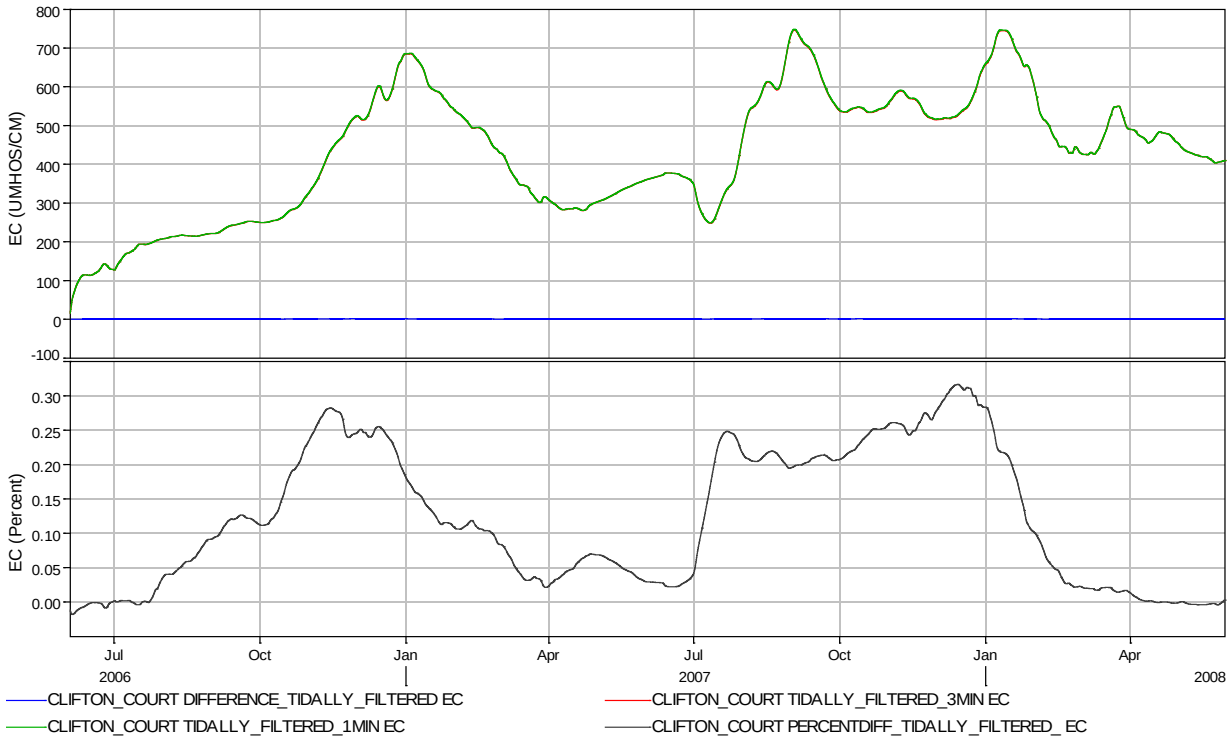
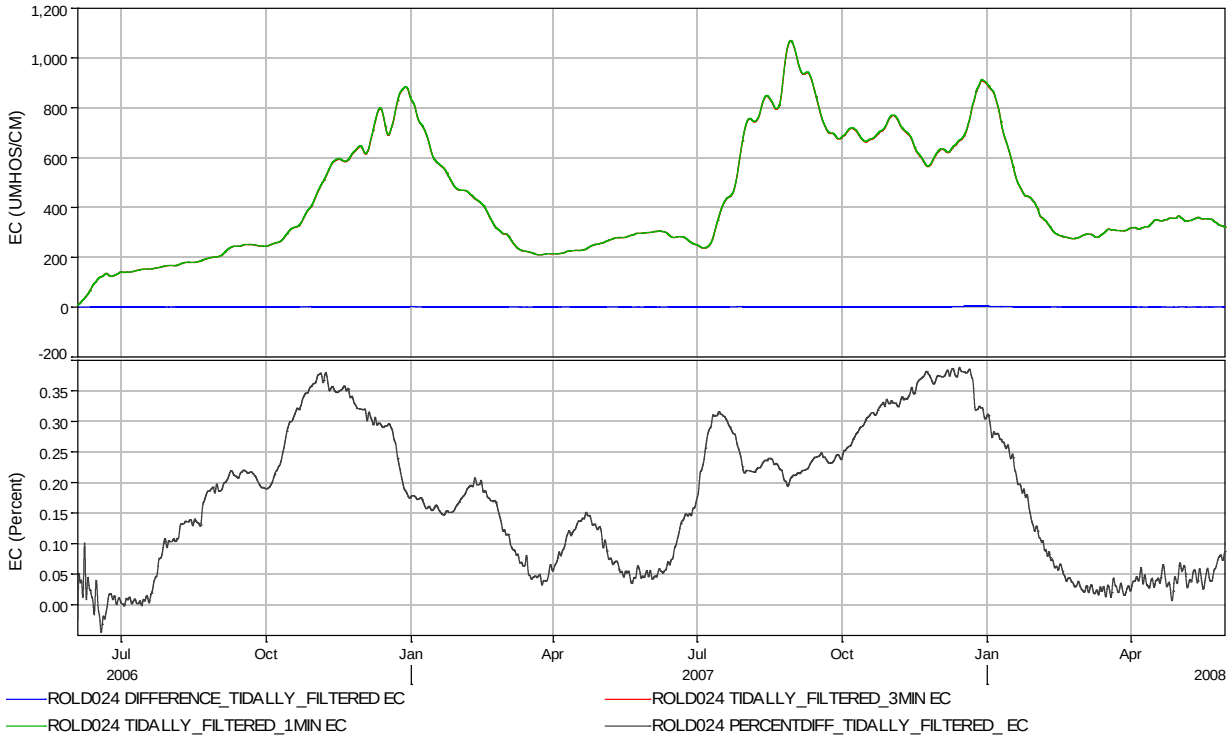


Figure 3-10 Comparison of Simulated EC with Time Steps of 3 Minutes and 1 Minute at Bacon Island



3.4 Test for Tidefile Time Steps

The four time steps compared for the tidefile were 1 hour, 30 minutes, 15 minutes, and 5 minutes. To be consistent, all Hydro and Qual runs used the same 5-minute time step. For 30, 15, and 5 minutes, the results show good convergence (Figures 3-11 to 3-14). The difference in output results between the 30-minute and 15-minute time steps is within 1% (Figures 3-17 and 3-18). The difference in output results between the 1-hour and 30-minute time steps is around 3% to 4% (Figures 3-15 and 3- 16). This further proves that using 1-hour time step for tidefile would not be ideal.

Furthermore, for a 16-year run, the size of the tidefile is about 4 GB for the 30-minute interval versus 8 GB for the 15-minute interval. Thus, for striking a practical balance between accuracy and disk space, we recommend using the 30-minute interval.

Figure 3-11 Tidefile Time Step Sensitivity at Clifton Court Forebay

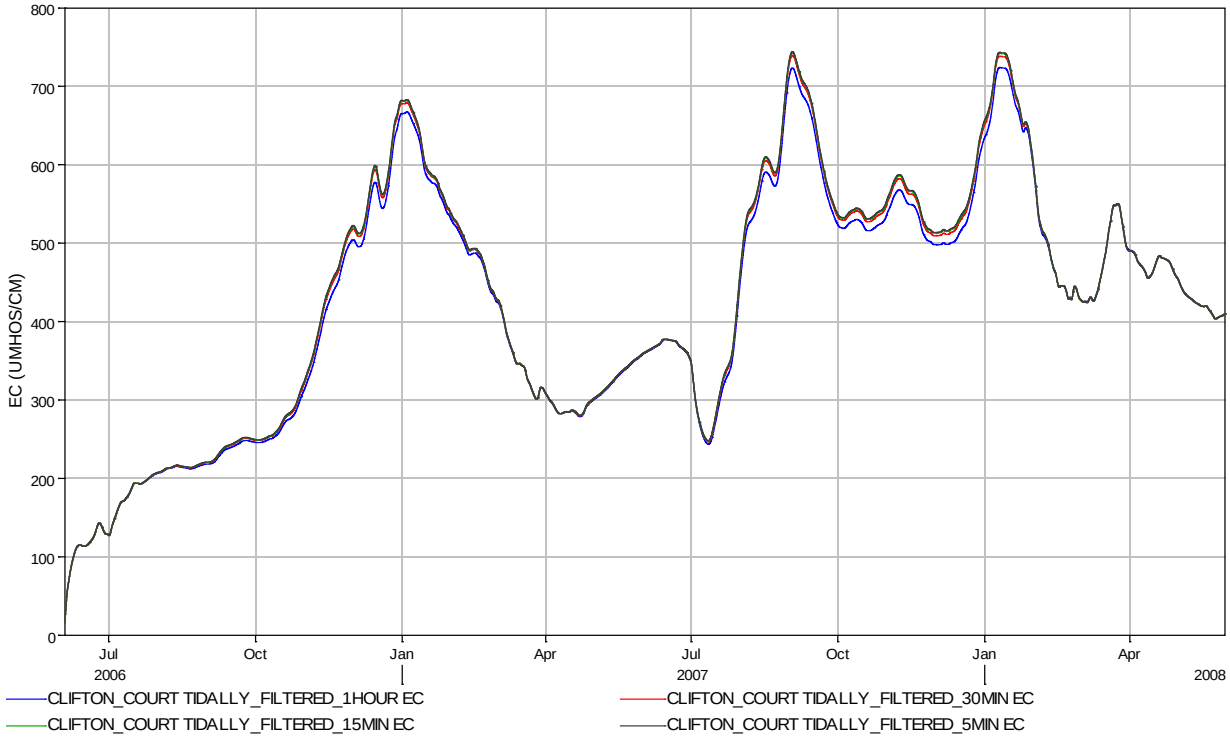


Figure 3-12 Tidefile Time Step Sensitivity at Bacon Island

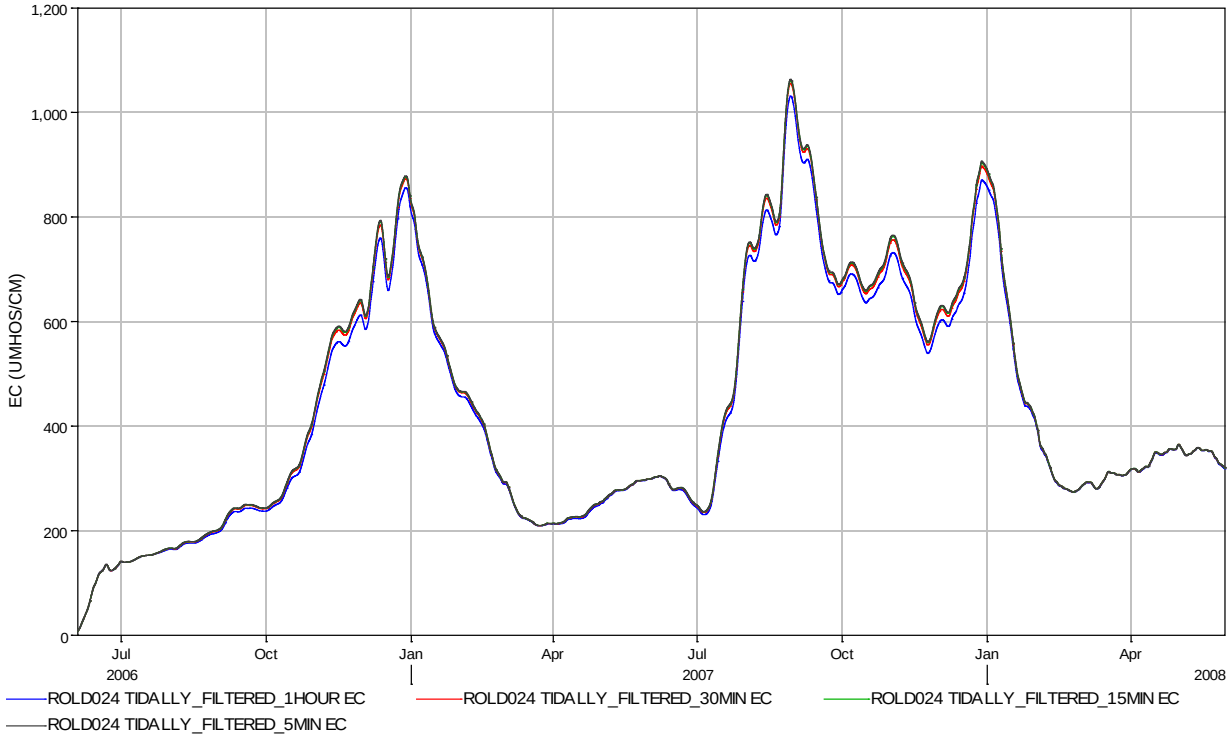


Figure 3-13 Tidefile Time Step Sensitivity at Jersey Point

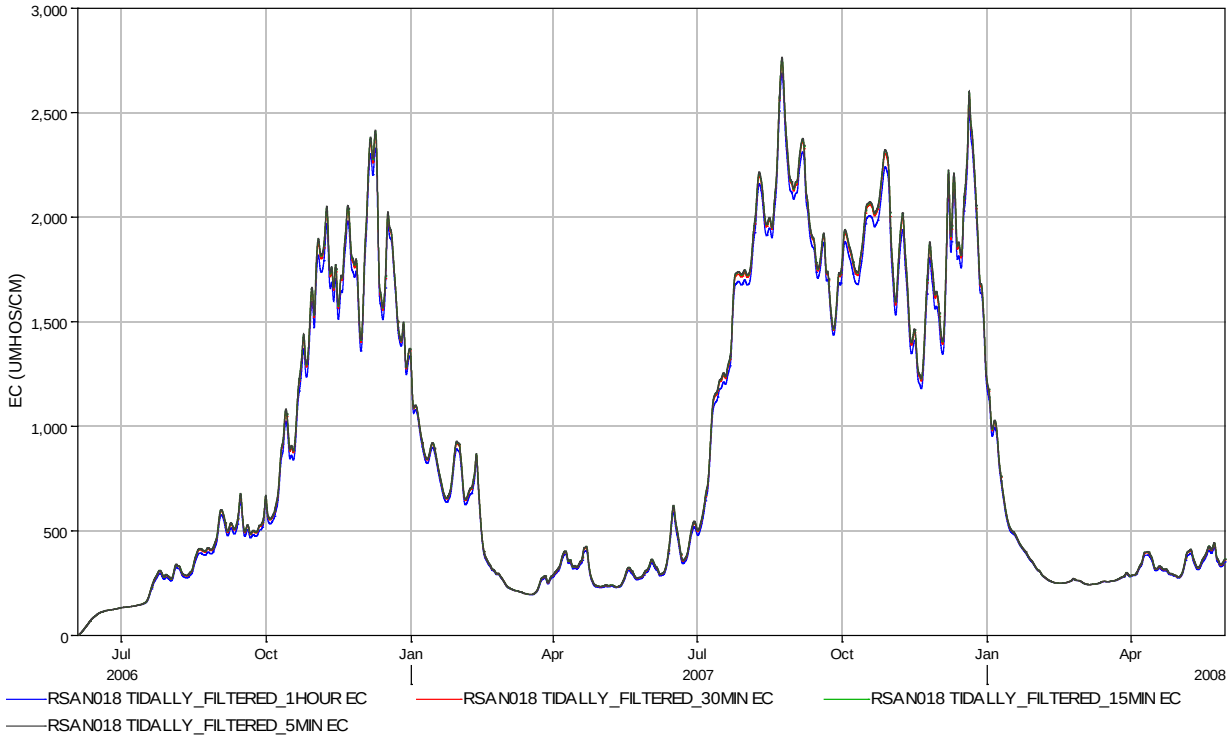


Figure 3-14 Tidefile Time Step Sensitivity at Antioch

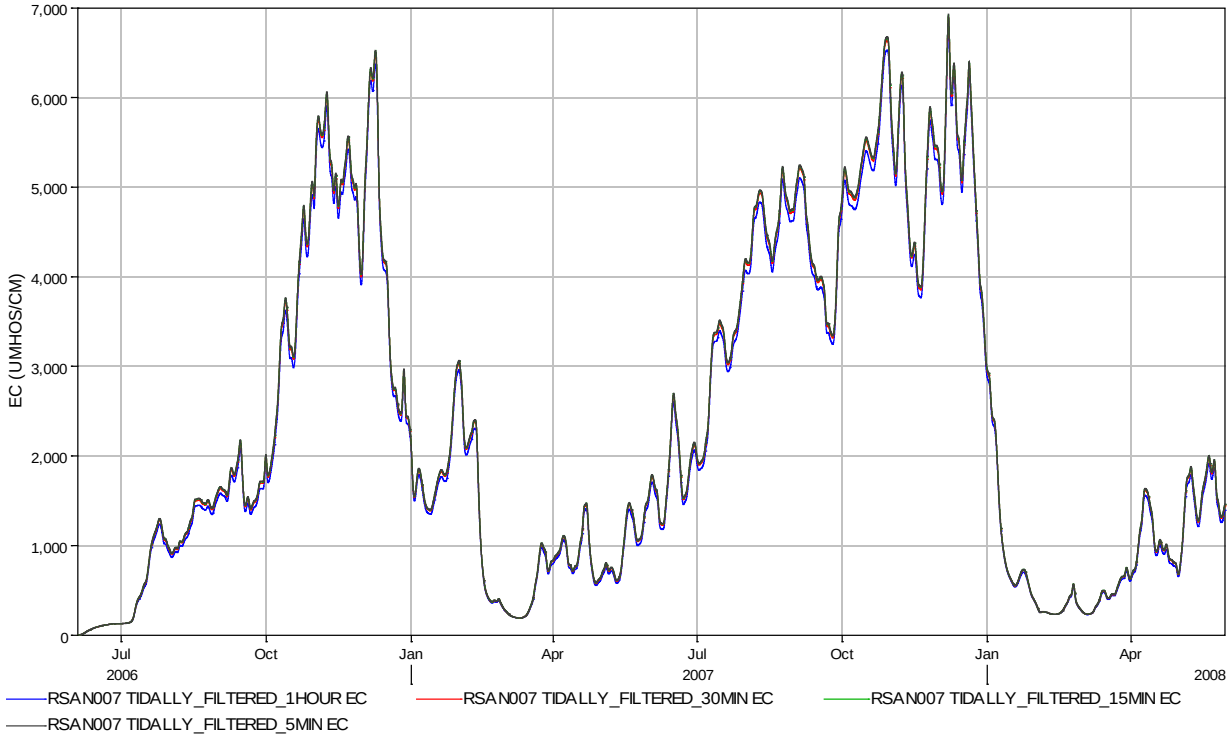


Figure 3-15 Comparison of EC results with 1 Hour and 30 Minute Tidefiles at Clifton Court Forebay

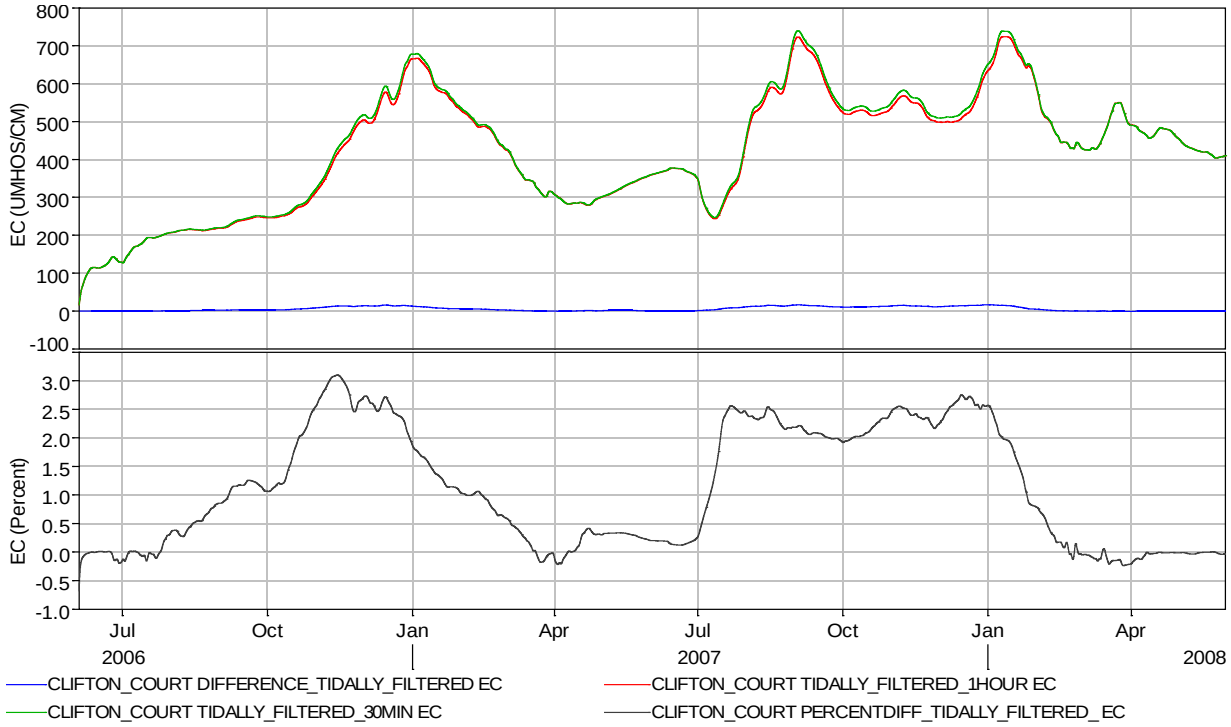


Figure 3-16 Comparison of EC Results with Time Steps of 1 Hour and 30 Minute Tidefiles at Bacon Island

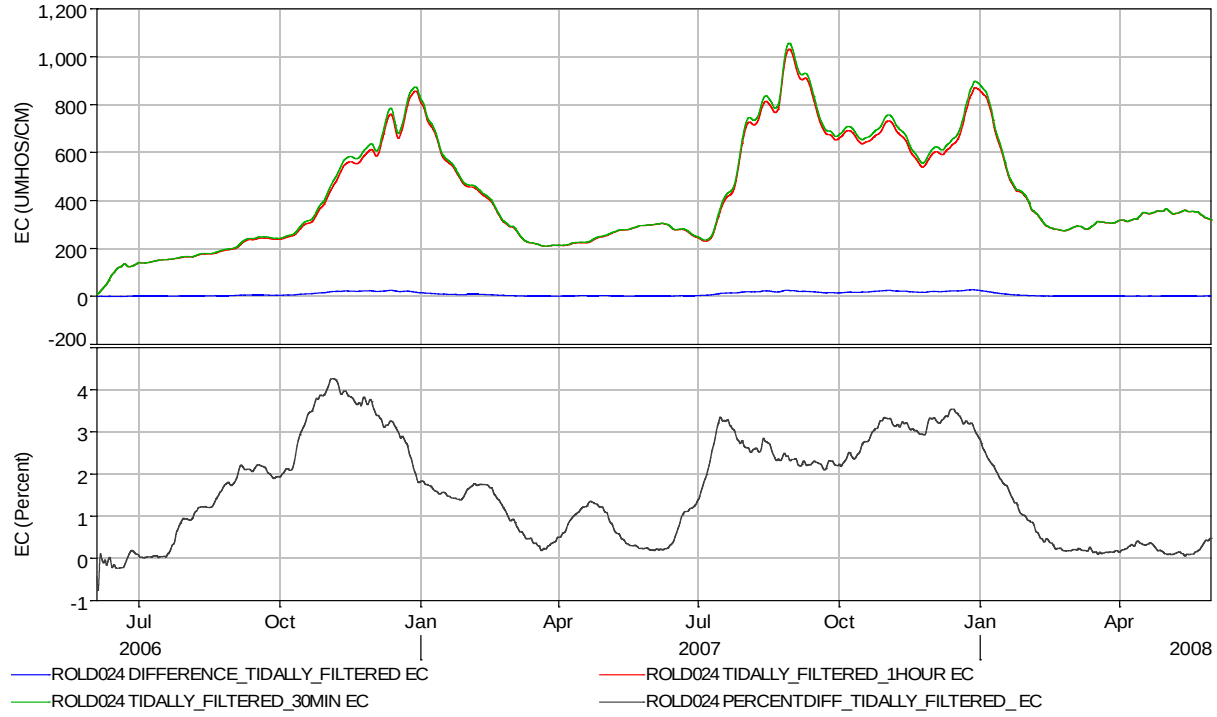


Figure 3-17 Comparison of EC Results with 30 Minute and 15 Minute Tidefiles at Clifton Court Forebay

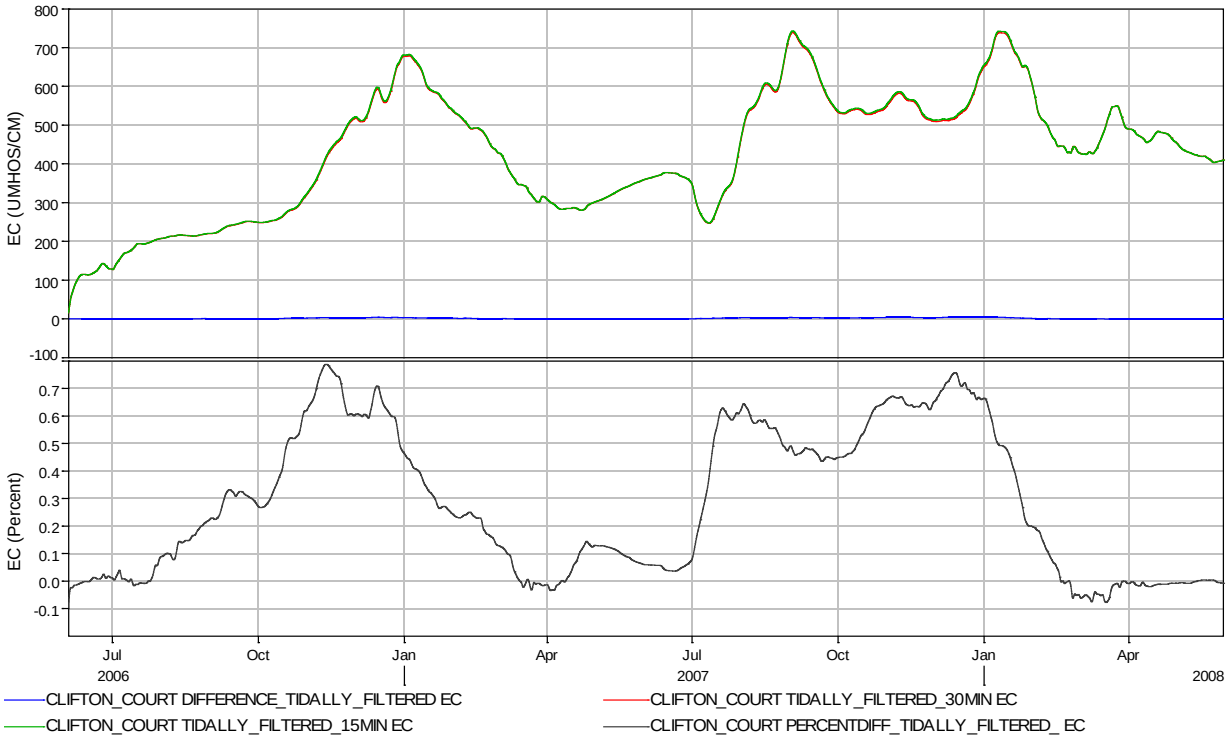
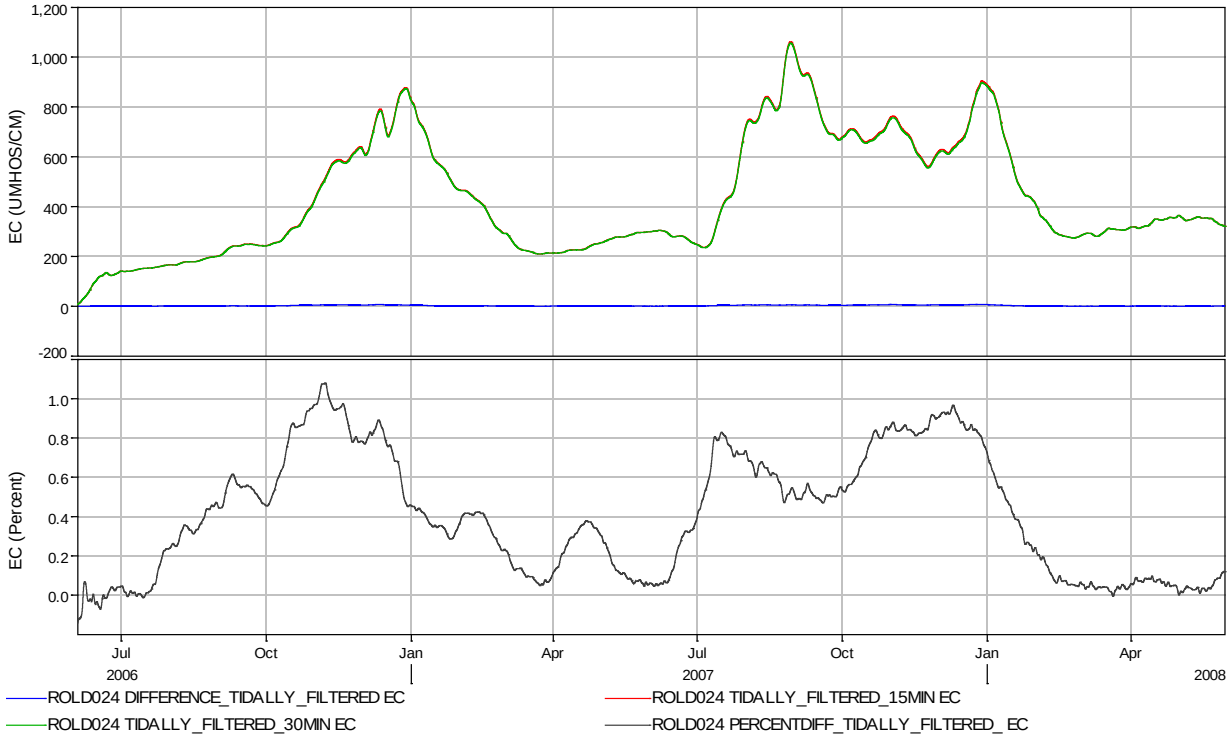


Figure 3-18 Comparison of EC Results with 30 Minute and 15 Minute Tidefiles at Bacon Island



3.5 Test for Hydro Time Steps

Three Hydro time steps of 15, 5 and 3 minutes were tested. For all simulations, the tidefile was generated at 15-minute intervals; Qual used a 5-minute time step. The simulated EC at a few key stations (CLIFTON_COURT, ROLD024, RSAN018, and RSAN007) are plotted in Figure 3-19 through Figure 3-22. The maximum difference in EC results between the 15-minute and 5-minute time steps is less than 2%. The maximum difference in EC results between the 5-minute and 3-minute time steps is around 0.3% (see Figures 3-23 and 3-24).

Figure 3-19 Comparison of EC with 15 Minute and 5 Minute Hydro Time Steps at Clifton Court Forebay

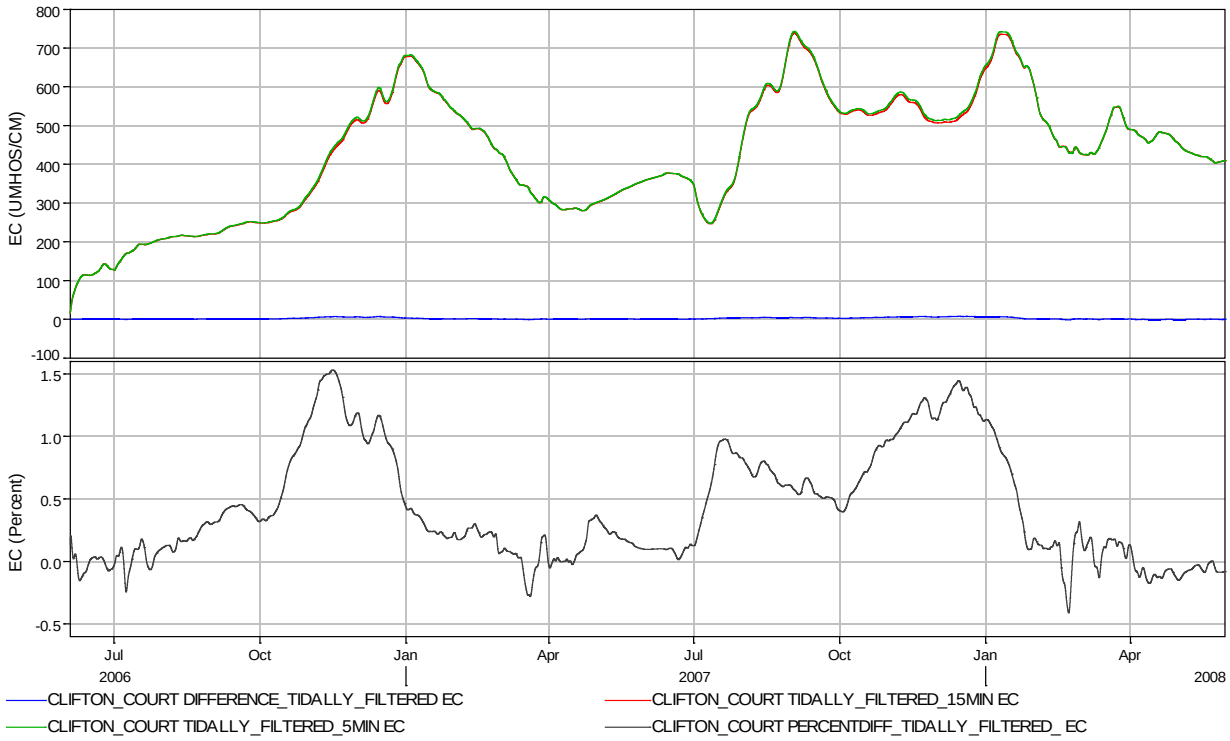


Figure 3-20 Comparison of EC with 15 Minute and 5 Minute Hydro Time Steps at Bacon Island

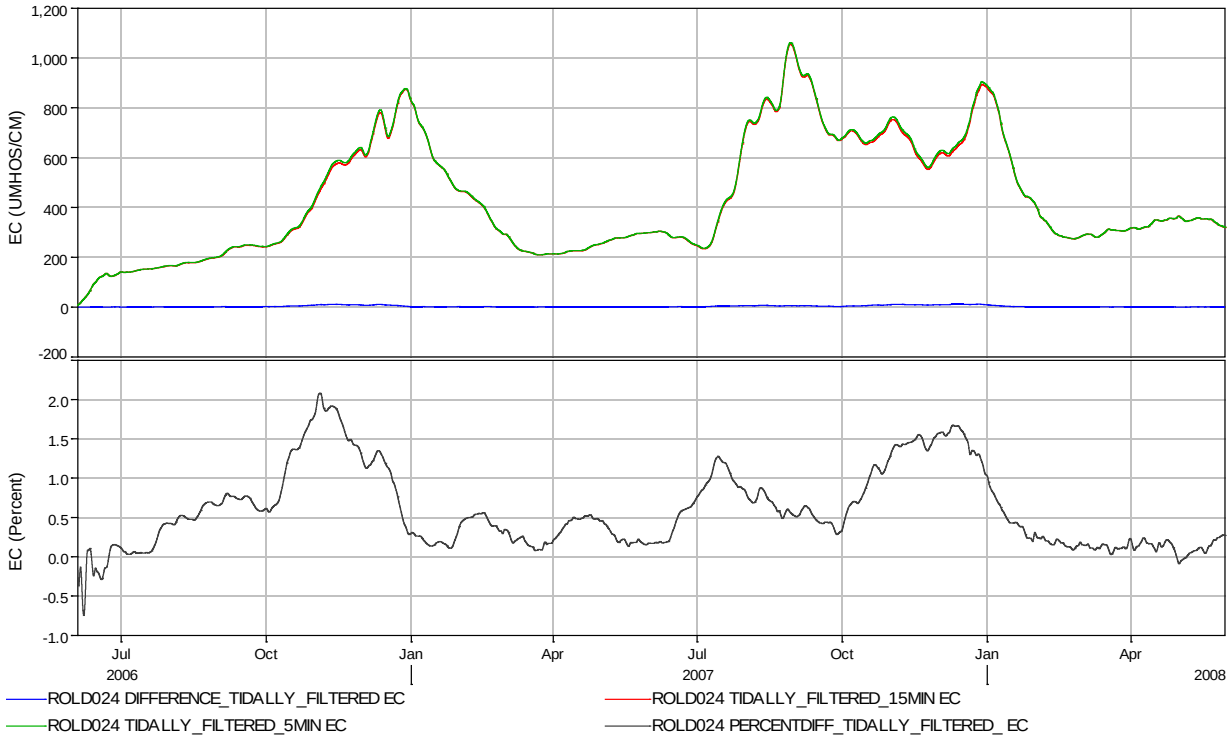


Figure 3-21 Comparison of EC with 15 Minute and 5 Minute Hydro Time Steps at Jersey Point

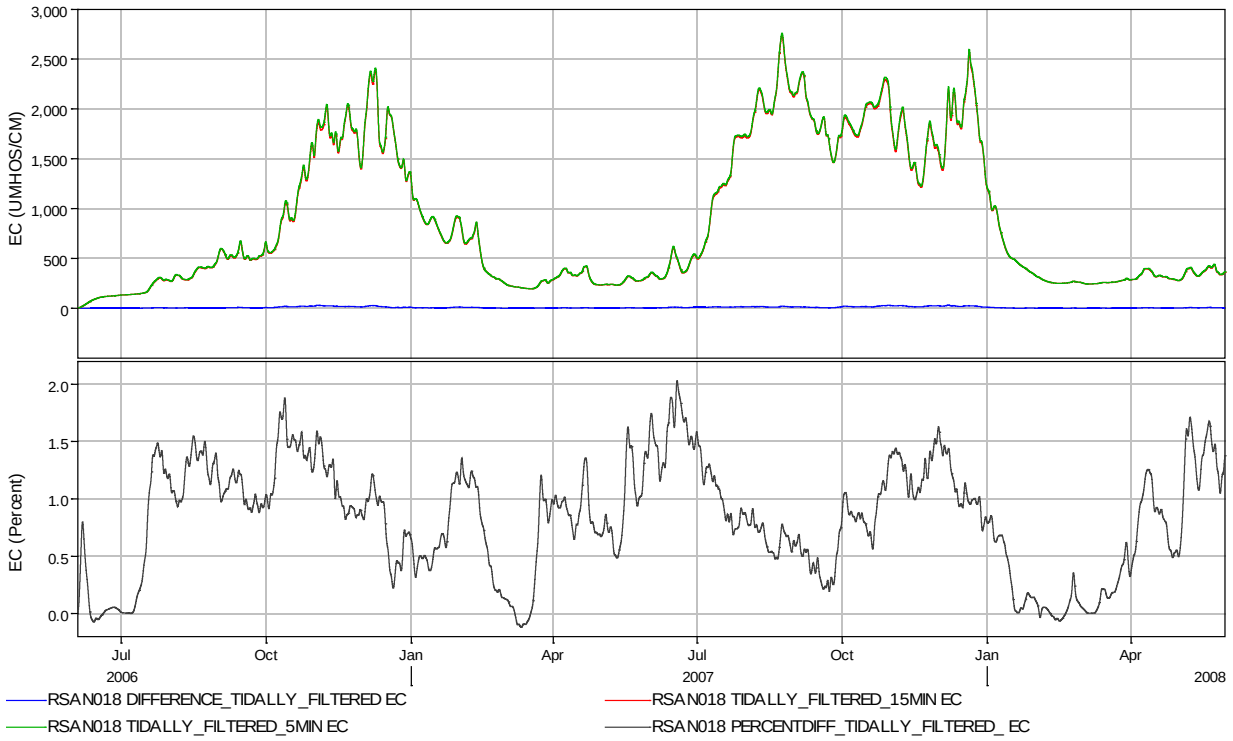


Figure 3-22 Comparison of EC with 15 Minute and 5 Minute Hydro Time Steps at Antioch

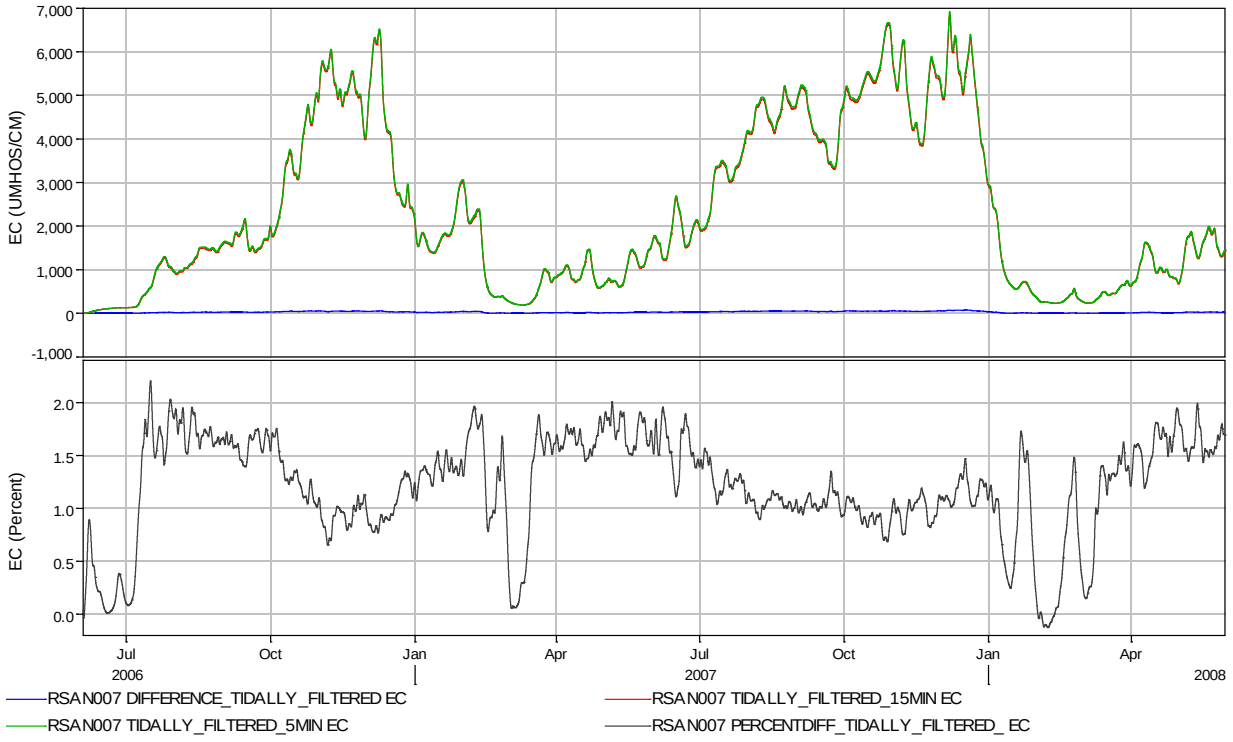


Figure 3-23 Comparison of EC with 5 Minute and 3 Minute Hydro Time Steps at Clifton Court Forebay

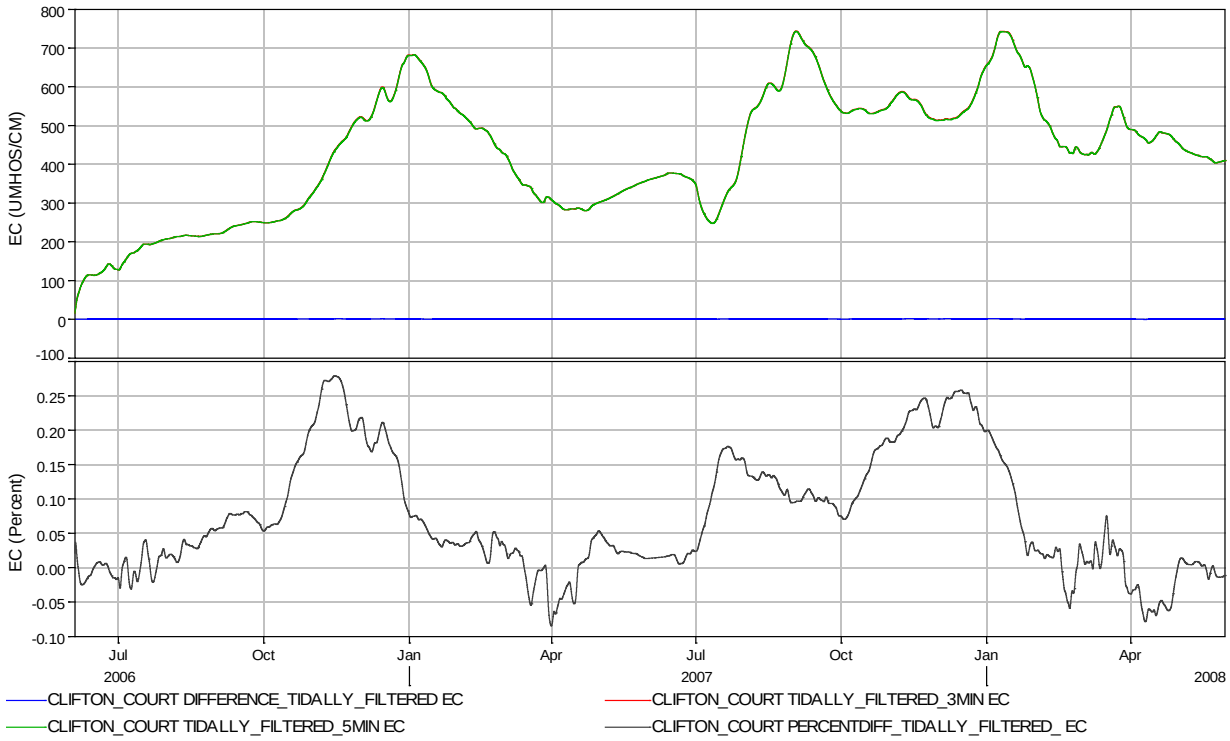
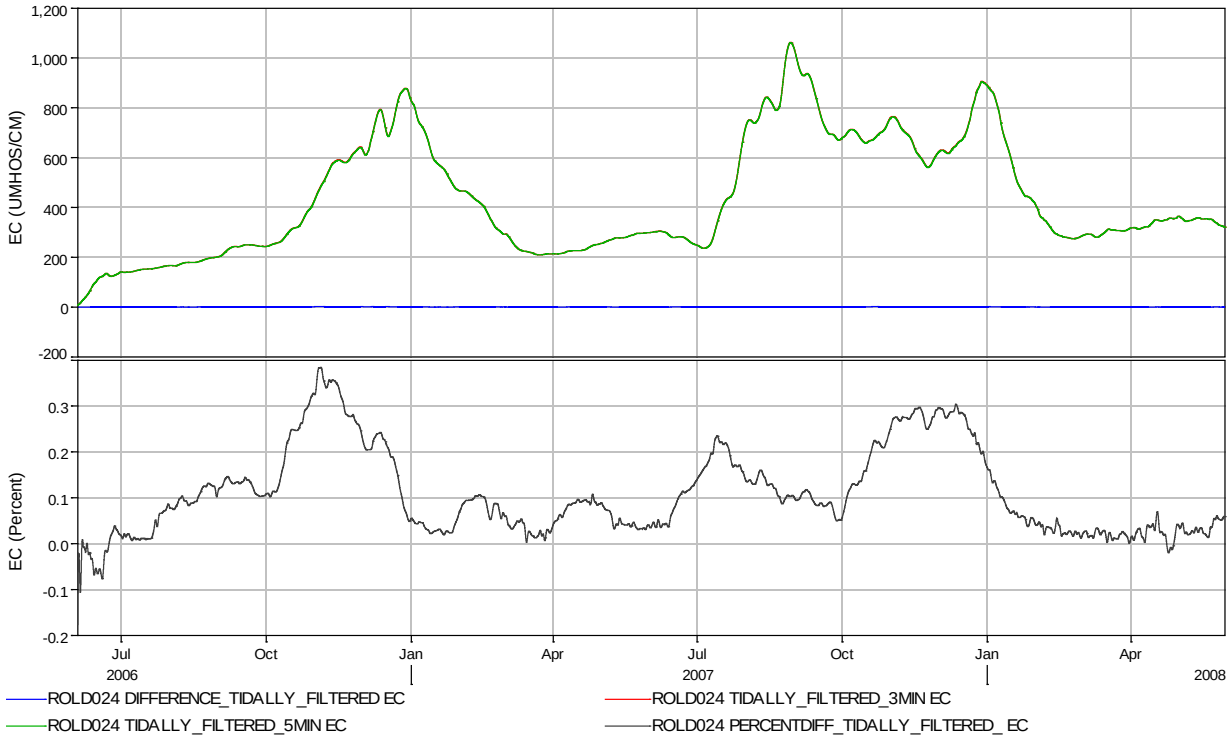


Figure 3-24 Comparison of EC with 5 Minute and 3 Minute Hydro Time Steps at Bacon Island



3.6 Comparing Time Step Combinations for Hydro, Tidefile, and Qual

The two most preferred time step combinations are compared. One combination uses time steps of 15, 30, and 15 (15/30/15) minutes for Hydro, the tidefile, and Qual (Hydro/tidefile/Qual), respectively. The other combinations uses time steps of 5, 15, and 5 minutes for Hydro/tidefile/Qual. The results show the difference in EC is around 4% at key stations (see Figures 3-25 through 3-28). The difference can be made up with calibration parameters, e.g. dispersion coefficient. The time steps chosen for the calibration were 15/30/15 minutes for Hydro/tidefile/Qual. For better accuracy, 5/15/5 minutes for Hydro/Tidefile/Qual could be used; however, that would result in a doubling of run time and doubling of the tidefile size.

Figure 3-25 Comparison of EC Results at Antioch (RSAN007)

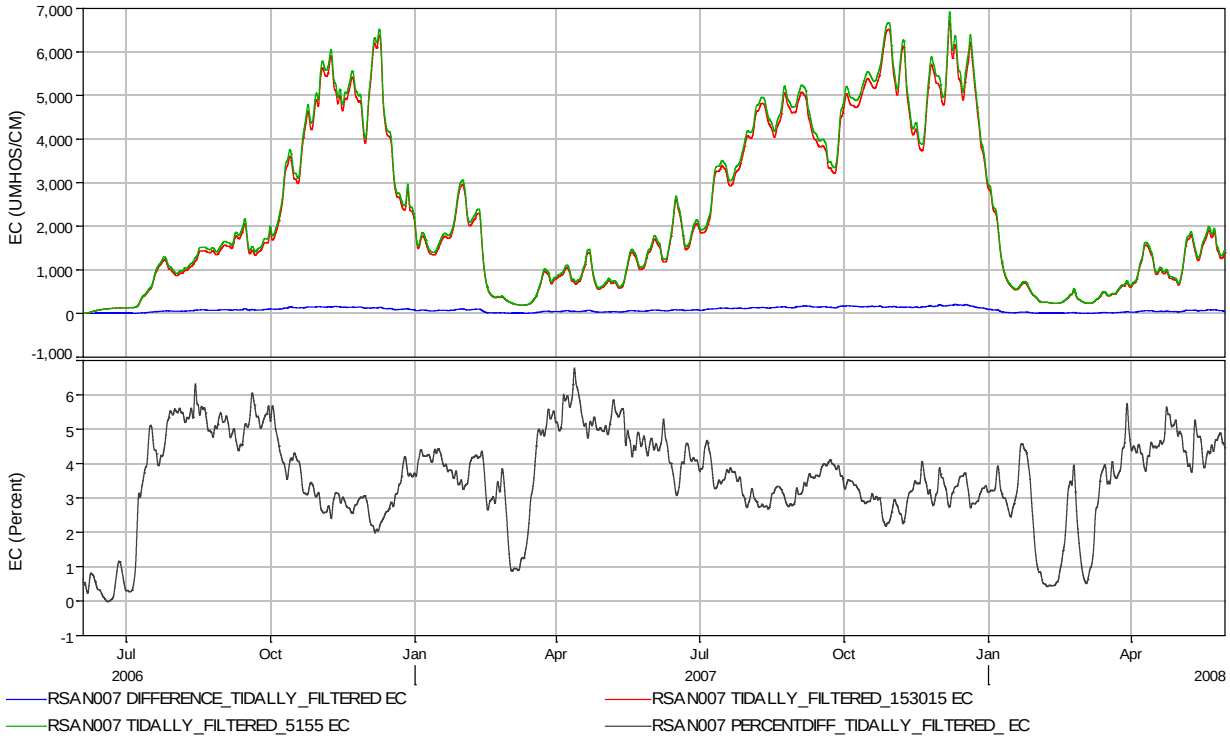


Figure 3-26 Comparison of EC Results at Jersey Point

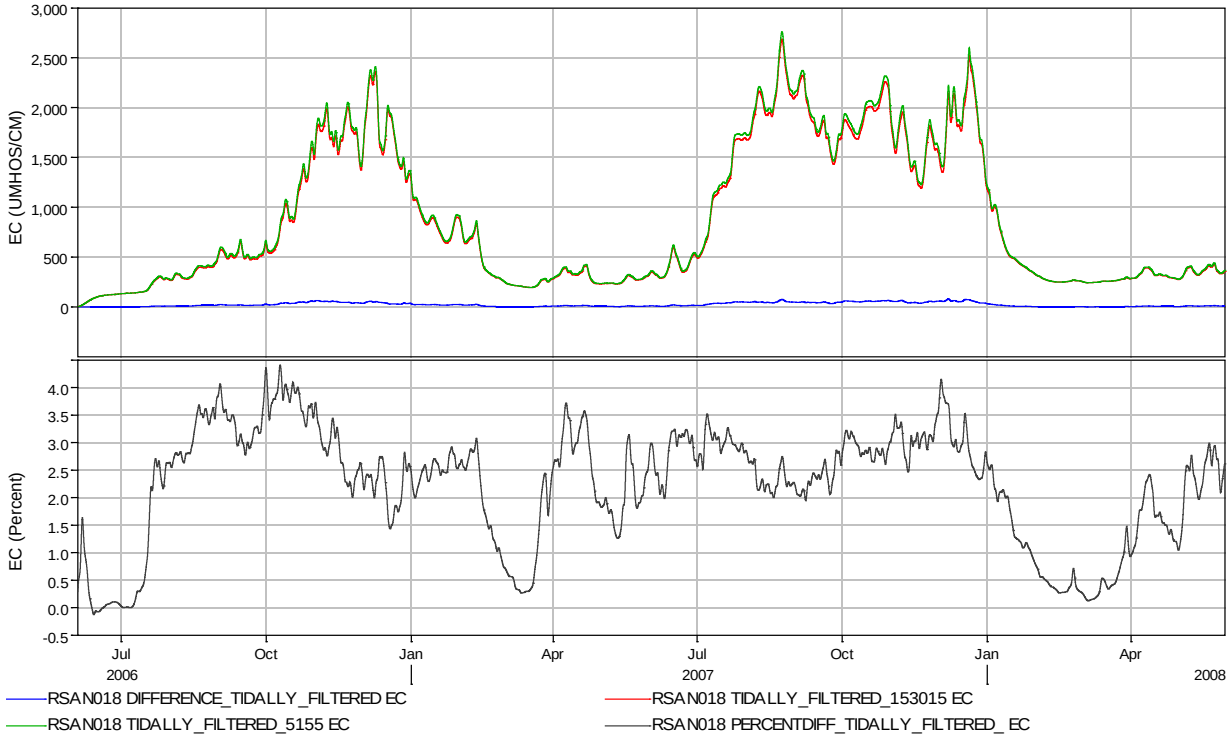


Figure 3-27 Comparison of EC Results at Bacon Island

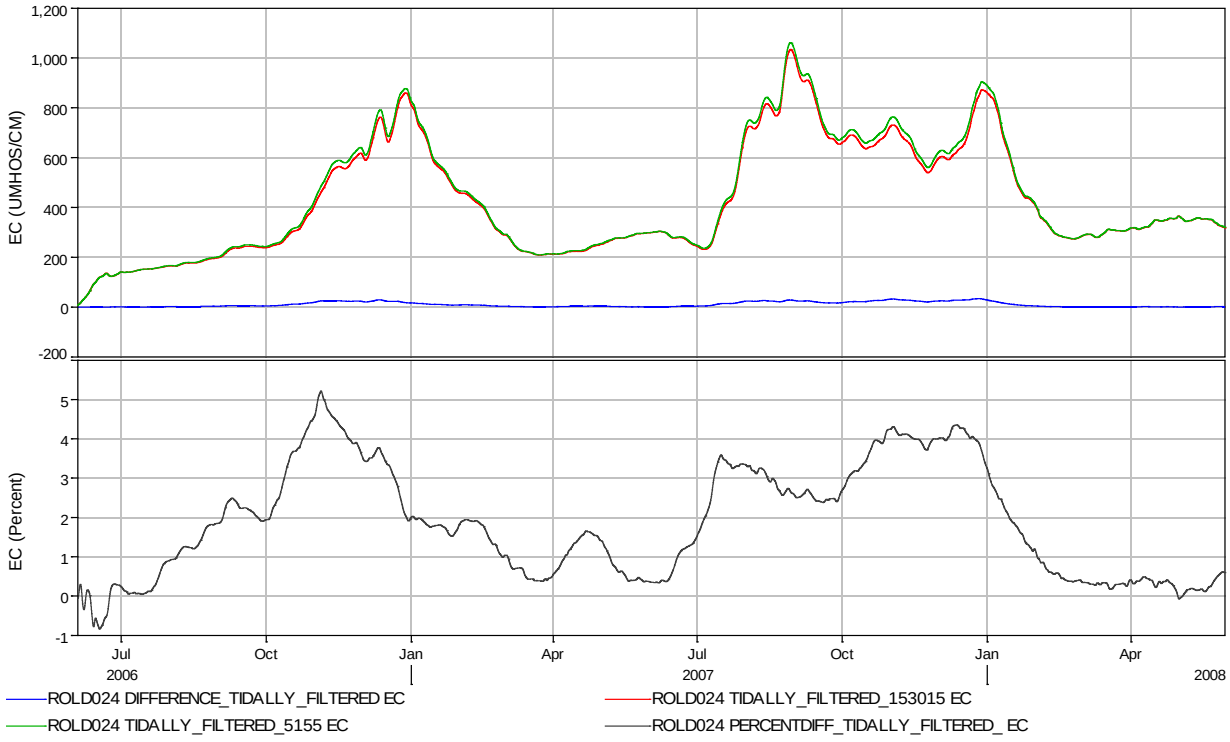
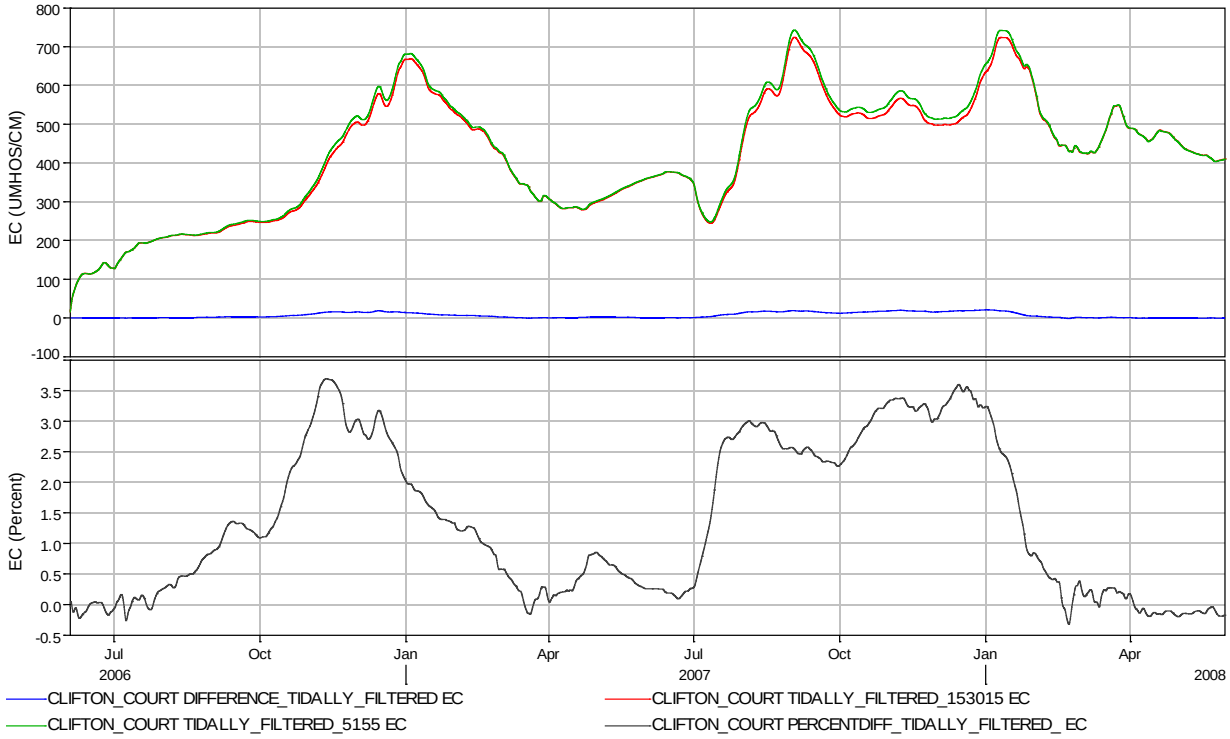


Figure 3-28 Comparison of EC Results at Clifton Court Forebay



3.7 Summary

The sensitivity tests were done in terms of reviewing the effects of time steps on simulated EC. The time steps chosen for the calibration were 15, 30 and 15 minutes for Hydro, the tidefile and Qual, respectively. For Hydro, the difference in EC results between 15-minute and 5-minute time steps is less than 2%. For the tidefile, the difference in EC results between 30-minute and 15-minute time steps is less than 1%. For Qual, the difference in EC results between 15-minute and 5-minute time steps is about 1%. With the longer time step combinations, running a typical 16-year planning study consumes about 1 hour of CPU time on a 3.2 GHz desktop computer.