Ten Mile Creek Amendment
Appendix 4

Countywide Stream Protection Strategy Score Change Esimtate (CSCE) Model: Description and Results

Updated October 2013

The CSPS Score Change Estimate (CSCE) Model for Potential Stream Biology Impacts

A statistical regression model was developed for the Potomac Subregion Master Plan (2002) to estimate the potential effects of development on stream health, as measured by the County's Indices of Biotic Integrity (IBIs). The model was termed the Potomac Subregion Cumulative Impact (PSCI) model. The PSCI model was revised while preparing the Upper Rock Creek Master Plan (2004) and re-named the Countywide Stream Protection Strategy Score Change Estimate (CSCE) Model. The CSCE model was developed to provide better estimates of potential impacts to stream conditions throughout the County.

An IBI measures the biological health of a stream using invertebrate (mostly insect) and vertebrate (fish) diversity and abundance. The CSCE regression model uses potential changes in impervious cover area as the predictor variable for estimating potential changes in IBI scores. Other watershed variables were also analyzed for potential use as predictor variables, but were found to be too highly correlated with impervious cover to be useful in a statistically-based model. As a result, in the CSCE model, impervious cover functions as an integrator of all of the stream health-related impacts of development, not just the effects of impervious cover itself. After the Upper Rock Creek master plan was completed, the CSCE model was used to estimate potential IBI score changes in other master plans including Olney, Damascus, Germantown, and Great Seneca Science Corridor.

The CSCE model was developed using countywide IBI data collected by the Montgomery County Department of Environmental Protection, and the M-NCPPC Parks Department up to the time when the Potomac Subregion master plan was being prepared (1994-2000). Because of the variability in the data, the regression model was found to be too inaccurate to usefully estimate potential changes in individual IBI scores. But when used to predict potential IBI score changes, rather than individual IBI scores, the model estimates of the 95 percent confidence intervals have substantially improved. This is because there is more error involved in estimating an individual IBI score than an estimated change in an IBI score.

The score changes estimated by the CSCE model are used in conjunction with actual monitored IBI scores to produce estimates for changes in those scores in response to different potential development scenarios. Used this way, the estimated IBI score change resulting from development in a given watershed is subtracted from the monitored pre-development score to provide an estimate of the resulting post-development IBI score.

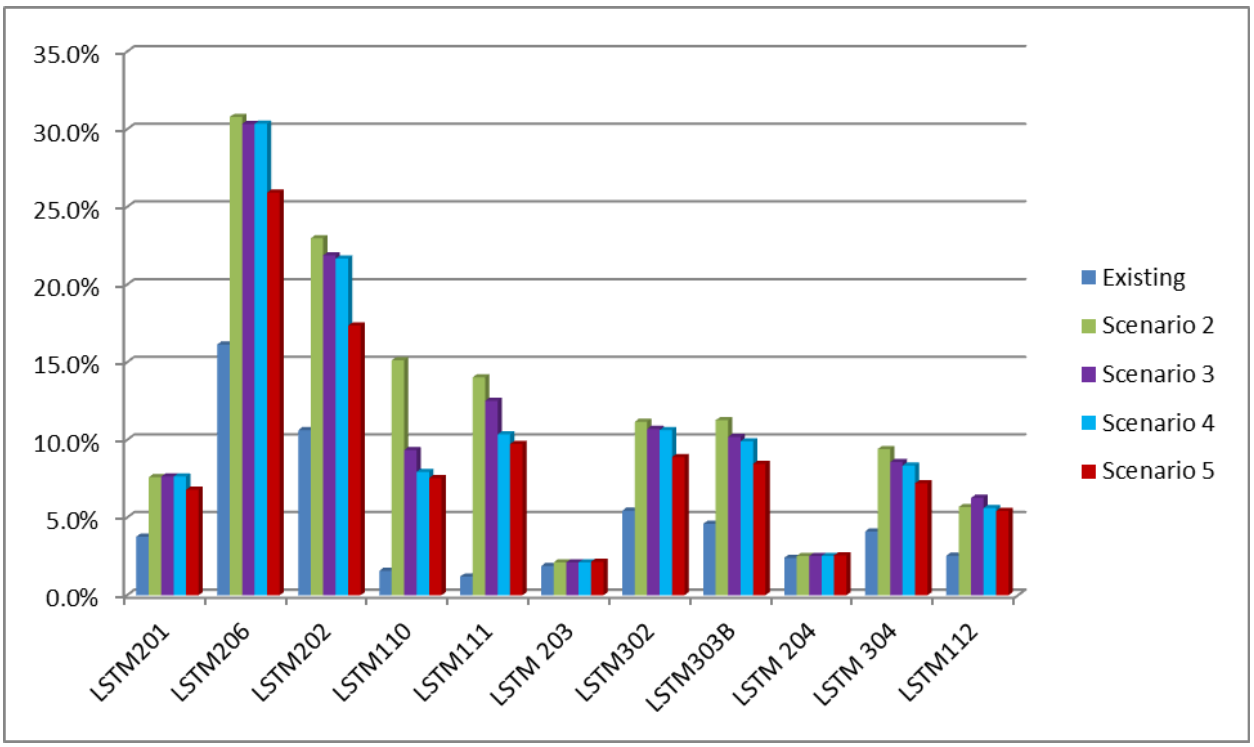
The CSCE model was developed using data that reflects pre-ESD development standards (and even most Special Protection Area requirements), and therefore cannot be used to predict potential changes in IBIs that might result from development that uses ESD. Although not enough watershed-scale data exists to predict the additional benefits of ESD on stream health, the model can be used to estimate the potential stream health impact under traditional stormwater management. This estimated impact at least provides an estimate for the degree of impact that could result from traditional stormwater management. ESD would provide an additional safety factor, assuming that it is an improvement over traditional stormwater management.

Cumulative Imperviousness Analysis

The following chart reflects the imperviousness by subwatershed resulting from five different development scenarios in the Ten Mile Creek watershed. The subwatersheds are generally shown from the headwaters on the left to the most downstream point on the right. Cumulative imperviousness is calculated by dividing the total projected impervious acreage within an area that drains to a specific point by the total area of that drainage area. As one moves downstream from headwater areas, imperviousness acreage of subwatersheds that receive flow from upstream is aggregated with the upstream imperviousness and divided by the total area of all the subwatersheds upstream. This is done because the total imperviousness of the entire watershed upstream of the monitoring station is the imperviousness that affects the biology at the monitoring site. The watershed totals for the free-flowing part of the Ten Mile Creek watershed is expressed in the values shown for LSTM304, the most downstream point in the watershed of the free-flowing stream. LSTM112 is a separate subwatershed that flows directly to Little Seneca Lake.

This analysis shows the dramatic increase in the percentage of imperviousness in parts of the Ten Mile Creek watershed under the tested scenarios. The overall watershed cumulative imperviousness is approximately doubled with the 1994 Plan (Scenario 2) from 4.1 percent to 9.4 percent (measured at LSTM304). Scenario 5 has the lowest increase, with approximately 7 percent overall imperviousness.

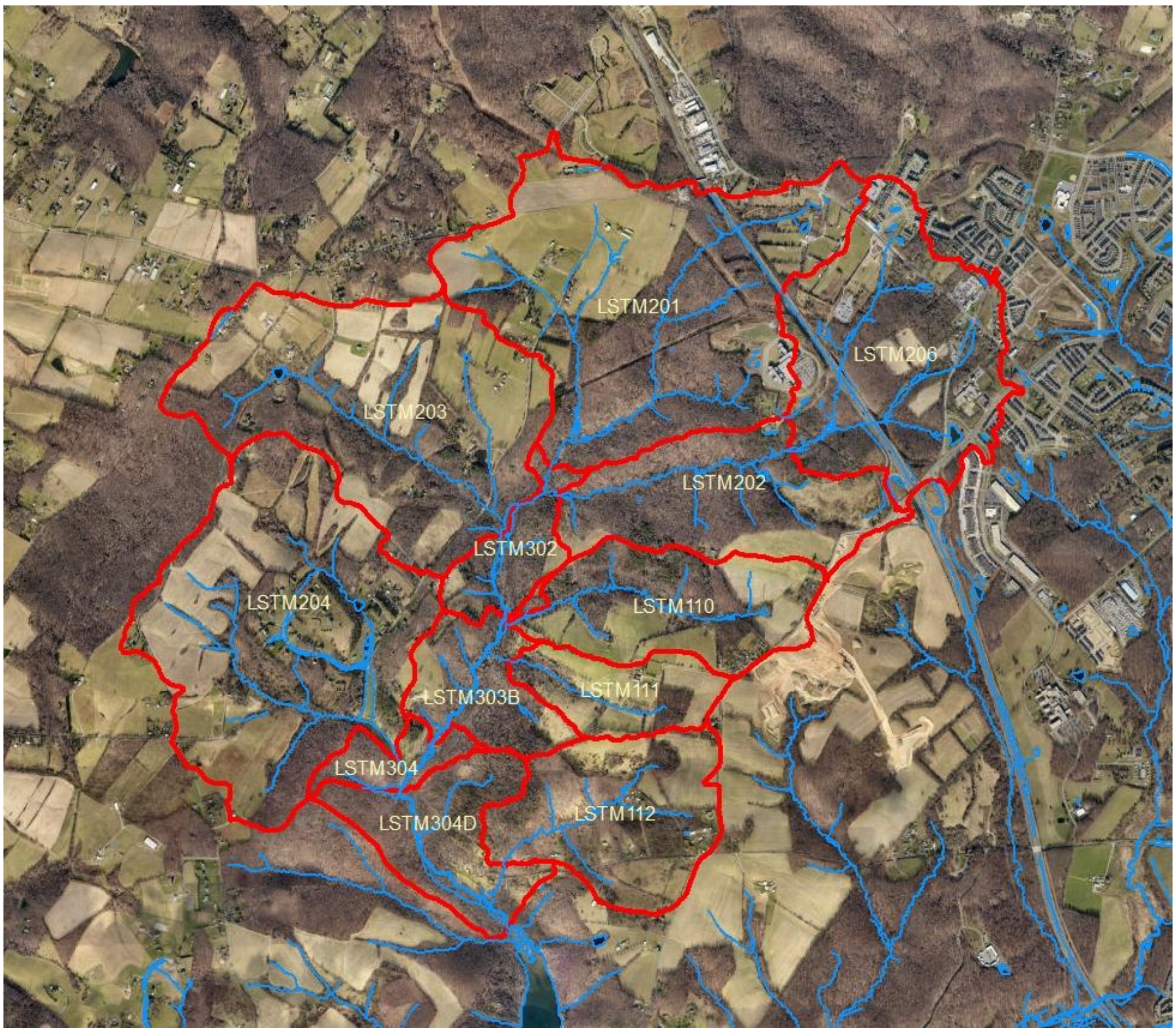
Cumulative Imperviousness for Ten Mile Creek Subwatersheds



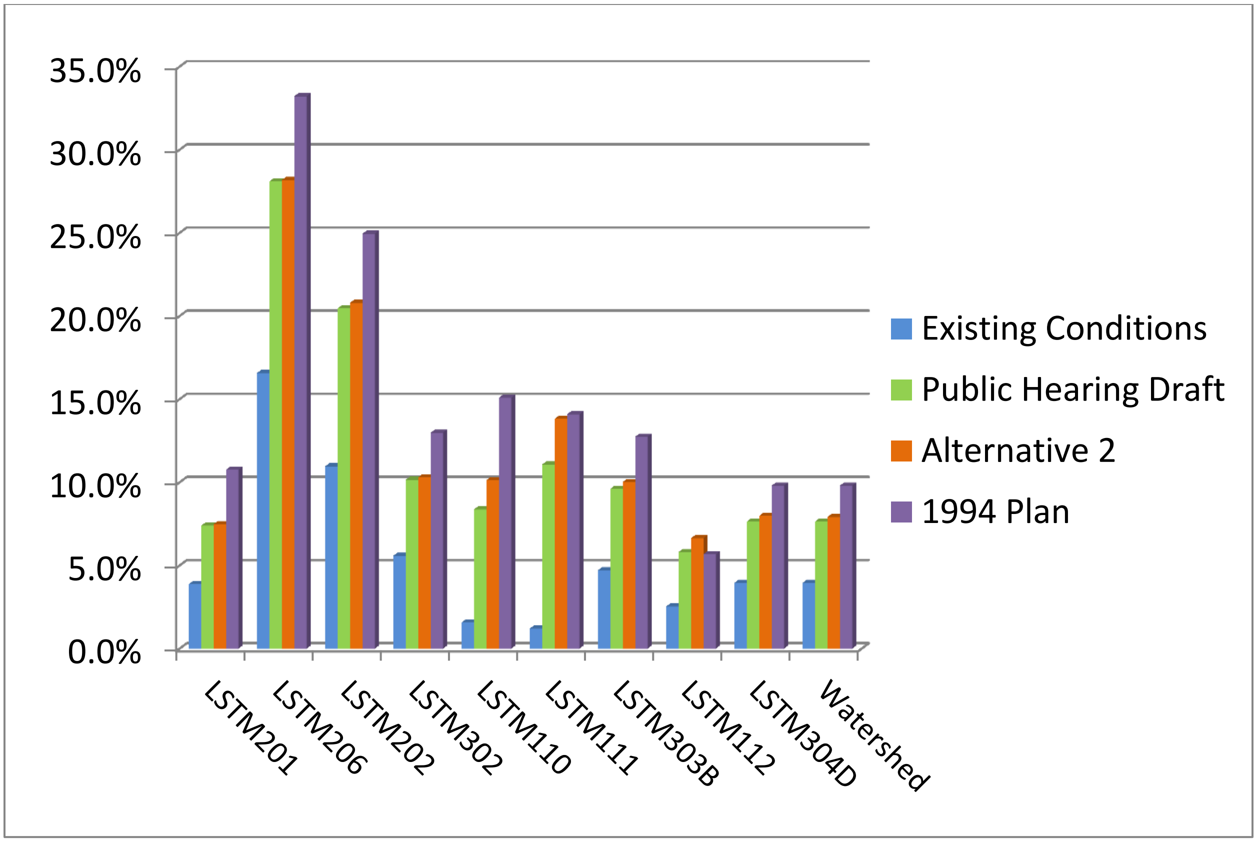
Additional Analyses

During the Planning Board worksessions, questions were raised about the extent of the watershed above Little Seneca Lake and the Department of Environmental Protection was consulted on the whether or not to include two subwatersheds that flow to a short segment of stream below Old Baltimore Road. LSTM112 was added which includes a portion of the Pulte and King properties and a small, unnamed subwatershed (shown as “LSTM304D”) that encompasses the mainstem into which LSTM112 and two other small tributaries flow.

The 1994 Plan scenario was re-run as well as the Public Hearing Draft and the Developer requests voiced at the Public hearing. In addition, the Planning Board asked staff to run an alternative scenario (Alternative 2) that would increase the density on the Pulte and King Properties. The tables below give the assumptions and resulting watershed imperviousness. See the graphic below for the subwatersheds used in the second set of analyses.



The imperviousness percentages from this analysis are shown below.



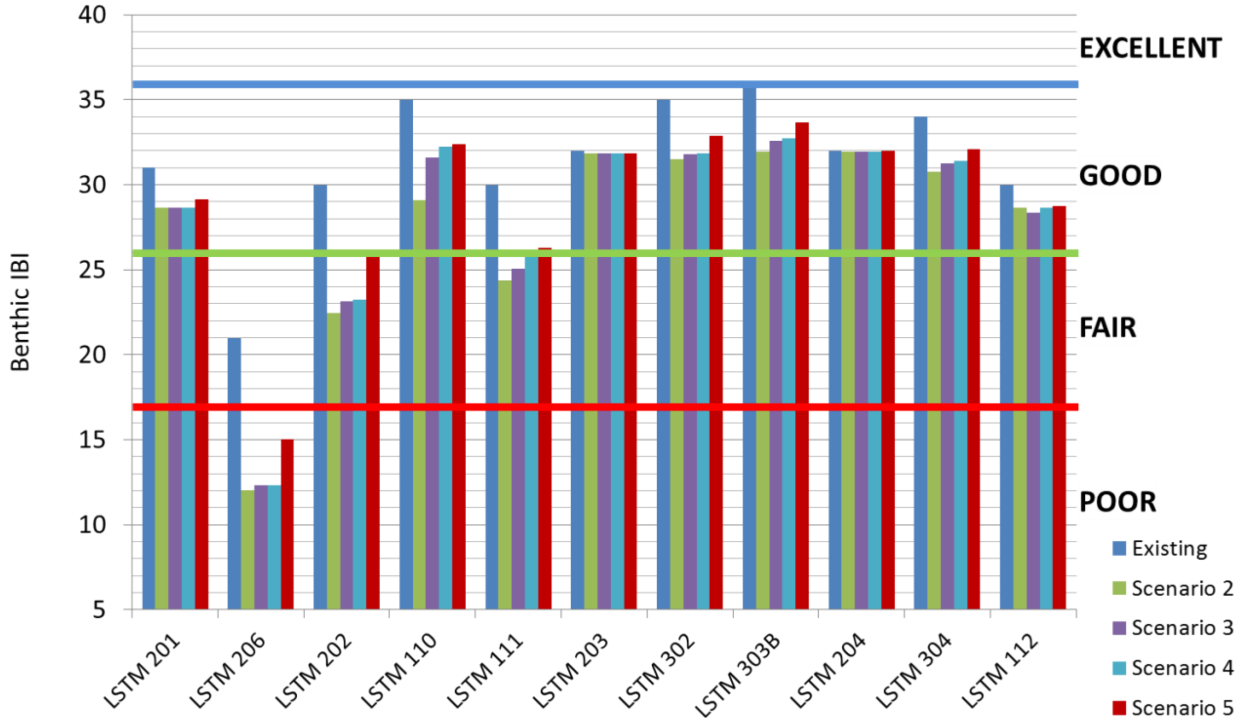
Application of the CSCE Model in Ten Mile Creek

Since it was created, Little Seneca Lake has had a negative effect on the fish community in the upstream portion of Ten Mile Creek, which comprises the study area for the Clarksburg plan amendment. The presence of the lake blocks fish passage between the upper and lower reaches of Ten Mile Creek (and from Seneca Creek), and provides a source of lake fish to the stream, which disrupts natural stream fish communities. Because of this, and the predominance of headwater streams in the Ten Mile Creek study area, the decision was made in conjunction with DEP and Department of Parks staff, to use the benthic macroinvertebrate IBI scores (which are not affected by the lake) as the best indicator of the biological health of Ten Mile Creek. Accordingly, the version of the CSCE model that was developed to estimate changes in the IBI for benthic macroinvertebrates was used to assess potential stream biology changes in Ten Mile Creek.

Using the imperviousness projections for five development scenarios, the Countywide Stream Protection Strategy Score Change Estimate (CSCE) Model was applied, which is used to estimate changes in the Index of Biological Integrity (IBI) scores, in response to different development scenarios. By this method, the estimated IBI score change from development in a given watershed is subtracted from the monitored pre-development score to provide an estimate of the resulting post-development IBI score. In addition to this estimated IBI score, the CSCE model also provides a +/- 95 percent confidence interval of scores around the estimate.

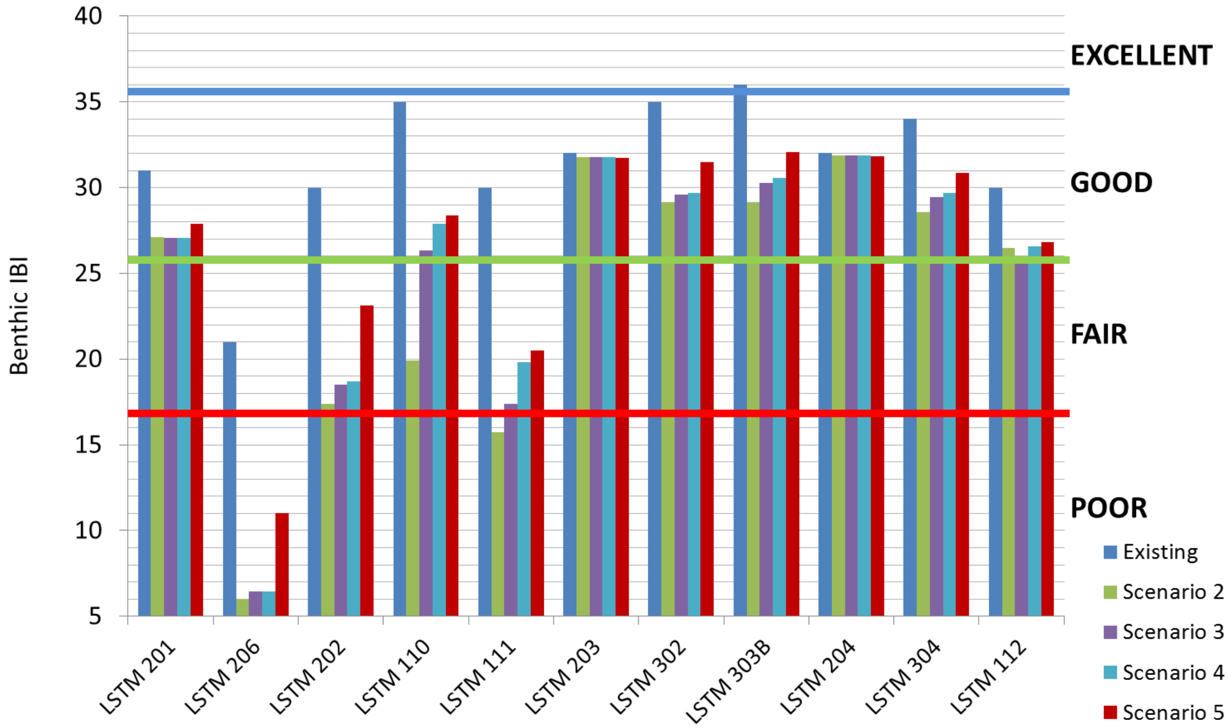
The CSCE model was developed using data that reflects pre-ESD development standards, and therefore cannot predict potential changes in IBIs that might result from development that uses ESD. Until enough data exist to update the CSCE model to predict the benefits of ESD the model can still be used to estimate the potential stream health impact under the old regulations. This model predicts a range of potential results with high-score and low-score predictions. The following chart shows the estimated high IBI scores (upper 95 percent confidence interval) assuming ESD would produce at least the best result that could be generally achieved with traditional stormwater management.

Comparison of 1994-2012 Average Benthic IBI with Estimated Post-Development IBI (High score estimate)



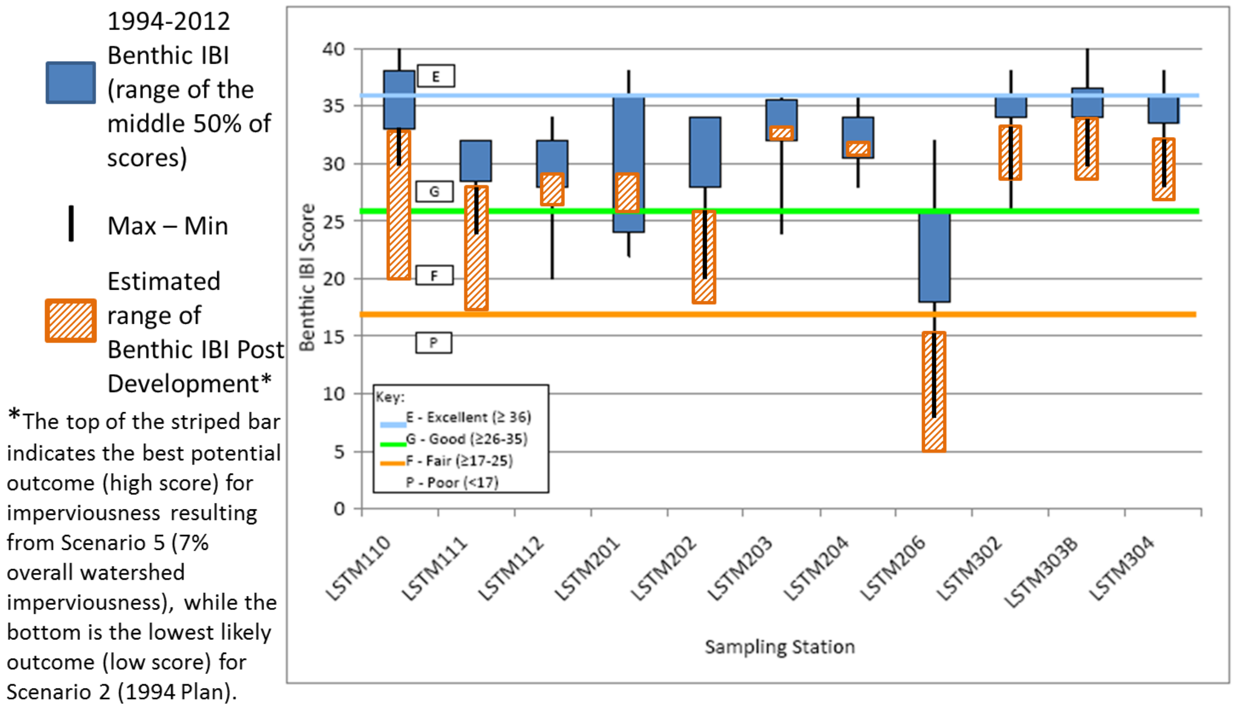
The following chart shows the estimated low IBI scores (95 percent confidence interval) with traditional stormwater management.

Comparison of 1994-2012 Average Benthic IBI with Estimated Post-Development IBI (Low score estimate)



The following chart shows a composite comparison of the CSCE model, which shows results that would be generally expected with traditional stormwater management within a +/- 95 percent confidence interval. This chart shows full range of estimated potential outcomes (resulting from the model) within that confidence interval taken from the two charts above, with the top of the striped bar showing the best potential outcome under Scenario 5 and the worst potential outcome of Scenario 2 at the bottom of the striped bar. The cumulative result for Ten Mile Creek as it reaches the ford at Old Baltimore Road is shown as LSTM304 at the far right.

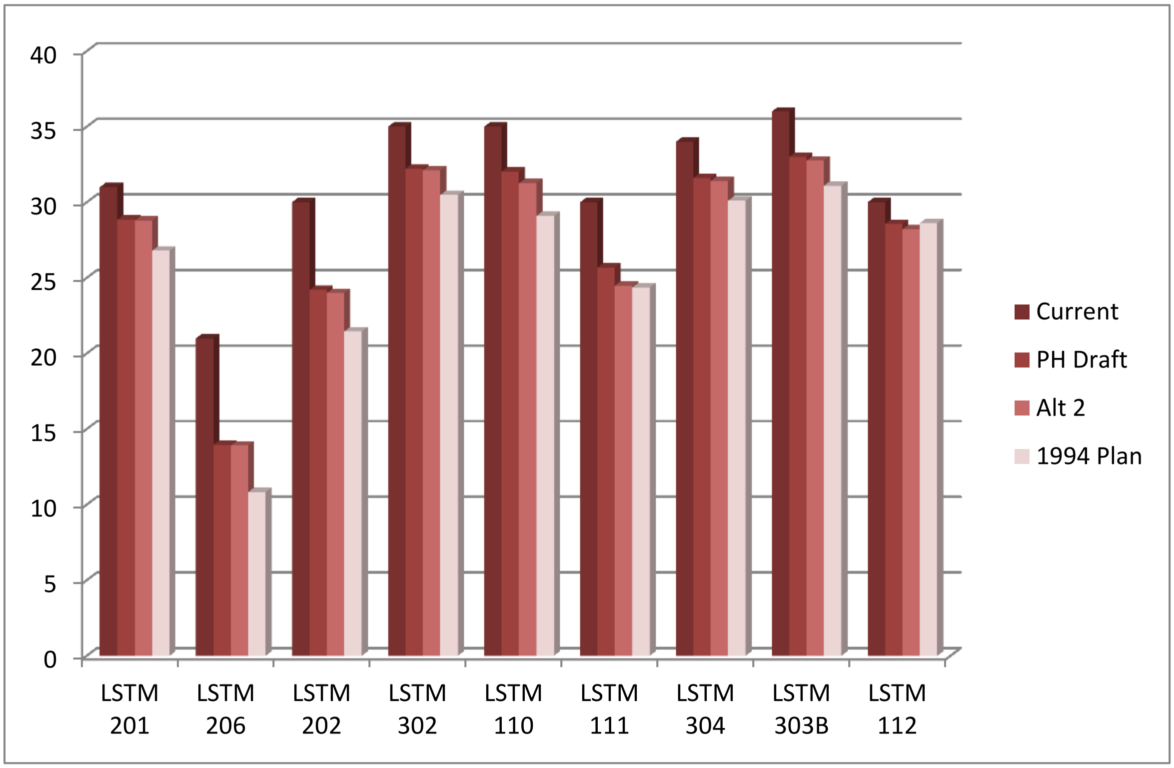
Comparison: Existing Benthic IBI with Estimated Post-Development IBI



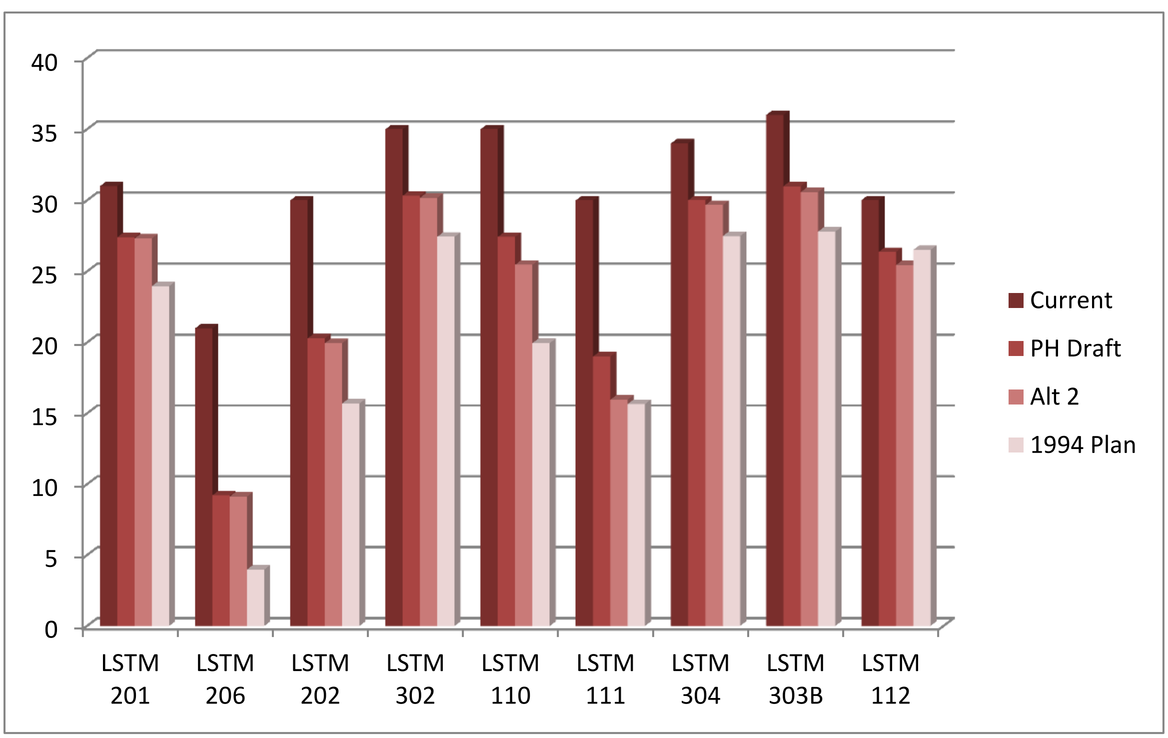
Additional Analysis

The additional scenarios and the larger watershed area were also analyzed for their potential effect on CSCE model results. The results of that additional analysis is shown below.

Comparison of 1994-2012 Average Benthic IBI with Estimated Post-Development IBI (High score estimate)



Comparison of 1994-2012 Average Benthic IBI with Estimated Post-Development IBI (Low score estimate)



The large increase in imperviousness in the headwaters LSTM206 affects all of the mainstem tributaries downstream. Even with the use of ESD, which cannot completely mitigate development impacts, all the scenarios (beyond existing conditions) will affect stream conditions, almost certainly resulting in a loss of the stream's status as a reference stream (against which other streams are measured). The projections for individual watersheds give a wide range of potential results. With the use of ESD, it is more likely that the higher projections would be realized.