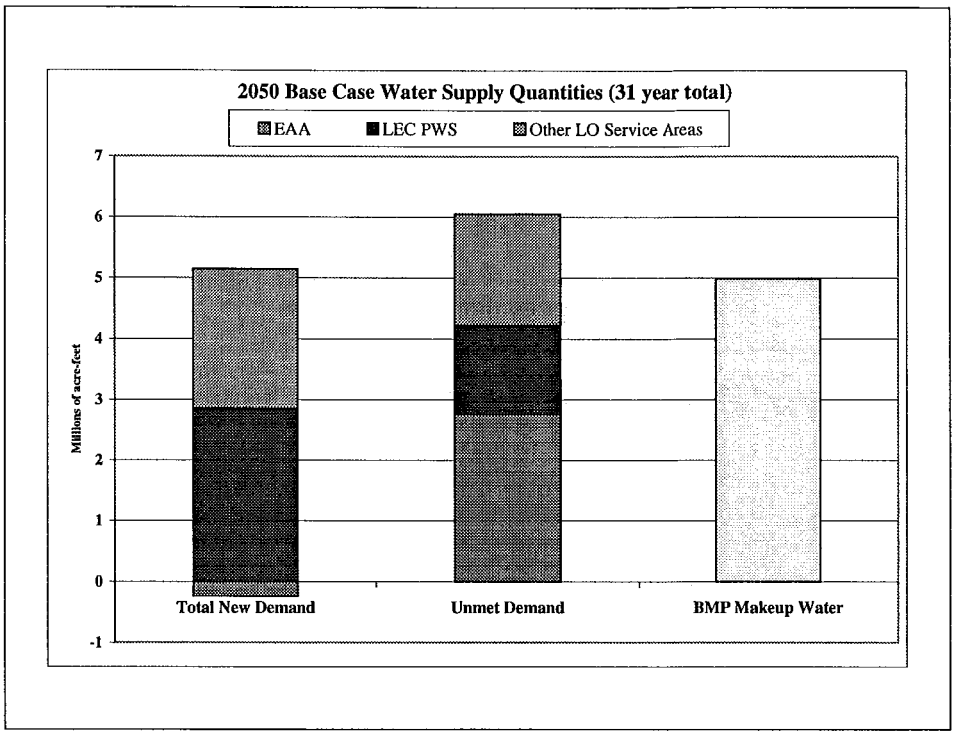
BMP Replacement Water

- Significant Factor in Restudy Evaluations
- Began Dialogue with WMD staff in 1997
- Work shared with Bill Walker
- Numerous approaches tried; none indicated a significant change in rainfall runoff relationship
- Presentations at several public meetings, including a detailed presentation at a rule workshop specifically for this purpose.
- All analyses reviewed and critiqued by professional statisticians Jim McClave and Cindy Hewitt.

Presented to the Everglades Technical Oversite Committee

West Palm Beach

February 9, 2001

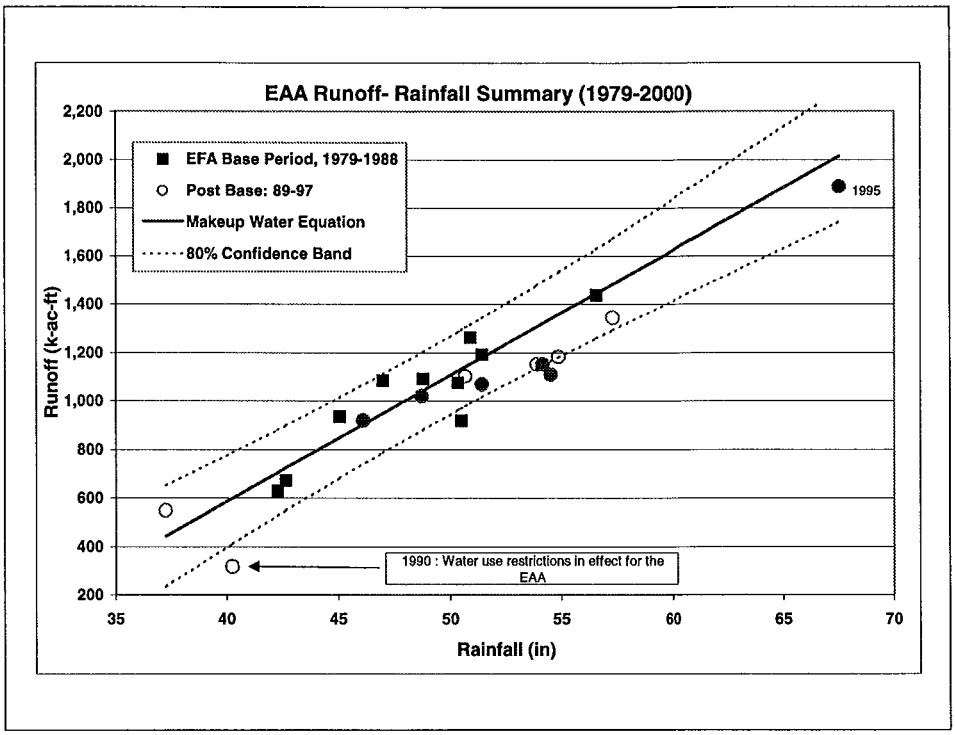


NOTES

The assumption regarding the magnitude of BMP Replacement water was an important consideration in the computer modelling done in support of the COE Restudy.

Both the current Replacement Water Rule and the Restudy model assumptions had to be formulated before any actual experience with the program was available. In order to match early projections of a 20% reduction in runoff due to BMPs the District's hydrologic model was adjusted to increase ET from the EAA until the runoff amount on average was reduced by approximately 20%. The BMP program was therefore treated as a large new water user in the simulation model.

This contributed to a chronic water supply shortfall for future conditions simulated by the model. Although the Restudy and the LEC Plan recommend a new delivery scheme for flow to the Everglades, and do not continue BMP makeup water releases, the water loss assumed to occur with BMPs is still included in the model.

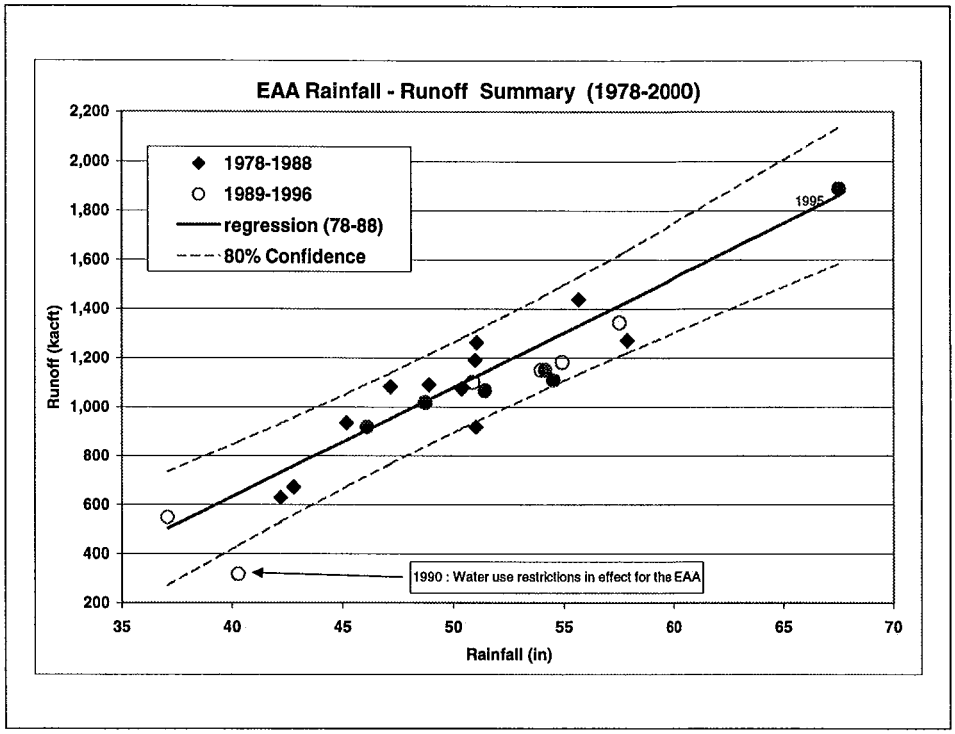


NOTES

4 of the 12 post-base period rainfall totals are completely outside the range of rainfall values recorded in the Base Period.

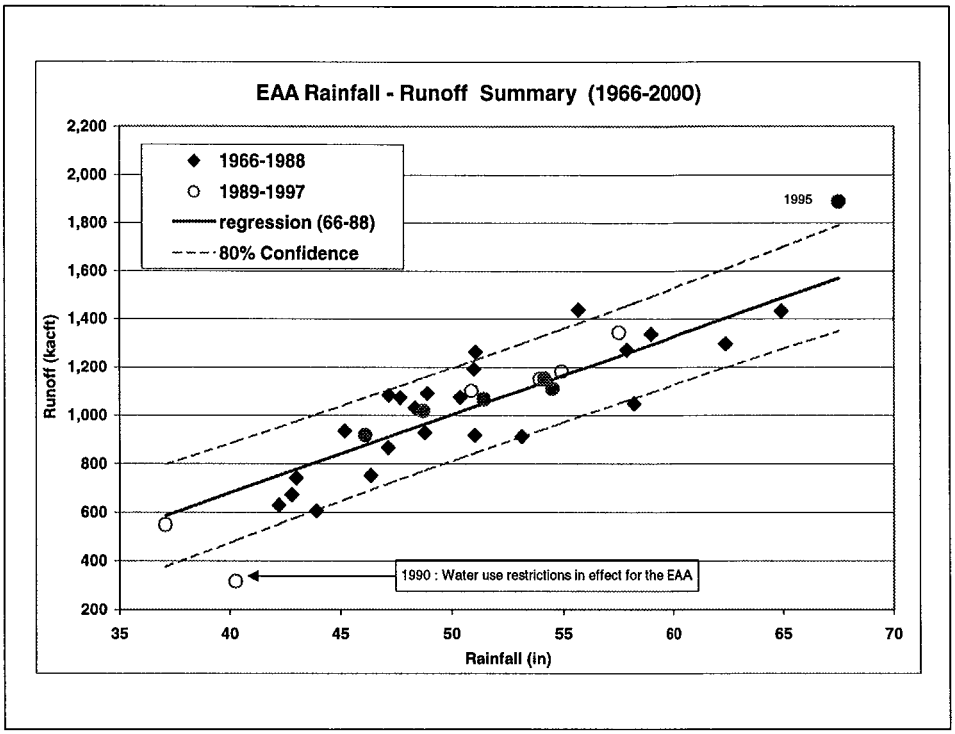
8 of the 12 post-base period rainfall totals are outside the range of values defined by 9 of the 10 years in the base period.

Variation within the base period is assumed to be random, while variation after installation of BMPs is attributed to the BMPs. A five-year averaging period is used to smooth out the non-BMP variability in the post-BMP period.



NOTES

Adding a single year to the base period brings all but one year (1995) into the envelope of values defined by the Base period.

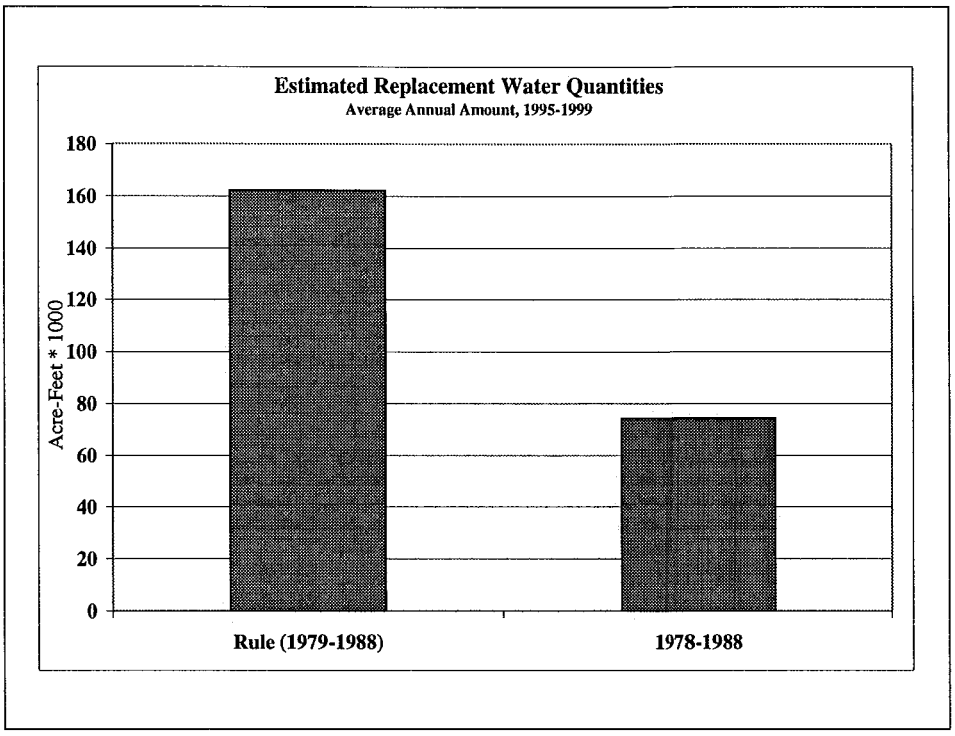


NOTES

Using data back to the late 1960s to pick up additional wet years changes the slope of the regression line and seems to indicate no change in the runoff volume characteristics .

Going that far back in time raises questions about land use changes in the watershed that may make the early data unrepresentative of the present conditions.

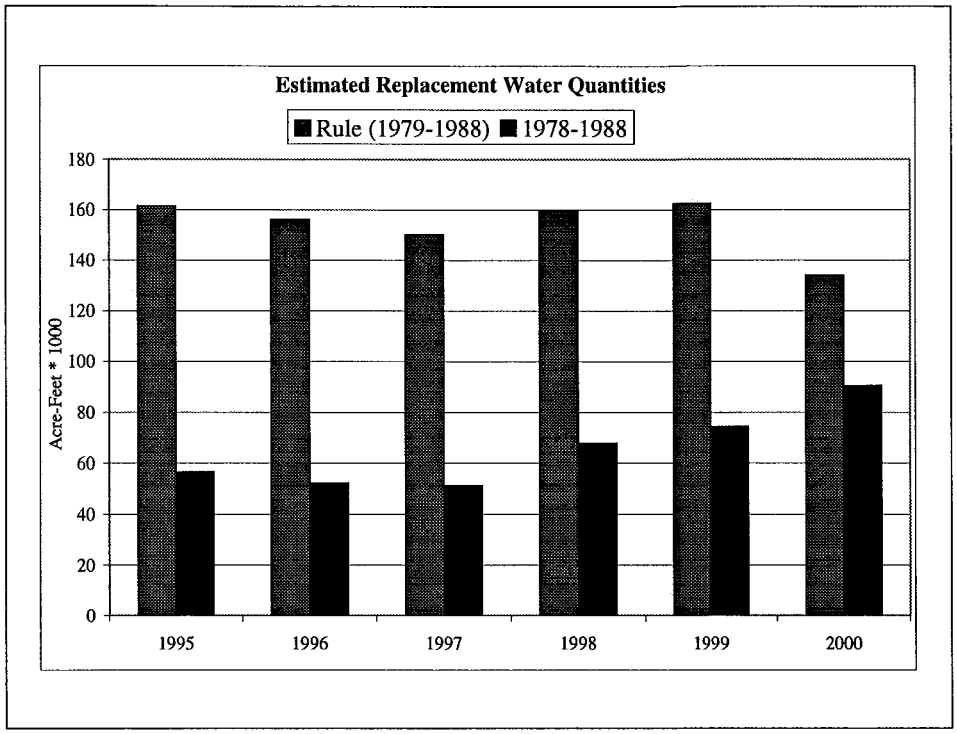
For that reason a method was sought that used only data from the base period.



NOTES

Using an eleven year (78-88) base period rather than the ten year (79-88) period specified in the rule results in more than a fifty percent reduction in the amount of replacement water required by the rule in 1999.

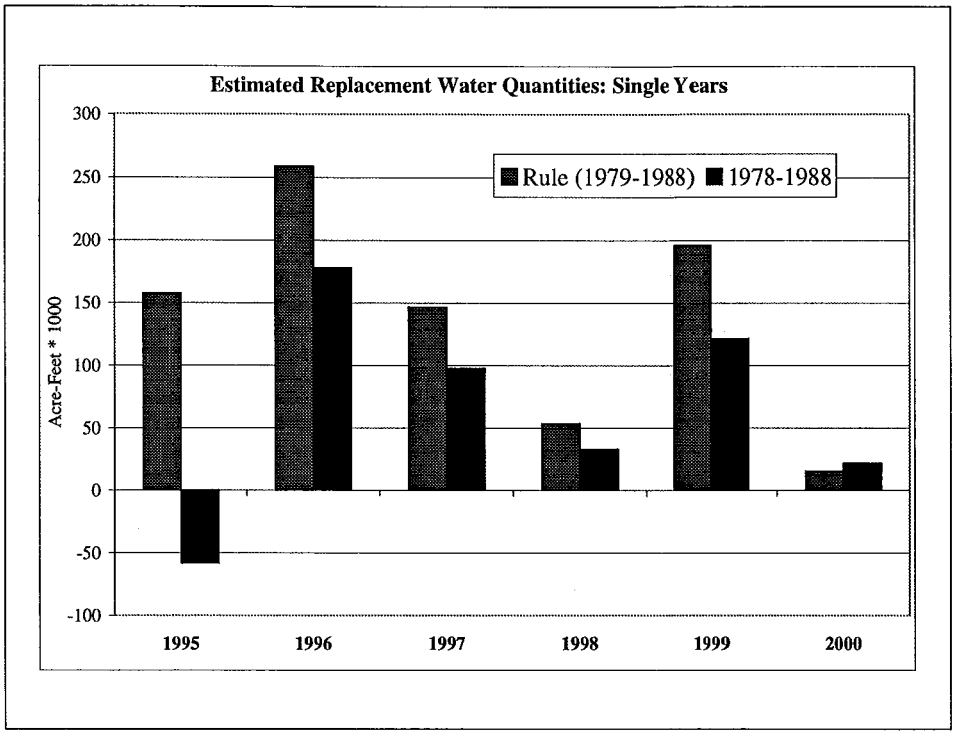
There is no evidence that any changes to the landscape or local water management practices took place in 1978 which would have changed the rainfall runoff relationships. To the contrary, the only difference was that 1978 was a high rainfall year which expanded the range of values which illustrates the instability of the ten data point model.



NOTES

This chart provides further evidence of the impact of adding one data point to the base period would have on the resulting replacement water quantity computed by the rule.

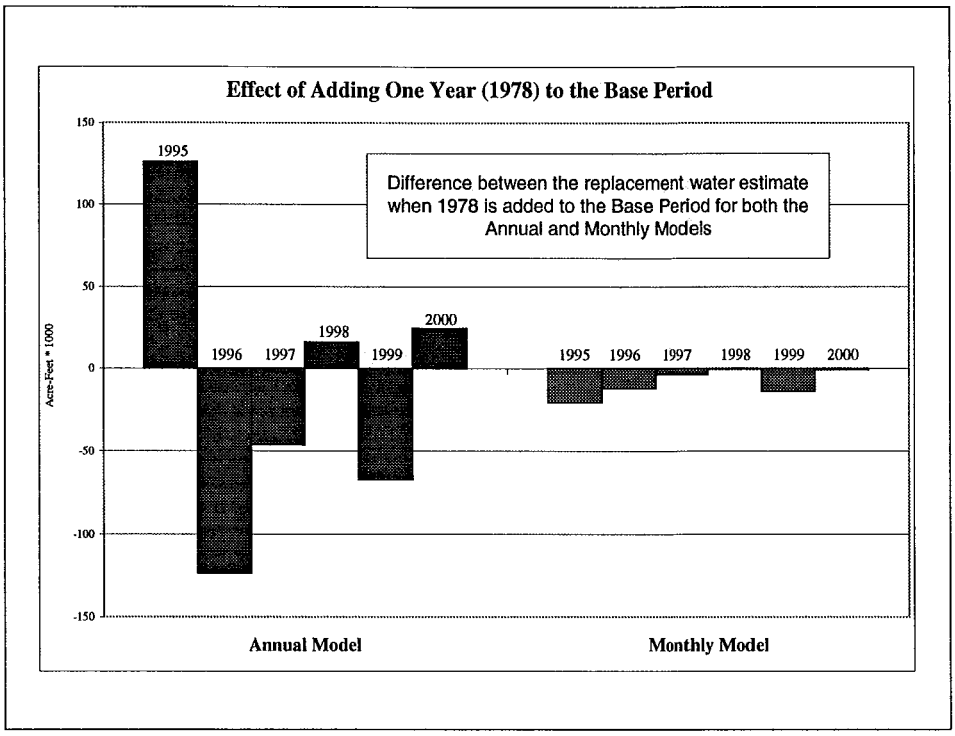
The existing rule produces a relatively stable result because of the five-year rolling average that the rule requires. It has nothing to do with the appropriateness of the 10 data point regression in detecting or quantifying the change in runoff volume.



NOTES

This graph shows the results of the applying the regression in the rule without using a 5-year average.

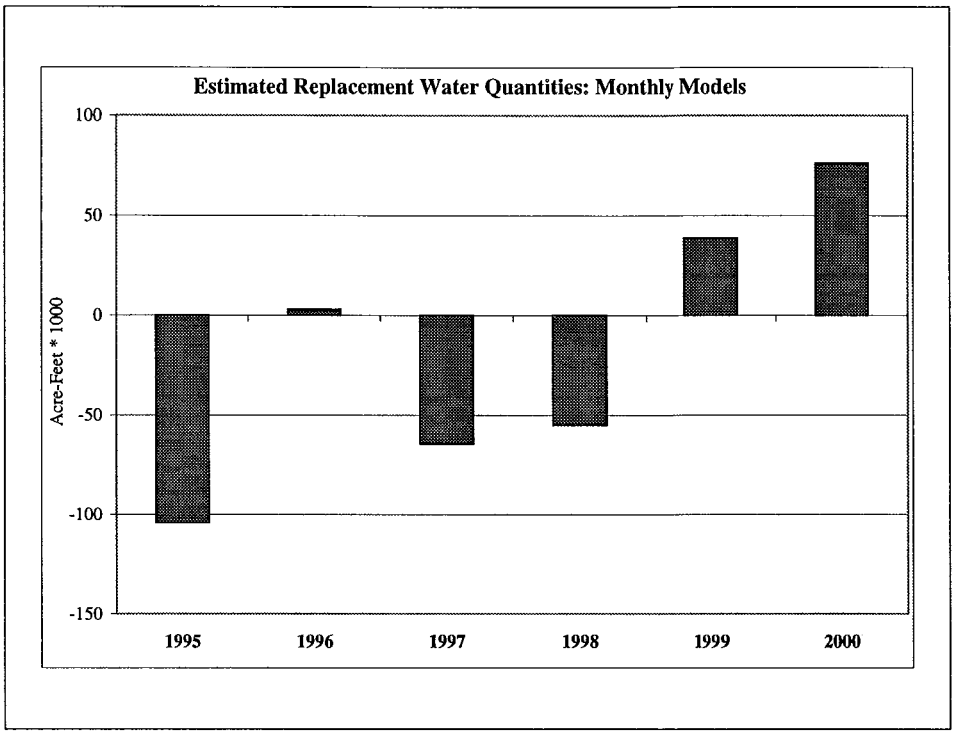
The significant difference when 1978 is added to the base period is also apparent each year.



NOTES

This graph shows the difference between the results for each year using the ten year base period and the eleven year period with both the annual and the monthly model approach.

The monthly approach shows very little sensitivity to the addition of the additional year, which amounts to an additional 12 data points in the monthly regression.



NOTES

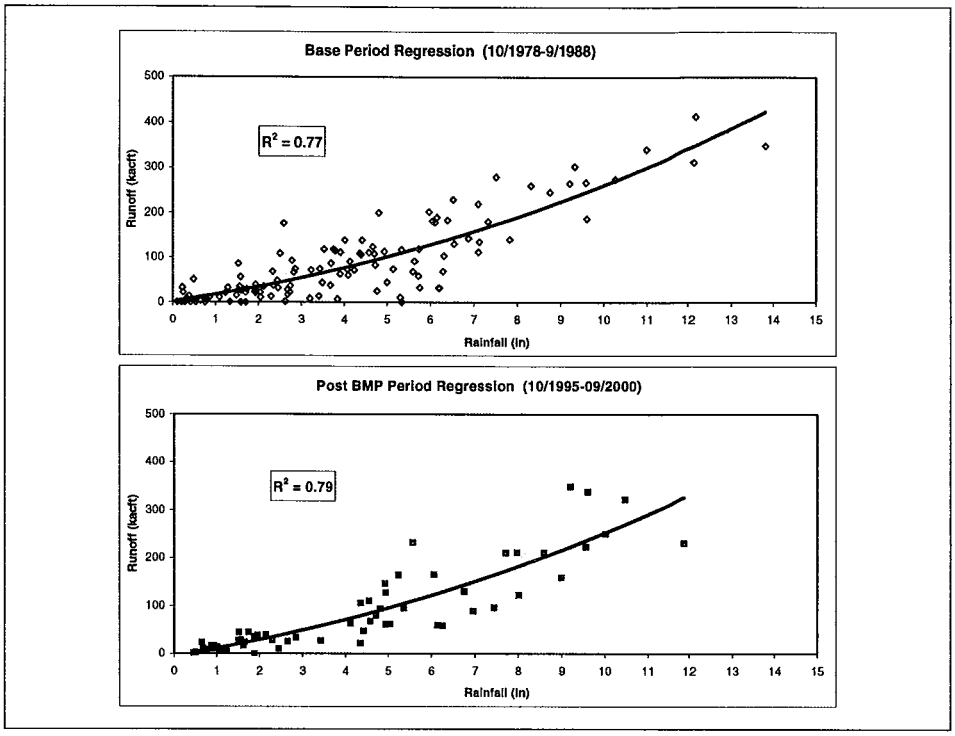
This shows the actual replacement water quantities computed by applying the monthly, two-model approach since 1995.

Two points are worth noting:

- Since the approach uses the previous five years to compute the regression equation the early estimates are influenced by data from the period before BMP installation was required. All BMPs had to be in place by January, 1995.
- The early years were high rainfall years and not only is it unlikely that the farmers could, or would have, reduced their discharge, but the everglades to the south were experiencing high water damage do to the large amount of runoff that did occur.

The Monthly Model Concept

- Base Period and Post-BMP period regressions are computed using monthly rainfall and runoff data
- An F-test is performed to determine if a change has occurred
- If Post BMP data are different, Makeup water is computed and delivered
- The replacement water quantity is equal to the difference between the runoff estimated using the base period model and that estimated with the Post BMP model. Differences due to random variations are eliminated.



NOTES

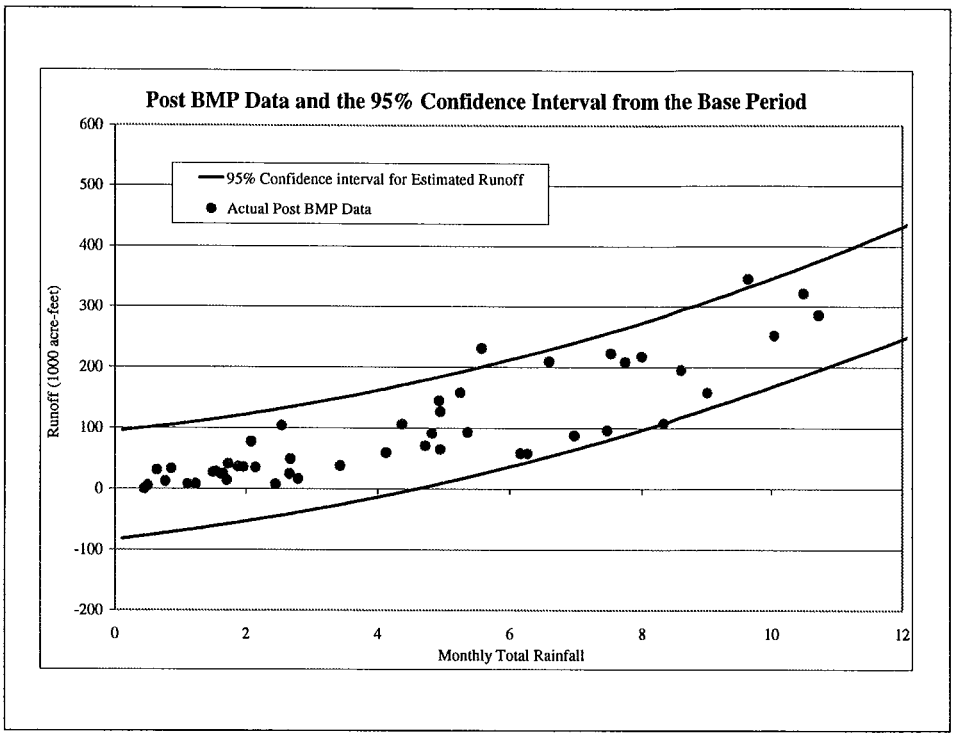
Second order regressions were calculated for the monthly rainfall versus monthly total runoff for the Base Period (1979-1988) and the Post-BMP Period (1995-2000).

Both models show a good fit to the data and have similar r-square values.

There are no post-BMP data points outside of the range defined by the Base Period values.

Computing similar regressions for each data set removes the requirement for an arbitrary averaging method to smooth out the random variations.

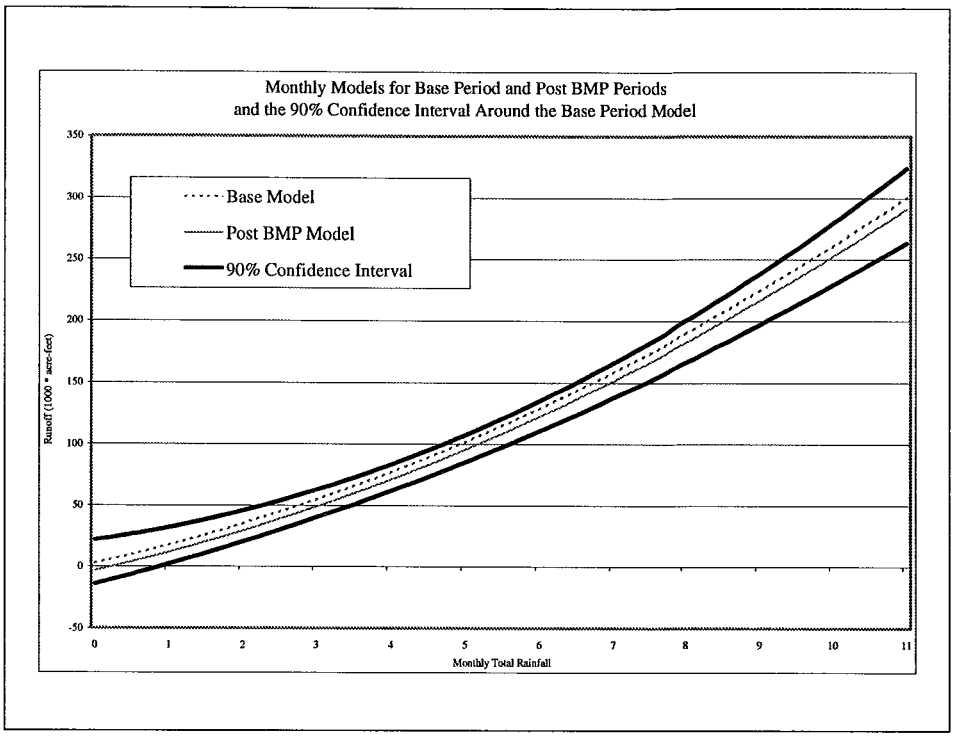
Comparing models provides assurance that when a change is detected it is because the two data sets are really different, not because of a weakness in the base period data set.



NOTES

The Post-BMP data points are clearly within the confidence limits defined by the Base Period data set.

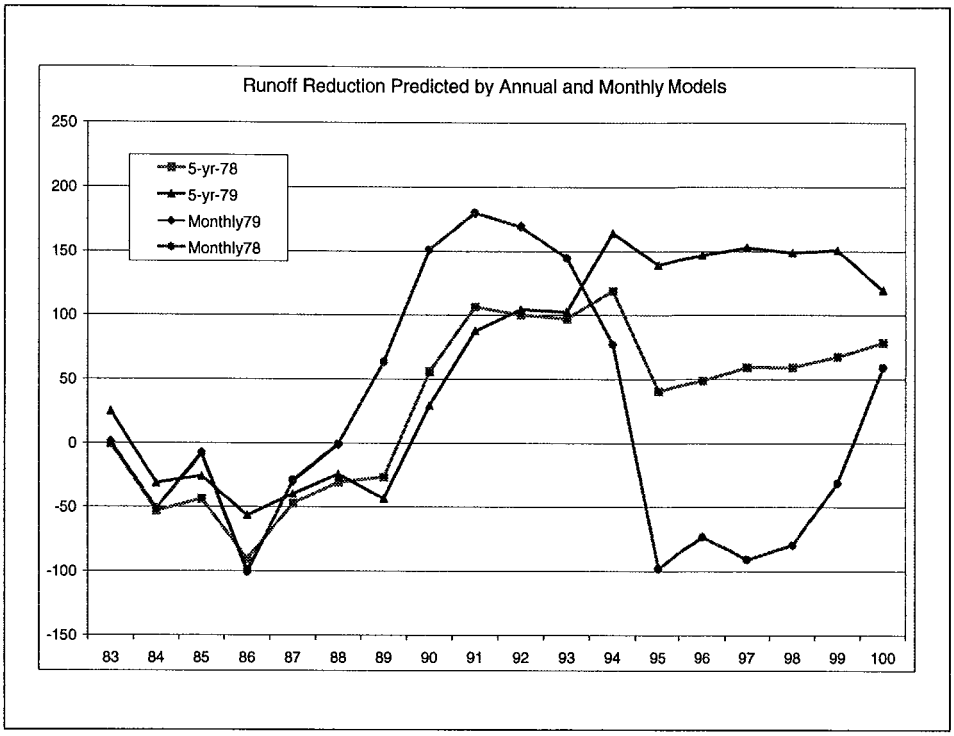
At a 95% confidence level, sixty data points could be expected to include 2 to 3 points outside the limits.



NOTES

This slide gives an idea of the concept of using the two models to determine if the data sets are different. This slide is for visualization purposes only since an F-test on the mregression coefficients is used to confirm significance, not a confidence range around the lines themselves.

The F-test was recommended because of its sensitivity to any significant difference in the two data sets. If any of the model coefficients indicate a difference in the characteristics of the two data sets then the rule will require that makeup water be computed and delivered.



NOTES

This is a reproduction of a portion of figure 1 from Bill Walker's January 30th memo showing the 5-year Rolling average of runoff reduction computed with the rule model, the monthly model, and both models with the addition of 1978 to the base period.

The additional data has no effect on the monthly model while the impact on the annual model is clearly significant.

It is important to remember that the BMP program was not fully implemented until 1995. Since these data points are five year averages, any results prior to 1999 include some data from the period prior to installation of the BMPs.

Summary

The Annual Model now in the rule is flawed

- Too few data points: Model is unstable
- Severely limited range
- High values in wet years and low in dry years
- Normal variations drive results, not reduced runoff

Summary

The Monthly, Two-Model approach has several advantages

- Full range of data values covered in base period
- Large number of data points by comparison
- Higher replacement water in dry years, lower in wet years
- Random variations are filtered out
- Error in the Monthly Model is not significantly different than the error in the Annual Model