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To : Kathleen Baskin, EEA, Water Policy

From : Stephen H. Kaiser, PhD

Comment #3 on SWMI Framework : Calibrating for Accuracy

On March 8, I submitted my comment #1, seeking a calibrated result for the Parker River watershed. On March 21, I sent in my second comment, focusing on legal aspects of the Water Management Act and its implications for safe yield. In retrospect I realize now that I might have done better to consider the legal aspects first.

This Comment #3 should be considered as a total revision and replacement for Comment #1. The changes are substantial and build upon the work of DEP and DCR staff who shared detailed spreadsheets on safe yield and WMA permit/registration actions.

Several environmental activists and lawyers have helped me to sift through the information, obtain key information on highly stressed watersheds like Parker and Ipswich, identify photos and share other raw data on well pumping and peaking characteristics. I expanded my detailed review of specific watersheds to include both the Parker and Ipswich watersheds. The nature of the Environmental Protection Factor is a matter I assessed as a variable .... to be treated as proportional to safe yield. The Environmental Protection Factor or EPF can be varied for each watershed.

Primary Results of SWMI

At this point in the process, there seems to be a split in opinion about water management .... either cautious support for state proposals or sharp negative criticism. The real focus should be for all participants to ask : if anything is missing or wrong, how do we fix it?

Late last year I perceived the SWMI process as a failure, seemingly adrift. My comments at the EEA budget listening session let the Secretary and all commissioners know of my unhappiness

with SWMI process and progress. Formal meetings had stopped the previous May. Momentum seemed stalled.

EEA's latest water management "framework" represented a revived period of presentations, questions, explanations and learning. Below I offer two lists of what SWMI did and did not accomplish. I feel today the process is on the edge of true utility. Calibration or validation of safe yield is possible for all watersheds. Safe yield and baseline flows can be tied together more closely, but agencies must provide examples of how streamflow criteria apply in specific cases.

Primary Achievements of SWMI

To date, the achievements of the SWMI Analysis are as follows :

* A new SWMI process to respond to the Water Management crisis of October 2009

* With the process in a stalemate, EEA stopped the public process for detailed staff work and generation of a new "framework" product, before reopening the public process.

* Assembly of 44 years of USGS empirical gage data

* Consideration of both basins and sub-basins

* Inclusion of alternative safe yield formulas

* Circulation of spreadsheet data on safe yield and baseline flows

* Illustrating key differences in watersheds, in terms of river flows and water use

* Illustrating fish impacts as continuous, in contrast to a more limited perspective of considering only severe damage that might occur during extreme droughts

I was searching for alternative safe yield formulas and found them in the spreadsheets. These spreadsheets allowed outsiders such as myself the opportunity to understand the application of the formulas in terms of specific numbers and real watersheds. Now it was possible to follow a step-by-step procedure to estimate safe yields for each watershed. The opportunity was there to ramp up the learning curve and gain understanding of how these complex processes are intended to work.

The Disappointments in the SWMI Process

I find there are several possible achievements currently absent in the SWMI Analysis :

* The procedures are complicated and hard to understand
* There is no representation of examples, such as the Parker River and streamflow analysis
* DEP personnel will be baffled how to apply the requirements when writing WMA permits
* There appeared to be no one checking the technical work to be sure that the results made practical sense. The most obvious example is safe yield for the Parker River.
* The unwise use of both PowerPoint and a facilitator tended to stifle discussion and dissent, rather than bringing the differences out onto the table. As a result, learning was inhibited.
* No organized opportunities for public comment until the last meeting on March 28 .
* No calibration of safe yield accuracy for basins and sub-basins
* No release of evaluations of sub-basins
* No distinction for larger relative withdrawals in small sub-basins
* No direct inclusion of "returns" (where water use is non-consumptive use)
* No inclusion of users < 100,000 gpd ... for golf courses .... or for agricultural uses.
* No consideration of where wells were located ... depth to bedrock or closeness to rivers.
* No trend data -- adjustments for increased impermeable land or water use.
* No appreciation that watersheds are different and one safe yield formula does not fit all
* Improper definition and identification of drought periods and flows
* Unwise efforts to change from an August focus to annualized results
* In its recommendation for safe yield results, SWMI picked the wrong procedures among several alternative choices. The error was especially evident for the Parker River.
* SWMI may not have changed any opinions during the two-year process.

The downside of the SWMI framework is that the procedures for both safe yield and streamflow criteria are extremely complicated. It is a bit like being given a complex new computer -- but with no manual or training courses. There may be only three people or fewer in the whole world can understand what the SWMI safe yield and streamflow numbers are all about. I fear most

participants in the process have "hit the wall" in their understanding. They become more aware of what they do not understand that what they actually know.

This result was in evidence at the final SWMI meeting of March 28. Most of the statements offered by the participants seemed to reflect the opinions that each individual probably before SWMI even started. In effect, actual learning of anything new was probably quite minimal.

The meeting process was too cautious at first. I recall the First Commandment of famed labor mediator Theodore Kheel, who would always ask the participants "what do you want." With SWMI, the state officials seemed to be satisfied with silence from the advisory committees, rather than a rousing debate. Mediators cannot play avoidance games and be successful.

We are short many specific examples : safe yield for the Parker River -- which I knew had dried up in August 2010 ..... application of streamflow criteria .... and DEP permits that applied useful special conditions. With good examples, agency staff might have seen something wrong with the excessively high safe yield at Parker. Here was a safe yield over six times higher than current usage, yet the river ran dry two years ago. The best learning experience comes from good examples.

A constant plague on the process was PowerPoint, eating up the clock and preventing discussion and debate. This failure to engage in dialogue is a societal problem -- seduced by an mind-deadening drug from Microsoft, and seemingly endemic to almost all meeting formats today. Over a year ago, an environmental "workshop" on safe yield was held. I was fit to be tied. The citizen group spent almost four hours on PowerPoint presentations ... people talking to the screen or to their written notes and not among the group. There should be an outright ban on PowerPoint.

Resolving the gaps in the SWMI Process

After 25 years of WMA stalemate, EEA might wonder at this point : is there any light at the end of the tunnel? I believe there is, if we build on the positive achievements of SWMI so far, and also deal with the omissions or wrong turns that have been identified above.

This work program would include :

* Clarifying and simplifying the proposals so more people can understand them

* Working through examples of key stressed rivers such as Parker River, for both safe yield and streamflow criteria

.....

* Showing DEP personnel a proper transition between current ways of writing permits and conditions ..... and the new procedures.

* Both basins and sub-basins should be calibrated for safe yield accuracy.

* Resolve issues of returns for non-consumptive use .... significance of small water users without permits .... golf courses .... and agricultural uses.

* Evaluate how the depth of wells and location close to rivers can affect river flows.

* Consider trend data for water conservation .... increased water usage .... and forecasts of impermeable lands.

* EEA should take a close comparative look at the safe yield alternatives. Do a new evaluation to choose the simplest and most accurate methodology.

* Start building a credible consensus for a new water policy.

I believe that all of the above items can and should be addressed in the coming months.

Five Major Elements of Water Management

The common perception is that SWMI is represented as two large, separate pieces -- safe yield and streamflow criteria. I would prefer to identify five fundamental pieces .... safe yield (including a complex assessment of reservoirs) ... baseline flows .... streamflow criteria .... and DEP permit conditions .... and enforcement.

DCR has shown us how to calculate safe yield with various different methods. DEP has shown calculations for baseline flows. We should have taken a sample permit application -- say a permit request for an additional 0.25 MGD in the upper reaches of the Parker watershed -- and work through the implications of the procedures for every step of the way.

The Need for Calibration

DCR says its work on safe yield is "not a model"and has not been validated or calibrated. By contrast, the F&W work on streamflow <u>is</u> a model and has been "validated." Normally the best way to calibrate a model is to take the modeled results and compare them with measured or observed conditions. Where there is an error, a calibration factor or adjustment can be used to bring the model into alignment with reality. The assumption is that any model able to replicate <u>existing conditions</u> should be capable of producing a valid and trustworthy prediction for <u>the future</u>.

Definitions of Drought Flow and Safe Yield

Safe yield is essentially a summer phenomenon. The limits usually occur in the months of July, August, September and October. There have been rare instances of both low and high streamflows occurring in December. It is acceptable shorthand to refer to "August low flows."

Neither DEP regulations nor SWMI give us a definition of drought, or how drought is related to safe yield. I believe that the statute requires us to consider the lowest daily flow in a river over a period of years, up to the 44 years of data used in SWMI. Terms like “drought year” have little value except in identifying the year that the lowest river flows occurred.

Any time that a river reaches zero flow or “dries up”, we can say the safe yield has been exceeded. We need to take an additional step beyond safe yield and judge any safe yield estimate based on the number of days a year that the river will reach zero-flow if the presumed safe yield is completely allocated.

This situation is further compounded by the typical summer rise in water use by customers – for watering lawns, cooling, swimming pools, etc. Human society is placed in a double bind, because the drop in river flows happens at about the same time that summer water use is rising and peaking. If people changed and used more water in the winter and less in the summer, the river conditions would be more balanced. But the world is not made that way.

Instead, the more common condition of our rivers is a pendulum swing from flood to drought. The year 2010 was an excellent example, when record rains and floods occurred in March, and thereafter an intense drought followed resulting in record low flows in the Parker River in August. It was a stunning contrast .... all in one year. Total rainfall during the year was about average.

Sensitivity of Sub-Basins and the Environmental Protection Factor

The Parker River is most stressed in the upper reaches of its watershed, especially in Georgetown and at the Byfield gage -- located in the upper quarter of the watershed. This small sub-basin carries between 30 and 40 percent of total basin allocations. The upper reaches of a river are often more vulnerable to stress and drying up than the lower reaches near the estuary.

Midway through the SWMI process, state officials introduced the concept of the Environmental Protection Factor. Early SWMI work had considered several alternative values for

the EPF. Unfortunately, the annualization of safe yield means that during a drought the low flow protection of the EPF is completely lost, and rivers can still dry up. The EPF numbers and promises disappear because of high safe yields and larger possible withdrawal allocations.

In the evaluation that follows, I will consider four values for the EPF, ranging from zero .... 10% .... 20% .... 33% ....to 50% of safe yield. These EPF volumes are indeed real flows during a drought and could be called a "Restoration Flow" for rivers that are struggling close to extinction during bad droughts. My approach here is quite different from the annualized SWMI effort.

Alternate Models for Safe Yield

SWMI looked at four alternative safe yield formulas, and I will introduce a fifth -- the Calibration Model -- which is empirically derived. The full list of five is :

* Annualized Q90
* 25% of August Median
* 10%-10%-25%-15% Q90 or four-month-weighted Q90
* 10%-10%-25%-15% Q50 or four-month-weighted Q50
* Calibration Model

The Empirical Calibration Model

My first comment of March 8 described an empirical Gage Flow or Calibration Model. I have revised this model and included a technical description in Appendix A. The concept is based on a drought day, using USGS flow measurements during a summer month. The drought stream flow combined with the August usage is a measure of the low point in the ability of the watershed to provide water.

The input information necessary is :

* the USGS gage low flow reading
* the watershed area upstream of the gage

* the total watershed area
* the average water usage during the year
* the relative August use vs. average month peak use (SWMI uses a ratio of 1.16)
* reservoir storage
* allocated withdrawals (registered and permitted) by DEP

The Parker and Ipswich Rivers : Calibration and Evaluation

The Parker River includes one USGS gage at Byfield. There are two gages along the Ipswich, one just upstream of Ipswich and the other near East Middleton. The safe yield values for the three gage locations with various EPF values produces basin-wide safe yields are shown in Table 1.

TABLE 1 CALIBRATION MODEL SAFE YIELD FROM THREE GAGES

EPF RATIO	*PARKER SAFE YIELD* (Byfield data)	*IPSWICH SAFE YIELD* (Ipswich data)	*IPSWICH SAFE YIELD* (Middleton data)
0%	2.72 MGD	28.7 MGD	28.2 MGD
10%	2.47 MGD	26.1 MGD	25.7 MGD
20%	2.26 MGD	23.9 MGD	23.5 MGD
33%	2.04 MGD	21.6 MGD	21.2 MGD
50%	1.81 MGD	19.1 MGD	18.8 MGD

TABLE 2 TRENDS IN WATER USE ON PARKER RIVER (at Byfield gage) ... by decade

	1/65 thru 12/74	*1/75 thru 12/84*	*1/85 thru 12/94*	*1/95 thru 12/04*	*1/10 thru 12/11*
	=======	======	=======	======	======
Qmax	465	369	779	858	712
Q10	88	107	74	92	113
Q50	24	24	24	23	30
Q90	1.6	1.9	1.8	0.39	0.30
Q99	0.38	0.29	0.20	0.06	0.02
Qmin	0.21	0.10	0.05	0.03	0.02

At Parker, Table 2 shows how drought records have been dropping, while flood volumes are increasing. The rise in flood flows and runoff has been from 334 cfs in the 1940s ... to 454 cfs in the 1950s ... 433 cfs in the 1960s ... 347 cfs in the 1970s ... 779 in the 1980s ... and 858 cfs in the 1990s. The second highest flood flow was 851 cfs in May 2006. The fourth highest flood flow was 712 cfs in March 2010, just two years ago.

These increasing flood flows over the decades are in contrast to the decreasing drought flows. These changes occurred while median flows remained fairly steady through the years. For the parker River, low flows such as Q90 and Q99 have been reduced to a small fraction of their levels in the 1960s. This data is indicative of more runoff and less infiltration.

Many factors contribute to these changes, but we know that weather conditions may be changing slowly, while increased impervious areas and runoff effects without infiltration are a worrisome problem clearly identified in SWMI studies. We can no longer assume that the 1960s are an accurate marker of drought. A more accurate simulation would take the rainfall characteristics of a 1960s drought, and apply them to today's different conditions having :

1. Increased impervious areas
2. Increased runoff due to larger "big storms", with less infiltration
3. Increased summer uses of water
4. Increased evaporation due to climate change and higher temperature trends

Such a study is advisable but very complex and beyond the reach of SWMI and those who have participated in the process. A long-range USGS study would be appropriate to provide us with the information and results needed to achieve this next level of accuracy in understanding river flows now and in the future. We must use the information we have at hand today.

Selecting the Best Safe Yield Methodology

The results for various EPF scenarios are shown in Table 3. Note that the annual average safe yield must be adjusted upwards by 16% to provide an August withdrawal rate. The uncalibrated annualized method <u>for Parker</u> appears extraordinarily high and virtually beyond reason. Meanwhile, <u>two of the alternate models</u> considered by SWI (25% of August Median and a four-month Q90 combination) offer results that are very close the results of the Calibrated Model for the Parker River.

The results for the Ipswich River are startlingly different and illustrate the variations between watersheds. The Ipswich safe yields for the Calibrated Model are much closer to the Annualized Q90 results, which are still on the high side. However, it is the 25% of August Median and the four-month-weighted Q90 which are much lower than current use and must be calibrated upwards.

TABLE 3 RESULT OF SAFE YIELD METHODS for PARKER and IPSWICH RIVERS

METHOD	*EPF%*	*SAFE YIELD at Parker*	*Safe Yield at Ipswich*
Annualized Q90	(claimed 45%)	14.80 MGD	29.4 MGD
August Annualized Q90	--	17.20 MGD	34.1 MGD
25% of August median	--	3.15 MGD	6.42 MGD
10%-10%-25%-15% Q90	--	3.14 MGD	6.28 MGD
Calibration Model, zero EPF	0	2.72 MGD	28.7 MGD
Calibration Model, 10 % EPF	10%	2.47 MGD	26.1 MGD
Calibration Model, 20 % EPF	20%	2.26 MGD	23.9 MGD

Dangers of Annualized Q90

I see further use of the uncalibrated model recently recommended by EEA -- the annualized Q90 -- to be extremely unrealistic for use in the Parker watershed. The method either needs to be calibrated (modified) or it should be abandoned.

The dangers of annualization can be seen in a consideration of flow frequencies at the Byfield gage. The drought flow used by SWMI would translate into 7.3 cfs at Byfield. Over a 44-year period, 7.3 cfs would rank at the 27th percentile level of low flows. In other words, annualized Q90 is more like Q73 .... not Q90. SWMI is not using a drought number, at a time when drought conditions are what the law calls for.

Additional dangers of annualization can be seen by the number of days a year that a river will run dry because of increased future withdrawals. An annualized "safe yield' of 14.8 MGD for Parker translates into added withdrawals of 5.8 cfs at the Byfield gage. This withdrawal exceeds Parker River flows for 24% of the days in 66 years of USGS records at this site. The new "safe yield" would not be safe at all. The river would be drained dry 24% of the time or about 86 days a year.

However, all is not lost. No matter how inaccurate the safe yield for annualized Q90 is at Parker, a calibration coefficient can bring the number back to reality and practicality. A calibration coefficient is a numerical adjustment which takes an inaccurate or inappropriate number and adjusts it to match real or desired conditions. If you drive a car and the speedometer says 40 mph, but accurate radar says it is 50 mph, the speedometer has an error of 10 mph or twenty percent. The calibration coefficient for the speedometer to get the accurate speed is 1.20.

Calibration Results

The Calibration Method typically estimates lower safe yields than the Annualized Q90 method. A Calibration Coefficient of 1.00 indicates perfect calibration, and the further either way from 1.00 the less accurate the methodology becomes. The Calibration Coefficient necessary to achieve an EPF of 10 percent is C_{10}. From Table 4, C_{10} is the ratio of 2.47/17.2 = 0.144 at Parker and 0.765 at Ipswich. At Parker, the Annualized Q90 method does very poorly but much better at Ipswich. For the other methods, the results are the opposite -- good at Parker and poor at Ipswich.

TABLE 4 CALIBRATION COEFFICIENT AT PARKER AND IPSWICH, Various SY Methods

METHOD	*EPF%*	*Calibration Coefficient at Parker*	*Calibration Coefficient at Ipswich*
Annualized Q90	10%	0.167	0.887
August Annualized Q90	10%	0.144	0.765
25% of August Median	10%	0.784	4.07
August Median	10%	0.196	1.02
10%-10%-25%-15% Q90	10%	0.782	4.16

Once the calibration Coefficients have been applied, we find that all methods -- no matter their basic faults -- will operate comparably to the Calibrated Method and should represent real-world conditions.

Safe Yield Conclusions

The issue is not which formula for safe yield one selects, but rather has there been a proper calibration of the formula for the individual water basin and in particular the sub-basins. For safe yield, one-size-does-not-fit-all. Each watershed needs to be treated as separate and special, and

needs to be calibrated individually. Proper calibration is essential not only for individual watersheds but also for individual sub-basins.

For the overall Parker River watershed, the calibrated formulas for safe yield as summarized in Table 4 are 0.144 Annualized Q 90 = 2.47 MGD safe yield. For the Ipswich River, the safe yield would be 0.659 Annualized Q90 = 26.1 MGD. The dramatic differences between the two basins can be seen by the fact that the annual average water use and safe yield are about ten times higher for the Ipswich, while the Ipswich watershed area in only about twice that of the Parker. Ipswich is an intensively used watershed, while the Parker is a less intensively used watershed whose river nevertheless dries up.

Fluvial Fish Analysis

A great deal of measurement, data assessment and effort has gone into the formulation of fluvial fish impacts as a function of river flows. State F&W has stated that the model has been validated. The research effort concludes that the decline in environment for aquatic life is gradual, and is not a matter that can be ignored until some type of crisis threshold has been reached.

Unfortunately, procedures for applying the new streamflow methodology are not clear. I am looking for a step-by-step procedure similar to orderly ways of assessing all impacts warranting state actions. It is extremely important to present an example of how Streamflow Criteria and baseline flows can be applied for what is ultimately an evaluation and permit writing exercise by DEP staff. I suggest we consider a sample permit application of 0.25 MGD high in the Parker watershed. As an engineer, I cannot accept the streamflow criteria method until I see such a example fully worked out for a stressed basin.

Miscellaneous Additional Comments

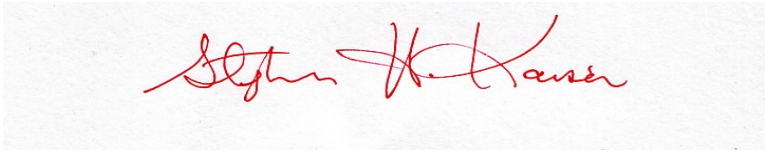
Finally, I believe that there is a third tier of defense -- in the form of the special conditions that DEP can attach to any new or renewed permits. The best example is the 2008 permit written for Russell Biomass. State Fish and wildlife requested that the additional withdrawals of power plant cooling water should not further stress the Westfield River in low-flow conditions. DEP engineers added a condition to the effect that the 40-year low flow in the river (which occurred in 1970) should become a threshold, and that the power company should start reducing withdrawals as flows receded close to the 40-year threshold. DEP said that when flows dropped to the 40-year level, all withdrawals from the plant should cease. This provision was a guarantee that water would remain in the river during low flow periods in the future. And the applicant accepted the condition.

Baseline flows become another accounting procedure. The DEP procedure of assuming 5 to 8 percent growth in baseline flows appears to run counter to goals for water conservation. Furthermore, baseline appears to be an annualized feature which does not address the August or peak summer demands placed on the river systems. Data for Parker is incomplete, because Byfield was inadvertently left out of the analysis. Here again we need an example to be worked through to indicate the relationship between safe yield and baseflow. DEP appears to be increasing the 2003-2005 use by eight percent, with no special consideration for how the Parker watershed would respond to such an increase. Given the fact that the river dried up only 18 months ago, the 8 percent increase in baseline flow appears unjustified, to say the least.

Reservoir assessment have varied during the SWMI process, with earlier work showing almost all basins being assigned reservoir storage benefits. Now fewer than a third of the basins have any reservoir benefit assigned to them. The methodology developed in recent months is very arcane and complicated. Observers would benefit from having an example worked out using the Westfield River as a model for step-by-step calculation.

EEA should begin a program to phase out the use of water for power plant cooling. I recall several years ago the City of Springfield denied a request for a power plant to use city drinking water for cooling purposes. A proposed 400 MW plant in Westfield is planning to use drinking water from either Holyoke or Westfield for wet cooling. The Brockton power plant is seeking to use water from a desalination plant for cooling. In all these cases, new WMA permit requests for cooling water should be turned down as a matter of state policy. Water is too valuable a commodity to be wasted in waste heat evaporation when dry cooling options are available.

Sincerely,



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APPENDIX A APPLICATION OF THE CALIBRATION METHOD : THE PARKER RIVER EXAMPLE

The overall approach is to begin with the basic critical safe yield as

Safe Yield = SY = August water use + Measured August flow

Safe yield is subject to two key limits : one cannot legally pump a water source dry, and the August safe yield is never less than the August water use.

The default value used in the SWMI calculations for most watersheds with a ratio of 1.16 between water use in August vs. average annual use. An Environmental Protection Factor is includes as a variable, while SWMI used a fixed relationship. The ratio of EPF to safe yield is identified as EPF%.

SY - EPF = 1.16 * Annual Water Use + August low flow

SY - EPF% * SY = SY(1 -EPF%) = 1.16 * Annual Water Use + August low flow

We know the August low flow at Byfield from the USGS gage data. (0.02 cfs).
We know the upstream watershed at the gage (Byfield is 21.3 square miles).
We know the total watershed areas (assumed by SWMI to be 81.8 square miles for Parker).
We know the annual water use from the DEP reporting data. (2.3 MGD total use).
We can make the same assumption of SWMI that water yield and use are uniform over the watershed.

When the value of EPF is set to zero (protection ignored), the uniform safe yield at the Byfield Gage becomes :

SYb = 1.16 * 2.3 MGD * 21.3/81.8 + 0.02 cfs /1.547 MGD/cfs =

0.695 MGD + 0.013 = 0.708 MGD at Byfield. say 0.71 MGD.

To get the uniform safe yield for the entire Parker basin, multiply 0.708 by 81.8/21.3 to obtain the value of 2.72 MGD as the Parker Safe Yield for zero EPF. The historical low flow at the Byfield gage is 0.02 cfs or 0.012 MGD, with the total Parker watershed low flow of 0.05 MGD.

Considering variations in the Environmental Protection Factor of 10%, then 20%, then 33%, and finally 50% means that a ten-percent ratio will result in every ten gallons of withdrawal water being matched by one gallon to be retained for river flow. A fifty percent EPF means that for every two gallons of water available for withdrawal, one gallon is retained for river flow.

A safe yield based on a 10% EPF is reasonable, and for Parker this value is 2.47 MGD. For 20% EPF it is 2.26 MGD. For 33% EPF it is 2.04 MGD. For 50% EPF it is 1.81 MGD. All of these safe yield values are based on an August condition, when water use is at its highest and river flows are at their lowest.

The existing average usage must be adjusted by a factor of 1.16 in order to represent a actual summer usage. For the Parker, the annual average of 2.3 MGD is thus 2.67 MGD in the summer. This number compares with a calibrated zero-EPF safe yield of 2.72 MGD. Existing low flow in the Parker of a 0.05 MGD would be totally consumed and the river would be marginally dry if August use increases by only 0.05 MGD.

Continuing with the Parker example, a ten-percent EPF means that a safe yield of 2.45 MGD would be exceeded by a 2.67 MGD demand for use. The difference or 0.22 MGD would be the necessary reduced use or required water conservation in order to provide for the 10% EPF flow in the river. A fifty-percent EPF would have a 1.82 MGD safe yield and would require about a 0.8 MGD reduced demand from today by Parker users.