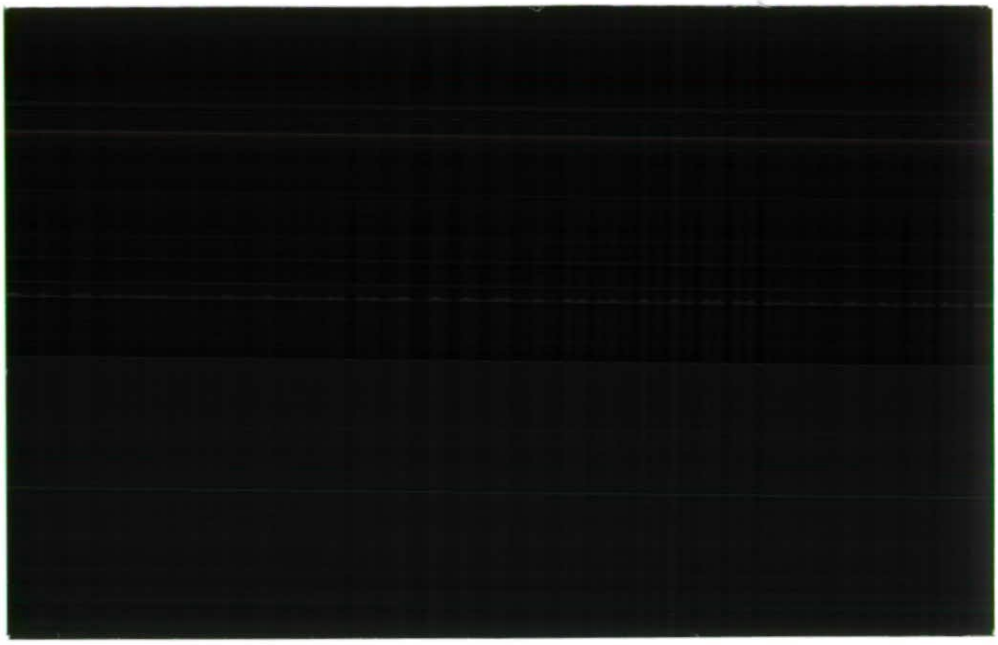
Institute of Hydrology



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SAUR (UK) GENERAL UTILITIES

# Identifying the Relationship between Medway Yield, Residual Flow and Beneficial Bewl Water Releases

B.N.Austin and F.M.Law

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Centre for Ecology and Hydrology
Wallingford
OX10 8BB

## PURPOSE

Following a suggestion by the EA, it was decided to look into the feasibility of increasing the Q95 flow into the Medway estuary. The target is an increase of the order of 25%. It was thought that this can be obtained through manipulation of the Minimum Residual Flow (MRF) at Teston and of the Bewl release factor. It was not known how this would affect the 2% yield of the Medway system - in particular the yield at Burham treatment works.

## METHODOLOGY

The original spreadsheet model of the Medway system (used for the initial investigation and assessment of the yield of the Medway system - IH draft report 1996) has been expanded to include calculation of the Q95 at Allington. For the time being, the Bewl - Darwell link has been "disconnected" to reduce computation time and thus the Medway yield is not affected by the performance of the Rother/Darwell system. The upper Medway reservoirs (Bough Beech and Weir Wood) remain in the model.

The planning yield is calculated based on the performance of the system of reservoirs during the synthetic 2% drought (1 in 50 year event). In the baseline case, which is the system at present, the yield at Burham treatment works is 89.2 Ml/day (seasonally adjusted). There is an additional 13 Ml/day removed directly from Bewl. In all simulations, the yield is assessed by allowing Bewl to run to empty before filling again. During the 2% drought on the Medway, Bewl does not empty during the first year, but does not fully recover during the following wet season. As a consequence, the critical drawdown period, when the reservoir empties, is seen during the second summer.

The spreadsheet model holds all the variables controlling the yield of the Medway system. Each of these variables can be changed to note their effect on the overall yield of the system (or the yield of any of the individual reservoirs). The model now runs 5 continuous years of daily data at a time.

## RESULTS

The obvious way to increase the Q95 flow at Allington is to increase the Bewl release factor for abstraction at Springfield when flows in the Medway are below the MRF. The current release factor is 1.2 and the MRF is 275 Ml/day (see Appendix A for licence details). Increasing the release factor has a negative effect on the planning yield of the system, and so this is balanced by reducing the Teston MRF. Lowering the MRF reduces the Q95 at Allington, but not as rapidly as the increase in yield. By optimisation using trial and error within the spreadsheet model, a balance of 1.32 for the release factor and 200 Ml/day for the Teston MRF was deemed an acceptable balance between gain in Q95 and gain in yield (25.4% and 15.9 Ml/day respectively). In this scenario, the flow at Allington fares better during dry spells and slightly worse during the wet season and periods of rain (see Figure 1). An increase in demand which is met, results in greater effluent returns to the river and it was thought that 10 Ml/day out of the 15.9 Ml/day modelled is a realistic figure. This is also incorporated into the model. Figure 1 does not allow for the increase in flow from tributaries and direct runoff between Teston and Allington. This graph can be used for any period of analysis using the current licence agreements.

The true test of the effect of changing the Medway operating rules is seen by plotting the flow at Allington with time during the critical period of the 2% drought (Figure 2). As expected, during the very dry period of the first year (May through September inclusively) the flow at Allington fares better with the revised operating rules than with the current ones. In fact, whenever the flow for the baseline case is below 220 Ml/day, the high yield scenario results in more water flowing to the estuary. This is confirmation of the results in Figure 1.

Interestingly, the increased yield over the baseline case as seen in the 2% drought is not always seen in the historic runs. In the 1975-1979 run, the baseline yield is 102.9 Ml/day at Burham TW. The high yield run (1.32 Bewl release factor and 200 MRF at Teston) results in an only 9 Ml/day higher yield. This run is presumably not as important as the 2% run, and higher than the planning yield in any case. It is thought that this lower increased yield is due to the fact that the flow at Teston does not remain in the intermediate range (Teston flows between 220 Ml/day and 370 Ml/day) and thus able to take advantage of the lower MRF during this period as long as during the 2% drought. For other historic runs, and during wetter periods, the yield of the two scenarios is very similar.

At this stage it is not known how the Q95 flows at Allington are affected by the proposed change in operating rules during wetter periods, but presumably wetter periods are of less concern to the EA.

Getting the balance between the needs of the Medway estuary and the projected increase in water demand in the catchment can be determined by optimising for those parameters in the model. As previously mentioned, an increase in the Bewl release factor reduces the planning yield, but increases the Q95 into the estuary. Reducing the Teston MRF has a considerable effect on the yield which is not so noticeable on the Q95. Figure 3 shows various yield - Q95 scenarios which should enable a beneficial change of the current operating rules. Using this graph it is possible to select the best increase in Q95-Yield scenario. For example, for a projected increase in demand of 20 Ml/day and an increase in Q95 of 25%, the Teston MRF would have to be lowered to 185 Ml/day while the Bewl release factor would have to be increased to 1.3.

It should be noted that Figure 3 applies only to the 5-year 2% drought. It is expected that the effect of changing the operating rules will be similar for similar dry periods (for example the 5-year '75-'79 period), but perhaps not so noticeable for wet periods.

## DISCUSSION

When carrying out the increased yield scenarios, the licence agreement at Burham was relaxed. It is assumed that this will be changed with any of the operating rule changes discussed. Yalding and Smallbridge licences remain unchanged for the modelling exercise.

A change in the operating rules to those suggested (1.32, 200) without a corresponding increase in the demand and effluent returns results in only an 11% increase in the Q95 at Allington. The 25% suggested by the EA is only achieved when an additional 10 Ml/day effluent return is seen in the Medway and the demand increases to 104.2 Ml/day at Burham TW (the Q95 increases with increasing demand because of the Bewl over-release).

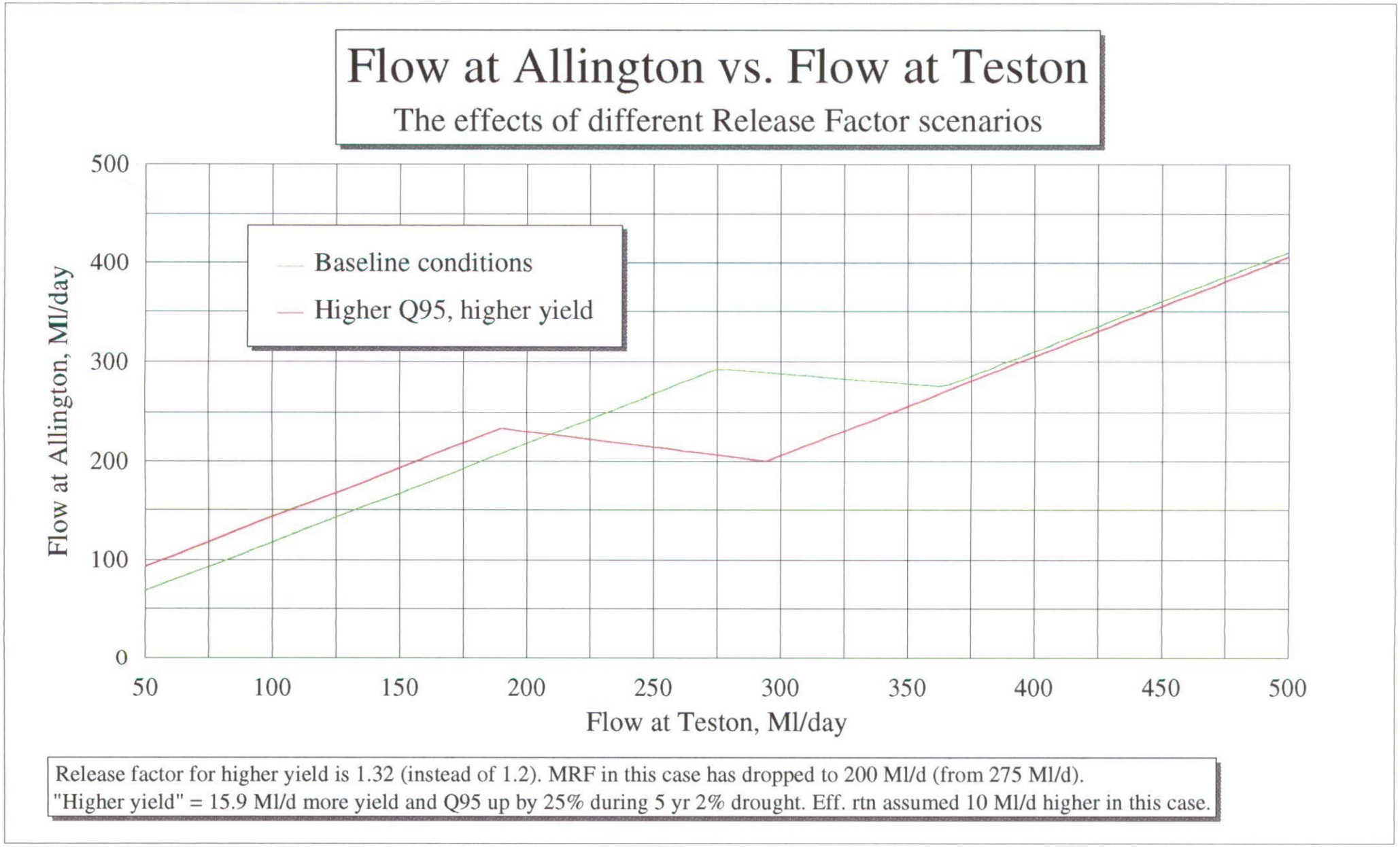
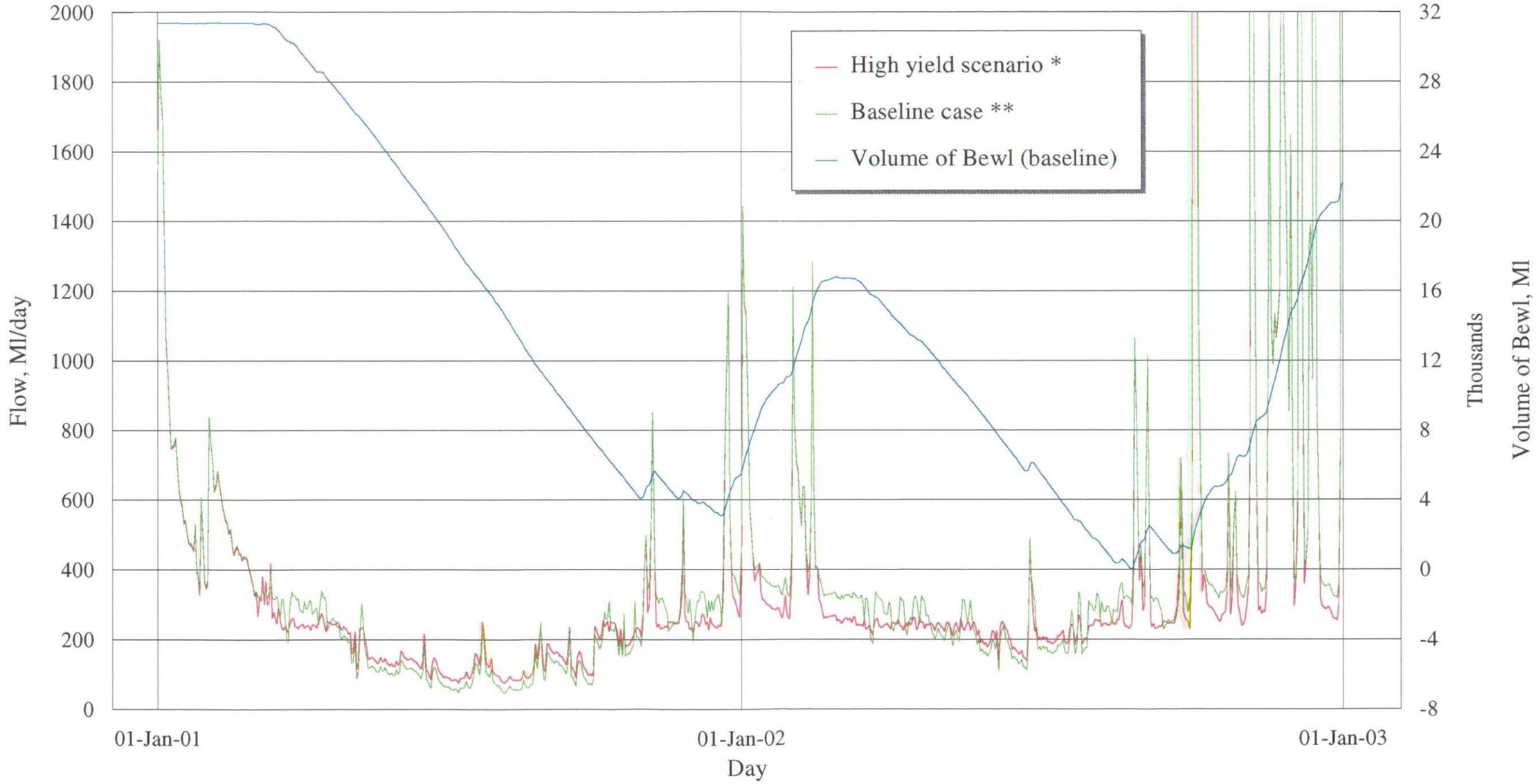

Flow at Allington vs. Flow at Teston
The effects of different Release Factor scenarios
Baseline conditions
Higher Q95, higher yield
Flow at Allington, Ml/day
0
100
200
300
400
500
50
100
150
200
250
300
350
400
450
500
Flow at Teston, Ml/day
Release factor for higher yield is 1.32 (instead of 1.2). MRF in this case has dropped to 200 Ml/d (from 275 Ml/d).
"Higher yield" = 15.9 Ml/d more yield and Q95 up by 25% during 5 yr 2% drought. Eff. rtn assumed 10 Ml/d higher in this case.

Figure 1

# Flow at Allington Under Different Medway Operating Rules

Model input data : The Teston 2% drought




* High yield : 105.1 Ml/day at Burham TW. Effl. rtn. extra 10 Ml/day. MRF at Teston = 200 Ml/day. Rel. factor = 1.32. Q95 25.3% higher than baseline case.
** Baseline case: 89.2 Ml/day at Burham TW. MRF at Teston = 275 Ml/day. Bewl release factor is held at 1.2 (as in current licence).

Figure 2.

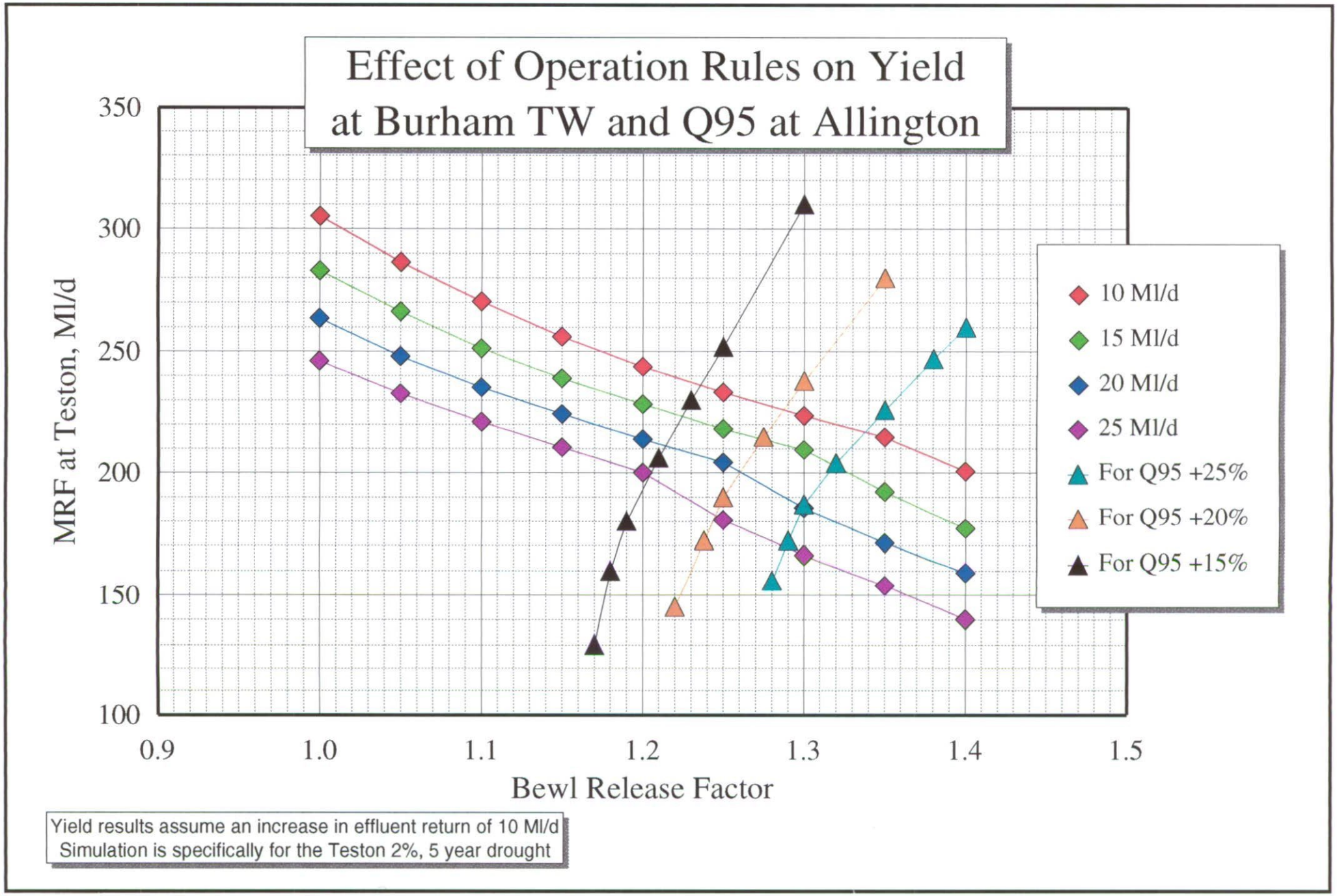

Effect of Operation Rules on Yield
at Burham TW and Q95 at Allington
MRF at Teston, Ml/d
350
300
250
200
150
100
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Bewl Release Factor
10 Ml/d
15 Ml/d
20 Ml/d
25 Ml/d
For Q95 +25%
For Q95 +20%
For Q95 +15%
Yield results assume an increase in effluent return of 10 Ml/d
Simulation is specifically for the Teston 2%, 5 year drought

Figure 3

| | Location | Licence Number | Schedule or Variation | Date | Volume Annual Ml/year | Peak Day Ml/d | Notes |
|---|---|---|---|---|---|---|---|
| 1 | Abstraction from River Tiese at Smallbridge PS to Bewl Water | 2/114 | S1 | 02-Apr-92 | 56 818* | 137 | * 5 year volume (11 363 Ml/yr average). |
| 2 | Abstraction from River Medway at Yalding PS to Bewl Water | 2/114 | S2 | 02-Apr-92 | 25 000 | 250 | |
| 3 | Abstraction from the Medway at Springfield to Burham WTW | 2/114 | S3 | 02-Apr-92 | 37 700 | 136 | In aggregate with abstraction from Bewl Water, and transfers from Bewl to Darwell. |
| 4 | Abstraction from Bewl Water to Bewl WTW | 2/114 | S4 | 02-Apr-92 | 4 650 | 20 | |
| 5 | Transfer from Bewl Water to Darwell Reservoir | 4/098 | - | 05-Jun-95 | 2 630 | 10 | Abstraction to be included with the volume in Schedule 1 of 2/114. |
| 6 | Abstraction from River Rother at Robertsbridge to Darwell Reservoir | 6/162/SR | V4 | 22-Aug-94 | 8 183 | 56.8 | |
| 7 | Abstraction from Darwell Reservoir to WTW for treatment at Hastings | 6/163/SR | V5 | 24-Jul-95 | 8 462 | 34 | |

| Flow Constraints | Number | Variation | Date | Flow, Ml/d | Notes |
|---|---|---|---|---|---|
| River Teise at Stonebridge GS | 2/114 | S1 | 02-Apr-92 | 22.8 | |
| River Medway at Teston GS | 2/114 | S2 | 02-Apr-92 | 275 | |
| River Rother downstream of intake | 6/162/SR | V4 | 22-Aug-94 | 4.6 | } Different residual flow conditions apply for different |
| River Rother at Udiam | 6/162/SR | V4 | 22-Aug-94 | 28.5 | } times of the year. |

| Compensation releases | Flow, Ml/d | Notes |
|---|---|---|
| From Bewl Water into the Teise | 3.4 | Special condition for abstraction at Springfield |
| From Darwell reservoir into the Rother | 0.78 | } April to September |
| | 0.26 | } October to March |

Appendix A : Summary of Licence Controls on the Medway System