

Alleviation of Low Flow Studies



**THE RIVER AVON
AND ITS TRIBUTARIES
NEAR MALMESBURY**

**Towards
a Solution**

June 1997

*Yessex
Water*



ENVIRONMENT AGENCY

**BRISTOL
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background



Tetbury Avon, downstream St Leonard's Bridge

The study area includes the upper reaches of the River Avon above Great Somerford gauging station. The two main tributaries, the Sherston and Tetbury Avon, meet at Malmesbury. These and a number of other minor tributaries are fed by surface runoff and by springs from the Great Oolite aquifer. Wessex Water abstract from the Great Oolite for public water supply. Bristol Water's supplies mostly come from the Inferior Oolite. Wessex Water also abstract from the Inferior Oolite aquifer and pump the water directly into the river for stream support.

The River Avon and its tributaries near Malmesbury have been the subject of detailed investigation since 1990. Consultants, WS Atkins, were appointed in 1991 to determine the impact of abstraction and other management practices on river flows, river biology and fisheries. WS Atkins used the MIKE-SHE computer model to represent the drainage processes in the catchment and to assess the impact of abstraction.

The study concluded that abstraction by Wessex Water and Bristol Water significantly reduce river flows throughout the catchment. Both the Sherston and Tetbury tributaries suffer a loss of flow due to river bed leakage caused by depressed groundwater levels in the Great Oolite aquifer around the abstraction boreholes near Malmesbury. Although the Great Oolite is overlain by clay-like deposits to the south and east and separated from the underlying Inferior Oolite by Fullers Earth these clays are not total barriers to water movement. Geological investigations have shown that near Malmesbury the clays are thin and the Great Oolite aquifer is close to the surface. During the winter when water levels in the aquifer are high, water flows from the Great Oolite into the river. As water levels in the aquifer drop during the summer the flow reverses and leakage takes place from the river to the aquifer.

Wessex Water and Bristol Water accept that their groundwater abstractions in the catchment are having an adverse impact on river flows. Both companies are working closely with the Environment Agency to effect early improvements to river flows by implementing a combination of measures involving increasing stream support and changing abstraction arrangements. Following the recommendations in the Atkins study all parties have agreed that the trials should be implemented on a staged basis, starting with those measures that may provide an immediate benefit.

In August 1995 Wessex Water increased the output from their stream support boreholes at Luckington, Stanbridge and Tetbury. The month long trial showed that considerably more water could be obtained from the Inferior Oolite aquifer and that most of the water added as stream support remained in the river down at least as far as Great Somerford. Bristol Water voluntarily reduced their average summer abstraction for public water supply at Shipton Moyne and Long Newton thereby leaving more water in the Inferior Oolite aquifer for stream support.

Further trials in 1996 were designed to see if the benefits observed in 1995 could be sustained over a longer period. The prescribed flows at Fosseway and Brokenborough gauging stations that determine when water should be pumped into the river for stream support were increased. Wessex Water used its stream support boreholes to maintain new target flows set by the Environment Agency and Bristol Water continued to abstract at reduced rates.

The results of these and other work conducted during 1996 are summarised in this leaflet. The leaflet also contains an outline of work to be undertaken in 1997 and the issues that need resolving before full and lasting remedies can be finalised. These remedies will be finalised by the year 2005 at the latest.

$$1 \text{ MI/d} = 0.22 \text{ Mg/d} = 0.0116 \text{ m}^3/\text{s}$$

Cover photo: Sherston Avon at Silk Mills, September 1996.
Inset photo: August 1995, prior to stream support trial

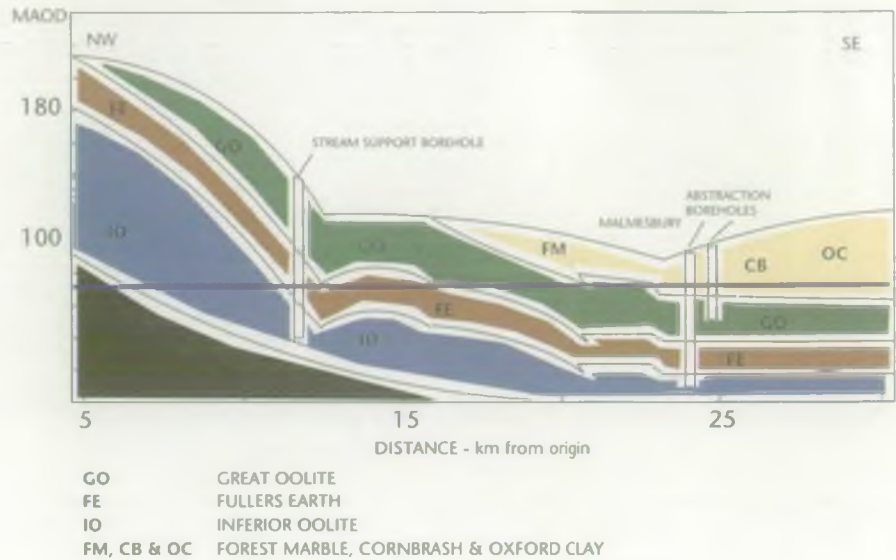
CATCHMENT MAP SIMPLIFIED





Tetbury Avon, Abbey Mill

Conceptual Geological Section



Stream Support Trials

Prescribed Flows

To compensate for the reduction in river flows due to abstraction for public water supply Wessex Water are required under the terms of its licence to pump water into the river from its stream support boreholes. The licence stipulates that pumping should start when flows at the gauging stations at Fosseway, Brokenborough or Great Somerford fall below prescribed levels.

In 1995, as a trial, the prescribed flow at Fosseway gauging station was increased from the licensed value of 8 MI/d to 12MI/d. In 1996 the prescribed flow at Fosseway was increased again, this time to 14 MI/d. This increase led to stream support being introduced two to three weeks earlier than normal on the Sherston Avon. Although the prescribed flow at Brokenborough was increased from 6 MI/d to 8 MI/d in 1996, stream support was actually turned on before flows at Brokenborough reached 8 MI/d. Support therefore started about four to five weeks earlier than required under licence conditions.

In 1997 stream support on the Sherston Avon will be started when flows at Fosseway gauging station fall below 14 MI/d and on the Tetbury Avon when flows at Brokenborough gauging station fall below

8 MI/d. Depending on the weather this year these measures may lead to several weeks more stream support than would be normal under the license conditions. Flows at the gauging stations will be used to trigger stream support. Once support has begun the support boreholes will be used to try to maintain target flows in Malmesbury and the existing prescribed flow (28 MI/d) at Great Somerford.

Target Flows

Malmesbury

The licence limits output from each of the stream support boreholes at Luckington, Stanbridge and Tetbury to 2.5 MI/d. Pumping at 2.5 MI/d has generally not been sufficient to maintain flows at the gauging stations at prescribed levels, or prevent the flows in Malmesbury receding to very low levels.

In August 1995, for example, prior to the start of the stream support trials flow in the Sherston Avon at Silk Mills was reduced to a trickle (see photo insert on the cover). Now, as part of the trial, Wessex Water are able to add a total of 24MI/d from the three stream support boreholes instead of the 7.5MI/d specified on the existing licence.

As part of the trial the Agency has developed two new target flows to help protect the lower reaches of the Sherston Avon and Tetbury Avon in Malmesbury. The target flows are located in Malmesbury at St Johns Bridge (Sherston Avon) and Back Bridge (Tetbury Avon). During the summer of 1996 output from the stream support boreholes was not limited to 2.5 MI/d but allowed to increase to maintain the following targets:

St John's Bridge (Sherston Avon) 7.2 MI/d
Back Bridge (Tetbury Avon) 6.8 MI/d

The targets are based on the results of a river diary exercise completed by local people in 1992 and 1993 and are designed to protect the important amenity value of the rivers in Malmesbury. The target flows were generally met or exceeded, the main exception being due to a pump failure in mid August. Because of rainfall flows were generally well above target levels. Stream support continued at Luckington, Stanbridge and Tetbury until water levels increased in the Inferior Oolite in the autumn.

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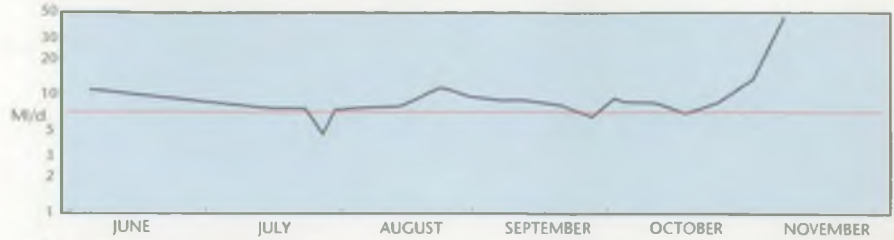


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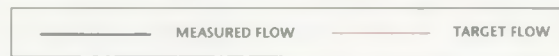
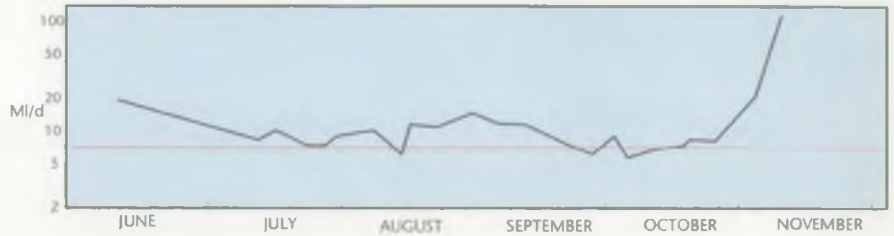


Stream support, Luckington

FLOW AT BACKBRIDGE 1996



FLOW AT ST JOHNS BRIDGE 1996



During the trials the Environment Agency, Wessex Water and Bristol Water have been actively seeking the views of the public about the benefits observed. The Malmesbury Liaison Group has been formed to provide a direct link between the Agency, the water companies and residents and organisations who have an interest in the river. In general the feedback that we have received has been very positive. Most people considered that flows through Malmesbury were maintained at an acceptable level in 1996. We will therefore again try and maintain flows, at, or above these targets in 1997. Stream support will start at a relatively low rate (2.5 MI/d) but gradually increase as river flows decline during the summer.

The Agency will be regularly monitoring river flows and groundwater levels throughout the trial and liaising closely with both water companies. Wessex Water

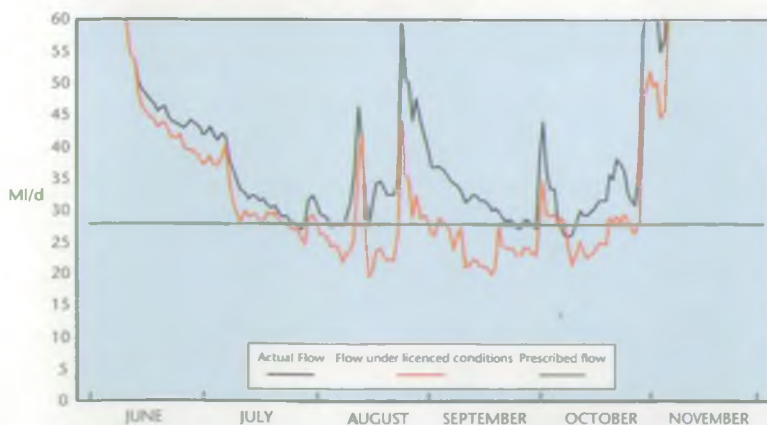
will also be monitoring groundwater levels around their stream support boreholes. Information on the quantities abstracted for stream support, groundwater levels and river flows will be publicised by the Agency during the trial.

Great Somerford

In addition to maintaining target flows in Malmesbury in 1996 the prescribed flow of 28 MI/d at Great Somerford was exceeded for most of the summer. Whilst flows at Great Somerford benefited from the increase in stream support to meet the targets in Malmesbury there is still concern, particularly amongst anglers, that flows there remain too low.

The Agency is reviewing the prescribed flow at Great Somerford and will identify what changes are necessary to create acceptable in-river conditions. As an integral part of this work the Agency has engaged the Institute of Freshwater Ecology (IFE) to undertake an angling survey on the river. IFE have already conducted a preliminary investigation which has indicated that it is possible to quantify the relationship between angling conditions and flow. The main study, which starts in 1997, is designed to objectively assess the potential benefits of changes in the flow regime on wet and dry fly angling conditions for trout. The results will be used to help in assessing an environmentally acceptable flow at Great Somerford. The eventual target flow is likely to reflect a reasonable balance between water use and the environment.

Actual flow at Great Somerford and flow if the licence conditions had been followed, 1996



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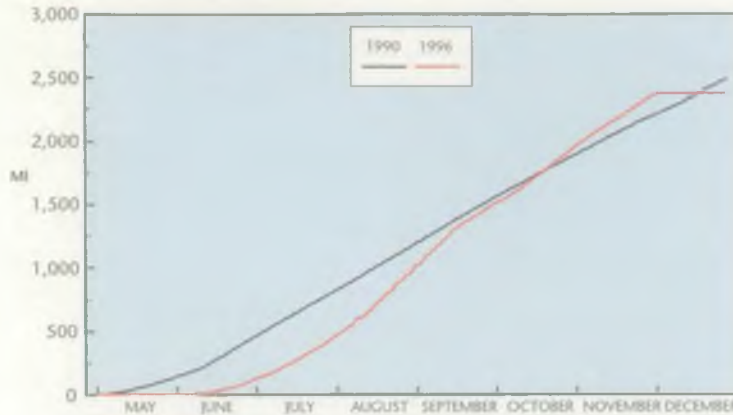
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Cumulative Output from all Inferior Oolite Stream Support Sources



Impact on Inferior Oolite groundwater water levels

The water for stream support is abstracted from the Inferior Oolite aquifer. The combined cumulative output from Inferior Oolite stream support sources at Luckington, Stanbridge and Tetbury in 1996 was similar to that in 1990. In 1996 the Luckington and Tetbury boreholes were pumped well into the Autumn, even when river flows had risen well above target levels. In 1990 output at each source was constrained to 2.5 Ml/d by licence conditions but, due to the very dry weather, flows were below prescribed levels for much of the year.

Because there were no dramatic changes in output from the stream support boreholes in 1996, the quantities pumped only increased slowly, the effect of abstraction on water levels in the Inferior Oolite aquifer is difficult to determine, other than at the stream support boreholes themselves. However, the 1995 test indicated that the abstraction does effect the water level in the Inferior Oolite over a wide area.

The rain in October and early in November did not significantly reduce the seasonal decline in water levels in the Inferior Oolite. This suggests that the connection between the Inferior Oolite and the Great Oolite is poor and therefore that the opportunities for recharge are limited. What is not clear from the field trial is whether after a dry winter the Inferior Oolite aquifer will recharge sufficiently to maintain the target flows, without adversely impacting other licensed abstractors. In 1997 the Agency will use its MIKE SHE groundwater model to explore this issue.

Impact on Great Oolite groundwater water levels

There was no evidence of lowering of water levels in the Great Oolite as a result of pumping from the Inferior Oolite. Indeed, as was seen in 1995, water levels in the Great Oolite boreholes downstream of the stream support discharge increased when the rate of stream support increased, probably due to recharge of the Great Oolite aquifer from the river.

Impact on Other abstractions

Bristol Water

Bristol Water's public water supply source at Tetbury is less than 2 km from Wessex Water's stream support borehole. Both abstractions are from the Inferior Oolite. Abstraction for stream support in 1996 reduced water levels in the public water supply borehole. If the level had fallen another 5 to 10 metres then Bristol Water would have difficulty maintaining sufficient output to meet public water supply demand in the local area. This winter Bristol Water have installed a new larger pump at a lower level in the existing hole.

Because 1996 was not especially dry and Bristol Water reduced their abstraction the fall in water levels at their public water supply borehole at Long Newnton and Shipton Moyne did not present a problem. However, in a drier year abstraction for public water supplies coupled with higher levels of abstraction for stream support might lead to a problem at Shipton Moyne. If water levels fall to the height of the adits, 46 metres below the ground surface, then abstraction for public water supply could be interrupted as sediment at the base of the adits is swept into the main collecting well. Bristol Water are



River Avon at Great Somerford

considering the possibility of pumping from the peripheral boreholes rather than the main collecting well. No problems are anticipated at Long Newnton where the pump sets have been renewed and lowered.

Other Sources

Thirty-nine privately owned boreholes and springs have been identified which might be affected by increased pumping for stream support. During the summer water levels were measured in twenty five. Three private supplies in the Inferior Oolite are believed to be vulnerable to low water levels. In all three cases there may be scope to lower the pump further down the borehole.

There are four private wells in the Great Oolite which are currently experiencing low water levels. The trials so far have indicated that increased pumping from the Inferior Oolite aquifer does not have any impact on levels in the Great Oolite. It therefore follows that increased pumping from the Inferior Oolite is not likely to be the cause of present or future supply problems in the Great Oolite. However, Wessex Water will continue to monitor these wells and many other boreholes in the Great Oolite until the extent and nature of the link between the two aquifers is confirmed.

Bristol Water

Last summer Bristol Water temporarily reduced abstraction from its boreholes at Shipton Moyne and Long Newnton to 9 MI/d. Prior to 1995 abstraction frequently ranged between 14 MI/d to 18 MI/d. By reducing its abstraction Bristol Water left more water in the Inferior Oolite for Wessex Water to use for stream support. Water from Bristol's Purton Water Treatment works, which is supplied by the River Severn, was used to make up the shortfall. Bristol Water will continue to abstract at a reduced rate in 1997. The Agency will use its groundwater model to assess whether target flows can be maintained without further changes to abstraction arrangements at Shipton Moyne and Long Newnton.

Wessex Water

WS Atkins suggested that Wessex Water's Cowbridge abstraction may have more impact on the river than any other source. To test this theory more rigorously Wessex Water agreed to stop using Cowbridge for an extended period last summer and to make up the lost output from their Milbourne and Charlton sources. In the event not all the lost output could be switched to the others sources due to the limitations of the existing infrastructure and individual source licences. Nevertheless, the test, which started on 12 August and continued until 24 October, confirmed the theory that Cowbridge does have a significant impact on the river. Shutting down Cowbridge led to a marked increase in water level in nearby Great Oolite boreholes. There also appeared to be a

significant reduction in leakage from the Sherston Avon between Fosseyway and St John's Bridge which almost certainly helped make it possible to maintain the target flow at St John's Bridge with relatively moderate rates of stream support. However, as the changes are relatively small it is difficult to determine the overall benefit accurately. Wessex Water will repeat the trial in 1997 and the Agency will continue to monitor groundwater levels and river flows in the area.

Daniels Well Leakage

In the past the very low flows on the Sherston Avon in Malmesbury have been exacerbated by leakage near Daniels Well. During 1995 a series of temporary repairs using sand bags and clay were carried out. These significantly reduced the losses in this area and led to a marked improvement in flows through Malmesbury.

In 1996 a number of minor leaks in the clay seal that appeared over the winter were repaired. Although gaugings in the river and the leat indicate that the sand bags and clay are effective, river water is still being lost along the stretch from Riversdale to St John's Bridge. During the low flow period in 1996 about 32% of the flow measured at Riversdale was being lost. In absolute terms losses averaged approximately 4.7 MI/d.

During 1997-98 the Agency intends to develop plans for a more permanent restoration of the river bank and leat at Daniel's Well. All relevant parties will be fully consulted. If the preferred solution is acceptable it will be implemented, but not before 1998. In the meantime the Agency will continue to maintain the clay and sand bag system to ensure leakage at Daniel's Well is kept to a minimum. In addition the Agency will consider whether it is possible to reduce leakage elsewhere along the Riversdale to St John's Bridge stretch.



Daniels Well leat after sealing with sand bags and clay

Habitat Improvements

The Malmesbury Avon and its tributaries have been subjected to a wide range of degrading influences over recent decades that have reduced both the aesthetic and environmental quality of the river. In addition to trialing measures designed to improve flows the Agency and Wessex Water are also funding a number of other initiatives in the catchment that will lead to local improvements in the river environment. At Silk Mills on the Sherston Avon, for example, Wessex Water have cut notches in the weir and installed gabion planting baskets on each step of the weir. These baskets have been planted with yellow flag and water lilies to improve the visual amenity of the river as it passes through the town.

Downstream of Malmesbury, fisheries consultants have worked with local river bank owners, fishing leaseholders and Agency staff to improve the river environment by cleaning spawning gravel, building weirs and groynes and managing bank side vegetation. The pools and gravel riffles that have been created have been shown to hold much higher numbers of coarse fish than adjacent areas.

Following an electro-fishing survey on the Sherston last year that showed that the distribution of wild brown to be extremely patchy a number of options for habitat improvements have been identified. Where appropriate these will be implemented in 1997. The value of the habitat improvements will be monitored by electro-fishing.

Assessment of Potential Costs and Benefits to the Environment

The Agency accepts that should it be necessary to carry out greater changes to public water supply arrangements it must provide a rigorous assessment of the economic value and environmental benefits of any changes. Consultants, working on behalf of the Agency have identified a range of potential benefits. These benefits have been derived from the following:

- a survey of non-use values (see definition below)
- a recreational fishing survey
- a survey of informal recreation
- a study of property price effects

The consultants concluded that most of the lower cost remedies such as changes to stream support could be justified without including the benefit associated with 'non use' (the amount people who do not use the river are willing to pay to resolve the low flow problem).

Next Steps

A number of important issues require resolution before a final remedy is recommended. The Agency needs to develop its review of an environmentally acceptable flow at Great Somerford. The sustainability of the new stream support and abstraction arrangements also need to be tested using the Agency's MIKE SHE groundwater model. In particular the Agency must be confident that increased pumping for stream support will not adversely impact any other legitimate water interests.

At this stage there is promise that the preferred solution may be based, at least in part, on the increased stream support and altered abstraction arrangements described in this document. The Agency will develop a fully costed business case to support these or additional proposed changes and consult with all interested parties before submitting proposals to OFWAT (The Office of Water Services) for inclusion within the third periodic review (AMP3). If OFWAT do not approve the inclusion of this scheme in the water companies Strategic Plans the Agency will continue to look for other possible sources of funding. Whatever the outcome of the AMP3 submission the Environment Agency, Wessex Water and Bristol Water agree that full and lasting remedies shall be finalised by 2005 at the latest.

ACKNOWLEDGMENTS

The Environment Agency, Wessex Water and Bristol Water are indebted to the people of the Malmesbury Area, and in particular to those on the Malmesbury Liaison Group, for their support during the stream support trials.



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