On-farm reservoir storage

Summer abstraction is increasingly unreliable for many existing abstraction licence holders, and new summer licences are unobtainable in many catchments. However, abstraction during the winter and/or at high flows into reservoirs is usually possible, and can provide a more reliable resource. Once the water is in the reservoir, the farmer has control of where, when and how it is used.

Some reservoirs are also used for balancing steady slow abstraction, e.g. from groundwater, to peaky irrigation demands.

Current status and uptake

There is little reliable data on the number or total capacity of on-farm irrigation reservoirs. The best data comes from abstraction licence returns. The volumes refilled each year depend on the preceding irrigation season’s usage; the highest reported total winter abstractions are just over 21 Mm$^3$ (2009/10). This implies an even higher total storage capacity, as most reservoirs would not have been totally empty at the end of the preceding season.

The proportion of irrigation water that is abstracted in the winter months (October to March) has increased from 20% to 25% over the period 2005 to 2010.

New reservoirs are being constructed, many with government financial support, as a response to the reduced availability and reliability of summer abstraction. The number of “spray irrigation – storage” abstraction licenses is growing at about +2.8% per annum, while the total volume licensed for storage is growing at around +4% per annum, reflecting the trend towards larger licences and larger reservoirs.

Suitability and target use

Due to the substantial capital investment required, on-farm reservoirs are most suited to the irrigation of high value crops and/or where reliability of supply is demanded by the farmer’s customer, e.g. supermarkets. Some clients now insist on reliable water resources as a contract condition.

Reservoirs are only required in situations where direct abstraction in unreliable or impossible, but only sensible where winter or high-flow abstraction will be reliable, particularly under climate change. This makes them unsuitable for some catchments; the advice of the Environment Agency should be sought at an early stage.

Investment cost

Reservoirs are expensive investments. A review of 73 reservoirs constructed between 1996 and 2012 revealed overall mean capital costs (construction only) of £173,000 in 2012 prices, equivalent to £2.50 per m$^3$ of storage capacity. Design, supervision, permitting and environmental assessment can add a further 15% to capital costs, and fencing and landscaping a further 5%, depending on circumstances. The land taken is proportionate to reservoir size. Lined reservoirs are much more expensive than unlined ones. The marginal capital cost of additional capacity averaged about £0.75 per m$^3$ for unlined reservoirs and £1.55 per m$^3$ for
lined reservoirs. Unit costs also appeared to vary depending on underlying geology (e.g. sand, clays and presence of flints), reservoir shape (whether regular or irregular) and site topography (whether flat or sloping).

**Design and management issues**

Unlined reservoirs are substantially cheaper than lined reservoirs, and costs vary with other site conditions; hence a major first issue is to select the best site. This need not necessarily be near the water source or the irrigated area. A higher site offers some advantages in reducing pumping costs during the irrigation season, and avoids potential flood problems. Safety and the risks caused by a breach, albeit unlikely, affect the ease of obtaining planning permission. Most new farm reservoirs now fall under the Reservoirs Act 1975 (more than 25000 m³ stored above lowest natural ground level), now enforced by the Environment Agency. This imposes conditions on the design and management, which are worth following anyway.

In “flashy” catchments, the intake design needs to be able to cope with short peaky flows, either using a temporary storage forebay or very large pumps.

**Other issues (e.g. environmental, legal)**

Moving river abstraction from summer to winter, or from low-flow to high flow conditions, has considerable beneficial effects for the aquatic environment. Considerate design can make the reservoirs themselves environmentally beneficial, particularly unlined reservoirs, for example using bankside plantings, deep water reserves for fish and floating nest platforms for birds. Care is needed though not to impose disproportionate costs or risk damage to the reservoir; it is often more cost-effective to provide environmental benefits on adjacent land.

There are potential negatives from disturbance to the existing habitats, introducing open-water features into dry landscapes, and issues with landscaping, underlying archaeology, traffic, etc., which should be addressed in the planning phase.

**Documented case studies**

The majority of farm irrigation reservoirs built in the last few decades have all been single venture investments made by farmers or agribusinesses for the sole benefit of their company, many in response to concerns regarding the future availability and reliability of water for irrigation. More recently, there has also been interest in collaborative or shared venture reservoirs, although there is limited evidence on how these schemes operate in practice, including their legal status, approaches to abstraction licensing and water allocation. Two detailed case studies on reservoir investment as an adaptation strategy to future water scarcity are included in a recent report by Morris et al (2013) and repeated here for convenience.

**Case Study Heronhill LLP (Norfolk)**

In 2010 three farms in West Norfolk – Gayton and Westacre Estates and Great Barn Farm (CE Cross & Son, a Westacre Estate tenant) formed Heronhill LLP to jointly invest, plan, build, and share two water storage reservoirs and irrigation infrastructure to annually irrigate 300 ha of potatoes from the nearby River Nar. The farms mainly grow cereals and sugar beet with some oil seed and livestock. They have no history of using irrigation on the farms but the land is drought prone having light sands which are vulnerable to changes in climate. The 2011 drought and its impact on cereal yields served to highlight the farms’ concerns about their future production security.
The catalyst for change was a local experienced grower who was looking to rent irrigable land to supply potatoes to two large local processors in Wisbech and Norwich. The circumstances were also favourable – high quality land suited to growing potatoes; an adequate winter abstraction licence available on the nearby River Nar; no major objections from Natural England for an abstraction within an SSSI; the possibility of a reservoir construction grant from the rural development agency (EEDA); and three farms willing to invest in a joint enterprise and reap the potential benefits of scale.

The three farms formed Heronhill LLP and with grant support they built two lined reservoirs and the irrigation infrastructure capable of supplying water for 300 ha of potatoes. The scheme was designed to bring over 2000 ha into command across all three farms within reach of the reservoirs and pumping system so that potatoes could be grown on a six-year rotation. This investment is seen as an adaptation strategy to secure the farms’ future for the next 40-50 years. Potatoes are the current preferred crop but irrigation provides flexibility to change to other high value crops should the need/opportunity arise.

The licence is for surface water abstraction during the winter months. Anglian Water also abstract substantial amounts from the River Nar and other farms in the catchment have groundwater and surface water licences. The nature of the soil and the underlying geology means that they are hydrologically linked and so abstraction from one impacts the other. For this reason, Heronhill formed a Nar Water Resources Group to enable them to work more effectively together to make best use of the available resources.

Heronhill LLP owns the abstraction licence and the two reservoirs. The partnership leases the land the reservoirs occupy from the two land-owners. Heronhill holds the legal agreement to manage abstractions in accordance with EA regulations and shares water among the partners in accordance with the partner’s share of Heronhill. Each farm then independently decides how they will use their land and their water allocation.

At present all potato production is managed by a local grower who rents both land and water independently agreed between each farm and the grower. There is no overall legally binding long-term agreement between the grower (to rent land and water) and the farms (to supply land and water). But both parties are well aware of the local circumstances and both have invested substantially – Heronhill LLP in reservoirs and irrigation infrastructure and the grower in a 5,000 tonne potato store. Both parties see it as their moral obligation to work together. Geography would seem to play an important part in how such informal agreements are made. In West Norfolk the options available for alternative arrangements are limited and working and living in close proximity means that people need to get on and trust each other.

The irrigation scheme includes two reservoirs (land-take approx. 10 ha for each reservoir). The Westacre reservoir is 100 million gallons (45,000 m³) and Gayton reservoir 80 million gallons (36,000 m³) with a 47 km ring main. It takes 116 days to fill the reservoirs pumping c6000 m³/day (with an abstraction licence for 682,000 m³). Approximately 2000 ha of land is within irrigation command with up to 300 ha potatoes irrigated each year across 3 partner farms. The plan is to engage in a one-in-six rotation so that in each year circa 300 ha are irrigated. The arrangements have only been in place since 2011 but the partners report that they are working well.

**Case Study Russell Smith Farms (Cambridge)**

In the early 1990s Russell Smith Farms in Duxford, Cambridge was subjected to a total ban on irrigation abstraction half through the growing season with serious consequences for the farm. As a result of this the farm embarked on the construction of a major 500,000 m³ storage reservoir not just protect their own business but they saw the opportunity to share this asset with other farmers around them. The farm specialises in growing premium quality vegetables – potatoes, onions, sweet corn, parsnips, red beet and artichokes – for the leading supermarkets on 800 ha of undulating light sandy loam soils where irrigation is essential for both quality and
timeliness. The farm’s licence was for summer abstraction from the River Cam and some boreholes but the sources were increasingly unreliable. The owner, Robert Smith, said at the time of the ban that growing high value, high risk crops without a guaranteed water supply can only be described as commercial suicide.

Moving to a winter abstraction licence and constructing the reservoir was not straightforward. It proved difficult to find a suitable site that was both near the River Cam and not too far from the existing irrigation command area. In 2007, following extensive investigations, work finally started on constructing the reservoir and installing underground irrigation mains with grant support from EEDA.

Although the reservoir and mains are owned by Russell Smith Farms the plan was always to share the resource with 16 local farms and unlock some 6000 ha of land for irrigation enabling longer rotations and less dependency on pesticides. To do this required the installation of 28 km of underground main which crosses neighbouring farms and passes under a trunk road, a motorway, a river and a railway. Obtaining all these easements caused major delays in planning and added significantly to the project costs. Farm easement delays were caused more by the agents and solicitors involved rather than the farmers themselves. The reservoir construction also involved mineral extraction and this too slowed the project because of the recession and consequent knock-on impacts from reduced aggregate demands from the construction industry.

The scheme is now expected to come into operation with reservoir filling in the winter of 2013 and water available for irrigation in summer 2014. Russell Smith Farms will retain the right to take all the water if they so require. But they plan to share water on the basis that farmers must contract in the Autumn prior to the irrigation season to take a given amount. For this they will pay a charge per cubic metre and also a fixed fee which contributes to the costs of the irrigation infrastructure. These charges are payable irrespective of whether the water is used or not in the following season. It now remains to test this strategy in practice.

**Relevant references**

Thinking about an irrigation reservoir; a guide to planning, designing, constructing and commissioning a water storage reservoir.  

Farm Reservoir Design Guide; a guide to good planning and design of farm reservoirs in the Suffolk Coast and Heaths Area of Outstanding Natural Beauty.  
[http://www.suffolkcoastandheaths.org/](http://www.suffolkcoastandheaths.org/) then search on “reservoirs”

Agricultural Reservoirs Design Guide; Isle of Wight Area of Outstanding Natural Beauty.  