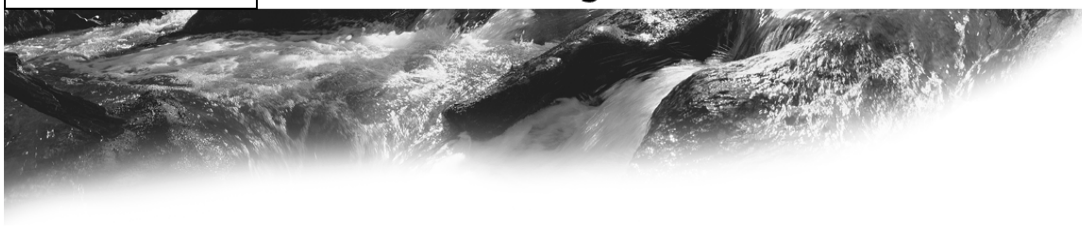
Advice to Water Management Committees

NSW Government



No. 11 Integrating water quality and river flow objectives in water sharing plans

The responsibilities of water management committees

Water Quality and River Flow Objectives are a crucial part of the agreed framework to guide plans and actions to achieve healthy rivers in NSW. As Water Management Committees now focus on developing Water Sharing Plans for priority rivers, River Flow Objectives provide an essential tool to assist in developing flow rules that provide for the management of the riverine system as a whole.

Whilst Water Sharing Plans cannot address all elements of water quality in a river system, implementing key River Flow Objectives can protect the components of the natural flow regime which positively influence water quality. In this way, the protection and enhancement of water quality can be a key outcome of the Plans.

Links between river flows and water quality

Water quality and river flows are fundamentally linked. These links can be direct or indirect and will vary over time and between river reaches. Direct influences include instances where concentrations or transport of pollutants in streams is influenced by flows. Indirect influences refer to the ways that flow regime influences stream habitat and ecological health, which in turn influences ecological processes occurring in those streams.

These ecological processes (for example the natural processing of organic matter and nutrient inputs to streams) in part determine the prevailing water quality. In other words, biological responses to different flow events may modify water quality. At other times this will be reversed and the prevailing water quality will affect the biota.

Many water quality problems are caused or exacerbated by altered river flows. Therefore a flow regime that maintains and restores each component of the natural flow regime (as per the River Flow Objective framework) is necessary to protect water quality and the ecological habitats and processes that in turn modify water quality.

Managing river flows also impact on estuaries – see *Advisory Note No. 10: Freshwater flows to estuaries and coastal waters*. Changing the frequency distribution of the freshwater inflows to estuaries and increasing water residence times has increased the probability of algal blooms even before increasing nutrient loads. Environmental water provisions for coastal rivers will be beneficial in cleaning out coastal bays and estuaries, as they will be in maintaining river and wetland health.

Table 1 summarises how the implementation of River Flow Objectives 1, 2, 3, 4, 6, 7, 9, 10 and 11 can positively influence on water quality.

Interactions of flows and water quality – key management issues

Barriers

Humans have constructed dams and weirs to control water. The resultant upstream impacts include pooling and thermal stratification of water, trapping of sediments, accumulation of nutrients and toxicants and increased propensity for blue-green algal blooms. The downstream water quality impacts generally result from:

- the reduction of flow,
- loss of freshes relied upon by some aquatic organisms, and
- changes in water chemistry such as increases in nutrient, manganese and iron concentrations

and decreases in dissolved oxygen (DO) and temperature resulting from releases from the base of stratified weirs or dams. The low DO in this bottom layer can release nutrients and toxicants such as iron and manganese from sediments, allowing them to be discharged with the released flows.

Table 1 Water quality benefits of implementing the river flow objectives

River Flow Objective		Process of influencing water quality
1 	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flow	✓ Decreases the rate at which water quality detrimentally changes in pools that represent refuge habitat. ✓ Prevents further concentration of pollutants.
2 	Protect natural low flows	✓ Improves pool connectivity and minimises stagnation and stratification of pools, preventing further concentration of pollutants during low flows. ✓ Suppresses conditions favourable to blue-green algal blooms. ✓ Minimises the impact of groundwater recharge where groundwater is saline.
3 	Protect or restore a proportion of moderate flows (freshes) and high flows	✓ Freshes transport sediment, nutrients and organic carbon downstream, increase dissolved oxygen, and break up stratification of pools. ✓ Freshes wet banks and benches of rivers to maintain habitat, stimulating ecological processes that regulate water quality.
4 	Maintain or restore natural inundation and distribution of floodwaters supporting natural wetland and floodplain ecosystems	✓ Regular floods add floodplain inputs to stimulate natural processes that regulate water quality. ✓ High flows support healthy riparian zones that act as buffers and stabilise banks.
6 	Maintain or mimic natural flow variability in all streams	✓ Natural variable flows disadvantage exotic species such as carp, which cause water quality problems. ✓ Variable flows minimise stratification of pools and conditions favourable to blue green algae. ✓ Natural variable flows help maintain a dynamic ecosystem and diverse biological community, in turn stimulating ecological processes that regulate water quality.
7 	Maintain rates of rise and fall of river heights within natural bounds	✓ Natural rates of rise and fall minimise bank slumping which increase turbidity.
9 	Minimise the impact of instream structures	✓ Flow management and structure operation can prevent or address weir pool stratification and accumulation of pollutants. ✓ Minimising weir pool stratification can reduce or eliminate conditions favourable to blue green algae. ✓ Structure operation should attempt to minimise low level releases which may be cold or high in sediment, nutrients and/or toxicants.
10 	Minimise downstream water quality impacts of storage releases	✓ Structure operation can minimise releases that may be cold or high in sediment, nutrients and/or toxicants. ✓ Structure operation can minimise scouring of rivers downstream from release points, mobilising sediments.
11 	Ensure river flow management provides for contingencies	✓ In some circumstances, can provide flushing flows.

Management responses include consideration of removing or modifying the barriers or minimising their impact by mimicking the natural flow regime in flow release rules. This is consistent with the NSW Weirs Policy. Where possible the operation of weirs and associated flow management should be optimised to prevent stratification of weirs for longer than ten days. (Deoxygenation of the bottom layer generally takes around a week; the release of phosphorous and toxicants from sediments generally requires a further week or more of stratification.)

Dam operational management responses should also be considered. For example where releases can be made from a variable level offtake or by floodgate control, rather than from deep level offtakes, this should be considered.

Relevant RFOs:

Eutrophication and algal blooms

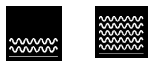
In a river system, nutrient concentrations are typically low in upland streams and accumulate downstream. Nutrients move through aquatic ecosystems attached to soil particles or in dissolved or gaseous forms during high flow events and accumulate during periods of low flow.

In eutrophic systems, the accumulation of the macronutrients nitrogen and phosphorous is such that the productivity of the system ceases to be limited by nutrient availability. This provides conditions favourable to forming algae blooms or increased growth of aquatic plants if light and other conditions are also favourable. Algal blooms are a natural occurrence, although current river and land management practices have exacerbated the number, frequency and magnitude of blooms. Severe blooms can impact on human uses of water as well as on the aquatic environment and ecological processes.

The management of eutrophication involves not only controlling and managing the source of excess nutrient loads, but also maintaining river flows, particularly protection of flushing flows, low flows and flow variability. Flow management can minimise the accumulation of excess nutrients and prevent stratification behind barriers that may increase the bio-availability of nutrients that have accumulated. Management of the operation of weir pools and dams to avoid stratification is also relevant to managing eutrophication.

In many lowland Murray Darling Basin rivers, existing in stream and sediment nutrient levels are sufficient to support blooms permanently, with light availability and other factors limiting bloom occurrence. Under these circumstances, flow management is critical in managing both turbidity and nutrient availability through limiting stratification of pools.

Relevant RFOs:



Exotic Species

A more regulated water flow regime will favour dominance of exotic species such as carp. Carp are known to create water quality problems by stirring up bed and bank sediments through their feeding habits by increasing turbidity.

Relevant RFOs:

Water quality during low flows

Most pollutants in a river will become concentrated during low flow periods. Therefore the environmental impact of point source discharges is increased during these times.

Low flows can induce groundwater discharge into streams if the hydraulic gradient between the river and the adjacent aquifer changes to favour this outcome. If this groundwater is of poorer quality (eg saline) it can degrade water quality in the stream. Groundwater can also support water quality and aquatic habitat, however, by supporting the occurrence of low flows during extended dry periods.

Protection of low flows helps to maintain connectivity between pools. These pools become refuge habitat during periods of very low or no flow. In addition to protecting the habitat it is also necessary to protect the water chemistry in these pools for the protection of aquatic ecosystems. Lowering of water levels of these pools, or further reductions in interconnecting flows during these dry times may detrimentally affect water quality by increasing the rate at which stratification of pools occurs, decreasing dissolved oxygen, or increasing water temperature and salinity.

Any water extraction from a stream during natural very low and low flows can exacerbate these problems.

Relevant RFOs:

The role of medium and higher flows

Freshes are important in flushing the system, increasing DO levels and reducing (diluting) salinity levels. Flushing flows can destratify water bodies and flush out or break up algae blooms. The first major flood or fresh after low flow periods is particularly important to be protected. Protection of higher flows will help to maintain water quality in end-of-system features such as wetlands or estuaries by providing flushing flows and freshwater inputs.

Natural systems are characterised by periodic floods (over bank flows) of various magnitudes. During these over bank flows, water becomes more turbid and carries more nutrients and organic matter from the floodplain back into the stream ecosystem. The movement of sediment and organic matter through the system is an important process and therefore periodic flooding needs to be maintained. River regulation, construction of levees and water extraction all reduce the number of smaller over bank flows as well as reducing the influence of larger floods. As a result, organic matter, sediment and nutrients that would otherwise have been added to streams during these smaller over bank flows accumulate on river banks and flood plains. This accumulated organic matter can contain large amounts of polyphenols that can be extremely toxic to fish. When the unavoidable large floods inundate the floodplains, the accumulated organic matter is rapidly decomposed by biological processes that reduce the dissolved oxygen in the water, leaving the water flowing back into the stream high in sediment, nutrients and polyphenols and low in dissolved oxygen. Floodplain drainage often transports this water rapidly to the stream. In extreme cases, this can be a contributing cause to significant fish kills. By maintaining the frequency of small over bank flows in Water Sharing Plans, the harmful water quality impacts of the less frequent large floods are reduced.

Higher flows and variable flows in natural flow regimes also help to maintain in stream habitat and habitat variability (eg banks, bars, benches, woody debris and aquatic vegetation). Maintaining this habitat variation is critical for invertebrate and fish health and in maintaining overall ecosystem health. In a healthy functioning ecosystem, these invertebrates and fish help to process natural levels of organic matter and nutrient inputs to maintain a balance within that ecosystem, thus naturally regulating water quality. Any change in the functioning of these processes by, say, loss of habitat, can modify water quality as a result.

Higher and variable flows are necessary to maintain the health of the riparian ecosystem. Riparian vegetation can improve water quality by regulating water temperature and light which influence algae blooms, stabilising stream banks and providing a buffer to reduce pollutants and sediment entering streams from inappropriate adjacent land use. Freshes and medium sized floods should be protected to water the banks of the river and the riparian zone.

Relevant RFOs:


Rates of water level rise and fall

The flow height in a river can change rapidly as a result of releases from dams, especially those with hydroelectric power facilities. Large scale pumping of water can have similar effects. Under these conditions water levels rise or fall quickly over periods of hours or a day, rather than periods of several days or a week under natural conditions. Under these conditions, exposed water logged banks can collapse under the additional unsupported weight of the water held in the soil, resulting in erosion, increased water turbidity and sedimentation. The loss of banks can have additional impacts by destroying riparian or in stream/aquatic vegetation and on water quality, as previously discussed.

Relevant RFOs: