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Integrated Management of the Disposal of Sewage Effluent and Environmental Flows: Turning a Flush into a Flow.

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SUMMARY: The design and management of sewage treatment plants has traditionally focused on selecting a site on a river, nearest a town, for discharging a constant stream of effluent. More recently, the focus has shifted to improving the quality of the effluent and/or requiring that it be discharged to land. Neither approach has however, explicitly recognised the impacts of constant discharges on river flows and the associated changes in instream ecosystems. Similarly, recognition is now being given to the fact that water extractions are, in many rivers, approaching levels at which the remaining river flows are simply inadequate to sustain the most basic ecological conditions.

It is argued that recognition needs to be given to the impacts of discharging effluent and extracting water from rivers. For example, this will require that highly treated effluent from STPs be discharged at an appropriate location and in a variable pattern of releases. This approach should influence the process of determining the most cost effective options for future STP augmentations and new plants. This should create new opportunities, using a systemic view of river health, to integrate the management of effluent discharges, water extractions and the provision of environmental flows. It also raises significant environmental, institutional and resourcing implications for resource managers, regulators and operators.

This paper draws on the analyses undertaken by the New South Wales Healthy Rivers Commission in its independent public inquiry into the Hawkesbury Nepean River system, which is the context for a number of illustrative examples of the alternative approach.

MAIN POINTS

- Traditionally, rivers have been treated as a 'free' means to dispose of sewage effluent and a 'free' source of water supplies, with significant adverse impacts on river flows and instream ecosystems.
- An alternative approach would recognise the real impact of discharging effluent and extracting water from rivers. For example, this should include requirements for the discharges from STPs to be released in a variable pattern and in an appropriate location.
- The alternative approach would create an appropriate framework and opportunity for assessing the cost effectiveness of alternative sewage and water supply strategies, such as incorporating highly treated sewage effluent into the make-up of environmental flows.

1 INTRODUCTION

The design and management of sewage treatment plants has traditionally focused on selecting a site on a river, nearest a town, for discharging a constant stream of effluent. More recently, the focus has shifted to improving the quality of the effluent and/or requiring that it be discharged to land. Neither approach has however, explicitly recognised the impacts of constant discharges on river flows and the associated changes in instream ecosystems. Similarly, it is only relatively recently that recognition has been given to the fact that water extractions are, in many rivers, approaching levels at which the remaining river flows are simply inadequate to sustain the most basic ecological conditions.

A number of people involved in the management of riverine resources have recognised the need to find whole of water cycle solutions. Recognition of the real cost of discharging effluent and extracting water from rivers raises questions about the cost effectiveness of other options, such as requiring highly treated effluent to be discharged at an appropriate location and in a variable pattern of releases. Further, this approach creates new opportunities, using a systemic view of river health, to integrate the management of effluent discharges, water extractions and the provision of environmental flows. It also raises significant environmental, institutional and resourcing implications for resource managers, regulators and operators. It is emphasised that this approach forms only one component of the various strategies that are available to resource managers in order to achieve better river health outcomes.

This paper draws on the analyses undertaken by the New South Wales Healthy Rivers Commission in its independent public inquiry into the management of the Hawkesbury Nepean River system, which is the context for a number of illustrative examples of the alternative approach.

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2 TRADITIONAL APPROACH

2.1 Disposal of Sewage Effluent

The return of effluent from sewage treatment plants (STPs) often has a profound impact on instream ecosystems in a number of rivers in New South Wales, particularly in the Hawkesbury catchment (HRC, 1998; Gehrke & Harris, 1996). The primary example used in this paper involves the discharge of effluent and the extraction of water from South Creek and the Nepean River, in the Hawkesbury catchment, near Sydney.

Historically, the design and management of STPs has typically focused on selecting a site immediately downstream of a township for the discharge of effluent. More recently, the focus has switched to the quality of effluent and funds have been expended on improving its treatment to improve water quality standards, either at the point of discharge or at a designated downstream location (HRC, 1998). The later approach particularly utilises the capacity of the stream to continue treatment of the effluent. This has commonly been the case in the Hawkesbury catchment wherein the tributaries have historically and frequently been essentially sacrificed for an array of reasons, including convenience and cost (eg South Creek) (HRC, 1998).

Presently, much greater attention is being given to designing effluent disposal systems to achieve improved water quality in tributary streams (SWC, 1998). A range of options have received preliminary evaluation, including improving the treatment of sewage discharges from key STPs and disposal to land. The former option builds on a recent innovation introduced by the NSW Environment Protection Authority to apply a ‘bubble’ licence to the STPs that discharge effluent into the into South Creek subcatchment. The bubble licence enables the operator, Sydney Water Corporation, to develop the most cost effective means to achieve improved water quality in the downstream Hawkesbury River. It is proposed that the bubble licence be modified in the future to include a requirement for the operator to achieve more rigorous water quality objectives in the tributary streams. The later option, to dispose the effluent to land, may exacerbate the impact of reductions in stream flows, due to significant levels of water extractions, in many downstream areas. This also could have significant adverse implications for instream ecosystems and consumptive water users.

However, neither the historical or the more recent approaches, have explicitly recognised the impact of constant discharges on river flows and the associated changes in instream ecosystems. The significance of those impacts on tributaries usually increases with population, as discharge volumes continue to increase. In the case of the South Creek subcatchment, the total volume of effluent discharged under dry weather conditions from the Quakers Hill, Riverstone and St Mary’s STPs is expected to increase from approximately 65 to 130 megalitres per day by 2021 (SWC, 1998). The creek would have otherwise had extended episodes of no or minimal flow under natural conditions (SKM, 1997). Further, a number of irrigation enterprises have established downstream of the STPs to take advantage of the resultant reliable water supply, making proposals to modify the discharge regime problematic (HRC, 1998).

2.2 Extraction of Water

Traditionally, rivers have been treated as a relatively accessible and cheap source of water for towns, industrial and agricultural activities. More recently, considerable attention has been given to determining and implementing measures to protect a proportion of river flows for environmental purposes (Knights et al, unpubl.; COAG, 1994).

A critical impediment to the implementation of environmental flows, particularly in unregulated coastal rivers, has been the significant implications that they present for the security of supplies for consumptive uses and the second order effects that they may create in other rivers (HRC, 1998). For example, preliminary estimates indicate that the adoption of the 90th percentile exceedence flow condition in the Hawkesbury Nepean River system would bring forward the need to augment Sydney’s water supply (SWC, 1997a) by several years. This could involve the construction of an additional water storage on the nearby Shoalhaven River and the increased operation of inter-valley transfers.

3 AN ALTERNATIVE APPROACH

The longer term protection of river health demands that water extractions for consumptive purposes be replaced, at least in part, by appropriate ‘return flows’ in streams with a high level of water use demand. There is also no real option but to require STPs discharging to rivers to incorporate appropriate design features which allow variable patterns of effluent release, particularly during dry weather, while also recognising the need to improve water quality in the immediate receiving stream.

In the Hawkesbury Nepean River system, the Healthy Rivers Commission has recommended that these constraints be applied to the discharge of sewage effluent and that a ‘cap’ be imposed on water extractions from the river system (HRC, 1998). The cap would effectively limit the extractions that would occur for a given level of population and development, under varying climatic conditions. (The cap has initially been set at the 1997 level of development.) The cap creates the necessary imperative for water supply operators to seek alternative means to service demand, including those to achieve more efficient water use practices (HRC, 1998).

This approach should play a significant part in the process of determining the most cost effective options for future STP augmentations and the construction of new plants. The resultant complexity and cost of such approaches may cause a shift towards the adoption of alternative effluent management options, including non potable and potable reuse. For example, indicative estimates show that restricting discharges from the St Marys STP during low flow periods in South Creek would require the construction of a storage at an approximate capital cost of $190 million (SWC, 1997b). This compares with an approximate capital cost of $80 million to divert much of the dry weather effluent from St Marys STP to the Prospect water treatment plant for potable reuse (SWC, 1998).

The development of alternative sewage disposal systems needs to be considered within a system wide approach to address river health. The assessment of alternative options would need to also address requirements to achieve high levels of effluent treatment, in order to satisfy rigorous public health criteria. Analyses undertaken by the Healthy Rivers Commission suggest a range of alternative opportunities to reuse effluent, within a whole water cycle context, that warrant further consideration in the Hawkesbury catchment. For example, the impact of higher levels of environmental flow protection on urban water supplies would be modified, if:

- STP discharges could be returned to the river system within close proximity to major storages, in an appropriate release pattern and at an acceptable level of treatment (HRC, 1998).
- Highly treated STP discharges were returned to the water supply system upstream of reservoirs, under conditions and at a location which could be demonstrated to ensure that natural processes would complete biological treatment, or to drinking water treatment plants for human consumption. (Many country water supply systems draw on river water into which treated sewage effluent has been introduced upstream, thereby relying in part on continued biological treatment by the river itself. However, this approach may have been set back by the recent water quality contamination difficulties in Sydney's water supply.)

The Healthy Rivers Commission assessed several conceptual scenarios in regard to the former approach. For example, one such approach, as shown in Figures 1 and 2, could involve the diversion of some dry weather effluent from the South Creek subcatchment, via a new pipeline, to be discharged directly into the Nepean River, immediately downstream of Penrith Weir. The diverted effluent, of acceptable quality, combined with that discharged from the Penrith STP (giving an approximate total of 160 megalitres per day in 2021), could be used to off-set or replace the need for additional releases from Warragamba Dam for environmental flow purposes. An effluent transfer system would need to operated in such a way as to ensure that a variable pattern of flows was achieved in the Nepean River. (A variant on this approach is utilise the storage capacity of a nearby major quarry, being excavated in the Nepean floodplain as part of the Penrith Lakes Scheme, prior to re-releasing the effluent to the Nepean River. Notably, this would also enable the PLS to obtain the water supply that it requires within the constraints of the proposed cap on extractions.)

Surplus effluent could be used to achieve an even higher environmental flow in the Nepean River and/or to provide an augmented water supply for downstream irrigators. At other times, particularly during dry weather when rivers naturally exhibit reduced flow, the effluent could be used to provide an alternative water supply to irrigators along the Hawkesbury estuary (via the river and/or preferably by a reticulated system).

This approach would also provide the opportunity to use effluent as a substitute for releases from Warragamba Dam in a way inversely related to irrigation demand. As such, the present over-supply of freshwater (ie highly treated effluent) to the estuary during periods of very low natural inflows, could be overcome by encouraging irrigators to abstract water either directly from the river or via a reticulated supply system. The latter option, or a combination of both, would be preferable from a river water quality perspective. Either option would also address the significant concerns expressed by irrigators and other water users along the estuary that Sydney Water may progressively move towards the land disposal of effluent and hence by reducing volume in the river significantly reduce the reliability of their water supply and their economic viability. (It is important to note that the water users along the Hawkesbury estuary do not have any viable alternate means of augmenting their water supplies in response to the introduction of flow restrictions).

It has been estimated that the construction and operation of such a scheme would have a capital cost in the order of $78 million (SWC, 1997c). This compares favourably with the cost of the previously mentioned potable reuse option of $80 million(SWC, 1998). The diversion of effluent from the St Marys STP on its own is estimated to cost $33 million (SWC, 1997d). Further, the likely advantages of such a scheme could include the following.

- Deferring the need to augment Sydney's water supply infrastructure (ie Welcome Reef Dam on the Shoalhaven River). For example, using effluent from the St Marys STP as a substitute for releasing inflows from Warragamba Dam, up to the natural 90th percentile exceedence condition, would defer augmentation for 10 years (HRC, 1998).

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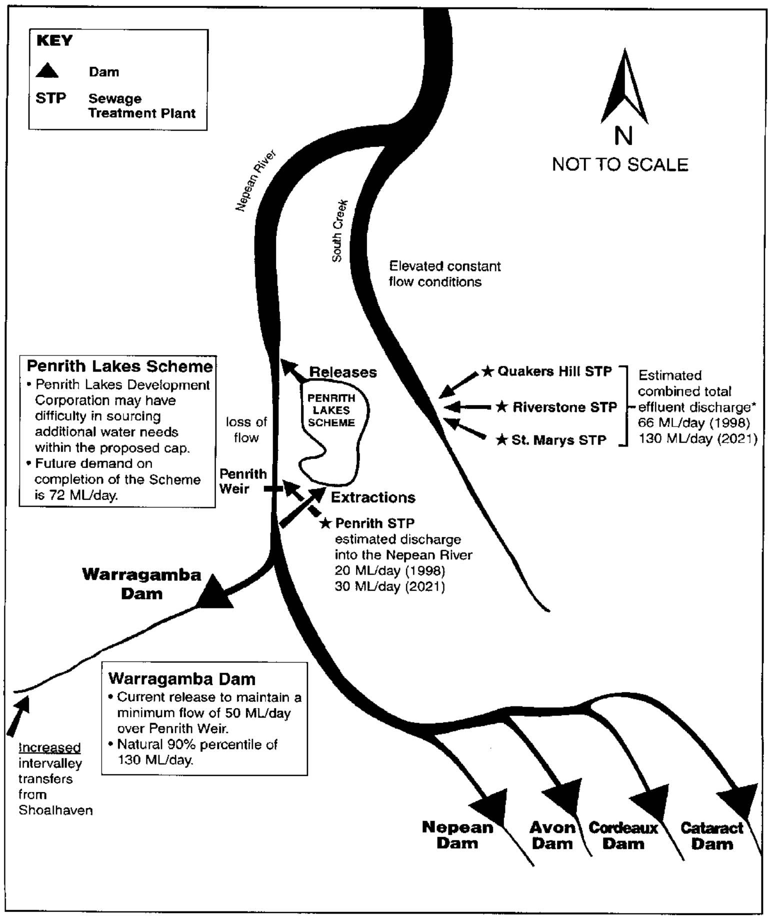
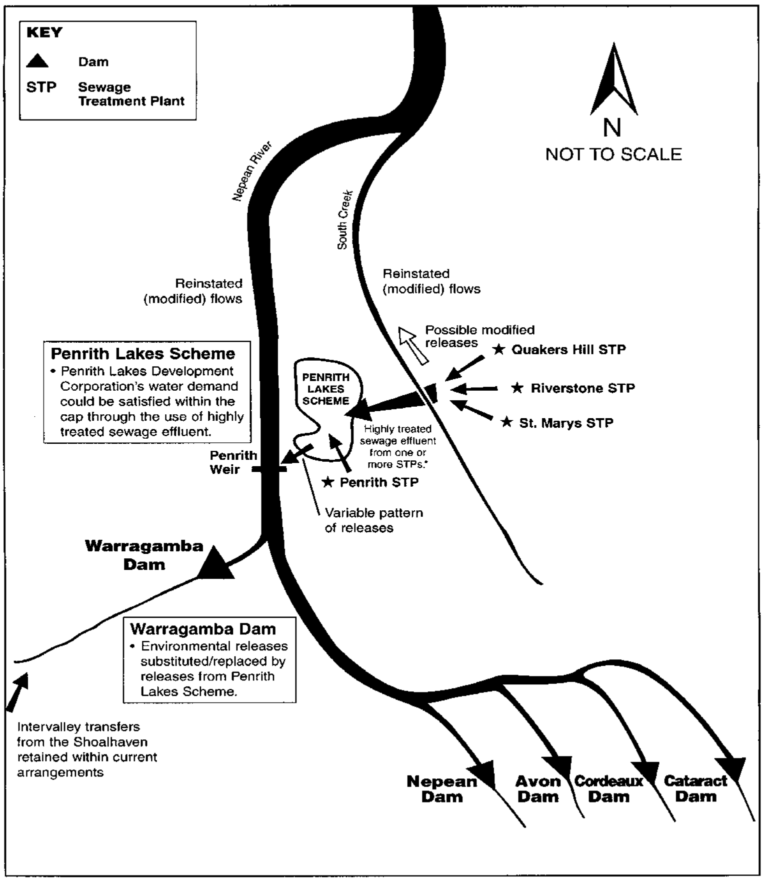
Figure 1: Fragmented Scenario



* Includes effluent discharges to Eastern Creek

Figure 2: Integrated Scenario



* Includes effluent discharges to Eastern Creek

- Satisfying the water supply requirements for the Penrith Lake Scheme, if the effluent is transferred via the scheme. (Earlier investigations indicate that the quality of the effluent would be generally suitable for use in the lakes scheme, subject to devising a means to manage salts.)
- Achieving a variable, although substantially modified, pattern of river flows in South and Eastern Creeks.
- Improved water quality in the sensitive freshwater reaches of the Hawkesbury estuary

The Commission has therefore recommended that integrated water management strategies should be more extensively examined. This should include examination of the cost effectiveness of incorporating the discharge of the STP effluent into the make-up of environmental flows, subject to meeting high water quality, location and variable release requirements (HRC, 1998). Additionally, it has recommended that all future projects to reuse sewage effluent should be directed towards the replacement of a water supply drawn form the river by an existing (economically viable) enterprise, as distinct from fostering new demands (such as woodlots) (HRC, 1998). This would reduce the amount of water extracted from the river, particularly during periods of critically low flows (HRC, 1998).

4 IMPEDIMENTS TO THE ALTERNATIVE APPROACH

A critical element that acts to impede the adoption of alternative effluent disposal and water supply strategies is the prevailing economic framework that is used for assessing options, which treats the river as 'free' (HRC, 1998). For example, in the Hawkesbury catchment, the river represents a 'free' effluent transport service for Sydney Water and a 'free' source of water supply for Sydney Water and the Penrith Lakes Corporation. However, if both parties were forced to confront the real costs of their respective uses of the river, their individual and joint analysis of the options could lead to a different outcome. That is, if a requirement to greatly reduce its effluent discharge to South Creek (and/or its tributaries) prompted Sydney Water to offer treated effluent at a lower price, it could become more attractive/economic for the Lakes scheme. At the same time, more severe limitations on the Lakes scheme's direct extractions from the river, as a result of the cap on extractions, could increase the price for effluent at which it would become economic for the Penrith Lakes Development Corporation to substitute effluent for river water. Effluent could then be used to supplement environmental releases from Warragamba Dam, by re-releasing it from the lakes scheme.

There is also a need to set a clear set of signals to promote the adoption of these alternative scenarios by reviewing and modifying, where necessary, other policy arrangements. For example, in NSW, the present load based licensing provisions create disincentives for the discharge poorly treated effluent to rivers and, inadvertently, the use of highly treated effluent in the make-up of environmental flows. This could be amended however, to support the above strategies.

There will however, be legitimate circumstances where it would not be appropriate, for ecological or social reasons, not to use sewage effluent for some alternative purposes. Nevertheless, the analysis of other options would be enhanced by recognising the cost of extracting additional water supplies and/or discharging effluent to rivers.

5 CONCLUSION

The longer term protection of river health demands that water extractions for consumptive purposes be replaced, at least in part, by appropriate 'return flows' in streams with a high level of water use demand. There is also no real option but to require STPs discharging to rivers to incorporate appropriate design features which allow variable patterns of effluent release, particularly during dry weather, while also recognising the need to improve water quality in the immediate receiving stream.

Recognition of these realities should play a significant part in the process of determining the most cost effective options for future STP augmentations and the construction of new plants. The resultant complexity and cost of such approaches may cause a shift towards the adoption of alternative effluent management options, including non potable and potable reuse. The potential also arises to use highly treated effluent in the make-up of environmental flows, in order to achieve higher levels of flow protection than otherwise may be possible. Hence, it is possible to turn a flush into a flow.

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