Detailed Catchment Condition Report
for inclusion on www.gbcma.vic.gov.au as a supplement to Annual Report 2008-09

Although this report is a draft it is likely to provide useful background information on dryland salinity.

Goulburn Broken Dryland salinity:

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Background to managing salinity in the GBD

See www.gbcma.vic.gov.au for details.

Salinity has been the biggest natural resource challenge since 1989. The original goal of the plan was to manage the catchment to the point where it was in equilibrium, i.e the amount of groundwater leaving from the catchment matched the amount entering into the catchment.

- Estimated impacts/salt load exports currently based on reduced flows and maintenance of baseflow
- Estimated costs based on Wilson
- Response to reveg information and link to current rate of tree planting
- Problem with equilibrium concepts (ANU salt and water balance study)
- Consequence of HARTT analysis

Low impact concept

The 2CSalt model was used to identify the relative contribution of different areas, across the catchment, to salt and water flow. The shift in recent years has been to preserve stream flows as best as possible and to concentrate more on the management of saline groundwater discharge where it can be shown to impact directly on catchment assets.
Areas that generate high catchment yield (or stream flow) have been quarantined from salinity risk assessment to preserve fresh water (diluting) flows due to the stress on environmental flows as a result of the extended dry period.

- Concept of low impact-where it arose and how it is applied

The long dry period, along with the possibility of a drier climate phase or climate change has cast the light on water supply. It is now a key issue at all level of government and the community. Salinity mitigation

- Some information on 2C Salt
  - MDBC accredited
  - Steady state
  - Scale
    - And the implications for planning
    - With reference to the work by Ian Oppy
- Include map
- Identify key areas
- Link to current investment priorities
  - CFOC
  - NRIP

Desktop Review of SMP

A desktop review of the salinity management plan has confirmed the logic that underpins the Dryland Landscape Strategy and the directions in salinity management at the Regional level. The review also noted that the decision by the catchment community to discount the projected future impact of dryland salinity on the condition of the River Murray was well based. Recommendations to review the local priority setting process are under consideration in conjunction with the recommendations of the Engineering Options report

- Review scope
- Comments
- Key recommendations

Tradeoffs report

The final report on the Exploring Tradeoffs for NAP Resource Condition Change was tabled. It described an end to end process of adaptive management. The modelling was carried out using 2C Salt. The outcomes described a situation in which there was a tradeoff between environmental conditions and supply of water for consumptive use but also highlighted that issues of this kind are complex, confounded by political and policy imperatives and multiple information sources. It also highlighted the lack of explicit processes to deal with these issues

Background to tradeoffs project with links

The objectives of the project were to:

- Explore the trade-offs in policy development, implementation and practice, and resource condition change targets inherent in addressing the water quality objectives of the NAP and Regional Catchment Strategies.
- Build the capability of stakeholders to engage with knowledge, including an increased appreciation and understanding of the merits of numerical models.
- Identify and address a range of issues with a view to increasing the quality and quantity of modelling in NRM

Two study areas were selected - the south west Goulburn and south west Victoria. It was decided that the more run of the mill elements of tradeoff investigations could be investigated in the south west Goulburn whilst the broader issues of tradeoff between state policy objectives could be tested at a much larger regional scale.

One of the drivers of the project was to link modellers, scientists with the policy makers. This was seen as important to ensure that the modelling and scientists embraced real world issues and that policy makers were aware of the level of information available to support policy development.

As part of the process DPI were commissioned to undertake an analysis, using CAT 1D and 2C Salt, of the impacts of increasing revegetation on stream flow, base flow and salt export. For the purposes of modelling and comparing results it was important to ensure that the percentage vegetation cover for the land use change scenarios were the same. There were five levels of vegetation cover, current (24%), 38%, 53%, 67% and 100%.

An important issue was to which areas vegetation was allocated. Three objectives were investigated by allocating vegetation to:

1. maximise biodiversity cover. The areas were identified according to EVC status and using the landscape context tool
2. to maximise reduction in salt load export by assigning vegetation cover to areas of high salt load export
3. to minimise reduction in stream and base flow by omitting vegetation cover from areas of high flow generation

vegetation cover layers were developed for each of the above land use options for current tree cover through to 100% tree cover as listed above.

It was felt this was the minimum data set required to generate trend curves.

As well as looking at land use change options it was also necessary to figure in the likely impact of climate change. Three possible climate change outlooks based on high, moderate and low emission scenarios were run against all land use options.

The impact of the changes in land use and climate on stream EC was also included in the report.

In commissioning the study we were more interested n the trends and the interaction between land use and climate change than in the absolute changes in stream flow, baseflow and salt export, for that reason the results were reported in terms of percent change.

Key results of the modelling

In the case of increasing vegetation cover for biodiversity the response of stream flow, base flow and salt export is largely linear. A 50 % increase in tree cover would decrease stream flow and baseflow by around 17% and annual salt load export by 20%. By targeting areas of high salt load generation there would be a minimal impact on the stream and baseflow but salt export would be reduced a further 10%. Alternatively by aiming to protect stream flow the impact on salt load export would still result in a reduction of around 15% but the impact on stream flow would be reduced to a 10% loss in flows.

With regards to stream salinity the major impact from both land use and climate change was expressed in both summer and autumn. Assessing the impact of changes in stream salinity due to changes in land use or climate is very difficult because of the natural high variability of stream salinity. The modelling did show that the "...amplitude of impact [of stream salinity] typically increases with climate change and level of biodiversity planting." , estimates of the increase were of the order of 100EC.

Some key points that emerge from the project are:

1. What level of increase in tree cover is sufficient to achieve the biodiversity outcomes?
2. That the compromise between terrestrial biodiversity and aquatic biodiversity requires further study
3. The indicative figures suggest that reaching the EOVT requires a level of land use change (>80% vegetation cover) that is not likely to be accepted by the community at large and would potentially run counter to other government policies aimed at fostering development opportunities in the regions. The question then becomes one of being clear about the purpose of the salinity plan in the dryland catchments
4. That it is possible to minimise the impacts on flows without significantly compromising the level of salt load export, point 2 above notwithstanding.
5. The impacts on salt load reduction, biodiversity outcomes and flow impacts very hugely over the time it takes for them to be realised, regardless of which land use option is chosen:. And in general the losses will be felt well before the gains are made.
6. In general the impact of even moderate climate change is greater than that of revegetation but as vegetation cover increases the relative impact of climate change diminishes at each successive level of increased vegetation cover.
7. The increase in EC was unlikely to be significant but it is important to determine if the increased amplitude also reflects an increased duration of higher salinity and if this has an impact of stream biodiversity

Many of these issues continue to be worked on by various agencies and research bodies. At this stage it remains that there is no clearly identified process to work through the policy implications at the regional and State level. The only explicit tradeoff to date, in the dryland program, has been a unilateral decision on the part of the salinity program in the dryland to quarantine areas of high yield generation from salinity plantings.

However such a decision could easily be compromised, even negated, if a greenhouse carbon sequestration scheme resulted in large areas of land in high rainfall areas being planted to trees.

In 2009/10 the CMA will work with DSE and other relevant agencies to further the Exploring tradeoffs for natural resource management, but unless the concept is picked up in the White paper process or funded as a special initiative it may be difficult to get much traction with the issues.

Engineering Options Report
In 2008 the study into engineering options concluded that intervention, in the landscape, using engineering methods would be too difficult to target effectively and could only be justified where there was an unequivocal link between the condition of a high value asset, its degradation by salinity accompanied by a strong causal link between some form of engineering intervention and the mitigation of the salinity problem. Even in these circumstances the cost of deploying an engineering option could often be prohibitive.
The engineering options work also revisited some of the conceptualisations that underpin the salinity management priority setting processes. It argues that a distinction be made between the scale of planning for strategic level impacts and scale of planning for intervention in sites of high risk of salt export. Many active discharge sites require higher levels of understanding of the driving processes if they are to be treated effectively.

A review of the Engineering Options Program (1997-2008) was undertaken to assess the effectiveness of the program and to document lessons learnt

Although the current regional dryland salinity threat is low due to the dry conditions, salinity remains a local threat at currently active groundwater discharge sites and/or sites that are responsive to higher rainfall events. In wetter years baseflow contributes significant salt to streams but with the drying conditions years the majority of salt in waterways is from point sources. Individually point sources may be small salt contributors but as a series of point sources (eg. along a hill) they may contribute significant salt to a waterway. Site specific investigations provide a detailed understanding of salinity threat and monitoring provides a measurement of potential benefits from works.

Historically most works have been implemented based upon an understanding of salt transport processes and mechanisms characterised by Groundwater Flow systems. By necessity these types of conceptualisations have to simplify some complex processes. An assessment of salinity mitigating works in selected sub-catchments under the Engineering Options Project led to the conclusion that there is a lower likelihood of implementing effective works to remediate groundwater discharge at sites where there is local and regional flow with complex water inputs and where discharge is from the a perched watertable in the regolith of sedimentary rocks. Conversely, there is a higher likelihood of implementing effective works to remediate groundwater discharge at sites where there is local flow with simple water inputs and discharge is either from a shallow alluvial aquifer or a perched watertable in the regolith of igneous rocks. These aquifers therefore provide the best targets for success in the absence of investigation/monitoring data.

The Incentives Program, implemented under the Engineering Options Program, was more effective when eligibility was tightened to sites either where processes were understood and/or by locating works at or near groundwater discharge sites.

Implications of the conceptualisation

The findings of the report give cause to reconsider the most effective means to combat salinity in the dryland catchment. Most planning in salinity management in the dryland has occurred at whole of dryland catchment scale. At the inception of the GBDSMP plan the planning unit was Land Management Units. Following the work by Coram and coinciding with the release of the BSMS groundwater flow systems became the preferred planning unit. One of the advantages of using the GFS conceptualisations was that it:

- Provided a common language throughout Australia to discuss and understand groundwater process
- Was linked to the new generation of models designed to support catchment managers to identify high risk areas, areas generating high salt loads as well as make more informed estimates of the likely response times to intervention

The key limitations were that the GFS conceptualisation focussed on surface and near surface hydrology, a consequence of its simplification, and overlooked the often complex interplay between surface hydrology and the underlying geology

It is this interplay that determines the local aspects of the salinity problem and where questions of the appropriateness of different conceptualisations often arise. These local conditions are critical to understanding the salinity issue and determining the most effective intervention.

For this reason it is very important that the suite of modelling tools that aim to provide information on interventions activities capture these local conceptualisations. Otherwise they run the risk of providing insufficient information on which to base effective intervention programs; this also has implications for the BSMS goals and EOVTs.

In 2009/10 key tasks will be to:

- ensure that local conceptualisations are adequately captured in the CMF modelling to support catchment decision making.
- Integrate the information contained in the Engineering options review into the management planning for on ground interventions

Salt register reporting
Under the Federal Water Act 2007 the region is responsible for reporting on progress towards end of valley targets through the salinity registers. At this stage there is no consistent process for carrying out that obligation. The GBCMA along with the Victorian Salt Disposal Working Group has been instrumental in instigating a review of obligations and methods to report on accountable actions and impact on salt exports. DSE is an active partner in working with three CMA regions and the VSDWG to establish a modelling and accounting framework for dryland salinity. Work should commence in 2009/10.

Background to the reporting

MDBSMS

Original projects of future salinity conditions at the end of valley target sites were:

Increase of xx EC at Goulburn weir by the year 20XX

Increase of vv EC at Casey's weir by the year 20VV.

The requirements under the interim EOVT proposed in the BSMS were to maintain current EC levels at Goulburn Weir and to limit the increase at Casey's Weir to WWW EC

These estimates were based on modelling commissioned by the MDBC. In hindsight and with improved data and models as well as greater awareness of benchmark conditions, it is clear that the projected salt exports from dryland tributary valleys were too high. In any event the estimates of the area that would need to be revegetated to deliver the EOVT's was deemed by the community to be unacceptable and therefore the catchment could not undertake the necessary intervention in the dryland to deliver the required reduction in stream EC at the EOVT sites. This situation was confirmed by the authors of the BSMS Mid term review when they wrote:

> *However, given the predictions of future dryland salinity have changed, it is also unclear whether we need to achieve 10 EC from in-valley actions at all. What is clear is that the end-of valley targets need revision and effort in dryland salinity management needs to be concentrated in areas where the risk of salinity induced damage is greatest. At present, the availability of finer scale data to identify within-valley values and assets is limited. However, new tools (i.e. 2Csalt) are being delivered that will improve evaluation of impacts of land management changes on in-stream salinity and river system models (for example, IQQM) for translating these impacts to end-of-valley target sites*

(Basin Salinity Management Strategy Mid-Term Review 2001-2015.- Final Report December 2007)

Salinity A and B registers

The registers are the agreed means to keep account of salinity debits (increases) and credits (decreases) and are a measure of the average salinity costs to water users.

Only those actions that have "a significant effect" are recorded on the registers where a "significant effect" is equal to or greater than 0.1 EC change at Morgan.

> ***Register A** lists actions that have occurred after the baseline date (1 January 2000 for Queensland and 1 January 1988 for the other states), ...Examples of actions listed in Register A that can increase salinity at Morgan include new irrigation developments, construction of irrigation drains, and wetland flushing. Examples of Register A actions that can offset increases in salinity include the salt interception schemes.*
>
> ***Register B** records, for each tributary valley, debits for actions that occurred before the baseline date, ... Register B addresses the 'legacy of history' or delayed salinity impacts that will have future effects. It also records credits for actions taken after the baseline date that will offset 'legacy of history' impacts.*

(From: Murray-Darling Basin Commission 2004–05 Basin Salinity Management Strategy Annual Implementation Report — Summary)

Delayed salinity impacts (Legacy of history)

Delayed salinity impacts are those that occur after January 1 2000 and for which the contributing action occurred prior to 1 January 1988 (the Baseline date). Delayed salinity debits and credits are recorded on Register B. Debits and credits that occur after the Baseline date are recorded in Register A.

> *The debits in register B represent the predicted increases in salinity at Morgan attributed to each tributary valley in the 1999 Basin Salinity Audit. Register B Actions that attract credits will include the state partners' Program of Actions to meet end of valley targets*
>
> MDBC 2005 BSMS Annual implementation Report 2004-05

In the Goulburn Broken dryland estimates of salt impacts from dryland areas is well understood. The use of 2C Salt, a model accredited by the MDBA, allows us to predict the impact of works on changes in levels of salt export although, as will be noted below, the reporting mechanism to the MDBA does not require that we provide that information.

The salt export from the Riverine plain is another matter. The plain is a difficult system to conceptualise

> *The complexity and arises from the nature of alluvial sedimentation whereby systems are commonly of the shoe-string sand type, occurring at random depth and with variable cross-*

> *sectional area. Only the deeper regional aquifers have the thickness and distribution to make it position predictable.*

(Macumber 1984)

Historically the Plains have been treated as one hydrological unit. This approach says more about the difficulty of conceptualising the Plains than it does about the hydrology of the riverine plains. Significant recharge events on the Plains are likely to occur sporadically. As Macumber (1984) went on to write:

> *... that while there is general recharge into the aquifer through time, major recharge events occur at times of excessively high rainfall (and stream flow).... ...perhaps even more important [than preferential recharge] are the discreet recharge events, as occurred throughout northern Victoria in 1973 to 1975 (and probably 1956 and 1964)*

This complexity and the recharge behaviour make modelling of events on the Plain and predicting its behaviour –and therefore the salt exports and the partitioning of salt exports in to pre 1988 and post 1988 actions - extremely difficult.

The release of the Catchment Modelling Framework holds out the hope of being able to make some useful predictions of future salt loads and impact on hydrology of the whole catchment in the near future. However whilst this would allow us to better predict future conditions it still will not allow us to identify that component of the salt export that is a consequence of pre 1988 actions

Federal Water Act 2007

Under the Federal water Act 2007 and as detailed in the Water Amendment Bill 2008 No. , 2008 *(Climate Change and Water)* A Bill for an Act to amend the *Water Act 2007*, and for related purposes the State and regional authorities have clearly defined responsibilities for reporting on and taking the necessary actions to prevent the EC level at Morgan exceeding 800EC for 95% of the time..

Given:

1. the uncertainties as outlined in the mid term review about the dryland targets
2. the problems with modelling complex systems like the Riverine plain that are in non equilibrium state and
3. the lack of a verifiable method for discerning the future salt export that is a result of pre 1988 actions

it is difficult to see how the catchment can meet it's obligations for reporting to the salt registers in the foreseeable future . The CMA will continue to work with DSE to develop the protocols and tools necessary for us to meet our joint obligations and, at the same time maintain our capacity to account for actions that impact on the salt balance of the catchment.

Current status of reporting

In catchment estimates-Outcomes based on SWG modelling

Current estimates of the impact of actions taken to mitigate the effects of salinity are based on 2C Salt modelling. At this stage we use the regressions of revegetation (ha) versus salt load reduction (tonnes) derived from a number of studies in the South West Goulburn , adjusted for the salt load generation potential of the area where the actions have been taken.

Ideally we would seek to link the reporting of mitigation activities with a dryland catchment wide model to generate area specific estimates of changes to salt and water balance and integrate these into an annual budget of changes to salt and water balance in the dryland catchment. The roll out of the catchment modelling framework offers this opportunity and, subject to confirming its predictive capacity in 2009-10, we would look to linking the model to output reporting in 20010-11.

A pressing need at the local scale is more information on the impact of changes in salt and water flows on the quality of aquatic habitat. The challenges are twofold

1. understanding the likely response of aquatic biota to different salinity regimes and the links and dependencies that make up the ecology of the streams and wetlands.
2. being able to predict stream conditions, peak salinity flows and salinity duration on a daily and weekly basis

In both cases the resolution of data required to address these issues is well in excess of our current capacity to deliver. The analysis by Dixon (2007) provided a theoretical framework for assessing possible impacts of salinity but also served to show that the information requirements were onerous. This and other work remain in the development phase. Our task will be to remain aware of advances in this area of research and look to adapting it when it is more suited to an implementation phase.

MDBSMS annual reporting on works

At present the obligations on the dryland plan are to provide data on areas planted to perennial vegetation under the agency of the SMP to then MDBC. It is assumed these arrangements will continue under the MDBA.

The information supplied is not required to be spatially referenced so it is not possible to make any reasonable estimates of the likely impact on salt and water balance in the catchment; it is unclear how the MDBA can make use of the data they require. This is despite the spatially referenced information being available along with appropriate models, accredited by the MDBA, to predict the likely impact of the actions taken. The difficulty for the MDBA, in particular, is that they require a Basin wide approach to measuring the impact of actions to reduce salt exports and there is a wide disparity between regions and States as to how far they have progressed in their ability to capture information and report it. Nevertheless there is an opportunity to advance reporting of dryland salinity to the next level and steps should be taken to develop the processes and protocols for doing so.

In the process of thinking through how reporting to the registers could work most effectively it was recognised that taking account of perennial pasture was potentially misleading. Any effort to reduce salt export from the catchment requires a net increase in perennial pasture. Whilst we could readily account for perennial pasture established through the SMP there remains, no mechanism for assessing the net change in area of perennial pasture. Before we go to the trouble of developing appropriate accounting systems (e.g with the assistance of the Australian Bureau of Statistics) the thornier issues of how this information is, or would be, taken into account and reported on the B Register needs to be resolved.

The GBCMA is well placed to trial improved reporting methods and processes and can only continue to raise the issues at the appropriate times and fora and continue to work through DSE to try to ensure there is progress in the issue of salinity reporting at the regional, state and national level.

Catchment Modelling Framework

The steady state component of the Catchment Modelling Framework has been validated and calibrated for use in the GB. This is the precursor to a transient state model that will provide, for the first time, some indication of the link between changes in land use and climate on salt and water balance from the Riverine plains work. Further work is required to assess the validity of steady state models for non equilibrium conditions and is currently being negotiated with DSE.

- Background to CMF
- Steady state and transient state

- Is it important

Questions that arise from this distinction between steady state and transient state include "How important is it?" or "Will additional investment in development and implementation of a transient state model materially improve our decision making?". The answer is that we do not know. The natural conservativism of scientists facing the unknown is to seek more information, and in this case, to develop improved models. For modellers the point of more sophisticated models is to test the boundaries of knowledge and thereby learn. This is not the same thing as a catchment manager wanting the answer to a pressing problem.

To the extent that the CMA only needs to invest in the implementation of the models made available to us the risk is not large, so long as the models are appropriately accredited as 'fit for purpose'. What is important is that the investor and policy makers within DSE and the MDBA agree on the use of the models and the use of the outputs of the model for predictive purposes and that there is a policy that guides their consistent use across regions and over time.

It will be important in 2009-10 to seek this confirmation from DSE and the MDBA on the application of the CMF to catchment reporting and prediction of future states of the catchment, and this is best done through the agency of the VSDWG.

- Status of models

Need to update this closer to final draft stage of the Annual report. It is likely that the status of the models will become clearer sometime in the period from June to August.

- Relevance to the legacy of history

The CMF should provide useful information on the future salt and water balance of the catchment according to possible climate scenarios and changes in land use. However the model cannot run 'backwards' to allow us to discriminate the sources of salt exports post 1 January 2000. Therefore the model, as it stands now, cannot assist in unravelling the delayed impacts of salinity and thereby provide a measure of the obligations on the State and the CMA under the Federal Water Act 2007.

- Need to continue with some modelling work
    - At a statewide level
- Process for implementing in the dryland

Bore monitoring update

In 1999 the program completed a review of the bore hydrograph response in the catchment and has recently redone this work to see what changes have occurred in hydrograph characteristics in the intervening time

Will include the original info along with the new info as I get it

Groundwater salt management coordinating and working groups

The dryland community is represented on the Groundwater salt coordinating group because there are still significant policy issues around End of valley targets and salt reporting that need to be addressed. It was decided that representation on the working group was not an effective use of time because of the obligations on the group to deal with many complex irrigation issues, leaving little time to properly consider dryland issues. Consideration is being given to establishing a dryland technical support group.

- Background and aims
- Potted history
- Successes and failures
- Whereto
    - Dryland Technical Reference Group
        - Requires accountability

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Comment on progress towards targets

- Area planted
- Assumptions
  - Equilibrium status-full grown trees
  - Link to Big Mod and REALM-reports from the SWG tradeoffs investigation