Structured Decision Making as a tool for better water policy

A report from the Upper Murrumbidgee Decision Sketch Workshop, Canberra, 13 and 14 November 2024

Watertrust Australia Ltd

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Credits

Michael Harstone and Brian Crawford from Compass Resource Management acted as analysts and facilitators of the decision sketch, with support from Lee Failing (also of Compass). Without them this workshop would not have been possible.

We gratefully acknowledge the generous support of a Technical Reference Group that helped frame the Upper Murrumbidgee Case Study. The group consisted of Jeremy Kinley (Water Policy Manager, Snowy Hydro Ltd.), Mark Lintermans (Freshwater ecologist), Andy Lowes (Chair, Upper Murrumbidgee Catchment Network), Siwan Lovett (CEO, Australian Rivers Restoration Centre), Alex McNee (water expert, ACT and Region Catchment Management Coordination Group), James Pirozzi (Manager, Water Services, Snowy Hydro Ltd.), Danswell Starrs (Director, Water Information Services, ACT Environment, Planning and Sustainable Development Directorate), Deep Singh (River Murray Accounting Improvements, Murray Darling Basin Authority) and Emma Wilson (Senior Environmental Water Management Officer, NSW Department of Climate Change, Energy, Environment and Water).

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Watertrust Australia acknowledges the Traditional Custodians of land, sea and waters throughout Australia and their continuing connection to culture and Country. We pay our respects to Elders past and present.

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1 Workshop Summary

The upcoming review of the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) is an opportunity to consider using Structured Decision Making (SDM) approaches that have been proven internationally to deliver better and fairer water outcomes in situations with multiple interests, high stakes, and uncertainty. SDM is not an alternate decision making process but rather a process that supports decision makers to make better-informed choices.

Compelling case studies from Canada and the USA showed how SDM helps multiple interest groups collectively evaluate technical information and diverse values in complex environmental decisions, often leading to the creation of new and novel management outcomes. A mock case study of the Upper Murrumbidgee then allowed a rapid step through of the details of SDM applied to this local context.

This generated strong enthusiasm for SDM to be applied locally given its proven ability to deliver workable water agreements in situations of conflict and deadlock.

The workshop participants then discussed a range of issues that local implementation would need to address, notably:

1. The scope of any future SDM would need to be resolved early. Two possible scopes were discussed (just the Upper Murrumbidgee or the broader SWIOID), with pros and cons of each.
2. Early, consequential and sustained involvement of Traditional Custodians is essential, with the process being co-designed by the Traditional Custodians.
3. Early buy-in of decision makers for a future SDM process is needed to give confidence that the outcomes will inform the SWIOID review. Implemented well, SDM translates complex technical ideas and judgements into language and information that can be accessed by decision makers to inform their choices.
4. SDM needs to be organised and transparent. Governance arrangements for one of the Canadian case studies were presented as an example of how this can be achieved. Local implementation of SDM would need to clarify early how the process will be organised and implemented, who is involved, their roles and responsibilities, how information gaps critical for the decision process will be filled and how the broader public will be kept informed.

‘No regrets’ immediate next steps were suggested to ensure that momentum built for SDM was not lost. These included developing a Decision Charter (or ‘process terms of reference’) to establish a shared understanding about the details of a future SDM process applied to the Upper Murrumbidgee.

2 Context

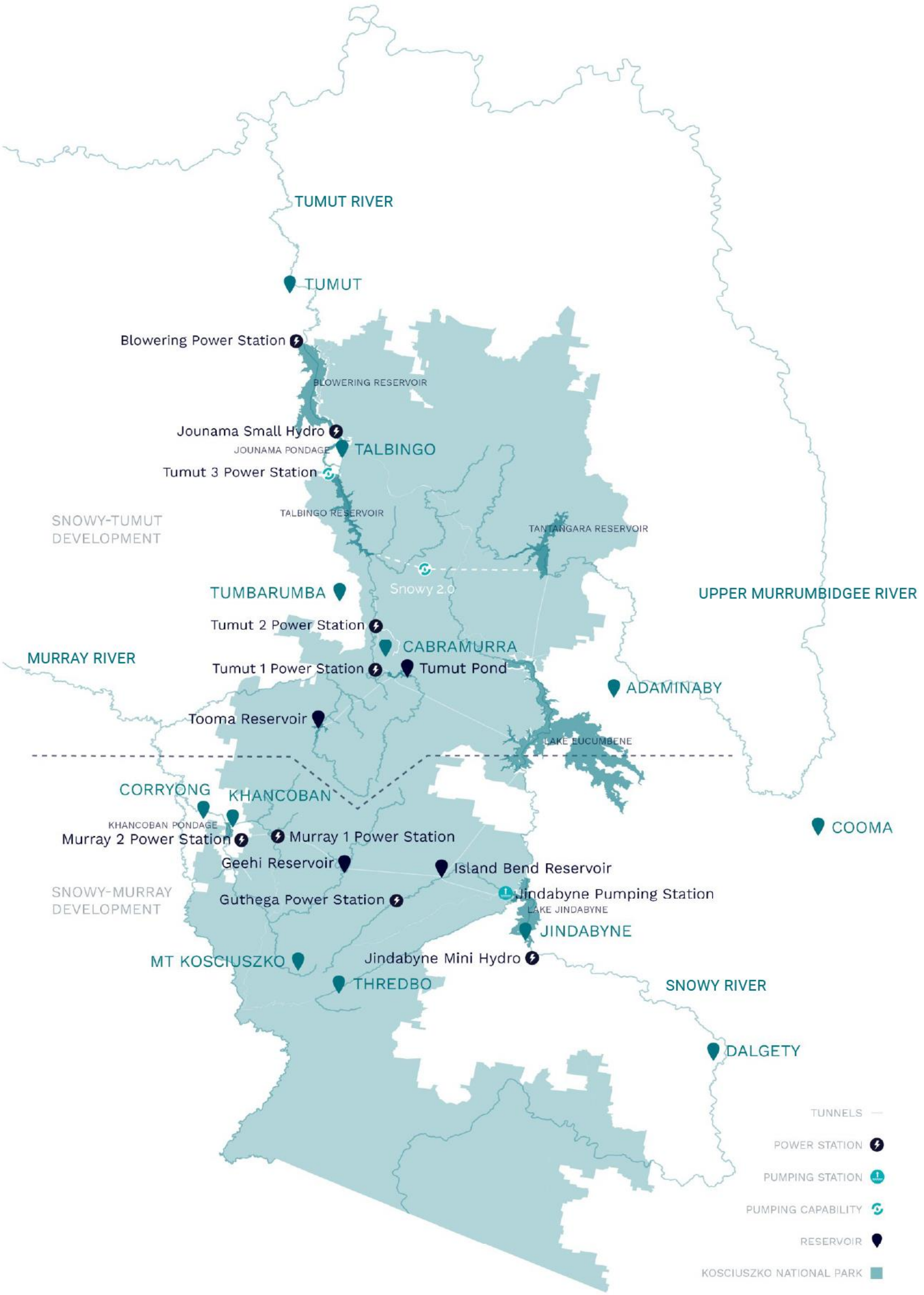
The Snowy Scheme (see Figure 1) was built to send water from the high country of southern NSW westwards via the Murray and Tumut Rivers for irrigation and, in the process, generate electricity. Most of the headwaters of the Snowy and Murrumbidgee rivers (and numerous other tributaries) were diverted this way, leaving sections of those rivers downstream of the diversions running at greatly reduced levels compared with their natural flows. The Scheme was a high stakes project of national significance and the values of water apart from irrigation and electricity were not a high consideration at the time.

By the 1990s, however, growing public discontent about the poor health of these rivers led to the 2002 Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) between New South Wales, Victoria and the Commonwealth. The SWIOID established water flow targets for these rivers aimed at better balancing irrigation, electricity and environmental interests.

While the SWIOID delivered additional flows, public concern remained that the targeted provisions were not met and they were inadequate to ensure river health, provide for Traditional Custodians' enduring cultural connections with these rivers, and ensure the survival of critically endangered species. The SWIOID did not, however, have any provision for regular review.

These issues gained a higher public profile in 2019 when, just south of Canberra, the Upper Murrumbidgee River ran dry. Public advocacy campaigns over the next three years ultimately led to the intervention of Senator David Pocock from the ACT that resulted in the SWIOID being opened for review by the Commonwealth in December 2023.

Figure 1 Snowy Scheme Map



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3 Potential role of Structured Decision Making in the Upper Murrumbidgee

Structured Decision Making (SDM) was designed for exactly this kind of context. SDM is an organised framework for making defensible choices in situations where there are multiple interests, high stakes, and uncertainty. It has been applied internationally over two decades across different scales and complexities, delivering workable decisions where often there had previously been only conflict and deadlock. SDM was developed specifically for once such context in British Columbia, Canada (see Box 1).

Box 1. BC Hydro and Water Use Planning – A Case Study

In the late 1990s in British Columbia, growing conflict and public mistrust of water management decision processes linked to hydro-electricity generation led the Provincial government to require British Columbia Hydro and Power Authority (BC Hydro) to re-licence 32 hydro-electric facilities using collaborative processes with multiple stakeholders. Over a period of five years, Structured Decision Making (SDM) approaches were first developed and then implemented. Core attributes of the approach were systematically involving diverse stakeholders who worked together defining objectives, creating and assessing alternatives, and managing trade-offs.

These SDM processes convened 23 multi-party 'tables' involving governments, First Nations, regulators, BC Hydro, environmental groups and citizens over periods ranging from six months to two years. They delivered 22 workable agreements for re-licensing all 32 hydroelectric facilities where previously there had been only conflict and disagreement. Importantly, not one of those agreements was envisaged as possible by any stakeholder before the SDM processes were implemented. All but one of the agreements were delivered through consensus even though this was not required. All agreements are still in place and currently under review.

BC Hydro subsequently adopted these SDM approaches, known locally as Water Use Planning, as core company process to "find a better balance between competing uses of water, such as domestic water supply, fish and wildlife, recreation, heritage, flood control and electrical power needs, which are environmentally, socially and economically acceptable to British Columbians."

The parallels of SDM in the British Columbia case with the SWIOID review led Watertrust to host a workshop in Canberra in June 2024 with two of the architects of BC Hydro's SDM program, known as Water Use Planning[1]. This exposed participants from multiple interests in the Upper Murrumbidgee to the concept of SDM[2] and generated sufficient interest for Watertrust to convene this second workshop in November 2024.

1 Daryl Fields, was an executive of BC Hydro at the time SDM was developed and implemented, and is a current BC Hydro board member. Lee Failing is a decision scientist who went on to co-found Compass Resource Management. The Water Use Plan guidelines developed are available here: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-planning/water_use_plan_guidelines.pdf.

2 Resources from their visit are available at https://watertrustaustralia.org.au/news/lessons-canada-water-use-planning

4 Workshop scope

This workshop was convened to allow participants to have a closer look at the workings of SDM to enable a more informed judgment about whether these processes could usefully support decisions in the Upper Murrumbidgee.

The workshop was run as a Decision Sketch. Much of what we conventionally think of as problem solving becomes far easier once the problem is well structured. Decision sketching involves rapidly moving through the first steps of SDM steps (the red ticks in Figure 2) with the purpose of building collaboration, gaining a shared understanding of the problem, and discovering key elements of a decision that could be investigated further. This decision sketch used the Upper Murrumbidgee as an illustrative, mock case study which allowed participants, at a coarse-grained scale, to experience what a real SDM process might look like in this context. Refer to Annex B for more information on decision sketching.

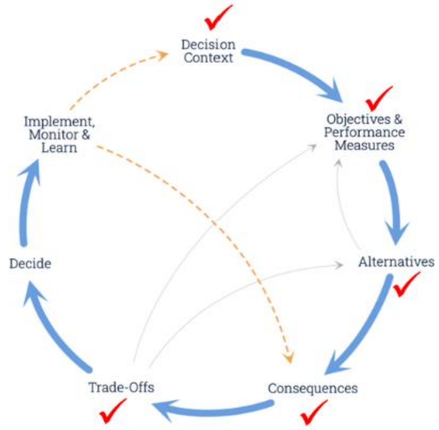


Figure 2 Steps in SDM with iterative processes as grey arrows, learning feedback as dotted orange arrows, and decision sketch steps as red ticks.

Participants were selected to represent the diversity of rights, interests and responsibilities connected to the Upper Murrumbidgee. This included Snowy Hydro Ltd, non-government organisations, governments, Traditional Custodians, industry, a regional council and researchers. The list of participants is in Annex E. As this was a workshop aiming to allow everyone in the room to contribute, the participant list was kept broad but small.

Specifically, the participants in this workshop

1. Became familiar with the steps of SDM through the illustrative Upper Murrumbidgee case study
2. Discussed the elements of SDM that would be needed for any future process in the Upper Murrumbidgee to be successful.
3. Discussed possible next steps and information needs if an SDM process were to be adapted to the Upper Murrumbidgee.

5 The Upper Murrumbidgee case study

In the months before the workshop, Compass and Watertrust Australia convened a Technical Reference Group to help build an illustrative Upper Murrumbidgee case study to use during the workshop as an example of how SDM could be applied to a real situation. It would have been possible to simply showcase how SDM has been used in other contexts. While that would demonstrate that the processes are real and proven at scale, it would not address justifiable cautiousness about the relevance of processes applied in contexts outside Australia.

It is important to emphasise that this case study is a mock up.

It is an illustrative example only to better demonstrate the steps and some of the tools commonly used by SDM in water use planning. In the workshop, it served as a 'prop' in order to build understanding of what an SDM process could look like for the Upper Murrumbidgee, and to highlight key questions and uncertainties that would need to be addressed through the design and implementation of a future process. It did not replace the need for a more detailed process to support the SWIOID review.

The Technical Reference Group was composed of a small cross section of specialists selected for their knowledge, expertise, and strong interest in better outcomes for the Upper Murrumbidgee to frame the case study. The group acted as a sounding board to provide initial impressions and ideas related to the issues and interests, hydrology and flow changes, and the trade-offs that could be expected if flow releases from the Tantangara Dam were changed. Members of the Technical Reference Group were:

Reference Group Member	Affiliation
Jeremy Kinley Water Policy Manager	Snowy Hydro Ltd.
Mark Lintermans Professor of freshwater ecology	University of Canberra
Andy Lowes Chair, Program Manager	Upper Murrumbidgee Catchment Network
Siwan Lovett CEO	Australian Rivers Restoration Centre
Alex McNee Water expert	ACT and Region Catchment Management Coordination Group
James Pirozzi Manager, Water Services	Snowy Hydro Ltd.
Danswell Starrs Director, Water Information Services	ACT Environment, Planning and Sustainable Development Directorate
Deep Singh River Murray Accounting Improvements	Murray Darling Basin Authority
Emma Wilson Senior Environmental Water Management Officer	NSW Department of Climate Change, Energy, Environment and Water

The group reviewed the decision context, identified key objectives (values) and performance metrics related to flow release alternatives, brainstormed 'bookend' flow alternatives, evaluated these alternatives across metrics, and discussed possible consequences of each alternative for all of the objectives. The output of their work (presented in Annex C) was provided to all participants prior to the workshop which included their responses to these questions:

1. What is the context/scope of the decision, including elements that were defined as out of scope for the case study?
2. What objectives and performance measures could be used to identify and evaluate the alternatives? (see Table 1 in Annex C)
3. What are the alternative actions or strategies under consideration? (see Table 2 in Annex C – a first round of bookend alternatives were used)
4. What are the expected consequences of these actions or strategies on the different objectives? (see Table 3 in Annex C)

6 Workshop outcomes

6.1 A closer look at Structured Decision Making

At the start of the workshop, a case study ('Water Management in Cowichan Valley' – see Box 2) was presented to show how an SDM process was applied over a nine month period for a difficult water planning challenge in British Columbia, and led to a consensus agreement. Other case studies were referenced that collectively added credibility to the SDM processes by demonstrating a proven track record.

Box 2. Cowichan Water Use Plan (Sep 2017 to May 2018) – A Case Study

The 795 km^2 Cowichan River watershed in southern Vancouver Island, British Columbia, which includes a large artificially-created lake, had become a complex water use planning challenge by 2017. Changes in water demand, land use, and a shifting hydrological cycle from climate change were placing increasing pressures on the availability of water resources to meet current, let alone future, water use needs of residents, businesses and the environment.

The Cowichan water management system and weir built in the 1950s no longer had the capacity to reliably support the varied water uses that had come to be expected. Lower flows down the Cowichan River below the weir were threatening endangered salmon populations and significantly impacting other important values. First Nations had been advocating for decades about the need for a long-term solution to address this situation and ensure their rights and values were being protected in the watershed. Increasing the weir storage capacity of the lake was proposed but seen as negatively impacting the 800 lakefront properties and so this issue sat unresolved for over 20 years. The problem was recognised as one of the most entrenched and contentious water management issues in the province.

In 2017, the Regional District, Cowichan Tribes, the Cowichan Watershed Board, and Catalyst Paper (weir owner, operator, and water license holder) partnered and hired a consulting team led by Compass to initiate and carry out a comprehensive community planning process towards a long-term, broadly supported solution that balanced the many competing interests and values. Compass designed and implemented an SDM process, formed an overarching Steering Committee, technical sub-committees and a diverse multi-party Public Advisory ('Working') Group and ran a broad public outreach program. The process evaluated the potential long-term (to 2050) impacts across a set of different water supply and storage options for the Cowichan Lake and River system and considered trade-offs between adequate flows and water levels for fish and other aquatic species, avoiding flood risk for lakefront property owners, and minimising impacts on water users on the lake and river.

The Public Advisory Group reached consensus on the design of a new weir structure and a set of recommendations on water use that almost doubled summertime lake storage while avoiding flooding at unacceptable times for lake front properties. The recommendations from the Water Use Plan have now been accepted and approved by Cowichan Tribes, Cowichan Valley Regional District, the Province of British Columbia, the Government of Canada, and Catalyst Paper.

The Upper Murrumbidgee case study (Annex C) was then used to drill down into the details of SDM in a locally-relevant context. Participants were asked to imagine they were about halfway through a full SDM process focussed on the Upper Murrumbidgee (~12 months into an 18 to 24 month process) and that, as a result, they would have been actively involved in the co-development of the objectives and performance measures, and would have understood the significance and context behind the highlighted trade-offs and estimated consequences.

Using this case study, participants walked rapidly through the first steps of SDM. The focus was not on the specific details and numbers, but the typical tools and steps to better illustrate SDM and the planning process.

A key tool for this process was a consequence table (Annex C Table 3) that summarised the estimated consequences for each performance measure from seven alternatives for the Upper Murrumbidgee case study. These were compared using an interactive decision support tool called Altaviz[3].

The participants then conducted two online values-based ranking exercises typical of SDM:

1. **Direct ranking of different alternatives:** Participants ranked the alternatives in the illustrative case study by their individual preferences.
2. **Swing weighting:** Participants ranked the objectives and performance measures according to which were most important to them. Based on this, the tool calculated a ranking of alternatives for that individual.

The discussion highlighted:

1. 'The magic' in SDM comes from iteratively learning through multiple rounds of developing and evaluating alternatives to better learn about each other's values and build more broadly-supported hybrid alternatives that better balance those values. Finding alternatives that acceptably balance multiple competing values rarely, if ever, happens in one try. Improving alternatives through three to four rounds is normally sufficient for finding a balanced solution with broad support from the group.
2. A common cause of deadlocks in water planning processes is when technical experts have competing opinions and/or studies to estimate the impacts of different options (also known as "duelling science") leaving non-technical participants and decision makers ill-equipped to move forward in the decision process. SDM generally adopts a more collaborative approach to testing hypotheses and collecting information needed to assess impacts through technical working groups (or expert panels or in some cases outside consultants). A good SDM process translates complex technical ideas and judgements into language and decision-relevant information that allows people without technical expertise to meaningfully inform their preferences and concerns.
3. SDM approaches can work at in contexts that are much bigger and more complex than the Upper Murrumbidgee case. The scale and scope of a full SWIOID review is not dissimilar to some larger water use plans that have been developed in Canada and the US, with one example being the Missouri River (see Box 3 Missouri River).

[3] https://compassrm.com/what-we-do/services/altaviz/

Box 3. Missouri River Recovery Implementation Committee & SDM – A Case Study

The Missouri River drains one-sixth of the United States, encompassing over 1 million square kilometres. The river flows over 3,000 kilometres through seven states. The Missouri River system comprises six major dams to provide flood control, hydroelectric power (with an annual capacity of about 10,000 GWh), irrigation, navigation, and recreation, while supporting fish and wildlife habitats.

The Missouri River Recovery Implementation Committee (MRRIC) played a pivotal role in guiding the planning process for the U.S. Army Corps of Engineers' (USACE) Missouri River Management Plan (MRMP) and Environmental Impact Statement. This complex effort aimed to balance the competing needs of flood control, navigation, ecosystem restoration, endangered species recovery, and other authorised river purposes. Key elements of the planning process included collaborative governance by bringing together diverse federal and state government agencies, tribal nations, industry groups, NGOs, and other stakeholders. The process integrated robust scientific research, data on ecological impacts, and stakeholder values. Various management strategies for the river were explored to achieve both compliance with environmental laws, and the broader objectives of river management.

SDM was central to this process being able to facilitate clear, transparent, and informed decision making in the face of complexity and uncertainty. MRRIC and USACE defined the objectives and challenges related to the competing needs in the river. Multiple objectives were identified, including ecological restoration, economic impacts, and compliance with legal mandates. Criteria were developed to evaluate the performance of alternatives against these objectives. Diverse stakeholders helped generate a range of potential management actions, each reflecting a different balance among the competing river uses and ecological needs. Quantitative and qualitative tools, including predictive ecological models and cost-benefit analyses, were used to assess how each alternative would meet the defined objectives. The committee systematically analysed trade-offs to identify options that balanced ecological benefits with economic and operational feasibility.

SDM emphasized flexibility by embedding adaptive management principles, allowing for ongoing monitoring and adjustment of strategies as new data became available or conditions changed. It enabled MRRIC and USACE to navigate complex stakeholder dynamics and ecological uncertainties, ensuring the plan incorporated diverse perspectives and robust analyses. The resulting plan sought to balance compliance with environmental laws and river system demands while laying a foundation for long-term, sustainable management of the Missouri River.

4. Non-flow management options (such as river habitat restoration, species management, agriculture practices, engineering solutions to riverbed issues) provide more management levers to pull and can allow for more creative ways of meeting objectives. For illustrative purposes, the case study only highlighted flow alternatives. In a full SDM process, non-flow alternatives could be built into the process upfront by adjusting the planning scope to include different types of management actions. In this way the exploration of alternatives would be comprised of portfolios of different combinations of actions. An example of how non-flow management alternatives have been managed in other SDM processes (Box 4) was provided.

Box 4. Example of non-flow management alternatives in SDM

BC Hydro's water use plans allowed for the consideration of non-flow options towards the end of the SDM process when agreement was building around one (or more) emerging preferred flow alternatives. At that point, non-flow alternatives could be considered as a more efficient way to deliver commensurate benefits that the emerging new flow regime could provide. For example, physical river works such as gravel removal or habitat enhancement might be considered as an alternative to flow options aimed at delivering the same outcome.

6.2 Enabling a successful future SDM process

Participants discussed the following enabling factors for a future SDM process in the context of the Upper Murrumbidgee.

Decision Charter

Once there is support to further scope out an SDM process, a next step that is commonly used is the development of a Decision Charter. This helps establish a shared understanding among stakeholders about the key elements of a future SDM process, especially:

1. The issue(s) that triggered the decision process, their relationship to other decisions, and scope (such as geography, regulatory, roles, information and modelling requirements)
2. The decision process (including who are the decision makers and what boundaries (such as time frame) constrain the process)
3. The SDM process to support the decision (including who needs to be involved from the start)
4. How the process will be organised (including roles and responsibilities to guide the collaborative process)
5. The broad scope of alternatives under consideration
6. Preliminary objectives to be addressed (with flexibility to add more as the process progresses)
7. Uncertainties and trade-offs that are expected to be central to the decision
8. Critical information gaps and how they can be resolved
9. A process implementation plan including (i) milestones and (ii) touch points for decision maker updates and input
10. Budget and timeline

Scope

Two potential scopes for a future SDM process were discussed: a smaller scope focused on the Upper Murrumbidgee River and a larger scope that would include the entire SWIOID geography. The smaller scope was seen as enabling a faster and less costly process to achieve better outcomes for the Upper Murrumbidgee while there was political support to do so. It would involve fewer jurisdictions and has a strong information base to start the SDM, making it logistically easier. Others supported the larger scope option given that flow decisions in the Upper Murrumbidgee will inevitably have consequences and interactions with other parts of the Snowy Scheme and that the SWIOID review is a rare opportunity which may not be available in the future. A phased approach was also suggested, starting at the smaller Upper Murrumbidgee scale to demonstrate the value of SDM and then possibly expanding the approach to other parts of the SWIOID review if requested.

Early, consequential and sustained involvement of Traditional Custodians

The Upper Murrumbidgee River is part of Country for Ngunnawal/Ngunawal, Ngambri, Wolgalu, Ngarigo and Yuin peoples. Many workshop participants emphasised the need for stronger engagement of Traditional Custodians from the start of an SDM process. One of the Traditional Custodians who attended the workshop commented that they are consulted frequently but rarely do they see their input go anywhere.

The Compass facilitators presented an example of an indigenous-led SDM process in Canada (Wood Buffalo National Park) that worked through impacts of water control structures on indigenous rights and values in water. They also pointed to the governance structures of the Cowichan Valley case study where First Nations had a separate parallel engagement process whilst also being represented on each of the SDM committees.

While there is no suggestion that similar processes would work in Australia, it is clear that for any future SDM process linked to the Upper Murrumbidgee, Traditional Custodians of the different Nations (and clans within Nations) will need to have a consequential say in the process. A future SDM process would need to:

- Work with all Traditional Custodians from the start so they can co-design the process for their involvement
- Develop agreements of how cultural knowledge can be used in support of decision making
- Develop agreements of how cultural knowledge that is shared is appropriately protected

Buy-in of decision makers

While there was broad enthusiasm for SDM among the participants, there was a desire to know that decision makers were also committed to a future SDM process at the outset and that there was a clear understanding of how outcomes of the SDM would inform the SWIOID review decisions (whether it is at the Upper Murrumbidgee or broader scope).

Decision maker participation in an SDM process can take many different forms. There are examples of SDM processes being initiated from the top down as an outcome of negotiations between or across government agencies. Conversely other processes have started from the bottom up with concerned citizens, community groups, and other stakeholders taking the lead only to have government decision makers join at some point afterwards. For the Cowichan Water Use Plan example (Box 2), the First Nation, local government, one NGO and the weir owner and licensee initiated the SDM process together. Soon after the provincial and federal governments joined the process, but it was the original local groups who spearheaded and established the process. On voluntary processes, it is also not uncommon for regulators and government agencies to participate as stakeholders at the table alongside the other interest groups. But as a general rule, it is better to have the decision makers actively involved at the start of a process.

Who needs to be involved from the start

In a full SDM process, all connected interests would be encouraged to participate in the core group working through SDM. As this core group needs to be small enough to work through the SDM, the process can usefully be complemented with external surveys, focus groups and expert testimony to ensure that the core group is on track with values and alternatives that would be supported more broadly by the general public. This speaks to the importance of having good representation across all the interests that are likely to affect or be affected by the outcomes of a process.

In an SDM process, it is often the case that the decision makers will participate on the same core group working through the SDM steps as other stakeholders. If structured appropriately, this will not hinder their decision making after the process but rather ensure that their interests (and any other regulatory considerations) are considered alongside other interests and help to guide the process. In other words, decision makers' participation will be similar to others at the main working table during the process, and if the group reaches broadly supported recommendations, this will be forwarded to them for their consideration after the process. Accordingly, any recommendations should serve as a core input into their regulatory processes without hindering their decision making. The goal should always be to ensure that they have clear, accurate information to base decisions upon (and this includes clarity on the significance of the trade-offs and the level of acceptance surrounding any recommendations, given their associated risks and uncertainties).

The process will fall apart if representatives are not accountable to their communities and keep them informed with regular feedback opportunities. Other responsibilities include the importance of continuity of attendance at meetings and to come prepared to meetings. The facilitators have a role in this both in terms of providing strategic briefing documents in advance of meetings to allow participants to check in with their organisations. These roles, responsibilities and resources for participants are often described through a Decision Charter.

How the process is organised

The organisational structure and process workflow that was used for the Cowichan Water Use Plan was presented as an example where a number of working groups were woven together into five inter-connected engagement streams. It also included a separate First Nations engagement stream (that was defined by First Nations before the process began) as well as a broad public engagement stream to communicate and seek input at crucial points. These streams were integrated and reliant on one another, with each stream having a unique function.

While there are a multitude of ways that an SDM process can be structured and organised, there are some core functions that are common to all SDM processes. They are summarised below and further detail on each is provided in Annex D, along with examples of how these functions were addressed in the organisational structure for the Cowichan Water Use Plan process.

- **Establishing and implementing the process:** setting the parameters and scope for the planning process; initiating the planning; securing funding; convening the participants who will be on the various working groups; providing direction and troubleshooting any process, stakeholder, or additional scope issues which emerge during the planning that could derail the process
- **Managing and supporting the process:** doing the legwork to set up the process and working group structure; convening and providing logistical support to hold the meetings; providing coordination, decision analysis, and facilitation support to the various working groups; supporting follow-up actions to keep the process moving
- **Making recommendations (through the SDM steps):** a main deliberative group that actively works through the SDM steps and is responsible to seek agreement on broadly supported recommendations at the end of the process
- **Providing technical support:** providing the needed technical support to the main deliberative group as they work through the SDM steps, such as issues scoping, development of performance measures, and technical input into the development of alternatives
- **Providing updates to and seeking input from the public**

Addressing critical information gaps

For the Upper Murrumbidgee River case study, some early information gaps were identified (such as where physical barriers to spawning of Macquarie perch are located and what quantity and timing of flows would be needed to enable passage past these barriers). Identifying and developing a strategy for approaching critical information gaps will be key to informing judgements about the predicted consequences of alternatives. For example, this could involve pre-process studies, adaptive management, and/or structured expert elicitations.

Adaptive management was mentioned as a key feature in water use planning as there will always be imperfect information on some level. This can be passive adaptive management where a new flow regime is implemented and then monitored with a fixed review period to assess whether the expected benefits are occurring (or that negative unintended consequences were not) or active adaptive management where flow trials of different flow regimes are experimentally tested over a period of years to address the critical uncertainties.

In the consequences table for the illustrative Upper Murrumbidgee case study, the economic costs of infrastructure and foregone power generation were relatively well quantified, but environmental impacts, such as the possibility of species extinction, were not. A challenge is how to trade-off flow alternatives that have high costs but uncertain environmental benefits.

Independent convening and facilitation

It is very difficult for a stakeholder in a complex decision to be the convenor of the SDM that informs that decision. Having an independent convenor and facilitator builds confidence in the process, trust in the information presented, and independence from outcomes.

Adequate time and resources

Depending on the context, SDM processes can take weeks, months or years. The Cowichan Water Use Plan process, for example, took ~nine months once a decision charter was established and a consulting team was hired and cost about $1.1 million AUD (adjusted to 2024 dollars). Time and resource constraints can apply pressure to curtailing iteration in SDM. There almost always are significant benefits to allowing iteration to enable co-learning, building trust, and improving the alternatives under consideration.

Guiding principles

The Compass facilitators presented some of the typical guiding principles they have found useful in the design and implementation of SDM processes elsewhere:

1. **Transparency and accountability.** The planning process will follow a defined set of steps designed to ensure that participants and observers know what to expect at each stage of the process.
2. **Evidence-based decisions.** Water management is complex and any decisions will include trade-offs and consequences. To make sound decisions, it is important to understand these trade-offs and consequences, along with the benefits based on best available evidence.
3. **Multiple objectives and value-based choices.** Recommendations from the process will be based on consideration of multiple objectives. It is understood that different parties will attach different importance to different objectives.
4. **Informed choices.** All participants should have a full understanding of the issues, the alternatives proposed to address them, and the likely consequences of the alternatives. They should have timely access to the same information (such as data and studies) and work toward building a common understanding of technical findings.
5. **Collaborative process.** The process should provide opportunities for interested parties to be involved in a meaningful way. Decisions will respect the different views of participants and will be made on the basis of shared discussions.
6. **Striving for consensus while not requiring it.** Through iteration on alternatives, collective learning occurs that can often lead to consensus where none seemed possible at the start. Although consensus does not need to be required, SDM processes facilitated by Compass almost always end with group consensus around a recommendation. If a group does not reach agreement, competing preferences and rationales are clearly documented and provided to decision makers to inform their final choices.
7. **Learning, adaptive management and review.** Recognising that uncertainty will always be present, provision should be made for ongoing review and refinement of the understanding of social, cultural, economic and ecological systems and their response to the different options.

7 What next?

The following 'no regrets' immediate next steps were suggested to maintain momentum and continue to build support for SDM processes linked with the Upper Murrumbidgee:

- Define the role of a **Coordination (Steering) Group** and identify membership to initiate the process and provide support and direction on matters of scope, process and funding that affect tasks and timelines of other groups in the process. This group can also identify: (a) Who can substantially affect or be affected by potential decisions and needs to be fully involved in the SDM process? (b) Who needs to be consulted? (c) Who needs to be informed?
- With the Coordination Group, and through consultation with the diversity of interest groups, draft a **Decision Charter** (see section 6.2) to develop a shared understanding of the scope of the SDM process and identify the full diversity of people who should be involved.
- Consult with **Traditional Custodians** whose Country overlaps the process's spatial scope to start co-designing a process for their consequential engagement with SDM.
- Develop a summary of **budget and resourcing requirements**.
- **Compile information** that will be needed to move the process forward. In the case of the Upper Murrumbidgee, this might include compiling and summarising the available environmental information base; scoping and screening environmental water issues that could be affected by flow changes on the Upper Murrumbidgee and possibly other Snowy montane rivers; and identifying and developing preliminary performance measures for screened environmental issues.
- Identify the kinds of **process support** that will be needed.

Further reading

Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D. (2012). Structured decision making: a practical guide to environmental management choices. John Wiley & Sons. https://doi.org/10.1002/9781444398557

Mattison, J., et al. (2014). Water for Power, Water for Nature: The Story of BC Hydro's Water Use Planning Program. Vancouver: WWF Canada. https://wwf.ca/report/water-for-power-water-for-nature-october-2014/

NSW Government. Legislative context: Information about the legislative context and governance arrangements relating to the Snowy scheme. https://water.dpie.nsw.gov.au/our-work/projects-and-programs/snowy-scheme/legislative-context

Scodanibbio, L. (2011) Opening a policy window for organisational change and full-cost accounting: The creation of BC Hydro's water use planning program. Ecological Economics 70: 1006-1015. https://doi.org/10.1016/j.ecolecon.2010.12.022

Snowy Water Inquiry (NSW and Vic) (1998). Snowy Water Inquiry issues paper. Sydney, NSW. Snowy Water Inquiry. https://catalogue.nla.gov.au/catalog/525700

Snowy Water Inquiry (NSW and Vic) (1998). Snowy Water Inquiry final report. Sydney, NSW. Snowy Water Inquiry. https://catalogue.nla.gov.au/catalog/2060290

Structured Decision Making. https://www.structureddecisionmaking.org/

Annexes

Annex A. Structured decision making

Overview

Structured Decision Making, or SDM, is an organised framework for making defensible choices in situations where there are multiple interests, high stakes, and uncertainty. It is designed to provide stakeholders and decision makers with insight about the decision by clarifying objectives, identifying creative alternatives, evaluating how well different objectives are satisfied by different alternatives, exploring how risky some alternatives are relative to others, and exposing the fundamental trade-offs or choices that need to be made. It is particularly useful for groups working together on complicated planning and decision making projects.

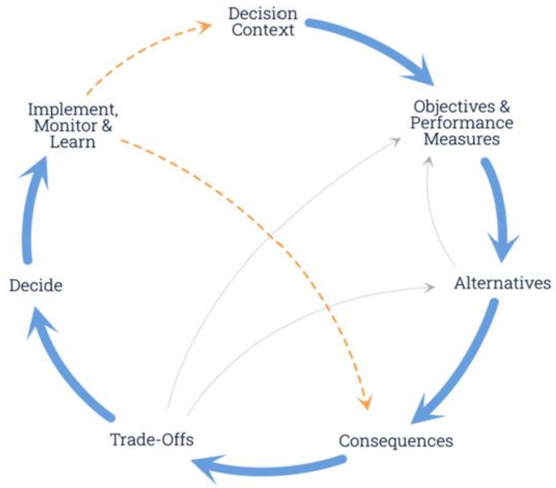


Figure A1: Steps in SDM with iterative processes as grey arrows and learning feedback as dotted orange arrows

SDM helps people make decisions that are defensible (based on sound technical information), value-based (based on “what matters” to people), transparent (based on clearly communicated reasons), and efficient (with people’s time and resources). It estimates impacts based on best available information, which can include both science and traditional and local knowledge, and it actively deals with uncertainty. The collaborative process promotes dialogue and constructive debate and helps people focus on interests rather than positions.

SDM is based on well-recognised methods developed in the decision sciences. As a result, it is rigorous, defensible and well-suited for decisions that will be subject to a high degree of scrutiny. Importantly, although it is based in sound theory, it is adapted for use in the real world, and it is proven itself in a wide range of applications.

This annex provides an overview of the benefits and the steps involved in an SDM process.

Benefits

SDM does not make tough choices easy. But it does make them more explicit, better informed, more transparent and more efficient. It does this by:

- Structuring the process – clear steps (a road map) and well defined roles for stakeholders, decision makers and technical experts help keep the decision process on track;
- Structuring judgments – by decomposing and simplifying complex judgments it helps experts, stakeholders and decision makers think clearly about complex problems and make better and more transparent judgments;
- Directly addressing what matters – even when what matters is hard to value using conventional economic methods;
- Linking analysis and consultation – by creating linkages among decision making tasks it makes the decision process more efficient and improves the relevance of technical and stakeholder inputs to decision making;
- Providing a sound technical basis for decisions – SDM is based on rigorous evaluation of the consequences of proposed alternatives and emphasises the development of a strong decision-relevant information base including economic, environmental and socio-economic analyses;
- Providing an explicit values-basis for decisions – in contrast to other approaches SDM does not purport to be objective or value-free. It explicitly incorporates the values of stakeholders and decision makers in a structured and transparent way;
- Exposing choices – choices among competing objectives are at the core of difficult decisions and, again in contrast to other approaches, SDM addresses them directly;
- Exploring creative solutions – by emphasising the search for joint gains and exposing the nature and magnitude of residual effects, the quality of the solutions is improved;
- Clarifying risk – SDM helps people deal clearly and consistently with uncertainty, explore risk tolerance, make judgments about acceptable levels of risk and precaution, and find creative ways to manage residual risk;
- Leveling the playing field – by distilling complex technical analyses into a small number of well understood performance measures, and carefully separating value judgments and technical judgments, anyone with a stake in the decision can participate at an appropriate level, whether they have technical expertise or not.

Step 1. Clarify the Context

The first step is to establish the process and clarify the decision context: What is the underlying problem or opportunity? What is the decision to be made and who will make it? What is the scope or limitations of the process and the decision (i.e., what is in and what is out of scope?) What are the real constraints for the process (timelines, budget, legal issues)? Who needs to be involved in developing solutions, and how will they work together? There are usually several different ways the decision could be framed. The challenge is making sure it is framed in a way that addresses the underlying problems, recognises institutional complexities, and challenges assumptions while accepting hard constraints. Quickly running through the SDM steps at a scoping level (known as "decision sketching") can help clarify what the scope is, what information is required, and where resources should be focused throughout the process.

Step 2. Identify Objectives and Measures

At the core of an SDM process is a set of well-defined objectives and measures that clarify "what matters" – the things that people care about and could be affected by the decision. Objectives should include all the things that matter, not just the ones that are easily quantified (for example, increase the abundance of salmon, minimise greenhouse gas emissions, increase cultural value). Together, objectives and evaluation criteria drive the search for creative alternatives and become the framework for comparing alternatives. It is important to separate fundamental or ends objectives (the outcomes participants really care about and are trying to achieve) from means objectives (the ways decision makers can achieve the ends). For example, a fundamental objective might be "maximise air quality" and a means objective would be "minimise vehicle emissions". Both means and ends are important in decision making, and it is important to understand the relationship between them. To get from means to ends, facilitators will ask "why is that important?" to get from ends to means, facilitators will ask "how could we achieve that". To clarify hard to quantify objectives (such as spiritual quality or visual quality), facilitators will ask "what do you mean by that?" or "how could that be affected by this decision?"

A good set of objectives is complete (all the things that matter are included), concise (no double accounting), sensitive to (or affected by) the alternatives under consideration, relevant and understandable to everyone.

Measures define exactly what is meant by an objective for the purposes of the decision at hand. They are used to consistently estimate and report the predicted consequences of different alternatives, for the purposes of making a choice. Measures can be either quantitative or qualitative, but care must be used to ensure qualitative criteria are unambiguous ("low", "medium" and "high" are rarely good enough). Structuring tools such as influence diagrams or effect pathways that link actions at one end to outcomes at the other, are useful in communicating complex systems and selecting appropriate measures.

The goal of this step is to produce one common set of objectives and evaluation criteria that everyone agrees will be used to evaluate the alternatives. It is neither necessary nor useful to weight them at this stage.

It takes effort to confirm a good set of objectives and especially measures. However the investment pays off as they facilitate and streamline many group decision making tasks. They allow a group to compare alternatives accurately and consistently, to clarify key trade-offs, including trade-offs among different degrees of uncertainty, and to generate productive discussion about better alternatives. They also help a group to prioritise and streamline information needs, because data, modelling and expert judgment processes are focused on producing decision-relevant information. Ultimately, they streamline choices, especially group choices, because large numbers of complex options can be consistently and efficiently evaluated by multiple decision makers.

Step 3. Develop Alternatives

Alternatives are the various actions or strategies that are under consideration. Good decisions are only possible if there are good alternatives, and it is worthwhile to spend some time generating good ones. In some contexts, alternatives are easy to identify and the work is in evaluating them. In many environmental management contexts however, the alternatives are complex sets of actions that need to be thoughtfully developed (for example alternative ways of managing a park, sharing water, or sequencing development). This step therefore involves iteratively developing, comparing and refining alternatives in the search for one(s) that offers the best balance across objectives.

A "value-focused thinking" approach involves using the objectives to generate and evaluate a broad range of creative alternatives. Initially, the focus is on identifying exploratory alternatives that promote collective learning, often beginning with "bookends" that represent very different approaches. A good range of alternatives will reflect substantially different approaches to a problem based on both different technical or policy approaches, and different priorities across objectives. In most environmental management contexts, it is important to search for alternatives that are robust to key uncertainties or that are likely to reduce them over time. "Strategy tables" can help when the number and diversity of individual actions under consideration are overwhelming, and need to be grouped into logical packages.

During this step alternatives are iteratively refined, often with the aid of simple decision support tools (such as pair wise comparisons, dominance and sensitivity assessments). Poor performers are eliminated from further consideration, and desirable elements from different alternatives are combined to create new ones. Short-listed alternatives should be small in number but high in quality; they should be creative but practical. They should be value focused (designed to address the fundamental objectives) and technically sound (based on best available information about cause-and-effect relationships). If a good set of alternatives has been identified, it will expose key trade-offs, and therefore offer decision makers a real choice.

Step 4. Estimate consequences

At this step the consequences of the alternatives for each objective are estimated or characterised. A consequence table summarises the estimated consequences of each alternative on each objective, as reported by the measures (refer to Annex C Table 3 for an example). It creates a shared understanding of how different alternatives affect different values and stakeholders, and it exposes key trade-offs among objectives across the alternatives under consideration. Simple colour coding of key trade-offs can be effective.

A good consequence table summarises the best available information about what will happen to the objectives under each alternative. It needs to be understandable to the entire audience, and to highlight any uncertainties. Consequences are estimated using available knowledge, and both quantitative and qualitative methods may be applied.

Sometimes there is a need to gather more information before the consequences can be estimated. An important principle in SDM for ensuring decision quality and for managing project timelines and budgets is a commitment to decision-focused information. Proposed studies are scoped to deliver information directly relevant to the estimation or understanding of the consequences for the stated objectives and measures. A combination of predictive modelling and expert judgment is normally used to estimate consequences. Where expert judgment is used, it should be performed according to accepted standards, incorporating accepted best practices, elicitation protocols, bias avoidance, treatment of uncertainty, documentation and peer review.

Step 5. Evaluate Trade-offs and Preferences

Although a good SDM process typically finds a number of win-wins (alternatives that perform well on multiple objectives), trade-offs of some sort are usually required. The SDM process requires that participants make explicit choices about which alternatives are preferred, based on what is gained and lost on each objective. They are asked to do this based on their own values and their understanding about the values of others (which they have learned about through the process). Key questions at this stage include: Are the trade-offs clear enough that an informed choice can be made? If not, it may be necessary to go back and refine the estimation of consequences. Do the trade-offs suggest a new alternative? The process is intended to be iterative, so if a new and better alternative is suggested, it may be appropriate to spend time evaluating it before a decision is made.

A variety of methods from the decision sciences are used to facilitate constructive deliberations about trade-offs and to ensure that trade-off judgments are informed, consistent and transparent. Often, a deliberative approach is sufficient to lead to informed choices. In this approach, participants think and talk about what matters (as defined by the objectives and measures), about which outcomes are more or less important, and about which set of trade-offs is more or less acceptable. If there are challenges in reaching a widely supported alternative, it may be useful to use more structured preference assessment methods for explicitly weighting the measures and deriving scores and ranks for the alternatives. These methods can be used to focus deliberations on productive areas and maintain an interest-based (or performance-based) dialogue, rather than a positional one. The emphasis with all such methods is on group learning and collaborative exploration of trade-offs, with the goal of finding an alternative that achieves a balance across multiple objectives and is acceptable to a broad range of people. It is not to apply a formula to prescribe a solution.

Consensus is desirable of course, but not mandatory. Often the exploration of trade-offs leads to a clearly preferred solution. Even when it does not, the structured exploration of trade-offs and documentation of areas of agreement and disagreement will, at minimum, inform decision makers and help to identify a more broadly acceptable set of recommendations or management actions.

Step 6. Implementation, Monitoring and Learning

A commitment to learning is one of the things that sets SDM apart as a framework for decision making. Throughout the process, people participating in SDM will need to be prepared to listen and learn about values, to explore completing hypotheses about cause-effect relationships, and to build a common understanding of what constitutes the best available information for identifying alternatives and assessing consequences. This forms the basis for working collaboratively on solutions.

At this final stage, the SDM process focuses on what learning is needed to improve future decision making. The challenge is to implement the decision in a way that reduces uncertainty, improves the quality of information for future decisions, and provides opportunities to revise and adapt based on what is learned. In some cases, there may be a focus on strengthening management capacity to make better decisions in the future, and recommendations may include actions related to human resources (for example training local community members in monitoring methods) or institutional capacity (for example, building trust and partnerships and/or developing systems for tracking and storing data). Many SDM processes result in recommendations for appropriate governance and oversight of monitoring programs, and include triggers and mechanisms for review and amendments.

Where uncertainty about outcomes affects the selection of a preferred action, commitment to structured learning over time and a formal review of the decision when new information is available can be the key to reaching agreement on a way forward. SDM is consistent with and supports a formal adaptive management process. To make best use of resources, it's necessary to focus on the most important sources of uncertainty, those for which reductions would be of greatest value to future decision makers. To ensure the relevance to future choices any monitoring programs will be closely linked to the objectives and performance measures used to evaluate management alternatives.

Annex B. Decision sketching

Usefully structuring a problem requires some combination of skill, experience, inspiration and providence. Taking a trial run at a decision is referred to as decision sketching. It is often one of the first steps in an SDM process. This workshop was constructed around a decision sketch.

On complex resource management problems, decision sketching generally means walking quickly through the first five steps of the SDM process at a scoping level. "Quickly" typically means something between a few hours or a couple of days depending on the complexity of the situation. At a minimum, a decision sketch involves defining and framing the decision, identifying preliminary objectives and identifying a range of possible alternatives. In some cases, it will also involve identifying candidate performance measures, characterising consequences and uncertainties, and identifying potential trade-offs. Doing this encourages participants to treat the problem as a decision right from the beginning: not a scientific endeavour or an economic valuation exercise, but a multidimensional decision problem seeking the best possible solution(s) to a management or policy challenge. Undertaking an initial decision sketch can quickly and efficiently shift the focus of a decision, resulting in substantial savings of effort, time, and other resources.

The decision sketch is often particularly effective when working collaboratively on a complex multi-objective problem. Different people usually come to the table with different framings of the problem and its possible solution. The decision sketch organises the issue at hand in a way that helps to build a shared understanding of the key elements of the decision. A key outcome from a decision sketch is often a consequence table –or at least the skeleton of one. A consequence table links objectives, performance measures, and proposed actions and illustrates very visibly that, analytically, the emphasis is on developing information and tools that culminate in an estimation of the consequences of management actions–not baseline studies, or a ranked list of hazards, but the estimated consequences of management alternatives. In addition to providing insight about the nature of analytical tools that will be required, the consequence table also helps to provide some early insight into some of the potential trade-offs and uncertainties. Identifying these early and thinking about which have the potential to become showstoppers, helps again to understand the relative priority to place on information needs.

Annex C. Upper Murrumbidgee River case study

Introduction

This Upper Murrumbidgee River case study is an illustrative mock up. It is only meant as an illustrative example to better demonstrate the steps and some of the tools commonly used by SDM in water use planning. It serves as a prop in order to (a) build understanding of what an SDM process could look like to support a SWIOID review, and (b) to highlight key questions and uncertainties that would need to be addressed and sorted out through the design and implementation of a future process. The Technical Reference Group supported Compass Resource Management to develop the case study prior to the workshop.

The case study is framed around different example flow release options from Tantangara Dam into the Upper Murrumbidgee River. These flow options are better characterised as “bookend” flow alternatives in that they are meant to collectively illustrate the boundaries and range of what is possible, but not what would be acceptable or supported by stakeholders. Bookend alternatives are generally designed to focus solely on one theme or water use interest as a starting point to learn from. Accordingly, none of the bookend alternatives in the case study should be confused with what might be a balanced alternative, as that would come later in a process.

In the workshop, participants used the coarse grained yet believable case study while keeping things at an illustrative level. They did not go into the details because that is what a future process would be designed to address.

Step 1. Illustrative Decision Context

The case study is primarily focused on exploring different flow release alternatives from Tantangara Dam initially to explore making improvements to the ecological health of the Upper Murrumbidgee River alongside other consequences to social, cultural, and economic interests. The only exception to this was the inclusion of possible infrastructure changes (for example, an upgraded outlet at Tantangara Dam) in order to release higher flows associated with some of the flow alternatives identified for the case study.

Step 2. Illustrative Objectives & Performance Measures

Objectives represent the fundamental interests that the group is seeking to achieve. Importantly in this case, they are affected by flow options and can therefore be used to evaluate and compare the performance of the different flow alternatives options.

The short timeframe available to prepare this decision sketch was not suitable for a culturally-appropriate process designed by and for Traditional Custodians. Traditional Custodians’ enduring connection with Country and their rights and interests in water must be central to any future process that makes decisions about how the Upper Murrumbidgee River is managed.

The objectives discussed in the workshop related to the following categories:

- Environmental/ecological restoration of the Upper Murrumbidgee River system, including in-river and riparian habitat and viability of species of concern (for example, Macquarie perch)
- Environmental/ecological effects of "connected" river systems, including impacts to other Snowy Montane rivers and downstream Murrumbidgee River systems
- Reliable power production from the Snowy Scheme for consumers
- Reliable water supply for irrigators, local shires, and other users
- Other socio-economic interests, including recreation opportunities and flood risk to different areas
- Water management considerations, including infrastructure cost and ease of implementation

The objectives captured many key interests within this context but are not exhaustive and would need to be broadened in a full SDM process that would be co-developed with Traditional Custodians and participating stakeholders.

One or more illustrative performance measures (PMs) associated with each objective were developed by the Technical Reference Group in order to assess the consequences and performance of each flow option (Table C1). The PMs in the case study are very simplistic given the limited time and information (for example, models) with a majority of PMs relying on a simplistic five-point constructed scale to assess potential impacts on the objectives.

Table C1 Summary of Illustrative Performance Measures for Upper Murrumbidgee Case Study

Objective	Sub-Objective	Performance Measure	Unit
Environment – Upper Murrumbidgee River			
Endangered aquatic species	Macquarie Perch	Probability of Macquarie Perch species persistence over the next 25 yrs	(H-M-L)
In-stream aquatic habitat	In-stream habitat	Constructed scale for the availability, suitability and diversity of in-stream aquatic habitat to support river vegetation, macroinvertebrates, and fish communities (1-poor / 5-excellent)	1-5
Riparian habitat	Riparian habitat	Constructed scale for the availability, suitability and diversity of key riparian habitat to support vegetation, amphibians, platypus, etc. (1-poor / 5-excellent)	1-5
Environment – Other Locations			
Aquatic Habitat	Other Snowy Montane River	Constructed scale for degree of flow reductions of other Snowy Montane Rivers based on SMRIF flows re-allocated to Upper Murrumbidgee River flow releases (1-significant / 5 – none)	1-5
Aquatic Habitat	Murrumbidgee (below Gundagai)	Constructed scale on potential +/- ecological effects from Upper Murrumbidgee River flow changes on regulated portion of Murrumbidgee River (1-potential negative effect / 3-no change / 5-potential positive effect) [Note. Changes are mostly caused by less spilling during flooding which allows for more water being available in subsequent years to support e-baseflows and to lessen flood disturbance on riparian ecosystems]	1-5
Industry and Commercial			
Snowy Hydro	Annual Revenue	Average Foregone hydropower generation (per year)	GWh
	Long-term storage	Constructed scale for foregone long-term energy storage (1- Significant (~350 GWh) / 5-minimal)	1-5
	Ancillary Benefits	Constructed scale of impacts/benefits to Snowy Hydro's ability to deliver purpose and objectives (reliability, electricity prices, NEM emissions, firming renewables, company value, return on investment, etc.) (1-significant negative impacts / 3-neutral / 5-significant benefits)	1-5
Irrigation	Unregulated Murrumbidgee	Constructed scale on likelihood of potential decrease in water availability for entitlement holders in dry years (i.e., 1:5 drought) (1-very likely / 5-very unlikely)	1-5
	Regulated Entitlements (below Gundagai)	Constructed scale of potential additional impact to Total Allocations to licensed water holders in dry years (drought 1:5) relative to current operations	1-5

		1 – Significant Loss >10% (>100 GL) 2 – Moderate Loss (4 to 10%) 3 – Small Loss (1-3%) 4 – Limited (<1%) 5 – Net Gain >1% (>10 GL+)	
Water Supply			
Municipal (local townships)	Total water delivery	AVG annual volume of water delivered in Upper Murrumbidgee River	GL
	Reliability	AVG # of days / year access is curtailed (based flows < 32ML/day at Mittagang or < 20ML/day at Township of Tharwa)	Days
Critical Human Water Needs	Supply for Towns, Stock & Domestic needs	AVG # days / year over the next 20 years that access to critical water for licenced water holders is likely to be curtailed on the regulated Murrumbidgee system	Days
Flood Risk			
Regulated Murrumbidgee	Flooding Risk	Constructed scale for change in flood risk below Gundagai 1 – potential significant increase, 2 – potential increase, 3 – likely no change, 4 – potential decrease, 5 – potential significant decrease.	1-5
Regulated Tumut	Flooding Risk	Constructed scale for change in flood risk on regulated Tumut River	
Unregulated Upper Murrumbidgee	Flooding Risk	Constructed scale for change in flood risk on regulated Upper Murrumbidgee River	
Other Socio-Economic			
Recreation	Whitewater Rafting	AVG # days / year that flows are at preferred levels during prime season (~from mid-Sep to the end of Oct)	Days
	Bathing - Swimming	AVG # days / year that flows are between 40 to 100 ML/day during summer months	Days
	Recreational Fishing	Constructed scale on angler fishing success below Cooma (1-low success / 5-high success)	1-5
Private property	River Crossing Access	AVG # of days / year where flows are at risk of restricting vehicle access over private river crossings (based on flow releases ≥ 1400 ML/day in wetter years)	Days
Water Management			
Infrastructure $	Tantangara Dam	Capital costs for any needed improvements to meet required max flow releases (estimated at ~$300 M)	$
Supplemental Environmental Upper Murrumbidgee River Water $	Snowy Scheme	Average annualised costs to deliver any supplemental environmental water (i.e., beyond SMRIF) Tantangara flow releases to Upper Murrumbidgee River (e.g., improving water infrastructure efficiency, water buybacks)	$
Ease of implementation	Inter-jurisdictional collaboration	Constructed scale on the relative ease of implementation required between the Parties / regulatory environment (1-difficult / 5-easy)	1-5

Step 3. Illustrative Flow Alternatives

Table C2 outlines seven flow release alternatives for managing flows and related actions in the Upper Murrumbidgee River that are intended to achieve the objectives listed above. The Technical Reference Group brainstormed distinct alternatives that varied the timing, magnitude, and frequency of flow changes from Tantangara Dam. As noted above, these "bookend alternatives" are not designed to be acceptable options but instead be reference points from which to learn. For illustrative purposes, the alternatives are not constrained by current regulatory policies or the current gate limitation of the dam.

To develop these flow alternatives, the Technical Reference Group consulted historical data for the river[4], as well as modelled data under current operations and an unimpaired flow scenario.[5] Note that modelled data came from the ACT Environment, Planning and Sustainable Development Directorate's latest water resource model has not undergone peer review but was informative for this case study.

The Technical Reference Group also reviewed and provided input into representative hydrographs for each alternative to better demonstrate the general nature of flow releases throughout the year. Figure C1 is an example of one of these hydrographs. The hydrographs served as a key input in the estimation of consequences (refer to Step 4 below).

[4] Australian Bureau of Meteorology, https://mdbwip.bom.gov.au/murrumbidgee/

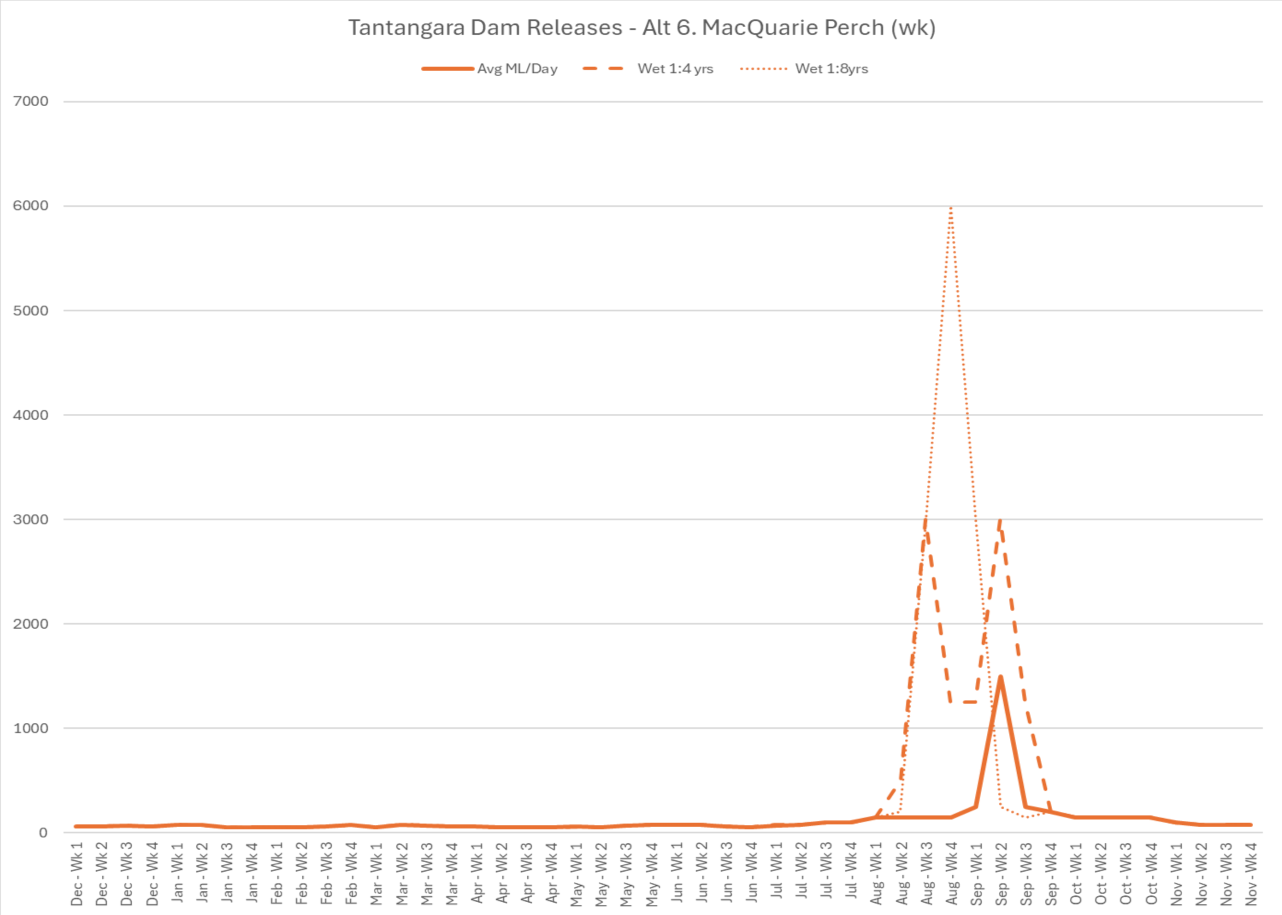
[5] Provided by Danswell Starrs, ACT EPSDD

Table C2 Summary of Illustrative "Bookend Flow Alternatives" for Upper Murrumbidgee River

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Primary Purpose	**Maximise Power** *To store and release water to maximise resource use for hydropower generation*	**Maximise Water Resource** **Release to Upper Murrumbidgee River to maximise resource** *To maximise regulated resource by balancing spill risks between Blowering and Burrinjuck, with consideration of constraints in the Tumut and Murrumbidgee regulated rivers for flood risk and water deliveries.*	**Historical** (Actual Flows to Upper Murrumbidgee River) *Represents actual flow releases pre-SWIOID*	**SWIOID** (Current targets) **Improve River Health** *Originally Intended to increase flows to improve river health on Snowy montane rivers*	**Adaptive Env Flows** **Upper River & Side Channels (above Cooma)** *Allows for weekly in-season adjustments to respond to actual weather and snow conditions (within current SWIOID water budget)* *Re-distribution of baseflows to improve aquatic & riparian habitats above Cooma* *Includes annual pulse flow to connect river to side channels / wetlands*	**Macquarie Perch** **Fish & Aquatic Ecosystems** *Clean substrate and improve habitat for key life stages.* *Significant initial Flush to clean substrate in riffle areas (1 in 8 yrs).* *Migration / passage flows during higher water years (1 in 4 yrs)*	**Unimpaired Flows** *To pass all water coming into Tantangara Dam to the Upper Murrumbidgee River*
Operational							
Annual water storage for release to Upper Murrumbidgee River	*0 GL/yr* *(any water to Upper Murrumbidgee River is based on spills)*	**Varies** Volume dependent on extent of the lower spill risk in Burrinjuck over Blowering. In average years storage based on historical volume of ~18GL/yr. In high flood risk years on Tumut (and lower risk on BRJK) divert up to 50GL to Burrinjuck via TTGA	**Varies** ~18 GL/yr (on avg) From 2 GL/yr (avg) to SWIOID	**Varies** *Target 27 GL/yr* *Up to ~35 GL/yr (in wetter years)* *Max 41GL/yr*	**Varies** Target 27 GL/yr Target up to ~ 35 GL/y (in wetter years 1:4)	Target 41 GL/yr (non-pulse years) Target Approx 100 GL/yr (1 in 4 wetter years)	~245 GL/y

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Flow targets	*0 ML/day at Mittagang* *Note an addn ~18GL (on avg) is available for generation*	In high inflow, Target up to max 1450ML/day to balance spill risks across Burrinjuck - Tumut system. *(up to ~50GL of flood water diverted)* Maintain minimum 32 ML/day at Mittagang.	*Min 32 ML/day at Mittagang*	*Min 32 ML/day at Mittagang*	Target 30ML/day average dam release (with +/- 25% daily variance) Target 1,500 ML from dam for 4-7 days from Sep to mid-Oct period	Min Flow Release between 50 - 80 ML/day (AVG 65 ML/d with +/- 25% daily variance) Target 3,000ML+ from Dam (~4GL further downstream) to allow passage for spawning during for 2 - one week periods from Sep to mid Oct (~1 in every 4 yrs coord w/ natl high flow events) Target up to 6,000ML @ dam (~8-10GL + @ Cooma) substrate flushing flow at dam for 7 days+ in Aug or Sep (~1 in every 6-8 yrs coord w/ natural high flow events)	

Figure C1 Illustrative hydrographs for Alternative 6. Hydrographs were created for all seven alternatives. They assisted workshop participants by roughly representing the flow changes for each alternative. This example is provided as a demonstration.



Step 4. Illustrative Consequences

A final step in the development of the case study preparation was to coarsely estimate the expected outcomes of each bookend flow alternative using the PMs in Step 2. The Technical Reference Group discussed and briefly reviewed a preliminary scoring of the flow alternatives using the PMs along with the illustrative hydrographs.

A key tool in the evaluation process is a summary of all the expected consequences, called a Consequence Table. These are useful for summarising the multiple types of expected outcomes, identifying which PMs did not meaningfully change across the range of alternatives, identifying key trade-offs, and deliberating with other group members toward an option that may have the best balance among the group's interests. Table C3 is the Consequence Table for the illustrative case study.

The estimated consequences are colour coded to better highlight differences across the alternatives. The colours are not intended to imply that all differences are significant and important. The tool also has a function to select an alternative and colour code the other alternatives where they perform better or worse than the selected alternative, providing a useful visual summary.

Table C3 Illustrative Consequence Table Summarising the Performance of the Bookend Flow Alternatives for Upper Murrumbidgee River

Objective (Less Preferred – More Preferred)	Performance Measure	Unit	Preferred Direction	Max Power	Max Resource	Historical	SWIOID (Current)	Adaptive EFlows	Macquarie Perch	Unimpaired Flows
Environment Upper Murrumbidgee										
Endangered Species	Probability of Persistance for Macquarie Perch over next 25 years		Higher	Low	Low	Low	Low-Med	Low-Med	High	High
Instream Aquatic Habitat	Avail, suitability and diversity of habitat	Scale	Higher	1	1.5	1.5	2	3	4	5
Riparian Habitat	Availability, suitability of diversity of key habitat	Scale	Higher	1	1.5	1.5	2	3	3	5
Environment - Other Locations										
Aquatic Habitat	Degree of flow reductions on Other Snowy Montane Rivers	Scale	Higher	3	3	3	5	4	2	5
Aquatic Habitat	Potential effects from UMR flow changes on Murrumbidgee (below Gundadai)	Scale	Higher	3	4	3	3	3	2	1
Industry & Commercial										
Snowy Hydro	Foregone hydropower generation	GWh	Lower	-50	25	0	150	150	230	550
Snowy Hydro	Foregone long-term energy storage	Scale	Higher	5	4	5	3.5	3.5	3	1
Snowy Hydro	Ancillary Benefits	Scale	Higher	5	4.5	5	4	4	3	1
Irrigation - Unregulated UMR	Likelihood of decrease in water availability for entitlement holders (dry yrs)	Scale	Higher	1	3	3	3	4	5	5
Regulated Irrigation - Below Gundagai	Potential addn impact to Total Allocation to licensed water holders	Scale	Higher	4	5	4	4	4	3	1
Water Supply										
Municipal / Local Townships	Average annual volume water delivered (for UMR)	GL	Higher	10	15	15	18	21	22	22
Municipal / Local Townships	Average # days/ year that access is curtailed	Days	Lower	20	5	5	5	5	0	0
Critical Human Needs	Average # days / year that access to critical water is curtailed	Days	Lower	5	0	5	5	5	5	10
Flood Risk										
Regulated Murrumbidgee	Change in flood risk below Gundagai	Scale	Higher	2	4	3	3	2.5	2	1
Regulated Tumut	Change in flood risk on regulated Tumut River	Scale	Higher	2	5	3	3	3.5	4	5
Unregulated UMR	Change in flood risk on UMR	Scale	Higher	4	3	3	3	2.5	2	1
Other Socio-Economic										
Whitewater Rafting	Average # days / yr that flows are at preferred levels (Oct)	Days	Higher	5	5	5	5	20	20	50
Bathing & Swimming	Avg # days / yr that flows are betw 40-100ML during peak season (Jan-Feb)	Days	Higher	5	5	5	5	45	60	10
Recreational Fishing	Angler fishing success	Scale	Higher	1	2	2	3	4	5	4
River Crossing Access	Average # days / yr where flows impede and/or restrict access over private crossings	Days	Lower	2	10	2	5	10	20	60
Water Management										
Infrastructure Costs	Capital costs for needed upgraded infrastructure	$ (Millions)	Lower	0	0	0	0	30	300	0
Supplemental UMR Environ Water	Average annualised costs to deliver supplemental water	$ (Millions)	Lower	0	0	0	0	2	35	250
Ease of Implementation	Relative ease to implement alternative (e.g., institutionally, regulations, etc.)	Scale	Higher	1	2	2	5	2	1	1

Annex D. Organisational structure

The organisational structure and process workflow that was used for the Cowichan Water Use Plan is provided as an example (see Figure D1). This structure is indicative of core functions that are needed to support an SDM process, as shown in Table D1.

Table D1 Core functions in an SDM process, with reference to the Cowichan Water Use Plan.

Core Function	Discussion
Establishing and implementing the process	This function includes setting the parameters and scope for the planning process, initiating the planning and providing direction and/or troubleshooting any process, stakeholder, or additional scope issues which emerge during the planning that could derail the process. This function also includes securing funding and convening the participants who will be on the various working groups. This function is typically carried out by project sponsors representing the decision making organisations and often with senior representatives from key project partner organisations (such as other government agencies, hydropower operator, First Nations, and depending on the context sometimes a key funding agency or NGO). It is common to establish some form of working group (or steering committee) during this early step. It needs to be emphasised that a steering committee would not be involved in running through the SDM steps or making the trade-offs towards a recommendation: their role is establishing the process and scope to make sure it aligns with the necessary context. The steering committee's work is therefore normally centred at the beginning of the process to get it off the ground, and may be called upon during the process if there are different interpretations of the scope or the regulatory context that need to be clarified or there are specific stakeholder issues or conflicts that need be resolved and are unable to be resolved within the process. For the Cowichan Water Use Plan, a steering committee was established that consisted of senior representatives from the provincial government, the water license and dam owner, the local government, a First Nation, and a well-established NGO that had been actively involved and undertaking research and restoration work on the river over the past 20 years.
Managing and supporting the process	This function consists of managing the process, which can include doing the legwork to set up the process (as directed by the steering committee) and working group structure; convening and providing logistical support to hold the meetings; providing coordination, decision analysis (SDM), and facilitation support to

	the various working groups; supporting follow-up actions to keep the process moving (including communications with participants between meetings and taking meeting notes); and often developing and implementing the broader communications and engagement strategy that may be required. Much of this support can be provided through staff from the project sponsors with the exception of the decision analysis and facilitation support which are almost always provided through an independent third party (e.g., research institute or private consultant). Generally, the structure of this function takes the form of a project management team consisting of one or more project sponsor staff (who also manage the contracts) and the consultants / third parties who are providing decision analysis and facilitation support. For the Cowichan Water Use Plan, the project team consisted of Compass and the local regional government (who managed the contracts). Compass was responsible for the decision analysis, facilitation, public communication and coordinating and leading all the engagement streams (with the exception of the First Nations stream that was a government-to-government responsibility with technical support from Compass).
Making recommendations *(through the SDM steps)*	This function relates to a main deliberative group who actively work through the SDM planning steps and are responsible to seek agreement on broadly supported recommendations at the end of the process. The general roles for this working group will be: (a) considering the needs and interests of all the different water uses identified during the process, (b) taking into account the best available information about the consequences of proposed alternatives, (c) identifying a preferred alternative along with other considerations that are within the scope, (d) outlining criteria for any ongoing monitoring and assessment programs, and (e) establishing the timeline for a review of the recommendations, if they are implemented. The main deliverable from this deliberative group will be a summary report of their discussions and recommendations during the process. It will typically be written by the facilitator / analysts. For the Cowichan Water Use Plan, the main deliberative group was referred to as the Public Advisory Group. It consisted of representatives from each interest area that could affect or be affected by a flow decision and included: responsible government agencies (federal, provincial and regional), Catalyst

	Paper who owned the water control structures and held the water license, First Nations (who decided to participate within the committee structure), drinking water districts (who relied on the surface and ground water for their municipal water), recreation users, environmental organisations, lakefront property owners (whose shorelines would be affected), and other stakeholders and local citizens.
Providing technical support	This function consists of providing the needed technical support to the main deliberative group as they work through the SDM planning steps. This support typically includes (a) issues scoping (to assess and screen the validity of identified issues as to whether they will be affected by the alternatives), (b) development of performance measures to assess the alternatives, (c) technical input into the development of alternatives, (d) review and ground truthing of the draft performance measures through the process (and revising and updating them as required), (e) supporting the development of any needed monitoring programs to assess the recommendations overtime and to address critical data gaps, and (f) providing other technical advice as requested by the main deliberative group (e.g., identification and assessment of non-flow physical works). This function can be carried out through a combination of different ways: (a) government technical staff provide this role, (b) technical working group is formed with experts from the participating agencies / organisations, (c) independent science panel can also be formed to peer review the work, or (d) independent third party / consultants are hired to do the technical work. What is most common on larger planning processes is the establishment of a technical working group who oversee, guide, and help interpret the work of a consultant who does all the heavy lifting and technical analysis. In a process, it may be necessary to have different technical working groups depending on the nature of the issues to be assessed and characterised. Therefore, there may need to be for example an aquatic (fish) ecosystem group, a riparian and terrestrial ecosystem group, and a socio-economic group. It may also be important to also have an Indigenous Knowledge working group to better address environmental and socio-cultural effects and these can run in parallel to better protect the knowledges that may be generated and used. For the Cowichan Water Use Plan, an environmental consultant was hired to support and carryout the work under the instruction

	of a riparian and aquatic technical working group that was established. As well, a socio-economic technical working group was formed to primarily assess and quantify impacts specific to lakefront property owners and this group was facilitated by Compass. The characterisation and assessment of other interest areas were all carried out within the main deliberative group's meetings.
Providing updates (and seeking input) with the public	This function is almost always a feature of an SDM process. It can take different forms as passive communication (where the focus is providing information out in terms of updates) to more active engagement (where views and opinions are sought by a broader audience at key times in the process). The latter can serve to ground truth whether the main deliberative group has missed something or if their direction does not align with the greater public. The opportunity for broader public participation is normally defined at the beginning of the process by the Steering Committee through a communications and engagement strategy. Typical engagement activities can include public communiques and update newsletters; public websites that are regularly updated on progress and can include key documents (meetings agendas and minutes, presentations); public meetings and open houses; targeted focus groups; and public surveys. For the Cowichan Water Use Plan, public meetings and open houses were held at the start and at the end of the process; a project website was created and provided regular progress updates to the public; an online survey was carried out towards the end of the process to feed into the process and gauge public opinion on their priorities and preferences; and at regular intervals advertisements were posted in local paper with updates and invitations for the public to learn about the progress of the work.

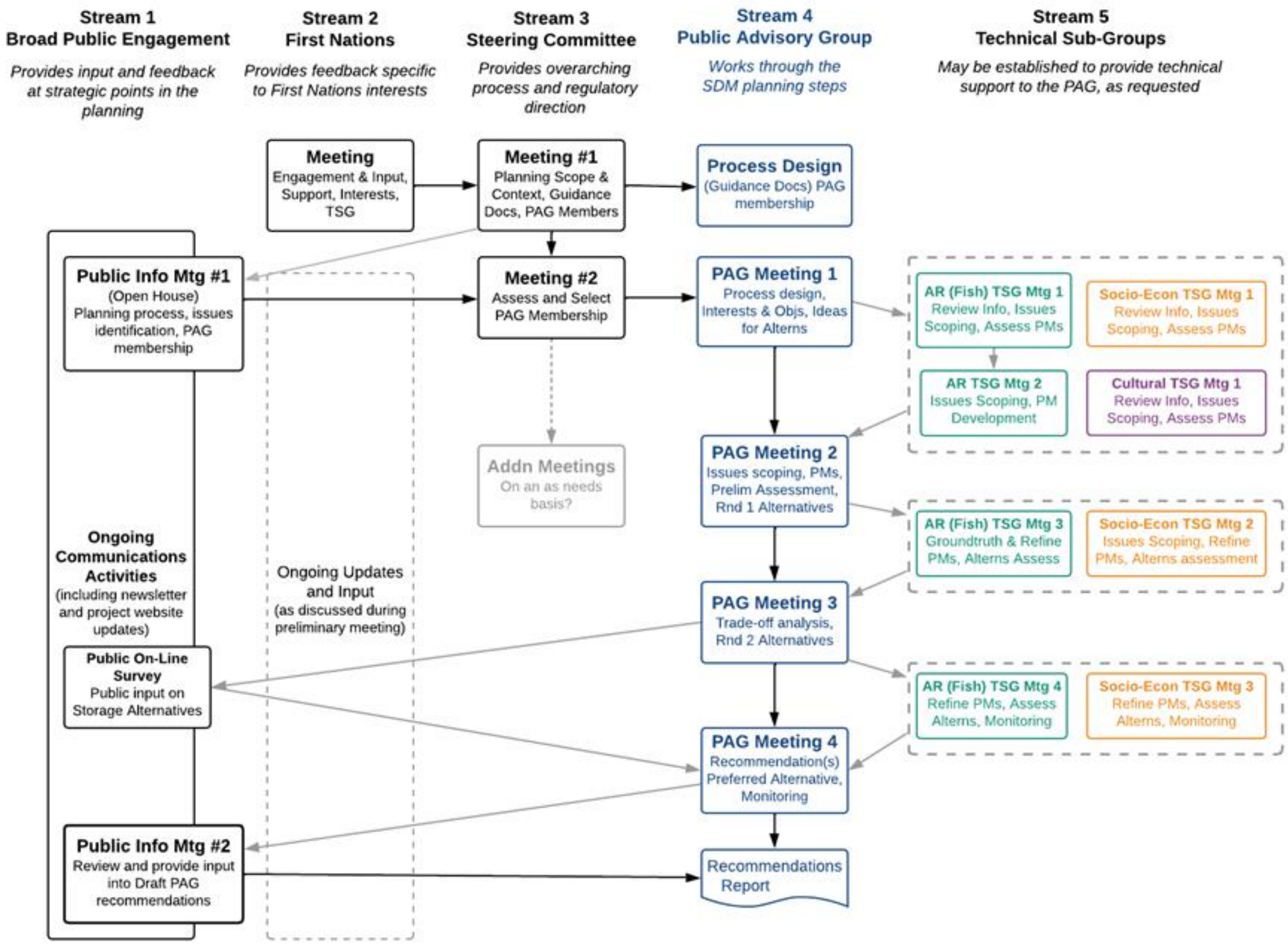


Figure D1: Organisational structure for the Cowichan Water Use Plan

Annex E. Workshop participant list

The following table lists those participants who approved their name being made public.

Name	Position	Organisation
Tanya Koeneman	Branch Head	Australian Government - Department of Climate Change, Energy, the Environment and Water
Ryan Breen	Director - Upper Murrumbidgee Infrastructure and Investment	Australian Government - Department of Climate Change, Energy, the Environment and Water
Pete Pfitzner	Assistant Director (Water) - Snowy & Upper Murrumbidgee	Australian Government - Department of Climate Change, Energy, the Environment and Water
Kara Boughton	Assistant Director – National Energy Transformation Division	Australian Government - Department of Climate Change, Energy, the Environment and Water
Adam Sutherland	Director – Snowy Hydro Governance	Australian Government - Department of Climate Change, Energy, the Environment and Water
Mahala McLindin	Manager - Snowy Water Licence	NSW Department of Climate Change, Energy, the Environment & Water - Water
Ben Cirulis	Director Energy Data and Analytics	NSW Department of Climate Change, Energy, the Environment & Water
Emma Wilson	Senior Environmental Water Management Officer - Snowy & Montane	NSW Department of Climate Change, Energy, the Environment & Water
Fiona Wright	Executive Group Manager - Climate Change Energy and Water	ACT Government
Danswell Starrs	Director - Water Information Services	ACT Government
Libby Chilvers	Director - Water Trade	ACT Office of Water
Rinzin Lhamo	Policy Officer	ACT Office of Water
Nic Morgan	Senior Advisor / Program Manager	Icon Water
Wally Bell	Ngunawal Traditional Custodian	

Name	Position	Organisation
Karen Denny	Ngunawal Traditional Custodian	
James Pirozzi	Manager Water	Snowy Hydro
Jeremy Kinley	Manager Policy and Planning	Snowy Hydro
John Rodger	Chair	Snowy Advisory Committee
Gina McConkey	Coordinator Strategy Development	Snowy Monaro Regional Council
Maxine Cooper	Chair	ACT & Region Catchment Management Coordination Group
Alex McNee	Water Expert	ACT & Region Catchment Management Coordination Group
Mark Lintermans	Director	Fish Fondler Pty Ltd
Siwan Lovett	Chief Executive Officer	Australian River Restoration Centre
Andy Lowes	Chair	Upper Murrumbidgee Catchment Network, ACT & Region Catchment Coordination Group
Deep Singh	River Murray Accounting Improvements	Murray Darling Basin Authority
Brett Jones	Chief Executive Officer and Managing Director	Murrumbidgee Irrigation
Brian Crawford	Decision Scientist	Compass Resource Management
Michael Harstone	Principal/ Decision Analyst	Compass Resource Management
Karen Hutchinson	Chief Executive Officer	Watertrust Australia
Peter Horne	Principal	Watertrust Australia
Chris Cumming	Principal	Watertrust Australia
Leila Noble	Policy Analyst	Watertrust Australia
Sophie Eickelman	Executive and Communications Officer	Watertrust Australia