waterSMART
Water Management Solutions

Alberta Water Council

Memorandum of Results
Drought Simulation Exercise
Final Report

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In May 2021 WaterSMART Solutions Ltd. (WaterSMART) was engaged as a consultant to the Alberta Water Council (AWC) project team to plan and execute a drought simulation exercise focused on drought in the South Saskatchewan River Basin (SSRB). This exercise was subsequently titled the SSRB Drought Simulation Exercise. The AWC project team and WaterSMART worked closely together to plan and design the exercise.

This memorandum style document compiles the key information gathered and synthesizes the key takeaways from the SSRB Drought Simulation Exercise. This document is intended to be a reference for the AWC project team in preparing their final report.

Drought Simulation Exercise summary description

The SSRB Drought Simulation Exercise event was held on June 10th, 2022 as a full-day, collaborative planning exercise that used a computer model to support exploring sub-basin group responses to a drought scenario. A diverse group of experts and stakeholders took part, and they worked in sub-basin groups for the Red Deer, Bow and Oldman River basins within the scenario of drought for the overall SSRB. The computer model (i.e., SSROM) was used as a tool to support understanding and conversation around drought management decisions. The key learnings from the exercise came from the conversations and the perspectives shared by participants, not from the model results. A list of participating organizations is included in Appendix A.

The key learnings described in this document come from individual sub-basin tables, from the plenary discussions, and from overall learnings from the whole exercise. This document is organized into subsections that align directly with what the AWC project team identified as the objectives and desired outcomes for the exercise.

SSRB Drought Simulation Exercise objectives and desired outcomes

Alberta Environment and Parks (AEP) has documented water shortage procedures for the SSRB for internal government use. The purpose of the water shortage procedures is to guide provincial government response to water shortage through identification of drought severity and mitigation actions undertaken at the provincial government level. The SSRB Drought Simulation Exercise sought to use the AEP guidance as a basis to test the drought response process amongst water managers and stakeholders within the SSRB. The SSRB Drought Simulation Exercise had four objectives:

- Assess current drought vulnerabilities within the watershed,
- Identify gaps in current drought mitigation actions, legislation, and policy,
- Identify procedures and mitigations to address current gaps in procedure or policy within the SSRB,
- Identify lines of communication between stakeholders.

Each of these objectives sought to support the broader goal of assessing current drought mitigation processes and identifying gaps in plans, policy, and legislation. The information gathered from the exercise will be used to inform the development of the AEP Provincial Drought and Water Shortage Plan.

The SSRB Drought Simulation Exercise did not seek to change legislated water management under the Water Act or alter the existing AEP Provincial Drought and Water Shortage Plan. Instead, it sought to test the existing procedures with stakeholders to identify risks and vulnerabilities in drought response.

Progress of the drought stages through the exercise

For the purpose of the exercise, participants needed to understand what role they were playing in the system of drought management. Participants assumed the role of a Watershed Planning and Advisory Council (WPAC) in each sub-basin, enabling them to bring their actual experience and diverse perspectives to the table for managing a drought at an appropriate scale for decision-making (i.e., by sub-basin). As the exercise progressed the drought severity changed, and each sub-basin progressed through five drought stages (see Appendix B for descriptions of the drought stages). The "chair" of the Intrabasin Water Coordinating Committee (IWCC) relayed the ultimate decision made by the AEP Minister regarding the drought stage for each sub-basin based on the advice of the participants. The IWCC is an actual group established by the Approved Water Management Plan for the SSRB (2006). The IWCC is made up of representatives of each of the WPACs in the SSRB. Its primary responsibilities include providing guidance to AEP, preparing and maintaining an apportionment operations plan for meeting the requirements of the Master Agreement on Apportionment, and communicating to the public. The roles of the IWCC committee chair and the Minister were played by WaterSMART staff. The Minister balanced the advice with the needs of all concerned basins and a perception of the needs of the broader economy, historical advice, and operational limits, which occasionally led to decisions that were contrary to advice provided by the IWCC. Table 1 summarizes in the points in the exercise when there was a change in drought stage and when the change was advised by the sub-basin WPAC.

Table 1 Summary of exercise progression through drought stages

Month	Red Deer River Basin	Bow River Basin	Oldman River Basin/South Saskatchewan River Basin
March 2035	Stage 2 *(based on WPAC advice)*	No stage level	No stage level
April 2035	Stage 2	No stage level	Stage 1 *(based on WPAC advice)*
May 2035	Stage 2	No stage level	Stage 1
June 2035	Stage 2	Stage 1 *(WPAC advised no stage level – overruled by Minister)*	Stage 1 *(WPAC advised Stage 2 – overruled by Minister)*

Month	Red Deer River Basin	Bow River Basin	Oldman River Basin/South Saskatchewan River Basin
July 2035	Stage 2, on the verge of Stage 3	Stage 1	Stage 3 *(based on WPAC advice)*
August 2035	Stage 3 *(based on WPAC advice)*	Stage 1 *(WPAC now agree with this stage)*	Stage 3
September 2035	Stage 3	Stage 1	Stage 3
March 2036	Stage 4 *(declared basin wide by the Minister)*	Stage 4 *(declared basin wide by the Minister)*	Stage 4 *(based on WPAC advice)*
April 2036	Stage 5 *(based on WPAC advice)*	Stage 5 *(declared basin wide by the Minister)*	Stage 5 *(based on WPAC advice)*
May 2036	Stage 5	Stage 5	Stage 5
June 2036	Stage 5	Stage 5	Stage 5
July 2036	Stage 5	Stage 5	Stage 5
August 2036	Stage 5	Stage 5	Stage 5

Key Observations

Several key observations were identified across the sub-basins as the exercise progressed. The drought scenario impacted each sub-basin differently and water shortages were observed at different times. Overall, the Bow sub-basin was less severely impacted by the drought, while the Oldman and Red Deer sub-basins experienced severe water shortages.

Sub-basin observations

The sub-groups of the Red Deer, Bow, and Oldman River sub-basins each experienced the drought differently in the scenario, and there were different individuals and expertise represented at each table. Below are the overarching observations that were noted from each sub-group.

Red Deer River sub-basin

The Red Deer sub-basin experienced a severe water shortage and was forced to implement extreme measures by restricting water use. Managing the drought proved extremely challenging due to the limited storage available in the sub-basin, which only has the Gleniffer Reservoir (Dickson Dam). The Gleniffer Reservoir is a fraction of the storage capacity of either of the other sub-basins. Below are some key observations the participants identified in the Red Deer sub-basin.

A key observation in the Red Deer sub-basin was that there are not many tools available to mitigate a drought because the volume of storage is minimal. Gleniffer Reservoir is the only significant storage in the basin and is operated to maintain the Water Conservation Objective (WCO) of 16 m^3/s outflow. In the exercise, the model attempted to maintain the WCO target when possible, which meant the reservoir was drawn down over winter and little water was available when needed in the spring/summer months. In the real world, the reservoir would likely be operated differently during a drought with preference given to storing water to meet demand rather than maintaining the 16 m^3/s outflow throughout the winter months. This approach, which was not simulated, would have violated the WCO but may have reduced the impact of the drought in the summer months. This exercise highlighted that it would not be possible to meet both the full water supply demands and the WCO in a severe drought, which may have environmental implications.

Because the Red Deer River WCO was violated during the exercise, the participants noted that those water licences which are subject to the WCO would not have been able to withdraw any water, regardless of their priority. They noted that this would need to be considered in a drought and relating to the Gleniffer Reservoir operations.

An action the participants felt was necessary to take was to implement restrictions which cut water use to 40% of expected use. However, because the Red Deer sub-basin does not have a large volume of licenced water allocations, even this significant reduction in licenced water use did not result in a significant river flow increase. This suggests that other forms of drought mitigation will be needed in the Red Deer sub-basin, which ideally would create bigger improvements with less severe economic and social impacts than restricting water use to 40%.

Participants noted that it would be valuable to expand storage or change the operations of the Dickson Dam/Gleniffer Reservoir to effectively mitigate a drought in the Red Deer River sub-basin. The change in operation during a severe drought situation could acknowledge that, as seen in this exercise, meeting environmental targets (the WCO) at one time in the year can prevent meeting targets at other times and smaller flow releases throughout the year may be preferable. The change in operation may also be necessary to allow prioritisation of water supply for essential human use.

Early in the exercise, participants in the Red Deer sub-basin had an opportunity to hold back water but did not because they were conscious of apportionment obligations. It was noted that better communication with neighbouring sub-basins could have resulted in better drought response as they could have relied on the Bow River sub-basin providing a larger contribution to apportionment. The role of the IWCC and its potential to manage communications during a drought was not well understood by participants. There has not been a great deal of need for this communication in recent years thanks to

good water supply. In the event of water shortage, communication from the IWCC members becomes crucial and there is a need for water users to understand their role in a drought.

The exercise also highlighted the vulnerability of the Red Deer sub-basin to multi-year droughts. In a multi-year drought, it is possible that there will not be enough flow in the river to fill the reservoir. If Gleniffer Reservoir cannot fill, then the Red Deer sub-basin can experience severe water shortage very quickly.

During the exercise, participants in the Red Deer River group expressed uncertainty around what methods and options were available to them, and if water uses would just be determined by a licence priority call and government decision. The group noted various points where they would expect the government to support drought management and water use priority decisions.

In the Red Deer sub-basin groundwater information was overlooked during the exercise which indicated that this is not a key consideration for most participants. There may be an opportunity to educate water managers on the significance of shallow groundwater and identify pathways to use groundwater to mitigate water shortages where possible.

The participants in the Red Deer sub-basin discussed at length the options and challenges associated with cutting off Temporary Diversion Licences (TDLs). In the Red Deer sub-basin TDLs are often used for livestock watering and there was concern that blanket cut-off would put livestock at risk.

Bow River sub-basin

The Bow River sub-basin was less severely impacted by the drought in this scenario, which provided an opportunity to explore the possible tensions arising between portions of the SSRB experiencing greater and lesser supply at the same time and to prompt discussion on the application of blanket restrictions across the basin. Although river levels were below normal, there was enough flow in the river to meet minimum flow requirements and maintain close to normal reservoir levels. This resulted in some discussion by the participants around the opportunities to assist neighbouring sub-basins.

Participants identified that limited tools are available to Bow sub-basin participants to alleviate drought in neighbouring basins. Participants in the Red Deer requested a transfer of water from the Bow using irrigation return flow infrastructure; however, this was not deemed practical because the drought conditions would encourage efficiencies in the districts resulting in very low return flows. Eventually, the Bow sub-basin participants elected to use the upstream TransAlta reservoirs to store water in the system as a pre-emptive measure to help meet apportionment when it was clear other sub-basins would be placed in a position of extreme difficulty trying to meet their share. This also included modifying the agreement on Ghost reservoir to begin filling before the agreed July 7th date as defined by the 2021 agreement between TransAlta and the Government of Alberta. The goal was to keep water as far upstream as possible to provide maximum benefit to river health if it was needed.

Participants in the Bow sub-basin were focused on the status of surface water, and shallow groundwater information was overlooked as a potential water source until late in the exercise. At that point investment in real time groundwater monitoring and mapping was identified as an action that would help drought preparedness.

Communication to the general public and licence holders was challenging because the Bow sub-basin had

water available, but a severe drought had been declared across the SSRB. The participants elected to focus communications on voluntary reductions to help their basin neighbours, stressing there was no need to panic for water users in the Bow sub-basin. This balanced approach to communication was implemented to prevent licence holders storing water in anticipation of drought and leading to greater water use. The City of Calgary offered their expertise in managing restrictions efficiently to other municipalities which suggests that information sharing could lead to more knowledgeable water managers across the SSRB.

Participants primarily used reservoir status to gauge general water availability in the basin; however, it was recognised that this metric is less useful for certain water users, such as Western Irrigation District, who are reliant on flow in the river for their water. This caused the group to shift to reviewing the reservoir status alongside the river flow.

Oldman River sub-basin

The participants for the Oldman River sub-basin table were diverse and included people who are current key water management decision-makers and people with experience managing drought. Since water users and water managers in the Oldman River sub-basin are familiar with water-scarce situations, this expertise resulted in less uncertainty, with concrete actions for drought management being more easily identified.

The Oldman River sub-basin was able to manage a single year drought fairly comfortably, with the reservoirs and reservoir levels that they were given at the beginning of the scenario. Participants noted that the second year of drought is when the severe impacts are felt; this was observed in the exercise. The system of onstream and off-stream reservoirs provides the Oldman River sub-basin with more water management options and resilience for one year of drought. The participants relied heavily on the reservoir level information from the model for the decision-making in the exercise.

The participants were attentive to the reservoir levels in the Oldman Reservoir in particular because of the instream flow needs downstream, the need to meet apportionment, and for downstream municipal demand including the City of Medicine Hat. Participants highlighted there would be severe consequences to instream flow needs and all downstream users if the Oldman Reservoir was empty.

Water licence assignments, also called water sharing agreements, were a key part of the drought management in the Oldman River sub-basin. The group recognized that establishing the agreements would be a time-consuming process and would have to start in the winter prior to the demand season. They also recognized that smaller watersheds within the Oldman River sub-basin would likely need their own localized sharing agreements.

Irrigation District representatives articulated the decisions that would be made for reducing water use and limiting the economic impacts through preparedness, which centred around determining the farm-gate allocation based on the stored water and snowpack. The timing for communicating the farm-gate allocation decisions must be early in the season because producers will order their seed based on the amount of irrigation water available to them.

Municipality representatives at the table discussed the demand reduction measures that would be taken by municipal water users. They identified up to a 30 percent reduction (which would amount to the

municipal demand being 70% of normal) to conserve water and help manage the drought.

The participants highlighted the importance of frequent meetings of key water user groups (e.g., irrigation districts, municipalities, hydropower generation companies, etc.) and management decision-makers during a drought, similar to the exercise format of frequent collaborative decision-points. The planning meetings would be more frequent than each month, and at stage 5 drought, the decision-making would be on a day-to-day basis. The group also noted that reaching certain points during the drought would prompt specific communication to the provincial government or the other sub-basins. For example, projecting the Oldman Reservoir could empty would be one of those key communication points because of the basin not being able to meet apportionment, among other serious impacts. The group suggested that it would be helpful to have a list of contact information for key people for drought management in the sub-basin, including decision-makers and people who manage water use. The list would be updated regularly to remain current and would be designed to shorten the time required to coordinate and sign water licence assignments.

At Stage 5 drought the participants prioritized municipal needs and livestock water, noting that irrigation districts deliver water to livestock operations so shutting down irrigation districts completely would not be advisable. They discussed an opportunity for Stage 5 emergency management involving communication with AEP to change the operation of the Oldman Dam. The operational change would purposefully not meet instream flow needs (IFNs) over winter with the aim of holding water back to be released for municipal uses in early spring before the snow melts.

Does the overall drought management process in Alberta work?

In the SSRB Drought Simulation Exercise, the drought management process was likely applied slightly differently than it would be in the real world. However, the results can still inform whether the process works effectively. The exercise showed that a staged drought response process works well as long as it is supported by reliable data, knowledgeable water managers and, ideally, reliable drought forecasting. The exercise highlighted the need for proactive drought management through the development of local, regional, and provincial drought response best practices and accepted procedures. The exercise highlighted that drought planning is not just the responsibility of provincial government; municipalities, irrigation districts, and water managers who had their own plans in place were able to take appropriate action at the right time.

Local management of water shortages

The exercise highlighted that the three sub-basins of the SSRB respond to drought differently and may choose different approaches within the provincial legal framework based on the local context and needs of each basin. The drought response process within Alberta is structured to encourage bottom-up management during early stages of drought. Specifically, water managers within a sub-basin are able to coordinate to identify the best approach and advise the government. This approach can lead to better outcomes as it incorporates local context and collaboration between water users.

Use of water assignments

During later stages of drought, there is still opportunity for water users to balance their own sub-basin

needs through the use of assignments, as opposed to the priority system which could result in cutting off some users. This system, enabling voluntary water licence assignments with government support, was key to the results seen in the exercise. When it is deemed necessary, the drought management process allows government to actively manage drought through water management actions in the AEP Provincial Drought and Water Shortage Plan. This approach encourages those closest to water use to play a more active role in managing water shortage. However, the exercise demonstrated that there was some ambiguity surrounding the scope and role of government and the expectations of water users and water managers.

Organizational roles and responsibilities and communication

Participants noted that in reality, WPACs do not play the role that they did in the SSRB Drought Simulation Exercise. WPACs do not recommend what actions should be taken but may act as one of the many inputs to the decision making process. In the real world, there are small groups of key water users and decision makers who do meet regularly and take on the role mirrored in the exercise.

The exercise included robust communication between many major water users and government. However, participants felt operational decisions made by government could be communicated more broadly as these decisions can impact their own actions.

Feedback on drought stages

The drought stage descriptors used in the SSRB Drought Simulation Exercise are appended to this report in Appendix B. These stages were adapted from the defined stages detailed in the AEP Provincial Drought and Water Shortage Plan. It is understood that the drought stage descriptors are used internally by AEP as a reference and framework for drought response. Exercise participants found that the drought stages were useful for defining and communicating the severity of the drought. Exercise participants felt that the drought stage thresholds could be defined more clearly so that they are less open to interpretation. It was unclear if all descriptive points must be met to declare a drought stage.

Exercise participants expressed that it was unclear what action would be taken at each drought stage. It may be beneficial for the AEP to provide guidance to water users so they better understand the government actions that may be implemented during a drought. As an example, guidance could be provided outlining when statutory actions such as priority calls might be taken and when community decisions such as voluntary conservation and water assignments might be implemented. This guidance may also help water users develop or refine their own procedures. A guidance document could also define expectations of water users and clarify when government would impose actions, especially during severe Stage 4 or Stage 5 drought when government may impose control over water uses. During the exercise, participants felt this boundary between self-governance by water users and government control was not always clear.

Oldman sub-basin participants noted that according to the definition of Stage 1 as it is currently written, the Oldman likely qualifies as Stage 1 drought almost every year in early spring. The Oldman water managers monitor snow pillows closely to understand the drought potential in that year, especially in the spring. The definition of frequency of monitoring and how it differs from normal monitoring frequency

could be better defined in future drought response plans.

Participants in the Red Deer River sub-basin suggested that Stage 3 may need to be reworded because there is too much focus on apportionment and not enough focus on the available water for meeting user needs. They suggested that the river flow was violating the WCO because there was no remaining stored water to supplement natural flows, and that this could potentially indicate being at Stage 3. The impact on the environment from violating the WCO was not known but monitoring for impacts of these violations was discussed.

Participants in the Red Deer River sub-basin did not understand which stage of drought relates to the legislative authority for the government to alter the water licence priority system, and which stage relates to a declaration of a state of emergency. Participants noted the need for the government to intervene to enforce reductions in licence diversions and ensure water for essential human uses, which was experienced when the Red Deer River sub-basin was declared to be in stage 4 drought. This points to a need for clarification of legislative authority and responsibility at each drought stage.

Drought vulnerabilities

Loss of crops, risk to human health and a high likelihood of extensive fish kills were some of the catastrophic impacts were observed in the second year of drought during this exercise highlighting the vulnerability of the SSRB to multi-year droughts. The simulated drought was very severe, but it is conceivable that a drought period could be less severe but extend beyond a two-year period, which would also result in catastrophic conditions. It is also conceivable that all three sub-basins within the SSRB experience similar drought severity in the same time period, in which case there would be challenges meeting apportionment. In addition, low reservoir levels as a consequence of a multi-year drought threaten the water supply for large municipalities such as Medicine Hat, Calgary, Red Deer, and Lethbridge.

The Red Deer River sub-basin was identified as vulnerable to even a single year of severe drought because of the sub-basin's limited storage. The participants at the Red Deer River table attempted to mitigate the drought through implementing usage restrictions, but they found that the Gleniffer Reservoir operations to meet the WCO through the winter used up any water they managed to store during the summer and early fall. This identified a vulnerability to municipal and livestock water users downstream of the reservoir as the natural river flow (flow-through the empty Gleniffer Reservoir) during summer of a drought year was not sufficient to meet their needs.

Some rural municipalities and livestock producers are supplied water from irrigation districts, which may make them more vulnerable if irrigation district water use is restricted. This adds complexity to restricting irrigation water diversions and may potentially result in restrictions to supply where it is not intended. AEP may consider addressing water supply for these users directly in localized plans.

The SSRB Drought Simulation Exercise used a high-level approach and defined drought severity by sub-basin. In reality, there may be smaller watersheds within a sub-basin that are more vulnerable to drought; participants noted Willow Creek and Little Bow as two such watersheds. To manage this, AEP uses more localized Water Management Areas (WMAs) to identify water supply status. This exercise validated that

approach and showed that drought can be very localized, and plans need to be in place to manage at the local scale. Water users in more vulnerable watersheds such as Little Bow and Willow Creek should be proactive to discuss and outline potential water sharing agreements before there is a need to implement them.

Exercise participants in the Oldman River sub-basin identified the agriculture industry as particularly vulnerable in drought. The irrigation districts try to provide producers information early for buying seed and planting crops that align with the available water that year. Irrigators often have access to stored water, which provides some resilience against drought. Dryland farming is always vulnerable to drought as these farmers rely only on precipitation.

The Oldman River sub-basin group relied on water licence assignments for sharing water within the context of the priority system. For assignments to work, water licence holders must willingly participate and understand the benefits of such an agreement. Low participation in the water licence assignment requires more AEP resources to manage licence priorities as well as a water licence assignment.

It is time consuming to set up agreements, and water licence holders must feel confident that no one is able to cheat without consequence. There is a vulnerability in the current drought management system in that there is no formal established approach for mass water licence user assignments and there is a reliance on undocumented historical knowledge of previous agreements. There may also be a lack of trust in the role of government to enable these assignments to be agreed upon in the event of a drought. Exercise participants noted that senior water licence holders may not be willing to join water sharing agreements, so a means of making the case to them could be a key measure toward effectively mitigating impacts of drought.

Gaps in current drought mitigation actions, legislation, and policy

Participants in the Oldman River sub-basin quickly assumed water-sharing agreements would be the primary mitigation action against shorting water users; however, there is a gap in understanding the specific mechanisms for how water assignments would work and if every user can functionally take part. The concept of ‘sharing the pain’ was agreed to be the preferred approach, although participants did not seem to know exactly how to move forward in thinking through what that would look like. Participants needed guidance from those who had experience in developing historical water sharing agreements. The participants noted that some users may not physically be able to access water due to their location within the river system. For example, there are ranchers who are upstream of irrigation districts; there is no physical way an irrigation district can convey water to their land, these water users may still wish to be a part of the agreements to prevent their licences from being cut off in favour of supplying water downstream.

During severe droughts when reservoir levels are low there is little guidance for water managers and operators to determine appropriate reservoir operations. There is a balance between storing what little water is available and meeting demands. During the exercise participants had to determine when water should be released to meet demands and when it should be stored as a precautionary measure which prompted significant debate during severe water shortage conditions. A decision making matrix could

help water managers assess and mitigate risk in these scenarios.

It is possible that the conditions observed during the exercise in which a drought stricken sub-basin is next to a sub-basin with ample water could occur in the real world. Participants in the Bow sub-basin did not identify an effective method to directly aid their neighbouring sub-basins within the current regulatory structure. Although intra-basin transfers are not limited by the Water Act, during the exercise participants were concerned that using this mechanism for transfer would set a precedent. The concern was that their own sub-basin may be seen as a 'water bank' that could be drawn upon by others during water stressed times and would remove the incentive for their own efficiencies. Discussion of water transfers between basins drew concern regarding how the sub-basin losing water would be compensated if an emergency transfer were imposed. Compensation would likely be a topic of contention in the event of a transfer application.

Operations of the Oldman Reservoir contributes significantly to Alberta's apportionment obligation to Saskatchewan. During severe drought, the reservoir may have limited capacity to provide meaningful contribution to apportionment or may undergo temporary operational changes to meet demands. There appears to be a gap in the ability to meet apportionment if the Oldman Reservoir cannot provide any meaningful contribution to river flow.

The Oldman River sub-basin discussed the possibility of releasing lower-than-required flow volumes from the Oldman Reservoir through winter to mitigate the impacts of drought to users and to the river in the spring/summer, especially before the snowpack melts. There is currently a gap in government policy around when the required operation of the dam can be changed to mitigate extreme drought situations. An official government guidance document might be drafted to define the circumstances under which the reservoir operation can be changed. Essentially, at what point is the original purpose of the required releases superseded by the need to store an unknown amount of water to meet future demand. The Red Deer River sub-basin identified a similar challenge with the operations of Gleniffer Reservoir which releases during the winter months to meet the WCO, causing un-mitigatable challenges during the summer season when demand is highest. The pressure of an ongoing drought highlights the need for these discussions ahead of drought but it is recognized this may be a difficult topic to find time to address when there isn't an imminent need to address a water shortage.

The Red Deer River sub-basin had several discussions around licence priority decisions by the government, and how water use might be prioritized during severe water shortages. Participants suggested that water conservation measures would likely occur in the form of a water sharing agreement but during very severe drought there may be a need for government to assign water based on the use. Participants suggested municipal use be highest priority followed by livestock but there was not time to consider the implications of these to their full extent. Some large commercial entities use municipal water for their operations while their competitors may not as they are outside municipal boundaries. Prioritizing municipal water may result in a competition issue if a commercial entity is allowed water while their competitor is cut off. Existing policy and guidance documents provide little guidance to decision-makers how to prioritize water during severe droughts. Some general guidance on potential issues to be aware of such as those highlighted here provide helpful insight for decision makers during a drought.

Procedures and mitigations suggested by participants to address current gaps

A gap identified through the exercise is general understanding of what the drought stages (see Appendix B) mean, what are the tools available at each stage, and what forms of mitigation actions can be implemented. A way to mitigate this gap and improve understanding would be to have a guidance and interpretation document developed to supplement the list of the five drought stages. The document would be designed for a public audience and the government could send it to all water license holders when Stage 1 drought is declared. It was suggested that this document include historical case studies and narrative descriptions of the drought stages and subsequent mitigation actions. The language should not be prescriptive or instructional for decision-makers; the target audience is water managers to provide considerations and improve understanding.

The exercise identified a gap related to groundwater data; participants recognized that decisions could be made in a drought based on groundwater status. In various instances during the exercise, participants noted that the groundwater status was concerning, but that this did not impact their decisions. Participants also identified where the available groundwater data appeared to be unreliable. Addressing the gap in data relates to improving the system of monitoring wells, data collection and management. A possible means of addressing the gap in understanding is related to education. There is an opportunity for the provincial government to provide information on which water users rely on shallow groundwater and suggestions for how to address the risk of drought for them, as well as how interpreting shallow groundwater status may indicate context of a drought.

A common point of interest from participants was the quantity and quality of data (e.g., water use data) and increasing user-friendly modelling capacity. The Red Deer River sub-basin table discussed wanting more forecasting information and more monitoring data to support their decision-making.

In the winter of the first drought year, the Oldman River group noted that they had concerns about being able to meet apportionment from the Oldman River in the following year due to the level of the Oldman Reservoir. This early flag about a concern, and notifying the relevant authorities and other basins, could be considered when meeting apportionment expectations.

Participants at the Oldman River group noted that they would be interested in having access to the model that was supporting the exercise as a tool for real-world decisions.

Lines of communication

The exercise highlighted the importance of communication between sub-basins, especially regarding apportionment. It was recognized that communication between and within AEP occurs from the monitoring stages of drought. During the exercise, communication between sub-basins allowed participants in the drought stressed Red Deer and Oldman sub-basins to note that they would not be able to meet their expected apportionment contribution and the Bow River sub-basin agreed to make up the difference. The Bow River sub-basin took the initiative, even before the communication, to store water in upstream reservoirs to help meet apportionment in the second year of drought.

The Red Deer River sub-basin discussed the need to communicate with the other two sub-basins to ask for their assistance in any form possible, particularly in terms of water management operations. The Red

Deer sub-basin requested the Bow River sub-basin transfer water to the Red Deer River to help meet the WCO and user demands. Although this request was unsuccessful, the communication between basins was acknowledged as important.

As previously noted, implementing water sharing agreements/water licence assignments requires significant effort, and communication with water licensees is a significant portion of that. Time to act during a drought situation may be limited and expediting the identification of water users who should be involved with drafting water sharing agreements could help reduce the impacts of drought. Exercise participants suggested maintaining a list of key contacts who could be quickly called upon to provide input to the decision-making process.

The participants in the SSRB Drought Simulation Exercise represented key water managers, water users, government, and NGOs within the SSRB. The exercise provided an opportunity for broad communication in the context of drought. Participants expressed that involving WPACs in drought planning was a beneficial exercise, since it provided input into government plans but also provided an educational opportunity for water managers to learn of plans and procedures that are outside of their normal scope of work. A semi-regular planning or training exercise could support water managers in making connections, identifying best practices, and raising awareness.

Participants also identified an opportunity for more frequent communication between water managers and water users at a local scale, even in the early stages of drought. Frequent communication could help water users rationalize mandatory actions and encourage voluntary reduction of water demand when necessary.

Although not included as material in the simulation exercise, the Oldman River sub-basin participants identified that yield and demand forecasts, which are produced currently by Alberta Agriculture, Forestry, and Rural Economic Development (AAFRED), are important for decision-makers early in a drought. These reports are a key form of communication as they arm everyone with the same information about available water in the current year.

The Red Deer River group discussed declaring a state of emergency as a means of communicating the urgency of the drought, and to support and justify the extreme reduction in water usage being enforced. In this context an emergency would enable the government to override licence priorities to restrict water use. The emergency status would also allow access to more funding to implement emergency measures. This is particularly relevant because the municipal uses are among the largest water licence holders in the Red Deer sub-basin. This conversation points to the recognized need for communicating to the public and to water users in general the level of drought, in order to garner support and buy-in for the hardships that would come from extreme reduction in water use.

Unexpected results from the exercise

There is an opportunity and a challenge in that the three sub-basins manage water supply and demand separately but are essentially jointly responsible for meeting apportionment. The format of the exercise and the participants themselves tended toward collaboration. This may or may not be the case in managing a real-life drought situation; however, it is encouraging to note that there was some clear

willingness to support other sub-basins.

The apportionment obligation of Alberta to Saskatchewan is a central theme in water management, and a key concern during a drought, but operating to meet apportionment is difficult. The need for meeting apportionment obligations was discussed in all the sub-basin groups, but there were very few choices for actions that related to operating to meet it, except for precautionary measures in upstream storage by the Bow River group. The exercise highlighted that apportionment is generally approached in a manner akin to 'let's see how we do at the end of the year' and operating to meet apportionment is not precise. The exercise also highlighted that an in-depth and nuanced understanding of apportionment is not widespread among water managers.

In this exercise two sub-basins experienced a severe drought, while the third one experienced only minor drought. This situation posed a different form of challenge for the Bow River sub-basin compared with the other two, as the challenge was more around managing human behavior and messaging than about water supply and demand. An unexpected result from the exercise, arising from this situation, was that the drought Stage 1 and later drought Stage 5 were imposed on the Bow River sub-basin by the Minister even though they did not feel their situation warranted that decision.

One unexpected result from the exercise was the need for careful planning around reducing demand from various municipal water uses. The participants identified that some water uses serviced by municipal treatment plants are more essential than others, and that there would be value in differentiating and prioritizing these different demands for reducing water use. However, the complexity of prioritizing between uses in a municipality is challenging. The discussions identified socio-economic and industry investment implications; for example, if locating an industrial processing facility in an urban centre provides more reliable water in a drought than being located in rural areas near the source of primary production, this could impact where development occurs. These conversations in the SSRB Drought Simulation Exercise pointed to the need for municipalities to have established response plans that include the mechanism and the approach for managing and reducing water demand within the municipality during a drought. When developing these plans, municipalities must be aware of the larger developmental and economic consequences associated with water use restrictions. For example, municipalities may consider indoor water rationing during severe water shortage. The impacts of reducing indoor water consumption for residential and commercial entities needs to be fully understood when developing a drought response plan.

Exercise success at meeting desired outcomes

The SSRB Drought Simulation Exercise was successful at meeting the objectives of the exercise. The exercise successfully identified risks and vulnerabilities within the SSRB during a severe drought and highlighted the need for proactive water shortage response plans to be in place ahead of a drought. The drought scenario was able to test decision-making through all five drought stages. The exercise also highlighted the need for collaboration and communication between water management areas, especially between sub-basins.

The discussions throughout the exercise clearly demonstrated the procedures and actions that could be

used to address a severe drought; this also indirectly identified a variety of gaps, as well as potential procedures or mitigation options to address the gaps.

The exercise was designed to test the drought response process in Alberta, rather than optimizing water management operation in a drought, and this was successful. The exercise facilitation, the duration (one day), the length of the simulated drought (two years), and the large number of participants from various sectors all aligned to guide lively discussion and thoughtful reflection toward the overall response process.

Participants were placed in a high-pressure scenario in which they made decisions about two years of drought in a single day. Normally there would be more time to communicate, discuss ideas and consider options which would likely result in better outcomes.

Participant feedback

At the end of the exercise all participants were invited to complete a feedback form ranking various aspects of the exercise on a scale from one to five. A full summary of participant feedback is available in Appendix C. Based on this feedback, participants found that the exercise realistically represented a potential drought in the SSRB and provided an appropriate scenario for planning and decision-making. Participants felt relevant interests were represented in the exercise, which provided opportunity for participants to identify lines of communication between water managers.

In general, exercise participants agreed that the simulated drought scenario represented a realistic potential drought in Alberta (average score 4.38 out of 5). Some felt the Bow River sub-basin could have been challenged more by simulating a drought of similar severity to the Red Deer and Oldman sub-basins; however, it was recognized that a less severe drought in one sub-basin led to valuable conversations surrounding apportionment and intra-basin water transfers.

The average scores from participants indicate that the exercise was very successful at providing an opportunity for meaningful discussion (score 4.76), that the number of participants was appropriate for meaningful discussion (score 4.57), and that the facilitators provided meaningful guidance (score 4.81).

Participants only somewhat agreed that the exercise highlighted the roles and responsibilities of individuals with an average score of 3.57 (see Appendix C). Participants also noted that not all individuals with drought responsibilities were present in the room for the exercise. Although not a primary goal of this exercise, there may be an opportunity to focus on individual roles and responsibilities in a future workshop or exercise on a more local scale.

Identified benefits beyond the primary objectives of the exercise

Several benefits were achieved beyond the primary objectives of the exercise. Participants expressed that the exercise provided a valuable learning opportunity, particularly noting how they learned from other participants at their table. Some improved their understanding of how drought is managed in Alberta. Although simplified, the exercise included the realistic procedure of the IWCC advising the Minister, who makes drought management decisions for the whole SSRB, and participants noted this provided valuable understanding. Several participants left the exercise with a better understanding of apportionment requirements because of the explanation of apportionment provided in the introductory portion of the

exercise event.

The exercise was an opportunity for participants to build relationships with one another and connect with those in neighbouring basins. Participants learned through the plenary discussions of the experience of the drought for other sub-basin groups and the actions chosen in response. The Minister's summary and decision at the end of discussions each month helped build an understanding of drought management across the SSRB. These discussions led to a better overall understanding of drought management.

The participants were able to gain an understanding of the risks and opportunities for their sub-basin in a severe drought, and considerations that are relevant to their real-life roles in water use and water management decision-making.

Modelling with the South Saskatchewan River Operational Model (SSROM) allowed participants to explore the connectivity of the sub-basins and see the impacts of their mitigating actions.

Future Opportunities/considerations

Considerations for the Provincial Drought Response Strategy

The SSRB Drought Simulation Exercise highlighted the importance of developing effective water shortage response plans at local, regional, and provincial scales. Having an effective plan allows faster and more integrated response to a drought.

Drought preparedness

The exercise highlighted the importance of continuous monitoring of surface water, groundwater, and snow pillows. As water shortage conditions become apparent, it should be possible to increase the monitoring frequency, and the preference is for real time data to be available from these sources.

The drought management system encourages water managers to proactively respond to drought and implement their own drought plans so impacts can be mitigated without prescriptive action from government. Although this process works well, there is some ambiguity on the scope and timing of government response. As such, water users may not be aware of what conditions may prompt government intervention, which can result in confusion, especially for water managers with less experience managing drought. It is recommended that the role of government and the expectations of licence holders are well defined and clearly communicated ahead of a drought.

Currently some key water managers and decision makers regularly meet to discuss drought response. This semi-formal process encourages a more localized approach to drought response. A list of key contacts and water managers should be kept and regularly updated by the government and shared among the listed contacts. Maintaining an up-to-date contact list will allow key water managers to convene quickly in the event of water shortage. It would also be prudent to advise large licence holders and key water users to maintain their own local contact list as part of their water shortage management plans.

There is a risk that knowledge of drought response could be lost when experienced water managers leave their roles. Documenting best practices through local water shortage response plans will help mitigate this risk, and regular meetings on drought response for water managers and decision makers should be

encouraged. Meetings could be in the form of lectures, workshops, or further simulation activities. Communication between water managers provides valuable learning opportunities for knowledge transfer, sharing best practices and networking with other decision makers.

A consideration for AEP would be to prepare a document that defines the criteria for changing the operation of major reservoirs (particularly the Oldman and Gleniffer) in the event of a drought. There may also be guidance needed for the legislative process to approve temporary changes, and possibly examples for calculating what the new reservoir operations could be for the specific purpose of managing extreme water shortage.

Drought response

The Red Deer sub-basin had limited tools with which to mitigate the impacts of severe drought since there is not much water storage available. In areas of the province where there is little water storage there is limited time to react to a significant change in water availability. These areas should focus on creating well defined drought plans with a focus on approaches to demand management, monitoring, and accurate forecasting. Rapid communication and implementation of drought response actions will be key to limiting the severity of drought impacts in areas with no significant water storage. In areas with limited storage water licence assignments may be even more important as there may be a need to implement these even during a less severe drought. It is important that decision makers and water users understand how to implement assignments and the level of effort involved. This process could also be integrated into drought response plans.

The SSRB Drought Simulation Exercise used drought thresholds adapted from the AEP Provincial Drought and Water Shortage Plan, which are used internally by the Government of Alberta to help define drought. Exercise participants identified an opportunity for some contextual descriptors of drought to be provided to water users as part of communication plans. For example, an indicator of the severity of the water shortage conditions could be provided through comparison to historical droughts and examples of response actions that were used in those past circumstances. This communication could be designed for the general public or for key water users.

Exercise participants found there were few tools available to assist neighbouring sub-basins. Guidance could be provided to those who are proximate to water management areas experiencing drought but who are not themselves experiencing drought. This guidance could include precautionary actions such as encouraging voluntary water reductions, or more active steps such as holding water to meet apportionment.

Restricting water use by cutting off temporary licences is a mitigation that is often undertaken to protect the health of the watershed, and TDLS are generally issued with the applicant understanding that they can be cut-off with no notice in the event of water shortage. TDLs are often used for industrial purposes so there is the perception that the only impacts would be economic. In fact, TDLs are often used for livestock watering and a cut-off could put livestock at risk. Future plans might consider reviewing TDLs more holistically and reviewing their specific purposes before cutting them off.

Addressing gaps in legislation and policy

Water sharing agreements were adopted in the exercise to prevent water users being cut off; however, participants were not clear on the process for entering into an agreement. If water sharing agreements are considered as part of a drought response plan, then guidance should be provided to outline the process for creating water sharing agreements. Consideration should be given to the timeline required for drafting and implementing such an agreement, as it may be necessary to begin the process in anticipation of the potential need for an agreement rather than waiting until the crisis has arrived.

The Oldman Reservoir is operated to meet apportionment. The regulatory system allows for reservoirs such as the Oldman to be operated to another objective with the consent of the Director. During severe drought this could be a barrier preventing quick response to deteriorating water supply conditions. One potential consideration is to trigger a review of reservoir operations when a certain threshold is reached. This may allow a quicker response and potentially mitigate some of the impacts of drought.

Inter-basin transfers are transfers between basins such as transferring water from outside the SSRB to alleviate an SSRB wide drought. These transfers require a special act of the Legislature. Intra-basin transfers allow the transfer of water between sub-basins within a connected watershed e.g. a transfer between the Bow and the Red Deer sub-basins. This type of transfer is permitted under the Water Act.

Water shortages can be localized, and it is possible that a water management area (WMA) could experience severe drought while the neighbouring WMAs experience close to normal conditions. In extreme cases inter-basin transfers may be considered via a special act of the Legislature; however, initiating such a transfer is a slow process. An intra-basin transfer may be a better and more legally feasible alternative, although geographic distance or infrastructure can still be prohibitive. Consideration could be given to defining when an intra-basin or an inter-basin transfer could be considered in extreme cases such as drought, and the possible process to follow.

In a very severe drought, the Government of Alberta has the authority to override the priority system and assign water through emergency measures. This government may identify the highest priority uses and determine how much water is available to assign to each use. Existing drought plans, policy and guidance documents provide very little guidance to government to assign priority by use in these extreme cases. How water could be assigned should be considered in some detail ahead of a drought and built into a drought plan or guidance document.

Future opportunities

Exercise participants expressed interest in having access to software that could be used to model severe drought in local watersheds. Broad access to modelling software that helps visualize and assess the effectiveness of their response would allow water users to run their own drought scenarios and assist with development of their own drought response plans. The South Saskatchewan River Operational Model (SSROM) has recently been updated and will be publicly accessible via the University of Lethbridge. Open access to the SSROM could provide this opportunity.

There is an opportunity to implement additional collaborative stakeholder drought modelling exercises within the SSRB and elsewhere in the province. Other simulation exercises could have similar goals to

gauge vulnerabilities in the drought response process, or alternative goals such as optimization of reservoir operations. A similar exercise to the SSRB Drought Simulation Exercise could focus on the Bow River sub-basin and test existing drought response plans and help operators optimize their response. There is also an existing OASIS model for the Athabasca River Basin which could be leveraged to investigate the impact of changes in water supply to an area that historically has had little issue with water supply.

Localized drought response plans and procedures could be tested by undertaking local exercises focusing on a single Water Management Area or a single watershed. A localized exercise could allow all appropriate parties to be present and facilitate a more detailed discussion on individual roles and responsibilities.

Appendix A Participating organizations

Below is a list of organizations that were represented as part of the SSRB Drought Simulation Exercise held on June 10, 2022.

- Eastern Irrigation District
- St. Mary River Irrigation District
- Alberta Irrigation Districts Association
- Special Areas
- Bow River Basin Council
- Red Deer River Watershed Alliance
- City of Calgary
- City of Red Deer
- City of Lethbridge
- Alberta Wilderness Association
- Southern Alberta Group for the Environment
- Alberta Environment and Parks
- Alberta Energy Regulator
- Ministry of Agriculture, Forestry and Rural Development
- Alberta Emergency Management Agency
- TransAlta
- Alberta Beef Producers
- Blood Tribe Agricultural Project

Appendix B Definitions for the five Drought Stages used in the SSRB Drought Simulation Exercise

Drought Stage Thresholds

During this exercise a comprehensive drought response plan is not available to water managers. A partial drought response plan describes five drought stages and the conditions at which a new drought stage can be declared. Participants must use the drought stage descriptors below to determine when a drought stage has been reached and whether additional action is required.

Stage 1

- River flows and reservoir water levels trending and generally persisting at levels at or below the lower statistical quartiles.
- Water availability trend is a concern, reservoir operations trend towards not filling; monitoring increases for drought potential in water management areas, participants identify resources needed to prepare for drought.

Stage 2

- Flows and water levels consistently below the lower statistical quartiles and trending and generally persisting at the lower statistical deciles.

Stage 3

- Participants are concerned an apportionment agreement may not be met.
- An individual licensee may wish to enforce their licence priority to continue receiving water. The receipt of a priority call may require participants to enforce priority within their sub-basin.

Stage 4

- Large scale drought with risk to the majority of household users/licensees/traditional agricultural users across multiple areas of a basin, an entire basin and/or more than one basin in the province.
- A significant number of licensees/traditional agricultural users/household users in the water management areas are impacted and are unable to divert water; and/or
- Drought persists or is projected to persist.

Stage 5

- Elevated risk to human health and safety due to insufficient water supply;
- Elevated risk to human health and safety due to water quality degradation as a result of insufficient flow to dilute effluent releases to a water body; and/or
- Elevated stress on the health of the aquatic environment to a point where fish mortality occurs.

Appendix C Participant response survey results

After the exercise was completed, participants were invited to complete a ten-question survey. The responses are compiled in the table below.

Participants were given a sheet with ten statements and asked to assess their level of agreement with each statement using the following scale. Each response was assigned a weighting between 1 and 5 with 1 indicating strong disagreement and 5 indicating strong agreement.

- Strongly disagree = 1
- Somewhat disagree = 2
- Neutral = 3
- Somewhat agree = 4
- Strongly agree = 5

Responses were received from 21 participants with some also providing additional comments. Table 2 shows the collated responses from the exercise. An average score was taken for each participant to provide an indication of overall exercise satisfaction. All

The following additional comments were also received from participants:

- *Would have been more valuable to have a more significant event on the Bow, not enough to have a single monitoring point*
- *The facilitators and modellers at the RDR table were awesome!*
- *Great job WaterSMART Team! This was worth taking a day out of our schedules. It highlighted risks and opportunities.*

Table 2 Summary of participant feedback responses

Question	Respondent number																					Average
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
The exercise helped identify relevant lines of communication during a drought.	3	4	4	5	5	4	4	2	5	4	3	5	5	3	5	5	5	5	2	4	4	4.10
The Exercise provided an appropriate scenario and context for planning and decision making.	4	4	4	5	5	3	4	2	4	5	4	4	4	5	4	5	5	5	3	5	5	4.24
The scenario realistically represented a potential drought in Alberta.	4	3	3	5	5	4	5	2	5	5	4	4	5	5	5	5	5	4	4	5	5	4.38
The exercise identified potential vulnerabilities and risks in the SSRB during a drought.	4	4	5	5	5	4	4	4	5	5	4	3	5	5	4	5	4	4	5	5	4	4.43
The exercise highlighted the roles and responsibilities of individuals.	3	3	5	5	4	2	3	3	4	4	3	4	4	3	4	5	4	3	1	4	4	3.57
The exercise provided an opportunity for meaningful discussion.	5	5	5	5	5	5	4	4	5	5	4	5	5	4	5	5	5	5	4	5	5	4.76
The relevant stakeholders and interests were represented at the exercise.	4	4	5	4	5	2	4	5	5	5	5	5	5		5	5	5	5	2	5	4	4.45
The number of exercise participants was appropriate to allow meaningful discussion.	3	5	5	4	5	4	4	5	5	4	4	5	5	4	5	5	5	5	4	5	5	4.57
The length of the exercise was appropriate.	4	5	5	5	4	5	4	4	5	5	4	4	5	4	5	5	5	4	4	5	5	4.57
The facilitators provided meaningful guidance to the participants.	5	5	5	5	5	5	5	4	5	5	5	4	5	4	5	5	5	5	5	5	4	4.81

Key	1 = completely disagree	2 = somewhat disagree	3 = Neutral	4 = Somewhat agree	5 = completely agree	Did not respond