Story Line for POS comments

on

Apportionment, Water Quality, Aquatic Ecosystem Health

POS Work Plan

Task PF4: Roadmap for taking study products to address apportionment, water quality, and aquatic ecosystem health concerns

The ISRSB has the resources to effectively address flooding and water supply issues, as well as to examine the impacts of alternative operating plans on apportionment. Impacts of alternative operating plans for the purposes of understanding water quality and aquatic ecosystem health concerns are beyond the resources (of time and money) that were made available to the board. However, the ISRSB can provide a roadmap to provide guidance for how the study products, particularly the integrated modelling system, could be altered and used in the future to address water quality and aquatic ecosystem health concerns. This task will also document, in one place, the impacts of alternative operating plans on the apportionment agreement.

Introduction:

The focus of the International Souris River Study Board's 2017 reference from the IJC is to investigate and make recommendations regarding improvements to the Operating Plan contained in Annex A of the 1989 Agreement with respect to flooding and water supply risks in the Souris River basin. In addition, the reference requested the Study Board to consider the implications of the proposed improvements to the Operating Plan on apportionment as well as water quality and aquatic ecosystem health.

The purpose of this section is to highlight the findings of the study that may have implications on apportionment as well as water quality and aquatic ecosystem health aspects of the Souris River.

It is important to note that the Study has developed a number of modeling and evaluation tools that can be used post-study to further the understanding of potential operations changes with respect to these themes under a long-term adaptive management strategy. There is potential for the tools developed to be utilized to improve analysis of water quality and aquatic ecosystem health, how apportionment is calculated, and to support an adaptative management process. These analyses would further increase our knowledge of the system and help inform future improvements to the sustainable use of water in the Souris River.

Apportionment:

It is important to note that the Study did not specifically study the apportionment rules but believe it is important to present a brief discussion on apportionment in order to understand the context of the proposed shift in the apportionment period from a 'calendar year' to a 'November 01 to October 31' period.

The apportionment rules for the Souris River Basin are stated in Annex B of the 1989 Agreement. Under the rules, Saskatchewan is entitled to 50 percent of the flow which would have occurred in a state of nature at the Sherwood Crossing. An exception to the 50 percent entitlement is made in years when either of the following conditions apply as per the "Interim Measures as Modified in 2000":

i. Annual natural flow volume is greater than 50,000 dam^3 (40,500 acre-feet) at the Sherwood Crossing, and the Lake Darling elevation is greater than 486.095 m (1594.8 ft) on June 1

or

ii. Annual natural flow volume is greater than 50,000 dam^3 (40,500 acre-feet) at the Sherwood Crossing and the Lake Darling elevation is greater than 485.79 m (1593.8 ft) on June 1 provided that the elevation has not been lower than 485.79 m (1593.8 ft) since the last time Lake Darling had an elevation of 486.095 m (1594.8 ft) on June 1

These conditions allow Saskatchewan to retain 60% of natural flow in recognition that a portion of North Dakota share will be in the form of evaporation from Rafferty Reservoir and Alameda (Grant Devine) Reservoir. The lesser amount to North Dakota is in recognition of Saskatchewan's agreement to operate both Rafferty Dam and Alameda Dam (Grant Devine) for flood control and for evaporation as the result of the Project.

Apportionment calculations are based on the estimation of natural flow. Natural flow is defined as the quantity of water that would naturally flow in any watercourse had the flow not been affected by human interference or intervention. The location where natural flow is to be calculated is at the Souris River near Sherwood flow gauging station. The station is located close to where Souris River crosses the Canada-United States international boundary and is located in North Dakota. The site is referred to as Sherwood Crossing in Annex B.

Natural flow is calculated as the recorded flow at Souris River near Sherwood station plus water interventions occurring upstream of the station that could have contributed to the recorded flow volumes. Water interventions refer to volumes of water consumed or otherwise removed from the natural flow of the stream. Water interventions are often referred to as depletions. Examples of depletions include irrigation projects, municipal use, storage in reservoirs, and evaporation resulting from storage in reservoirs.

The determination of natural flow is based on standard procedures developed and approved by the International Souris River Board (ISRB). Natural flow apportionment calculations are traditionally provided to the ISRB three times per year in order to estimate the natural flow occurring in the following three time periods: January 1 - May 31; January 1 – August 31; and January 1 – December 31.

The January 1 – May 31 apportionment is conducted to determine if Saskatchewan has delivered to North Dakota, 50 percent of the first 50,000 dam^3 (40,500 acre-feet) of natural flow that occurred prior to June 1, as required by Annex B.

The January 1 – August 31 apportionment is conducted to support the ISRB in determining the apportionment balance on or about October 1. Any shortfall that exists as of that date shall be delivered by Saskatchewan prior to December 31. Determining the apportionment balance on or about October 1 provides Saskatchewan with an opportunity to deliver any shortfalls during the fall period to meet the Annex B requirements.

The January 1 - December 31 apportionment is conducted to provide a final annual natural flow apportionment result. This determination of natural flow and the final apportionment balance is provided to the ISRB in February at its winter meeting.

Additional determinations of natural flow may be requested by the ISRB to support operational planning. These additional determinations of natural flow are typically required in low flow non-flood years.

A more detailed description of apportionment procedures may be found in the *Procedures for the Apportionment of Flows on the Souris River*. This document is maintained by the ISRB Committee on Hydrology and is presently under review and updating.

The Study has not investigated improvements to the methods or procedures used for the determination of natural flow. However, the Study has investigated shifting the period for the determination of entitlements from a calendar year to a 'November 01 to October 31' period.

The Study has made a significant investment in hydrologic model development for the Souris River basin. These models provide useful insight on the implications of proposed operational changes as well as support the use of Performance Indicators (PIs) to show potential response of these operations for a range of water related interests in the basin.

The modelling results and PIs also provide additional information that may be useful to refine the procedures used for the determination of natural flow. Accordingly, the Study Board suggests that the ISRB review and update the Natural Flow Procedures, considering the technical studies and modelling done under the Study.

Water Quality:

Water quality of the Souris River was identified as an important issue during the Study's public engagement process.

The Study captured the public interest in water quality through the development of a series of water quality PIs. To support the development of these PIs, the USGS undertook an analysis of the water quality in relation to flow under the guidance of the Study Board. The investigators used a statistical time-series model (R-QWTRENDS) developed by the USGS for evaluating complex flow-related variability in constituent concentrations. They selected the following water-quality constituents for analysis: Chloride, Sodium, Sulfate, Total dissolved solids, Total iron, Total suspended solids, Total nitrogen, Total phosphorus, Nitrate plus nitrite nitrogen, and Dissolved ammonia.

The analysis was conducted for these constituents at three locations: Sherwood, Minot, and Westhope, ND. The R-QWTREND model was used to determine relationships of constituent concentrations to flow, time, and seasonality for the period 1993 to 2018. To address seasonality, each year was partitioned into four seasons: spring (March to May), summer (June to August), Fall (September to November), and Winter (December to February).

The R-QWTREND analysis found that variability in concentration for chloride, sodium, sulfate, and total dissolved solids are largely explained by the variability in flow, and can be used to evaluate minimum flow thresholds for each season. The variability in other constituents such as total iron, total suspended

solids, and nutrients was more explained by factors such as seasonality, therefore the implications of minimum flow thresholds were difficult to evaluate.

For reference the ISRB has a mandate to report annually on compliance with the established water quality objectives (WQOs) for the two international border crossings: one near Sherwood and one at Westhope, ND. Under this mandate the ISRB has developed a two-year IWI project for evaluating water quality trends for the entire Souris River basin. The ISRB IWI project has run in parallel to the Study. The USGS is leading the effort and will investigate water quality trends for up to 34 sites in the basin, which includes the two international sites at Sherwood and Westhope, ND. The ISRB IWI project began in the spring of 2020, and has the following objectives:

1. Perform a comprehensive, integrated, up-to-date water quality trend analysis for selected constituents at sites with sufficient data
2. Describe flow-related variability and flow-normalized concentration trends for selected constituents and sites, and statistically describe data from sites with insufficient data for R-QWTREND trend analysis
3. Evaluate the exceedance rates of the WQOs at the two transboundary locations for the five constituents which consistently have periods of exceeding the WQO and will include the period of record to identify when exceedances began occurring

The analysis performed under the ISRB IWI project has consolidated water-quality data from various agencies and will provide insight into how processes in the basin affect exceedances of the WQOs at the two international sites. A database was created and will be maintained to ensure a basin wide picture of water-quality in the Souris River Basin.

The water-quality analysis performed under the ISRB IWI project could be used to enhance the water quality PIs developed by the Study. The improved water quality PIs will help assess the effectiveness of the operational changes with respect to water quality conditions.

Given the public interest in water quality conditions in the basin, the Study Board suggests water-quality monitoring should be continued as a basin wide, long-term activity. It is expected that such an activity would capture a full range of hydrologic conditions, changes on the landscape, and reservoir operations. The resulting long-term data set will be critical for evaluating changes in water-quality as well as improving our knowledge of interconnections between hydrologic conditions, landscape changes, and reservoir operations on water quality.

The Study Board notes that artificial drainage is a growing concern of interest to the public in the Souris basin. The Study did conduct a review of artificial drainage in the basin. However, the Study Board suggests further investigations should be conducted on artificial drainage and its effect on water quality conditions within the basin.

Aquatic Ecosystem Health:

The IJC reference to the Study Board noted aquatic ecosystem health as an important issue. This was further identified as an important issue during the Study's public engagement process.

Dissolved oxygen (DO) is a critical indicator of aquatic ecosystem health. Low DO conditions result in fish kills and has negative effects on the health of the aquatic ecosystem. Low DO conditions can also

cause constituents such as phosphate, iron, and manganese, which can be present in sediments, to become soluble and enter the water column. Therefore, it is important to mitigate low DO conditions to prevent adverse effects to the aquatic ecosystem.

Although the Study did not investigate aquatic ecosystem health directly, it did develop a number of PIs, which provide a measure of the influence that a proposed operational change may have.

Similar to the water quality trends analysis being conducted by the ISRB, the Study recognized that the continuous DO monitoring investigation being conducted by the ISRB as an IWI project will contribute greatly to improving our understanding of processes affecting DO concentrations.

The ISRB DO study began in 2019 and has a five-year duration. Under the project the USGS has installed continuous DO monitors on the Souris River at Sherwood, above Minot, and at Westhope. These monitors are providing 15-minute near real-time continuous water quality data including DO, water temperature, and specific conductance. The resulting data will be used to improve our understanding of DO dynamics and how DO is affected by flow and other factors such as nutrient dynamics, algal growth in the channel, and sediment oxygen demand for different times of the year. Data collected for the project in 2019 and 2020 have indicated that DO has a complex relation with streamflow and many other factors such as water temperature, algal activity, aeration from wind and turbulence in the water column and organic decomposition have more of an influence on DO than streamflow depending on the time of year. Data collected over the remainder of the project will provide more information on how DO changes over the range of streamflow conditions and how streamflow may affect the factors influencing DO concentrations on the Souris River.

The Study Board suggests that the findings of the continuous DO monitoring study will be useful to improve the aquatic ecosystem health PIs developed under the Study. The improved PIs will help assess the effectiveness of the operational changes with respect to aquatic ecosystem health conditions.

In addition to the improvements in the aquatic ecosystem health PIs developed under the Study, the Study Board believes that the potential for coupling or interconnecting water quantity and quality modelling should be explored. The additional data and knowledge gained from the efforts related to water quality trend analysis and continuous water quality monitoring will offer new insight into the possible interactions between hydrology, climate driven flow conditions, aquatic ecosystem health, and landscape changes.