



The Äshèyi Chu/Aishihik River - River Ice Model: YukonU Research Centre's RIMA

Low-flow Update | April 2026



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Photo Credit:

Benoit Turcotte

1. Context

The YukonU Research Centre (YRC) developed a river ice model to simulate river ice formation and melt as well as associated (reach-scale) relative water levels on the regulated Aishihik River (Äshèyi Chu, Turcotte et al., 2025). The RIMA model was originally calibrated using data and observations from 4 winters (2019-2020 to 2022-2023) and tested on data collected during winter 2023-2024, with overall defensible results (back in March 2025).

The authors considered that RIMA was reliable enough to predict reach-scale, ice-affected water levels between the Aishihik Generating Station (AGS) and the Dezadeash River (Titl'at Män Tágà) for flows that remain within the “normal” (or design) operation range of 15 to 23 m³/s. The report indicated that lower flow conditions would generally result in lower ice-induced water levels, but that, given the model’s empirical (data-driven) nature, its accuracy could be reduced for winter flows consistently below 15 m³/s.

The loss of a turbine during the fall of 2024 imposed operating AGS at a maximum flow of about 12 m³/s during winter 2024-2025, which could be considered an “opportunity” for model developers and future users. Comments on the Turcotte et al. (2025) report, received from the Core Team composed of the Champagne and Aishihik First Nations (CAFN), Yukon Energy (YEC), and the Government of Yukon (Department of Environment), stressed the need to recalibrate RIMA to better account for low-flow conditions. This modification was successfully completed, and this update report, a complement to the original report, describes the changes performed on the model.

2. RIMA Model - updates

The YRC, developer of the model’s previous version, was hopeful that a simple adjustment to reach-specific parameters used in the equations governing ice cover formation could yield the desired results. This recalibration was accomplished and is presented here.

Equations 1 and 2, presented in the original report (Turcotte et al., 2025) are replicated here without modification:

$$Cov_{sim}(t) = \frac{(-T_{air\ mean}(t-1) + T_{eff}(t-1))}{CDDF_R} + Cov_{sim}(t-1) < Cov_{max} \quad [1]$$

$$T_{eff}(t) = \frac{T_{air\ R}}{\left(\frac{Q_T}{Q_{mean}(t) \leq Q_{high}}\right)^{a_{QR}}} \quad [2]$$

Cov_{sim} represents the reach-averaged ice coverage during the river ice formation period, whereas $T_{air\ mean}$ and Q_{mean} are input variables (respectively presenting daily-averaged air temperatures and river flow). All other variables represent constants, with original and modified (in light green) values presented in Table 2.1. The recalibration of these parameters for 6 winters (2019-2020 to 2024-2025) was followed by a reassessment of simulated vs. measured water levels, as described next. Readers will note that a_{QR} , an exponent, is the parameter that was most significantly adjusted for Reaches 3 to 5 in order to force the equations to better capture the impact of low flow conditions (Q_{mean}) on Cov_{sim} .

Table 2.1. Original and updated variables used in Equations 1-2 to calculate the daily, reach-averaged ice coverage.

Parameter			R1-2	R3	R4	R5	R6	R1-2	R3	R4	R5	R6
Symbol	Unit	Description	Original values					Update values				
$CDDF_R$	°C-days	Cumulated degree-days of freezing threshold for full cover	275	580	435	360	380	275	475	375	350	350
T_{airR}	°C	Air temperature threshold for ice cover formation	-18	-10	-10	-10	-8	-17	-10	-10	-10	-8
Q_T	m ³ /s	Discharge threshold to evaluate the ice coverage	18.5					17.5				
Q_{high}	m ³ /s	Maximum flow considered for the ice coverage calculation	22					22				
a_{QR}	-	Exponent in Equation 2 to calculated T_{eff}	0.25	0.50	0.75	1.00	1.50	0.50	1.25	1.25	1.25	1.50

3. Model results

Figure 3.1 presents an example of the model results for the low-flow winter of 2024-2025 for Reach 6. Readers will note that the rise in ice coverage is captured correctly (+/-10%, within the range of uncertainty when assessing the reach’s ice coverage using limited observations), whereas ice melt occurs earlier than anticipated. This issue was reported across several simulated winters and, as explained in Turcotte et al. (2025), may be associated with an underestimation of the ice contained in the channel across all river reaches (note that the ice-induced water level is generally correctly captured by the model).

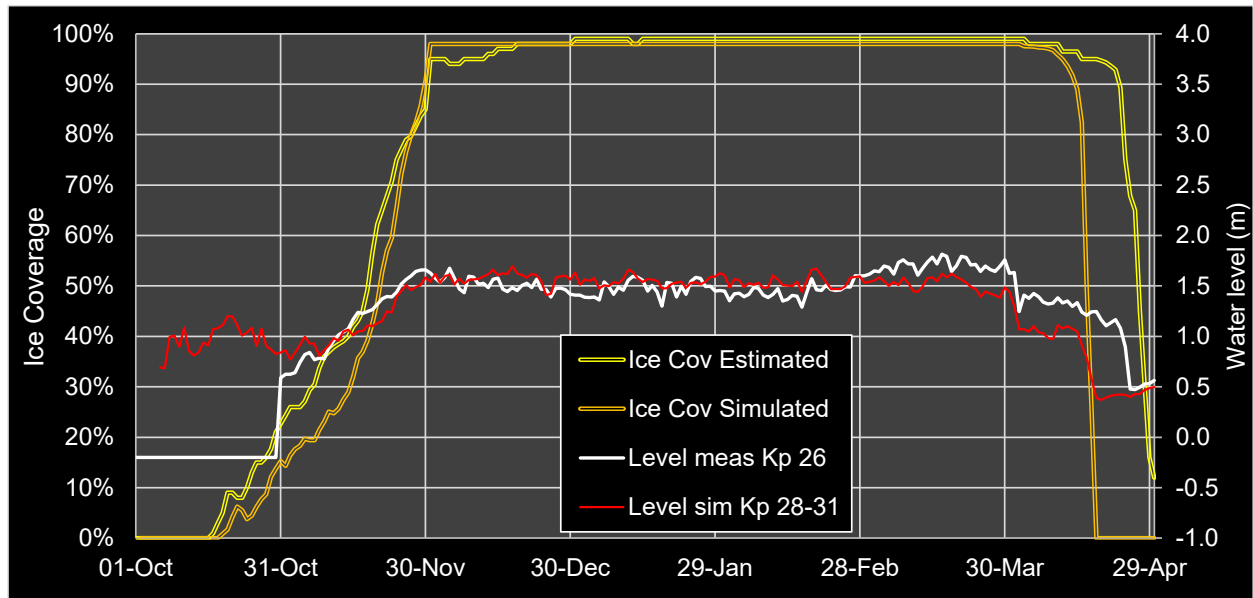


Figure 3.1. Example of RIMA’s results for the low-flow winter of 2024-2025, Reach 6.

The following table summarizes the model performance after recalibration (including two additional winters compared with was presented in Turcotte et al., 2025). Readers will note that winter 2020-2021 remains the most challenging to simulate (and calibrate), whereas results from other winters are generally satisfactory, including for the low-flow winter 2024-2025. All model results from the newer RIMA 17 version can be shared upon request.

Table 3.1. Summary of the model performance, based on a qualitative assessment.

Winter	Reaches 1-2	Reach 3	Reach 4	Reach 5	Reach 6
2019-2020	80%	90%	No data	No data	90%
2020-2021	80%	80%	60%*	70%*	70%
2021-2022	80%	80%	70%	80%	70%
2022-2023	90%	70%	80%	80%	90%
2023-2024	90%	80%	80%	80%	90%
2024-2025	80%	90%	No data	70%*	90%

The stars (*) denote less-accurate data sets that may be due to the water level sensor being deployed at a different location (in terms of km mark along the reach) than usual (e.g., Km 20 rather than 25).

4. Conclusion

The developer of RIMA was fortunate that the physics underlying its model were robust enough that the only adjustment to reach-specific ice-coverage variables (to account for low flow conditions; Table 2.1) could yield reasonably accurate results, in terms of daily maximum ice-induced water levels.

The YRC now has a greater confidence that the model can be used “to inform future AGS strategic flow management (and future co-management)”, as originally stated in the project Charter. This assertion applies to a wider range of winter flows (including daily-averaged or daily-maximum flows in the range of 8 to 15 m³/s). This answers the main comment from the Core team following the review of Turcotte et al. (2025) as well as the first long-term recommendation presented by the authors in that same report. All other recommendations (immediate, short-term, long-term) and other sections of the original report remain relevant and applicable.

Appendix A presents an update of RIMA’s parameters, including the above-mentioned modifications as well as small corrections (also in light green) that had not been captured accurately in Appendix B of Turcotte et al. (2025).

Reference

Turcotte, B., Saal, S., Horton, B., Zammit, A., 2025. The Āshèyi Chu/Aishihik River – River Ice Model YukonU Research Centre’s RIMA. Presented to the Champagne and Aishihik First Nations, The Government of Yukon, and Yukon Energy. YukonU Research Centre, 100p.

Appendix A

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
X	date	Defining the X axis (time and date) on graphs	Fixed, depends on time step				
Δt	hours	Time step in the model	24				
Cov_{est}	%	Estimated ice coverage for adjustment purposes	Correction variable				
Cov_{sim}	%	Simulated ice coverage without breakup consideration	Variables				
$CDDF_R$	°C-days	Cumulated degree-days of freezing threshold for full cover	275	475	375	350	350
Cov_{corr}	%	Corrected simulated ice coverage considering breakup	Variables				
Cov_{adj}	%	Adjustment of ice coverage formation rate	0				
$Cov_{corrmax}$	%	Maximum ice coverage in reaches	90	96	95	96	98
Q_{min}	m ³ /s	Minimum flow of the day from tailrace and East Aishihik River	Input variable				
Q_{mean}	m ³ /s	Mean flow of the day from tailrace and East Aishihik River	Input variable				
Q_{max}	m ³ /s	Maximum flow of the day from tailrace and East Ashihik River	Input variable				
ΔQ	m ³ /s	Daily flow variability or fluctuation	Variables				
Menu	-	Flow range from the West Aishihik River (low, average, high)	Input variable				
Q_{rWA}	m ³ /s	Synthetic recession flow from West Aishihik River	Variables				
T_{wWA}	°C	Water temperature from the West Aishihik River	0				
$T_{air\ mean}$	°C	Measured air temperature at AGS tailrace	Input variable				
$T_{air\ R}$	°C	Air temperature threshold for ice cover formation	-17	-10	-10	-10	-8
Q_T	m ³ /s	Discharge threshold to evaluate the ice coverage	17.5				
Q_{high}	m ³ /s	Maximum flow considered for the ice coverage calculation	22				
A_{QR}	-	Exponent in Equation 2 to calculated T_{eff}	0.50	1.25	1.25	1.25	1.50
T_{eff}	°C	Effective air temperature for ice cover formation	Variables				
$CDDF$	°C-days	Cumulated degree-days of freezing	Variables (not used in model)				
E_{net}	W/m ²	Net heat flux estimated by a linear equation	Variables				

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
a_E	$W/m^2 \text{ } ^\circ C$	Net heat loss (or gain) for each $^\circ C$ below (above) $0^\circ C$	14				
T_{corr}	$^\circ C$	Correction in $T_{air\ mean}$ to consider warmer air near highway	0	0	0	1.5	2
$T_{corr\ mod}$	$^\circ C / \text{day}$	Daily increase in T_{corr} after Feb 15 to consider sun power	0.06				
$T_{tailrace}$	$^\circ C$	Measured water temperature in AGS tailrace	Input v.	Only applies to R1-2			
T_{kpX}	$^\circ C$	Simulated water temperature from upstream reach	Tailrace	Variables			
$Y_{measKpX}$	m	Measured water level at a given location (KpX)	User defined / for calibration or comparison				
$Y_{meas\ adj}$	m	Adjustment of $Y_{measKpX}$ for comparison/calibration	User defined / for calibration or comparison				
$T_{measKpX}$	$^\circ C$	Measured water temperature at a given location (KpX)	User defined / for calibration or comparison				
HC_{KpX}	kW	Heat content in the flow at the head of the reach	Variables				
ρ	kg/m^3	Density of water (property of water)	1000				
C_w	$J/kg^\circ C$	Specific heat capacity of water (property of water)	4186				
W_{ow}	m	Reach-averaged channel width in open water conditions	Variables				
W_{slope}	m/m	Lateral slope of left bank (right bank is vertical)	27	27	27	30	27
Y_{ow}	m	Maximum channel depth in open water conditions	Variables				
S	%	Reach-averaged channel slope	0.35	0.34	0.22	0.25	0.20
A_{ow}	m^2	Open water cross-section	Variables (not used in model)				
V_{ow}	m/s	Open water average velocity	Variables (not used in model)				
T_{Kp2}	$^\circ C$	Water temperature at Kp2 (entering Reach 2)	Variable	Only applies to R1-2			
HC_{Kp2}	kW	Heat content at Kp 2 (entering Reach 2)	Variable	Only applies to R1-2			
$I_{prodKp2}$	Tons	Ice production in Reach 1 (entering Reach 2)	Variable	Only applies to R1-2			
$F_{in\ KpX}$	Tons	Frazil transported from the upstream reach	NA	Variables			
$IR_{in\ KPX}$	Tons	Ice run from upstream reach	NA	Variables			
$L_{T=0}$	m	Streamwise location where water cools to $0^\circ C$ without ice	Variables				
L_{down}	m	Location of end of reach along the river	6000	12000	18000	24700	30000
L_{reach}	m	Length of reach	4000	6000	6000	6700	5300
L_{up}	m	Location of start of reach along the river	2000	6000	12000	18000	24700

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
$HC_{Kpx\ no}$	kW	Heat content in flow at end of reach without ice	Variables				
$T_{kpX\ no}$	°C	Water temperature at end of reach (or any Kp) without ice	Variables				
L_{mon}	m	Location of a monitoring point (depth and temperature)	3000	2000	Year-dep.	2000	800
$I_{melt\ pot}$	Tons	Melting potential of the ice content of the reach	Variables				
$F_{in\ melt}$	Tons	Melting of frazil entering the reach	NA	Variables			
$IR_{in\ melt}$	Tons	Melting of ice runs entering the reach	NA	Variables			
Spring	Binary	Spring conditions when Cov_{corr} is controlled by ice melt	Variables				
$Srping_T$	%	Spring conditions may start if maximum winter $Cov_{corr} >$	20	70	80	80	80
I_{melt}	Tons	Melting of the ice content of the reach	Variables				
$EFF_{AI\&FJ}$	%	Adjustment of melt between anchor ice and frazil jam	Variables				
$Actual_{melt}$	Tons	Sum of the melt of each stationary ice types	Variables (not used in model)				
$Melt_{error}$	%	Difference between the simulated and calculated melt	Variables (not used in model)				
I_{melt}	kW	Melting of the ice content of the reach (heat loss)	Variables				
$L_{T=0\ ice}$	m	Streamwise location where water cools to 0°C with ice	Variables				
$HC_{Kpx\ ice}$	kW	Heat content in flow at end of reach with ice	Variables				
l_{ice}	J/Kg	Latent heat of fusion of ice (property of ice)	333,550				
$T_{kpX\ ice}$	°C	Water temperature at end of reach (or any Kp) with ice	Variables				
$T_{melt\ corr}$	%	Correction of water temperature if there is under melt	NA	50	50	50	50
$Area_{ip}$	m ²	Channel area (reach) where heat is lost (open water)	Variables				
I_{prodT}	%	Ice coverage above which heat loss is 0 (= Cov_{max})	90	96	95	96	98
$I_{prodKpX}$	Tons	Ice production in Reach	Variables				
FI to SI	Tons	Frazil production transferred into surface ice	Variables				
$\rho_{ice\ rel}$	-	Relative density of ice	0.92				
$t_{SI\ ini}$	m	Initial thickness of surface ice cover	0.15	0.15	0.2	0.2	0.2
SI_p	-	Initial porosity of frazil forming the surface ice cover	0.4	0.4	0.5	0.5	0.5
SI_{cumul}	Tons	Cumulative mass of surface ice in reach	Variables				

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
SI_{ETR}	W/m^2	Heat budget threshold below which SI freezes entirely	-60				
$SI_{thickness}$	m	Reach-averaged surface ice thickness	Variables				
SI_{melt}	Tons	Quantity of surface ice melt per time step	Variables				
$SI_{breakup}$	Tons	Quantity of surface ice leaving the reach as an ice run	Variables				
AI_{cond}	Binary	Condition for anchor ice to form in the reach	Variables				
AI_{covTR}	%	Maximum Cov_{corr} for anchor ice to form	30	50	35	30	30
AI_{ETR}	W/m^2	Heat budget threshold below AI forms	-220	-220	-220	-195	-190
AI_{ETR2}	W/m^2	Heat budget threshold below AI can form above AI_{tTR}	-305	-350	-300	-280	-280
AI_{tTR}	m	Maximum, reach-averaged anchor ice thickness	0.5	0.5	0.5	0.3	0.2
AI_{prod}	Tons	Quantity of frazil transformed in anchor ice in reach	Variables				
AI_{grR}	m/h	Growth (or accretion) rate of anchor ice in reach	0.004	0.003	0.0035	0.0025	0.0015
AI_{meltR}	%	Time-dependent ratio of AI melt vs. Frazil jam (FJ)melt	Variables				
$AI_{meltbias}$	%	Bias towards preferential melt of AI compared with FJ	50				
AI_{cumul}	Tons	Cumulative mass of anchor ice in reach	Variables				
$AI_{thickness}$	m	Reach-averaged anchor ice thickness	Variables				
AI_p	-	Initial porosity of anchor ice in reach	0.4	0.3	0.3	0.3	0.3
$AI_{settled}$	m	Re-evaluation of AI thickness cons. Settlement (creep)	Variables				
$AI_{settleRR}$	m/day	Settlement rate of anchor ice during settlement episodes	0.04	0.02	0.02	0.02	0.02
AI_{volIRR}	%	Ratio of AI volume loss caused by settlement	30				
AI_{melt}	Tons	Quantity of anchor ice melt per time step	Variables				
AI_{meltRR}	Tons	AI melt from other heat sources (when $E_{net} = 0$)	250	250	200	200	100
AI_{lifted}	Tons	Anchor ice lifted from the bed (rather than melted)	Variables				
AI_{lmR}	-	Ratio of AI lifted (relaxed) from the bed vs. melted in situ	2				
AI_{lcov}	%	Ice coverage (Cov_{corr}) above which AI cannot be lifted	30	70	70	35	35
SF_{supply}	Tons	Available frazil that is not stored as SI or AI	Variables				
SF_{max}	Tons	Maximum amount of frazil that can be stored under SI	Variables				

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
SF _{cov min}	%	Minimum ice coverage (Cov _{corr}) for SF to accumulate in reach	15				
SF _P	-	Porosity of stored frazil in reach	0.3	0.3	0.4	0.4	0.4
SF _{cov max}	%	Maximum ice coverage (Cov _{corr}) for SF to accumulate in reach	50	45	40	40	35
SF _{cumul}	Tons	Balance of stored frazil in reach	Variables				
SF _{thickness}	m	Reach-averaged stored frazil thickness	Variables				
SF _{daily}	Tons	Daily flux of ice in stored frazil in reach	Variables				
SF _{melt}	Tons	Melting of stored frazil in reach	Variables				
SF _{breakup}	Tons	Amount of stored frazil that exits the reach as an ice run	Variables				
TF	Tons	Frazil not stored as SI, AI or SF and therefore transported	Variables				
FJ _{supply}	Tons	Available frazil that is not stored as SI, AI, or SF	Variables				
FJ _{E TR}	W/m ²	Minimum heat flux (E _{net}) for FJ to form in reach	-220	-220	-220	-195	-190
FJ _{cov min}	%	Minimum ice coverage (Cov _{corr}) for FJ to form in reach	30	40	40	40	50
FJ _{RR1}	-	Rate of frazil interception into SF for Cov _{corr} > F _{Jcov min}	1	1	1	1	0.2
FJ _{cov int}	%	Intermediate ice coverage for FJ to keep growing in reach	45	40	40	40	80
FJ _{RR2}	-	Rate of frazil interception into SF for Cov _{corr} > F _{Jcov int}	0.6	0.3	0.35	0.3	0.25
FJ _{cov max}	%	Ice coverage above which at TF is sent downstream	60	95	90	95	95
FJ _{cov spring}	%	At breakup, frazil jam can no longer extend if Cov _{corr} is lower	5	5	5	20	20
FJ _{thermal}	Tons	Ice forming in unfrozen water within TF at each time step	Variables				
FJ _P	-	Initial porosity of frazil jam in reach	0.3				
FJ _{ET TR}	W/m ²	Heat flux (E _{net}) above which all new FJ freezes entirely (FJ _P =0)	-305	-350	-300	-280	-280
FJ _{cumul}	Tons	Balance of frazil jam in reach	Variables				
FJ _{daily}	Tons	Daily flux of ice in frazil jam in reach	Variables				
FJ _{cumul}	m ³	Balance of frazil jam in reach considering density	Variables				
FJ _{density}	-	Relative density of ice in frazil jam as a verification (max = 0.92)	Variables				
FJ _{thickness}	m	Reach-averaged frazil jam thickness	Variables				
FJ _{thickmax}	m	Maximum FJ average thickness in reach	NA				0.6

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
$FJ_{meltbias}$	%	Bias towards preferential melt of AI compared with FJ	Variables				
FJ_{melt}	Tons	Amount of frazil jam melted at any time step	Variables				
FJ_{mRR}	Tons	SF melt from other heat sources (when $E_{net} = 0$)	0	0	100	200	100
$FJ_{breakup}$	Tons	Amount of frazil jam that exits the reach as an ice run	Variables				
BR_{cond1}	Binary	Breakup condition 1 based on warming air temperatures	Variables			NA	
$BR_{E_{rise}}$	W/m^2	Rise in E_{net} for breakup to occur	250	290	290		
$BR_{E_{riseD}}$	Days	Maximum number of days over which E_{net} must rise	7				
$BR_{covE_{min}}$	%	Minimum Cov_{corr} for BR_{cond1} to occur	10	5	5		
$BR_{covE_{max}}$	%	Maximum Cov_{corr} for BR_{cond1} to occur	80	50	50		
BR_{cond2}	Binary	Breakup condition 2 based on warm air temperatures	NA			Variable	
BR_{melt}	W/m^2	E_{net} for breakup to occur				0	-20
BR_{meltD}	Days	Number of days over which breakup cannot be repeated				4	
$BR_{covm_{min}}$	%	Minimum Cov_{corr} for BR_{cond2} to occur				5	
$BR_{covm_{max}}$	%	Maximum Cov_{corr} for BR_{cond2} to occur				90	55
BR_{cond3}	Binary	Breakup condition 3 based on new minimum flow	Variables				
$BR_{Q_{min}}$	m^3/s	Drop in minimum flow (Q_{min}) for breakup to occur	5	4	4	6	6
$BR_{E_{Q_{min}}}$	W/m^2	E_{net} below which condition does not apply	-305	-350	-300	-280	-190
$BR_{Q_{minD}}$	Days	Number of days over which new minimum is established	5				
$BR_{covQ_{minl}}$	%	Minimum Cov_{corr} for BR_{cond3} to occur	10	5	10	10	10
$BR_{covQ_{minh}}$	%	Maximum Cov_{corr} for BR_{cond3} to occur	40	45	50	99	55
BR_{cond4}	Binary	Breakup condition 4 based on daily flow variations	Variables				
$BR_{\Delta Q}$	m^3/s	Minimum daily variation in flow (ΔQ) for breakup to occur	10	8	8.5	8.5	8.5
$BR_{E_{\Delta Q}}$	W/m^2	E_{net} below which condition does not apply	-305	-350	-300	-195	-190
$BR_{\Delta Q_{min}}$	%	Minimum Cov_{corr} for BR_{cond4} to occur	10	5	5	5	5
$BR_{\Delta Q_{max}}$	%	Maximum Cov_{corr} for BR_{cond4} to occur	60	60	60	55	55
BR_{cond5}	Binary	Breakup condition 5 based on massive anchor ice release	Variables				NA

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
BR _{AI%}	%	Minimum loss in AI for condition to apply	75				NA
BR _{AI}	tons	Minimum amount of AI released for condition to apply	15000	15000	15000	12000	
BR _{cond6}	Binary	Breakup condition 6 based on new maximum flow	NA				Variable
BR _{Qmax}	m ³ /s	Maximum flow (Q _{max}) threshold for breakup to occur					18.5
BR _{EQmax}	W/m ²	E _{net} below which condition does not apply					-190
BR _{QmaxD}	Days	Maximum number of days over which E _{net} must rise					5
BR _{covQmaxl}	%	Minimum Cov _{corr} for BR _{cond6} to occur					5
BR _{covQmaxh}	%	Maximum Cov _{corr} for BR _{cond6} to occur					40
BR _{cond7}	Binary	Breakup condition 7 based on new minimum spring flow	Variables				
BR _{QminS}	m ³ /s	Drop in minimum flow (Q _{min}) for spring breakup events to occur	4				
BR _{EQminS}	W/m ²	E _{net} below which condition does not apply	NA		-195	-190	
BR _{QminDS}	Days	Number of days over which new minimum is established	4				
BR _{covQminlS}	%	Minimum Cov _{corr} for BR _{cond7} to occur	5	3	3	3	2
BR _{covQminhS}	%	Maximum Cov _{corr} for BR _{cond7} to occur	80	80	90	99	99
BR _{covR}	%	Reduction in Cov _{corr} when breakup occurs (includes BR _{cond7})	5	3	3	3	2
BR _{DR}	Days	Number of days after which a new breakup event can occur	5	5	5	5	4
IR	Tons	Amount of broken ice leaving the reach as an ice run	Variables				
IR _{cov}	%	Maximum Cov _{corr} for ice runs to occur	35	50	40	40	40
IJ _{indicator}	-	Indicator of the occurrence of an ice jam	Variables				
IJ _{rubble}		Amount of ice in the spring melting front rubble (no impact)	5000				
IJ _{cov spring}	%	Ice jam no longer occur below this Cov _{corr} = FJ _{cov spring}	5	5	5	20	20
IJ _{influence}	-	Days when ice jam influence water levels	Variables				
IJ _D	Days	Duration of recent ice jam influence	4				
IJ _{covh}	%	Breakup Ice jam has an influence above this Cov _{corr}	50	60	80	95	96
I _{cumul}	Tons	Cumulative amount of ice in reach	Variables				
F _{out}	Tons	Amount of frazil leaving reach	Variables				

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
IR_{out}	Tons	Amount of ice rubble (ice runs) leaving reach	Variables				
n_{rise}	-	Manning's n (channel roughness) for ice cover forming	Variables				
n_{open}	-	Manning's n (channel roughness) for open water conditions	0.025	0.025	0.022	0.022	0.023
n_{icemax}	-	Maximum intact ice Manning's n (channel roughness)	0.035	0.032	0.030	0.028	0.030
$Mn_{covrise}$	%	Covcorr at which maximum Manning's n is reached	20	70	70	70	70
n_{smooth}	-	Manning's n (channel roughness) for mid-winter conditions	Variables				
n_{full}	-	Manning's n (channel roughness) for full ice coverage	0.032	0.030	0.026	0.026	0.027
n_{jam}	-	Manning's n (channel roughness) for ice jams, when applicable	Variables				
n_{jamC}	-	Manning's n (channel roughness) for ice jams	0.040	0.035	0.033	0.032	0.032
S	-	Water surface slope	Variables				
S_{open}	%	Open water surface slope	0.35	0.34	0.22	0.25	0.20
S_{IJ}	%	Ice jam surface slope	0.32	0.32	0.20	0.23	0.18
Y_{va}	m	Vertical adjustment of water depth to consider ice forms	Variables				
a_{SI}	-	Multiplicator for surface ice	1.0	1.0	1.0	1.0	1.0
b_{SI}	-	Exponent for surface ice	1.0	1.1	1.1	1.1	1.1
a_{AI}	-	Multiplicator for anchor ice	1.0	0.9	1.0	0.9	0.9
b_{AI}	-	Exponent for anchor ice	1.0	1.1	1.0	1.1	1.1
a_{SF}	-	Multiplicator for stored frazil	1.0	1.0	0.9	1.0	0.9
b_{SF}	-	Exponent for stored frazil	1.0	1.1	1.1	1.1	0.9
a_{FJ}	-	Multiplicator for frazil jam	0.9	0.9	0.9	0.9	0.9
b_{FJ}	-	Exponent for frazil jam	1.0	1.1	1.1	1.1	1.1
Y_{simKpX}	m	Simulated water depth at a Kp using modified Manning Eq.	Variables				
Y_{max}	m	Maximum water level over the course of winter	Variables				
OF	m	Overflow caused by a rise in Y_{sim}	Variables				
OF_{covmin}	%	Minimum Cov_{corr} for overflow to occur	20				
$OF_{rise\ min}$	m	Minimum rise in Y_{sim} in one time step for significant overflow	0.02				

Parameter			R1-2	R3	R4	R5	R6
Symbol	Unit	Meaning	Values				
AU	m	Freezing of overflow to form aufeis	Variables				
AU _{Tair}	°C	T _{air} threshold for overflow to freeze	-5				
AU _{overbank}	m	Aufeis thickness above the top of bank	Variables				
Y _{bank}	m	Elevation of bank (to be adjusted by the user)	1				
IJ	-	Occurrence of ice jam for visualization purposes	Variables				
IJ2	-	Occurrence of ice jam for visualization purposes	Variables				
Y _{sim adj}	m	Adjusted water elevation for visualization purposes	Variables				