Cooper Creek Draft SNTEMP Model Review
R2 Resource Consultants

Phase	Item	Features	Relevance	How to Resolve	Potential to Influence Flow Management Decisions	Ease of Resolving	HDR/Chugach Response	Adjustment to Model
Data Collection	1	Water temperatures were not measured in any of the tributary streams to Cooper Creek, except for Stetson Creek. A constant water temperature of 4.1°C was assumed in the SNTEMP model for all of the tributary streams (including Stetson Creek).	From May to October (the non-freezing period when SNTEMP is appropriate to use), tributary streams are a major source of cooling and heating to Cooper Creek. They will provide cool water in the spring and fall, and warm water in the summer. If SNTEMP is to be calibrated and utilized to examine alternative operational scenarios, these processes must be accounted for.	Although water temperatures for Stetson Creek were not provided in the review package sent out for review, they can be calculated directly from flow and water measurements in Cooper Creek just upstream from the confluence with Stetson Creek (Gage CCA) and just downstream from the confluence with Stetson Creek (Gage CCB). The derived water temperatures demonstrate a seasonal pattern (cool water in the spring and fall and warm water in the summer). The seasonal variation of water temperatures in the other tributary streams of Cooper Creek should be similar to the seasonal variation in Stetson Creek, and should be adjusted to calibrate the SNTEMP model.	H	M	A presumably significant percentage of the inflow to Cooper Creek is groundwater accretion. For these flows, a temperature of 4.1°C is a reasonable assumption. A significant percentage of inflows are from small tributaries. The temperatures of these inflows are unknown, but mostly are short tributaries that are fed by groundwater or runoff, and many likely do not see significant warming. The assumed temperatures of these inflows can also be adjusted as part of the temperature calibration process. The major tributary to Cooper Creek is Stetson Creek. Stetson Creek temperatures were measured for the modeling period and will be entered into the final model.	The tributary inflow temperatures were adjusted as a component of the model calibration process. Stetson Creek measured temperatures were entered into the final model.
	2	The elevation of the meteorological station adopted for the SNTEMP model was based on the SNOTEL station near the Cooper Lake Intake. An elevation of 350.52 meters (1,150 feet) was used in the model. However, the current full pool elevation of Cooper Lake is 1,194 feet (44 feet above the elevation used for the meteorological station. The meteorological station would be ineffective if it was submerged.	The SNTEMP model calculates air temperatures at different locations in the modeled stream network based on difference in elevation between the point of interest and the elevation of the meteorological station, using the moist air lapse rate (an increase of 6.56°C per 1,000 meters drop in elevation)	The NRCS website reports that the elevation of the SNOTEL station near the Cooper Lake Intake is 1,200 feet (6 feet above the full pool level of Cooper Lake). This should be adopted following confirmation with the NRCS.	L	H	The SNOTEL station is indeed at 1200 feet.	The meteorological station elevation was adjusted in the model to reflect the elevation of the SNOTEL station 1200 feet.
	3	The daily mean air temperatures obtained from the NRCS for the SNOTEL station near the Cooper Lake Intake do not match daily mean air temperatures for the same location downloaded from the NRCS website. Although the seasonal patterns are somewhat similar, the temperatures differ when compared on a daily basis.	Air temperature is another major source of heat input to Cooper Creek.	Contact the NRCS and resolve the discrepancies.	H	H	It appears the air temperature input data set in the preliminary model is different than the NRCS data set available on the internet. HDR has received an air temperature data set that was reduced and QC'd by NRCS. This data set differs from the data set available on the interet in the measured air temperatures are displayed to the 100th of a degree, and some errors were corrected. This data set was provided by Richard McClure of NRCS and will be used in the final model.	The new NRCS air temperature data set was used in the final model.
	4	The average annual air temperature (4.09°C) at the SNOTEL station near the Cooper Lake Intake seems warm when compared to the long-term average air temperature and from the nearby Cooper Lake Project station (3.00°C based on 44 years of record). The elevation of the Cooper Lake Project station is about 212 meters below the elevation of the SNOTEL station near the Cooper Lake Intake. If the moist air lapse rate is applied to this difference in elevation, this would suggest that the average annual air temperature at the Cooper Lake Intake is 1.61°C.	Downstream from Cooper Lake Dam, Cooper Creek receives accretion flows from groundwater and surface water sources. In the absence of measured temperatures, the long-term average annual air temperature is recommended for the water temperature from groundwater sources.	The NRCS website reports that this station has recorded air temperatures since 1999. These few years should be examined, using a nearby station with a long period of record, to see if it was warmer than normal. If so, a reduced temperature should be adopted for average annual air temperature.	L	H	The average annual air temperature at the SNOTEL station is 4.09°C; however using the moist air lapse rate the adjusted average annual air temperature would better represent air temperatures at the air-water surface of Cooper Creek. The SNTEMP model will further adjust air temperatures based on elevation.	An average air temperature of 1.61°C was used in the final model.

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Data Entry	5	A shade file was not used for the SNTEMP model developed for Cooper Creek.	Cooper Creek flows through a deep canyon, which should provide shade for Cooper Creek in the morning and evening. The shade effect should be more pronounced in the evening hours because the canyon has a Southeast-Northwest alignment.	Use a shade file for the SNTEMP model.	M	H	A shade file increases the level at which topographic and vegetative shading is considered in the calculation of solar radiation entering the stream surface, and thus affects calculation of water temperatures. As vegetative and especially topographic shading are both significant in the Cooper Creek basin, a shade file will be developed for the final model.	A shade file, describing the vegetative and topographic shading characteristics of the Cooper Creek basin, was used in the final model.
	6	Relative humidity was obtained from a different meteorological station from the reference station adopted for the SNTEMP. However, the SNTEMP model calculates relative humidity at different locations in the modeled stream network based on the air temperature the point of interest and the air temperature at the meteorological station, using the ideal gas law.	Relative humidity influences the cooling effect that occurs during evaporation.	The relative humidity records should be transposed from the station where the relative humidity was measured to the reference station adopted for the SNTEMP model, using the air temperatures from the two stations and by applying Equation II(56) from the SNTEMP model.	M	H	Relative humidity data were not collected at the SNOTEL station on Cooper Lake. The nearest data were collected on Kenai Lake, at a lower elevation. Equation II(56) in the SNTEMP manual gives a lapse rate equation based on the ideal gas law to correct relative humidity as a function of elevation. The equation assumes that total moisture content is the same over the basin and the station. This is probably not the case as Kenai Lake would likely have a higher moisture content than the high-mountain Cooper Lake. However, the total moisture content is not known between these two regions. Assuming the moisture contents of the two basins are equal, the equation can be applied to correct the Kenai Lake data (elev. 475 ft) to the Cooper Lake SNOTEL Station (elev. 1200 ft).	The lapse rate equation was used to correct the relative humidity data to the elevation of the model meteorological station.
	7	The water surface stream width in the stream geometry file was specified to remain constant, regardless of the streamflow.	The water surface stream width will increase as flow increases. As stream width increases, the heat exchange rate through the water surface will also increase. Thus, heating or cooling effects will be more pronounced at higher flow rates.	Develop a water surface stream width/discharge rating curve, utilizing field data collected from PHABSIM sites and incorporate results in stream geometry model.	M	H	Measured stream widths do not change much as a function of flow. However, they do change and as such an equation of this relationship should be entered into the final. Relationships will be developed on a reach-by-reach or a site-by-site basis.	A flow-top width relationship was developed and entered into the geometry file in the final model.
Calibration	8	The SNTEMP model, in its present condition, is not adequately calibrated. There is poor agreement between a plot of time series of predicted and observed water temperatures, for the non-freezing period from May to October, when the SNTEMP model is appropriate to use.	The SNTEMP model can't be used to evaluate alternative operational scenarios until it has been adequately calibrated.	Reset the global calibration coefficients for air temperature and solar radiation back to 1.0. Use measured or derived water temperatures in Stetson Creek in the SNTEMP model. The seasonal variation of water temperatures in Stetson Creek should be used as a guide for estimating the water temperatures in the other tributaries. Water temperatures from the accretion sources should be adjusted, as necessary, to calibrate the model.	H	M	The above changes should improve the model calibration, particularly adding measured water temperatures to Stetson Creek inflow file. The calibration method of adjusting the unknown small tributary input water temperatures should lead to an adequately calibrated model.	This method, used for the final model, resulted in better calibration statistics than the draft model.