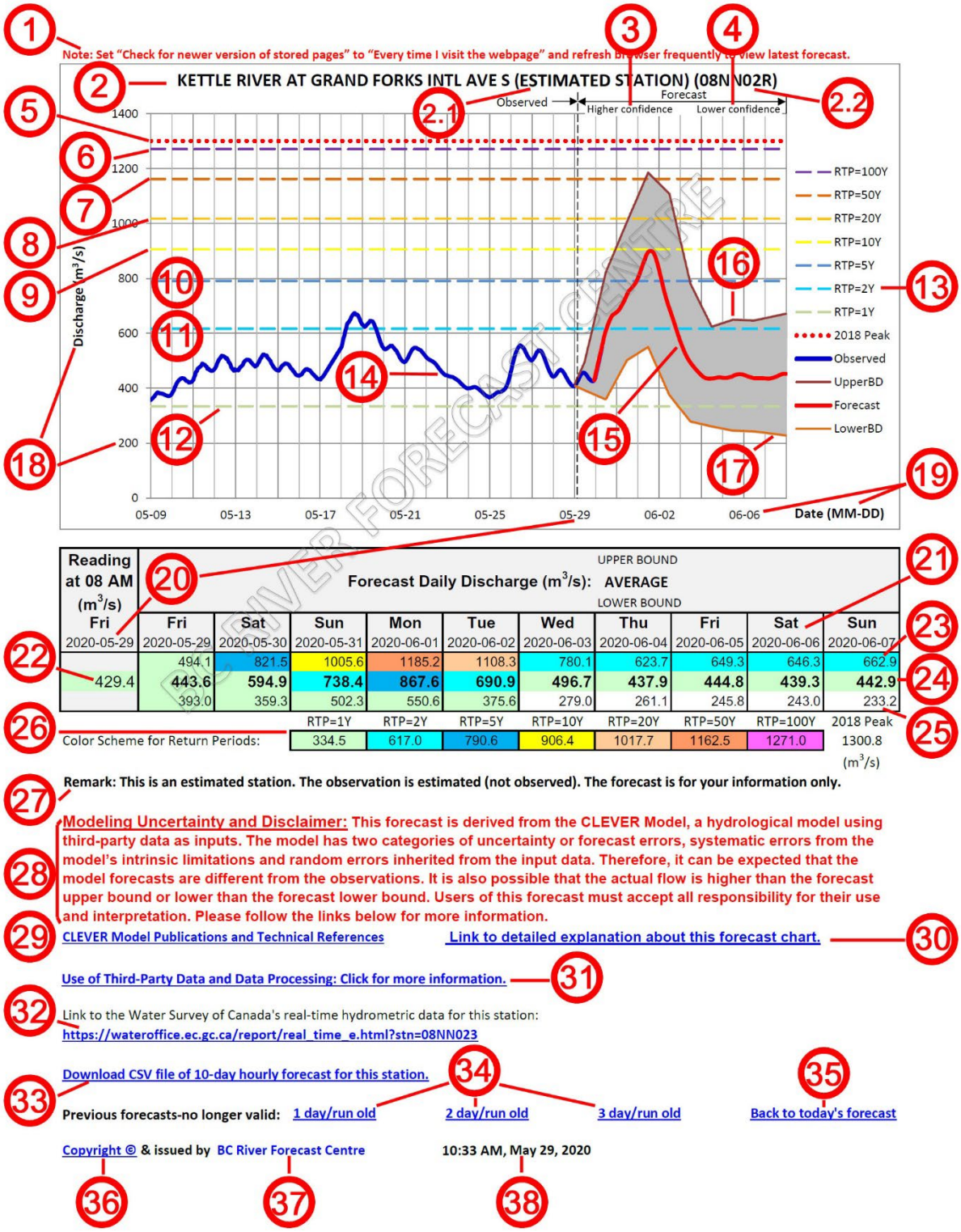
Detailed explanation about the CLEVER Model forecast chart

BC River Forecast Centre

Updated May 25, 2023



Reading at 08 AM (m³/s) Fri 2020-05-29	Fri 2020-05-29	Sat 2020-05-30	Sun 2020-05-31	Mon 2020-06-01	Tue 2020-06-02	Wed 2020-06-03	Thu 2020-06-04	Fri 2020-06-05	Sat 2020-06-06	Sun 2020-06-07
	494.1	821.5	1005.6	1185.2	1108.3	780.1	623.7	649.3	646.3	662.9
429.4	**443.6**	**594.9**	**738.4**	**867.6**	**690.9**	**496.7**	**437.9**	**444.8**	**439.3**	**442.9**
	393.0	359.3	502.3	550.6	375.6	279.0	261.1	245.8	243.0	233.2

RTP=1Y	RTP=2Y	RTP=5Y	RTP=10Y	RTP=20Y	RTP=50Y	RTP=100Y	2018 Peak
334.5	617.0	790.6	906.4	1017.7	1162.5	1271.0	1300.8 (m³/s)

(Clicking on a circle will direct you to the explanation.)

(1) Note for web browser settings to view the latest forecast:

a. For Internet Explorer, set “Tools/Internet Options/Settings/Temporary Internet Files/Check for newer versions of stored pages” to “to “Every time I visit the webpage.”
b. For Microsoft Edge, set “Settings/Privacy, search, and services/Clear browsing data/Choose what to clear every time you close the browser/Cached images and files” to “On.”
c. For Google Chrome, refresh the browser manually or set “Settings/Privacy and security/Cookies and other site data/General settings/Clear cookies and site data when you quit Chrome” to “On.”

(2) Hydrometric/Flow station name.

(2.1) Station category. There are five categories:

d. Active real-time Water Survey of Canada (WSC) hydrometric station. For this category, the category indicator is omitted.
e. Inactive WSC station, shown as, “(INACTIVE STATION).”
f. Non-WSC station, shown as, “(NON WSC STATION).”
g. Estimated station, shown as, “(ESTIMATED STATION).” Estimated stations are NOT real stations. They are imagined stations that are not physically installed in the locations, and the "observed hydrometric data” for these stations are estimated only using observational data from the adjacent WSC hydrometric stations. The estimated stations are used to improve model performance for the downstream locations. However, it may be beneficial to hydrometric condition monitoring if the estimated stations become real. Within the CLEVER model, an estimated station is calibrated against the estimated flow data. However, forecasts for the estimated stations are for information purposes only.
h. Routing station, shown as, “(ROUTING STATION).” Routing stations are NOT real stations either. They are also imagined stations that are not physically installed in the locations. For the routing stations, no observed hydrometric data is available or estimated. This is the key difference between an estimated station and a routing station. The routing stations are used for model calibration purposes only. Both "observed" and "forecast" flows included in the chart are estimated by the model and calibrated at the downstream locations. This means that the forecast for a routing station is only partly calibrated. Forecasts for the routing stations should not be used as predictions of streamflow in those locations. However, these forecasts may give rough ideas about the relative changes of streamflow in the adjacent regions/locations in which no WSC hydrometric station is available.

(2.2) Station ID

The Station ID is the WSC hydrometric ID if it is a WSC station. Otherwise, it is an ID which is used in the model.

(3) Forecast of high confidence.

The CLEVER Model is calibrated in every run against the Water Survey of Canada's (WSC) real-time hydrometric data (provisional discharges and/or water levels) for a 20-day period immediately before the current day when the model is run so that the model estimated flows agree with the WSC observations. Generally speaking, the shorter the lead time, the more accurate the forecast flows. It is recommended that the forecast flows for the coming three days, or at most for the coming five days, should be looked at.

In the case when there is forecast moderate to heavy rainfall for a watershed for the coming days, the confidence of the forecast flows highly depend on the forecast rainfall intensity and the location of the storm center (please refer to Section (31) for "Note of Use of Third-Party Data and Data Processing"). In this case due to the immense uncertainty in the forecast rainfall, the best strategy would be "Prepare for the worst and hope for the best."

During the freshet, the River Forecast Centre updates the forecast on a daily basis, and the forecast flows are always changing. The forecast could also be changed several times a day when the River Forecast Centre hydrologists find that the meteorological and/or hydrological data or conditions have changed. Please always make sure to check the latest forecast.

(4) Forecast of low confidence.

The forecast flows for a lead-time longer than five days are for information only. These forecast flows are posted because sometimes they may be useful when people are looking at a longer-term plan. But please be aware that the forecast flows for a lead time of five or more days are generally of low confidence.

During the freshet, the River Forecast Centre updates the forecast on a daily basis, and the forecast flows are always changing. The forecast could also be changed several times a day when the River Forecast Centre hydrologists find that the meteorological and/or hydrological data or conditions have changed. Please always make sure to check the latest forecast.

(5) Historical record line.

The historical line shows the historical maximum discharge or water level (instantaneous peak) recorded in the year shown in the legend. This line may be at any height on the vertical axis (discharge or water level). Historical maximum values are based on available annual maximum data available from the WSC. In some instances, historic data may be incomplete, and higher flows may have occurred.

(6) The 100-year return period flood line.

This line shows the 100-year return period discharge or water level. Return period, or recurrence interval or repeat interval, is an average time between two floods/flows. "100-year return period flood" is only a probability term about the flood level, which means that a flood of this magnitude might occur once in a hundred-year period based on the historical statistics. However, a "100-year return period flood" could occur in any year in reality, even if a "100-year return period flood" had just occurred a year ago.

All return periods and their theoretical floods are estimated by a flood frequency analysis (FFA) using available WSC annual instantaneous peaks of discharge/water level as the input, which may be treated when insufficient data is available and/or inconsistent data are present for a station. In the FFA, the observational data were fitted in eight probability distributions and the best fitted distribution was selected based on certain criteria to determine the theoretical floods for the return periods for a station. The return periods and their theoretical floods are meant to assist with interpreting the relative magnitudes of the forecast streamflows. The values of return periods and their theoretical floods may be different from published values in other studies or assessments and should not be used as official values. These theoretical floods and return periods must NOT be used for design purposes.

(7) The 50-year return period flow line.

This line shows the 50-year return period discharge or water level. About "return period", please refer to (6).

(8) The 20-year return period flow line.

This line shows the 20-year return period discharge or water level. About "return period", please refer to (6).

(9) The 10-year return period flow line.

This line shows the 10-year return period discharge or water level. About "return period", please refer to (6).

(10) The 5-year return period flow line.

This line shows the 5-year return period discharge or water level. About "return period", please refer to (6).

(11) The 2-year return period flow line.

This line shows the 2-year return period discharge or water level. About "return period", please refer to (6).

(12) The 1-year return period flow line.

This line shows the 1.01-year return period discharge or water level. About "return period", please refer to (6).

(13) Legend of the chart.

(14) Hourly average of the observed flow.

The observed discharge /water level data are hourly averages (discharge in m^3/s and water level in m). See "30. Note of Use of Third-Party Data and Data Processing" for more information about the observed flow data.

(15) Forecast hourly average flow.

The unit is m^3/s for the forecast discharge and m for the forecast water level. The color scheme of the station marker on **the map** is determined by the forecast maximum flow in the consecutive five days next to, and including, the forecasting day (see 20 and 37).

(16) Upper bound of the forecast flow.

The forecast upper bound (discharge in m^3/s or water level in m) is estimated with the average forecast errors in the previous year for the same station. For a new station or a routing station, forecast errors of the adjacent WSC stations are used. The upper bound is derived from the historical statistics only. Because of this reason and the model uncertainty, it is possible that the actual flow is higher than the forecast upper bound. For the model uncertainty, please refer to 28.

(17) Lower bound of the forecast flow.

The forecast lower bound (discharge in m^3/s or water level in m) is estimated with the average forecast errors in the previous year for the same station. For a new station or a routing station, forecast errors of the adjacent WSC stations are used. The lower bound is derived from the historical statistics only. Because of this reason and the model uncertainty, it is possible that the actual flow is lower than the forecast lower bound. For the model uncertainty, please refer to 28.

(18) Vertical axis for discharge (m3/s) or water level (m).

(19) Horizontal axis for date in MM-DD.

(20) Date of the forecasting day.

This date is in MM-DD or YYYY-MM-DD, on which the model was run and the forecast was issued/updated.

(21) Date (in YYYY-MM-DD) and day of week for table output below the hydrograph chart.

(22) Latest reading of the observed flow on the forecasting day.

The reading time (hour in PST) is shown in the box above it.

(23) Value of the forecast upper bound for the day.

(24) Value of the forecast daily average for the day.

(25) Value of the forecast lower bound for the day.

(26) Color scheme:

Color scheme and return periods, discharges (or water levels) for different return periods, and the historical maximum discharge (or water level). For return period, please refer to 6.

(27) Remark for special stations

Such stations include routing stations, estimated stations, inactive stations, regulated stations, etc.

(28) Modeling Uncertainty and Disclaimer:

This forecast is derived from the CLEVER Model, which is driven by the observed and forecast climate data and calibrated with the observed (provisional) flow data. These data are referred to as "input data." The input data are from the third parties and may include errors. Please refer to "(31). Note of Use of Third-Party Data and Data Processing" for more details about the input data.

The CLEVER Model is a hydrological model. The core of the model is an integration of computer codes (about ten thousand lines) which solves numerically and iteratively a series of complicated scientific equations, including partial differential equations. Please refer to the CLEVER Model Publications and Technical References page for details about the methodology and science of the CLEVER Model.

Because of the intrinsic limitations of the model's methodology and the errors inherited from the input data, the CLEVER Model's forecasts may include forecast errors, which is the so-called "modeling uncertainty." There are two categories of modeling uncertainty. The first category of modeling uncertainty is the CLEVER Model's forecast errors stemmed from the model's intrinsic limitations, which are referred to as "systematic errors," and which are recurring and relatively constant. The second category of modeling uncertainty is the CLEVER Model's forecast errors inherited from the input data, which are referred to as "random errors," and which are dependent on case-specific conditions. It is acknowledged that meteorological modeling, which provides input forecast climate data for hydrological modeling, is super complicated and that forecasting of extreme weather events such as atmospheric rivers (ARs), which have been becoming more frequent, intensified, and widespread across BC under climate change impacts, is extremely difficult and challenging. Sometimes the errors in the forecast climate data could be significant with respect to the forecast rainfall intensities and forecast storm centre locations due to climate change, which in turn could incur significant errors to the hydrological forecasts. Meanwhile, large errors could also be present in the observed (provisional) flow data, which could negatively impact the model calibration significantly, and the model calibration errors would also transfer into the model forecast errors.

As the result of modeling uncertainty, the forecast included in this chart, the CSV file for users to download, and the map may also include errors. It can be expected that the actual observed discharges and water levels will be different from the model forecasts. Moreover, it is also possible that the actual flow is higher than the forecast upper bound or lower than the forecast lower bound and the reason given in 16 and 17. **Users of this**

forecast and data must accept all responsibility for their use and interpretation.

(29) CLEVER Model Publications and Technical References page.

A link to the CLEVER Model Publications and Technical References page.

(30) Link to detailed explanation of this forecast chart.

A link to this document.

(31) Note of Use of Third-Party Data and Data Processing (a link to this document):

The observed climate data, which drive the CLEVER Model, are from Environment and Climate Change Canada (ECCC) and Province of British Columbia. The forecast climate data are the Numerical Weather Prediction (NWP) GRIB2 data (terms and conditions) from the Canadian Meteorological Centre (CMC), ECCC. For ECCC's observed and forecast climate data, please check the Licence Agreement for Use of Environment and Climate Change Canada Data. The CLEVER Model may use daily and/or hourly climate data. Daily maximum and minimum temperatures and daily precipitation are calculated from the above source data. When the daily climate data are used In the CLEVER Model, the daily climate data are distributed into 24 hours by using typical distribution lines for the temperature and precipitation. When observed temperatures and/or precipitation are missing for a station, the data are estimated with the data from the adjacent stations. The forecast temperature data may be subject to bias corrections. But no bias correction is done to the precipitation data.

The observed discharge and water level data for the model calibration are from the Water Survey of Canada (WSC) real-time hydrometric data and B.C. Real-time Water Data, which are provisional and subject to changes. Please refer to WSC's Hydrometric data and information service standards and Disclaimer for Hydrometric Information and Copyright statement of Province of British Columbia for these data. When missing data are present in the observed flow data series (discharges and/or water levels), or there is no data for a station, methods such as interpolation, extrapolation, referring to the rating curves or extensions of the rating curves, correlations to other stations, etc., are used to estimate the "observed" flow data.

(32) Link to the WSC real-time hydrometric data website/ B.C. Real-time Water Data site for this station.

Only an active WSC real-time hydrometric station or B.C. Real-time Water Data station has such a link.

(33) Link to an Excel CSV file of the numerical forecast for the station.

Users may click the link to download the hourly forecast data in an Excel CSV file.

(34) Links to previous forecasts:

Three links to three previous forecasts, which have been issued on the recent consecutive three days if the model has been run consecutively, or from the latest three runs if the model has not been run on previous

consecutive days. Previous forecasts are not considered to be the current valid forecasts, however they provide information on how forecasts have changed day-to-day and can assist in forecast interpretation.

(35) Link directing back to today's (the current/latest) forecast.

(36) Link to Copyright statement of Province of British Columbia.

(37) Link to the homepage of BC River Forecast Centre.

(38) Time and date when the forecast was issued/updated.