

WASHINGTON DEPARTMENT OF ECOLOGY
ENVIRONMENTAL ASSESSMENT PROGRAM
FRESHWATER MONITORING UNIT
STREAM DISCHARGE TECHNICAL NOTES

STATION ID: 01N060
STATION NAME: Bertrand Creek near Mouth
WATER YEAR: 2011
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Introduction

Watershed Description

The Bertrand Creek watershed straddles the U.S. - Canadian border and drains nearly 30 square miles of the Nooksack River lowlands upstream from this station. Land use is mostly agricultural with berry crops and dairy farms predominating. About 14.1 square miles of this basin lie on the U.S. side of the border. Elevations range from about 33 feet at the gage up to about 400 feet near the headwaters in Canada. No significant part of the basin has slopes greater than 30 percent. About 11 percent of the basin showed forest canopy in a 2001 survey. Annual precipitation is about 36 inches.

Gage Location

The gage is on the upstream side of the Rathbone Road bridge, about 0.8 miles above the mouth as the creek joins the Nooksack River.

Table 1. Basin Area and Legal Description

| | |
|---------------------------------------|--------------|
| Drainage Area (square miles) | 30 (approx) |
| Latitude (degrees, minutes, seconds) | 48, 55, 27 |
| Longitude (degrees, minutes, seconds) | -122, 31, 48 |

Table 2. Discharge Statistics.

| | |
|---|---------|
| Mean Annual Discharge (cfs) | 98 cfs |
| Median Annual Discharge (cfs) | 62 cfs |
| Maximum Daily Mean Discharge (cfs) | 794 cfs |
| Minimum Daily Mean Discharge (cfs) | 5.8 cfs |
| Maximum Instantaneous Discharge (cfs) | 995 cfs |
| Minimum Instantaneous Discharge (cfs) | 5.4 cfs |
| Discharge Equaled or Exceeded 10 % of Recorded Time (cfs) | 220 cfs |
| Discharge Equaled or Exceeded 90 % of Recorded Time (cfs) | 9.5 cfs |
| Number of Days Discharge is Greater Than Range of Ratings | None |
| Number of Days Discharge is Less Than Range of Ratings | 9 days |
| Number of Un-Reported Days | 35 days |
| Number of Days Qualified as Estimates | 46 days |
| Number of Modeled Days | None |

Note: Statistics displayed in Table 2 may not include values in which the predicted discharge exceeds the range of ratings.

Table 2 Discussion (Discharge Statistics)

The 35 unreported days had a high probability of backwater effect due to high water levels on the Nooksack River. Of the 46 days qualified as estimated data, 28 days had possible backwater effects from the Nooksack River, and three days had instrument drift that caused potential errors greater than 20 percent of mean daily flow. Six days had data gaps filled based on data from another station. On nine estimated days with discharge less than the range of ratings, the actual discharge values may have been less than the values shown.

For an explanation of the methods used to identify periods of likely backwater effect and periods of possible backwater effect, please see Appendix A to these Notes.

Table 3. Error Analysis Summary.

| | |
|--|-----|
| Potential Logger Drift Error (% of discharge) | 5% |
| Potential Weighted Rating Error (% of discharge) | 12% |
| Total Potential Error (% of discharge) | 17% |

Table 3 Discussion (Error Analysis)

| |
|--|
| |
|--|

Table 4. Stage Record Summary

| | |
|--------------------------------|---------|
| Minimum Recorded Stage (feet) | 1.67 ft |
| Maximum Recorded Stage (feet) | 12.71 |
| Range of Recorded Stage (feet) | 11.04 |

Table 4 Discussion (Stage Record)

The minimum recorded stage occurred on September 8 and resulted in an instantaneous discharge of 5.4 cfs and a mean daily discharge of 5.8 cfs for that date. The maximum recorded stage occurred on December 12 during a period of likely backwater effect from the Nooksack River. No discharge statistics were reported for that date due to the likelihood of the backwater effect.

Table 5. Rating Table Summary

| | | | |
|------------------------------|--------------------|-----------------------|--------------------|
| Rating Table No. | 12 | 702 | 13 |
| Period of Ratings | 10/1 to 10/25/2010 | 10/1/2010 to 1/3/2011 | 11/15 to 9/23/2011 |
| Range of Ratings (cfs) | 0.01 to 664 cfs | 0.01 to 1250 cfs | 0.01 to 1200 cfs |
| No. of Defining Measurements | 15 | 16 | 20 |
| Rating Error (%) | 14 % | 13 % | 11 % |

| | | | |
|------------------------------|-------------------|--|--|
| Rating Table No. | 14 | | |
| Period of Ratings | 9/13 to 9/30/2011 | | |
| Range of Ratings (cfs) | 7.4 to 1200 cfs | | |
| No. of Defining Measurements | 15 | | |
| Rating Error (%) | 9 % | | |

| | | | |
|------------------------------|--|--|--|
| Rating Table No. | | | |
| Period of Ratings | | | |
| Range of Ratings (cfs) | | | |
| No. of Defining Measurements | | | |
| Rating Error (%) | | | |

Table 5 Discussion (Rating Tables)

The channel substrate at this station includes a large amount of sand and silt. This easily moved material combines with periodic backwater episodes to result in frequent cycles of scour and fill. In water year 2011, ratings 702 and 14 reflect periods of channel fill, while ratings 12 and 13 are periods of channel scour.

Table 6. Model Summary

| | |
|--|------|
| Model Type (Slope conveyance, other, none) | None |
| Range of Modeled Stage (feet) | N/A |
| Range of Modeled Discharge (cfs) | N/A |
| Valid Period for Model | N/A |
| Model Confidence | N/A |

Table 6 Discussion (Modeled Data)

High flow modeling was not used for this station due to the frequent occurrence of a backwater effect.

Table 7. Survey Type and Date (station, cross section, longitudinal)

| Type | Date |
|----------------|-----------|
| Station survey | 8/18/2010 |

Table 7 Discussion (Surveys)

A station survey was done on August 18, 2010, just prior to the start of the water year.

Activities Completed

Routine station maintenance, data downloads, and discharge measurements. Replaced rain gage with a recently calibrated unit.

Appendix

Appendix A: Identifying periods in which backwater conditions are likely or possible at Ecology's stream gaging station on Bertrand Creek near the mouth (01N060)

The backwater effect at Ecology station # 01N060 on Bertrand Creek is dependent on the difference between the water level in the Nooksack River and the incoming flow from Bertrand Creek itself. The USGS gage on the Nooksack River at Ferndale (USGS# 12213100) is about four miles downstream from the mouth of Bertrand Creek. An analysis of 27 high flow events, in which crest times could be identified at both stations, indicates a typical travel time of about three hours between crests at 01N060 and 12213100. Travel times did vary significantly in response to varying runoff patterns between storm events.

A similar comparison of hydrographs from both stations was made for prolonged dry periods with low flow at 01N060, but with active diurnal snowmelt runoff on the Nooksack River. That comparison found a fairly consistent pattern in which a peak stage of 9.2 ft. or greater at 12213100 was needed to cause a distinct bump in the hydrograph at 01N060 (again with a travel time of about three hours between the peak at 01N060 and 12213100). This comparison would indicate that a stage of at least 9.2 ft. at 12213100 would be required to produce any backwater effect at 01N060.

Finally, 15 discharge measurements at 01N060 were analyzed to determine possible backwater effect at the time of flow measurement. The difference between the back-routed (-180 minutes) stage at 12213100 and the 9.2 ft. backwater threshold is subtracted from the mean gage height (mgh) for the discharge measurement at 01N060. Of the 15 measurements analyzed, five had a difference between the 01N060 mgh and the exceedence of the 12213100 stage above the 9.2 ft. backwater threshold of between 2.18 ft. and 3.62 ft. Each of those 5 measurements had comments indicating some degree of backwater or obstruction of flow downstream. Each of the five also had a significantly lower measured discharge than would have been predicted by the rating that was in effect for the preceding and following measurements. Measurements in which the back-routed 12213100 stage was less than 9.2 ft., or in which the difference between the 01N060 mgh and the exceedence of the 12213100 stage above the 9.2 ft. backwater threshold was greater than about 6.0 ft. had no recorded evidence of backwater.

Likely periods of backwater are identified in the 01N060 dataset by plotting a reference trace of points in which the difference between the back-routed (-180 minutes) stage at 12213100 and the 9.2 ft. backwater threshold is subtracted from the gage height at 01N060. Periods when the stage at 12213100 is less than 9.2 ft. are excluded from the reference trace.

A backwater effect is considered to be likely in periods when the difference between the stage at 01N060 and the 12213100 backwater threshold exceedence is about 4.0 ft. or less. Those periods are given quality code (QC) 220.

A backwater effect is considered to be possible in periods when the difference between the stage at 01N060 and the 12213100 backwater threshold exceedence is between about 4.0 ft and 6.0 ft. Those periods are given QC 50.

Application of this method is subjective and has similarities to the problem of identifying ice-impacted data. However, recent experience suggests that a backwater condition occurs at this station more frequently than was recognized in the past. Silt deposition patterns at mid and upper levels on the stream banks following periods of high water indicate that high water is often accompanied by low stream velocity, suggesting backwater conditions.

More recent technological methods such as Velocity Indexing using a fixed – mount Acoustic Doppler Velocity Meter (ADVM) could remove some of the uncertainty about backwater conditions at this station.