

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedure for Measuring Gage Height of Streams

Version 1.0

Author – James R. Shedd

Date – 08/29/2008

Reviewer – Don Watt

Date – 09/22/2008

QA Approval - William R. Kammin, Ecology Quality Assurance Officer

Date -

EAP042

APPROVED: October 7, 2008

SIGNATURES ON FILE

*Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.*

*Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.*

*Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.*



## Environmental Assessment Program

### Standard Operating Procedure for Measuring Gage Height of Streams

#### **1.0 Purpose and Scope**

- 1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for determining the stage of a stream using a staff gage, wire weight gage, laser level, weighted measuring tape (tape down), and crest stage gage.

#### **2.0 Applicability**

This procedure is to be followed when determining or verifying the gage height or relative water surface elevation of a stream.

#### **3.0 Definitions**

- 3.1 Stage/Water Surface Elevation/Gage Height — Stage is the confirmed water surface elevation above a datum. Gage height is the water surface reading on a particular gage (Rantz, et al., 1975). At most Stream Hydrology stations an arbitrary zero datum is used.
- 3.2 Primary Gage Index — The primary gage index is the base gage for the station and is directly referenced to the recording gage. The primary gage index is the most stable and reliable gage at a site. All other gages at a station are considered secondary gage indexes.
- 3.3 Secondary Gage Index — Secondary gage indexes are used to confirm the primary gage index. The secondary gage can be used to estimate the value of the primary gage if the primary gage is damaged or missing.
- 3.4 Recording Gage — Typically an automated bubbler or pressure transducer measures and records the stage to an electronic data logger maintaining a continuous record of stage through a specified period of time. The bubbler or transducer is calibrated to match the primary gage index.
- 3.5 Reference Mark — A reference mark is a permanent marker of known elevation above the zero datum, installed in the ground or on a stable structure in the vicinity of the gauging station.
- 3.6 Reference Point — A reference point is a marker above the zero datum from which the water surface elevation can be determined by measuring down to the water surface.

3.7 Zero Datum— Zero datum is an arbitrary plane below the elevation of zero flow and maximum scour on a control.

3.8 Laser Beam Elevation— Laser beam elevation is the elevation of the plane of the laser emitted by the laser instrument.

3.9 Differential— Differential is the difference in elevation between the laser rod reading and the water surface rod reading.

Control— The physical features of a stream that control the relationship between stage and discharge at a gage site.

3.10 Point of Zero Flow— Stage at which water ceases to flow over the control. The point of zero flow is the lowest point on the control

#### **4.0 Personnel Qualifications/Responsibilities**

4.1 Personnel using this SOP should have training and field experience in making stream gage site visits, recording and documenting pertinent data.

#### **5.0 Equipment, Reagents, and Supplies**

5.1 Copies of the standard Ecology field forms (Attachment A) for recording times, gage readings, and actions taken while at the gage site are kept in a suitable field notebook. These forms are usually printed on Rite in the Rain™ paper for outdoor durability.

5.2 A stadia rod is used to determine the difference in elevation between the water surface and laser level beam.

5.3 A circular bubble level is attached to the stadia rod to ensure rod is held vertically.

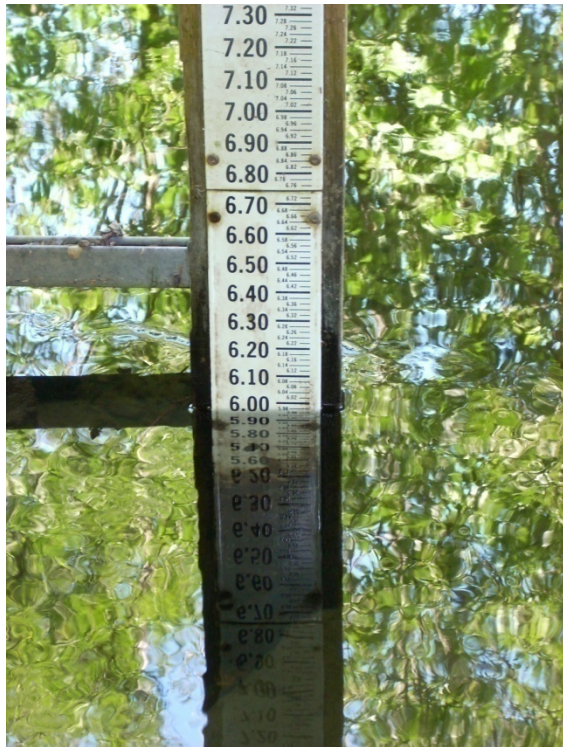
5.4 A laser level instrument emits a laser beam illuminating a horizontal plane of known elevation. The laser beam elevation is used to determine water surface elevation.

5.5 An engineer's tape measure is used to measure the high water mark on a crest stage gage.

5.6 A weighted measuring tape is used for measuring a tapedown to the water surface from a reference point.

## 6.0 Summary of Procedure

- 6.1 Establishing Gage Datum — The stage or water surface elevation at a stream gauging site and the elevations of all reference marks, reference points, and gages used to determine stage are relative to a common datum. At most stations a zero datum is arbitrarily assigned corresponding to the elevation of the primary gage index. Primary gages are installed such that the assumed zero point of the primary gage is below the point of zero flow and expected scour of the control.
- 6.1.1 Movement of the structures supporting the primary gage disturbs the datum. Periodic levels should be run to check the relative position of the primary gage against reference marks of known elevation.
- 6.1.2 Levels should be run at a minimum of every 3 years. Levels should be run as soon as possible when there are unresolved discrepancies between gage observations or movement of gage structures, reference marks, or reference points is suspected.
- 6.1.3 When the primary gage has moved, the gage should be recalibrated to the datum and/or relocated to the proper elevation when possible.
- 6.1.4 In some applications relocation of the gage is not possible. The ways in which these circumstances are handled are presented in the following discussions of each type of gage.
- 6.2 Placement of Gages — Primary and secondary gages are placed in the gage pool subject to the same station control and as close in proximity as possible to the recording gage.
- 6.2.1 Gages should not be placed in a stream section regulated by different controls, as channel dynamics and geometry are not the same. Stage fluctuates at different rates and magnitudes, relative to changes in discharge.
- 6.3 Determining Stage Height by Observing a Staff Gage — A vertical standing staff gage is a singular or a successive series of porcelain enameled steel plates mounted to a secure structure. Most staff plates used by the Washington State Department of Ecology are graduated in 0.02 feet increments. Staff gage observations are recorded to 0.01 feet resolution.



**Figure 1** A typical Ecology staff gage with 0.02 feet increments. (Photo by Washington Dept. of Ecology)

- 6.3.1 In many locations the water level may surge against the staff gage structure, causing the water surface to fluctuate or bounce on the staff gage. If the water level is fluctuating on the staff, read the average level and note the reading with the range of water level fluctuation (uncertainty) i.e. 4.16 +/-0.04, where 4.16 is the average of the peaks and troughs of the waves and +/- 0.04 is the range of the peaks and troughs.
- 6.3.2 In situations where the fluctuation is excessive or there is significant velocity head build-up on the staff gage structure, a makeshift stilling well may be used. A good makeshift stilling well consists of a 5-gallon bucket with the bottom cut out and a cut up the side to permit spreading of the bucket walls to surround the staff gage structure. Open the bucket walls and wrap around the staff gage with the bottom of the bucket walls at a depth of 0.5 to 1 feet. This should calm the water around the staff gage enough to obtain a more reliable reading.
- 6.3.3 Take the necessary time to obtain the most accurate observation. It is very important to record the uncertainty of the observation for future analysis.
- 6.3.4 Record the date, time, the staff gage observation and the uncertainty on the field site visit form or appropriate discharge measurement form.
- 6.3.5 In situations when it is determined the staff gage elevation has changed, the staff plate should be repositioned to the original elevation.

6.3.6 If the staff plate cannot be repositioned and the datum is tied to the original elevation of the staff gage, either the staff gage is discontinued as the primary gage index and a new primary gage index is established relative to the existing datum, or a new datum is established and related records are adjusted and documented accordingly.

6.4 Determining Stage Height Using a Wire Weight Gage — Wire weight gages are stage height measuring instruments typically attached to a bridge railing or parapet over a stream. The gage is housed in a locked protective covering.



**Figure 2 Wire Weight Gage (photo courtesy Rickly Hydrological Company)**

6.4.1 The basic parts of a wire weight gage include a drum wrapped with a single layer of cable, and a weight attached to the end of the cable. A readable disc, graduated in tenths and hundredths of a foot is attached to the side of the drum. A Veeder counter, reading in whole feet is also included.

6.4.2 One complete turn of the drum represents one foot of vertical movement of the weight.

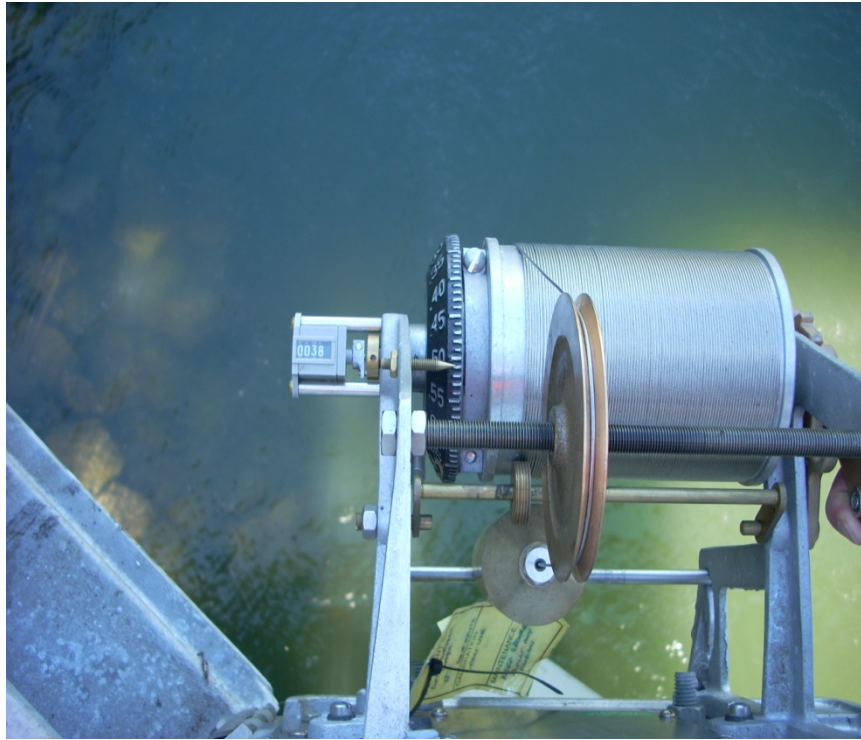
6.4.3 The cable is guided to and from the drum by a threading sheave. The weight is held in place at any desired elevation with a pawl and ratchet mechanism.

6.4.4 A moveable check-bar is mounted at the front of the instrument. When the bar is moved to the forward position the weight rests on it. The check-bar, moved to the forward position is the reference point for the wire weight gage.

6.4.5 *Operating a wire weight gage* — Open the wire weight gage house. Move the check-bar forward so it rests in position under the weight.

6.4.6 While grasping the drum crank handle, disengage the pawl and lower the weight until it touches but not fully rests on the check bar.

- 6.4.7 Read the interval at the pointer on the graduated disc. The numbered hash marks correspond to tenths and five-hundredths of a foot graduations (e.g. 38.45, 32.50, 32.55, etc.). The small hash marks correspond to one-hundredth foot increments (e.g. 38.51). Record the CHECK BAR value on the Stream Gage Logger Notes in the space provided.



**Figure 3** Prior to and after obtaining gage height lower weight to check bar and record this value to notes. (Photo by Washington Dept. of Ecology)

- 6.4.8 The check-bar value as read on the counter and disc should be the same every time the check-bar is read. The station description notes should include the check-bar elevation and the latest date on which levels were run to establish or confirm the elevation.
- 6.4.9 If the check-bar value does not match, perform the following inspections: Make sure the check-bar is set correctly. Check that the cable is wrapped on the drum properly and the threading sheave is positioned properly, directly above the wrap on the drum. Make sure the graduated disc is not slipping (caused by loose clutch screws). Check the Veeder counter for proper operation. Occasionally the counter is not synchronized with the graduated disc and will not turn over to the next whole foot in synchronization with the disc.
- 6.4.10 If the check-bar value is satisfactory, slide the bar back and slowly lower the weight to the water surface. The weight should only touch the water surface enough to form a distinctive “V” shape on the water surface.

- 6.4.11 Read the Veeder counter and disc as previously described. Record the stage height in the WIRE WEIGHT space on the Stream Gage Logger Note form. Wind in the weight. Confirm the check bar elevation and reengage the pawl before closing and locking the wire weight gage enclosure.
- 6.4.12 The best conditions to read a wire weight gage is when current is moving slowly under the weight and there is no wind. Stage height observations can be difficult in higher velocities when surface waves are present. Attempts should be made to discern the average surface elevation of the peaks and troughs of the waves. Conversely it is sometimes difficult to determine when the weight touches the water surface when the water is quiescent. Windy conditions cause the cable to bow resulting in under reporting of the water surface (Rantz, et, al., 1975).
- 6.4.13 Difficulties encountered reading a wire weight gage should always be documented. Quantifying errors in reading wire weight gages is difficult, however noting the potential for error without necessarily quantifying them is still useful in records and measurement evaluations.
- 6.4.14 Secondary gage indexes can be used as a cursory check of the relative accuracy of the wire weight gage. If there is indication the position of the gage has changed, levels should be run immediately to verify the elevation of the gage.
- 6.4.15 The datum typically will not change when a wire weight gage is relocated. Using station reference marks the gage can be re-set and adjusted mechanically to calibrate the check bar relative to the established datum.
- 6.5 Determining Stage Height Using a Laser Level
- 6.5.1 Laser levels are useful instruments to determine stage height, particularly in areas where staff gages are not practical. The laser level is a portable device mounted on a permanently installed structure or pad of known elevation and emits a laser beam on a level plane.



**Figure 4 Laser level mounted on laser level pad. (Photo by Washington Dept. of Ecology)**

- 6.5.2 Stage height is determined by measuring the difference between the known laser beam elevation and the water surface elevation. The elevation of the laser level is confirmed with the use of reference marks placed near the laser level pad.



**Figure 5 Reference mark placed near laser level is used to confirm elevation of laser level beam. (Photo by Washington Dept. of Ecology)**

- 6.5.3 *Confirmation of Laser Beam Elevation* — At the time the laser level is installed; levels are run to establish the elevation of the laser level pad relative to the station datum.

- 6.5.4 The laser beam elevation is the elevation of the pad plus the difference between the laser beam plane and the bottom of the laser level instrument mounted on the pad. It is important to distinguish between the elevation of the pad and the laser beam plane. The pad elevation remains the same until the pad is disturbed and the elevation changes. The beam elevation is variable depending on the manufacturer dimensions of the particular laser level model used. All reference mark and water surface elevations are noted and calculated with reference to the beam elevation.
- 6.5.5 In the immediate vicinity of the laser pad three reference marks are installed and levels run to establish their respective elevations. The reference marks are placed in locations where a stadia rod can be used with the laser level to verify elevations.
- 6.5.6 The elevations of the reference marks and the last date levels were run to confirm their elevations are included in the station description.
- 6.5.7 To confirm the laser beam elevation place the laser level on the pad and power up the instrument. The instrument will self-level if the surface upon which it is placed is level within 5 degrees. If it cannot self-level, the laser light will flash off and on. The pads are installed at or near-level so unless the pad has been disturbed or the laser level is malfunctioning, the instrument should self-level.
- 6.5.8 Place the stadia rod on one of the reference marks. Using a circular bubble level as a guide, hold the rod as vertical as possible.



**Figure 6** A circular bubble level is used to vertical the stadia rod. (Photo by Washington Dept. of Ecology)

- 6.5.9 With the laser level powered on and set at level, rotate the device until the laser beam intersects the stadia rod.

- 6.5.10 Read the rod to the one-hundredth of a foot. The center of the laser light dot projected on the rod is the point at which the stadia rod is read. If the same model of laser level is used for each observation, the rod reading should be the same at each of the three exclusive reference marks.



**Figure 7 The center of the laser light dot projected on the rod is the point at which the stadia rod is read. (Photo by Washington Dept. of Ecology)**

- 6.5.11 To check the elevation of the reference marks, compare the rod reading of the laser beam at each reference mark to the established rod reading value for that respective mark. The established rod reading for each reference mark is recorded in the station description notes. Record the established rod reading and the observed rod reading for each laser level reference mark in the appropriate space on the Stream Gage Logger Notes form.
- 6.5.12 If the laser elevation cannot be confirmed at a given reference mark, check the other reference marks. If the measured elevations of those reference marks match known elevations, it is assumed the unconfirmed reference mark has been disturbed but the position of the laser level has not changed.
- 6.5.13 If the rod readings of the other marks do not match, it is assumed the laser has been disturbed and the (previously established) laser elevation is no longer valid.
- 6.5.14 If the laser elevation is no longer valid check the differences in elevation between individual reference marks if possible. If these differences remain the same as shown

by previous levels, it can be concluded until subsequent levels are run, the reference marks have not moved and only the laser level pad has been disturbed. If this is the case, a temporary elevation can be assigned to a new position of the laser level based on the established elevations of the reference marks. The water surface elevation can be measured based on the new laser beam elevation. This water surface elevation will be considered an estimate until levels are run. In most circumstances the water surface elevation can be checked against secondary gages.

- 6.5.15 When the laser beam elevation has shifted or reference marks have moved, a set of levels should be a high priority and run as soon as possible.
- 6.5.16 The datum typically will not change when a laser level is relocated. Other reference marks at or near the station are tied to the datum elevation and can be used to reset the laser level at a datum relative elevation.
- 6.5.17 *Measuring Water Surface Elevation with Laser Level* — After the laser level beam elevation has been confirmed, measure the water surface elevation.
- 6.5.18 The stadia rod handler stands the rod vertically on a solid, steady section of substrate in the calmest water practical in the gage pool subject to the station control. The rod should be placed as close to the primary and recording gage as possible.



**Figure 8** The rod is held perpendicular on solid substrate in calm water. (Photo by Washington Dept. of Ecology)

- 6.5.19 The instrument person rotates the laser level toward the stadia rod until the laser beam is illuminated on the rod. The illuminated point on the rod is read and recorded in the Stream Gage Logger notes under LASER: STADIA ROD READING.

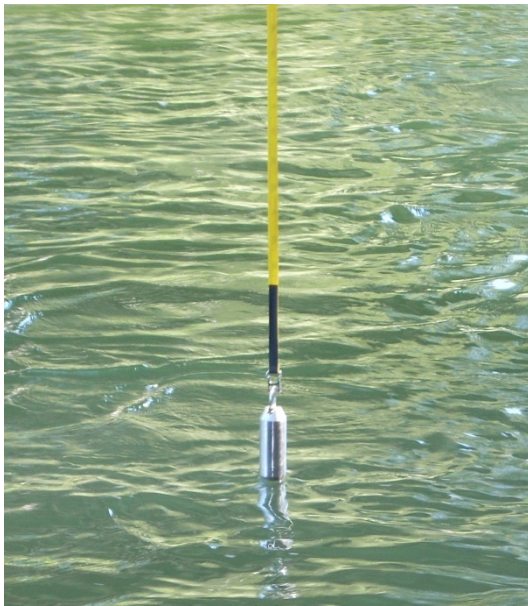
- 6.5.20 Observe and record the water surface level on the stadia rod in the Stream Logger Gage notes under WATER SFC. ROD READING. Note fluctuations or bounce of the water surface against the stadia rod.
- 6.5.21 *Calculating Water Surface Elevation* — Subtract the WATER SFC. ROD READING from the LASER: STADIA ROD READING to give the DIFFERENTIAL and enter this value in the space provided on the Stream Gage Logger Notes. The differential is the difference in elevation between the laser beam plane and the water surface.
- 6.5.22 Subtract the DIFFERENTIAL from the LASER BEAM ELEVATION to give STAGE HEIGHT. Enter this value in the space provided on the Stream Gage Logger Notes.

LASER: STADIA ROD READING	<b>6.25</b>				
- WATER SURFACE, ROD READING	<b>0.34</b>				
= DIFFERENTIAL, LASER TO WATER SFC	<b>5.91</b>				
LASER BEAM ELEVATION	<b>11.90</b>				
- DIFFERENTIAL	<b>5.91</b>				
= STAGE	<b>5.99</b>				

**Figure 9 Example of calculation of stage from laser level readings on Stream Gage Logger Note form. (Washington Dept. of Ecology form)**

- 6.6 Determining Stage Height by Tape Down
  - 6.6.1 Measuring stage height by tape down involves lowering a weighted measuring tape to the water surface from a reference point. The reference point is usually a stainless steel washer secured to a bridge railing.
  - 6.6.2 The degree of accuracy and reliability of tape downs in determining stage height is generally inferior to the other methods described in this document. Tape downs should be used only as a secondary gage.
  - 6.6.3 Fiberglass tapes are light with a wide surface area and prone to errors even in light wind conditions. Fiberglass tapes tend to stretch over time causing biases in tape down measurements. Like the wire weight gage it can be difficult to determine stage height when surface waves are present or conversely when water is extremely calm. When waves are present try to determine the average water surface elevation between the peaks and troughs.

- 6.6.4 *Measuring Tape Down from Reference Point* — Locate the reference point. Lower the weighted tape to the water surface. The weight should only touch the water surface enough to form a distinctive “V” shape on the water surface.



**Figure 10** Tape down weight touching water surface. (Photo by Washington Dept. of Ecology)

- 6.6.5 Read the tape at the edge of the reference point to one-hundredth of a foot. Enter this value under TAPE DOWN in the space provided in the Stream Gage Logger notes. Note any difficulties reading the tape caused by wind or wave action.
- 6.6.6 Because the weight is attached to the end of the fiberglass tape a correction factor is applied to the reference point reading. This correction factor is usually written in permanent marker on the tape housing. Enter this value under CORR. FACTOR in the Stream Gage Logger Notes.
- 6.6.7 *Calculating Water Surface Elevation* — Add the correction factor to the tape down and enter the sum to CORRECTED TD in both spaces provided in the Stream Gage Logger Notes.
- 6.6.8 Enter the reference point elevation in the space labeled TD RP ELEVATION on the note form.

6.6.9 Subtract the corrected tape down from the reference point elevation to give the water surface elevation. Enter this value under = WS ELEV@TD on the note form.

TAPE DOWN	<b>16.32</b>				
CORR. FACTOR	<b>0.37</b>				
CORRECTED TD	<b>16.69</b>				
TD RP ELEVATION:	<b>25.33</b>				
CORRECTED td	<b>16.69</b>				
=WS ELEV@TD	<b>8.64</b>				

**Figure 11** Example of calculation of stage from tape down readings on Stream Gage Logger Note form.

6.6.10 The datum typically will not change when a tapedown reference point is relocated. Using station reference marks the reference point can be re-set relative to the established datum.

6.6.11 The elevations of the reference mark and the last date levels were run are included in the station description notes.

## 6.7 Determining Peak Stage with Crest Stage Gage

6.7.1 The stage measurement equipment and methods previously described are designed to determine stage instantaneously. Crest Stage Gages provide a valuable record of peak stages after the occurrence of high flows. The gage is reliable and relatively simple to install and operate (Rantz, et, al., 1975).

6.7.2 Crest stage gages consist of a 4 foot long, 2 inch diameter galvanized pipe capped on both ends, and a wooden staff contained in the pipe. The bottom pipe cap has an arrangement of 6 quarter-inch intake holes. The top cap has a small vent hole. The wooden staff rests on a bolt extending through the bottom of the pipe. The extension of the bolt on the outside of the pipe also serves as a reference point.

6.7.3 The bottom cap contains granulated cork. As water rises in the pipe, the cork floats on the water. When the water reaches its peak and begins to recede the cork sticks to the wooden staff, marking the crest of the high-water event.

6.7.4 At a site visit subsequent to a high flow event, remove the top cap from the crest gage pipe. Carefully pull out the wooden staff. Measure from the bottom of the staff to the high water mark with an engineer's tape measure.

- 6.7.5 Clean the cork from the wooden staff to avoid confusion with subsequent high water marks. Rinse residual cork from the inside of the pipe. Replace the granulated cork in the bottom cap. Return the wooden staff into the pipe so that it rests on the bolt. Replace the top cap hand tight keeping aware of the nail at the top of the staff for flush fit with the cap and to keep the staff vertical in the pipe.
- 6.7.6 *Calculating Crest Stage* — Record the high water mark in the space HWM \_\_\_\_ FT ON STICK on the back of the Stream Gage Logger Notes form. Record the elevation of the reference point in the space REF ELEV \_\_\_\_ FT adjacent to the high water mark entry.
- 6.7.7 Add the high water mark and the reference mark elevation and enter the sum under =HWM ELEV \_\_\_\_ FT. on the Stream Gage Logger Notes form. This value is the crest stage height.
- 6.7.8 The datum typically will not change when a crest stage gage is relocated. Using station reference marks the gage reference point can be re-set relative to the established datum.
- 6.7.9 The elevation of the reference point and the last date levels were run are included in the station description notes.

## **7.0 Records Management**

### **7.1 Field Note Forms Archives**

- 7.1.1 All original field note forms including levels notes, stream gage logger notes, and discharge measurement notes are stored in a central locations at Ecology Headquarters, regional, and field offices.
- 7.1.2 All discharge measurement notes will contain the hand written, original primary gage observations associated with a particular discharge measurement.
- 7.1.3 Stream gage logger notes contain written stage-height observations of all primary and secondary gages at a site.
- 7.1.4 Levels notes contain the original notes of gauging site surveys as well as calculations of reference marks and reference point elevations.

### **7.2 Stage Records in Hydstra Database**

- 7.2.1 All primary and secondary gage observations are recorded and stored electronically to a Hydstra database.
- 7.2.2 Stage height observations associated with discharge measurements are stored in the Gaugings Database within Hydstra.

7.2.3 A future Standard Operating Procedure document will describe the procedures to enter and store this data to Hydstra data bases.

## **8.0 Safety**

8.1 Personal Flotation Devices are required for persons working in or near streams.

8.2 All EAP safety policies are followed when obtaining stage heights. Refer to the [EAP Safety Manual](#) (pages 1-35 and 2-17) for further information about working in and around streams.

8.3 Always consider the safety and traffic situations when obtaining gage heights from a bridge and take appropriate actions including suspension of the activity if unsafe conditions exist. Consult the EAP Safety Manual (page 1-37) for further guidance regarding bridge safety.

8.4 When operating laser levels, do not stare into the beam or direct the beam at other persons. Check the path of the beam and ensure there is no danger of inadvertently pointing the beam at people in the vicinity.

## **9.0 References**

9.1 Environmental Assessment Program, 2006. Environmental Assessment Program safety Manual.

9.2 Rantz, S.E., and others. 1975. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. United States Geological Survey Water-Supply Paper 2175.

# Attachment A



Washington State Department of Ecology

DEPARTMENT OF  
**ECOLOGY**  
State of Washington

## EAP-FMU Stream Gage Logger Notes

Sta. Name \_\_\_\_\_

Sta. No. \_\_\_\_\_ Party \_\_\_\_\_

DATE					
TIME (PST)					
LOGGER					
STAFF					
WIRE WEIGHT					
CHECK BAR					
TAPE DOWN					
CORR. FACTOR					
CORRECTED TD					
TD RP ELEVATION:					
CORRECTED td					
-WS ELEV@TD					
LASER: STADIA ROD READING					
- WATER SURFACE, ROD READING					
= DIFFERENTIAL, LASER TO WATER SFC					
LASER BEAM ELEVATION					
- DIFFERENTIAL					
= STAGE					
WATER TEMP				ELEVATION	READING
THERMISTER			LL BM1		
AIR TEMP			LL BM2		
THERMISTER			LL BM3		

Batt V \_\_\_\_\_ Min \_\_\_\_\_ Max \_\_\_\_\_

Reset Stats Y/N                      Batt replaced Y/N

GOES Time OK Y/N

Data downloaded Y/N              .NEW file erased Y/N

Desiccant condition \_\_\_\_\_ Changed Y/N

CSG checked Y/N

HWM \_\_\_\_\_ ft on stick + Ref Elev \_\_\_\_\_ ft

= HWM Elev \_\_\_\_\_ ft.              Cleaned Y/N

Added cork Y/N

Remarks: