Identifying Bankfull

The bankfull discharge is a frequently occurring peak flow whose stage represents the incipient point of flooding. It is often related to the elevation associated with a shift in the hydraulic geometry of the channel and is often associated with a return period of 1–2 years, with an average of 1.5 years. Bankfull discharge is expressed as the momentary maximum of instantaneous peak flows rather than the mean daily discharge.

The role of the bankfull discharge in shaping the morphology of all alluvial channels is the fundamental principle behind stream classification. The dimension, pattern and profile of rivers at the bankfull discharge provide a consistent reference point that can be used to compare the morphology of rivers from around the world.

Correctly identifying the elevation or stage of the bankfull discharge is the most important task when classifying a stream. Most of the morphological variables used in stream classification are expressed as bankfull values. For example, *Width/Depth Ratio* is the width of the bankfull channel divided by the bankfull mean depth.

Because site visits are not often made during a bankfull event, physical indicators (floodplains, depositional features, breaks in slope, changes in vegetation) must be relied on that represent the water surface of the stream at the bankfull discharge. There are many bankfull indicators, but each indicator is not always reliable for all stream types in all climates. Locating bankfull is a skill that is developed over time by field observations of many different stream types in a variety of climates. However, field observers can improve their ability to recognize features associated with bankfull flows in a given region by visiting streamgaging stations where bankfull elevations can be calibrated to a known discharge and return period.

The appropriate use of any bankfull stage indicator requires adherence to four basic principles (Rosgen, 1996):

1. Seek indicators in the locations appropriate for specific stream types.
2. Know the recent flood and drought history of the area to avoid being misled by spurious indicators (e.g., colonization of riparian species within the bankfull channel during drought or flood debris accumulations caught in willows that have rebounded after flood flows have receded).
3. Use multiple indicators wherever possible for reinforcement of a common stage of elevation.
4. Where possible, calibrate field-determined bankfull stage elevation and corresponding bankfull channel dimensions to known recurrence interval discharges at gage stations. This procedure can verify the difference between the floodplain of the river and the low terrace and is explained in the *Calibrating Bankfull Stage* section.

Bankfull Discharge Indicators

The following are common bankfull stage indicators:

1. **Floodplains.** The term bankfull elevation is often associated with the point at which the stream begins to spread out onto the floodplain. This definition can be applied to stream types C, D, DA and E, which often have well-developed floodplains. However, this approach does not apply to entrenched stream types (A, B, F and G), which generally do not have floodplains. Do not confuse the low terrace with the floodplain. *Terraces* are abandoned floodplains that often have perennial vegetation and definite soil structure.
2. **Highest active depositional feature.** The elevation on top of the highest depositional feature (point bar or central bar) within the active channel is often associated with bankfull stage. These depositional features are especially good bankfull stage indicators for confined channels.

3. **Slope breaks or change in particle size distribution.** Breaks in slope of the banks or a change in the particle size distribution from coarse to fine is often associated with deposition by overland flow.
4. **Evidence of an inundation feature such as small benches**
5. **Staining of rocks**
6. **Exposed root hairs below an intact soil layer indicating exposure to erosive flow**
7. **Lichens and, for some stream types and locales, certain riparian vegetation species**

Many species of riparian plants are widely distributed across a variety of hydro-physiographic provinces. Using vegetation to identify bankfull stage must be done cautiously because some species and age classes can often establish themselves within the bankfull channel. Bankfull stage is frequently underestimated when determined solely on the basis of vegetation, and such unilateral determinations should be avoided. Nonetheless, some common riparian species can be used as indicators of bankfull stage, such as certain mature species of birch (Betula spp.), dogwood (Cornus spp.), cottonwood (Populus spp.) and alder (Alnus spp.), which can colonize from seed and become established at levels close to bankfull stage. Mature alders are not generally found within the bankfull channel unless a steep, erodible bank was undercut and "slumped in." Smaller woody plants, grasses and forbs can colonize within the bankfull channel, especially during drought, as can certain species and age classes of willows (Salix spp.). These species should not be used as indicators. In cases where there is little choice but to use vegetation as an indicator, it is best to seek the advice of a riparian ecologist familiar with the study area and to verify the relations of these species to stream stage at gaged sites within the same hydro-physiographic province.

Before selecting a reach for bankfull cross-section data, it is essential to study the longitudinal profile for at least 20 to 30 bankfull widths both upstream and downstream to determine representative bankfull indicators for that reach. Bankfull indicators should be consistent on an individual stream reach basis. For example, an observed break in slope or depositional feature must be present through the entire reach at a fairly consistent elevation above the existing water surface, which can be verified by plotting a longitudinal profile (**Figure A-3**: Notice the consistent stage of the bankfull line above the water surface).

Consistent measured values for bankfull stage can be determined when corroborating, representative indicators have been identified. Establishing corroborating indicators greatly improves the resulting field estimates. Again, it is important to first measure bankfull cross-sections at gaged reaches to calibrate the interpretation of geomorphic features to a known streamflow and corresponding return period.

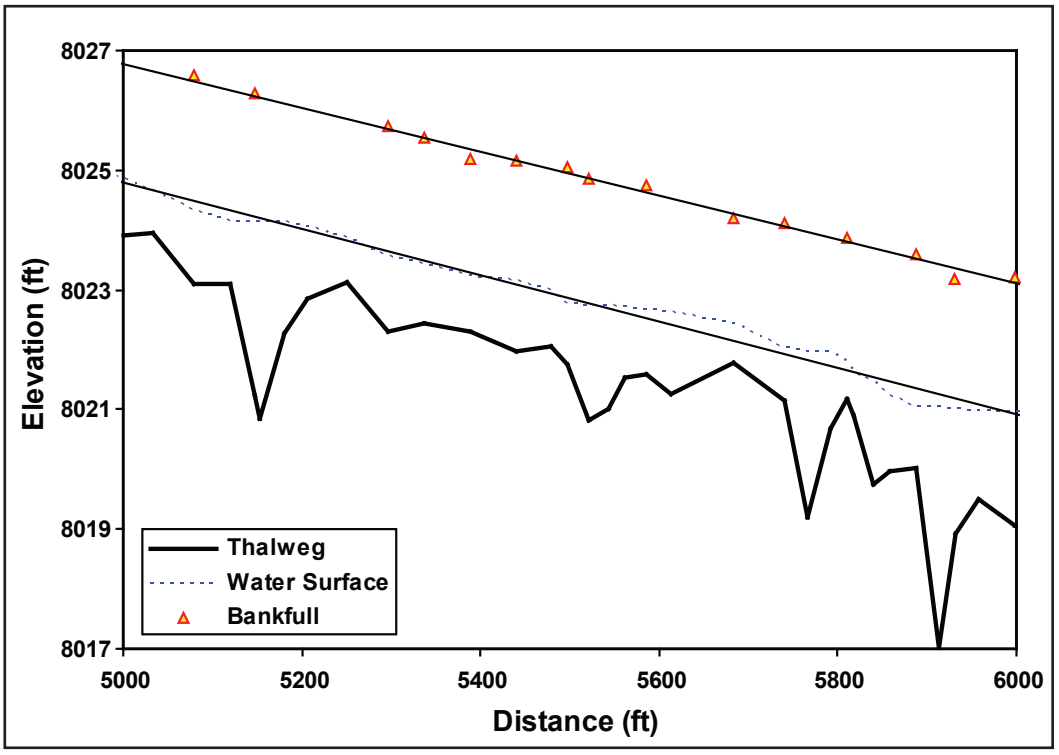

Figure A-3. Example longitudinal profile showing consistent bankfull indicators.

TOOTHPICK SURVEY

Walk the entire reach and mark bankfull indicators and a representative riffle for your cross-section with pin flagging. Mark riffle, pool, run, and glide locations as you go.

Bankfull Indicators

Select and measure representative riffle cross-section to determine if a bankfull feature is present and its location elevation. This is a survey point needed before longpro and pebble counts can be started. Record the cross-sections' location on the longpro tape.

Confirm your selection of a bankfull indicator with a quick cross-sectional area measurement.

a) Stretch a camline, set at the elevation of the selected indicator, across the stream to the opposite bank. Use a line level to make certain it is level. Record the width or distance.

b) Using the pocket or surveyors rod, measure at least 10 equi-distance depth measurements along the top edge of the camline. (For narrow streams you can stretch out another rod, set on edge to minimize sag for these depth measurements. Make sure the rod is level).

c) Divide the sum of the depth measures by the number of depth measurements taken to determine mean depth; multiply the mean depth by the width measurement to determine bankfull cross-sectional area. Compare with expected values from regional curve information (Next Page).

d) If calculated cross-sectional area does not meet or come close to expected values select and measure other observed features that may be the bankfull indicator; you may have to move to another portion of your reach. In extreme examples there might not be a measurable bankfull feature.

e) If the cross-sectional area is within the expected range for the bankfull channel take note on how you may recognize this feature elsewhere along the reach. Measure the distance from water surface to bank full elevation, you'll use this value later to confirm bankfull elevation during the longitudinal profile.

f) The bankfull indicator measured should be distinct enough to find elsewhere along the reach. Whether it is a depositional feature, vegetation line, you need to be able to follow it and measure its' elevation as part of the longitudinal profile.

Plug your catchment size (in square miles) into the regional curves listed below. Use the curve for the combined Allegheny Plateau and Valley and Ridge physiographic provinces. Determine expected bankfull discharge, cross-sectional area, width, and mean depth for the sample site.