Flow Fact Sheet

What is Flow?

Stream *flow*, or discharge, is the amount of water that moves past a fixed point during a given period of time. Flow may be described in terms of different time scales:

- *Instantaneous Flow* is a single measurement at one place at one time.
- A *hydrograph*, or record of changing flow for a selected period of time, is developed from repeated measurements at one location. Hydrographs may be determined in various ways: for a single storm or span of time such as individual years or seasons, or as statistical averages of many storms, years or seasons.
- *Flow regime* refers to patterns in a stream's hydrographs, whether natural or the result of human activities. Characteristics of flow regimes that might be important for stream assessment include annual peaks or lows, duration of peaks or lows, and average time between recurrences of a particular size storm.

Why is Flow Important?

Flow is linked to conditions throughout the watershed (the area of the earth's surface from which water runs toward the stream, above the measurement site). Flow affects many aspects of aquatic systems at all of the above time scales:

Instantaneous Flow

- Wetted area of stream and amount of aquatic habitat present
- Increased or decreased numbers of organisms that prefer certain velocities
- Aeration of water, amount of dissolved oxygen available for aquatic organisms
- Stability and level of water temperature
- Dilution of pollutants entering the creek

Hydrograph for storm events

- Frequency and extent of flooding
- Dislodging of flow-sensitive organisms or microhabitat structures
- Distribution and transport of pollutants along the creek
- Erosion and movement of sediment from creek bed and banks

Flow Regime

- Seasonal or annual water supply to stream and surrounding riparian zone
- Flushing that reduces silt or debris clogging some habitats, e.g. spawning gravel
- Groundwater recharge
- Requirements of animals and plants at different ages during their life cycles
- Long-term channel-forming processes such as downcutting or siltation

How is Flow Measured?

Instantaneous Flow

While there are only a few basic approaches to measuring flow, many variations have been developed for varying objectives and in response to the wide range of field conditions encountered. Below are a few common approaches and variations:

Direct measurement

- Measure time required to fill a container of known size
- Variations: use aprons, weirs and other temporary structures to direct flow and improve its capture in the container

Calculation from separate measurements of velocity and cross-sectional area

- Measure water depth at several points on a transect across the stream and calculate cross-sectional area; take a corresponding velocity measurement at some or all points, using a current meter or floating object. Variations include:
  - use of weirs or temporary structures to alter cross-section to be more convenient for measurement
  - surveying the channel shape in advance; measuring water depth and using its relationship to the channel cross-section to calculate wetted cross-section.
  - using repeated measurement of velocity and area at a range of different water depths at the same location as a basis for estimating instantaneous flow for other water depths
  - using other characteristics such as "hydraulic jump" or channel slope and roughness to estimate velocity.

Tracer

- Calculate flow by placing a dye, salt or other substance in the creek and monitoring its passage at a point farther downstream.

Continuous flow monitoring to characterize hydrographs and flow regime

Automated stations are frequently used to record flow observations at regular time intervals for extended periods. These stations usually convert water depth measurements to flow using the principles of the velocity-area method described above.

Qualitative assessments

This category includes a variety of observations that usually relate the discharge to channel features. An example is included in the Visual Assessment SOP 5.2.1. Such techniques may be useful for preliminary evaluations of flow as a component of habitat (e.g. "is there potential for the velocity or volume of water to prevent fish passage?").

What Affects Flow in Streams and Rivers?

Natural Factors

- The amount and timing of rainfall or snowfall in the watershed
- Watershed size and topography (whether the ground is hilly or flat; the steepness, location and orientation of sloping areas)
- Geology and soil characteristics throughout the watershed
- Shape and size of the stream channel and the adjacent floodplains
- Height of the underground water table and movement of groundwater
- Logs and other debris in the channel
- Suspended sediment in the water
- Vegetation: amount and type growing in the watershed, channel and floodplain
- Evaporation and evapotranspiration (water taken up by plants from the ground)

Human Factors

- Dams
- Diversions or pumping of water into or out of the stream
- Impervious surfaces on parts of the watershed (roads, sidewalks, buildings,etc.)
- Alterations to channel and floodplain, installation of culverts or other structures
- Alteration of water table by wells or groundwater pumping
- Litter and debris which clogs pipes and culverts

What are the Water Quality Objectives[1] for Flow?

Water quality objectives for flow vary from region to region. Check with the Regional Water Quality Control Board in your area. Although many Regional Boards may not include numerical flow objectives in their Basin Plans, they can also address the effects of flow on beneficial uses of waterbodies through permitting or other activities.

Other agencies that may establish flow objectives for individual streams include:

- DWR and local water suppliers
- CDFG, USFWS and NMFS (as an important aspect of habitat, especially for threatened or endangered species)
- FERC (for licensing of dams and dam operations)
- CALFED (in regard to inflows to the Delta and San Francisco Bay)
- USGS

[1] A water quality objective is a law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the uses of that particular waterbody and an antidegradation statement.

Sources and Resources

This Fact Sheet is implemented by the Clean Water Team (CWT), the Citizen Monitoring Program of the California State Water Resources Control Board. This Fact Sheet has been authored by Arleen Feng, Neil Berg, and Mark Abramson, members of the Flow work-group of the 2000-2001 Technical Advisory Council for Citizen Monitoring. The original fact sheet is presented, without any revisions.

Please contact your Regional CWT Coordinator for further information and technical support. For an electronic copy, to find many more CWT guidance documents, or to find the contact information for your Regional CWT Coordinator, visit our website at www.swrcb.ca.gov/nps/volunteer.html

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