California Environmental Flows Framework FAQs

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These FAQs provide responses to questions that came up during public review of the California Environmental Flows Framework version 1.0. They have been grouped into the following categories based on similar themes: Clarity of terms/presentation, underlying conceptual approach, modeling and analysis, and implementation challenges.

<u>Clarity of terms/presentation:</u>

What is the California Environmental Flows Framework (Framework)?
The Framework is a structured process for developing consistent, science-based, and ecologically protective environmental flow recommendations for all stream types in California. The Framework highlights the specific steps, tools and methods that are useful for developing environmental flow recommendations.

The Framework does not:

- satisfy any specific regulatory requirements
- replace or modify any existing authority, code, rules, or agreements
- address water needs of estuarine systems nor the SF Bay Delta (legal delta)

In summary, Section A of the Framework provides information on expected natural functional flow ranges needed to support ecological functions throughout all rivers and streams in California. Section B of the Framework provides a process to work through site specific modifications to the functional flow ranges, where necessary, to achieve ecological management objectives. Section C provides a process to examine trade-offs between multiple objectives for water use, including human and ecological needs, and provides suggestions for implementation, monitoring, and adaptive management.

How do state agencies intend to use the Framework and how does it relate to regulatory action and compliance?
Individual agencies may develop specific processes for implementing the Framework. The Framework does not establish, replace, or modify any specific agency requirements set forth under existing regulations and laws, but it may be

used to inform agency actions, decisions, or the development of policies or regulations. For more information on how state agencies intend to use the Framework, see [link to other fact sheets or websites].

Who are the intended users of the Framework? What kind of subject matter expertise (or access to subject matter experts) are needed for this process? What stakeholders should be involved in the process?
Intended users are any stakeholder interested in protecting the health of California's rivers and streams. This includes scientists, agency personnel, non-governmental organizations, and local watershed groups. The Framework could be implemented by a practitioner or a stakeholder group familiar with instream flow science and supported by experienced practitioners with expertise in stream ecology, hydrology, geomorphology, or other disciplines, as needed.

Does the Framework provide flow criteria or tell users how much water has to be left instream for each functional flow component?
No, the Framework establishes a standardized process for developing ecological flow criteria and environmental flow recommendations. Sections A and B of the Framework outline a process for developing ecological flow criteria, or flows that should be left instream if ecological outcomes were the only management objective. Section C outlines a process for developing environmental flow recommendations that balance ecological management goals with other non-ecological (i.e. human use) water management goals.

Underlying conceptual approach:

What is the difference between natural ranges of functional flows and unimpaired flows?
In the context of the Framework, "natural flows" refer to the conditions observed at reference stream flow gages. These include current and historical USGS stream gaging stations located in watersheds with limited human disturbance, including from land use conversion, dams and diversions, and other land and water management activities. Streamflow at these sites is assumed to reflect natural hydrologic processes, recognizing that no watershed is completely free of influence from historical and on-going human activities.

Twenty-four metrics were calculated to characterize the natural ranges of functional flows from the reference streamflow gages using the functional flow calculator (Patterson et al. 2020; Appendix C) based on the natural streamflow classification for California (Lane et al. 2018; Appendix B). These metrics can be visualized and downloaded from the UC Davis Eflows website. The natural ranges of functional flow metrics have also been predicted for all stream segments in California, using a statistical model that estimates the natural range of each functional functional metric as a function of watershed characteristics. These model predictions can be viewed and downloaded from the California Natural Flows Database.

“Unimpaired flows” is defined as a flow rate or volume expected to occur in a river or stream in the absence of dams and diversions. For example, the California Department of Water Resources estimates unimpaired flows, also referred to as ‘full natural flow’, at several stream gaging stations by accounting for and removing the hydrologic effects of all upstream dams, diversions and any water imports to, or exports from, the basin. DWR’s method for estimating unimpaired flow does not account for other human activities that may have altered flow at the gauging station, including land use and vegetation cover change. As a result, estimates of unimpaired flows are likely to deviate from natural flows used in the Framework.

The State Water Board has also used unimpaired flows to develop environmental flow recommendations as part of the Bay Delta Water Quality Control Plan. Under the Plan, environmental flows for a select set of rivers are expressed as a percent of unimpaired flows. For example, in the months of February to June, the default flow objectives are 40% of unimpaired daily flow, based on a minimum 7-day running average, from each of the Stanislaus, Tuolumne, and Merced Rivers. See this blog for a detailed discussion of how the percent-of-impaired flow approach relates to the functional flows approach described in the Framework.

How does the Framework address non-flow factors such as channel modification, water quality, and invasive species?

If non-flow factors alter reference flow-ecology relationships, the user would follow Section B to determine the flows needed to achieve desired ecological functions. For example, channel incision may mean that natural ranges of flood flows no longer inundate the floodplain, and higher flows are required to support floodplain functions. In Section C, the Framework provides a process for analyzing tradeoffs between flow and non-flow management actions to offset impacts to ecology. In the example of the incised channel, habitat restoration could be a management action that would result in floodplain reconnection at lower flows.

How does the Framework address potential effects of climate change?
The Framework does not explicitly consider the effects of climate change on environmental flow needs. However, in Section B, climate change can be included as a factor altering flow-ecology relationships, for example, by considering projected increases in water temperatures under climate change. In Section C, climate change impacts should also be incorporated into the evaluation of flow and non-flow actions and in tradeoff assessments. Adaptive management plans developed under the Framework should include strategies to monitor and mitigate potential climate change impacts.

Modeling and analysis:

How are the functional flow metrics modeled?
Statewide models have been developed to predict the natural range of values for functional flow metrics (FFMs) in all stream reaches in California. The models rely on streamflow data from reference gages in California located on streams with minimal disturbance to natural hydrology and land cover (Falcone et al. 2010). Functional flow metrics were calculated at each reference gage from daily flow values, using algorithms described by Patterson et al. (2020; Appendix C and Appendix K) based on the natural streamflow classification for California (Lane et al. 2018; Appendix B). Separate statistical models were then developed for each functional flow metric, using machine learning methods to relate functional flow metric values to watershed characteristics, following the approach described by Zimmerman et al. (2018). Additional details of the modeling approach, input data, and performance evaluation are provided in Appendix D.

How were functional flow metric predictions ground-truthed?
We used a leave-one-out cross validation procedure to assess the predictive performance of the functional flow metric models. For this approach, each reference site was excluded in turn from a model calibration dataset, which was then used to generate predictions of functional flow metric values at the excluded reference site. This was done iteratively in order to generate predictions at all reference sites using models from which each site was systematically excluded. We then compared observed against (independent) predicted values to assess model accuracy, using several model performance criteria. See Appendix D for more detail.

What do the percentile ranges of functional flow metrics represent and how should they be interpreted?

Natural functional flow metrics can be viewed and downloaded from the California Natural Flows Database for any stream segment in the state. Metrics are quantified as a range of values expected to occur at locations of interest under natural conditions over a long-term period of record (15 or more years). The range of predicted metric values is defined by quantiles (the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles below which predicted values fall). In addition to reporting the expected range of values for each metric across all years, predictions are also provided for wet, moderate and dry water year types.

In Step 4 of the Framework, ecological flow criteria are selected for all functional flow components for which the natural range of metrics is expected to support ecosystem functions. These ecological flow criteria are defined by a median and bounded range of metric values for each flow component. The median represents the long-term value around which a metric is expected to center. The 10^{th} to 90^{th} percentiles represent the lower and upper bounds, respectively, in which the metric is expected to vary. For example, ecological flow criteria for the dry-season baseflow would be specified by median, 10^{th}, and 90^{th} percentile values of flow magnitude, timing, and duration. The annual values of these metrics are expected to vary under natural conditions, but over many years, are expected to be distributed around the predicted median value. The 10^{th} and 90^{th} percentiles of the ecological flow criteria represent an interval between which annual values of a metric are expected in fall in most years. This interval accounts for both inter-annual variation in the metric as well as model prediction uncertainty. Ecological flow criteria can be defined for all water years, or by water year type.

What information does the Framework provide about the frequency of pulse and peak flow events?

The fall pulse and winter peak flow components are events that are expected to occur with regularity in an unaltered flow regime. The fall pulse flow component does not include a frequency metric, although it may not occur every year under natural conditions. For example, in flashy streams in southern California, runoff may not occur until winter storms, or in north coast streams, small fall storms may not produce runoff. Users may want to explore the frequency of fall pulses in nearby reference gages if this is of concern in their location of interest.

Peak flows are expressed as recurrence intervals, which indicate the number of times a flow of a given magnitude is expected to occur over a multi-year period.

For example, the 2-year recurrence interval peak flow is expected to occur in one of every two years, on average. The peak flow component also includes a frequency metric, and the interpretation of that metric is the number of times a flow of that magnitude occurs in a year in which the event is observed. For example, the 5-year peak flow frequency is interpreted as the number of individual 5-year events that occur within a year in which a 5-year peak flow occurs.

How are baseflow magnitudes defined for the functional flows calculator and the modeled functional flow metrics?

Wet-season baseflow represents the flows sustained by overland and shallow subsurface flow in the periods between winter storms. The wet-season baseflow magnitude is calculated as the 10th percentile of mean daily flows during the wet season. Dry-season baseflow represents the flows sustained by groundwater inputs to rivers over the dry summer season. The dry-season baseflow magnitude is calculated as the 50th percentile of mean daily flows during the dry season. Other available wet-season and dry-season metrics include the wet-season median flow (50th percentile of mean daily flow) and the dry-season high baseflow (90th percentile of mean daily flow). Depending on the system, additional wet-season and dry-season metrics may be helpful to characterize flow-ecology relationships (see CEFF Section B).

Does the Framework include an 'ecological flow bottom line' that represents the minimum functional flows needed to sustain key watershed functions?

No, the Framework provides guidance on how to develop ecological flow criteria, expressed as ranges of functional flow metrics, that are expected to sustain key watershed functions and support ecosystem health.

How is alteration assessed and what is the basis behind alteration classification?

A flow alteration classification approach has been developed as part of the Framework (Appendix J). This approach involves comparison of the distribution of predicted natural values of functional flow metrics to a distribution of current values. The current values may be derived from observed records at flow gaging stations or from hydrologic models calibrated to simulate current hydrology at a location of interest. Based on the degree of overlap between the current and natural distributions of values, each functional flow metric will be classified as likely altered, likely unaltered, or indeterminate. The flow alteration assessment is performed in Step 9 of the Framework. If current conditions are found to be likely altered relative to natural flow conditions, the user proceeds to Step 10 to explore opportunities to modify existing management practices to reduce alteration. The alteration assessment description in Appendix J assumes that natural values are obtained from the statewide hydrologic models developed as part of CEFF (and described in Appendix D). If other locally-calibrated hydrologic models are used to predict natural flows, then other assessment classification rules may be appropriate.

How does a user determine the most appropriate period to represent current flow conditions and what are the recommended minimum years for the period of record?
We recommend that at least 15 years of contemporary (1980 or later) flow records be used to characterize current conditions. Shorter periods may be acceptable if specific functional flow metrics show limited variation, whereas longer periods of record may be warranted if flow metrics show a high degree of variation. Estimates of peak-flow recurrence intervals are particularly sensitive to the length of record. USGS has not published specific guidelines on the minimum length of record needed to accurately estimate peak flood flows. However, a study from peak flows in Connecticut indicated that 18 or more years of observations were needed to accurately predict 10-year recurrence interval events (USGS 2003). Given that California rivers exhibit higher variability in flows than those in the eastern US, we recommend that at least 20 years of data be used to characterize current peak-flow conditions in California streams.

Implementation challenges:

Do we have to use all five functional flow components, or can we use only a portion?
Yes, all five functional flow components must be considered when developing ecological flow criteria. Justification must be included for any components that are not represented in the final environmental flow recommendations. For example, in certain flashy, ephemeral, rain-driven streams without groundwater contributions, stakeholders may determine that management of a spring recession flow is not applicable to their system. In that case, the stakeholders would include a justification for the exclusion of the spring recession, and would move forward with the other four functional flow components.

What if the resulting flow recommendations don't adequately support all beneficial uses?
Section C of the Framework provides a process to evaluate tradeoffs between flow and non-flow management objectives and actions (including social, cultural,

economic, etc). The Framework recommends that stakeholders and interested parties be included throughout all steps of the Framework to ensure that beneficial uses are met to the fullest extent possible.

How should a user construct an ecological flow regime (hydrograph for implementation)?

Through the Framework, the user will develop a set of functional flow metrics for the reach of interest. The most appropriate combination of these metrics into a hydrograph for implementation will depend on the stream class, the types of human impacts to the system, and the ecological management goals. In all cases, the final ecological flow regime should consider all five functional flow components and incorporate variation in flow between years (for example, using water year types and peak flows of varying magnitudes). Several case study examples are currently in development to apply the Framework to real stream systems throughout California. These case studies will be posted online with the Framework documentation to provide some models for the construction of an ecological flow regime using the Framework.

Does the Framework characterize dry-season hydrology as a “baseflow,” which is essentially a static flow value maintained throughout the dry season?

Summer hydrology in many regions of California represents a continuation of the spring flow recession, often producing the lowest flows of the year during early fall. Many streams also experience intermittent or disconnected flow in the summer and early fall. There are two baseflow metrics for the dry season provided through the California Natural Flows Database: a baseflow (representing median conditions) and a high baseflow. Either or both metrics could be used to develop ecological flow criteria through implementation of the Framework. The dry-season baseflow magnitude represents an average value that should be maintained over the entire dry season, but does not require that flows be maintained at a static level. Environmental flow recommendations could require higher flows at the beginning of the dry season, and lower flows at the end of dry season, following the natural, seasonal flow recession. In some systems, additional dry-season metrics may be appropriate. For example, targets for early and late dry-season flows could be established. In systems that experience intermittency, the timing or duration of disconnectivity could also be included as ecological flow criteria.

What tools should be used when implementing the Framework?
There are a variety of tools and approaches that can be used when implementing the Framework. The Framework does not advocate for a specific tool; the choice of the tool is case specific and should be informed by the conceptual models, stream setting, and management goals. Section B (Step 6) of the Framework provides a broad description of the types of tools available to quantify and evaluate flow-ecology relationships. Section C of the Framework suggests tools to help the user appropriately balance ecological management goals with other non-ecological management goals. The choice of approach and tools should be made as part of the stakeholder process.

Does CEFF provide recommendations for developing monitoring programs?
Section C (Step 12) of the Framework describes key elements to consider when developing an ecological monitoring program. Monitoring should be designed to evaluate whether the expected outcomes are being achieved with the implemented environmental flows. Careful monitoring and evaluation of outcomes of projects implementing the Framework will be critical to the continued development of the Framework.

Is it possible to use the ecological flow criteria determined though the Framework during the development of Groundwater Sustainable Plans (GSPs) for SGMA Compliance?
Where SGMA or GSPs require actions to address adverse impacts on interconnected surface waters, the ecological flow criteria developed through the Framework could be used to represent surface flow needs. Similarly, ecological flow criteria could represent wet-season baseflow and peak flow needs to inform decisions to divert surface flows for groundwater recharge.