U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center

Klamath Natural Flow Study
Study Overview

Study Purpose

The study purpose is to develop estimates of natural (pre-development) streamflow for identified locations in the Klamath River Basin. Natural streamflow is defined as the streamflow that would have occurred in the absence of human intervention (agriculture, infrastructure, and land use changes). This study will estimate natural streamflow in a pre-development basin, under current weather conditions from water years 1981-2020. The motivation of the of the 2025 Revised Natural Flow Study is to:

- Contribute to the Klamath Basin Science Initiative,
- Provide rigorous scientific information to support habitat studies, drought planning, and water supply/allocation planning, and
- Address deficiencies in the 2005 Natural Flow Study identified by the National Research Council (2008).

The revised natural streamflow estimates will add to the scientific understanding of current and pre-development basin conditions. It will provide a baseline data set and suite of tools to evaluate questions throughout the basin. Furthermore, this study will provide a strong scientific foundation for future studies and purposes.

Overall Modeling Approach

The study will employ a mass balance approach to quantify streamflow under current and natural (pre-development) conditions at twelve locations throughout the basin. Components of the hydrologic cycle will be represented by integrating six numerical modeling analyses:

- Surface hydrology,
- Groundwater hydrology,
- Net evapotranspiration (net consumptive use),
- Open water evaporation,
- Surface hydraulics, and
- Mass balance for the development of natural flows.

Geographically, the study is split into three phases: Phase 1 – above Link River Dam, Phase 2 – Link River Dam to Iron Gate Dam, and Phase 3 – Iron Gate Dam to the confluence with the Trinity River. In some cases, phases have been combined based on extents of existing numerical models or where it does not make scientific sense to separate them.

Comparison Between the 2005 and 2025 Natural Flow Study

The purpose of the 2005 Natural Flow Study was to "provide an estimate of monthly natural flows in the Upper Klamath River at Keno. The estimate of natural flow [in the 2005 study] represents typical flow without agricultural development" (Bureau of Reclamation, 2005). The National Research Council reviewed the study and offered several recommendations to improve the analysis and results. Some key differences between the 2005 study and the 2025 study are highlighted in the table below.

2005 Study	2025 Study
Monthly time step	Daily time step
Pre-agricultural or undepleted flow	Pre-development flow
Climate data period of record: 1949-2000	Climate data period of record: 1981-2020
Spreadsheet analysis	Riverware numerical modeling
No sensitivity analysis	Sensitivity & uncertainty analysis for each modeling component
Best methods and data available in 2005	Improved technology, numerical modeling platforms and data

Current Conditions Representation

The first step for each modeling component will be to calibrate each modeling component under current conditions (water years 1981-2020). Calibration ensures proper representation of the physical conditions of the basin within the numerical modeling space. The most current data were applied to each component and described in individual factsheets.

Natural Flow Representation

Once each numerical model effectively represents current conditions, features can be removed or added to simulate pre-development conditions. Features that were modified within the current landscape are:

- Infrastructure (Figure 1),
- Agricultural impacts and extent,
- Logging effects were removed to represent pre-development forest vegetation,
- Groundwater marshes, wetlands, riparian and otherphreatophyte areas were expanded to pre-development extent,
- All impervious surfaces were removed,
- Land subsidence,
- Natural mainstem river hydraulic controls (reefs) wererepresented at their pre-development elevation, and
- Lakes/reservoirs were modified to pre-developmentdepths and extents.

The most influential infrastructure are dams, levees, and roads, but also includes urbanization and municipal/industrial infrastructure. Agricultural impacts include canals, drains, pumps, wells, crop consumptive use and the Rogue Basin export. Lake and reservoir modifications include Fourmile, Clear, and Upper Klamath Lake. Tule Lake and Lower Klamath Lake Wildlife Refuges were represented

Key References

Bureau of Reclamation (BOR). 2005. Natural Flow of the Upper Klamath River-Phase I. Prepared by Technical Service Center, Denver, Colorado, for U.S. Department of the Interior, Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, Oregon.

National Research Council (NRC). (2008). *Hydrology, ecology, and fishes of the Klamath River basin*. National Academies Press.

Key Definitions

Phreatophyte: a plant with a deep root system that draws its water supply from near the water table.

Natural or Pre-development Flow: flow of water caused by nature. Water that would exist within a watercourse absent of substantial human intervention/development.

Undepleted Flow: "the stream flow in a watershed without the effects of diminishment by water uses for specific beneficial purposes including, but not limited to, irrigation, municipal, domestic, mining, commercial, industrial, stockwatering, recreational, and environmental concerns." (www.lawinsider.com)

Current conditions: existing hydrologic and climate conditions that occurred over the approximate time period of water years 1981-2020.

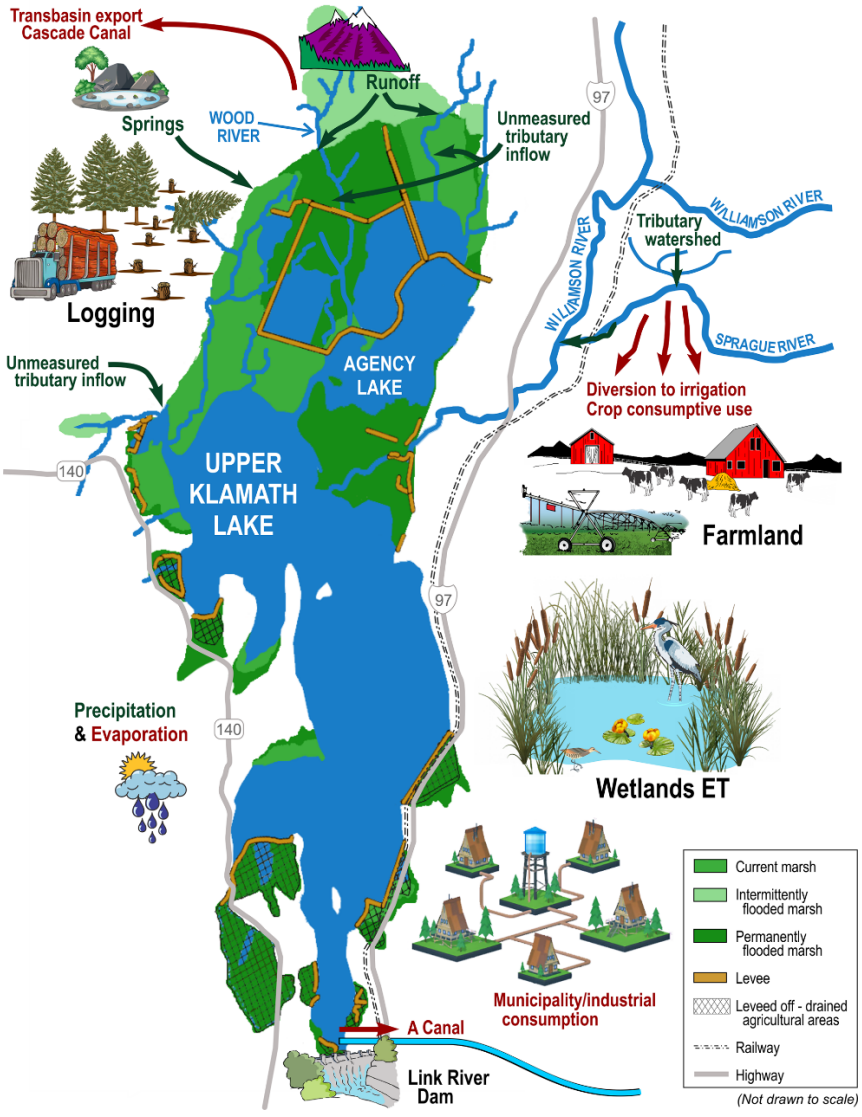

Figure 1. Representation of current conditions features removed to calculate natural (pre-development) flows.