## Hypotheses

Preamble

This project aims to assist stakeholders in the Napa River watershed to address the implementation needs of the Napa River Sediment TMDL. We also recognize selected information needs recently documented by the WICC. The following hypotheses provide an initial starting point for investigations on how to achieve management objectives. However, we recognize that hypotheses about how the system functions presently and how it will respond to management will evolve as further information is developed through this and other projects.

TMDL Goals

The ultimate goals of the Napa River Sediment TMDL and Habitat Enhancement Plan are to:

- Conserve the steelhead trout population
- Establish a self-sustaining Chinook salmon population
- Enhance the overall health of the native fish community
- Enhance the aesthetic and recreational values of the river and its tributaries

To achieve these goals, specific actions are needed to:

- Attain and maintain suitable gravel quality and diverse streambed topography in freshwater reaches of Napa River and its tributaries
- Protect and/or enhance base flows in tributaries and the mainstem of the Napa River
- Reduce the number and significance of human-made structures in channels that block or impede fish passage
- Maintain and/or decrease summer water temperatures in tributaries to the Napa River

TMDL Targets

- The mean depth of scour ($d_s$) shall be ≤ 15 cm below the level of the overlying streambed substrate at typical pool-tails/riffle-heads in all gravel-bedded reaches of mainstem Napa River and in the lower alluvial reaches of its perennial tributaries in reaches where the streambed slope is gentle (S= 0.001 to 0.01). The target applies in response to all peak flows ≤ bankfull discharge.

- The median value for streambed permeability shall be ≥ 7000 cm per hour at potential spawning sites for steelhead and salmon in the Napa River watershed. It is estimated that this target corresponds to approximately 50 percent or greater survival of eggs and larvae from spawning to emergence.

- Total sediment delivery to channels associated with land use activities needs to be reduced by 50 percent from contemporary rates (1994-2004 average) by 2025. Interim goals are also defined for sediment load reduction and habitat enhancement to be achieved by 2010, 2015, and 2020. Estimates for rates of sediment input to channels will be updated approximately 10 years after TMDL adoption in 2017. Measures of success (with regard to erosion and sedimentation and fish populations) would include: a) monitoring of spawning gravel permeability and redd scour in response to changes in sediment loads; b) monitoring to estimate status and trends in steelhead and Chinook salmon smolt production from Napa River watershed.

Selected WICC monitoring objectives / information needs

***F) MO: Identify and characterize essential hydrologic processes and trends***

AQ1: What are the essential hydrologic processes?

i) What is the relationship between surface water flows and groundwater?

ii) What are the natural patterns of surface and groundwater flow?

AQ2: Where are hydrologic processes relatively undisturbed?

AQ3: To what extent have hydrologic processes been modified over the past?

AQ4: Where is it feasible to restore hydrologic processes to meet multiple goals of flood protection, habitat restoration, water use efficiency, supply and storage improvements?

AQ5: How does flood protection relate to protecting and restoring hydrologic processes?

AQ6: What indicators are reasonable representations of sustainable hydrologic processes?

Hypotheses

H1 Land use change through time has increased runoff volume and peak flow in the lower reaches of tributaries and in the mainstem Napa River due to net influence of reservoir storage (runoff from 30% of the land area) and farm dam storage, changes in vegetation cover (in some cases increases in forest/woodland cover and in most cases a shift from open space to agriculture), soil compaction, hardening of channels, increased drainage density and connection of tributaries.

Note: Kimball, Bell, Hennessey, Rector, and Milliken have a combined storage volume equal to approximately 30% of the average annual runoff in Napa River near Napa. Also, note that the storage capacity in Hennessey, which represents approximately 75% of the total municipal storage capacity, is equal to about 160% of average annual inflow. About 1/8 of the watershed area is upstream of Hennessey. Where Conn Creek joins the Napa River, 49% of upstream land area drains into tributary dams.

H2 Land use change through time has increased fine sediment supply to the lower reaches of tributaries and mainstem Napa River through headward extension of channels and gullies due to increased runoff, increased prevalence and connection of shallow landslides to channels associated with gullies and soil compaction, increased sheet erosion associated with increased overland flow, erosion associated with roads (sheet and rill erosion, runoff, levee building, channel straightening, clearing of debris jams, large tributary dams, historical flood control dredging and gravel mining in mainstem), and bank erosion in first and second order channels associated with vineyard plumbing outfalls.

H3 Land use change through time has increased the ratio of fine sediment supply to coarse sediment supply through increased fine sediment supply and a lesser increase in coarse sediment supply associated with the balance of sediment retention behind reservoirs, supply from land use related erosion processes on watershed surfaces and in channels, and removal of natural fine sediment sinks (i.e. river corridor wetland, sloughs and islands).

H4 Depth of channel scour in the lower reaches of tributaries and mainstem has changed through time in response to increased stream power and greater area of the bed that is fine, river corridor encroachment and bank hardening by landowners/public agencies.

H5 Streambed permeability in the lower reaches (and some upper reaches) of tributaries and mainstem has decreased through time in response to the increased ratio of fine to coarse sediment supply and localized fine sediment provided from bank erosion and slumps and adjacent land uses.

H6 Land use change through time has caused an increase in depth to groundwater and a decrease in base flow in the lower reaches of tributaries and mainstem in response to increased evaporation, decreased infiltration and recharge on hillslopes, swales, and alluvial fans, increased storage in reservoirs and agricultural dams, surface water extraction, groundwater extraction, and channel incision.

H7 Habitat complexity in the lower reaches of tributaries and mainstem has decreased through time in response to land use related river corridor encroachment and hardening, loss of river corridor width and slough/island complexes, channel incision, ditching and channel straightening, extensive levee building, increase to groundwater depth, riparian vegetation removal and decreased woody debris recruitment, and wood removal.

H8 Land use change through time has caused increased water temperatures associated with decreased winter recharge, lower base flows, lower prevalence of gaining reaches, and a decreased amount of riparian shading.

H9 Specific changes in land use in the future, combined with land, water uses, and river corridor management, over 10-20 years or more can change river corridor form and function in a predictable way and can improve the lower reaches of tributaries and mainstem for the desirable beneficial uses described in the TMDL as adversely impacted by sediment: recreation (fishing), cold freshwater habitat, fish spawning, and preservation of rare and endangered species. More specifically, management can:

- Conserve the steelhead trout population
- Establish a self-sustaining Chinook salmon population
- Enhance the overall health of the native fish community
- Enhance the aesthetic and recreational values of the river and its tributaries