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GOALS AND OBJECTIVES FOR A "LIVING" NAPA RIVER SYSTEM

Based on Geomorphic, Water Quality and Habitat Considerations

Prepared for the
Community Coalition for a Napa River Flood Management Plan
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The "Water Quality/Fish Habitat" design review workgroup created the attached report as part of the design review process for the Napa River flood management plan. Our goal is to provide a working definition for a "living" Napa River system. Additionally, we provide specific guidance to the Design Review Committee and general information to the Community Coalition regarding the geomorphic, water quality and habitat elements of the Napa River management plan. This report is intended to serve as a "living", dynamic document which will be modified as we learn more about the living Napa River system.

EXECUTIVE SUMMARY

The Napa River system is currently a partially degraded, "living" river. Although it has areas of degraded habitat and water quality, it continues to support a diverse array of aquatic and terrestrial wildlife. Many of its degraded elements can be restored and must be restored to ensure the long term functioning of the river as an ecosystem. We have defined a healthy and vital "living" Napa River system as follows:

> A "living" Napa River and its tributaries is a river system with structure, function, and diversity. It has physical, chemical, and biological components that function together to produce complex, diverse communities of people, plants, and animals. The health of the entire watershed, from the smallest headwater trickle on the slopes of Mt. St. Helena to the broad expanse of the estuary, is the summation of natural and human activities in the basin and how they affect certain undeniable physical processes common to all river systems. A "living" Napa River system functions properly when it conveys variable flows and stores water in the floodplain, balances sediment input with sediment transport, provides good quality fish and wildlife habitat, maintains good water quality and quantity, and lends itself to recreation and aesthetic values. A"living" Napa River conveys equilibrium and harmony with all that it touches and resonates this through the human and natural environment.

To protect, enhance and insure the long term viability of the "living" river system, our committee developed four goals for the flood management plan (see figure 1). We further developed specific objectives for geomorphology, water quality and habitat to support the goals. In our opinion, if the flood management plan incorporates these goals and objectives, the "living" Napa River will be protected and significantly enhanced.

To be self-sustaining in the long-term, the "living" river must be geomorphically stable; have good water quality with adequate flows; and have a complex, uninterrupted, linear habitat. All of these must be present. With regards to the flood management plan, what is the best means of achieving these objectives? The key is geomorphic stability.

between these systems. The following discussion is a brief summary of the environmental objectives which we have developed for geomorphology, water quality and habitat.

We identified fourteen geomorphic objectives. A summary objective for the Napa River system is to achieve a state of geomorphic equilibrium. This entails identifying and maintaining (or re-creating) equilibrium river channel geometry (width,depth, etc.) and equilibrium sediment transport rates such that the River will sustain itself. These values will vary as the system changes from upstream to downstream, and freshwater to estuarine. The River should also be reconnected with the floodplain wherever feasible.

The workgroup identified water quality objectives for dissolved oxygen, salinity, temperature, turbidity, toxicity, and nutrients. The most important objectives include: 1) to maintain/enhance dissolved oxygen levels and salinity gradients sufficient to sustain a healthy ecosystem; and 2) to maintain/reduce turbidity and erosion. A flood management plan which involves minimal dredging and is based on geomorphic equilibrium principles, should satisfy these objectives.

We defined habitat objectives for vegetation, aquatic species, and wildlife. We have acknowledged that the river habitat is currently degraded, but functional. A properly designed flood control management plan can restore significant portions of the lost or degraded habitat. Numerous components of a healthy ecosystem are listed in the report. The most critical elements involve creating a linear continuum of complex habitats both aquatic and terrestrial with sufficient in-stream water flows. This continuous habitat will provide fish and wildlife with the resources needed for survival and reproduction. As an example, a migrating steelhead should be able to find an uninterrupted continuurn of places to hide, rest and feed. Wetland plants, overhanging banks and tree roots all provide this function. Once upstream at its spawning grounds, there should be sufficient water quality and quantity for spawning and survival of the young fish.

Specifically stated, the three most critical habitat elements are: 1) vegetation should exist in an uninterrupted continuum both longitudinally (from upstream to downstream) and in the cross section(from water surface to upland); 2) in-stream habitat complexity is essential. Channel complexity, which includes meanders, a low flow channel, pools, mudflats, and sand bars, is the essential building block for creating in-stream complexity; and 3) seasonally varying minimum flows are necessary to support steelhead/rainbow trout, and other aquatic species.

The first two objectives can be attained through creating a self-sustaining system which is geomorphically in dynamic equilibrium. Generally, if the River is in equilibrium and contains features such as mudflats, shallows, sloped banks and an integrated floodplain, the plant community will respond. It will create a vegetated continuum with the desired diversity and structure (some intervention to insure the proper seed sources are present and introduced species do not proliferate may be needed). Wildlife will thrive when provided a diverse and continuous habitat.

The third objective of maintaining "minimum in-stream flows" may be more difficult to achieve as part of this flood management project. Methods evaluated include: increasing the groundwater infiltration rate, selectively building new dams and reservoirs, increasing the height of existing dams, and other means of providing water

OUTLINE (CONT.)

3. Flows, depth, and velocity
4. Substrate composition, habitat, and water quality

Appendices:

APPENDIX A: Plant Communities in the Napa Valley
APPENDIX B: Minimum In-stream Flow Requirements
APPENDIX C: Glossary

banks, reducing erosion and improving water quality. The vegetation will also provide refuge, food and nesting sites for wildlife.

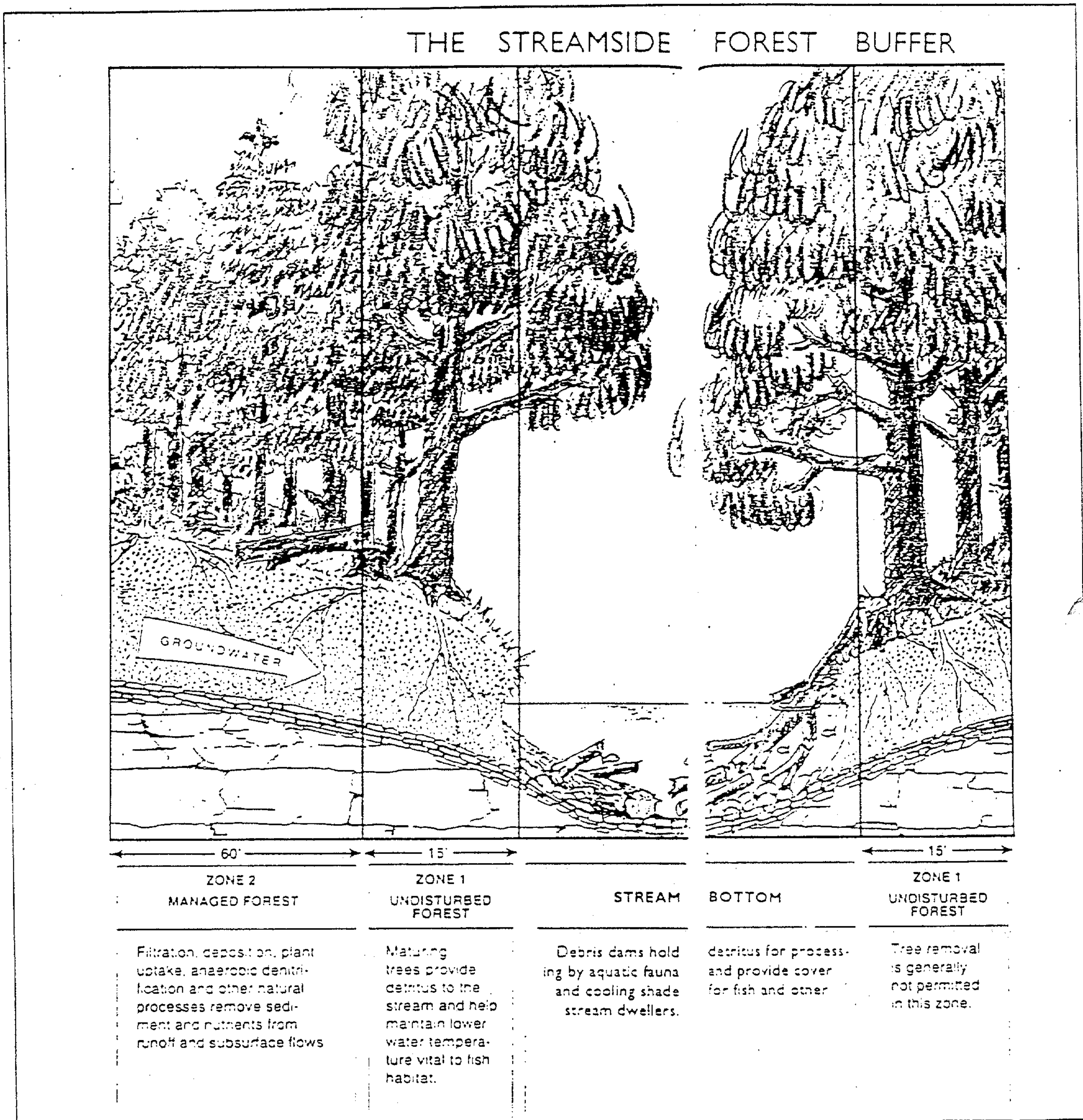

Figure I

times a day; by wind stress on the surface; and by river discharge forcing its way towards the Bay. The strength of each of these mixing processes varies depending on the tide conditions, prevailing winds and river discharge. The salinity difference between the river and the Bay water is about 20 parts per thousand which creates a density difference of about 2% (this varies seasonally with changes in freshwater flow). Even though this is small, it is sufficient to cause stratification (different salinities at different depths) and circulation patterns over the depth of flow. (see Figure II)

The meeting of freshwater and saline water creates a circulation pattern in which the heavier saline water flows underneath the lighter, less dense freshwater. The currents cancel each other out in an area called the null zone. The low currents in the null zone and the circulation patterns of fresh and salt water create an "entrapment zone". Nutrients are concentrated in the entrapment zone which becomes an area of maximum productivity in the estuary.

The boundary between the estuarine and freshwater reaches is not clearly defined. Generally, the reach South of Trancas is considered the estuary because this is the upstream extent of tidal influence and of "salt water" incursion. However, the situation is complex because the upstream extent of saline water varies greatly with the season, due to the great variation of freshwater flow down the Napa River from winter to summer. It advances to the North of Lincoln (all the way to Trancas) in late summer (particularly in dry years) and retreats to the southern part of Kennedy Park and beyond in late winter (particularly in "wet" years). The location and extent of the null and entrapment zones also vary seasonally with the seasonal changes in freshwater flow.

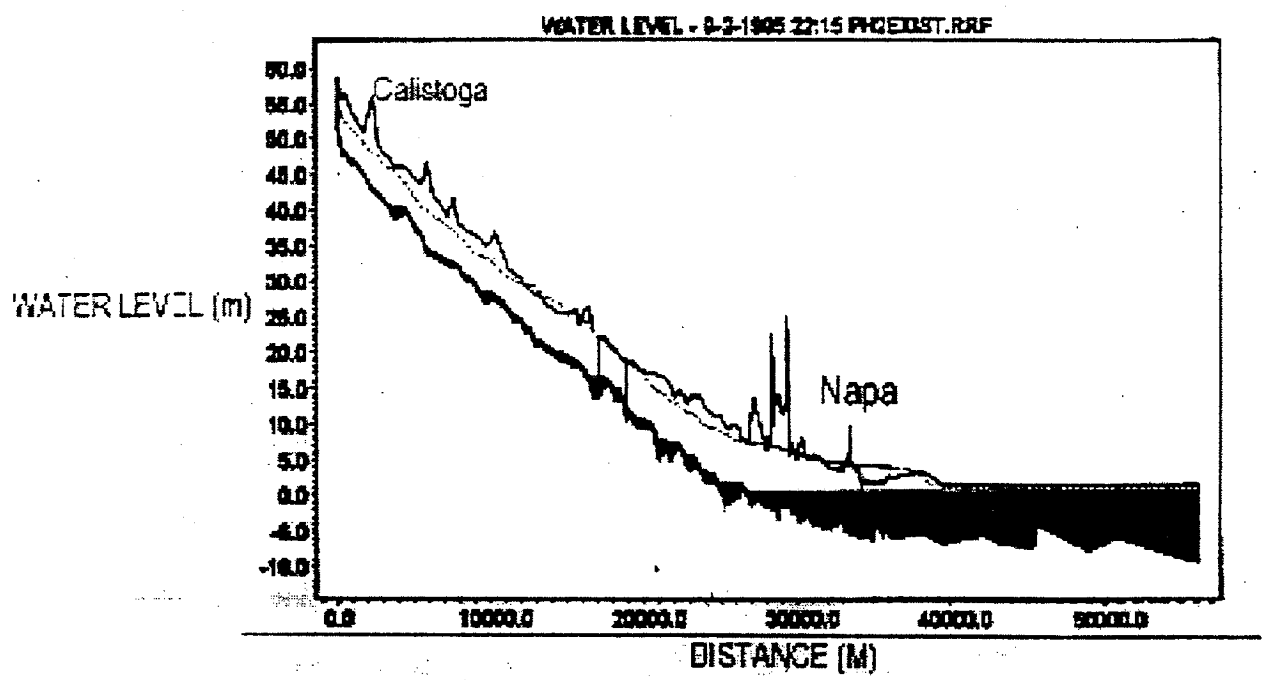

Figure A

The vegetation begins to transition from riparian to estuarine (from upstream to downstream) south of Trancas near the oxbow. This is in response to increased soil salinity as well as average water salinity. Generally, the location of this vegetative transition zone does not geometry (width, depth, and width/depth ratio) must be based on these principles and allow the River to function in a self-sustaining, dynamic equilibrium. Additionally, the flood management plan must take into account that the river's plan form (shape of a river as viewed from an airplane) is not fixed over time, but rather will change its course through a variety of natural processes (i.e., meandering).

A. RIVER CHANNEL

BANKFULL CHANNEL

"The first and most important aspect of the river channel is that it is self-formed and self-maintained. The flowing water carves the groove in which it flows. The water fashions the depth, the cross section, the areal configuration, and the longitudinal profile" (Leopold, 1962). The discharge that transports the most amount of sediment in the long term is called the channel forming flow (or dominant discharge). In river systems that are close to a dynamic equilibrium, the bankfull discharge and channel forming discharge are the same. The bankful discharge is approximately the 1.5 to 3 year flood event in many regions of Northern California. This moderate and relatively frequent flow is responsible for creating the characteristic morphology (size and shape) of the riverine channel. A river carries flows at the bankfull width approximately 3-5 days per year.

CHANNEL GEOMETRY (Width, Depth And Width/Depth Ratio)

The channel geometry (width, depth) is adjusted to carry tidal flows, normal river flows and the major floods. The channel geometry should be based on natural, undisturbed sections and observations of similar geomorphically stable river systems (i.e., reference reaches of a stream or reference river systems).

B. RIVER FLOODPLAIN

A river will not maintain a channel big enough to carry the largest flow. " The river channel is large enough to accommodate all the water coming from the drainage area only in the relatively frequent event. The flat area bordering most channels - the floodplain - must flood to some extent on the average every other year. To overflow the floodplain is an inherent characteristic of a river" (Leopold, 1962). Thus, the river floodplain is an integral part of the river system. A successful flood management strategy will involve reconnecting the River to its floodplain to the extent feasible.

C. SLOPE AND MEANDER

The slope of a river is developed over a very long time. If the slope of a river is altered in one reach, the rest of the system will tend to react and either downcut or aggrade. When this happens, it will take a long time for the river to equilibrate. Therefore, this project should avoid significantly altering the slope of the River.

Slope is by definition a measurement of the change in height divided by the change in length (change height/ change length). Thus, slope can be altered by a change in river depth (where the water surface elevation is altered) or a change in river length. Human activities which alter

D. SEDIMENT TRANSPORT

Rivers are agents of erosion and transportation, removing the water and sediment supplied to them from the land surface to the oceans (Knighton, 1984). The mechanics of sediment transport are different in riverine versus estuarine systems. Riverine channel stability is a relative term often defined in terms of the balance between sediment supply and transportability. When the sediment supply exceeds the transport capacity, the river bed tends to aggrade (the bed elevation increases due to the deposition of sediment). When the sediment supply is less than the transport capacity, a river bed tends to degrade (the bed elevation decreases due to scouring, if the bed materials are transportable).

Generally, the Napa River north of Oak Knoll (riverine) is degrading. The cause of the degradation is unknown, but may be due to at least two factors:

1. Dredging of the navigation channel; and
2. Channel clearing and excavation.

A state of dynamic equilibrium is desired in which the amount of sediment that enters the system equals the amount that leaves the system. A long-term goal of the flood management plan and an Upper Valley Watershed Plan should be to re-establish a state of equilibrium for sediment transport. To the extent that this is not achieved, the River will continue to downcut in the upper reaches and tributaries.

Sediment transport becomes more complicated in estuarine systems. Fine sediment particles (clays and silt) which would normally stay in suspension in a freshwater riverine system, begin to settle out and deposit on the river bed in an estuarine system. This is due, in-part to the effects of salinity on clay particles (increased flocculation) and to tidal backwater effects. The depositional patterns in the estuarine reach of the Napa River are complex and not yet understood. The issues to be assessed in this reach are:

1. Whether the current deposition rate is in equilibrium; and
2. The effect of a flood management plan on the deposition rate.

Accelerated degradation or increased aggradation are not desirable from either an environmental or economic standpoint. Downcutting (degradation) causes bank erosion, bank failure, loss of land, loss of habitat, and groundwater depletion. Accelerated aggradation often requires maintenance dredging to maintain channel capacity. Dredging and dredge disposal can be extremely costly with significant environmental effects.

The water quality impacts associated with excessive erosion and deposition in a river system are also significant. An increase in the sediment load above the Napa River's natural load will result in increased water turbidity, the destruction of steelhead/rainbow trout spawning gravels[2],

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[2] The term steelhead/rainbow trout is used throughout this document to highlight that these fish are the same species. A rainbow trout is a landlocked steelhead. This rainbow trout could have become an anadromous steelhead, migrating to the ocean, given the proper conditions.

Steelhead/rainbow trout will not spawn and/or the eggs do not survive when silt/sand/clay become heavily embedded between the gravels. This is because these fine materials prevent adequate water flow through the gravels and the dissolved oxygen levels become too low to support the eggs. Additionally, the young fish (fry) may be prevented from leaving the gravel.

ensures a range of habitat type and age within the system. It is important that the river is not constricted to such an extent that the increased velocity removes all vegetation in a given flood event. This condition leads to a uniformity of habitat age and type and may favor fast colonizing exotic vegetation. (See III.. B3 and appendix for a discussion of minimum in-stream flows).

OBJECTIVES:

12. **Maintain seasonal flows of sufficient magnitude and duration to sustain channel morphology within a floodplain and sustain estuarine system components.**

13. **Maintain adequate flows and velocities for sediment transport.**

14. **Maintain velocities in the ranges that might be expected in a natural system.**

15. **Identify measures throughout the watershed to increase infiltration and decrease stormwater runoff.**

F. DYNAMICS OF THE NULL/ENTRAPMENT ZONE

The point at which the freshwater River discharge meets and mixes with saline water from San Francisco/San Pablo Bay is called the null or entrapment zone (see Introduction and section II.B). The size and location of the null zone varies seasonally with changes in freshwater flow from the River. Because this is an area of maximum productivity in the estuary, the flood management plan should not alter the natural location or size of the entrapment zone. Example activities which might have this effect include: activities which would reduce the volume of normal freshwater flow (dams without adequate water releases); or actions which would increase the relative volume of saltwater (i.e., altering the tidal prism by channel widening).

OBJECTIVES

16. **Preserve the size and seasonally varying location of the null/entrapment zone and its ecological characteristics.**

II. WATER QUALITY OBJECTIVES

What is the best means of achieving the water quality and habitat objectives? The key is geomorphic stability. If the geomorphic objectives are met, then most of the water quality and

Minimum at all times[3]: 7.0 mg/L

19. All Waters
Minimum[4] (three month median): 6.8-7.2 mg/l[5] (summer, 80% of saturation)

QUALITATIVE OBJECTIVES:

In order to maintain optimal DO levels, characteristics of the River system should be maintained or restored that positively contribute to the oxygen dynamics of the system. The project should not adversely alter the oxygen dynamics of the system. To maintain healthy oxygen dynamics, the project should:

20. **Maintain or restore the River to a state of geomorphic equilibrium. This should eliminate the need for extensive ongoing maintenance dredging.**

21. **Maintain or restore a riparian zone to provide shade for the River in order to reduce temperatures.**

22. **Maintain or restore adequate low flows.**

23. **Maintain adequate water velocity during low flow months.**

24. **Maintain adequate circulation patterns.**

25. **Maintain or decrease nutrient loading. Nutrients should not be increased through discharge of dredge material or sediment resuspension, such that increased primary production occurs.**

26. **Maintain water temperatures appropriate to the needs of the local biota.**

B. SALINITY (See introduction and section I.F)

The Napa River tends to be estuarine below Trancas and riverine above Trancas. The boundary location is not precise and varies depending on the season and the amount of freshwater flow; moving towards Trancas St. in late summer/fall and southward to Kennedy Park and beyond in late winter (particularly in "wet" years). The interface and subsequent mixing zone of fresh and saline water is called the "entrapment zone". In this zone, during the

[3] These lower oxygen limits are based on the oxygen requirements of the different species of fish. Fish residing in the estuary are generally more tolerant of lower oxygen levels than cold water fish such as steelhead/ rainbow trout.

[4] This is an oxygen standard required by the San Francisco Bay Regional Water Quality Control Board Basin Plan. The Napa River system will need to be evaluated to determine if the system currently meets this standard. This standard is a median value, rather than an instantaneous value as in the previous standards.

[5] range in values provided to account for varying temperature and levels of salinity.

months, the lower River becomes more saline and supports fish species which are typically better adapted for warmer water and estuarine conditions such as striped bass.

Factors that affect temperature include:

1. The daily and seasonal fluctuations of direct sunlight radiation;
2. The amount of stream shade or cover;
3. Water depth;
4. Inflow of groundwater (usually colder than stream);
5. Inflow of other water (surface water) into stream that is at a different temperature than the stream (e.g., a drainage ditch, hot tub, or another stream); and
6. Channel width (deep, narrow channels help maintain low temperatures and sediment transport).

QUALITATIVE OBJECTIVES

29. The natural river/creek water temperatures should be maintained.

30. Velocity, circulation patterns, and mass flow should not be altered in a manner that causes an increase in temperature.

31. Avoid increases in turbidity from dredging or other project activities that can cause an increase in water temperature.

32. Avoid creating thermal barriers to migration or movement by project activities (e.g., dredging).

D. TURBIDITY

Turbidity is a measurement of light penetration through the water column. Turbidity of the Napa River increases as suspended sediment concentrations and algal populations increase. Suspended sediment in the Napa River system originates from river bank and bed erosion, land erosion (both naturally occurring and human induced), and from the transport of suspended solids from San Pablo Bay. Water turbidity affects plant species composition and is important in predator-prey interactions. For example, in highly turbid water, a steelhead/rainbow trout cannot adequately see in order to catch the insects it feeds upon.

Possible sources of the flood management project-related turbidity include the following:

1. Resuspension of sediment through dredging;
2. Increased upstream bank and River bed erosion; and
3. River bank erosion downstream of any newly created reservoirs or dams.

OBJECTIVES

To minimize the negative effects from these activities:

33. **Increases from normal background light penetration or turbidity should not be greater than 10 % in areas where normal turbidity is greater than 50 NTU.**

34. **The flood control project should not:**
    - **Increase sedimentation rates in the lower River (below Trancas),**
    - **Increase bank and bed erosion upstream or in the tributaries,**
    - **Cause resuspension of sediments from dredging,**
    - **Increase algal growth.**

E. TOXICITY

Examples of toxic substances that might be released during the construction phase of the flood control project or during maintenance operations from dredging include diesel fuel, metals (mercury, arsenic, lead, silver, etc.), and pesticides (e.g., DDT). The kinds of activities that can cause the release of these toxic substances include:

1. Disturbance of contaminated sites adjacent to the River which have not been properly cleaned up or stabilized;
2. Resuspension of contaminated sediment through dredging activities; and
3. Discharge of water from dredging dewatering operations (where contaminated sediments are involved).

QUALITATIVE OBJECTIVE:

35. **All waters should be maintained free of toxic substances in concentrations that are lethal to or produce other detrimental responses in aquatic organisms. Detrimental responses include decreased growth rate and decreased reproductive success of resident or indicator species. *(See San Francisco Bay Regional Water Quality Control Board, Basin Plan for specific numeric limits).***

III. HABITAT OBJECTIVES: *SOUTH OF TRANCAS STREET*

A. VEGETATION (See appendix A for detailed description of existing plant communities)

Generally, if the River is geomorphically stable and contains features such as mudflats, shallows, sloped banks and an integrated floodplain, the plant community will respond. It will create a vegetated continuum with the desired diversity and structure (some intervention to insure the proper seed sources are present and introduced species do not proliferate may be needed).

RIVER CROSS SECTION (FROM WATER SURFACE TO UPLAND)

There are three basic vegetative transition zones from water surface to upland. These are:

- Root zone wet all of the time and plant partially submerged (i.e.,cattails, bulrush)
- Root zone wet the majority of the time (i.e.,willows)
- Root zone wet periodically - flooded periodically (i.e.,oak, grassland)

OBJECTIVE:

39. **The vegetative transition zones should exist from the low water level to the upper floodplain. Each zone should be of sufficient width to sustain habitat complexity and ecosystem function. There is no set width. Specific widths will vary with topography and bank slope. To create a self-sustaining river system, widths should be set by studying and mimicking natural conditions to the greatest extent feasible.**

40. **Design a project that minimizes the need for erosion control measures such as rock rip-rap or other hard structures/materials.**

RIVER LONGITUDINAL PROFILE (From upstream to downstream)

Vegetation changes can be seen as you travel from downstream to upstream along the Napa River. The transitions are represented by pickleweed - tule- willows -oak (from mudflat to sandbar as you go upstream). The changes in vegetation are driven by changes in salinity (increasing freshwater upstream).

Without a linear continuum of habitat, aquatic species and wildlife cannot successfully travel up and down the river corridor. In the case of juvenile fish, without the cover provided by vegetation they are very susceptible to predation. The vegetation also provides a source of water depths (e.g., wetland vegetation grows in shallow water and phytoplankton is found floating at many depths. Channel complexity, which includes meanders, a low flow channel, pools, mudflats, and sand bars, is the essential building block for creating in-stream complexity.

The diverse habitats provide food, escape from predation, corridors for movement, and multiple niches for a spectrum of organisms from insects to clams to fish.

Fish require different depths of water during different life stages. Juvenile fish rely on vegetative cover, tree roots, and overhanging banks to escape predation. Adult fish move from deep water refuges during the day to shallow water at night for feeding. During migratory periods, anadromous fish often travel upstream in shallow areas where the water velocity is less than in the deeper reaches.

Disturbances of the river channel from this flood management project should be minimal. Ongoing or frequent dredging destroys complexity by eliminating pools, shallows, mudflats, and sand bars, and destroying the benthic community. This disturbance results in a benthic community that is comprised of species more opportunistic and disturbance-tolerant. These species may be less important as food for fish and birds. A diverse macroinvertebrate population (insects clams, snails, crayfish, etc.) and a diverse plant community require water of different depths and lack of disturbance. Ongoing disturbances of the water column or benthos would result in a long-term reduction in the biological productivity of the River.

OBJECTIVE

43. Post-project conditions should include:

- **geomorphic features (e.g., meanders) that will foster continued development of varying water depths over mudflats, sand bars, pools;**
- **gradation of depth from bank to bank;**
- **presence of pools, low flow channels, mudflats, and sand bars;**
- **banks at a slope and with appropriate substrate to support vegetation;**
- **minimal maintenance dredging or other disturbances that eliminate structural complexity.**

B. 3 Minimum Flows and Velocity

Flows in the winter months are currently sufficient to attract migrating steelhead and to maintain a natural variation in flow characteristic of a living river. Flows in the spring months are sufficient for out-migrating young steelhead trout (typically 1-3 years old). Summer and fall flows should be preserved and restored for sufficient steelhead/rainbow trout habitat, and for estuary water quality enhancement.

The project should strive to reduce peak flows during major flood events while not significantly altering the winter migration flows which serve to attract the steelhead and allow access into small tributaries. If water detention facilities up the valley are incorporated into the project, then they should be designed to release sufficient storm flows to ensure upstream migration of adults in the winter (Jan-Mar), outmigration of juveniles (Dec-May), and to provide

Rather, the trail should be located a distance away from the River, with discrete access points for viewing, fishing, etc. (Exceptions to this would be within the City downtown area where parks, trails could be located as enhancements to that area).

The estuarine reach can be broadly defined as where the freshwater river discharge is mixed with tidally influenced saline water from San Francisco /San Pablo Bay. In this reach, the water is saline and the vegetation within the tidal zone is characterized by saline tolerant species such as tule or bulrush. The overhead canopy is relatively open. The channel shape is influenced both by freshwater flows from the upper watershed and the tides. Therefore, the channel is relatively wide and deep.

The meeting of freshwater and saline water creates a circulation pattern in which the heavier saline water flows underneath the lighter, less dense freshwater . The currents cancel each other out in an area called the null zone. The low currents in the null zone and the circulation patterns of fresh and salt water create an "entrapment zone". Nutrients are concentrated in the entrapment zone which is an area of maximum productivity in the estuary.

A boundary between the estuarine and freshwater reaches is not clearly defined. Generally, the reach South of Trancas is considered the estuary because this is the upstream extent of tidal influence and of "salt water". However, the situation is complex as the upstream extent of saline water varies greatly with the season, due to the great variation of freshwater flow down the Napa River from winter to summer. It advances to the North of Lincoln (all the way to Trancas) in late summer (particularly in dry years) and retreats to the southern part of Kennedy Park and beyond in late winter (particularly in "wet" years). The location and extent of the null zone also varies seasonally with the seasonal changes in freshwater flow.

The vegetation begins to transition from riparian to estuarine (moving downstream) south of Trancas near the oxbow. This is in response to soil salinity as well as average water salinity. Generally, the location of this vegetative transition zone does not change significantly seasonally or yearly. Significant shifts may occur if the water salinity is altered for an extended period such as during an extended drought.

The environmental objectives for the Napa River system have been appropriately tailored for the different reaches, riverine and estuarine, to reflect the differences between these systems. The following discussion is a brief summary of the environmental objectives which we have developed for geomorphology, water quality and habitat.

B. AQUATIC SPECIES HABITAT

B.1 BARRIER-FREE MIGRATION

Examples of possible conditions that could produce barriers include hydraulic control structures (i.e. weirs or dams), grade control structures, wide shallow channels, narrow constricted channels. Successful migration requires both upstream and downstream resting areas such as pools, eddies, and backwater zones.

The principal attributes of this cover type include

1. Streambanks composed of naturally eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water and
2. Instream habitat characterized by variations in depth, velocity, current, and the amount of woody debris.

These attributes provide high-quality feeding areas, burrowing substrates, escape cover, and reproductive cover for numerous regionally important fish and wildlife species.

The density and quality of the riparian habitat decreases downstream from Lincoln Avenue through the City of Napa. Most of the native riparian vegetation along this portion of the river has been displaced by residential and commercial developments, rock riprap, and concrete rubble vegetated with nonnative species.

The riparian habitat downstream from Kennedy Park still supports patches of brackish emergent marsh vegetation. Marsh vegetation has been divided into three zones of plant growth by the USFWS: low marsh (mean tide level or lower), middle marsh (mean tide level to mean higher high water), mixture of cattails (Typha latifolia) and bulrushes, and the high marsh with a variety of halophytes, including saltgrass (Disticlis spicata) and baltic rush (Juncus balticus).

Intertidal mudflats also are present in the vicinity of Kennedy Park as an exposed linear band of river bottom at low tide between the river and the riverbanks. Emergent species grow at the landward edges of the mudflats. Mudflats provide habitat for a variety of aquatic invertebrates which serve as a primary food source for a number of fish and animal species.

A limited amount of oak woodland is found in the vicinity of the City of Napa. Oak woodland is characterized by an open tree canopy (10-50% cover) of valley and live oak species ranging from 25 to 75 feet tall (USFWS, 1993). Oak woodlands in this area support a herbaceous layer characteristic of annual grasslands and little to no shrub understory layer.

Rare, Threatened, and Endangered Vegetative Species: Two plants, Baker's stickyseed (Blennosperma bakeri) and Sebastopol Meadowfoam (Limnanthas vinculans), were identified during USFWS Section 7(c) Endangered Species Act consultation as listed endangered species that may grow in the project area. Surveys of the project area failed to locate individuals of either species. Therefore, no plant species which are currently listed as endangered or threatened are considered to be present in the project area.

Fourteen plant species which are candidates for Federal listing and/or considered sensitive by the California Native Plant Society may grow in the Project area (Table 2). Two species, Mason's lilaeopsis (Lilaeopsis masonii) and soft bird's beak (Cordylanthus mollis), are listed by the State of California as rare species, but only Mason's lilaeopsis is present in the project area.

TABLE 2: Species Considered Candidates for Federal Listing and/or Sensitive by the California Native Plant Society Which May Occur in the Project Area

COMMON NAME	SCIENTIFIC NAME	STATUS
Mason's lilaeopsis	Lilaeopsis masonii	FC2, Rare, CNPS 1B
Delta tule pea	Lathyrus jepsonii spp.	FC2, CNPS 1B
Suisun Marsh aster	Aster chilensis var. lentus	FC2, CNPS 1B
Soft bird's-beak	Cordylanthus mollis var. mollis	FC1, Rare, CNPS 1B
Legenere	Legenere limosa	FC2, CNPS 1B
Contra Costa goldfields	Lasthenia conjugens	FC1, CNPS 1B
Marin knotweed	Polygonum marinense	FC2, CNPS 1B
Showy Indian clover	Trifolium amoenum	FC2, CNPS 1A
Mudwort	Limosella subulata	CNPS 1B.
Dwarf downingia	Downingia humilis	CNPS 1B
Calistoga ceanothus	Ceanothus divergens	FC3, CNPS 1B
Bakers manzanita	Arctostaphylos bakeri ssp. bakeri	FC2
Alkali milk-vetch	Astragalus tener var. tener	FC2
Rincon ridge ceanothus	Ceanothus confusus	FC2
Sonoma ceanothus	Ceanothus sonomensis	FC2
Few-flowered navarretia	Navarratia leucocephala ssp. pauciflora	FC1

Definition of species status is as follows:

FC1: Category 1 Candidate for Federal listing (Taxa for which the U.S. Fish and Wildlife Service has sufficient biological information to support a listing as either threatened or endangered)

FC2: Category 2 Candidate for Federal listing (Taxa for which existing information indicates may warrant listing, but for which substantial biological information to support a proposed rule is lacking)

FC3: Widespread or not threatened

CNPS 1A: Plants presumed extinct by the California Native Plant Society

CNPS 1B: Plants rare, threatened, or endangered in California or elsewhere

APPENDIX C

GLOSSARY

Abiotic: The non-living components of an environment.

Active channel: The physical environment of the permanently submerged bed, together with the frequently disturbed adjacent substrates. It is usually characterized by having little or no permanent vegetation.

Acre-foot (AF): The quantity of water that will cover an acre of land to a depth of one foot (i.e., 43,560 cubic feet or 325,900 gallons).

Aggrade: Pertaining to the building up of a river bed and flood plain with deposited sediment.

Algae: A diverse group of simple aquatic plants, some microscopic, which may grow in rivers in great profusion (blooms).

Algal blooms: Sudden growth of algae in an aquatic ecosystem; naturally due to photosynthetic production exceeding consumption by aquatic herbivores, or induced by nutrient enrichment of water due to pollution; a symptom of eutrophication.

Alluvial fan: A mass of sediment deposited at a sharp increase in gradient, such as between a mountain range and a plain; the land-bound equivalent of a river-delta formation.

Anadromous: Pertaining to fish that spend part of their life cycle in the ocean and return to freshwater streams to spawn.

Anaerobic: Pertaining to organisms occurring, living or growing in the absence of free oxygen.

Aquatic plants: A term given to plants that grow entirely covered by water, like water-milfoil, or at the surface, such as yellow water-lily. Some plants have both aquatic and emergent forms.

Bankfull discharge: Discharge that fills a channel without overtopping the banks. It is an intermediate discharge which is considered to be a critical or dominant channel-forming event in natural rivers.

Base flow: The sustained summer low river or stream flow, free of overland flows and storm runoff, and derived from natural groundwater sources.

Bedload: The larger, heavier particles of sediment, such as sand and gravel, sometimes up to boulder size, that move along the bed by rolling, sliding, and bouncing.

Beneficial use: Uses of waters of the state that may be protected against water quality degradation. They include, but are not limited to, domestic municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and excavation of sand or gravel.

Discharge: Volume of water flowing past a reference point per unit of time (e.g., cubic feet per second, cfs).

Dissolved oxygen: Oxygen that is present (dissolved) in water and therefore available for fish and other aquatic animals to use. If the amount of dissolved oxygen ("DO") in the water is too low, aquatic animals may die. Wastewater and naturally occurring organic matter contain oxygen-demanding substances that consume dissolved oxygen.

Drainage basin: Land area drained by a given river or stream; watershed.

Dredging: Excavating unconsolidated alluvial deposits from beneath standing water or from saturated soils adjacent to watercourses.

Dynamic equilibrium: A condition in which the amounts of sediment entering and transported through a river system maintain what appears to be a stable channel and flood plain form.

Ecosystem: A community of living organisms interacting with one another and with their physical environment. Damage to any part of a complex system may affect the whole. A system such as the Bay/Delta estuary can also be thought of as the sum of many interconnected ecosystems such as the rivers, wetlands, and bays. Ecosystem is thus a concept applied to communities of different scale, signifying the interrelationships that must be considered.

Emergent vegetation: Plants that grow in water but have leaf structures that emerge above the surface, e.g. bulrush.

Enhancement: Small-scale environmental improvements.

Entrapment zone: An area in an estuary where seaward surface flows and landward bottom currents cause suspended materials (including certain small plants and animals) to accumulate. Particles that sink from the surface flows into the bottom currents are carried upstream and toward the surface. Because the entrapment zone concentrates phytoplankton and zooplankton, it is an important area for some estuarine fish.

Equilibrium profile: The grade or slope of the river where a balance of erosion and deposition over many years is maintained. A dynamic, not static, balance is the usual case.

Estuary: A partially enclosed, coastal body where ocean water is diluted by out-flowing fresh water.

Eutrophication: A condition in an aquatic ecosystem where high nutrient concentrations stimulate blooms of blue-green algae. Algal decomposition may generate odors and lower dissolved oxygen concentrations. Although eutrophication is a natural process in the aging of lakes, it is accelerated by point and nonpoint pollutant loads.

Flood plain: The low relief area of valley floor adjacent to a river that is periodically inundated by flood waters.

Null zone: The region in a partially- or well-mixed estuary where the residual bottom currents are effectively zero. Landward of this point there is a net seaward residual velocity along the bottom caused by river inflow; seaward of the null zone, gravitational circulation produces a net landward transport of denser more saline water along the bottom. The null zone is the theoretical upstream boundary of the entrapment zone.

Nutrients: Essential chemicals needed by plants or animals for growth. If other physical or chemical conditions are optimal, excessive amounts of nutrients can lead to degradation of water quality by promoting excessive growth, accumulation, and subsequent decay of plants, especially algae. Some nutrients can be toxic to animals at high concentrations.

Oxbow: Section of a meander loop. With time, the oxbow is cut off by a lateral channel shift, and no longer carries the main river flow.

Planform: Layout as viewed from above.

Point bars: Sediment bars deposited by water slowing along the concave (inside) bank of a meandering stream.

Point source: Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant: A substance that adversely alters the physical, chemical or biological properties of the environment. The term includes pathogens, toxic metals, carcinogens, oxygen-demanding materials, and all other harmful substances. With reference to nonpoint sources, the term is sometimes used to apply to materials released in low concentrations from many activities which collectively degrade water quality.

Reaches: Sections of a stream or river between two specified points or possessing some common characteristic(s).

Restoration: The return to a pristine state.

Revetment: Facing built to support a bank (e.g., rock rip rap).

Riparian: Relating to or situated on the bank of the river or stream.

Rip rap: Rock revetment placed to armor banks, usually at a given slope, e.g., 2:1.

River terrace(s): Lateral bench between a river channel and its valley sides.

Salinity: The salt content of water, usually expressed as ppt (grams/liter) or ppm (milligrams/liter).

Salinity intrusion: The movement of saltwater into a body of freshwater. It can occur in either

Weir: A barrier built in a stream to divert water.

Wetlands: Habitats where the influence of surface- or groundwater has resulted in development of plant or animal communities adapted to aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas.

C. Short of some major changes in winter, spring (and fall) current flows[1], the primary focus is (to preserve and enhance, in some cases restore) late summer (e.g., August, September) 'good quality' "Minimum In-stream Flows.

In Cubic Feet Per Second (cu. ft. per sec.)

	Napa River Location	Mean Monthly Exist. Min./Max.	Mean Monthly Recommended	Recommended approx. Min. Flows (cu. ft. per sec.)
(1)	North of Napa (Oak Knoll)	-0- / 7+	4 - 6+[2]	2+ - 4+
(2)	South of St. Helena (Zinfandel Lane)	-0- / 3+	2 - 4+	1+ - 3+
(3)	Calistoga (Lincoln St. Bridge)	-0- / 1+	2+	1+
(4)	For Tributaries (historic surface flowing reaches normally above the Valley floor[a]; while restorations measured normally at Napa River)	-0- / 1+	1+	½ - 1

([a] Creeks flowing into estuary normally also have Valley flowing reaches, e.g., Milliken, Napa Creek

NOTE: One (1) cu. ft. per sec. is equivalent to either (approximately) 450 gallons per minute or two acre-feet a day. A relatively small reservoir* that provided a net su[illegible] of water, after allowances for evaporation and net 'in-flow'/'out-flow' including percolation, of 360 acre-feet, would provide one (1) cu. ft. per sec. for 180 days (6 months) or two (2) cu. ft. per sec. for 3 months. Four hundred acre-feet is equivalent to forty (40) acres of water an average of 10 feet deep (or 20 acres an average of 20 feet deep, etc.). Milliken Creek's and Napa Creek's late summer surface flow into the Napa River are normally between one half (½) and one (1) cu. ft. per sec.

* Example(s): Calistoga's Kimball Dam/Res. -400+ acre-feet total capacity. (Napa's Conn Dam/Lake Hennessey -31,000 acre-feet total capacity; considered enlargement - 5.000 acre-feet. Rector - 4,400 tot. cap.)

1 Assumes major diversions for filling 'farm ponds' will continue in the winter; and that existing ground water resources will not be significantly mismanaged.

2 Could provide for 'fall run' salmon spawning above estuary (i.e., above Trancas St.) - e.g., fall 1995.

Acknowledgements

This document was developed by the "Water Quality/Fish Habitat" design review workgroup; a workgroup of the Community Coalition for a Napa River Flood Management Plan/ Design Review Committee.

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Disclaimer: The workgroup acknowledges that a detailed, quantitative baseline condition analysis is insufficient or is not available as of the writing of this document. This poses difficulty when attempting to measure impacts or directions toward or away from the goals, except in a very general way. After this current conceptual review is concluded, it will be necessary to obtain a more specific quantitative statement of the existing conditions of the Napa River for evaluating or fine-tuning project proposals.

Fluvial geomorphology refers to a river's processes (i.e., sediment transport, tidal and flood flows) and how they create the forms in a river (i.e. bends/meanders, point bars and pools). If the geomorphic objectives are met, then most of the water quality and habitat objectives will also be met. For instance, if the River is allowed to take its natural form, meandering, creating point bars and shallows, etc., the desired wetland vegetation will naturally colonize these areas. The vegetation will stabilize the banks, reducing erosion and improving water quality. The vegetation will also provide refuge, food and nesting sites for wildlife.

In understanding the Napa River ecosystem, it is important to realize that the system changes from a freshwater riverine system upstream to an estuarine system downstream. The water chemistry, geomorphic and biological components of riverine and estuarine systems are different. The freshwater riverine system is characterized by a relatively narrow and shallow active channel. The channel size and shape are influenced by flows originating from the Napa watershed. The vegetation, as seen north of the oxbow, is comprised of riparian scrub shrub and forest species such as willows, cottonwood, and an adjacent overstory of valley oak.

The estuarine reach can be broadly defined as where the freshwater river discharge is mixed with tidally influenced saline water from San Francisco/San Pablo Bay. In this reach, the water is saline and the vegetation within the tidal zone is characterized by saline tolerant species such as tule or bulrush. The overhead canopy is relatively open. The channel shape is influenced both by freshwater flows from the watershed and tidal flows. Therefore, the channel is relatively wide and deep.

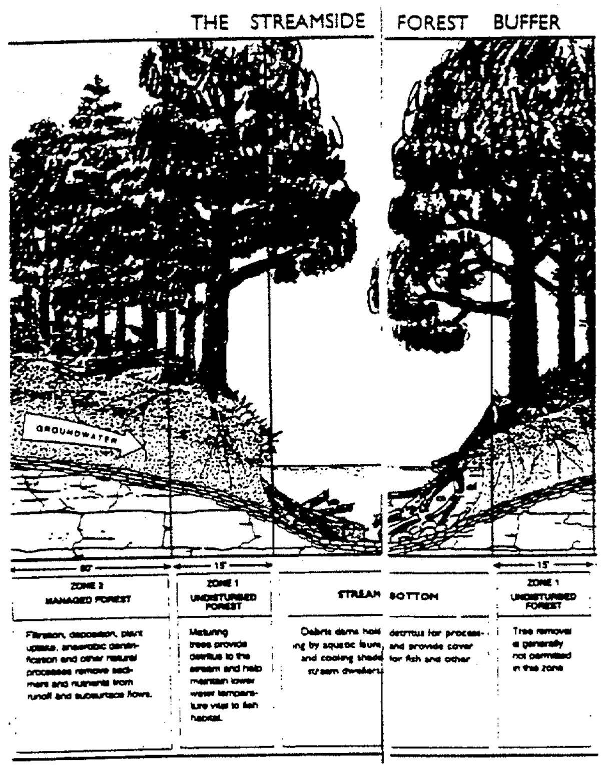
The meeting of freshwater and saline water creates a circulation pattern in which the heavier saline water flows underneath the lighter, less dense freshwater. The currents cancel each other out in an area called the null zone. The low currents in the null zone and the circulation patterns of fresh and salt water create an "entrapment zone". Nutrients are concentrated in the entrapment zone which becomes an area of maximum productivity in the estuary.

The boundary between the estuarine and freshwater reaches is not clearly defined. Generally, the reach South of Trancas is considered the estuary because this is the upstream extent of tidal influence and of "salt water" incursion. However, the situation is complex because the upstream extent of saline water varies greatly with the season, due to the great variation of freshwater flow down the Napa River from winter to summer. It advances to the North of Lincoln (all the way to Trancas) in late summer (particularly in dry years) and retreats to the southern part of Kennedy Park and beyond in late winter (particularly in "wet" years). The location and extent of the null and entrapment zones also vary seasonally with the seasonal changes in freshwater flow.

The vegetation begins to transition from riparian to estuarine (from upstream to downstream) south of Trancas near the oxbow. This is in response to increased soil salinity as well as average water salinity. Generally, the location of this vegetative transition zone does not change significantly seasonally or yearly. Significant shifts may occur if the water salinity is altered for an extended period, such as during an extended drought.

The environmental objectives for the Napa River system have been appropriately tailored for the different reaches, riverine and estuarine, to reflect the differences for summer/fall releases. These continue to be evaluated for technical and economic feasibility, as well as overall environmental impact.

In summary, this report describes geomorphic, water quality and habitat objectives. The majority of these objectives must be satisfied in order to maintain a long-term, sustaining river ecosystem that is a "living" Napa River system. If the geomorphic objectives are satisfied, the majority of the other objectives will be automatically satisfied.



OVERALL GOALS

1. The project should preserve or enhance the habitats, water quality and natural geomorphic characteristics of the Napa River system.

2. The project should provide enhancement of the River system to the fullest extent possible, and not preclude or eliminate future restoration opportunities.

3. The project should incorporate the geomorphic, water quality and habitat objectives to the fullest extent possible.

4. The project should incorporate the geomorphic, water quality and habitat objectives so that the intended functions are self-sustaining.

Goals and Objectives For Geomorphology, Water Quality, and Fish & Wildlife Habitat

Prepared by: *Bay Area Water Quality Control Board*

GOALS AND OBJECTIVES [illegible] WATER QUALITY AND FISH AND WILDLIFE HABITAT

OUTLINE

A LIVING RIVER

OVERALL GOALS

I. GEOMORPHIC OBJECTIVES

- A. River channel (bankfull channel and channel geometry)
- B. River floodplain
- C. Slope and meander
- D. Sediment transport
- E. Flow and velocity
- F. Dynamics of null/entrapment zone

II. WATER QUALITY OBJECTIVES

- A. Dissolved oxygen
- B. Salinity
- C. Temperature
- D. Turbidity
- E. Toxicity
- F. Nutrients and algal blooms

III. HABITAT OBJECTIVES: SOUTH OF TRANCAS STREET

- A. Vegetation
  - 1. Cross section
  - 2. Longitudinal profile
- B. Aquatic species
  - 1. Barriers to migration
  - 2. Complexity of in-stream habitat
  - 3. Minimum flows and velocity
- C. Wildlife

IV. HABITAT OBJECTIVES: NAPA CREEK, ALL TRIBUTARIES WITH STEELHEAD AND TROUT, AND NAPA RIVER (north of Trancas St.)

- A. Vegetation
  - 1. Cross section
  - 2. Longitudinal profile
- B. Aquatic species
  - 1. Barriers to migration
  - 2. Complexity of in-stream habitat

The "Water Quality/Fish Habitat" design review workgroup created the attached report as part of the design review process for the Napa River flood management plan. Our goal is to provide a working definition for a "living" Napa River system. Additionally, we provide specific guidance to the Design Review Committee and general information to the Community Coalition regarding the geomorphic, water quality and habitat elements of the Napa River management plan. This report is intended to serve as a "living", dynamic document which will be modified as we learn more about the living Napa River system.

INTRODUCTION

A "LIVING" NAPA RIVER SYSTEM

The Napa River system is currently a partially degraded, "living" river. Although it has areas of degraded habitat and water quality, it continues to support a diverse array of aquatic and terrestrial wildlife. Many of its degraded elements can be restored and must be restored to ensure the long term functioning of the river as an ecosystem. We have defined a healthy and vital "living" Napa River system as follows:

A "living" Napa River and its tributaries is a river system with structure, function, and diversity. It has physical, chemical, and biological components that function together to produce complex, diverse communities of people, plants, and animals. The health of the entire watershed, from the smallest headwater trickle on the slopes of Mt. St. Helena to the broad expanse of the estuary, is the summation of natural and human activities in the basin and how they affect certain undeniable physical processes common to all river systems. A "living" Napa River system functions properly when it conveys variable flows and stores water in the floodplain, balances sediment input with sediment transport, provides good quality fish and wildlife habitat, maintains good water quality and quantity, and lends itself to recreation and aesthetic values. A"living" Napa River conveys equilibrium and harmony with all that it touches and resonates this through the human and natural environment.

To protect, enhance and insure the long term viability of the "living" river system, our committee developed four goals for the flood management plan (see figure 1). We further developed specific objectives for geomorphology, water quality and habitat to support the goals. In our opinion, if the flood management plan incorporates these goals and objectives, the "living" Napa River will be protected and significantly enhanced.

To be self-sustaining in the long-term, the "living" river must be geomorphically stable; have good water quality with adequate flows; and have a complex, uninterrupted, linear habitat. All of these must be present. With regards to the flood management plan, what is the best means of achieving these objectives? The key is geomorphic stability. Fluvial geomorphology refers to a river's processes (i.e., sediment transport, tidal and flood flows) and how they create the forms in a river (i.e. bends/meanders, point bars and pools). If the geomorphic objectives are met, then most of the water quality and habitat objectives will also be met. For instance, if the River is allowed to take its natural form, meandering, creating point bars and shallows, etc., the desired wetland vegetation will naturally colonize these areas. The vegetation will stabilize the

dOVERALL GOALS

1. The project should preserve or enhance the habitats, water quality and natural geomorphic characteristics of the Napa River system.

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4. The project should incorporate the geomorphic, water quality and habitat objectives so that the intended functions are self-sustaining.

In understanding the Napa River ecosystem, it is important to realize that the system changes from a freshwater riverine system upstream to an estuarine system downstream. The water chemistry, geomorphic and biological components of riverine and estuarine systems are different. The freshwater riverine system is characterized by a relatively narrow and shallow active channel. The channel size and shape are influenced by flows originating from the Napa watershed. The vegetation, as seen north of the oxbow, is comprised of riparian scrub shrub and forest species such as willows, cottonwood, and an adjacent overstory of valley oak.

In the estuarine reach, the water is saline and the vegetation within the tidal zone is characterized by saline tolerant species such as tule or bulrush. The overhead canopy is relatively open. The geomorphic characteristics of the estuarine reach of the Napa River are complicated by the influence of the tides in combination with freshwater river flow from the Napa watershed. The slope of the channel bed is much less within the estuarine reach and under normal river flow conditions the depths are much larger.

The estuarine processes are not simple (Dyer, 1979). The mixing of freshwater and San Francisco/San Pablo Bay water is accomplished by tidal flows which change direction four

Estuarine Circulation

In the Estuary's northern reach, river water and ocean water meet in the mixing zone, where fresher water flows downstream near the surface, and a net current of saltier water flows upstream near the bottom. These currents meet and cancel out in a region at the head of the mixing zone called the null zone. Small particles and organisms are concentrated in the entrapment zone at and just downstream of the null zone.

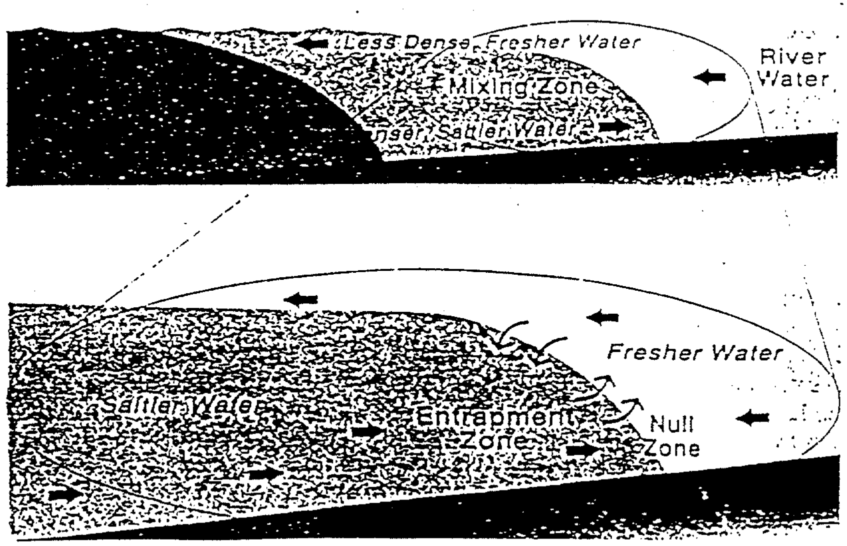

Figure II

change significantly seasonally or yearly. Significant shifts may occur if the water salinity is altered for an extended period, such as during an extended drought.

The environmental objectives for the Napa River system have been appropriately tailored for the different reaches, riverine and estuarine, to reflect the differences between these systems. The following discussion presents the environmental objectives which we have developed for geomorphology, water quality and habitat.

I. GEOMORPHIC OBJECTIVES

"Rivers are ecological systems with many interacting variables. Interrelated river system variables include: the size of the watershed; the amount of sediment; the size of the sediment transported in the river channel; the channel shape, size, slope, and roughness (trees, bushes, rocks, stream bed forms, stream bank surface, floodplain obstructions, channel bends, etc.); and amount and frequencies of flow discharges. A stream in equilibrium is a stream in which these variables are in balance with each other. Such a stream is sometimes described as being graded. A condition of equilibrium does not represent a steady state condition at any one particular stream flow because the variables change among stream reaches and over time. The dynamic equilibrium of a channel represents the average condition of a river during its relatively recent history.

Under conditions of dynamic equilibrium, the stream's energy is such that the sediment loads entering a stream reach are equal to those leaving it. Over the long-term evolution of a river, it will attempt to evolve to transport the sediment delivered to it with the available run-off. A graded stream refers to one in which over a period of years, slope and channel characteristics are delicately adjusted to provide, with available discharge, just the velocity required for the transportation of the sediment load supplied from the drainage basin. If we consider a long geologic time scale, the evolution of a stream is governed by the geology and climate influencing the region. Viewed against a shorter time scale, in days, weeks or months, streams seldom achieve a steady state because of the continuous small and large changes in water, sediment discharges, changes in vegetation, stream bed forms, and other factors.

Conventional engineering practices often have had the objectives of stabilizing streams and conveying flood flows. The channel width, depth, slope, and meander are engineered so as to prevent or minimize changes to these dimensions. This is done to make the waterway more predictable, erode less, and convey more flood discharges at lower stages. Streams and rivers are, however, dynamic systems which are adjusting to natural or human imposed changes in watersheds" (Riley, 1996).

Efforts to confine, widen or deepen a river often fail and result in unwanted side effects such as increased sediment deposition, increased scour (bed erosion) and loss of vegetation (see section I.D).

A successful flood management plan for the Napa River will be based on geomorphic principles involving river channel geometry and sediment transport dynamics, and will take into account the differences between estuarine and riverine reaches. Any alterations of river channel river depth include: land use changes that increase sediment delivery to the stream (causing aggradation), and dredging. The river can be shortened by straightening or by creating a bypass.

Rivers tend to meander and generally are sinuous rather than straight (certain reaches of a river may be straight for short distances). The wavelength of the meander and the rate of meandering across the floodplain are different in riverine versus estuarine systems. In the Napa River system, it is important to distinguish between the estuarine reaches and the riverine reaches in determining the geomorphic components of a stable system.

OBJECTIVES

1. **Maintain or restore the River to a state of geomorphic equilibrium.**

2. **Maintain the natural slope of the River. The slope of the River should not be altered significantly by dredging or straightening.**

3. **Maintain the natural width of the River.**

4. **Maintain the natural width/depth ratio of the River.**

5. **To the maximum degree possible, maintain or restore the connection of the River to its floodplain. This should be of sufficient width to accommodate river meandering caused by naturally occurring flows.**

6. **Provide sufficient setbacks to allow natural meandering processes.**

7. **Maintain channel features such as mudflats, shallows, a naturally uneven bottom configuration, and sandbars.**

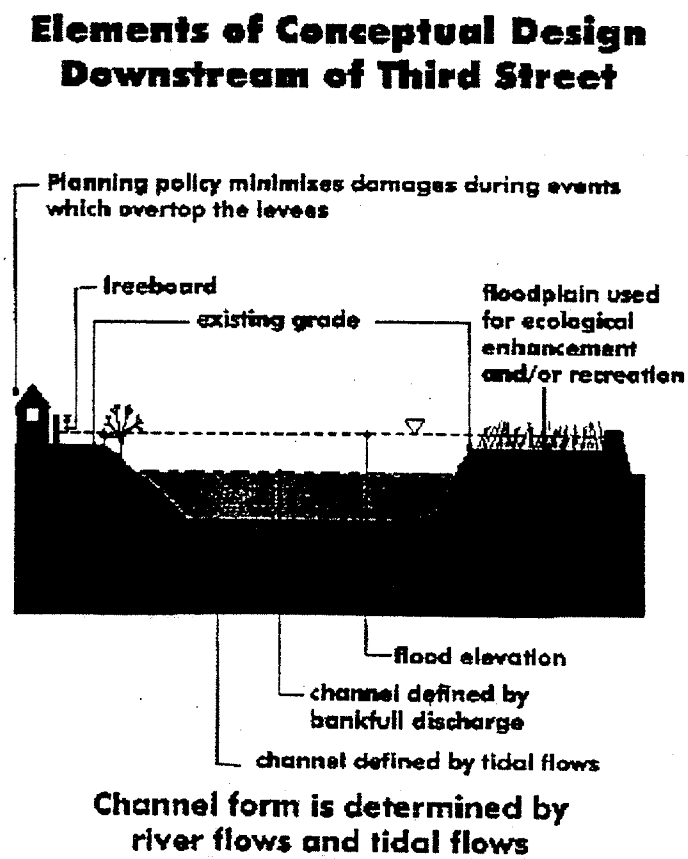

Figure III

and the loss of highly productive macroinvertebrate habitat (riffles). It can also lead to an increase in the nutrient load (phosphates are often bound to soil particles) which may result in algal blooms. Algal blooms often lead to a process called eutrophication which results in depleted dissolved oxygen levels (see section II.A & F).

Based on the above discussion, it can be seen that it is preferable to implement a flood management plan that will not accelerate river bed/bank degradation or increased aggradation. To the extent possible the plan should be designed to re-create a stable system in equilibrium.

OBJECTIVES

8. Restore the River to a state of sediment transport equilibrium as follows:

Upstream of Trancas (riverine):

- **The amount of sediment entering and leaving the system should be equal.**
- **Restore the natural relationship between the floodplain, riparian edge and River.**

Downstream of Trancas (estuarine):

- **Re-establish natural deposition rates .**

This will require adequate flow and channel geometry providing appropriate velocity, slope, width, and depth to transport the sediment load. The project should not increase the sediment load or alter the settling capacities of the sediment such that there is an increase in sediment deposition South of Third Street.

9. Quantify the overall sediment load to the system. Long-term watershed management measures should be determined to reduce the sediment load to the system to re-establish equilibrium.

10. Design a project that re-establishes a system in equilibrium and decreases upstream erosion rates, rather than relying on maintenance dredging to maintain the channel capacity.

11. Design a project that minimizes the need for erosion control measures such as rock rip-rap or other hard structures/materials.

E. FLOW AND VELOCITY

The flow velocity is proportional to the scouring ability of the river at flood flows. In a natural flood, some vegetation will be scoured and lost and some will survive. This natural process habitat objectives will also be met. For instance, if the River is allowed to take its natural form; meandering, creating point bars and shallows, etc., the desired wetland vegetation will naturally colonize these areas. The vegetation will stabilize the banks, reducing erosion and improving water quality.

The workgroup identified water quality objectives for dissolved oxygen, salinity, temperature, turbidity, toxicity, and nutrients. The most important objectives include: 1) to maintain/enhance dissolved oxygen levels and salinity gradients; and 2) to maintain/reduce turbidity and erosion. A flood management plan which involves minimal dredging and is based on geomorphic equilibrium principles, should satisfy these objectives.

A. DISSOLVED OXYGEN

The term "dissolved oxygen concentration" refers to the amount of oxygen in the water column. Dissolved oxygen (DO) is important because aquatic organisms need oxygen to survive and grow. If there is not enough oxygen in the water, fish populations will be affected by:

1. Increased mortality of adults and juveniles;
2. Reduction in growth;
3. Lower survival rates of eggs and larvae; and
4. Changes in species composition.

For example, some species require high DO (e.g., trout and stoneflies) whereas other species thrive in lower levels (e.g., catfish, worms and dragonflies). A decrease in the dissolved oxygen supply may not lead to the death of fish, but rather cause a shift in species composition, for example from steelhead to carp.

Examples of agents that alter dissolved oxygen levels include:

1. Low flows (may result in increased water temperature and poor circulation);
2. Water temperatures (higher Temp. = lower DO);
3. Nutrients contained in resuspended sediments (see section II.F);
4. Suspended sediment (increased sediment = decreased DO, particularly when sediment is anoxic);
5. Organic pollutants;
6. Sulfides (released during dredging of anoxic sediments); and 8) algal blooms (section II.F).

QUANTITATIVE OBJECTIVES

17. Tidally Influenced Waters (South of Trancas)
Minimum at all times: 5.0 mg/L

18. Cold Water Fishery (North of Trancas)

winter (normal rainfall) the heavier, saline water sinks to the river bottom and lighter, freshwater flows on top. This creates a cyclical circulation pattern (see Figure II).

The size of the zone of entrapment has a large impact on the aquatic life that the River can support. The smaller the zone, the fewer species can survive. The majority of species require a gradual shift in salinity concentration (a mild salinity gradient). Very few species can tolerate a rapid change in water salinity. Additionally, nutrients are concentrated in this zone. As a result, the entrapment zone is the area of maximum productivity for algae and macroinvertebrates. Thus, the larger the zone, the more food is available over a larger range. The abundance of food affects the size of the fish population which the River can support.

QUALITATIVE OBJECTIVES:

27. Water quality factors should not increase the total dissolved solids or salinity so as to adversely affect the location of the entrapment zone, or beneficial uses of the River, particularly fish migration and estuarine habitat.

28. The project should not have any the following effects on salinity (seasonally or in worst case conditions such as summer low-flow or droughts):

1. **Compress or alter the location of the null/entrapment zone;**
2. **Steepen the salinity gradient;**
3. **Alter the average salinity concentrations (seasonal); or**
4. **Alter the location of the seasonally varying upstream extent of salinity.**

C. TEMPERATURE

Temperature is one of the most important water quality parameters because it affects water chemistry and functions required by aquatic organisms. Water temperature influences:

1. The amount of oxygen that can be dissolved in water (as temp. increases, dissolved oxygen levels decrease);
2. The rate of photosynthesis by algae and other aquatic plants (as temp increases, photosynthesis increases) ;
3. The metabolic rates of organisms (as temp. increases the metabolic rates increase); and
4. The sensitivity of organisms to toxic wastes, parasites and diseases.

In general, in the Napa River system, lower water temperatures are better than higher temperatures because of the presence of steelhead/rainbow trout, which require relatively low temperatures (optimum = 10.0 degrees C or 50 degrees F) and high dissolved oxygen levels. The presence of steelhead/trout in the tributaries and upper River, signify that conditions are sufficient to support survival of these fish. However, the limited temperature data available suggests that the summer temperatures are higher than the optimum. During the summer

33. **Increases from normal background light penetration or turbidity should not be greater than 10 % in areas where normal turbidity is greater than 50 NTU.**

34. **The flood control project should not:**
- **Increase sedimentation rates in the lower River (below Trancas),**
- **Increase bank and bed erosion upstream or in the tributaries,**
- **Cause resuspension of sediments from dredging,**
- **Increase algal growth.**

E. TOXICITY

Examples of toxic substances that might be released during the construction phase of the flood control project or during maintenance operations from dredging include diesel fuel, metals (mercury, arsenic, lead, silver, etc.), and pesticides (e.g., DDT). The kinds of activities that can cause the release of these toxic substances include:

1. Disturbance of contaminated sites adjacent to the River which have not been properly cleaned up or stabilized;
2. Resuspension of contaminated sediment through dredging activities; and
3. Discharge of water from dredging dewatering operations (where contaminated sediments are involved).

QUALITATIVE OBJECTIVE:

35. **All waters should be maintained free of toxic substances in concentrations that are lethal to or produce other detrimental responses in aquatic organisms. Detrimental responses include decreased growth rate and decreased reproductive success of resident or indicator species.** ***(See San Francisco Bay Regional Water Quality Control Board, Basin Plan for specific numeric limits).***

F. NUTRIENTS/ALGAL BLOOMS

High levels of nitrates and phosphates may cause excessive plant growth, known as algal blooms. This, in turn, may lead to a condition of degraded water quality through the process of eutrophication. A simplistic diagram of eutrophication is shown below.

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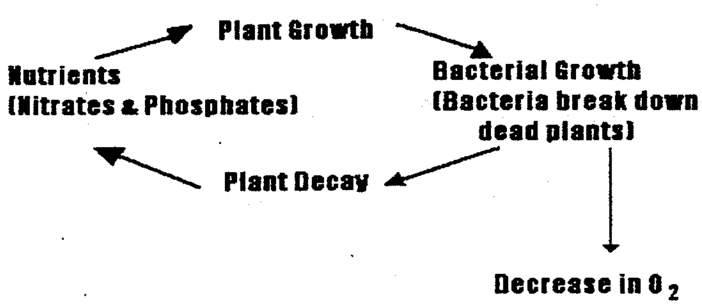


Among other water quality problems, eutrophication usually results in low dissolved oxygen levels and increased turbidity.

OBJECTIVE

36. **The project should not result in the release or discharge of nitrates and phosphates in concentrations that promote aquatic growths to the extent that such growths cause a nuisance or adversely affect beneficial uses.**

37. **A recommended maximum level for nitrate is 0.3 mg/L.**

38. **The project should not result in a wide, shallow low-flow channel (this would result in increased water temp., causing increased plant growth).**

food. In the case of terrestrial wildlife, the lack of a linear continuum prevents movement along the River.

OBJECTIVE:

41. From saltwater to freshwater, the vegetation should exist in a linear uninterrupted continuum. This continuum should have the successional variation, diversity and structure to provide cover and habitat for a natural variety of aquatic and terrestrial life.

B. AQUATIC SPECIES HABITAT

B. 1 Migration Barriers

Anadromous fish should have barrier-free access to their spawning and nursery areas. Other fish and aquatic species travel up and down the River corridor in response to food supply, the salinity gradient, etc., and also require unobstructed access to the entire corridor. Barriers to movement and migration can be physical (dams, submerged structures, etc.) or water quality related. Water quality barriers include zones of high temperature, low dissolved oxygen, or sulfides.

Examples of possible project conditions or activities that could produce these types of barriers include:

1. A nick-point[6] moving upstream to a hydraulic control (e.g., a grade control structure or an artificially armored bed);
2. Dredging, which may create zones of warm temperature, low dissolved oxygen, or turbidity that inhibit fish migration or movement; and
3. Levees, which strand fish behind them after flood waters recede.

OBJECTIVE

42. No physical or water quality barriers to migration.

B. 2 Complexity of In-stream Habitat

A healthy river ecosystem requires complexity of in-steam habitat. In-stream habitat complexity is created by a gradation of water depth from bank to bank which forms areas of shallow, moderate and deep water. Complexity is also created from the presence of in-stream structures such as tree roots, logs, boulders and overhanging banks. Vegetation responds to different

[6] This refers to a location where the river is artificially deepened. This deepening causes the river to erode the river bed in an upstream direction. The river bed continues to erode upstream until it encounters something in the river bed (i.e., a cement sill associated with a bridge or grade control structure) which will not erode. At this location the upstream erosion stops, but river bed may scour, thus lowering the downstream elevation relative to the upstream. The change in elevation may be great enough that it impedes fish migration.

adults in the winter (Jan-Mar), outmigration of juveniles (Dec-May), and to provide augmentation for sufficient life sustaining "summer" flows (Jun-Nov, particularly Aug-Sep) (F.Kerr, see appendix B). They should additionally be designed to allow fish migration where applicable and to not trap fish.

OBJECTIVE:

44. Maintain seasonal flows in the Napa River and its tributaries that permit upstream migration, summer residence, and outmigration of steelhead.

C. WILDLIFE

The Napa River and surrounding areas support a great diversity of bird species, both resident and migratory. These include raptors, wading birds, waterfowl, and shorebirds. Numerous mammals inhabit the area, such as raccoon, muskrat, blacktail dear, jack rabbit, brush rabbit and vagrant shrew. Additionally, the various cover types in the area provide habitat for many amphibians and reptiles (e.g., western pond turtle, western aquatic garter snake, and Pacific tree frog).

Wildlife are dependent on the various habitats for food, cover, burrowing habitat, nesting sites, and access to water. The presence of a linear continuum of vegetation is necessary to allow wildlife movement up and down the River corridor.

In the area south of the Oxbow, mudflats and shallow water areas are used for wintering habitat as well as resting areas during migration by shorebirds. Tidal mudflats are an important feeding habitat for shorebirds (e.g., willets, godwits and sandpipers). Specific species of concern include the black rail, clapper rail, and Mason's lilleopsis.

An evaluation of much of the wildlife habitat south of the Oxbow will reveal that there has been degradation of this resource and tremendous opportunity for enhancement exists. However, it must be noted that even in this degraded state, the Napa river and its surrounding areas are supporting a diverse array of species and play a critical role in the ability of these species to exist in the area.

OBJECTIVES:

45. Restore or maintain riparian and wetland habitat. Re-establish a linear continuum of vegetation and a buffer of sufficient width to protect plants and animals from human disturbance.

46. Maintain mudflats and shallow areas.

47. Restore or maintain a riparian corridor that is predominantly undisturbed by human activity. Minimal disturbance can be achieved by creating a trail system that is not located directly along the River banks in most places.

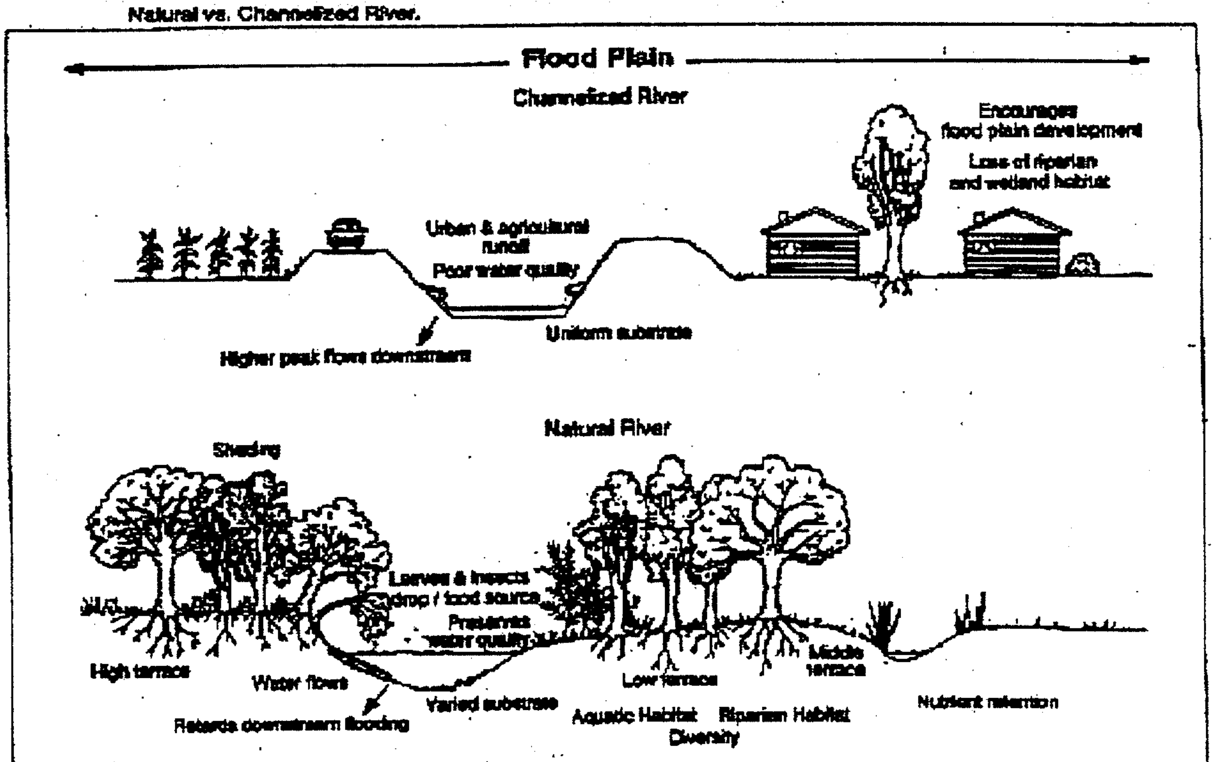
IV. HABITAT OBJECTIVES: NAPA CREEK, ALL TRIBUTARIES WITH STEELHEAD/RAINBOW TROUT, NAPA RIVER *NORTH OF TRANCAS STREET*

Napa Creek should not be altered in any manner that would place the existing steelhead run at risk.

The geomorphic goals and objectives stated in the previous sections apply to these reaches. Additionally, the following more specific objectives apply due to the presence of steelhead, trout, and other cold water fish species.

A. VEGETATION : North of Trancas and on Tributaries

Natural vs. Channelized River.



Adapted from [illegible]

Figure IV

In understanding the Napa River ecosystem, it is important to realize that the system changes from a freshwater riverine system upstream to an estuarine system downstream. The water chemistry, geomorphic and biological components of these systems are different. The freshwater riverine system is characterized by a relatively narrow and shallow active channel which has significantly downcut from the valley floor. The channel size and shape is influenced by flows originating from the Napa watershed. The vegetation , as seen North of the oxbow, is comprised of riparian scrub shrub and forest species such as willows, cottonwood, and an adjacent overstory of valley oak.

OBJECTIVE

47. No physical or water quality barriers to migration.

B.2 COMPLEXITY

The complexity of Napa Creek and other tributary ecosystems is one of its most important characteristics. The channel bottom, in-stream vegetation, riparian vegetation, submerged structures such as logs and boulders, and overhanging banks create habitat for all lifestages of aquatic species.

OBJECTIVES

48. **The project should provide for a gradation of depth from bank to bank.**

49. **Maintain existing riffle:run:pool ratios in the upstream areas, and try to replicate this in the downstream areas. Maintain a low flow channel and gravel bars.**

50. **Maintain geomorphic features (e.g., meanders) that foster continued development of varying water depths, pools, etc. (See Figure V).**

Characteristic Channel Morphology for a Meandering Reach

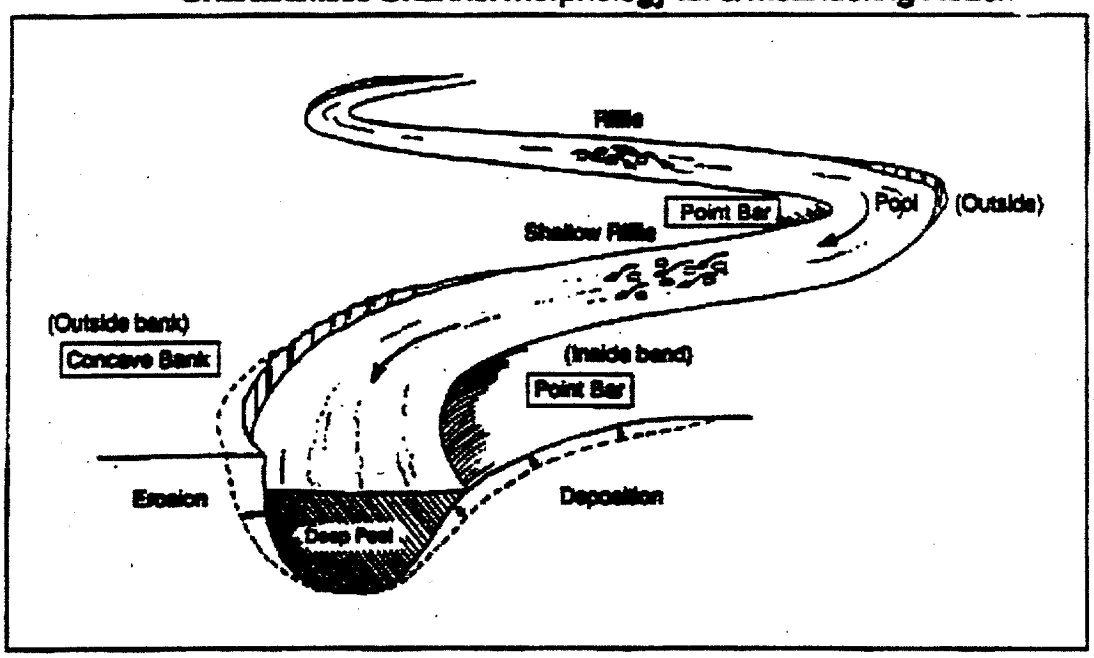


Figure V

51. **Provide for sufficient cover for various fish life stages, particularly nursery habitat for steelhead and contiguous bank escape cover for outmigrating steelhead smolts (wooden snags, rootwads, large rocks and submerged vegetation).**

QUANTITATIVE OBJECTIVES

61. **Ensure conditions that create clean, well rounded gravels for spawning.**

62. **Embeddedness[7] less than 25%.**

[7] the degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment. Usually measured in classes according to percentage of coverage of larger particles by fine sediments.

APPENDIX A

The Napa Valley is a mosaic of grassland, woodlands, vineyards, and other cultivated agricultural crops. The majority of the valley bottomlands are dedicated to the production of wine grapes. A number of vernal pools still dot the grasslands on the valley floor and hillsides in the southern portion of the drainage. The hills in the upper Napa Watershed support a foothill-woodland community dominated by oak, Douglas fir, and digger pines. Chaparral dominates mountain slopes on the eastern side of the valley, while a large portion of the western valley consists of fir/hardwood forest (CRWQCB, 1992).

A dense canopy of riparian habitat dominated by cottonwoods and willows historically lined the Napa River along most of its upper reaches. Today the majority of the gallery forest bordering the riparian zone is gone, and most of the vegetation is restricted to near the channel. A large portion of this area is farmed right up to the very edge of the river (CRWQCB, 1992). Near downtown Napa, streamside vegetation consists of riparian scrub and herbaceous vegetation with small patches of brackish marsh (CRWQCB, 1992). Throughout downtown Napa, riprap and concrete rubble are vegetated with herbs and shrubs (CRWQCB, 1992). Farther downstream, oak and mixed woodlands line the banks, while diked pasturelands and tidal marsh flank the river to its mouth at San Pablo Bay (CRWQCB, 1992).

Riparian Vegetation Within the City of Napa:
The following description of vegetation along the Napa River between Trancas Street and Kennedy Park has been adapted from the USFWS Coordination Act Report (1993). A list of flora expected along the Napa River within the City of Napa is presented in Table 1.

The Napa River from Trancas Street to Lincoln Avenue and Napa Creek provides freshwater stream habitat, including a narrow but dense corridor of mature riparian forest and scrub-scrub habitat. Native riparian tree species include cottonwood (Populus spp.),black walnut (Juglans hindsii), black locust (Robinia pseudoacacia), valley oak (Quercus lobata), and California buckeye (Aesculus californica) and high marsh (at or above MHHW). The low marsh is dominated by California bulrush (Scirpus californicus); the middle marsh is a mixture of cattails and bulrushes; and the high marsh is a variety of halophytes, including saltgrass and baltic rush. Native shrubs and vines include sandbar willow (Salix hindsiana), arroyo willow (Salix lasiolepis), elderberry (Sambucus sp.), poison oak (Rhus diversiloba), wild rose (Rosa californica), and blackberry (Rubus ursinus). Nonnative tree and shrub species include eucalyptus (Eucalyptus spp) and acacia (Acacia spp.). Nonnative vegetation provides cover for wildlife and perching and roosting sites for birds, but is of minimal forage value to native wildlife species.

The riparian vegetation along the Napa River from Trancas Street to Lincoln Avenue and along Napa Creek provides important forest habitat components, such as snags and debris, dense cover, and high botanical diversity. Shaded riverine aquatic cover, also known as SRA, is an important component of this habitat along the upper Napa River. SRA cover is defined as the nearshore aquatic area at the interface between a river and adjacent woody riparian habitat.

TABLE 1: Flora Expected Along Napa River Within City of Napa *(Compiled from: COE, 1975; USFWS, 1993)*

Acacia
Box elder
Yarrow
California buckeye
Anise
Dutchman's pipe
Mugwort
Slender wild oat
Coyote bush
Mule fat
Mustard
Yellow star thistle
Chicory
Bindweed
Bermuda grass
Jimson weed
Salt grass
Eucalyptus
Fig
Gum plant
Foxtail
Black walnut
Baltic rush
Prickly lettuce
Mallow
Horehound
Salt cedar
Bristly oxtongue
Plantain
Fremont cottonwood
Valley oak
Coast live oak
Wild radish
Poison oak
Black locust
Wild rose
Blackberry
Curly dock
Pickleweed
Weeping willow
Sandbar willow
Arroyo willow
Sage
Elderberry
Common tule
California bulrush
Olney bulrush
Alkali bulrush
Milk thistle
Cord grass
California bulrush
Olney bulrush
Alkali bulrush
Milk thistle
Cord grass
Common snowberry
Cattail
American elm
California bay
Wild grape
Spiny clotbur

APPENDIX B

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preservation and enhancement of fish, wildlife and other aquatic resources or preserves. [California Water Code Sec. 13050(f)].

Benthos: The whole assemblage of plants or animals living on the bottom of a water body: distinguished from plankton.

Best Management Practices (BMP): Techniques in various land use activities to mitigate or prevent harm to or inhibition of natural attributes or processes.

Biological diversity ("biodiversity"): The variation in living things in a particular area or region, at the level of genes, species, communities, ecosystems or landscapes.

Biological Oxygen Demand (BOD): The amount of molecular oxygen taken up by microbial decomposition of organic matter.

Biota: The animals, plants, and microbes that live in a particular location or region.

Buffer strip: A strip of undisturbed land and vegetation on each side of a stream left to protect it from the effects of adjacent land use or development.

Bypass: A channel built to divert water from a primary channel (main river).

Channelization: The straightening and smoothing of river channels, primarily for flood control, often accompanied by paving or armoring.

Community: The assemblage of organisms living in a particular environment or geographic location.

Confined reaches: Stream or river segments which have relatively constrained, well-defined channels, with narrow flood plains.

Conventional pollutant: Conventional pollutants as specified under the federal Clean Water Act are total suspended solids, fecal coliform bacteria, biochemical oxygen demand, pH, and oil and grease. Today a large number of nonconventional and toxic pollutants are of concern in addition to conventional pollutants.

Conveyance: Flow capacity of a channel (degree to which discharge is dependent on cross-section properties and friction).

Corridor: That part of the floodplain or land either side of the river extending from bankfull banktop to 50-meter width.

Cultural eutrophication: Nutrient enrichment, rampant algal growth and subsequent oxygen depletion in a body of water caused or accelerated by human activities.

Degradation: A lowering of the elevation of streambeds and flood plains by erosional removal of alluvium; may be caused when upstream sources of sediment are blocked as by dams or by

Fluvial: Pertaining to, or produced by, stream action.

Fluvio-geomorphology: Study of the physical nature of the earth's surface as affected by rivers.

Geomorphology: The study of earth surface features and their formation.

Habitat: The particular living place which provides an environment suitable for survival of an organism, a species or a community.

Historic flows: The actual flows recorded during a specific period of time in the past.

Hydrology: The science of water in nature: its properties, distribution and behavior.

Incision: Extensive degradation or down-cutting of a stream or river bed.

Indicator (species): A plant or animal species sensitive to one or more environmental factors, the presence of which indicates a particular environmental condition.

Intermittent: Streams or rivers which flow only part of a year.

Intertidal area: The area between high and low tide levels. The alternate wetting and drying of this area makes it a transition between land and water and creates special environmental conditions.

Levees: A raised bank along a river or riverine floodplain.

Low flow channel: The river channel containing the lowest or the residual flow, reached in any given year; also called the wetted channel.

Marsh: A wetland where the dominant vegetation is non-woody plants such as grasses and sedges, as opposed to a swamp where the dominant vegetation is woody plants like trees.

Meander: Broad, looping bend in a stream channel.

Morphology: Science of form and structure of, eg a river channel.

Nick point: Abrupt step in the long-profile of a stream channel, often present in a straightened reach which is downcutting.

Nonpoint source pollution: Pollution that enters water from dispersed and uncontrolled sources (such as surface runoff) rather than through pipes. Nonpoint sources (e.g., forest practices, agricultural practices, on-site sewage disposal, and recreational boats) may contribute pathogens, suspended solids, and toxicants. While individual sources may seem insignificant, the cumulative effects of nonpoint source pollution can be significant.

surface water or ground water bodies.

Scour: Localized erosion by flowing water.

Scrub: The collective term for small shrubs and trees.

Sediment: Material suspended in or settling to the bottom of a liquid, such as the sand and mud that make up much of the bottom of San Francisco Bay.

Shaded Riverine Aquatic cover (SRA): The habitat formed at the interface of woody riparian vegetation and water.

Spawning: The deposit of eggs (or roe) by fish and other aquatic life.

Species diversity: The number of species within a community of organisms. Areas of high diversity are characterized by a great variety of species. A biological community with high diversity is better capable of withstanding environmental disturbances. Pollution tends to reduce biological diversity.

Subtidal: Below the ebb and flow of the tide. Used to refer to the marine environment below mean lower low tide.

Suspended load: Clays, silts, and sometimes sand that are held in suspension by turbulence in river water.

Swales: Low, usually damp, areas of land; wetlands.

Total suspended solids (TSS): Particles of all sizes that are suspended in a measured volume of water. TSS reduce light penetration in the water column, can clog the gills of fish and invertebrates, and are often associated with toxic pollutants because organic materials and metals tend to bind to particles.

Turbidity: A measure of the amount of material suspended in the water (i.e., opaqueness or cloudiness of the water). Increasing the turbidity of the water decreases the amount of light that penetrates the water column. Sustained, high levels of turbidity are harmful to aquatic life.

Water column: The water in a lake, estuary, or ocean which extends from the bottom sediments to the water surface. The water column contains dissolved and particulate matter and is the habitat for plankton, fish and marine mammals.

Water quality: A term to describe the chemical, physical and biological characteristics of water, usually with regard to its suitability for a particular purpose.

Watershed: The geographic region within which water drains into a particular river, stream, or body of water. A watershed includes hills, bottom land, and the body of water into which the land drains. Watershed boundaries are defined by the ridges of separating watersheds. The Bay/Delta estuary's watersheds include those of the estuary basin and the Central Valley.

4-17-96 DRAFT
F. Kerr, AICP, CE
(not a biologist)
At this stage, based primarily on FK's experience, knowledge and beliefs. Subject to further review by CA. F.& G., etc., etc.

3/4 - 96/cc: L. Ferguson
J. Swanson; Geo. Carl
Woody Trihey; Larry Week

Napa River Flood Mgmt Program/DRF Committee
"WATER QUALITY/FISH HABITAT" WORK GROUP

"MINIMUM IN-STREAM FLOWS" [1]
(Napa River/Tributaries)

I. Primary GOALS [2]

A. Maintain seasonal flows in the Napa River and its tributaries that will preserve and enhance (in some cases restore) an appropriate quantity and quality of flowing surface (and below surface) waters to (primarily) provide:

1) Habitat for steelhead trout (and salmon[a]) normal* migration and spawning cycle, freshwater phase; and for other concomitant aquatic and riparian life.[3]

2) Freshwater 'offsets' (partial) to possible decrease in water quality/increase in salt content of estuary waters, due to the proposed flood control project.

3) Enhanced water quality.

4) Enhanced human recreational activities.

B. Historic records indicate that:

1) Current flows in the winter months are sufficient to attract migrating steelhead (and salmon[4]) and to help maintain a natural 'varying flow' living River.

2) Current flows in the spring months are (normally) sufficient for 'out-migrating', typically one to three year old juvenile steelhead trout (also young salmon).

3) Current flows during late summer/fall are often so low they limit the survival of immature steelhead in the River system.

4) Although it could and should be improved, the quality of the waters currently supports steelhead, (salmon) and a wide variety of other fish and aquatic life.

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1 Refer to "ISSUES STATEMENT", 2-19-96 DRAFT, (F. Kerr).

2 Refer also to general ("qualitative") statement presented by the "Friends of the Napa River" to the DRF Comm. organizing comm., 2/2/96 (file).

3 The California Freshwater Shrimp may also be of special consideration.

4 In average years, also 'fall run' salmon, e.g., fall of 1995, believed to be 'stray' chinook.

* "Napa Steelhead's" hatchery plantings are considered an *interim* solution not native, steelhead trout normalization per se.

a (Ideally 'once native' *coho* salmon, perhaps *chinook*).