Data Assessment and Model Input Values

The data available for characterizing the outfall and channel geometry, and effluent and receiving water quality are presented in this section. Based on the values and information presented in this section, CORMIX input values are given in **Table 1** and **Table 2**.

Table 1. CORMIX input values applied to all scenarios. Scenario values are in a separate table, as noted in column "Value".

Term	Value	Units	Notes
Effluent Data			
Pollutant Type	Conservative		
Pollutant Concentration	100	mg/L	Level above background, use 100 to represent %
Flow Rate	{see Table 2}	mgd	10 scenarios
Temperature	18.9	°C	Avg during months of discharge, 2007-2009
Ambient (River) Parameters			
Bounded?	Yes		
Width	{see Table 2}	ft	Assume independent of flow scenario
Appearance	Uniform		Channel is essentially straight in near-field downstream of constriction by outfall
Average Depth	{see Table 2}	ft	Depends on flow scenario and period
Depth at Discharge	{=Avg. Depth}	ft	Uniform within outfall zone: same as avg depth
Wind Speed	0	m/s	Conservatively assume zero
Manning's n	0.035	--	Clean and straight natural rivers; high end of range for pools
Flow Rate	{see Table 2}		Depends on scenario and period
Stratification Type	Uniform	--	
Fresh or Non-fresh water	Freshwater	--	
Temperature	15.0	°C	Average 2007-2008 data
Discharge Geometry Data			
Submodel	CORMIX3	--	Buoyant surface discharge
Nearest Bank	Right	--	Looking downstream
Horizontal Angle	80	deg	Discharging essentially perpendicular to river
Bottom Slope	45	deg	Very steep bank
Depth at Discharge	{=Average Depth}	ft	Uniform within outfall zone: same as avg depth
Discharge Channel Width	2	ft	Bulk of outfall culvert
Discharge Channel Depth	{see Table 2}	ft	Deepens for higher flows
Configuration	Flush	--	Cascades over rocks on bank

Table 2. Scenario-specific CORMIX input values.

Applicable Objectives	Future Critical Flow Rates (MGD) Basis	Effluent	River[1]	Other CORMIX Input Values River Depth (ft)	River Width (ft)	Discharge Depth (ft)
Acute	Maximum daily average	1.9	75	3.8	40.9	0.4
	Minimum daily average	0.26	10	1.4	39.4	0.1
Chronic	Maximum four-day average	1.6	63	3.5	40.7	0.3
	Minimum four-day average	0.29	12	1.5	39.4	0.1
Human Health	Long-term average	0.54	22	2.0	39.8	0.2

[1] Calculated at 40:1 dilution from effluent flow rate.

CHANNEL GEOMETRY

As noted above, CORMIX requires that a uniform, rectangular channel describe the actual channel cross-section. Licensed surveyors measured the Napa River channel's geometry in November 2009. The results of that survey are presented in **Appendix A**. As seen in the appended topographic map, the near-field reach (~300 feet upstream and downstream) is relatively straight and trapezoidal in cross-section.

The channel is narrowed by riprap on both banks from approximately 40 feet wide to approximately 30 feet wide around the outfall. This hourglass constriction has scoured the channel deeper than elsewhere. Cross sectional profiles at the outfall and at three points downstream are shown in **Figure 6**. The narrow constriction is evident in section "0"; the change in depth is evident in the higher bottom elevation in section "207". The channel bottom is sandy and contoured in the first 100 feet downstream, transitioning to larger gravel and relatively flat farther downstream. The channel banks and bottom fringes are heavily vegetated with riprap, brush and large trees. Within the mixing zone study reach, the overall channel is essentially straight downstream of the constriction by the outfall.

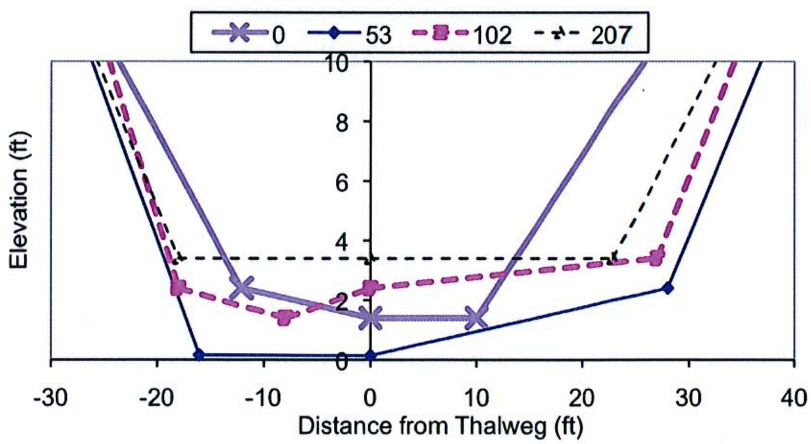

Figure 6. Selected cross sections at the outfall ("0") and three distanced downstream (53, 102 and 207 feet). Elevation is relative to the lowest point in the riverbed (along the "thalweg"), found at approximately 35 feet downstream from the outfall.

The channel's longitudinal slope is extremely variable, ranging from over four feet deep on the downstream side of the outfall to dry (flowing only through the underlying gravel bed) at distant reaches upstream and downstream. Assuming the channel's width, depth, Manning's *n* and representative slope (*S*), flow rate (*Q*) under uniform, steady-state conditions can be calculated from Manning's equation:

$$Q\ (cfs) = 1.49/n * A * R^{2/3} * S^{1/2}$$

where *A* is the cross-sectional area and *R* is the hydraulic radius (cross-sectional area divided by wetted perimeter). Channel slope is estimated from survey measurements over the 1,225-feet reach surveyed. Water depth (*d*) was calculated from the power curve that provided the best overall fit (sum of squared error terms = 0) between the simulation flow rates and flow rates estimated by Manning's equation. Width at each depth was estimated from a trapezoidal representation of the channel cross-section assuming 40-ft width at 2-ft depth. The representative widths and depths produced by these estimates are given in **Table 3**. "Q Est." refers to the flow rate estimated from Manning's equation based on each row's values. The values tabulated approximate channel conditions throughout the range of simulated flow rates under uniform flow in a prismatic channel. The depths tabulated here are increased by 20% for model input, to account for the deeper water in the near-field.

Table 3. River geometric values for normal flow at simulated flow rates, based on Manning's equation.

Scenario	River Flow Rate (MGD)	River Flow Rate (cfs)	n	w (ft)	Slope	d (ft)	Q Est. (cfs)
Maximum daily average	75	117	0.035	40.9	1.0E-04	3.14	107
Minimum daily average	10	16		39.4		1.16	21
Maximum four-day average	63	98		40.7		2.88	92
Minimum four-day average	12	18		39.4		1.23	23
Long-term average	22	33		39.8		1.68	38

OUTFALL CONFIGURATION AND DISCHARGE CONDITIONS

During lower river flows, effluent falls onto a sandy bottom before reaching the river water. For simulation, the outfall is represented as a 3-ft wide surface discharge with a depth varying from 0.1 to 0.4 feet depending on the scenario. For minimum and long-term average flow rates, the effluent's depth at the discharge point is back-calculated assuming a discharge velocity of 2 ft/s; for maximum flow rates, 4 ft/s. The depth at minimum flows was calibrated from tracer study measurements.

FLOW RATE DATA

Plant staff measure effluent flow rate continuously. The US Geological Survey measures and reports river flow rate upstream in St. Helena and downstream above the City of Napa (see gages identified in Figure 1 above). Yountville's current permit calculates available dilution as 27% of the flow rate at the St. Helena gage plus 73% of the flow rate at the Napa gage. The new permit will be based exclusively on the downstream Napa gage. For consistency, only the Napa gage's data are used in this analysis. Daily average flow rates for both Yountville effluent and the Napa

River at Napa gage for water years 2006-2008 are presented in **Figure 7** for effluent discharge periods only.

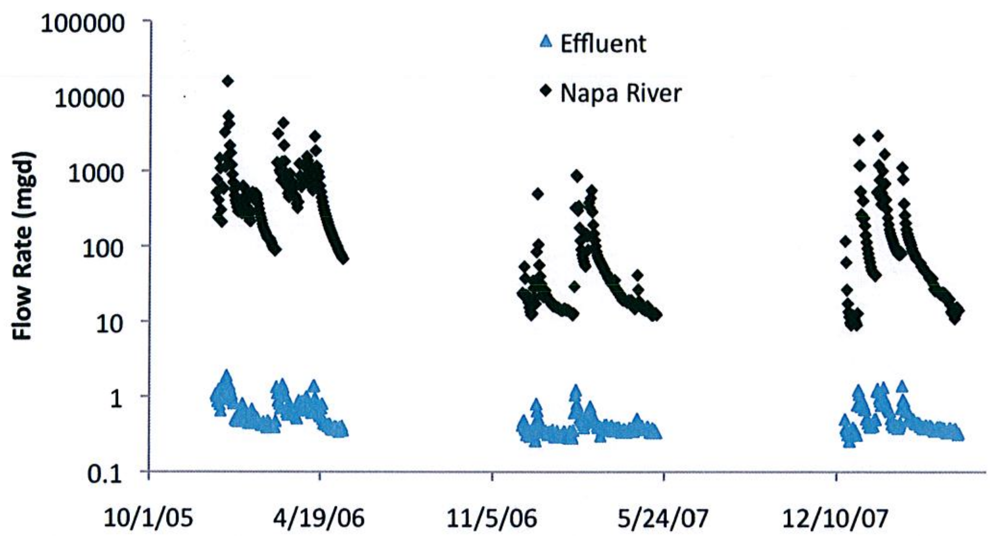

Figure 7. Daily flow rates for the Yountville WWRF's discharges to the Napa River and for the Napa River at Napa gage, for effluent discharge days in water years 2006-2008.

To represent critical discharge conditions, Yountville has simulated a range of <u>effluent</u> flow rates bound by those specified in the SIP (i.e., maximum daily average for acute criteria, continuous four-day average for chronic criteria, and long-term mean for human health criteria) and alternative minima for acute and chronic criteria. The period of record is December 2005 – April 2008, encompassing the three most recent river discharge seasons. Critical <u>receiving water</u> flow rates are 40 times greater for future permit conditions. The representative flow rates are shown in Table 2 above.

The future dilution values simulated are put into context with actual river-to-effluent flow ratios over the past three discharge seasons in **Figure 8**. The scale of this plot encompasses 96% of the data. The actual river-to-effluent flow ratio exceeded 100:1 over 62% of days, and has been as high as 8259:1.

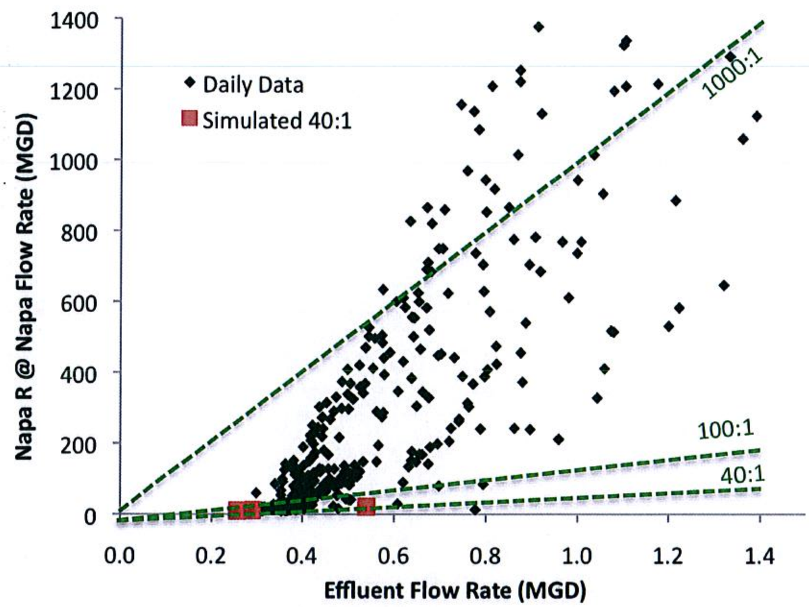

Figure 8. Daily mean effluent and river flow rate pairs on discharge days in water years 2006-2008 indicating 1000:1, 100:1 and 40:1 river-to-effluent flow ratios.

WATER QUALITY DATA

Water in the Napa River upstream of the Yountville WWRF comes from groundwater seepage, surface rainfall runoff, agricultural runoff, and municipal wastewater from the City's of Calistoga and St. Helena. The Napa River Collaborative Monitoring Program measures water temperature of the Napa River annually for the Cities of Calistoga and St. Helena and Town of Yountville in compliance with their NPDES permits. Monitoring is conducted during the discharge period at two locations: upstream of the Calistoga outfalls and downstream of the Yountville outfall. The average river water temperature measured downstream of Outfall E-1 during the discharge seasons in years 2007 and 2008, 15 °C, is input to CORMIX to estimate ambient density. The shallow, turbulent river is assumed to be fully-mixed vertically (i.e., not stratified).

Yountville monitors effluent water quality for the pollutants of concern at variable frequencies ranging from daily for temperature to annually for trace organics. Reasonable potential to cause or contribute to exceedance of a water quality objective was identified for five pollutants with no dilution credit: copper, cyanide, dichlorobromomethane, zinc, and total ammonia. California Toxics Rule (CTR) criteria applicable to the river include freshwater acute and chronic aquatic life criteria, and human health criteria (water and organism consumption). Default USEPA conversion factors were used to translate CTR criteria expressed as dissolved metals to criteria expressed as total metals; site-specific metals translators for Yountville WWRF effluent have not been developed.

Applicable water quality objectives for the five pollutants are given in **Table 4**, which also notes the dilution credit that is related to compliance with each objective. The highest dilution credit (D=12) is needed for ammonia acute criteria.

Table 4. Yountville WWRF Applicable Water Quality Objectives for Study Pollutants. Dilution Credits Related to Compliance are Shown in Parentheses.

Constituent	Aquatic Life Criteria[1]		Human Health Criteria[1]
	Acute[2]	Chronic[2]	Water & Organisms[3]
Copper, total[4]	15 (6)	9.8 (7)	1300
Zinc, total[4]	126 (5)	126 (5)	--
Cyanide	22 (2)	5.2 (5)	700
Dichlorobromomethane	--	--	0.56 (6)
Ammonia	1.93 (12)	1.17 (7)	--

[1] All units are ug/L for total recoverable concentrations.
[2] Freshwater objectives apply. Acute are 1-hour; chronic are 4-day.
[3] The receiving water is designated as having a MUN beneficial use; therefore, the Human Health criteria are for water and organism consumption.
[4] Receiving water hardness is 106 mg/L as $CaCO_3$ for converting dissolved criteria to total recoverable objectives.
Default conversion factors used.

AQUATIC LIFE

Yountville has been discharging treated municipal wastewater for 70 years with no record of adverse impacts. Nonetheless, staff members at the California Department of Fish Game (CDFG) and Napa County Resources Conservation District (Napa RCD) were contacted to obtain input on aquatic life concerns.[3] Informal comments aided in the production of this report, but do not constitute formal consent or approval of this report or its findings.

Aquatic species of concern in the Napa River are those listed under federal or State endangered species laws for which potential habitat exists in the proposed regulatory mixing zone. According to the California Natural Diversity Database[4], steelhead (*Oncorhynchus mykiss irideus*), which spawn in the Napa River during January and February, are federally listed as "threatened" in the Napa River. The western pond turtle (*Actinemys marmorata*) is a "species of special concern" by CDFG. California freshwater shrimp (*Syncaris pacifica*), has been found far upstream in Calistoga but not in the valley floor section.

The spatial scale of interest is the regulatory mixing zone volume. The side bank discharge and lighter effluent density provide a large zone of passage (approximately two-thirds of the channel cross section) along the East bank and along the channel bottom. The regulatory mixing zone length is limited to the first 200 feet downstream, the length of channel corresponding to the abnormally deep pool. The temporal scale of interest is related to the travel time for organisms passing through the mixing zone. Under the worst-case conditions evaluated, the travel time of drifting organisms (e.g., freshwater shrimp) passing through the regulatory mixing zone is less than five minutes. This time scale is much shorter than the one-hour exposure times assumed for setting the criteria. To assess potential effects of effluent on aquatic organisms, the City also conducts acute toxicity tests monthly (on fathead minnows) based on one-hour exposure times. Nine acute toxicity tests were conducted from 2005 through 2008, all of which had 100% survival with 100% effluent.

[3] Personal communications with Tim Stevens (CDFG) and Jonathan Koehler (Napa RCD) by Stephen McCord (LWA), December 2009 – February 2010. Mr. Stevens also visited the outfall reach in early February 2010.

[4] See http://www.dfg.ca.gov/biogeodata/cnddb/.