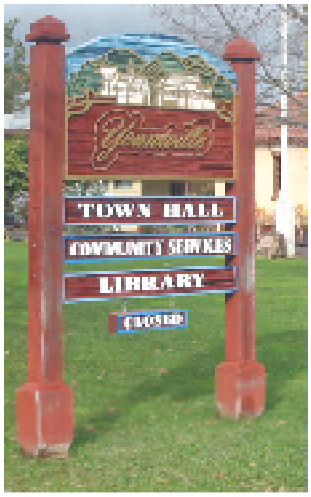
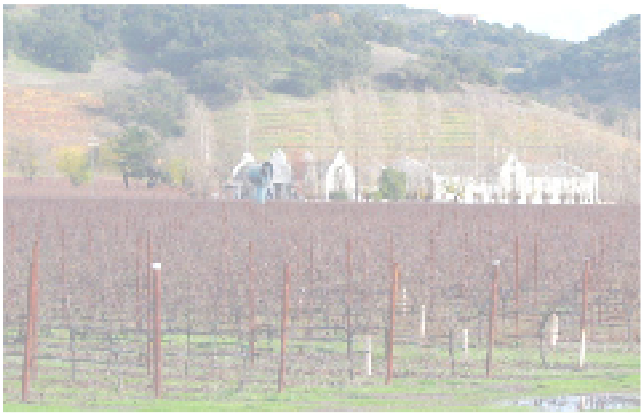



# FEASIBILITY AND PRELIMINARY DESIGN REPORT FOR THE RECYCLED WATER AND EXPANSION PROJECT

**TOWN OF YOUNTVILLE / CALIFORNIA VETERANS HOME**
**Joint Wastewater Treatment Facilities**
**Yountville, California**

**September 2005**



WHITLEY BURCHETT *& Associates*
Walnut Creek · California

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**September 2005**

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# Chapter 1

# Introduction

## BACKGROUND

The Town of Yountville is studying the feasibility of expanding the use of tertiary effluent from the Yountville/California Veterans Home Joint Treatment Plant by existing and potential new recycled water users. The major objectives of the Town are to maximize recycled water usage in the Yountville area and to minimize the discharge of treated effluent to the Napa River. Ultimately, the Town would like to eliminate regular effluent discharges to the river entirely (Zero Discharge).

Current recycled water reuse and disposal practices include a combination of vineyard and golf course irrigation as well as winter discharge to the Napa River. Treated effluent is reused for irrigation at three vineyards located east of the Town along the Silverado Trail as well as the Vintner's Golf Course located on Veterans Home lands adjacent to the Joint Treatment Plant site.

Recently, the owners of several additional vineyards in the area have approached the Town regarding using recycled water for all or part of their irrigation water needs. This Report summarizes an evaluation of the modifications to the existing Joint Treatment Plant facilities and the additional land and storage requirements needed to maximize the use of recycled water in the Town's service area and to minimize or eliminate the discharge of treated effluent to the Napa River.

## CURRENT EFFLUENT DISPOSAL PRACTICES

In 2004, the Yountville/Veterans Home Joint Wastewater Treatment Plant treated a total of 169.4 million gallons (mg) of influent wastewater. This is equivalent to an annual average daily flow of 0.464 mgd. Of the total 169.4 mg, approximately 149.5 mg were either used for irrigation or construction dust control or discharged to the Napa River. The remaining 19.9 mg were lost within the treatment plant proper, probably by evaporation and percolation from the effluent holding pond, used as plant water, and during sludge disposal. In addition, some of the difference may be due to normal limitations in flow meter accuracy.

Of the total 149.5 mg of effluent from the plant, approximately 17.5 percent (26.1 mg) was used to irrigate the Vintner's Golf Course, 33.0 percent (49.3 mg) was used to irrigate three vineyards east of the Town and 49.4 percent (73.8 mg) was discharged to the Napa River. A minor amount (0.2 percent) was used for dust control. The 2004 effluent disposal volumes are summarized in **Table 1-1.** Also included in Table 1-1 are the dates and duration for each disposal method.

**Table 1-1**

**Y/VH Joint Wastewater Treatment Plant**
**Effluent Disposal for 2004**

| Disposal Option | Crop | Area (ac) | Volume (mg) | Duration |
|---|---|---|---|---|
| Irrigation | Vineyards | 390 | 49.3 | April 1 - November 30[a] |
| | Golf Course | 45(56.4)[c] | 26.1 | March 1 - October 31[b] |
| Napa River Discharge | | | 73.8 | October 1 - May 15 |
| Dust Control | | | 0.33 | April 1 - October 31 |
| Total | | | 149.5 | |

a Plus a few days in December, January and March.
b Plus a few days in November.
c Acreage increases to 56.4 ac during fall per agreement

For the three vineyards, effluent is pumped through a 6-inch pipeline where it is discharged to on-site storage ponds and used to drip irrigate approximately 435 acres of vineyard. Approximately 45 acres of the adjacent Vintner's Golf Course is currently being irrigated at

agronomic rates for golf course turf. A total of 56.4 acres are available for irrigation during the critical fall months when natural Napa River flows are too low to permit discharge of significant volumes of treated effluent.

Current (2005) waste discharge requirements applicable to effluent discharged to Napa River or reused for irrigation or frost protection are summarized in **Table 1-2**. All facilities included in the alternatives analysis in this study are needed to satisfy these standards.

**Table 1-2**

**Summary of Current Treated Effluent Requirements**

| Parameter | Discharge to Napa River (Oct. 1 - May 15) Dilution @1:25 | Reuse Effluent for: Vineyard Irrigation | Reuse Effluent for: Golf Course Irrigation | Reuse Effluent for: Frost Protection* | Title 22 Tertiary Requirements |
|---|---|---|---|---|---|
| BOD, mg/L | 30/45/ - [a] | 30/60[b] | 30/60[b] | 10/20[b] | - |
| TSS, mg/L | 30/45/ - [a] | 30/60[b] | 30/60[b] | 15/30[b] | - |
| Oil & Grease, mg/L | 10/20[b] | - | - | 5/10[b] | - |
| Settleable matter, mL/L | 0.1/0.2[b] | - | - | - | - |
| Chlorine residual, mg/L | 0[c] | - | - | 1.0[d] | - |
| Chlorination CT value, mg/L·min | - | - | - | - | 450[i] |
| Coliform bacteria, MPN/100 mL | 23/240[c] | 2.2/23[e] | 2.2/23[e] | 2.2/23/240[f] | 2.2/23/240[f] |
| Turbidity, NTU | - | - | - | 2/5/10[h] | 2/5/10[h] |

* Not currently practiced; included for possible future reuse option

a 1st number = monthly average; 2nd number = 7-day average; 3rd number = daily maximum

b 1st number = monthly average; 2nd number = daily maximum

c Instantaneous maximum

d Minimum after 1 hour

e 1st number = median of 5 consecutive samples; 2nd number = maximum sample

f 1st number = median of 7 days; 2nd number = max. value no more than 1 per month; 3rd number = maximum value

g Daily value not exceeded at least 95% of time during 24-hour period

h 1st number = average value; 2nd number = daily value not exceeded at least 95% of time during 24-hour period; 3rd number = maximum value

i Minimum product of chlorine residual in mg/L times modal contact time in min (minimum modal contact time = 90 min)

# Chapter 2

# Summary of Findings, Conclusions and Recommendations

## FINDINGS

### Joint Treatment Plant Title 22 Upgrades

Several modifications to the existing Joint Treatment Plant facilities are needed to fully comply with the requirements of Title 22 of the California Code of Regulations governing the unrestricted reuse of recycled water. These include at least the following:

- modify the existing Fuzzy Filter to comply with California Department of Health Services (DHS) requirements
- modifications to the existing coagulation chemical feed system and controls
- increase the modal chlorine contact time from the current ±30 minutes to the required 90 minutes
- upgrade the plant alarm system

In addition, it would be desirable to provide a direct connection to the recycled water pumps from the existing bypass around the effluent storage pond to improve the quality of the recycled water delivered to the Town's recycled water customers.

This report evaluates the feasibility and cost of a range of treatment plant upgrade alternatives, including the following:

- Minimum Upgrade: the existing facilities are modified or reused to the maximum extent possible (e.g. modify existing head tank to provide additional chlorine contact time, upgrade existing chemical facilities, install floating baffle walls in the existing effluent storage pond to provide additional contact time). The existing chemical storage and feed equipment is upgraded to provide automatic control of coagulating chemicals. And finally, the Fuzzy Filter is modified as required by the DHS process approval conditions.
- New Chlorine Contact Tank/New Coagulation Chemical Facilities: Provide a new concrete structure to include the needed additional chlorine contact time and an effluent clearwell to house new pumps for filter backwash water. As an alternative, a new bypass pipeline around the effluent storage pond can be oversized to provide the additional detention time. Provide new, permanent chemical storage and feed equipment for coagulating chemicals. Modify Fuzzy Filter as required by DHS approval conditions.
- Combination Upgrade and New Facilities: A combination of the improvements from the above alternatives may provide a more cost-effective way to satisfy Title 22 requirements.

**Effluent Reuse/Disposal Alternatives**

Land for effluent irrigation and storage ponds is expensive, especially in the Napa Valley. In addition, construction of lined storage ponds is relatively expensive. Therefore, the most cost effective recycled water reuse and disposal option will be one that uses recycled water on local agricultural lands and golf course turf and minimizes discharges to the Napa River and recycled water storage requirements.

The purpose of this analysis is to find the optimum combination of storage ponds and irrigated acreage to maximize reuse of recycled water and minimize the discharge of effluent to the Napa River under all critical climatic conditions. Critical climatic conditions include both "wet" and "dry" climatic conditions. Because crop irrigation requirements and the potential for discharge to the Napa River are different under wet and dry climatic conditions, the combination of storage and river discharge generally will be different for each. The optimum solution is the

configuration of effluent reuse and disposal facilities that accommodates both critical climatic conditions and minimizes the total amount of effluent discharged to the Napa River.

The evaluation of alternative effluent reuse and disposal options for the Yountville/Veterans Home Joint Wastewater Treatment Plant was made using a spreadsheet-based water mass balance model and projected 2020 effluent flow rates. The model uses a modification of the method recommended in the California State Water Resources Control Board publication entitled "*Irrigation with Reclaimed Municipal Wastewater, A Guidance Manual*", July 1984. In this method, the recommended irrigation rates are estimated using the evapotranspiration rates of the specific crops being irrigated, in this case, vineyards and golf course turf. Details of the water mass balance model are presented in Chapter 4 and Appendix A.

A series of water mass balance model runs were made to determine the capacity of the existing irrigation and storage facilities under various climatic conditions, assuming Silverado Vineyard will be served with recycled water. Model runs were also made to determine the total storage volume that will be needed to completely serve the existing users and the four additional vineyards that have expressed interest in using recycled water. Finally, model runs were made to determine the storage and irrigated land requirements assuming that all the recycled water is used for irrigation and none is discharged to the Napa River (Zero Discharge Alternative).

### Recycled Water Distribution And Service Requirements

The existing recycled water distribution facilities to serve the current golf course and vineyard customers are adequate and do not require any improvements. Additional distribution and service facilities are needed, however, to serve new users that have expressed interest in using recycled water from the Joint Treatment Plant. The locations of potential new users and the new facilities needed to serve them are shown on Figure 4-7 and are discussed in Chapter 4.

## RECOMMENDED TITLE 22 UPGRADE PROJECTS

A recommended phased upgrade program for the Joint Treatment Plant, effluent reuse/disposal facilities and recycled water distribution and service facilities is presented. It is recommended that the Phase One improvements be designed to provide Title 22 unrestricted use recycled water for the current Peak Dry Weather Flow design capacity of 1.16 mgd. The facilities provided at

this time, however, should be located and designed so that they can be expanded to a Peak Wet Weather design flow of 2.0 mgd in future phases.

**Joint Treatment Plant Projects**

The following Joint Treatment Plant improvements are recommended:

***Fuzzy Filter Modifications.*** The following Fuzzy Filter modifications are needed to satisfy the current DHS requirements:

- Rearrange the filter effluent and backwash piping
- Add an automatic valve on the filtered effluent outlet
- Modify the existing filter control and alarm system
- Provide a connection to the existing filter backwash piping to allow filtered water to be used to backwash the filter
- Add a gravity overflow on the Fuzzy Filter housing connected to the backwash outlet piping

These improvements are shown on Figure 3-1 in Chapter 3.

As an alternative to using filtered water to backwash the filter, it may be possible to negotiate an approval from the DHS to substitute a "filter-to-waste" step in the filter backwash cycle. In this step, the water remaining in the filter after the filter backwash is completed will be wasted to the headworks for a short period of time rather than discharged as filtered effluent.

In addition, it is recommended that the filter backwash flows be diverted from the excess flow pond to the plant headworks to reduce future operation and maintenance costs. With this change, the solids contained in the backwash water will be settled out in the primary sedimentation basin and reprocessed by the treatment plant.

***Plant Alarm System.*** It is recommended that improvements to the plant alarm system be included to provide automatic notification of failure of the following systems:

- Failure of the biological process
- Failure of the coagulation process

Further, all of the alarms must be tied to a single master alarm that will notify the operations staff and/or the police station.

***Effluent Storage Pond Bypass.*** It is recommended that a direct connection to the existing reclaimed water pumps be provided by adding a sluice gate to the inlet to the 15-inch Napa River outfall and constructing an 8-inch suction pipeline between the manhole and the existing pumps. Variable speed drives will be provided to prevent excessive start-stop cycling and possible overheating of the existing effluent pump motors. A new pipe connection between the effluent storage pond and the existing excess flow return pumps will be provided to allow return of excess flows from the effluent storage pond to the headworks.

***Chemical Feed System.*** The Title 22 regulations require that the coagulating chemical feed system be automatically controlled for feed rate and dosage. It is recommended that a new building adjacent to the storage tank and new chemical feed pumps with both speed and dosage controls be provided. The building would be approximately 8 feet by 8 feet of wood frame or prefabricated metal construction.

***Chlorine Contact Basin Expansion.*** It is recommended that the existing head tank be abandoned and a new, expanded concrete contact basin be constructed to supplement the existing chlorine contact basin. The additional contact tank volume to achieve the needed 90 minute modal detention time can be provided by a new concrete basin of approximately 12,250 cubic feet of volume for a design Peak Dry Weather flow of 1.16 mgd. This would consist of 6-8 channels similar to the left-hand four channels shown in Figure 3-3 in Chapter 3. It is further recommended that the additional chlorine contact time required to provide Title 22 Unrestricted Use recycled water for Peak Wet Weather flows, if needed in the future, be provided using floating baffle curtains located at the inlet to the Effluent Storage Pond. The floating baffle curtains are shown on Figure 3-4 in Chapter 3.

### Recycled Water Distribution and Service Projects

Three recycled water distribution and service projects are recommended for implementation at the time the potential recycled water users request service - Robert Mondavi Vineyards, Silverado Vineyards and Hartwell Vineyards.

***Robert Mondavi Vineyards.*** It is recommended that the needed valve and metering station be provided when this user is ready to receive recycled water service from the Town. The user must provide on-site piping and other facilities required to use the recycled water on private property. The agreement between the user and the Town must specify the areas and types of crops to be irrigated, the volume and schedule of recycled water to be used and the working volume of ponds available for the storage of recycled water.

***Silverado Vineyards.*** An existing turnout to the pond serving Silverado's west vineyard, which is not currently being used, will be activated. Two alternative routes are available to connect the Town's recycled water pipeline with the existing Silverado well and on-site irrigation system. The first alternative, S-1, would provide a direct connection of approximately 850 ft between the existing recycled water pipeline and the Silverado well using combination of open cut construction and a pipeline installed by directional drilling under the Napa River. The second route, Alternative S-2, would be located on the east side of the Napa River, so that a river crossing would not be required. This service line would run along a dirt roadway at the base of the hill approximately 1,400 ft and terminate at the Silverado well site. A final decision on the routing of the connection to the Silverado Vineyard should be made after geotechnical investigations of both routes are completed and the extent of rock excavation for Alternative S-2 is known. A positive, physical separation between the reclaimed water line and the existing irrigation well, required by the Title 22 regulations, will consist of a swivel elbow arrangement, together with a reduced pressure backflow preventer on the well discharge pipe.

***Hartwell Vineyards.*** A 2,350 ft extension of the existing distribution pipeline from the Stag's Leap Wine Cellars to the Hartwell Vineyards northward along the west side of Silverado Trail is recommended when this potential user is ready for recycled water service. The same on-site facility and user contract requirements described previously should be applied to this user.

## ESTIMATED COSTS OF RECOMMENDED PROJECTS

The estimated costs of the recommended Title 22 modifications are presented in Chapter 5. The cost estimates assume that the work will be accomplished during 2006. If the projects are delayed beyond 2006, the estimated costs need to be adjusted for general inflation in construction costs. The estimated costs assume that the work will be accomplished by general

engineering contractors using traditional design, bid and build procedures with open competitive bidding.

The estimated costs for the improvements are combined into phases and summarized in **Table 2-1.** The Phase One projects will allow the Joint Treatment Plant to produce Title 22 Unrestricted Use recycled water for the design peak dry weather flow of 1.16 mgd, assuming that discharges of excess recycled water to the Napa River will continue. Phase Two projects include the new distribution and service facilities required to serve the potential new recycled water customers and will be constructed at the time the service is required. Phase Three projects will be required if, and when, the Town needs to provide full Title 22 treatment to all flows to the Joint Treatment Plant peak wet weather capacity of 2.0 mgd. It is possible that the additional Fuzzy Filter may not be required in the future if it is found that lower wet-weather flows, improved peak flow management and limited river discharges at permitted dilution ratios can be achieved.

**Table 2-1**

**Estimated Costs of Recommended Title 22 Upgrade Projects**

| Phase & Project Element | Estimates Costs, $1,000 |
|---|---|
| **Phase One Projects (PDW Flows and Continued Discharge)** | |
| Fuzzy Filter Modifications | |
| Fuzzy Filter | 103 |
| Divert Backwash to Headworks | 26 |
| Chemical Feed System – New at Storage Tank | 15 |
| Chlorine Contact Expansion | |
| New Concrete Contact Basin (Includes Head Tank Demo) | 202 |
| Alarm System Upgrade (Allowance) | 25 |
| Bypass Effluent Storage Pond | 94 |
| **Total Estimated Cost - Phase One** | **$465** |
| **Phase Two Projects (Distribution and Service Facilities)** | |
| Mondavi Vineyards Turnout | 8 |
| Silverado Vineyards Service Connection | |
| Alt. S-1 Directional Drilling | 296 (alt) |
| Alt. S-2 East of Napa River | 121 (alt) |
| Hartwell Vineyards Service Connection | 164 |
| **Total Estimated Cost - Phase Two** | **$293 - $468** |
| **Phase Three Projects (PWW Flows)** | |
| Additional Fuzzy Filter | 407 |
| Chlorine Contact Expansion | |
| Floating Baffle Walls in Effluent Storage Pond | 74 |
| **Total Estimated Cost - Phase Three** | **$481** |

# Chapter 3

# Title 22 Disinfected Tertiary Recycled Water Alternatives

## INTRODUCTION

Several modifications to the existing Joint Treatment Plant facilities are needed to fully comply with the requirements of Title 22 of the California Code of Regulations governing the unrestricted reuse of recycled water. These include at least the following:

- modify the existing Fuzzy Filter to comply with the conditions of the California Department of Health Services (DHS) approval of the Fuzzy Filter as a tertiary filtration process
- modifications to the existing coagulation chemical feed system and controls
- increase the modal chlorine contact time from the current ±30 minutes to the required 90 minutes
- upgrade the plant alarm system

In addition, it would be desirable to provide a direct connection to the recycled water pumps from the existing bypass around the effluent storage pond to improve the quality of the recycled water delivered to the Town's recycled water customers.

The purpose of this analysis is to evaluate the feasibility and cost of a range of treatment plant upgrade alternatives, including the following:

- Minimum Upgrade: In this alternative, the existing facilities are modified or reused to the maximum extent possible (e.g. modify existing head tank to provide additional chlorine contact time, upgrade existing chemical facilities, install floating baffle walls in the existing effluent storage pond to provide additional contact time). The existing chemical storage and feed equipment will be upgraded to provide automatic control of coagulating chemicals. And finally, the Fuzzy Filter will be modified as required by the DHS process approval conditions.
- New Chlorine Contact Tank/New Coagulation Chemical Facilities: Provide a new concrete structure to include the needed additional chlorine contact time and an effluent clearwell to house new pumps for filter backwash water. As an alternative, a new bypass pipeline around the effluent storage pond can be oversized to provide the additional detention time. Provide new, permanent chemical storage and feed equipment for coagulating chemicals. Modify Fuzzy Filter as required by DHS approval conditions.
- Combination Upgrade and New Facilities: A combination of the improvements from the above alternatives may provide a more cost-effective way to satisfy Title 22 requirements.

## REQUIRED TREATMENT FACILITY MODIFICATIONS

The required modifications to satisfy Title 22 regulations are discussed in the following paragraphs, arranged by major unit process:

- Fuzzy Filter modifications
- Chemical Feed system
- Chlorine Contact Basin expansion
- Plant alarm system
- Effluent Storage Pond Bypass

### Fuzzy Filter Modifications

The existing Fuzzy Filter was installed at the Joint Treatment Plant in 1998 to replace the original sand filters included in the 1977 Joint Treatment Plant project. The Fuzzy Filter was installed before the California DHS had approved the Fuzzy Filter as an "acceptable" tertiary

effluent filtration process. The DHS approval of the Fuzzy Filter process was issued in 2002 and included several requirements that the existing Fuzzy Filter does not meet. The following modifications are needed to satisfy the current DHS requirements:

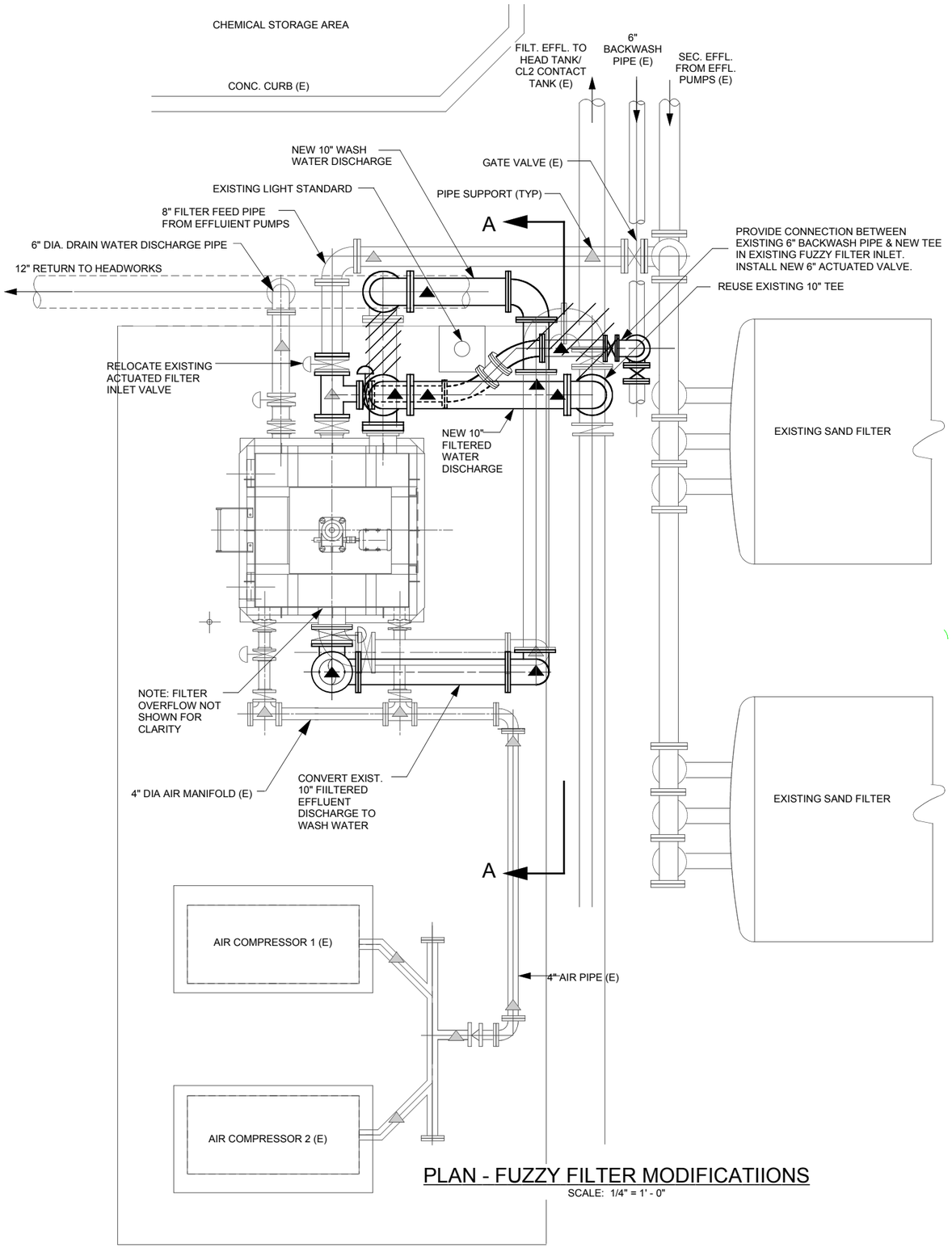
- Rearrange the filter effluent and backwash piping
- Add an automatic valve on the filtered effluent outlet
- Modify the existing filter control and alarm system
- Provide a connection to the existing filter backwash piping to allow filtered water to be used to backwash the Fuzzy Filter
- Add a gravity overflow on the Fuzzy Filter housing connected to the backwash outlet piping

As an alternative to using filtered water to backwash the filter, it may be possible to negotiate an approval from the DHS to substitute a "filter-to-waste" step in the filter backwash cycle. In this step, the water remaining in the filter after the filter backwash is completed will be wasted to the headworks for a short period of time rather than discharged as filtered effluent.

In addition, future operation and maintenance costs would be substantially reduced if the filter backwash flows were diverted from the excess flow pond to the plant headworks. With this change, the solids in the backwash water would be settled out in the primary sedimentation basin (rather than the excess flow pond) and reprocessed by the treatment plant.

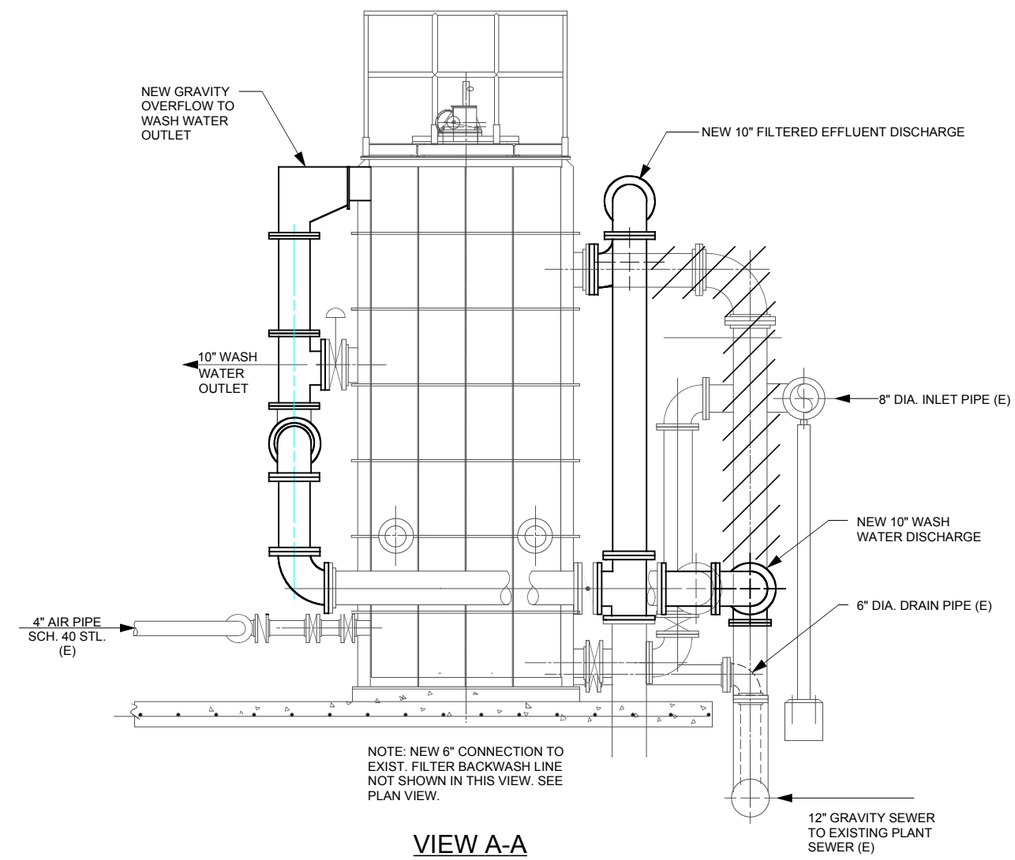
Finally, the existing Fuzzy Filter has the capacity to produce Title 22 effluent for dry weather flows only. Therefore, if the Zero Discharge Alternative is to be implemented, a second Fuzzy Filter will have to be added to treat the higher wet weather flows that occur during the winter months. The second filter unit would be the same size as the existing unit. This step may be delayed if minor modifications are made to the existing excess flow/effluent storage pond system and if the reduced population of the Town results in lower wet-weather flows at the Joint Treatment Plant. A final determination of the need for an additional Fuzzy Filter should be made at such time as the actual wet-weather flows approach the capacity of the existing unit.

**Figure 3-1** has been prepared to illustrate the Fuzzy Filter modifications described above. Estimated costs for the modifications are presented in a later section.




PLAN - FUZZY FILTER MODIFICATIIONS

SCALE: 1/4" = 1' - 0"




VIEW A-A

SCALE: 1/4" = 1'-0"

YOUNTVILLE/VETERANS HOME JOINT TREATMENT PLANT
ZERO DISCHARGE STUDY

FIGURE 3-1 - REQUIRED FUZZY FILTER MODIFICATIONS

### Chemical Feed System

The Title 22 regulations require that the coagulating chemical feed system must be automatically controlled for feed rate and dosage. The existing feed pumps are manually controlled and need to be upgraded to provide automatic control. The existing storage tank is satisfactory. At the present time, the feed equipment is located indoors in the Utility Room at the Treatment Unit.

As a minimum, an automatic control system must be added to the existing pumps. Improvements would include variable speed controllers for the pump motors using effluent flow rate as the control parameter. As an alternative, new chemical feed pumps with both speed and dosage controls could be provided. Another alternative would include providing a new building adjacent to the storage tank for the new feed pumps and controllers. The building would be approximately 8 feet by 8 feet, wood frame or prefabricated metal construction.

### Chlorine Contact Basin Expansion

The existing chlorine contact basin, located beneath the Sludge Heater Room in the Treatment Unit, has a volume of approximately 3,300 cubic feet. The theoretical detention time of this basin is 56 minutes at the design Average Dry Weather (ADW) flow of 0.63 mgd and 30 minutes at the design Peak Dry Weather (PDW) flow of 1.16 mgd. The Title 22 regulations require a "modal" detention time of 90 minutes at the peak design flow. The "modal" detention time is defined as the time that the peak concentration of slug addition of a tracer is measured at the basin outlet. Field measurements made in 1998 indicate that the "modal" time of the existing contact basin is approximately 39 percent of the theoretical detention time. This indicates that the performance of the existing contact basin is relatively inefficient.

The existing head tank from the 1977 treatment plant improvements has approximately the same volume as the chlorine contact basin at the Treatment Unit. When the head tank and contact basin were tested together, the basin efficiency improved to 55 percent. Therefore, the estimated "modal" detention time of the two existing tanks is 33 minutes (55 percent of 60 minutes) at the Peak Dry Weather flow of 1.16 mgd. Minor modifications to the head tank are needed to permit it to be used together with the Fuzzy Filter and existing chlorine contact basin. The modifications are shown on **Figure 3-2**.

NOTES:

1. ALL CUT EDGES IN STEEL SHALL BE POWER GROUND SMOOTH.
2. ALL NEW STEEL AND STEEL SURFACES DISTURBED BY CUTTING, GRINDING AND WELDING SHALL BE REPAINTED AS FOLLOWS:

A. INTERIOR - IMMERSION AND NON-IMMERSION

SURFACE PREPARATION: SSPC - 11 POWER TOOL CLEANING TO WHITE METAL

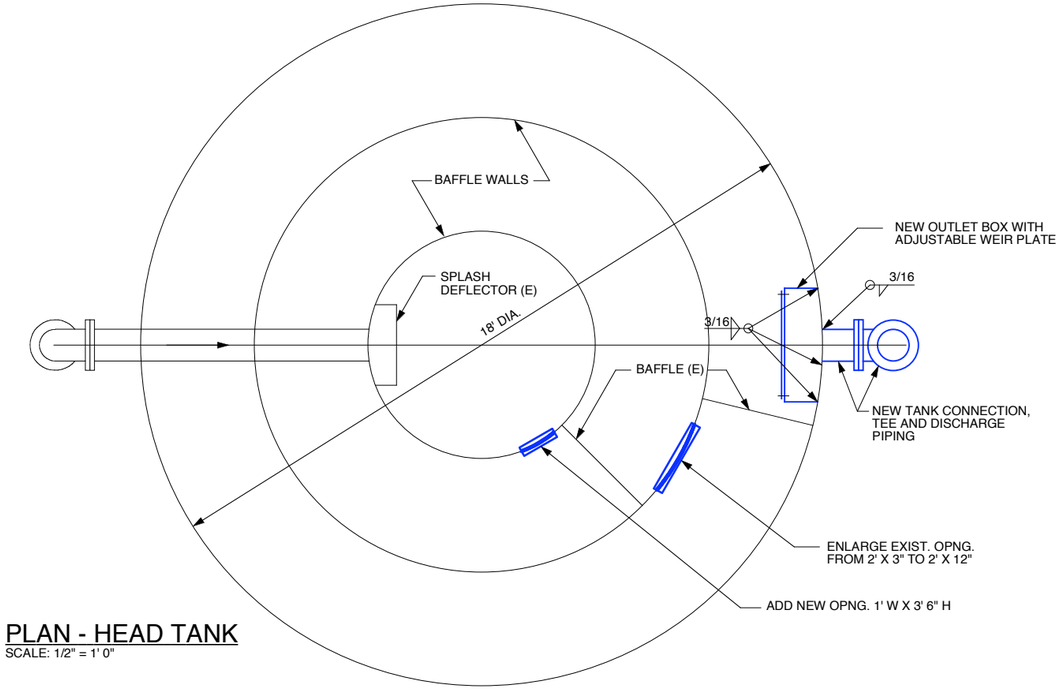
COATING: EPOXY, 2 COATS @ 4-6 MIL D.F.T. EACH, 8-12 MIL D.F.T. TOTAL, TNEMEC 69 HI-BUILD EPOXOLINE II, CARBOLINE 890, OR EQUAL.

B. EXTERIOR

SURFACE PREPARATION: SSPC - 7 BRUSH-OFF BLAST CLEANING, OR EQUAL

COATING: PRIMER: ZINC, 1 COAT @ 2.5-3.5 MIL DFT, SERIES 90-97 TNEME-ZINC, CARBO-ZINC 11 HS, OR EQUAL

TOP COAT: EPOXY, 2 COATS @ 2-3 MILS D.F.T. EACH, 4-6 MIL D.F.T. TOTAL, TNEMEC 69 HI-BUILD EPOXOLINE II, CARBOLINE 890, OR EQUAL, COLOR TO MATCH EXISTING

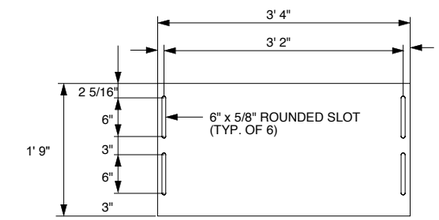



## PLAN - HEAD TANK

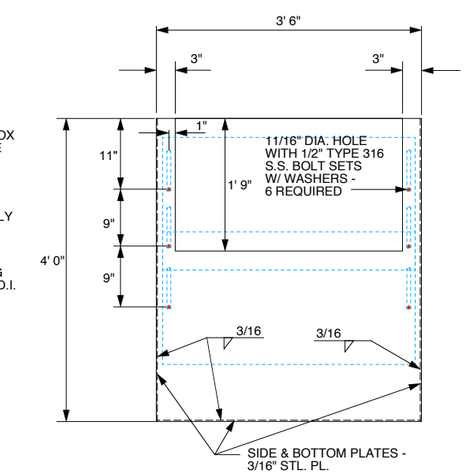
SCALE: 1/2" = 1' 0"

OUTLET BOX NOTES:

1. ALL STEEL SHALL BE ASTM A36 PLATE, 3/16" THICK.
2. SEE NOTE 2 THIS DWG. FOR PAINTING REQUIREMENTS.
3. PROVIDE GASKET AROUND OPENING IN FRONT PLATE - 2"W X 3/16"THICK, HYPALON OR EPDM RUBBER



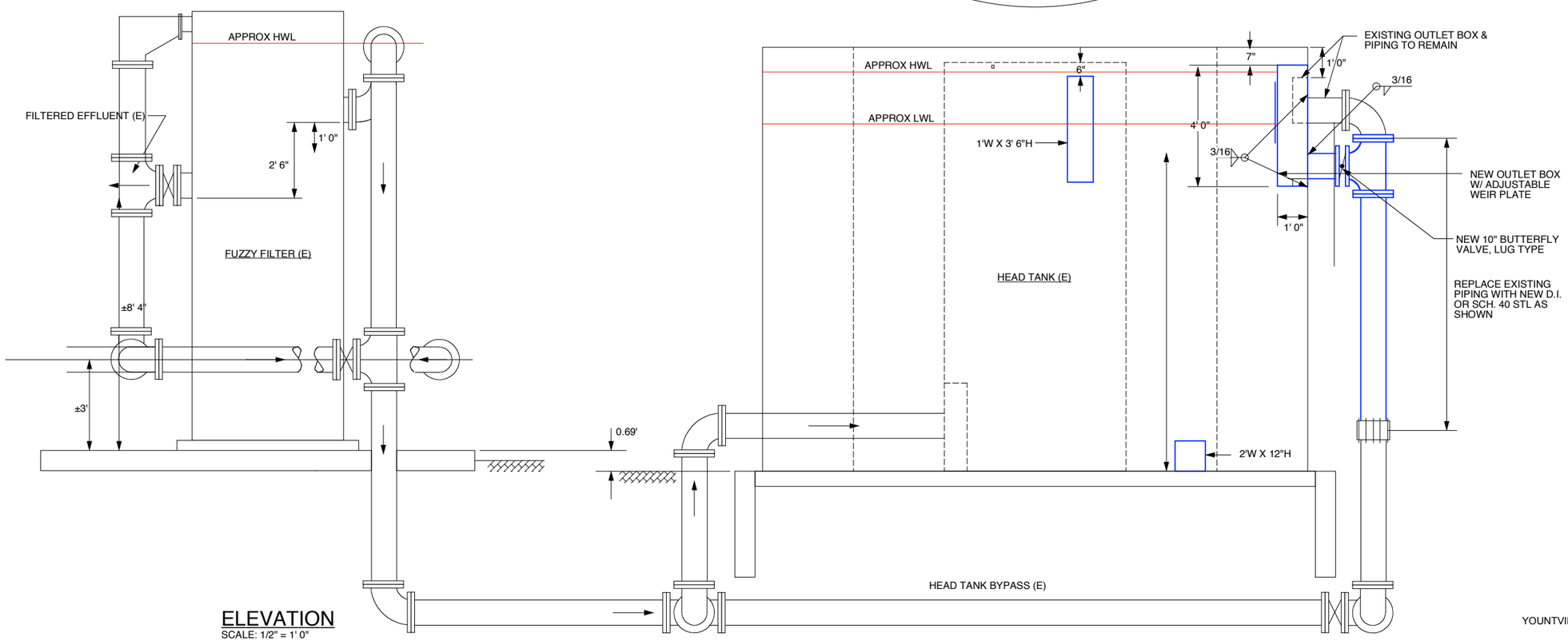

## ADJUSTABLE WEIR PLATE




## FRONT ELEVATION

## NEW OUTLET BOX

SCALE: 1" = 1' 0"




## ELEVATION

SCALE: 1/2" = 1' 0"

YOUNTVILLE/VETERANS HOME JOINT TREATMENT PLANT
ZERO DISCHARGE STUDY

FIGURE 3-2 - REQUIRED HEAD TANK MODIFICATIONS

The additional contact tank volume to achieve the needed 90 minute modal detention time can be provided by one of three alternatives. The first alternative would provide a new concrete basin of approximately 6,150 cubic feet of volume for a design Peak Dry Weather flow of 1.16 mgd. For the Zero Discharge alternative, where the design Peak Wet Weather flow is 2.0 mgd, an additional 15,000 cubic feet of volume would be required. **Figure 3-3** has been prepared to show what new concrete contact basins for these two scenarios would look like. In Figure 3-3, only the left-hand four channels are needed if only dry weather flows need to meet Title 22 requirements. The additional six channels would be needed for the Zero Discharge alternative.

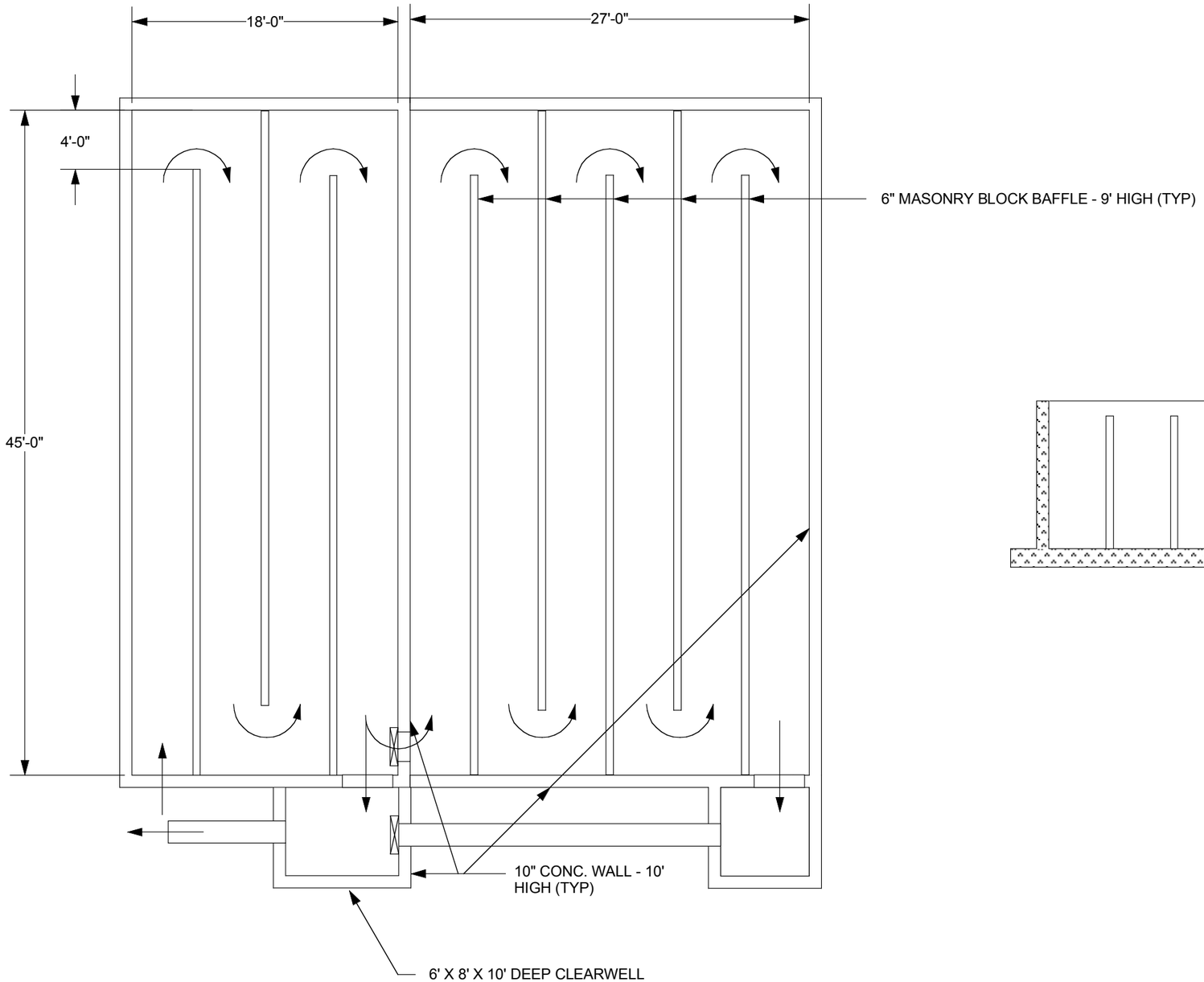
A second method for providing the additional detention time would be to install baffles in the inlet to the effluent storage pond. These baffles could take several forms, including a series of wooden "fences" or floating baffle curtains anchored to the sides of the pond. These alternatives are shown on **Figure 3-4**.

The third alternative would provide the additional contact volume using a series of buried pipelines beneath the plant entrance road. For example, a single 48-inches diameter reinforced concrete pipe along the side of the effluent storage pond would provide the added volume for the design Peak Dry Weather flow of 1.16 mgd. For a design Peak Wet Weather flow of 2.0 mgd, three side-by-side pipelines of 48-inch diameter would be needed. This alternative is also shown in Figure 3-4.

**Plant Alarm System**

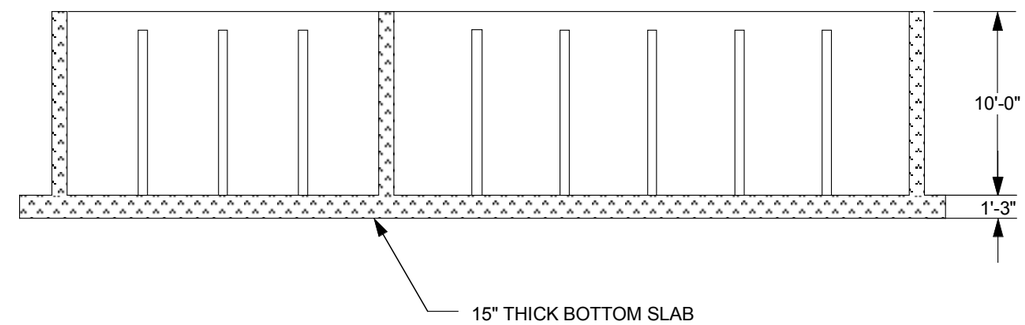
The Title 22 regulations require an upgrade to the existing alarm system at the Joint Treatment Plant. The alarm system must provide automatic notification of failure of each of the following systems:

- Loss of power
- Failure of the biological process
- Failure of the disinfection process
- Failure of the coagulation process
- Failure of the filtration process




PLAN - CHLORINE CONTACT BASIN

SCALE: 1/8" = 1'-0"

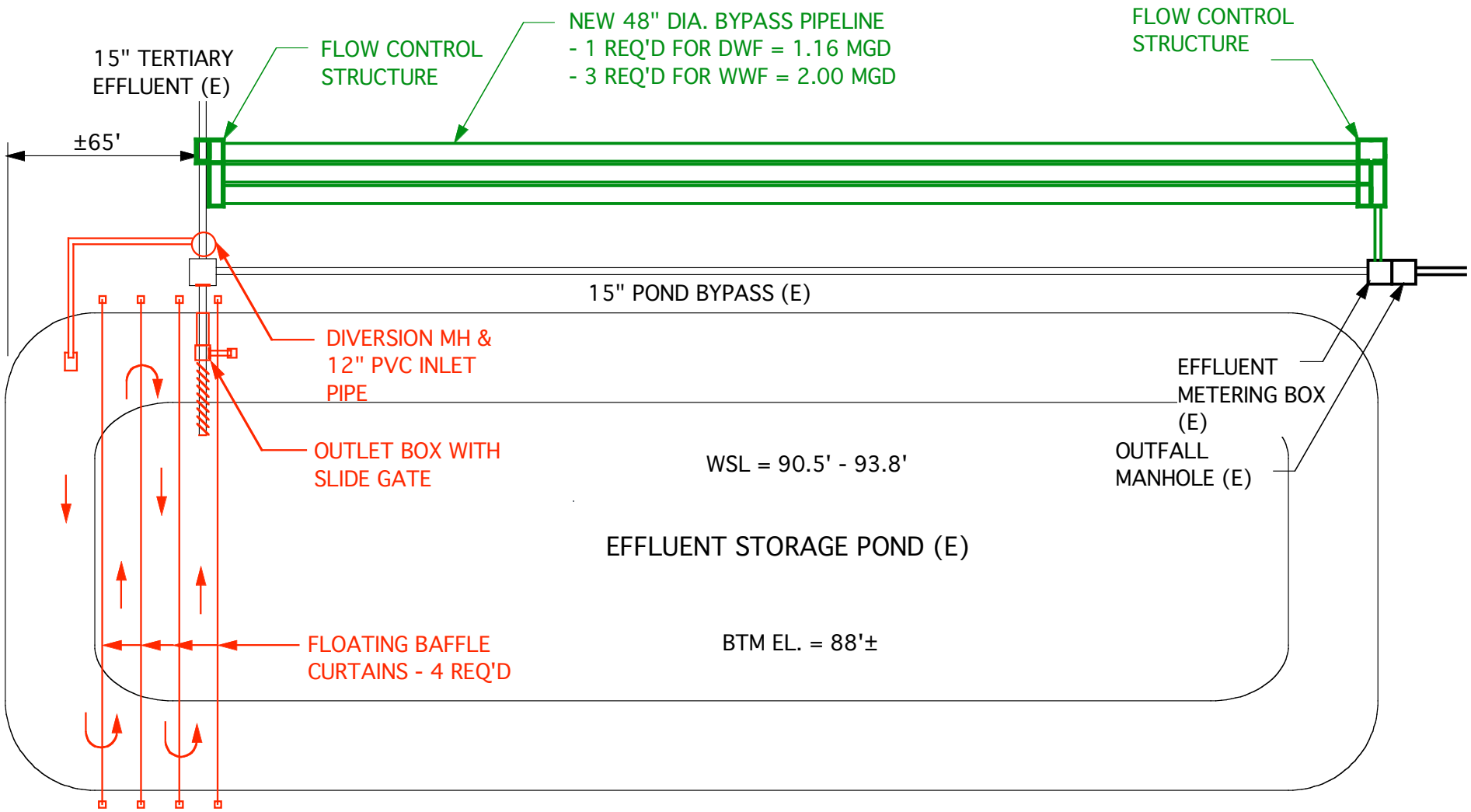


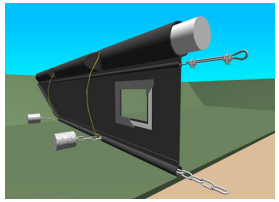

SECTION

SCALE: 1/8" = 1'-0"

YOUNTVILLE/VETERANS HOME JOINT WASTEWATER TREATMENT PLANT
ZERO DISCHARGE STUDY

FIGURE 3-3 - PROPOSED CHLORINE CONTACT BASIN EXPANSION





LEGEND

FLOATING BAFFLE CURTAIN ALT.

OVERSIZED POND BYPASS ALT.

YOUNTVILLE/VETERANS HOME JOINT TREATMENT PLANT
ZERO DISCHARGE STUDY

FIGURE 3-4 - CHLORINE CONTACT BASIN EXPANSION ALTERNATIVES

Of the above, alarms already exist for three of the failure modes - loss of power, failure of disinfection process and failure of filtration process. The alarm system must be upgraded to indicate failure of the biological process and failure of the coagulation process. Further, all of the alarms must be tied to a single master alarm that will notify the operations staff and/or the police station.

**Effluent Storage Pond Bypass**

A 15-inch bypass pipeline around the effluent storage pond already exists as shown on Figure 3-4. At present, the bypass is connected to a manhole at the existing outfall metering structure and any effluent bypassed using this pipeline flows directly to the Napa River through the existing outfall line.

A direct connection to the existing recycled water pumps can be provided by adding a sluice gate to the inlet to the 15-inch Napa River outfall and constructing an 8-inch suction pipeline between the manhole and the existing pumps. In addition, because the pumps would no longer be pumping from the pond, variable speed drives will be needed to prevent excessive start-stop cycling and possible overheating of the existing pump motors.

Finally, minor modifications to the existing excess flow/effluent storage pond system to allow return of excess flows from the effluent storage pond to the headworks would increase the capacity and reliability of the Joint Treatment Plant to handle wet-weather flows. The modifications would consist of providing a new connection between the effluent storage pond and the existing excess flow return pumps.

## ESTIMATED COST OF ALTERNATIVES.

The estimated cost of the required modifications and alternatives are presented in the following sections. The cost estimates assume that the work will be accomplished during calendar year 2006. If portions of the project are delayed beyond 2006, the estimated costs will have to be adjusted for general inflation in construction costs. Over the past several years, construction cost inflation has averaged about 3 to 5 percent annually, although some costs have risen at a higher rate over the past year (e.g. steel, reinforcing steel and concrete). In addition, cost estimates

assume that the work will be accomplished by general engineering contractors using traditional design, bid and build procedures with open competitive bidding.

### Fuzzy Filter Modifications

The modifications needed to comply with California DHS requirements for the Fuzzy Filter are presented in **Table 3-1**. The costs are summarized in the top portion of the table, while a breakdown of the items making up the estimate is shown in the bottom portion. These modifications must be done whether a Zero Discharge alternative is selected or the Town continues to discharge to the Napa River during the winter months.

Most of the work in Table 3-1, consisting of modifications to the Fuzzy Filter housing and control system, will be performed by the Schreiber Corporation, the manufacturer of the equipment. The remainder of the work will be carried out by a general engineering contractor.

The cost of diverting the filter backwash water from the existing excess flow pond to the headworks is shown in **Table 3-2**. This work consists of connecting to the existing 12-inch sewer at the Fuzzy Filter and constructing a new 12-inch line to the feed channel at the primary sedimentation basin.

The estimated cost of adding a second Fuzzy Filter unit for the Zero Discharge Alternative, based on a preliminary estimate by the manufacturer, is $470,000. This estimate includes the cost of the equipment, installation and an engineering & contingency allowance of 35 percent.

### Chemical Feed System

The estimated cost to upgrade the existing chemical feed equipment with variable speed controllers is shown in **Table 3-3**. The top portion of the table assumes that the equipment will remain at its current location in the Treatment Unit. The bottom portion of the table includes the cost of providing new feed equipment in a new wood frame building located at the existing storage tank.

**Table 3-1**

**Cost Estimate - Fuzzy Filter Modifications**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 4,100 |
| Div. 1 | General Requirements | | | | 1,500 |
| Div. 11 | Equipment | | | | 63,000 |
| Div. 15 | Mechanical | | | | 14,800 |
| Div. 16 | Electrical | | | | 2,000 |
| | *Subtotal* | | | | *85,400* |
| | Engineering & Contingency allowance | % | 20.0% | | 17,100 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$103,000*** |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds, insurance and permits | % | 5.0% | 1.0 | 4,065 |
| | *Division Total* | | | | *4,065* |
| | ***Division Total (Rounded)*** | | | | ***4,100*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500 | 1.0 | 1,500 |
| | *Division Total* | | | | *1,500* |
| | ***Division Total (Rounded)*** | | | | ***1,500*** |
| **Div. 11** | **Equipment** | | | | |
| 11100 | Furnish Equipment | | | | |
| | Materials for Fuzzy Filter mods by Schreiber | ls | 36,000.00 | 1.0 | 36,000 |
| 11200 | Installation of Equipment | | | | |
| | Fuzzy Filter mods + control changes by Schreiber | ls | 27,000.00 | 1.0 | 27,000 |
| | *Division Total* | | | | *63,000* |
| | ***Division Total (Rounded)*** | | | | ***63,000*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Metal Pipe | | | | |
| | Ductile Iron - 10" | lf | 100.00 | 20.0 | 2,000 |
| | 6" | lf | 50.00 | 10.0 | 500 |
| | DI flanges - 10" | ea | 435.00 | 3.0 | 1,305 |
| | 6" | ea | 263.00 | 4.0 | 1,052 |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 10" | ea | 925.00 | 3.0 | 2,775 |
| | 6" | ea | 355.00 | 1.0 | 355 |
| | Els - 45 degree - 6" | ea | 480.00 | 2.0 | 960 |
| | Tees - 10" | ea | 1,425.00 | 1.0 | 1,425 |
| | 6" | ea | 515.00 | 1.0 | 515 |
| | 8" x 6" | ea | 1,275.00 | 1.0 | 1,275 |
| | Gate Valves - 6" | ea | 1,325.00 | 2.0 | 2,650 |
| | *Division Total* | | | | *14,812* |
| | ***Division Total (Rounded)*** | | | | ***14,800*** |
| **Div. 16** | **Electrical** | | | | |
| 16400 | Electrical | | | | |
| | Hardware | | | | |
| | Wiring Labor | ls | 1,000.00 | 1.0 | 1,000 |
| | Conduit & Wire Material | ls | 1,000.00 | 1.0 | 1,000 |
| | *Division Total* | | | | *2,000* |
| | ***Division Total (Rounded)*** | | | | ***2,000*** |

**Table 3-2**

**Cost Estimate - Divert Backwash to Headworks**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 1,000 |
| Div. 1 | General Requirements | | | | 2,500 |
| Div. 2 | Site Work | | | | 3,800 |
| Div. 15 | Mechanical | | | | 14,300 |
| | *Subtotal* | | | | *21,600* |
| | Engineering & Contingency allowance | % | 20.0% | | 4,300 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$26,000*** |
| | | | | | |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds | % | 2.0% | 1.0 | 412 |
| | Insurance | % | 2.0% | 1.0 | 412 |
| | Permits | % | 1.0% | 1.0 | 206 |
| | *Division Total* | | | | *1,030* |
| | ***Division Total (Rounded)*** | | | | ***1,000*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500 | 1.0 | 1,500 |
| | Inspection and Testing Fees | ls | 1,000 | 1.0 | 1,000 |
| | *Division Total* | | | | *2,500* |
| | ***Division Total (Rounded)*** | | | | ***2,500*** |
| **Div. 2** | **Site Work** | | | | |
| 02200 | Excavating, Filling & Grading | | | | |
| | Mobilization | ls | 500.00 | 1.0 | 500 |
| | Excavation | | | | |
| | Trenches (12" Pipe) | cy | 8.00 | 65.0 | 520 |
| | Gravel base | | | | |
| | Trenches (12" Piper) | cy | 17.00 | 30.0 | 510 |
| | Backfill | | | | |
| | Trenches (12" Pipe) | cy | 12.00 | 33.0 | 396 |
| | Compaction | | | | |
| | Trenches (12" Pipe) | cy | 4.00 | 33.0 | 132 |
| | Pavement (4" Over Aggregate Base) | | | | |
| | Trenches (12" Pipe) | sy | 35.00 | 50.0 | 1,750 |
| | *Division Total* | | | | *3,808* |
| | ***Division Total (Rounded)*** | | | | ***3,800*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Metal Pipe | | | | |
| | Ductile Iron - 12" | lf | 100.00 | 10.0 | 1,000 |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 12" | ea | 925.00 | 3.0 | 2,775 |
| | Els - 45 degree - 12" | ea | 480.00 | 2.0 | 960 |
| | Fla 10" | ea | 500.00 | 1.0 | 500 |
| | Plastic Pipe | | | | |
| | 12" PVC C900 Pipe | lf | 25.00 | 140.0 | 3,500 |
| | Plastic Pipe Fittings | | | | |
| | 12" DI 90 els | ea | 925.00 | 6.0 | 5,550 |
| | *Division Total* | | | | *14,285* |
| | ***Division Total (Rounded)*** | | | | ***14,300*** |

**Table 3-3**

**Cost Estimate – Modifications to Existing Chemical Feed Equipment**

**Alternative A – Upgrade Existing Equipment**

| Item | Description | Estimated Cost |
|---|---|---|
| 1. | Add VFD Controllers to existing pumps | 2,000 |
| 2. | Misc. piping improvements | 1,700 |
| | *Subtotal* | *3,700* |
| | Contingency allowance @ 35% | 1,300 |
| | **Total Estimated Cost** | **5,000** |

**Alternative B – Relocate to New Building at Storage Tank**

| Item | Description | Estimated Cost |
|---|---|---|
| 1. | New chemical feed pumps with VFD | 5,000 |
| 2. | New chemical feed piping & valves | 3,000 |
| 3. | New building – 8' x 8' | 1,000 |
| 4. | New electrical service | 2,000 |
| | *Subtotal* | *11,000* |
| | Contingency allowance @ 35% | 4,000 |
| | **Total Estimated Cost** | **15,000** |

### Chlorine Contact Basin Expansion

The size of the new concrete tank can be minimized by modifying the existing head tank to allow the effluent from the Fuzzy Filter to flow through the tank. In this way, the theoretical Peak Dry Weather chlorine contact time can be increased from the current 30 minutes to 60 minutes at minimal expense. The estimated cost of modifying the existing head tank is shown in **Table 3-4**.

The most cost-effective method to expand the "modal" chlorine contact time to the needed 90 minutes is to install floating baffle curtains at the influent end of the existing effluent storage pond. The estimated cost of this alternative is shown in **Table 3-5**. One of the major advantages of this alternative is that the cost is nearly the same, regardless of the design flow rate – 1.16 mgd Peak Dry Weather flow or 2.0 mgd Peak Wet Weather flow. This is because the needed number and length of baffle curtains are the same for both flow rates – only the channels are wider for the Peak Wet Weather flow.

**Table 3-4**

**Cost Estimate - Head Tank Modifications**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 1,200 |
| Div. 1 | General Requirements | | | | 1,500 |
| Div. 2 | Site Work | | | | 500 |
| Div. 5 | Metals | | | | 1,500 |
| Div.9 | Finishes | | | | 13,800 |
| Div. 15 | Mechanical | | | | 7,400 |
| | *Subtotal* | | | | *25,900* |
| | Engineering & Contingency allowance | % | 20.0% | | 5,200 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$32,000*** |
| | | | | | |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds, insurance and permits | % | 5.0% | 1.0 | 1,235 |
| | *Division Total* | | | | *1,235* |
| | ***Division Total (Rounded)*** | | | | ***1,200*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500 | 1.0 | 1,500 |
| | *Division Total* | | | | *1,500* |
| | ***Division Total (Rounded)*** | | | | ***1,500*** |
| **Div. 2** | **Site Work** | | | | |
| 2100 | Demolition | | | | |
| | Removal of Pipe, Valves and Fittings at Exist. Head Tank | ls | 500.00 | 1.0 | 500 |
| | *Division Total* | | | | *500* |
| | ***Division Total (Rounded)*** | | | | ***500*** |
| **Div. 5** | **Metals** | | | | |
| 05500 | Miscellaneous Metal | | | | |
| | Outlet box with weir plate | ls | 1,000.00 | 1.0 | 1000 |
| | Cut new openings in baffles | ls | 500.00 | 1.0 | 500 |
| | *Division Total* | | | | *1,500* |
| | ***Division Total (Rounded)*** | | | | ***1,500*** |
| **Div. 9** | **Finishes** | | | | |
| 09900 | Painting | | | | |
| | Interior - epoxy (include. surf. prep.) | sf | 4.00 | 2650 | 10,600 |
| | Exterior - urethane (include. surf. prep.) | sf | 4.00 | 800 | 3,200 |
| | *Division Total* | | | | *13,800* |
| | ***Division Total (Rounded)*** | | | | ***13,800*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Metal Pipe | | | | |
| | Ductile Iron - 10" | lf | 100.00 | 10.0 | 1,000 |
| | DI flanges - 10" | ea | 435.00 | 4.0 | 1,740 |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 10" | ea | 925.00 | 3.0 | 2,775 |
| | Tee 10" | ea | 1,425.00 | 1.0 | 1,425 |
| | Flanged coupling adaptors - 10" | ea | 500.00 | 1.0 | 500 |
| | *Division Total* | | | | *7,440* |
| | ***Division Total (Rounded)*** | | | | ***7,400*** |

**Table 3-5**

**Cost Estimate – Floating Baffle Curtain Alternatives**

| Item | Description | Estimated Cost |
|---|---|---|
| 1. | Furnish floating baffle curtains | 35,000 |
| 2. | Install baffle curtains, including conc. anchors | 5,000 |
| 3. | Inlet diversion manhole & 12" inlet pipe | 4,000 |
| 4. | Outlet box & outlet pipe | 11,000 |
| | *Subtotal* | *55,000* |
| | Contingency allowance @ 35% | 19,000 |
| | **Total Estimated Cost** | **74,000** |

Estimated costs for constructing a new concrete chlorine contact tank are shown in **Table 3-6**. Two estimates are shown - one for continued winter discharge to the Napa River and one for the Zero Discharge alternative. A sub-alternative to keeping the head tank would be to use the money for the head tank modifications for a new concrete contact basin expanded to provide the added contact time. Preliminary estimates indicate that the net increase in cost would be approximately $40,000 for the continued discharge alternative and no additional cost for the Zero Discharge alternative.

Finally, estimated costs for providing the additional contact time by oversizing the bypass line around the effluent storage pond are shown in **Table 3-7**. In addition to being relatively costly, there may not be sufficient width to construct the needed pipelines within the plant entrance road for the larger Zero Discharge alternative. This alternative is not recommended because of cost and construction difficulties.

### Plant Alarm System

It is not possible to prepare a cost estimate for the needed alarm system improvements at the existing plant to satisfy the Title 22 regulations. This is primarily because the exact nature of the needed improvements is not known at this time. These will need to be determined in consultation with the California DHS during the preliminary design phase of the work. In the meantime, an allowance of $25,000 is provided for this work.

**Table 3-6**

**Cost Estimate - New Concrete Chlorine Contact Basin**

| Group | Alt. A: Peak Dry Weather | | | | Alt. B: Wet Weather | | | |
|---|---|---|---|---|---|---|---|---|
| | Qty | Units | Unit Cost | Total* | Qty | Units | Unit Cost | Total* |
| Concrete Walls | 51 | cy | 530.00 | $27,000 | 90 | cy | 530.00 | $47,700 |
| Concrete Slabs | 52 | cy | 300.00 | $15,600 | 118 | cy | 300.00 | $35,400 |
| Masonry | 1107 | sf | 10.00 | $11,100 | 2952 | sf | 10.00 | $29,500 |
| Gravel Bases | 20 | cy | 37.00 | $700 | 46 | cy | 37.00 | $1,700 |
| Excavation | 709 | cy | 3.00 | $2,100 | 1422 | cy | 3.00 | $4,300 |
| Compaction | 299 | cy | 5.00 | $1,500 | 479 | cy | 5.00 | $2,400 |
| Backfill | 299 | cy | 3.00 | $900 | 479 | cy | 3.00 | $1,400 |
| Sheeting | 2005 | sf | 10.00 | $20,100 | 2631 | sf | 10.00 | $26,300 |
| Gates | 2 | unit | 8500.00 | $17,000 | 2 | unit | 8500.00 | $17,000 |

*Totals rounded to nearest $100

| | | | |
|---|---|---|---|
| Sub-Total Construction = | $96,000 | Sub-Total Construction = | $165,700 |
| Engin. & Contingency. (35%) = | $33,600 | Engin. & Contingency (35%) = | $58,000 |
| CONSTRUCTION TOTAL = | $129,600 | CONSTRUCTION TOTAL = | $223,700 |
| **Say =** | $130,000 | **Say =** | $230,000 |

**Table 3-7**

**Cost Estimate - Oversize Effluent Pond Bypass**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 22,400 |
| Div. 1 | General Requirements | | | | 2,500 |
| Div. 2 | Site Work | | | | 380,300 |
| Div. 3 | Concrete | | | | 34,700 |
| Div. 11 | Equipment | | | | 30,000 |
| | *Subtotal* | | | | *469,900* |
| | Engineering & Contingency allowance | % | 20.0% | | 94,000 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$564,000*** |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds | % | 2.0% | 1.0 | 8,950 |
| | Insurance | % | 2.0% | 1.0 | 8,950 |
| | Permits | % | 1.0% | 1.0 | 4,475 |
| | *Division Total* | | | | *22,375* |
| | ***Division Total (Rounded)*** | | | | ***22,400*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500 | 1.0 | 1,500 |
| | Inspection and Testing Fees | ls | 1,000 | 1.0 | 1,000 |
| | *Division Total* | | | | *2,500* |
| | ***Division Total (Rounded)*** | | | | ***2,500*** |
| **Div. 2** | **Site Work** | | | | |
| 02200 | Excavating, Filling & Grading | | | | |
| | Mobilization | ls | 1,500.00 | 1.0 | 1,500 |
| | Excavation | | | | |
| | Trenches (48" Pipe) | cy | 3.00 | 6600.0 | 19,800 |
| | Gravel base | | | | |
| | Trenches (48" Piper) | cy | 37.00 | 1850.0 | 68,450 |
| | Backfill | | | | |
| | Trenches (48" Pipe) | cy | 8.00 | 4750.0 | 38,000 |
| | Compaction | | | | |
| | Trenches (48" Pipe) | cy | 4.00 | 4750.0 | 19,000 |
| | Pavement (4" Over Aggregate Base) | | | | |
| | Trenches (48" Pipe) | sy | 35.00 | 1100.0 | 38,500 |
| | Reinforced Concrete Pipe | | | | |
| | 48" dia. Class 4 | lf | 1,300.00 | 150.0 | 195,000 |
| | *Division Total* | | | | *380,250* |
| | ***Division Total (Rounded)*** | | | | ***380,300*** |
| **Div. 3** | **Concrete** | | | | |
| 03300 | Cast in Place Concrete | | | | |
| | Control structure foundation slab (12" thick base) | cy | 300.00 | 15.0 | 4,500 |
| | Control structure walls (8" thick) | cy | 530.00 | 40.0 | 21,200 |
| | Control structure top slab (12" thick) | cy | 600.00 | 15.0 | 9,000 |
| | *Division Total* | | | | *34,700* |
| | ***Division Total (Rounded)*** | | | | ***34,700*** |
| **Div. 11** | **Equipment** | | | | |
| 11000 | General Equipment Provisions | | | | |
| 11050 | Equipment Mounting | | | | |
| | Furnish Equipment | | | | |
| | 24" x 24" sluice gate | ea | 10,000.00 | 3.0 | 30,000 |
| | *Division Total* | | | | *30,000* |
| | ***Division Total (Rounded)*** | | | | ***30,000*** |

### Effluent Storage Pond Bypass

The estimated cost to modify the existing 15-inch pond bypass system to provide a direct connection to the Recycled Water Pumps and modifications to the existing excess flow/effluent storage pond return piping is shown in **Table 3-8**.

### Combined Costs of Title 22 Upgrade Alternatives

Estimate costs for the separate improvements from the above discussion are combined in **Table 3-9** to indicate the range of costs for the major Title 22 upgrade alternatives. Note that the costs of most of the improvements required for Title 22 compliance are common to all of the alternatives. The primary differences in cost among all the alternatives are the method for providing the needed additional chlorine contact time and whether there is a discharge to the Napa River.

From Table 3-9, the minimum cost alternative would use floating baffle curtains installed in the inlet end of the existing effluent storage pond to provide the needed additional chlorine contact time. The additional cost to use a new concrete tank to provide the needed contact time would be approximately $56,000, or an additional 16 percent for the continued discharge alternative. If the expanded concrete basin is used in lieu of using the head tank, the additional cost would be $96,000. For the Zero Discharge alternative, the additional cost for concrete contact basins would be approximately $156,000, or 19 percent.

**Table 3-8**

**Cost Estimate - Pond Bypass to Effluent Pumps**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 3,700 |
| Div. 1 | General Requirements | | | | 1,500 |
| Div. 2 | Site Work | | | | 1,000 |
| Div. 11 | Equipment | | | | 8,000 |
| Div. 15 | Mechanical | | | | 35,700 |
| Div. 16 | Electrical | | | | 28,000 |
| | *Subtotal* | | | | *77,900* |
| | Engineering & Contingency allowance | % | 20.0% | | 15,600 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$94,000*** |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds, insurance and permits | % | 5.0% | 1.0 | 3,710 |
| | *Division Total* | | | | *3,710* |
| | ***Division Total (Rounded)*** | | | | ***3,700*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500 | 1.0 | 1,500 |
| | *Division Total* | | | | *1,500* |
| | ***Division Total (Rounded)*** | | | | ***1,500*** |
| **Div. 2** | **Site Work** | | | | |
| 02200 | Excavating, Filling & Grading | | | | |
| | Mobilization | ls | 500.00 | 1.0 | 500 |
| | Excavation | | | | |
| | Trenches (10" suction) | cy | 10.00 | 11.0 | 110 |
| | Gravel base | | | | |
| | Trenches (10" suction) | cy | 20.00 | 7.0 | 140 |
| | Backfill | | | | |
| | Trenches (10" FM) | cy | 15.00 | 10.0 | 150 |
| | Compaction | | | | |
| | Trenches (10" FM) | cy | 6.00 | 10.0 | 60 |
| | *Division Total* | | | | *960* |
| | ***Division Total (Rounded)*** | | | | ***1,000*** |
| **Div. 11** | **Equipment** | | | | |
| 11100 | Furnish Equipment | | | | |
| | 15" Sluice Gate | ls | 6,000.00 | 1.0 | 6,000 |
| 11200 | Installation of Equipment | | | | |
| | 15" Sluice Gate | ls | 2,000.00 | 1.0 | 2,000 |
| | *Division Total* | | | | *8,000* |
| | ***Division Total (Rounded)*** | | | | ***8,000*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Metal Pipe | | | | |
| | Ductile Iron - 8" | lf | 100.00 | 100.0 | 10,000 |
| | DI flanges - 8" | ea | 435.00 | 20.0 | 8,700 |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 8" | ea | 600.00 | 6.0 | 3,600 |
| | Tees - 8" | ea | 850.00 | 4.0 | 3,400 |
| | Plug Valves - 8" | ea | 2,500.00 | 4.0 | 10,000 |
| | *Division Total* | | | | *35,700* |
| | ***Division Total (Rounded)*** | | | | ***35,700*** |
| **Div. 16** | **Electrical** | | | | |
| 16400 | Electrical | | | | |
| | Hardware | | | | |
| | AFD Panel and Assessories | ea | 10,000.00 | 2.0 | 20,000 |
| | Level control system | ea | 6,000.00 | 1.0 | 6,000 |
| | Wiring Labor | ls | 1,000.00 | 1.0 | 1,000 |
| | Conduit & Wire Material | ls | 1,000.00 | 1.0 | 1,000 |
| | *Division Total* | | | | *28,000* |
| | ***Division Total (Rounded)*** | | | | ***28,000*** |

**Table 3-9**

**Estimated Costs of Combined Title 22 Upgrade Alternatives**

| Alternative & Project Element | Estimated Costs, $1,000 | |
|---|---|---|
| | **Napa River Discharge Alternative** | **Zero Discharge Alternative** |
| **Minimum Cost Alternative** | | |
| Fuzzy Filter Modifications | | |
| Fuzzy Filter | 103 | 103 |
| Divert Backwash to Headworks | 26 | 26 |
| Additional filter unit for wet weather flows | - | 470 |
| Chemical Feed System – Upgrade Existing | 5 | 5 |
| Chlorine Contact Expansion | | |
| Modify Head Tank | 32 | 32 |
| Floating Baffle Curtains | 74 | 74 |
| Alarm System Upgrade (allowance) | 25 | 25 |
| Bypass Effluent Storage Pond | 94 | 94 |
| **Total Estimated Cost - Base Alternative** | **$359** | **$829** |
| **New Chlorine Contact Basin Alternative** | | |
| Fuzzy Filter Modifications | | |
| Fuzzy Filter | 103 | 103 |
| Divert Backwash to Headworks | 26 | 26 |
| Additional filter unit for wet weather flows | - | 470 |
| Chemical Feed System – New at Storage Tank | 15 | 15 |
| Chlorine Contact Expansion | | |
| Modify Head Tank | 32 | 32 |
| New concrete contact basin | 130 | 230 |
| Add'l cost for expanded concrete basin (alt) | 40 (alt) | 0 |
| Alarm System Upgrade (allowance) | 25 | 25 |
| Bypass Effluent Storage Pond | 94 | 94 |
| **Total Estimated Cost - New Contact Basin Alternative** | **$425 - $465 (alt)** | **$995 (base & alt)** |

# Chapter 4

# Recycled Water Irrigation, Storage and Discharge Alternatives

## INTRODUCTION

The purpose of this alternatives analysis is to find the optimum combination of storage ponds and irrigated acreage to maximize reuse of recycled water and minimize the discharge of effluent to the Napa River under all critical climatic conditions. Critical climatic conditions include both "wet" and "dry" climatic conditions. Because crop irrigation requirements and the potential for discharge to the Napa River are different under wet and dry climatic conditions, the combination of storage and river discharge generally will be different for each. The optimum solution is the configuration of effluent reuse and disposal facilities that accommodates both critical climatic conditions and minimizes the total amount of effluent discharged to the Napa River.

## EFFLUENT REUSE/DISPOSAL ALTERNATIVES ANALYSIS

Land for effluent irrigation and storage ponds is expensive, especially in the Napa Valley. In addition, construction of lined storage ponds is relatively expensive. Therefore, the most cost effective recycled water reuse and disposal option will be one that uses recycled water on local agricultural lands and golf course turf and minimizes discharges to the Napa River and recycled water storage requirements.

The alternatives analysis must consider a range of climatic conditions from wet to dry. During wet conditions, precipitation and Napa River flows are high and irrigation demand is reduced because some of the demand is satisfied by precipitation rather than irrigation. At the other extreme during dry conditions, precipitation and Napa River flows are low and more of the vineyard and golf course turf water requirements must be provided by irrigation. Both climatic conditions affect the volume of effluent that can be reused or discharged, and each will have its specific storage requirement.

## ALTERNATIVES ANALYSIS METHODOLOGY

The evaluation of alternative effluent reuse and disposal options for the Yountville/Veterans Home Joint Wastewater Treatment Plant was made using a spreadsheet-based water mass balance model and projected 2020 effluent flow rates. The model uses a modification of the method recommended in the California State Water Resources Control Board publication entitled "*Irrigation with Reclaimed Municipal Wastewater, A Guidance Manual*", July 1984. In this method, the recommended irrigation rates are estimated using the evapotranspiration rates of the specific crops being irrigated, in this case, vineyards and golf course turf.

The model accounts for all water inflows and outflows on a weekly basis that affect the volume of storage, irrigation rates and discharges to the river. The inflows and outflows are listed in **Table 4-1**.

**Table 4-1**

**Summary of Model Inflows and Outflows**

| | |
|---|---|
| **Inflows** | Joint Treatment Plant effluent |
| | Direct precipitation on storage pond surfaces |
| | Local runoff – storage pond levees and Lake Hinman watershed lands |
| **Outflows** | Evapotranspiration by plants and turf |
| | Allowance for salinity control in plant root zone |
| | Evaporation from storage pond and lake surfaces |
| | Percolation from storage ponds – assumed to be zero for lined ponds |
| | Discharges to Napa River |

With all of the inflows, outflows and irrigation needs of the vineyards and golf course turf accounted for, the total amount of water used for irrigation, discharged to the Napa River, and the required storage volume can be determined for each week. A solution to the mass balance model exists when the total quantity of water entering the system over a complete year is equal to the total quantity of water leaving the system.

For this analysis, the crops included in the model runs are vineyards and golf course turf. The total irrigated areas are summarized in **Table 4-2.** The theoretical plant evapotranspiration coefficients ($k_C$) for vineyard irrigation have been adjusted to reflect actual water use for drip irrigation as estimated by the vineyard owners. The adjustment reflects the fact that drip irrigation applies water to the immediate vicinity of each plant rather than over the total vineyard area.

**Table 4-2**

**Summary of Existing and Proposed Irrigation and Storage Facilities**

| Entity | Existing | Proposed | Area Under Irrigation, ac | Total Storage Volume, ac-ft | Contracted Water Use[a], ac-ft/yr |
|---|---|---|---|---|---|
| **Vineyard** | | | | | |
| Chimney Rock | X | | 137 | 35 | 40.66 - 64.44 |
| Clos du Val | X | | 180 | 71 (59)[b] | 40.66 - 64.44 |
| Stags Leap | X | | 118[c] | 6 | 56.93 - 76.72 |
| *Subtotal-existing* | | | *435* | *112 (100)* | |
| Silverado - West | | X | 92 | 28 | |
| - East | | X | 93 | 44 | |
| Other | | X | not avail. | not avail | |
| **Total vineyard** | | | **620+** | **184+ (172+)** | |
| **Golf Course Turf** | | | | | |
| Vintner's Golf Course | X | | 45(56.4)[d] | 25 | |
| **Totals – vineyard + turf** | | | **665 (676.4)+** | **209+ (197+)** | |

a minimum and maximum contracted amounts

b 12 ac-ft additional storage available after Title 22 upgrade to Joint Treatment Plant

c includes 15 ac landscape and lawn irrigation

d irrigation area increases to 56.4 ac during critical fall period per water management agreement between Town and Vintner's Golf Course

The period for river discharge used in the model is the same as that contained in the Town's NPDES permit, that is, October 1 through May 15. The minimum river dilution ratio in the model is the permitted level of 25 to 1, which means that effluent discharge is constrained so that it is never greater than one part effluent for 25 parts of natural river flow. Other dilution ratios greater than 25 to 1 are also modeled to determine the effect of limiting discharges during certain portions of the year.

Both wet and dry climatic conditions and river flows, as well as various discharge and reuse configurations, were used in the analysis.

**Climatic Conditions**

To use the model for the various effluent reuse and disposal alternatives, estimates of the "design" wet and dry years must be developed. This is necessary because the irrigation rates, river discharge rates and required storage volumes are different under "wet" and "dry" climatic conditions. The climate condition that results in the largest storage volume will determine the final facility requirements. The method used to develop the design wet and dry conditions for the model runs is described in Appendix A.

***Rainfall and River Flows*.** In general, estimating the climatic conditions for wet and dry years consists of coupling estimates of high and low precipitation rates together with high and low Napa River flows, respectively. This assumes that when there is high precipitation, there is also a high river flow. Conversely, low precipitation is coupled with a low river flow. It is unlikely that there will be a period of high rainfall that is not accompanied by a high river flow, and visa versa for low rainfall and low river flow.

Thirty-one years of rainfall data for Yountville collected by the staff at the Joint Treatment Plant site were used to estimate the high and low annual precipitation values. These data are shown on **Figure 4-1** arranged in increasing order of magnitude and plotted on probability paper. From the figure, the median annual rainfall (i.e. 1/2 of values are lower and 1/2 are higher) is approximately 34 in/yr. Estimates of the "dry" and "extremely dry" annual rainfall amounts for use in the model are assumed to be the 10 percent and 5 percent values from the figure. "Wet" and "extremely wet" annual rainfall amounts are estimated from the 90 percent and 95 percent values on the figure. Annual rainfall data used in the model are summarized in **Table 4-3**.

**Figure 4-1**
**Probability of Occurance - Total Annual Rainfall - Yountville**

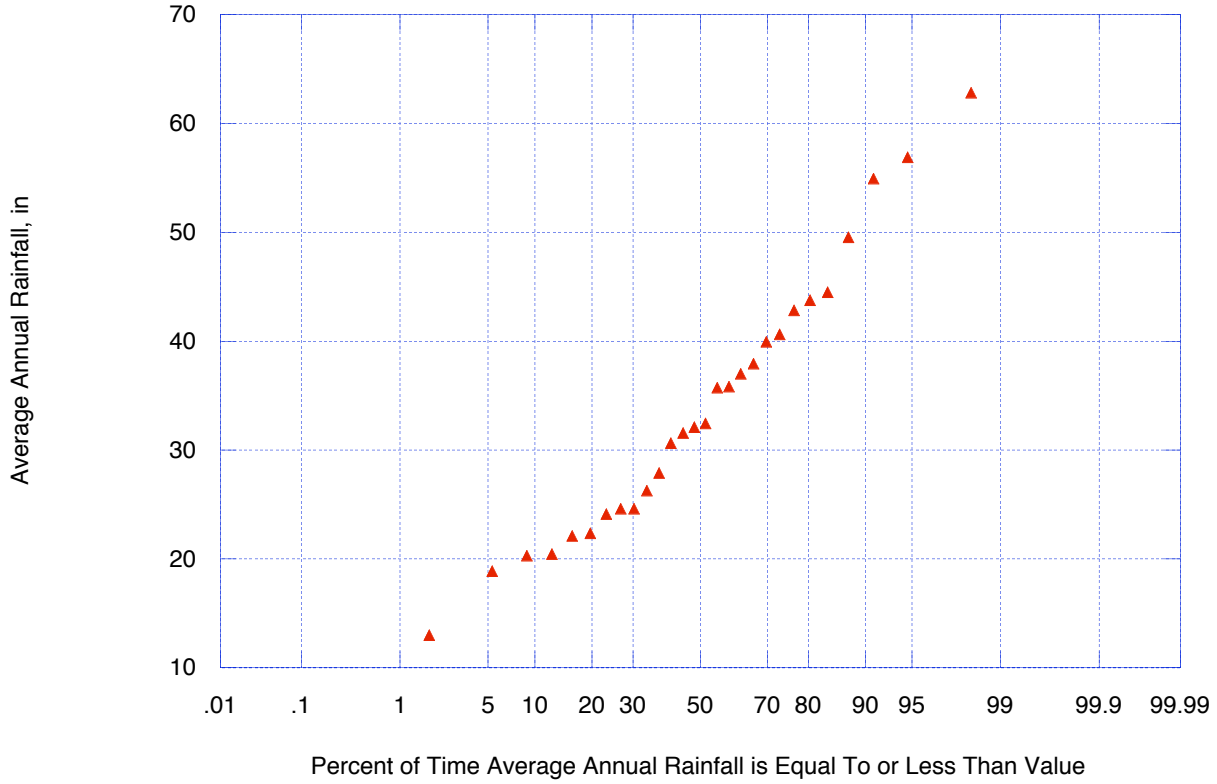


**Table 4-3**

**Summary of Annual Rainfall Used in Mass Balance Model**

| Rainfall Condition | Percent from Probability Plot | Precipitation, in/yr | Percent of Median |
|---|---|---|---|
| Extremely dry | 5 | 20 | 58 |
| Dry | 10 | 21 | 61 |
| Median* | 50 | 34 | 100 |
| Wet | 90 | 54 | 161 |
| Extremely wet | 95 | 60 | 176 |

* approximately equivalent to average

Similarly, forty years of data for Napa River flows are shown in **Figure 4-2**. Weighted averages of the Napa River flows measured at Napa and St. Helena were used in accordance with the current NPDES permit for the Joint Treatment Plant as described in Appendix A (*i.e.* near Napa - 0.73, near St. Helena - 0.23). Design river flow conditions, taken from Figure 4-2, are summarized in **Table 4-4**.

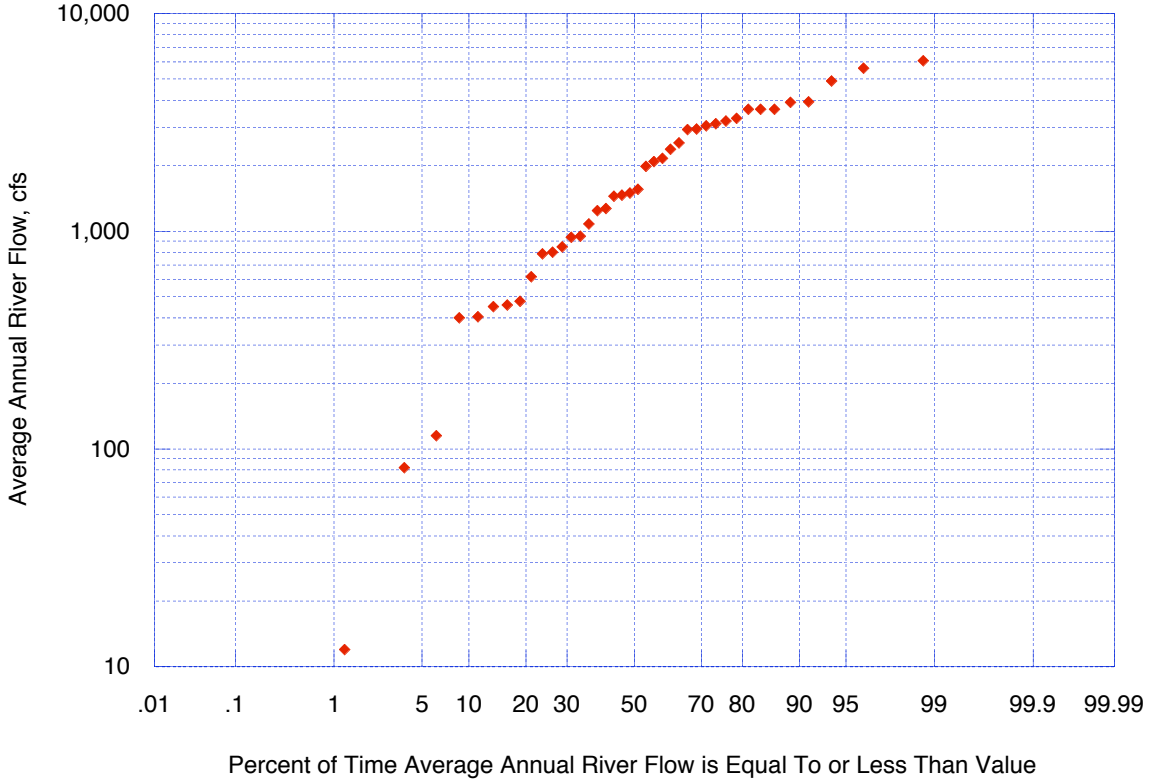
**Table 4-4**

**Summary of Annual River Flows Used in Mass Balance Model**

| River Flow Condition | Percent from Probability Plot | Cubic feet per second | Percent of Median |
|---|---|---|---|
| Extremely dry | 5 | 110 | 7 |
| Dry | 10 | 410 | 27 |
| Median | 50 | 1,500 | 100 |
| Wet | 90 | 3,900 | 260 |
| Extremely wet | 95 | 4,900 | 330 |

Note that the variability of the Napa River flows is much greater than the annual precipitation as measured by the percent of median value for each climatic condition. This is particularly important during dry and extremely dry conditions when allowable discharges to the Napa River during the critical fall months are significantly limited.

**Figure 4-2**
**Probability of Occurance - Average Annual River Flow**



### Storage Pond Depth

A maximum storage pond depth of 12-ft is used in the model runs to minimize the land required and construction costs for storage ponds while maximizing the supply of recycled water available for irrigation.

### Pond Lining

All of the model runs were made assuming the storage ponds are lined to minimize percolation and any potential impact on groundwater quality.

### Lake Hinman

Lake Hinman is a small reservoir located on Veterans Home lands west of the Joint Treatment Plant as shown on Figure A-3 in Appendix A. One of the objectives of the Zero Discharge study is to determine if Lake Hinman can be incorporated into a recycled water program for the Joint Treatment Plant. One of the variables considered in the alternatives analysis is the option to include or exclude local runoff from the Lake Hinman watershed. Since actual measurements of watershed runoff for Lake Hinman are not available, data for the nearby Rector Dam watershed (Ref: *Rector Reservoir Yield Study (Draft)*, June 15, 2000) was used to estimate runoff from the Lake Hinman watershed area. For this analysis, the unit runoff (*i.e.* ac-ft per year per acre) for Lake Hinman is assumed to be the same as the unit runoff for Rector Reservoir.

## RESULTS OF WATER MASS BALANCE MODEL RUNS

A series of water mass balance model runs were made to determine the capacity of the existing irrigation and storage facilities under various climatic conditions, assuming Silverado Vineyard will be served with recycled water. Model runs were also made to determine the total storage volume that will be needed to completely serve the existing users and the four additional vineyards that have expressed interest in using recycled water. Finally, model runs were made to determine the storage and irrigated land requirements assuming that all the recycled water is used for irrigation and none is discharged to the Napa River (Zero Discharge Alternative).

**Capacity of Existing Irrigation and Storage Facilities**

The following assumptions were used in estimating the capacity of the existing irrigation and storage facilities:

- the Silverado Vineyard (185 acres of vineyard and 72 ac-ft of storage) will be included in the recycled water program
- discharge to the Napa River will continue with dilution ratios of 25 to 1 or higher
- actual working storage of existing facilities is equal to 85 percent of the total storage volume

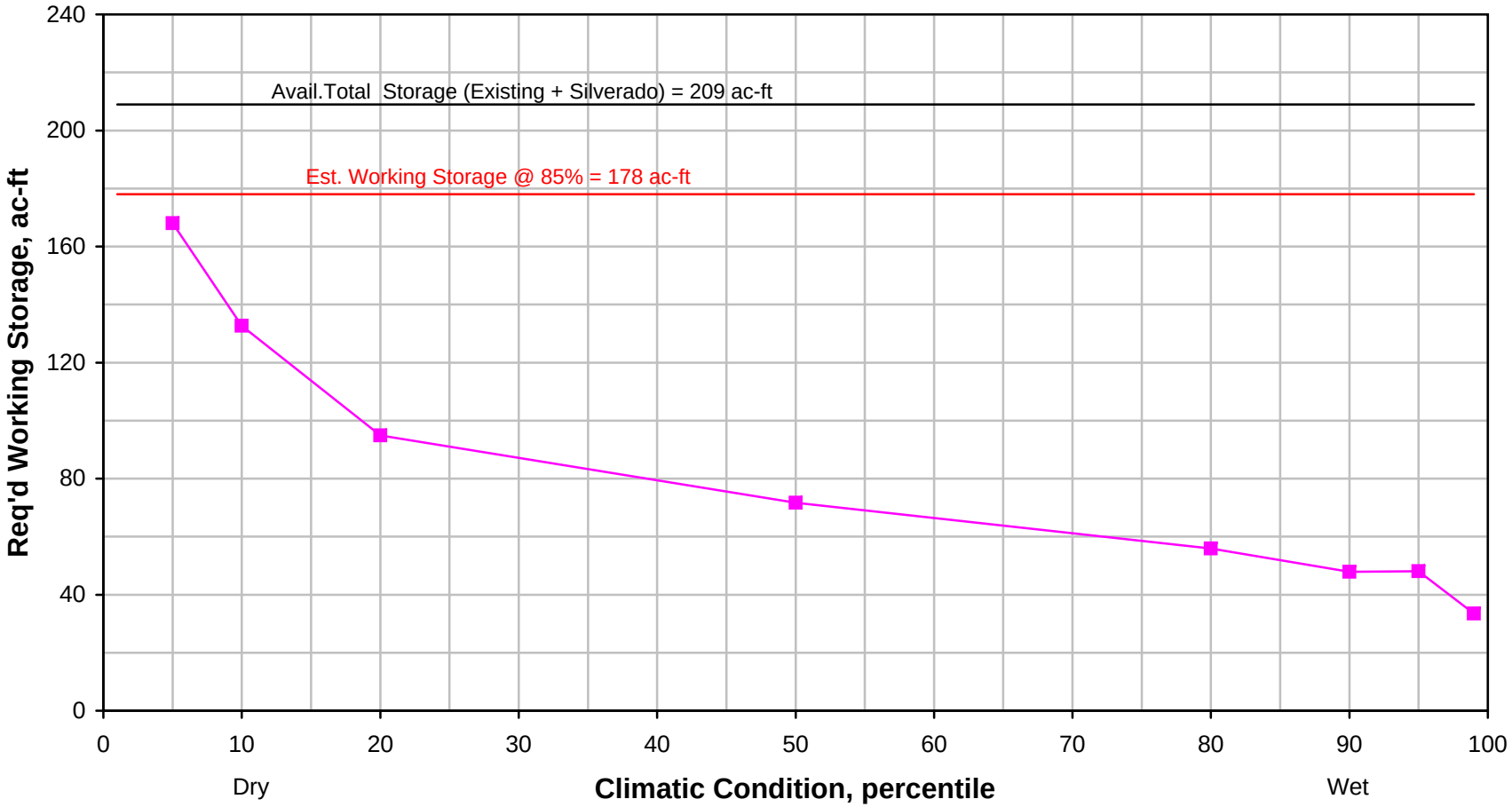
Model runs were made for various dry and wet climatic conditions to determine the storage volume required for each combination of annual precipitation and river flows. The results of the model runs are shown in **Figure 4-3**.

In Figure 4-3, the required working storage is shown for climatic conditions ranging from extremely dry to extremely wet. The total existing storage and estimated working storage volumes are also shown on the figure. Note that, in general, more storage is required under dry conditions than wet conditions. Note also, the existing storage facilities are adequate for all climatic conditions except extremely dry conditions (less than 5-percentile). This means that all of the recycled water can be used beneficially for irrigation and any discharges of excess recycled water to the Napa River will meet the applicable dilution requirements under all climatic conditions except the most extreme.

Under severe drought conditions (less than 5-percent), not enough land is currently being irrigated to use all of the available recycled water and natural river flows during the late fall are so low that excess effluent flows during that time cannot be discharged within the minimum dilution requirement. In this case, the excess tertiary effluent would have to be discharged to the river at dilutions less than 25 to 1 during the October-November period.

According to the model, all other discharges to the Napa River would be tertiary effluent at dilutions of at least 25 to 1 for all other climatic conditions.

**Figure 4-3**
**Working Storage Requirements**
**(With Discharge @ 25 to 1 or Greater)**



Finally, the available recycled water is insufficient to completely support the irrigation needs of all the current users under all climatic conditions. Under dry conditions, recycled water shortfalls could last up to 20 weeks during the summer and early fall months and a supplemental source of irrigation water would have to be obtained by the vineyards. Therefore, any additional users of recycled water will need to be served on an "interruptible" basis.

**Storage Requirements for Additional Recycled Water Users**

The mass balance model was used to determine the total storage volume needed to serve any additional recycled water users. For three climatic conditions - Dry (10-percentile), Average (50- percentile), and Wet (90- percentile), the required total storage volume to serve each increment of additional vineyard area is shown in **Figure 4-4.** The resulting model solutions are optimized for each given climate condition; that is, the total storage volume is sufficient to meet all irrigation demands while maintaining a dilution of 25 to 1 or greater for all discharges to the Napa River. For example, if an additional 200 acres of vineyard is to be served with recycled water, the total working storage (existing + new) would have to be approximately 240 ac-ft under wet climatic conditions and 375 ac-ft for average climatic conditions. Under dry climatic conditions, only an additional 77 acres of vineyard can be supported and approximately 323 ac-ft of working storage would be required. Since an estimated 178 ac-ft of total working storage already exists, the new vineyard areas would have to provide additional working storage of at least 197 ac-ft to satisfy most climatic conditions.

From Figure 4-4, a maximum value exists for additional irrigation acreage under each climatic condition - approximately 77 ac (Dry), 210 ac (Average) and 515 ac (Wet). These values represent the maximum additional vineyard area that can be fully served with the available recycled water. Any additional users could only be served on an interruptible basis.

**Storage Requirements for Zero Discharge Alternative**

Model runs were made to determine the additional irrigation area and total storage requirements if all discharges to the Napa River were eliminated – the zero discharge alternative. The results are shown on **Figure 4-5**. For example, under wet climatic conditions (90-percentile) an additional 604 acres of vineyard area and 461 ac-ft of working storage would be required to fully utilize all the recycled water without discharge to the Napa River. Therefore, approximately 283

**Figure 4-4**
**Additional Irrigation vs. Working Storage Required**

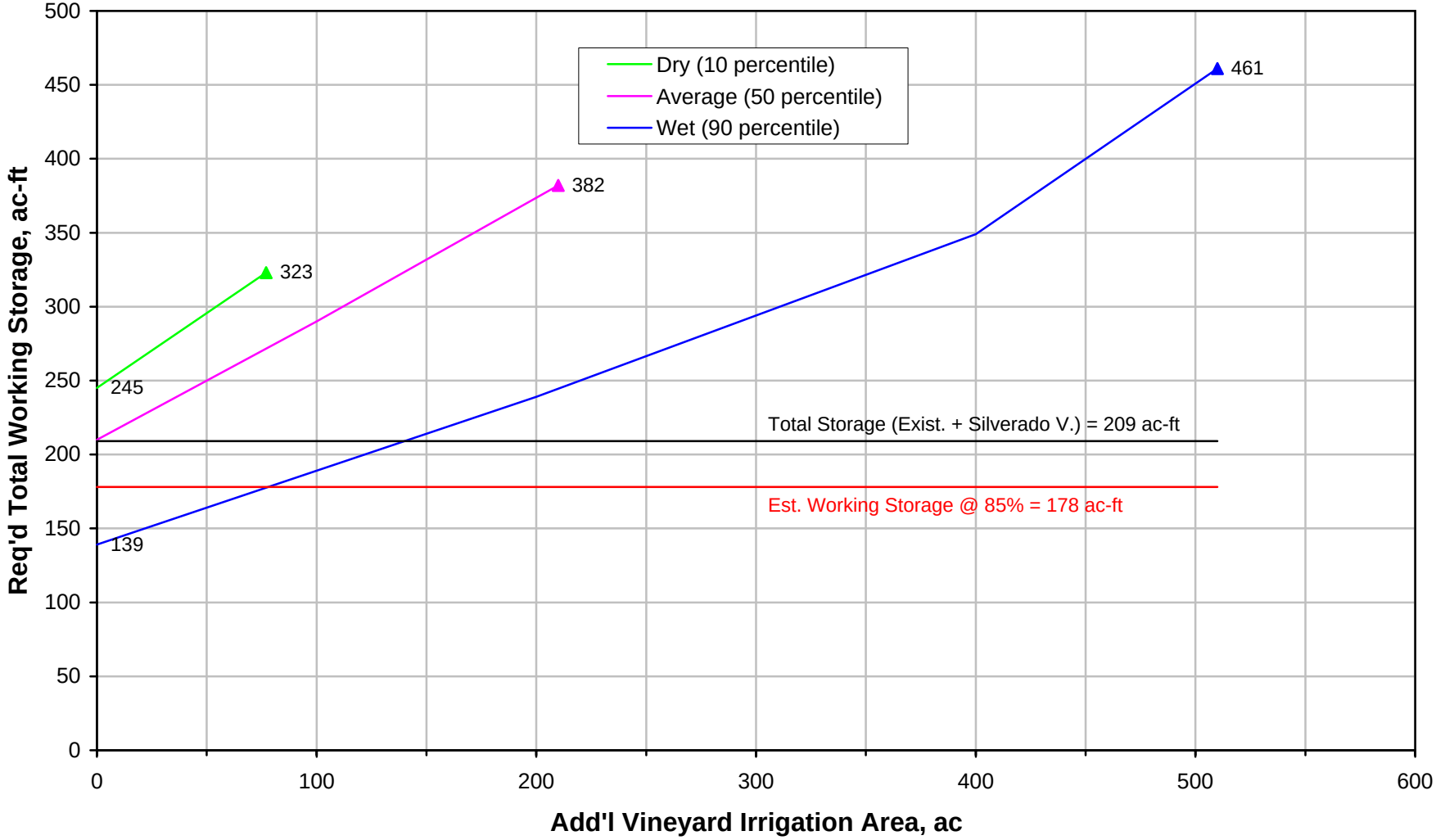
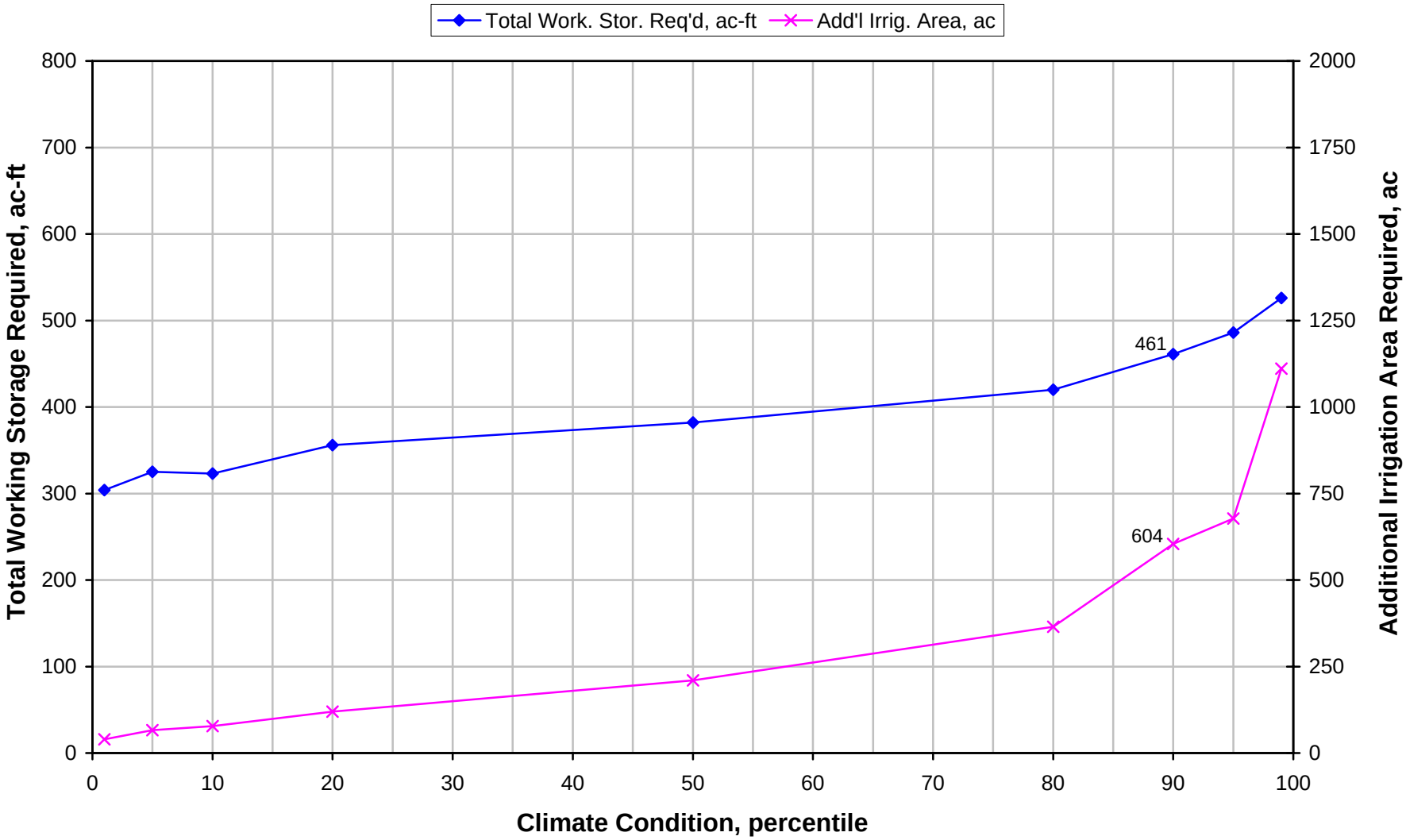


**Figure 4-5**
**Summary - Zero Discharge Alternative**



ac-ft of new working storage would be required in addition to the 178 ac-ft that currently exists. In this configuration, the project would be "Zero Discharge" for all climatic conditions up to 90-percentile. For climatic conditions wetter than 90-percentile (statistically one year out of ten), limited discharges to the Napa River would occur only during extremely wet years at dilutions of 100 to 1 or greater.

**Impact of Lower Population Projections for the Town of Yountville**

All of the model runs presented above were made using 2020 population and design flows developed in 1996 for the *Wastewater Treatment Facility Upgrade Study* (March 1996, WBA). Populations and flows in that report were based on the updated General Plan adopted by the Town in 1992.

Recent data from the *Water Supply Plan Update* (July 2004, West, Yost and Associates) indicates that population growth in the Town has proceeded at a slower rate than expected in the General Plan. In the 1996 *Wastewater Treatment Facility Upgrade Study*, the population of the Town in 2020 was projected to be 2,892 and the average dry weather flow (ADWF) for that population was estimated to be 0.362 mgd. Combined with the estimated ADWF from the Veterans Home of the 0.267 mgd, the total ADWF for the Joint Treatment Plant was estimated to be 0.629 mgd.

Based on projected water usage in the 2004 *Water Supply Plan Update*, the Town's population at buildout is estimated at 2,496, or approximately 400 fewer than the original estimated population. Using water usage estimates from the *Water Supply Plan Update*, the estimated ADWF for the Town's lower population would be 0.305 mgd and, when combined with the Veterans Home, the total ADWF for the Joint Plant would be 0.572 mgd.

Additional model runs were made using the reduced ADWF to determine the impact on the additional storage pond and vineyard requirements. The result of this analysis is shown on **Figure 4-6**. The reductions in flows, working storage requirements and additional vineyard irrigation areas are summarized in **Table 4-5**. Note that the reductions in required working storage volumes under all climatic conditions are essentially equal to the reduction in ADWF. On the other hand, the maximum additional vineyard irrigation areas that can be supported are reduced by a much greater extent with the lower ADWF.

**Figure 4-6**
**Additional Irrigation vs. Working Storage Required - Reduced Town Population**

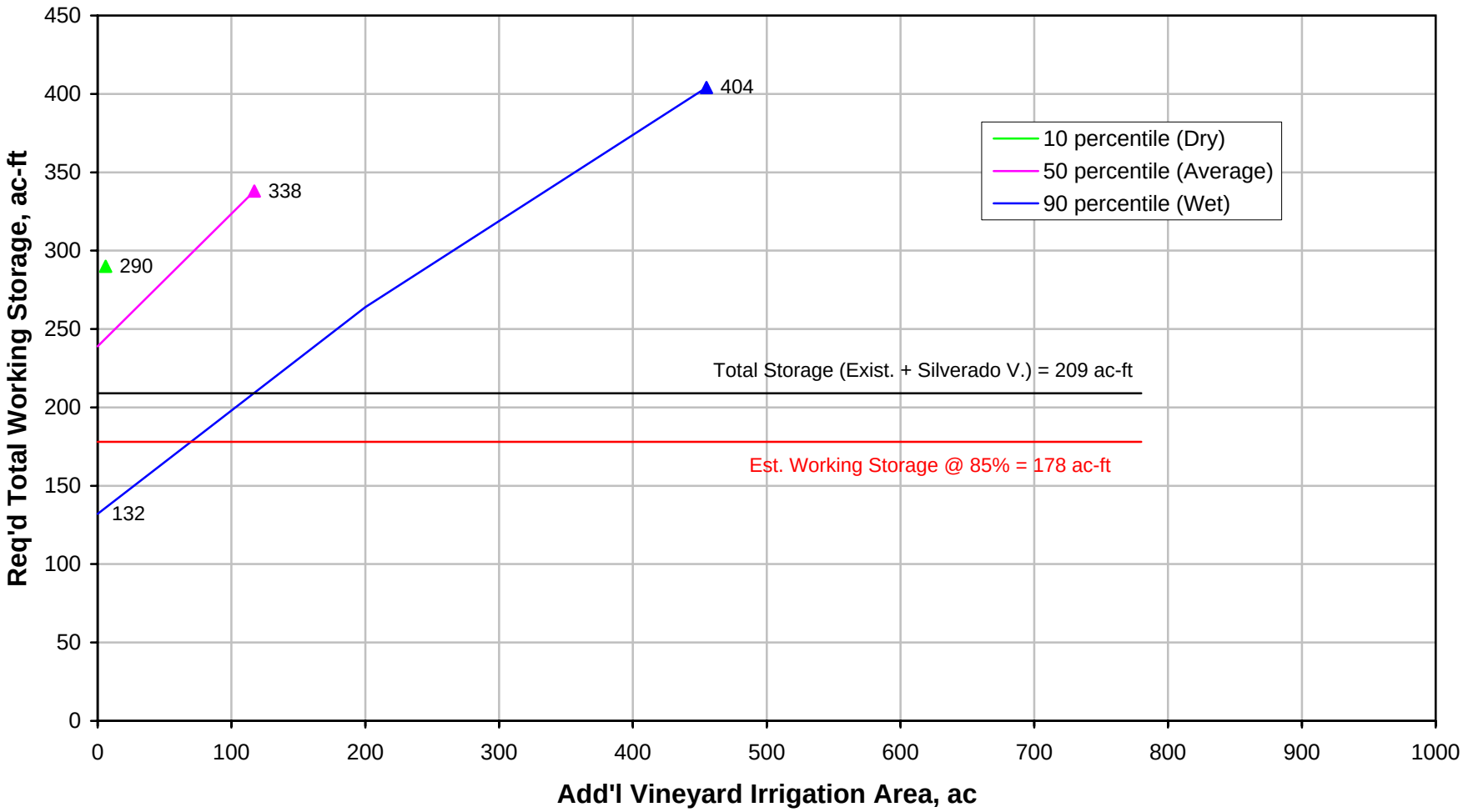


**Table 4-5**

**Summary of Irrigation and Working Storage Requirements For Reduced Town Population**

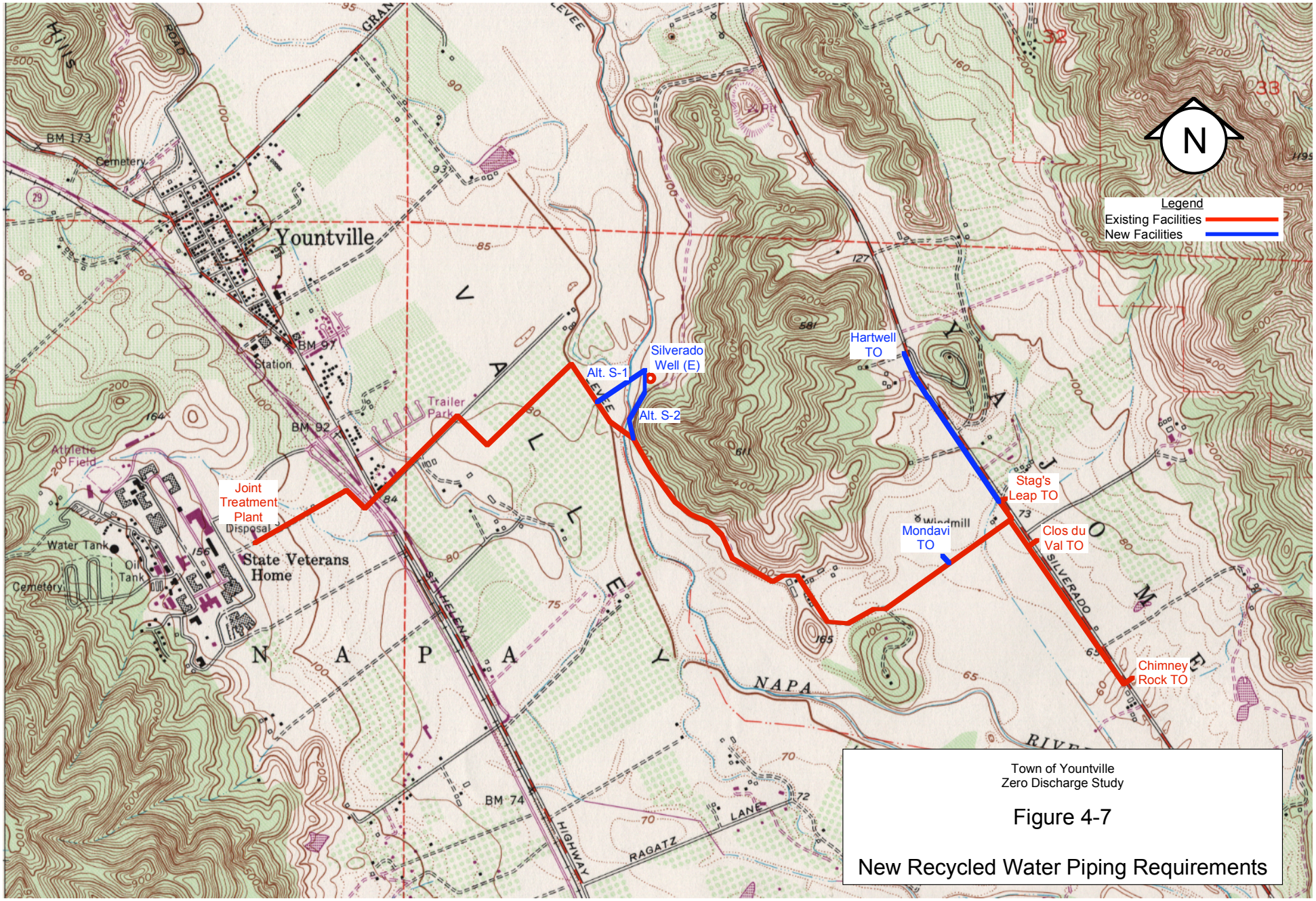
| Parameter | 1996 JWTP Master Plan Flows | Revised for 2004 Water Master Plan Flows | Percent Reduction |
|---|---|---|---|
| Average Dry Weather Flow (ADWF), mgd | 0.629 | 0.572 | 9.1% |
| Total Annual Flow, mg | 249.4 | 226.7 | 9.1% |
| Max. Add'l Vineyard Irrigation, ac | | | |
| @ Dry Conditions (10%) | 77 | 6 | 92.2% |
| @ Average Conditions (50%) | 210 | 117 | 43.9% |
| @ Wet Conditions (90%) | 510 | 455 | 10.8% |
| Max. Working Storage Required, ac-ft | | | |
| @ Dry Conditions (10%) | 323 | 290 | 10.2% |
| @ Average Conditions (50%) | 382 | 338 | 11.5% |
| @ Wet Conditions (90%) | 461 | 404 | 12.4% |

## RECYCLED WATER DISTRIBUTION AND SERVICE REQUIREMENTS

The existing recycled water distribution facilities to serve the current golf course and vineyard customers are adequate and do not require any improvements. Additional distribution and service facilities are needed, however, to serve new users that have expressed interest in using recycled water from the Joint Treatment Plant. The locations of potential new users and the new facilities needed to serve them are shown on **Figure 4-7** and are discussed in the following paragraphs.

### Robert Mondavi Vineyards

The existing recycled water pipeline currently passes through the Mondavi property and includes a tee connection as shown on Figure 4-7. The only new facilities needed to serve this user are a valve and metering station. The cost of the metering station and valve is estimated to be $8,000. The vineyard acreage and existing storage volume is not known at this time, but there are currently two storage ponds on the site.




Town of Yountville
Zero Discharge Study

Figure 4-7

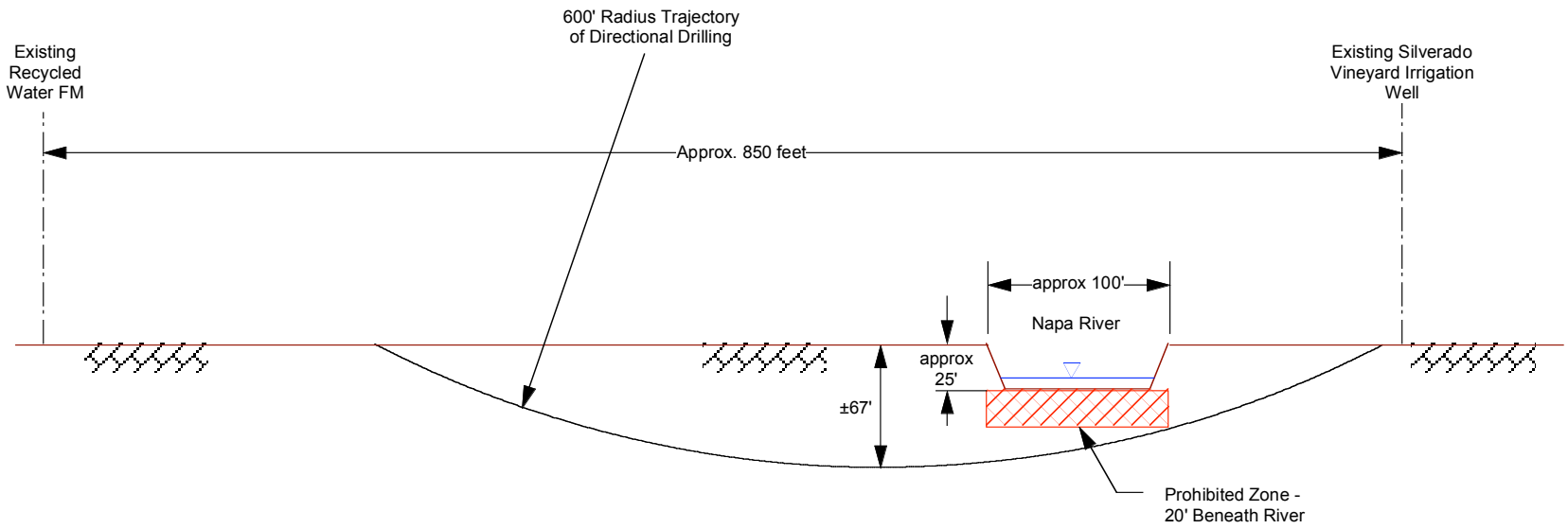
New Recycled Water Piping Requirements

**Silverado Vineyards**

Silverado Vineyards has approximately 185 ac of vineyard located on both sides of the Napa River north and east of the existing recycled water pipeline. In addition, three ponds with a total of 72 ac-ft of storage are located on the property. Currently, some of the irrigation needs of the vineyard are served by a well located east of the Napa River approximately 850 ft from the existing recycled water pipeline. The storage pond serving the vineyard west of the river can be served by a turnout from the existing recycled water pipeline.

Two alternative routes are evaluated to provide a connection between the Town's recycled water pipeline and the existing Silverado well and on-site irrigation system. The first alternative, S-1, would make a direct connection from the existing recycled water pipeline to the Silverado well by a combination of open cut construction and a pipeline installed by directional drilling under the Napa River. This alternative has the advantage of constructing the pipeline underneath the river without disturbing the natural riparian habitat. The drilling operation would pass at least 20-ft beneath the river bed to prevent blowout of drilling fluids to the river. One special feature of providing recycled water service to the Silverado Vineyards is the need to provide a positive, physical separation between the recycled water line and the existing irrigation well as required by the Title 22 regulations. It is assumed that a swivel elbow arrangement, together with a reduced pressure backflow preventer on the well discharge pipe, will be used. A schematic drawing of the directional drilling alternative is shown on **Figure 4-8**. The estimated cost of Alternative S-1 is summarized in **Table 4-6**.

The second alternative pipeline route, Alternative S-2, is also shown on Figure 4-7. The connection to the existing recycled water pipeline would be located on the east side of the Napa River, so a river crossing would not be required. The service line would run along a dirt roadway at the base of the hill approximately 1,400 ft and terminate at the Silverado well site. The estimated cost of Alternative S-2 is presented in **Table 4-7**. This estimate does not include extra costs for trench excavation in rock. If hard rock is found during further geotechnical investigation, the cost could increase by an estimated 50 percent. A final decision on the routing of the connection to the Silverado Vineyard should be made after a geotechnical investigation is completed.




Town of Yountville
Zero Discharge Study

Figure 4-8

Alternative S-1 -- Directional Drilling

**Table 4-6**

**Cost Estimate - Recycled Water Service to Silverado - Alt S-1**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 9,400 |
| Div. 1 | General Requirements | | | | 7,800 |
| Div. 2 | Site Work | | | | 153,600 |
| Div. 15 | Mechanical | | | | 26,500 |
| | *Subtotal* | | | | *197,300* |
| | Overhead and Profit | % | 20.0% | | 39,500 |
| | *Subtotal* | | | | ***$236,800*** |
| | Engineering & Contingency allowance | % | 25.0% | | 59,200 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$296,000*** |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds, insurance and permits | % | 5.0% | 1.0 | 9,395 |
| | *Division Total* | | | | *9,395* |
| | ***Division Total (Rounded)*** | | | | ***9,400*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500.00 | 1.0 | 1,500 |
| | Surveys/soils investigation | ls | 5,000.00 | 1.0 | 5,000 |
| | Inspection and Testing Fees | ls | 1,000.00 | 1.0 | 1,000 |
| | Field Office | mo | 300.00 | 1.0 | 300 |
| | *Division Total* | | | | *7,800* |
| | ***Division Total (Rounded)*** | | | | ***7,800*** |
| **Div. 2** | **Site Work** | | | | |
| 2100 | Site Preparation | | | | |
| | Clear & grub brush include stumps | ac | 5,850.00 | 0.07 | 410 |
| 02200 | Excavating, Filling & Grading | | | | |
| | Mobilization - equipment | ls | 1,000.00 | 1.0 | 1,000 |
| | Excavation | | | | |
| | Trenches (6" Force Main) | cy | 14.60 | 58 | 847 |
| | Gravel base | | | | |
| | Trenches (6" Force Main) | cy | 23.20 | 13 | 302 |
| | Backfill | | | | |
| | Trenches (6" Force Main) | cy | 5.80 | 39 | 226 |
| | Compaction | | | | |
| | Trenches (6" Force Main) | cy | 8.61 | 39 | 336 |
| | Directional drilling - 6" HDPE (include oioe) | ls | 150,000.00 | 1 | 150,000 |
| | Erosion control area | sy | 1.50 | 333 | 500 |
| | *Division Total* | | | | *153,621* |
| | ***Division Total (Rounded)*** | | | | ***153,600*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 6" | ea | 385.00 | 2.0 | 770 |
| | Reducers - 6x4 | ea | 353.00 | 1.0 | 353 |
| | Plastic Pipe | | | | |
| | 6" HDPE Force Main | lf | 8.90 | 200 | 1,780 |
| | Gate Valves - 6" | ea | 1,120.00 | 2.0 | 2,240 |
| | Flow meter - 4" with box & lid | ea | 5,380.00 | 1.0 | 5,380 |
| | BF Protect/swivel el station | ls | 15,000.00 | 1.0 | 15,000 |
| | Wet tap - 6" | ea | 1,010.00 | 1.0 | 1,010 |
| | *Division Total* | | | | *26,533* |
| | ***Division Total (Rounded)*** | | | | ***26,500*** |

**Table 4-7**

**Cost Estimate - Recycled Water Service to Silverado - Alt S-2**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 3,800 |
| Div. 1 | General Requirements | | | | 5,100 |
| Div. 2 | Site Work | | | | 19,300 |
| Div. 15 | Mechanical | | | | 52,200 |
| | *Subtotal* | | | | *80,400* |
| | Overhead and Profit | % | 20.0% | | 16,100 |
| | *Subtotal* | | | | ***$96,500*** |
| | Engineering & Contingency allowance | % | 25.0% | | 24,100 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$121,000*** |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds, insurance and permits | % | 5.0% | 1.0 | 3,830 |
| | *Division Total* | | | | *3,830* |
| | ***Division Total (Rounded)*** | | | | ***3,800*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500.00 | 1.0 | 1,500 |
| | Surveys | ls | 2,000.00 | 1.0 | 2,000 |
| | Inspection and Testing Fees | ls | 1,000.00 | 1.0 | 1,000 |
| | Field Office | mo | 300.00 | 2.0 | 600 |
| | *Division Total* | | | | *5,100* |
| | ***Division Total (Rounded)*** | | | | ***5,100*** |
| **Div. 2** | **Site Work** | | | | |
| 2100 | Site Preparation | | | | |
| | Clear & grub brush include stumps | ac | 5,850.00 | 0.48 | 2,808 |
| 02200 | Excavating, Filling & Grading | | | | |
| | Mobilization - equipment | ls | 1,000.00 | 1.0 | 1,000 |
| | Excavation | | | | |
| | Trenches (6" Force Main) | cy | 14.60 | 408 | 5,957 |
| | Gravel base | | | | |
| | Trenches (6" Force Main) | cy | 23.20 | 91 | 2,111 |
| | Backfill | | | | |
| | Trenches (6" Force Main) | cy | 5.80 | 272 | 1,578 |
| | Compaction | | | | |
| | Trenches (6" Force Main) | cy | 8.61 | 272 | 2,342 |
| | Erosion control area | sy | 1.50 | 2333 | 3,500 |
| | *Division Total* | | | | *19,296* |
| | ***Division Total (Rounded)*** | | | | ***19,300*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 6" | ea | 385.00 | 2.0 | 770 |
| | Reducers - 6x4 | ea | 353.00 | 1.0 | 353 |
| | Plastic Pipe | | | | |
| | 6" PVC C900 Force Main | lf | 19.60 | 1400 | 27,440 |
| | Gate Valves - 6" | ea | 1,120.00 | 2.0 | 2,240 |
| | Flow meter - 4" with box & lid | ea | 5,380.00 | 1.0 | 5,380 |
| | BF Protect/swivel el station | ls | 15,000.00 | 1.0 | 15,000 |
| | Wet tap - 6" | ea | 1,010.00 | 1.0 | 1,010 |
| | *Division Total* | | | | *52,193* |
| | ***Division Total (Rounded)*** | | | | ***52,200*** |

### Hartwell Vineyards

As shown on Figure 4-7, the Hartwell Vineyards can be served by extending the existing recycled water pipeline to the Stag's Leap Wine Cellars by approximately 2,350 ft along the west side of Silverado Trail. The estimated cost of this service pipeline is summarized in **Table 4-8**.

### Pineridge Vineyards

The Pineridge Vineyard is located approximately 1,600 ft north of the Hartwell Vineyards on the Silverado Trail. Construction of a service to this potential user would be relatively difficult because the route passes over a high point and a rocky outcropping along the highway. In addition, this new service would require modifications to the existing recycled water pumps located at the Joint Treatment Plant to pump over the higher elevation. A cost estimate has not been prepared for this alternative because of the relatively difficult and expensive construction.

### Summary of Additional Distribution and Service Facilities

The estimated costs of the additional recycled water distribution and service facilities are summarized in **Table 4-9**.

**Table 4-9**

**Summary of Distribution and Service Facilities**

| Project Element | Estimated Cost[a] |
|---|---|
| Robert Mondavi Vineyards turn out | $8,000 |
| Silverado Vineyard service - Alt. S-1 | $296,000 (alt) |
| - Alt. S-2 | $121,000 (alt) |
| Hartwell Vineyards turn out | $164,000 |
| Total estimated cost | $293,000 - $468,000 |

[a] Estimates include an allowance of 25 percent for contingencies and engineering costs

**Table 4-8**

**Cost Estimate - Recycled Water Service to Hartwell**

| Item No. | Description | Unit | Unit Cost | Quantity | Cost |
|---|---|---|---|---|---|
| | **Summary** | | | | |
| Div. 0 | Contract Requirements | | | | 5,200 |
| Div. 1 | General Requirements | | | | 5,100 |
| Div. 2 | Site Work | | | | 42,200 |
| Div. 15 | Mechanical | | | | 56,600 |
| | *Subtotal* | | | | *109,100* |
| | Overhead and Profit | % | 20.0% | | 21,800 |
| | *Subtotal* | | | | ***$130,900*** |
| | Engineering & Contingency allowance | % | 25.0% | | 32,700 |
| | ***Total Estimated Cost, rounded up*** | | | | ***$164,000*** |
| **Div. 0** | **Contract Requirements** | | | | |
| | Bonds, insurance and permits | % | 5.0% | 1.0 | 5,195 |
| | *Division Total* | | | | *5,195* |
| | ***Division Total (Rounded)*** | | | | ***5,200*** |
| **Div. 1** | **General Requirements** | | | | |
| | Submittals | ls | 1,500.00 | 1.0 | 1,500 |
| | Surveys | ls | 2,000.00 | 1.0 | 2,000 |
| | Inspection and Testing Fees | ls | 1,000.00 | 1.0 | 1,000 |
| | Field Office | mo | 300.00 | 2.0 | 600 |
| | *Division Total* | | | | *5,100* |
| | ***Division Total (Rounded)*** | | | | ***5,100*** |
| **Div. 2** | **Site Work** | | | | |
| 2100 | Site Preparation | | | | |
| | Clear & grub brush include stumps | ac | 5,850.00 | 0.81 | 4,739 |
| | Excavate working platform | cy | 3.02 | 1741 | 5,258 |
| 02200 | Excavating, Filling & Grading | | | | |
| | Mobilization - equipment | ls | 1,000.00 | 1.0 | 1,000 |
| | Excavation | | | | |
| | Trenches (6" Force Main) | cy | 14.60 | 685 | 10,001 |
| | Gravel base | | | | |
| | Trenches (6" Force Main) | cy | 23.20 | 152 | 3,526 |
| | Backfill | | | | |
| | Trenches (6" Force Main) | cy | 5.80 | 457 | 2,651 |
| | Compaction | | | | |
| | Trenches (6" Force Main) | cy | 8.61 | 457 | 3,935 |
| | Fine grade after pipe installation | cy | 3.02 | 1741 | 5,258 |
| | Erosion control area | sy | 1.50 | 3917 | 5,876 |
| | *Division Total* | | | | *42,244* |
| | ***Division Total (Rounded)*** | | | | ***42,200*** |
| **Div. 15** | **Mechanical** | | | | |
| 15050 | Piping Systems | | | | |
| | Ductile Iron Pipe fittings | | | | |
| | Els - 90 degrees - 6" | ea | 385.00 | 2.0 | 770 |
| | Tees - 6" | ea | 371.00 | 2.0 | 742 |
| | Reducers - 6x4 | ea | 353.00 | 1.0 | 353 |
| | Plastic Pipe | | | | |
| | 6" PVC C900 Force Main | lf | 19.60 | 2350.0 | 46,060 |
| | Gate Valves - 6" | ea | 1,120.00 | 2.0 | 2,240 |
| | Flow meter - 4" with box & lid | ea | 5,380.00 | 1.0 | 5,380 |
| | Wet tap - 6" | ea | 1,010.00 | 1.0 | 1,010 |
| | *Division Total* | | | | *56,555* |
| | ***Division Total (Rounded)*** | | | | ***56,600*** |

# Chapter 5

# Recommended Title 22 Upgrade Projects

## INTRODUCTION

In the previous chapters, facility requirements and cost estimates are presented for several alternative upgrade projects that would allow the Town of Yountville to produce Title 22 Unrestricted Reuse recycled water for all or a portion of the effluent from the Joint Treatment Plant. In this chapter, a phased capital program is presented that will enable the Town to achieve its objective of maximizing reuse of recycled water from the Joint Treatment Plant.

## RECOMMENDED TITLE 22 UPGRADE PROJECTS

A recommended upgrade program for the Joint Treatment Plant is outlined in the following discussion. It is recommended that the Phase One improvements be designed to provide Title 22 unrestricted recycled water for the current Peak Dry Weather Flow design capacity of 0.63 mgd. The facilities provided at this time, however, should be located and designed so that they can be expanded to a Peak Wet Weather design flow of 2.0 mgd in future phases.

### Joint Treatment Plant Projects

Several of the recommended upgrade projects are required and have no alternatives, including the Fuzzy Filter modifications, plant alarm system and Effluent Storage Pond bypass. The other

upgrade projects have alternatives, including the chemical feed system upgrade and the chlorine contact basin expansion.

The following Joint Treatment Plant improvements are recommended:

***Fuzzy Filter Modifications.*** The following Fuzzy Filter modifications are needed to satisfy the current DHS requirements:

- Rearrange the filter effluent and backwash piping
- Add an automatic valve on the filtered effluent outlet
- Modify the existing filter control and alarm system
- Provide a connection to the existing filter backwash piping to allow filtered water to be used to backwash the filter
- Add a gravity overflow on the Fuzzy Filter housing connected to the backwash outlet piping

These improvements are shown on Figure 3-1 in Chapter 3.

As an alternative to using filtered water to backwash the filter, it may be possible to negotiate an approval from the DHS to substitute a "filter-to-waste" step in the filter backwash cycle. In this step, the water remaining in the filter after the filter backwash is completed will be wasted to the headworks for a short period of time rather than discharged as filtered effluent.

In addition, it is recommended that the filter backwash flows be diverted from the excess flow pond to the plant headworks to reduce future operation and maintenance costs. With this change, the solids contained in the backwash water will be settled out in the primary sedimentation basin and reprocessed by the treatment plant.

***Plant Alarm System.*** It is recommended that improvements to the plant alarm system be included to provide automatic notification of failure of the following systems:

- Failure of the biological process
- Failure of the coagulation process

Further, all of the alarms must be tied to a single master alarm that will notify the operations staff and/or the police station.

***Effluent Storage Pond Bypass.*** It is recommended that a direct connection to the existing reclaimed water pumps be provided by adding a sluice gate to the inlet to the 15-inch Napa River outfall and constructing an 8-inch suction pipeline between the manhole and the existing recycled water effluent pumps. Variable speed drives will be provided to prevent excessive start-stop cycling and possible overheating of the existing effluent pump motors. In addition, a connection between the effluent holding pond and the existing excess flow return pumps is recommended to increase the capacity and reliability of the excess flow/effluent storage pond system.

***Chemical Feed System.*** The Title 22 regulations require that the coagulating chemical feed system be automatically controlled for feed rate and dosage. It is recommended that a new building adjacent to the storage tank and new chemical feed pumps with both speed and dosage controls be provided. The building would be approximately 8 feet by 8 feet of wood frame or prefabricated metal construction.

***Chlorine Contact Basin Expansion.*** It is recommended that the existing head tank be abandoned and a new, expanded concrete contact basin be constructed to supplement the existing chlorine contact basin. The additional contact tank volume to achieve the needed 90 minute modal detention time can be provided by a new concrete basin of approximately 12,250 cubic feet of volume for a design Peak Dry Weather flow of 1.16 mgd. This would consist of 6-8 channels similar to the left-hand four channels shown in Figure 3-3 in Chapter 3. It is further recommended that the additional chlorine contact time required to provide Title 22 Unrestricted Use recycled water for Peak Wet Weather flows, if needed in the future, be provided using floating baffle curtains located at the inlet to the Effluent Storage Pond. The floating baffle curtains are shown on Figure 3-4 in Chapter 3.

### Recycled Water Distribution and Service Projects

Three recycled water distribution and service projects are recommended for implementation when the potential recycled water users request service - Robert Mondavi Vineyards, Silverado Vineyards and Hartwell Vineyards.

***Robert Mondavi Vineyards.*** It is recommended that the needed valve and metering station be provided when this user is ready to receive recycled water service from the Town. The user must provide on-site piping and other facilities required to use the recycled water on private property. The agreement between the user and the Town must specify the areas and types of crops to be irrigated, the volume and schedule of recycled water to be used and the working volume of ponds available for the storage of recycled water.

***Silverado Vineyards.*** An existing turnout to the pond serving Silverado's west vineyard will be activated. Two alternative routes are available to connect the Town's recycled water pipeline with the existing Silverado well and on-site irrigation system. The first alternative, S-1, would provide a direct connection of approximately 850 ft between the existing recycled water pipeline and the Silverado well using combination of open cut construction and a pipeline installed by directional drilling under the Napa River. The second route, Alternative S-2, would be located on the east side of the Napa River, so that a river crossing would not be required. This service line would run along a dirt roadway at the base of the hill approximately 1,400 ft and terminate at the Silverado well site. A final decision on the routing of the connection to the Silverado Vineyard should be made after geotechnical investigations of both routes are completed and the extent of rock excavation for Alternative S-2 is known.

A positive, physical separation between the reclaimed water line and the existing irrigation well, required by the Title 22 regulations, will consist of a swivel elbow arrangement, together with a reduced pressure backflow preventer on the well discharge pipe.

***Hartwell Vineyards.*** A 2,350 ft extension of the existing distribution pipeline from the Stag's Leap Wine Cellars to the Hartwell Vineyards northward along the west side of Silverado Trail is recommended when this potential user is ready for recycled water service. The same on-site facility and user contract requirements described previously should be applied to this user.

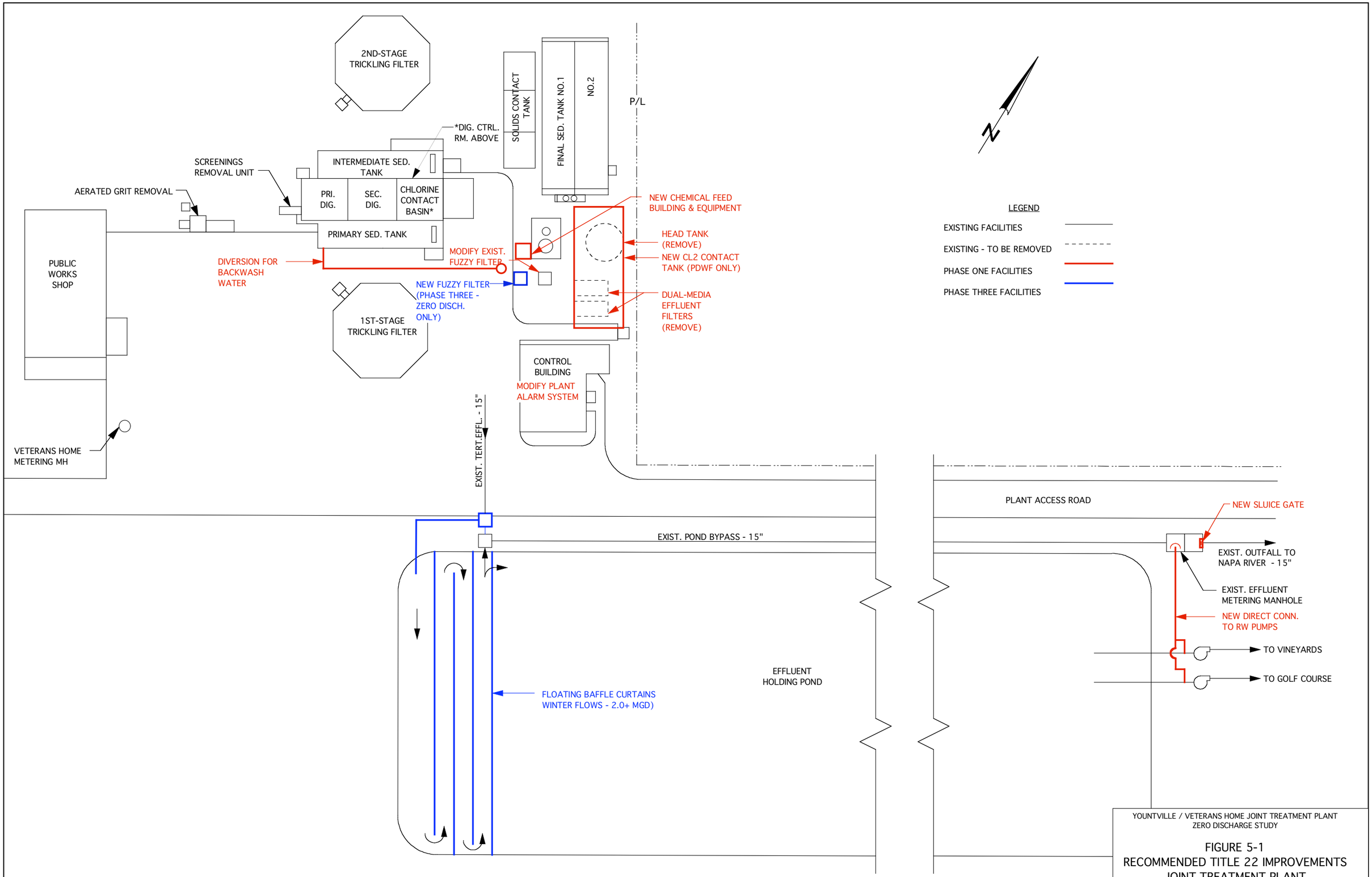
## ESTIMATED COSTS OF RECOMMENDED PROJECTS

The estimated costs of the recommended Title 22 modifications are presented in this section. The cost estimates assume that the work will be accomplished during 2006. If the projects are delayed beyond 2006, the estimated costs need to be adjusted for general inflation in

construction costs. The estimated costs assume that the work will be accomplished by general engineering contractors using traditional design, bid and build procedures with open competitive bidding.

The estimated costs for the improvements are combined into phases and summarized in **Table 5-1.** The Phase One projects will allow the Joint Treatment Plant to produce Title 22 Unrestricted Use recycled water for the design peak dry weather flow of 1.16 mgd, assuming that discharges of excess recycled water to the Napa River will continue. Phase Two projects include the new distribution and service facilities required to serve the potential new recycled water customers and will be constructed at the time the service is required. Phase Three projects will be required if, and when, the Town needs to provide full Title 22 treatment to all flows to the Joint Treatment Plant peak wet weather capacity of 2.0 mgd. The additional Fuzzy Filter may not be required in the future if it is found that lower wet-weather flows, improved peak flow management and limited river discharges at permitted dilution ratios can be achieved.

The phased Joint Treatment Plant projects are shown on **Figure 5-1**.




YOUNTVILLE / VETERANS HOME JOINT TREATMENT PLANT
ZERO DISCHARGE STUDY

FIGURE 5-1
RECOMMENDED TITLE 22 IMPROVEMENTS
JOINT TREATMENT PLANT

**Table 5-1**

**Estimated Costs of Recommended Title 22 Upgrade Projects**

| Phase & Project Element | Estimates Costs, $1,000 |
|---|---|
| **Phase One Projects (PDW Flows and Continued Discharge)** | |
| Fuzzy Filter Modifications | |
| Fuzzy Filter | 103 |
| Divert Backwash to Headworks | 26 |
| Chemical Feed System – New at Storage Tank | 15 |
| Chlorine Contact Expansion | |
| New Concrete Contact Basin (Includes Head Tank Demo) | 202 |
| Alarm System Upgrade (Allowance) | 25 |
| Bypass Effluent Storage Pond | 94 |
| **Total Estimated Cost - Phase One** | **$465** |
| **Phase Two Projects (Distribution and Service Facilities)** | |
| Mondavi Vineyards Turnout | 8 |
| Silverado Vineyards Service Connection | |
| Alt. S-1 Directional Drilling | 296 (alt) |
| Alt. S-2 East of Napa River | 121 (alt) |
| Hartwell Vineyards Service Connection | 164 |
| **Total Estimated Cost - Phase Two** | **$293 - $468** |
| **Phase Three Projects (PWW Flows)** | |
| Additional Fuzzy Filter | 407 |
| Chlorine Contact Expansion | |
| Floating Baffle Walls in Effluent Storage Pond | 74 |
| **Total Estimated Cost - Phase Three** | **$481** |

# Appendix A

# Water Mass Balance Model
# For
# Yountville Zero Discharge Study

## WATER MASS BALANCE METHODOLOGY

The evaluation of alternative effluent reuse and disposal options for the Yountville/Veterans Home Joint Wastewater Treatment Plant (Joint Treatment Plant) was made using a spreadsheet-based water mass balance model and projected 2020 effluent flow rates. The model uses a modification of the method recommended in the California State Water Resources Control Board publication entitled *Irrigation with Reclaimed Municipal Wastewater, A Guidance Manual*, July 1984. In this method, the recycled water irrigation rates are matched to the site-specific evapotranspiration rates of the crops being irrigated - in this case, golf course turf and vineyards.

The model accounts for all the water inflows and outflows on a weekly basis that affect the volume of storage, irrigation and river discharge. The inflows and outflows are listed in **Table A–1.**

**Table A-1**

**Summary of Model Inflows and Outflows**

| | |
|---|---|
| **Inflows** | Joint Treatment Plant effluent |
| | Direct precipitation on storage pond surfaces |
| | Local runoff – storage pond levees and Lake Hinman watershed lands |
| **Outflows** | Evapotranspiration by plants and turf |
| | Allowance for salinity control in plant root zone |
| | Evaporation from storage pond and lake surfaces |
| | Percolation from storage ponds – assumed to be zero for lined ponds |
| | Discharges to Napa River |

Other outflows, such as frost and heat protection, structural fire protection, or other direct applications can be accommodated in the mass balance model with minor modifications.

With all of the inflows, outflows and the irrigation needs for golf course turf and vineyards accounted for, the total amount of water available for irrigation and the corresponding land required for irrigation and storage ponds can be determined. A solution to the mass balance model exists when the total quantity of water entering the system over a complete year equals the total quantity of water leaving the system.

Joint Treatment Plant influent flows used in the model are based on actual 1994 influent flows that are projected to future estimated 2020 dry-weather flows. Actual average influent flows for each week during 1994 were taken from plant operating records. The average annual flow in 1994 was 0.461 million gallons per day (mgd), and the average dry-weather flow (May 1 - October 30) was 0.424 mgd. For use in the model, the 1994 flows were multiplied by a constant (*i.e.* 1.4855) to produce the weekly influent flows associated with the dry-weather capacity of the Joint Treatment Plant of 0.63 mgd estimated in the 1996 Master Plan (WBA, 1996). The associated average annual flow rate is 0.69 mgd. Because actual flows from 1994 are the basis of the flows used in the model, infiltration/inflow (I/I) flows are automatically incorporated in the model results. Influent flow rates, rather than effluent flows, are used in the model because miscellaneous losses through the plant and effluent used for other reuse types (dust control, etc.)

are minimal and using influent flows is a conservative estimate of possible discharges in the future.

In the model, the main crops under irrigation are golf course turf and vineyards. The total irrigated areas are summarized in **Table A-2**.

**Table A-2**

**Summary of Existing and Proposed Irrigation and Storage Facilities**

| Entity | Existing | Proposed | Area Under Irrigation, ac | Total Storage Volume, ac-ft | Contracted Water Use[a], ac-ft/yr |
|---|---|---|---|---|---|
| **Vineyard** | | | | | |
| Chimney Rock | X | | 137 | 35 | 40.66 - 64.44 |
| Clos du Val | X | | 180 | 71 (59)[b] | 40.66 - 64.44 |
| Stags Leap | X | | 118[c] | 6 | 56.93 - 76.72 |
| *Subtotal-existing* | | | *435* | *112 (100)* | |
| Silverado - West | | X | 92 | 28 | |
| - East | | X | 93 | 44 | |
| Other | | X | not avail. | not avail | |
| **Total vineyard** | | | **620+** | **184+ (172+)** | |
| **Golf Course Turf** | | | | | |
| Vintner's Golf Course | X | | 45(56.4)[d] | 25 | |
| **Totals – vineyard + turf** | | | **665 (676.4)+** | **209+ (197+)** | |

a minimum and maximum contracted amounts

b 12 ac-ft additional storage available after Title 22 upgrade to Joint Treatment Plant

c includes 15 ac landscape and lawn irrigation

d irrigation area increases to 56.4 ac during critical fall period per water management agreement between Town and Vintner's Golf Course

The theoretical plant evapotranspiration coefficients ($k_c$) for vineyard irrigation have been adjusted in the model to reflect actual water use for drip irrigation as estimated by the vineyard owners. The adjustment reflects the fact that drip irrigation applies water to the immediate vicinity of each plant rather than over the total vineyard area.

The irrigation rates for the Vintner's Golf Course is assumed to be at agronomic rates or greater, when necessary. The golf course is obligated by an agreement with the Veterans Home to use all

of the effluent produced by the Veterans Home. The agreement generally requires the golf course to irrigate its turf at higher than agronomic rates after October 1st, when nominal turf irrigation needs are reduced and natural river flows are too low to permit discharge to the Napa River.

The period for river discharge used in the model is the same as that contained in the Town's NPDES permit, that is, October 1st through May 15th. The minimum river dilution ratio in the model is the permitted level of 25 to 1, which means that the effluent discharge is constrained so that it is never greater than one part effluent for every 25 parts of natural river flow. Other dilution ratios can be modeled also to determine the effect of using other dilution ratios (e.g. 50 to 1, 100 to 1, etc.) during other times of the year.

Several variations of climatic conditions and river flows, pond sizes (both lined and unlined), and discharge and reuse configurations were tested with the model. These included wet and dry conditions for precipitation and river flow and 12' pond depths with and without linings. Details of these variables are described below.

### *Climatic Conditions*

In order to use the model for the Yountville/Veterans Home effluent reuse and disposal alternatives, estimates of the "design" wet and dry years must be developed. This is necessary because irrigation rates, river discharge rates and required storage volumes are different under "wet" and "dry" climate conditions. The climate condition that results in the largest storage volume will determine the final facility requirements. The methods used to develop the design wet and dry conditions for the model runs are described in the following paragraphs.

***Rainfall and River Flows.*** In general, estimating the climatic conditions for wet and dry years consisted of coupling estimates of high and low precipitation rates together with high and low Napa River flows, respectively. High precipitation rates were estimated by using the 90-percentile and 95-percentile total annual rainfall amounts determined on an annual basis. The 90-percentile value is the value in a set of rainfall data for which 90 percent of the values will be lower. The 90-percentile rainfall is considered to be a "wet" year that will statistically be exceeded 1 year in 10 years. The 95-percentile rainfall is considered to be an "extremely wet" year that statistically will be exceeded only 1 year in 20 years. For the estimated low

precipitation conditions, the 10-percentile and 5-percentile annual rainfall amounts were used. Therefore, the 10-percentile ("dry") annual rainfall amount will be less than the value 1 year in 10 years and the 5-percentile ("extremely dry") annual rainfall will be less than the value only 1 year in 20 years.

Thirty-one years of rainfall data for the Yountville area, collected by the staff at the Joint Treatment Plant site, were used to estimate the high and low annual precipitation values. These data are shown on **Figure A-1** arranged in increasing order of magnitude and plotted on normal probability paper. From the figure, the median (*i.e.* 1/2 of values are lower and 1/2 are higher) annual rainfall at Yountville is approximately 34 in/yr. Annual rainfall totals used in the mass balance model runs are summarized in **Table A-3**. For reference, the estimated annual 99-percentile precipitation (i.e. occurrence in one year in 100-years) is approximately 69 in/yr. By comparison, for the 2004-05 water year (October 1, 2004 to September 30, 2005), Yountville received 48.18 inches through July 12, 2005 and were able to meet regulatory requirements.

**Table A-3**

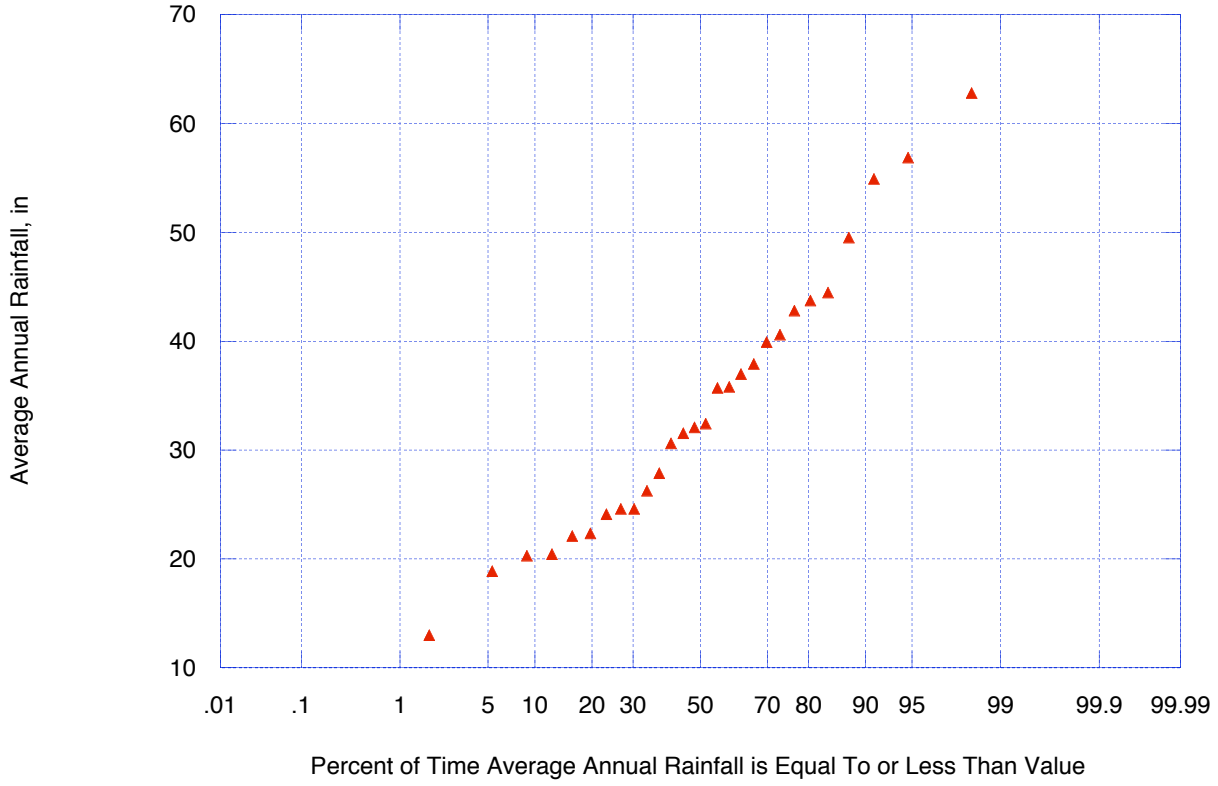
**Summary of Annual Rainfall Used in Mass Balance Model**

| Rainfall Condition | Percent from Probability Plot | Inches/year | Percent of Median |
|---|---|---|---|
| Extremely dry | 5 | 20 | 58 |
| Dry | 10 | 21 | 61 |
| Median* | 50 | 34 | 100 |
| Wet | 90 | 54 | 161 |
| Extremely wet | 95 | 60 | 176 |

* approximately equivalent to average for a normal distribution of data

Similarly, data for average daily river flows from 1929 to 2002 were used to calculate dilution rates for discharges of excess recycled water. Several years during this period, incomplete data were available and, as a result, a total of 40 years of actual data were used. Weighted averages of Napa River flows measured near Napa (USGS Sta. No. 1145800) and near St. Helena (USGS Sta. No. 11456000) were used to estimate river flows at the Yountville discharge location in accordance with the current NPDES permit for the Joint Treatment Plant (i.e. near Napa - 0.73,

**Figure A-1**
**Probability of Occurance - Total Annual Rainfall - Yountville**



near St Helena - 0.27). These data are shown in **Figure A-2**. Design river flow conditions, taken from Figure A-2, are summarized in **Table A-4**.

**Table A-4**

**Summary of Average Annual River Flows Used in Mass Balance Model**

| River Flow Condition | Percent from Probability Plot | Cubic feet per second | Percent of Median |
|---|---|---|---|
| Extremely dry | 5 | 110 | 7 |
| Dry | 10 | 410 | 27 |
| Median | 50 | 1,500 | 100 |
| Wet | 90 | 3,900 | 260 |
| Extremely wet | 95 | 4,900 | 330 |

In the model, high precipitation values are coupled with high river flow values. This assumes that when there is high precipitation, there is also a high river flow. Conversely, low precipitation is coupled with low river flows. It is unlikely that there will be a period of high rainfall that is not accompanied by high river flows, and similarly for low rainfall and low river flows.

The total annual rainfall and river flows are distributed to the individual months in the following manner. The appropriate percentile (*e.g.* 5, 10, 50, 90, 95) is determined for each of the individual months as well as the annual total for the climate condition being modeled. The sum of the individual monthly percentile values is compared to the percentile value based on annual total rainfall or river flow data. The individual monthly values are then adjusted to "annualized" monthly design values so that the sum of the adjusted individual months is equal the annual total value based on annual data. Such an adjustment is needed because when the individual monthly percentile values are combined, the resulting total is significantly more restrictive than the percentile values computed using annual total rainfall and river flow data. This procedure is illustrated for 90-percentile rainfall data in **Table A-5**.

## Figure A-2
## Probability of Occurance - Average Annual River Flow

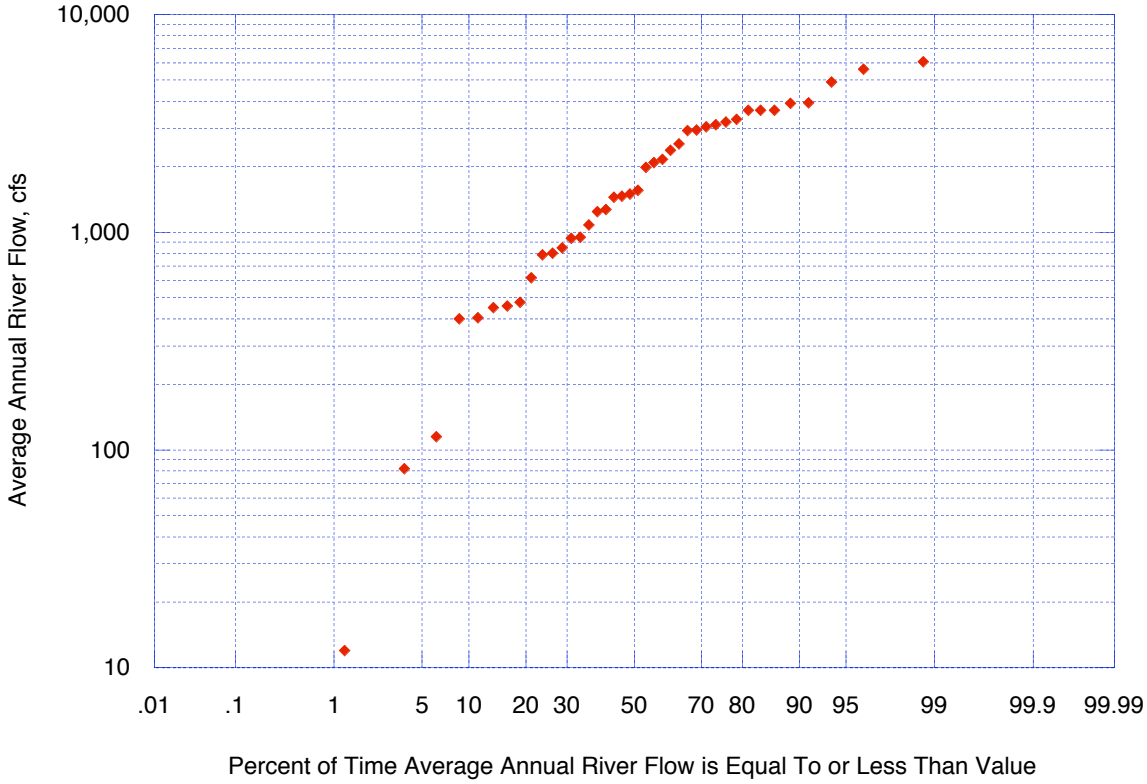


**Table A-5**

**Example of Rainfall Adjustment Procedure**

| | Monthly Values, in | | | | | | | | | | | | Sum of values |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| 90-percentile monthly values | 15.02 | 12.65 | 10.04 | 4.09 | 2.12 | 0.51 | 0 | 0.33 | 1.16 | 4.47 | 10.27 | 13.22 | 73.88 |
| | | | | | | | | | | | | *90-percentile annual total based on annual total data, in =* | *54.41* |
| | | | | | | | | | | | | *Adjustment factor = 54.41/73.88 =* | *0.736* |
| adjusted 90-percentile values | 11.07 | 9.32 | 7.39 | 3.01 | 1.56 | 0.38 | 0 | 0.24 | 0.85 | 3.29 | 7.56 | 9.74 | 54.41 |

### *Storage Pond Depth*

Pond depth is important for two reasons. First, shallow ponds require a larger surface area to have the same volume as a deeper pond. Since the objective is to minimize the land required for storage, deeper ponds will result in a more cost-effective solution.

Second, pond depth is important because the amount of evaporation and percolation from a storage pond depends on the surface area of the pond. Therefore, a shallow pond with a large surface area will lose more water to evaporation and percolation, and this can significantly reduce the volume of recycled water available for beneficial reuse.

A storage pond depth of 12-feet is used in all the current model runs. Previous model runs for joint plant effluent discharge and reuse studies have included both 9-feet and 12-feet pond depths. The deeper 12-feet ponds are used in the current model runs because they are more cost-effective from a construction and land requirement perspective and they will increase the supply of recycled water available for irrigation.

### *Pond Lining*

All of the model runs were made with lined ponds only. Pond lining affects the water mass balance because significant amounts of water can percolate from an unlined storage pond. It is

assumed that a lined pond would have a layer of clay on the bottom that would reduce the water losses due to percolation.

### *Lake Hinman*

Lake Hinman is a small reservoir located on Veterans Home lands west of the joint treatment plant. One of the objectives of the Zero Discharge study is to determine if Lake Hinman can be incorporated into a recycled water program for the joint plant. The location of Lake Hinman is shown on **Figure A-3**. Incorporation of Lake Hinman into the mass balance model required development of stage/area and stage/volume relationships for the reservoir. These were developed using the USGS Quad map for the area and information from the Town staff. The data used for the two relationships are shown in **Table A-6**.

**Table A-6**

**Data for Stage/Area and Stage/Volume Relationships – Lake Hinman**

| Reservoir Stage, ft | Surface Area, ac | Volume, ac-ft |
|---|---|---|
| 0 | 0 | 0 |
| 10 | 0.74 | 12.4 |
| 20 | 1.23 | 22.5 |
| 30 | 1.50 | 30.0 |

One of the variables considered in the analysis is the option to include or exclude local runoff from the Lake Hinman watershed. From the USGS map, the watershed area was estimated to be approximately 185 acres. Since actual measurements of watershed runoff for Lake Hinman are not available, runoff from the watershed area was estimated using actual rainfall and runoff data for the nearby Rector Dam watershed (Ref: *Rector Reservoir Yield Study (Draft)*, June 15, 2000). These data are shown on **Figure A-4**. For this analysis, the unit runoff (*i.e.* ac-ft per year per acre) for Lake Hinman is assumed to be the same as the runoff for Rector Reservoir.

## WATER MASS BALANCE SOLUTION PROCEDURE

The water mass balance model consists of three worksheets in a Microsoft Excel workbook. The first worksheet includes the mass balance model itself. The second worksheet contains historic

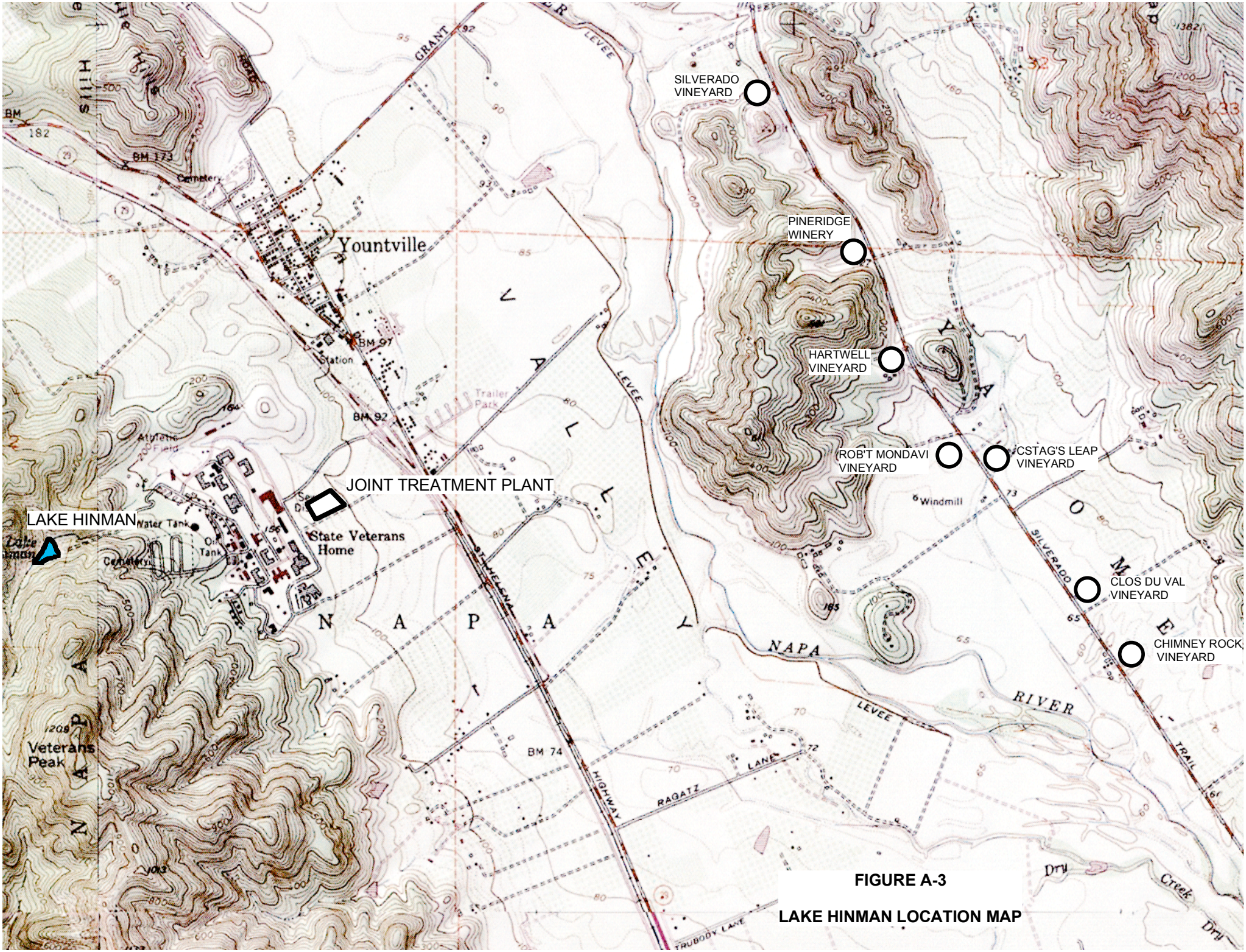
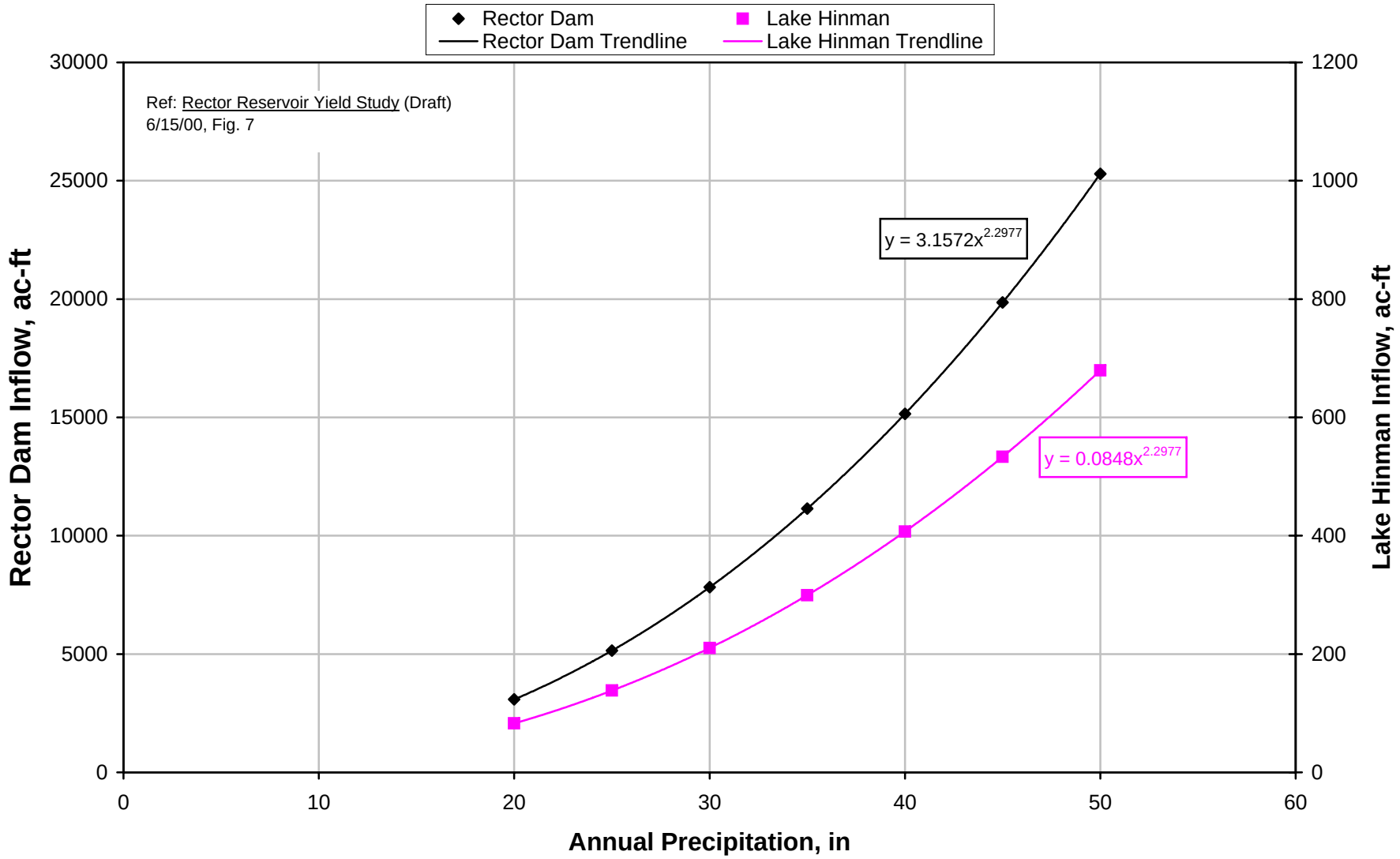



**FIGURE A-3**

**LAKE HINMAN LOCATION MAP**

# Figure A-4
# Lake Hinman Inflow



Napa River flow data and the third worksheet includes historic rainfall data for the Yountville area.

The first page of the mass balance model is a summary of all the input data and model results for the particular set of conditions being modeled. A sample of the summary page is shown on **Figure A-5**. The areas shaded in yellow are values that can be changed to set the conditions for the model run. Water depths in the ponds throughout the year are shown in the chart along the bottom of the page.

The model solution procedure consists of the following steps:

1. Set the input conditions for the model run. These will generally include values for:
   - average dry weather flow to joint treatment plant
   - $k_c$ values for the various crops
   - irrigation efficiency
   - runoff coefficient for pond levees
   - nominal surface area/pond
   - acres under irrigation for various users and crop types
   - discharge to Napa River (Y/N)
   - climate conditions (e.g. dry, wet, average) for precipitation and river flow
   - local runoff at Lake Hinman (Y/N)
2. General procedure: change the acreage for non-existing users (e.g. add'l vineyard, city park, etc.) and the discharge dilution ratios until the starting and ending pond depths are equal. This means that the model solution is balanced and the total inflow equals the total outflow for the year.
3. First, change the starting pond depth so that: 1) the ending pond depth is equal to the starting pond depth and 2) the minimum pond depth is greater than zero, if possible.

**YOUNTVILLE WW RECLAMATION FACILITIES -- ZERO DISCHARGE STUDY WATER BALANCE**

DATA INPUT SHEET: ADWF = 0.63 MGD, WET CONDITIONS | DILUTION RATIO =1/- | 90 YR RETURN RIVER FLOW | 90 YR RETURN PRECIP. | NO L. HINMAN RUNOFF

**ADJUSTMENT FACTORS AND DATA SUMMARY**

(Note: Values in red = input values, black = calculated values)

AVERAGE DRY WEATHER FLOW (MGD) 0.629

| | adj. factor | TOTAL TO IRR. | TOTAL ANNUAL |
|---|---|---|---|
| DOMESTIC WASTE FLOW (MG) | 1.4855 | 175.9 | 249.5 |
| PRECIPITATION (IN) | 1.0066 | | 54.45 |
| TOTAL RIVER FLOW (cfs/yr) | | | 16,809 |
| TOTAL LOCAL RUNOFF (mgal/yr) | | | 0.00 |
| PAN EVAPORATION (IN) | 1.00 | | 53.97 |
| MINIMUM GOLF IRRIGATION RATE (IN/WK): | 0.25 | | |
| ETo | 1.00 | | |
| kc landscape | 0.80 | | |
| kc Chimney Rock | 0.206 | | |
| kc golf turf-Vintners Peak | na | per agreement | |
| kc city park turf | 0.70 | | |
| kc Clos Du Val vineyard | 0.18 | | |
| kc Stags Leap vineyard | 0.13 | | |
| kc Silverado vineyard | 0.11 | | |
| kc addl vineyard | 0.22 | | |
| Factor for pond spacing -- levees | | | |
| IRRIGATION EFFICIENCY: | 80.0% | | |
| RUNOFF COEFFICIENT | 0.0001 | | |
| POND PERCOLATION (in/day) | 0.000 | | |
| NOMINAL POND SURF. AREA acres each= | 10 | | |
| DIVERSION - 2° EFFL. OUT PRIOR TO PONDS (MG): | 0.0 | FROST CONTROL | |

Used to calibrate model

Different design options

Applied Irrigation Demand

| | | | | |
|---|---|---|---|---|
| Chim Rock V | | 0.4 ft/yr | = 5.2 in/yr |
| golf VP | golf req. 2.6 | 3.5 ft/yr | = 42.3 in/yr |
| Stags L | | 2.6 ft/yr | = 30.7 in/yr |
| Stags V | | 0.2 ft/yr | = 2.8 in/yr |
| Clos du Val | | 0.4 ft/yr | = 4.3 in/yr |
| Addl Vineyard | | 0.5 ft/yr | = 5.7 in/yr |
| Cit Parks | | 2.2 ft/yr | = 25.9 in/yr |

**TOTAL AREA USED FOR CROPS: (ACRES)**

| | Chim V | Golf VP | Stags L | Stags V | Clos du Val | Silverado | Addl Vine | City Parks | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 137.0 | 45.0 | 14.0 | 103.0 | 150.0 | 93.0 | 250.0 | 0.0 | 792.0 | ac |
| | 17.3% | 5.7% | 1.8% | 13.0% | 18.9% | 11.7% | [illegible] | [illegible] | 100% | |
| kc | 0.21 | na | 0.80 | 0.13 | 0.18 | 0.11 | [illegible] | 0.70 | | |

TOTAL # PONDS 1.8500 = = = => 22.9 ac land

20.8 ac water surf.

TOTAL ACREAGE (for irrigation, ponds, etc) = = = => 814.9 ac

Available Storage at Reclaimed Water User Sites, ac-ft: 38 | 25 | 33 | 71 | 40 | 207 ac-ft

TOTAL GALLONAGE TO IRRIGATION : (MG)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| actual req. | 19.4 | 56 | 12 | 7.8 | 17.3 | 24.7 | 39 | 176 | MG to irr. |
| VP golf req. | 37.7 | (VH share of DWF) | | | | | | | |

**MODEL INPUT CONDITIONS:**

| | |
|---|---|
| DISCHARGE TO NAPA RIVER (Y/N) | Y |
| MINIMUM DILUTION RATIO, 1 TO ___ | - |
| RIVER FLOW CONDITIONS (WET/DRY/AVERAGE) | WET |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 90 |
| PRECIPITATION CONDITIONS (WET/DRY) | WET |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 90 |
| DISCHARGE FROM STORAGE? (Y/N) | N |
| LOCAL RUNOFF @ LAKE HINMAN? (Y/N) | N |

Set model run conditions

#1

0.0 MG fr store to disch.

81.8 MG effl discharged

257.7 TOTAL Stor+Disch.+Irr.

% of Recy Water to Lake Hinman = 0.00 %

| | Pond Stage | Lake Stage | |
|---|---|---|---|
| START | 1.8 | 10.00 | |
| END | 1.8 ft. | 10 ft. | |
| MAX: | [illegible] | 10 ft. | 30 |
| MIN: | 0.09 ft. | 10 ft. | 10± |

Start = end @ design condition

#3

> 0 ft, if possible

**Pond Data**

Tot. Pond Flow:

IN: 195.9 mgyr

OUT: 195 mgyr

**STORAGE: 222.5 acft**

Pond Hydraulics (Natural)

| | |
|---|---|
| WATER IN FROM PRECIP (MG) = | 27.16 MG |
| WATER LOST TO POND EVAP (MG) = | 19.13 MG |
| WATER LOST TO POND PERC (MG) = | 0.00 MG |
| NET WATER OUT (MG) = | -8.03 MG |

ALTERNATIVE WATER SOURCE ANNUAL TOTAL MG = 0.000 MG

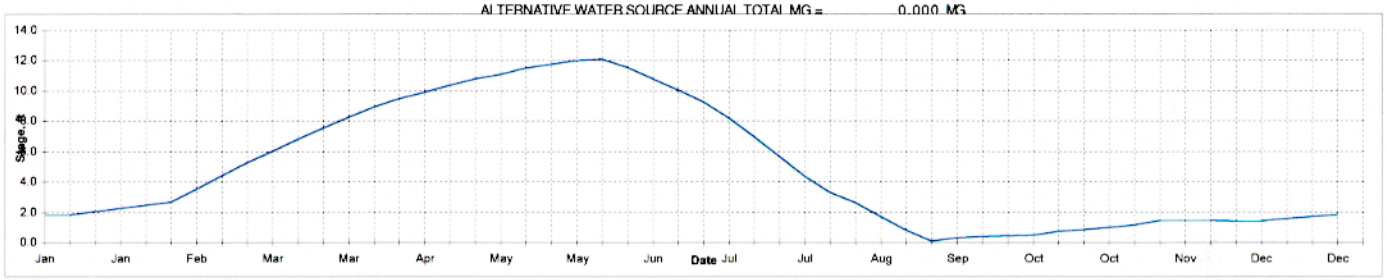
#2 How much add'l land needed for design conditions?

Used to determine storage req'd

#4

#5

| MONTH | DILUTION RATIO 1 TO ... | % POT. EFFL. DISCH'D |
|---|---|---|
| Jan | 1,094 | 100.0% |
| Feb | 1,500 | 43.8% |
| Mar | 1,000,000 | 0.1% |
| Apr | 1,000,000 | 0.0% |
| May | 1,000,000 | 0.0% |
| Jun | 1,000,000 | 0.0% |
| Jul | 1,000,000 | 0.0% |
| Aug | 1,000,000 | 0.0% |
| Sep | 1,000,000 | 0.0% |
| Oct | 25 | 27.5% |
| Nov | 137 | 100.0% |
| Dec | 537 | 100.0% |




| SUPPLEMENTARY WATER SUPPLY | |
|---|---|
| DATE | Mgal/wk |
| 1-Jan | 0.000 |
| 8-Jan | 0.000 |
| 15-Jan | 0.000 |
| 22-Jan | 0.000 |
| 29-Jan | 0.000 |
| 5-Feb | 0.000 |
| 12-Feb | 0.000 |
| 19-Feb | 0.000 |
| 26-Feb | 0.000 |
| 5-Mar | 0.000 |
| 12-Mar | 0.000 |
| 19-Mar | 0.000 |
| 26-Mar | 0.000 |
| 2-Apr | 0.000 |
| 9-Apr | 0.000 |
| 16-Apr | 0.000 |
| 23-Apr | 0.000 |
| 30-Apr | 0.000 |
| 7-May | 0.000 |
| 14-May | 0.000 |
| 21-May | 0.000 |
| 28-May | 0.000 |
| 4-Jun | 0.000 |
| 11-Jun | 0.000 |
| 18-Jun | 0.000 |
| 25-Jun | 0.000 |
| 2-Jul | 0.000 |
| 9-Jul | 0.000 |
| 16-Jul | 0.000 |
| 23-Jul | 0.000 |
| 30-Jul | 0.000 |
| 6-Aug | 0.000 |
| 13-Aug | 0.000 |
| 20-Aug | 0.000 |
| 27-Aug | 0.000 |
| 3-Sep | 0.000 |
| 10-Sep | 0.000 |
| 17-Sep | 0.000 |
| 24-Sep | 0.000 |
| 1-Oct | 0.000 |
| 8-Oct | 0.000 |
| 15-Oct | 0.000 |
| 22-Oct | 0.000 |
| 29-Oct | 0.000 |
| 5-Nov | 0.000 |
| 12-Nov | 0.000 |
| 19-Nov | 0.000 |
| 26-Nov | 0.000 |
| 3-Dec | 0.000 |
| 10-Dec | 0.000 |
| 17-Dec | 0.000 |
| 24-Dec | 0.000 |
| TOTAL | 0.00 |

KEY

Variables that can change

#1 Key to solution procedure steps (Pg. A-9 & 10)

**Figure A-5**

**Sample of Mass Balance Summary Page**

4. Then, change the number of ponds (nominal 10 ac each) to determine the total storage volume required to provide a maximum pond depth of 12 ft.

5. If the input conditions include discharge to the Napa River, change the monthly dilution values so that: 1) the discharge is equal to or less than 100 percent and 2) the dilution ratio is equal to or greater than the permitted value of 25 to 1.

6. By changing the appropriate variables, a balanced solution can be achieved for most input conditions.

## TYPICAL MASS BALANCE SOLUTIONS

During the conduct of the Yountville Zero Discharge study, three types of model solutions were encountered. These included: 1) not enough irrigated area to use all of the recycled water available, 2) not enough recycled water to satisfy all of the irrigation demands, and 3) optimized solutions where the exact amount of recycled water was available to satisfy the irrigation demands while meeting all regulatory dilution ratios.

An example of the first solution type is shown on **Figure A-6**. In this case, only the existing users (not including Silverado Vineyard) are using recycled water and the climate conditions are extremely wet. Note that discharges to the Napa River are maximized while maintaining a minimum dilution of 25 to 1. The starting pond depth is 6.8 ft and the ending pond depth is 8.2 ft. The minimum pond depth is approximately 0 ft. This solution is not balanced because more water is entering the system annually than is used – either beneficially for irrigation or discharged to the river at 25 to 1 dilution or greater. This means that the existing facilities cannot satisfy all the regulatory requirements <u>under these climatic conditions</u>. For reference, a balanced solution is obtained for the configuration in this example under 90-percentile climate conditions.

The second type of solution occurs when there are dry climate conditions and more land is available for irrigation than can be supported. **Figure A-7** is an illustration of this condition. Input conditions include: dry climate (10-percentile) and Silverado Vineyard is included. Note that limited recycled water is discharged at 25 to 1 dilution during the months of October, November and December. During January and February, all of the recycled water is discharged.

# Figure A-6

## Example Solution - Not Enough Irrigated Area Available

**YOUNTVILLE WW RECLAMATION FACILITIES -- ZERO DISCHARGE STUDY WATER BALANCE**

**DATA INPUT SHEET: ADWF = 0.63 MGD, WET CONDITIONS DILUTION RATIO =1/- 95 YR RETURN RIVER FLOW 95 YR RETURN PRECIP. NO L. HINMAN RUNOFF**

**ADJUSTMENT FACTORS AND DATA SUMMARY**

(Note: Values in red = input values, black = calculated values)

AVERAGE DRY WEATHER FLOW (MGD) **0.629**

| | adj. factor | TOTAL TO IRR. | TOTAL ANNUAL |
|---|---|---|---|
| DOMESTIC WASTE FLOW (MG) | 1.4855 | 110.7 | 249.5 |
| PRECIPITATION (IN) | 1.0066 | | 59.61 |
| TOTAL RIVER FLOW (cfs/yr) | | | 21,286 |
| TOTAL LOCAL RUNOFF (mgal/yr) | | | 0.00 |
| PAN EVAPORATION (IN) | 1.00 | | 53.97 |
| MINIMUM GOLF IRRIGATION RATE (IN/WK): | 0.25 | | |
| ETo | 1.00 | | |
| kc landscape | 0.80 | | |
| kc Chimney Rock | 0.206 | | |
| kc golf turf-Vintners Peak | na | *per agreement* | |
| kc city park turf | 0.70 | | |
| kc Clos Du Val vineyard | 0.18 | | |
| kc Stags Leap vineyard | 0.13 | | |
| kc Silverado vineyard | 0.11 | | |
| kc addl vineyard | 0.22 | | |
| Factor for pond spacing -- levees | 1.1 | | |
| IRRIGATION EFFICIENCY: | 80.0% | | |
| RUNOFF COEFFICIENT | 0.0001 | | |
| POND PERCOLATION (in/day) | **0.000** | | |
| NOMINAL POND SURF. AREA acres each= | 10 | | |
| DIVERSION - 2° EFFL. OUT PRIOR TO POND | 0.0 | FROST CONTROL | |

**TOTAL AREA USED FOR CROPS: (ACRES)**

| | Chim V | Golf VP | Stags L | Stags V | Clos du Val | Silverado V | Addl Vine | City Parks | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 137.0 | 45.0 | 14.0 | 103.0 | 150.0 | 0.0 | 0.0 | 0.0 | 449.0 | ac |
| | 30.5% | 10.0% | 3.1% | 22.9% | 33.4% | 0.0% | 0.0% | 0.0% | 100% | |
| kc | 0.21 | na | 0.80 | 0.13 | 0.18 | 0.11 | 0.22 | 0.70 | | |

**TOTAL # PONDS** **0.4670** = = = => 5.8 ac land

5.2 ac water surf.

**TOTAL ACREAGE (for irrigation, ponds, etc)** = = = => 454.8 ac

**Available Storage at Reclaimed Water User Sites, ac-ft**

| | | | | | | |
|---|---|---|---|---|---|---|
| 38 | 25 | 33 | 71 | 40 | 207 | ac-ft |

**TOTAL GALLONAGE TO IRRIGATION : (MG)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| actual req. | 18.9 | 56 | 11 | 7.5 | 17.0 | 111 | MG to irr. |
| *VP golf req.* | 37.7 | (VH share of DWF) | | | | | |

**MODEL INPUT CONDITIONS:**

| | |
|---|---|
| DISCHARGE TO NAPA RIVER (Y/N) | Y |
| MINIMUM DILUTION RATIO, 1 TO ___ | - |
| RIVER FLOW CONDITIONS (WET/DRY/AVERAGE) | WET |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 95 |
| PRECIPITATION CONDITIONS (WET/DRY) | WET |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 95 |
| DISCHARGE FROM STORAGE? (Y/N) | N |
| LOCAL RUNOFF @ LAKE HINMAN? (Y/N) | N |

0.0 MG fr store to disch.

142.2 MG effl discharged

252.8 TOTAL Stor+Disch.+Irr.

% of Recy Water to Lake Hinman = **0.00** %

| | Pond Stage | Lake Stage | | |
|---|---|---|---|---|
| START: | **6.8** | **10.00** | | |
| END: | 8.2 ft. | 10 ft. | | |
| MAX: | 12 ft. | 10 ft. | 12 | 30 |
| MIN: | 0.026 ft. | 10 ft. | >0 | 10± |

**Pond Data**

Tot. Pond Flow:

IN: 117.6 mgyr

OUT: 115.5 mgyr

**STORAGE: 55.8 acft**

Applied Irrigation Demand

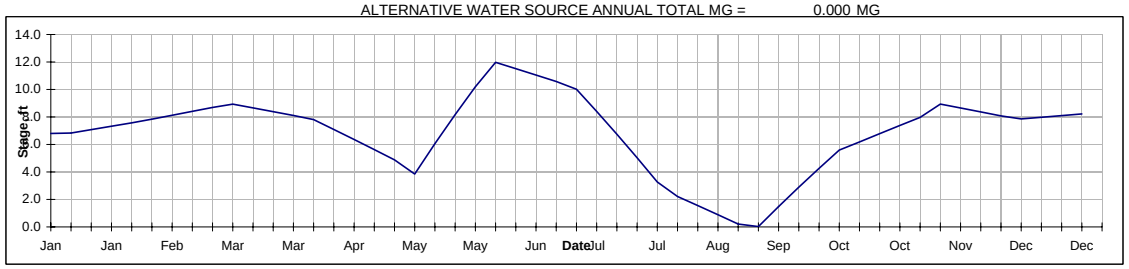
| | | | |
|---|---|---|---|
| Chim Rock V | | 0.4 ft/yr | = 5.1 in/yr |
| golf VP | *golf req. 2.6* | 3.5 ft/yr | = 42.3 in/yr |
| Stags L | | 2.4 ft/yr | = 28.9 in/yr |
| Stags V | | 0.2 ft/yr | = 2.7 in/yr |
| Clos du Val | | 0.3 ft/yr | = 4.2 in/yr |
| Addl Vineyard | | 0.5 ft/yr | = 5.6 in/yr |
| Cit Parks | | 2 ft/yr | = 24.2 in/yr |

Pond Hydraulics (Natural)

| | | |
|---|---|---|
| WATER IN FROM PRECIP (MG) = | 9.03 | MG |
| WATER LOST TO POND EVAP (MG) = | 4.84 | MG |
| WATER LOST TO POND PERC (MG) = | 0.00 | MG |
| NET WATER OUT (MG) = | -4.19 | MG |

| MONTH | DILUTION RATIO 1 TO ... | % POT. EFFL. DISCH'D |
|---|---|---|
| Jan | 1,231 | 100.0% |
| Feb | 780 | 100.0% |
| Mar | 706 | 100.0% |
| Apr | 429 | 100.1% |
| May | 1,000,000 | 0.0% |
| Jun | 1,000,000 | 0.0% |
| Jul | 1,000,000 | 0.0% |
| Aug | 1,000,000 | 0.0% |
| Sep | 1,000,000 | 0.0% |
| Oct | 25 | 34.4% |
| Nov | 292 | 100.0% |
| Dec | 676 | 99.9% |

ALTERNATIVE WATER SOURCE ANNUAL TOTAL MG = 0.000 MG




| SUPPLEMENTAR WATER SUPPL DATE | Mgal/wk |
|---|---|
| 1-Jan | 0.000 |
| 8-Jan | 0.000 |
| 15-Jan | 0.000 |
| 22-Jan | 0.000 |
| 29-Jan | 0.000 |
| 5-Feb | 0.000 |
| 12-Feb | 0.000 |
| 19-Feb | 0.000 |
| 26-Feb | 0.000 |
| 5-Mar | 0.000 |
| 12-Mar | 0.000 |
| 19-Mar | 0.000 |
| 26-Mar | 0.000 |
| 2-Apr | 0.000 |
| 9-Apr | 0.000 |
| 16-Apr | 0.000 |
| 23-Apr | 0.000 |
| 30-Apr | 0.000 |
| 7-May | 0.000 |
| 14-May | 0.000 |
| 21-May | 0.000 |
| 28-May | 0.000 |
| 4-Jun | 0.000 |
| 11-Jun | 0.000 |
| 18-Jun | 0.000 |
| 25-Jun | 0.000 |
| 2-Jul | 0.000 |
| 9-Jul | 0.000 |
| 16-Jul | 0.000 |
| 23-Jul | 0.000 |
| 30-Jul | 0.000 |
| 6-Aug | 0.000 |
| 13-Aug | 0.000 |
| 20-Aug | 0.000 |
| 27-Aug | 0.000 |
| 3-Sep | 0.000 |
| 10-Sep | 0.000 |
| 17-Sep | 0.000 |
| 24-Sep | 0.000 |
| 1-Oct | 0.000 |
| 8-Oct | 0.000 |
| 15-Oct | 0.000 |
| 22-Oct | 0.000 |
| 29-Oct | 0.000 |
| 5-Nov | 0.000 |
| 12-Nov | 0.000 |
| 19-Nov | 0.000 |
| 26-Nov | 0.000 |
| 3-Dec | 0.000 |
| 10-Dec | 0.000 |
| 17-Dec | 0.000 |
| 24-Dec | 0.000 |
| TOTAL | 0.000 |

# Figure A-7

## Example Solution - Not Enough Recycled Water Available

**YOUNTVILLE WW RECLAMATION FACILITIES -- ZERO DISCHARGE STUDY WATER BALANCE**

**DATA INPUT SHEET: ADWF = 0.63 MGD, DRY CONDITIONS DILUTION RATIO =1/- 10 YR RETURN RIVER FLOW 10 YR RETURN PRECIP. NO L. HINMAN RUNOFF**

**ADJUSTMENT FACTORS AND DATA SUMMARY**

(Note: Values in red = input values, black = calculated values)

AVERAGE DRY WEATHER FLOW (MGD) **0.629**

| | adj. factor | TOTAL TO IRR. | TOTAL ANNUAL |
|---|---|---|---|
| DOMESTIC WASTE FLOW (MG) | 1.4855 | 181.6 | 249.5 |
| PRECIPITATION (IN) | 1.0066 | | 20.64 |
| TOTAL RIVER FLOW (cfs/yr) | | | 1,717 |
| TOTAL LOCAL RUNOFF (mgal/yr) | | | 0.00 |
| PAN EVAPORATION (IN) | 1.00 | | 53.97 |
| MINIMUM GOLF IRRIGATION RATE (IN/WK): | 0.25 | | |
| ETo | 1.00 | | |
| kc landscape | 0.80 | | |
| kc Chimney Rock | 0.206 | | |
| kc golf turf-Vintners Peak | na | *per agreement* | |
| kc city park turf | 0.70 | | |
| kc Clos Du Val vineyard | 0.18 | | |
| kc Stags Leap vineyard | 0.13 | | |
| kc Silverado vineyard | 0.11 | | |
| kc addl vineyard | 0.22 | | |
| Factor for pond spacing -- levees | 1.1 | | |
| IRRIGATION EFFICIENCY: | 80.0% | | |
| RUNOFF COEFFICIENT | 0.0001 | | |
| POND PERCOLATION (in/day) | **0.000** | | |
| NOMINAL POND SURF. AREA acres each= | 10 | | |
| DIVERSION - 2° EFFL. OUT PRIOR TO POND | 0.0 | FROST CONTROL | |

**TOTAL AREA USED FOR CROPS: (ACRES)**

| | Chim V | Golf VP | Stags L | Stags V | Clos du Val | Silverado V | Addl Vine | City Parks | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 137.0 | 45.0 | 14.0 | 103.0 | 150.0 | 93.0 | 0.0 | 0.0 | 542.0 | ac |
| | 25.3% | 8.3% | 2.6% | 19.0% | 27.7% | 17.2% | 0.0% | 0.0% | 100% | |
| kc | 0.21 | na | 0.80 | 0.13 | 0.18 | 0.11 | 0.22 | 0.70 | | |

**TOTAL # PONDS** **0.9400** = = = => 11.6 ac land

10.6 ac water surf.

**TOTAL ACREAGE (for irrigation, ponds, etc)** = = = => 553.6 ac

**Available Storage at Reclaimed Water User Sites, ac-ft**

| | | | | | | |
|---|---|---|---|---|---|---|
| 38 | 25 | 33 | 71 | 40 | 207 | ac-ft |

**TOTAL GALLONAGE TO IRRIGATION : (MG)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| actual req. | 35.8 | 56 | 15 | 15.9 | 33.5 | 24.7 | 182 | MG to irr. |
| *VP golf req.* | 37.7 | (VH share of DWF) | | | | | | |

**MODEL INPUT CONDITIONS:**

| | |
|---|---|
| DISCHARGE TO NAPA RIVER (Y/N) | Y |
| MINIMUM DILUTION RATIO, 1 TO ___ | - |
| RIVER FLOW CONDITIONS (WET/DRY/AVERAGE) | DRY |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 10 |
| PRECIPITATION CONDITIONS (WET/DRY) | DRY |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 10 |
| DISCHARGE FROM STORAGE? (Y/N) | N |
| LOCAL RUNOFF @ LAKE HINMAN? (Y/N) | N |

0.0 MG fr store to disch.

79.0 MG effl discharged

260.6 TOTAL Stor+Disch.+Irr.

% of Recy Water to Lake Hinman = **0.00** %

| | Pond Stage | Lake Stage | |
|---|---|---|---|
| START: | **8.5** | **10.00** | |
| END: | 8.5 ft. | 10 ft. | |
| MAX: | 12 ft. | 10 ft. | 30 |
| MIN: | 0 ft. | 10 ft. | 10± |

12 >0

**Pond Data**

Tot. Pond Flow:

IN: 176.9 mgyr

OUT: 191.2 mgyr

**STORAGE: 112.9 acft**

Applied Irrigation Demand

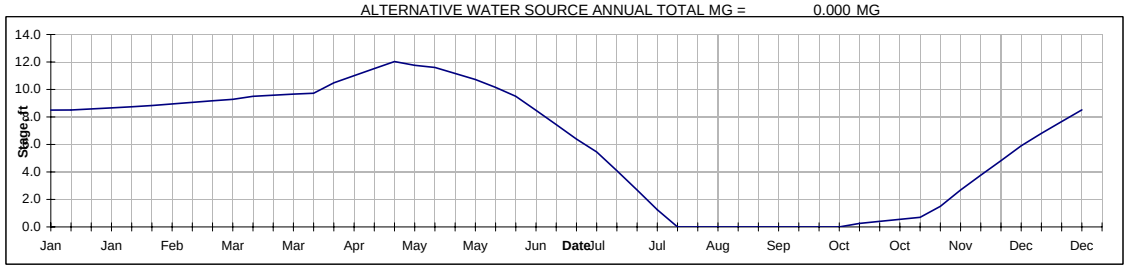
| | | | |
|---|---|---|---|
| Chim Rock V | | 0.8 ft/yr | = 9.6 in/yr |
| golf VP | *golf req. 2.6* | 3.5 ft/yr | = 42.3 in/yr |
| Stags L | | 3.4 ft/yr | = 40.6 in/yr |
| Stags V | | 0.5 ft/yr | = 5.7 in/yr |
| Clos du Val | | 0.7 ft/yr | = 8.2 in/yr |
| Addl Vineyard | | 0.9 ft/yr | = 10.3 in/yr |
| Cit Parks | | 2.9 ft/yr | = 35.3 in/yr |

Pond Hydraulics (Natural)

| | | |
|---|---|---|
| WATER IN FROM PRECIP (MG) = | 5.94 | MG |
| WATER LOST TO POND EVAP (MG) = | 9.62 | MG |
| WATER LOST TO POND PERC (MG) = | 0.00 | MG |
| NET WATER OUT (MG) = | 3.69 | MG |

| MONTH | DILUTION RATIO 1 TO ... | % POT. EFFL. DISCH'D |
|---|---|---|
| Jan | 75 | 100.4% |
| Feb | 50 | 99.3% |
| Mar | 150 | 75.1% |
| Apr | 1,000,000 | 0.0% |
| May | 1,000,000 | 0.0% |
| Jun | 1,000,000 | 0.0% |
| Jul | 1,000,000 | 0.0% |
| Aug | 1,000,000 | 0.0% |
| Sep | 1,000,000 | 0.0% |
| Oct | 25 | 0.8% |
| Nov | 25 | 15.8% |
| Dec | 25 | 51.7% |

ALTERNATIVE WATER SOURCE ANNUAL TOTAL MG = 0.000 MG




| SUPPLEMENTAR WATER SUPPL DATE | Mgal/wk |
|---|---|
| 1-Jan | 0.000 |
| 8-Jan | 0.000 |
| 15-Jan | 0.000 |
| 22-Jan | 0.000 |
| 29-Jan | 0.000 |
| 5-Feb | 0.000 |
| 12-Feb | 0.000 |
| 19-Feb | 0.000 |
| 26-Feb | 0.000 |
| 5-Mar | 0.000 |
| 12-Mar | 0.000 |
| 19-Mar | 0.000 |
| 26-Mar | 0.000 |
| 2-Apr | 0.000 |
| 9-Apr | 0.000 |
| 16-Apr | 0.000 |
| 23-Apr | 0.000 |
| 30-Apr | 0.000 |
| 7-May | 0.000 |
| 14-May | 0.000 |
| 21-May | 0.000 |
| 28-May | 0.000 |
| 4-Jun | 0.000 |
| 11-Jun | 0.000 |
| 18-Jun | 0.000 |
| 25-Jun | 0.000 |
| 2-Jul | 0.000 |
| 9-Jul | 0.000 |
| 16-Jul | 0.000 |
| 23-Jul | 0.000 |
| 30-Jul | 0.000 |
| 6-Aug | 0.000 |
| 13-Aug | 0.000 |
| 20-Aug | 0.000 |
| 27-Aug | 0.000 |
| 3-Sep | 0.000 |
| 10-Sep | 0.000 |
| 17-Sep | 0.000 |
| 24-Sep | 0.000 |
| 1-Oct | 0.000 |
| 8-Oct | 0.000 |
| 15-Oct | 0.000 |
| 22-Oct | 0.000 |
| 29-Oct | 0.000 |
| 5-Nov | 0.000 |
| 12-Nov | 0.000 |
| 19-Nov | 0.000 |
| 26-Nov | 0.000 |
| 3-Dec | 0.000 |
| 10-Dec | 0.000 |
| 17-Dec | 0.000 |
| 24-Dec | 0.000 |
| TOTAL | 0.000 |

Finally, during March through May most or all of the recycled water is stored for use during the summer months. Even so, the stored recycled water supply is depleted during July and the irrigation demands cannot be fully satisfied during the remainder of the summer. This solution is balanced but it is not optimized.

An example of the third type of solution (i.e. an optimized solution) is shown on **Figure A-8** for the following model input conditions:

- Climate conditions "Wet" (90-percentile)
- Silverado Vineyard included yes
- Additional vineyard irrigation area 143 acres

Note that under these input conditions an optimum balance exists between storage volume and acres under irrigation such that stored recycled water will be available throughout the summer until October, when discharge is again permitted. Then, beginning in March and continuing through the spring, all of the recycled water is stored for use later during the summer.

This solution is optimum for these model input condition. However, if the climate conditions or the number of additional acres under irrigation are changed, the volume of available recycled water (inflow) and/or the irrigation demand (outflow) will also be changed and a new combination of recycled water storage and discharge volumes must be found.

In general, balanced solutions can be found for most model input conditions except for the most extreme. For example, there is a limit to the additional acres of vineyard that can be fully irrigated that is related to the available recycled water supply. If additional acres of vineyard needed to be irrigated, this would require recycled water that is not available and, as a result, the solution of the mass balance model would revert to a second type solution where the recycled water reservoirs would be depleted before the end of the irrigation season.

# Figure A-8

## Example Solution - Optimized Design

**YOUNTVILLE WW RECLAMATION FACILITIES -- ZERO DISCHARGE STUDY WATER BALANCE**

**DATA INPUT SHEET: ADWF = 0.63 MGD, WET CONDITIONS DILUTION RATIO =1/- 90 YR RETURN RIVER FLOW 90 YR RETURN PRECIP. NO L. HINMAN RUNOFF**

**ADJUSTMENT FACTORS AND DATA SUMMARY**

(Note: Values in red = input values, black = calculated values)

AVERAGE DRY WEATHER FLOW (MGD) **0.629**

| | adj. factor | TOTAL TO IRR. | TOTAL ANNUAL |
|---|---|---|---|
| DOMESTIC WASTE FLOW (MG) | 1.4855 | 159.4 | 249.5 |
| PRECIPITATION (IN) | 1.0066 | | 54.45 |
| TOTAL RIVER FLOW (cfs/yr) | | | 16,809 |
| TOTAL LOCAL RUNOFF (mgal/yr) | | | 0.00 |
| PAN EVAPORATION (IN) | 1.00 | | 53.97 |
| MINIMUM GOLF IRRIGATION RATE (IN/WK): | 0.25 | | |
| ETo | 1.00 | | |
| kc landscape | 0.80 | | |
| kc Chimney Rock | 0.206 | | |
| kc golf turf-Vintners Peak | na | *per agreement* | |
| kc city park turf | 0.70 | | |
| kc Clos Du Val vineyard | 0.18 | | |
| kc Stags Leap vineyard | 0.13 | | |
| kc Silverado vineyard | 0.11 | | |
| kc addl vineyard | 0.22 | | |
| Factor for pond spacing -- levees | 1.1 | | |
| IRRIGATION EFFICIENCY: | 80.0% | | |
| RUNOFF COEFFICIENT | 0.0001 | | |
| POND PERCOLATION (in/day) | **0.000** | | |
| NOMINAL POND SURF. AREA acres each= | 10 | | |
| DIVERSION - 2° EFFL. OUT PRIOR TO POND | 0.0 | FROST CONTROL | |

**TOTAL AREA USED FOR CROPS: (ACRES)**

| | Chim V | Golf VP | Stags L | Stags V | Clos du Val | Silverado V | Addl Vine | City Parks | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 137.0 | 45.0 | 14.0 | 103.0 | 150.0 | 93.0 | 144.0 | 0.0 | 686.0 | ac |
| | 20.0% | 6.6% | 2.0% | 15.0% | 21.9% | 13.6% | 21.0% | 0.0% | 100% | |
| kc | 0.21 | na | 0.80 | 0.13 | 0.18 | 0.11 | 0.22 | 0.70 | | |

**TOTAL # PONDS** **1.4100** = = = => 17.4 ac land

15.8 ac water surf.

**TOTAL ACREAGE (for irrigation, ponds, etc)** = = = => 703.4 ac

**Available Storage at Reclaimed Water User Sites, ac-ft**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38 | 25 | 33 | 71 | 40 | | 207 | ac-ft |

**TOTAL GALLONAGE TO IRRIGATION : (MG)**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| actual req. | 19.4 | 56 | 12 | 7.8 | 17.3 | 24.7 | 22 | 159 | MG to irr. |
| *VP golf req.* | 37.7 | (VH share of DWF) | | | | | | | |

**MODEL INPUT CONDITIONS:**

| | |
|---|---|
| DISCHARGE TO NAPA RIVER (Y/N) | Y |
| MINIMUM DILUTION RATIO, 1 TO ___ | - |
| RIVER FLOW CONDITIONS (WET/DRY/AVERAGE) | WET |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 90 |
| PRECIPITATION CONDITIONS (WET/DRY) | WET |
| RETURN PERIOD (Dry=1,5,10, etc; Wet = 90, 95, 99, etc) = | 90 |
| DISCHARGE FROM STORAGE? (Y/N) | N |
| LOCAL RUNOFF @ LAKE HINMAN? (Y/N) | N |

0.0 MG fr store to disch.

97.2 MG effl discharged

256.6 TOTAL Stor+Disch.+Irr.

% of Recy Water to Lake Hinman = **0.00** %

| | Pond Stage | Lake Stage | |
|---|---|---|---|
| START: | **2.3** | **10.00** | |
| END: | 2.3 ft. | 10 ft. | |
| MAX: | 12 ft. | 10 ft. | 30 |
| MIN: | 0.03 ft. | 10 ft. | 10± |

12

>0

**Pond Data**

Tot. Pond Flow:

IN: 174.4 mgyr

OUT: 174 mgyr

**STORAGE: 169.6 acft**

Pond Hydraulics (Natural)

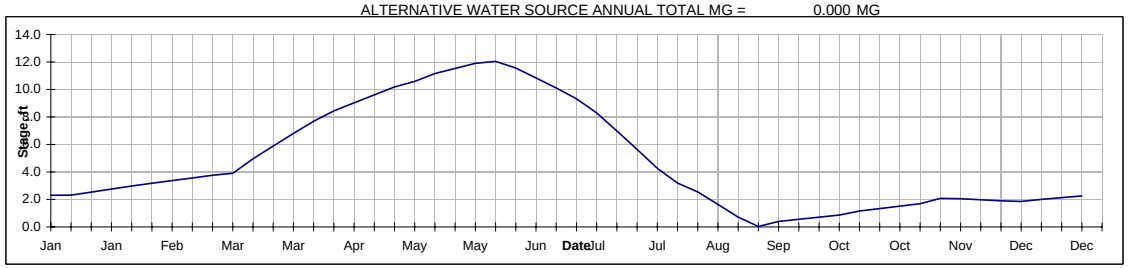
| | | |
|---|---|---|
| WATER IN FROM PRECIP (MG) = | 20.94 | MG |
| WATER LOST TO POND EVAP (MG) = | 14.53 | MG |
| WATER LOST TO POND PERC (MG) = | 0.00 | MG |
| NET WATER OUT (MG) = | -6.41 | MG |

Applied Irrigation Demand

| | | | |
|---|---|---|---|
| Chim Rock V | | 0.4 ft/yr | = 5.2 in/yr |
| golf VP | *golf req. 2.6* | 3.5 ft/yr | = 42.3 in/yr |
| Stags L | | 2.6 ft/yr | = 30.7 in/yr |
| Stags V | | 0.2 ft/yr | = 2.8 in/yr |
| Clos du Val | | 0.4 ft/yr | = 4.3 in/yr |
| Addl Vineyard | | 0.5 ft/yr | = 5.7 in/yr |
| Cit Parks | | 2.2 ft/yr | = 25.9 in/yr |

| MONTH | DILUTION RATIO 1 TO ... | % POT. EFFL. DISCH'D |
|---|---|---|
| Jan | 1,094 | 100.0% |
| Feb | 657 | 100.0% |
| Mar | 1,000,000 | 0.1% |
| Apr | 1,000,000 | 0.0% |
| May | 1,000,000 | 0.0% |
| Jun | 1,000,000 | 0.0% |
| Jul | 1,000,000 | 0.0% |
| Aug | 1,000,000 | 0.0% |
| Sep | 1,000,000 | 0.0% |
| Oct | 25 | 27.5% |
| Nov | 137 | 100.0% |
| Dec | 536 | 100.0% |

ALTERNATIVE WATER SOURCE ANNUAL TOTAL MG = 0.000 MG




| SUPPLEMENTAR WATER SUPPL DATE | Mgal/wk |
|---|---|
| 1-Jan | 0.000 |
| 8-Jan | 0.000 |
| 15-Jan | 0.000 |
| 22-Jan | 0.000 |
| 29-Jan | 0.000 |
| 5-Feb | 0.000 |
| 12-Feb | 0.000 |
| 19-Feb | 0.000 |
| 26-Feb | 0.000 |
| 5-Mar | 0.000 |
| 12-Mar | 0.000 |
| 19-Mar | 0.000 |
| 26-Mar | 0.000 |
| 2-Apr | 0.000 |
| 9-Apr | 0.000 |
| 16-Apr | 0.000 |
| 23-Apr | 0.000 |
| 30-Apr | 0.000 |
| 7-May | 0.000 |
| 14-May | 0.000 |
| 21-May | 0.000 |
| 28-May | 0.000 |
| 4-Jun | 0.000 |
| 11-Jun | 0.000 |
| 18-Jun | 0.000 |
| 25-Jun | 0.000 |
| 2-Jul | 0.000 |
| 9-Jul | 0.000 |
| 16-Jul | 0.000 |
| 23-Jul | 0.000 |
| 30-Jul | 0.000 |
| 6-Aug | 0.000 |
| 13-Aug | 0.000 |
| 20-Aug | 0.000 |
| 27-Aug | 0.000 |
| 3-Sep | 0.000 |
| 10-Sep | 0.000 |
| 17-Sep | 0.000 |
| 24-Sep | 0.000 |
| 1-Oct | 0.000 |
| 8-Oct | 0.000 |
| 15-Oct | 0.000 |
| 22-Oct | 0.000 |
| 29-Oct | 0.000 |
| 5-Nov | 0.000 |
| 12-Nov | 0.000 |
| 19-Nov | 0.000 |
| 26-Nov | 0.000 |
| 3-Dec | 0.000 |
| 10-Dec | 0.000 |
| 17-Dec | 0.000 |
| 24-Dec | 0.000 |
| TOTAL | 0.000 |

# Appendix B

# Hydrologic Data

**RAINFALL DATA FOR WATER MASS BALANCE MODEL**

**RIVER FLOW DATA FOR WATER MASS BALANCE MODEL**

Yountville/Veterans Home Joint Treatment Plant
Zero Discharge Study

**Rainfall Data for Water Mass Balance Model**

| Year | Yountville VH Rainfall, inches | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total Annual | |
| 1972 | | | | | | | 0.00 | 0.00 | 0.70 | 4.80 | 7.00 | 4.00 | 16.50 | partial year |
| 1973 | 15.15 | 9.10 | 3.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 2.90 | 13.90 | 4.80 | 49.55 | |
| 1974 | 5.90 | 1.70 | 8.20 | 2.30 | 0.40 | 0.00 | 1.20 | 0.00 | 0.00 | 1.40 | 0.90 | 2.10 | 24.10 | |
| 1975 | 0.90 | 15.20 | 8.70 | 1.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.60 | 0.40 | 0.50 | 32.10 | |
| 1976 | 0.40 | 1.50 | 1.90 | 1.80 | 1.60 | 0.00 | 0.00 | 1.60 | 0.40 | 1.10 | 1.40 | 1.29 | 12.99 | |
| 1977 | 2.71 | 1.90 | 3.20 | 0.10 | 1.40 | 0.00 | 0.00 | 0.00 | 1.20 | 0.50 | 9.70 | 3.90 | 24.61 | |
| 1978 | 16.00 | 5.00 | 6.10 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 2.81 | 0.81 | 35.82 | |
| 1979 | 10.99 | 7.54 | 1.79 | 1.70 | 0.67 | 0.00 | 0.00 | 0.00 | 0.04 | 4.48 | 3.49 | 7.23 | 37.93 | |
| 1980 | 8.95 | 12.04 | 2.25 | 2.49 | 0.55 | 0.18 | 0.07 | 0.00 | 0.00 | 0.29 | 0.24 | 5.22 | 32.28 | |
| 1981 | 6.74 | 2.03 | 4.65 | 0.40 | 0.13 | 0.00 | 0.00 | 0.00 | 0.23 | 3.79 | 8.46 | 8.78 | 35.21 | |
| 1982 | 9.54 | 4.54 | 9.23 | 5.87 | 0.00 | 0.06 | 0.00 | 0.00 | 1.42 | 3.30 | 10.41 | 5.43 | 49.80 | |
| 1983 | 11.34 | 12.70 | 16.28 | 4.57 | 0.49 | 0.00 | 0.00 | 0.26 | 0.57 | 0.94 | 10.96 | 11.92 | 70.03 | |
| 1984 | 0.59 | 2.28 | 2.81 | 1.08 | 0.15 | 0.20 | 0.01 | 0.35 | 0.09 | 1.94 | 11.12 | 1.72 | 22.34 | |
| 1985 | 1.71 | 4.95 | 5.33 | 0.14 | 0.01 | 0.03 | 0.00 | 0.00 | 0.59 | 1.36 | 4.16 | 3.81 | 22.09 | |
| 1986 | 6.38 | 24.42 | 9.38 | 0.61 | 0.32 | 0.00 | 0.00 | 0.00 | 1.23 | 0.20 | 0.05 | 1.88 | 44.47 | |
| 1987 | 4.83 | 8.05 | 5.23 | 0.11 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 1.47 | 3.53 | 9.19 | 32.42 | |
| 1988 | 6.18 | 0.57 | 0.29 | 2.86 | 0.67 | 0.16 | 0.00 | 0.00 | 0.00 | 0.13 | 5.23 | 4.21 | 20.30 | |
| 1989 | 1.33 | 1.17 | 10.11 | 0.55 | 0.04 | 0.07 | 0.00 | 0.00 | 1.74 | 2.86 | 2.59 | 0.00 | 20.46 | |
| 1990 | 5.97 | 4.71 | 1.44 | 0.15 | 4.50 | 0.00 | 0.00 | 0.00 | 0.07 | 0.31 | 0.64 | 1.08 | 18.87 | |
| 1991 | 0.51 | 4.40 | 15.73 | 0.33 | 0.19 | 0.56 | 0.00 | 0.38 | 0.01 | 1.73 | 1.22 | 2.84 | 27.90 | |
| 1992 | 2.16 | 10.20 | 6.77 | 0.89 | 0.00 | 0.88 | 0.00 | 0.00 | 0.00 | 4.44 | 0.21 | 11.45 | 37.00 | |
| 1993 | 17.09 | 9.04 | 2.52 | 1.73 | 1.54 | 0.54 | 0.00 | 0.00 | 0.00 | 1.49 | 3.53 | 5.37 | 42.85 | |
| 1994 | 2.79 | 5.85 | 0.17 | 1.94 | 1.39 | 0.01 | 0.00 | 0.00 | 0.03 | 0.98 | 6.97 | 4.49 | 24.62 | |
| 1995 | 25.54 | 0.79 | 19.38 | 1.87 | 2.15 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 12.30 | 62.81 | |
| 1996 | 10.69 | 11.24 | 2.82 | 4.03 | 3.99 | 0.00 | 0.00 | 0.00 | 0.00 | 1.81 | 4.31 | 17.99 | 56.88 | |
| 1997 | 14.50 | 0.46 | 1.28 | 0.49 | 0.44 | 0.28 | 0.00 | 0.62 | 0.07 | 1.27 | 7.50 | 3.75 | 30.66 | |
| 1998 | 11.42 | 21.44 | 3.25 | 3.16 | 4.56 | 0.03 | 0.00 | 0.00 | 0.07 | 0.72 | 8.73 | 1.54 | 54.92 | |
| 1999 | 3.68 | 11.30 | 4.11 | 2.57 | 0.11 | 0.05 | 0.00 | 0.00 | 0.04 | 0.69 | 3.08 | 0.64 | 26.27 | |
| 2000 | 6.64 | 12.45 | 2.66 | 2.16 | 1.56 | 0.23 | 0.00 | 0.02 | 0.15 | 3.31 | 1.35 | 1.00 | 31.53 | |
| 2001 | 5.27 | 9.32 | 2.18 | 1.24 | 0.00 | 0.07 | 0.00 | 0.00 | 0.35 | 0.95 | 9.26 | 15.12 | 43.76 | |
| 2002 | 4.68 | 1.74 | 3.89 | 0.31 | 1.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 5.03 | 23.18 | 39.96 | |
| 2003 | 3.14 | 2.40 | 3.36 | 6.27 | 1.83 | 0.00 | 0.00 | 0.24 | 0.14 | 0.00 | 5.37 | 12.97 | 35.72 | |
| 2004 | 5.56 | 10.15 | 1.35 | 0.95 | 0.04 | 0.22 | 0.00 | 0.00 | 0.08 | 6.39 | 2.63 | 13.28 | 40.65 | |
| 2005 | 6.81 | 4.86 | | | | | | | | | | | 11.67 | partial year |
| **Design Percentile 0.900** | | | | | | | | | | | | | **54.41** | Annual Total @ Design Percentile |
| Monthly Values @ Design Percentile | 15.02 | 12.65 | 10.04 | 4.09 | 2.12 | 0.51 | 0.00 | 0.33 | 1.16 | 4.47 | 10.27 | 13.22 | **73.88** | Sum of Monthly Values |
| Design rainfall (adjusted) | 11.06 | 9.32 | 7.39 | 3.01 | 1.56 | 0.38 | 0.00 | 0.24 | 0.85 | 3.29 | 7.56 | 9.73 | **54.41** | Monthly Sum of Adjusted Values |

Yountville/Veterans Home Joint Treatment Plant
Zero Discharge Study

**River Flow Data for Water Mass Balance**

**REGULATORY NAPA FLOW DATA** **NEAR NAPA = 0.73** **NEAR ST. HELENA = 0.27** Note: all flows in cfs

| Water Year Beginning Oct. | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.0 | 0.5 | 380.9 | 358.2 | 263.0 | 381.3 | 54.2 | 20.8 | 5.7 | 1.3 | 0.2 | 0.2 | 1466 |
| 1930 | 0.2 | 1.1 | 1.1 | 45.0 | 14.9 | 36.9 | 10.9 | 4.4 | 0.4 | 0.0 | 0.0 | 0.0 | 115 |
| 1931 | 0.0 | 0.1 | 605.7 | 329.1 | 240.3 | 51.8 | 24.0 | 13.7 | 5.6 | 0.7 | 0.2 | 0.0 | 1271 |
| 1932 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1933 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1934 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1935 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1936 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1937 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1938 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1939 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1940 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1941 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1942 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1943 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1944 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1945 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1946 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1947 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1948 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1949 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1950 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1951 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1952 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1953 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1954 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1955 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1956 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1957 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1958 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1959 | 1 | 1 | 3 | 35 | 664 | 287 | 62 | 24 | 5 | 0 | 0 | 0 | 1081 |
| 1960 | 0 | 4 | 44 | 102 | 240 | 148 | 56 | 21 | 4 | 0 | 0 | 0 | 619 |
| 1961 | 0 | 4 | 65 | 55 | 885 | 467 | 60 | 19 | 3 | 0 | 0 | 0 | 1559 |
| 1962 | 295 | 24 | 205 | 459 | 893 | 315 | 733 | 94 | 25 | 5 | 2 | 1 | 3051 |
| 1963 | 6 | 96 | 30 | 237 | 54 | 31 | 16 | 5 | 2 | 0 | 0 | 0 | 478 |
| 1964 | 1 | 54 | 901 | 1089 | 138 | 52 | 240 | 46 | 11 | 3 | 3 | 2 | 2540 |
| 1965 | 2 | 50 | 119 | 759 | 394 | 112 | 42 | 16 | 4 | 1 | 1 | 0 | 1498 |
| 1966 | 1 | 113 | 535 | 1403 | 348 | 452 | 604 | 102 | 48 | 15 | 4 | 3 | 3627 |
| 1967 | 4 | 7 | 48 | 380 | 524 | 370 | 78 | 23 | 5 | 2 | 2 | 1 | 1444 |
| 1968 | 3 | 8 | 298 | 1602 | 1383 | 435 | 103 | 36 | 14 | 5 | 3 | 1 | 3894 |
| 1969 | 5 | 7 | 467 | 2312 | 440 | 314 | 56 | 21 | 5 | 2 | 1 | 1 | 3632 |
| 1970 | 2 | 205 | 1088 | 414 | 103 | 207 | 90 | 32 | 12 | 4 | 2 | 2 | 2161 |
| 1971 | 2 | 7 | 77 | 75 | 138 | 51 | 32 | 12 | 3 | 0 | 0 | 1 | 399 |
| 1972 | 7 | 113 | 142 | 1374 | 1037 | 478 | 92 | 32 | 9 | 2 | 1 | 2 | 3290 |
| 1973 | 5 | 562 | 455 | 846 | 263 | 971 | 436 | 54 | 20 | 11 | 6 | 7 | 3636 |
| 1974 | 6 | 6 | 28 | 41 | 894 | 853 | 174 | 49 | 17 | 8 | 4 | 5 | 2084 |
| 1975 | 9 | 12 | 10 | 9 | 7 | 18 | 14 | 3 | 0 | 0 | 0 | 0 | 82 |
| 1976 | 1 | 1 | 1 | 3 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 12 |
| 1977 | 0 | 66 | 210 | 1342 | 713 | 603 | 186 | 53 | 16 | 7 | 4 | 3 | 3203 |
| 1978 | 2 | 4 | 5 | 255 | 563 | 250 | 95 | 49 | 11 | 5 | 3 | 2 | 1245 |
| 1979 | 11 | 19 | 185 | 1010 | 1351 | 392 | 91 | 36 | 12 | 5 | 3 | 3 | 3118 |
| 1980 | 2 | 3 | 71 | 321 | 161 | 192 | 66 | 22 | 6 | 2 | 2 | 1 | 849 |
| 1981 | 6 | 452 | 1124 | 1199 | 864 | 679 | 1137 | 78 | 32 | 14 | 7 | 10 | 5600 |
| 1982 | 11 | 222 | 453 | 1025 | 1560 | 2205 | 320 | 190 | 43 | 16 | 8 | 6 | 6059 |
| 1983 | 9 | 451 | 1281 | 262 | 138 | 139 | 52 | 28 | 12 | 5 | 4 | 3 | 2383 |
| 1984 | 5 | 163 | 96 | 64 | 345 | 150 | 81 | 26 | 10 | 3 | 3 | 4 | 948 |
| 1985 | 4 | 12 | 44 | 194 | 3470 | 1009 | 99 | 38 | 14 | 7 | 4 | 5 | 4901 |
| 1986 | 4 | 4 | 7 | 19 | 181 | 178 | 40 | 14 | 5 | 3 | 2 | 1 | 457 |
| 1987 | 1 | 5 | 210 | 400 | 68 | 25 | 20 | 15 | 7 | nd | nd | nd | nd |
| 1988 | 1 | 25 | 44 | 32 | 15 | nd | nd | nd | nd | nd | nd | nd | nd |
| 1989 | 7 | 11 | 7 | 99 | 146 | 57 | 19 | 36 | 18 | 3 | 1 | 1 | 405 |
| 1990 | 1 | 1 | 2 | 2 | 10 | 789 | 91 | 28 | 8 | 3 | 1 | 1 | 939 |
| 1991 | 1 | 2 | 5 | 15 | 389 | 291 | 64 | 22 | 7 | 3 | 1 | 0 | 800 |
| 1992 | 2 | 3 | 205 | 1460 | 860 | 242 | 90 | 43 | 26 | 5 | 2 | 2 | 2940 |
| 1993 | 1 | 5 | 61 | 50 | 237 | 46 | 25 | 17 | 6 | 2 | 0 | 0 | 451 |
| 1994 | 1 | 14 | 68 | 2571 | 294 | 2098 | 195 | 150 | 35 | nd | nd | nd | nd |
| 1995 | 2 | 2 | 205 | 702 | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1996 | nd | nd | nd | nd | nd | nd | nd | 16 | 5 | 1 | nd | 1 | nd |
| 1997 | 1 | 32 | 106 | 631 | 2490 | 249 | 201 | 110 | 75 | 18 | 5 | 3 | 3921 |
| 1998 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1999 | 2 | 6 | nd | nd | nd | nd | nd | nd | 10 | 3 | 0 | 0 | nd |
| 2000 | 3 | 5 | 7 | 65 | 385 | 267 | 34 | 16 | 4 | 1 | 0 | 0 | 785 |
| 2001 | 0 | 58 | 834 | 685 | 137 | 181 | 56 | 23 | 8 | 2 | 0 | 0 | 1984 |
| 2002 | 0 | 5 | 1391 | 578 | 245 | 217 | 219 | 238 | 29 | 7 | 2 | 0 | 2930 |

| Design Percentile | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Total @ Design Percentile |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.9000 | **8.3** | **188.0** | **880.6** | **1394.0** | **1288.4** | **846.4** | **311.8** | **100.6** | **31.3** | **11.1** | **4.3** | **4.5** | **3896** |

| | | |
|---|---|---|
| Sum of Mo. Percentiles | **5069.2** | **0.7686** Correction Factor |

| Design Monthly Flows | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6.4 | 144.5 | 676.8 | 1071.4 | 990.3 | 650.6 | 239.6 | 77.3 | 24.1 | 8.5 | 3.3 | 3.5 | **3896** |

Yountville/Veterans Home Joint Treatment Plant
Zero Discharge Study

**River Flow Data for Water Mass Balance**

**NAPA RIVER FLOW DATA - NEAR ST HELENA (USGS STA. NO. 11456000)** Note: all flows in cfs

| Water Year Beginning Oct. | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.1 | 0.49 | 321 | 202 | 163 | 174 | 26.2 | 13.4 | 4.77 | 1.75 | 0.5 | 0.4 | 908 |
| 1930 | 0.4 | 0.5 | 1.04 | 31.1 | 9.04 | 27.9 | 8.61 | 3.98 | 0.8 | 0.14 | 0.1 | 0.1 | 84 |
| 1931 | 0.1 | 0.1 | 340 | 159 | 106 | 24.5 | 13.6 | 10.6 | 4.58 | 1.35 | 0.3 | 0.1 | 660 |
| 1932 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1933 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1934 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1935 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1936 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1937 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1938 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | 0 |
| 1939 | 0.1 | 0.13 | 0.24 | 307 | 864 | 485 | 139 | 22.9 | 11.5 | 4.75 | 2.56 | 1.25 | 1838 |
| 1940 | 0.91 | 2.76 | 444 | 683 | 537 | 328 | 489 | 38.8 | 14.5 | 7.66 | 4.43 | 3.11 | 2553 |
| 1941 | 1.57 | 3.49 | 337 | 371 | 826 | 137 | 243 | 51.7 | 15.9 | 7 | 3.16 | 1.63 | 1998 |
| 1942 | 1.2 | 22.1 | 95 | 525 | 141 | 142 | 45.5 | 22.4 | 8.89 | 4.32 | 1.86 | 0.74 | 1010 |
| 1943 | 0.47 | 1.1 | 2.57 | 20.5 | 200 | 231 | 24.8 | 13.9 | 6.95 | 2.81 | 1.25 | 0.59 | 506 |
| 1944 | 0.75 | 21.8 | 39.1 | 47.5 | 362 | 156 | 48.2 | 18.1 | 6.42 | 3.02 | 1.26 | 1.06 | 705 |
| 1945 | 1.29 | 42.5 | 479 | 152 | 49.1 | 44.2 | 40.8 | 12.1 | 4.26 | 1.63 | 0.92 | 0.46 | 828 |
| 1946 | 0.52 | 11.8 | 42.8 | 7.71 | 116 | 133 | 43.6 | 9.3 | 4.13 | 0.96 | 0.72 | 0.24 | 371 |
| 1947 | 3.25 | 4.5 | 4.77 | 53 | 10.4 | 87.5 | 228 | 60.6 | 15.3 | 4.09 | 1.79 | 0.84 | 474 |
| 1948 | 0.69 | 1.64 | 23.9 | 28.7 | 107 | 388 | 34.5 | 12.7 | 3.04 | 1.94 | 1.22 | 0.53 | 604 |
| 1949 | 0.37 | 0.63 | 3.42 | 205 | 359 | 91 | 48.5 | 13.9 | 4.45 | 1.32 | 0.87 | 0.51 | 729 |
| 1950 | 2.27 | 137 | 450 | 385 | 175 | 121 | 24.5 | 21.5 | 6.23 | 2.75 | 1.31 | 0.89 | 1327 |
| 1951 | 1.1 | 22.2 | 361 | 771 | 310 | 264 | 46.2 | 16.9 | 6.29 | 2.73 | 1.38 | 0.99 | 1804 |
| 1952 | 0.57 | 1.82 | 446 | 618 | 47.6 | 116 | 67.7 | 35 | 11.6 | 3.34 | 1.69 | 1.31 | 1351 |
| 1953 | 2 | 12.9 | 9.76 | 285 | 316 | 197 | 185 | 23.8 | 6.96 | 1.92 | 1.31 | 0.33 | 1042 |
| 1954 | 0.48 | 23.5 | 60.3 | 86.8 | 39.5 | 24.9 | 41.4 | 16.8 | 4.08 | 0.95 | 0.22 | 0.047 | 299 |
| 1955 | 0.077 | 0.78 | 1088 | 848 | 729 | 92.4 | 31.7 | 24.8 | 6.05 | 1.65 | 0.88 | 0.12 | 2823 |
| 1956 | 2.75 | 3.13 | 3.64 | 21.5 | 220 | 145 | 39 | 75.3 | 14.6 | 2.44 | 0.84 | 0.64 | 529 |
| 1957 | 22.3 | 14.5 | 82.8 | 294 | 1107 | 378 | 491 | 29.7 | 11.4 | 4.29 | 1.73 | 0.89 | 2438 |
| 1958 | 1.04 | 1.74 | 2.78 | 77.5 | 274 | 39.2 | 14.9 | 5.46 | 0.9 | 0.14 | 0.029 | 1.11 | 419 |
| 1959 | 0.57 | 0.94 | 2.1 | 28.3 | 456 | 186 | 37.6 | 13.2 | 2.97 | 0.65 | 0.19 | 0.46 | 729 |
| 1960 | 0.33 | 3 | 28.5 | 71.9 | 183 | 116 | 41.7 | 12.6 | 3.94 | 0.55 | 0.35 | 0.37 | 462 |
| 1961 | 0.23 | 4.37 | 34.6 | 31.2 | 509 | 230 | 32.4 | 10.3 | 2.79 | 1.11 | 0.59 | 0.063 | 857 |
| 1962 | 179 | 13.9 | 144 | 321 | 394 | 162 | 367 | 45.9 | 14.1 | 4.32 | 2.55 | 1.17 | 1649 |
| 1963 | 3.01 | 75.3 | 18.8 | 168 | 32.8 | 22.2 | 10.5 | 5.02 | 2.37 | 0.46 | 0.31 | 0.24 | 339 |
| 1964 | 1.04 | 40.7 | 686 | 608 | 67.6 | 24.9 | 148 | 27.5 | 8.48 | 2.56 | 1.8 | 1.42 | 1618 |
| 1965 | 1.44 | 33.3 | 86.8 | 458 | 199 | 62.3 | 27.5 | 11.5 | 4.07 | 1.42 | 0.37 | 0.8 | 887 |
| 1966 | 1.13 | 68.4 | 353 | 753 | 158 | 235 | 317 | 53.9 | 27.3 | 6.47 | 2.6 | 1.54 | 1977 |
| 1967 | 2.09 | 6.23 | 32.5 | 257 | 268 | 171 | 27.6 | 10.7 | 3.02 | 0.75 | 1.63 | 1.13 | 782 |
| 1968 | 1.77 | 4.59 | 239 | 906 | 697 | 193 | 52.3 | 19.1 | 7.43 | 2.91 | 2.09 | 1.31 | 2127 |
| 1969 | 3.94 | 4.76 | 354 | 1338 | 241 | 175 | 24 | 10.5 | 4.44 | 2.31 | 1.07 | 1.18 | 2160 |
| 1970 | 2.63 | 174 | 737 | 298 | 50.1 | 133 | 47.9 | 18 | 7.23 | 2.41 | 1.24 | 0.73 | 1472 |
| 1971 | 0.73 | 3.05 | 47.9 | 53.3 | 98.4 | 38.5 | 20.8 | 9.11 | 3.18 | 1.13 | 0.32 | 0.52 | 277 |
| 1972 | 7.14 | 64.4 | 104 | 691 | 471 | 206 | 39.1 | 13.9 | 5.95 | 2.44 | 0.77 | 1.07 | 1607 |
| 1973 | 8.48 | 415 | 280 | 475 | 159 | 556 | 220 | 24.6 | 10.1 | 5.75 | 3.1 | 2.92 | 2160 |
| 1974 | 2.99 | 3.84 | 16.3 | 25.5 | 542 | 487 | 79.6 | 24.4 | 8.08 | 3.88 | 1.84 | 1.9 | 1197 |
| 1975 | 5.68 | 7.78 | 6.37 | 6.45 | 7.53 | 10.3 | 11.4 | 3.49 | 1.17 | 0.013 | 0.007 | 0.21 | 60 |
| 1976 | 0.49 | 1.74 | 2.43 | 3.73 | 4.34 | 7.45 | 1.81 | 0.89 | 0.081 | 0 | 0 | 0 | 23 |
| 1977 | 0 | 39.9 | 146 | 756 | 429 | 294 | 90.5 | 26.2 | 8.29 | 2.82 | 1.4 | 1.34 | 1795 |
| 1978 | 1.12 | 2.06 | 2.35 | 124 | 343 | 137 | 53.9 | 30.6 | 7.07 | 2.65 | 1.37 | 0.66 | 706 |
| 1979 | 7.16 | 14.2 | 124 | 564 | 619 | 180 | 40.9 | 17.2 | 6.53 | 2.2 | 1.06 | 0.84 | 1577 |
| 1980 | 1.04 | 1.76 | 50.6 | 233 | 112 | 120 | 40.5 | 12.6 | 2.95 | 0.76 | 0.81 | 0.44 | 576 |
| 1981 | 3.17 | 222 | 598 | 478 | 444 | 329 | 584 | 38.8 | 14.4 | 5.85 | 2.81 | 6.44 | 2726 |
| 1982 | 8.62 | 156 | 283 | 541 | 867 | 1144 | 146 | 93 | 19.5 | 7.33 | 3.43 | 2.35 | 3271 |
| 1983 | 3.43 | 298 | 758 | 122 | 85.9 | 84.8 | 32.9 | 13.4 | 7.29 | 2.83 | 3.45 | 1.08 | 1413 |
| 1984 | 3.14 | 125 | 70.1 | 42.5 | 219 | 101 | 45.9 | 13 | 6.28 | 0.75 | 0.98 | 1.67 | 629 |
| 1985 | 1.67 | 6.4 | 30.6 | 136 | 1797 | 443 | 44.8 | 19.9 | 7.72 | 3.55 | 1.57 | 2.71 | 2495 |
| 1986 | 2.18 | 2.22 | 3.7 | 14 | 117 | 136 | 24.3 | 7.92 | 2.76 | 0.8 | 0.4 | 0.2 | 311 |
| 1987 | 0.81 | 4.26 | 152 | 253 | 39.2 | 14.1 | 12.2 | 9.12 | 4.86 | 1.05 | 0.54 | 0.38 | 492 |
| 1988 | 0.46 | 21.6 | 33.2 | 24.3 | 12.5 | 378 | 42.1 | 13.9 | 5.64 | 1.52 | 0.58 | 0.77 | 535 |
| 1989 | 6.58 | 8.2 | 4.69 | 72.8 | 98.3 | 38 | 12.8 | 27.1 | 14.1 | 3.21 | 0.88 | 0.49 | 287 |
| 1990 | 0.8 | 1.55 | 2.24 | 2.17 | 8.55 | 485 | 46.7 | 15.5 | 4.66 | 1.98 | 0.72 | 0.34 | 570 |
| 1991 | 1.12 | 1.99 | 5.51 | 9.25 | 230 | 137 | 33.6 | 11.9 | 4.24 | 1.88 | 0.45 | 0.19 | 437 |
| 1992 | 2.02 | 2.18 | 135 | 780 | 398 | 106 | 48.3 | 21.1 | 15.6 | 3.29 | 0.97 | 0.41 | 1513 |
| 1993 | 0.49 | 3.05 | 42.3 | 35.3 | 144 | 31.2 | 14.1 | 8.79 | 2.86 | 0.53 | 0.23 | 0.051 | 283 |
| 1994 | 0.071 | 10.6 | 48.1 | 1186 | 148 | 929 | 108 | 105 | 20 | nd | nd | nd | nd |
| 1995 | 1.48 | 2.04 | 140 | 719 | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1996 | nd | 3.03 | nd | 5.85 | nd | nd | nd | 3.02 | 2.86 | 2.77 | nd | 2.69 | nd |
| 1997 | 2.71 | 3.19 | 3.65 | 5.38 | 7.08 | 4.16 | 4.19 | 3.6 | 3.42 | 3.1 | 2.95 | 2.91 | 46 |
| 1998 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1999 | 2.93 | 3.25 | nd | nd | nd | nd | nd | nd | 7.68 | 2.92 | 0.78 | 0.44 | nd |
| 2000 | 3.51 | 5.01 | 5.43 | 48.6 | 230 | 164 | 20.8 | 8.27 | 1.97 | 0.47 | 0.4 | 0.21 | 489 |
| 2001 | 0.18 | 38.2 | 482 | 332 | 79.2 | 97.8 | 31.5 | 14 | 3.85 | 0.84 | 0.31 | 0.31 | 1080 |
| 2002 | 0.13 | 4.24 | 792 | 356 | 115 | 121 | 135 | 126 | 18.6 | 4.91 | 1.53 | 0.53 | 1675 |

Yountville/Veterans Home Joint Treatment Plant
Zero Discharge Study

**River Flow Data for Water Mass Balance**

**NAPA RIVER FLOW DATA - NEAR NAPA (USGS STA. NO. 11458000)** Note: all flows in cfs

| Water Year Beginning Oct. | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.0 | 0.4 | 403.0 | 416.0 | 300.0 | 458.0 | 64.6 | 23.5 | 6.1 | 1.1 | 0.1 | 0.1 | 1673 |
| 1930 | 0.1 | 1.3 | 1.1 | 50.1 | 17.1 | 40.2 | 11.8 | 4.5 | 0.2 | 0.0 | 0.0 | 0.0 | 126 |
| 1931 | 0.0 | 0.1 | 704.0 | 392.0 | 290.0 | 61.9 | 27.9 | 14.9 | 6.0 | 0.5 | 0.1 | 0.0 | 1497 |
| 1932 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1933 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1934 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1935 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1936 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1937 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1938 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1939 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1940 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1941 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1942 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1943 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1944 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1945 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1946 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1947 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1948 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1949 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1950 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1951 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1952 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1953 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1954 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1955 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1956 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1957 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1958 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| 1959 | 0.7 | 1.4 | 3.1 | 37.5 | 741.0 | 324.0 | 70.8 | 27.8 | 5.2 | 0.2 | 0.0 | 0.0 | 1212 |
| 1960 | 0.0 | 4.4 | 49.9 | 113.0 | 261.0 | 160.0 | 61.6 | 23.5 | 3.4 | 0.0 | 0.0 | 0.0 | 677 |
| 1961 | 0.0 | 3.5 | 76.7 | 63.7 | 1024.0 | 554.0 | 70.4 | 22.4 | 3.5 | 0.0 | 0.0 | 0.0 | 1818 |
| 1962 | 338.0 | 28.2 | 228.0 | 510.0 | 1077.0 | 371.0 | 868.0 | 112.0 | 28.5 | 5.2 | 1.7 | 1.6 | 3569 |
| 1963 | 7.3 | 103.0 | 34.4 | 263.0 | 61.7 | 34.0 | 18.5 | 5.2 | 2.5 | 0.4 | 0.0 | 0.1 | 530 |
| 1964 | 0.7 | 59.3 | 980.0 | 1267.0 | 164.0 | 62.7 | 274.0 | 52.2 | 12.4 | 3.1 | 3.5 | 2.0 | 2881 |
| 1965 | 2.4 | 56.5 | 131.0 | 870.0 | 466.0 | 130.0 | 46.8 | 17.2 | 3.5 | 0.4 | 0.6 | 0.2 | 1725 |
| 1966 | 0.4 | 130.0 | 602.0 | 1643.0 | 418.0 | 532.0 | 710.0 | 120.0 | 55.6 | 18.2 | 4.5 | 3.1 | 4237 |
| 1967 | 4.9 | 7.4 | 53.3 | 425.0 | 618.0 | 444.0 | 97.3 | 27.1 | 6.3 | 2.5 | 2.7 | 1.1 | 1690 |
| 1968 | 3.7 | 9.9 | 320.0 | 1860.0 | 1637.0 | 525.0 | 122.0 | 42.2 | 16.6 | 6.4 | 3.6 | 0.7 | 4547 |
| 1969 | 5.6 | 8.2 | 509.0 | 2672.0 | 513.0 | 366.0 | 68.4 | 24.8 | 5.8 | 1.8 | 1.0 | 1.1 | 4177 |
| 1970 | 1.9 | 216.0 | 1218.0 | 457.0 | 122.0 | 234.0 | 106.0 | 37.5 | 13.6 | 4.5 | 2.2 | 3.0 | 2416 |
| 1971 | 3.1 | 8.1 | 87.5 | 83.7 | 153.0 | 56.3 | 35.5 | 13.5 | 2.5 | 0.2 | 0.0 | 0.6 | 444 |
| 1972 | 7.1 | 131.0 | 156.0 | 1626.0 | 1247.0 | 578.0 | 112.0 | 39.2 | 9.6 | 2.2 | 1.6 | 2.6 | 3912 |
| 1973 | 3.8 | 616.0 | 520.0 | 983.0 | 301.0 | 1124.0 | 516.0 | 65.1 | 23.5 | 13.6 | 7.7 | 8.3 | 4182 |
| 1974 | 6.8 | 7.5 | 32.2 | 46.3 | 1024.0 | 988.0 | 209.0 | 58.1 | 19.9 | 9.1 | 5.0 | 6.7 | 2412 |
| 1975 | 10.3 | 13.7 | 11.1 | 10.6 | 6.5 | 20.2 | 14.9 | 2.5 | 0.1 | 0.0 | 0.0 | 0.2 | 90 |
| 1976 | 0.6 | 1.2 | 0.7 | 2.9 | 0.4 | 2.6 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9 |
| 1977 | 0.0 | 75.2 | 234.0 | 1559.0 | 818.0 | 717.0 | 222.0 | 63.5 | 18.8 | 8.2 | 4.3 | 3.1 | 3723 |
| 1978 | 2.5 | 4.7 | 5.8 | 304.0 | 645.0 | 292.0 | 110.0 | 55.3 | 13.1 | 6.0 | 4.1 | 2.6 | 1445 |
| 1979 | 12.3 | 21.3 | 207.0 | 1175.0 | 1622.0 | 470.0 | 110.0 | 42.6 | 14.5 | 5.6 | 3.9 | 3.4 | 3688 |
| 1980 | 2.8 | 3.5 | 78.5 | 353.0 | 179.0 | 218.0 | 75.9 | 25.6 | 7.1 | 2.2 | 2.7 | 1.5 | 950 |
| 1981 | 7.2 | 537.0 | 1318.0 | 1465.0 | 1019.0 | 808.0 | 1341.0 | 92.1 | 38.7 | 17.3 | 9.1 | 10.7 | 6663 |
| 1982 | 11.4 | 247.0 | 516.0 | 1204.0 | 1816.0 | 2597.0 | 384.0 | 226.0 | 52.1 | 19.4 | 9.4 | 7.6 | 7090 |
| 1983 | 11.7 | 507.0 | 1474.0 | 314.0 | 157.0 | 159.0 | 58.6 | 33.5 | 13.5 | 5.5 | 4.6 | 3.7 | 2742 |
| 1984 | 6.0 | 177.0 | 105.0 | 72.0 | 391.0 | 168.0 | 93.3 | 30.4 | 11.5 | 4.1 | 3.5 | 4.2 | 1066 |
| 1985 | 5.0 | 13.7 | 49.0 | 216.0 | 4089.0 | 1218.0 | 119.0 | 45.2 | 16.3 | 8.5 | 5.1 | 5.4 | 5790 |
| 1986 | 4.8 | 5.1 | 7.7 | 20.3 | 204.0 | 194.0 | 46.0 | 16.7 | 5.8 | 3.4 | 2.2 | 1.0 | 511 |
| 1987 | 1.4 | 5.0 | 232.0 | 455.0 | 78.2 | 29.3 | 23.4 | 17.8 | 7.7 | 2.6 | 1.8 | 1.3 | 855 |
| 1988 | 1.1 | 26.8 | 47.8 | 35.5 | 16.5 | 523.0 | 88.4 | 26.1 | 10.0 | 4.2 | 1.5 | 1.6 | 782 |
| 1989 | 6.9 | 11.7 | 7.9 | 109.0 | 164.0 | 64.3 | 21.0 | 39.8 | 19.3 | 2.7 | 1.5 | 0.8 | 449 |
| 1990 | 0.9 | 1.1 | 2.6 | 2.2 | 10.3 | 902.0 | 108.0 | 32.0 | 9.2 | 3.7 | 1.6 | 1.4 | 1075 |
| 1991 | 1.1 | 1.5 | 5.3 | 17.3 | 448.0 | 348.0 | 74.8 | 25.1 | 7.5 | 3.6 | 1.6 | 0.4 | 934 |
| 1992 | 2.3 | 3.9 | 231.0 | 1711.0 | 1031.0 | 292.0 | 105.0 | 51.3 | 29.4 | 5.3 | 3.0 | 2.3 | 3468 |
| 1993 | 1.7 | 5.9 | 67.9 | 55.7 | 271.0 | 51.6 | 28.5 | 20.6 | 7.7 | 1.9 | 0.3 | 0.5 | 513 |
| 1994 | 1.0 | 15.6 | 76.0 | 3083.0 | 348.0 | 2530.0 | 227.0 | 166.0 | 40.1 | 13.5 | 2.8 | 2.1 | 6505 |
| 1995 | 1.9 | 2.6 | 229.0 | 696.0 | 1335.0 | 516.0 | 211.0 | 111.0 | 42.8 | 14.0 | 5.5 | 2.8 | 3168 |
| 1996 | 2.5 | 35.4 | 750.0 | 2481.0 | 336.0 | 97.8 | 41.0 | 20.8 | 6.0 | 1.0 | 0.2 | 0.2 | 3772 |
| 1997 | 0.6 | 43.0 | 144.0 | 862.0 | 3408.0 | 340.0 | 274.0 | 149.0 | 101.0 | 23.9 | 5.5 | 3.1 | 5354 |
| 1998 | 2.8 | 54.2 | 131.0 | 122.0 | 1276.0 | 518.0 | 354.0 | 72.2 | 26.3 | 5.8 | 2.7 | 0.8 | 2566 |
| 1999 | 1.2 | 6.7 | 7.8 | 104.0 | 1034.0 | 593.0 | 85.1 | 40.1 | 11.0 | 2.6 | 0.3 | 0.1 | 1886 |
| 2000 | 2.3 | 4.6 | 6.9 | 71.5 | 442.0 | 305.0 | 38.9 | 18.4 | 4.3 | 0.7 | 0.0 | 0.0 | 895 |
| 2001 | 0.0 | 65.6 | 964.0 | 815.0 | 159.0 | 212.0 | 65.1 | 26.6 | 9.4 | 1.8 | 0.0 | 0.0 | 2318 |
| 2002 | 0.0 | 4.7 | 1613.0 | 660.0 | 293.0 | 252.0 | 250.0 | 279.0 | 33.5 | 7.5 | 1.8 | 0.1 | 3395 |
| 2003 | | | | | | | | | | | | | |