Artesa Vineyards & Winery

Faifax Timberland Conversion and Vineyard Development Project

Hydrologic Evaluation

Prepared for

Raney Planning and Management

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FAIRFAX TIMBERLAND CONVERSION AND VINEYARD DEVELOPMENT PROJECT - HYDROLOGIC EVALUATION

INTRODUCTION

The purpose of this report is to provide a review of the hydrologic information for the proposed Fairfax Timberland Conversion and Vineyard Development Project that will be developed by Artesa Vineyards and Winery (Artesa). This report is intended to be a stand-alone document, which will then be combined with other documents prepared by the Raney Planning and Management (RPM) project team to ultimately develop an Environmental Impact Report (EIR) for review and approval by the California Department of Forestry and Fire Protection (CDF). The major topics discussed in this report are as follows:

- Background
- Water Supply
- Hydrologic Impacts
- Water Quality Impacts
- Flooding Potential
- Cumulative Watershed Impacts
- Conclusions

The above-mentioned topics are discussed in the following sections of this report. Each section identifies issues, if applicable, for each of the hydrologic areas. If any issues were determined to be potentially significant or significant, then mitigation measures are recommended for those issues. If mitigation measures were proposed, the significance of the particular hydrologic issue is reevaluated taking into account the proposed mitigation measures. The issues associated with erosion and sediment control are addressed in two draft reports prepared by Matt O'Connor titled, "Hydrologic Analysis, Artesa Fairfax THP and Conversion" May 2007, and "Erosion Analysis, Artesa Fairfax THP and Conversion", May 2007.

BACKGROUND

A list of the items reviewed for this report and a site description of the proposed vineyard development project is presented in this section.

General

The proposed layout of the proposed timberland conversion and vineyard installation project was developed by North Coast Resources Management (NCRM) and Erickson Engineering Inc (Erickson). Two figures showing some of the details of this layout are included in Attachment A.

The proposed project will be located within three assessor parcels (123-040-022, 123-040-024, and 123-040-027) totaling approximately 324 acres in size. Of this area, it is proposed that 190 acres will be potentially disturbed, and the remaining approximate 134 acres will not be modified. Approximately 170 acres of valuable timber species and non-commercial vegetation is proposed to be removed within the 190 acre development area. This will be followed by grading and ripping vineyard block areas, installing vineyard infrastructure, and planting wine grapes. It is estimated that of an approximate 190-acre area (which includes the 170-acre harvested timber area), approximately 1-acre will be used to develop a site corporation yard, approximately 9 acres will be used to develop the onsite storage reservoir, and approximately 170 gross (135 net) acres will be available for grape production.

Reviewed Items

The following documents were reviewed for the proposed vineyard development project hydrologic evaluation:

1. Timberland Conversion Permit Application and Plan; and Fairfax Conversion Timber Harvesting Plan (THP).
2. Erosion Control and Mitigation Plan - Fairfax Ranch Vineyard (ECP), dated February 3, 2004 (revised June 5, 2007); and a letter and revised ECP drawings from Erickson Engineering outlining modifications to the February 3rd ECP, dated March 26, 2004.
3. Sonoma County Vineyard Erosion and Sediment Control Ordinance, Ordinance Numbers 5216 and 5352 and Resolution Number 00-0133.
4. Fairfax Timberland Conversion - Initial Study/Mitigated Negative Declaration, dated March 24, 2004. Associated documents include the following:
    - Operations Map
    - Cumulative Impacts Map
    - Estimated Soil Surface Erosion Hazard Calculation Sheet
5. Assessment of Potential Hydrologic Effects, Fairfax Timber Harvest Plan and Conversion Number 1-01-171-SON, dated March 15, 2002.
6. Baseline Soil Analysis Report, dated October 26, 1999.
7. The following supplemental information provided by Erickson Engineering, Inc and O'Connor Environmental Inc:
    - Pre-Harvest Inspection Comment Response Letter, dated December 10, 2001 (Erickson).
    - Assessment of Potential Hydrologic Effects Fairfax, Erosion Control Plan – Design Revisions, dated March 11, 2002 (Erickson).
    - Response to Comments on Hydrologic and Geomorphic Assessment Pertaining to Negative Declaration, dated June 9, 2003 (O'Connor).
    - Response to Jackson Memo, dated July 20, 2003 (Erickson).

- Response to Floerke (CDFG) Memo, Kamman Memo; Response to Higgins Memo, July 20, 2003 (Erickson).

8. Gualala River Watershed Technical Support Document For Sediment, North Coast Regional Water Quality Control Board; Gualala River Total Maximum Daily Load for Sediment, US Environmental Protection Agency Region IX; The Gualala River Watershed Assessment Report, North Coast Watershed Assessment Program; the KRIS Gualala Project, Klamath Resource Information System; and *Proceedings of the Conference on Coastal Watersheds: The Caspar Creek Story.*
9. Hydrologic Analysis, Artesa Fairfax THP and Conversion, draft report prepared for Raney Planning and Management dated May 2007 (O'Connor).
10. Erosion Analysis, Artesa Fairfax THP and Conversion, draft report prepared for Raney Planning and Management dated May 2007 (O'Connor).
11. Vineyard Water Availability Evaluation – Artesa Fairfax Vineyard, dated June 5, 2007 (Erickson).

These items are discussed briefly below. It is assumed that the reviewed information accurately depicts the intended vineyard development project.

Reviewed Items No. 1

The documents listed under Number 1 were developed by North Coast Resources Management (NCRM) on behalf of Artesa. These documents describe the currently proposed timberland harvesting plan and practices, and include details regarding the proposed soil stabilization measures during timber harvesting operations; winter operation practices; construction and removal of roads and landings used for timber harvesting purposes; and watercourse and lake protection zones. The Timberland Conversion Permit and Application is required by the California Department of Forestry and Fire Protection (CDF) to obtain a permit for conversion of timberland to an alternative use and the Timber Harvesting Plan (THP) is required to obtain a permit through the CDF to sell the harvested timber commercially. The THP also includes a detailed cumulative impact assessment for the proposed conversion.

Reviewed Items No. 2

The documents listed under Number 2 were developed by Erickson Engineering on behalf of Artesa. These documents and associated figures describe the erosion control practices that will be employed during the timberland conversion operations and subsequent vineyard development. These documents are intended to address the concerns of the CDF, North Coast Regional Water Quality Control Board (RWQCB) and the California Department of Fish and Game (DFG).

Reviewed Items No. 3

The proposed project is defined as a "Level II Planting" under the Sonoma County Vineyard Erosion and Sediment Control Ordinance (Number 3). As such, a certified ECP must be approved by the Sonoma County Agricultural Commissioner prior to initiation of vineyard development. As stated in the Sonoma County Ordinance, the ECP must include the following items:

- Date, name, and county of preparer.
- Site description including: APN #'s, topography, soils, vegetation, streams, lakes, reservoirs, roads, homes, and existing drainage improvements.
- Summary of temporary and permanent measures for protection and prevention of stormwater runoff and to minimize sediment movement from the site.
- A schedule for implementation, maintenance and upkeep of temporary and permanent measures, and provisions for responsibility of maintenance.
- Location map using the appropriate USGS quadrangle map.
- Topographic site plan of a scale not less than 1" = 200' showing all of the following:
    1. Perimeter boundary and vineyard layout (row spacing, row direction, and terraces).
    2. Existing and finished contours of intervals not more than 5 feet.
    3. Location of soils.
    4. Flow lines of surface waters onto and off the site.
    5. Location, direction of flow, approximate location of center line and top of banks of and required setback distances from designated streams.
    6. Location and general types of existing vegetation.
    7. Location of buildings, structures, onsite sewage disposal systems, wells, and overhead utilities.
    8. Location of soil protection measures, including, but not limited to cover cropping, mulching, netting, revegetation, and other surface stabilization features.
    9. Location of stormwater and sediment control features including: drainage swales, interceptor and diversion ditches, pipes and culverts, berms, energy absorbing structures, vegetative filter strips, sediment buffers, sediment basins, channels and drop inlets.
- Construction details of all surface and subsurface drainage features and erosion and sediment control measures, including materials of construction and installation requirements.
- A plan showing the drainage area of the stormwater management systems. Supporting hydrologic and hydraulic calculations.
- Design calculations for storage capacities of any sediment basins.
- Other plans drawings, calculations, photographs, or other information deemed necessary or appropriate.

Reviewed Items No. 4

Number 4 was also developed by NCRM on behalf of Artesa. This report was originally submitted on behalf of Artesa in 2003 for review and approval by CDF. Since that time, the proposed project description has been modified, and this report and its associated documents were updated to reflect these changes.

Reviewed Item No. 5

Number 5 was developed by O'Connor Environmental on behalf of NCRM for a 105 acre conversion project that was originally proposed at the project site. Many of the analyses presented in this report are still valid for the proposed expanded conversion area.

Reviewed Item No. 6

Number 6 was developed by Crop Care Associates on behalf of Artesa. An overview of the soils on the entire 299 acre property and a description of their suitability for wine grape production are provided in this document along with recommend amendments and soil management activities for the vineyard.

Reviewed Items No. 7

Number 7 includes detailed information developed by both Erickson Engineering and O'Connor Environmental Inc. in response to comments on the original Initial Study/Mitigated Negative Declaration report that was submitted in 2003.

Reviewed Items No. 8

The documents listed under Number 8 were reviewed to provide appropriate background information and technical support for the conclusions developed in conjunction with this report. The first four documents were developed by environmental agencies in response to identified impairments in the Gualala River watershed. These documents describe the likely causes of impairments in the Gualala River watershed and provide recommendations for monitoring and control of these impairments.

The third document listed provides detailed accounts of logging studies conducted on the Caspar Creek Watershed between 1962 and 1998. The Caspar Creek study, formally described as "Study 2-1, a study of logging effects upon streamflow, sedimentation, fish life and fish habitat in the north coast redwood-Douglas-fir forest type Jackson State Forest, Fort Bragg, California," can be used to help identify likely impacts of logging in the Gualala River watershed, as these two locations have similar rainfall patterns and potential sedimentation issues associated with logging in hillside areas. The Proceedings are the written product of the *Conference on Coastal Watersheds: The Caspar Creek Story*, organized by Bill Baxter (California Department of Forestry and Fire Protection), Liz Keppeler (Pacific Southwest Research Station), and Greg Giusti (University of California Extension). The Conference was held May 6, 1998 at the Mendocino Community College in Ukiah, California.

Reviewed Item No. 9

Number 9 was developed by O'Connor Environmental, Inc. on behalf of Raney Planning and Management. This document evaluated the potential impact to the hydrologic process by converting timberland to vineyard. The evaluation included changes in evapotranspiration due to changes in existing site vegetation and changes in soil and hydrologic conditions. This document relied in part on a watershed experiments conducted at Caspar Creek in Mendocino County. This report evaluated the anticipated hydrologic effects of the proposed vineyard development including a water balance analysis, potential peak runoff increases, and impacts of channel erosion hazards.

Reviewed Item No. 10

Number 10 was developed by O'Connor Environmental, Inc. on behalf of Raney Planning and Management. This document evaluated the issues associated with the potential increases in erosion and sedimentation resulting from the project's construction and operation. This evaluation estimates the Patchett Creek sediment yield pre- and post-project and assesses the proposed mitigation measures to be included in the project.

Reviewed Item No. 11

Number 11 was developed by Erickson Engineering, Inc. on behalf of Artesa. This document evaluated the vineyard water budget and the proposed collection, diversion and storage of surface runoff to meet irrigation demands.

Site Description

The paragraphs below present a description of the proposed vineyard development site, and include a discussion of the following topics:

- Location
- Slope
- Soils and Geologic Setting
- Watershed and Drainage Information

Location

The project location is shown in Figure 1. The property is located on Annapolis Road, approximately ¾ of a mile southwest of the town of Annapolis in Sonoma County and is within Sections 17 and 18 of Township 10N Range 13W of the Mount Diablo Baseline and Meridian.

Proposed Vineyard Block Areas

The gross area of the proposed vineyard blocks in the project is about 170 acres. Table 1 presents the net acreage of each of the proposed vineyard blocks. As indicated, the proposed net area of the vineyard blocks is 135.0 acres.

Table 1. Proposed Vineyard Block Areas[a]

Block	Area, net acres
1a	13.1
1b	2.1
1c	4.3
1d	6.0
2	14.3
3	1.6
4	6.1
5a	9.5
5b	6.2
5c	0.4
6a	3.7
6b	6.4
6c	9.9
7a	19.9
7b	6.3
7c	0.4
8a	5.8
8b	9.0
8c	10.0
Total	135.0

a) Source: Erickson Engineering, Inc

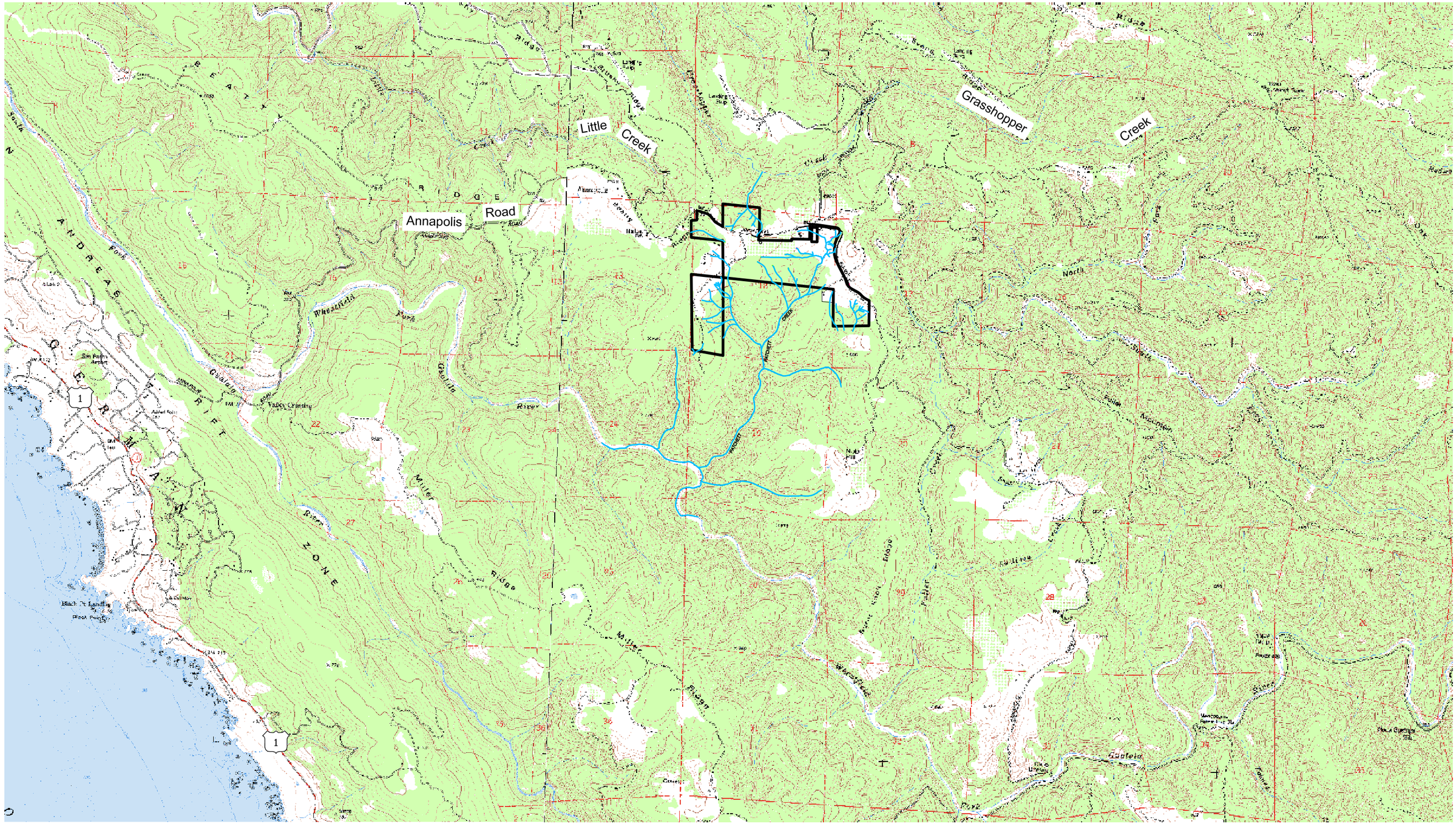

Figure 1

Artesa-Faifax
PROJECT LOCATION MAP

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Soils and Geologic Setting

Detailed information, including mapping, of the site soils and the underlying geologic strata were provided in the ECP and the O'Connor report and will not be repeated in this document.

As discussed in the ECP, the predominant soils in the area are Goldridge fine sandy loam. The runoff potential for these type soils varies from medium to very rapid and the hazard of erosion is moderate at low slope to high at elevated slopes. Furthermore, the Goldridge series of soils are defined as "highly erodible soils" in the "Sonoma County Vineyard Erosion and Sediment Control Ordinance."

DWR Groundwater Investigation of Sonoma County geologic mapping shows the project area as having a large-scale block of the Coastal Belt Franciscan Formation subsurface geology, with smaller ridge-top areas capped by the Ohlson Ranch Formation. Based on site surveys conducted in conjunction with the development of the ECP, the majority of the project area appears to have an Ohlson Ranch Formation substrata with an underling Coastal Belt Franciscan Formation. However, it is likely that there is significant diversity in subsurface features.

The Ohlson Ranch Formation is considered water bearing while the Coastal Belt Franciscan formation is not. Thus, where these two formations meet, water would tend to move laterally along the plane of contact. Without actual groundwater measurements, however, it is difficult to know the precise direction of groundwater flow. An approximation of the location of the Ohlson Ranch Formation was provided in the O'Connor report based on site topography, locations of seeps, springs, channels and channel heads within the project area. The assessment presented appears to be a valid estimation of the direction of groundwater flow.

Watershed Information

The proposed timberland conversion site is located on a broad flat ridge between Grasshopper Creek and the Wheatfield Fork of the Gualala River. The watercourses located within the property boundary are mainly the headwater portion of these larger drainages. The majority of the project area (approximately 174 acres) is located within the Annapolis CAL Watershed (#1113.840303). Flows within this watershed area enter Patchett Creek, which then flows into the Wheatfield Fork of the Gualala River, which eventually flows into the South Fork of the Gualala River. Approximately 14 acres is within the Grasshopper Creek CAL Watershed (#1113.83.0003), and approximately 2 acres lies within the Little Creek CAL Watershed (#1113.830004). Flows within these two northern watershed areas drain into Grasshopper Creek, which then drains to Buckeye Creek and then the South Fork of the Gualala River.

The Gualala River watershed flows into the Pacific Ocean near the Town of Gualala, approximately 114 miles north of San Francisco and 17 miles south of Point Arena. The Gualala River drains approximately 300 square miles, or 191,145 acres, of mostly mountainous and rugged terrain in both Sonoma and Mendocino Counties. The land use within the watershed is predominantly timber production, along with grazing and rural residential development. Orchards and vineyards are also present. Approximately thirty-four (34%) percent of the Gualala watershed is owned by timber companies - Pioneer Resources, Gualala Redwoods and Mendocino Redwood Company. Unstable geology and high precipitation rates, typical of the Mendocino coast, make the region susceptible to high natural erosion and erosion caused by different land use practices.

All of the watercourses located adjacent to the conversion area will be protected by a Watershed and Lake Protection Zone (WPLZ) in accordance with California Forest Practice Rules. No timber harvest activity will occur within the Class II WPLZ, including timber falling. Therefore, no watercourses exist within the proposed development area. However, several Class II and III watercourses were identified in the project vicinity. No Class I watercourses are present on the project site. In accordance with the California Forest Practice Rules, a 50-foot WPLZ will be provided around all Class II and Class III streams.

A discussion of the field investigation conducted of all the watercourses, drainages, and swales within the project vicinity is presented in the Initial Study/Mitigated Negative Declaration document. These watercourses were checked for erosion, channel stability, canopy cover, large woody debris, and aquatic habitat and were categorized in accordance to the classification system included within the California Forest Practice Rules.

In general, the watercourses have a gentle gradient and are shallow channels with only seasonal flow. Furthermore, the streams are generally stable with varying amounts and types of streamside vegetation. A large majority of the streams have a canopy cover greater than 70 percent. The Class II watercourses contain limited amount of aquatic habitat with some pool structure and large woody debris. The Class III watercourses contain limited large woody debris, little or no pool structure and no aquatic habitat.

WATER SUPPLY

Detailed information regarding water supply for the proposed project was presented in the Water Availability Report. As discussed in that document, the water supply for the proposed vineyard will be provided by collecting surface runoff from a watershed with a total tributary area of 36 acres. The runoff is diverted to a 2 acre-foot sump and pumped to an upland 73 acre-foot reservoir. No groundwater will be used for onsite irrigation and subsequent impact to neighboring wells is not anticipated. A summary of the following information related to available water supply for the proposed project is presented below:

- Runoff Collection
- Irrigation Demands
- System Losses
- Supply-Demand Water Balance
- Summary of Water Supply

Runoff Collection

It has been proposed that the vineyard water supply will be developed from surface water runoff from a 36-acre watershed within the project area. Major factors of concern when evaluating the potential runoff that can be collected from this watershed are as follows:

- Runoff Factors

- Annual Average Rainfall
- Sump Pumping Capacity

Runoff Factor

In the Water Availability Report, Erickson Engineering estimates that the surface runoff factor for this area ranges between 30 and 60 percent. Sonoma County Water Agency (SCWA) Flood Control Design Criteria Plate B-1 shows an appropriate rainfall runoff factor for an area covered in vegetation would be 45 percent. From discussions with SCWA staff, a reasonable estimate for runoff in this area would be 40 percent. Additionally, NOAA has published rainfall and runoff maps for the Annapolis area that indicates for the period from 1931 to 1970 the average annual runoff was approximately 40 percent. Therefore, 40 percent is assumed to be the annual average runoff factor.

Annual Average Rainfall

Two certified rainfall isohyetal graphs that have been developed for this area were evaluated to determine the approximate annual average rainfall. An isohyetal graph developed by the Sonoma County Water Agency shows an annual average rainfall in the Annapolis area of approximately 70 inches. This average was developed based on a period of record from 1872 to 1983 (111 years). The National Oceanic and Atmospheric Administration (NOAA) has also developed a rainfall isohyetal graph for the area that shows the annual average rainfall for the Annapolis area of approximately 58 inches. This information was developed based on a period of record from 1931 to 1970 (39 years).

Typically, the longer period of record would likely be considered more reliable for long-term planning. However, both of these isohyetal graphs were developed using data from the Fort Ross rain gauge, which is the closest long-term rain gauge near the site. When looking at historic rainfall amounts for this gauge, rainfall amounts from 1872 to 1920 (when old growth redwood forests covered the hills to the east) compared with rainfall from 1921-2000 show a dramatic difference in the average annual total. In the 47 years from 1872-1920, the average rainfall was 54.18 inches annually. This contrasts with an average of 38.38 inches in the 79 years since.

The rainfall data measured at Fort Ross, Healdsburg, and Ukiah are provided in Attachment B. Note that the long-term rain gauge records in the area for Ukiah and Healdsburg do not show the same changes noted for the Fort Ross gauge. However, the rain gauge type at Fort Ross was changed in 1939 to a standard 8-inch model (USDC, 1955), which may have affected these averages. Therefore, although the NOAA period of record is shorter, it may be a more accurate representation of long-term rainfall patterns.

For purposes of the analyses presented in this report, it has been conservatively assumed that the average annual rainfall for the project area is 58 inches when developing water supply estimates. However, for determination of runoff volumes it will be conservatively assumed that the average annual rainfall is 70 inches.

Sump Pumping Capacity and Available Water Supply

Details regarding the sump pumping capacity are provided in the Water Availability Report. Several pump capacities were compared to various runoff events to determine the runoff capture efficiency. It was determined that a 4 cfs pump would capture about 78 percent of total rainfall volume under an average annual rainfall of 58 inches (assuming 40 percent runoff).

Total capture of both the 36-acres tributary watershed and the 5.5 acres of the sump and reservoir would be about 80 acre-feet. As a result, complete recharge of the reservoir from dry conditions is anticipated under an average year of rainfall. Capture efficiency would be reduced under wetter than average conditions, but complete recharge is probable because greater rainfall would also occur.

The California State Water Resources Control Broad (SWRCB) uses a modified Rational Method analysis to estimate streamflow statistics. The SWRCB flow-statistic estimation method is described in a USGS report titled, "Evaluation of Methods Used for Estimating Selected Streamflow Statistics, and Flood Frequency and Magnitudes for Small Basins in North Coastal California." This method is summarized below and was used to verify sufficient water supply is available for the proposed vineyard.

For estimating runoff volumes the Rational Equation is defined as:

$$Q = C \times I \times A$$

where:

Q = Total runoff in acre-feet

C = Runoff Coefficient

I = Rainfall total depth, in feet, for period of interest

A = Tributary area in acres

To determine the effects of vineyard conversion and estimate the available water supply, the SWRCB modified rational method was used to estimate the annual runoff from the watershed under both existing and proposed project conditions. The runoff coefficient for existing woodland conditions is 0.3 or 30 percent and for the proposed vineyard conditions 0.4 or 40 percent. The total watershed area encompassing the proposed project, draining to both Patchett Creek and Grasshopper Creek, is about 429 acres. Up to 160 acres is assumed to be converted from woodland to vineyard. Assuming an average annual rainfall of 58 inches, the resulting annual volume of runoff under existing conditions would be about 677 acre-feet and under proposed conditions the annual runoff would be about 754 acre-feet. This is an increase of 77 acre-feet. Therefore, the proposed project appears to have a sufficient water supply without adversely impacting the downstream creeks.

Irrigation Demands

Details regarding the estimated irrigation demands for the proposed vineyard were provided in the Water Availability Report. As discussed in that report, estimated maximum irrigation demands during vine establishment will be 100 gallons per vine per year. At a density of 1,090 vines per acre, the total irrigation demand will be approximately 1/3 acre-foot per acre per year.

Once the vines are established they may be dryland farmed, thereby requiring no irrigation. Additionally, no frost or heat protection will be used at the site according to the Water Availability Report.

Rhonda Smith from UC Cooperative Extension stated that an anticipated 100 gallon per vine water demand is reasonable for this area and that dryland farming could potentially occur depending on site specific conditions.

The Water Availability Report states that estimated plantable area is about 135 acres. However, for determining irrigation demand 160 acres was used to provide flexibility in planting densities and to account for potential variation in plantable acreage during the development of the vineyard site. Therefore, it has been conservatively assumed that a total of 56.3 acre-feet of irrigation demand will be required.

Water for washing and other incidental needs of vineyard workers will be provided by a small onsite well.

System Losses

In addition to irrigation demands, stored water in the vineyard reservoir will be lost due to evaporation and seepage. As discussed in the Water Availability Report, seepage losses will be eliminated by the use of a lined reservoir. It should be noted, however, that if a clay liner is used, some seepage may occur; but a synthetic liner will provide assurances that no seepage occurs. For purposes of this analysis it has been assumed that a synthetic liner will be used.

The Water Availability Report estimates that evaporative loses in the Annapolis area are approximately 40 inches per year. This also compares closely with information presented by USGS and the California Department of Water Resources (DWR). Therefore, it has been determined that 40 inches per year is a reasonable estimate for evaporation in the project area. Assuming 40 inches of evaporation, the reservoir would lose about 12.7 acre-feet due to evaporation.

Irrigation system losses may also be a concern for long-term irrigation supply planning. Losses in a subsurface-type irrigation system are limited to deep percolation, which is affected by site specific conditions such as soil type, crop type, metrological conditions, system design and management. Typical efficiency ratings for a subsurface irrigation system range from 85 to 95 percent (*Irrigation System Design – An Engineering Approach*, Cuenca, R.H., 1989). Due to the expected high degree of management that will be used on the site, the estimated efficiency of the proposed project irrigation system is assumed to be 95 percent.

Supply-Demand Water Balance

A water balance analysis was developed for average annual conditions assuming the water supply, irrigation demand, and system loss parameters described above adequately represent the project site.

These analyses are provided in Attachment C and the results are shown graphically in Figure 2. As indicated, the reservoir capacity required to meet annual irrigation needs and system losses for 160 acres of vineyard is about 67 acre-feet. The proposed reservoir has a capacity of about 73 acre-feet, providing about 8 percent reserve. Therefore, there should be adequate water supply (with some carry-over water supply) to meet the consumptive demands of the proposed project in an average rainfall year if 160 acres of vineyard are developed. The annual stored water volume required if only 135 acres of vineyard are irrigated as proposed would be about 57 acre-feet.

The proposed water supply system is conservatively designed. Consequently, there will be carry-over under most operating conditions. Furthermore, 67 acre-feet are necessary to meet annual system needs, which can be achieved with somewhat less than average rainfall. Nevertheless, during vineyard establishment and under severe drought conditions maintaining an adequate water supply may not be possible. It has been proposed by the landowner that irrigation volumes will be reduced as necessary during dry year conditions at the expense of reducing vineyard yields. Additionally, Artesa proposes to plant rootstock that is known to be drought resistant and deep-rooted, thereby minimizing total irrigation requirements. These actions should mitigate potential water supply issues that may occur as a result of adverse annual rainfall conditions.

It should be noted that the analysis presented in this report is only intended to provide an indication of water supply needs. The actual required water supply will be contingent upon very site specific conditions.

HYDROLOGIC IMPACTS

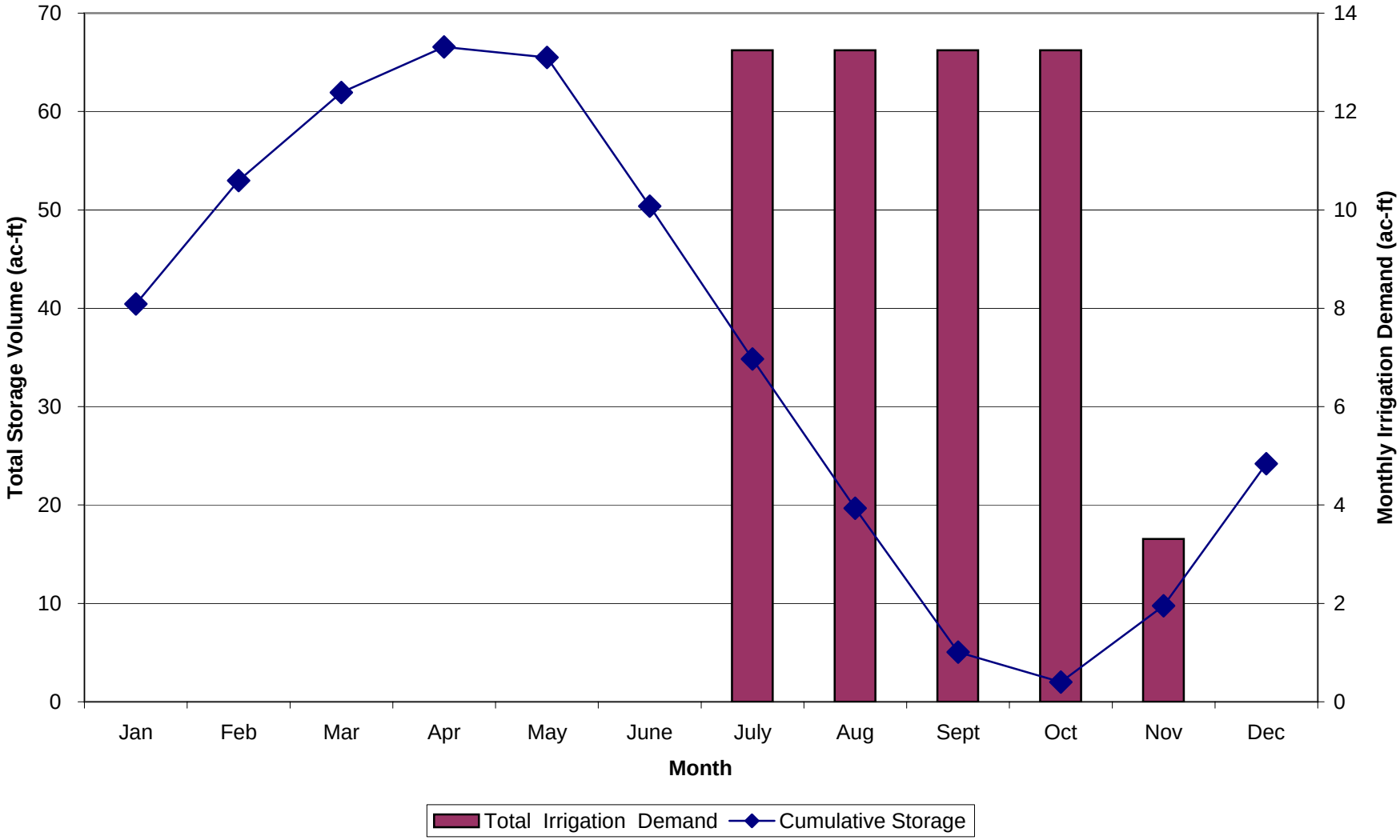
Based on a review of available information, potential hydrologic impacts could occur as a result of implementation of this project. A brief discussion of the following major components of the hydrologic evaluation is presented below:

- Increases in Peak Runoff Flows
- Reduction in Downstream Summer Flows
- Summary of Hydrologic Impacts

Peak Runoff Flows

Peak runoff flows for existing and post-project conditions were estimated for the Patchett Creek Watershed using the SCS Curve Number Method and a HEC-1 model. Additionally, the O'Connor Report included a detailed assessment of the peak flow increases that may be associated with the project. Hydrologic processes are complex and these assessments provide only a relative estimation of the changes to flows due to the proposed project.

Figure 2. Fairfax Vineyard Development Project
Water Supply Summary - 160 Acre Vineyard



This analysis was performed using a HEC-1 model of the watershed to assess the potential change in peak flows due to the project. The results seem reasonable for conducting a comparative analysis to predict the percentage change in peak flows due to land use modification. However, the absolute values of peak stream discharge may be conservatively overstated when compared to estimates prepared using other hydrologic methodologies.

It should be noted that this assessment focused on peak flow increases in the small drainages that feed Patchett Creek. Evaluation of the change in peak flows to Grasshopper Creek or Little Creek were not developed because the acreage of vineyard to be developed in these watersheds associated with the proposed project are very small. The potential for adverse hydrologic impacts is very small, significantly less than the potential impacts anticipated on Patchett Creek.

HEC-1 Model Analysis

Peak storm flows were determined at two locations (Nodes) on the Patchett Creek as shown on Figure 3. Node 1 is located just below the second major confluence on Patchett Creek (estimated to be approximately 4,800 feet downstream from the vineyard discharge point), where the creek is described as having a very steep section that "blocks the migration of salmonids", according to the RWQCB PH1 report (Erickson March 26, 2002). The tributary area at this node is 830 acres. Below this location Patchett Creek would be defined as a Class I watercourse. Node 2 is defined as the confluence of the Patchett Creek and the Wheatfield Fork of the Gualala River. The tributary area for this node is approximately 1,124 acres. Peak runoff calculations were made for the 24-hour 2-year, 10-year and 100-year events using an HEC-1 model of the watershed.

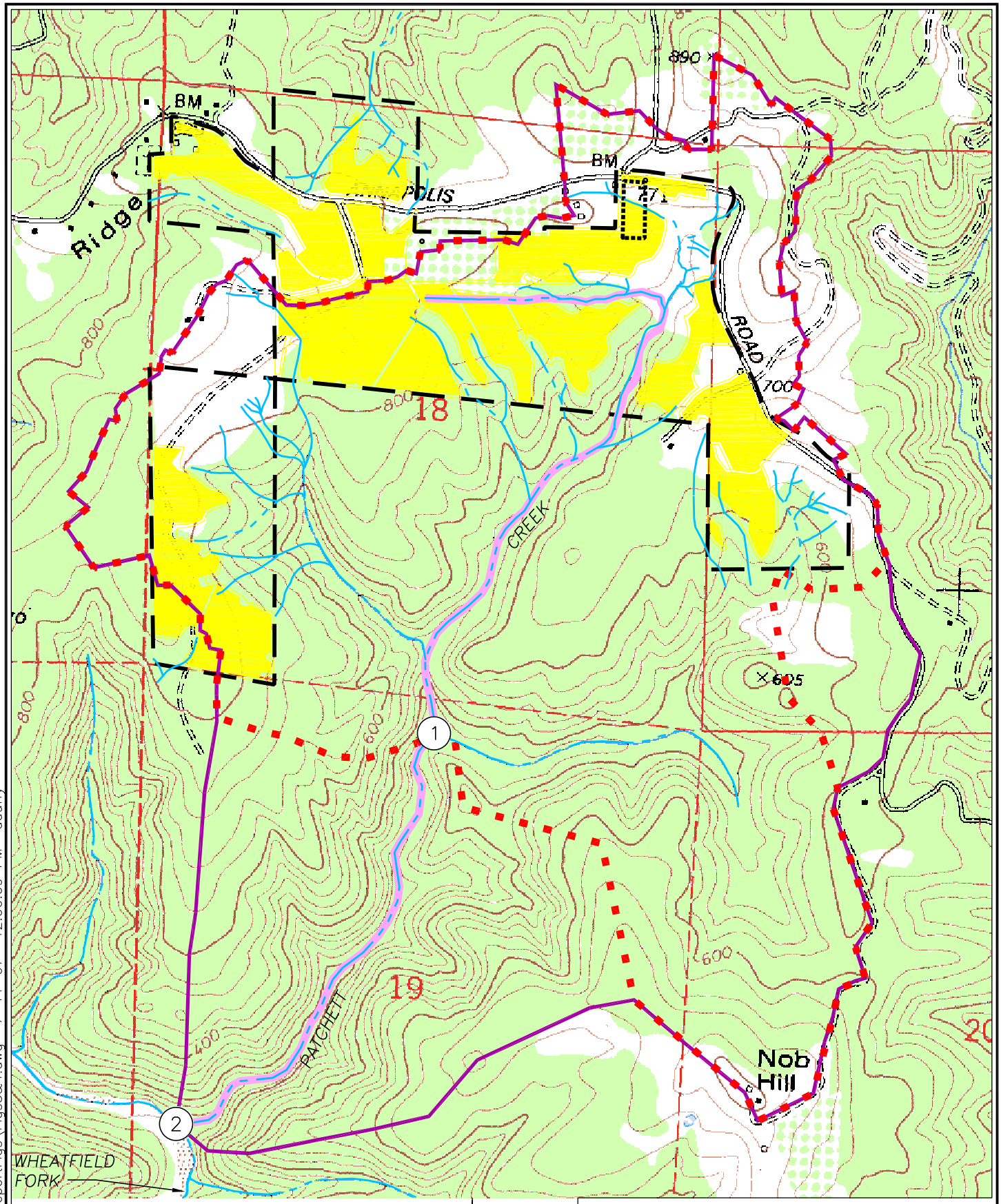
Although the runoff from approximately 36 acres (out of a total 830 acres draining to Node 1) on the project site will be captured in the onsite storage reservoir, it was conservatively assumed for purposes of this analysis that the reservoir would be full and that all flows would be directed to Patchett Creek. However, during most storm events, the reservoir will not be full and a small portion of the total site runoff would be collected and pumped to the reservoir for storage. Under such operating conditions, the peak runoff under a 2-year storm is estimated to decrease by 4 percent at Node 1 and by 3 percent at Node 2.

When the rainfall into the reservoir alone gets captured while the runoff to the sump overflows to the Patchett Creek, the change in peak runoff under a 2-year storm is estimated to be negligible.

The HEC-1 model requires the following input parameters to define peak runoff:

- Basin Area
- Weighted Average Curve Number
- Precipitation Depth
- Lag Time

Following a description of each of these parameters, a summary of the results from the HEC-1 analysis peak flow are presented.



LEGEND

- PROPOSED VINEYARD DEVELOPMENT
- PROJECT BOUNDARY
- NODE 1 WATERSHED
- NODE 2 WATERSHED
- FLOW PATH

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SCALE IN FEET

Figure 3

Artesa-Fairfax
HEC 1 ANALYSIS

WEST YOST & ASSOCIATES

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Basin Area

The study area was delineated into subsheds for each individual tributary area within the project site as shown in Figure 4. Each of these sub-basin areas were defined using a scaled USGS quad map and an aerial photograph on which the vineyard project extents were overlaid. Areas estimated using the AutoCAD computer program are presented in Table 2.

Table 2. Estimated Tributary Areas for Nodes on Patchett Creek

Node	Area
Node 1	1.30 sq.mi. (830 acres)
Node 2	1.76 sq.mi. (1,124 acres)

Note: Areas draining into Patchett Creek include some areas beyond the project boundary

Weighted Average Curve Number

Using the USGS quad map and available aerial photographs, the percentages of each type of land use and cover was estimated for both the existing and future conditions within each subshed, and the weighted average curve number was calculated. Curve Numbers for the Forest and Open Pasture land uses within the project area were obtained from the NRCS manual. However, the NRCS manual does not define a Curve Number for vineyard areas; therefore, a value was assumed for this area that is slightly lower than open pasture. This is justified because groundcover in the vineyard area will be closely managed to approximately 80 percent cover. Furthermore, in the event that groundcover crops are not adequate to assure 80 percent coverage, mulching at a rate of 2 tons per acre will be applied. Curve Number values used for the analysis are as follows:

- Vineyard = 70
- Forest = 63
- Open Pasture = 74

The calculated weighted curve number values are shown in Table 3.

Table 3. Estimated Weighted Curve Number for the Patchett Creek Watershed

Site Conditions	Node 1	Node 2
Existing	64.4	64.0
Post Development	65.5	64.9

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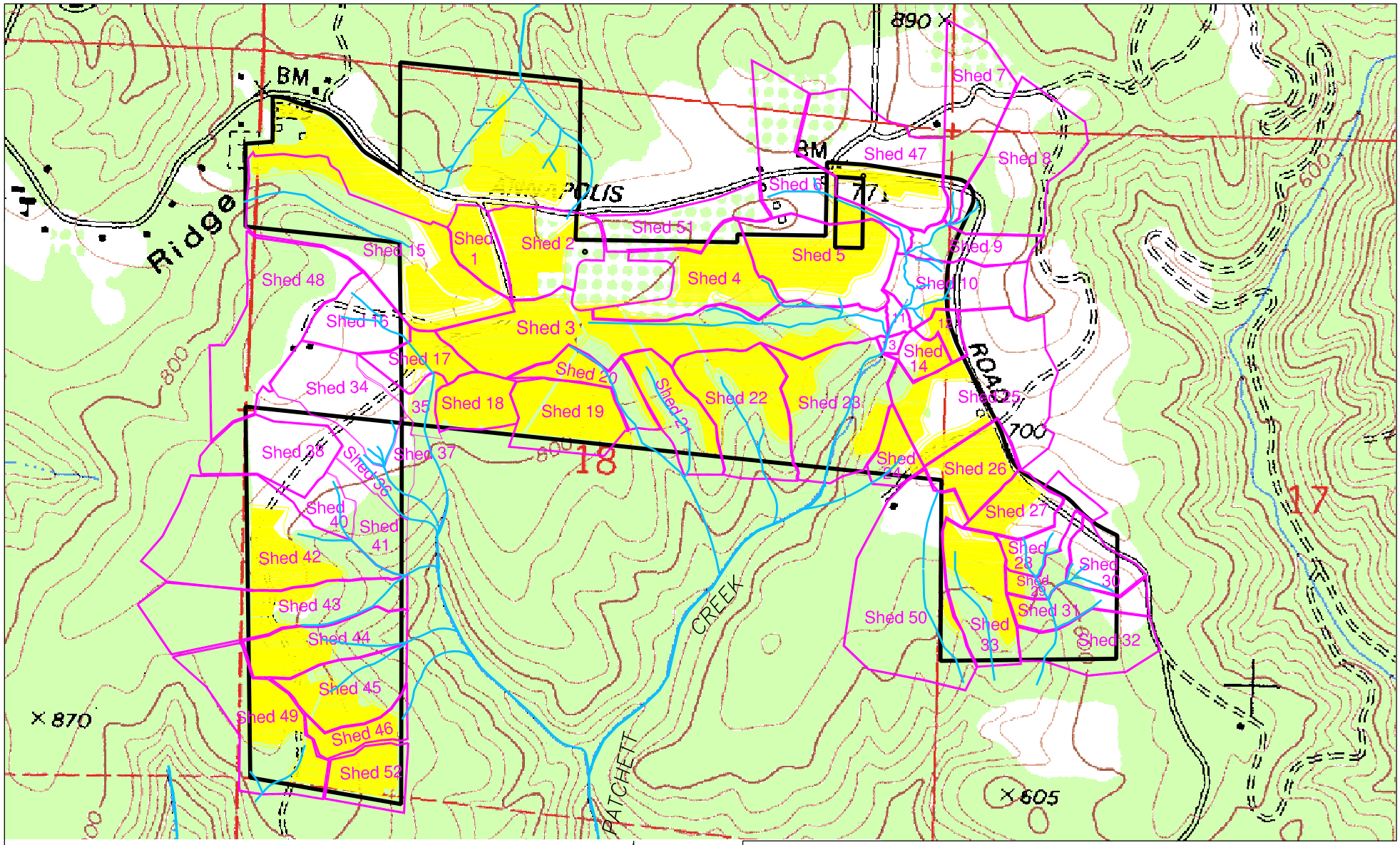


LEGEND

VINEYARD DEVELOPMENT

PROJECT BOUNDARY

Shed 2 SUBSHED

N

0 500 1000

SCALE IN FEET

Figure 4

Artesa-Fairfax

CURVE NUMBER ANALYSIS

SUB-WATERSHEDS

WEST YOST & ASSOCIATES

Precipitation Depth

Rainfall intensity for Sonoma County is defined in the Sonoma County Water Agency Flood Control Design Criteria Manual. As described, the following equation defines the average rainfall intensity for the county:

$$\text{Intensity (inches/hr)} = K \times 5.12Y^{0.1469}t^{-0.528}$$

K = 2.3 (converts the Sonoma county wide intensity value to a site-specific value based on the site specific mean seasonal precipitation of 70 inches versus the county-wide mean seasonal precipitation of 30 inches)

Y = Return Frequency (2, 10, 100)

t = Time (in minutes)

The calculated 2-year, 10-year, and 100-year 24-hour precipitation depths are shown in Table 4.

Table 4. Estimated Precipitation Depth for Patchett Creek Watershed

Return Period	24-Hour Rainfall, inches
2-yr	6.73
10-yr	8.52
100-yr	11.95

Lag Time

As defined by the HEC-1 model, Lag Time is described by the following equation:

Lag Time (hrs) = 0.6 x Time of Travel (hr)

Time of travel = Overland flow travel time[(1)] + Creek flow travel time[(2)]

1. Overland flow travel time was estimated using the nomograph method

2. Creek flow travel time was computed assuming a velocity of 6 feet per second (fps) under 2-yr storm condition and velocity of 10 fps under 10-yr and 100-yr storm conditions

Table 5 provides a summary of the estimated travel time (in minutes) calculated for each Node described above. The estimated travel time for the pre- and post-project conditions is not anticipated to change.

Table 5. Estimated Travel Time for Nodes Within the Patchett Creek Watershed

Storm Event Return Period	Total Travel Time to Node 1, minutes	Total Travel Time to Node 2, minutes
2-yr	43.3	56.4
10-yr	35.6	43.4
100-yr	35.6	43.4

Note: Travel times for pre- and post-project conditions are not anticipated to change.

Summary of Results

Estimated peak flows for existing and post project conditions are provided for Node 1 and Node 2 in Tables 6 and 7, respectively.

Table 6. Estimated Peak Flows for Node 1 on Patchett Creek

Return Period	Flow Under Existing Conditions, cfs	Post-Project Conditions Flow, cfs	Increase, percent
2-yr	585	614	5
10-yr	1,230	1,270	3
100-yr	2,126	2,172	2

Table 7. Estimated Peak Flows for Node 2 on Patchett Creek

Return Period	Flow Under Existing Conditions, cfs	Post-Project Conditions Flow, cfs	Increase, percent
2-yr	675	703	4
10-yr	1,500	1,541	3
100-yr	2,604	2,652	2

In general, the comparison of the results of the HEC-1 model analysis indicate that the peak discharge flow would increase slightly due to the modified land use. The model results also show that the impacts to runoff flows decrease further downstream within the watershed. These conclusions were also demonstrated through the O'Connor analysis. Therefore, it has been concluded that the time of concentration and peak discharge flow calculations adequately describe the proposed project, and a minor impact to downstream water bodies is anticipated with respect to increased flows.

Protection of the Natural Hydrograph

With the anticipated slight increase in the 2-year, 10-year and 100-year peak runoff at Node 1 due to the change in the ground cover as a result of the establishment of the vineyard, the project with the 4 cfs diversion to storage for irrigation supply will not cause an appreciable diminishment of the natural hydrograph and the frequency and magnitude of the high flows necessary for channel maintenance.

In addition, the runoff diverted to storage will result in less than a two percent reduction in the expected runoff during a normal water year at Node 1 under existing conditions. The maximum volume stored in the irrigation supply reservoir is 69 acre-feet as previously discussed in the water supply section. The expected volume of runoff available at Node 1 under post project conditions during the period of October 1 through March 31 in a normal water year is estimated to increase from about 1,065 acre-feet to about 1,120 acre-feet. The maximum stored volume of 69 acre-feet is about 6 percent of the expected total runoff in the wet season at Node 1. However, when compared to the pre-project conditions, the resultant runoff at Node 1 with the diversion to the irrigation reservoir is estimated to be 1,051 acre-feet, or about 1.3 percent less than under existing conditions. This reduction in the volume of runoff is not expected to cause an appreciable change in the creek flow at Node 1 or further downstream.

O'Connor Hydrologic Assessment

An assessment of the magnitude and location of expected peak flow increases within the project area was presented in the O'Connor Hydrologic Assessment Report. Using the Rational Method approach, peak flow increases were calculated based on a 2-year return period storm event. The assessment was conducted under two reservoir conditions – (i) assuming the reservoir is filling; (ii) assuming the reservoir is at full storage capacity. Using the calculations as well as site-specific field observations, an assessment of erosion hazards was also presented. The study found that no significant increases in erosion were expected to occur. The study also recommends implementing an erosion monitoring program that would detect any significant channel erosion that may occur. The program would help identify if erosion controls need to be implemented.

Summer Flows

Based on a review of available information, salmonid populations are believed to be present in the lower reaches of Patchett Creek, starting approximately 4,800 feet downstream of the project area (the location of Node 1 discussed above). Therefore, a summary of the potential impact to flows in this downstream reach during the summer and late fall months when salmonids may be present is warranted.

Late summer and early fall stream flows are dominated by groundwater seepage or discharge with some runoff occurring during occasional rainfall events. Therefore, the potential impact to these two sources of late summer flows was evaluated.

Groundwater Discharge

The irrigation water supply for the project will be derived from winter runoff flows captured in the onsite reservoir. Therefore, although a small well will be drilled onsite to provide cleaning water for farm workers, additional groundwater pumping will not be significant and negative impacts to later summer groundwater discharge to streams is not likely to occur.

Studies show that removal of forest vegetation may impact groundwater seepage or discharge to small drainages. The USDA Forest Service's Redwood Sciences Laboratory in conjunction with the Jackson State Forest has conducted extensive research on watershed scale hydrologic processes at Caspar Creek. The information developed in conjunction with these studies can be used to estimate the likely impacts to downstream summer flows associated with the proposed timber harvesting project; however, these studies do not demonstrate the potential hydrologic impacts associated with vineyard development.

A summary of the Caspar Creek study information is presented in the O'Connor report. As stated in that report, the Caspar Creek research suggests that annual water yield and summer stream flows can be expected to increase due to the following factors:

- Reduced evapotranspiration that occurs once trees are replaced with less water demanding crops.
- Use of stored winter runoff flows to meet vineyard evapotranspiration demands in lieu of stored groundwater (that is used to maintain existing vegetation).

WYA reviewed the Caspar Creek study reports and agrees with these conclusions presented in the O'Connor report.

Late Summer Rainfall Capture

There has been some suggestion by project critics that impacts to summer flows would occur due to the development of the sump and reservoir, which would capture all runoff flows from approximately 36 acres of the project area (total capture area of 41.5 acres including the reservoir). The proposed operation of the sump and reservoir is to collect and store runoff in the reservoir during the winter months. During the spring and summer months it is anticipated that any runoff that occurred would not be pumped to the reservoir. The only runoff that would be captured during the summer is that falling on the 5-acre reservoir. Furthermore, as discussed above, the change in land use would result in an increase in runoff as compared to existing conditions. Therefore, any runoff captured by the reservoir would be mostly offset by increased runoff resulting from development of the proposed vineyard. Also, at low flow conditions, a portion of the flow in Patchett Creek would also originate from groundwater seeps and interflow.

Summary of Hydrologic Impacts

Issue No. A1 - Increased Peak Flows

Minor increases in peak flows during storm events are expected to occur within the project area. Therefore, additional analysis of downstream channel stability would be needed to determine the potential for scouring and stream bank erosion associated with these increases in peak flows. Based on information developed in conjunction with the THP, downstream channels are somewhat stable. Additionally, the increase in peak flows should be evaluated by a fisheries biologist to determine if such increases would lead to any impacts to downstream fisheries. Further downstream from the nodes evaluated, the increase in flow would be an even smaller fraction of total flow and is not anticipated to have an impact on these channels.

Issue No. A2 – Decreased Summer Flows

Late summer and early fall runoff flows are expected to increase as a result of the proposed project. Information collected from similar watershed areas indicate that logging practices within coastal hillslope areas can lead to an increase in groundwater recharge due to decreased evapotranspiration. Therefore, the overall impact to downstream summer flows is probably small but is uncertain.

The most conservative analysis would assume that summer flows would decrease slightly due to the capture of runoff in the reservoir. However, increased runoff resulting from the change in land use condition would offset most of the captured runoff. Nevertheless, additional analyses by fisheries biologist familiar with existing flow conditions in downstream water bodies is needed to determine whether the potential flow decreases associated with capture of runoff flows from the project site would adversely impact downstream fisheries.

WATER QUALITY IMPACTS

A summary of the potential water quality impacts that may be associated with the vineyard development project is presented in this section. The downstream water quality concerns were identified and the proposed chemical application information was reviewed for the project. The following information related to water quality for the proposed vineyard development site is presented below:

- Increased Sediment Loadings
- Proposed Chemical Applications
- Temperature Impacts

Sediment Loadings

Runoff from the proposed vineyard development site flows to the Gualala River, which is currently on the Clean Water Act (CWA) Section 303d listing as impaired with respect to impairment and/or threat of impairment to water quality by sediment. See the O'Connor Erosion Analysis for Evaluation of Sedimentation.

Proposed Chemical Applications

Artesa will potentially apply the following constituents during the growing season: sulfur, fertilizer, pesticides and herbicides. Additionally, Crop Care Associates has recommended broadcast application of lime prior to deep tillage to increase soil pH levels and applications of high quality compost to increase soil organic matter.

Pesticide and Herbicide Applications

It is the intent of Artesa to minimize the use of pesticide and herbicides through the use of Integrated Pest Management (IPM). IPM refers to a broad array of practices that focus on using "natural" means to encourage beneficial animals, insects, and microorganisms and/or discourage control of or eliminate harmful animals, insects, and microorganisms. IPM practices that may be used include habitat control (fencing), beneficial predator inducement (nest boxes for raptors) and predator enhancement via importation (importation of beneficial insects).

Artesa Vineyards has had many years of experience with water quality management for their existing vineyards in Napa and Sonoma Counties. Therefore, it is likely that the IPM strategies and pesticide application methods will be similar to the already established methods.

Specifically, Artesa intends to control nuisance mites with predacious mites. Predacious mites are purchased and placed in the vines; as they repopulate, they feed on the bad mites. This IPM strategy has been successfully used on one of the owner's other vineyards where they, as a result, have not had to spray with any insecticides for mite control. In addition, phylloxera resistant rootstock will be utilized to eliminate or reduce the need to fumigate the soil in order to kill phylloxera fungus. Artesa will not use Methyl Bromide to fumigate the soil within units prior to vineyard development.

In the event that pesticides and herbicides are required during the development and operation of the vineyard, only pesticides and herbicides permitted for use by Federal, State and local regulations shall be used. Furthermore, application of pesticides and herbicides shall be done in compliance with Federal, State and local regulations and under the supervision of a qualified vineyard manager.

Pest and disease control activities will take place generally between April and July depending on the type of grapes and weather conditions. Materials will be applied approximately every seven to fourteen days throughout this period for a total of seven to nine applications. Each application will take place over two days and will require the use of a 60-hp tractor. Materials will be applied at night between 3:00 a.m. and 9:00 a.m. This time provides cool temperatures and minimal wind (wind could cause drift from the vine rows). Pesticides will be kept in a locked storage container (approx. 8 feet x 20 feet). The vineyard employees will be trained annually in the usage, storing, and handling of all pesticides that will be used.

Weeds will be controlled mechanically and chemically. Mechanical weed control will include manual hoeing, and tractor mowing (between vine rows). Minimal chemical weed control, namely Roundup, will be used under the vines, and will be limited to non-leaching pre- or post- emergence formulations. Applications of Roundup will be made between the rows as spot treatments made to eliminate unwanted weeds that grow in the planted cover crop. The under-vine controls will be applied approximately two to three times annually between February and June. Application between vine rows will occur approximately two to three times, between May and September. Usually, after the first three years, weed control is not required because the cover crop will dominate the area. Fifteen gallons of Roundup will be stored at a time in one-15 gallon container.

One pallet of dusting sulfur (approximately 3,000 pounds) will be stored and used during the growing season. Dusting sulfur will be used early in the growing season. Later in the growing season when the weather is hot, water-soluble fungicides, most likely 'Serenade', will be used instead. The use of dusting sulfur, when it is hot, can burn the plants and fruit, and also enhance mite populations.

Based on the information presented above, the proposed herbicide and mildewcide applications should be appropriate, as long as they are applied in accordance with applicable laws. Furthermore, since drip irrigation will be used and rain is minimal during the growing season when these chemicals would be applied, it is likely that these constituents would not runoff into the surrounding streams if irrigation waters are applied at the prescribed agronomic rates. Finally, the presence of 50 foot forested buffer areas between the vineyard blocks and onsite waterways will help to prevent these chemicals from leaving the site in the event that significant runoff does occur following an application.

Fertilizer Applications

For the purposes of this report, it has been assumed that Artesa Vineyards will not apply fertilizers as recommended in the Crop Care Baseline Soil Analysis Report prior to vineyard establishment. However, in the spring and through the growing season fertilizer may need to be injected into the drip irrigation system using approximately 10 to 15 gallons of concentrated fertilizer per acre per year. This application will likely be done once during the growing season, but only during those years when needed. In addition, an application of 12-26-26 fertilizer or gypsum (form of calcium, dry material) may be used at a rate of 500 to 1,000 pounds tons per acre when called for, but not every year.

The gypsum or solid fertilizer will either be broadcast with a tractor and a spreader over the entire area at the higher rates, or at the lower rates placed under the drip emitters for each vine. Liquid fertilizer will be injected into the drip irrigation system. The quantity of fertilizer needed per application will be a maximum of about 15 gallons per acre. Fertilizer will be delivered in plastic containers to the vineyard site and injected at the specific blocks where the application is needed. Any spills that may occur will be directly in the vineyard and will be diluted with water and contained with dirt berms to avoid any run off. The injection sites will not be adjacent to wells.

As with any fertilizer application, there is potential for excessive nutrients in the site runoff to affect downstream water bodies. However, since the drip irrigation system will be used to apply fertilizers at agronomic rates (and rain is minimal during the growing season when they would be applied), it is likely that these constituents would not runoff into the surrounding streams. Furthermore the presences of 50-foot forested buffer areas between the vineyard blocks and onsite waterways will likely entrap applied fertilizers before leaving the site in the event that significant runoff does occur following an application.

Temperature Impacts

Increases to downstream temperatures may also be an issue for protection of downstream aquatic habitats. However, the project area is located in the upper portion of the watershed and the very small headwater streams are mostly or entirely dry in the summer months. In addition, due to the presence of a 50-foot forested corridor around all streams, stream temperatures are not likely to be increased as a result of vineyard development.

Summary of Water Quality Impacts

Issue No. B1 – Chemical Applications

Some chemical applications are a necessary component of the proposed project. However, based on the information presented above, the use of IPM to reduce such applications and the proposed site controls and chemical application methods should provide adequate mitigation to reduce the potential for downstream water quality impacts to less than significant.

FLOODING POTENTIAL

The flooding potential of the proposed vineyard development site is discussed in this section. Based on the available information, it does not appear that a flood analysis has been conducted for the proposed vineyard development site. Therefore, a flooding analysis was conducted. Based on this analysis it was determined that flooding potential would be extremely low for this site and downstream. Therefore, no potential flooding issues are associated with the proposed project.

Flooding Summary

The following information related to potential flooding of the proposed project is presented below:

- FEMA Mapping
- Peak Runoff Flows Calculations
- Streambed Alteration Impacts

FEMA Mapping

Although it was likely that flooding would not be an issue due to the site elevation and terrain, FEMA flood insurance rate maps were reviewed to determine if flooding could have a potential impact to the vineyard development area. Upon inspection of these maps, it was determined that the proposed vineyard development would not be susceptible to flooding from local creeks.

Peak Runoff Flows

As stated above, peak runoff flows would slightly increase as a result of the proposed vineyard development. However, due to the rural nature of the downstream areas, this increase will not likely contribute to downstream flooding effects.

CONCLUSIONS

The following conclusions have been drawn from the evaluation of the hydrologic issues for the proposed vineyard project:

- The proposed runoff capture system should be adequate to provide the necessary water supply for the irrigation of up to 160 acres of plantable area during the vineyard development phase under average water year conditions. During drier years, water supplies could be limited.
- Groundwater impacts are not anticipated to occur due to limited use of this resource.
- Peak flows are expected to increase slightly. These increases could lead to additional erosion in downstream channels.
- No water quality impacts are anticipated from the proposed pesticide and herbicide applications
- Temperature increases in streams are not anticipated due to the presence of forested buffer areas around all waterways on the project site.
- No flooding effects are anticipated from the proposed vineyard development.

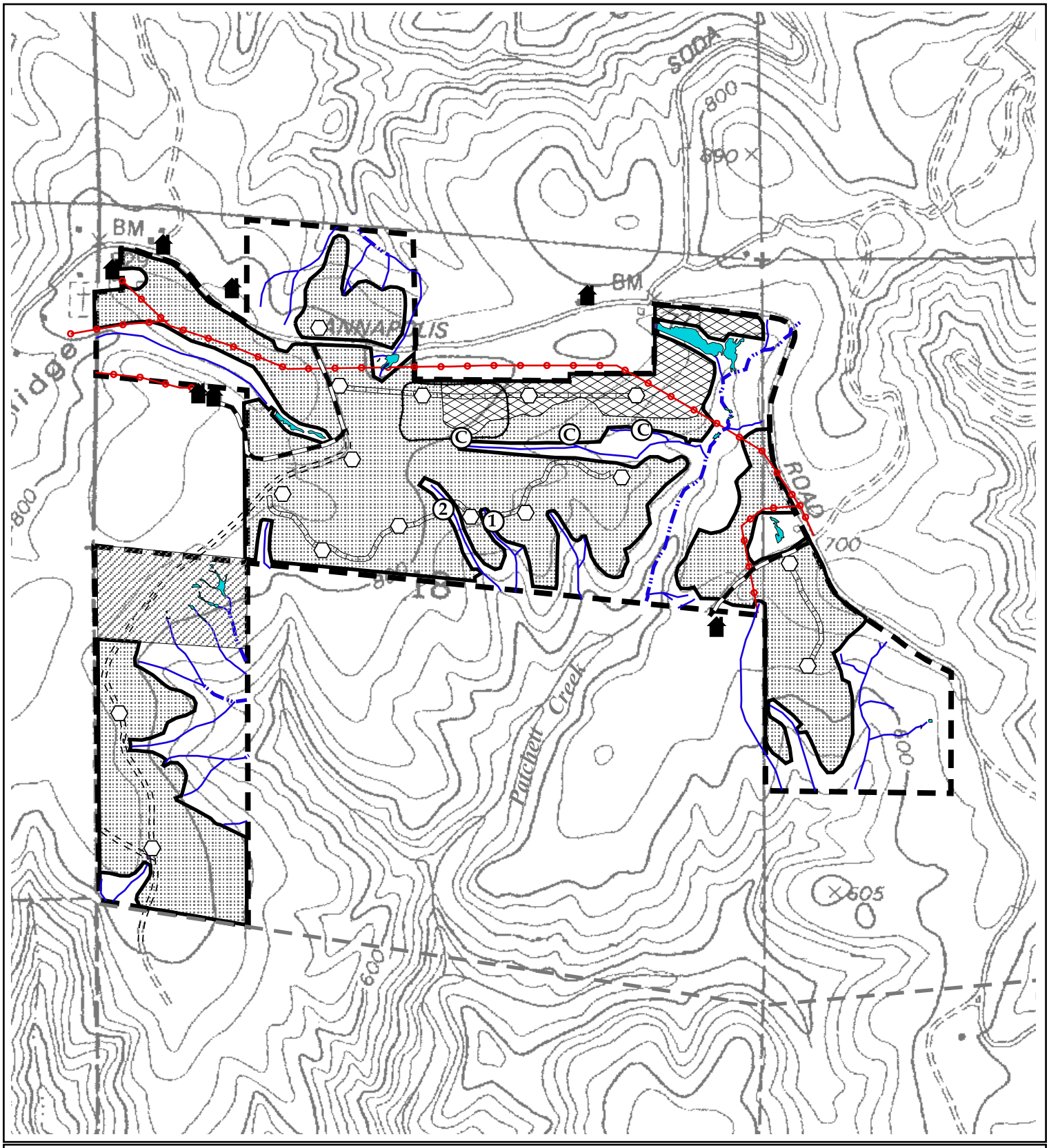
Table 8 provides a summary of the determined significance and mitigation measures for each hydrologic issue.

Table 8. Summary of Major Issues, Significance, and Proposed Mitigation Measures

Issue No.	Hydrologic Issue	Significance	Recommended Actions	Other Actions	Resulting Significance
A1	Increase to Peak Flows	Potentially Significant	Provide contour planting, terracing, grading, or v-ditches in all vineyard block areas. Consult with a fisheries biologist to determine impact potential.		Unknown
A2	Decrease to Summer Low Flows	Potentially Significant	Consult with a fisheries biologist to determine impact potential.		Unknown
B1	Chemical Applications	Potentially Significant		Use of IPM when feasible. Apply all chemicals in accordance with applicable laws and regulations. Maintain 50 foot buffer areas around all waterways. Controls and chemical application methods should provide adequate	Less than Significant

ATTACHMENT A

Figures Showing the Proposed Project Layout



Property Boundary:
Vineyard/Project Boundary:
THP/Conversion Boundary:
Meadow/Non-timberland area:
Existing Permanent Road:
Existing Seasonal Road:
Proposed Temporary Road:
Potential Landing:
Comment Point:
Structure:
Powerline:

Fairfax Timberland Conversion

Operations Map

May 17, 2007

T10N R13W MDB&M
Portions of Sections 17&18
Annapolis 7.5' USGS Quad

Class II watercourse:
Class III watercourse:
Reservoir location:
Horkelia reserve area:
Wetland areas:

Scale 1:12000
1" = 1000 ft

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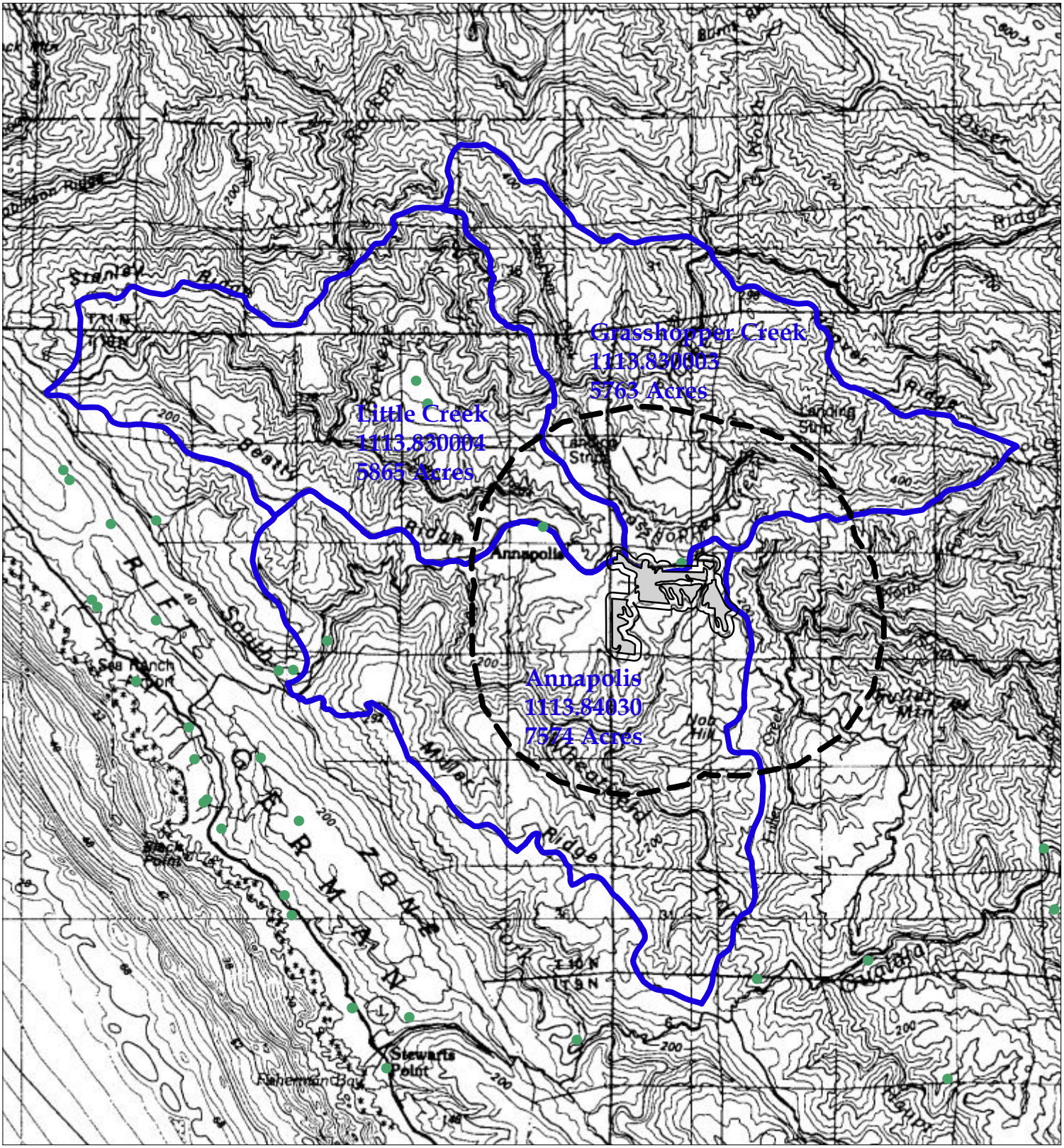

Fairfax Timberland Conversion

Cumulative Impacts Map

February 5, 2004

Watershed Assessment Area
Biological Assessment Area:
Project Area/Soils Assessment Area:
Recreational Assessment Area:

T10N R13W MDB&M
Portions of Sections 17&18
Annapolis 7.5' USGS Quad

Scale 1:80,000
1" = 1.26 miles

N
W E
S

ATTACHMENT B

Rainfall Data for Western Sonoma and Mendocino Counties

Attachment B. Rainfall Data for Western Sonoma and Mendicino Counties

YEAR	Annual total rainfall (inches)		
	Fort Ross	Healdsburg	Ukiah
1872	61.84		
1873	35.21		
1874	54.13		
1875			
1876	58.97		
1877	30.77		
1878	94.75	68.27	55.93
1879	50.45	41.60	35.90
1880	67.17	45.11	42.14
1881	66.49	45.94	29.71
1882	44.02	30.85	27.21
1883	46.91	39.27	24.55
1884	47.34	30.89	23.97
1885	36.28	15.35	19.62
1886	55.45	54.05	45.54
1887	27.29	29.82	22.63
1888	28.70	35.48	26.81
1889	28.78	36.28	29.13
1890	59.34	72.65	60.97
1891	32.33	32.09	25.29
1892	54.89	38.49	28.21
1893	61.83	55.00	45.40
1894	62.41	36.63	46.83
1895	79.13	61.53	53.59
1896	52.77	45.06	39.47
1897	64.53	38.91	43.01
1898	41.00	23.97	20.55
1899	48.88	29.59	27.13
1900	53.65	41.75	36.76
1901	48.62	40.63	35.07
1902	61.90	52.22	43.67
1903	59.37	39.17	34.55
1904	83.54	67.70	57.72
1905	64.96	48.50	39.94
1906	62.60	52.21	44.84
1907	67.84	54.39	48.56
1908	38.52	28.90	30.09
1909	75.19	62.34	57.48
1910	49.12	28.93	29.37
1911	46.08	32.86	33.00
1912	42.43	28.30	28.65
1913	39.46	26.72	30.65
1914	73.02	60.42	54.80
1915	74.05	56.78	49.15
1916	59.81	46.20	35.36
1917	42.30	25.82	30.07
1918	37.55	25.18	24.64
1919	46.23	32.11	36.82

YEAR	Annual total rainfall (inches)		
	Fort Ross	Healdsburg	Ukiah
1920	28.52	18.82	18.78
1921	65.97	55.54	47.34
1922	29.11	28.92	28.59
1923	33.73	32.04	33.45
1924	17.68	15.37	13.09
1925	50.23	50.30	48.11
1926	24.89	34.87	25.66
1927	48.83	51.30	47.22
1928	34.40	36.15	35.03
1929	24.47	24.33	24.35
1930	32.34	38.81	31.57
1931	21.82	23.67	19.58
1932	28.70	30.34	27.66
1933	23.64	26.67	24.82
1934	27.38	31.17	25.28
1935	38.52	45.56	33.36
1936	38.90	37.44	37.51
1937	35.06	33.93	29.15
1938	48.39	45.09	55.34
1939	29.18	19.27	22.81
1940	46.63	57.05	41.77
1941	58.99	72.19	55.90
1942	44.56	54.87	48.21
1943	41.64	38.47	40.51
1944	32.66	31.83	26.04
1945	37.37	34.59	31.94
1946	43.85	37.54	36.51
1947	25.05	25.82	25.33
1948	43.02	36.11	33.20
1949	34.84	28.04	27.29
1950	34.59	30.10	29.49
1951	44.42	40.08	42.39
1952	54.94	52.82	47.48
1953	48.52	46.13	45.40
1954	43.57	42.00	36.63
1955	30.36	29.39	24.15
1956	57.30	57.28	50.67
1957	38.69	34.42	34.85
1958	61.64	65.98	55.88
1959	28.34	33.80	28.15
1960	29.38	30.32	29.97
1961	38.01	36.07	33.93
1962	33.01	38.08	33.74
1963	36.61	49.80	43.34
1964	26.11	26.50	25.10
1965	38.98	47.97	51.06
1966	35.19	39.75	35.32
1967	39.30	57.55	42.75
1968	32.22	35.50	34.33
1969	46.36	61.40	49.80

YEAR	Annual total rainfall (inches)			
	Fort Ross	Healdsburg	Ukiah	
1970	42.03	56.51	48.70	
1971	41.42	40.14	38.83	
1972	26.24	21.35	25.61	
1973	47.28	52.07	41.75	
1974	67.96	64.62	57.04	
1975	35.22	41.13	38.78	
1976	22.68	18.27	19.55	
1977	16.01	16.92	16.12	
1978	48.10	61.76	52.47	
1979	26.14	31.35	28.42	
1980	43.78	51.76	44.60	
1981	28.01	33.25	22.54	
1982	57.38	64.12	57.29	
1983	65.70	83.26	68.06	
1984	36.12	46.25	42.12	
1985	29.95	34.00	29.79	
1986	42.76	56.02	52.00	
1987	26.55	26.09	23.05	
1988	22.20	33.34	29.80	
1989	35.37	30.32	33.23	
1990	24.99	25.98	24.64	
1991	22.47	28.56	24.47	
1992	28.11	31.61	30.57	
1993	39.95	50.11	50.49	
1994	24.69	27.07	23.69	
1995	54.55	71.38	63.35	
1996	39.71	46.59	47.67	
1997	37.78	45.35	43.44	
1998	66.06	73.19	71.15	
1999	38.31	38.85	38.09	
2000	34.88	40.62	36.21	
Overall Average	**43.58**	**41.06**	**36.98**	
Average 1880-1900	50.44	39.94	34.22	
Average 1900-1920	54.99	41.43	38.09	
Average 1920-1940	34.69	35.08	31.93	
Average 1940-1960	41.92	41.85	37.70	
Average 1960-1980	36.76	41.85	37.68	
Average 1980-2000	38.06	44.65	40.77	
Average 1990-2000	37.41	43.57	41.25	
Average 1872-1983	44.81	41.00	36.65	SCWA isohyetal time frame
Average 1931-1970	38.49	40.53	36.63	USGS isohyetal time frame
Average 1983-2000	37.23	43.81	40.66	End of SCWA time frame to 2000
Average 1970-2000	37.82	43.29	39.47	End of USGS time frame to 2000

Note: The Source Table rainfall_gualala.dbf shows the annual rainfall totals in inches at Fort Ross (1872-2000), Healdsburg (1878-2000), and Ukiah (1878-2000) California. Data were provided by Jim Goodridge, climatological consultant, and passed on to KRIS IFR team by Department of Water Resources NCWAP staff.

ATTACHMENT C

Water Balance for Proposed Vineyard Water Supply Average-Year Conditions

Attachment C-1. Water Balance for Proposed Vineyard Water Supply
Average-Year Conditions
160 Acre Vineyard Area

Month	(1) Average Rainfall (in./mo)	(2) Reference E.T. (in./mo)	(3) Sump Runoff (ac-in./mo)	(4) Sump Rainfall (ac-in./mo)	(5) Sump Evap. (ac-in./mo)	(6) Sump Pumped to Storage (ac-in./mo)	(7) Storage Reservoir Rainfall (ac-in./mo)	(8) Storage Reservoir Evap. (ac-in./mo)	(9) Storage Reservoir To/From Storage (ac-in./mo)	(10) Storage Reservoir Cumulative Storage (ac-ft)	(11) Total Irrigation Demand (ac-in./mo)	
Jan	12.05	1.13	135.3	6.0	(0.6)	140.8	59.8	(5.6)	16	40	0	Jan.
Feb	9.56	1.70	107.4	4.8	(0.8)	111.3	47.4	(8.4)	13	53	0	Feb.
Mar	7.42	3.01	83.3	3.7	(1.5)	85.5	36.8	(14.9)	9	62	0	Mar.
Apr	4.64	4.00	52.1	2.3	(2.0)	52.4	23.0	(19.8)	5	67	0	Apr.
May	2.30	4.88	25.8	1.2	(2.4)	0.0	11.4	(24.2)	(1)	65	0	May
June	0.95	5.45	10.7	0.5	(2.7)	0.0	4.7	(27.1)	(15)	50	159	June
July	0.09	5.64	1.0	0.0	(2.8)	0.0	0.4	(28.0)	(16)	35	159	July
Aug	0.20	4.88	2.2	0.1	(2.4)	0.0	1.0	(24.2)	(15)	20	159	Aug.
Sept	0.70	4.00	7.9	0.4	(2.0)	0.0	3.5	(19.8)	(15)	5	159	Sept.
Oct	3.41	3.01	38.3	1.7	(1.5)	0.0	16.9	(14.9)	(3)	2	40	Oct.
Nov	6.05	1.45	68.0	3.0	(0.7)	70.3	30.0	(7.2)	8	10	0	Nov.
Dec	10.63	0.75	119.4	5.3	(0.4)	124.3	52.7	(3.7)	14	24	0	Dec.
Totals	58.0	39.9								**Total**	**676**	(ac-in)
(in./yr)											**56.3**	(ac-ft)

MAIN INPUT PARAMETERS

		Sump	Storage Reservoir	Winter Runoff	Vineyard
Max. Deep Percolation Rates (in./mo.):		0.0	0.0		
Evapotranspiration Coefficient:		1.0	1.0		
Surface Areas (ac.):		0.5	4.96	36	160
Irrigation Efficiency				95%	
Runoff Factor				40%	
Irrigation Demands					
	1,089 vine/ac	100 gal/vine	17.4 mil gal	1.02 mil gal/week	37.75 ac-in/week
Annual Rainfall (inches)			58		
Annual Evaporative Demand (inches)			40		
Sump Capture Effieiency			78%		

(1). Average Annual Rainfall x Rainfall Factor. Rainfall factors were developed based on rainfall distribution observed at Fort Ross rainfall gauge
(2) Average Annual Evapotranspiration x ET Factor. ET factors were developed based on monthly ET data provided by DWR.
(3) Col (1) x Winter Runoff Area x Runoff Factor
(4) Col (1) x Sump Surface Area
(5) Col (2) x Sump Surface Area
(6) Col (3) + Col. (4) + Col. (5)
(7) Col (1) x Storage Reservoir Surface Area
(8) Col (2) x Storage Reservoir Surface Area
(9) Col (6) + Col. (7) + Col. (8) - Col. (9)
(10) Previous Month Col. (10) + Col (9) / 12
(11) Irrigation Demand (ac-in/wk) x Number of Weeks / Irrigation Efficiency