EXHIBIT 9

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July 2, 2009

Thomas N. Lippe
329 Bryant Street, Suite 3D
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re: Napa River Sediment TMDL

Dear Mr. Lippe:

You have asked me to review and comment on the proposed Napa River Sediment TMDL. I have reviewed the following documents

a) the revised Proposed Basin Plan Amendment: Napa River Sediment Reduction and Habitat Enhancement Plan dated May 2009,
b) the revised Napa River Sediment Total Daily Maximum Load Staff Report dated September, 2008,
c) the Response to Comments dated May 2009.

These documents were obtained from the San Francisco Bay Regional Water Quality Control Board web site.

In my opinion, the Napa River Sediment TMDL, in its current form, will not be able to achieve its objective of reducing the sediment load of the Napa River to 125% of the natural background sediment load. There are two reasons why I believe the TMDL in its current form will not achieve its objective. First, the fundamental problems underlying the high sediment load should be re-framed to be in accord with fundamental fluvial geomorphic principles. Second, the performance standard and other details need be strengthened.

The portion of the TMDL and Basin Plan Amendment directed towards enhancing and protecting salmonid habitat can not succeed until it is recognized that the low flows in the Napa River are primarily the result of extensive groundwater pumping exacerbated by spring and summer surface water diversions.

Natural Hydrograph

The TMDL and Basin Plan Amendment (BPA) estimate that the current sediment load of the Napa River is 185% of the natural background sediment load. Leopold, Wolman, Miller, Emmett and many other researchers have established that a river constructs and maintains its channel. The water discharge delivered to the channel supplies the energy necessary to shape the channel. Merely reducing the sediment load supplied to the channel network is not sufficient to reduce the sediment transport capacity of the water flowing down the channel.

While it is important to reduce the sediment load delivered to the Napa River it is also important to reduce the peak stormwater discharge in the Napa River and its tributaries. Many of the land use changes that have resulted in an increase in sediment load in the Napa River system have also caused an increase in stormwater discharge. Reducing the sediment discharge from the altered land surface without simultaneously reducing the stormwater discharge will not achieve the objective of the TMDL and BPA but will only result in erosion of the channel network.

The TMDL and BPA do recognize that channel incision (progressive lowering of the streambed) is a significant source of the sediment load in the river. Instead of taking action to reduce the stormwater discharge in the Napa River system the TMDL and BPA seek to encourage voluntary projects to physically alter the shape of the channel. Projects to change the shape of the Napa River may be beneficial but they do not affect the channel elsewhere in the watershed. However, systematically reducing the stormwater discharge associated with human land use will reduce the magnitude of stormwater runoff throughout the watershed.

In the Response to Comments dated May 2009, in their discussion of *Comment 3.DJ5* (Napa County Conservation Regulations), the Regional Board staff acknowledges that various land uses have increased the discharge of the Napa River.

> We also concur it is likely that vineyard development, urban development, and roads have increased storm runoff and peak flow in the Napa River and its tributaries. The real question is by how much, and what is the significance of such changes? To address these questions, more field data collection and analysis is needed to determine how much runoff may be increasing and under what circumstances, and to evaluate potential consequences with regard to location(s) and effects on channel physical habitat structure.

The channel incision in the Napa River is the result of both the reservoirs capturing bedload and the increased discharge from vineyards, over grazed land, conversion of forests, roads, urban areas, and other impervious surfaces.

The goal of the TMDL and BPA is to reduce the current estimated sediment discharge from 185% of the natural sediment load down to 125% of natural sediment load. Reducing the sediment load of the Napa River to 125% of the natural sediment load will require bringing the stormwater discharge regime of the Napa River into alignment with the target sediment load. The discharge regime of the Napa River must be changed to resemble a natural hydrograph capable of transporting 125% of the natural background sediment load of the Napa River. The TMDL and the BPA should develop the parameters of the natural hydrograph (stormwater discharge regime) that will be in alignment with the goal of reducing the sediment load to 125% of the natural sediment load. Discharge load allocations could then be made for each source of increased discharge.

Failure to address the distorted discharge regime of the Napa River will undermine the effectiveness of the TMDL and BPA and prevent the sustainable obtainment of reducing the sediment load to 125% of the natural background sediment load.

Sources of Increased Discharge

The major land uses in the Napa River watershed are vineyards, grazing, rural residential, urban areas and undeveloped land in the form of open space, parks and forest. These land uses have altered the hydrologic response of the Napa River watershed. The observed changes in land use have contributed to an increase in the magnitude of the largest annual flood (instantaneous discharge event). The prediction of an increase in flood peaks appears to be supported by local perception.

Residents of the Napa River watershed believe that the magnitude and frequency of large flood events have increased during recent years. In 1998 residents of the Napa watershed passed Measure A to reduce flood hazards by using the “living river” approach instead of channelization. The Napa County Flood Control and Water Conservation District works with the Army Corps of Engineers to provide more channel storage and create bypass channels.

Intensive land use changes the vegetative cover and the ground surface. Reduction in vegetative cover is usually associated with an increase in stormwater discharge. For example, clearing a forest to create pasture will increase the stormwater runoff from the area. Changes in the ground surface from intensive land use usually reduce the infiltration rate and results in increases in stormwater runoff. For example, construction of buildings and roads creates impervious surfaces that increase the amount of surface runoff from the area. The cumulative impact of all the changes in the hydrologic characteristics of the land surface in the Napa River watershed is significant.

The scale of the problem of altered land surface can be estimated from some information posted on the Winebusiness.com web site (http://www.winebusiness.com/wbm/?go=getArticle&dataId=4903). I make no claims about the accuracy of the following data. I propose that the Regional Board use available Geographic Information System (GIS) data to create a dataset that more accurately addresses the issue of altered hydrologic properties leading to increased stormwater runoff.

Land Use Category	Area, acres	Percent of Watershed
protected status	110,000	41%
hardened pavement or rooftops	20,000	7%
vineyards	38,000	14%
range and grazing land	102,000	38%
Total acres of Land Uses	270,000	100%
watershed area, acres	270,000	

The land use of “protected status” is described on the Winebusiness.com web site as:

> There are currently 134,500 acres of Napa River watershed land in protected status in public or quasi-public ownership. This includes over 50,000 acres protected through fee title or conservation easement by the Napa County Land Trust.

The conservation easements probably include areas that are in the vineyard and range and grazing land categories. If this assumption is accurate there would be 110,000 acres (41% of the watershed) in the “protected status” category that are not already counted in the other categories. The above table has been changed to reflect the probable double counting of “protected status” land. Some of the area within the “protected status” category has been hydrologically altered.

The category of “hardened pavement or rooftops” represents impervious surfaces in the watershed. If the 20,000 acre estimate is accurate then about 7% of the watershed is covered by an impervious surface. Rain falling on an impervious surface would not be absorbed by the surface. Impervious surfaces generate the most stormwater runoff.

Vineyards account for 14% of the watershed. Vineyards increase the stormwater runoff of a land surface. The “range and grazing land” accounts for 38% of the watershed. The level of hydrologic alteration of grazing land depends on the intensity of the grazing. Vineyards and range and grazing would also include some areas of impervious surfaces such as roads and rooftops.

Water supply reservoirs with no flood control capacity are another source of impervious surface in the Napa watershed. The municipal and private reservoirs in the Napa River watershed are not capable of controlling flood releases, that is they are “fill-and-spill” reservoirs. Once a “fill-and-spill” reservoir is filled, any additional inflows are directly routed through the reservoir. In addition, once a reservoir is filled the surface acts as if it were impervious so any rain that falls on the surface of the reservoir is immediately routed to the channel network. An off-stream reservoir will have these impacts as long as it has a spillway. Only reservoirs that have sufficient storage capacity to contain the 100-year storm event will not exhibit these characteristics. The impacts of the reservoirs are discussed in more detail below.

The according to a GIS layer of major water bodies in Napa County, total surface area of the five municipal reservoirs in the Napa River watershed is 1,002 acres. Dietrich et al. (2004) estimated the number of reservoirs in the Napa River watershed to be more than 1,000. A recent aerial photo survey of private reservoirs in the Napa River watershed by Stetson Engineering located 269 ponds that had not filed with the Division of Water Rights. The total surface area of these 269 non-filer ponds is 677 acres. The average surface area is 2.52 acres. Assuming that the non-filer reservoirs are a representative sample of all private reservoirs the total surface area can be estimated by multiplying the estimated average surface area of 2.52 acres by the estimated 1,000 reservoirs to get a total surface area of 2,520 acres.

The total surface area of the reservoirs in the Napa River watershed is estimated to be 3,522 acres or 5.5 square-miles or 1.3% of the entire watershed (422 square-miles). Adding the surface area of the reservoirs to the estimate of impervious surfaces brings the total impervious surface area to 8.3% of the watershed. The reservoir surface area accounts for 15.6% of the impervious surfaces in the watershed.

Reservoirs

The municipal and private reservoirs in the Napa River watershed are not capable of controlling flood releases, that is they are “fill-and-spill” reservoirs. Once a “fill-and-spill” reservoir is filled, any additional inflows are directly routed through the reservoir. In addition, once a reservoir is filled, any rain that falls on the surface reservoir is immediately routed to the channel network and contributes to downstream flooding and to the erosion of the bed and banks of the mainstem of the Napa River. During a storm event, the surface of any reservoir that is spilling essentially acts as an impervious surface and actually contributes to the magnitude of downstream discharge. This impact occurs as long as the reservoir has no flood control storage and has a spillway. An off-stream reservoir with a spillway will contribute downstream increases in discharge once it is filled.

Once a reservoir is filled, any land use that increases the rate or volume of storm flow upstream of reservoir directly contributes to increased discharge downstream of the dam. Increasing the volume of stormwater runoff from land upstream of the reservoirs will cause the reservoirs to fill faster and thus increase the frequency of reservoir spilling and will also increase the magnitude of the reservoir spill events. These effects apply to municipal water supply reservoirs and to private reservoirs.

The proposed TMDL and BPA specifically exempt land use upstream of the municipal reservoirs from the performance standards of the TMDL and BPA. The resulting uncontrolled increases in storm water discharge from land uses upstream of the municipal reservoirs will be passed through the municipal reservoirs and contribute to increased storm water discharge downstream of the reservoirs. The increased stormwater discharges from land excluded from the performance standards of the TMDL and BPA upstream of the reservoirs will be passed through the reservoirs and will contribute to downstream flooding and erosion of the bed and banks of the mainstem of the Napa River. Rain falling on the surface of the municipal reservoirs will also contribute to downstream flooding and erosion.

The public and private reservoirs are typically drawn down by late summer or early fall. The runoff from land upstream of the reservoirs (estimated at 30% of the Napa watershed) from the first few storms are captured in the reservoirs and farm ponds. The reduction in the first few storm peaks has an adverse impact on the early season discharges that act to signal to salmonids that it is time to migrate upstream. Shaving the first few storm peaks by reservoirs and ponds also diminishes the magnitude of the discharge downstream and can create flow dependent barriers or impediments to upstream salmonid migration.

The numerous (more than 1,000) private reservoirs in the Napa River watershed have a profound effect on the environment. Over 30% of the watershed area of the Napa River is upstream of either private reservoirs or the municipal reservoirs. As discussed above, the private reservoirs and municipal reservoirs are typically drawn down through the summer. The cumulative available storage capacity of all the private reservoirs will capture the early fall stormwater runoff from the land upstream. The capture of this early season runoff delays the fall pulse of freshwater that salmonids use to signal upstream migration.

Once the private reservoirs are full, any rain that falls on them is immediately routed into the channel network that is, they act as impervious surfaces. The cumulative impact of rain falling on the combined surface of all spilling private reservoirs is a significant cumulative increase in the downstream flood magnitude. The “affective attenuation of downstream flood peaks” performance standard in the TMDL and BPA should be applied to the private reservoirs.

The use of sediment detention ponds will contribute to the creation of impervious surfaces during storm events when they are spilling and will resulting downstream increase in the magnitude of storm water runoff. Requiring or allowing the use of sediment detention ponds will result in increased off-site peak stormwater runoff and associated erosion of the channel. The increased stormwater runoff contributes to the magnitude the erosion of the bed and banks of the Napa River and its tributaries. The contribution of increased discharge from sediment detention ponds needs to be evaluated in the environmental assessment for the TMDL and BPA.

The TMDL and BPA need to provide a mechanism to bring the stormwater discharge regime of the Napa River system into alignment with the discharge regime that would produce 125% of natural sediment load.

Discharge Performance Standard

The May 2009 BPA sets performance standard to achieve reduction in non-point source sediment discharges to the Napa River for various land uses in Tables 4.1 through 4.4. Those performance standards are listed below.

BPA-Table 4.1 Vineyards:

- Surface erosion associated with vineyards: Comply with conservation regulations (County Code, Chapter 18.108); and
- Roads: Road-related sediment delivery to channels ≤ 500 cubic yards per mile per 20-year period; and
- Gullies and/or shallow landslides: Avoid and control human-caused increases in sediment delivery from unstable areas to a less than significant level; and
- Effectively attenuate significant increases in storm runoff. Runoff from vineyards shall not cause or contribute to downstream increases in rates of bank or bed erosion.

BPA-Table 4.2 Grazing:

- Surface erosion associated with livestock grazing: Attain or exceed minimal residual dry matter values consistent with University of California Division of Agriculture and Natural Resources guidelines and
- Roads: Road-related sediment delivery to channels ≤ 500 cubic yards per mile per 20-year period and
- Gullies and/or shallow landslides: Avoid and control human-caused increases in sediment delivery from unstable areas to a less than significant level

BPA-Table 4.3 Rural Lands:

- Roads: Road-related sediment delivery to channels ≤ 500 cubic yards per mile per 20-year period; and
- Gullies and/or shallow landslides: Avoid and control human-caused increases in sediment delivery from unstable areas to a less than significant level.

BPA-Table 4.4 Parks and Open Space and Public Works

- Roads: Road-related sediment delivery to channels ≤ 500 cubic yards per mile per 20-year period2; and
- Gullies and/or shallow landslides: Avoid and control human-caused increases in sediment delivery from unstable areas to a less than significant level.

The performance standards for each of the four classes of land use in BPA-Tables 4.1-4.4 seek to reduce human caused sediment. However vineyard is the only land use subject to a performance standard to "effectively attenuate significant increases in storm runoff". Overgrazing is typically associated with an increase in storm runoff. Roads typically increase storm runoff compared to the natural pre-road condition. Gullies and shallow landslides are often associated with increases in storm runoff. Controlling sediment from grazing, rural lands and Parks, open space and public works without also controlling storm discharge from these land uses will result in downstream erosion of the bed and banks of the stream channel. The discharge regime for these land-uses needs to be brought into alignment with the goal of reducing the sediment load to 125% of the natural load.

Therefore, I propose that the following performance standard be applied to all four land use categories listed in BPA Tables 4.1 through 4.4.

- Effectively attenuate significant increases in storm runoff. Runoff from all land uses listed in Tables 4.1 through 4.4 shall not cause or contribute to downstream increases in rates of bank or bed erosion relative to the discharge regime that carries 125% of the natural sediment load.

County Conservation Ordinance

The Napa County Conservation Ordinance is insufficient to ensure that projects in domestic water supply watersheds do not contribute increased stormwater runoff. Only the following section specifically deals with stormwater discharge from a project. The ordinance only asks that concentration of runoff be avoided whenever feasible. A much stricter standard needs to be applied to ensure that a project does not increase stormwater runoff.

> 18.108.027 Sensitive Domestic Water Supply Drainages.
>
> D. Drainage facilities. Concentration of runoff shall, wherever feasible, be avoided. Runoff shall instead be spread in small incremental doses into relatively flat buffer areas. Those drainage facilities and outfalls that unavoidably have to be installed shall be sized and designed to handle the runoff from a one hundred-year storm event without failure or

unintentional bypassing. Outlets shall be protected against erosion in the one hundred-year storm event.

The County Conservation Ordinance only applies to new projects and not to existing projects. In order to bring the discharge regime of the Napa River into alignment with the natural hydrograph that would transport no more than 125% of the natural background sediment load it is necessary to ensure that stormwater runoff from new projects does not contribute additional stormwater runoff and that excess stormwater runoff from past land uses is reduced.

The municipal reservoirs have no flood control capacity so once they are full they pass all stormwater flows generated upstream. In addition, once they are full they act as an impervious surface and actually increase stormwater discharge downstream.

Therefore, excluding land upstream of the municipal water supply reservoirs from the performance standards and other requires of Tables 4.1 through 4.4 of the BPA and the TMDL will undermine the achievement of reducing the sediment load of the Napa River to 125% of the natural sediment load.

All lands upstream of the municipal reservoirs should be subject to the proposed performance standard.

- Effectively attenuate significant increases in storm runoff. Runoff from all land uses listed in Tables 4.1 through 4.4 shall not cause or contribute to downstream increases in rates of bank or bed erosion relative to the discharge regime that carries 125% of the natural sediment load.

Low Flows

Regional Board staff has not adequately addressed my comments regarding low flows in the Napa River. Furthermore, I have found evidence, not previously discussed in the TMDL process, showing that groundwater pumping in the Napa Valley is having adverse impacts on streamflow during consecutive dry years. In the following text I repeat my comment on low flow and give staff's response. I then introduce the evidence for adverse impacts from groundwater pumping.

<u>Comment 3.DJ4</u> (Low flows): The revised Basin Plan amendment does not adequately address low flow problems that occur in dry years with a cold spring season. Minimum bypass flows for the frost protection period (March 15 through May 15) in the Napa River are too low. The Department of Fish and Game has demonstrated that diversions and on-stream reservoirs have played a significant role in the decline of salmonids in the watershed. Because diversions during the spring for frost protect impact baseflow, the Department of Water Resources Watermaster should be brought into the coordinated interagency process that you have proposed (Basin Plan amendment, Table 5.2, Action 2.1). What actions will the Water Board take, if the inter-agency plan is not implemented by the fall of 2010? Finally, the revised Basin Plan amendment and Staff Report do not address my earlier recommendation (attached as part of the comment letter submitted to the State Board in May of 2008) that near-stream wells should be examined to determine if they are impacting streamflow discharge.

<u>Staff Response</u>: All diversions during the March 15 through May 15 frost protection period are controlled by a court appointed Watermaster, who has enrolled all mainstem and tributary diverters, who withdraw between March 15 and May 15, in the frost protection program. With regard to increasing minimum bypass flows, it is our understanding that the Watermaster retains authority to modify the definition of "ample streamflow" and/or based on experience gained in administering the program, to suggest to the Superior Court that the definition of "available water supply" be refined or revised (Napa County Superior Court, 1976). By modifying one or both of these definitions, instream flows to protect fish could be increased. Key information needs to guide policy in this area may include: a) analyses of current relationships between fish passage and streamflow at critical riffles and man-made structures in the Napa River and key tributary reaches; b) streamflow monitoring in key tributaries to protect critical baseflows for steelhead; and c) steelhead and Chinook salmon smolt trapping to determine the timing of outmigration, smolt fitness, and smolt population levels and trends. We actively support these data collection efforts, and their application to water rights policy and regulation.

With regard to the proposed inter-agency plan, please note that participation is voluntary and the plan would focus solely upon municipal water supply facilities in relation to opportunities to jointly enhance water supply reliability and native fish populations. The City of Napa previously has indicated its support for, and willingness to participate in development of the proposed plan (Brun, 2007). Perhaps the most significant obstacle to development of the proposed plan is the availability of staff and contract resources to conduct necessary studies, direct the process, and prepare the plan. The Water Board remains committed to helping to obtain necessary resources and to working cooperatively with other partners on the plan.

Finally with regard to the concern that near-stream wells need to be examined to determine if they are affecting streamflow, please note that as a condition of the WDR waivers, staff will propose that the Water Board require compliance with all water rights laws in order to obtain coverage. We also are open to receiving additional input regarding analytical approaches that could be used to determine whether well pumping affects streamflow.

<u>My Response to the Staff Comment</u>: Staff notes that the Watermaster has the authority to modify the definition of “ample streamflow” and recommend that the definition of “available water supply” be changed. My comment was actually a request for the Regional Board and its staff to actively include the Napa River Watermaster in all discussions regarding low flows in the Napa River. One way to include the Watermaster in discussions regarding low flows in the river would be to include them in the inter-agency cooperative partnership envisioned by Action 2.1 in BPA Table 5.2.

The staff response to my comment quoted above notes that the voluntary proposed inter-agency plan would focus solely upon municipal water supply facilities in relation to opportunities to jointly enhance water supply reliability and native fish populations. The proposed plan, as described in the staff response to my comment, fails to carry out Action 2.1 in Table 5.2 of the BPA which states that action 2.1 is:

> 2.1 Local, state, and federal agencies to participate in a cooperative partnership to develop a plan for joint resolution of water supply reliability and fisheries conservation concerns

The proposed inter-agency plan focuses solely on municipalities and apparently does not include the Watermaster or Fish and Game or the NMFS. This deficiency should be corrected.

Will the Regional Board or its staff send a memorandum to the Napa River Watermaster indicating that the minimum bypass discharge of 10 cfs during the frost protection season may be too low and that the “key information” listed by staff needs to be developed? Furthermore, the result of any low flow studies should be incorporated into the Watermaster’s policy.

Regarding the issue of the impact of near-stream wells, Staff is proposing that the Water Board require compliance with all water rights laws in order to obtain coverage. It is my understanding that in California water law that a well is presumed to tap “freely percolating water” and does not require a water right permit. Furthermore, I believe that the burden-of-proof to demonstrate otherwise is on the complaining party. If this is an accurate assessment of water law then, it would appear that the TMDL would leave the status quo unchanged and that interested citizens would be left with the task of demonstrating the affect of individual wells on flows in the Napa River.

Staff says that they are open to receiving additional input regarding analytical approaches that could be used to determine whether well pumping affects streamflow. I offer the following analysis to show that the current level of ground water extraction in the Napa Valley has changed the Napa River from a gaining stream to a losing stream during consecutive dry years. This means that, during consecutive dry years, the flow in the river diminishes in the downstream direction to recharge the groundwater table instead of being supplied by the groundwater table and increasing in the downstream direction as it did in the past.

Evidence for Impact of Wells on Streamflow

Faye (USGS, 1973) studied the ground water hydrology of the northern part of the Napa Valley from Oak Knoll Avenue just north of the City of Napa to the northern end of the valley. The area is a distinct topographic basin covering about 60 square miles of valley floor and is surrounded on three sides by foothills and mountains.

Faye (USGS, 1973) notes that;

> At the present time (1972), the Napa River is a gaining stream and contributes little recharge to the water table. Even during years of limited rainfall, when the river flows intermittently, water is discharged from the aquifer in those reaches where the river is flowing and water recharges the alluvium in reaches where the river channel is dry; thus net recharge to the alluvial aquifer is negligible.

Faye (USGS, 1973) simulated groundwater levels in the Napa Valley groundwater basin. His simulation model used the distributions of wells in 1970 and the estimated 1970 pumping rate of 5,900 acre-feet. Simulations of critical drought conditions with four times the 1970 pumping rate (23,600 af) showed that:

> The pumping depression near Maple Lane would expand and another depression would develop directly east of it. In the center of the valley, between Rutherford and Oakville, much of the upper 50 feet to 70 feet of the alluvial aquifer would be dewatered and a cone of depression would extend northward towards the periphery of the valley. Also, dewatering of the upper part of the alluvial aquifer would occur between Yountville and Oak Knoll Avenue. In the vicinity of Oak Knoll Avenue, large simulated withdrawals made between Highway 29 and the Napa River would cause a cone of depression to extend westward towards the periphery of the valley. South of St. Helena, relatively shallow wells having depths of 60 feet or less would be dry under such conditions.

Faye (USGS, 1973) concludes that:

> (1) groundwater levels should not decline significantly until groundwater pumpage exceeds 24,000 acre-feet per year; (2) after two consecutive years of little to no recharge, groundwater withdrawals in excess of 24,000 acre-feet per year could cause significant declines in groundwater levels and significantly redistribute the hydraulic gradients in the valley between Zinfandel Lane and Oak Knoll Avenue; and (3) the alluvial aquifer and the stream system can provide water sufficient to meet most projected groundwater requirements, even under protracted, adverse climatological conditions.

In 2005, West Yost and Associates produced a series of seven Technical Memorandums to report their assessment of the water supply situation for the Napa Valley for the years 2020 and 2050.

West Yost and Associates subdivided the Napa Valley floor into seven sub-regions, as described in their Table 1 of their TM-3 presented below. The Main Basin consists of sub-regions 1-4 and sub-region 7. The MST Study Area and the Carneros area are sub- regions 5 and 6, respectively. (West Yost & Assoc TM-3, 2005). The Main Basin roughly corresponds to Faye’s (USGS, 1973) northern Napa Valley.

West Yost TM-3; Table 1. Sub-region Description:

Sub-region Number	Sub-region Name	Sub-region Description
1	Calistoga	North Study Area Boundary south to Lodi Lane
2	St. Helena	Lodi Lane south to Oakville Crossing
3	Yountville	Oakville Crossing south to Oak Knoll Road
4	Napa	Oak Knoll Road south to Imola Avenue
5	MST Study Area	Napa River east to Base of Howell Mountains
6	Carneros	Based upon the Carneros Appellation
7	American Canyon	Imola Avenue south to Napa County Line
8	Hillside	Outside of valley floor yet inside 2050 Study Area

West Yost and Associates (TM-7, 2005) draws the following conclusions from their 2050 study relative to groundwater use in the Napa Valley.

> Based on the findings of the 2050 Study, several conclusions can be made. These conclusions reflect the importance of cooperation between and among the municipalities and various interests within the Napa Valley to ensure that the Valley's valuable water resources will be available for use by existing and future generations.
>
> - Unincorporated area and agricultural water users are the primary users of groundwater in the County, with the exception of a very small quantity pumped by some of the municipal agencies. Unincorporated and agricultural demands will continue to grow and further increase extractions from the groundwater basin. As described in TM 5, based on the estimated perennial yield of the Main Basin and the existing agriculture demands, about 10 percent of the Main Basin's available storage capacity is currently being used for "working storage" or seasonal use (10 to 15 percent is fairly typical). However, as agricultural demands continue to increase in the future, a larger percentage of the Main Basin's storage capacity will be seasonally used.
> - Municipalities are also considering very small increases in the quantities of groundwater they pump. While municipalities may pursue individual project opportunities to increase the use of local groundwater resources, it is recommended that the groundwater basin be managed appropriately, if used as a supply source for M&I supply reliability during a drought condition. As municipalities are considering increases in groundwater pumpage, they should exercise caution as they move forward, so that they do not adversely impact existing groundwater users.

West Yost and Associates Technical Memorandum 6 (2005) estimates that the unincorporated groundwater extraction rate from the Main Basin in 2000 was 26,750 afa (acre-feet per annum) in normal years or 4.5 times the 1970 extraction rate reported by Faye (USGS, 1973). It is reasonable to assume that dry year pumping rates after 2000 would be higher than the normal year extraction rate estimate for 2000 by West Yost and Associates. Thus, the groundwater extraction rates during the dry years of 2001, 2007 and 2008, as measured at the Napa Fire Station, would have exceeded 26,750 afa (4.5 times the 1970 extraction rate).

Faye's (USGS, 1973) report predicts that groundwater extraction would have lowered the groundwater levels during 2007 and 2008 significantly below the bed of the Napa River. According to Faye's (USGS, 1973) simulation, lowering the groundwater levels in the Napa Valley during consecutive dry years would diminish the streamflow in the Napa River since the river would become a losing stream that is, the river would contribute water to the aquifer instead of receive water from the aquifer. The cumulative effects of groundwater pumping may have caused the channel to go dry in 2007 and 2008. In dry years, the impact of groundwater pumping on streamflow in the Napa River is not limited to wells adjacent to the river but is the result of the general lowering of the groundwater surface due to the combined pumping of all wells in the Napa Valley aquifer.

The West Yost and Associates technical memos note that agricultural water demand will continue to increase suggesting that the frequency and intensity low flows in the Napa River will increase over time. The number of days of zero flow may also increase in the Napa River in response to increased groundwater extraction during dry years.

Evidence of Groundwater Level Decline

In this section, a preliminary study of the record of the water surface elevation of a well is compared to the elevation of the bed of the Napa River to explore the relationship between the water in the river and the groundwater table. A more in depth version of this preliminary study could be done by making a contour map of the fall groundwater surface and comparing it to the elevation of the bed of the Napa River derived from LIDAR and ground surveying.

The California Department of Water Resources maintains a *Water Data Library* on their web site that stores the water surface observations from a large number of wells in the Napa Valley. The water level record of a well (State Well Number 07N05W09Q002M) near the confluence of Bale Slough and the Napa River is presented below. This well is in the vicinity of the depression in the groundwater surface predicted by Faye's (USGS, 1973) simulation of the groundwater surface at four times the 1970 extraction rate.

The well is reported as not being used so its record is not influenced by its own pumping. It is near two other wells. A total of 489 groundwater-surface-elevation observations were made between October 1949 and June 2009. Figure 1 shows the location of the well. The well is approximately 1,100 feet west of the confluence of Bale Slough with the Napa River. The ground surface elevation at the well is given as 155 feet above mean sea level (amsl). The 7.5-minute topographic map shows the elevation at the confluence of Bale Slough and the Napa River is about 140 feet amsl.

Figure 2 shows all of the groundwater surface elevation measurements. The elevation data has been adjusted by subtracting 140 feet from the water surface elevation. An elevation of zero on the graph occurs when the water surface in the well is at the same elevation as the estimated elevation of the bed of the Napa River at its confluence with Bales Slough. The elevation data shown in Figure 2 is *relative* to the estimated bed of the Napa River at its confluence with Bales Slough. When the relative elevation of the water surface in the well is greater than zero, groundwater from near the well is assumed to be flowing into the river. When the relative elevation of water surface in the well is less than zero, water is assumed to be flowing out of the river and entering the groundwater system. The Napa River at Bales Slough changes from a gaining-stream to a losing-stream when the relative water-surface-elevation in the well declines to zero.

Figure 3 shows the March water surface elevations in the well are declining over time. A linear regression line was fit to the data using the year of record as the independent variable. The year of record is used as an index of change over time. Both the coefficient and intercept are statistically significant at alpha = 0.05. The regression explains only 12% of the variation in the March water surface elevations. However, regression line indicates that the March water surface elevation is declining over time since the coefficient is negative. A stronger regression relationship can be obtained if the March 1977 observation is excluded.

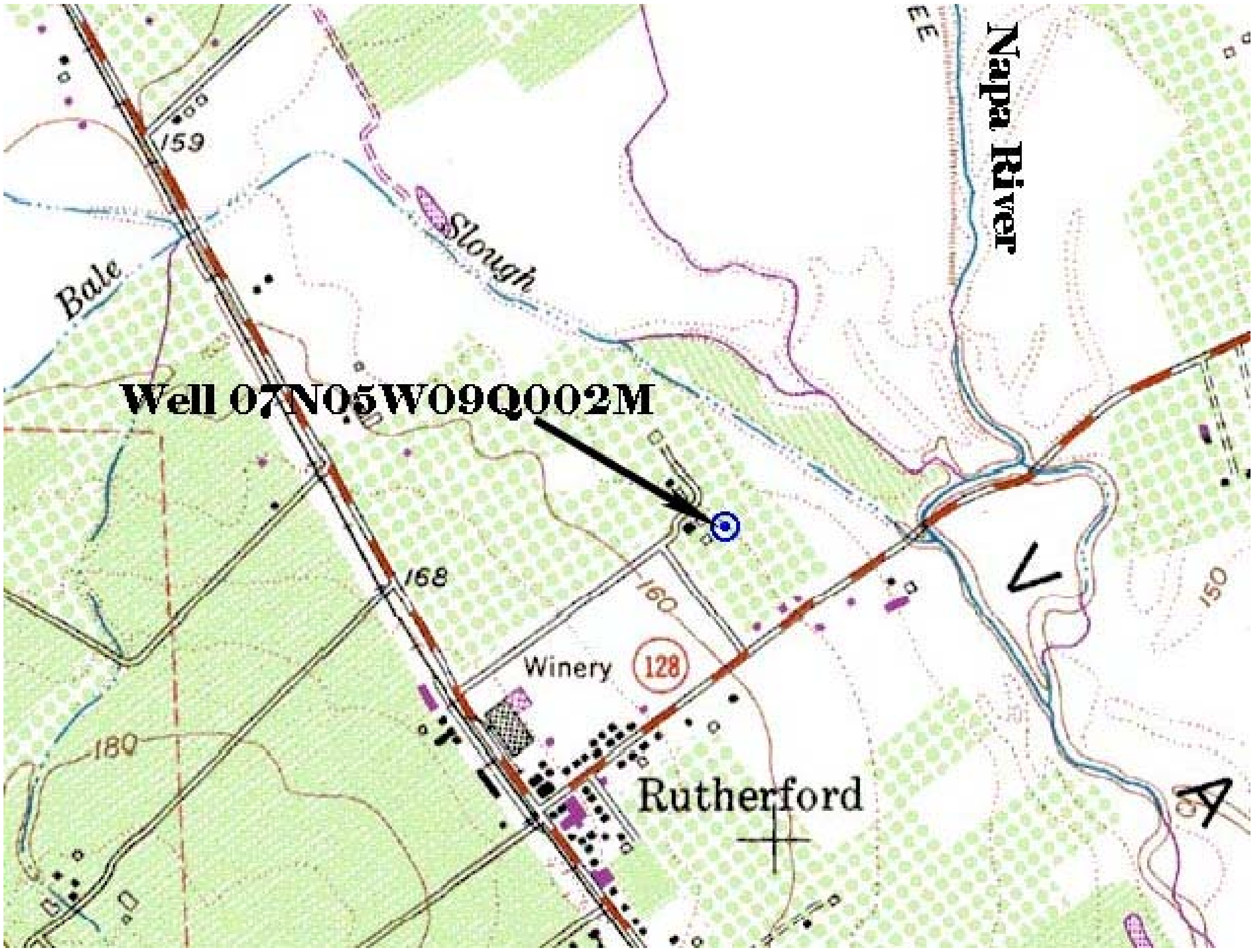

Figure 1. Location of Well 07N05W09Q002M near the confluence of Bale Slough and Rutherford.

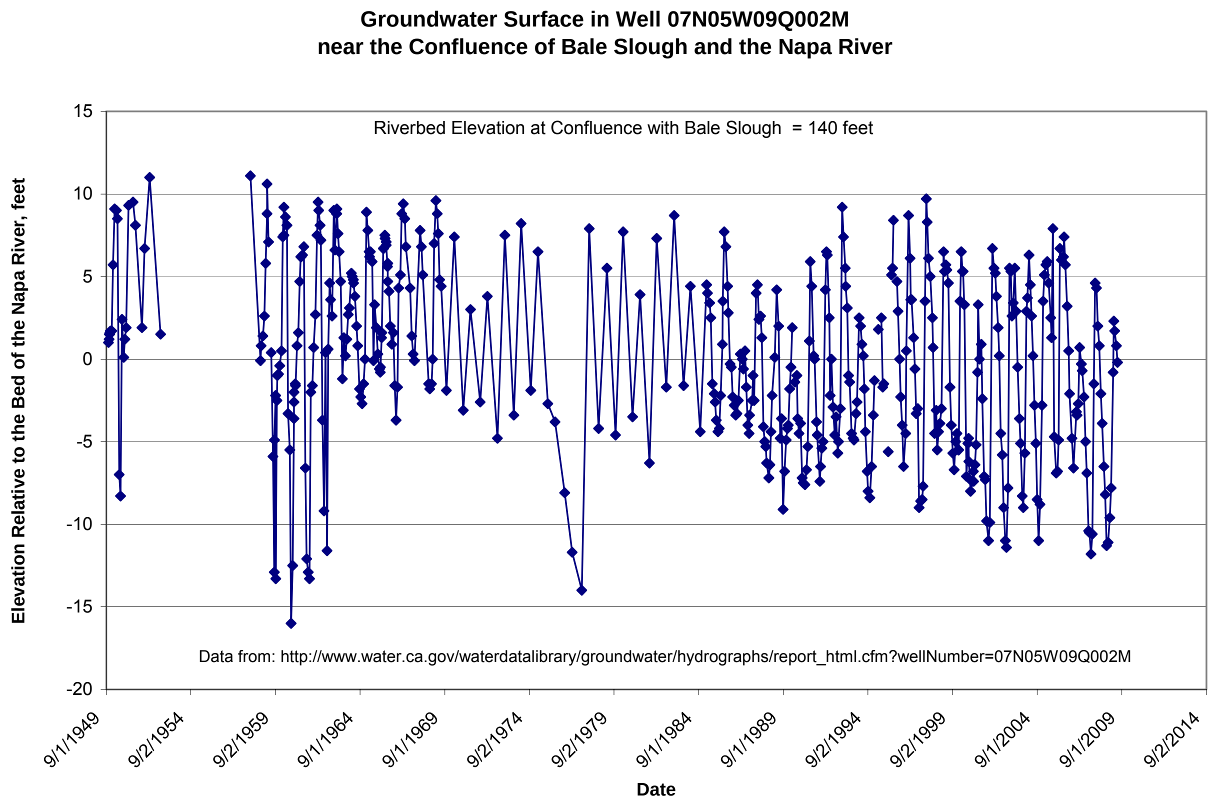

Figure 2. The complete record of groundwater surface elevations from Well 07N05W09Q002M. The elevation data has been adjusted by subtracting 140 feet from the water surface elevation. An elevation of zero on the graph occurs when the water surface in the well is at the same elevation as the estimated elevation of the bed of the Napa River at its confluence with Bales Slough. The well is about 1,100 feet from the confluence.

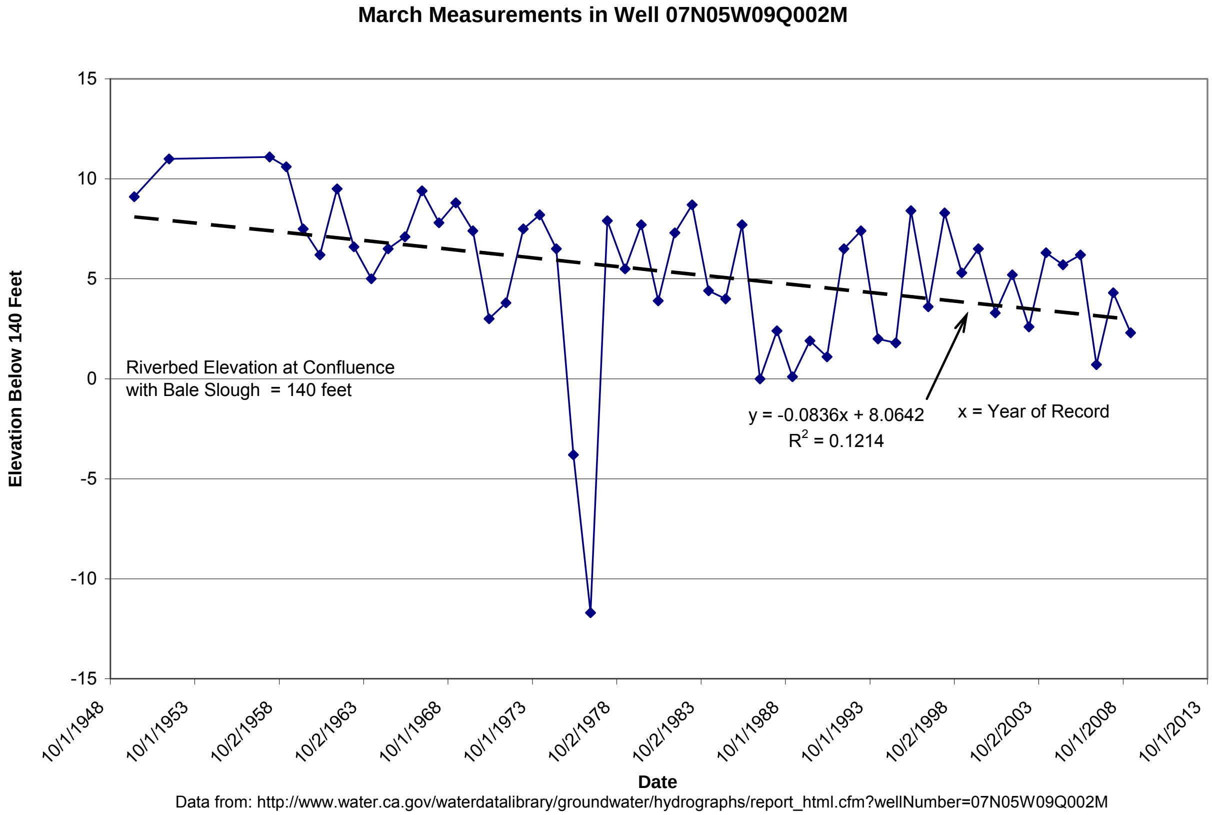

Figure 3. The March water surface elevations in the well are declining over time. A linear regression line was fit to the data using the year of record as the independent variable. The year of record is used as an index of change over time. Both the coefficient and intercept are statistically significant at alpha = 0.05. The regression explains only 12% of the variation in the March water surface elevations. However, regression line indicates that the March water surface elevation is declining over time since the coefficient is negative. A stronger regression relationship can be obtained if the March 1977 observation is excluded.

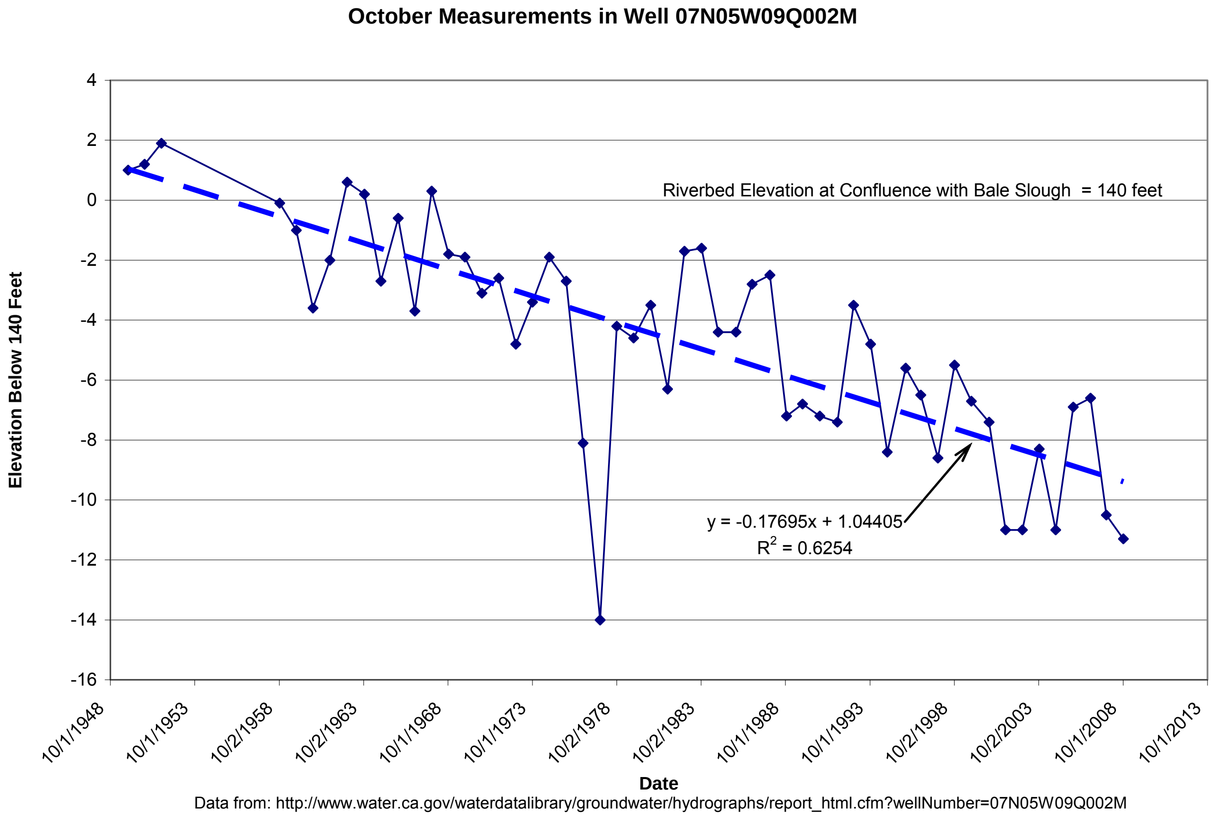

Figure 4. The October water surface elevations in the well are declining over time. A linear regression line was fit to the data using the year of record as the independent variable. The year of record is used as an index of change over time. Both the coefficient and intercept are statistically significant at alpha = 0.05. The regression explains 62% of the variation in the October water surface elevations. The regression line indicates that the October water surface elevation is declining over time since the coefficient is negative. In most years, the October water surface elevation in the well is below the estimated elevation of the bed of the Napa River at its confluence with Bales Slough (140 feet amsl).

Figure 4 shows that the October water surface elevations in the well are declining over time. A linear regression line was fit to the data using the year of record as the independent variable. The year of record is used as an index of change over time. Both the coefficient and intercept are statistically significant at alpha = 0.05. The regression explains 62% of the variation in the October water surface elevations. The regression line indicates that the October water surface elevation is declining over time since the coefficient is negative. In most years, the October water surface elevation in the well is below the estimated elevation of the bed of the Napa River at its confluence with Bales Slough (140 feet amsl).

The day that the relative water surface elevation in the well declines to zero (day of zero elevation) can be estimated by assuming that the change in the groundwater surface is linear. Dividing the total decline from the March reading to the October reading and dividing by the number of days between the readings gives the rate of daily decline of the groundwater surface.

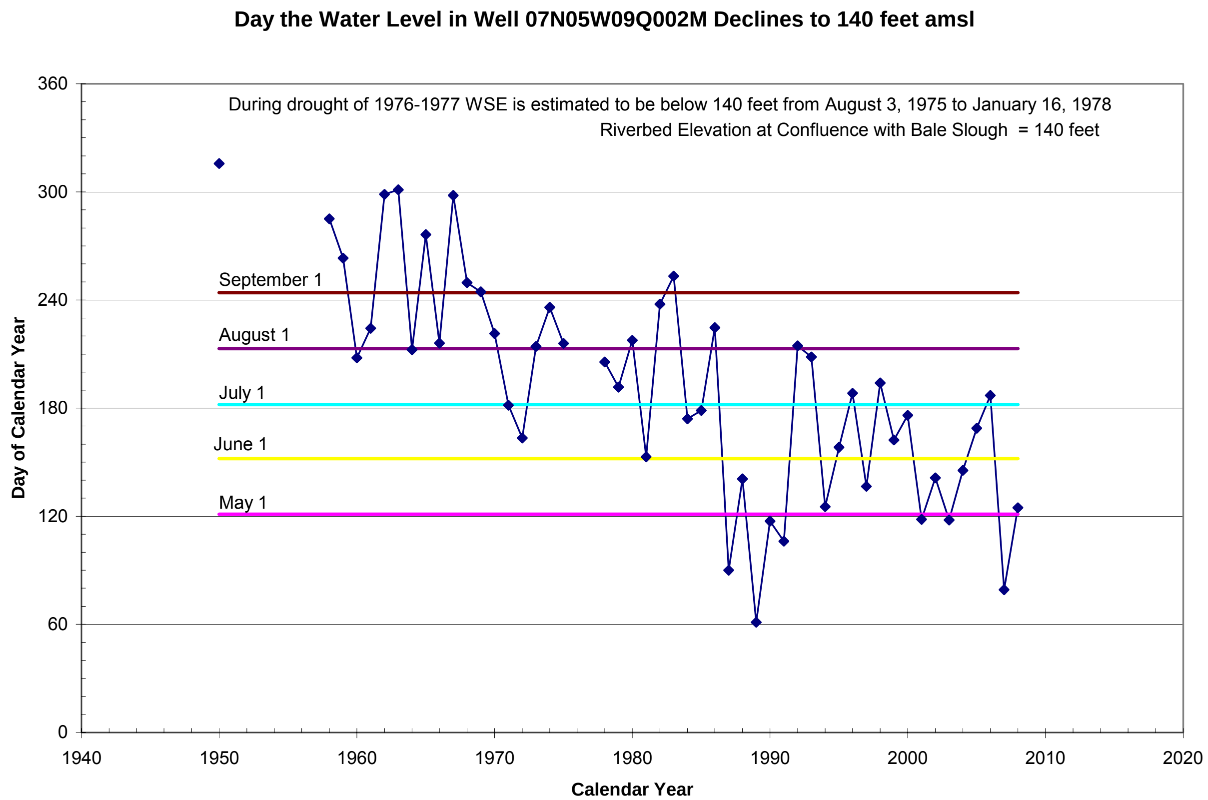

Figure 5. Estimate of the calendar day that the relative water surface elevation in the well declined to zero. The estimate was made by calculating the daily decline in the groundwater surface as explained in the text. Prior to 1970, the relative water surface in the well declined to zero sometime after August 1. In most years (17 out of 22) after 1986, the relative elevation of the water surface in the well declined to zero by July 1.

Table 1. The record was divided into three period, 1958 to 1970, 1971 to 1986 and 1987 to 2008. Two-sample t-Tests, assuming equal variances, were performed on the mean calendar day that the relative water surface elevation in the well declined to zero for each pair of periods. All three two-sample t-tests were statistically significant at the alpha = 0.05 level.

	1958 to 1970	1971 to 1986
Mean Calendar Day	253.7	203.4
Variance	1254.6	913.6
Observations	13	14
Pooled Variance	1077.3	
Hypothesized Mean Difference	0	
df	25	
t Stat	3.98	
t Critical one-tail	1.71	
t Critical two-tail	2.06	

	1958 to 1970	1987 to 2008
Mean Calendar Day	253.7	143.7
Variance	1254.6	1708.5
Observations	13	22
Pooled Variance	1543.4	
Hypothesized Mean Difference	0	
Df	33	
t Stat	8.01	
t Critical one-tail	1.69	
t Critical two-tail	2.03	

Table 1 Continued.

	1971 to 1986	*1987 to 2008*
Mean Calendar Day	203.4	143.7
Variance	913.6	1708.5
Observations	14	22
Pooled Variance	1404.6	
Hypothesized Mean Difference	0	
df	34	
t Stat	4.66	
t Critical one-tail	1.69	
t Critical two-tail	2.03	

Table 2. The mean calendar day that the relative water surface elevation in the well declines to zero is given as a month and day.

Time Period	Mean Calendar Day Relative Well Water Surface Elevation Declines to Zero
1958 to 1970	Day 253.7 = Sept 10
1971 to 1986	Day 203.4 = July 22
1987 to 2008	Day 143.7 = May 23

Figure 5 shows the estimate of the day-of-the-year that the relative water surface elevation in the well declined to zero (day of zero elevation). The estimate was made by calculating the daily decline in the groundwater surface as explained in the text. Prior to 1970, the day of zero elevation occurred sometime after August 1. In most years (17 out of 22) after 1986, the day of zero elevation occurred by July 1.

The record was divided into three period, 1958 to 1970, 1971 to 1986 and 1987 to 2008. The mean day of zero elevation (expressed as a number) was calculated for each of the three time periods. A set of t-Tests, assuming equal variances, were performed on the mean day of zero elevation for each pair of periods. All three two-sample t-tests were statistically significant at the alpha = 0.05 level. Table 2 converts the mean day-of-the-year to the month and day for the mean day of zero elevation for each time period.

Figures 4 and 5 and Tables 1 and 2 show that, prior to 1970, the day of zero elevation in the well would be expected to occur around September 10. Prior to 1970, the Napa River became a losing stream at Bales Slough in the late summer, if at all. However, during the 1987-2008 time period the day of zero elevation would be expected to occur on May 23. So, in the most recent time period, the Napa River at Bales Slough would be expected to be a losing stream from the late spring through fall.

The water surface elevation data from well 07N05W09Q002M show that groundwater extraction is progressively lowering the water table surface under the Napa River to the point where the Napa River loses water to the groundwater system each year. And that the date on which the Napa River changes from a gaining stream to a losing stream is happening at an earlier date. Since 1987, the date that the switch from a gaining to losing stream occurs is expected to be on or around May 23.

Faye's simulation of the groundwater surface when the pumping rate was four times the 1970 level demonstrated that in consecutive dry years the Napa River became a losing stream. West Yost and Associates estimated that the 2000 pumping rate was 4.5 times the 1970 rate referenced by Faye. So, according to Faye's simulation under present pumping levels the Napa River should become a losing stream. However, my analysis of the water level data from the well near the confluence of Bales Slough and the Napa River suggests that in most recent years the Napa River is a losing stream from late spring through early fall. These facts demonstrate that valley-wide groundwater extraction is having an adverse impact on streamflow in the Napa River.

Water Diversions

Margaret Lang (2008) submitted Peer Review Comments on the draft *Policy for Maintaining Instream Flows in Northern California Coastal Streams.* Lang observes that recent evidence shows that diversions decrease water velocity and that decreased water velocity adversely impacts juvenile salmonid growth. Reduction in juvenile salmonid growth has been shown to decrease the likelihood of survival in the ocean and results in a reduction in the number of salmonids that return to spawn. Lang's comments follow.

> 1. Setting seasonal limits on diversion
>
> The draft policy sets the seasonal limit on diversion as October 1 through March 31. DFG/NMFS and others recommended a seasonal limit of December 15 through March 31 because, in most years, reliable rainfall does not begin until late-November to mid-December. Thus, the December 15 start date is much more likely to prevent water diversion during the extreme low flows present before the onset of consistent rainfall.
>
> The minimum bypass flow requirements may prevent diversion before instream flows are sufficient to meet a diversion need, but the MBFs were selected to provide minimal flow requirements to meet spawning and upstream passage needs. There is new but very convincing evidence that there are other important benefits to instream flows (e.g. food production/availability, maintaining water quality) that are especially important to late summer/early fall conditions in Northern California coastal streams. As an example, Harvey et al. (2006) found that resident salmonids had growth rates 8.5 times greater over a 6-week period in undiverted reaches of the same stream, at a northern California coastal site. In these experiments, the flow diversion rate decreased the water velocity in the riffles but did not significantly decrease available habitat area or volume. The invertebrate drift, or food availability, was much higher in the undiverted stream reaches. The experimental stream reaches in the study were adjacent and within the same stream. Growth of salmonids is very highly related to survival; thus, the assumption that maintaining instream flows only for upstream passage and spawning is protective of anadromous salmonids may not be appropriate. Additional research on these issues is ongoing (Harvey, Pers. Comm 2008).
>
> There is also evidence that spring (March) flow is also important for similar reasons. Lobon-Cervia (2003) observed that in a northern Spanish stream "increased discharge in March apparently increased essential resources for brown trout at or just after emergence." The emergence timing of brown trout and Mediterranean climate of northern Spain are similar to California's hydrologic climate and anadromous salmonid emergence timing, respectively. As far as I am aware, local or regional research on these issues is not available.
>
> An additional concern is that for many diverters the likelihood of having water available for diversion in October is low. For most watersheds, the early fall storms replenish soil moisture but do not significantly increase instream flows. Thus, expectations should be clearly spelled out to applicants. A possible alternative is to tie diversion timing to actual and persistent flow increases.

Lang (2008) notes a connection between water velocity and juvenile salmonid growth. Surface water diversions are known to reduce water velocity downstream of the point of diversion. The numerous surface water diversions in the Napa watershed are likely reducing the growth rate of juvenile salmonids. The reduction in juvenile salmonid growth reduces the number of salmonid that return from the ocean to spawn. These two affects of surface water diversions are amplified in dry years because there is less streamflow in dry years. These affects are further amplified in the Napa River when valley-wide cumulative groundwater extraction causes the groundwater table to drop below the bed of the Napa River resulting in a discharge of streamflow into the groundwater table.

The actions to protect or enhance baseflow proposed by the TMDL and the BPA are not adequate to counter the adverse impact of groundwater extraction on streamflow. The proposed actions to protect or enhance baseflow from BPA Table 5.2 are listed below.

BPA-Table 5.2 Recommended actions to protect or enhance baseflow

Stressor: Low flows during dry season

Management Objective: Maintain suitable conditions for juvenile rearing, and smolt migration to Napa River estuary

Actions:

2.1 Local, state, and federal agencies to participate in a cooperative partnership to develop a plan for joint resolution of water supply reliability and fisheries conservation concerns

2.2 Install and maintain dial-up water-level gage programs and implement public education program in 10 key tributaries for steelhead

2.3 Develop water-level guidelines to support juvenile salmonid rearing and migration

2.4 Conduct water rights compliance survey to protect fish and water rights

The BPA and the TMDL can not achieve the goal of protecting or enhancing baseflow without; 1) including the Watermaster in the agency cooperative partnership, 2) address the impact of valley-wide groundwater extraction on flows in the Napa River and 3) address the impact of late spring and summer surface diversions on the flow in the Napa River.

Summary

In addition to reducing the sediment load to 125% of the natural background sediment load the TMDL and BPA should require that the stormwater discharge regime of the Napa River be brought into alignment with the natural hydrograph that would transport no more than 125% of the background sediment load.

The following performance standard shall be applied to all four land use categories listed in BPA Tables 4.1 through 4.4.

- Effectively attenuate significant increases in storm runoff. Runoff from all land uses listed in Tables 4.1 through 4.4 shall not cause or contribute to downstream increases in rates of bank or bed erosion relative to the discharge regime that carries 125% of the natural sediment load.

The above discharge performance standard should be applied to all lands upstream of the municipal water supply reservoirs. Reservoirs that lack flood control capacity (fill-and-spill) contribute to increased discharge during storm events when they are full. The increased discharge from rain falling on the surface of a filled reservoir contributes to downstream erosion of the stream channel. Any reservoir that has a spillway contributes to this effect even those reservoirs that are off-stream.

Valley-wide groundwater extraction rates are currently high enough to lower the groundwater table below the bed of the Napa River and change it into a losing stream. The loss of discharge to the groundwater system can adversely affect the growth of salmonid juveniles. In some locations, the loss of river discharge to the groundwater system may be sufficient to dry up portions of the riverbed.

The goal of enhancing salmonid habitat in the Napa River will not be achieved if the lowering of the groundwater surface by valley-wide groundwater pumping is not accounted for.

Sincerely,

Dennis Jackson

Dennis Jackson
Hydrologist

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Redwood City Engineering Design Standards Attachment Q

http://www.redwoodcity.org/cds/engineering/standards/design/Attachment-Q.pdf

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Index of Wet Yost and Associates Technical Memorandums

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