4.4 Water Quality

Water quality data collected in the New Alamo Creek and Ulatis Creek watersheds were compiled to characterize the levels of contaminants of concern to drinking water supplies that are known to be contributed by the nonpoint and point sources identified in the watershed. Specifically, data were compiled for nitrate, total dissolved solids (TDS), pathogens, pesticides, THM compounds, and organic carbon. Sources of the data included monitoring conducted by the City of Vacaville and the Sacramento Valley Water Quality Coalition. These data are summarized in *Use Attainability Analysis for New Alamo Creek and Ulatis Creek, Technical Memorandum No. 4, Water Quality Characteristics of Alamo Creek, Ulatis Creek, and Cache Slough* (RBI 2007c).

5 EVALUATION OF MUN ATTAINABILITY

5.1 Is MUN an Existing Use?

5.1.1 Has the Use Occurred Since November 28, 1975?

A search of the State Water Board water rights records for Ulatis Creek and all of its tributaries revealed the following findings (RBI 2007b):

- There are a total of 65 water rights that have been filed with the State Water Board on Ulatis Creek or its tributaries, which include Alamo Creek, Laguna Creek, Encinosa Creek, McCune Creek, Sweeny Creek and a number of other named and unnamed smaller tributaries.

- Only two water rights exist for the purpose of domestic uses, D030686R and S009276, both of which are located in the upper reaches of Ulatis Creek, upstream of the UAA study segment for this water body.

- No water rights for domestic water uses exist within the UAA study segments. Only irrigation water rights exist within the UAA study segments, for both New Alamo Creek and Ulatis Creek.

Field surveys of the UAA study segments conducted in June and July 2004, and July 2007 to identify residents capable of diverting surface water for domestic use from New Alamo and lower Ulatis Creek (below the confluence of New Alamo Creek) revealed the following findings (RBI 2007b):

- There are nine residential dwellings adjacent to New Alamo Creek and none adjacent to the UAA study segment for Ulatis Creek.

- Only one parcel has a small privately operated pump capable of diverting surface water from New Alamo Creek; however, this diversion lead to a ditch in a field, indicating that

diverted water is used for irrigation purposes. This was confirmed by interviewing this landowner (RBI 2007b, Appendix B).

- All other diversions are operated by Solano Irrigation District or Maine Prairie Water District for irrigation uses.

Interviews were held with DHS, Solano County Department of Resources Management, Solano County Resource Conservation District, Solano Irrigation District, Solano County Water Agency, Dixon Resource Conservation District, and Maine Prairie Water District staff and with rural residents living adjacent to New Alamo Creek to determine whether municipal or domestic use of UAA study segment water has occurred at any time since November 28, 1975. All parties interviewed indicated that they are not aware of any current or past municipal or domestic use of water diverted from the UAA study segments (RBI 2007b).

The water rights records, field surveys, and interviews indicate that the MUN use has not occurred in the UAA study segments since November 28, 1975.

5.1.2 Has Water Quality been Sufficient to Allow the Use to Occur Since November 28, 1975?

Current water quality conditions within the UAA study segments are characterized in section 0. As stated in Section 0, the human-caused contamination of the water quality within New Alamo Creek and Ulatis Creek, which is dictated by the primary sources of the water being agricultural drainage water, agricultural and urban storm water runoff, and the Easterly WWTP, is currently precluding the MUN use from being attained in the UAA study segments. The Easterly WWTP began discharging treated effluent at its current location in 1959. Although its discharge rate was lower in 1959, relative to current conditions, so too was its effluent quality lower than that which exists presently. In the early 1960s, the Ulatis Soil Conservation District, Solano Irrigation District, and Solano County Flood Control and Water Conservation District jointly developed the "*Watershed Work Plan: Ulatis Creek Watershed*" to reduce flooding of the agricultural properties within the Ulatis Creek watershed (Ulatis Soil Conservation District et al. 1961). The improvement works identified in the 1961 Ulatis Creek Watershed Work Plan consisted of: 1) land treatment measures (e.g., conservation cropping system, proper range use, pasture plantings) and 2) structural measures. The structural measures included "*...improvement or realignment of 51.9 miles of floodwater channels together with the construction of drop and grade stabilization structures and inlet structures to convey local runoff into the channels.*" Hence, the routing of storm water runoff from agricultural and urban lands into the UAA study segments has occurred since the early 1960s. Moreover, since the channel realignments were completed in the 1960s, the UAA study segments have been used to convey agricultural return flows during the irrigation season. Finally, the natural precipitation-driven hydrology of these segments (see Section 5.2.1) is believed to have remained similar throughout the 1975-present period.

Because the combined factors that currently make water quality within the UAA study segments unsuitable for the MUN use have occurred throughout the November 28, 1975 to present period, it can be concluded that water quality within the UAA study segments has never been sufficient to allow the MUN use to occur since November 28, 1975.

Based on the information presented in Sections 5.1.1 and 5.1.2, it is concluded that MUN is not an existing use.

5.2 Is MUN an Attainable Use?

The regulations at 40 CFR § 131.10(g) specify six factors that may provide the legal basis for changing or removing a designated use. As discussed below, the factors that apply to the attainability of the MUN use in the UAA study segments are:

- Natural, ephemeral, intermittent and low flow conditions or water levels prevent the attainment of the use, and cannot be compensated for by the discharge of sufficient volume of effluent discharges (40 CFR § 131.10(g)(2));
- Human caused conditions and sources of pollution prevent the attainment of the use and cannot be remedied (40 CFR § 131.10(g)(3)); and
- Hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water bodies to their original condition (40 CFR § 131.10(g)(4)).

The following sub-sections provide information and discussion that serve as the basis for determining whether these factors preclude the attainment of the MUN use within the water body segments. Among the key considerations discussed below are:

- seasonal sources of water to the segments,
- human sources of contamination of water quality within the segments,
- modifications to channels to convey runoff from adjacent urban and agricultural lands,
- costs to POTWs to upgrade treatment processes to meet current water quality standards and effect on attainability, and
- availability of alternative, higher quality water sources within the area for MUN use.

Treatment upgrades required at the Easterly WWTP are identified and compared to treatment trains needed to meet effluent limits under sections 301(b)(1)(A) and (B) and section 306 of the CWA.

5.2.1 Hydrologic Conditions

The hydrologic characteristics of New Alamo Creek and Ulatis Creek are described below according to precipitation season, non-precipitation season, and non-irrigation/non-precipitation season. These periods were chosen because they represent distinct hydrologic regimes of these creeks.

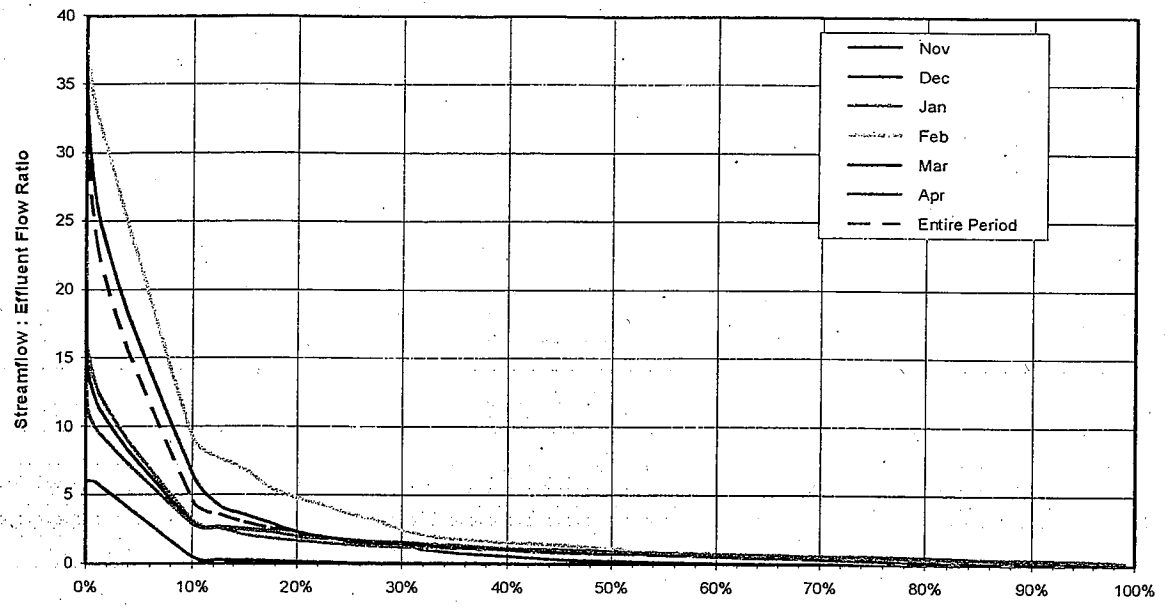
Precipitation Season

During the precipitation season (i.e., primarily November through April), the water in lower New Alamo Creek and Ulatis Creek is comprised of runoff from the upper watershed, urban runoff, runoff from agricultural lands, and Easterly WWTP effluent (RBI 2007a). The relative fraction of effluent throughout the precipitation season varies depending on the size of each storm event and the frequency and size of antecedent storms. The dilution study found the portion of Easterly WWTP present in March 2004 to be approximately 50% of the flow in New Alamo Creek and 25% of the flow in Ulatis Creek (Flow Science 2005). **Figure 14** demonstrates that there are periods when the flow in New Alamo Creek is largely runoff from the watershed lands, and that there are periods when very little flow is contributed by the watershed and most of the flow is Easterly WWTP effluent. For the period 1998-2006, the dilution ratio (New Alamo Creek flow:WWTP flow) was 5:1 or less approximately 90% of the time (Figure 14). As shown in **Figure 15**, the Easterly WWTP effluent is a smaller fraction of the Ulatis Creek flow as compared to New Alamo Creek (RBI 2007a). For the period 1998-2006, the dilution ratio (Ulatis Creek flow:WWTP flow) was 10:1 or less approximately 80% of the time and was 5:1 or less approximately 60% of the time (Figure 15).

Non-precipitation Season

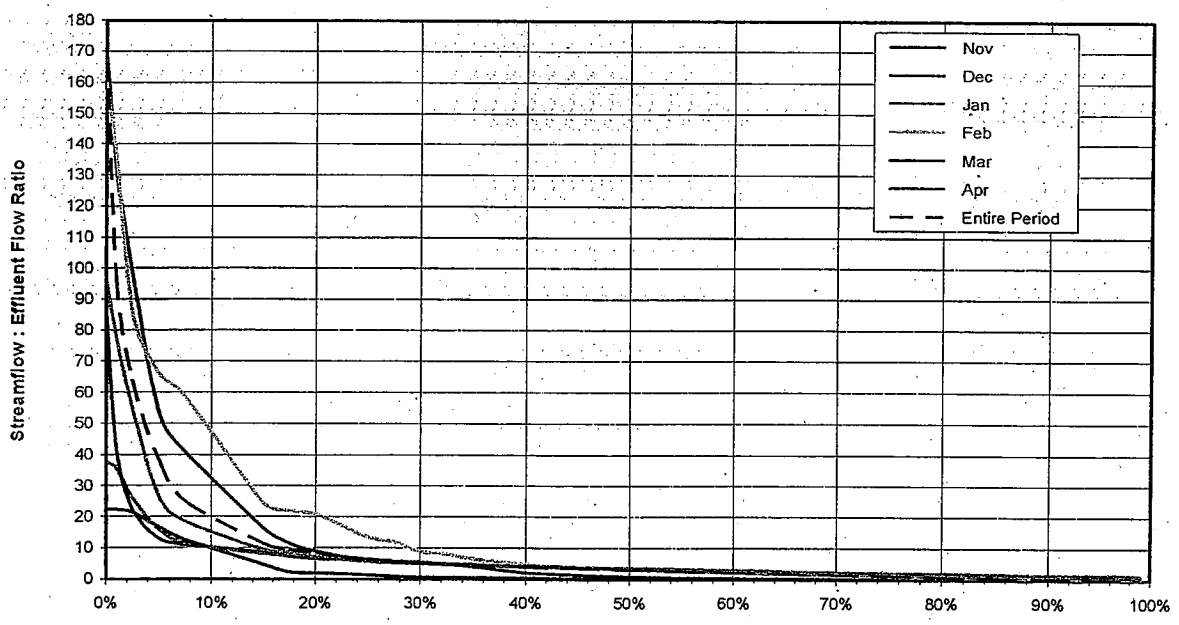
Natural base flow in the UAA study segments annually goes to zero, typically in June, and remains in a zero-flow condition until adequate rains have occurred, typically in November (RBI, 2007a). During the irrigation season (Mid-April through October), significant inflows of agricultural drainage and irrigation water enter lower New Alamo Creek and Ulatis Creek, and significant volumes are pumped out of the creeks. Additional inputs to the creeks include urban runoff and Easterly WWTP effluent. A schematic of flow measurements recorded July 27, 2004 on New Alamo Creek and Ulatis Creek, provided in **Figure 16**, illustrates the relative contribution of these sources. On this day, which is typical of operations throughout the irrigation season, there was no flow input to either New Alamo Creek or Ulatis Creek from the upper watershed. Of the 35 cfs of flow in New Alamo Creek downstream of the Old Alamo Creek confluence, 11 cfs (31%) came from the Easterly WWTP, 23.5 cfs (67%) came from agricultural drainage water, and 0.5 cfs (2%) came from urban runoff. Additional inputs to Ulatis Creek included approximately 5 cfs of water (agricultural drainage water or Solano Project inputs) plus 23 cfs of agricultural drainage water.

Within Ulatis Creek, Easterly WWTP effluent comprises a relatively smaller fraction of the total flow, as compared to New Alamo Creek. This is a result of the additional inputs of irrigation and drainage water to Ulatis Creek, and pump out of water on New Alamo Creek and Ulatis Creek for irrigation of adjacent agricultural lands. A dilution study conducted at the same time the flow measurements were conducted found that Easterly WWTP effluent was 5% of the flow in Ulatis Creek at Brown Road, with the remainder of flow constituted by imported irrigation water, agricultural drainage water, and urban runoff (Flow Science 2005).



Source: RBI 2007a.

Figure 14. Approximate dilution ratio of Easterly WWTP effluent in New Alamo Creek immediately below confluence of Old Alamo Creek for water years 1998–2006.



Source: RBI 2007a.

Figure 15. Approximate dilution ratio of Easterly WWTP effluent in Ulatis Creek immediately below confluence of New Alamo Creek for water years 1998–2006.

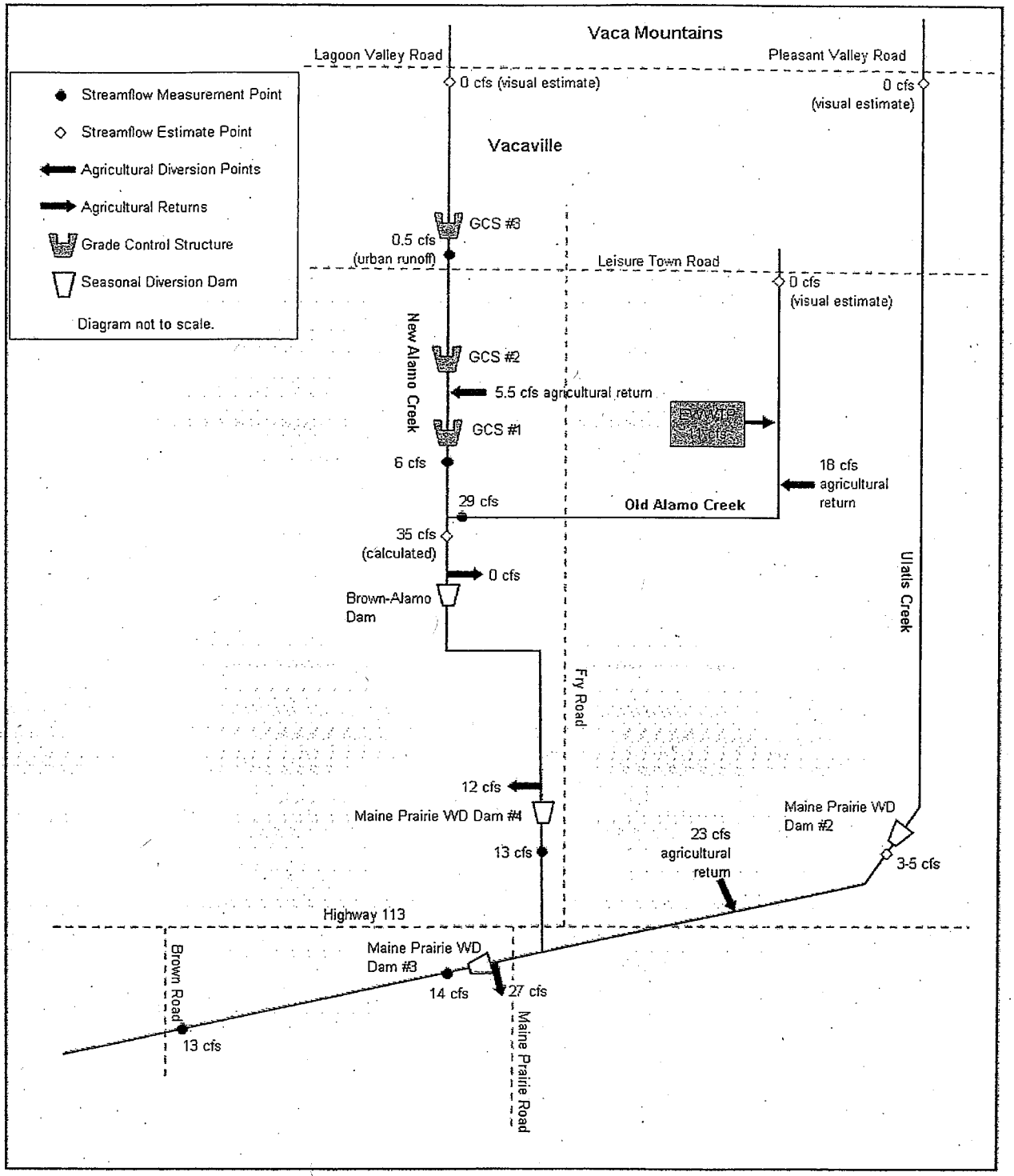


Figure 16. Schematic of New Alamo Creek and Ulatis Creek flow measurements and diversions for July 27, 2004.

The watershed hydrology precludes the MUN use during the non-precipitation season, because there is no natural flow within the UAA study segments that could be diverted for MUN use during this time of year (RBI 2007a). The water that does flow within the UAA study segments during the non-precipitation season is constituted by: 1) Easterly WWTP effluent; 2) fully-allocated irrigation and agricultural drainage water; and 3) urban runoff. These source waters are either already allocated for irrigation uses or are not of a source or of a quality to be suitable to serve as MUN source water, or both. The latter is particularly true when acknowledging that alternative, higher quality MUN water sources are available for municipal and domestic uses (i.e., North Bay Aqueduct, Lake Berryessa, groundwater). The cities of Vacaville and Vallejo rely upon North Bay Aqueduct and Lake Berryessa water sources and local residents rely upon higher quality groundwater.

Non-irrigation and Non-precipitation Season

In the fall, prior to the initiation of precipitation and runoff, but when irrigation activities have ceased, the flow in the UAA study segments is primarily Easterly WWTP effluent and urban runoff. A dilution study conducted in November 2003 found that the flow in New Alamo Creek at Brown-Alamo Dam was nearly 100% effluent, and that approximately 50% of the flow in Ulatis Creek at both Maine Prairie Road and Brown Road was Easterly WWTP effluent (Flow Science 2005).

5.2.2 Water Quality

Water Quality Effects on Locating the North Bay Aqueduct Diversion Intake

In 1982, the U.S. Army Corps of Engineers and the California Department of Water Resources (DWR) released their final ES/EIR for the planned Phase II facilities of the North Bay Aqueduct (NBA). In early 1984, concerns were raised regarding: 1) the quality of Cache Slough water (the selected location for the Phase II NBA intake) relative to higher water quality at alternative locations within the Delta evaluated in the ES/EIR, and 2) the declining quality of Cache Slough water. The DWR initiated a re-assessment of NBA Phase II alternatives in mid 1984 to further examine water quality in the vicinity of Cache Slough and to investigate possible alternatives for improving water quality for the NBA. The report produced from this assessment, titled: *North Bay Aqueduct Water Quality Improvement Alternatives,* was issued in October 1984 (DWR 1984).

At the time this re-assessment was performed by DWR, the current plan was to locate the Phase II NBA diversion intake in Cache Slough and to relocate the City of Vacaville's Easterly WWTP's discharge from Alamo Creek (a tributary to Cache Slough) to the Lindsey Slough basin. Based on DWR's assessment, it determined Cache Slough water quality, absent Easterly WWTP's effluent, would be of lower quality than water diverted from Barker Slough, a tributary of Lindsey Slough. DWR's recommendation from its 1984 reanalysis was: 1) locate the NBA diversion intake in Barker Slough rather than Cache Slough; 2) incorporate relocation of the City of Vallejo intake (then at Cache Slough) into the design of the new Barker Slough NBA intake; and 3) leave the City of Vacaville's Easterly WWTP discharge at its current location of Alamo

Creek, which is tributary to Cache Slough. DWR's three recommendations listed above were accepted and implemented.

Water Quality Conditions

Data indicate that the UAA study segments are not currently meeting drinking water quality standards for a number of constituents, and are expected to have other characteristics (e.g., pathogen levels) that make the water unsuitable for MUN use. Primary factors causing this condition are area agricultural and urban land uses and Easterly WWTP discharges. Such conditions are expected to have occurred since November 28, 1975. Potential watershed contaminant sources in the New Alamo Creek and Ulatis Creek watersheds include drainage from agricultural lands used for grazing and crop production, urban runoff, as well as effluent discharges from the City of Vacaville's Easterly WWTP. Agricultural land uses comprise approximately 57% of the New Alamo Creek watershed, and approximately 80% of the Ulatis Creek watershed (California Department of Forestry & Fire Protection 2002). Urban land uses comprise approximately 18% of the New Alamo Creek watershed, and approximately 9% of the Ulatis Creek watershed (California Department of Forestry & Fire Protection 2002).

Contaminants associated with agricultural activities with the potential to runoff into New Alamo Creek and Ulatis Creek include sediment (soil), nutrients, pathogens, pesticides, metals, salts, and organic carbon (U.S. EPA 2005, Tetra Tech 2006a). Contaminants commonly found in urban runoff include: trash; sediment; oil, grease, and toxic chemicals from motor vehicles; pesticides and nutrients from lawns and gardens; viruses, bacteria, and nutrients from pet waste and failing septic systems; and heavy metals from roof shingles, motor vehicles, and other sources (U.S. EPA 2003a; Tetra Tech 2006b). Urban land uses also contribute organic carbon to runoff (Tetra Tech 2006a).

A review of water quality data collected in New Alamo Creek, Ulatis Creek, and Cache Slough revealed the following (RBI 2007c).

Pathogens

E. coli, total coliform, and fecal coliform levels in New Alamo Creek, Ulatis Creek, and Cache Slough are orders of magnitude higher than levels in the Easterly WWTP effluent, indicating that the greater watershed land uses are the primary sources of these pathogens. Fecal coliform levels often exceed 1,000 MPN/100 ml within the UAA study segments, with total coliform bacteria levels recorded as high as >24,200 MPN/100 ml (RBI 2007c). Total coliform levels in the Easterly WWTP effluent are required to be maintained at levels that are orders of magnitude lower than those cited above. No data exist for other pathogens such as viruses and protozoans in the UAA study segments. Treated wastewater effluent and agricultural drainage water may contain other human pathogens including the protozoans *Cryptosporidium* and *Giardia*, both of which have maximum contaminant level goals of zero. The extensive agricultural land uses, including the Fry Ranch, which maintains an intensive cattle operation, likely load these protozoans to the UAA study segments (**Figure 17**). Other pathogens, such as viruses (e.g., poliovirus and hepatitis virus), and a variety of nematode and trematode parasites may also occur, for which no numeric criteria have been established to protect MUN-designated waters.

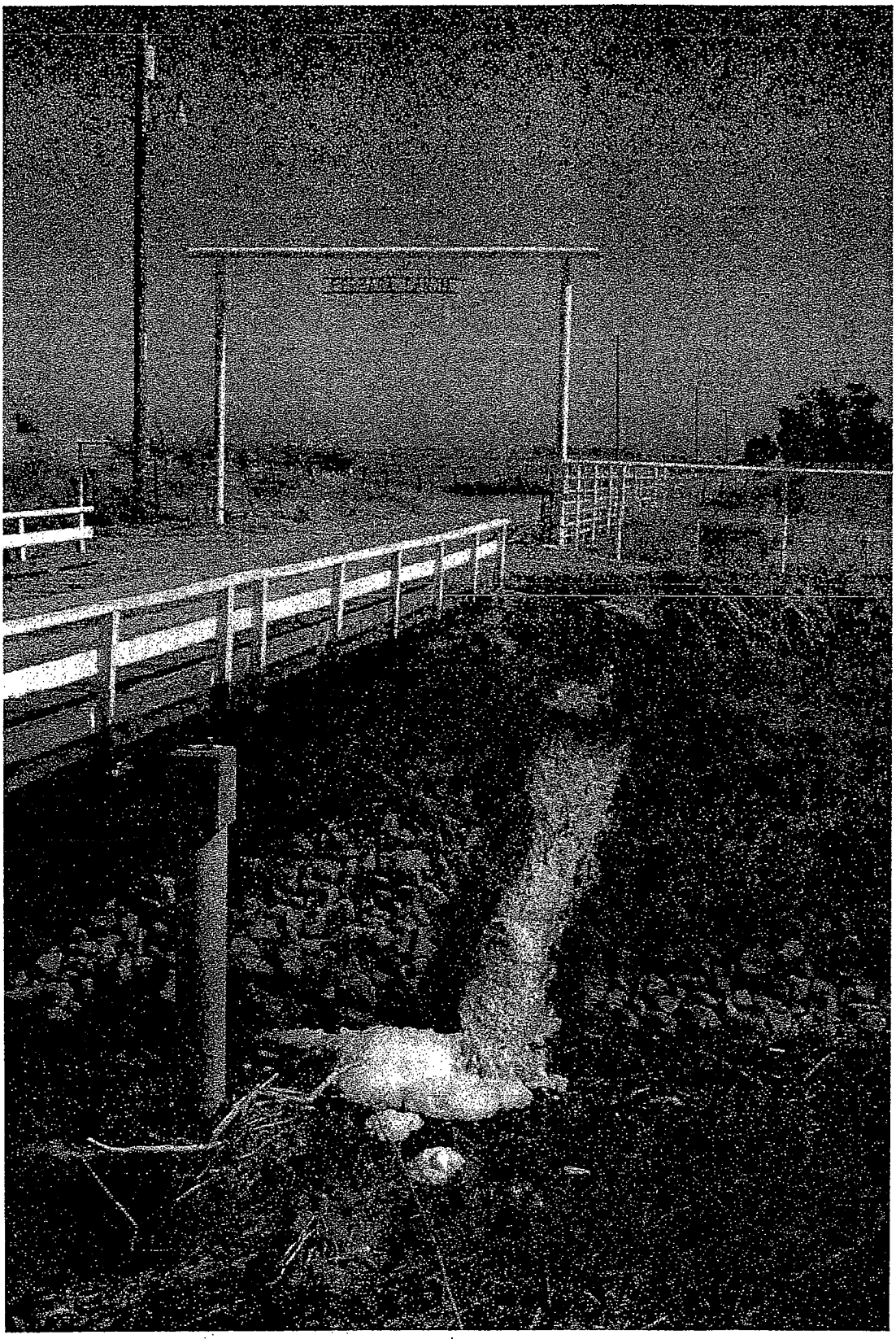


Figure 17. Discharge from Ferrara Ranch into New Alamo Creek, 0.8 miles upstream of confluence with Ulatis Creek.

Given the high percentage of agricultural land uses surrounding the study segments and the WWTP effluent, it is highly likely that these other pathogens occur in the UAA study segments, increasing the risk to human populations that might depend on this water as a domestic or public water supply (RBI 2007c, Tetra Tech 2004).

Nitrate

Nitrate often exceeds the drinking water MCL within lower New Alamo Creek and Ulatis Creek. Nitrate is contributed by agricultural drainage water, as well as the Easterly WWTP. Infants below the age of six months that drink water containing nitrate in excess of the MCL could develop methemoglobinemia or "blue-baby syndrome," which can be lethal (Greer et al. 2005). Data presented in RBI (2007c) and Tetra Tech (2004) demonstrate that significant concentrations of nitrate are contributed by the surrounding agricultural uses.

Organic Carbon

Organic carbon concentrations generally exceed the 2 milligrams per liter (mg/L) threshold of the Stage 1 Disinfectants and Disinfection Byproduct Rule, which requires drinking water utilities to reduce total organic carbon concentrations by specified percentages prior to adding disinfectants. The greater watershed land uses (agricultural, urban, natural) and the Easterly WWTP are sources of organic carbon to the water body segments. The organic carbon levels that exist in the UAA study segments raise concerns regarding the formation of disinfection by-products should this water be disinfected using chlorination for MUN use (RBI 2007c).

Total Dissolved Solids (TDS)

TDS concentrations and electrical conductivity (EC) levels often approach and sometimes exceed their secondary MCLs during the irrigation season in lower New Alamo Creek and Ulatis Creek. TDS and EC are elevated in these segments by agricultural drainage flows and by the Easterly WWTP discharge (RBI 2007c).

Pesticides

While pesticides are used extensively in the New Alamo Creek and Ulatis Creek watersheds, available data shows their concentrations to be less than primary drinking water MCLs for those pesticides with MCLs (RBI 2007c). Nevertheless, more monitoring would be required to fully characterize the pesticide levels in the study segments. Certain toxic pesticides are used in fairly high quantities within the watershed by Solano Irrigation District, including chlorpyrifos, diuron, 2-4 D, paraquat, and carbamate (Tetra Tech 2004). These pesticides are used on tomatoes, alfalfa, rights-of-way, and for structural pest control. Tetra Tech (2004) reported these applications used 378,785, 80,925, 100,595, and 28,459 pounds of pesticides, respectively, much of which was comprised of toxic chemicals such as those listed above. MCLs for these pesticides have not been established, except for 2-4 D (0.07 mg/L). Those pesticides that do have MCLs are generally near zero. Many of the pesticides listed above cause nervous system diseases leading to respiratory and circulatory problems. Chlorpyrifos, paraquat, and carbamate all are cholinesterase inhibitors that cause neurological dysfunction, labored breathing, and coma

at elevated, but sub-lethal levels of exposure. Under short-duration, lower-level exposure, all of the above pesticides can cause nausea, diarrhea, and skin irritations (Tetra Tech 2004).

Trihalomethanes (THMs)

THM compounds are present in the lower reaches of New Alamo Creek and Ulatis Creek at levels exceeding CTR human health criteria for the consumption of water and organisms. At the defunct Vallejo Pump Station, just into Cache Slough, CTR criteria for THMs are not exceeded. Chloroform concentrations in New Alamo Creek and downstream water bodies do not exceed the 2003 draft U.S. EPA human health criteria, but do exceed chloroform criteria derived from Office of Environmental Health Hazard Assessment (OEHHA) thresholds. Total THM concentrations are less than the drinking water MCL. The Easterly WWTP is the primary source of THMs in the UAA study segments (RBI 2007c).

The quality of source water dictates the level of treatment necessary for MUN uses to protect human health from contaminants of concern. The primary contaminants of concern in New Alamo Creek and Ulatis Creek that would need, at a minimum, to be addressed through drinking water treatment technologies are pathogens, nitrate, THMs, organic carbon, and possibly pesticides. Pathogens (e.g., *Cryptosporidium*, *Giardia lamblia*, *E. coli*) are of concern, because of their potential to cause gastrointestinal illness. Nitrate is of concern, because of its potential to cause methemoglobinemia, known as "blue-baby syndrome." THMs are of concern, because they are carcinogens. Organic carbon is of concern because it reacts during chlorination of MUN water supplies to form disinfection byproducts, including THMs and halogenated compounds, which are carcinogens. It should be noted that discharges from the Easterly WWTP do not cause exceedances of any adopted water quality criteria or objectives within Cache Slough, as measured at the defunct Vallejo Pump Station (RBI 2007c).

The actual source of the water also dictates the level of treatment necessary for drinking water. During much of the year, the primary sources of water to the UAA study segments are agricultural drainage water, urban runoff, and Easterly WWTP effluent. DHS developed Policy 97-005 to address the drinking water use of such waters, which it classifies as "extremely impaired" source waters (DHS 1997). DHS will not approve use of an extremely impaired source water if another source water of lesser risk to human health is available. DHS has already opposed future drinking water uses of Cache Slough by the City of Vallejo at its now defunct Vallejo Pump Station due to poor microbiological water quality (DHS 1995). DHS cites the surrounding land uses, primarily agricultural activities, as the basis of its concerns. In its letter to Mr. Tompkins of the City of Vacaville dated January 27, 1995, DHS stated, "*While we do not believe it is appropriate to withdraw drinking water downstream of a wastewater treatment plant discharge, no matter how highly treated, there is good reason to believe that water quality in Cache Slough would remain very poor even if Easterly Wastewater Treatment Plant effluent were removed from it. Water quality in Cache Slough remained poor during previous water quality monitoring conducted when the Easterly plant was not discharging treated effluent upstream.*" (RBI 2007c). DHS concerns would be even greater for waters within the UAA study segments, which are primary source waters to the Vallejo Pump Station site, and which lack the dilution from other sources waters found within Cache Slough at the Vallejo Pump Station. This DHS position was confirmed by Ms. Leah Walker of the DHS, who, when attending the

Regional Water Board's California Environmental Quality Act scoping public meeting for this UAA/standards setting project on June 28, 2007 stated that the DHS supports the dedesignation of MUN from the UAA study segments.

The human-caused contamination of the water quality within New Alamo Creek and Ulatis Creek, which is dictated by the primary sources of the water being agricultural drainage water, agricultural and urban storm water runoff, and the Easterly WWTP, is currently precluding the MUN use in the UAA study segments. While DHS policy is not entirely determinative of whether MUN is attainable, it serves as an indication that other available sources (e.g., groundwater, North Bay Aqueduct, Lake Berryessa) would better and much more likely serve the municipal supply of cities in the region and domestic supply of homeowners adjacent to the creeks.

5.2.3 Potential for New Diversions

Attainment may be assessed either by pollutant concentrations present in a water body or by identifying an entity that has or will employ the water for the beneficial use. Even if known chemical and pollutant concentrations met all relevant criteria and objectives, it is unlikely that any person or population would directly employ the UAA study segments of New Alamo Creek or Ulatis Creek as a source of drinking water in light of the quality of the water within these segments, the primary sources of the water, and the fact that higher quality alternative sources are available within the area.

The only municipality in the vicinity that might consider use of either New Alamo Creek or Ulatis Creek as a water supply is the City of Vacaville. The City's water supplies consist of groundwater, Solano Project water, and the Delta via the North Bay Aqueduct (SCWA 2004). The City's supplies have been evaluated as part of its 2005 Urban Water Management Plan and it has been determined that these supplies are in excess of the General Plan buildout demand (Nolte Associates 2005). Neither New Alamo Creek nor Ulatis Creek are identified as sources of drinking water for the City of Vacaville currently, or in the future.

The likelihood of a riparian diversion for MUN is similarly remote. Riparian water rights attach only to the natural flow of a stream, not to "foreign" or imported water supplies, including agricultural drainage from imported water. Thus, any riparian right holder, existing or future, with a desire to use the water within the UAA study segments of New Alamo Creek and Ulatis Creek for MUN would have the right only to the natural flow of the creek and of the tributaries that enter into the creek above the riparian right holder's land.

As described in Section 5.2.1, natural flow is only available seasonally. Individuals are unlikely to pay for installation of diversion and treatment systems suitable to be permitted for MUN use of water diverted from the UAA study segments when such systems could not provide the individual's water supply during the non-precipitation season when no natural base flow is available. Moreover, riparian water rights holders along small water bodies such as these typically exercise their riparian rights for irrigation water supply, not MUN water supply, particularly when abundant, higher quality groundwater is available. In this situation, a well or municipal supply also would be required to obtain a year-round, safe, dependable MUN supply

to the home. With a well or municipal supply in place for use during much of the year, there becomes no need for a surface water diversion from the UAA study segments during the precipitation season of the year. Use of the well or City municipal supply year-round would be easier and more cost-effective for the individual than would installing the diversion, storage, and treatment system necessary to be permitted for MUN use of the diverted water under any riparian right that may exist. None of the residents interviewed along New Alamo Creek have in the past, are currently, or are planning in the future to utilize a riparian water right to produce a legal, permitted, MUN supply to their residence (RBI 2007b, Appendix B). As stated previously, there are no residents living immediately adjacent to the segment of Ulatis Creek under consideration in this UAA.

A further constraint on the use by adjacent landowners of flows within the UAA study segments is the fact that they must obtain a water rights permit for use of any foreign or imported water. (*Stevinson Water District v. Roduner* (1950) 36 Cal.2d 264, 223 P.2d 209) It is not likely that a water rights permit would be granted for municipal or domestic use of waters within the UAA study segments. New Alamo Creek and Ulatis Creek are eventually tributary to, or within, the Delta. The Delta and its tributaries, from the Delta upstream, have been designated as fully appropriated during the period June 15 to August 31. As such, a water right application for use of water during this period would not be accepted. (Wat. Code §§ 1205(b) and 1206.) Any application pending, as of the date of designation, for use during that period, may be cancelled. (Wat. Code § 1206(a).). As stated above, if use of a riparian water right cannot result in a year-round, cost-effective, safe, and dependable MUN supply to the home, in part because it could not be utilized during most of the irrigation season due to lack of natural base flow and the fully appropriated nature of Delta waters, there exists little to no reason for an individual, in this situation, to attempt to exercise a riparian right for MUN supply, assuming such rights exist.

5.2.4 Economic Considerations

CWA § 301(b)(1)(B) requires POTWs to meet secondary treatment standards. Secondary treatment standards are defined by numeric effluent limitations for 5-day biochemical oxygen demand, suspended solids, and pH (40 CFR § 133.102). More stringent limitations beyond those required to meet the definition of secondary treatment may be incorporated, if necessary, to achieve certain water quality standards (CWA § 301(b)(1)(C)).

The only POTW with a point source discharge that flows into the UAA study segments of New Alamo Creek and Ulatis Creek is the City of Vacaville's Easterly WWTP. The Easterly WWTP currently meets the CWA Section 301 requirements for the secondary treatment of wastewater. Because of the current designation of New Alamo Creek and Ulatis Creek with the MUN use, the following water quality criteria are among those that apply to these water bodies:

- Bromoform – 4.3 µg/L
- Dibromochloromethane – 0.41 µg/L
- Dichlorobromomethane – 0.56 µg/L

- Nitrate – 10 mg/L (as nitrogen)

The additional treatment processes that the City would be required to install and operate at the Easterly WWTP to not cause exceedance of these criteria in either New Alamo Creek or Ulatis Creek include:

- Expanded effluent storage, primary treatment, and secondary treatment facilities
- Membrane filtration
- Reverse osmosis
- Ultraviolet disinfection

Construction of treatment plant upgrades to comply with THM limits would cost the City approximately $171.7 million (in year 2007 dollars) (West Yost Associates 2007).

5.2.5 Factors Precluding Attainment of MUN

Because there is little or no natural flow input from the upper watershed during the irrigation season (i.e., generally from late-May/early-June through October), MUN is not an attainable use during this time of year simply because there is no natural base flow to use. Thus, natural flow conditions during approximately half the year prevent attainment of the use, because no base flow exists to support the use (40 CFR § 131.10(g)(2)).

During the non-precipitation season, not only is there no natural base flow to support the MUN use, the water that is present in the UAA study segments is comprised of Easterly WWTP effluent, agricultural drainage water, imported fully-allocated irrigation water, and urban runoff. Hence, the water that may be available (i.e., Easterly WWTP effluent and urban runoff) is of an unsuitable source and quality for MUN use (DHS 1995; DHS 1997; L. Walker, DHS, pers. comm., June 28, 2007). The surrounding agricultural and urban land uses that result in the available sources of poor quality water to the UAA study segments cannot be changed in a manner that would make the available water suitable for MUN use. Consequently, human caused conditions or sources of pollution during the non-precipitation period of the year also prevent the attainment of the MUN use and cannot be remedied (40 CFR § 131.10(g)(3)).

Hydrologic modifications resulting from the Ulatis Creek Watershed Protection and Flood Prevention Project in the early 1960s have resulted in the UAA study segments being used for collecting and conveying storm water runoff from adjacent urban and agricultural lands during the precipitation season (i.e., generally from late-October/November through May). Consequently, highly impaired source water conditions exist during the precipitation season. Although agricultural drainage water is not present during the precipitation season, storm water runoff from adjacent urban and agricultural lands and Easterly WWTP effluent is present. The Ulatis Creek watershed work of the early 1960s resulted in the UAA study segments being modified to collect and convey storm water runoff from adjacent urban and agricultural lands to minimize the flooding of these lands. Only during short periods (e.g., hours to days) surrounding large precipitation events does natural runoff from upper watershed areas adequately dilute these

other low quality source waters to produce water quality conditions within the UAA study segments that is potentially suitable for MUN use. As stated previously, for the period 1998-2006, the dilution ratio (New Alamo Creek flow:WWTP flow) of Easterly WWTP effluent in the New Alamo Creek segment was 5:1 or less approximately 90% of the time during the precipitation season (Figure 14). During this same period, the dilution ratio (Ulatis Creek flow:WWTP flow) of Easterly WWTP effluent in the Ulatis Creek segment was 10:1 or less approximately 80% of the time and was 5:1 or less approximately 60% of the time (Figure 15). Water having these characteristics is unsuitable for MUN supply, particularly when higher quality alternative sources are available within the area (DHS 1995; DHS 1997; L. Walker, DHS, pers. comm., June 28, 2007). The justifications provided by DHS for discouraging the use of Cache Slough water by the City of Vallejo (DHS 1995, 1997) are compounded for the UAA study segments, because UAA study segment water is a primary source water to the Vallejo Pump Station site, yet it does not receive any or as much dilution with higher quality Cache Slough water compared to waters at the Vallejo Pump Station site.

The infrequent occurrence of available water of suitable water quality within the UAA study segments during the precipitation period of the year (i.e., a matter of days to weeks in a given year) is inadequate to justify attainment of the MUN use seasonally. Thus, human-caused conditions and sources of pollution (including system hydrologic modifications resulting from the Ulatis Creek watershed work of the early 1960s which routed additional urban and agricultural storm water runoff into newly constructed channels to rapidly drain surrounding lands) prevent the attainment of the use throughout the precipitation season as well, and cannot be remedied or operated in a manner that would attain the use (40 CFR § 131.10(g)(3), as affected, in part, by 131.10(g)(4)). Human health concerns associated with UAA study segment waters are primarily pathogen related. This would be the case regardless of whether the Easterly WWTP effluent discharge met all drinking water MCLs and CTR human health criteria (DHS 1995).

5.3 Is Restoration to an Attainable Use Condition Feasible?

The following sections discuss the feasibility of restoring conditions to allow attainment of MUN in the New Alamo Creek and Ulatis Creek UAA study segments. Although it is not likely that conditions sufficient to allow the MUN use to occur have ever existed in the UAA study segments and, thus, technically could never be "restored," the feasibility of attainment is further evaluated.

5.3.1 Enhancement of Natural Flow Conditions

The regional climate is such that precipitation and natural flows from the upper New Alamo Creek and Ulatis Creek watershed occur seasonally, primarily from November through March (see Figure 9 on page 12). Thus, currently any natural flow for MUN use would be available only during part of the year, which cannot be changed. A future MUN user would have to secure a water right to divert, store, and treat segment water to produce a year-round MUN supply. An on-stream water storage facility (i.e., dam) would not be a feasible option. Such a facility would not be compatible with the current use of New Alamo Creek and Ulatis Creek for conveying storm water flows in the winter, and irrigation and agricultural drainage water in the summer.

To overcome seasonal flow constraints and provide for a MUN supply year-round, an off-stream facility (e.g., tank, pond, reservoir) would be required for storing water diverted when base flow supply was available. This would require an appropriative water right to be secured and would require permitting of the treatment and storage system for this highly impaired water source. Such a water right could not interfere with existing water rights. Off-stream storage of water diverted from the UAA study segments for MUN use is not within the current or future plans of the City of Vacaville, the only municipality close enough to realistically consider such an action. At an individual homeowner level, overcoming ephemeral flow limitations by constructing off-channel storage for year-round treatment and use is possible; however, it is highly unlikely to occur for three reasons. First, easier, safer, and more reliable alternative MUN supplies, such as groundwater, are available. Second, public perception of utilizing these highly impaired water supplies, which typically contain a relatively high percentage of Easterly WWTP effluent, would discourage area residents from selecting this option, regardless of its feasibility. This was affirmed in peer review of the Old Alamo Creek UAA of MUN (Hermanowicz 2004). Third, the cost of obtaining a water right; obtaining any needed easement from Solano Irrigation District or Solano County Water Agency; constructing diversion, storage, and treatment facilities; securing Solano County Health Department approval for use of these facilities; and maintaining these facilities is expected to be far more costly that installing a domestic well.

5.3.2 Restoration of Water Quality

As discussed in Section 0, water quality in lower New Alamo Creek and Ulatis Creek is influenced by the watershed land uses and the Easterly WWTP discharge. Thus, actions to restore or establish water quality such that the MUN use could be attained would have to involve extensive treatment controls at both the Easterly WWTP and on nonpoint runoff from urban and agricultural land, or substantially reducing or eliminating runoff from these lands. The following sections discuss the feasibility of implementing adequate treatment controls to improve water quality to a level that would attain the MUN use in the UAA study segments.

Treatment of Easterly WWTP Discharge

Treatment technologies exist that would allow the City of Vacaville to produce Easterly WWTP effluent of a quality that would meet most chemical pollutant objectives and criteria intended to protect MUN. However, nearly all approved domestic and public water supplies depend on a raw source water that is relatively free of human influences (e.g., contaminants, pathogens), or in which human influences are substantially diluted so that water treatment is likely to be effective in minimizing risks to those drinking the water. No matter how highly treated, municipal wastewater effluent that is minimally diluted or not diluted by other high quality waters would not be suitable as a MUN supply (DHS 1995). Even tertiary treatment and alternative forms of disinfection (e.g., ultraviolet radiation) cannot guarantee the lack of undesirable byproducts or pathogens. As discussed previously, viral and protozoan pathogens are likely to be present in wastewater effluent, even with tertiary treatment, due to the source of the wastewater. As most of these non-bacterial pathogens do not have criteria, and are not easily quantified in a continuous, rapid manner, these contaminants would pose a risk to populations that consistently rely on such water sources for MUN use. Given the importance of nonpoint sources of pollutants and pathogens loaded to the UAA study segments, and the concern regarding residual

pathogen levels in even highly treated municipal wastewaters, meeting MCL and CTR human health criteria in Easterly WWTP effluent in this situation may have little relevance in terms of attaining MUN. Further treatment of Easterly WWTP wastewater would need to be accompanied by either extensive treatment of storm water runoff and irrigation return waters, and/or major changes in surrounding land use practices in order to reduce risks from pesticides, pathogens, and nitrates below acceptable levels. The Easterly WWTP effluent, no matter how highly treated, would be mixed with storm water runoff from agricultural and urban lands and agricultural return flows, thereby resulting in water quality that remains unsuitable for MUN use (DHS 1995).

Treatment of Urban and Agricultural Runoff

Easterly WWTP effluent would be mixed with lower quality water downstream. Thus, extensive treatment of agricultural and urban runoff, or major changes in land uses, to reduce risks from nonpoint source loading of pathogens and nitrates, in particular, below acceptable levels also would be required to attain MUN. Storm water runoff is generally treated using BMPs (e.g., vegetation buffers, detention ponds) at inlets and outlets that are designed to reduce pollutants. BMPs generally contribute to the reduction of heavy metals in urban runoff, and some are designed to remove toxic organics and pathogens (U.S. EPA 2004). The efficiency of a BMP is dependent on a number of factors including the BMP's design, the volume of water being treated, and the contaminant load to the BMP (U.S. EPA 2004). The effectiveness of BMPs for removing pathogens from urban runoff is highly variable, with some BMPs actually showing an increase pathogen levels (U.S. EPA 2003b), due potentially to BMPs such as detention ponds attracting wildlife. The effectiveness of BMPs in treating agricultural runoff is expected to be affected by similar factors. Based on the high percentage of the watersheds draining to the UAA study segments that are in agricultural and urban land use (i.e., 75% for New Alamo Creek watershed and 89% for the Ulatis Creek watershed) and the hydrologic modifications made to these segments and elsewhere in the watersheds to drain storm water from adjacent agricultural and urban lands through the segments, it is not expected that even full implementation of storm water BMPs would produce water quality within the segments suitable for MUN use.

Restoration of Hydrologic Modifications

Structural modifications made to New Alamo Creek and Ulatis Creek in the 1960s as part of the Ulatis Creek Watershed Protection and Flood Prevention Project are extensive and include realignment and expansion of the channels, concrete gradient stabilization structures, and inlet structures to rapidly and effectively convey local runoff from urban and agricultural lands into the channels as a means of controlling local flooding. Without these drainage improvements in place, the adjacent agricultural and urban lands would be at risk for widespread flood damage because neither on- or off-channel detention/storage was seen as a viable option for addressing this issue. The improvements were designed to reduce the risk of flooding on adjacent lands to a once in ten-year event for agricultural lands and once in fifty-year event for urban areas. Historically, damaging floods occurred on an average of once in three years (Ulatis Soil Conservation District et al. 1961). Hence, although generally described as a flood-control project, the specific hydrologic modifications made in the 1960s were made to collect and convey storm water runoff from urban and agricultural lands.