the systems, and the potential for future system repairs. Survey data indicate that currently, approximately 90% of the systems appear to be functioning satisfactorily. This performance should be expected to improve as a result of system repairs, which are currently taking place at rates up to 5% a year. Technically, the new systems are much improved over the older systems, with all but only 8-16% of the systems repaired adequately meeting current repair criteria. Even most of the substandard systems would be expected to perform adequately, given the past satisfactory performance of existing systems, two thirds of which probably do not meet current criteria.

Where existing systems have shown signs of past chronic problems, there has been good success at improving system performance through system repair. During the survey process, over 80% of the systems that had had past indications of significant problems, were found to now be working satisfactorily as a result of earlier system repairs (see Section 5.3.2.4). Of the leachfield repairs made since 1985, 40 of the systems (6%) had already been repaired once since 1979, and were less than 10 years old when they were found to be failing again. However, 90% of these were able to be upgraded to meet current repair criteria during their recent repair.

Current repairs are generally able to provide for significant system improvements, and current repair rates indicate at least 20-30 year average system performance. There is potential for the current success rate to diminish as available options for repair are exhausted on the more constrained parcels, but it does not appear that this will be a widespread problem in the near future. The current success rate for repairs is still quite high, and systems currently being installed should last longer than the systems they replaced, due to the increased compliance with repair criteria and new technologies for water conservation.

In the very long term, when all the available area on a piece of property is taken up by old leachfields, there still appears to be potential for onsite repair through renovation of the old leachfields, if site conditions are suitable. While this is more difficult, the old leachfield can be excavated, with the clogged soil along the sidewalls removed, creating a wider trench, which is then backfilled with drain rock to create a new leachfield. This has only been required for a few repairs at this time, but it does indicate a good potential for repairs in the more distant future.

Despite the good potential for repair of most systems, there is a certain proportion of parcels where future onsite system functioning will be limited by severe site constraints. The survey program showed that 20% of the systems with past problems were still experiencing significant problems that were not remedied by previous repairs. This category of chronic problem system represented 3% of all parcels in the surveyed areas. Although most of these were able to make further system improvements under the current program, the systems remain substandard, and are expected by field staff to require ongoing attention. Of all the repairs performed in the watershed, staff has estimated that aproximately 10 to 15 repairs per year are very marginal and not expected to perform well in the long-term. It thus appears that, based both on statistical analyses and experience of field staff, 2-5% of the septic systems can be expected to have severe chronic problems, which in the long term would require some solution other than onsite disposal. A similar proportion of properties might be expected to have problems that could not be handled through conventional repairs, but could be addressed through use of an alternative system.

Parcels which cannot support conventional onsite wastewater disposal in the long term will need to utilize other alternatives, depending on their location. Many of the problem parcels which have been identified are isolated parcels, surrounded by other parcels with adequate onsite disposal. For these parcels the best long term solution is an alternative system, disposal on another property, or haulaway. In a few cases, a number of problem parcels are in close proximity to each other, and there may be potential for pooling resources to develop a neighborhood or community disposal system. A review of the findings from the Class II investigations indicates that there available cluster or community disposal sites in most areas (CH2M Hill, 1984).

Long-term system performance is also dependent on an adequate level of system monitoring and maintenance. While there are good indications that current repair procedures have adequately resolved past problems on most parcels, further monitoring of repaired systems will be required to promote and evaluate the longterm performance of repaired systems. Such monitoring can also lead to further corrections, if necessary. The current program provides for both monitoring and maintenance, as discussed in the following section.

5.4.3 Improved System Maintenance

In an area such as the San Lorenzo Valley, where there is a high concentration of older systems which marginally meet technical criteria for septic system performance, it is important to provide for monitoring and maintenance of systems. Although most system repairs are currently able to meet repair criteria, there are a substantial number of repaired systems and pre-existing systems which still do not. Monitoring is needed to promote the future system repairs that will be needed and maintenance is needed to ensure adequate performance of all systems. The current County program seeks both to promote maintenance by individual property owners and to provide an adequate level of monitoring of system performance.

Property owner maintenance responsibilities include pumping the tank to remove solids every 3-7 years, limiting the volume and nature of the wastewater discharge to prevent overloading of the system, pumping the tank during winter months if needed to prevent overloading or failure of the system, and replacement or repair of the system when needed to correct system failures. Historically, property owner maintenance in the San Lorenzo Valley does not appear to have been adequate, as indicated by questionnaire results and the results from the past streamside inspection programs.

Septic system maintenance has been promoted through distribution of brochures on septic system maintenance, holding of community meetings, and encouragement of articles on the subject in the local press. Discussions with individual property owners and community groups have also served to promote the concepts of proper system management. The current management cannot directly measure maintenance activities, although the mandatory submittal of pumper reports will allow the future monitoring of pumping activities. Discussions with property owners during the field survey have indicated that many residents, particularly in high groundwater areas, are aware of the potential need to regulate the volume of discharge and possibly to pump periodically during the winter months. The doubling of voluntary repair rates in the last three years provides a good indication that many owners are taking seriously the need to ensure that their systems are working properly.

In addition to the promotion of property owner maintenance, the current management program includes several elements to directly require adequate system maintenance. The survey program is designed to identify failing systems during the periods of most likely failure, and to require correction of the problem. It is likely that many of the problems identified, particularly greywater bypasses, would not otherwise be corrected by the owners for some time. The survey program was intended to evaluate all developed areas within ten years, and then begin to reinspect all areas on a ten year cycle. Efforts are currently underway to redesign the program and establish a funding source to provide a five year inspection cycle. In addition to the regular survey cycle, the current program also includes the identification of marginal or potential problem systems for regular checking during winter conditions.

Independent of the survey effort, the current County program provides for the establishment of specific operating and maintenance conditions for systems that do not meet repair criteria. This can include mandatory water conservation, monitoring of effluent levels in the leachfield, or the requirement of winter haulaway. Under such circumstances, constructive notice of the system limitations and special needs for maintenance are provided to the current owners and potential future owners. Such marginal systems are also subject to reinspection by County staff during winter months. These procedures will become more frequent and more formalized through the increased use of operating permits in the future.

5.4.4 New System Installations

The current wastewater management program for the San Lorenzo River Watershed includes the requirement of special design standards for systems to serve new development, including both new homes, large remodels (over 50% of floor area), and bedroom additions. These standards are designed to provide an improved level of wastewater disposal to prevent any worsening of the low to moderate impacts which already result from the high density of substandard systems. As discussed in the water quality portion of the report, the cumulative impacts of development include increased nitrate levels in groundwater and surface water, and increased background levels of bacterial contamination that are unrelated to wastewater disposal.

In order to prevent increased cumulative impacts, current standards have required a one acre minimum lot size for all new developments in the San Lorenzo Watershed since July 1983. Seepage pits are also prohibited for new development. As currently defined, the area of the designated San Lorenzo Watershed, where the strict new system standards are required, only includes the area north of Henry Cowell State Park, and does not include the Bean Creek, Carbonera Creek or Branciforte Creek Watersheds, which are the areas with the highest nitrate levels. Future expansion of current restrictions to include these areas will be considered.

In addition to the Watershed wide requirements, there are also specific standards required in the designated Class I and Class II areas. All new development or expansion of existing uses has been prohibited in the Class I areas since November of 1982. In the Class II areas, for any new system or system addition, a maximum leachfield depth of 4 feet is required. In other areas of the Watershed, this is also required, unless there is insufficient suitable area, in which case disposal shall be as shallow as possible.

Since January 1, 1986, 527 new systems have been applied for, and 54 applications for system additions to allow remodels or expanded uses have been applied for outside the Class I areas. Although the database does not include approval or installation data for new systems, the large majority of applications are approved and subsequently installed.

5.4.5 Influence on Water Quality

As discussed in Section 4.7, most septic system improvements would not be expected to result in direct improvements in water quality. However, since the beginning of the current program, there have been instances where there have been very significant improvements in bacterial quality following the repair of systems which had been failing and discharging greywater or untreated wastewater to a waterway. Improvements in bacterial quality have been particularly pronounced in lower Boulder Creek and in the San Lorenzo River below Boulder Creek at River Street. Although other repairs have not resulted in such dramatic improvements, many have eliminated situations of public health hazard or nuisance where effluent was surfacing near public right-of-ways.

In addition to reduction of the surfacing of untreated effluent, the system improvements that have been made show good potential for long-term reductions in the release of nitrates to groundwater. This would be an expected result of the significantly reduced depth of leachfields currently being installed, as described in Section 5.3.1.4. The more stringent standards for new systems would also be expected to prevent any further increase in nitrate levels in groundwater and surface water.

5.5 Comparison of Current Findings to Past Studies

The findings of the County's current wastewater management program differ substantially from the findings of the prior wastewater studies conducted in the early 1980's by Montgomery Engineers (JMM, 1981, 1983), H. Esmaili and Associates (HEA, 1982), Larry Walker Associates (LWA, 1984), and CH2M Hill (1984). Those studies made the basic finding that the large majority of septic systems in the San Lorenzo Valley were substandard, were significantly degrading water quality, and could not be upgraded to provide adequate onsite disposal. The only viable longterm solution proposed was abandonment of most of the systems and connection to a sewer system for export of the sewage from the area.

Contrary to the above conclusions, the investigations of the current study have lead to the following conclusions:

- The large majority of systems have a limited impact on water quality.

- Although most systems in the Valley are substandard in many aspects, the large majority have been performing satisfactorily for many years.

- Most systems can be substantially upgraded to meet a reasonable set of repair standards, as currently established by the County.

- For at least 95% of the systems in the San Lorenzo Watershed, onsite wastewater disposal appears to be a viable longterm method of wastewater disposal.

The current program has arrived at a different set of conclusions primarily because much more data was available in the areas of water quality and individual system performance. Use of this data resulted in development of a different set of repair criteria, and a different interpretation of the significance of system repairs. This larger set of data allowed individual systems to be judged on their own merits, instead of being lumped into larger communities. The specifics of these differences in approach are discussed in the following subsections. Much of this information is summarized from previous sections of this report.

5.5.1 Water Quality Impacts

As discussed in Section 4 of this report, the extensive investigations of surface and groundwater quality in the San Lorenzo Watershed during the past three and a half years have lead to the conclusion that the majority of septic systems in the San Lorenzo Watershed have limited impact on water quality. The current studies utilized a tremendous volume of data as compared to the previous studies. This allowed a thorough statistical analysis of the data, which presented a more accurate picture of water quality in the Watershed.

Although septic systems had previously been implicated as the prime suspects for the high fecal bacteria levels in the Watershed streams, the recent investigations showed that there were other, more prevalent sources of bacterial contamination. Most of the bacterial contamination found results from background contamination from urban development, and is unrelated to wastewater disposal. Where wastewater has been observed to cause bacterial contamination, it has been caused by surface failures of isolated, individual systems.

The current studies confirmed the findings of the prior work regarding release of nitrogen from septic systems. Nitrogen from septic systems has had a significant cumulative impact on surface and ground water quality. The current investigations have indicated that this has had low to moderate impacts on established beneficial uses of the River. The release of nitrates is primarily significant where systems are located in highly-permeable soils. It is aggravated if seepage pits or deep leachfields are used.

The findings of the current program regarding water quality lead to substantial differences in the development and application of repair standards, and in the definition of a system failure. Based on the lack of any significant water quality impacts under many conditions which would have been prohibited by the Class II standards, it was felt that the repair criteria could be relaxed from the Class II standards, and still provide more than adequate water quality protection.

5.5.2 Repair Standards

As discussed above, and in Section 5.1.3, the current criteria for guiding system repairs are more relaxed than the Class II standards developed by Larry Walker and Associates and applied by CH2M Hill in their evaluation of Class II areas. The current criteria recognize that most septic systems in the San Lorenzo Valley have been performing satisfactorily for many years, and that with some improvements, they can continue to support existing development and provide an adequate and improved level of water quality protection.

The major elements of the current repair criteria which are different from the Class II standards are: 1) no requirement for dual leaching systems, 2) reduced vertical separation between seasonal groundwater and the bottom of the leachfield, and 3) reduced setback from embankments. Furthermore, the current repair criteria have been used as guidelines, rather than absolute requirements. The ultimate test of system adequacy is whether the system can function consistently without any surfacing of untreated effluent. The details and the reasoning for these changes have been presented in Section 5.1.3.

The application of more relaxed repair criteria has resulted in substantially different findings regarding the suitability of existing systems and their capability for improvement. As an example, in the Class II Forest Lakes area (which generally has better conditions than many areas), although 19% of the systems could not be upgraded to meet the Class II standards, it is estimated that only 2% would have difficulty meeting the current repair criteria. In all the Class II areas, 98% of the systems did not meet the Class II standards, and on 46% of the parcels, site conditions would prevent the system from being able to be upgraded to meet Class II standards. As a comparison, of all the parcels currently contained in the County's database, it is estimated that 65% do not meet the repair criteria, but that all but 10% are performing satisfactorily and do not need immediate improvement. It is further estimated that all but 8% can be improved to at least marginally meet the repair criteria (Section 5.4.2).

5.5.3 Definition of Failure

The earlier studies equated system repairs with system failures, and high rates of repair were interpreted as an indication of significant ongoing problems. This approach does not recognize that system repairs are most commonly needed because of old age of the system and that a repair in most instances represents a significantly improved disposal system that should be expected to perform well for some time to come. Upon further investigation of repair information under the current program, it was found that 74% of the repairs in the last three and a half years were for replacement of systems that had been installed prior to 1970, or for which the date of installation was unrecorded. Even where current repairs were made for systems that had been installed more recently, most resulted in a system that met repair criteria, and did not show further evidence of system malfunction.

Equating repairs with evidence of septic system problems, Montgomery Engineers determined that Kings Creek, Boulder Creek, and Ben Lomond had problem rates of 35%, 25%, and 45%, respectively (JMM, 1983). The current study found past problem rates of 16%, 13%, and 12%, with current failure rates (based on the parcel survey) of 18%, 11%, and 10%, respectively (Table 11). Using more realistic and specific criteria for determining problem rates and failure rates, the current program has identified much lower incidence of problems.

5.5.4 Evaluation Methods

Another key difference in findings resulted from a difference in approaches for evaluating problem areas. The current program evaluated each parcel on its own merits, whereas the Montgomery study lumped parcels into larger communities, and evaluated those communities based on average conditions (JMM, 1981 and 1983). Where the broad evaluation indicated relatively unfavorable conditions, five entire communities were designated as Class I areas, with prohibitions on future onsite discharge. This discharge prohibition was applied across the board to all parcels in the community, even if conditions on many individual parcels might be suitable for onsite disposal.

In the Class II areas, where the overall community evaluation was less unfavorable, a less stringent management approach was mandated, which would promote use of upgraded onsite systems and cluster systems. The Class II approach did allow for evaluation and management of each parcel on its own merits. But the Class II approach provided a much higher level of management to parcels located within the Class II boundary than was provided to parcels located outside the area, which might be experiencing the same type of problems.

The designated community boundaries do not appear to be based on any physical factors or constraints, and so can not effectively distinguish between suitable and unsuitable parcels. Soil and groundwater conditions in the San Lorenzo Valley are highly variable, and certainly cannot be generalized across large areas of 500 parcels or more, as was done in the Montgomery study. Montgomery's own maps which evaluated potential for septic system performance based on mapped physical characteristics showed large areas "suitable for conventional septic systems with high effective density" within the Class I areas.

The current study sought to evaluate each parcel on its own merits, and to make recommendations for future wastewater disposal for that parcel, based on performance of the existing system, and the actual presence of constraints. Information has been summarized by community, but primarily for informational purposes, and for comparison to previous studies. In the greater Kings Creek area, where both Class I areas and unclassified areas were surveyed in 1986, the failure rate was found to be 50% higher for the non-Class I parcels. Furthermore, the Class II areas of San Lorenzo Park and Riverside Grove, seem to have more serious constraints to septic system performance than many Class I areas, as indicated by information on slope, groundwater, and clay soils contained in Table 11.

A review of overall repair rates from January 1986 through July 1989 shows annual rates of repair for all Class I and II areas combined to be about 4%, which is double the rates in the unclassified areas. However the proportions of repairs which meet, or marginally meet the repair criteria are practically the same for all three types of areas: 87% in Class I, 89% in Class II, and 83% for unclassified parcels.

From a number of different perspectives, the current investigations have shown that the broad community designations of Class I or Class II have limited meaning, and that it is more meaningful to evaluate and manage individual parcels, based on the conditions that occur on those parcels. Even where there are groups of adjacent parcels which share a common physical constraint, such as a high groundwater area, or zone of clay soils, future community approaches to wastewater management can be effectively addressed outside of the current Class I or Class II distinctions.

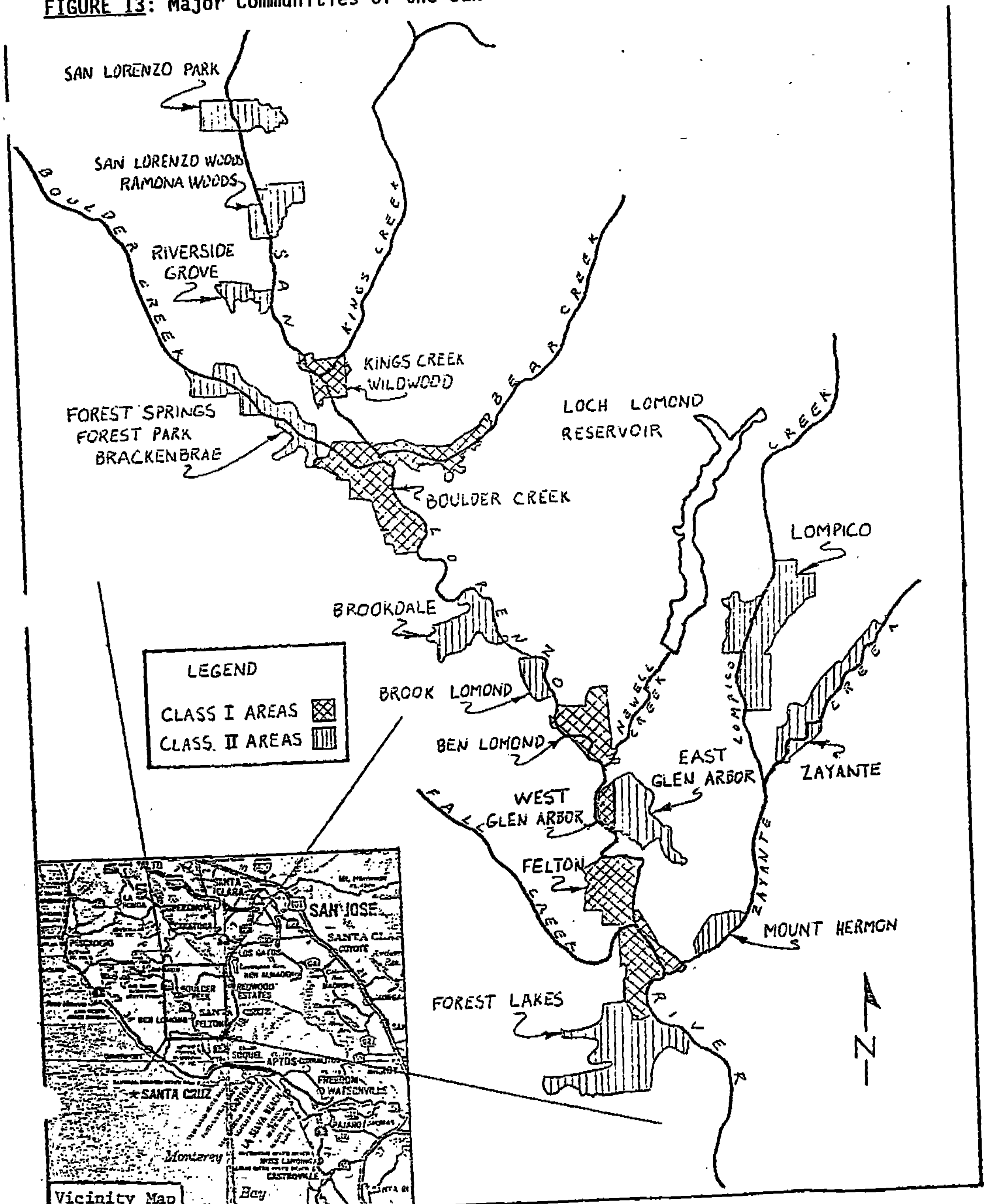
5.6 Description of Areas and Communities

The preceding sections have presented a summary of general conditions affecting wastewater disposal throughout the San Lorenzo Watershed. The specific conditions in individual communities are described in the following sections. Information regarding these specific areas is derived from the Class II investigations, from the parcel database developed under the current program, from soil and groundwater investigations that have been conducted in some areas, and from the parcel-by-parcel surveys of some areas. For areas which have not yet been investigated under current or past programs, information from the County's maps of septic system constraint areas has also been consulted. The various communities are shown in Figure 13. Summaries of statistics for the areas which are contained in the database are presented in Table 11.

5.6.1 Greater Kings Creek

The greater Kings Creek area includes about 800 developed parcels in the neighborhoods of Wildwood, Redwood Grove, River Rights, Lower Kings Creek, Sunbeam Woods, Blue Ridge, Madrona and Sequoia Drives, Lower Two Bar Creek, and Juanita Woods. About 65% of the parcels are included in the Kings Creek/Wildwood Class I area. The remainder are unclassified. This was the first area to be surveyed under the current program. The survey took place during the period of April 2 to May 15, 1986, with approximately 700 (90%) of the parcels surveyed. This was the wettest period that has occurred during the current program, with a total annual rainfall amount almost 50% above the normal amount. About 15 boreholes were drilled at various locations in the study area to better determine soil and groundwater conditions. (Information for this area is contained in Table 11)

FIGURE 13: Major Communities of the San Lorenzo Valley



As in other parts of the Valley, site conditions in this area are quite variable. Most of the area has soils with a significant clay content, although the amount of clay only appears to be problematic in a few areas, perhaps affecting 5-10% of the parcels. About 45% of the parcels experience winter groundwater less than 10 feet from the surface, but less than 5% have groundwater less than 3 feet from the surface on portions of the parcel. Other potential constraints in some areas are presence of steep slopes, shallow depth to bedrock, and close proximity to streams. Small lot size is also a significant constraint, with 55% of the parcels less than 10,000 square feet in size. Of all the areas that have been subject to the recent winter survey, Kings Creek has one of the highest occurrences of constraints.

During the survey period, 7% of the surveyed parcels were found to have sewage failures, and 11% were found to have greywater bypasses, with the other 82% of the systems performing satisfactorily. The problems tended to be concentrated in neighborhoods with small parcels, clay soils, and old systems. A higher failure rate (22%) was found in the unclassified areas than in the Class I area (14%). The potential for cluster systems was investigated, but there were no particularly favorable sites for combined disposal of effluent, and individual onsite repairs were determined to be suitable. Only two systems could not be satisfactorily repaired and were placed on partial winter haulaway requirements. About 50% of the repair actions in the Kings Creek area during the recent study period resulted from the survey efforts. The repair compliance rate for Kings Creek is similar to overall rates for the Watershed, with all but 16% of the repair actions made since January 1986 resulting in systems which at least marginally meet the repair criteria.

The prognosis is good for ongoing onsite wastewater disposal in the greater Kings Creek area. Despite the presence of significant potential constraints to septic system functioning, over 80% of the systems were found to be performing adequately during the wet winter of 1986, and practically all of the remainder could be adequately upgraded. The findings in this area are expected to be indicative of potential septic system performance in other communities with similar site conditions.

5.6.2 Upper San Lorenzo Valley

The upper San Lorenzo Valley area encompasses the communities along the River corridor north of the Kings Creek/Wildwood area. This includes about 300 developed parcels in the communities of San Lorenzo Park, San Lorenzo Woods, Ramona Woods, and Riverside Grove. All of these communities were placed in Class II. Subsequent investigations showed that over 90% of the parcels could not meet Class II standards, and the areas were proposed to be hooked up to the Class I sewer. Information from the Class II investigations for San Lorenzo Park and Riverside Grove has been compiled and is shown in Table 11. Survey work or other investigations have not yet been performed for the Upper San Lorenzo Area under the current program.

Site conditions in this area generally break into two categories: the alluvial areas and the upland areas. The alluvial areas occur on flat benches along the River and have moderately permeable alluvial soils with winter groundwater levels of 4-8 feet (CH2M Hill, 1984). The upland areas have steep slopes, cutbanks, and clay soils with perched winter groundwater estimated at

2-3 feet in many areas (Ibid.). It was estimated that 20-30% of the parcels in these parcels can have winter groundwater less than 3 feet from the surface. These estimates were based on presence of soil mottling and measured water tables during the very wet winter of 1982. It is not clear whether this represents an actual free water table, or the effect of saturated soil conditions resulting from limited permeability. Soils in these areas have very high clay content, are poorly drained, and are highly affected by rainfall. Even though these are steeply sloped areas, saturated conditions persist for significant periods after rainfall. Whatever the nature of this soil water, the saturated conditions can be expected to limit septic system functioning on the affected parcels.

Existing septic systems in these areas appear to be below standards, with less than 3% probably meeting current criteria for system size. Although these areas have not been surveyed under the current program, at least parts of the areas seem to have relatively high problem rate, as indicated by the number of failures observed during the Class II investigations. San Lorenzo Park appears to have the worst site conditions and the highest failure rate, with 20% of the systems having failures or greywater bypasses during the Class II investigations.. Site and system conditions appear to be better in Riverside Grove and an 8% combined failure and bypass rate was found there (SLVWD, 1983).

This area has not yet been surveyed or evaluated under the current program, but the potential for improving system performance might be expected to be similar to that found for areas of Kings Creek, which are quite similar geologically and topographically. It is likely that a large majority are either performing adequately and/or can be substantially upgraded to perform adequately, as in Kings Creek. Furthermore, the available water quality data does not indicate that there is any significant number of system failures in the area. However, from the old Class II information on system performance and site constraints, it could be expected that there is a higher proportion of parcels in this area than in Kings Creek, that have very substantial limitations for long-term onsite disposal, without some special attention, such as an alternative system, stringent water conservation, partial haulaway, or a cluster system. The Class II investigations identified potential sites for cluster or community disposal systems, which could serve up to 25 or more homes near each one of the Upper San Lorenzo communities.

5.6.3 Boulder Creek

The Boulder Creek area includes the developed area centered on downtown Boulder Creek, and extending up the valleys along Bear Creek, Boulder Creek, and the San Lorenzo River. As delineated for this project the Boulder Creek area includes about 800 parcels, about 80% of which are in the designated Boulder Creek Class I area. The remainder are unclassified. Information for Boulder Creek is available from the database, from the survey program, and from special soil and groundwater investigations conducted in the main town area. The available data is summarized in Table 11.

Most of the Boulder Creek area consists of relatively deep, permeable alluvial and colluvial soils, with some localized areas of clay soils. The area receives substantial subsurface flow from the adjacent mountains, and the toe of the slopes and adjacent flat areas are subject to high groundwater and spring activity. To determine the extent of this, about 20 boreholes were constructed in the town area during 1986 under the current program. This work was expanded in 1988 by the construction of eight 20 foot deep monitoring wells and 13 soil borings in the immediate downtown area, to determine the depth of bedrock, level of groundwater and extent of local clay layers.

The work that was done indicated that the groundwater problems in Boulder Creek were not as bad as expected. Although most parcels in the larger downtown area are estimated to experience winter groundwater levels less than 10 feet from the surface, it only rises to less than 3 feet from the surface on fewer than 5% of the parcels, which are mostly concentrated in a three block area downtown and west of Highway 9. Much of this same area is also underlain by a dense clay lens. Winter groundwater levels in most of the other areas were found to be over 6 feet deep. No indications of cumulative bacterial contamination of groundwater were found, although nitrate levels were significantly elevated.

In the winter of 1987, 460 parcels in the Boulder Creek area were surveyed for failures, and in 1988, an additional 90 parcels in the area were surveyed. Of all the parcels surveyed during both years, 24 parcels (4%) were found to have surfacing sewage, and 40 (7%) had greywater bypasses. In addition, 18 systems in the immediate downtown area have been required to use haulaway systems for a number of years. The haulaway systems are all located in the area with very high groundwater and clay soil discussed above.

Although the survey work and investigative work was done in drier than normal winters, it was done at times when typical winter groundwater conditions prevailed, as compared to historical records from the files. It is likely that during wetter than normal winters groundwater levels would be higher, possibly resulting in a somewhat higher occurrence of failures. This increased is not expected to be substantial, due to the moderately permeable nature of most area soils, facilitating effluent absorbtion even under saturated conditions. To follow-up on the current work, groundwater levels and septic system performance will be further monitored during wetter conditions.

Repair actions resulting from the survey amounted to about 30% of the total repair actions performed during the period of January 1986 through June 1989. Of all the repair actions, all but 20% of the repair actions resulted in systems that at least marginally met the current repair criteria.

During the survey, over 85% of the parcels in the Boulder Creek area appeared to be performing adequately, and it is expected that at least 80% can be upgraded to at least marginally meet repair criteria. However, on some parcels where groundwater is very high, it is expected that special designs, such as a mounded bed system, will eventually be needed when existing systems require repair. Furthermore, it is also apparent that up to 30 or 40 properties in the immediate downtown area will either be dependent on permanent haulaway, or will require a community disposal system where the effluent is discharged to nearby properties which have suitable conditions for disposal. Preliminary investigations have already been conducted, and development of such a system does appear to be technically feasible for downtown Boulder Creek. More detailed work, including developing accurate cost estimates remains to be done. This is discussed further in Section 6.2.

5.6.4 Boulder Creek Corridor

The Boulder Creek Corridor, as currently designated in this report, includes the communities between the Boulder Creek area and the sewered areas near Boulder Creek Country Club. As such, the corridor area includes about 400 parcels in the communities of Forest Springs, Forest Park, Forest Pool, and Bracken Brae. Virtually all of these parcels are in a designated Class II area. The only information currently available for this area is from the files and the Class II investigations. No survey work or groundwater investigations have been performed in this area under the current program. Information for this area is summarized in Table 11 under the designation of Forest Springs.

Based on the file information contained in the database, there are no obvious problems in the area, other than small lot size (over 50% of the parcels less than 10,000 square feet). However, under the Class II program, almost 80% of the parcels were deemed technically unsuitable for onsite disposal by Class II standards and were proposed to be connected to the Class I sewer. Limitations in the hillside areas were steep slopes, presence of cutbanks, clay soils, and in some areas, perched groundwater at 20-40 inches over clay subsoils. In the flatter areas along Boulder Creek, slopes were gentle and soils were well drained to excessively drained, with upgrades limited by small lot size and proximity to the creek.

Although no survey work has been done in this area, there is no indication that problems are as severe as indicated in the Class II findings. The past problem rate is low (9%), and all but 17% of recent repair actions have resulted in systems which at least marginally meet current repair criteria. There is also a high proportion of vacant parcels in these areas, which may provide room for repairs. It is expected that onsite systems should be able to perform adequately in the future in this area. Some of the more limited parcels may require use of strict water conservation or use of alternative systems such as mounds, pressure distribution systems, or sand filters. One sand filter has been installed in this area where the system was located 35 feet from Boulder Creek. Potential areas for cluster systems or community disposal were identified which could serve up 75 houses (CH2M Hill, 1984).

Additional areas of concern are located in the Boulder Creek Watershed above the Boulder Creek Country Club. Part of this area is underlain by clay soils and has had a history of problems. These outlying areas along the creek corridor will be included in the survey area.

5.6.5 Bear Creek Corridor

The Bear Creek corridor includes the moderately developed area along the relatively wide valley bottom paralleling Bear Creek. This area is beyond the Boulder Creek Class I area and none of it is classified. There are an estimated 150 small developed parcels along the creek and the side canyons, excluding the Bear Creek estates area, which is served by a community leachfield. Much of this area is underlain by well drained alluvial soil, with some occurrence of high groundwater and clay soils. Although there are no indications of significant problems in this area, it is expected that a substantial number of systems are old and undersized, and the area will be surveyed to minimize the chance of a failure impacting water quality in the nearby creek.

5.6.6 Brookdale

The Brookdale community is located south of Boulder Creek and includes over 400 developed parcels. About 10-12% of these were designated as Class II, the rest were unclassified. Of the Class II parcels, only 20% could not be upgraded to meet the Class II standards, and were projected to be connected to the Class I sewer. About 7 boreholes were placed in the Brookdale area as a part of the County's groundwater investigations. Some of the parcels were inspected under the survey program, but the survey was discontinued due to dry conditions.

Brookdale generally has few constraints to septic system performance. The alluvial soils are well drained rocky and sandy loams, with groundwater generally deeper than 10 feet below the surface (CH2M Hill, 1984). In the upland areas, soils tend to be more fine grained, a few with significant clay fractions. File information and the County's soil borings indicate a small number of scattered parcels, probably fewer than 2-5%, have groundwater at less than 10 feet, or bedrock between 5 and 10 feet. There is no evidence of any significant septic problems in the area, and it is expected that parcels can easily continue to be served by onsite systems.

5.6.7 Brook Lomond

The Brook Lomond area is a small community located between Ben Lomond and Brookdale, consisting of about 105 developed parcels. Seventy-five percent of the parcels are in the designated Brook Lomond Class II area, and the remainder are unclassified. The information for this area that is contained in Table 11, was derived from file records, past groundwater investigations conducted by HEA (1982), and survey and groundwater investigations conducted under the current program. No site-specific Class II investigations were conducted.

This area has permeable alluvial soils with high groundwater. CH2M Hill estimated that most of the area had winter groundwater at about 1.5 feet. All but 2 of the Class II parcels were determined to be unsuitable for onsite disposal and were projected to be connected to the Class I sewer. A review of file information and construction of boreholes under the current program has indicated that groundwater conditions are not uniformly as high as indicated in the Class II report, but does probably occur at less than 10 feet throughout the area. If file records are extrapolated, it is estimated that up to 35% of the parcels may have groundwater less than 3 feet and 45% may have groundwater at 3 to 6 feet.

The high groundwater levels appear to be affecting system performance on some parcels, but are not creating problems for most of the area, probably as a result of the good permeability of the soils. Half of the parcels in this area were surveyed for failures in 1987 in the expected worst parts of the Class II areas and the unclassified areas. Of the parcels surveyed, 6% were found to be failing, and 10% were found to have greywater bypasses. The file records for all systems indicate a relatively low past problem rate of only 8%, but the incidence of tank pumping is higher than in other areas of the Watershed, possibly indicating a need to pump more frequently in the winter to prevent failures. During the Class II investigations, 88% of the property owners indicated no problem with their systems. Except for increases in nitrate levels, there are not indications of any other contamination of either surface or groundwater.

Except for the repair actions associated with the survey, there have been few repair actions in this area since 1985, providing a limited database for evaluation of the repair potential. For all but one of the leachfield failures encountered, a shallow (less than 3 feet) leachfield addition or replacement was installed which allowed the system to at least marginally meet repair criteria. Due to the gentle slopes, good soil permeability, moderate parcel sizes, and presence of vacant lots, there would also be good potential for future installation of mounded bed systems and cluster systems in this area, if needed.

5.6.8 Ben Lomond

The Ben Lomond area includes about 600 developed parcels, including one of the three commercial centers of the San Lorenzo Valley. This includes about 500 developed parcels in the designated Ben Lomond Class I area. Information for about 50% of the parcels from the Ben Lomond Class I area has been entered into the database and is summarized in Table 11. Additional information for Ben Lomond is provided by soil and groundwater investigations (12 boreholes) and the parcel survey of the current program.

There do not appear to be any predominant constraints to septic system performance in most of the Ben Lomond area. Much of the area is underlain by well drained alluvial soils. There are two localized areas where there is high groundwater less than 3 feet from the surface, and some pockets of clay soil. Records in the database indicate less than 8% occurrence of potential past problems. More of the existing systems meet the current criteria for system size (43%) than the average for all parcels in the database (32%). Historically, the water quality in Ben Lomond has been the best of any developed area in the Watershed.

In 1989, 105 parcels were surveyed for failures under the current program, concentrating on the downtown area and an area of known high groundwater. Only 2 parcels were found to have surface failures, and 8 were found with greywater bypasses. Of all the repairs made in the Ben Lomond Class I area from January 1986 through June 1989, all but 10% resulted in systems that at least marginally met the repair criteria. This is a better rate than the overall average of 16% for all areas in the database. It would thus appear that there is very good potential for continued onsite disposal in Ben Lomond.

5.6.9 Glen Arbor

The Glen Arbor area is located immediately south of Ben Lomond, generally on the east side of the River. The area includes almost 500 parcels, 30% of which are in the designated Glen Arbor Class I area, and 63% are in East Glen Arbor Class II area. Of the Class II parcels, only 15% could not be upgraded to meet Class II standards. No special soil investigations have yet been conducted in this area under the current program and only limited survey work has been performed.

The Glen Arbor area consists of three different types of areas. The upland areas are underlain by Santa Margarita sandstone, with excessively well drained soils and only very limited occurrence of groundwater less than 10 feet deep (CH2M Hill, 1984). Below this area are relatively steep slopes, some exceeding 50%, with shallow, well drained soils and little groundwater (Ibid.). The lower area is the Class I area, which occurs on generally well drained alluvial soils of the river terrace and flood plain. There are a few pockets of clay soil, and widespread occurrence of shallow groundwater perched over bedrock. Probably 20-25% of the parcels in the Class I area (5% of the parcels in the Glen Arbor area) have groundwater less than 3 feet from the surface.

Much of the lower portion of Glen Arbor has a reputation as a septic system problem area due to high groundwater and some pockets of clay soil. During late winter and early spring months there have been occurrences of bacterial contamination from wastewater in the River downstream from Glen Arbor. Although the systems perform well in the upland areas, they would be expected to contribute to elevated nitrate levels resulting from discharge to the highly permeable sandy soils.

In recent years a number of repairs utilizing shallow systems, mound systems, or pressure distribution systems have been used to successfully repair past problems in the lower Glen Arbor area. There appears to be good potential to correct most problems in the lower (Class I) area using those types of systems. The parcels in the upper area would be able to continue use of onsite systems. The impacts of nitrate release would be reduced through the limitation on lot size for new development, and the requirement for more shallow systems when repairs take place. More work will be done to investigate potential alternative designs to promote more nitrate removal in those sandy soils.

5.6.10 Quail Hollow

The Quail Hollow area is located on the sandy hills immediately to the east of Ben Lomond and Glen Arbor. It includes approximately 400 parcels, none of which were designated as Class I or Class II. No investigations have been conducted in this area under the current program. Underlying groundwater quality has been monitored by the County and the water district, and had previously been monitored by HEA (1982).

The entire area is underlain by deep highly permeable sandy soils of the Santa Margarita sandstone. Groundwater only occurs within 10 feet of the surface immediately adjacent to Newell Creek. Although the septic systems rarely fail in the highly permeable soils, the increase of nitrate levels in the underlying groundwater is well-documented (Section 4.5.3.1). Nitrate levels in the wells appear to have stabilized at about 30% of the drinking water standard. Further increases in nitrate should be limited by the current restrictions on septic systems for new development, and the increased use of more shallow systems for repairs. Some experimental systems have been installed which are designed to reduce the surrounding soil permeability, but it is unknown to what extent they have actually improved nitrate removal. This will be the subject of continuing work in the next two years.

5.6.11 El Solyo Heights

El Solyo Heights is a separate neighborhood located at the north end of the Felton Class I area. It is delineated in this report as a separate community because it appears to have a more difficult set of constraints, and because it was surveyed as a distinct area in 1989. The area includes about 80 developed parcels, information from which is contained in the database and is summarized in Table 11. Ninety-three percent of these parcels are designated Class I. Development here is relatively new, with most of it occurring in the late 1960's and early 1970's.

Much of this area experiences high groundwater, clay soils, shallow depth to bedrock, and presence of cuts and fills. Although the file information on groundwater is limited, if it is extrapolated to the whole area, up to 12% of the parcels might be expected to have winter groundwater less than 3 feet, with 20% having groundwater at 3 to 6 feet. At least 25% of the parcels have soils with significant clay content. It is estimated that 16% of the parcels have shown indications of past problems.

A survey of this area was conducted during the wettest portion of 1989. The survey focussed on the expected problem areas and covered 53% of the parcels. Of the surveyed parcels, 13% had sewage failures and 8% had greywater bypasses. Correction of these problems has required use of alternative systems, disposal on adjacent vacant lots, reconstruction of curtain drains, and in some cases, requirement of winter haulaway. There is good potential for further use of mounded beds to repair existing systems on the relatively high concentration of vacant undevelopable parcels located in the area. This is an area which will continue to be watched closely by County staff to ensure the systems are performing adequately, and to require further improvements if needed.

5.6.12 Felton

The Felton area includes about 700 developed parcels, most of which are designated as Class I. This does not include the Class II areas of South Felton, which are discussed under the Forest Lakes area. With the exception of the El Solyo Heights area discussed above, no parcel information for Felton has been entered into the database, and none of the area has yet been surveyed. Eleven boreholes were placed in the Felton area to monitor soils and groundwater levels during the current study.

Much of the Felton area is situated on a broad alluvial flat, with additional development extending up the adjacent hillsides. The primary constraints to septic system performance are high groundwater, and in some areas small lot size. There are also some areas of moderately clayey soils. During the groundwater investigations conducted as a part of this study, groundwater was not encountered in most of the boreholes, indicating that in most of the area winter groundwater would be greater than 6 or 10 feet in depth. Although no areas were encountered where groundwater was less than 3 feet, this might be expected to occur in some limited localities. More investigations will be done when the area is surveyed and file information is compiled. In one area of Felton, the Felton Grove area, about 50 parcels are located within the one hundred year floodplain, and have been subject to flooding several times in the past 20 years.

There has not been any unusual incidence of septic system problems in the Felton area. Two small creeks, Shingle Mill and Bull Creeks, have dense development very close to their banks and have occasionally shown indications of septic failures. During the past four years, repair rates in Felton have been relatively low (3% per year) and the proportion of compliance with repair criteria has been high (94%). It is not anticipated that significant limitations to ongoing onsite disposal will be encountered in Felton. Even if problems are found in the downtown area, there are a number of vacant lots that would be suitable for wastewater disposal.

5.6.13 Forest Lakes

The Forest Lakes area is located immediately south of Felton. For the purposes of this discussion, the Forest Lakes area includes about 650 developed parcels that are in the designated Class II area of Forest Lakes. There are an additional 100 or so unclassified parcels located in South Felton immediately south of Forest Lakes, that would be expected to have generally similar site conditions, but larger lot size. Information from the Class II investigations and file information has been entered in the database and is summarized in Table 11. This area has not been surveyed, but 6 boreholes were placed in the area as part of the current study.

About 20% of the parcels were determined to be unable meet to the Class II repair standards. The primary constraints are pockets of high groundwater and very dense clay soils. Conditions are quite variable over very short distances. Several cluster sites with a total capacity to serve 20-40 houses as well as a large community disposal site were identified. Only 2% of the systems were noted to have problems during the Class II survey.

Except for a few difficult lots, there have been no indications of unusual problems in this area. The repair rate for the last four years has been quite low (less than 3%), with at least 90% of the repairs able to adequately meet the repair criteria. There has been no indication of wastewater contamination in Gold Gulch, the stream that drains most of the area. There is good potential for continued use of onsite systems, with some limited use of alternative or cluster systems as may be needed for a few lots.

5.6.14 Lompico

Lompico is a densely developed community of 580 parcels located in the steep canyon of Lompico Creek. All of the area was designated as Class II. Twenty-four percent of the parcels (139 parcels) were determined to be unable to meet the Class II standards, and were proposed to be connected to the Class I sewer. The primary constraints are stream setback, steep slopes and cutbanks, and in some cases shallow depth to groundwater (CH2M Hill, 1984). A further limitation is the small size of many lots and old age of the systems. Fourteen cluster sites were found which could serve a total of 77 homes. This area has not yet been subject to any survey work or follow-up work under the current study.

Annual repair rates have been relatively low (about 2.5%), and 85% of the repairs have been able to adequately meet current repair criteria. Water quality in Lompico Creek has shown occasional degradation by wastewater, and fairly regular background bacterial contamination from non wastewater sources. Most of the parcels appear to be suitable for continued, and upgraded, onsite wastewater disposal, with good potential for use of offsite cluster systems, if needed.

5.6.15 Zayante

Zayante contains a little over 200 parcels in the narrow canyon along Zayante Creek. All of the parcels were designated as Class II, and none were judged able to be upgraded to meet Class II standards. The primary constraints to upgrade were stream setback, steep slope, shallow soil over bedrock, and setback from cutbanks. No nearby cluster sites were identified and it was recommended that all effluent form the area be conveyed to the Class I sewer (CH2M Hill, 1984).

Despite the findings from the Class II investigations, the majority of existing systems in Zayante appear to be performing adequately. Repair rates have been low, and most repairs have been able to meet current repair criteria. There has been occasional indication of wastewater contamination in the creek, but where failures have been identified, the systems have been adequately repaired. More information will be available for an evaluation of this area after the area has been surveyed and file information has been evaluated.

5.6.16 Lower Zayante and Mount Hermon

The lower Zayante and Mount Hermon areas include about 500-600 developed parcels. This area includes 88 parcels in the designated Lower Mount Hermon Class II area. It also includes the community of Olympia and the developed areas along East and West Zayante Roads. Much of this area is characterized by sandy soil overlying shallow bedrock, with high groundwater, and it has been known as a potential septic system problem area. In the Mount Hermon area, there are the additional constraints of steep slopes and very small lots. Of the Class II parcels, 75% were determined to be unable to meet the Class II standards. A community disposal site was identified which could serve all the parcels (CH2M Hill, 1984).

Although a number of failures have been encountered in this area, repairs have generally been accomplished through use of shallow conventional systems or alternative systems. Water quality data has not indicated any significant contamination from failures in this area, but there is a substantial input of nitrate to Zayante Creek as it flows through the area. This entire area will be inspected and further evaluated as a part of the overall wastewater management program.

5.6.17 Bean Creek and Lockhart Gulch

The Bean Creek watershed includes an estimated 1000 developed parcels outside the communities of Mount Hermon and Scotts Valley. About half of these are probably located in concentrations of development on small parcels, with potential for adversely affecting water quality. The Bean Creek watershed includes the areas of Lockhart Gulch, Mission Springs, Geyer Road, and Nelson Road, and Glenwood. These areas are generally limited by high groundwater, limited stream setback, small lots, and in the upper areas, clay soils and steep slopes. There is also an indication in the files of potential septic system problems in these areas.

The Bean Creek watershed was not included in the original study area for the San Lorenzo Valley Wastewater Facilities Planning Studies. However, Bean Creek contributes a significant portion of the nitrate to the River at Felton and has shown past indications of wastewater contamination. All of these conditions would indicate a need to include the developed areas of the Bean Creek watershed in the ongoing management program.

5.6.18 Paradise Park

Paradise Park is located between the City of Santa Cruz and Henry Cowell Park. It contains an estimated 200 homes located on a large alluvial flat along the River, and extending up the adjacent hillsides. Although the lots are generally very small, a large proportion of the homes are only used on a seasonal basis, and there has been little history of septic problems. Soils are well drained and groundwater does not appear to be a constraint. Due to the age of the systems and the very small lot sizes, it is felt that this area should be included in the wastewater management program.

5.6.19 Pasatiempo

The Pasatiempo area is here used to designate areas that lie on the ridge between the San Lorenzo River and Carbonera Creek, between the cities of Scotts Valley and Santa Cruz. This area includes about 800-1000 developed properties. The area includes the communities of Rolling Woods, Manana Woods, Beulah Park, Pasatiempo, Kite Hill, El Rancho Drive and La Madrona Road. The area was the subject of a wastewater facilities planning study in 1979 (James M. Montgomery Engineers, 1979). Geologic conditions are variable in the area and present the following constraints: high groundwater, clay soils, and in some places, excessively sandy soils. There are a number of localized neighborhoods which experience chronic septic system problems, due primarily to high winter groundwater and/or clay soils. There is also a significant contribution of nitrate to Carbonera Creek from this area.

The prior study recommended that about half the area, the more densely developed portion, be sewered, with continued use of onsite disposal for the remainder. At this time, there are no pending efforts to provide any sewering of the area, other than the existing facilities for 30 homes in the Rolling Woods Area. Although system failures continue to occur, in many cases repairs have been accomplished through the use of alternative systems, seepage pits, or some conventional systems. This area should be included in the management program for ongoing management and follow-up evaluation of future disposal needs.

5.6.20 Branciforte Creek

The Branciforte Creek watershed includes over 1200 developed parcels. There are no densely developed communities in the watershed, but there is a high occurrence of older development along stream channels of Branciforte Creek and its tributaries. The areas along the creeks frequently have clay soil and/or high groundwater, and have been indicated as having septic system problems. Past and present water quality sampling in Branciforte Creek indicates periodic contamination from wastewater sources and elevated nitrate levels. It is recommended that the wastewater management program provide for the periodic inspection of all developed parcels along Branciforte Creek and its tributaries.

5.6.21 Outlying Areas

It is estimated that one third of all the developed parcels in the San Lorenzo Watershed are located outside of areas of concentrated development, usually on large parcels well in excess of one acre in size. The large lot size, low density of development, and location away from stream channels all combine to limit the potential for water quality or public health impacts form those parcels. Unless such outlying parcels have septic systems in close proximity to a creek, it is probably not necessary to include them in the wastewater management program. Further evaluation of soils, septic problems, and water quality will be conducted to determine which parcels in outlying areas should be included in the management program.

6 ALTERNATIVES FOR WASTEWATER DISPOSAL

This section will discuss the expected results and potential impacts of various alternatives for long-term wastewater disposal that could be considered for the San Lorenzo River Watershed. The major types of alternatives include onsite disposal, community disposal, or sewering and export of sewage. An overall management approach could include a combination of all three different elements, applied to different properties in the Watershed. Determination of the best approach should take into account impacts on water quality, other environmental impacts, financial impacts on the property owners, and long-term effectiveness. This should also consider incremental benefits from an approach in relation to incremental costs. The following sections will discuss the expected effectiveness, costs, and impacts associated with different alternatives for wastewater management.

6.1 Individual Onsite Disposal

The continued use of individual onsite wastewater disposal systems in the San Lorenzo River Watershed could include a combination of different types of onsite disposal methods: conventional septic systems (including upgrades to meet specified repair criteria), alternative systems where site conditions are marginal, and haulaway systems where site conditions are completely unsuitable. Onsite disposal has been the primary approach that has been used to date in the Watershed, and the specific aspects of this approach have already been discussed at length in this report. However, there are substantial variations in the potential results and impacts of this approach, depending on the repair criteria utilized to guide the installation, repair and maintenance of systems. Various alternatives within this approach will be discussed in the following subsections.

6.1.1 Conventional Systems

Conventional methods of onsite wastewater disposal utilize a standard tank and leachfield. The size of the leachfield and the conditions under which it can be installed are determined by the new installation standards and the repair criteria. The situations which require leachfield replacement are also determined by the repair criteria.

Based on the information cited in this report, about 90-95% of the properties in the Watershed can be served by conventional septic systems that at least marginally meet the repair criteria. Approximately 2-4% of the properties each year will need to have such a replacement system installed, and that system will be expected to last an average of at least 20 years, with adequate maintenance. In the initial 5-10 years of the current management program, there would be a significantly higher rate of system upgrades, as the worst systems are identified through the survey process. The cost for installation of a conventional system meeting the current repair criteria presently averages about $3500. If there is inadequate room on the site, there may be an additional cost of $200 for water conservation devices to reduce the volume of wastewater for compliance with the repair standards for an undersized system. Operating costs are about $150-175 every five years for pumping of the tank.

Implementation of this alternative (in conjunction with other elements of the program) will result in improved water quality through reduced bacterial contamination from system failures. The occurrence of significant failures should be eliminated in the next five years of the program through the parcel survey and water quality monitoring aspects of the management program. Nitrate levels would be expected to ultimately decline to some extent, resulting from installation of more shallow systems and other improvements. The magnitude of this decline can not be determined at this time.

The effects of this alternative for wastewater disposal could change significantly if a different set of repair criteria were used. As an example, if the Class II repair standards were used, over 95% of the systems would be required to be upgraded immediately, but over half of those would need to utilize some alternative other than a conventional repair, because the site constraints could not meet the standards. Under the Class II standards, the upgraded conventional systems would probably cost an additional $2000 for the dual leachfield, but it might be expected to last twice as long. Use of the Class II standards would provide the benefit of longer system life, but would probably not result in any significant additional increment of improved bacterial quality or nitrate reduction. Other means of wastewater disposal for the large number of systems not able to meet Class II standards would have to be provided, at an increased cost.

6.1.2 Alternative Systems

For properties which cannot adequately meet the standards for conventional onsite repair, one option for continued onsite disposal is the use of alternative systems which utilize other technologies to provide for enhanced treatment or improved disposal of the wastewater. The primary types of systems utilized are mounded bed systems, pressure-distribution systems, or sand filters.

Mounded bed systems are appropriate in areas of high groundwater and gentle slope. They provide for improved treatment through dosing and aerobic filtration through unsaturated material prior to the effluent reaching the groundwater. Pressure distribution systems are appropriate for disposal on steeper slopes with shallow soil or poor soils. They provide for improved treatment and dispersed disposal through dosing of effluent and very shallow disposal. The cost for installation of a mounded bed or pressure distribution system for a repair presently ranges from about $10,000 to $15,000, depending on the circumstances of the site. There is also a higher operating cost for pump maintenance, monitoring, and payment of the annual operating permit fee. The longevity of these alternatives would be expected to be greater than a conventional system due to the maintenance of aerobic conditions in the leaching device. Sand filters can be used in many circumstances where a higher quality effluent is needed prior to disposal, such as in close proximity to a creek. They are estimated to cost $3000 in addition to the cost of the disposal system, and have similar operating costs to a mound system. Sand filters are used much less frequently than the other systems.

Altogether, about 15 alternative systems have been installed in the Watershed, most of them in the past year. It is expected that in the future, 5-10% of the repairs will utilize alternative systems. This proportion would be much greater if the repair criteria were more stringent. The use of alternative systems results in greater initial cost, higher annual costs, longer system life, reduced nitrate levels through significantly improved treatment, and reduced bacterial contamination as a result of providing for onsite disposal where a conventional system might fail.

Other types of alternative onsite systems may be considered in the future for use in the San Lorenzo Watershed. There may be a need to provide for better nitrate removal, particularly in highly permeable sandy soils. Several types of systems have been developed which promote denitrification and can reduce nitrate release by 80-95%. However, these also require much higher levels of maintenance than other alternative systems, and have a higher initial cost. Another type of alternative system, the composting toilet, has been considered for the San Lorenzo Watershed, but so far a safe, reliable, toilet that would be acceptable by the general public has not been identified.

6.1.3 Haulaway Systems

Haulaway systems have been used on properties where onsite wastewater disposal cannot take place in conformance with standards for either conventional disposal or use of alternative technologies. Haulaway systems may involve the haulaway of all wastewater or just the toilet waste (with greywater disposed onsite). Haulaway may be required on a year round basis or just in the winter months when soils may be too saturated for onsite disposal. Initial capital costs may amount to as much as $1600 for installation of a waterproof tank and alarm system. At about $125 per pumping, year round haulaway of all effluent costs about $3100 per year. Winter haulaway would be about $1100 per year.

Haulaway may be used on an interim basis until another method of disposal can be provided, or it may be used on a permanent basis if there is no other feasible alternative. Currently, about 20 systems in the Boulder Creek area are on permanent haulaway, and about 5-10 scattered systems are on winter haulaway. It is anticipated that this number may increase as more problem systems are identified, but it is also hoped that other long-term solutions can be developed.

The use of a haulaway system represents a significant financial burden on the affected property owner, but allows them continued use of their property. With a haulaway system, there is increased potential for bacterial contamination resulting from inadequate pumping. Effective use of haulaway systems is dependent on adequate monitoring by the property owner and/or County staff, and minimizing the number of systems on permanent haulaway.

6.1.4 Maintenance and Management

The adequacy of any type of onsite disposal is dependent on an adequate level of system monitoring and maintenance, which can be done by the property owner or County staff. This is particularly needed in an area such as the San Lorenzo Watershed where systems are older, and operating under various potential technical constraints. If property owners monitor their systems, pump their tanks as necessary, perform needed maintenance, and replace or upgrade the system before it fails, little involvement from the County would be needed. However, experience to date has shown that a significant number of owners have not adequately maintained their systems and that County involvement is needed to monitor marginal systems, to survey for system failures, and to promote more property owner maintenance through education and other means. The current basic County program, which was described in Section 5.2, operates at a cost of about $5 per parcel per year, if it is assumed there are 12,500 parcels in the management area. Consideration is currently being given to doubling the cost of the program and strengthening it to provide for more frequent parcel inspections (every 5 years), better management of information on system maintenance, and more education and assistance to property owners.

As an alternative, the County could implement a much more intense management program which could include the County assuming complete responsibility for tank inspections, periodic tank pumping, and upgrading systems as needed. Such a program was considered for Class II areas in 1984, with the annual cost estimated at about $150 per house (with almost 2000 homes), not including costs of pumping or system repairs (LWA, 1984). This would have provided for a complete system inspection and evaluation every two years, and a number of other management services. Such a program would probably provide for a slight increment of water quality protection by reducing system failures through the short inspection cycle and more in-depth inspection. However, the additional increment is not believed to be significantly greater than that provided by the proposed program which will provide winter inspections every 5 years, with regular water quality monitoring to identify interim problems.

6.2 Cluster Systems and Community Systems

Where properties are unsuitable for onsite disposal by either conventional, or alternative means, there may be opportunity for effluent disposal on another property nearby, which has adequate conditions for onsite disposal. Offsite disposal may utilize conventional or alternative systems to dispose of effluent from one or more parcels. Small sites may be suitable for cluster systems, with disposal of effluent from 2-5 parcels, whereas larger, community sites, would have adequate capacity for disposal of effluent from entire communities.

Potential cluster and community disposal sites were investigated as a part of the Class II investigations. Although not as many suitable sites were found as was anticipated, there were generally at least several sites found for each community. In many communities investigated, there was not adequate capacity at potential offsite disposal sites to handle the large volume of effluent from parcels that could not meet Class II repair standards. However, under the current repair criteria, it is expected that only 5-10% of those parcels would need off-site disposal (2-5% of all parcels). It is also likely that additional suitable disposal sites would be found, if sites were evaluated according to the County's current repair criteria. There is thus good potential for eventual use of cluster systems in the old Class II areas.

Offsite disposal involves significantly greater costs than onsite disposal due to the cost of property acquisition, pipeline construction, pumping, and increased operation and maintenance costs. The cost per parcel is dependent on the project and cannot be easily generalized. A community disposal project is currently being considered for up to 20-40 parcels in the commercial area of downtown Boulder Creek. The project is technically feasible and would involve the collection and transport of septic tank effluent to mounded bed systems located on vacant lots within the downtown area. It is estimated that the capital cost per parcel would probably be similar to the cost for an individual alternative system ($10,000-$15,000). This project would relieve many property owners of the burden of permanent haulaway, and would result in significantly reduced incidence of bacterial contamination that results from inadequate pumping. County staff intends to work with the local community to further develop this alternative, and to pursue similar alternatives in other communities as the need is identified.

6.3 Valleywide Sewer

A final alternative for wastewater disposal in the San Lorenzo Valley would involve the construction of a large sewer system to collect wastewater from all parcels in developed areas and export it for centralized treatment and possible ocean disposal. This was the type of project that was envisioned to serve all Class I parcels and almost half of the Class II parcels. Although treatment and disposal in the lower part of the basin was proposed, there were significant questions regarding potential impacts on water quality, and a substantial increase in cost for treatment necessary to eliminate those potential impacts. It is likely that the most cost-effective alternative for sewage disposal would be export to the Santa Cruz treatment plant with discharge to the ocean.

The Class I project was intended to utilize a conventional sewer system. However, a reevaluation of the project by a private consultant in 1985, indicated that the costs of the collection system could be reduced by about 45% if a system was utilized that consisted of individual specialized septic tanks with collection of septic effluent by variable gradient hybrid sewers (Baker, 1985). This sort of system has been installed in the Sierra foothills. The savings involve result primarily from greatly reduced cost of the collection system which is of smaller diameter, and can more easily follow the topography, making it much easier to install.

The cost of sewering the whole Valley and paying for treatment would be quite high, although it is difficult to realistically determine what it might be at current prices. In 1984, even with 87.5% federal and state funding, the local share of the project (12.5%) did not meet the criteria for affordability. It was estimated that the capital cost per household would be about $4500 per parcel (1985 dollars), with an annual cost of $700 (Metcalf and Eddy, 1984). Grants are now no longer available and construction costs have increased substantially. A valleywide sewer project would be expected to be much less affordable now.

If a valleywide sewer system were built, some improvement in water quality would be expected to result. Bacterial quality would be expected to decline for at least two years during the design and construction phase, as people awaited the sewer, and failures resulted from construction. After all systems were connected, bacterial quality would be expected to improve somewhat for a time. Background levels of bacterial contamination would remain the same. After an indeterminate period of time, bacterial quality could be expected to decline to near pre-project levels or less, as a result of sewer leaks, periodic pump failures, and breaks in the line in areas of instability which abound in the Santa Cruz Mountains. The relatively high frequency of breaks and low level leakage in existing water mains and distribution lines provides a good indication of the ultimate potential for sewer leakage. The original Class I project would not have significantly reduced nitrate levels in the River below Ben Lomond, as the areas which contribute the most nitrate were not to be sewered. However, if all developed areas were sewered, nitrate levels would be expected to decline substantially.

In addition to the above effects, connection to a sewer system would provide benefits to property owners of reduced nuisance of living with an onsite system and, for those with parcels that have severe limitations for onsite disposal, a sewer would provide greater potential for adding on to their home or otherwise expanding use of their property. Construction of a valleywide sewer system would also have potentially significant adverse impacts on the environment, including stream flow reduction, loss of fishery habitat, increased water use, and potential growth inducement (Gilchrist and Associates, 1984). Some of these impacts could be mitigated at additional cost to the project.

At this time, it cannot be shown that the benefits of a valleywide sewer would outweigh the costs and potential adverse impacts. The water quality impacts of current wastewater disposal are not severe. The large majority of onsite systems can be upgraded to provide adequate water quality protection at a reasonable cost to the property owner. For the more difficult systems, there are technically feasible alternatives that generally do not cost more than connection to a sewer, if it were available. Thus a combination of approaches for onsite wastewater disposal and use of cluster or community systems appears to be the most appropriate approach for wastewater management in the San Lorenzo Watershed.

7 ONGOING MANAGEMENT PROGRAM

The forgoing discussion of alternatives for wastewater management, and the overall findings of this report lead to the conclusion that the County should continue ahead with its current program for long-term wastewater management. The findings from this report do indicate the need for some refinements or additions to the program in the areas of water quality investigations, frequency of system inspection, monitoring of pumping activities, and promotion of off-site disposal systems. Efforts are already underway to incorporate these elements into the current program.

Following is a description of the elements of the County's ongoing wastewater management program for the San Lorenzo River Watershed. This includes water quality monitoring, field evaluations of existing onsite disposal systems, supervision of required system improvements, promotion of ongoing disposal system maintenance, requirement of adequate standards for new development, and assistance in the development of offsite disposal systems.

7.1 Water Quality Monitoring

The purpose of the water quality monitoring program has been to evaluate the long-term impacts of wastewater disposal on surface and ground water quality in the San Lorenzo River Watershed, to identify sources of degradation, and to help measure the effectiveness of management programs. Now that substantial background investigations have been performed over the past four years, it is proposed that the monitoring program be modified somewhat to focus more on specific investigations of problems. The program will include the following elements:

- Regular Surface Water Monitoring - Twenty-one stations have been monitored on a monthly basis, with 9 of those stations monitored weekly. Parameters measured each time include: temperature, pH, electroconductivity, dissolved oxygen, turbidity, nitrate, fecal coliform, and fecal streptococcus. It is proposed that regular monitoring efforts be reduced by about 50% in order to allow more time for investigation of specific instances of water quality degradation and further investigation of the sources and significance of nitrate in surface water and groundwater.

- Investigations - Approximately 10-15 samples per week will be collected to investigate specific problem areas and to sample locations that are not otherwise tested regularly. This will allow for more rapid investigation, identification, and control of septic systems that are failing and degrading water quality. The findings of work to date have indicated that bacterial degradation resulting from septic systems results from isolated individual failures, and that one failure can have a very significant impact on downstream water quality.

- Investigation of Algal Growth and Nitrate Sources - Since 1987, staff has conducted field investigations of the sources of nitrate in surface water and the significance of its impacts. Preliminary findings were discussed in Section 4.6. More time will be allocated to pursue and complete these investigations, which will be greatly assisted by the anticipated receipt of a Section 205j grant from the State Water Resources Control Board. This work will include the monitoring of nitrogen levels in surface and ground water, determination of significant nitrogen sources, further evaluation of the extent of biological growth in watershed streams, determination of its impacts on beneficial uses, determination of the relationship between nitrate levels and amount of algal growth, and development of effective nitrate control measures. This work, which is scheduled for completion in 1991, should ultimately result in an objective for nitrate in surface water, and a workable plan for achieving that objective.

- Groundwater Quality Sampling - Periodic sampling of shallow and deep groundwater for nitrate and bacteria is done to assess possible impacts of wastewater disposal in different areas. Work has been focussed in Boulder Creek, but this will be shifted to other areas which will be subject to survey work, such as Glen Arbor and the Bean Creek area.

- Data Analysis - Water quality data is maintained in a computerized database, with data summaries and analyses prepared on an annual basis for submittal to interested parties and the Regional Board.

7.2 Parcel Inspection Work

The performance of the existing sewage disposal systems within developed areas of the Watershed is being evaluated through field inspections of system performance, review of file information, and additional investigation of soils and groundwater levels, as necessary. This work is also coordinated with investigations of sources of observed water quality degradation. To organize the work most effectively, the developed portions of the Watershed have been divided into sub-areas, which will be assessed area-by-area. Specific procedures for the area surveys are as follows:

- Period of Winter Survey Work - Inspections are made during the wet winter months when soils are saturated and groundwater is high, and marginal systems are most likely to be failing. Rainfall and shallow groundwater levels are monitored to identify when "normal" winter saturated conditions are reached, generally when surface soils are saturated and groundwater levels reach the high levels that normally persist throughout the winter. It is expected that the survey period will normally last 3-4 months, from January to April.

- Survey Procedure - Each developed parcel within the survey area is inspected to determine if there is surfacing of septic effluent, surface discharge of greywater, or any other indication that the sewage disposal system is contributing to pollution of surface or groundwater or creating a public health hazard. Systems with the above conditions are determined to be problem systems, requiring improvement. If the system is creating a significant public health hazard, improvements are required immediately. Otherwise, improvements are required in the spring, after the findings from the survey area have been evaluated. Site constraints such as clay soils or high groundwater are noted. Vacant parcels which may serve as potential community disposal sites are also evaluated.

- Soil and Groundwater Investigations - Shallow monitoring wells are placed in the areas being surveyed to monitor groundwater levels and assess soil types. This information is extrapolated to nearby parcels to evaluate the potential for system improvement and help determine the design parameters for system repairs.

- Evaluation of Results - The survey findings and file information regarding the history of septic system performance in the area are utilized to evaluate the potential for onsite repair of each parcel, and to evaluate the severity of existing or potential problems in the neighborhood, with regard to the possible need for a neighborhood solution. Based on this information, a recommended approach to upgrade problem systems is developed. For the very large majority of parcels, individual onsite repairs will be the method of system improvement.

- Schedule of Survey Work - Field surveys of existing onsite systems will be completed according to the schedule shown below, with about 700 parcels to be surveyed per year. This schedule has been delayed and could be further delayed by uncontrollable circumstances such as unusual hydrologic conditions (i.e., drought or flood), natural disaster, or unexpected severe economic constraints. However, it is expected that additional resources will become available in fiscal year 1990-91, which will allow up to 1500 systems to be inspected each year, provide for an average 5 year inspection cycle, and allow acceleration of the schedule shown.

  1986 - Greater Kings Creek - COMPLETED
  1987 - Initial work in Greater Boulder Creek, Brooklomond (delayed by unusually dry winter) - COMPLETED
  1988 - Greater Boulder Creek - COMPLETED (Additional work was limited by dry weather.)

1989 - Ben Lomond, El Solyo Heights (North Felton) - PARTIALLY COMPLETED
(Additional work was limited by dry weather.)

1990 - Glen Arbor, Ben Lomond (Completion) Part of Brookdale

1991 - Upper San Lorenzo Valley, Felton

1992 - Lompico, Upper Zayante, Bear Creek Corridor

1993 - South Felton, Boulder Creek Corridor

1994 - Brookdale, Lower Zayante, Mount Hermon, Bean Creek

1995 - Quail Hollow, Pasatiempo

1996 - Carbonera Creek, Branciforte Creek, Paradise Park

7.3 Repairs

After the survey results are evaluated, the County takes action to require the needed system improvements, which are ultimately the responsibility of the property owner to design and carry out. The role of the County is to require that improvements be done, provide advice, ensure that improvements meet County criteria, provide information on possible financial assistance, and generally help facilitate the work as much as possible. Improvements are required for problem systems identified through the survey work, for problem systems identified through complaint investigations or other means, and for those systems where the property owners voluntarily initiate a repair of their system.

- Standard Repairs - Repairs are made pursuant to the procedures discussed in Sections 5.2.4 and 5.4.1. Repairs may involve plumbing repair, removal of the washing machine, installation of a greywater sump, use of water conservation measures, and/or modification or replacement of the septic system. System replacement is required whenever there is significant, ongoing surfacing of effluent. For minor problems, the property owner may be allowed to pursue other means of correcting the situation, such as flow reduction or construction of a greywater sump, before a full replacement is required. If a system replacement is required, the work is performed according to the County's repair criteria, as described in Section 5.1.3. If there is concern that the site conditions are marginal, or that the system does not meet the conventional repair criteria, the property is rechecked the following winter to confirm that the problem has been satisfactorily corrected. If the problem has not been corrected, further work will be required or the property will be required to convert to a haulaway system.

- Alternative Systems - An alternative system may be required for a repair if site conditions are such that a conventional system cannot be expected to perform adequately. The typical alternative systems used include mound systems for use in areas of high groundwater, and pressure distribution systems for use in areas with shallow or clay soils. In 1989, the County began implementation of a formal alternative system program, with specific guidelines and permit requirements for use of alternative systems, and one staff position allocated to supervision of alternative systems. In addition to other requirements, use of an alternative system requires obtaining an operating permit on an annual basis; the permit provides for regular monitoring by County staff of system functioning. Under the new alternative system program, it is expected that there will be much greater use of alternative systems for repairs in the San Lorenzo Watershed.