STORM DRAINAGE
&
FLOOD CONTROL
MASTER PLAN

Rancho Murieta Community Services District

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RANCHO MURIETA COMMUNITY SERVICES DISTRICT

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1. EXECUTIVE SUMMARY

In August, 1987, the District Board of Directors established a Drainage Committee. The Committee was directed to work with Staff in the preparation of a Storm Drainage and Flood Control Master Plan and a Drainage Ordinance. This Master Plan document is the result of the Drainage Committee's work over the last several months.

This Master Plan document evaluates many important aspects of drainage and flood control. The key principles that have guided this work are as follows:

1. The major functions of a storm drainage system are to protect life and property and to minimize inconvenience to the public.
2. The District should create a realistic balance between elimination of inconvenience and protection against hazard.
3. The storm drainage system should include adequate measures to protect the natural resources within the community.
4. The community's drinking water supplies should be protected against urban runoff contamination.
5. The storm drainage system should be properly maintained to provide the desired level of service.

6. Public and private responsibilities for operation and maintenance of the drainage system should be clearly delineated.
7. The restricted access rights of the community's private streets should not be violated.
8. The District should adopt minimum design and construction standards for future drainage and flood control improvement.

The annual cost to operate and maintain the existing public drainage system is estimated at $76,000. This annual cost does not include allowances for depreciation and replacement of facilities which are estimated to be an additional $35,000-53,000 per year. The Master Plan includes a preliminary rate structure to pay for the annual maintenance of the existing system. The District will need to develop a capital reserves funding program for depreciation and replacement of the system.

The existing drainage system shows signs of deferred maintenance. In addition, some remedial repairs are needed. The costs of these repairs have been estimated at $46,000. The District will need to develop a funding program for remedial repairs.

Finally, the Master Plan discusses the merits of various programs to fund the extension of the drainage system. The District will need to develop a program for funding of future extensions of the drainage system.

2. INTRODUCTION

A. HYDROLOGIC SETTING:

Rancho Murieta is located on the east side of the Sacramento Valley at the general area where the foothills of the Sierra Nevada range begin. The 3,500-acre community is divided by the Cosumnes River, which flows from east to west with a slight southerly trend.

The Storm Drainage and Flood Control Master Plan exhibit (Exhibit No. 1) indicates the major hydrologic features within the community. This exhibit also shows the major components of the drainage system. This system includes natural streams and man-made drainage and flood control facilities.

The Community varies in elevation from about 110-feet to about 330-feet above sea level. Slopes within the foothill region range from 8-25%. The soils within the community have a moderate to high potential for erosion. Natural vegetation within the community includes grasslands, oak woodlands, and riparian woodlands.

The Cosumnes River is a virtual wild river in that only about 4% of the 536-square-mile watershed upstream of Rancho Murieta is controlled by a dam and reservoir. As a result, the vast majority of the watershed's 38 inches of mean seasonal precipitation flows through Rancho Murieta uncontrolled. Previous hydrologic studies have estimated the 1% change peak flow (100 year peak flow) of the Cosumnes River at Rancho Murieta is 62,000 cubic feet per second (CFS).

The U.S.G.S. stream gage at Michigan Bar has recorded the peak flows in the Cosumnes River since the early 1900's. This gaging station is located one mile upstream of Rancho Murieta. The peak flow recorded to date occurred February, 1986 when the Cosumnes River reached 45,100 CFS. It appears that this peak flow may have been exceeded to some degree by the March, 1907 flood, but accurate flow data is not available to estimate the peak flow in that year.

The stream gage records indicate that significant river flows have occurred in recent history. These peak flows are shown below:

DATE	PEAK FLOW
December, 1955	42,000 CFS
January, 1969	18,800 CFS
January, 1980	19,000 CFS
February, 1982	25,400 CFS
March 1983	18,400 CFS
December, 1984	19,800 CFS

The January, 1980 flood inundated portions of the South Golf Course. As a result of the damage to Fairway Numbers 10 and 11, the developer constructed a dike around these fairways to protect them from the 25-year design flow of the river.

The mean seasonal precipitation at Rancho Murieta is 20 inches. The relatively steep slopes of the foothills and this amount of precipitation result in a medium to very rapid runoff potential. The community is transversed by a series of naturally occurring streams, tributaries and swales which, acting together, comprise the area's natural surface water drainage system.

The significant hydrologic features within the community include:

* Primary natural drainage courses which convey seasonal runoff.
* The 100-year floodplain limits of the Cosumnes River.
* Perennial water bodies, both man-made and natural, such as reservoirs, lakes and rivers.
* Marsh and wetland areas.
* Seasonal transient water such as areas where persistent runoff ponding occurs.

B. DRAINAGE & FLOOD CONTROL SERVICE:

Of the 3,500 acres within Rancho Murieta, approximately one-half of the area has undergone urbanization of one degree or another. The areas that have not been urbanized are more or less still in their natural state. Those areas of the community that have been urbanized include:

* Residential subdivisions (a total of 1,775 dwelling units in Units 1, 2, 3, 3B, 4, Murieta Village, and Murieta Lodge)
* Man-made lakes and reservoirs
* Golf courses and Country Club
* Agricultural lands
* Water & wastewater treatment facilities
* Commercial lands, including Murieta Plaza, RMTC, airport and Equestrian Center.

Drainage and flood control facilities have been developed in the urbanized areas. These facilities include:

* Drainage channels (improved and unimproved)
* Drainage pipelines, culverts, etc.
* Flood control levees
* Drainage flood control structures

In the past, storm drainage and flood control jurisdiction has been the overlapping responsibility of property owners, homeowner associations, Sacramento County and the District. The respective areas of responsibility between these entities were not well defined. Collectively, the effort of these entities in providing these services has been minimal. There is a large need to provide this service in an organized manner to benefit the present and future residents of Rancho Murieta.

The District has voter-approved latent authority to provide drainage and flood control service. In addition to the latent authority, the District's 1983 de-annexation from Sacramento County's Metropolitan Storm Drainage Maintenance District ("Metro") obligated the District to provide drainage service to those areas that had been previously annexed to Metro, principally Unit No. 1 and Murieta Village.

In August, 1987, the District Board of Directors established a Drainage Committee to work with staff in the preparation of a Drainage Master Plan and Drainage Ordinance that could be adopted by the District. This Master Plan document is the result of the Drainage Committee's work over the last several months.

3. DRAINAGE & FLOOD CONTROL

A. STORM DRAINAGE SYSTEMS:

In an undeveloped area, the storm drainage system is provided by nature. Some storm water stands where it falls and some percolates into the ground. The remainder gradually or quickly collects in quantity and speed as it hurries down the watershed through swales and streams to its ultimate destination - the river and then the sea. This simple yet complex natural system is constantly undergoing change to accommodate severe storms.

As urbanization occurs, new drainage systems are required due to the increased runoff rates that result from the placement of large, impervious surfaces over natural areas that were relatively pervious. The problem faced by man as a result of urbanization is an increasing level of inconvenience and/or loss of life or property from increased runoff flows.

Ideally, an urban storm drainage system should remove runoff as quickly as possible to minimize inconvenience and the loss of life or property. These two objectives are not mutually achievable without extremely high "cost". The need is obvious - to strike a realistic balance between elimination of inconvenience and protection against hazard.

The existing storm drainage and flood control system within Rancho Murieta has been developed in an attempt to achieve such a balance. The system is composed of both natural and man-made elements. The system has major and minor functions. The major

function of the system is to minimize loss of life or property during an infrequent storm. The minor function is to minimize inconvenience that results from more frequently occurring, less significant storms.

The planning of new developments should make maximum use of existing open channels and natural streams as a part of the drainage system. In addition to the resulting lower total system costs, the stream corridors are preserved as open space and recreational areas.

Within the system there are facilities that are designed to avoid inconvenience to the public in the smaller sections of the system during a minor storm, for example, a street intersection. During a major storm, the capacity of many of these convenience-oriented facilities will be exceeded, while major components of the system are designed to provide safety and to minimize loss of life or property. It must be recognized and emphasized that a total storm drainage system subject to an infrequent major storm cannot be expected to totally prevent inconvenience and minor property damage.

The provision of drainage and flood control service comes with an inherent liability. Flooding, minor or major in nature, can result in property damage and loss of life. The prediction of peak storm runoff quantities is as much an art as it is a science. Even the peak runoff from a 1% chance (100-year) design storm will be exceeded at some point in time. The resulting loss of property and life can be significant.

While the utilization of generally accepted engineering standards in the design of the drainage and flood control facilities should minimize the probability of flooding during the design storm, there is always the chance that some flooding will occur.

It is for this reason that the drainage purveyor has a liability. Proper levels of insurance should be carried by the purveyor to protect against this liability.

B. NATURAL STREAMS:

One major component of Rancho Murieta's storm drainage system is the extensive amount of natural swales, streams and tributaries. These natural components are made up of floodplains and floodways. The floodway is the main channel portion of the stream that carries floodwaters away. The floodplain is that portion of the stream adjoining the floodway that may be periodically submerged by floodwaters.

A major function of the stream floodways is to provide the necessary drainage of storm water runoff in the area. During the wet winter season, the often-dry floodplains are filled by rainwater as it drains from higher ground to stream channels. Once every hundred years on the average, a major storm will occur which will fill the floodplain out to a line defined as the one hundred-year floodplain. Any development within the hundred year floodplain will be subject to flooding and harm by the one hundred year storm. Storms of lesser intensity will result in less severe flooding on a periodic basis.

The drainage capacity and natural character of the streams are being significantly changed by urban development in the area. The impervious surfaces, drainage alterations, and land filling activities associated with development can cause some serious alterations in the hydrology of the natural streams. This results in an increase in runoff and stream flows, and in many instances a decrease in the carrying capacity of the waterways. Flood hazards are increased by these hydrologic changes. Although the

impact of higher and faster flows may not be damaging at a point of origin upstream, the flows can be damaging to property as they accumulate at a downstream location.

The development of residential lots in natural settings can result in building envelopes that are separated from the adjoining street by a drainage swale or channel. In this case, it is important that the District consider the establishment of control mechanisms over the construction of driveway culverts. Improperly designed or constructed culverts can create severe upstream flooding.

The development of urban areas should be directed away from the one hundred year floodplain of natural streams and other significant hydrologic features within Rancho Murieta for the following reasons:

1. To minimize loss of life and property.
2. To minimize environmental disruption.
3. To preserve or enhance the aesthetic qualities of natural drainage courses in their natural state.
4. To prevent encroachment of fills and structures into the floodplain.

Exhibit No. 1 indicates the extent of the significant natural streams that make up the natural drainage system within Rancho Murieta. The natural system has been extensively incorporated into the drainage system in urbanized areas.

C. WATER QUALITY:

The quality of storm drainage runoff is a function of the level of natural and man-made pollutants that exist within the watershed. The cleansing action of a storm washes these pollutants from the watershed and transports them through the drainage system

to the lakes and rivers.

The quality of water in the drainage system changes as urbanization occurs. The urban storm water draining from streets, roofs and storm drains into the system has higher levels of organic and inorganic pollutants than natural storm water. The dumping of trash and refuse into the system degrades the quality of the water when the dumpings are carried off by storm waters. Erosion and sedimentation are also increased by development activities which disturb the natural protective covers of the land and add loosely compacted fills.

Pollutants are frequently generated throughout a watershed, a process known as "non-point source discharges." A second source of pollutants known as "point source discharges" are specific properties or individuals within a watershed. These sources can be any business storage yards, industrial sites, or residences where pollutants are stored or used in large quantities.

Pollution loads are the result of:

* soil erosion and dissolving of minerals in the natural ground cover;
* overland flow which picks up fertilizer, animal droppings, and organic material;
* flow on parking lots, roofs and streets which carries petroleum products, trash, dust fall and debris from cars and trucks into the drainage system, and;
* accidental or willful discharge of toxics or pollutants from storage areas or transportation modes.

Three basic methods of treatment can be used:

* The first controls pollution loads at their source. For example, proper erosion control and sediment control will

reduce the suspended solids levels. Also, periodic street cleaning will reduce pollution loads.

* Storm water runoff can be treated at the source. Temporary storage of runoff to allow suspended solids to settle out is one example. The fact that most runoff pollution results from the "first flush" of runoff should be considered when planning source treatment facilities.

* Treatment of storm water runoff at a centralized plant downstream is the third alternative. This is usually the most costly method because of the vast volume of water requiring treatment. Consideration may be given to storage facilities enabling storm water to be released to treatment plants at a gradual rate after the runoff peak has passed.

It is quite obvious that the least costly method of treatment is to control pollution at its source. Treatment of runoff pollution loads is probably unnecessary for most low-density residential development. It also seems obvious that the cost of such treatment will be high, so it follows that treatment should not be considered unless there is documentation of the need and a demonstration that the benefits from treatment will be consistent with its costs.

The U. S. Environmental Protection Agency (EPA) is in the process of requiring small communities such as Rancho Murieta to obtain drainage discharge permits. These drainage discharge permits may require compliance with discharge requirements, including quality standards. Small communities will have to have the necessary permits in place by 1992. The State Central Valley Regional Water Quality Control Board will be administering the

permit process for EPA. It is too early to determine what discharge requirements, if any, will be set for Rancho Murieta.

The District should consider creating a permit procedure to monitor and control large users of chemicals, pesticides, fertilizers, etc. Enforcement mechanisms could be adopted that will discourage willful or accidental discharge of pollutants into the storm drainage system.

D. PROTECTION OF DOMESTIC WATER SUPPLY RESERVOIRS:

Rancho Murieta's domestic water supply reservoirs, Lakes Chesbro, Calero and Clementia, are surrounded by small, medium and large watersheds, respectively. Runoff from these watersheds enters the reservoirs and mixes with stored water. As urbanization of these watersheds occurs, the potential for contamination of the community's water supply increases.

As explained earlier, runoff from developed areas can contain high levels of pollutants. Potentially, these pollutants can enter the community's domestic water supply undetected. It is important that proper steps be taken in the handling of runoff from developed areas to minimize the potential for contamination of the community's drinking water supply.

1) Lake Chesbro:

Lake Chesbro is one of the community's two primary drinking water storage reservoirs. The water stored in this reservoir is delivered directly to the District's water treatment plant in order to meet the consumption demands of the community. Contamination of this lake would have an immediate and adverse effect on the quality of the water consumed by the District's customers.

The California State Department of Health Services (DOHS), first advised the District of their concerns regarding the potential contamination of Lake Chesbro in late 1984. The District, in conjunction with the developer and his engineer, Raymond Vail & Associates, developed a mitigation program for the western shoreline of Lake Chesbro in early 1985. This program was approved by the DOHS in mid-1985.

Implementation of the southern portion of this mitigation program has been completed. The northern portion of this program will be implemented with the development of the currently proposed Unit No. 4A.

The Lake Chesbro mitigation program includes a lake perimeter ditch system to intercept and divert urban runoff outside the lake's watershed. Lake Chesbro's watershed is very small and diversion is easily accomplished. Similar mitigation measures will be required around the remainder of Lake Chesbro as further development occurs in its watershed.

The critical link in the Lake Chesbro protection system is the perimeter interceptor and diversion ditch system. It is vital that this ditch system be kept free of blockages to prevent the accidental discharge of urban runoff into the reservoir. The District should exercise very tight control over urban encroachment into or over the ditch system.

This ditch system is located on the uphill side of the lake's maintenance and pedestrian/bicycle path. The lake is a major recreational feature within the community. Adequate provisions should be made for maintenance and recreational access to the lake while still providing the necessary protection of the water supply.

Individual crossings of the interception and diversion ditch system from adjoining lakeview lots should not be allowed. The District should develop a few combined maintenance and recreational access points around the lake's perimeter. Strategic placement of these access points would provide convenient access to this recreational amenity while not jeopardizing the integrity of the lake's protective ditch system.

Potential access points to Lake Chesbro have been shown on Exhibit No. 1. The District, in coordination with Rancho Murieta Association (RMA), should develop these access points and prohibit any other encroachments or crossings of the protective ditch system.

2) Lake Calero:

The protection of Lake Calero is equally important but it may be somewhat more difficult to implement. Lake Calero's watershed is much larger than that of Lake Chesbro. The volume of runoff that would have to be intercepted and diverted is considerably larger than that of Lake Chesbro. The topography around Lake Calero does not allow for convenient discharge of intercepted runoff outside of its watershed.

Like Lake Chesbro, Lake Calero is a principal domestic water supply reservoir. Water stored in this lake is delivered directly to Lake Chesbro to make up the quantity of water drawn from Lake Chesbro into the treatment system. There is as a direct link between urban runoff into Lake Calero and the potential for contamination of the drinking water treatment and distribution system as exists with Lake Chesbro.

The physical constraints to diversion of urban runoff from Lake Calero's watershed may require the development of an expensive

mitigation program to prevent urban runoff contamination of this important reservoir. While this issue will require further study, it is important to note that urbanization of Lake Calero's watershed should not occur until a feasible method to prevent urban runoff contamination of the lake is developed.

3) Lake Clementia:

Lake Clementia is the community's secondary water supply reservoir. The water stored in this reservoir is the last choice of water supply due to the following reasons:

a) The lake is relatively shallow and suffers from algae and other aquatic plant growth during the summer.
b) The water in storage is typically of poorer quality and taste than water stored in the District's primary reservoirs.
c) The lake is utilized for body contact water sports by the community's residents.

The watershed of Lake Clementia is in excess of two (2) square miles in size. The vast majority of this large watershed is located outside of the District and therefore, out of the District's control with regards to water quality of storm runoff.

As the community continues to grow, there is an increasing likelihood that the water stored in Lake Clementia will need to be used for domestic consumption. While nearly all of this reservoir's extensive watershed is undeveloped at this time, the District should continue to monitor the land uses within the watershed and the resulting levels of contaminants in the reservoir. In this way the District will be able to reasonably anticipate the treatment requirements that will be necessary to purify Lake Clementia water for domestic consumption.

E. EROSION CONTROL:

Erosion and sediment movement and deposition are parts of a natural cycle in which land forms are built up, worn down, and again built up. Most of the time the cycle is slow, thereby providing enough time for nature and special segments of the ecosystem to adjust to the changing landscape. Man is a participant in these adjustments.

Urbanization changes the lay of the land and the types of vegetation found on the land. It also increases the rate of storm runoff from the watershed. These changes upset the delicate balance and speed up the natural erosion cycle. The result of upsetting this balance can often cause a large increase in the rate of erosion.

As mentioned earlier, Rancho Murieta's soils have a moderate to high potential for erosion. Once disturbed these native soils will erode and the resulting sediment is transported through the drainage system. The sediment settles in streams, pipes and lakes within the system, is highly undesirable, and requires expensive maintenance work to clean up the system.

This erosion problem exists both during the construction of streets and utilities (short-term) and, to a lesser degree, on a continuing basis from home and landscape construction (long-term). Special erosion control measures can be very successful in minimizing short and long-term erosion problems.

Measures should be taken to preserve the natural streams within Rancho Murieta. This should include a strong emphasis on "natural" engineering and land planning techniques, which will not only preserve and enhance natural features of the land, but protect them. Natural streams should be used as a design theme within the

community and adequate steps should be taken to control erosion within these natural resources.

The design of culverts and drainlines should include adequate provision for the dissipation of energy at their outlets. Energy dissipators will significantly reduce the potential for erosion in the downstream channel.

With the resulting increase in peak flows that occurs with urbanization, there is an increased potential for erosion of the banks of natural channels. Natural channels should be evaluated during the design of each phase of development to determine the type and extent of mechanical erosion protection that may be needed to minimize the potential for channel erosion.

Underground utility trenching within Rancho Murieta generates large volumes of shot rock spoils. This material cannot be used as trench backfill and it must be disposed of at a high cost to the developer. Shot rock makes excellent erosion control material as rip rap. This material should be used for erosion control along drainage channels and at the discharge of drain pipes and culverts. This material could be utilized as much as possible to create "natural" appearing erosion control structures in each development. Excess material could be stockpiled for future use by the District in erosion repair work.

Appendix A contains a copy of "Principles of Reduced Erosion and Sediment from Developing Areas", which was prepared by the High Sierra Resource Conservation and Development Council. Appendix B contains a copy of "Measures to Control Soil Erosion in Rancho Murieta", which was prepared by Raymond Vail & Associates. The successful implementation of these types of programs on a community-wide basis will significantly reduce the potential for erosion related problems at Rancho Murieta.

F. GRADING CONTROL:

Proper control of grading activities can significantly reduce drainage and erosion problems. While Rancho Murieta is currently under the jurisdiction of the County's Grading Ordinance, past history indicates that the County has not exercised its authority sufficiently to control some grading activities. Some significant drainage and erosion control problems have resulted.

In addition, the County Building Department has not historically exercised significant authority over on-site grading and drainage in conjunction with the construction of structures. Significant drainage problems exist around many homes within the community as a result of this lack of exercise of authority provided to Sacramento County by the Uniform Building Code (UBC).

The District's drainage ordinance should include prohibitions on certain grading and drainage activities that can result in the creation of grading and drainage problems on private property. The adopting of such prohibitions should not pre-empt the County's authority nor require the District's review and approval of grading and site plans.

The District should encourage the County and the Architectural Review Board of the various homeowner's associations to actively enforce their existing requirements. In this way, drainage and lot grading problems can be minimized in the future.

G. OPEN SPACE & RECREATION:

The most important function of Rancho Murieta's drainage system is to minimize the loss of life and property from flooding. Besides the important function in the drainage system, natural

stream corridors provide open space, scenic, and recreational opportunities to the citizens of Rancho Murieta, healthy living environments for wildlife, air cooling and cleansing, and improvements to water quality. Neighborhood parks and off-street bicycle, hiking, and riding trails could be established along the stream corridors.

Urban development has a major effect on the recreational potential of the stream corridors. Uncoordinated urban development may completely preclude the construction of recreational facilities by using up necessary land and access points. Often, the homeowners themselves become obstacles to the development of recreational facilities because of their concerns about privacy, vandalism, noise and litter. Financial constraints can also hamper recreational development.

The quality of life within Rancho Murieta is greatly enhanced by the community's natural setting. The development of the community utilizing sound environmental planning concepts that complement the natural setting, including natural stream corridors, will greatly contribute to the overall quality of life within the community.

Open space areas within the community can be developed as active recreational areas. The network of natural stream corridors has the potential to connect these recreational areas with an off-street trail system.

Footpaths connecting these areas may be both established, as in a surfaced or landscaped path, or meandering, such as may become established by repetitive use by children playing or families walking to visit adjacent areas. Footpaths have been contemplated around the lakes and reservoirs. In some instances, specifically around the larger reservoirs, these paths parallel or follow the

same path as maintenance roads.

The design of lotting patterns should make allowances for the opportunity for future development of foot and bicycle paths in common space areas by the homeowner's association`s or the District as they deem necessary to meet the needs of the community's residents.

This Master Plan envisions that recreational and aesthetic improvements will be made within the stream corridors so long as they do not restrict the capacity of the drainage system. For example, improvements to Lake Guadalupe could be made for recreational or aesthetic benefits without interfering with the capacity and function of this component of the drainage system.

H. LEVEL OF SERVICE:

The desired level of service will have the most significant influence on the capital and maintenance costs of the drainage and flood control system. The establishment of excessive design requirements will result in the greatest protection against flood hazard, but at a very large construction cost. The reverse is also self-evident. Substandard design requirements will result in a significantly less expensive system, higher maintenance costs, and a very low level of protection from flood hazard.

The goal is to establish levels of service that balance the need for an adequate level of protection with reasonable construction and maintenance costs. This dilemma has been addressed many times before by other communities. A level of service that balances these opposing interests has become somewhat standard.

The level of service envisioned in this Master Plan is as follows:

1. Protection of developable areas from the 100-year peak flow of the Cosumnes River.
2. Street drainage systems should be designed for the 10-year design storm.
3. Curbs and street drainage should be designed for the 100-year design storm when the buildable portion of the adjoining lot is below the top of the curb.
4. Culverts, open channels, and natural streams should be designed for the 100-year design storm.
5. Finish floor elevations of habitable structures should be a minimum of 1-foot above the 100-year water surface.
6. Structures and fills should not encroach into the 100-year plain.
7. Drainage easements should be obtained for all areas within the 100-year flood plain.

I. MAINTENANCE:

Maintenance includes those factors that are essential to keeping the drainage system in good condition, maintaining an adequate staff to accomplish the work, and common practices and procedures that should be used for the maintenance of structures and facilities within the system. The objectives of the drainage system maintenance should be to:

1. Keep the system in top operating condition at all times through proper maintenance;
2. Obtain the longest life and greatest use of the system's facilities; and,
3. Achieve the foregoing two objectives at the lowest possible cost.

Maintenance factors should be considered in the design of the drainage system and not relegated to living with the resulting

maintenance problems of a short-sighted design. Total life cycle costs should be evaluated in the design of drainage facilities, as they commonly are with water and sewer systems.

The level of maintenance should be sufficient to keep the drainage system operating at all times to provide the desired level of service. This requires that the maintenance program should be based on the understanding of the level of protection and convenience desired by the community.

In addition to the impacts from development and use of the natural stream corridors, there are several important public concerns relating to the maintenance of the natural stream areas. Maintenance of the stream channels consists mainly of removing drainage obstructions, abating weeds, making repairs, and collecting refuse.

The maintenance of channels and swales in homeowner's association's common areas also deserves special discussion. Typically, maintenance activities of channels and swales is utility-oriented. The work is focused on keeping the drainage course free of debris and growth that may cause flow blockage during a storm, not on the aesthetic appearance of the facility.

Due to neighborhood concerns regarding aesthetics, it is anticipated that the homeowner's associations will continue to perform maintenance activities in the floodplain portion of the drainage courses. Their activities will keep these areas aesthetically pleasing to neighboring residents. These aesthetic maintenance activities will have a beneficial side effect of reducing the growth of grasses and weeds in the floodplain that can impede flows.

Maintenance of flood control levees should be limited to the utility aspects of the levee, namely structural stability for flood protection. While maintenance of landscaping along a levee is the choice of the private landowner for aesthetic reasons, the District should control the extent and nature of landscaping activities, including tree planting, to insure that the structural stability of the levee is not jeopardized.

The District should maintain only those portions of the drainage system that are operated and maintained by the District. In addition, the District should maintain only those facilities contained in proper easements and that have been properly dedicated to the District.

While the development of a maintenance program is beyond the scope of this Master Plan, it is important to point out at this time the major components of such a maintenance program. A drainage maintenance program should, at a minimum, include:

1. ANNUAL MAINTENANCE PROGRAM -
   An annual preventative maintenance program should be designed to keep the system operating. This program could include periodic maintenance of mechanical equipment, cleaning of silt, brush, trees, weeds and debris from the system, repair of deteriorated facilities, periodic inspections of levees, etc.

2. EMERGENCY RESPONSE PLAN -
   A plan on how to respond with trained personnel in the event of a major storm or failure of a key facility that may result in serious flooding.

3. STAFF & EQUIPMENT PLAN -
A plan to adequately staff, train and equip a maintenance crew to insure that the desired level of service can be maintained.

4. POST EVENT INSPECTIONS -
A plan to inspect the drainage and flood control system after major storms to identify areas in need of immediate repair or maintenance.

An evaluation of the anticipated cost for annual maintenance of the existing drainage system is presented in a later section of this Master Plan.

Private landowners and the various homeowner associations should develop maintenance programs for their respective drainage systems. Significant problems can result if the private portions of the community's drainage system are not properly maintained.

J. DIVISION OF PUBLIC & PRIVATE RESPONSIBILITIES:

One of the problems faced by a public agency which provides drainage and flood control services is the determination of the limit of public responsibilities in the provision of service to private lands. Since each drainage purveyor has had to struggle with this problem, a rather standard understanding of the limit of public responsibility has developed.

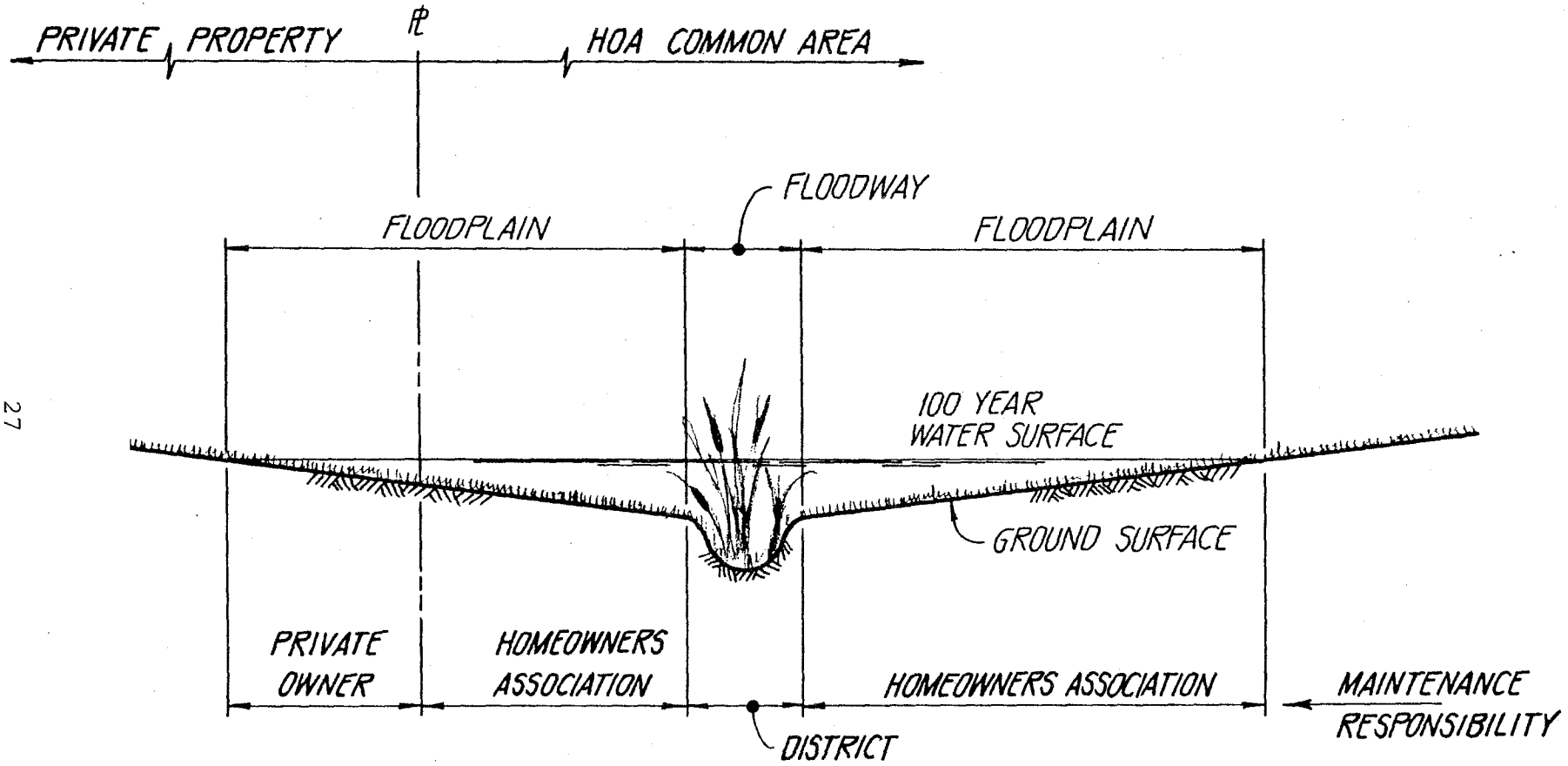
Drainage law has evolved over time to allow the owner of a higher parcel to use his property in a reasonable manner and to discharge runoff from his lands onto an owner of a lower parcel. In essence, the higher land has an "easement" over the lower land for drainage.

Rancho Murieta is somewhat unique due to the private nature of the streets and common areas. Since the streets and drainage channels are a significant component of the drainage system, it is important for the District to develop a mutually acceptable understanding of the point of interface between public and private responsibilities for drainage and flood control.

The District should work closely with the various homeowner associations in developing mutually agreeable limits of public and private responsibilities. Care should be taken not to violate the restricted access rights enjoyed by the residents within the various homeowner's associations.

The division of public and private maintenance responsibilities for drainage channels and swales is depicted in Figure No. 1. It is proposed that the District perform all maintenance activities in the floodway. The respective property owner or homeowner's association would then be responsible for maintenance of the remainder of the floodplain. The District should maintain some enforcement authority to insure that the floodplain will be properly maintained by the respective private parties.

FIGURE NO. 1



PUBLIC / PRIVATE MAINTENANCE RESPONSIBILITY FOR DRAINAGE CHANNELS & SWALES

Golf course drainage facilities also deserve special discussion. Typically, these facilities have been designed to handle only small intensity storms and summer time nuisance flows. During periods of high intensity runoff, these facilities are designed to overtop, thereby allowing floodwaters to flow across the surface of the fairways. The siting of homes on the upstream side of these facilities has been designed to prevent inundation when the golf course fairways are overtopped during a high intensity storm.

It is the recommendation of this Master Plan that the following criteria be used to define the point of interface between public and private responsibilities for drainage:

1. The District be responsible for drainage within the floodway of natural channels and streams, for man-made drainage channels, culverts, and public drainage pipelines equal to or larger than 10-inches in diameter, except golf course drainage facilities.
2. The District be responsible for drainage below the theoretical plane of the top of the grate of a drainage inlet on private streets.
3. The District be responsible for flood control levees designed to protect from the 100-year peak flow of the Cosumnes River.
4. The private party be responsible for drainage across private parcels and common areas to the point of discharge into a drainage channel or public drainage pipeline.
5. The private party be responsible for maintenance within the floodplain of natural channels and streams.
6. The District establish certain grading and drainage requirements to minimize drainage and erosion problems within the District.

7. The homeowner's associations continue to be responsible for control and coordination of architectural and landscape design, including site grading and drainage.

K. STATE & FEDERAL REGULATIONS:

The District's authority over drainage and flood control is not exclusive. Several State and Federal agencies have at least some control over or influence over the rivers and streams within the District. It is easiest to understand the overlapping areas of authority by listing these agencies and their area of authority as it relates to drainage and flood control.

The list of State and Federal agencies is as follows:

1. FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA):
FEMA is responsible for identifying special flood hazards from the 100 and 500-year events. In order for land-owners to be eligible for federal flood insurance, a local city or county must institute certain zoning requirements on those properties identified by FEMA as having a potential for inundation from the 100-year flood. FEMA requirements are enforced by Sacramento County.

2. U.S. CORPS OF ENGINEERS:
The Corps is responsible, in conjunction with other federal agencies, for protection of the nation's waterways and wetlands. Any project that proposes to modify or alter a waterway or wetland requires the approval of the Corps. The Corps approval is frequently issued in conjunction with the approval of the U. S. Fish & Wildlife Services.

3. CALIFORNIA STATE DEPARTMENT OF FISH & GAME:
The Department is responsible for the protection of the State's streams, rivers, waterways, wetlands and fisheries. Any project that proposes to alter or modify a stream or wetland requires the Department's approval.

4. CALIFORNIA STATE BOARD OF RECLAMATION:
The Board is responsible for protection of the State's rivers and waterways. Any project that proposes to alter the capacity of a stream, river or waterway requires the approval of the Board.

5. CALIFORNIA STATE REGIONAL WATER QUALITY CONTROL BOARD:
The Regional Board is responsible for water quality within the waterways of the State. The Board has authority to control the discharge of wastes into these waterways. Any project proposing to discharge wastes to the State's waterways requires the Board's approval.

L. FEMA 100-YEAR FLOOD PLAIN:

FEMA Flood Insurance Rate Maps for the portion of Sacramento County surrounding Rancho Murieta indicate the extent of the 100-year flood hazard area along the Cosumnes River. The flood hazard area generally covers the areas immediately adjacent to the river, the Clementia Valley below Clementia Dam, Fairways 1, 10 and 11 of the South Golf Course, the airport and the vast majority of the agricultural lands within the community. This area of inundation has been shown on Exhibit No. 1.

Other areas within the community are also subject to inundation of lesser degrees during major storms. While localized flooding may occur during higher intensity storms, the drainage system has been designed to prevent localized flooding from causing

significant property damage. These areas are not significant enough to warrant inclusion on the FEMA maps.

4. THE SYSTEM

A. THE EXISTING SYSTEM:

The existing storm drainage and flood control system within Rancho Murieta has been constructed in conjunction with development activities that started in the early 1970's. The existing system primarily serves the developed areas within the community. These developed areas constitute approximately 30% of the total acreage within the District.

The major components of the existing system are listed below and shown as Exhibit No. 1:

1. Flood control levee protecting the South Course.
2. Flood control levee protecting the commercial areas, including the Business Park, Training Center, Murieta Village, Murieta Plaza, Equestrian Center, etc.
3. Laguna Joaquin acts as a detention pond to reduce peak flows from the developed areas north of Jackson Road.
4. The Laguna Joaquin Drainage channel.
5. The natural and man-made channels and swales in Unit No's. 1-4.
6. Major culverts at street crossings of natural and man-made channels and swales in Unit No's. 1-4.
7. Major drainage channels around the new water and wastewater treatment plant sites and downstream of Lake Clementia.
8. The drainage pump station under construction in the Murieta Airport Business Park.

The existing system has been designed and constructed under the jurisdiction of Sacramento County Department of Public Works. The older portions of the system, principally the commercial area and Unit No. 1, were designed in accordance with Sacramento County's then standard hydrologic runoff criteria.

Subsequent engineering studies determined that the hydrologic conditions in the Rancho Murieta area result in higher runoff flows than those predicted by the County standard criteria. Starting in about 1978, all new facilities were designed to handle the higher runoff flows that are predicted by the use of site-specific Intensity-Duration-Frequency Curves. This new criteria has resulted in a better designed drainage system.

According to the new criteria, the portions of the system that were constructed from designs based on the County`s standard criteria are inadequately sized. During the early 1980's, the project developer authorized an analysis of the adequacy of the older portions of the system to identify critical "capacity deficiencies" that resulted from the adoption of new design criteria. This analysis revealed that several major culverts in Unit No. 1 were inadequate. The developer subsequently funded the construction of additional improvements to provide adequate capacity at these critical points.

The analysis also identified that major components of the commercial area storm drainage system were inadequate under the new design criteria. The analysis indicated that a separate river outfall was needed to serve the undeveloped 52-acre commercial area located south of Murieta Drive and west of Jackson Road. Once this additional outfall is constructed, the existing system will adequately serve the existing portions of the commercial area, including the Mobile Home Village, RMTC and Murieta Plaza.

Over the years several minor drainage facilities have experienced capacity problems. No significant property losses or inconveniences have been reported. This Master Plan does not envision remedial repairs to increase the capacity of these minor facilities unless it can be demonstrated that sufficient economic benefit would result from the capital investment.

A May 1988 reconnaissance level inspection of the existing system revealed that the system is in very good condition overall. The inspection revealed many conditions that are typical of systems experiencing deferred maintenance. These conditions are as follows:

1. Minor erosion of channels.
2. Buildup of weeds, brush and trees in areas of standing water.
3. Debris from home building activities.
4. Debris from landscaping activities.
5. Fallen tree limbs.
6. Lot grading fills encroaching into the flood plain and floodways.
7. Silt buildup in low velocity areas.
8. Driveway and lot drainage pipes discharging in the channels.

These conditions can be easily rectified by periodic routine maintenance activities. These conditions do not present a significant reduction in the system's effectiveness.

The inspection also revealed the following conditions that may require immediate maintenance attention or remedial repairs to insure proper operation of the system:

1. The commercial area 60-inch diameter river outfall pipe is partially filled with silt that is significantly reducing its effective capacity. This needs prompt maintenance attention.
2. The Laguna Joaquin Discharge Channel is choked with growth significantly reducing its effective capacity. This channel needs prompt maintenance attention.
3. Channel and bank erosion along approximately 1,500 lineal feet of channels in Unit No.'s 1-4. This will require remedial repair work in the near future.
4. Evidence of home building related concrete dumping partially clogging drainage pipes. This needs prompt maintenance attention.
5. Automation of the operation of the slide gate that protects the commercial area, including Murieta Village, Murieta Plaza & RMTC, from flooding during periods of high flood stages in the Cosumnes River. This will require remedial repairs in the near future.
6. Replacement of the trash rack on the Lake Guadalupe spillway to eliminate the potential of flow blockage. This will require remedial repairs in the near future.

B. THE FUTURE SYSTEM:

It is anticipated that future extensions of the system will be very similar in nature to the existing system. Future residential subdivisions on the undeveloped lands within the District will, for the most part, incorporate the same planning concepts that have been used to date within Rancho Murieta.

The resulting drainage systems will therefore make extensive utilization of the natural channels and swales shown on Exhibit No. 1. These future systems will experience the same types of problems that are common to the existing system. Maintenance requirements

on the future systems will therefore be very similar to those of the existing system.

Future system extensions should be designed in accordance with the new drainage criteria to accommodate the higher intensity storms that frequent the Rancho Murieta area. Construction of future system components should comply with the requirements of District design and construction standards. The requirements for future system extensions will need to be closely coordinated with the architectural control requirements of the various homeowner associations with regards to roof and yard drainage.

Future major components of the drainage and flood control system include the following:

1. An existing major drainage channel along the east side of Fairway No's. 11 & 12 of the South Golf Course.
2. A major drainage pump station to be located near the No. 3 Tee of the South Golf Course.
3. A major drainage pump station to be located on the 52-acre commercial parcel on Murieta Drive.
4. Extensive natural and man-made drainage channels and drainage culverts to serve the future development.

It is beyond the scope of this Master Plan study to estimate the size and location of all of the future facilities that will make up the drainage and flood control system. The development of the system will require the close coordination of the project proponent, the responsible homeowner's associations, and the District. Future improvements will be designed and constructed incrementally as development within the community progresses.

C. DESIGN & CONSTRUCTION STANDARDS:

The District will need to adopt minimum design and construction standards for future drainage and flood control improvements. Minimum design and construction standards closely modeled after those of Sacramento County will result in an excellent set of standards at minimal expense to the District.

Over the years, the developer's engineers have used Sacramento County standards, modified for site specific conditions, to guide the design and construction of storm drainage and flood control facilities at Rancho Murieta. The formal adoption of similar standards should not pose an undue hardship on the design professional, the developers or their contractors.

While the development of minimum design and construction standards is beyond the scope of this Master Plan study, it is important to note the significant differences between the County's minimum standards and the standards that have been used at Rancho Murieta. The significant differences are as follows:

1. Storm runoff quantities for small watersheds are estimated by the modified rational method utilizing site specific Intensity-Duration-Frequency curves.
2. Storm runoff quantities for large watersheds are estimated utilizing the Soil Conservation Service methodology and site specific Intensity-Duration-Frequency curves.
3. A 100-year flood surface profile is developed for drainage channels and swales.
4. Lots adjacent to drainage channels and swales are assigned a minimum finished floor elevation of at least 1-foot above the projected 100-year water surface.

5. Side opening curb galleries are allowed on drainage inlets to increase their inlet capacity.
6. Minimum slopes on streets and pipes are steeper creating higher velocities to assist in cleaning silts off the streets and out of drainage pipes.
7. Compaction of trenches is done by mechanical methods, jetting is not permitted.

5. FUNDING

A. OPERATION AND MAINTENANCE:

In order for the drainage and flood control system to meet its objective of protecting life and property and to minimize inconvenience to the public, it must be properly maintained. Preventative maintenance will assure that the system is in full and complete working order during periods of high runoff.

It is important to note that the District's maintenance budget will be predicated on utility orientated maintenance activities required to properly maintain the existing system. The budget is not intended to maintain the natural drainage system within the undeveloped portions of the District. The homeowner's associations will have an on-going responsibility to perform aesthetic maintenance of the non-floodway portions of the drainage channels and swales.

The homeowner's associations will also have to keep the streets and drainage inlet grates free of debris. The potential for localized flooding resulting from clogged inlet grates is certainly real. Each year localized flooding and property damage occurs in Sacramento County due to clogged drainage inlet grates.

The annual costs of operating and maintaining the existing system have been estimated. These costs are based on cost data supplied by Sacramento County reflecting their costs to operate the County's drainage system. In some cases, the estimated

maintenance costs are based upon engineering cost estimates to meet the specific needs of the existing system.

The estimated annual maintenance costs contained in Table No. 1 represent the direct costs of maintenance. In addition to these direct costs, the District should anticipate incurring indirect labor, administrative and insurance expenses.

Table No. 1
Estimated Annual Maintenance Cost
Existing Drainage and Flood Control System

Item No	Description	Quantity	Unit Price	Est Cost
1.	Flood Control Levee	12,000 LF	$0.75/LF	$ 9,000
2.	Drainage Pipe	48,000 LF	$0.05/LF	2,400
3.	Manholes	130 Ea	$4.00/Ea	500
4.	Drainage Inlets	280 Ea	$4.00/Ea	1,100
5.	Lined Channels	7,000 LF	$0.25/LF	1,800
6.	Earthen Channels	6,000 LF	$0.40/LF	2,400
7.	Natural Channels & Swales	31,000 LF	$0.30/LF	9,300
8.	Drainage Pump Station	1 Ea	$3,000/Ea	3,000
9.	Emergency Response	5 Ea	$ 500/Ea	2,500
			Total Direct Cost	$32,000

The District has estimated the annual indirect labor, administrative and insurance expenses as follows:

Indirect Labor Expenses	$15,000
Administrative & Supervision Expenses	12,000
Insurance Expenses	17,000
Total Indirect Cost	$44,000

Accordingly, the total annual direct and indirect expenses to maintain the existing drainage and flood control system are estimated at $76,000. This estimated cost does not include allowances for depreciation and replacement of facilities.

The value of the existing drainage and flood system has been roughly estimated at $3.5 million, with an average design life of 75 years. An annual allowance of at least 1 - 1-1/2% of the system's value should be reserved to fund system repair and replacement. This reserve would represent an additional $35,000 - 53,000 per year in service charges.

For the purpose of discussion we prepared a benefit/cost analysis for an annual maintenance budget of $76,000. This analysis may be helpful in the establishment of equitable rate structures for drainage service within the District. A summary of this benefit/cost analysis is shown in Table No. 2. This analysis is preliminary and will require refinement before the establishment of rate structures.

Table No. 2
Drainage and Flood Control
Benefit/Cost Analysis

Land Use	Benefit Ratio	Prorata Cost	Unit Basis	Approx Cost/Unit
Residential	70%	$53,200/Yr	1775± DU	$30.00/DU/Yr
Commercial & Industrial	20%	15,200/Yr	120± AC	$126.70/AC/Yr
Undeveloped	10%	7,600/Yr	1000± AC	$7.60/AC/Yr
	100%	$76,000/Yr		

B. REMEDIAL REPAIRS

The items identified during the reconnaissance survey that are in the need of remedial repair should be programmed for repair during the first year of operation of the system. The estimated cost of remedial repairs is shown in Table No. 3. For the most part this work can be accomplished by the District's maintenance staff.

Table No. 3
Estimated Costs of
Remedial Repairs to System

Item No.	Description	Estimated Cost
1.	Channel & Bank Erosion Repairs (1,500 LF)	$30,000
2.	Automation of Slide Gate at Airport Entrance	15,000
3.	Replace Trash Rack at Lake Guadalupe	1,000
	Total Remedial Repairs	$46,000

The District will need to fund these repairs in the near future. This could be done with an incremental increase in rate structures or from the establishment of a development fee structure, among others.

C. PERMIT AND COMPLIANCE:

The adoption of a drainage ordinance will require the District to perform technical review and approval of drainage plans. The District will also have to perform compliance inspections during construction.

The District should adopt a permit and inspection fee structure for drainage. This fee structure could be modeled after the fee structures currently used by the District for sewer and water system extensions.

D. FUTURE SYSTEM EXTENSIONS:

The District will need to develop a funding program for future extensions of the storm drainage and flood control system. Funding alternatives include:

1. Developer dedications
2. Development fees
3. Benefit assessments

The estimated cost of the future system is beyond the scope of this Master Plan study. Let it suffice to say that the cost of the system could vary significantly depending on the final land uses utilized in the development of the undeveloped areas within the District. Exhibit No. 1 indicates the future major components of the drainage and flood control system in a schematic manner.

Dedications from project proponents is perhaps the simplest approach. Under this approach the applicant would be required to construct system extensions to District standards and dedicate them for operation and maintenance. Since the vast majority of the undeveloped lands within the District are owned by one developer, this approach would be equitable.

Development fees could be levied on land as it is developed to generate the needed funds. Accurate estimates of the future cost of the system would have to be made to insure that adequate funds would be generated to pay for the system. The District would be responsible for funding system extensions either through direct contract or reimbursement procedures. Such an approach places a large responsibility on the District to be sure that funding levels

are adequate in light of the rather limited quantity of land yet to be developed. Should funding levels not be adequate, the District could be faced with a serious financial dilemma.

Benefit assessment proceedings could also be used to fund system extensions. In addition to fiscal responsibility issues similar to those discussed above, the costs of utilizing public financing programs can create a significant financial burden on the community.

It would appear that the developer dedication approach would be the simplest and most efficient method available to the District to extend the system. The District should evaluate the merits of the various funding alternatives and establish a policy on this matter.

APPENDIX A

Principles of Reduced Erosion and Sedimentation From Developing Areas

The following five principles can be integrated into an effective system of erosion and sedimentation control. This system consists of vegetative and structural measures and management practices. The development and use of this system can reduce the damage of erosion caused by land development and reduce costly clean-up procedures.

1. Plan the development to fit the particular topography, soils, waterways, and natural vegetation at a site.

Slope length and gradient are key elements in determining the volume and velocity of the runoff and erosion. Where possible, steep slopes should be left undisturbed. Erosion hazards and runoff volumes and velocity can be reduced by limiting the length and steepness of slopes.

Soils high in silt and very fine sands are generally the most erodible. Erodibility decreases as the percentage of clay or organic matter content increases. Even a highly erodible soil may show little evidence of erosion, by reducing the length and steepness of a given slope. Long steep slopes should be broken by benching, terracing or constructing diversion structures.

Natural vegetation is extremely important in controlling erosion since it: (a) shields the soil surface from rain, (b) increases infiltration, (c) reduces the velocity of runoff and (d) holds the soil in place as well as acting as a filter.

2. Expose the smallest practical area of land for the shortest possible time.

When the soil is to be disturbed and vegetation removed, keep the site and duration of exposure to a minimum. Phase the project so that only the areas currently being developed are left exposed. Grading should be completed as soon as possible. Vegetation (temporary or permanent) with mulching should be in place before the rainy season starts (about October 15).

After the best decision has been made as to land use, and the development process begins, effective erosion control and sediment reduction depends upon careful site planning,

judicious selection of conservation practices, adequate design, accurate installation in a timely fashion and sufficient maintenance to insure the intended results.

3. Apply "Soil Erosion" control practices as a first line of defense against on-site damage.

Numerous practices can be used on site to minimize potential damage. These practices can be used independently or with other methods. Soil should be kept covered as much as possible with temporary or permanent vegetation or with various mulches. Other practices include diversions to keep surface runoff from exposed areas and grade stabilization structures to control surface water. When erosion is not adequately controlled, sediment control is more difficult and expensive.

4. Apply "Sediment Control" practices as a perimeter protection to prevent off-site damage.

Control sediment once it is produced to prevent it from leaving the site. Diversion ditches, sediment traps, vegetative filters and sediment basins are examples. Generally, sediment can be retained by two methods: (a) filtering runoff as it flows through an area and (b) impounding the sediment laden water to settle it out.

5. Implement a thorough maintenance and follow up operation.

A site cannot be effectively controlled without thorough, periodic checks of the erosion and sediment control practices.

APPENDIX B

"MEASURES TO CONTOL SOIL EROSION IN RANCHO MURIETA"

The fundamental principle for minimizing soil erosion is to minimize the area of bared soils and the duration of exposure to natural erosive forces. During the construction phase of a project, this is best achieved by scheduling and limiting the extent of clearing, grading, trenching, etc., so as to assure completion of construction and soil stabilization prior to significant rainfall. Disturbed soils should be protected with mulch and/or vegetation, as best suits the situation, and runoff velocity should be controlled using structural measures. Up-slope diversion structures should be used to reduce the volume of runoff across denuded areas and prepared drainage ways should be constructed to handle the increased runoff due to placement of impervious coverage. However, some erosion usually occurs in spite of erosion control measures. For this reason, it may be desirable to construct temporary or permanent sediment basins to capture most of this suspended eroded material to prevent downstream siltation. Finally, a construction site should be inspected frequently to assure that control measures are maintained adequately.

Up to this point, the discussion has been conceptual in nature and is intended to elucidate the principles to be followed for controlling soil erosion during future development at Rancho Murieta. The remainder of this discussion is to describe more specific guidelines to be followed:

- All cut and fill banks will be left rough and will not exceed a slope of 1-1/2:1 (horizontal:vertical) as recommended by the Soil Conservation Service.

- Existing vegetation will be retained, protected and supplemented whenever possible. When vegetation must be removed, the method used will be one that will minimize soil disturbance and will be limited to the area required for immediate construction operations.

- Areas with the highest erosion hazard will be scheduled for disturbance when significant rainfall is least likely to occur.

- Excavated material from trenches will be stockpiled up-slope from the trench if there is a possibility of rain before backfilling. In this manner, the trench acts as a sediment catch basin if it rains.

- All areas where runoff concentrates will be protected from erosive forces by installing storm sewers, culverts, diversions, berms, drains, sediment traps, and grass or rip-rap lined channels as appropriate. Interceptor and roadside ditches will be lined with rip-rap, asphalt concrete or other suitable material when ditch flow-line slope exceeds two percent.

- If a time shortage should occur, a quick, short-term vegetation stand will be established on newly cleared areas by seeding with barley or wheat then raking lightly into surface soil. Permanent cover vegetation, which

takes longer to become established, may be seeded simultaneously for long-term protection. Table 1 will be used as a seeding guide. At the time of seeding or within 15 days prior, fertilizer will be applied uniformly at a minimum rate of two pounds of available nitrogen and two pounds of phosphoric acid per 1000 square feet. Using a fertilizer composition of 10-10-0 (nitrogen-phosphorus-potassium), this would be the equivalent to 20 pounds per 1000 square feet. As a substitute, 10 pounds of 16-20-0 fertilizer may be used. Scraped topsoil from grading operations will be stockpiled to apply later on areas otherwise unsuited for establishing vegetation. Stockpiles will be protected from erosive forces during the rainy season by plastic sheeting or equivalent protection.

- In the Central Valley, statistics show that planting a vegetative cover by September 15 provides a 98 percent probability that seeds will be in the ground in time for the first rain adequate to cause seed germination. There will also be a 90 percent probability that the first rain adequate to cause significant erosion will not occur for over 45 days. By comparison, planting by October 1 provides a 90 percent probability that seeds will be in the ground in time for the first germination-causing rain, and a 90 percent probability that the first erosive rain will

not occur for over 30 days.

- If scheduling permits, permanent vegetation cover may be established initially; omitting temporary measures. In which case, all road cut and fill areas and other disturbed areas will be seeded as recommended in Table 1 for long-term stands. After application, seeds will be raked lightly into soil and fertilized as described earlier with 20 pounds per 1000 square feet of 10-10-0 fertilizer or 10 pounds of 16-20-0 fertilizer. In the more level areas, the soil may be tilled two to four inches deep to prepare a seed bed then drill seeds to a depth not to exceed 1/2-inch with a range seed drill across slope or broadcast seeds and follow with a light harrow. Either method of seeding will be followed with a seed bed roller.

- An application of straw or wood fiber mulch to the seed bed not only aids in establishing vegetation cover, but provides temporary erosion control until permanent vegetation is established. Straw mulch, if used, would be spread at a rate of approximately 100 pound per 1000 square feet. On the more steep slopes, straw will be anchored in placed by "tucking" into soil with a spade or secured with fiber netting. If wood fiber mulch is used, it would be applied at a rate of 35 pounds per 1000 square feet and may be applied simultaneously with seed and fertilizer in a slurry (hydro-mulching).

- If a vegetative cover is used for stabilizing cut and fill banks, slopes will not be steeper than 50 percent (2:1 horizontal to vertical). Where slopes exceed 33 percent (3:1), seed beds with straw mulch will be secured with heavy jute netting of one-half to two-inch mesh. The mesh will be stapled together and anchored to the slope.

- If scheduling should warrant, "winterizing" the site may become necessary, in which case, the following measures may be implemented as most appropriate:
  - Plastic sheeting (i.e., Visqueen) or other suitable material may be used, if necessary, as an emergency measure to stabilize bare road cut and fill banks.
  - Temporary diversion ditches will be constructed, if needed, to divert runoff away from exposed banks toward protected drainage channels, e.g., pavement, grass, or rip-rap lined channels, street gutters, etc.
  - Where slopes do not exceed 30 percent, straw, peat moss, or wood chips will be applied to bare soil, if needed, for stabilization. A one-inch layer of wood chips or three inches of straw or peat moss worked into the top two or three inches of soil is a proven erosion control measure.

- If it is determined during final engineering studies that increased runoff due to placement of impervious cover could be substantial, some type of mitigation would be implemented. This could be in the form of storm water retention basins, infiltration trenches, or the installation of perforated pavement in place of conventional pavement.

- If construction occurs during the wet season, vehicle traffic will be limited to as few routes as possible across a construction site. The purpose is to minimize the accelerating effect on erosion caused by traffic. Preferably, temporary routes will be aligned where future roads or driveways are planned. In severe erosion hazard conditions, a few inches of gravel will be applied along temporary routes to provide additional protection.

- Typically, any soil erosion problems has a solution; however, due to economic or environmental costs created by some solutions, they may not be acceptable. Consequently, the erosion hazard at Rancho Murieta will be minimized by avoiding disturbance of erosive soils on slopes exceeding 30 percent. By not disturbing these fragile areas, naturally established vegetation will provide effective erosion control at no cost.

TABLE 1

SEEDING GUIDE

Seed 1/	Application Rate In Pounds Per 1000 Square Feet	Planting Date	Method of Application
SHORT-TERM STAND (one to two years):			
Wimmera 62 Ryegrass (or) Annual Ryegrass (or) Barley (or) Wheat	1 (or) 1 (or) 2 (or) 2	Sept. 15 to Oct. 15	Broadcast by hand or use mechanical spreader.
LONG-TERM STAND			
Rose Clover (or) Red Brome (or) Blando Brome (or) Alta Tall Fescue	1/2 (or) 1/2 (or) 1 (or) 1	Prior to Sept. 15	(seed drill)

Source: U.S.D.A. Soil Conservation Services

1/ All seed will be delivered to the site tagged and labed in accordance with the California Agricultural Code and shall be acceptable to the County Agricultural Commissioner. Seed shall have a minimum pure live seed content of 80 percent and contain no more than 0.5 percent weed seed.

REFERENCES

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