IRRIGATION SUITABILITY LAND CLASSIFICATION AND EXISTING AND POTENTIAL AGRICULTURAL LAND USES, WEST COUNTY RECLAMATION STUDY AREA

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

Prepared for

City of Santa Rosa
and
U.S. Army Corps of Engineers

May 1996

Prepared by

QUESTA ENGINEERING CORPORATION
1220 Brickyard Cove Road • Point Richmond, CA 94807 • 510/236/6114

For

HARLAND BARTHOLOMEW & ASSOCIATES, INC.

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1.0 INTRODUCTION

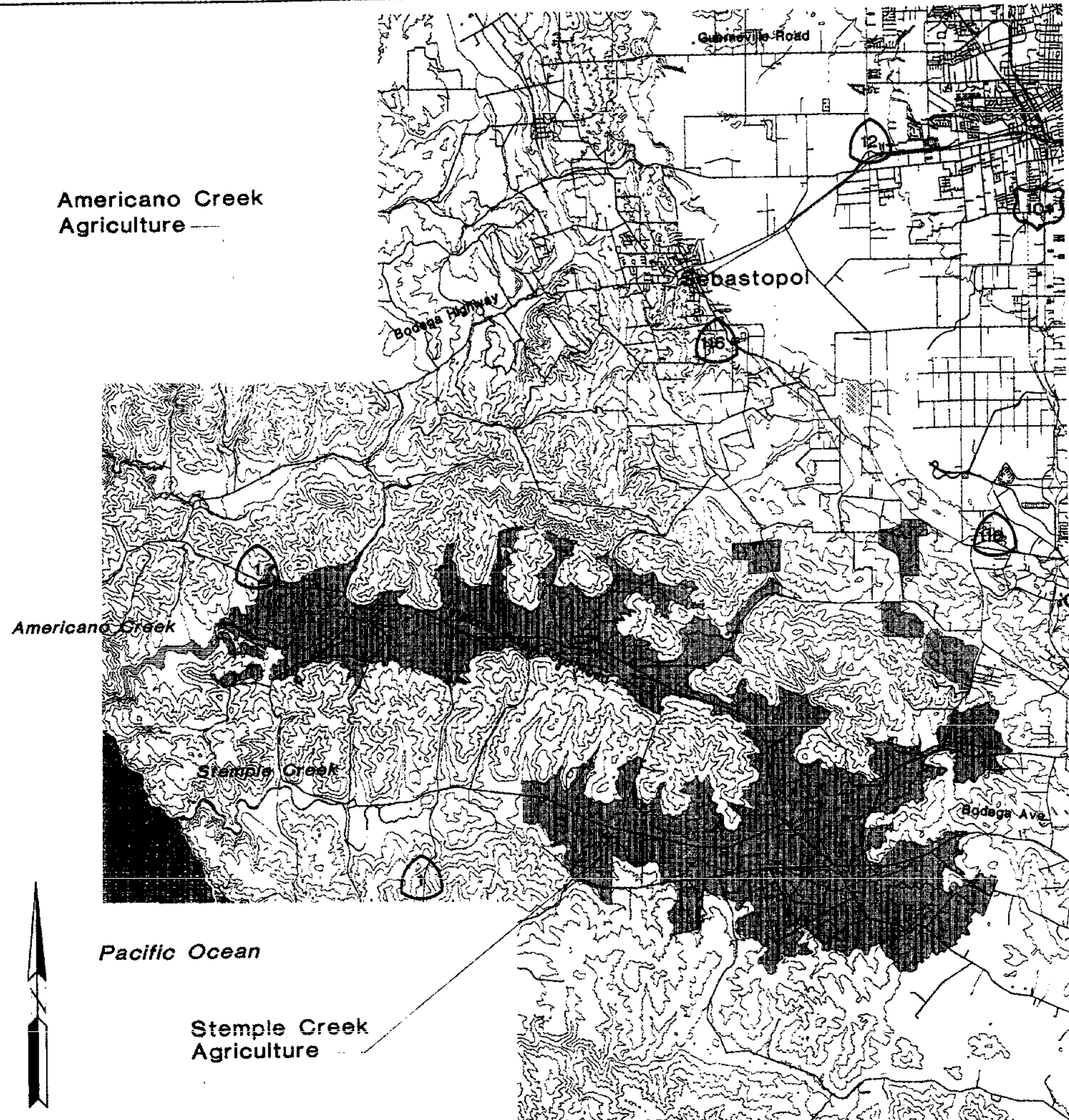
1.1 BACKGROUND AND OBJECTIVES OF INVESTIGATION

In February of 1990, CH2M Hill produced a report entitled *Santa Rosa Subregional Water Reclamation System Long-term Detailed Wastewater Reclamation Studies Draft Technical Memorandum No. R12 on the Irrigation Suitability Land Classification for the Stemple/Americano Creeks area of Sonoma County*. This report presented information on the soils, their physical and chemical characteristics, suitability for irrigated agriculture, and irrigation and drainage management requirements for the West County project area. The report also included a soils map (scale of one inch equals 2,000 feet) which divided the landscape into five irrigation suitability land classes. Classes 1 through 5 were considered irrigable, and Class 6 unsuited for irrigation. Based on U.S. Bureau of Reclamation Irrigation Land Classification criteria, no Class 4 lands, and only a small amount of Class 5 lands, were identified as occurring in the West County area.

This present addendum addresses several areas that were not covered in the 1990 report and updates information so that it is compatible with the *Irrigation Management Plan* (Questa Engineering, October, 1995). The information that has been added includes: 1) consumptive water use for various crops; 2) current land use; and, 3) potential crops. The areas of irrigation efficiency and drainage requirements have been updated.

Approximately 18,650 acres in the Stemple and Americano Creek watersheds are classified and evaluated in this report. Similar information on the 2,200-acre Sebastapol area is included in the companion technical memorandum *South County-Sebastapol Irrigation Suitability Land Classification and Existing and Potential Agricultural Land Uses* (Questa Engineering, May 1996). However, operationally the Sebastapol area can be managed as part of either a West or South County reclamation project, and is included as sub-alternatives to both in the project description. The original irrigation suitability maps have been slightly modified to include map symbol information on current agricultural land use, potential crops, and consumptive water use. The revised maps, redrafted at a graphic scale of one inch equals 1,000 feet (1:12,000), also show setbacks and buffers from wetlands and stream corridors. Detailed information on the geology, geomorphology and soils in the 1990 Technical Memorandum are not repeated in this report.

It may be possible to expand irrigation activities with reclaimed wastewater throughout western and southern Sonoma County. Currently, lands between Rohnert Park, Sebastapol and Santa Rosa are irrigated with reclaimed water from the Santa Rosa Subregional Wastewater Treatment Plant. Likewise, pastures and some forage crops (sudan grass and field corn) along Lakeville Highway south of Petaluma are irrigated with reclaimed water from the City of Petaluma’s treatment facility on Lakeville Highway. The City of Santa Rosa directed the project team to investigate the feasibility of increasing the irrigated pasture acreage and using reclaimed water to grow a variety of field, row and specialty crops within the West County.



Scale: 1"=10,000'

Source: Parsons Engineering Science
Questa Engineering
USGS quad maps

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PARSONS

Santa Rosa
Subregional Long-Term
Wastewater Project

WEST COUNTY
AGRICULTURE

Figure 1

1.2 SUMMARY OF FINDING AND CONCLUSIONS

Dry-farmed hay lands, dairies and livestock production are the major agricultural land uses in the West County study area. Presently, the principal crops consist of non-irrigated pasture and dry-farmed winter grown legume/grass silage and oat hay. There is also a small amount of acreage along Roblar Road where fruits and vegetables are grown for the organic fresh produce market, demonstrating the potential agricultural feasibility of growing a wider variety of crops on some of the better drained lands with more favorable micro-climates. The area is climatically suited to a number of fruit and vegetable crops, forage corps and pasture irrigation. The crop water requirement, or consumptive use, for improved pasture is estimated to be 19 inches during the approximately five-month irrigation season. Overall, for project planning purposes, an average annual irrigation water use of 23 inches per acre is estimated for the West County study area. This is based on an average crop consumptive water use of 20 inches per year and an irrigation efficiency of about 80 percent. This amount will vary considerably depending on the crop grown, type of irrigation system (sprinkler versus drip) and irrigation efficiencies achieved.

A summary of the land classification by class and acreage is shown in Table 1 for the West County area, which includes Americano and Stemple Creeks.

Table 1 Land Classification Summary

{PRIVATE }CLASS	ACRES	PROPORTION (percent)
Class 1	285	1.5
Class 2	4077	21.9
Class 3	6809	36.5
Class 5	123	0.6
Class 6	7348	39.5
Gross Survey Area	18,641	--

The total arable area is approximately 11,170 acres.[1] Class 1 and 2 lands (4,360 acres) are the best suited for irrigation with virtually no limitations. Class 3 and 4 lands (6,810 acres) contain some limitations that may restrict crop choice and yield, and require special management. Class 5 lands are marginally irrigable and best suited for pasture crops, and Class 6 lands cannot normally be irrigated. Some lands with observed wetlands characteristics are included in the Class 6 acreage.

1 Irrigable lands are Class 1 through 3, with Class 5 problematic and Class 6 non-irrigable.

Based on the project Water Balance Model (April 1996) completed by Parsons Engineering Science (using 23 inches per acre), approximately 6,200 acres of irrigable lands are required for land disposal for the one-percent river discharge alternative. This assumes a project with a high amount of irrigated hay, pasture and forage crops with relatively high water demands. Irrigation land requirements could expand 30 percent or more if less water demanding fruit and vegetable crops predominate, to as much as perhaps 8,000 acres. Drip irrigated fruit and vegetable crops, which are very water efficient, may allow for irrigation of virtually all suitable lands in the West County (approximately 4,300 acres of Class 1 and 2 lands, plus an additional acreage of suitable Class 3 lands). The exact water demands of such a mix of crops is difficult to predict, and would require on-going management planning as the character of West County agriculture changes over time. Inclusion of Sebastapol lands (2,200 acres) may be required for this alternative to be successful if the project (West County irrigation) evolves over time to one of more intensively farmed fruit and vegetable crops for the one-percent river discharge alternative. Higher river discharge alternatives reduce the irrigation land requirements correspondingly.

1.3 STUDY PARTICIPANTS

This Technical Memorandum was authorized by the City of Santa Rosa. Harland Bartholomew Associates, Inc. (HBA) is the prime consultant. The work was administered by Anders Hauge of HBA.

Originally, the irrigation land classification mapping was completed in the fall of 1989 by Tim Reilly of North State Resources, with a review on irrigation and drainage requirements completed by Don Fox and Jim Thayer of CH2M Hill. Additional field work, consisting of soils verification and land use mapping, was planned and conducted by Questa Engineering Corporation. Mr. Jeffrey Peters, CPSS/SC was the Project Manager for Questa, assisted by Ms. Nancy Dagle, Ms. Molly Brown, and Mr. Randall Smith.[2] Mr. Dennis Worrel of Parsons Engineering Science was involved in the early stages of the field work. Mr. Robert Moore conducted the determination of consumptive water use. Vern Marble, PhD, Agronomist, and Lynn Brittan, Soil Scientist, provided consultation on soil suitability, potential irrigation management systems, existing agricultural management practices, and potential crops. Mr. Norman Hantzsche, P.E., assisted in preparation of the irrigation and drainage sections of the report.

[2] CPSS/SC stands for Certified Professional Soil Scientist/Soil Classifier.

2.0 IRRIGATION LAND CLASSIFICATION AND LAND USE

2.1 GENERAL DESCRIPTION

The results of the previous irrigation land classification and the current land use investigations are portrayed on a series of map sheets, each with a scale of 1" = 2,200'. Four kinds of information are contained on the mapping symbol within each polygon:

1. Irrigation suitability land classification.
2. Existing land use.
3. Potential crop category.
4. Average consumptive water use for that crop category.

The irrigation suitability land classification methodology that was utilized was developed by the U.S. Bureau of Reclamation to identify and characterize lands suitable for sustained, profitable irrigation. Irrigation suitability land classification is an interpretative and predictive classification system which identifies and groups lands with similar irrigation potential on the basis of physical, chemical, and environmental characteristics. Soil (texture, coarse fragments and depth to restrictive layer), drainage, and slope gradient are among the most important factors considered.

The agricultural land-use classification system utilized was developed by the State of California Department of Water Resources (DWR) to identify existing agricultural land use. This information can be utilized to estimate crop water use and irrigation water requirements for large areas. Agricultural, native vegetation, urban, recreational, and irrigation use symbols from this land use classification system were combined with the Bureau of Reclamation's Irrigation Suitability Land Classification rating, along with an indication of potential future crop uses (crop choice), and consumptive water use (the average irrigation water demand of the crop category) to form the informational symbol found on project maps. Crop water requirement was calculated based on methods presented in the State Water Resources Control Board Guidance Manual, *Irrigation with Reclaimed Municipal Wastewater* (Pettygrove, S. and T. Asano, 1984).

The following is an example of the four-part mapping symbol which occurs within each polygon:

2(NV/P8) 15"

where:

2 = Irrigation land classification rating (ranges from 1, the highest, to 6, the lowest, non-irrigable).

NV = current land use symbol (see Table 3 for a complete list).

P8 = potential or future crop choice symbol

15" = consumptive water use for future land use

The gross survey area for this classification was initially identified by the BPU and project team. The study area boundary is similar to that evaluated in the 1990 CH2M Hill irrigation land classification survey. Landowners and operators were contacted to obtain permission to enter private property to make the necessary field investigations. Some owners and operators refused to authorize entry. In these cases, land classification and existing land use boundaries were photo interpreted without the opportunity for field verification. Checking and field verification of these areas was made by road-side observations, and extrapolations from nearby areas.

Additional soil drainage and wetland investigations may be needed for some parcels (particularly those to which access was denied or contain very complex landscapes) for confirming land class suitability and identifying wetlands. These investigations would be conducted as part of future planning/permitting and irrigation design studies as specific parcels are considered for inclusion within the reclamation system. Procedures for this are discussed in the *Irrigation Management Plan*.

2.2 LAND CLASSIFICATION SPECIFICATIONS

2.2.1 Irrigation Land Classification (Bureau of Reclamation)

Irrigation suitability land classification is based on the field appraisal of physical land characteristics and on the interpretation of laboratory results. The characteristics considered in irrigation suitability land classification are soils, topography, and drainage as well as the interrelationship of these with climatic conditions.

The numerical classification rating defines ranges for land characteristics that influence irrigation suitability and allows for the consistent grouping of lands with similar capacity to produce revenue to offset those production costs borne directly by the water user.

Land class specifications for this study are provided in Table 2. The classification assumes the use of sprinkler or drip irrigation. Arable land Classes 1, 2, 3 and 5 are recognized. Lands that are not considered arable are placed in Class 6.

Subclasses, deficiency modifiers, and degree of deficiency modifiers are included in the symbols. However, subclass symbols are only provided on the field copy maps. To simplify the mapping legend and its ease of use, only the overall land classes (1 through 6) are shown on the reproducible project maps.

Table 2 Land Classification Specifications

Land Characteristics	Deficiency modifier	Class 1 Arable	Class 2 Arable	Class 3 Arable	Class 6 Non Arable
	Subclass s - Soil				
Texture	v, c	Sandy loam to very permeable clay.	Loamy and to permeable clay.	Loamy sand to permeable clay.	Includes lands which do not meet the minimum requirement for arable lands
Depth to sand, gravel, or cobble	k	36" plus-good friable soil of fine sandy loam to clay loam or 42" of sandy loam	24" plus-good friable loam or heavier or 30" of sandy loam to loamy sand	18" plus-good friable soil of fine sandy loam or heavier or 24" of lighter-textured soil	
Depth to slowly permeable clay	h	None present.	48" or deeper.	12" or deeper.	
Depth to hardpan or bedrock	b	None present.	48" or deeper.	30" or deeper.	
Alkalinity	a	pH less than 8.3; SAR less than 8.	pH less than 8.5; SAR less than 18.	pH less than 9.0; SAR less than 38.	
Salinity	s	Electrical conductivity does not exceed 4 mmhos/cm.	Electrical conductivity does not exceed 8 mmhos/cm.	Electrical conductivity does not exceed 12 mmhos/cm.	
	Subclass t - Topography				
Slopes	g	Smooth slopes up to 3% in general gradient in reasonably large-sized bodies.	Smooth slopes up to 9% in general gradient in reasonably large-sized bodies.	Smooth slopes up to 15% in general gradient in reasonably large-sized bodies.	
Surface	u	Smooth enough to require only small amounts of smoothing.	Smooth enough to require only small amounts of smoothing.	Smooth enough to require only small amounts of smoothing.	
Irrigation pattern	j	Reasonably shaped bodies; slope configuration or field size will not constrain selection of irrigation systems.	Reasonably shaped bodies; slope configuration or field size may constrain selection of irrigation system slightly; slight potential for concentration of runoff.	Reasonably shaped bodies; slope configuration or field size may constrain selection of irrigation system significantly; significant potential for concentration runoff.	
	Subclass d - Drainage				
Soil and topography	w	Soil and topographic conditions such that only minor farm drainage is required.	Soil and topographic conditions such that some farm drainage may be required but with reclamation by artificial means appearing feasible.	Soil and topographic conditions such that some farm drainage may be required but with reclamation by artificial means appearing feasible.	

Source: CH2M Hill (1990) *Irrigation Suitability Land Classification, Stemple/Americano Creeks Area.*

2.2.2 Field Sheet Mapping Symbol

The following is an example of the complex mapping symbol placed on the field sheets:

$$\frac{2std\ (k_2g_2w_2)}{C21Y}$$

where:

Top Line Symbols:

2=	land class
s=	soils deficiency
t=	topography deficiency
d=	drainage deficiency

Bottom Line Symbols:

C=	land use
2=	productivity
1=	land development
Y=	substratum permeability

Deficiency Modifiers:

k_2=	shallow depth to coarse sand, gravel or cobble
g_2=	gradient
w_2=	subsurface drainage- water table

2.2.3 Agricultural Land-use (California Department of Water Resources)

The Department of Water Resources uses a breakdown of land use according to class symbol. More detail is obtained by adding the subclass number to the class symbol, or by use of a special condition symbol. The classification system is subdivided into agricultural crops, native rangelands and pasture, dairies and farmsteads, urban, and recreational classes. Land areas are also designated as irrigated or non-irrigated (note: as used in this context, native rangeland means unimproved volunteer grasses, both introduced Mediterranean annuals and native grasses and forbs). Table 3 identifies the symbols of the land use classifications used in this report. These symbols are used to denote both the existing land use and where there are soil and slope limitations for future land use. In general, the highest, most intensive land use is shown for soils with few limitations.

Table 3 Department Of Water Resources Land Use Classification

{PRIVATE }Symbol	Definition	Symbol	Definition
D1	apple orchard	P1	alfalfa & alfalfa mixtures
D8	prune orchard	P4	native pasture
D13	walnut orchard	P8	improved pasture
F6	corn	S1	farmstead
G6	miscellaneous mixed hay and grain	S3	dairy
NR1	riparian - marsh	SR	suburban residential
NR3	riparian - trees & shrubs	T9	melons, squash, cucumbers
NR5	riparian - duck marsh	T18	miscellaneous truck crops
NV	native vegetation	U	urban
NV-P	park	U12	extractive industries
NW	water surface	UR	urban residential
		V	vineyard

2.3 METHODS

Bureau of Reclamation Series 510 Techniques and Standards were followed by the CH2M Hill soil survey team in completing the 1990 investigation. The Bureau's land mapping symbols and the DWR land use legends were combined with a future crop symbol and the future consumptive water use to produce the mapping legend.

USGS topographic maps were enlarged to 1:12,000 scale and were used for field work along with 1990 1:12,000 aerial photography. The Bureau of Reclamation land class symbols (1, 2, etc.) were marked on these sheets. Land use polygon areas were drawn on 1:12,000 scale lot line topographic maps obtained from the Sonoma County Planning Department, using interpretation of the aerial photography and field observations. The final composite mapping symbol was then placed inside these polygons. The map information was inputted into the project AutoCADD GIS System to analyze data and determine acreages.

2.4 RESULTS OF THE LAND CLASSIFICATION

The land classification maps are included as separate plates to this report. A summary of the results of the land classification is provided in Table 4.

Principal subclasses are described in the following paragraphs. In some cases, the listing of subclasses may appear redundant because, for brevity, deficiency modifiers have been omitted from this general description.

Class 1

These lands are the best suited for irrigation. The soils are deep; medium textures are the most common. Topographic, soil, and drainage limitations are not present, although a few oxidation mottles indicative of high seasonal groundwater may be observed in the subsoil. Class 1 lands occur primarily on stream terraces and alluvial fans. Goldridge and Pleasanton clay loam soils are mapped in these positions. Inclusions of lands with observed wetlands characteristics occur infrequently in Class 1 delineations.

Class 2

These are lands with minor soil, drainage, and/or topographic deficiencies. Limitations on these lands are slight and include infiltration, fine textured clays, and slope gradient. Soils are deep and the textures range from fine to medium. The most common soils are clays and clay loams. Clear Lake Clay, Haire, Raynor, Spreckels, Goldridge, Cotati, and Sebastapol soils are in Class 2. These lands occupy terraces, alluvial fan surfaces and gently sloping foothill lands. The slopes are smooth and gently sloping. Inclusion of lands with observed wetlands characteristics occur occasionally and are usually localized as springs, wet spots and low areas and along stream corridors.

Class 3

These lands have soil, topographic and/or drainage deficiencies that may reduce crop yields and require additional management. Limitations on these lands are moderate and include infiltration, ponding, fine textured clays, slope gradient, moderate depth to coarse sand, gravel, or cobble, subsurface drainage, moderate depth to impermeable or root restricting bedrock or substrata, very coarse texture, and irrigation pattern difficulties. The soils range from moderately deep to deep and the textures range from fine to coarse. The most common soils are clays, clay loams, and sandy/gravely loams. Haire, Diablo, Raynor, Cotati, Alluvial land (sandy), Goulding, Clear Lake Clay-ponded, Blucher and Goulding soils are in this class. Alluvial lands (sandy) and Clear Lake Clay-ponded soils appear along stream bottoms and on alluvial fans. The remaining soils are found on older upland terraces and hilly terrain. The slopes range from gently sloping alluvial fans and stream beds to slopes up to eight percent. Wetland characteristics may be found along streams and in ponded or low lying areas.

Class 4

Lands in this class have soil, topographic and drainage deficiencies that will reduce crop yields and crop choice if not improved or managed correctly. In addition, they typically have moderate to high erosion hazards which will require management considerations. Limitations on these lands are moderate to severe and include shallow depth to coarse sand, gravel, or cobble, shallow depth to impermeable or root restricting bedrock, gradient, subsurface drainage, very fine

Table 4 Summary of Irrigation Suitability Land Class
West County

Area	Class 1	Class 2	Class 3	Class 5	Class 6
Americano Creek	147	1,397	3,122	0	2,550
Stemple Creek	138	2,680	3,687	123	4,797
TOTAL	**285**	**4,077**	**6,809**	**123**	**7,348**

Total Irrigable Land (Classes 1-3)	11,171
Total Marginally Irrigable Land (Class 5	123
Total Non-irrigable Land (Class 6)	7,348
Total Land Surveyed (Class 1-6)	18,642

Ref.: 930121LC

texture, infiltration, and irrigation pattern deficiencies. The soils range from moderately deep to deep, and the textures are clays and silty clays. Class 4 soils do not occur in the West County project area.

Class 5

These lands are marginally irrigable and have significant limitations regarding crop choice and management needs. The soils range from shallow to deep, and the textures are clays and silty clays. Slopes range to 15 percent. Most areas have irregular topography and complex inclusions of shallow soils or drainage problems that will make them difficult to irrigate. Wetland characteristics are generally found along drainage courses and lower lying lands.

Class 6

These are lands that do not meet the minimum requirements for irrigation as defined in the land classification specifications. Included are: slopes that are steeper than 15 percent; soils shallower than 30 inches to bedrock or to other slowly permeable material or restrictive layer; extremely wet areas; and, lands that have combinations of soil, topographic, and drainage deficiencies that, in the aggregate, are not correctable. Lands with observed wetlands characteristics commonly occur in these subclasses on flatter slopes.

3.0 EXISTING AND POTENTIAL AGRICULTURAL LAND USE

3.1 EXISTING LAND USE

Currently, most of the West County project area lands are not intensively farmed. Irrigated cropland accounts for less than two percent of the total project acreage. The West County areas are predominantly used as hay lands and pasture lands for dairy and beef cattle and sheep grazing. Suburban residential areas extend from the towns of Bloomfield and Valley Ford.

Dry-farmed oat hay, either bailed and stored in hay barns or put-up as silage in plastic silage bags or bunkers, is the most extensive cultivated agricultural land use. Oat hay production, along with native pasture and rangelands that are occasionally mowed, accounts for approximately 1,200 acres (± 6.5 percent) of the agricultural land use in the West County, as shown in Table 5. The amount of land in oat hay and cut as silage can vary from year to year to as much as approximately 15 percent.

In addition to the oat hay lands, there is extensive acreage in non-improved rangeland and pasture grazed by dairy animals, beef cattle, and sheep.[3] There are approximately 13,500 acres of pasture or rangeland, or about 75 percent of the West County project area. However, some of this acreage is on Class 6 lands that are not irrigable. Approximately 18 dairies are found in the West County area. The West County's fog-influenced climate limits the types of horticultural crops that may be grown. Acreage estimates and percentage of area for vineyards, orchards, and vegetables can also be found in Table 5.

The lack of a developed, dependable, and inexpensive water supply has significantly constrained irrigated agricultural development in the West County areas. The small amount of gently sloping valley bottom lands and the cool coastal climate have not provided the impetus for the development of an irrigation water storage and delivery system such as those that have been developed for other similar areas along the central California coast such as the coastal areas of Santa Cruz and Monterey. The West County lacks an extensive groundwater aquifer that can be developed for irrigation purposes; shallow production wells are only used locally.

Although most dairies and livestock operations have developed small, on-farm water storage reservoirs, which divert and store winter and spring runoff, the water is primarily utilized for

[3] "Native rangeland" is an imprecise agricultural term for unimproved grazing areas. Vegetation consists of both introduced annual grasses and forbs with some areas of native plant grasslands. It is not to be confused with "native grasslands," which are predominantly native, non-introduced grasses. Pastures consist of small fenced off grazing areas. "Native pastures" are similar to native rangeland, with a mix of introduced and native species. In addition, pastures an be "improved" by removing trees and brush and/or seeding to more desirable forage plant species. Improved pastures can be either "non-irrigated" or "irrigated."

management of animal wastes in dairy operations and feeding enclosures. The wastewater from dairy maintenance operations may be used to irrigate small pastures in the vicinity of the dairy operations, but the forage produced is largely insignificant to the dairy's feed needs. There are less than an estimated 200 acres of irrigated pasture in the West County project area.

The U.S. Coast Guard Two Rock Military Reservation leases land within the Reservation to local farmers for oat hay and silage production. The Reservation's sewage treatment plant sprays treated wastewater from their oxidation ponds onto fields in the eastern portion of their property.

3.1.1 Oat Hay and Silage Production and Grazing

Nearly all of the oat hay and silage grown in the West County area is used directly on the farms by ranchers and dairy operators; only a very small percentage of the crop is sold locally. The oat hay production supports an extensive dairy industry in the West County, with approximately 18 producing dairies in the project area.

However, despite the large oat hay production and extensive acreage of rangeland, most livestock and dairies are heavily dependent on imported feeds, since a dairy cow must be fed high protein feeds such as alfalfa and grain to insure continued good milk production. Often, over 75 to 80 percent of the required feed must be purchased by West County dairies. Beef and sheep livestock operations are usually more self-sufficient, producing up to an estimated 50 to 60 percent or more of their feed requirements.

In addition to oat hay, a small acreage of dry-farmed sudan grass and field corn is occasionally grown for green chop or silage in the West County area. Acreages of these crops typically total less than 200 per year. Local micro-climates in some portions of the West County may be too cool or foggy for these crops to do well, even with irrigation water available. The necessity to purchase large quantities of supplemental feeds from growers in the Central Valley is a reflection of the inability of most ranchers under current dry-farmed agriculture to produce the kind of high quality feeds necessary for lactating cows and for putting weight on beef cattle. This is particularly true during the summer and fall months when the range grasses are dry and less nutritious, and the stored dried oat hay or silage cannot meet the protein needs of the animals.

Oat hay may be seeded and harvested on slopes up to 20 percent, but is most commonly grown on slopes less than 10 percent. In some areas, steeper side slopes are not mowed, but the flatter ridgeland grasses are cut for silage. Both annually seeded oat-vetch and volunteer oat-rye grass mixes may be mowed and harvested. The steeper lands may only be grazed, and not mowed, particularly following drier than normal winters.

The oat-hay lands are usually cultivated and seeded in the fall, relying on early winter rains to germinate and establish the crop. Some spring planting is also practiced on wetter valley bottom lands. The hay is then cut and cured in the spring, and the bailed oat hay or silage is used to feed the dairy, beef cattle or sheep livestock during the remainder of the year. As defined in the Sonoma County Soil Survey, typical oat hay yields are 2-1/2 to 3 tons per acre on better lands in the wet years, to less than two tons per acre on poorer lands in dry years.

Table 5 Summary of Existing Agricultural Land Use
West County

Map Symbol	Land Use Name	Americano	Stemple	Total
NW	Wetland Buffer	933	952	1,886
S1, nS1	Farmstead	93	313	406
nS2	Feed Lot	30	64	93
SR	Suburban Residential	28	10	38
U, Urban	Urban	231	284	516
NV, NV-P	Native Rangeland	5,063	8,428	13,491
nG6	Hay and Grain	173	216	388
nP4	Native Pasture	47	464	511
nS3,ns3	Dairy	109	128	237
V	Vineyard	0	0	0
P4	Native Pasture	0	0	0
T18, nT18	Misc. Truck Crops	60	0	60
NR1	Riparian/Marsh	195	0	195
O	Misc.	0	0	0
nD1	Apple Orchard	0	0	0
nP3, np3, nG	Grasslands	129	424	553
nI1	Idle at Time of Survey/Photos	98	60	158
D10	Orchard	0	5	5
nF7	Sudan Grass	0	51	51
nF11	Misc. Field Crops	0	21	21
nT12	Potatoes	0	4	4
Totals		**7,189**	**11,425**	**18,615**

Ref.: 93012alu

In the early summer, cattle and sheep may graze the oat-hay stubble as well as the unmowed grass pasture. Most rangeland areas are not intensively managed by rotation systems through cross-fenced pastures, but cattle are allowed to graze throughout large field enclosures. On well managed lands, the dryland pastures typically support four animal unit months (AUM) per acre, with poorer lands supporting 2.7 AUM. An animal unit month is the amount of forage or feed required to maintain one animal unit (one cow, or two sheep) for a period of 30 days.

3.1.2 Orchards and Vineyards

Less than 50 acres of orchards are found in the West County project area. A small orchard exists along Hill Road, and approximately 35 acres of apples are grown on Canfield Road. The shallow soils and generally poor drainage conditions in the West County are not conducive for the deep rooting requirements of many orchards. Micro-climate conditions are generally not suitable for most wine grape varieties in the West County, although there is some interest in lands with favorable micro-climates for vineyard plantings, should a dependable irrigation water source be available.

3.1.3 Fruit and Vegetable Crops

Truck (fruit and vegetable) crops are currently grown in small quantities in the West County project area. There are about 30 acres in organically grown vegetables in the vicinity of Bodega Highway and Roblar Road in the West County and approximately 40 acres in dry-farmed potatoes. Potatoes were once grown extensively throughout the West County area.

3.2 POTENTIAL CROPS[4]

3.2.1 Pasture and Forage Crops

Most of the more gently sloping land currently utilized for dry-farmed oat hay can be converted to summer irrigated hay and silage. Yield increases of two to four times current dry-farmed yields can be expected from irrigation of these lands. More irrigated sudan grass and field corn can also potentially be grown. Cool summers and pockets of summer fog in small local micro-climate belts in portions of the West County may restrict somewhat the more extensive growing of these forage crops.

Considering the large amount of alfalfa hay imported, market conditions would seem ideal for the more extensive planting of alfalfa if there is a dependable source of irrigation water. However, even where irrigation water has been available, alfalfa hay has not been grown very successfully in western Sonoma County. There is a high risk of crop failure or reduced yields in many areas with poor drainage conditions, particularly following wet springs. Cooler than normal summers may also make curing of the cut hay difficult. New cultural practices, such as the use of raised bed planting techniques, and improved or more adaptable alfalfa varieties, must

[4] This section on potential crops was developed based on information provided in a letter/report by Vern Marble, PhD, Agronomist.

be developed before alfalfa can be considered as a potential crop for widespread use in the West County.

Some of the gently sloping lands and most of the steeper native pasture areas (with slopes up to 15 percent) can be converted to permanent irrigated pasture. Improved pasture mixes (i.e., fescue, clovers, harding grass) can be established using a no-till drill on these slopes. The larger dry-land pasture areas will require construction of perimeter fencing and cross fencing so that grazing can be more carefully controlled and managed utilizing a rest-rotation management system. The carrying capacity of well managed permanent irrigated pasture is expected to be in the range of 12 AUM's per acre.

3.2.2 Orchards and Vineyards

Less than 50 acres of orchards are found in the West County project area. The shallow soils and generally poor drainage conditions in the West County generally are not conducive to the deep rooting requirements of most commercial orchard varieties. Micro-climate conditions are also considered unsuitable for most wine grape varieties in the West County, although there is increasing interest in some varieties in more favorable micro-climates and soils.

3.2.3 Fruit and Vegetable Crops

Fruit and vegetable crops are grown in small quantities in the West County project area. Even with a source of irrigation water, more extensive development of these crops is limited in the West County due to wet soils, the lack of suitable flat lands, and poor quality soils. Approximately 2,500 acres of land are thought to be suited for irrigated fruit and vegetable crops in the West County area.

Potential crops that can be considered include:

- Asian vegetables
- bushberries
- broccoli
- cabbage
- carrots
- cauliflower
- chard
- garlic
- onions
- herbs
- leeks
- lettuce
- nursery and bedding plants
- parsnips
- peas
- potatoes
- pumpkins
- radish
- rutabagas
- snap beans
- spinach
- squash
- turnips

3.2.4 Other Specialty Crops

Approximately 3,000 acres of gentle to moderate sloping land (up to 10 percent slope) are potentially suited to such drip irrigated specialty crops as cut flowers, boysenberries, strawberries, and artichokes in the West County area. However, soil erosion is a significant concern with conversion to these crops. This is addressed in the *Soil Erosion Evaluation Technical Report* (Questa Engineering Corporation, September, 1995) and the *Irrigation Management Plan*. The use of winter cover crops, along with sprinkler irrigation, to establish the protective vegetative cover in the fall is strongly recommended. Areas of poor drainage and less favorable micro-climates also pose limitations.

Since the grower experience, irrigation/farm machinery, and a harvesting/shipping infrastructures are largely missing in the West County area, extensive rapid conversion of pasture and oat hay land to specialty crop production is not currently expected. Market conditions may encourage some growers to raise small acreages of these specialty crops for local markets.

3.3 POTENTIAL CROPS AND CONSUMPTIVE WATER USE MAP SYMBOLS

A wide variety of crops, including fruit and vegetables, possibly some vineyards and orchards in areas of favorable micro-climate, and extensive areas of forage and pastures, potentially can be grown with irrigation water in the West County area. No restrictions on crop choice are imposed by the state on use of reclaimed water that meets tertiary treatment standards (California Administrative Code, Title 22). From an agricultural perspective, the water is also of high quality with no restrictions on land use (see *Irrigation Water Quality and Salt Management Leaching Requirement*, Questa Engineering Corp., November, 1995). Constraints on the selection of crops (crop choice) are imposed, to a greater extent in the South County, by soil, slope, and drainage as well as local micro-climatic conditions. Successful, sustained production means that the planted crops have a favorable yield and return on investment at least four years out of five (80 percent) and can be grown over a prolonged period of time without damaging the soil resource due to soil erosion, significant loss of fertility, water table build-up, or salt or metals accumulations. Occasional diminished harvests or crop failure can occur due to unfavorable weather conditions, such as late frosts, high winds, or late spring and summer rains. These can be particularly damaging to hay and some fruit and vegetable crops.

In the West County area, there is a good correlation between soil limitations, soil erosion hazard and slope class. Generally the deeper soils with few soil limitations are found on the younger alluvial fans, valley bottoms and floodplain deposits with slopes less than six percent. The soils that occur on land areas with slopes from six to ten percent are typically on older fans and terraces and have some subsurface restrictions to water movement. The soils that occur on lands with slopes over ten percent are typically upland soils with moderate depths (30 to 40 inches) to restrictive layers; these areas have the highest soil erosion hazard if the cultivated, barren soils are exposed to fall and winter rains. In some cases, these areas are underlain by restrictive layers at depths less than 36 inches.

This relationship between soil limitation and slope provides an easily understood and convenient way to outline restrictions the City may place on delivery of reclaimed irrigation water to avoid development of drainage, erosion, and irrigation water quality problems. These possible crop restrictions and associated management recommendations are discussed more completely in the *Irrigation Management Plan*.

This is a general classification system useful in irrigation planning for large land areas. Slope is easily determined in the field and from topographic maps and soil surveys. More detailed, site-specific information on soils, drainage, wetlands and sensitive biological resources collected at the time of individual irrigation system designs will override the recommended restrictions shown on the land classification maps. For the restricted cultivation category, a conservation plan should be prepared to demonstrate areas considered as restricted for intensive agriculture can be placed in cultivation and still avoid soil erosion and water quality impacts.

In the West County area, slope and often poor drainage or winter ponding provide the greatest limitations on crop choice. Although fruit and vegetable crops can theoretically be grown on slopes up to 25 percent (e.g., with drip irrigation), it is recommended that the City impose restrictions on the use of reclaimed water due to potential concerns over soil erosion and water quality impacts. Soil erosion problems were assessed in *Soil Erosion Evaluation of West and South County Reclamation Alternatives*, Questa Engineering Corp., September, 1995. The limitations and restrictions are discussed more fully in the *Irrigation Management Plan*. Potential crops suitable for the West County area (considering climate and soils) were identified in a consultant's letter/report to Questa Engineering Corporation prepared by Vern Marble, PhD, Emeritus Professor of Agronomy at U.C. Davis.

Based on the irrigation land classification mapping and the limitations and constraints imposed by soil, drainage and slope conditions, potential irrigated crop categories were identified for each land area and slope. These are based on the concept that those crops with the greatest economic return could be grown, and with the understanding that the fruit and vegetable crops would have a higher return on investment than forage crops, and irrigated pasture would have the lowest return.

Although the City can choose to impose some restrictions on which general types of crops can be grown on sloping lands, the City cannot dictate which crops must be grown on private lands. This is the decision of the farmer/rancher. A technical memorandum on cropping scenarios was prepared by Questa Engineering Corp. (July, 1995) which outlines a variety of levels for farming intensity from "Low Tech" (most of the area used as pasture and forage lands) to "High Tech" (most suitable areas planted to vineyards, orchards or fruit and vegetable crops). This report provides an acreage basis for the evaluation of the economic and environmental impacts of conversion of dry-farmed haylands and pasture land to irrigated crop land. Three groupings of potential crop types were utilized in this study.

- Unrestricted cultivated crops (map symbol UC)
- Restricted cultivated crops (map symbol RC)
- Irrigated permanent pasture (map symbol P8)

1. Unrestricted (UC). In the West County area, a UC (unrestricted cultivated crop) potential crop designation was given when the slope was less than five percent and the land classification was either a one or a two. Significant soil wetness often was considered a serious problem for crop cultivation (identified wetland areas were considered Class 6 lands). Potential crops for a UC area would include fruit and vegetable crops with an average consumptive water use of 10.5 inches for drip or micro-irrigated crops (62 percent of 17 inches average fruit and vegetable consumptive water use). Sprinkler irrigation of these lands would have a typical consumptive water use of about 12 inches annually.

2. Restricted (RC). An RC (restricted cultivated crop) potential crop designation was given when the slope was between six and nine percent and the land classification was either a two or a three. Crops recommended for this designation would include forage crops such as oat hay, silage, sudan grass, or field corn. Provided that drip irrigation is utilized and a soil conservation plan developed and implemented, specialty crops such as strawberries, artichokes, cut flowers, and boysenberries may also be grown. These crops are affected by local micro-climates. The average consumptive water use for this classification averaged about 19 inches.

   A special category was assigned under the RC designation for the areas that received a Class 3 land use designation due to a wetness problem and where the current land use was other than NV (native vegetation). The consumptive water use for forage crops grown in an area with a wetness problem was estimated to be 18 inches. These areas were assumed to initiate irrigation later in the season.

3. Irrigated Pasture (P8). A P8 (irrigated permanent pasture) potential crop designation was given when the slope was between 10 and 15 percent, and the land classification was Class 3, 4 or 5. In most cases, the current land use was NV (native vegetation). The consumptive water use for this crop category was determined to average about 19 inches.

3.4 WET AREAS

Indicated wetland areas that had a current land use of NV (native vegetation) were not considered irrigable and received a land use classification of six. In a few cases, wet areas were currently cropped (often prior converted, farmed wetland or wetland pasture) and received a land use designation of RC or P8, depending on slope. Further wetland determination surveys will be required during the irrigation design phase to determine the suitability and desirability of irrigating these areas according to the Food Securities Act guidelines and criteria.

4.0 WATER USE AND WATER MANAGEMENT

4.1 CROP WATER REQUIREMENT

Crop water requirement, or consumptive water use is defined as the depth of water required to meet the evapotranspiration rate of the crop (Etcrop) when soil water is not a limiting factor to plant growth and productivity. The crop water requirement was determined for a variety of crops representative of those that could potentially be grown in several areas of the West County, as previously identified in this report.

The State Water Resources Control Board Report Number 84-1, *Irrigation with Reclaimed Municipal Wastewater, A Guidance Manual* (Pettygrove and Asano, 1984), was used as the basis for developing consumptive water use estimates for the project. The guidance manual offers three alternative approaches for determining normal year reference evapotranspiration (Eto): a) the pan evaporation method; b) area potential evapotranspiration (PET) method; and, c) isoline map method. According to the guidance manual, the isoline map method offers the greatest accuracy in determining Eto and was the method selected for database development. Reference evapotranspiration (ET) isoline maps (by day and month) were used to develop daily reference documentation for crop coefficients. This was supplemented by other data available from the California Department of Water Resources and U.C. Cooperative Extension.

Average rainfall data developed by the U.C. Cooperative Extension, *Climate for Various Location in Sonoma, Napa, Mendocino, Lake and Marin Counties, California,* compiled December 1993, were used as the source of rainfall data for each of the geographic study areas. Where rainfall data were unavailable for any study area, the closest station to the study area that had rainfall data, as shown in the U.C. Extension publication for Sonoma County, was used.

Average consumptive water use by crop was determined by taking monthly Eto data by area and adjusting them for rainfall to develop net monthly evapotranspiration. Crop coefficients for typical growing season conditions were then adjusted against net monthly Eto's (by area) to develop monthly and annual consumptive water use data. Total consumptive water use for each area and crop is summarized in Table 6. This assumes an irrigation season extending from early May through September. A weighted average, taking into account probable irrigated acreages, crop type and soil conditions, was then developed based on cropping patterns similar to the Medium Tech Cropping Scenario (see *Cropping Scenarios Technical Report,* Questa Engineering Corporation, November 1995). Based on this, an overall average of 20 inches of annual consumptive water use is estimated for the West County study area. This includes about two inches of water to establish fall erosion control cover crops on sloping cultivated lands. This average consumptive water use figure does not include an allowance for irrigation inefficiencies.

This consumptive water use demand could decrease significantly if large areas were planted to drip irrigated specialty or horticultural crops. Land requirements could increase 30 to 40 percent (to ± 8,000 acres) above the 6,200 acres currently projected by the water balance for the one-percent river discharge alternative. Virtually all irrigable lands in the West County could be irrigated in this alternative if the area evolves into a large area of drip or micro-irrigated specialty or horticultural crops.

At this point in project planning, consumptive water use estimates and the water balance model are used to provide an approximation of irrigation acreage needed for land application. This irrigation land classification inventory provides a feasibility test between acreage required and acreage suitable for irrigation. Upon project implementation, specific lands of interested farmers and ranches are then identified to meet irrigation land application needs on an on-going basis. Long-term planning will account for increases in wastewater volumes and the evolution and development of actual consumptive water use patterns and irrigation land use changes.

Table 6 Annual Crop Water Uses*

{PRIVATE }CROP	TWO ROCK (Inches)	VALLEY FORD (Inches)
Alfalfa	22.6	21.8
Improved Pasture	19.4	19.1
Vineyards	6.0	5.9
Field Corn	17.1	16.8
Apples	21.0	20.3
Sudan Grass	20.1	18.7
Tomatoes	16.8	16.5

* Does not include correction for irrigation efficiency or cover crop establishment.

4.2 IRRIGATION EFFICIENCY

Irrigation efficiency is defined as the amount of water required by a crop, divided by the amount applied and multiplied by 100. Typical efficiencies for sprinkler irrigation range from 60 to 80 percent, indicating approximately 20 to 40 percent more water is applied to a field beyond crop needs. Irrigation application efficiency is influenced by both system design and system management. In a sense, irrigation efficiency really means “inefficiency.”

Irrigation efficiency has two components: 1) water losses; and, 2) uniformity of application. If either water loss is significant or uniformity of application is low, the irrigation efficiency will also be low. Uniformity losses are predominantly affected by poor irrigation system design or complex topography and contrasting soil patterns while large water losses are almost always a result of poor management that results in runoff and excess deep percolation.

Over-irrigation, or applying more water than needed by the plant and in excess of soil intake rates, is the most significant cause of water loss in an irrigation system. Proper irrigation scheduling is essential if high irrigation efficiencies are desired. An ideal, well designed irrigation system would apply water evenly or uniformly over all parts of a field and at a frequency less than the smallest soil infiltration rate. In practice, this is difficult to achieve, particularly in areas of complex and variable soils and topography. A significant part of sprinkler irrigation system design and water application management is associated with problems of poor irrigation uniformity and soil variability.

The amount of excess water from irrigation lost to runoff and subflow can be reduced in two ways: 1) by increasing uniformity through good design; and, 2) by reducing irrigation applications (essentially under-irrigating). Under-irrigation, which creates a small water deficit in many drought tolerant crops in a portion of a field, results in negligible yield losses if managed correctly. Drought tolerant crops include many of the hay, forage and pasture grasses that can be grown. This type of irrigation management system is termed “deficit irrigation.” Deficit irrigation management is a recommend practice for all drought tolerant or non-water deficit sensitive crops in the West County. This includes irrigated pasture, hay and silage crops. Procedures for deficit irrigation will be based on Chapter 17 of *ASA Monograph on Irrigation Management* and *FAO Irrigation and Drainage Paper No. 33.*

Certain crops, such as lettuce and strawberries, are more sensitive to water deficits, particularly at key points in their growth. These crops do not lend themselves to deficit irrigation management; therefore, they are recommended to be managed by high efficiency irrigation management methods. High irrigation efficiencies can be achieved routinely through use of drip or micro-irrigation wetlands. A high level of care should be provided in scheduling and operating these applications. Only a small portion of the West County area is expected to be converted from dry-farmed oat hay to sprinkler irrigated crops that are not drought tolerant. Therefore, significant problems from careful irrigation of these areas are not expected.

Overall, an irrigation efficiency between 80 and 85 percent is anticipated for the West County area, based on a mix of approximately 80 percent efficiency sprinkler irrigated crops, 85 to 90 percent efficiency drip irrigated specialty crops, and an extensive acreage of deficit irrigated pasture and forage crops targeted at 85 percent efficiency.

4.3 FARM DELIVERY REQUIREMENT

Farm delivery requirement (FDR), or irrigation requirement, is the crop water requirement adjusted for irrigation system efficiency (SE), or:

RDR = Etcrop/SE

Based on a sprinkler irrigation system efficiency of 80 to 85 percent and an average crop consumptive water use of about 20 inches per acre per year, the study area RDR is approximately 23.5 to 24 inches per acre per year, or about 2.0 acre-feet per acre per year. Losses within the delivery system are not included in this figure, only irrigation system inefficiencies such as deep percolation, evaporation, runoff and wind drift that occur after water leaves the sprinkler head. This projected average annual water use in the West County is similar to that estimated by CH2M Hill in their 1990 Technical Memorandum based on the pan evaporation method for irrigated pasture. It is also similar to the calculated average water uses of the existing reclaimed water system.

4.4 IRRIGATION WATER MANAGEMENT

The proper use and management of applied irrigation water to avoid runoff and subsurface flows is critical to the success of the irrigation project and to avoiding adverse wetland and water quality impacts. Irrigation scheduling entails deciding when to irrigate and how much water to apply. The goal of a well managed irrigation scheduling program is to supply the crop with just enough water to meet the desired yield, and thereby minimize the loss of applied water to runoff, deep percolation or subflow. A high level of control can be provided in irrigation scheduling by direct participation in the irrigation programming by City reclamation staff and through the use of state-of-the-art irrigation scheduling technology, including automated real-time irrigation weather forecasting systems (CIMIS), the use of electronic soil moisture probes, and irrigation scheduling software. High efficiency irrigation management, including deficit irrigation management techniques, are recommended for use in the West County. This subject area is discussed in more detail in the *Irrigation Management Plan*.

4.5 WATER QUALITY AND SALT MANAGEMENT LEACHING REQUIREMENTS

The quality of the reclaimed water for agricultural irrigation purposes is high. A separate technical memorandum discusses water quality in more detail (see *Irrigation Water Quality and Salt Management Leaching Requirements*, Questa Engineering Corporation, January, 1996). The analysis in this report concludes that additional irrigation water applications for leaching and salt management are not required because of the high quality (low total dissolved solids) of the water and the natural leaching provided by winter rains in this region.

4.6 DRAINAGE MANAGEMENT

A high percentage of West County project areas have existing conditions of seasonal high groundwater or soil conditions (moderately deep restrictive layers) that are barriers to deep water percolation. Unless irrigated carefully, these areas could develop drainage problems. The rising groundwater table resulting from the cumulative addition of irrigation water perching on subsurface restrictive layers can significantly impact the agricultural viability of such drainage-effected farmlands. Without drainage improvements and under poor irrigation management, crop yields will begin to decrease, particularly in lower-lying or poorly drained portions of fields. In very wet years crops in portions of poorly drained fields can be “flooded-out.” Drainage problems can also cause a shift to growing more water tolerant and less intensive crops, such as pasture.

In general, because of undesirable impacts to surface water quality and aquatic biota, large-scale drainage improvements, such as tile drain lines and surface drainage ditches, will not be considered for the West County project areas. Such drainage improvements were identified as being potentially necessary for many of the valley bottom lands in the 1990 CH2M Hill Technical Report. The authors proposed a “wait and see” approach, with subsurface drainage improvements to be installed where needed following implementation of the irrigation project. Drainage improvements may be considered on a small localized basis (i.e. a portion of a field).

Correct irrigation management practices and avoiding lands particularly subject to development of drainage problems will be the keys to containing existing drainage problems and preventing more serious drainage problems. As identified in the *Irrigation Management Plan*, the following management practices are recommended to be utilized to avoid development of drainage problems:

1. Existing very poorly drained areas, areas with shallow restrictive layers, or areas with significant wetlands or other biological resources, as shown on the project irrigation suitability maps, generally should be considered unsuited for irrigation. These designations will be confirmed at the design level of the project.

2. Crop choice will generally be restricted to irrigated pasture for: a) suitable lands with potential drainage problems; b) somewhat poorly drained areas; and, c) areas with deeper restrictive layers or isolated, low value wetlands. More water tolerant crops such as fescue trefoil-clover pasture mixes can be grown in these areas.

3. A high level of irrigation management should be targeted through technical innovations. Over-irrigation, or application of irrigation water in excess of crop consumptive water demand should not be permitted. Over-irrigation of lands with problem soils is the most common cause of drainage problem development. Such “source control” measures are often cited as the most appropriate management practice for drainage problems.

4. Water levels in fields should be closely monitored and irrigation management (irrigation scheduling) adjusted accordingly. Occasional summer fallowing (e.g., growing a dry-land hay crop, or crop with greatly reduced irrigation application) may be needed (i.e., one year in five or seven) for problem sites which are developing drainage problems. This will allow the periodic re-establishment of the original water table and drainage condition.

5. Small scale drainage improvements (ditches and tile drain systems) will be considered for portions of fields where the above recommended management practices are insufficient to preclude localized development of drainage problems affecting crop performance.

4.7 TRACE METALS LOADING

A separate technical memorandum discusses the potential build-up of toxic levels of trace metals in the soil from metals contained in applied irrigation water (see *Trace Metals Loading Analysis*, Questa Engineering Corporation, March, 1996). The report concludes that there is no danger of toxic metal build-up in the soil from long-term applications of irrigation water throughout the life of the project (100+ years), because of the high quality (low metals content) of the reclaimed water.

5.0 SPECIAL CONSIDERATIONS AND RECOMMENDATIONS

1. Evaluations regarding drainage requirements assume a high degree of irrigation efficiency (80+ percent) and farm management. Such high levels of efficiency can only be achieved with a carefully managed, coordinated sprinkler system. If careful water management is not practiced, water logging of the soils during the growing season, excessive runoff and deep percolation, and accelerated soil erosion may occur. These may result in water quality and biological impacts.

2. Irrigation should be scheduled using a soil moisture depletion inventory method. This may require continual soil moisture and climatic monitoring throughout the growing season. The services of a professional irrigation management service or staff irrigation specialist should be considered in this regard.

3. Even careful irrigation of some marginal lands may result in the development of drainage problems in bottom lands, and increased erosion and mass movement on steeper slopes. Extensive areas of soils with barriers to water movement less than 30 inches deep or on steeper slopes should not be irrigated. Some such areas may have been missed during the soil survey and can be identified during design level studies. Small incidental acreages with these soil conditions could be included in an irrigation system layout as a practical matter so as not to overly dissect field boundaries.

4. Delineations of land classification map unit boundaries and composition, and representations regarding subsurface conditions, especially with respect to soil depth to barrier, are approximate. Unnamed inclusions of soils with more limiting properties occur in map units because of the complexity of natural systems and the assumptions that must be made in land classification mapping. Examples of these inclusions are shallower soils, wetter soils, and differences in slope relative to representations made on the land classification maps. For these reasons, the agricultural productivity of small areas within arable delineations may be diminished as a result of irrigation. Additional field investigations at the time of irrigation system design are warranted in complex soil areas and where field access was not allowed.

5. All significant wetlands and stream corridors in the survey area should be avoided in the irrigation system layout. Stream and wetland buffers, riparian restoration and streambank stabilization measures should be considered in the irrigation design of farms and ranches. This issue is addressed further in the IMP and the *Wetlands Determination - Agricultural Areas Technical Memorandum* prepared by Parsons Engineering Science (May 1996).

GENERAL INSTRUCTIONS

SYMBOLS USED FOR THE IRRIGATION SUITABILITY LAND CLASSIFICATION MAPS CLASSIFY AND DESCRIBE DEFINED PARCELS FOR AGRICULTURAL IRRIGATION. EACH SYMBOL MAY BE PARSED INTO FOUR COMPONENTS DELIMITED BY A SLASH MARK (/). THE FOUR COMPONENTS ARE:

1) CURRENT LAND USE CLASSIFICATION – THIS PARAMETER DEFINES THE SUITABILITY OF THE INDICATED AREA FOR IRRIGATION. THERE ARE SEVEN SUITABILITY CLASSES; 1 IS THE MOST SUITABLE AND 5 IS THE LEAST SUITABLE. 0 AND 6 REPRESENT WATER COURSES THAT ARE NOT SUITABLE FOR IRRIGATION (0=PONDS; 6=RIPARIAN). SUITABILITY IS AFFECTED IN PART BY SLOPE AND COMPOSITION OF THE SOIL.

2) CURRENT LAND USE – THIS PARAMETER DEFINES THE LAND USE PRESENTLY OBSERVED FOR THE INDICATED AREA. ABBREVIATIONS FOR THIS PARAMETER ARE ADOPTED FROM THE CALIFORNIA DEPARTMENT OF WATER RESOURCES (DWR) STANDARD LAND USE LEGEND. AN EXISTING LAND USE LEGEND FOR THE SOUTH AND WEST COUNTY IS PROVIDED ON THIS SHEET.

3) POTENTIAL CROPS – THIS PARAMETER DEFINES THE HIGHEST AGRICULTURAL LAND USE POSSIBLE FOR THE INDICATED AREA. POTENTIAL CROP RESTRICTIONS ARE IMPOSED ON PROJECT LANDS, BASED ON SOILS AND SLOPES. THESE ARE DESCRIBED IN THE IRRIGATION MANAGEMENT PLAN. SYMBOLS AND EXPLANATIONS ARE PROVIDED ON THIS SHEET UNDER "POTENTIAL CROP LEGEND."

4) CONSUMPTIVE WATER USE – THE AMOUNT OF WATER, IN INCHES PER ACRE, ESTIMATED FOR APPLICATION TO THE INDICATED AREA ON AN ANNUAL BASIS.

EXAMPLE: 4/NV/RC/24" – THIS SYMBOL REPRESENTS:

1) CURRENT LAND USE CLASSIFICATION – LAND USE CLASS 4
2) CURRENT LAND USE – NV OR "NATIVE VEGETATION"
3) POTENTIAL CROPS – RC OR "RESTRICTED CULTIVATION"
4) CONSUMPTIVE WATER USE – 24 INCHES PER ACRE ANNUALLY

SYMBOL NOTES:

A) FOR ANY OF THE FOUR COMPONENTS, A POUND SIGN (#) REPRESENTS A BLANK OR NO AVAILABLE DATA.

B) SOME SYMBOLS HAVE ONLY ONE OR TWO COMPONENTS. SINGLE-COMPONENT SYMBOLS REPRESENT CURRENT LAND USE ONLY.

EXAMPLE: SR = SUBURBAN RESIDENTIAL

TWO-COMPONENT SYMBOLS REPRESENT BOTH CURRENT LAND USE CLASSIFICATION AND CURRENT LAND USE.

EXAMPLE: 0/NW = LAND USE CLASSIFICATION "0" FOR PONDS AND CURRENT LAND USE "NW" FOR WATER SURFACE AND WETLAND CORRIDOR

EXISTING LAND USE LEGEND

D1	APPLE ORCHARD
D8	PRUNE ORCHARD
D10	MISCELLANEOUS DECIDUOUS ORCHARD
D13	WALNUT ORCHARD
F6	CORN
F7	GRAIN, SORGHUM
F11	MISCELLANEOUS FIELD CROPS
G6	MISCELLANEOUS MIXED HAY AND GRAIN
I1	LAND CROPPED IN THE LAST 3 YEARS BUT NOT CURRENTLY TILLED
NR1	RIPARIAN HABITAT – MARSH
NV	NATIVE VEGETATION (RANGE LAND)
NV-P	PARK
NW	WATER SURFACE AND WETLAND CORRIDOR
P3	MIXED PASTURE
P4	NATIVE PASTURE
RT	RECREATIONAL VEHICLE-CAMP SITES
S1	FARMSTEAD
S2	FEEDLOTS
S3	DAIRY
SR	SUBURBAN RESIDENTIAL
T9	MELONS, SQUASH, CUCUMBERS
T12	POTATOES
T18	MISCELLANEOUS TRUCK CROPS
U	URBAN
U12	EXTRACTIVE INDUSTRIES
UR	URBAN RESIDENTIAL
V	VINEYARD

PREFIXES TO LAND USES FOR IRRIGATED OR NONIRRIGATED AGRICULTURAL CLASSES:

1) "i" DENOTES AN IRRIGATED CROP
EXAMPLE: "iV" = IRRIGATED VINEYARD

2) "n" DENOTES A DRY-FARMED CROP
EXAMPLE: "nD1" = NONIRRIGATED APPLE ORCHARD

POTENTIAL CROP LEGEND

SEBASTOPOL/CAMP MEEKER AREA:

UTDV	UNRESTRICTED CULTIVATED CROPS – NO RESTRICTIONS PLACED ON CROP CHOICE WITHIN AREA; MOST OF AREA IS IN ORCHARDS AND VINEYARDS
RTDV	RESTRICTED CULTIVATED CROPS – SPECIALTY, TRUCK, VINEYARDS, AND ORCHARDS CAN BE GROWN IN THESE AREAS; BUT WILL REQUIRE CITY APPROVAL AND A CONSERVATION PLAN
G6-P8	IRRIGATED PASTURE AND HAY – AREA SUITABLE FOR IRRIGATED HAY AND PASTURE CROPS; OTHER CULTIVATED CROPS WILL REQUIRE CITY APPROVAL AND A CONSERVATION PLAN

WEST COUNTY, EAST OF ROHNERT PARK, NORTH PETALUMA VALLEY, ADOBE ROAD, LAKEVILLE, AND BAYFLATS:

UC	UNRESTRICTED CULTIVATED CROPS – NO RESTRICTIONS PLACED ON CROP CHOICE WITHIN AREA
RC	RESTRICTED CULTIVATED CROPS – GENERALLY IRRIGATED HAY AND PASTURE CAN BE GROWN; OTHER IRRIGATED CULTIVATED CROPS WILL REQUIRE CITY APPROVAL AND A CONSERVATION PLAN
P8	IRRIGATED IMPROVED PASTURE – GENERALLY ONLY IMPROVED PASTURE IS SUITABLE FOR THESE AREAS; OTHER IRRIGATED CULTIVATED CROPS WILL REQUIRE CITY APPROVAL AND A CONSERVATION PLAN

GRAPHIC NOTE:

A) SOME RIPARIAN CORRIDOR BOUNDARIES HAVE BEEN EXAGGERATED SLIGHTLY FOR GRAPHIC PURPOSES. THE OFFSET FOR THE RIPARIAN CORRIDORS IS TYPICALLY 66-99 FEET AND WIDENS TO INCLUDE WETLAND BOUNDARIES.

NO.	DATE	REVISIONS	BY			
				PROJECT NO	723129	DATE
				DESIGNED BY:	QUESTA ENGINEERING	8/95
				DRAWN BY:	ALAN MARSHALL	8/95
				CHECKED BY:	QUESTA ENGINEERING	8/95

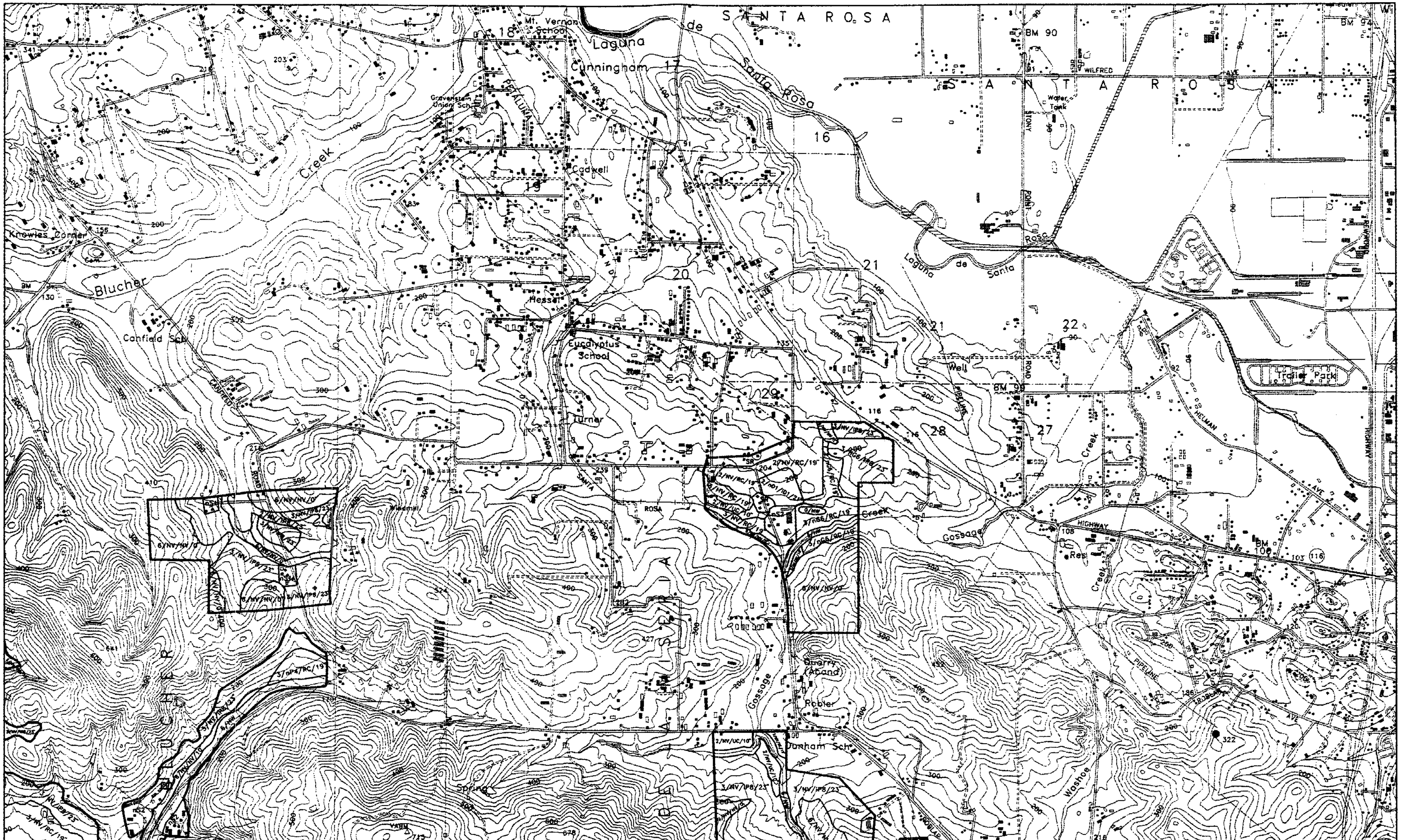
HARLAND BARTHOLOMEW AND ASSOCIATES
PARSONS ENGINEERING SCIENCE
PARSONS
OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION SYMBOLS AND ABBREVIATIONS

SCALE
SHEET NO. A-1-1
SHEET OF



NO.	DATE	REVISIONS	BY			
				PROJECT NO	723129	DATE
				DESIGNED BY:	QUESTA ENGINEERING	8/95
				DRAWN BY:	ALAN MARSHALL	8/95
				CHECKED BY:	QUESTA ENGINEERING	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES
PARSONS ENGINEERING SCIENCE
PARSONS
OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

1000' 0 1000' 2000'
SCALE:
CONTOUR INTERVAL: 40ft./20ft.

A	B
	D

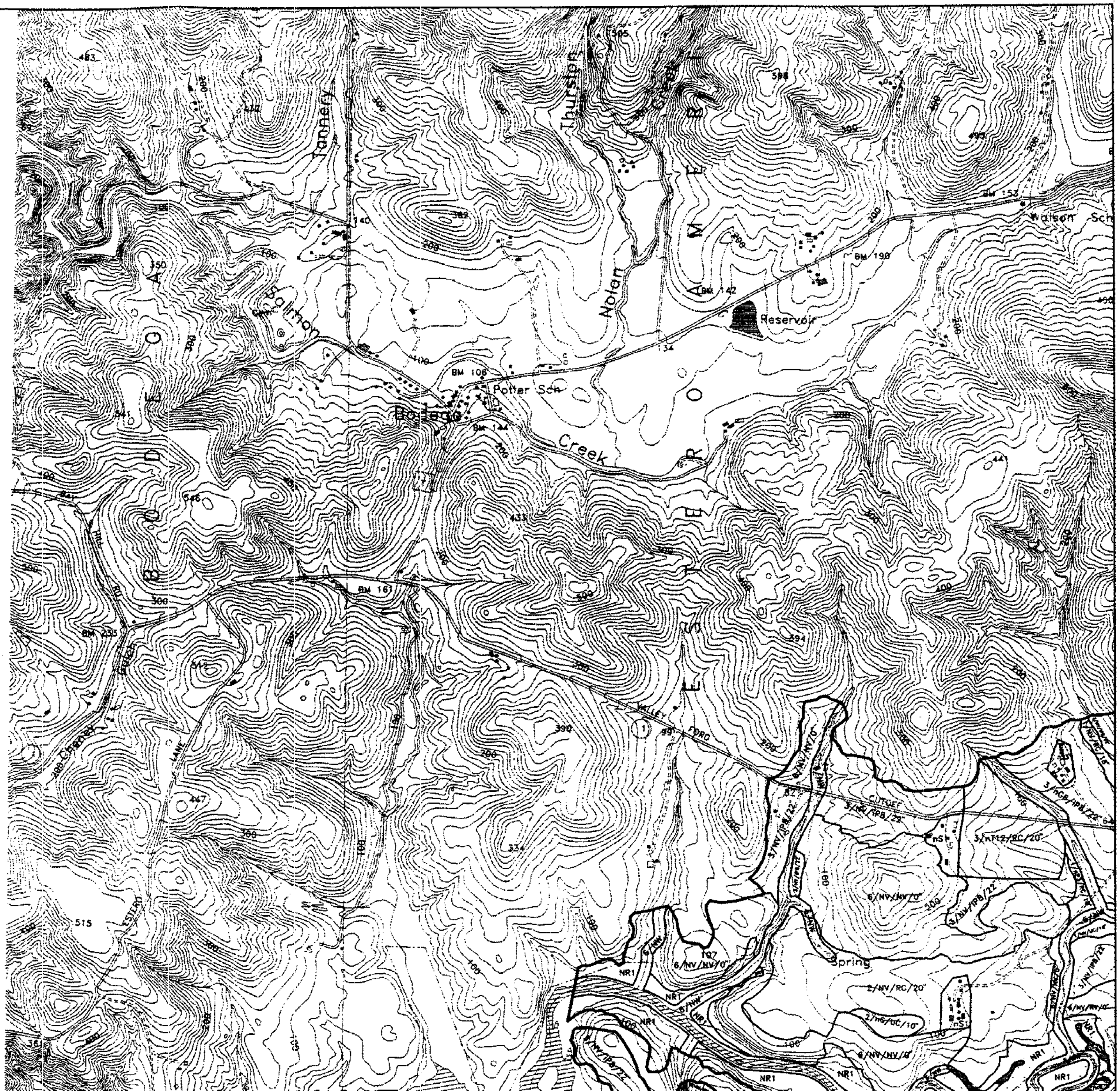
SHEET LOCATION

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE AS SHOWN
SHEET NO. F-2C-1
SHEET OF

AUG 30, 1995 - 09:29:10
ENG_DWG\STR\F-2C_1



D BARTHOLOMEW AND ASSOCIATES
RSONS ENGINEERING SCIENCE
SONS
OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

SCALE: 1000' 0 1000' 2000'

CONTOUR INTERVAL: 40ft./20ft.

SHEET LOCATION: A B / C D

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE: AS SHOWN

SHEET NO: F-3C-1

SHEET of

AUG 30, 1995 - 09:48:34 ENG_DWG\STR\F-3C_1

NO.	DATE	REVISIONS	BY

PROJECT NO	723129	DATE
DESIGNED BY:	QUESTA ENGINEERING	8/95
DRAWN BY:	ALAN MARSHALL	8/95
CHECKED BY:	QUESTA ENGINEERING	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES

PARSONS ENGINEERING SCIENCE

PARSONS

OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

1000' 0 1000' 2000'

SCALE:

CONTOUR INTERVAL: 40ft./20ft.

A	B
C	

SHEET LOCATION

ALTERNATIVES 2 & 3

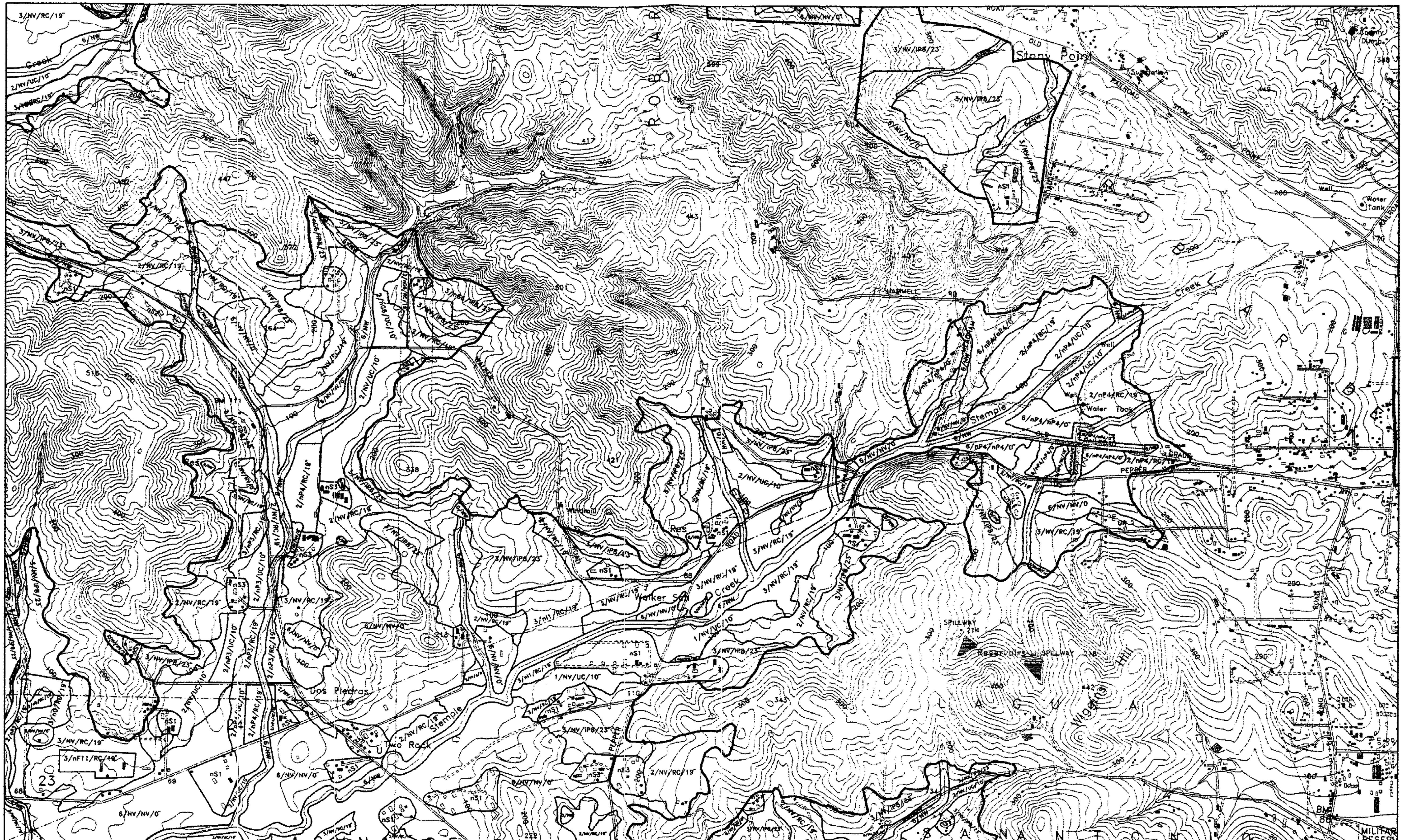
IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE AS SHOWN

SHEET NO. F-30-1

SHEET OF

AUG 30, 1995 – 10:07:15 ENG_DWG\STR\F-30_1



PROJECT NO.	723129	DATE
DESIGNED BY:	QUESTA ENGINEERING	8/95
DRAWN BY:	ALAN MARSHALL	8/95
CHECKED BY:	QUESTA ENGINEERING	8/95
NO.	DATE	REVISIONS	BY

HARLAND BARTHOLOMEW AND ASSOCIATES

PARSONS ENGINEERING SCIENCE

PARSONS — OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

SCALE: 1000' 0 1000' 2000'

CONTOUR INTERVAL: 40ft./20ft.

SHEET LOCATION: A B C D

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE: AS SHOWN

SHEET NO. G-2A-1

SHEET of

AUG 30, 1995 - 10:18:27 ENG_DWG\STP\G-2A_1

NO	DATE	REVISIONS	BY

PROJECT NO.	723129	DATE
DESIGNED BY:	QUESTA ENGINEERING	8/95
DRAWN BY:	ALAN MARSHALL	8/95
CHECKED BY:	QUESTA ENGINEERING	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES
PARSONS ENGINEERING SCIENCE
PARSONS
OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

1000' 0 1000' 2000'
SCALE:
CONTOUR INTERVAL: 40ft./20ft.

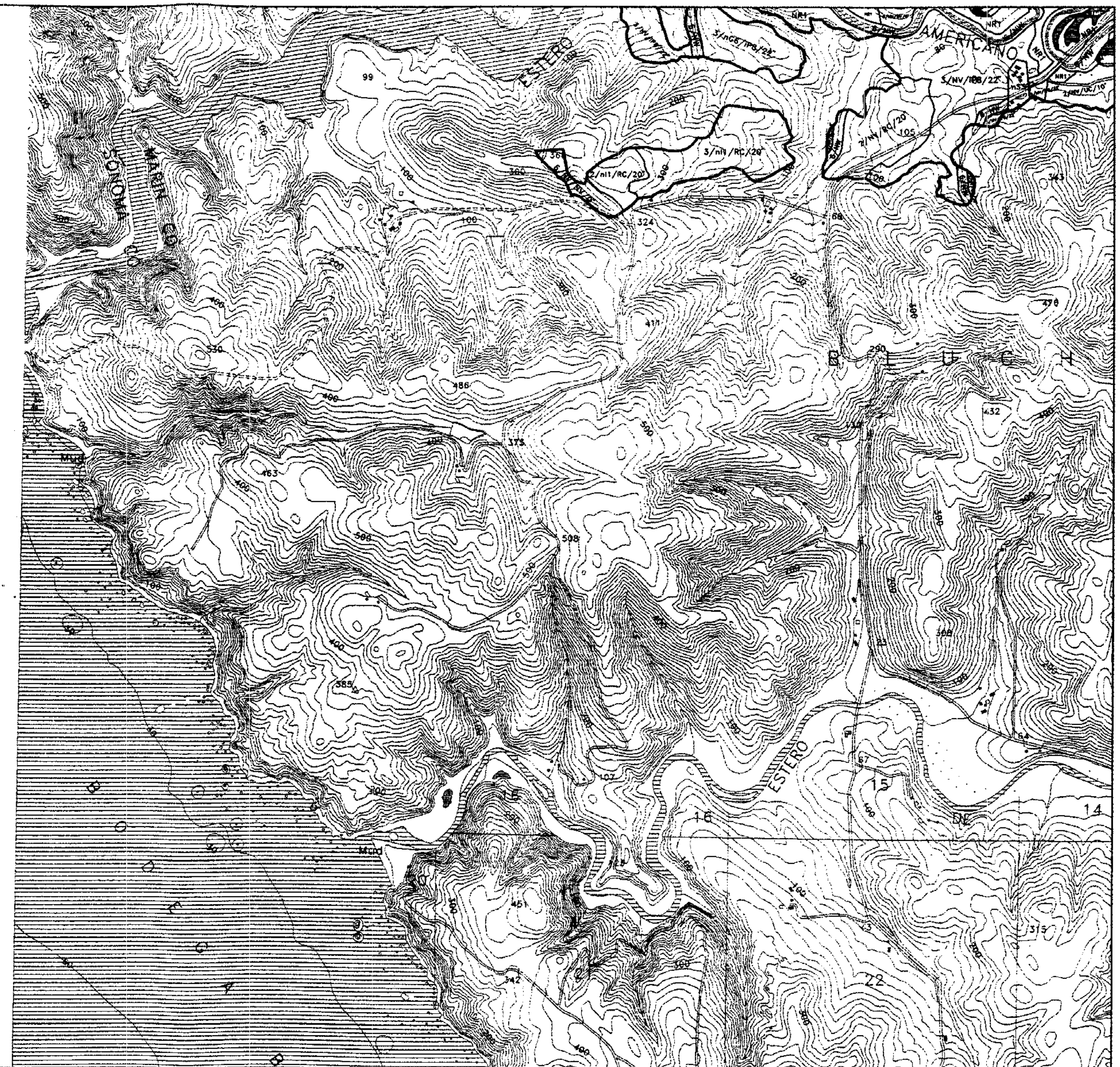
A B D
SHEET LOCATION

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE AS SHOWN
SHEET NO. G-2C-1
SHEET of

AUG 30, 1995 - 10:48:21



NO.	DATE	REVISIONS	BY

PROJECT NO	723129	DATE
DESIGNED BY:	QUESTA ENGINEERING	8/95
DRAWN BY:	ALAN MARSHALL	8/95
CHECKED BY:	QUESTA ENGINEERING	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES
PARSONS ENGINEERING SCIENCE
PARSONS
OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

1000' 0 1000' 2000'
SCALE:
CONTOUR INTERVAL: 40ft./20ft.

B
C D
SHEET LOCATION

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE AS SHOWN
SHEET NO. G-3A-1
SHEET OF

AUG 30, 1995 - 11:10:39 ENG_DWG\STR\G-3A_1

NO.	DATE	REVISIONS	BY

PROJECT NO	723129	DATE
DESIGNED BY:	QUESTA ENGINEERING	8/95
DRAWN BY:	ALAN MARSHALL	8/95
CHECKED BY:	QUESTA ENGINEERING	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES

PARSONS ENGINEERING SCIENCE

PARSONS

OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

SCALE: 1000' 0 1000' 2000'

CONTOUR INTERVAL: 40ft./20ft.

A | B
C | D

SHEET LOCATION

ALTERNATIVES 2 & 3

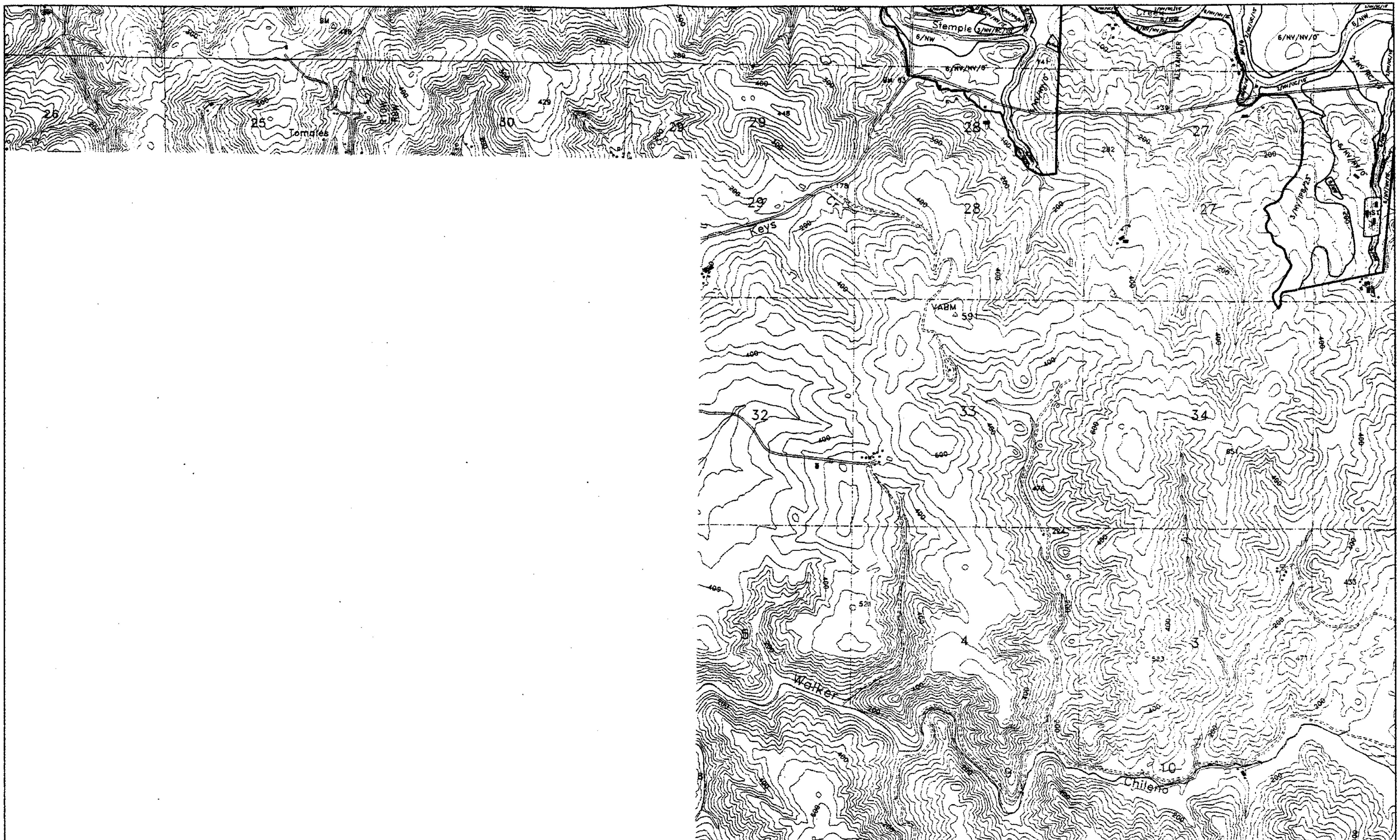
IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE: AS SHOWN

SHEET NO. G-3B-1

SHEET OF

AUG 30, 1995 - 11:18:45 ENG_DWG\STR\G-3B_1



				PROJECT NO. 723129	DATE
				DESIGNED BY: QUESTA ENGINEERING	8/95
				DRAWN BY: ALAN MARSHALL	8/95
NO.	DATE	REVISIONS	BY	CHECKED BY: QUESTA ENGINEERING	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES
PARSONS ENGINEERING SCIENCE
PARSONS
OFFICES IN PRINCIPAL CITIES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

1000' 0 1000' 2000'
SCALE:
CONTOUR INTERVAL: 40ft./20ft.

A	B
C	

SHEET LOCATION

ALTERNATIVES 2 & 3

IRRIGATION SUITABILITY LAND CLASSIFICATION

SCALE AS SHOWN
SHEET NO. G-3D-1
SHEET of

AUG 30, 1995 - 11:28:01 ENG_DWG\STR\G-3D_1