CABY Integrated Regional Water Management Group
2014 IRWM Drought Grant Solicitation

Attachment 3: Project Physical Benefits Table 5-- References

Attached are the references that relate to Table 5 Project Physical Benefits Tables for project:

- Georgetown Divide PUD Water Conservation, Supply Reliability and Environmental Protection Project

DROUGHT PLAN
FOR
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

December 2007

This report reflects a general approach that is subject to Georgetown Divide Public Utility District staff and Board of Director discretion and declaration.

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December 17, 2007

BROWN AND CALDWELL

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017-130868-001

Subject: Drought Plan for Georgetown Divide Public Utility District

Dear Mr. White and Mr. Hetland:

We are pleased to submit to you this Drought Plan for the Georgetown Divide Public Utility District. Drought preparedness is an essential element of the long-term water supply planning for El Dorado County. The Brown and Caldwell team has delivered a drought plan that presents the actions and procedures for preparing, identifying, and responding to a drought.

We enjoyed working with you and look forward to your feedback on this important project. Please contact Tess Kretschmann, Lisa Maddaus or myself at (916) 444-0123 to discuss this project report in further detail.

Sincerely,

BROWN AND CALDWELL

Paul Selsky, PE
Vice President

PS:ds
Enclosures

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LIST OF ACRONYMS

ac-ft	Acre-feet
Ag	Agricultural
County	El Dorado County
CUWCC	California Urban Water Conservation Council
DAC	Drought Advisory Committee
DICC	Drought Interagency Coordination Committee
DMM	demand management measures
DSR	days supply remaining
DWR	Department of Water Resources
EDCWA	El Dorado County Water Agency
EID	El Dorado Irrigation District
ENSO	El Nino Southern Oscillation
GDPUD	Georgetown Divide Public Utility District
GFCSD	Grizzly Flats Community Service District
IMS	Irrigation Management System
NOAA	National Oceanic & Atmospheric Administration
OES	Office of Emergency Services
Plan	drought preparedness and response plan
SMUD	Sacramento Municipal Utility District
SRI	supply remaining index
SVM	Shared Vision Model
UARP	Upper American River Project
USACE	United States Army Corps of Engineers
UWMP	Urban Water Management Plan
WTP	Water Treatment Plant

DROUGHT ACTION PLAN

Georgetown Divide Public Utility District (GDPUD) drought stage water supply conditions, objectives, and response actions including water use reduction targets, are summarized in Table 1. The Drought Plan involves an introductory Stage 1 drought response during which all customers are informed of drought. In Stage 1 total potable water customer demand reduction is targeted for 15 percent; raw water deliveries are managed at 50 percent. At Stage 2 water use decisions continue to be entrusted to the customer as long as the overall rationing goal for potable water customers of 30 percent is met; this is a voluntary/honor system approach. In Stage 2 raw water customers are curtailed up to 50 percent. If Stage 2 fails, then a strict allotment approach is implemented with a stiff penalty rate in Stage 3 with a total demand reduction goal of up to 50 percent for potable water customers and up to 100% for raw water customers.

Table 1. Drought Plan Summary

Water supply conditions	Drought stage	Objective	Response actions
Normal 0% Total Supply Reduction	None - Ongoing conservation measures; water waste ordinance in effect.	Public awareness	Normal actions
Slightly Restricted Water Supplies (below normal) Up to 15% Total Supply Reduction	Drought Stage 1 - Voluntary reductions in use. Managed raw water supplies.	Initiate public awareness of predicted water shortage and encourage conservation. Reduce raw water deliveries	Encourage voluntary measures to decrease "normal" demand up to 15%. Raw water deliveries curtailed up to 50%
Moderately Restricted Water Supplies Up to 30% Total Supply Reduction	Drought Stage 2 – Voluntary reductions on use. Managed raw water supplies.	Increase public understanding of worsening water supply conditions, encourage voluntary conservation measures. Reduce raw water deliveries	Encourage some voluntary measures to decrease "normal" treated water demand up to 30%. Raw water deliveries curtailed up to 50% Surcharge enacted
Severely Restricted Water Supplies Up to 50% Total Supply Reduction	Drought Stage 3 – Mandatory restrictions (severe prohibitions) on use	Ensure that water use is limited to health and safety purposes	Enforce extensive restrictions on water use and implement water rationing to decrease potable water demand up to 50% and raw water deliveries up to 100%

Ongoing Drought Plan Implementation Actions

Ongoing Drought Plan implementation actions will be completed both during periods of non-drought and drought periods. These activities can be characterized as proactive actions that prepare for drought through monitoring, public outreach, and resource management practices.

Policy and regulation

1. Review and update Drought Plan every 5 years or as needed based on new supply, operational changes, or change in expected water demand.
2. Enforce water waste ordinance.
3. Continue conservation policies and promote water-efficient plumbing codes.
4. Continue and advance Irrigation Management System (IMS) program.
5. Continue to evaluate new requests for agricultural service annually based on available supply. Permits not granted unless sufficient capacity to meet the service requested.
6. Review and refine rate stabilization policy relating to drought impacts every 5 years.
7. Understand and comply with legal and regulatory requirements for drought management.

Monitoring

1. Assess drought indicators and triggers quarterly.

Table 2. GDPUD Trigger Plan

Drought Stage	Stumpy Meadows Reservoir Level on 2nd Wed. in April	Response actions	
		Potable water customer cutbacks	Raw water managed supply cutbacks
1	17,000 ac-ft	Up to 15%	Up to 50%
2	15,000 ac-ft	Up to 30%	Up to 50%
3	13,000 ac-ft	Up to 50%	Up to 100%

2. Monitor system demands.

Public outreach

1. Develop and maintain drought awareness and public education materials, tools, and protocol.
2. Continue water efficiency programs including limiting sidewalk washing, car washing without a shutoff nozzle, and fixing leaks within 72 hours.
3. Develop website link for "Drought Stage" information.

Resource management

1. Maintain interagency coordination annually as shown in Figure 1. Figure 1 depicts the type and frequency of interagency coordination activities that will be pursued by the Drought Interagency Coordination Committee (DICC).
2. Confirm and maintain commitment of Drought Advisory Committee (DAC) members as shown in Figure 2. Figure 2 depicts the suggested interagency organizational structure.
3. Pursue development of potential drought impact avoidance projects.
   - Rubicon Supply Alternative 1A
   - Rubicon Supply Alternative 1B & PL101-514 supply
   - Additional water conservation
   - Canyon Creek Reservoir
   - Ditch lining
4. Consider establishing trucking contracts for water hauling.

5. Consider constructing tap manifolds for emergency water distribution through hydrants.
6. Establish procedure by which residents on wells within GDPUD service area apply for emergency relief.

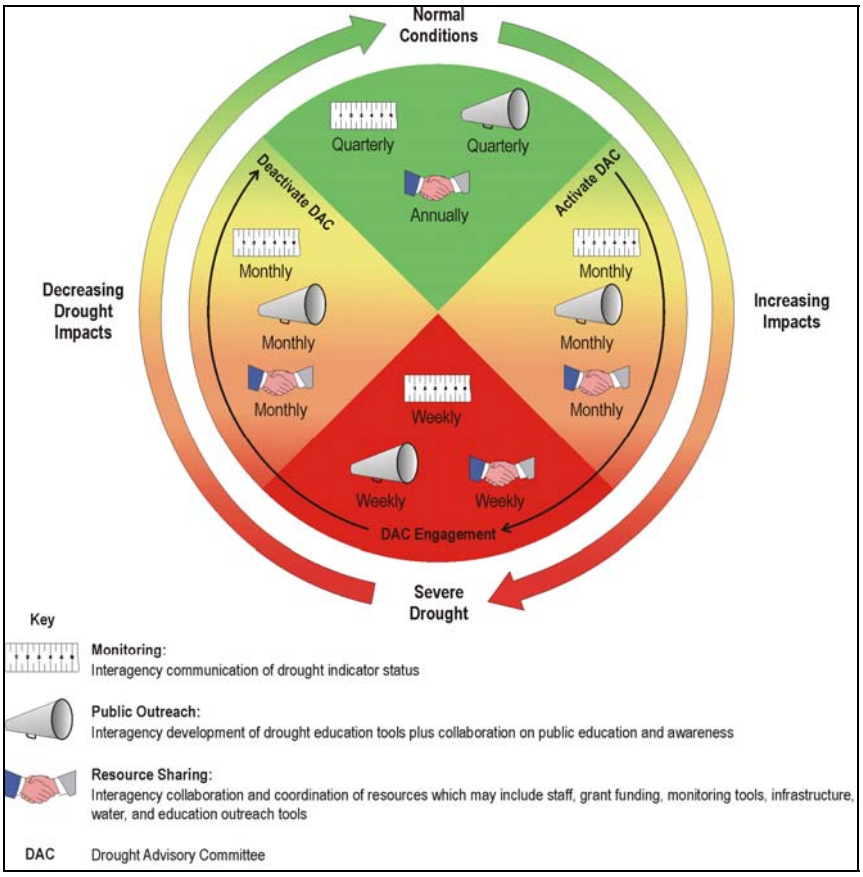


Figure 1. Drought Interagency Coordination Committee Activities

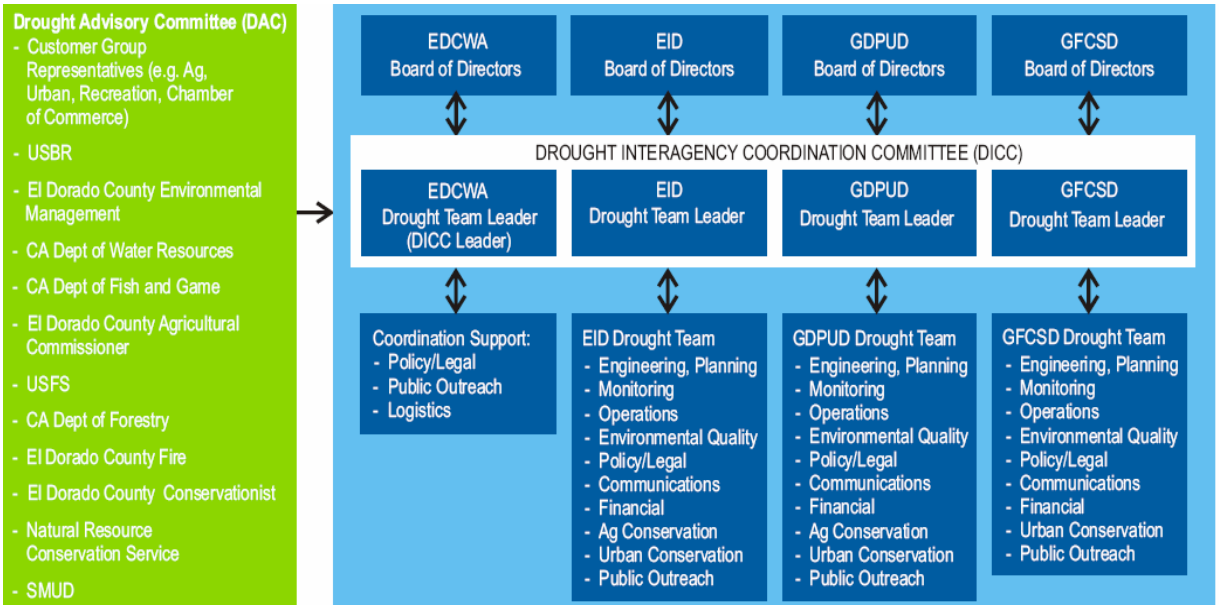


Figure 2. Drought Interagency Organization Structure

Drought Stage 1 Actions

Drought Stage 1 actions are intended to initiate public awareness of water shortages and encourage conservation. Stage 1 actions target a 15 percent demand reduction in potable water use through implementation of voluntary measures. Raw water deliveries are curtailed by up to 50 percent.

Policy and regulation

1. Implement Stage 1 water shortage response measures. Potable water customers are suggested to:
   - Apply irrigation water only during the evening and early morning hours (8 PM to 6 AM) to reduce evaporation losses.
   - Inspect all irrigation systems, repair leaks, and adjust spray heads to provide optimum coverage and eliminate avoidable over-spray.
   - Change the minutes of run-time for irrigation valves consistent with fluctuations in weather as determined by evapotranspiration data obtained from GDPUD or El Dorado County Water Agency (EDCWA).
   - Reduce minutes of run-time for each irrigation valve if water run-off (gutter flooding) is occurring.
   - Utilize water conservation incentive, rebate, and giveaway programs to replace high water-using plumbing fixtures and appliances with water efficient models.
   - Take advantage of the free information available from GDPUD on how to use water efficiently, read a water meter, repair leaks, and irrigate efficiently.
   - Do not refill a swimming pool that had been drained.
   - Fix leaks.
   - Wash vehicles from a bucket. Use a hose equipped with a shutoff nozzle for a quick rinse (commercial car washes exempted).

Affects on raw water customers are as follows:

- GDPUD Board has the discretion to limit new agricultural customers at any time if necessary. New requests for agricultural service are evaluated annually based on available supply and will not be permitted unless there is sufficient capacity to meet the service requested.
- Raw water deliveries curtailed up to 50 percent.
- Alternating days of managed raw water supply deliveries.
- The irrigation season, generally from May 1 to October 1, may be delayed.

2. Drought Team Leader provides monthly updates on drought status to GDPUD management.
3. GDPUD management provides monthly updates to Board.

Monitoring

1. Assess current drought stage monthly with current demand and supply information.
2. Consider potential future hydrologic conditions.
3. Monitor water demand monthly to assess water savings accomplished.

Public outreach

1. Initiate community-oriented drought awareness with focus on community water use reduction goals and range of voluntary steps to accomplish savings.
2. Reacquaint customers with GDPUD's Water Waste Prohibitions and introduce Stage 1 recommended water shortage response measures.
3. Inform agricultural customers of managed supply curtailment
4. Provide monthly updates to public on current drought stage.
5. Provide monthly updates to public on community demand response status.
6. Implement procedure for customer reporting of water waste.

Resource management

1. Monthly Drought Interagency Coordination Committee (DICC) meetings.
2. Confirm commitment by Drought Advisory Committee (DAC) members.

Drought Stage 2 Actions

Drought Stage 2 action items are intended to increase public understanding of worsening water supply conditions and encourage voluntary conservation measures by potable water customers to decrease "normal" demand up to 30 percent. In Stage 2, raw water deliveries continue to be curtailed by up to 50 percent. Stage 2 activities include a continuation of activities described previously under the Stage 1 actions and ongoing actions.

Policy and regulation

1. Implement Stage 2 water shortage response measures, including a continuation of Stage 1 activities. The following are recommendations to potable water customers:
   - Limit water use up to 30 percent of "normal" amount used.
   - No watering of any existing turf grass, ornamental plant, garden, landscaped area, tree, shrub or other plant except from a hand held hose or container or drip irrigation system.
   - No watering of new turf grass or replacement turf grass.
   - No initial filling of any swimming pool.
   - No automatic serving of drinking water at dining establishments except with patron request.
   - No new domestic accounts accepted unless the parcel has been assessed for improvements through a legal process.
   - Curtailment of any use of water from a fire hydrant, except for fighting fires, human consumption (hauling allowed to persons whose wells have gone dry), stock water, essential water quality flushing, and toxic clean-up purposes.

   Affects on raw water customers are as follows:
   - GDPUD Board has the discretion to limit new agricultural customers at any time if necessary
   - Raw water deliveries curtailed up to 50 percent.
   - Managed supply of alternating days with preference given to IMS program members.
   - The irrigation season, generally from May 1 to October 1, may be delayed or shortened.
2. Drought Team Leader provides weekly updates on drought status to GDPUD management.
3. GDPUD management provides at least monthly updates to Board.
4. GDPUD management provides the Board of Directors with an assessment of the need to enact a drought surcharge.

Monitoring

1. Assess current drought stage every two weeks with current demand and supply information.
2. Consider potential future hydrologic conditions.
3. Monitor water demand weekly to assess water savings accomplished.

Public outreach

1. Accelerate community-oriented drought awareness with focus on community water use reduction goal and range of voluntary steps to accomplish savings.
2. Inform agricultural customers of managed supply of up to 50 percent curtailment.
3. Reinforce with customers the GDPUD Water Waste Prohibitions and Stage 2 voluntary recommended water shortage response measures.
4. Customers are informed that individual meter records will not be audited or fees levied if overall water use reduction goal is achieved.
5. Customers who can conserve more are strongly encouraged to help customers who would incur economic hardship if they met the reduction levels cited.
6. Provide weekly updates to public on current drought stage.
7. Provide weekly updates to public on community demand response status.

Resource management

1. Weekly DICC meetings to coordinate on monitoring, public outreach, current status, and opportunities for resource sharing.
2. Enact participation by DAC members.

Drought Stage 3 Actions

The objective of Drought Stage 3, actions are to reduce potable water demand up to 50 percent through effective and consistent public outreach, the enforcement of extensive restrictions on water use, and implementation of water rationing. In Stage 3 raw water deliveries are curtailed by up to 100 percent. Protection of water supply for public health and safety purposes is the primary objective during Stage 3 drought conditions.

Policy and regulation

1. Implement Stage 3 water shortage response measures which includes enforcing Stage 1 and Stage 2 water shortage response measures.
   - Residential meters serving single family detached homes are granted a 68 gallons per day per person allotment.
   - Residential meters serving multiple units are granted up to 50 percent of the amount used by the customer during the corresponding billing period in the base year.
   - Meters serving any non-residential use are granted 60 percent of the amount used by the customer during the corresponding billing period in the base year. (Note: Vital healthcare and public safety use is set at 65 percent).
   - No new domestic accounts are accepted.

   Raw water customers are affected as follows:
   - GDPUD Board has the discretion to limit new agricultural customers at any time if necessary
   - Raw water deliveries curtailed up to 100 percent.
   - Alternating managed water supplies with preference given to IMS customers.
   - The irrigation season, generally from May 1 to October 1, may be delayed and/or shortened.
2. Drought Team Leader provides weekly updates on drought status to GDPUD management.
3. GDPUD management provides the Board of Directors with an assessment of the need to enact a drought surcharge.
4. GDPUD management to provide recommendation to the Board of Directors on increasing the frequency on residential meter reading to monthly for accelerated assessment of demand reduction.

Monitoring

1. Assess current drought stage every two weeks with current demand and supply information.
2. Consider potential future hydrologic conditions.
3. Monitor water demand weekly to assess water savings accomplished.

Public outreach

1. Accelerate community-oriented drought awareness with focus on community water use reduction goals, range of voluntary steps, and mandatory requirements to accomplish savings.
2. Reinforce with customers the GDPUD Water Waste Prohibitions and Stage 3 mandatory water shortage response measures.
3. Provide weekly updates to public on current drought stage.
4. Provide weekly updates to public on community demand response status.
5. Continue with procedure for customer reporting of water waste.

Resource management

1. Weekly DICC meetings to coordinate on monitoring, public outreach, current status, and opportunities for resource sharing.
2. Continue participation by DAC members.
3. Coordinate and schedule water hauling as needed.
4. Implement and monitor tap manifolds for emergency water distribution through hydrants as needed.

1. INTRODUCTION

This document presents the Drought Plan for the Georgetown Divide Public Utility District (GDPUD). This Drought Plan presents the actions and procedures for preparing for, identifying, and responding to a drought. The objective of the Drought Plan is to help GDPUD preserve essential public services and minimize the effects of a water shortage on public health and safety, economic activity, environmental resources, and individual lifestyle.

Drought occurs when precipitation over a season or longer is insufficient to meet the demands of human activities and the environment, resulting in water shortage conditions. Drought preparedness is an essential element of water supply planning.

This Drought Plan represents the results of the second phase of a two phase drought planning process. This section presents the plan need and objectives, planning overview, drought history, climate change, GDPUD water supply and demand, GDPUD drought management policy, stakeholder involvement, drought planning approach, and plan content.

1.1 Plan Need and Objectives

Residents of El Dorado County depend on surface water from the watersheds of the Sierra Nevada mountain range for their water supply. The Sierra Nevada snowpack serves as natural storage for much of the region's annual precipitation. These watersheds experience large variations in annual precipitation and resulting water supply. This area has experienced significant droughts in the past. The possibility of climate change may increase the frequency and severity of droughts. The population growth in El Dorado County and the resulting increase in water demand will amplify the severity of drought impacts. While the occurrence of droughts cannot be controlled, droughts and their impacts can be anticipated and planned for. A Drought Plan is needed to guide GDPUD to accomplish its mission of providing high quality water services in an environmentally and fiscally responsible manner during drought conditions.

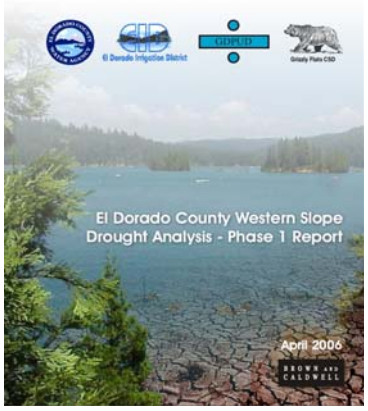
This Drought Plan is intended to satisfy multiple objectives that consist of:

- Defining a common understanding of drought susceptibility, monitoring, communication, response, and opportunities for drought avoidance among each of the El Dorado County west slope water agencies.
- Updating GDPUD drought planning to incorporate new water supplies, most recent water demand projections, expanding water conservation efforts, new methods of public outreach, and potential impacts of climate change.
- Defining drought indicators and trigger levels that declare droughts accurately and early enough.
- Defining water demand curtailments that can reasonably be accomplished in drought conditions, are financially sustainable, administratively appropriate, and user-friendly, and will perform well for all customers and stakeholders.
- Providing a roadmap for Drought Plan implementation that focuses GDPUD's continuing efforts on activities that will monitor for the onset of drought, minimize drought impact on customers and GDPUD, and implement projects and other measures to reduce the need to declare drought.

This Drought Plan reflects GDPUD's most recent advances in drought planning since the current GDPUD water shortage contingency plan as reflected in GDPUDs 2005 Urban Water Management Plan (UWMP).

1.2 El Dorado County Drought Planning Overview

In 2004, because of the need and value of drought planning and preparedness, the El Dorado County Water Agency (EDCWA), El Dorado Irrigation District (EID), Grizzly Flats Community Service District (GFCSD), and GDPUD initiated a drought planning process. The objective was to address the needs of residents on the western slope of El Dorado County (County) during drought conditions.



The drought planning process has been conducted in two phases. Both phases include a collaborative approach among drought plan stakeholders centered on a "shared vision" approach. This approach helped the County water community develop an understanding of each agency's drought susceptibility and the actions that can be pursued individually and as a community to reduce or mitigate drought impact. The shared vision process is highlighted by the use of a user-friendly, transparent Shared Vision Model (SVM) that stakeholders use to develop an effective and equitable drought management program. A copy of the most recent SVM can be found on a CD in Appendix A. Phase 1 drought planning included the analysis of drought impacts in GDPUD and the western slope of the County, with focus on the potential to reduce drought impacts through demand management and supply augmentation actions.

The *El Dorado County Western Slope Drought Analysis – Phase 1 Report* (Brown and Caldwell, 2006) describes the development of the SVM and the results of the drought analysis. At the conclusion of Phase 1, drought stakeholders understood the current water supply reliability during drought for each of County's three western slope water purveyors based on current policy, water rights, and infrastructure. Additionally, drought stakeholders understood the needs, opportunities, and constraints facing each agency in the future as they implement policies, programs, and projects to mitigate or avoid drought impacts.

This Phase 2 drought planning effort focused on the development of individual drought plans for GDPUD, EDCWA, GFCSD, and EID. Drought plans include actions to improve drought management within the service area of each water agency, and also include actions from the shared vision process that encourage collaboration across the County western slope community to gain efficiency in drought monitoring, provide water for essential public health and safety, synthesize outreach activities, and integrate drought avoidance projects at the County level. Phase 2 also includes updates and improvements to the SVM based on stakeholder comment and requested additions.

Stumpy Meadows Reservoir 1977
Picture courtesy of GDPUD

1.3 Drought History

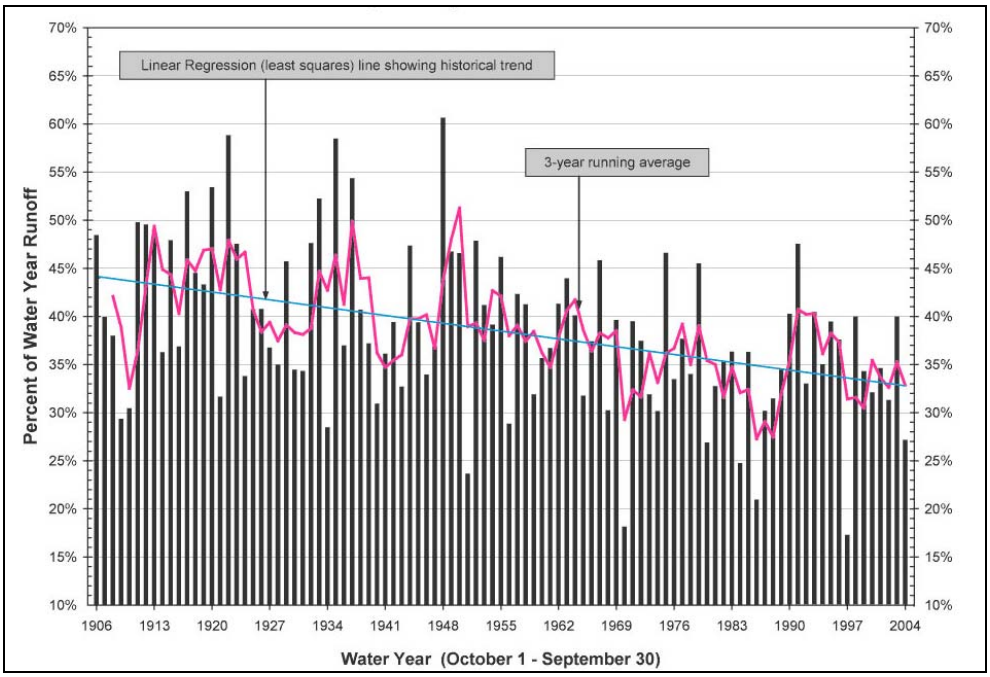
Founded in 1931, GDPUD has recently experienced drought periods in 1976-77 and 1987-92. Droughts also occurred in 1924, 1931-1934, 1939, and 1959-61. The paleoclimatic record indicates the occurrence of previous droughts of significantly greater severity and duration than these recent drought events. During the 1976-77 drought, the annual flow in the South Fork of the American River was 10 percent of the 1923-2003 average.

Historically, GDPUD has been able to react to drought with raw water cutbacks on agricultural customers. However, similar reductions in water use during future drought may be more challenging as the GDPUD customer base grows, water demands increase, and ongoing programs continue to improve water use efficiency. Additional detail of past droughts is provided in Section 2 of the Phase 1 Report.

1.4 Climate Change

Future climate change, caused by both naturally recurring cyclic patterns and human activities, may impact the intensity and duration of future droughts. As a result, future droughts may exhibit different characteristics than those observed during recent droughts. It is important to consider and plan for climate change because of the adverse effects of temperature and precipitation changes.

As an example, predictions are that average temperatures during the next 100 years will increase by approximately two degrees Celsius. Increasing average temperatures, resulting in earlier and heavier snowmelt runoff, will have greater affect on water purveyors reliant on surface water as compared with those reliant on groundwater. An existing trend of accelerated spring snowmelt and associated runoff in northern California is evidenced by late season (April – July) runoff in the Sacramento River as a percentage of total runoff for each year from 1906 to 2004 depicted in Figure 1-1.



Source: California Water Plan Update 2005 Volume 4 – Reference Guide

Figure 1-1. Sacramento River (April – July) Runoff in Percent of Water Year Runoff

Late season runoff constituted 44 percent of total runoff in the early 1900s, decreasing to 33 percent by the early 2000s. Melted Sierra Nevada mountain snowpack is the source for the majority of late season runoff for GDPUD. This snowpack is relied upon by GDPUD for measured release and late season water storage. Developed surface water storage, such as Stumpy Meadows Reservoir, will reduce the impact of earlier snowpack runoff on GDPUD supplies.

GDPUD recognizes the importance and potential implications of climate change to GDPUD and its customers. Development of the SVM during Phase 1 includes four potential climate change scenarios that allow for an assessment of future supply reliability and potential shortages under changed climate conditions.

1.5 GDPUD Water Supply and Demand

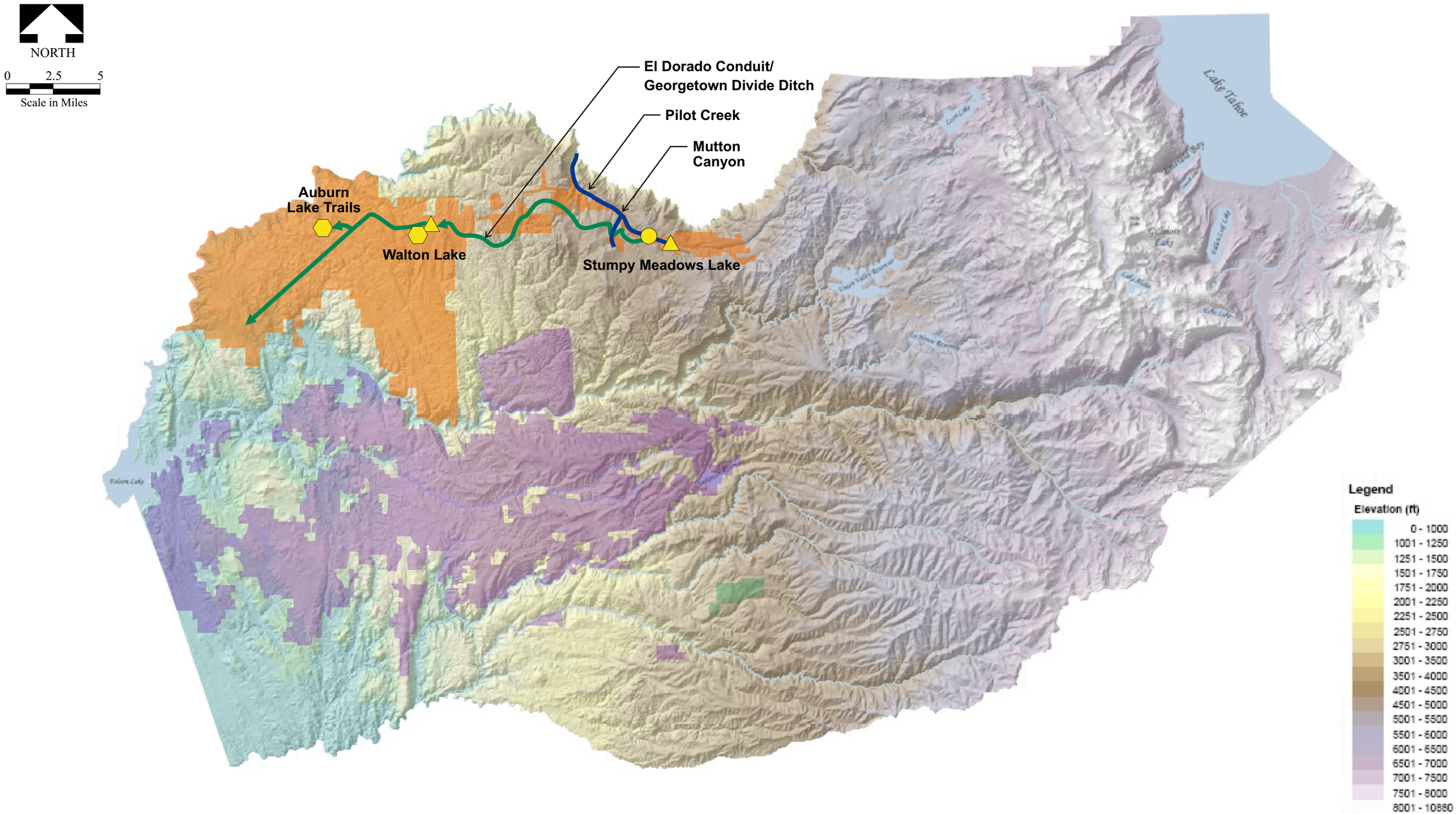
The following subsections provide a brief summary of GDPUD water supply and demand. Understanding the flexibility and constraints associated with each source of water supply and demand is of primary importance when considering approaches to monitor and mitigate drought. Water supplies and demands were considered during drought plan development, both for current conditions and future conditions extending to year 2030. The SVM incorporates the current and future conditions of GDPUD water supplies and demands as represented in the following subsections.

1.5.1 Water Supplies

GDPUD's primary source of water is Stumpy Meadows Reservoir. Releases from the reservoir are regulated and travel down Pilot Creek to a diversion structure. A map of GDPUD's service area and supply source is shown in Figure 1-2.

The GDPUD water system relies on Stumpy Meadows Reservoir to the east, and a system of pipes and ditches which convey water down slope to the various points of use. The reservoir has a capacity of 20,000 ac-ft with a firm yield of 12,200 ac-ft/yr that allows for critical dry year deficiencies in raw water and treated water deliveries. The reservoir's dead pool is at 1,200 ac-ft. Raw water from Stumpy Meadows Reservoir is diverted from Pilot Creek to the El Dorado Canal. This 90-percent unlined canal, made up of a series of transmission-mains and ditches, conveys the water to Walton Lake, which serves as a regulating reservoir and as a raw water storage facility for the Walton Lake Water Treatment Plant (WTP). Both raw and treated water is provided to the eastern portion of the service area, including the communities of Georgetown, Greenwood, Garden Valley, and Kelsey. Releases from Walton Lake WTP are conveyed by the Main Ditch to Greenwood Lake, which operates as a regulating reservoir. A system of pipes and open ditches conveys water to the Auburn Lake Trails WTP and the western portion of the service area including Cool and Pilot Hill. Releases from Greenwood Lake travel to the Auburn Lake Trails raw water storage facility and WTP.

GDPUD's Stumpy Meadows project includes pre-1914 water rights to divert and store water from Pilot Creek.



Water treatment plant

Reservoir

River diversion

Flow in stream/river

Flow in artificial channel

Service Area Boundary

El Dorado Irrigation District

Georgetown Divide PUD

Grizzly Flats CSD

Source: El Dorado County Water Agency, Water Resources Development and Management Plan, June 2003

SITE	Georgetown Divide Public Utility District
TITLE	Service Area
BROWN AND CALDWELL	PROJECT 130868
	DATE 7-30-07
	Figure 1-2

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1.5.2 Water Demands

The past, current, and projected water demands for GDPUD are described in the Drought Phase 1 report and EDCWA's 2007 Water Resources Development and Management Plan. GDPUD's current and projected water demands from 1999 through buildout are shown in Table 1-1. The demand projections include estimates of potential agricultural irrigation (raw water) requirements and are consistent with El Dorado County's General Plan and Environmental Impact Report process. Total projected water use growth from Year 1999 to Year 2025 is approximately 190 percent. Projected residential water demand in 2025 is 2,046 ac-ft, an increase of 463 ac-ft since 1999.

Table 1-1. GDPUD Current and Projected Water Demands, ac-ft

Purveyor/Demand Component	Total Water Demand (af/yr)		
	1999	2025[a]	Buildout[a]
GDPUD			
Residential			
Single-Family Households	1,351	1,700	4,137
Multi-Family Household	77	191	1,101
Mobile Home Households	155	155	155
Commercial			
Retail Employees	46	79	322
Service Employees	115	176	614
Other Employees	86	126	417
Other			
Irrigation	4,351	11,770	17,530
Property Owners Association	123	123	123
Unaccounted for & Beneficial Uses Water	3,265	3,601	4,025
Latent Demand	1,387	2,864	3,660
Total Water Demand for GDPUD	10,956	20,785	32,085

Source: (EDCWA, 2007)
[a] With the adoption of the 2004 El Dorado County General Plan, the County chose the 1996 land use alternative with minor adjustments.

It is important to note that demand reductions as a result of additional future water conservation efforts are not included in these projections. In this analysis conservation is included as a drought impact avoidance project alternative, and is further discussed in section 2.4.

1.6 GDPUD Drought Management Policy

GDPUD has established policy and associated regulations and procedures to identify and address drought conditions. Guidance provided in GDPUD policy and regulations is intended to reduce the potential for water supply shortfall and interruption of service. GDPUD is subject to additional required or water shortage planning guidance by state and federal agencies. Subsection 1.6.1 discusses current applicable GDPUD policy, administrative regulations, and supporting documents. Subsection 1.6.2 provides an overview of water supply shortage guidance from regulatory agencies. Subsection 1.6.3 discusses the reliability of GDPUD's water system under its current drought policy. A timeline mapping the evolution of GDPUD's water supplies, demand management, and associated policies is depicted in Figure 1-3.

1.6.1 Existing GDPUD Regulations and Procedures

Historically, GDPUD has responded to water supply shortages on an individual basis as they develop. Under drought conditions or any other long-term water supply shortage, GDPUD implements a program of water conservation measures that result in water use restrictions proportional to the severity of the reductions needed. In the past, such use restrictions have been associated with droughts. GDPUD's programs of voluntary and mandatory rationing developed in response to the increasingly severe actual and potential shortages in 1977-79 is the current model for planning responses to severe water shortages (GDPUD, 2005).

GDPUD's water shortage contingency plan, found in Appendix B, summarizes the principle resolutions adopted by the GDPUD Board regarding usage allocation and allotments, penalties of excessive use, prohibition of nonessential uses, and education. It includes four stages of water supply shortage stages. Stage 1 consists of voluntary measures and is an extension of GDPUD's ongoing education and financial incentive programs to encourage water conservation. Stages 2, 3, and 4 require mandatory rationing of agricultural water in addition to voluntary and mandatory conservation of domestic water in Stages 3 and 4 respectively. In the past, mandatory rationing of domestic customers has never occurred because of sufficient water savings through mandatory reductions in agricultural use. The priority of domestic water over agricultural water is a long standing policy in GDPUD and has been successfully used during periods of reduced water supply without noticeable long term impact on the community. No new agricultural accounts are accepted during mandatory stages 3 and 4. Although the GDPUD Board has the discretion to limit new agricultural customers at any time when it is deemed necessary. Additionally, no new domestic accounts are accepted during Stage 3 unless the parcel has been assessed for improvements through a legal process. During Stage 4, no new domestic accounts are accepted.

Presented in Appendix C, GDPUD's adopted 1982 "No Waste" Ordinance addresses wasteful and negligent water use. In 2005 GDPUD adopted Ordinance 2005-01 which allows GDPUD staff to respond to increased water demand issues derived from General Plan estimations of growth in agricultural water service. In an effort to plan for future domestic demands, GDPUD has taken steps to control the rate of increase of agricultural water service. New requests for agricultural service are evaluated each year based on available supply and will not be permitted unless there is sufficient capacity to meet the service requested. The irrigation season is generally from May 1 to October 1 of each year. A copy of Ordinance 2005-01 is included in Appendix D.

Historically, reductions in reservoir storage on April 15th have triggered rationing programs ranging from a voluntary to mandatory reduction goal for agricultural accounts of up to 50%. Four Stumpy Meadows Reservoir levels trigger the rationing stages and incorporate both supply and carry-over storage. The reservoir level is annually reviewed by GDPUD's Board of Directors in April prior to the release of irrigation water in May.

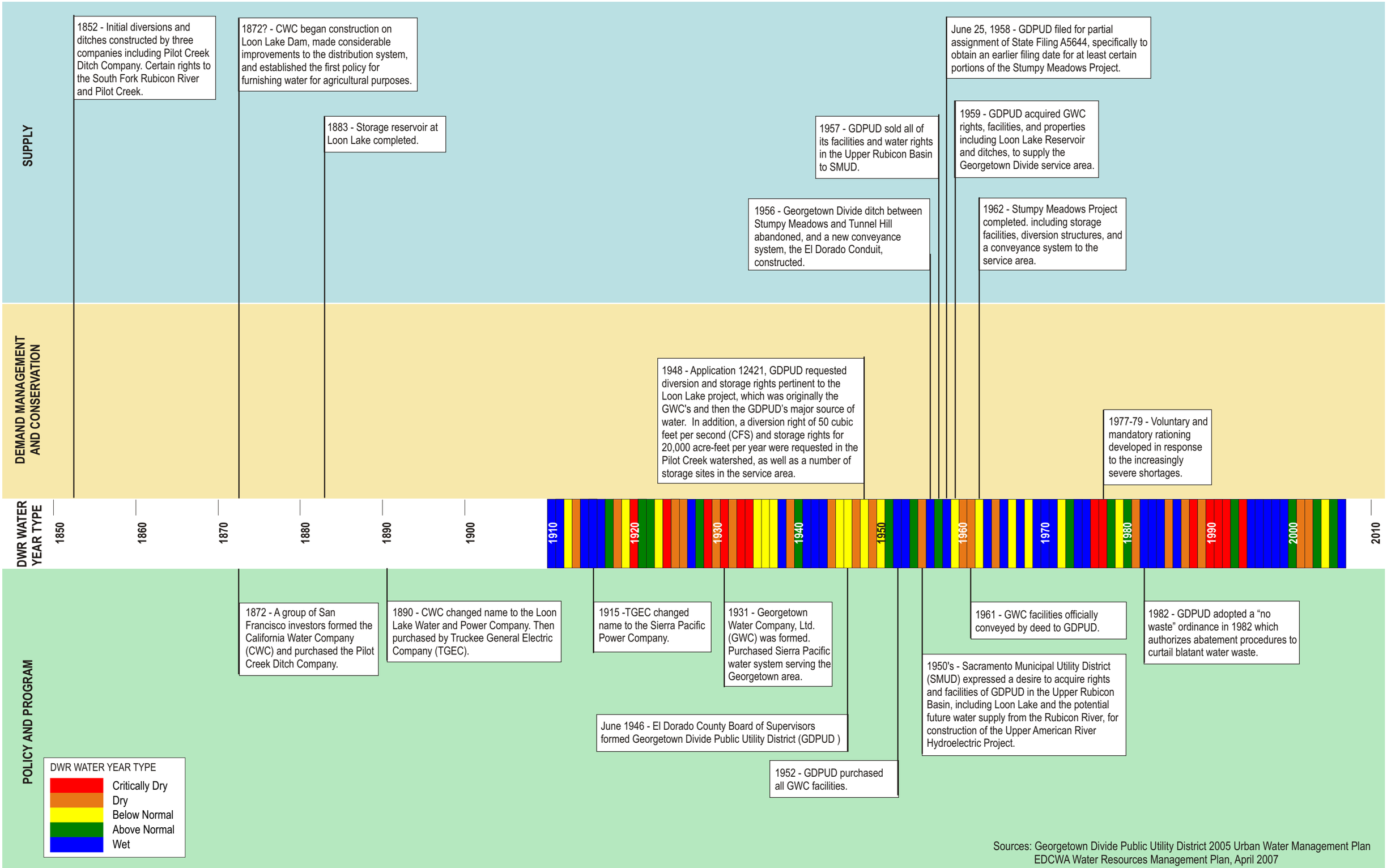

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Figure 1-3. GDPUD Demand Management Measures and Supply Source Timeline

Diversification of GDPUD's supply and increased operational flexibility are not recognized in their existing water supply trigger matrix. The development of the SVM as part of this current drought planning effort is intended to better represent the current GDPUD system and allow for the consideration of various drought management strategies that recognize GDPUD's diversification of supply and operational flexibility. A major component of this Drought Plan is to document the current and projected system reliability and projected supply shortfall using GDPUD's 4-stage water supply triggering levels and develop alternative approaches that maintain or improve system reliability while incorporating supply diversification and operational flexibility.

1.6.2 Regulatory Guidance

As the Drought Plan was being developed, GDPUD considered required and suggested drought-related policy and guidelines provided by agencies with which GDPUD maintains either a collaborative or contractual relationship. These guidelines are outlined in more detail in Appendix E. At the County level, there are currently no drought management guiding policies, neither by the EDCWA or from the El Dorado County Environmental Management Department.

At the state level two entities guide GDPUD drought preparedness and management. These state agencies and their requirements are summarized below.

- California Department of Water Resources (DWR) – A UWMP is required every five years and must incorporate a water shortage contingency plan. The UWMP for 2005 must project normal climate year water demands and supplies through 2025, and also define the single dry year water supply and the four year dry period. GDPUD's 2005 UWMP projects adequate water supplies during the single dry year through 2025 based on GDPUD mandatory dry year reduction of raw water deliveries.
- California Office of Emergency Services (OES) – The OES published a Water System Emergency Response Template in 1999 that includes a suggested Water Supply Interruption Action Plan consisting of four water use reduction stages including water alert with a 5 percent or greater water use reduction goal, water warning with a 15 percent or greater water use reduction goal, water crisis with a 30 percent of greater water use reduction goal, and water emergency with a 50 percent or greater water use reduction goal.

At the federal level the United States Army Corps of Engineers (USACE) guides GDPUD drought preparedness and management. In 1994, the USACE published a drought study that suggested that a drought response plan include triggers, forecasts, monitoring, enforcement, public affairs strategy, management measures, and a coordination mechanism.

1.6.3 Water Supply Reliability Status

As part of the development of this Drought Plan, the reliability of GDPUD's water system combined with GDPUD's current drought indicators and triggers were evaluated. For this analysis, reliability is defined as the volume of water supplied divided by volume demanded during the simulation period (historical or design drought) and expressed as a percentage. The demand volume can be less than normal demand during dry periods within the simulation period when demand cutbacks of up to 50 percent are made based on the drought stages defined by GDPUD's current plan. The analysis is described in detail in Section 2 of this report. The results are briefly described below.

The analysis results show that the current drought plan has a reliability of 100 percent in 2004, decreasing to 88.5 percent with 2030 demands, based on GDPUD's historical hydrologic record. The reliability percentage would be less for the specific drought years embedded with in the historical record. The percent of months

that drought stages would be declared during the historical record period is 12 percent with 2004 demands and 41 percent with 2030 demands. This analysis is based on the current amount of water supplies.

The analysis included a simulated 3-year drought that mimics the historical 1976-77 drought followed by a third year of 1977 hydrological conditions. The results show that the current system and plan would be 100 percent reliable for the three year period with 2004 demands, and 72 percent reliable with 2030 demands. Note that significant demand cutbacks of up to 50 percent occur when the appropriate Stumpy Meadows Reservoir levels are triggered.

1.7 Stakeholder Involvement

Stakeholder participation, in accordance with the shared vision planning approach, was an important component of the project. The stakeholder team, consisting of staff, Board members and customers, dedicated time and energy to developing this Drought Plan with analysis, input and review, as well as the extensive consideration of viable future drought monitoring efforts. With the recent media and political attention on climate change and the dry 2007 water year, both staff and the community have been focused on this drought plan development effort.

Considerable collaboration occurred during the Drought Plan development including the following:

- Initial meetings between the consultant and EDCWA to discuss regional drought analysis goals.
- A summary presentation at the El Dorado Water and Power Authority to familiarize regional stakeholders with the upcoming drought planning efforts.
- Several topic-oriented meetings with GDPUD staff.
- A workshop to present and receive comment on the suggested approach to drought management.
- A workshop to present and receive comment on the drought plan content.

Initial discussions with project stakeholders included the system's complexities, existing and potential drought indicators and triggers, current drought response plans, the coordination of drought management strategies within the region, and specific stakeholder drought management concerns. After these preliminary meetings, the participating stakeholders representing EDCWA, EID, GFCSD and GDPUD gathered in a workshop setting on December 20th, 2006 at EID to begin coordination between each individual's water purveyor's plans. On this date, industry experts Jon Olaf Nelson and William Werick traveled to El Dorado County to present their expertise on community drought response and drought indicators, respectively.

These meetings not only provided the system details, purveyor perspectives, and community insights necessary to best address drought monitoring and response for GDPUD, but derived a level of support, coordination, and opportunities available to and from GDPUD with their neighboring water agencies. Significant consensus was reached on a number of topics including:

- 3-stage target percent reduction.
- Methodology to evaluate drought indicators and triggers.
- Development of drought response plan that promotes voluntary compliance.

1.8 Drought Plan Approach

The approach to the development of the drought plan consisted of building off current policies and procedures, leveraging Phase 1 efforts, using the SVM, and incorporating GDPUD staff and Board knowledge and input.

The development of the Drought Plan builds from existing policy and procedures and recognized past successes and lessons from previous drought periods. Phase 1 was completed as a collaborative County-wide effort to understand commonality across the water community while recognizing the individual strengths and challenges faced by each of the County's three west slope water agencies.

The SVM was developed to assess current and future water supply reliability and potential water supply shortfall during both drought and non-drought periods. The incorporation of climate change scenarios allows GDPUD to consider future water supply conditions under a changing climate. The SVM was used extensively during development of the Drought Plan, specifically to identify the best combination of drought indicators and drought trigger levels that maintain high system reliability while accurately declaring a drought stage.

GDPUD and EDCWA Board members and staff were instrumental in the development of the Drought Plan by representing GDPUD and customer preferences and providing institutional knowledge of GDPUD's policies, operational practices, and public outreach procedures. The drought stages and associated target demand reduction, approach to achieve needed customer response during drought, and Drought Plan implementation actions reflect significant guidance from GDPUD and EDCWA Board and staff.

The Drought Plan and the associated SVM tool formalize and organize drought-related activities that staff will pursue as part of Drought Plan implementation. The Drought Plan is not intended to sit on the shelf and only be occasionally referenced for needed information. Section 3 of the Drought Plan outlines specific Plan implementation activities and the associated schedule for completion.

1.9 Drought Plan Content

The Drought Plan is organized into three sections as follows:

- Section 1 provides an overview of the need for drought planning, GDPUD water supply and demand with resulting water supply reliability, and policy and procedures guiding the development of the Drought Plan.
- Section 2 details the Drought Plan development process and results. Drought Plan elements include: 1) drought stages with associated demand reduction targets, 2) drought indicators and triggers, 3) methods to achieve the desired customer response during drought, and 4) projects that can be pursued to reduce the frequency of drought declaration.
- Section 3 provides guidance on implementation of the Drought Plan. The implementation plan includes actions that are recommended for immediate Board of Directors consideration and a wide range of implementation actions to be completed during non-drought periods and each stage of drought.

2. DROUGHT PLAN DEVELOPMENT

Section 2 provides details on the development of this Drought Plan's components including drought stage classification, drought indicators and trigger levels, GDPUD and community drought response, and long-term drought impact avoidance projects.

There are two primary goals in the development of this Drought Plan: (1) create an acceptable Drought Plan that meets demands in the driest conditions; and (2) determine if the current strategic mix of supply and demand drought management solutions will continue to be effective in the future. This evaluation focuses on the development of a drought plan that incorporates demand curtailments that can reasonably be met in drought conditions, is financially sustainable, is administratively appropriate and user-friendly, and will perform well for commercial, agricultural, environmental, and community interests (equity). The potential affects of climate change on drought conditions are also considered in this analysis.

In order to design a drought management strategy that is fair, understandable, a low administrative burden, and revenue neutral, several key plan elements were assessed:

- **Drought stages.** This refers to the escalating degrees of drought conditions that determine targeted percentages of customer demand reduction in order to avoid shortfalls. Water supply conditions were identified and corresponding drought stage defined.
- **Drought indicators and associated trigger levels.** Potential indicators include reservoir levels, precipitation, snowpack water content, etc. These were evaluated for a historical correlation with the occurrence of drought. Various trigger levels for specific indicators were tested and coordinated with drought-stage-demand reductions in order to minimize water supply shortfalls.
- **Drought response measures.** This refers to various customer-demand reduction actions in response to drought. Potential responses consider extensive customer water end-uses and water sources (potable and raw). The method of achieving effective water reductions (voluntary or mandatory), enforcement, and coordination with nearby water purveyors is also investigated.
- **Drought impact avoidance projects.** This refers to long-term projects (i.e. reservoir and additional water rights) which reduce the likelihood of future water supply shortages. Reliability based on GDPUD's historical record as well as under a potential drier climate change scenario was calculated for various potential projects.

Balancing these plan elements was critical in the development of this drought plan and involved:

- declaring drought accurately,
- declaring drought early enough,
- minimizing how often drought needs to be declared;
- minimizing the duration of drought declaration; and
- a reasonable and equitable customer response (fair treatment of customers).

After defining drought stages and researching potential drought indicators, an iterative process was used to coordinate indicators, triggers, and customer demand reductions. Potential indicators were tested for historical correlations with drought. Concurrently, drought stage triggers and demand reductions were assigned to these indicators in order to minimize GDPUD water supply shortfalls. An iterative process refined when water supply shortages were likely to occur and how soon curtailment of demand would have to

start to be effective. "Indicators" were chosen based on historical correlations with drought, and trigger levels for these indicators are defined. Trigger levels determine when a drought stages is declared. A balance between the indicators, triggers and response measures was critical to achieve water supply reliability. Section 2 summarizes the development of these elements.

2.1 Drought Stages

GDPUD's drought stages were defined by associating water supply conditions and demand reduction goals with drought stages. Drought stage definitions, as summarized in Table 2-1, were developed with input from a wide range of GDPUD and EDCWA Board members and staff, including many of those responsible for managing public outreach and water supplies and demands during drought. The percent of water supply reduction anticipated for each stage, and the corresponding percent of targeted demand reduction, are the basis for determining the most reliable drought indicators and trigger levels as well as the most feasible customer response actions. The anticipated supply reductions are up to fifteen, thirty, and fifty percent, for drought Stage 1, Stage 2, and Stage 3, respectively. To ensure an effective progression through drought stages (not too fast or too slow), three drought stages have been developed, as opposed to GDPUD's existing 4-stage plan.

Table 2-1. Preliminary Drought Stage Definitions

Water supply conditions	Drought stage
Normal 0% Total Supply Reduction	None - Ongoing conservation measures; "No Waste" ordinance in effect.
Slightly Restricted Water Supplies Up to 15% Total Supply Reduction	Drought Stage 1
Moderately Restricted Water Supplies Up to 30% Total Supply Reduction	Drought Stage 2
Severely Restricted Water Supplies Up to 50% Total Supply Reduction	Drought Stage 3

2.2 Drought Indicators and Trigger Levels

Drought indicators and associated trigger levels function to declare a drought early enough to maximize saved water, but not so early that false drought declarations are issued. False drought declarations can result in unnecessary revenue losses and compromised community faith in GDPUD. The best drought indicators for monitoring and assessing the onset and severity of drought are those with a strong correlation with actual GDPUD water supply conditions. Using the best drought indicators, multiple numeric trigger levels are defined that correlate to anticipated supply shortfalls (e.g. 15 percent, 30 percent, and 50 percent). Indicators and associated drought stage triggers coordinate with drought stage demand reduction actions to avoid water supply shortfall.

Using the SVM, four trigger plan scenarios are evaluated in this section based on resulting system reliability and percent time in drought:

1. No Plan – no drought indicators, triggers, or drought stage demand reduction goal.
2. Current – based on GDPUD's 4-stage water supply triggering plan (see Appendix B) that considers Stumpy Meadows Reservoir levels.
3. Experimental – more comprehensive than the current method with consideration of numerous indicators to improve GDPUD water supply reliability.

4. Supply Remaining Index (SRI) – most comprehensive plan and more robust in considering the status of all GDPUD supply sources along with projected future supplies and demand.

Triggers are determined experimentally with the intention of being as straightforward and effective as possible.

2.2.1 Current Trigger Plan

GDPUD's current trigger plan, described in Section 1 and found in Appendix B is based on Stumpy Meadows Reservoir levels. Since this drought planning effort initially defined 3 drought stages with associated water supply conditions and demand reduction goals, GDPUD's current Stumpy Meadows trigger plan was modified to be a 3 stage drought plan. GDPUD modified current trigger plan is presented in Table 2-2. GDPUD's system reliability with no drought plan (no drought triggers, therefore no demand curtailment) plan was evaluated against their current modified trigger plan; the percent time GDPUD needed to enact their drought plan was also measured. GDPUD's historical and projected system reliability is presented in Appendix F. Calculated system reliability is shown in Appendix F for GDPUD's historical record as well as under design drought 1976, 1977, and repeated 1977 dry year hydrological conditions. The "No Plan" scenario assumes no drought plan or demand curtailment is enacted over the course of the historical record or design drought conditions. The "Current Plan" scenario assumes GDPUD enactment of their current Stumpy Meadows triggers, including demand cutbacks of up to 50 percent if Stumpy Meadows Reservoir levels are low enough.

Table 2-2. GDPUD Modified Current Trigger Plan

Drought Stage	Stumpy Meadows Reservoir Level on 2nd Wed. in April
1	17,000 ac-ft
2	15,000 ac-ft
3	13,000 ac-ft

2.2.2 Experimental Trigger Plan

In developing the experimental trigger plan, the following regional indicators were evaluated: reservoir storage levels (including Stumpy Meadows, Sly Park and Folsom Lake), DWR water year type (shown in the adjacent text box), snow pack water content, precipitation, various streamflows, and (El Nino - Southern Oscillation (ENSO) climate cycle episodes (described in the information box). Specific indicator trigger values can reliably predict impending drought if developed from good statistical correlations, and if based on the historical database with a strong physical connection to water supply variability.

To determine the most reliable indicators for GDPUD, a computer model was created to identify correlations between projected SVM-derived GDPUD water supply shortfalls (with enacted drought response plan demand curtailment) and historical indicator data sets to see

Water Year Types

Sacramento Valley Water Year Index =

Sum of Sacramento River unimpaired flow above Bend Bridge, Feather River unimpaired inflow to Oroville Reservoir, Yuba River unimpaired flow at Smartville, and American River unimpaired inflow to Folsom Reservoir.

Sacramento Valley Water Year Index

= (0.4) x Current Apr-Jul runoff forecast (in million acre-feet) + (0.3) x Current Oct-Mar runoff (in million acre-feet) + (0.3) x Previous Water Year's Index.

This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the Sacramento Valley water-year type as implemented in SWRCB D-1641.

Year types are set by first of month forecasts beginning in February. Final determination is based on the May 1, 50 percent exceedance forecast.

Water years 1, 2, 3, 4, and 5 represent water years types wet, above normal, below normal, dry, and critically dry, respectively.

which indicators reliably predict drought. A monthly "shortfall" occurs when there is not enough water in storage (even with a given month's inflows) to meet monthly demand.

Ideally to avoid confusion, droughts would be declared for all utilities in the region at the same time. However, since water agencies have varying potential for carryover storage and shortfalls are driven by varying demand and inflows to storage, the differing County water systems cannot realistically declare drought at the same time and therefore do not have identical indicators and triggers.

Selecting robust indicators and setting a trigger value for each drought stage to minimize supply shortages requires trial and error experimentation. This process was informed by an understanding of how the GDPUD physical water supply system works and a mathematical analysis of potential water shortfalls. Various indicator values were tested to determine indicator values for each stage that were "triggered" soon enough to warn for drought and late enough to correlate well with drought. Potential drought indicators and corresponding trigger levels were tested by comparing how accurately they predict drought over the entire hydrological record. Those that perform well predict drought during past GDPUD drought periods and do not predict drought during periods of no drought. For each indicator and trigger iteration, the number of true positives and false negatives (good) were compared to the number of false positives and true negatives (bad). The concept is further described in the information box, Indicator-Trigger Result Types.

ENSO Climate Cycles

The ENSO cycle refers to the coherent and sometimes very strong year-to-year variations in sea-surface temperatures, convective rainfall, surface air pressure, and atmospheric circulation that occur across the equatorial Pacific Ocean. El Niño and La Niña represent opposite extremes in the ENSO cycle.

El Niño refers to the above-average sea-surface temperatures that periodically develop across the east-central equatorial Pacific. It represents the warm phase of the ENSO cycle, and is sometimes referred to as a Pacific warm episode.

La Niña refers to the periodic cooling of sea-surface temperatures across the east-central equatorial Pacific. It represents the cold phase of the ENSO cycle, and is sometimes referred to as a Pacific cold episode.

The indicator considered for use in the drought response plan is a measure of *anomaly* - the difference between current sea surface temperatures and the 1971-2000 base period in the so-called 1Niño 3.4 region (5°N-5°South, 120°-170°West).

An ENSO index of less than zero means cooler than normal sea surface temperatures – a La Niña event. The droughts that began in 1976 and 1988 were preceded by La Niña.

El Niño and La Niña Seasons (historical years)	
El Niño - Weak to Moderate	57-58, 65-66, 77-78, 87-88, 92-93, 94-95, 02-03
El Niño - Strong	72-73, 82-83, 91-92, 97-98
La Niña - Weak to Moderate	50-51, 56-57, 64-65, 70-71, 71-72, 74-75, 98-99, 00-01
La Niña - Strong	55-56, 73-74, 75-76, 88-89

Indicator-Trigger Iteration Result Types

True positive (TP) – drought happens (true) and the trigger is pulled (positive).
False negative (FN) –no drought (false), and the trigger reads "no drought" (negative)

True negative (TN) – drought happens, but the indicator didn't trigger a warning.
False positive (FP) – no drought, but the indicator triggers drought and reduces demand unnecessarily.

In determining the most reliable indicators, analyses included mathematical correlations and scatter diagrams to assess for possible relationships between indicator behavior and historical droughts. Individual historical dry year sequences were specifically examined to test if the indicators were truly identifying water supply shortages (when there was actually drought). There is strong correlation between GDPUD's shortfalls and Stumpy Meadows Reservoir levels, inflows, and ENSO episodes. On the other hand, for example, there was no consistent correlation found between GDPUD shortfalls (GDPUD drought) and snow pack water content or any regional precipitation gage data. The indicators and triggers successfully derived in the correlation model were iteratively built

into the SVM to function with demand reductions to improve the reliability of GDPUD's system. GDPUD's reliability was tested based on historical record, however, system reliability under the design drought conditions (1976, 1977, 1977 *repeated* hydrology) and varying climate change conditions was also analyzed. This was an iterative process between identifying reasonable triggers levels and achieving the most reliable system response. Both GDPUD's system reliability and the amount of remaining shortfall were examined.

From the indicator-trigger iterative process the most favorable combination of indicators for GDPUD consisted of a refinement of GDPUD's current plan's Stumpy Meadows storage levels. Summarized in Table 2-3, GDPUD's experimental indicator and trigger plan is as follows:

- Stage 1 drought is triggered when Stumpy Meadows falls below 10,000 ac-ft.
- Stage 2 drought is triggered when Stumpy Meadows falls below 9,000 ac-ft.
- Stage 3 drought is triggered when Stumpy Meadows falls below 8,000 ac-ft.
- The drought declaration ends when storage climbs above 12,000 ac-ft again.

Table 2-3. GDPUD Experimental Trigger Plan Summary Table

Month	Stumpy Meadows Reservoir Level	Previous month's drought stage	This month's drought stage
Any	Above 10,000 ac-ft	None	None
	Above 12,000 ac-ft	1,2,3	
Any	Below 10,000 ac-ft	Any	1
Any	Below 9,000 ac-ft	Any	2
Any	Below 8,000 ac-ft	Any	3

The reliability of GDPUD's system under no drought plan, GDPUD's current plan, and the GDPUD experimental drought trigger plan scenario is presented in Appendix F. GDPUD has adequate policies in place through 2010 with the current plan, but by 2020 would be able to further reduce time under drought declaration with the experimental trigger plan.

2.2.3 Supply Remaining Index Trigger Plan

In wanting to create a more robust trigger plan, incorporating more indicators as well as further increasing GDPUD's system reliability, a more sophisticated drought trigger plan was developed considering the number of days of water supply remaining. When the number of days supply remaining (DSR) is low, there are not many days of water supply left and drought restrictions should be imposed to stretch the supplies for a longer period of time. This more comprehensive indicator better represents GDPUD's water supply situation than the current and experimental trigger plan approaches, which only considers monitoring Stumpy Meadows Reservoir storage levels. The DSR indicator incorporates expected future supply and demand and is calculated at the end of each month in the simulation. DSR is a function of:

- Current storage in Stumpy Meadows;
- Worst case expected supplies - conservatively based on the minimum monthly hydrology (reservoir inflows) in the historical record; and
- Normal (unconstrained) demand in the coming months - projected demand by month. In determining the reliability under these conditions, demand projections are based on a modeled demand year.

It is important to stress that DSR is not the expected number of days of supply remaining, since it considers the historically worst inflows rather than probable inflows. Using probable inflows would increase the estimate of days supply remaining. On the other hand, DSR does not reflect leakage or evaporation, which

would slightly reduce the days supply remaining. DSR is a useful tool that predicts when the utility needs to reduce water demand.

To more accurately represent GDPUD's remaining water supply, a normalized days SRI was developed. SRI calculates the DSR remaining 20 months into the future, notes the month when supplies go negative (when shortfall occurs), and estimates the specific day that supplies go to zero. This SRI value represents the days supply remaining with a value between zero and one. For example, a monthly SRI value of zero indicates that the DSR is the lowest value in the entire historical record for that month. A SRI value of one means that the DSR is the highest possible DSR in the historical record for that month. For example, a SRI value of 0.5 means that the days supply remaining is halfway between the lowest DSR and the highest DSR for GDPUD's period of record. Figure 2-1 presents a flow chart of GDPUD's Drought Status SRI Trigger Plan. GDPUD's Drought Status SRI Trigger Plan also includes a subordinate indicator, ENSO episode (described in the information box). A real-time Drought Status SRI Model can be found on a CD in Appendix A.

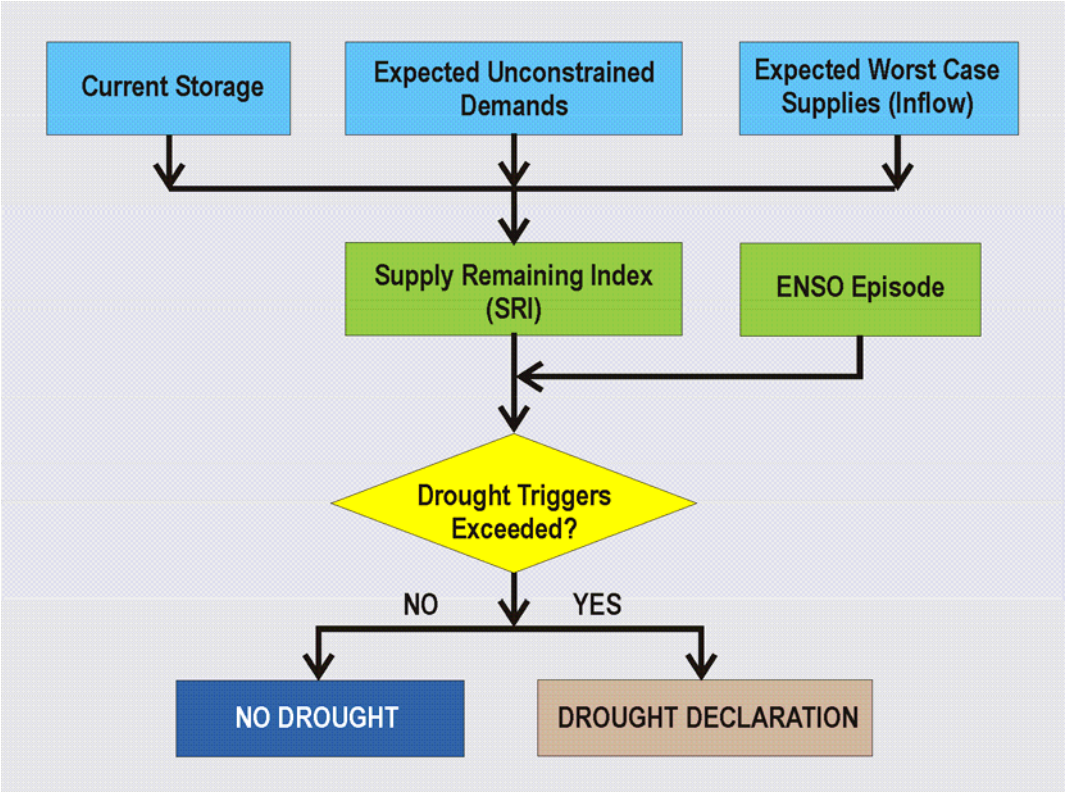

Figure 2-1. Drought Status SRI Trigger Plan Flow Chart

Input into the Drought Status SRI Model includes GDPUD reservoir levels at Stumpy Meadows and current drought status. Furthermore, the Drought Status SRI model determines the date and then fetches the ENSO episode value from the National Oceanic & Atmospheric Administration (NOAA) Climate Prediction Center website, picking the appropriate values based on the date. Then the Drought Status SRI model evaluates this latest actual data to calculate the drought stage for the coming month. ENSO values can also be manually entered, as can all of the other currently "set" input parameters. These parameters include projected monthly demand and inflows, and drought stage SRI and ENSO trigger values. Again, these indicators and trigger values were developed to achieve optimal GDPUD system reliability based on the historical record. A screen shot from the Drought Status SRI Model's dashboard sheet is shown in Figure 2-2.

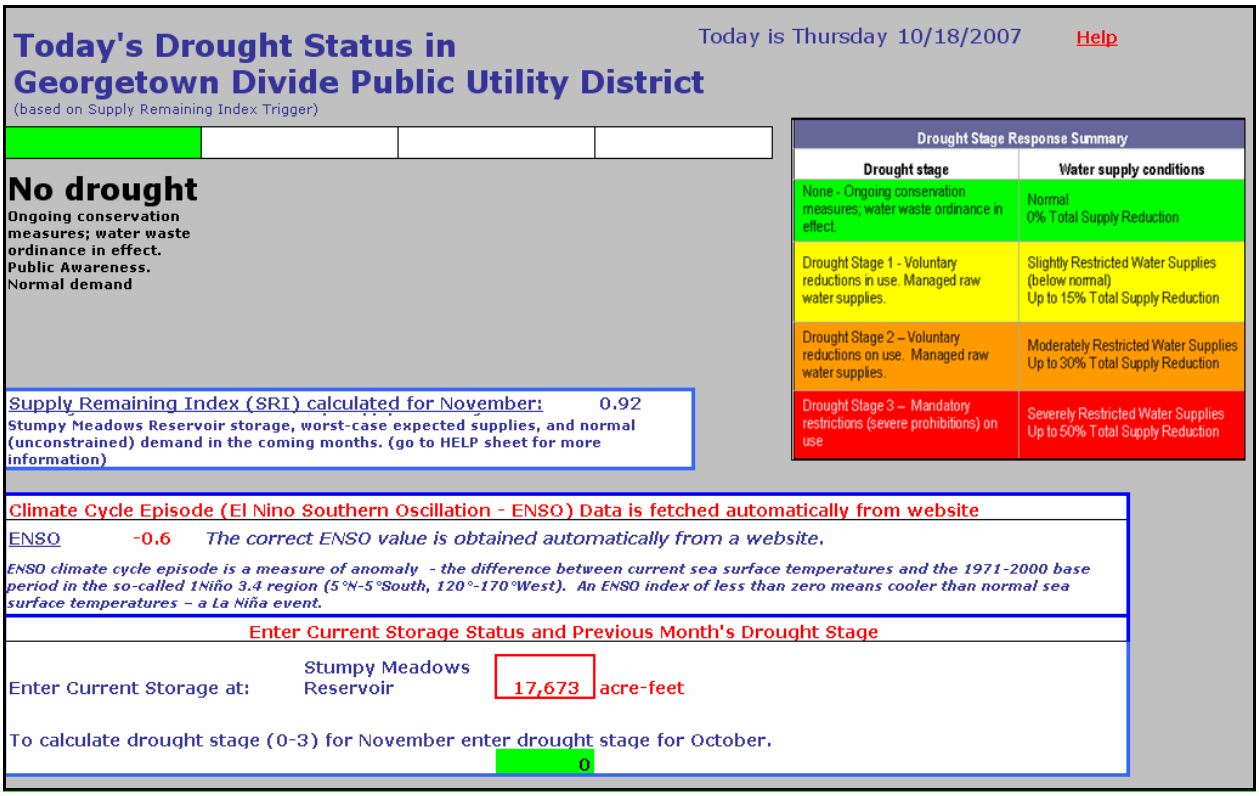

Figure 2-2. Drought Status SRI Model Screen Shot

The GDPUD SRI trigger plan is presented below and summarized in Table 2-4.

- If it's May and SRI is less than 0.3 go to Stage 1; if already in drought, stay at the stage from the month before.
- In June through September, if SRI is less than 0.10 and the previous month was in a Stage 2 drought, then go to Stage 3.
- In June through September, if SRI is less than 0.15 and the average previous three months ENSO is less than 0.35, then go to Stage 2; if the previous month was in Stage 3 drought, stay in Stage 3.
- In all months if SRI is greater than 0.70, there is no drought curtailment. (This either continues a period of no drought or ends the drought response of the month before).
- In all other cases, the drought stage this month is the same as last month.

Table 2-4. SRI Trigger Plan Summary Table

Month	ENSO	SRI	Last month's stage	This month's stage
May	Any	<0.3	0	1
		<=0.70	1,2,3	Last month's stage
June - Sept	Any	<0.10	2	3
	<0.35*	<0.12	0,1,2	2
	<0.35*	<0.12	3	3
Any	Any	>0.70	0,1,2,3	0

* the ENSO average of three previous months must be less than 0.35

To declare a drought, indicator levels can only be triggered starting in May. No indicator and trigger combination earlier in the year consistency improves GDPUD system reliability while minimizing drought declaration.

SRI plan trigger values were selected by SVM-based optimization experimentation under 2010 demands and 2004 GDPUD operations to achieve maximum supply and delivery reliability while minimizing GDPUD's enactment of curtailment policy stages. A summarized comparison of GDPUD's reliability based on no drought plan, the current plan, the experimental plan, and the SRI trigger plan is presented in Appendix F. Again, GDPUD has adequate policies in place through 2010 with the current plan, but by 2020 achieves an increase in system reliability with the SRI trigger plan and reduced time under drought declaration.

2.2.4 Trigger Plan Selection

A comparison of reliability and time under drought declaration for GDPUD's modified current trigger plan, experimental trigger plan and supply remaining index trigger plan is presented in Appendix F. Though the SRI trigger plan consistently declares drought less frequently than the experimental trigger plan and GDPUD's current plan, all three plans achieve similar reliability through Year 2020 of approximately 96 percent. The experimental trigger plan achieves the highest reliability in Year 2030 at 95 percent. The current plan and SRI trigger plan reliability are 89 percent and 88 percent, respectively. It is recommended that GDPUD use the modified current trigger plan, and consider the other trigger plans as additional resources for predicting drought accurately.

2.3 Drought Response

This section coordinates customer water end uses, water sources (potable and raw), and drought policy enforcement methods by drought stage. Additionally, the necessity for drought plan compatibility between GDPUD and its neighboring water purveyors is addressed.

The specific drought stage water use reduction targets as summarized in Table 2-5 were developed in a rationing model that uses output from the SVM to allocate water supplies to various customer classes during drought. The drought response component of the Drought Plan involves an introductory Stage 1 drought response during which all customers are informed of drought. In Stage 1, total potable water customer demand reduction is targeted for 15 percent. Raw water deliveries are managed up to 50 percent. At Stage 2 water use decisions continue to be entrusted to the customer as long as the overall reduction goal for potable water customers of up to 30 percent is met. This is a voluntary/honor system approach. In Stage 2 raw water customers are curtailed up to 50 percent. If Stage 2 fails, then a strict allotment approach is implemented with a stiff penalty rate in Stage 3 with a total demand reduction goal of up to 50 percent for potable water customers and up to 100% for raw water customers. Specific customer category allocations are based on water use typical of the region and regional customer response in drought.

Table 2-5. Drought Stage Response Summary

Water supply conditions	Drought stage	Objective	Response actions
Normal 0% Total Supply Reduction	None - Ongoing conservation measures; water waste ordinance in effect.	Public awareness	Normal actions
Slightly Restricted Water Supplies (below normal) Up to 15% Total Supply Reduction	Drought Stage 1 - Voluntary reductions in use. Managed raw water supplies.	Initiate public awareness of predicted water shortage and encourage conservation. Reduce raw water deliveries	Encourage voluntary measures to decrease "normal" demand up to 15%. Raw water deliveries curtailed up to 50%

Table 2-5. Drought Stage Response Summary

Water supply conditions	Drought stage	Objective	Response actions
Moderately Restricted Water Supplies Up to 30% Total Supply Reduction	Drought Stage 2 – Voluntary reductions on use. Managed raw water supplies.	Increase public understanding of worsening water supply conditions, encourage voluntary conservation measures. Reduce raw water deliveries	Encourage some voluntary measures to decrease "normal" treated water demand up to 30%. Raw water deliveries curtailed up to 50%. Surcharge enacted
Severely Restricted Water Supplies Up to 50% Total Supply Reduction	Drought Stage 3 – Mandatory restrictions (severe prohibitions) on use.	Ensure that water use is limited to health and safety purposes	Enforce extensive restrictions on water use and implement water rationing to decrease potable water demand up to 50% and raw water deliveries up to 100%

The two response approaches, (1) a voluntary honor system based approach, and (2) a mandatory, prescriptive approach, each have advantages and challenges for achieving customer water use reduction. The voluntary approach, which depends on the honor system, focuses on educating customers on water use practices. This tactic relies on voluntary behavior modification to achieve targeted water use reduction. For example, a residential customer may choose to shower faster in order to water her tomatoes. The prescriptive approach requires a very encompassing list of managed water use activities that are mandatory and require enforcement. A comprehensive set of prescriptive curtailment policy measures by drought stage for GDPUD are listed below.

2.3.1 Stage Zero. Normal Conditions and Ongoing Conservation

When water supply conditions are normal with no reduction in water supplies, GDPUD is in a Stage Zero drought. Under normal conditions, a water waste ordinance will identify items of waste that are to be avoided at all times. A proposed water waste ordinance for GDPUD to be enacted at all times, can be found in Appendix G. Prohibitions include limited sidewalk washing, no car washing without a shutoff nozzle, and fixing leaks within 72 hours. Additionally, there are several early preparedness components that GDPUD should consider to better handle drought:

- Trucking contracts
- Tap manifolds for emergency water distribution
- IMS expansion for agricultural customers
- Rate stabilization policies
- Communications plan
- Public outreach plan
- Long-term adjustments in reservoir release rules
- Institutional changes
- Legal changes
- Adjustment of plumbing codes to ensure use of more efficient equipment
- Water efficient indoor plumbing fixtures
- Agricultural customers are strongly suggested to have a water conservation plan on file and/or participate in the IMS program, and update this plan every 5 years.

2.3.2 Stage One. Introductory

When GDPUD water supplies are slightly restricted, with a reduction in supply up to 15 percent, GDPUD is in a Stage 1 drought. In this introductory stage, customers are informed of drought conditions and of actions to take that will reduce demand. Potable water customers are asked to voluntarily reduce water use by 15 percent. Raw water customer deliveries are managed at 50 percent. Domestic water is a priority over

agricultural demands in the GDPUD. In Stage 1 GDPUD should reacquaint customers with the water waste ordinance. Though this stage is voluntary for potable water customers, specific guidelines are listed below.

- Apply irrigation water only during the evening and early morning hours (8 PM to 6 AM) to reduce evaporation losses.
- Inspect all irrigation systems, repair leaks, and adjust spray heads to provide optimum coverage and eliminate avoidable over-spray.
- Change the minutes of run-time for irrigation valves consistent with fluctuations in weather as determined by evapotranspiration data obtained from GDPUD or EDCWA.
- Reduce minutes of run-time for each irrigation valve if water run-off (gutter flooding) is occurring.
- Utilize water conservation incentive, rebate, and giveaway programs to replace high water-using plumbing fixtures and appliances with water efficient models.
- Take advantage of the free information available from GDPUD on how to use water efficiently, read a water meter, repair leaks, and irrigate efficiently.

Additional supplementary water wasting prohibitions may include:

- Do not refill a swimming pool that had been drained.
- Wash vehicles from a bucket. Use a hose equipped with a shutoff nozzle for a quick rinse (commercial car washes excepted).

Affects on raw water customers are as follows:

- GDPUD Board has the discretion to limit new agricultural customers at any time if necessary. New requests for agricultural service are evaluated annually based on available supply and will not be permitted unless there is sufficient capacity to meet the service requested.
- Raw water deliveries curtailed up to 50 percent.
- Alternating days of managed raw water supply deliveries.
- The irrigation season, generally from May 1 to October 1, may be delayed.

2.3.3 Stage 2. Voluntary Reductions

When GDPUD water supplies are moderately restricted, with a reduction in supply up to 30 percent, drought Stage 2 with voluntary restrictions on use for potable water customers is enacted. Raw water deliveries continue to be curtailed 50 percent. The achievement of the reduction goal is measured by overall performance of the entire customer population based on GDPUD production meters. It is important to note that user category demand reduction goals are not by individual customer, but are the goal for the customer category. In this stage, results are reported weekly to customers in the local paper. Customers are informed that individual meter records will not be audited or fees levied if overall reduction goal is achieved. Furthermore, customers who can conserve more are strongly encouraged to help customers who would incur economic hardship if they met the reduction levels cited. There should also be a drought hotline for reports of misuse of water or when an official spots and reports a misuse. The violation process will be implemented for the violating site. Specific guidelines for potable water customers are listed below with additional "non essential" uses.

- Potable water customers are limited up to 30 percent of "normal" use when no rationing was required.
- Curtailment of any use of water from a fire hydrant - except for fighting fires, human consumption (hauling allowed to persons whose wells have gone dry), stock water, essential water quality flushing, and toxic clean-up purposes.

- No watering of any existing turf grass, ornamental plant, garden, landscaped area, tree, shrub or other plant except from a hand held hose or container or drip irrigation system.
- No watering of new turf grass or replacement turf grass.
- No initial filling of any swimming pool.
- No automatic serving of drinking water at dining establishments except with patron request.
- No new domestic accounts are accepted unless the parcel has been assessed for improvements through a legal process.

Affects on raw water customers are as follows:

- GDPUD Board has the discretion to limit new agricultural customers at any time if necessary.
- Raw water deliveries curtailed up to 50 percent.
- Managed supply of alternating days and preference given to IMS program members.
- The irrigation season, generally from May 1 to October 1, may be delayed or shortened.

2.3.4 Stage 3. Mandatory Rationing

When GDPUD water supplies are severely restricted, with a reduction in supply up to 50 percent, drought Stage 3 is enacted and all Stage 1 and Stage 2 water shortage response measures become mandatory. Additionally, if the Stage 2 voluntary approach is not effective or becomes unfair to too many customers, then the Stage 3 mandatory drought response measures will be implemented. In the case of a very severe drought, GDPUD may announce that Stage 2 is an interim step to be followed by Stage 3 on a date certain. Stage 3 includes an allotment for each customer account with a penalty rate applied for all water used in excess of the allotment. Stage 3 consists of up to 50% percent curtailment of potable water customers and up to 100% of raw water deliveries. Stage 3 is very expensive for the utility since an extraordinary amount of extra staff time and expense is required to conduct and manage the plan. Stage 3 requires in the enforcement of demand reductions by individual account. Also, many variance requests can be expected and must be dealt with. More specific rules are listed below.

- Residential meters serving single family detached homes are granted 68 gallons per day times per permanent occupant.
- Residential meters serving multiple units are allotted 50 percent of the amount used by the customer during the corresponding billing period in the base year.
- Meters serving any non-residential use are granted 60 percent of the amount used by the customer during the corresponding billing period in the base year. (Note: Vital healthcare and public safety use is set at 65 percent).
- No new domestic accounts are accepted.

Raw water customers are affected as follows:

- GDPUD Board has the discretion to limit new agricultural customers at any time if necessary
- Raw water deliveries curtailed up to 100 percent.
- Alternating managed water supplies with preference given to IMS customers.
- The irrigation season, generally from May 1 to October 1, may be delayed and/or shortened.

2.4 Drought Impact Avoidance

The substantial impacts of drought can be more effectively avoided with long-term planning efforts including water rights and infrastructure-based mitigation measures. Initially investigated and developed in Phase 1 of this effort, several drought impact mitigation alternatives for GDPUD's water system were enhanced and refined in updating the SVM for this Phase 2 analysis.

The SVM simulates several drought impact avoidance projects that include both demand reduction and supply augmentation alternatives. These projects are included as toggles and incorporate relevant capacities, hydrology, and infrastructure constraints. Many of these alternatives were researched by the participating purveyors independently, and all were discussed in detail and recommendations provided at the Phase 1 DAC workshops. The check boxes or drop down menus allow a user to compare various water agency "behavior" versus anticipated supply shortfalls.

Table 2-6 summarizes potential long-term reliability improvement projects (also referred to as drought mitigation and drought impact avoidance projects) for GDPUD.

Table 2-6. GDPUD Drought Impact Avoidance Project Alternatives

Project	Quantity
Rubicon Supply Alternative 1A	10,000 ac-ft/yr
Rubicon Supply Alternative 1B	17,500 ac-ft/yr
Canyon Creek Reservoir	17,000 ac-ft
Water conservation	300-500 ac-ft/yr
Ditch lining	2,436 ac-ft/yr

GDPUD potential drought mitigation projects include additional storage, revised water rights and contracts, ditch lining efforts, water conservation, and regionally collaborative projects. Details on these alternatives and the assumptions involved in their analysis as part of this effort are as follows:

Rubicon Supply Alternatives 1A and 1B. Rubicon Supply Alternative 1A consists of 10,000 ac-ft/yr of water from the Sacramento Municipal Utility District (SMUD) owned and operated Upper American River Project (UARP). Alternative 1B consists of 10,000 ac-ft/yr of SMUD UARP water and 7,500 ac-ft/yr from Public Law contract 101-514. The water supply from these alternatives is only available if Stumpy Meadows Reservoir is spilling the previous April, and only to the extent that the reservoir can be filled by diversions from the South Fork of the Rubicon River into Pilot Creek and Stumpy

Climate Change Factors

Projections of future climate change points to changes in seasonal river flow patterns. This includes decreased amounts of water stored in snow pack, reductions in annual precipitation, and an increase in the extent and frequency of drought. In this study climate change scenario factors are used that represent the relationship between actual hydrology and four types of potential shifts in hydrologic runoff conditions. Based on regionally applied scenarios developed by Dr. Jay Lund, these are the same data sets used in the forecasting tools for the Department of Water Resources, Bulletin 160: California Water Plan and the California Energy Commission Climate Change Report. Dr. Lund's information for American River watershed inflows to Folsom Lake under four different scenarios is used to index the runoff hydrology to reflect the possible impact due to climate change. The four climate change scenarios are (1) Scenario A – HCM 2050, a warmer and wetter climate in year 2050, (2) Scenario B – PCM 2050, a cooler and drier climate by year 2050, (3) Scenario C – HCM 2100, a warmer and wetter climate by year 2100, and (4) Scenario D – PCM 2100, a cooler and drier climate year 2100. Scenario D represents the potential "worst case" climate change scenario. Most climate change models in California project a warming trend. Additional information on how these climate change scenarios are modeled in this analysis can be found in the Phase I report.

Meadows Reservoir (Mead and Hunt, 2004).

Canyon Creek Reservoir. This storage option as described in the Georgetown Divide Water Management Study, is "centrally located in the service area, and it has a relatively high elevation, large tributary area, and potential to store GDPUD water from other sources" (DWR, 1992). The proposed dam, with a crest length of 980 feet and a height of 216 feet, would be located on Canyon Creek below the confluence with Dark Canyon Creek. Storage capacity would be 17,500 ac-ft, and water would be conveyed from Canyon Creek Dam to the existing GDPUD system through 2.6 miles of pipeline and tunnel to a site north of Greenwood. Stumpy Meadows Reservoir would continue to serve by gravity most of the eastern portion of GDPUD's service area, while the Canyon Creek gravity supply would be limited to the western and southwestern portions of the service area below 2,000 feet in elevation. Surplus water from Stumpy Meadows Reservoir could be conveyed in the existing GDPUD system and stored in Canyon Creek.

Additional Water Conservation. By enacting additional and ongoing demand measurement measures such as residential and commercial water audits, water waste prohibition, IMS, etc. GDPUD can potentially to save between 300 and 500 ac-ft/yr. Total projected conservation savings by year can be found in Appendix H. This drought impact avoidance alternative was incorporated into the SVM as part of the Phase 2 effort.

Georgetown Ditch Lining. 2,436 ac-ft/yr of raw water use can potentially be saved by lining the Georgetown Divide Ditch. Water savings are assumed to result from a 90 percent reduction in system-wide leakage and 50 percent reduction in evaporation, reducing Georgetown's current estimated water loss of 3,000 ac-ft/yr to 564 ac-ft/yr.

Since these drought impact mitigation alternatives are not currently being implemented, none have been included in developing the drought triggers and response policies that have been previously presented. As presented in Appendix F these projects do increase GDPUD's delivery reliability and decrease the number of times a drought is called and its duration, by varying degrees. Under cooler, drier climate conditions some projects increase GDPUD reliability, however, drought is declared much more frequently. Background information on climate change factors can be found in the information box. A screen shot from the SVM displaying GDPUD reliability using the experimental trigger plan under 2030 demands and worst-case climate change with drought impact avoidance projects, Rubicon Supply Alternative 1B and water conservation, is shown in Figure 2-3.

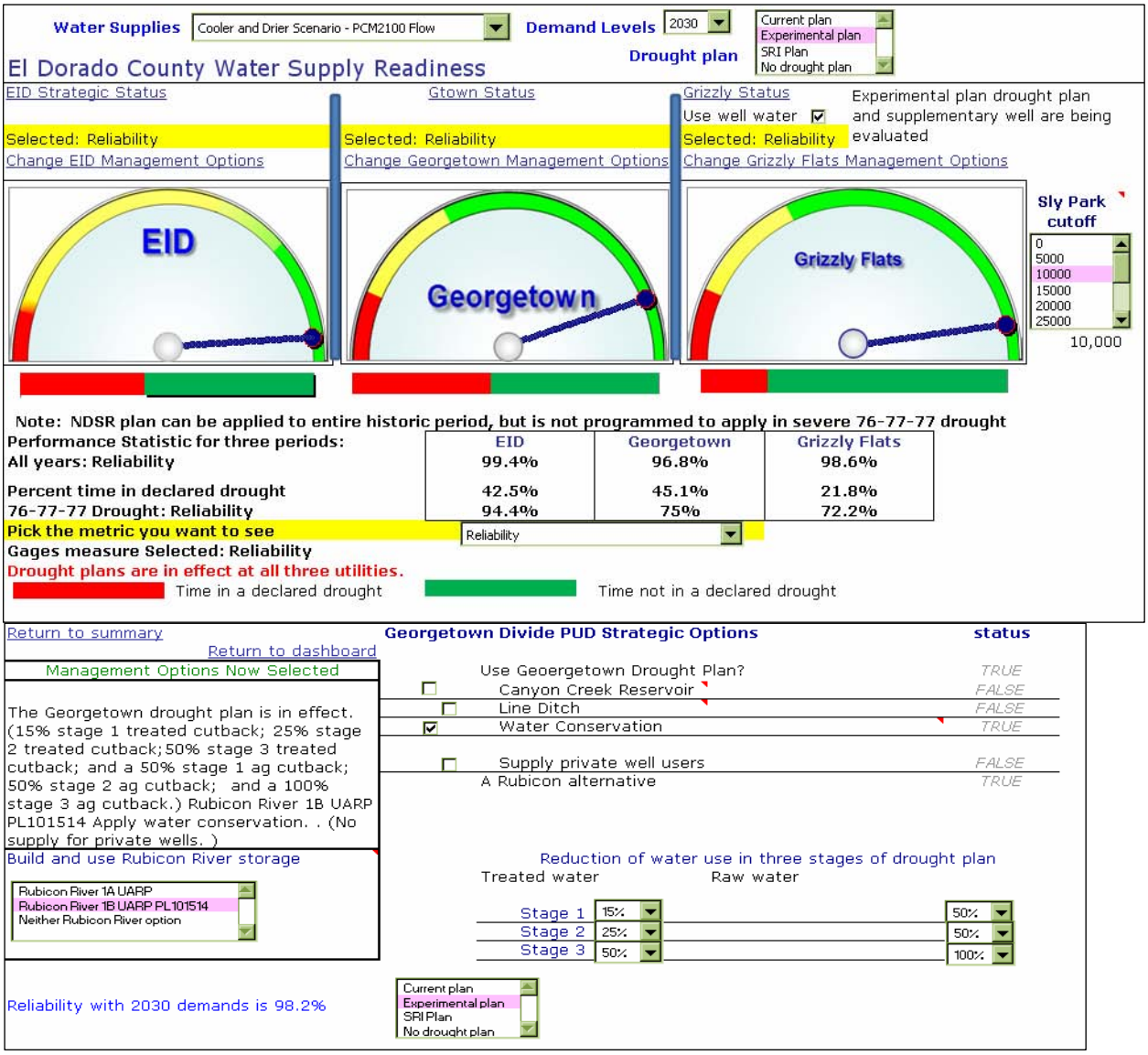

Figure 2-3. SVM Screen Shot of Regional 2030 Conditions with Worst –Case Cooler, Drier, Year 2100 Scenario Climate Change and GDPUD Drought Mitigation Projects Rubicon Supply PL101-514 Alternative and Water Conservation

3. DROUGHT PLAN IMPLEMENTATION

Section 3 provides guidance on implementation of the Drought Plan. The implementation plan includes actions that are recommended for immediate Board of Directors consideration and implementation actions to be completed during both non-drought periods and during each stage of drought. Drought Plan implementation action items are grouped under the following headings:

- Public Information and Outreach
- Interagency Drought Coordination
- Reconciliation with Existing GDPUD Board Policy and Regulation
- Initial Actions
- Ongoing Actions
- Drought Stage 1 Actions
- Drought Stage 2 Actions
- Drought Stage 3 Actions

3.1 Public Information and Outreach

Public information and outreach is an important element of the GDPUD Drought Plan because the customer response to drought will ultimately dictate the amount of water savings achieved. Interaction with the public will require a two way dialog. GDPUD will share information and provide guidance to its customers. Of equal importance, GDPUD will need to monitor the customer response and attitude toward both voluntary and mandatory customer response guidelines.

GDPUD customer outreach is required to successfully achieve targeted water savings during each drought stage. As discussed in Section 2.3 (Drought Response), the GDPUD drought team has recommended a drought response approach centered on voluntary compliance during drought Stage 1 and Stage 2, with mandatory restrictions implemented during Stage 3. GDPUD's staff with of help of EDCWA will need to effectively communicate information on drought stage, targeted water savings, and water saving guidelines that customers are expected to practice. Example materials to support public outreach are included in Appendix I.

Water savings guidelines for periods of non-drought and for each drought stage are included in Section 2.3. Prior to drought stage declaration, GDPUD will pursue outreach to inform customers of drought stages and definitions, targeted water savings for each drought stage, guidelines that customers are to follow during each stage, and sources of current information on GDPUD drought status.

Water savings guidelines are predicated on being equitable across the various customer account types. Maintaining a sense of fairness will help achieve community participation. It is anticipated that GDPUD customers will be provided various methods to communicate questions and provide comment to the GDPUD.

3.2 Interagency Drought Coordination

An interagency organizational framework is needed to facilitate drought coordination. Figure 3-1 depicts the suggested interagency organizational structure. Participating agencies include GDPUD, EID, EDCWA, and GFCSD. The organizational structure includes the following representation:

- **Board of Directors:** Final decision-making authority rests with each participating agency's Board of Directors. Status reports will be provided to the Board of Directors through information provided by the Drought Team Leader. The Board of Directors for each agency is encouraged to provide guidance consistent with the needs of their customers while pursuing opportunities for interagency collaboration and resource sharing.
- **Drought Interagency Coordination Committee:** Committee members will include the designated Drought Team Leader from GDPUD, EID, EDCWA, and GFCSD. The DICC is responsible for coordination activities for monitoring, public outreach, and resource sharing. The committee will also identify and recruit participation on a DAC when needed. The EDCWA representative will serve as the leader of the DICC.
- **Drought Team Leader:** Each participating agency will designate a Drought Team Leader. The Drought Team Leader will serve as the agency's liaison with the other agencies as a member of the DICC. The team leader will also be the agency point-of-contact with DAC members. The Drought Team Leader will also work closely with department staff from within GDPUD.
- **Drought Advisory Committee:** The DAC will include representation from agencies and individuals whose input will promote efficient and coordinated drought management activities. The DAC members will provide input and suggestions to the DICC. Figure 3-1 includes the suggested membership for the DAC.

Interagency drought coordination will require varying levels of engagement dependant upon current drought conditions. The level of interaction will increase in parallel with increasing drought severity. However, preparatory and proactive coordination will continue even during periods of non-drought. Interagency coordination will center on:

- **Monitoring:** Interagency communication of drought indicator status will allow each agency to understand current conditions for other water purveyors.
- **Public outreach:** Interagency development of drought education tools plus collaboration on public education and awareness will provide efficiency and consistency across the county.
- **Resource sharing:** Interagency collaboration and coordination of resources which may include staff, grant funding, monitoring tools, infrastructure, water, and educational outreach tools will allow agencies to provide support to others in the community.

Figure 3-2 depicts the type and frequency of interagency coordination activities that will be pursued by the DICC.

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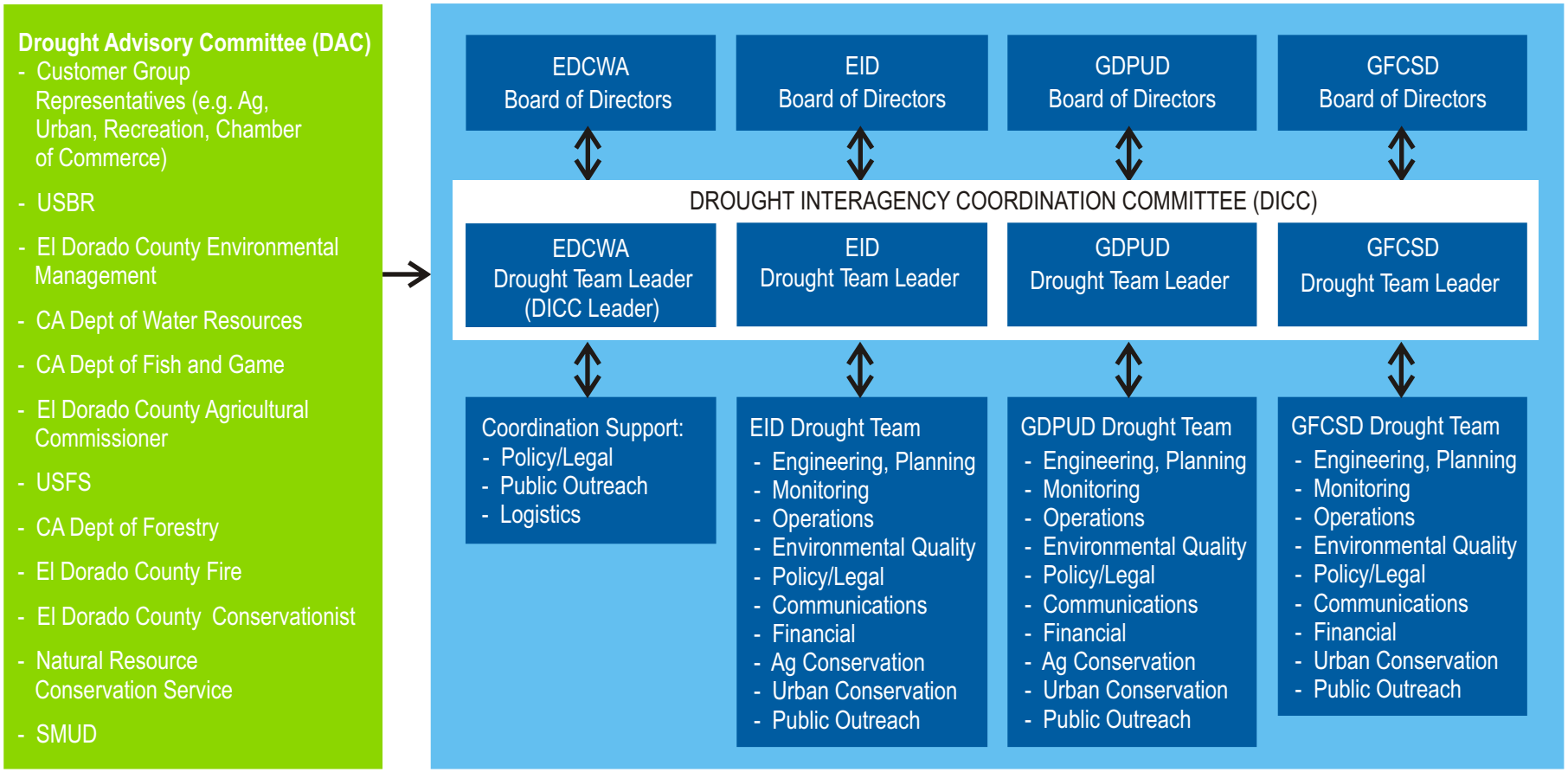
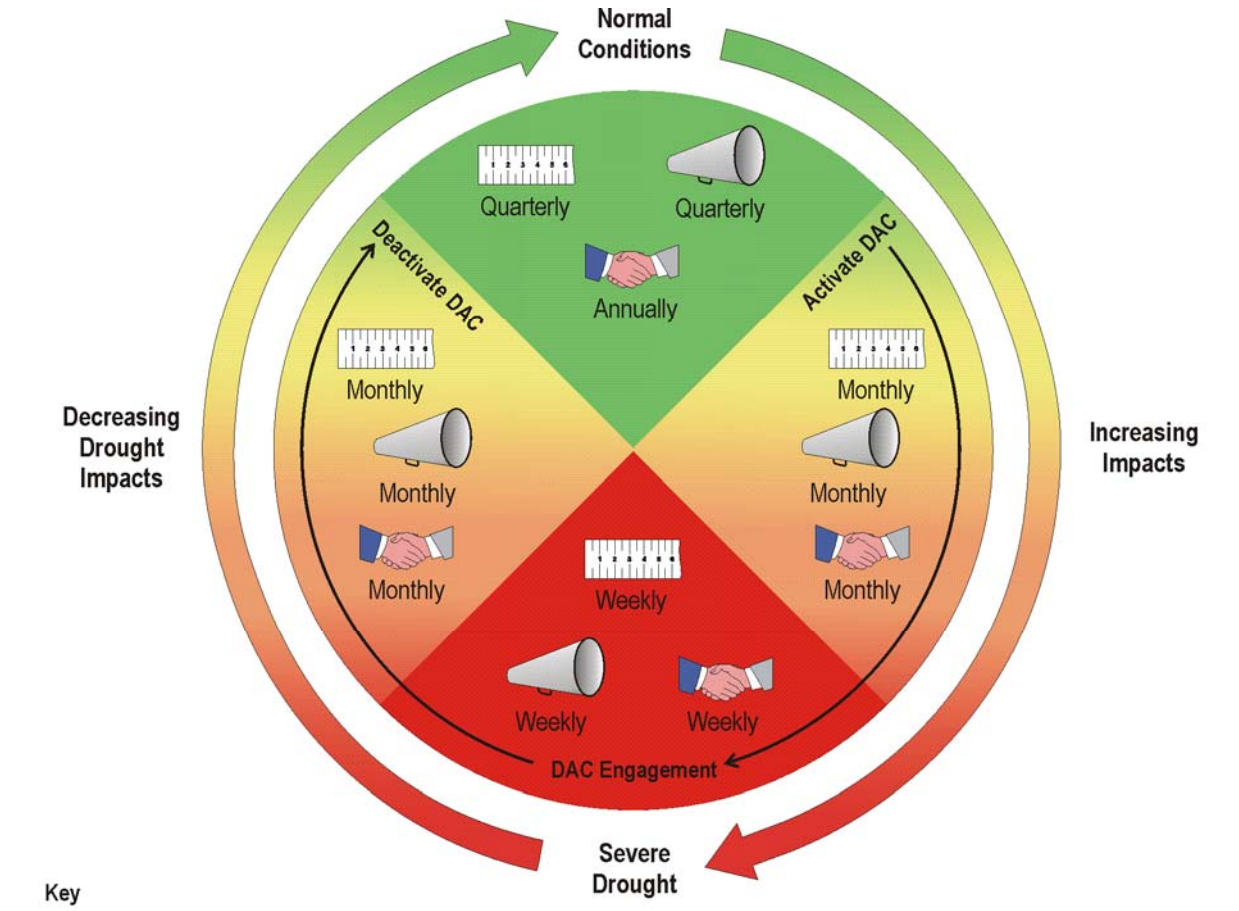


BROWN AND CALDWELL	PROJECT 130868	SITE Georgetown Divide Public Utility District	Figure 3-1
	DATE 10-25-07	TITLE Drought Interagency Organizational Structure	



Key

Monitoring:
Interagency communication of drought indicator status

Public Outreach:
Interagency development of drought education tools plus collaboration on public education and awareness

Resource Sharing:
Interagency collaboration and coordination of resources which may include staff, grant funding, monitoring tools, infrastructure, water, and education outreach tools

DAC Drought Advisory Committee

Figure 3-2. Drought Interagency Coordination Committee Activities

3.3 Reconciliation with Existing GDPUD Board Policy and Regulation

Implementation action: Board consideration of modification of existing standards to gain consistency with Drought Plan elements.

Background: Historically, GDPUD has responded to water supply shortages on an individual basis as they develop. Existing policies were reviewed to assess if adoption of the Drought Plan would result in conflict with current practices.

As described in their UWMP, GDPUD uses a 4-stage water shortage response and water supply triggering levels to manage water supply during periods of drought. Five water supply management conditions (or stages) ranging from Condition 0 - Normal or Unrestricted Water Supplies to Condition 4 – Declared Water Shortage Emergency.

Modification of GDPUD's current practices is needed with adoption of the Drought Plan. Inconsistencies between the Drought Plan content and GDPUD standards exist in the following areas:

Drought stages: Current GDPUD policy describes the 4-stage water supply shortage response plan as the current tool to monitor and manage water shortage, including a description of the five water supply management conditions. As described in Section 2.1, three drought stages are proposed. The main rationale for adoption of a 3-stage plan is to allow time for drought response measures to be effective and reduce the potential for moving between drought stages faster that GDPUD customers can reasonably respond to achieve the desired demand reduction. Drought stages are included in Table 3-1.

Drought indicators and triggers: The current drought plan relies on monthly Stumpy Meadows Reservoir water level elevations in April as the "indicator" of water shortage. Water level elevation stage triggers are defined, for the 2nd Wednesday in April, for each of the four stages. Though it is recommended that GDPUD adopt a modified version of their current drought plan triggers, additional monitoring tools including current ENSO episode, and DWR water year should also be monitored.

Drought stage response measures: Drought response measures are described in general terms for each of the four stages. As discussed in Section 2.3, demand reduction actions are coordinated with drought stage water supply conditions. Drought responses recognize the extensive end uses of water related to customer class and water source (potable and raw), the method of achieving effective water reductions, and reduction policy enforcement methods. As shown in Table 3-1, drought response includes an introductory phase - Stage 1 drought - during which all customers are informed of drought. In Stage 1 total treated water customer demand reduction is targeted for up to 15 percent, and raw water deliveries are managed at up to 50%. At Stage 2 water use decisions continue to be entrusted to the customer as long as the overall treated water reduction goal of up to 30 percent is met (Voluntary/Honor System). Consistent with GDPUD's current drought plan, in Stage 2 raw water supplies are managed at up to 50%. A strict allotment approach is implemented with a stiff penalty rate is implemented in Stage 3 with a total demand reduction goal of up to 50 percent.

Table 3-1 Drought Stage Response Summary

Water supply conditions	Drought stage	Objective	Demand actions
Normal 0% Total Supply Reduction	None - Ongoing conservation measures; water waste ordinance in effect	Public awareness	Normal actions
Slightly Restricted Water Supplies (below normal) Up to 15% Total Supply Reduction	Drought Stage 1 - Voluntary reductions in use. Managed raw water supplies	Initiate public awareness of predicted water shortage and encourage conservation. Reduce raw water deliveries	Encourage voluntary measures to decrease "normal" demand up to 15%. Raw water deliveries curtailed up to 50%
Moderately Restricted Water Supplies Up to 30% Total Supply Reduction	Drought Stage 2 – Voluntary reductions on use. Managed raw water supplies	Increase public understanding of worsening water supply conditions, encourage voluntary conservation measures. Reduce raw water deliveries	Encourage some voluntary measures to decrease "normal" treated water demand up to 30%. Raw water deliveries curtailed up to 50% Surcharge enacted
Severely Restricted Water Supplies Up to 50% Total Supply Reduction	Drought Stage 3 – Mandatory restrictions (severe prohibitions) on use	Ensure that water use is limited to health and safety purposes	Enforce extensive restrictions on water use and implement water rationing to decrease potable water demand up to 50% and raw water deliveries up to 100%

3.4 Initial Actions

Initial actions focus on beginning implementation of the Drought Plan. The objective of the initial implementation actions is to complete the steps necessary to begin implementation of the Drought Plan. These implementation actions are included in Table 3-2.

Table 3-2. Initial Drought Plan Implementation Actions

Policy and regulation	
1.	Board consideration of policy and regulation revision as described in Section 3.3
2.	Designate GDPUD Drought Team Leader
3.	Board consideration of refined Water Waste Ordinance (see Appendix G)
Monitoring	
1.	Staff to gain familiarity with drought monitoring tools.
2.	Initiate interagency communication of drought indicator status
Public outreach	
1.	Communicate Drought Plan adoption with community
2.	Initiate education on Drought Plan content
3.	Coordinate with Drought Team Leader on use of drought plan triggers to support public outreach
Resource management	
1.	Initiate interagency collaboration and coordination of resources through the DICC (see Section 3.2)
2.	Further consideration of DAC drought management strategy comments (Appendix J)

3.5 Ongoing Actions

Ongoing Drought Plan implementation actions will be completed both during periods of non-drought and drought periods. These activities can be characterized as proactive actions that prepare for drought through monitoring, public outreach, and resource management practices. The ongoing implementation actions were developed by the drought plan team as described in Section 2.3. Ongoing activities are included in Table 3-3.

Table 3-3 Ongoing Drought Plan Implementation Actions

Policy and regulation	
1.	Review and update Drought Plan every 5 years or as needed based on new supply, operational changes, or change in expected water demand
2.	Enforce water waste ordinance (see Appendix G)
3.	Continue conservation policies and support water-efficient plumbing codes
4.	Continue and advance IMS program
5.	Continue to evaluate new requests for agricultural service annually based on available supply. Permits not granted unless sufficient capacity to meet the service requested
6.	Review and refine rate stabilization policy relating to drought impacts every 5 years
7.	Understand and comply with legal and regulatory requirements for drought management
Monitoring	
1.	Assess drought indicators and triggers quarterly
2.	Monitor system demands
Public outreach	
1.	Develop and maintain drought awareness and public education materials, tools and protocol
Resource management	
1.	Maintain interagency coordination annually
2.	Confirm and maintain commitment of DAC members (see Figure 3-1)
3.	Pursue development of drought impact avoidance projects (see Section 2.4)
4.	Consider trucking contracts for water hauling during severe drought
5.	Consider construction of tap manifolds for emergency water distribution through hydrants
6.	Establish procedure by which residents within GDPUD on wells apply for emergency relief

3.6 Drought Stage 1 Implementation Actions

Drought Stage 1 implementation actions are intended to initiate public awareness of predicted water shortage and encourage conservation. Stage 1 actions target a 15 percent demand reduction in potable water use through implementation of voluntary measures. Raw water deliveries are curtailed by up to 50 percent. Stage 1 actions are described in Table 3-4.

Table 3-4. Drought Stage 1 Actions	
Policy and regulation	
1.	Implement Stage 1 water shortage response measures (see Section 2.3)
2.	Drought Team Leader provides monthly updates on drought status to GDPUD management
3.	GDPUD management provides monthly updates to Board
4.	Evaluate new requests for agricultural service annually based on available supply
Monitoring	
1.	Assess current drought stage bimonthly
2.	Consider potential future hydrologic conditions
3.	Monitor water demand monthly to assess water savings accomplished
Public outreach	
1.	Initiate community-oriented drought awareness with focus on community water use reduction goal and range of voluntary steps to accomplish savings
2.	Reacquaint customers with GDPUD's Water Waste Prohibitions and Stage 1 recommended water shortage response measures
3.	Provide monthly updates to public on current drought stage
4.	Provide monthly updates to public on community demand response status
5.	Develop procedure for customer reporting of wasted water
Resource management	
1.	Monthly DICC meetings
2.	Confirm commitment by DAC members

3.7 Drought Stage 2 Implementation Actions

Drought Stage 2 implementation action items are intended to increase public understanding of worsening water supply conditions and encourage voluntary conservation measures by potable water customers to decrease "normal" demand up to 30 percent. In Stage 2 raw water deliveries continue to be curtailed by up to 50 percent. Stage 2 activities include a continuation of activities described above under the Stage 1 actions and Ongoing actions. Table 3-5 includes a description of Stage 2 implementation actions.

Table 3-5. Drought Stage 2 Implementation Actions	
Policy and regulation	
1.	Implement Stage 2 water shortage response measures (see Section 2.3), including a continuation of Stage 1 activities
2.	Drought Team Leader provides weekly updates on drought status to GDPUD management
3.	GDPUD management provides at least monthly updates to Board
4.	GDPUD management provides the Board of Directors with an assessment of the need to enact a water surcharge
Monitoring	
1.	Assess current drought stage bimonthly
2.	Consider potential future hydrologic conditions
3.	Monitor water demand weekly to assess water savings accomplished

Table 3-5. Drought Stage 2 Implementation Actions	
Public outreach	
1.	Accelerate community-oriented drought awareness with focus on community water use reduction goal and range of voluntary steps and mandatory requirements to accomplish savings
2.	Reinforce with customers the GDPUD Water Waste Prohibitions and Stage 2 voluntary and mandatory recommended water shortage response measures
3.	Provide weekly updates to public on current drought stage
4.	Provide weekly updates to public on community demand response status
Resource management	
1.	Weekly DICC meetings to coordinate on monitoring, public outreach, current status, and opportunities for resource sharing
2.	Enact participation by DAC members

3.8 Drought Stage 3 Implementation Actions

The objective of drought Stage 3 implementation actions are to reduce potable water demand up to 50 percent through effective and consistent public outreach, the enforcement of extensive restrictions on water use, and implementation of water rationing. In Stage 3 raw water deliveries are curtailed by up to 100 percent. Protection of water supply for public health and safety purposes is the primary objective during Stage 3 drought conditions. Table 3-6 highlights Drought Stage 3 actions.

Table 3-6. Drought Stage 3 Implementation Actions	
Policy and regulation	
1.	Implement Stage 3 water shortage response measures (see Section 2.3), including a continuation of Stage 1 and Stage 2 activities
2.	Drought Team Leader provides weekly updates on drought status to GDPUD management
3.	GDPUD management provides at least monthly updates to Board
4.	GDPUD management provides the Board of Directors with an assessment of the need to enact a water surcharge
Monitoring	
1.	Assess current drought stage bimonthly
2.	Consider potential future hydrologic conditions
3.	Monitor water demand weekly to assess water savings accomplished
Public outreach	
1.	Accelerate community-oriented drought awareness with focus on community water use reduction goal and range of voluntary steps and mandatory requirements to accomplish savings
2.	Reinforce with customers the GDPUD Water Waste Prohibitions and Stage 3 mandatory water shortage response measures
3.	Provide weekly updates to public on current drought stage
4.	Provide weekly updates to public on community demand response status

Table 3-6. Drought Stage 3 Implementation Actions	
Policy and regulation	
5.	Implement procedure for customer reporting of water waste
Resource management	
1.	Weekly DICC meetings to coordinate on monitoring, public outreach, current status, and opportunities for resource sharing
2.	Enact participation by DAC members
3.	Consider coordinating and scheduling water hauling as needed
4.	Consider installing and monitoring tap manifolds for emergency water distribution through hydrants as needed

4. REFERENCES

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APPENDIX A

Shared Vision Model

Drought Status Supply Remaining Index Model

Model Help Resources

See enclosed CD.

APPENDIX B

Water Shortage Contingency Plan

WATER SHORTAGE CONTINGENCY PLAN

A. INTRODUCTION

Section 10632 of the California Water Code requires *Urban Water Management Plans* to include the preparation of a water shortage contingency analysis. The first part of this chapter describes the Georgetown Divide Public Utility District's emergency response plan for responding to a sudden water shortage or water quality emergency such as might occur in the event of significant system damage from a major earthquake, or during a prolonged power outage, or in the event of a water quality emergency from bacteriological or chemical contamination of the water supply. The second part of the plan describes the District's planning to address potential long-term water shortage conditions that could occur following one or more years of low precipitation (a drought).

B. WATER SUPPLY EMERGENCY RESPONSE

The District has a written Emergency Response Plan, designed to provide guidance and direction for the activities of the District's staff both during a water supply or water quality emergency and in mobilizing the post disaster response. Key provisions of the plan are summarized below:

Readiness: The District's primary emergency operations center would be created at the District office, at 6425 Main St. Georgetown CA. The District office is equipped with radios, telephones, telemetry equipment, emergency equipment, and supplementary documents and supplies. The emergency operations center would be the central point of coordination for government services, communications, and emergency public information.

Communication protocols have been established and damage evaluation procedures have been defined. In the immediate period following a major disaster, such as a fire, the District's initial task would be to evaluate the water supply system and to isolate breaks in order to minimize storage losses as quickly as possible.

The emergency operating center staffing would include the General Manager or his designee plus additional staff to help coordinate disaster control activities and communicate with the public. Other key District personnel would be assigned specific roles depending on the magnitude of the emergency as well as the time of occurrence. On non-business days and after hours, the District maintains 24-hour response capability with the assignment of trained on-call workers which can be summoned by calls from the District answering service or the local Police and Fire Departments.

The District has assembled an inventory of equipment and spare parts, and maintains key vehicles in a "ready to respond" condition. The District also has arrangements with vendors for emergency backhoe and underground work, in the event there is more damage than the District's staff can manage. Crews would assemble at the District Office and be taken to the emergency work site by District personnel who would also be responsible for operating the valves to isolate the break and oversee the emergency repair work.

Response: The goal of the District's post disaster response actions is to maintain the water transmission and storage system intact and operational to the greatest extent possible. Emergency response protocols specify the leadership role of the on-call worker if the emergency is in off-hours. The response plan is very specific with regard to operating protocols for the supply pumps and the monitoring of tank levels to ascertain the presence of significant leaks or pipeline breaks.

The repair or shut down work would be coordinated from the District Office and field crews would report progress to the emergency operations team. Regular progress reports would then be filed with the appropriate Police and/or Fire Department personnel.

C. STAGED RESPONSE PLAN FOR WATER SUPPLY SHORTAGES

The Georgetown Divide Public Utility District has in the past, and will continue in the future, to respond to water supply shortages on an individual basis as they develop. Generally, for droughts or any other long-term water supply shortage, the District will implement a program of water conservation measures that will result in use restrictions proportional to the severity of the reductions needed. In the past, such use restrictions have been associated with droughts. Although the circumstances surrounding future droughts (or any other long-term supply shortages) may not be identical to the droughts that the District has faced in the past twenty-five years, the programs of voluntary and mandatory rationing developed in response to the increasingly severe actual or potential shortages in 1977-79 provide the District with its model for planning future responses to severe water shortages.

Table 16 outlines the four stages of rationing for water supply shortages of up to 50%. Stage 1 consists of voluntary measures and is an extension of the District's ongoing education and financial incentive programs to encourage water conservation. Stages 2, 3 and 4 require mandatory rationing of agricultural water in addition to voluntary and mandatory conservation of domestic water in Stages 3 and 4 respectively. Mandatory rationing of domestic customers has never occurred in the past because of water conserved through mandatory reductions in agricultural use. The priority of domestic water over agricultural water is a long standing policy in the District and has been successfully used during periods of reduced water supply without noticeable long term impact on the community. No new agricultural accounts will be accepted during

mandatory stages of 3 and 4. However, the Board has the discretion to limit new agricultural customers at any time when it is deemed necessary. No new domestic accounts will be accepted during Stage 3 unless the parcel has been assessed for improvements through a legal process but during Stage 4, no new domestic accounts will be accepted.

Historically, reductions in reservoir storage on April 15th of have triggered rationing programs ranging from a voluntary to mandatory reduction goal for agricultural accounts of up to 50%. The reservoir levels in Table 17 trigger the rationing stages and incorporate both supply and carry-over shortages. The reservoir level is automatically reviewed by the District Board of Directors in April prior to the release of irrigation water in May.

TABLE 16
WATER SHORTAGE RESPONSES
A Program of Staged Responses

	Stage One	*Stage Two*	*Stage Three*	*Stage Four*
Type of Program Domestic Agricultural	 Voluntary Voluntary	 Voluntary Mandatory	 Mandatory Mandatory	 Mandatory Mandatory
Conservation Goal	15%	16% - 25%	26% - 35%	36 - 50%
District Actions	Initiate informational campaign. District Board has discretion to prohibit new agricultural accounts.	Establish allocations; Ban wasteful water uses; Intensify leak detection; Intensify public education District Board has discretion to prohibit new agricultural accounts	Establish more stringent allocations; Require retrofits prior to review of hardship exemptions; Increase rates. Prohibit new connections	Reduce allocations further; Monitor use weekly, if necessary; End deliveries to landscape meters; Prohibit new connections
Customer Actions	Reduce water consumption	Further reduce use; Comply with water waste ordinance;	Conform with allocations; Comply with landscape irrigation restrictions	Conform with allocations; Monitor usage weekly or daily; No new landscaping
Penalties	Education visit	Excess use charges; Citations; Flow restriction; Shutoff	Excess use charges; Citations; Flow restriction; Shutoff	Excess use charges; Citations; Flow restriction; Shutoff

TABLE 17 WATER SUPPLY TRIGGERING LEVELS		
Stage	% Supply Shortage	Reservoir Level on 2nd Wed. in April
1	Up to 15%	17,000 AF
2	16 -2 5%	15,000 AF
3	26 - 35%	13,000 AF
4	36% +	10,000 AF

1. MANDATORY PROVISIONS TO REDUCE WATER USE

The District adopted a "no waste" ordinance in 1982 which authorizes abatement procedures to curtail blatant water waste. According to the ordinance, The District may discontinue water service if such conditions are not corrected within five days after giving the customer written notice. If conditions warrant, the Board can enact more stringent measures to supplement the ordinance and will do what is required to ensure reasonable apportionment of water supplies during times of limited supply. The existing block rate schedule also provides the basis for penalizing excessive use. Additional tools for cases of flagrant waste include the installation of flow devices or termination of service.

Table 18 DOMESTIC CONSUMPTION REDUCTION METHODS	
Examples of Consumption Reduction Methods	Stage When Method Takes Effect
Demand reduction program	1
Reduce pressure in water lines	4
Flow restriction	3
Restrict building permits	4
Restrict for only priority uses	3
Use prohibitions	2
Water shortage pricing	3
Per capita allotment by customer type	4
Plumbing fixture replacement	2
Voluntary rationing	1
Mandatory rationing	2
Incentives to reduce water consumption	1
Education Program	1
Percentage reduction by customer type	1

Table 19 PER CAPITA HEALTH AND SAFETY WATER QUANTITY CALCULATIONS						
	Non-Conserving Fixtures		Habit Changes 1		Conserving Fixtures 2	
Toilets	5 flushes x 5.5 gpf	27.5	3 flushes x 5.5 gpf	16.5	5 flushes x 1.6 gpf	8.0
Shower	5 min x 4.0 gpm	20.0	4 min x 3.0 gpm	12.0	5 min x 2.0	10.0
Washer	12.5 gpcd	12.5	11.5 gpcd	11.5	11.5 gpcd	11.5
Kitchen	4 gpcd	4.0	4 gpcd	4.0	4 gpcd	4.0
other	4 gpcd	4.0	4 gpcd	4.0	4 gpcd	4.0
Total (gpcd)		68.0		48.0		37.5
HCF per capita per year		33.0		23.0		18.0

1 Reduced shower use results from shorter and reduced flow. Reduced washer use results from fuller loads.
2 Fixtures include ULF 1.6 gpf toilets, 2.0 gpm showerheads and efficient clothes washers.

2. Penalties or Charges for Excess Use

The District will establish penalties and charges above and beyond those that already exist as the water shortage stage increases.

3. Impacts on Revenues and Expenditures

The District has reserves established to respond to water shortage situations. Revenues are not expected to fluctuate significantly during a water shortage. Implementation of any stage of water rationing will not affect the minimum meter charge even though water usage will be reduced. The percentage increase in the increasing block rate schedule should be sufficient to compensate for the reduction in water sold. There will be no change in water cost to the District since the sole source of supply at this time is Stumpy Meadows Reservoir.

4. Mechanism for Monitoring Water Use

Since 99.8% of all Georgetown Divide Public Utility District customers are metered and the sources of supply are metered, the District is able to measure the effectiveness of any water shortage contingency plan that is implemented. As can be seen in Tables 5 and 6, the District collects sufficient data, in the normal course of operations, to determine actual reductions in sales, by user category, as compared to a given base year.

Normal Monitoring Procedure

In normal water supply conditions, production figures are recorded daily. Totals are reported monthly to the Operations Manager and incorporated into the water supply report.

Stage 1 and 2 Water Shortages

During a Stage l or 2 water shortage, daily production figures are reported to the Water Treatment Plant Supervisor. The Supervisor compares the weekly production to the target weekly production to verify that the reduction goal is being met. Weekly reports are then forwarded to the Operations Manager. Monthly reports are sent to the General Manager. If reduction goals are not met, the General Manager will notify the Board of Directors so that corrective action can be taken.

Stage 3 and 4 Water Shortages

During a Stage 3 or 4 water shortage, the procedure listed above will be followed, with the addition of a daily production report to the Operations Manager.

Disaster Shortage

During a disaster shortage, production figures will be reported to the Operations Manager hourly, and to the General Manager daily. Reports will also be provided to the Board of Directors and the El Dorado County Office of Emergency Services as necessary.

APPENDIX C

1982 “No Waste” Ordinance

1982 "No Waste" Ordinance

Excerpt of Georgetown Divide Public Utility District 1982 Ordinance

Section 7-5. Water Waste. No customer shall knowingly permit leaks or waste of water. Where water is wastefully or negligently used on a customer's premises, seriously affecting the general service, the District may discontinue the service if such conditions are not corrected within five (5) days after giving written notice.

APPENDIX D

Irrigation Ordinance

ORDINANCE 2005-01

AN ORDINANCE ESTABLISHING RULES AND REGULATIONS FOR IRRIGATION SERVICE IN THE GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

BE IT ENACTED by the Board of Directors of the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT, County of El Dorado, State of California, as follows:

The rules and regulations for irrigation service within the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT ("District") are adopted by the Board of Directors of said District as hereinafter set forth.

SECTION 1. General Conditions:

(a) Control of System: District Works shall be under exclusive control and management of District personnel duly appointed by the Board of Directors.

(b) The District shall not be liable for interruption, shortage or insufficiency of irrigation water supply, or for any loss or damage occasioned thereby.

(c) The District shall not be liable for damage to person or property resulting directly or indirectly from privately owned conduits, meters or measuring devices.

(d) Irrigation water is used at the customer's own risk and the customer agrees to hold the District, its officers and employees free and harmless from liability and damages that may occur as the result of defective water quality, shortages, fluctuation in flow or pressure, interruptions in service or for failure to deliver water.

(e) Pumping of water by the customer is done at the customer's risk. The District assumes no liability for damage to pumping equipment or other damages as a result of turbulent water, shortages, excess of water or other causes.

(f) No purchaser of water from the District acquires a proprietary or vested right by reason of use. No purchaser acquires a right to resell water or to use for a purpose other than that for which it

was applied nor to use it on premises other than indicated on the application. The terms, conditions, priorities and allocation of irrigation service may be altered and amended by the Board of Directors. The District does not guarantee irrigation service customers the right to future service.

(g) The District expressly asserts the right to recapture, reuse and resell all waters originating from District Works.

(h) Ditchtenders and other agents of the District shall have access to all lands irrigated from its water system and to all conduits for the purpose of inspection, examination, measurements, surveys or other necessary purposes of the District with the right of installation, maintenance, control and regulation of all meters and other measuring devices, gates, turnouts and other structures necessary or proper for the measurement and distribution of water.

(i) No bridges, crossing, pipe or other structures shall be placed in or over a canal without written permission of the District. Maintenance of the canal crossings shall not be the District's responsibility but shall rest with the owner of the crossing. Where the owner fails to maintain the crossing, the District may perform the necessary repairs or removal at the expense of the owner. Notice of the District's intent will be given, if possible, to the owner prior to the work commencing.

(j) No rubbish, garbage, refuse, chemicals or animal matter from any source may be placed in or allowed to be emptied into any ditch, canal or reservoir of the District.

(k) District canals or reservoirs shall not be used for swimming or bathing.

(l) Livestock shall not be permitted to contaminate the water supply nor destroy or damage the canal system or use thereof. Property owners are liable for any damage due to livestock.

(m) No conveyance system shall cause a cross connection with the District's water system with any other source of water.

(n) No buildings, corrals or other structures, fences, trees, lines or bushes shall be permitted upon rights-of-way or use thereof be made in any way except by written authority of the District. Construction of

fences and/or gates is not permitted without written approval of the specifications by the General Manager.

(o) Violation of Rules and Regulations: Failure to comply with rules and regulations of the District shall be sufficient cause for terminating irrigation service as determined by the Board of Directors.

(p) Any person dissatisfied with any determination of the District management shall have the right to appeal to the Board of Directors.

(q) Amendments: The Board of Directors of the District may at their discretion alter, amend or add to these rules and regulations. The Board of Directors will follow applicable laws during this process.

SECTION 2. Application for an Irrigation Service Account:

(a) No irrigation service will be rendered until a complete application for an Irrigation Service Account has been approved and is on file at the office of the District. Applications will be accepted between January 1st and March 1st for the impending irrigation season. The application for service shall state that the customer agrees to abide by the terms and conditions for service as established in the Irrigation Ordinance.

(b) Applications will be approved where the District Works have sufficient capacity to meet service requested. Applications will be considered for approval utilizing the following priority system:

Priority 1.	Applications for Irrigation Service to parcels that received irrigation service during the immediate past irrigation season.
Priority 2.	Applications for Irrigation Service to parcels with the most recent active Irrigation Service Account during the previous ten (10) irrigation seasons
Priority 3.	New applications for irrigation service to parcels that have been made after the 2003 irrigation season with priority established by the earliest season applied for. Applications and priority are specific to the section of ditch the parcel is located near.

Competing applications within the same priority level, will be determined by public lottery.

(c) Applications for an increase to service will receive Priority 3 status for the requested increase.

(d) Applications must in all cases be signed by the holder of title to the property requesting irrigation service. If the property requesting irrigation service is leased, two months of charges must be paid in advance. The landowner of leased property shall be responsible for all charges or assessments.

(e) Applications for an Irrigation Service Account to benefit a parcel of land that is not adjacent to the District Works must be accompanied by a legally recorded easement that allows the conveyance of water to the parcel requesting irrigation service. The easement shall grant the District the right of ingress and egress for inspection, installation and maintenance purposes.

(f) New applications for Out-of-District Irrigation Service Accounts will not be approved by the Board of Directors. An existing Out-of-District Irrigation Service Account that is inactive for two or more years will be deleted from the District's accounts and the service will be permanently removed.

SECTION 3. Distribution of Water:

(a) The irrigation season shall generally be from May 1 through October 1 of each year. The Board of Directors shall consider changes to the irrigation season to respond to climactic conditions and may implement such changes by a majority vote.

(b) The District does not guarantee irrigation water under pressure from the District Works. Pressure requirements of the customer are the sole responsibility of the customer and the District shall not be liable for any damage to equipment used to provide pressure to the customer.

(c) Water is distributed under continuous flow. Water must be used continuously during all days and nights including holidays and Sundays and no allowances shall be made for failure to use water when it is made available. Failure to use water on schedule shall not entitle the customer to any rebate.

(d) Irrigation service is provided for the entire irrigation season. Customers shall pay for irrigation service for the entire irrigation season regardless of their interest or ability to use water.

(e) When interruptions to irrigation service due to failure of the District Works extend beyond five (5) days, proportionate adjustments for such water loss will be made.

(f) Irrigation customers shall pay a proportionate amount for irrigation service when the irrigation season is extended or shortened by the Board of Directors.

(g) Unauthorized connections or the taking of water in an amount greater than applied and paid for, by any means, is a misdemeanor under California Penal Code Section 498 and shall be subject to criminal prosecution under Section 498 and any other applicable laws. In addition, the District may bring a civil action for damages and may refuse future service to the parcel.

(h) Irrigation customers shall prevent any unnecessary or wasteful use of water. Should a customer permit wasteful use of water, the District may discontinue service if such condition is not corrected within five (5) days after giving the parcel owner written notice of intention to terminate service.

(i) No more than one parcel shall be served through each Irrigation Service Account except with the prior written approval of the Board of Directors. Any such approval shall be recorded against each parcel with the caveat that the agreement expires upon any change of ownership. Each Irrigation Service Account shall have independent service lines and sumps.

(j) The minimum irrigation service for each Irrigation Service Account shall be one miner's inch, from the open ditch system, and one-half miner's inch from the irrigation pipeline system. In the future, the District may consider reducing the minimum irrigation service to one-half miner's inch from the open ditch system and one-quarter miner's inch from the irrigation pipeline system.

(k) All pumped services shall utilize a sump provided by the customer and acceptable to the District.

(l) All Irrigation Service Accounts must have an appropriate measuring device which shall be installed by the District. The customer shall pay the cost thereof including costs of installation. The District shall approve the location of the measuring device.

(m) Customers receiving irrigation service who request a change in flow rate during the season shall be charged a fee set by the Board of Directors for the adjustment.

(n) Replacement of measuring devices shall be at the expense of the customer if the replacement is necessary due to abnormal wear or abuse.

(o) Alternate Boxes –The Board of Directors shall not approve any new applications for Alternate Boxes.

(p) Unusual costs incurred by the District to provide irrigation service shall be paid in full by the applicant or customer. An estimate of the expense shall be approved by the property owner prior to work commencing.

SECTION 4. Charges, Rates and Billings:

(a) The District will maintain a uniform rate schedule which may be changed from time to time upon action of the Board of Directors. The rate schedule, by reference, is attached hereto and made a part of these rules and regulations.

(b) Irrigation billings are made bi-monthly (every two months) in advance.

(c) All penalties shall be charged as outlined on the billings

(d) Disconnected irrigation service accounts shall pay a fee to re-establish service

(e) Irrigation service accounts requesting verification of flow will pay a fee if the delivered flow is within 10% of the contracted amount

SECTION 5. REPEAL

(a) Upon the effective date of this Ordinance 2005-__ all previously adopted Ordinances pertinent to the Rules and Regulations for

Irrigation Service will be superceded and repealed, including, but not limited to, Ordinance 79-2, 79-8, 87-1, and 04-01.

PASSED AND ADOPTED at a regularly held meeting of the Board of Directors of the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT this tenth day of May, 2005.

AYES:	Bob Diekon, Norman Krizl, Doug Pickell, JoAnn Shepherd and Hy Vitcov
NOES:	None
ABSENT:	None

_____

Bob Diekon, President
Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

ATTEST:

_____

Henry N. White, Clerk and ex officio
Secretary, Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

* * * * * * * * * * * *

I hereby certify that the foregoing is a full, true, and correct copy of Ordinance 2003-02 duly and regularly adopted by the Board of Directors of the Georgetown Divide Public Utility District, El Dorado County, California, at a meeting duly held on the tenth day of May, 2005.

_____

Henry N. White, Clerk and ex officio Secretary of the
Georgetown Divide Public Utility District

APPENDIX E

Drought Stage Guidance Comparison Summary and Water Shortage Guidance Tables

Summarized Relevant Water Shortage and Drought Policies
for El Dorado County Water Agency and Georgetown Divide Public Utility District

Agency	Current Policy																					
	GDPUD				El Dorado County Environmental Management Department	El Dorado County Water Agency (EDCWA)	Department of Water Resources (DWR)		California Office of Emergency Services	Governor's Advisory Drought Planning Panel					United States Bureau of Reclamation (USBR)							United States Army Corps of Engineers (USACE)
	Stage 1 water supply shortage	Stage 2 water supply shortage	Stage 3 water supply shortage	Stage 4 water supply shortage	(NOTE: Information gathering in progress.)	(NOTE: There are no current EDCWA drought policies.)	Urban Water Management Plan	Long-term drought preparedness planning	Water Supply Interruption Action Plan	Tier 1 Critical Water Shortage Reduction Marketing Program	Tier 2 Critical Water Shortage Reduction Marketing Program	Tier 3 Critical Water Shortage Reduction Marketing Program	Assistance to small water systems and homeowners in rural counties	Development of local agency Integrated Water Management Plans	Water Management Plan Guidelines	Ag and M&I Shortage Allocations	Develop a strategy	Stage 1 - Minimal	Stage 2 - Moderate	Stage 3 - Severe	Stage 4 - Critical	Drought Response Plan Development
EDCWA					S			S	S	S	S	S	S	S								S
GDPUD	R	R	R	R	S		R	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

KEY
R = Required
S= Suggested
= Not Applicable

Relevant Water Shortage and Drought Policies
for El Dorado County Water Agency and Georgetown Divide Public Utility District

Agency	Current Policy	Current Procedure	
		Action	Schedule
PURVEYOR LEVEL			
GDPUD	Stage 1 water supply shortage	**Encouraged implementation of voluntary actions:** Initiate informational campaign, utilize District Board discretion to prohibit new agricultural accounts, reduce domestic consumption.	Implement if water supply is 0-15% less than "normal" (i.e., if Stumpy Meadows Reservoir level on the 2nd Wednesday in April is 15,000-17,000 AF).
GDPUD	Stage 2 water supply shortage	**Mandatory rationing of agricultural water:** Establish allocations, ban wasteful water uses, intensify leak detection, intensify public education, utilize District Board discretion to prohibit new agricultural accounts, reduce domestic consumption through: use prohibitions, plumbing fixture replacement, and mandatory rationing.	Implement if water supply is 16-25% less than "normal" (i.e., if Stumpy Meadows Reservoir level on the 2nd Wednesday in April is 13,000-15,000 AF).
GDPUD	Stage 3 water supply shortage	**Mandatory rationing of agricultural water, no new agricultural accounts, and no new domestic accounts unless the parcel has been assessed for improvements through a legal process:** Establish more stringent allocations, require retrofits prior to review of hardship exemptions, increase rates, and prohibit new connections. Reduce domestic consumption through: flow restriction, restrict for priority uses, and water shortage pricing.	Implement if water supply is 26-35% less than "normal" (i.e., if Stumpy Meadows Reservoir level on the 2nd Wednesday in April is 10,000-13,000 AF).
GDPUD	Stage 4 water supply shortage	**Mandatory rationing of agricultural water, no new agricultural accounts, and no new domestic accounts:** Reduce allocations further, monitor use weekly (if necessary), end deliveries to landscape meters, and prohibit new connections. Reduce domestic consumption through: reduce pressure in water lines, restrict building permits, and per capita by customer type.	Implement if water supply is 36%+ less than "normal" (i.e., if Stumpy Meadows Reservoir level on the 2nd Wednesday in April is less than 10,000 AF).
COUNTY LEVEL			
El Dorado County Environmental Management Department	(NOTE: Information gathering in progress.)	(NOTE: Spoke with Greg Stanton at El Dorado County Environmental Management Department on 08/15/06. Before providing information on County policies/regulations, Greg would like to discuss with his staff.)	
El Dorado County Water Agency (EDCWA)	(NOTE: There are no current EDCWA drought policies.)		

Relevant Water Shortage and Drought Policies
for El Dorado County Water Agency and Georgetown Divide Public Utility District

Agency	Current Policy	Current Procedure	
		Action	Schedule
STATE LEVEL			
Department of Water Resources (DWR)	Urban Water Management Plan	Include a water shortage contingency analysis in UWMPs and include each of the following elements: (a) Stages of action (including up to a 50% water supply reduction) and an outline of specific water supply conditions for each stage. (b) Estimate of the min. water supply available during each of the next 3 water years based on the driest 3-year historic sequence. (c) Actions to prepare for and implement during a catastrophic interruption of water supplies. (d) Mandatory prohibitions against specific water use practices during water shortages. (e) Consumption reduction methods in the most restrictive stages. (f) Penalties or charges for excessive use, where applicable. (g) Analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures, and proposed measures to overcome those impacts. (h) Draft water shortage contingency resolution or ordinance. (i) Mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.	Every five years
DWR	Long-term drought preparedness planning	1) Seek additional funding or partnerships to support DWR's basic water measurement programs 2) Update and publish DWR's water well standards 3) Develop a fact sheet and web page to ID county agencies administering well standards 4) Closely review shortage contingency elements of UWMPs 5) Develop an internal database-backed website for extracting information from UWMPs 6) Continue efforts to site more CIMIS weather stations in urban areas 7) Survey some of CA's larger urban areas to determine the extent to which the Model Water Efficient Landscape Ordinance is being implemented. 8) Identify and fund research in the areas of long-range weather forecasting, global climate change, and paleoclimatology	1) January of first water year: Submit funding request in Governor's May budget revision for drought water bank in the programmatic EIR and for placing additional mobile irrigation management labs in the field 2) Spring of first water year: Promote CIMIS through workshops and media outreach, and begin developing fact sheets and related information to respond to public and news media inquiries 3) Summer of first water year: Begin holding public workshops on well construction fundamentals and the DWR's well standards, targeting rural counties with large numbers of individual residences on wells 4) Near start of second water year: (a) Evaluate water supply and triggers. (b) If warranted, begin enhanced education and outreach program. (c) Evaluate staff resources available for procesing water bank contracts and contracts for other wheeling of non-SWP water. (d) Evaluate need for any new legislation to address drought-related conditions.
California Office of Emergency Services	Water Supply Interruption Action Plan	1) Normal Conditions: No water use reduction needed. 2) Water Alert: A 5% or greater reduction in water usage. 3) Water Warning: A 15% or greater reduction in water usage. 4) Water Crisis: A 30% or greater reduction in water usage. 5) Water Emergency: A 50% or greater reduction in water usage.	
Governor's Advisory Drought Planning Panel	Tier 1 Critical Water Shortage Reduction Marketing Program	**Water Shortage Preparedness:** Implement water use efficiency measures, develop local facilities to enable water transfers, and develop local groundwater management programs. Develop guidelines/criteria/action plans to prepare for Tier 2 and 3 occurrences. Begin a reserve fund to cover participation in the program.	CALFED Stage 1
Governor's Advisory Drought Planning Panel	Tier 2 Critical Water Shortage Reduction Marketing Program	**Purchasing Options and Allocating Water:** Make a declaration of probable impending critical water shortages absent a program purchase and demonstrate that resources are being maximized to purchase water	
Governor's Advisory Drought Planning Panel	Tier 3 Critical Water Shortage Reduction Marketing Program	**Water Shortage Emergency:** Coordinate with State regarding financial assistance for emergency water acquisitions, including water hauling, pipeline construction, or well drilling.	
Governor's Advisory Drought Planning Panel	Assistance to small water systems and homeowners in rural counties	Proposed State-funded DWR-developed program component: Development of a technical assistance/education program targeted to rural home-owners and small domestic water systems relying on self-supplied groundwater, to be implemented in consultation with rural county environmental health departments, including series of workshops designed to educate homeowners with private wells about well construction and maintenance fundamentals. Development of a website containing information on State and County well construction requirements, sources of groundwater level and well yield data, and State and County contacts for obtaining additional information.	Proposed State-funded DWR-developed program component: At time of Governor proposal and subsequent Legislature approval
Governor's Advisory Drought Planning Panel	Development of local agency Integrated Water Management Plans	Proposed DWR/other CALFED agencies-funded program: DWR/other CALFED agencies to work in partnership with local water agencies to assist them in developing plans to facilitate integrated management of supplies for agricultural, urban, and environmental purposes.	Proposed DWR/other CALFED agencies-funded program: At time of DWR allocation of funds (at least $2 million per year) to support proposed program.

Relevant Water Shortage and Drought Policies
for El Dorado County Water Agency and Georgetown Divide Public Utility District

Agency	Current Policy	Current Procedure	
		Action	Schedule
FEDERAL LEVEL			
United States Bureau of Reclamation (USBR)	Water Management Plan Guidelines	Attach to the USBR Water Management Plan a copy of the agricultural and/or urban water shortage policies, drought plan, or any similar document. Describe how reduced water supplies, including hardship water, are allocated. Describe the policies that address wasteful use of water and describe enforcement methods.	
USBR	Ag and M&I Shortage Allocations	**M&I Shortage Policy - Central Valley Project:** 1) Decrease ag water supplies to 75% of contractual water supply before M&I water supplies begin taking shortages. 2) Then ag and M&I shortages rachet down % by % until M&I water reaches 75% of its historic use and ag water is at 50% of its contractual water supply. 3) When the M&I's 75% reliability sets in, M&I will remain at 75% of its historic use, and reduce ag water until ag supplies reach 25% of their contract water supply. Evaluate CVP water supply availability, public health and safety levels, hardship water for agricultural demands, etc. 4) When ag water supplies are reduced to 25%, further reduce M&I water supplies.	
USBR	Develop a strategy	**Preparing for, minimizing, and responding to water shortages:** 1) Establish triggers for a water shortage response plan and actions to be taken before and during a water shortage. Balance supply and demand. 2) Develop a water shortage strategy with stages, select appropriate drought mitigation measures, match water shortage mitigation actions to strategy stages (i.e., supply augmentation methods, demand reduction methods, 3) When a water shortage is imminent, implement strategy: evaluate water saved by staged reductions and select stage 4) Monitor production and use 5) Implement public outreach strategy and involve the media 6) Analyze revenue and expenditure impacts	
USBR	Stage 1 - Minimal	Voluntary reductions to decrease "normal" demand by 5-10%.	
USBR	Stage 2 - Moderate	Some mandatory measures.	15-25% Total Supply Reduction
USBR	Stage 3 - Severe	Water rationing.	25-35% Total Supply Reduction
USBR	Stage 4 - Critical	Water rationing and extensive restrictions on water use to decrease demand by 50% of the "normal" demand.	35-50% Total Supply Reduction
United States Army Corps of Engineers (USACE)	Drought Response Plan Development	Include in Drought Response Plan the following elements: 1) Triggers 2) Forecasts 3) Monitoring 4) Enforcement 5) Public affairs strategy 6) Management measures 7) Coordination mechanism	

APPENDIX F

GDPUD Reliability

GDPUD Reliability - No Plan VS Current Plan

Table 1. GDPUD Reliability					
		Reliability based on historical record		Reliability based on design drought conditions (76-77-77 hydrology)	
Year	Description	No plan (no drought plan or demand reduction)	Current (based on Stumpy Meadows levels)	No plan (no drought plan or demand reduction)	Current (based on Stumpy Meadows levels)
2004	Reliability (%)	98.6	100	86.1	100
	% months drought declared	0 [a]	11.3	0 [a]	72.2
2010	Reliability (%)	88.5	100	66.7	86.1
	% months drought declared	0 [a]	27.5	0 [a]	72.2
2020	Reliability (%)	82.7	95.6	63.9	83.3
	% months drought declared	0 [a]	38.7	0 a	72.2
2030	Reliability (%)	76.0	88.5	55.6	72.2
	% months drought declared	0 [a]	41.2	0 [a]	72.2

Notes:
1. Based on SVM 101607 version.
[a] Since this alternative has no drought triggers, no drought policy is called in any month
[b] Percent time in drought for design drought conditions is not available (N/A).

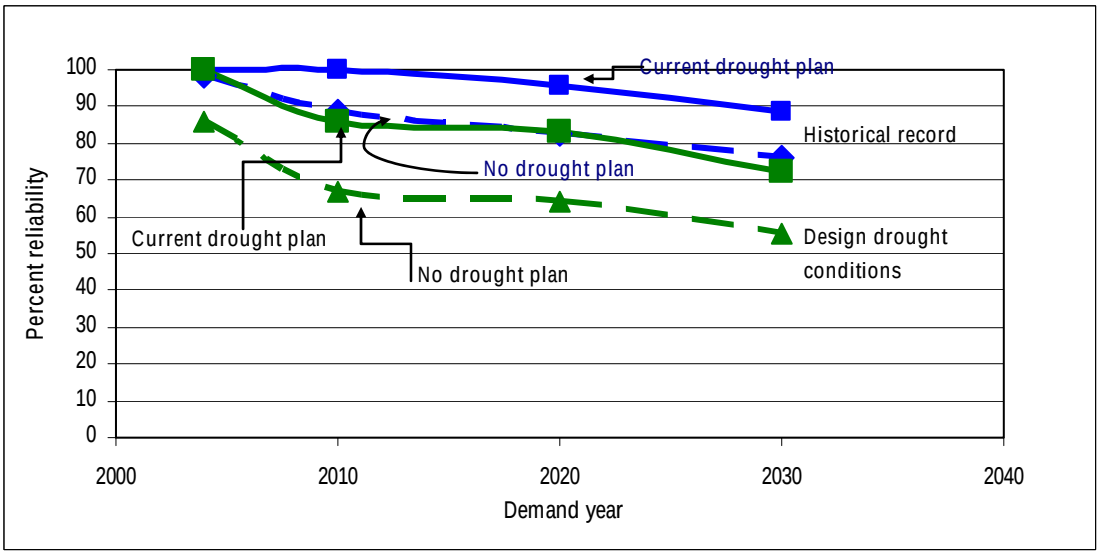

Figure 1. GDPUD Reliability

GDPUD Reliability - No Plan, Current, Experimental and SRI Trigger Plan Comparison

Table 2. GDPUD Trigger Plan Summary

Year	Description	Trigger Plan			
		No plan (no drought plan or demand reduction)	Current (based on Stumpy Meadows levels)	Experimental (based on Stumpy Meadows levels)	SRI (based on ENSO, Stumpy Meadows Reservoir levels, worst case expected inflows, projected normal demands)
2004	Reliability (%)	98.6	100	100	100
	% months drought declared	0 [a]	11.3	7.5	6.5
2010	Reliability (%)	88.5	100	96.6	99.3
	% months drought declared	0 [a]	27.5	25.3	18.8
2020	Reliability (%)	82.7	95.6	95.4	95.8
	% months drought declared	0 [a]	38.7	34.7	30.5
2030	Reliability (%)	76.0	88.5	95.2	87.9
	% months drought declared	0 [a]	41.2	41.6	39.6

Notes:
1. Reliability is based on the historical record.
2. Based on SVM 101607 version.
3. Bolded values represent best value.
4. The SRI indicators and triggers were optimized for 2004 and 2010 demands.
5. Reliability less than 100% means that additional curtailments would be necessary beyond whatever stage 3 measures are used.

[a] Since this alternative has no drought triggers, no drought policy is called in any month.

GDPUD Reliability – Drought Impact Avoidance Project Comparison

Table 3. GDPUD Drought Impact Avoidance Project Summary									
Year	Projects	No climate change				Worst climate change scenario			
		Current Trigger Plan		Experimental Trigger Plan		Current Trigger Plan		Experimental Trigger Plan	
		Reliability %	% drought declared	Reliability %	% drought declared	Reliability %	% drought declared	Reliability %	% drought declared
2010	No project	100	27.5	96.6	25.3	96.2	46.5	97.6	37.6
	Water conservation (WC)	99.6	28.2	96.8	25.1	97.4	44.2	97.8	37.4
2030	No project	88.5	41.2	95.2	41.6	88.1	55.8	90.7	49.9
	Water Conservation (WC)	92.7	42.0	96.0	40.0	89.3	55.2	91.1	49.5
	WC and Rubicon Supply Alternative 1A	98.2	42.0	98.0	38.2	96.8	55.2	95.6	46.9
	WC and Rubicon Supply Alternative 1B	99.8	42.0	98.2	36.0	100	55.2	96.8	45.1
	WC and Canyon Creek Reservoir	94.8	42.0	97.6	24.6	93.3	55.2	95.0	29.1
	WC and Ditch Lining	99.2	33.0	96.4	31.7	99.4	40.8	94.4	42.6

Notes:
1. Reliability is based on the historical record.
2. Based on SVM 061307 version.
3. In many cases a higher reliability is coupled with more time in drought declaration.
4. Reliability less than 100% means that additional curtailments would be necessary beyond whatever stage 3 measures are used.
5. Worst case climate scenario is PCM2100 – a cooler drier climate estimate.
6. Year 2010 "water conservation" presents a slightly lower reliability and increased time in drought because enacting water conservation because in the drought plan isn't triggered as early, and so the shortfall is a little bigger because the demand is higher, demand curtailment doesn't occur as early.
7. Bolded values are shown in Figure 2-3.

APPENDIX G

Suggested GDPUD Water Waste Ordinance

ORDINANCE NO. _____

AN ORDINANCE OF THE Georgetown Divide Public Utility District INSTITUTING WATER WASTE PROHIBITIONS

SECTION 1. The **Georgetown Divide Public Utility District** does hereby ordain as follows:

The <Code/Regulations> of the **Georgetown Divide Public Utility District** hereby amended by adding Section _____ to _____, to read as follows:

"Section _____ - Water Waste Prohibitions

A. Purpose. The purpose of this Section is to promote water conservation and the efficient use of potable water furnished by the **Georgetown Divide Public Utility District** by eliminating intentional or unintentional water waste when a reasonable alternative solution is available, and by prohibiting use of equipment which is wasteful.

B. Nonessential Uses. No customer of the **Georgetown Divide Public Utility District** shall use or permit the use of potable water from the **Georgetown Divide Public Utility District** for residential, commercial, institutional, industrial, agricultural, or other purpose for the following nonessential uses:

1. The washing of sidewalks, walkways, driveways, parking lots and other hard-surfaced areas by direct hosing, except as may be necessary to properly dispose of flammable or other dangerous liquids or substances, wash away spills that present a trip and fall hazard, or to prevent or eliminate materials dangerous to the public health and safety;

2. The escape of water through breaks or leaks within the customers plumbing or private distribution system for any substantial period of time within which such break or leak should reasonably have been discovered and corrected. It shall be presumed that a period of seventy-two (72) hours after the customer discovers such a break or leak or receives notice from the **Georgetown Divide Public Utility District**, is a reasonable time within which to correct such break or leak or, as a minimum, to stop the flow of water from such break or leak;

3. Irrigation in a manner or to an extent which allows excessive runoff of water or unreasonable over-spray of the areas being watered. Every customer is deemed to have his water system under control at all times, to know the manner and extent of his water use and any run off, and to employ available alternatives to apply irrigation water in a reasonably efficient manner;

4. Washing cars, boats, trailers or other vehicles and machinery directly with a hose not equipped with a shutoff nozzle;

5. Water for non-recycling decorative water fountains;

6. Water for single pass evaporative cooling systems for air conditioning in all connections installed after <insert effective date of ordinance> unless required for health or safety reasons;

7. Water for new non-recirculating conveyor car wash systems; and

8. Water for new non-recirculating industrial clothes wash systems.

C. Exempt Water Uses. All water use associated with the operation and maintenance of fire suppression equipment or employed by the **Georgetown Divide Public Utility District** for water quality flushing and sanitation purposes shall be exempt from the provisions of this section. Use of water supplied by a private well or from a reclaimed wastewater, gray water or rainwater utilization system is also exempt.

D. Variances. Any customer of the **Georgetown Divide Public Utility District** may make written application for a variance. Said application shall describe in detail why applicant believes a variance is justified.

1. The <manager or other authorized representative of the **Georgetown Divide Public Utility District** > may grant variances for use of water otherwise prohibited by this section upon finding and determining that failure to do so would cause an emergency condition affecting the health, sanitation, fire protection or safety of the applicant or public; or, cause an unnecessary and undue hardship on applicant or public, including but not limited to, adverse economic impacts, such as loss of production or jobs.

2. The decision of the <manager or other authorized representative of the **Georgetown Divide Public Utility District** > may be appealed to the Board of Directors by submitting a written appeal to the **Georgetown Divide Public Utility District** within fifteen (15) calendar days of the date of the decision. Upon granting any appeal, the Board of Directors may impose any conditions it determines to be just and proper. Variances granted by the Board of Directors shall be prepared in writing and the Board of Directors may require the variance be recorded at applicant's expense.

E. Enforcement and Fees. Depending on the extent of the water waste the **Georgetown Divide Public Utility District** may, after written notification to customer and a reasonable time to correct the violation as solely determined by the **Georgetown Divide Public Utility District**, take some or all of the following actions. Penalties, fees and charges noted below shall be established by resolution of the **Georgetown Divide Public Utility District**.

1. Written notice to the customer of the water waste violation including a specified period of time to correct the violation.

2. Personal contact with the customer at the address of the water service. If personal contact is unsuccessful, written notice of the violation including a date that the

violation is to be corrected may be left on the premises, with a copy of the notice sent by certified mail to the customer.

3. The **Georgetown Divide Public Utility District** may install a flow-restricting device on the service line.

4. The **Georgetown Divide Public Utility District** may levy a water waste fee to the customer.

5. The **Georgetown Divide Public Utility District** may cause termination of water service and the charge for same shall be billed to the customer. Except in cases of extreme emergency as solely determined by the <manager or other authorized representative of the **Georgetown Divide Public Utility District** >, service shall not be reinstated until verified by the **Georgetown Divide Public Utility District** that the violation has been corrected and all charges and fees have been paid.

SECTION II. SEVERABILITY

If any section, subsection, sentence, clause, phrase, or word of this ordinance is for any reason held to be invalid, the validity of the remaining portion of this ordinance shall not be affected.

SECTION III. ENVIRONMENTAL DETERMINATION

The **Georgetown Divide Public Utility District** determines that this ordinance is a Class 7 categorical exemption under section 15307 of the California Environmental Quality Act, which exempts actions by regulatory agencies for protection of natural resources.

SECTION IV. EFFECTIVE DATE

This ordinance shall become effective (30) days after the date of adoption.

PASSED, APPROVED AND ADOPTED this ____ day of _____, 20__, by vote as follows:

AYES:_____
NOES:_____
ABSTAIN: _____
ABSENT: _____

<PRESIDENT of BOARD>

ATTEST:

<CLERK or SECRETARY of BOARD>

APPENDIX H

Projected Conservation Savings by DMM

GDPUD Conservation savings by DMM						
DMM		Demand Category	2010	2020	2030	Remarks
1	Water survey programs for residential customers	Urban	68	136	136	Program runs through 2015 with 11.9 to 15.3 AF/yr savings. Assumes program savings last 25 years.
2	Residential plumbing retrofit	Urban	17	17	17	Program runs through 2010 with 1.08 MG/yr savings. Assumes program savings last 25 years.
3	Distribution system audits and leak detection repair	Urban and raw	0	0	0	Potential program when losses exceed 10%. GDPUD projects losses to continue at 1%.
4	Metering with commodity rates	Urban and raw	--	--	--	This program is fully implemented. Program savings are incorporated in demand projections.
5	Large landscape conservation programs and incentives	Urban	--	--	--	This program is fully implemented. Program savings are incorporated in demand projections.
6	High-efficiency washing machine rebate program	Urban	0	0	0	GDPUD has no plans to implement this program.
7	Public information	Urban	Not quantified	Not quantified	Not quantified	Ongoing program
8	School programs	Urban	Not quantified	Not quantified	Not quantified	Ongoing program
9	Conservation programs for CII accounts	Urban	0	0	0	GDPUD has no plans to implement this program.
10	Wholesale agency assistance programs	N/A	N/A	N/A	N/A	N/A. GDPUD is not a wholesale water supplier.
11	Conservation pricing	Urban and raw	Not quantified	Not quantified	Not quantified	This program is fully implemented.
12	Conservation coordinator	Urban and raw	Not quantified	Not quantified	Not quantified	This role is the responsibility of the General Manager.
13	Water waste prohibition	Urban and raw	Not quantified	Not quantified	Not quantified	This program is fully implemented.
14	Ultra low-flush toilet replacement	Urban	0	0	0	GDPUD currently has no plans to implement this program.
X	IMS	Raw	217	265	309	Assumed 2.5% savings of projected irrigation demand due to potential IMS programming participation.
X	Meter calibration and replacement program	Urban and raw	Not quantified	Not quantified	Not quantified	Ongoing program that supports conservation.
Total water savings		Urban	85	153	153	
		Irrigation	217	265	309	

Notes:
1. Source: GDPUD 2005 UWMP, 2005-2010.
2. DMM program savings targets and schedule in accordance with CUWCC implementation guidelines.
3. Savings include quantifiable DMM savings, and do not account for non-quantifiable DMMs or savings from fully implemented programs for DMM 4 (Metering with Commodity Rates) and DMM 5 (Large Landscape Conservation Programs and Incentives).

APPENDIX I

Public Outreach Example Resources

Public Outreach

Source: U.S. Bureau of Reclamation, SCCAO Drought Handbook for M&I Water Contractors, April 2003.

Example Menu of Options for Public Outreach

Place a checkmark by the options that you will consider including in your public awareness campaign during a water shortage.

Menu of Options for Public Outreach	Stage
Bill Inserts for water bills	
Public service advertising – run for free by local media	
Paid Advertising – Newspaper	
Paid Advertising – Radio	
Paid Advertising – Television	
Paid Advertising – Movie Slides for local movie theaters	
Paid Advertising – Chamber of Commerce Newsletter	
District newsletter	
Classroom Presentations	
Water Shortage Pamphlet – mass distribution to all customers	
Water Shortage Website	
Public Workshops – Drought Survival – Water conservation	
Water Shortage Information Center	
Public Advisory Committee	
Displays in District Office	
Water efficient fixture rebates	
Water efficient fixture distribution	
Promote use of Greywater	
Drought Tolerant Plant Tagging Program at local nurseries	
Promoting CIMIS information	
Water Shortage Hotline	
Water Audits	
Displays in Public Libraries, at local schools, shopping malls, etc.	
Bus ads	
Billboards	
Promotional Items with a conservation message (mugs, rulers, stickers, pens)	

Source: Santa Barbara County Water Agency, 2001.

Checklist for Keeping the Media Involved

____ 1. Create a media list to ensure that all available local media are used – select an official representative at each radio station, newspaper, and television station to serve as a point of contact for water shortage information released from your district. See Worksheet below.

____ 2. Establish a public advisory committee

____ 3. Include public and media in the water shortage planning process

____ 4. Organize water shortage information meetings for the public and the media.

____ 5. Publish and distribute pamphlets on water conservation techniques and water shortage management strategies

____ 6. Organize workshops on water shortage related topics

____ 7. Prepare sample ordinances on water conservation

____ 8. Establish a water shortage information center

____ 9. Write reports for the media early in the course of the water shortage and prepare weekly press releases with current water shortage conditions

____10. Establish a list of authorities on water shortage that can be distributed to the media for further reference.

____11. Organize education activities for the media.

____12. Establish a budget for advertising water shortage programs

____13. Write reports for media early in the event

____14. Prepare reports on the efforts of the water district to conserve water – conjunctive use, system audits, meter retrofits, training for staff, etc.

____15. Establish or use an existing newsletter to provide an overview of water shortage activities, tips for conservation, articles showcasing local conservation efforts on the part of homeowners and businesses.

____16. Conduct press conferences as needed. Use on-location approach if photo opportunities exist (i.e., a local reservoir when reservoir is visibly low)

Media List

Use this table to create your media contact list. Be sure to include all media in your community.

Media List			
	Name	Email	Phone/Fax
TV Stations - include government access channels			
Print Media - include newspapers from local colleges and news clipping services			
Radio Stations			
Chambers of Commerce			
Political leaders			
Water Dist. Board			
County Sups			
City Council			
Assembly			
Congress			

Source: Santa Barbara County Water Agency, 2001.

APPENDIX J

Drought Advisory Committee Comments on Drought Plan Strategy - October 29, 2007 Workshop

Drought Advisory Committee
Comments on Drought Plan Strategy
October 29, 2007 Workshop

1. Consider taking PL 101-514 contract water rights at an upstream location during declared Drought (Stage 2). Similar to the benefits of SMUD contracted rights of 15,000AF are less benefit if taken at Folsom Lake that requires pumping up hill to the extent possible.

2. Seek water rights and storage for 17,000AF of local sources of water (not just M&I water rights, but also water for agricultural use)

3. Revisit the agreements for Caples Lake storage for use in Drought Stage 2&3 (this is cheapest water available), The agreement has no dry year provision in the agreement and it is recommended to make dry-year conditions trigger the ability of maintaining lower storage levels for additional water supply.

4. Look to expand the uses of non-potable uses as the recycled water treatment systems expand (e.g. construction water, dust control). Currently, the recycled water system is maximized and requires make-up water to meet treatment and pressure system demands.

5. Need added flexibility to enhance system delivery reliability (e.g. water rights, dry year options)

6. Investigate the feasibility of using tunnels and mines to move or store water (outline the requirements for emergency transfers, i.e. Hazel Creek Tunnel from Project 184 Forebay to Sly Park Reservoir)

7. Incorporate into the Drought Plans for triggers from Governor Emergency declaration that would include communications, emergency transfers, interconnections, United States Bureau of Reclamation emergency funding (e.g., floating pumps to reach Folsom Lake levels for the El Dorado Hills Water Treatment Plant intake) and other response measures as appropriate.

8. Coordinate with Cosumnes American Bear Yuba (CABY) Planning Committee discussions to move more water to Folsom Lake (i.e. NID surplus water that could offset flow requirements from GDPUD and/or EID into Folsom Lake)

9. Follow-up on research in the CABY study on how to use meadow storage, restoration and recharge areas that were identified to investigate feasibility of added storage at higher elevations.

9. NEED ADDITIONAL STORAGE (both surface & groundwater) to offset the reduced snowpack natural storage that feeds our existing storage. Given scientists

currently project that more and more supplies will be from precipitation than snowpack and will need to be carried over from year to year, water providers need to better equilibrate rainfall and snowpack melt runoff conditions through more storage capability.

10. Need enhanced interagency coordination including day to day support now and then heightened frequency in dry-years (e.g. new Grizzly Flats reservoir on USFS land swap with El Dorado Irrigation District opportunity)

11. Need to promote drought and fire resistant plantings (e.g. immediate in coordinate with Fire Safe Council along with the new 100 ft clearance mandate)

12. Need to incorporate more demand for fires flows, and need more recycled water seasonal storage (i.e. quarries) and also exchange recycled water to Folsom for potable water rights.

13. Need to capitalize on conservation potential with grants funding that leads to action, get proposals ready for emergency grant funding.

14. Need fixes for supply infrastructure with County assistance (e.g., facilitation and contract negotiations).

15. Coordinate with California Department of Water Resources, who plans to hold small system workshops (e.g., support for GFCSD) and investigate funding assistance for more water supply reliability.

16. Consider cloud seeding

17. Enhance web sites and other notifications on actual customer water use in real time (e.g., self reading for water meters like the Badger remote data loggers that go on refrigerators such that customers can have a better self-assessment of their usage (AMR components now block ability to self-read meters).

18. Have signage on total monthly (or weekly) water use by neighborhood and remote reading to help customers have feedback on how they are doing.

19. Modify water shortage response actions by greatest water savings. Group by water use type vs. customer category.

20. Put into place interruptible supply contracts (e.g., parks have reduced rates for less reliability)

21. Create a mechanism that allows for higher allocations for those that already conserve (e.g., track accounts that have taken a rebate or performed a Water Wise House Call) and given them preferred allocations or lesser surcharges so they are not penalized for taking early action.

22. RESERVE FUND – establish an adequate funding reserve to sustain district operations in times of drought with the options for employing surcharges to trigger demand reductions and help with fiscal solvency in times of demand curtailment.

23. Estimate hidden costs of the drought like higher cost of services (e.g. water quality, energy use, manpower) that occur in times of demand shortfall to ensure that financial reserves and surcharge revenues will be adequate to meet needs.

the highest projected demand associated with the approval, in addition to existing and 20-year projected future uses within the area served by the water supplier, including but not limited to, fire protection, agricultural, and industrial uses, 95% of the time, with cutbacks calculated not to exceed 20% in the remaining 5% of the time.

Policy 5.2.1.10 The County shall support water conservation and recycling programs and projects that can reduce future water demand consistent with the policies of this General Plan. The County will develop and implement a water use efficiency program for existing and new residential, commercial/industrial, and agricultural uses. The County will also work with each of the county's water purveyors to develop a list of the type of uses that must utilize reclaimed water if feasible. The feasibility of using reclaimed water will be defined with specific criteria developed with public input and with the assistance of the El Dorado Irrigation District (EID), and will be coordinated with their ongoing reclaimed water (also referred to as recycled water) planning and implementation process. The County shall encourage all water purveyors to implement the water conservation-related Best Management Practices already implemented by EID and in compliance with the related criteria established by USBR.

Policy 5.2.1.11 The County shall direct new development to areas where public water service already exists. In Community Regions, all new development shall connect to a public water system. In Rural Centers, all new development shall connect either to a public water system or to an approved private water system.

Policy 5.2.1.12 The County shall work with the El Dorado Irrigation District (EID) to support the continued and expanded use of recycled water, including wet-season use and storage, in new subdivisions served by the Deer Creek and El Dorado Hills Wastewater Treatment Plants. To avoid the construction impacts of installing recycled water facilities, the County shall encourage the construction of distribution lines at the same time as other utilities are installed. Facilities to consider are recycled water lines for residential landscaping, parks, schools, and other irrigation needs, and if feasible, wet-irrigation-season storage facilities.

Policy 5.2.1.13 The County shall encourage water purveyors to design water supply and infrastructure projects in a manner that avoids or reduces significant environmental effects to the maximum extent feasible in light of the water supply objectives of a given project.

Policy 5.2.1.14 The County, in cooperation with the Water Agency and water purveyors, shall collect and make available information on water supply and demand.

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

2010 URBAN WATER MANAGEMENT PLAN

Final

July 22, 2011

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
6425 Main Street
P.O. Box 4240
Georgetown, California 95634

2010 URBAN WATER MANAGEMENT PLAN

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
6425 Main Street
P.O. Box 4240
Georgetown, California 95634

District Contact Information: Rebecca Siren
Operations Manager, Water Quality Division
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Georgetown Divide Public Utility District is a water retailer.

Georgetown Divide Public Utility District is not a Bureau of Reclamation Contractor.

Georgetown Divide Public Utility District is not a State Water Project Contractor.

Georgetown Divide Public Utility District provides the following utility services:

- Raw Irrigation Water
- Treated Potable Water
- Management of Onsite Wastewater Management Zone

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1.0 Introduction

This report has been prepared in compliance with the Urban Water Management Planning Act (Act), as amended (California Water Code, Division 6, Part 2.6; §10610, et. seq. established by Assembly Bill 797, 1983). All urban water suppliers as defined in Section 10617, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet annually are required to prepare an Urban Water Management Plan (UWMP). Urban water suppliers are required to prepare and/or update their UWMP and submit a complete plan to Department of Water Resources every five years. In January 2009, the Act was amended by Assembly Bill AB-1420, which required the implementation of demand management measures to be eligible for water grants or loans. The Act was most recently amended in November 2009 with the adoption of Senate Bill SBx7-7. The most significant revision in this amendment is the requirement for establishing per capita water use targets for 2015 and 2020.

This Plan will be presented to the Georgetown Divide Public Utility District's Board of Directors for review and adoption. It will be filed with the Water Efficiency Office in the Department of Water Resources, as required by law, and will be used by the Georgetown Divide Public Utility District (District) staff to guide the District's water conservation efforts through the year 2015. As required by §10621 (a) of the Water Code, the District will update the Plan again by December 2015.

1.1. List of Abbreviations

Table 1 presents a list of the abbreviations used in this Urban Water Management Plan.

Table 1 - List of Abbreviations

AF	acre-feet
CFS	cubic feet per second
CUWCC	California Urban Water Conservation Council
District	Georgetown Divide Public Utility District
DMM	Demand Management Measure
DWR	California Department of Water Resources
EDCWA	El Dorado County Water Agency
GDPUD	Georgetown Divide Public Utility District
gpcd	gallons per capita per day
mgd	million gallons per day
SMUD	Sacramento Metropolitan Utility District
UWMP	Urban Water Management Plan

2.0 Plan Preparation

2.1. Interagency Coordination

The District is a member of EDCWA, the El Dorado County Water Agency. The EDCWA is long-term water planning organization established by the El Dorado County Water Agency Act (California Water Code Appendix Section 96-1, et seq.). EDCWA's Board of Directors is composed of representatives from both the El Dorado County Board of Supervisors and public water purveyors within the County. EDCWA has the power to take actions necessary to ensure sufficient water may be available for present and future beneficial uses within the agency boundaries, including the power to carry on technical and other necessary investigations pertaining to water supply, water rights and use of water within the agency.

All land use planning and development approvals within the District's boundaries are the responsibility of the El Dorado County. **The District's service area does not include any incorporated cities.**

The District issued a 60-day notice to both El Dorado County and the EDCWA stating that the District was preparing its 2010 Urban Water Management Plan (UWMP) and intends to present its findings at a public hearing in July 2011 for adoption (see Appendix A). The coordination with these agencies is summarized in Table 2.

Table 2 - Agency Coordination

Coordinating Agencies	Was Sent a Notice of Intention to Adopt	Was Sent a Copy of the Draft Plan	Commented on Draft Plan
El Dorado County	Yes	Yes	No
El Dorado County Water Agency	Yes	Yes	Yes

2.2. Public Participation

The Georgetown Divide Public Utility District provided opportunities for community participation in its urban water management planning efforts during plan preparation. A Notice of Public Hearing was published twice in the Georgetown Gazette and copies of the draft UWMP were made available for public inspection at the District's office and on the District's website. A copy of the Notice of Public Hearing is provided in Appendix B.

A public hearing was held on this UWMP by the Board of Directors prior to its adoption on July 12, 2011. The resolution of the District's Board of Directors to adopt the UWMP is presented in Appendix C.

2.3. Plan Implementation & Distribution

The District will implement this 2010 UWMP to meet the SBx7-7 gallons per capita per day (gpcd) targets. The District will continue implementation of their existing water conservation programs. The District implemented their 2005 UWMP in accordance with the requirements included in the plan.

The District will provide the adopted UWMP to El Dorado County within 60 days of its submission to DWR.

The District will also provide the adopted UWMP to the California State Library within 30 days of its adoption.

The adopted UWMP will be made available for public review within 30 days of its submission to DWR on the District's website.

2.4. Plan Checklist

The 2010 UWMP is organized by subject matter per DWR's Urban Water Management Plan checklist (Table I-2). Appendix D presents the completed checklist for the District's 2010 UWMP.

3.0 System Description

3.1. Historical Background

The discovery of gold near the present site of Coloma by James W. Marshall in 1848 resulted in an influx of settlers to the Georgetown area. The general region now occupied by El Dorado County rapidly became one of the most populous areas of the State. The town of Georgetown was founded on August 7, 1849 by George Phillips and soon had the nickname "Growlersburg" from the large nuggets that "growled" in the miners pans. Millions of dollars worth of gold were taken from the area during the early years of the Gold Rush, and it was during this period that the original water system for the Georgetown Divide area was developed.

The initial diversions and ditches were constructed by three companies beginning in 1852. One of the companies, the Pilot Creek Ditch Company, later absorbed the other two, and expanded the system to supply water to nearly the entire area presently supplied by the District. In 1872, a group of San Francisco investors formed the California Water Company and purchased the Pilot Creek Ditch Company. The California Water Company subsequently constructed Loon Lake Dam, made considerable improvements to the distribution system, and established the first policy for furnishing water for agricultural purposes.

The name of this company was changed to the Loon Lake Water and Power Company in 1890, and shortly thereafter it was purchased by the Truckee General Electric Company. This company, in turn, changes its name to the Sierra Pacific Power Company in 1915. In 1931, the Georgetown Water Company, Ltd., was formed and purchased the water system serving the Georgetown area from Sierra Pacific.

In accordance with Ordinance Number 137 of the El Dorado County Board of Supervisors, formation of the Georgetown Divide Public Utility District was submitted to and approved by the electorate of the proposed District on June 4, 1946. The statutory authority enabling the District to construct, finance, maintain, and operate a water system is found in Section 16461 of the Public Utilities Code of California. By 1952, the District had purchased all of the facilities of the Georgetown Water Company. In 1961, these facilities were officially conveyed by deed to the District. The District sold all of its facilities and water rights in the Upper Rubicon Basin to the Sacramento Municipal Utility District (SMUD) in 1957. The proceeds of the sale were to be used by the GDPUD to develop an improved and enlarged source of supply on Pilot Creek. This development became known as the Stumpy Meadows Project and was financed by a loan under Public Law 984, with most of the loan to be repaid using the SMUD payments.

The Georgetown Water Company (Company), the immediate predecessor to the District, as well as its antecedents, held certain rights to the South Fork Rubicon River and Pilot Creek. Pilot Creek is a tributary of the Rubicon River which is in turn a tributary to the Middle Fork American River. Water use from these sources had been established as early as 1852, and the owners of the Georgetown Water Company claimed pre-1914 rights by acquisition and use to waters of those streams and several other minor watersheds. In addition, the Company claimed and held title to facilities and properties related to providing water to the Georgetown Divide, including a storage reservoir at Loon Lake (completed about 1883), and a conveyance system to bring

water from Loon Lake, re-diverting it from the South Fork Rubicon River into the Pilot Creek drainage, and re-diverting it at Stumpy Meadows (a meadow at that time, not a reservoir) to the Georgetown Divide Ditch. The water was primarily used for mining and agriculture along the Georgetown Divide although some was also used for domestic purposes.

After formation of the District in 1946, Application 12421 was filed in 1948. The District requested diversion and storage rights pertinent to the Loon Lake project, which was originally the Company's and then the District's major source of water. In addition, a diversion right of 50 cubic feet per second (CFS) and storage rights for 20,000 acre-feet per year were requested in the Pilot Creek watershed, as well as a number of storage sites in the service area. The District was then in the process of acquiring the Georgetown Water Company rights, facilities, and properties including Loon Lake Reservoir and ditches, to supply the Georgetown Divide service area. The facilities were finally acquired by the District in 1959. Application 12421 had been filed to formalize the rights that the District would eventually acquire from the Georgetown Water Company, and to provide for and protect a future potential water supply for the Georgetown Divide.

In the early 1950's, Sacramento Municipal Utility District (SMUD) expressed a desire to acquire rights and facilities of the District in the Upper Rubicon Basin, including Loon Lake and the potential future water supply from the Rubicon River, for construction of the Upper American River Hydroelectric Project. In turn, SMUD offered to provide financial assistance for planning and construction and to assist in acquiring the necessary water rights for an alternate District water supply in the Pilot Creek Basin, including the 20,000 acre-foot reservoir proposed by the District, as well as a diversion of 50 CFS from Pilot Creek. In return, the District was to withdraw its applications for rights in the Upper Rubicon watersheds under A12421 in favor of SMUD, but the District was to keep that portion of the application related to the reservoir and diversions on Pilot Creek.

During the period of negotiation, the District filed Application 16212 (1955, 1956) requesting additional necessary diversion rights for the alternative replacement water supply. The concepts regarding the various features of the replacement water supply had already been established, but only preliminary design studies and plans had been completed at that time. The project as originally proposed, envisioned the storage reservoir at Stumpy Meadows and direct diversion from Pilot Creek at the dam as described in A12421. In a later project revision, water was to be released from Stumpy Meadows Reservoir for re-diversion from Pilot Creek. The old Georgetown Divide ditch between Stumpy Meadows and Tunnel Hill was to be abandoned, and a new conveyance system, the El Dorado Conduit, constructed.

Application 16212 requested an additional 50 CFS diversion from Pilot Creek and diversion rights totaling 25 CFS from the tributaries to Pilot Creek and Otter Creek that would be intercepted by the proposed conveyance system. The application also requested 3,000 acre-feet of storage at Mutton Canyon and 4,000 acre-feet of storage on an unnamed canyon along the conduit route, but these storage amounts were eventually denied. The District also filed A16688 to divert water from Onion Creek in a similar fashion to that being used by predecessors. However, Onion Creek water would be diverted into Pilot Creek for off-stream

storage at Stumpy Meadows Reservoir and re-diverted from Pilot Creek into the El Dorado Conduit at a point near Mutton Canyon.

Decision 893 (3/18/58) allocated the various waters of the American River watershed including the waters of interest to the District and to SMUD. The District and SMUD had apparently reached agreement at this time as to the exchange of water facilities in the Rubicon River and Pilot Creek. Decision 893 resulted in permits 11304, 11305, and 11306 which approved the District's diversion and storage rights.

On June 25, 1958, the District filed for partial assignment of State Filing A5644, specifically to obtain an earlier filing date for at least certain portions of the Stumpy Meadows Project. The application requested:

1) 100 CFS direct diversion from Pilot Creek

2) 20,000 acre-feet storage on Pilot Creek as had been described in the Stumpy Meadows Project Feasibility Report prepared by consultant Clair A. Hill.

Permit No. 12827 (6/30/61) approved the 100 CFS diversion and 20,000 acre-feet storage. This permit was issued in compliance with the terms of Decision 1013.

3.2. Service Area

The Georgetown Divide is situated on the west slope of the Sierra Nevada foothills, approximately 45 miles northeast of Sacramento, California. It straddles a ridge which separates the drainage basin of the Middle Fork American River and the Rubicon River on the north from that of the South Fork American River on the south. The District's sphere of influence is bounded on the north, south, and west by these rivers (see Figure 1). The sphere of influence covers about 173,000 acres (270 square miles). The existing service area encompasses approximately 75,000 acres (112 square miles) with approximately 30,000 acres currently having some form of water service available.

GDPUD presently provides domestic water service to the communities of Georgetown, Buckeye, Garden Valley, Kelsey, Spanish Dry Diggins, Greenwood, Cool, and Pilot Hill. The entire service area is located in the unincorporated area of El Dorado County (see Figure 2). Through separate facilities, portions of these same communities also receive untreated water for irrigation purposes

Elevations in the District's service area vary from 500 feet at the southwestern boundary to 6100 feet at Silver Hill on the eastern boundary. The relief varies from rolling foothills in the west to steep slopes and deep canyons in the upper elevations. The community of Georgetown is located at the top of the Divide at an elevation of 2,650 feet.

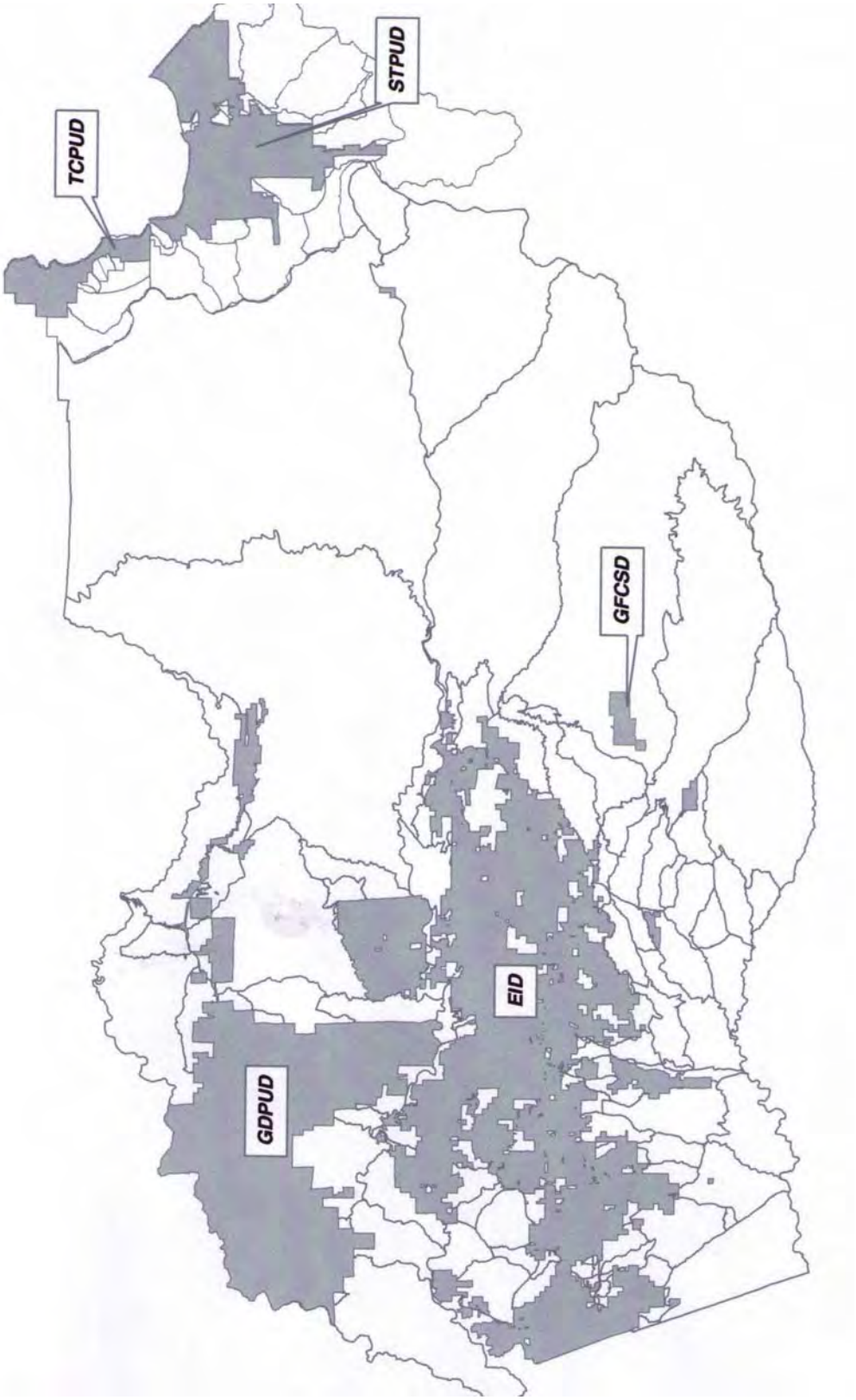

Figure 1 - District Location within El Dorado County

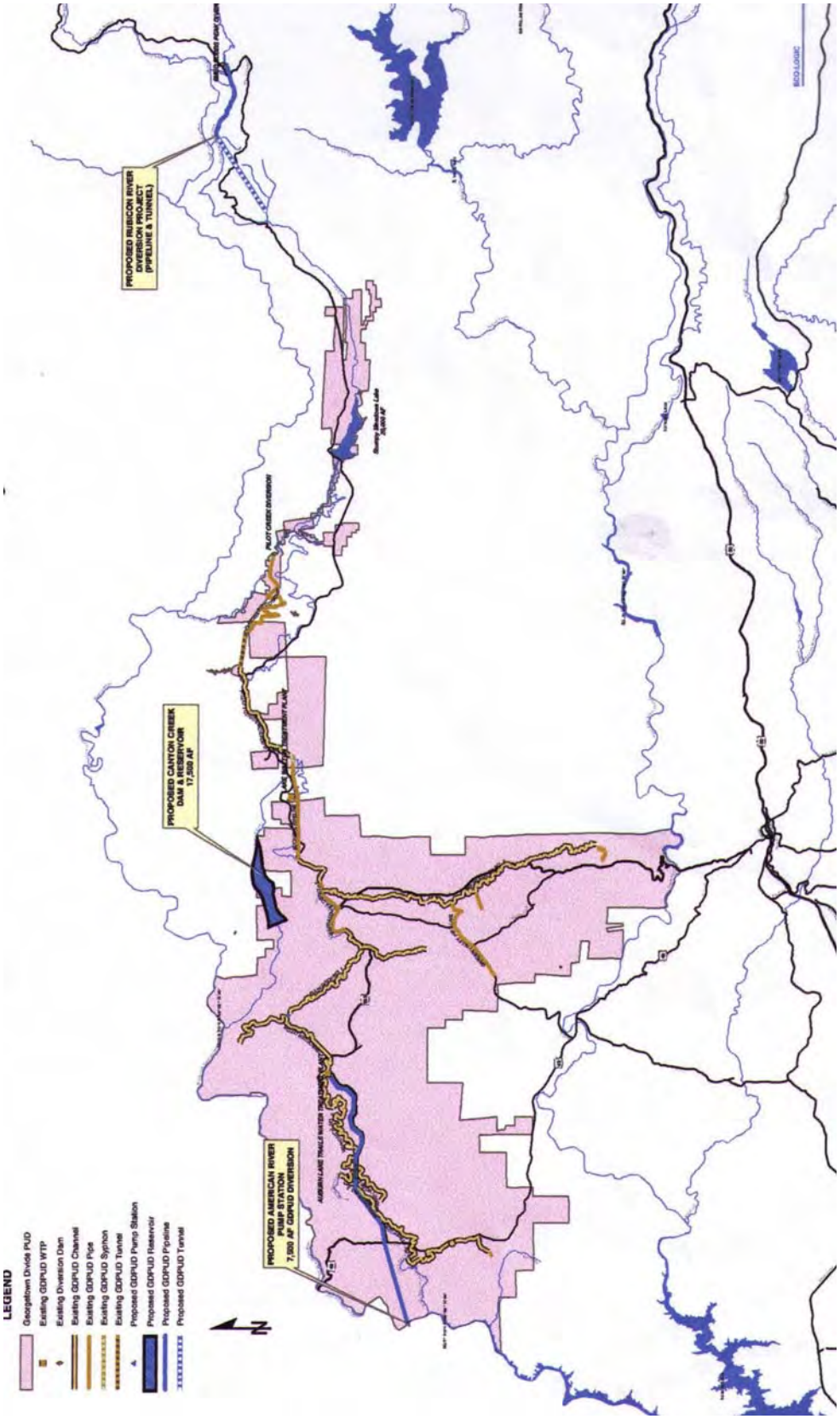

Figure 2 - District Service Area

3.3. Climate

The lower elevations have hot, dry summers and mild winters, whereas the mountainous regions toward the east experience cool summers and fairly severe winters. Near the western portion of the Divide, at Folsom Lake, the mean annual precipitation is 25 inches with a trace of snowfall during the winter. Precipitation increases with elevation, with 40 inches occurring at Garden Valley, 50 inches at Georgetown, and 56 inches at the Silver Hill Ridge. Average annual snowfall in the eastern portion is approximately 16.6 inches. Most of the precipitation falls between late October and mid-April.

The lower foothills have shallow, rocky soils underlain by metamorphic rock. Soil depth is generally less than three feet and, as a result, these lands have very limited agricultural potential. The soils in the higher elevations are weathered to a greater depth and are more suitable for agricultural use, depending upon slope, elevation, and other considerations. The soils in the eastern portion of the District are highly suited for mixed conifer timber stands, and the entire area is heavily forested.

3.3.1. Historical Precipitation Data

The District maintains records of reservoir inflow, storage, and use from which data on the hydrologic regime of Pilot Creek Watershed, including en-route diversions, are developed on a continuing basis. The District continuously updates studies regarding strategies for reservoir operation as demands on the system vary, including deficiency requirements in critically dry years. The District is well aware of the capabilities of the source, and how to handle operating contingencies in a situation such as what was experienced state-wide in the 1991 water year. Additionally, The District is evaluating alternative water supply projects to supplement the Stumpy Meadows Project.

Precipitation in the Pilot Creek drainage tributary to Stumpy Meadows Reservoir averages about 56 inches per year. Although much of the precipitation occurs as rain, particularly in the lower elevation, western portion of the watershed, there is snow pack accumulation, and often the time-distribution of the runoff hydrograph is controlled by snow accumulation and snow melt. Table 3 presents a summary of the climate information for the District's service area.

Table 3 - Monthly Climate Summary

Climate Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Average Maximum Temperature (degF) (1)	52	53	58	64	72	80	89	89	84	73	59	51	69
Average Minimum Temperature (degF) (1)	35	35	37	41	47	54	61	60	56	48	40	35	46
Average Total Precipitation (inches) (1)	9.6	7.8	7.3	4.3	1.9	0.7	0.1	0.2	0.7	2.9	6.6	8.4	50.5
Average Total Snow Fall (inches) (1)	5.3	2.7	2.8	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.5	2.7	15.5
Average Snow Depth (inches) (1)	1	1	0	0	0	0	0	0	0	0	0	0	0
Average Evapotranspiration (inches) (2)	1.5	1.8	3.5	4.3	6.6	7.9	9.1	8.2	6.2	3.8	1.9	1.1	55.8

(1) Source: Western Regional Climate Center, Georgetown Ranger Station, California (043384), Period of Record: 11/1/1946 to 12/31/2010
(2) Source: California Irrigation Management Information System, Sierra Foothill, Camino Station #13, Period of Record: 1/1/2000 to 12/31/2010

3.3.2. Runoff Characteristics

There is no set of observed data that will permit direct calculation of the actual inflow to Stumpy Meadows Reservoir. However, there is a USGS stream gaging station (No. 11431800) on Pilot Creek above Stumpy Meadows, which, with a drainage area of 11.7 square miles, represents approximately 77 percent of the watershed tributary to the Reservoir.

Although considered a relatively low elevation watershed at this latitude in the Sierra, snow accumulation and melt still play an important role in the time-distribution of runoff. On the average, approximately 46 percent of the annual runoff occurs during the April-July snowmelt period. Average annual runoff of Pilot Creek above the dam site for the 50 year period 1931-1980 is estimated at 22,370 acre-feet. Flows of record range from a low of 2700 acre-feet during the 1976-77 water year to a high of 59,100 acre-feet during the 1982-83 water year. A review of the variability in both seasonal and water year runoff amounts emphasizes the necessity for substantial storage for regulation of Pilot Creek flows on a multi-year basis in order to assure an adequate water supply to the GDPUD service area.

3.4. Demography

The District provides both untreated and treated water to nearly 4,000 customers. The District's billing software only has three water use categories: residential and commercial service for treated water and agricultural service for untreated water. The District modified their billing software in 2011 to include residential (both single and multi-family), commercial, large landscape, and governmental/institutional.

Treated water customers are primarily residential, with 96% of the accounts serving single family homes (3,411 accounts) and a few multi-family units (12 accounts, 94 households) in 2010. The District currently has 15 un-metered connections. The District had only 141 commercial accounts in 2010, which represent only 4% of the total treated water accounts in the District. The commercial category includes all business accounts, governmental offices, schools, and a golf course owned by the Auburn Lake Trails Property Owner's Association.

Untreated water for agricultural usage represents 72% of water sales in the District. In 2010, there were 393 agricultural accounts. Agricultural water is used in a variety of ways on the Divide. Christmas tree farms, vineyards, pasture, orchards and hay production are common uses of agricultural water. This untreated water usage is not included in the analysis of the potable water system demands.

3.5. Population

The 2000 U.S. Census Data was used to estimate the current population in the District's service area. The service area includes portions of three census tracts. The District's residential account locations were manually assigned to three census tracts that cover the District's entire service area. Table 4 presents the U.S Census and District customer data used to determine the average number of people per household for the District's service area. Based on the information presented in Table 4, the average number of people per household in the District's service area is 2.71. Therefore, the District's service area population in 2010, based on 3,505 residential households, was 9,499.

Table 4 - District's Number of People per Household

Census Tract	2000 Census Tract Data			District Information	
	Population	Number of Households	Average Household Size	Number of Households	Estimated Population
306.01	4,607	1,674	2.75	1,512	4,161
306.02	5,786	2,149	2.69	1,809	4,871
306.03	2,776	1,108	2.51	163	408
District's Weighted Average Number of People per Household					**2.71**

3.5.1. Population Projections

Residential and non-residential (employment) land forecasts for the Western Slope area of El Dorado County were developed by Economic & Planning Systems (EPS) as part of the 2004 County General Plan/EIR process. Due to topography, zoning, water supply, and sewage disposal constraints, the District's growth rate is not expected to significantly increase in the coming years. The Housing Element of the El Dorado County General Plan was updated in 2008 to revise the average annual population growth rate to 1.9% per year between 2010 and 2020 and 1.6% between 2020 and 2030. For comparison, the growth rate in the District's residential accounts between 1990 and 2000 was 3.1% and between 2000 and 2010 was 1.8%. Table 5 presents the estimated population growth between 2010 and 2030 based on an occupancy rate of 2.71 persons per household.

Table 5 - Population, Current and Projected Through 2030

District Service Area Population	2010	2015	2020	2025	2030
	9,499	10,436	11,466	12,413	13,438

3.6. Other Demographic Factors

There are no other demographic factors affecting the District's water management planning.

4.0 System Demands

4.1. Base Water Production

Per DWR's UWMP Guidance Manual, gross water use is defined as the total volume of water, whether treated or untreated, entering the distribution system of an urban retail water supplier excluding the following:

1. Recycled water that is delivered within the service area of an urban retail water supplier or its urban wholesale water supplier.

2. The net volume of water that the urban retail water supplier places into long-term storage.

3. The volume of water the urban retail water supplier conveys for use by another urban water supplier.

4. The volume of water delivered for agricultural use, except as otherwise provided in subdivision (f) of Section 10608.24 of the Act.

Water production is the volume of treated water, measured at the outlet of each WTP, that is metered to residential and commercial customers. Total water production also includes water that was produced, but not accounted for in the District's water meter system. This "unaccounted-for" water includes non-revenue water (fire hydrant flushing, fire-fighting, etc.), un-metered connections, and water losses. Water production does not include the untreated irrigation water distributed by the District through its canal system.

The Act requires evaluation of the District's water production over both a continuous 10-year and 5-year period. The 10-year period is required to end between 2004 and 2010. The 5-year period is required to end between 2007 and 2010. Table 6 and Table 7 present the District's five and ten year base daily per capita water use. Table 8 presents the basis for selection of the base period ranges.

Table 6 - Base Daily per Capita Water Use, 5 Year Range

Base period year		Distribution System Population	Daily System Water Production (mgd)	Annual Daily per Capita Water Use (gpcd)
Sequence Year	Calendar Year			
Year 1	2004	9,276	1.957	211
Year 2	2005	9,401	1.865	198
Year 3	2006	9,471	1.749	185
Year 4	2007	9,515	1.779	187
Year 5	2008	9,442	1.915	203
			Base Daily Per Capita Water Use	**197**

Table 7 - Base Daily per Capita Water Use, 10 Year Range

Base period year		Distribution System Population	Daily System Water Production (mgd)	Annual Daily per Capita Water Use (gpcd)
Sequence Year	Calendar Year			
Year 1	1999	8,108	1.702	210
Year 2	2000	8,312	1.616	194
Year 3	2001	8,599	1.747	203
Year 4	2002	8,875	1.731	195
Year 5	2003	9,035	1.684	186
Year 6	2004	9,276	1.957	211
Year 7	2005	9,401	1.865	198
Year 8	2006	9,471	1.749	185
Year 9	2007	9,515	1.779	187
Year 10	2008	9,442	1.915	203
			Base Daily Per Capita Water Use	**197**

Table 8 - Base Period Ranges

Base	Parameter	Value	Units
10- to 15-year base period	2008 total water deliveries	698.82	acre-feet/yr
	2008 total volume of delivered recycled water	0	acre-feet/yr
	2008 recycled water as a percent of total deliveries	0	percent
	Number of years in base period(1)	10	years
	Year beginning base period range	1999	
	Year ending base period range(2)	2008	
5-year base period	Number of years in base period	5	years
	Year beginning base period range	2004	
	Year ending base period range(3)	2008	

(1) If the 2008 recycled water percent is less than 10 percent, then the first base period is a continuous 10-year period. If the amount of recycled water delivered in 2008 is 10 percent or greater, the first base period is a continuous 10- to 15 year period.
(2) The ending year must be between December 31, 2004 and December 31, 2010.
(3) The ending year must be between December 31, 2007 and December 31, 2010.

4.2. GPCD Targets

Per the law as adopted in SBx7-7, the District must establish per capita water use targets using one of four methods:

1. Method 1 - Eighty percent of the urban retail supplier's baseline per capita daily water use.
2. Method 2 - The per capita daily water use that is estimated using the sum of several defined performance standards.

3. Method 3 - Ninety-five percent of the Sacramento hydrologic region target of 176 gpcd.

4. Method 4 - Calculated water savings based on indoor residential water savings, metering savings, commercial/industrial/institutional savings, and landscape and water loss savings.

Based on Method 3, the District selects the urban water use target of 167 gpcd for 2020 and an interim target of 182 gpcd for 2015. The interim 2015 target is calculated as the average between the District's base usage of 197 gpcd and the 2020 target of 167 gpcd.

4.3. Water Use Reduction Plan

On May 10, 2011, the District conducted a public hearing at its regular board meeting to discuss the District's implementation plan for complying with the AB 1420, the Water Conservation Bill of 2009. Since 2005, the District has implemented all applicable Demand Management Measures. No additional economic impacts are anticipated from the adoption of the 2010 UWMP.

4.4. Historical and Projected Water Use by Customer Type

The District's annual treated water demand represents water sales to residential and commercial customers. Commercial customers include commercial, industrial, and institutional water users. Between 1999 and 2008, the distribution of water use by customer type was as follows:

- 79% single family residential
- 1% multi-family residential
- 14% commercial
- 6% other

Other water use is the difference between total water sales and total water production or about 40 acre-feet per year on average between 1999 and 2008. This represents approximately 6% of the total water sales and includes a number of uses. Authorized uses include water for 15 un-metered water connections, fire-fighting and training, hydrant flushing, backwash water, construction water and other miscellaneous uses. Un-authorized uses include pipeline leaks, water meter inaccuracy, tank overflows, and possible stolen water. This component is also known as unaccounted-for water. It is estimated that about 25 AF of the un-metered water goes to authorized uses and the remaining 15 AF is unaccounted-for water. The District's unaccounted-for water volumes were about 2% between 1999 and 2008. The unaccounted-for water volumes have not been higher than 3% in any recent year, and the District will continue its vigilance in reducing water losses with on-going programs to repair pipeline leaks as soon as they are discovered, replace old, less reliable pipelines, and upgrade older, potentially inaccurate, water meters.

4.4.1. Past Water Use

Table 9 presents the past water use by customer categories for 2005. Note that the District's existing billing software provides information for residential, commercial and raw water agricultural users only.

Table 9 - Past Water Deliveries, 2005

Water Use Sectors	2005				
	Metered		Not metered		Total
	# of Accounts	Volume (acre-feet/yr)	# of Accounts	Volume (acre-feet/yr)	Volume (acre-feet/yr)
Single family	3,375	1,511.2	2	0.9	1,512.1
Multi-family	94	23.8	-	-	23.8
Commercial	143	233.0	4	6.5	239.5
Industrial	-	-	-	-	-
Institutional/governmental	-	-	9	14.7	14.7
Landscape	-	-	-	-	-
Agriculture (untreated)	382	4,744.3(1,2)	-	-	4,744.3
Other	-	-	-	299.2	299.2
Total (treated & untreated)	3,994	6,512.3	15	321.3	6,833.6
Total (treated only)	**3,612**	**1,768.0**	**15**	**321.3**	**2,089.3**

Notes: (1) Agricultural (untreated) water is metered using a subsurface orifice and is sold by the miner's inch.
(2) Agricultural (untreated) water demand does not include carriage and ditch losses. Losses are included for the treated water. Latent demand is included in the future projected demands.

4.4.2. Current Water Use

Table 10 presents the current water use by customer categories for 2010.

Table 10 - Current Water Deliveries, 2010

Water Use Sectors	2010				
	Metered		Not metered		Total
	# of Accounts	Volume (acre-feet/yr)	# of Accounts	Volume (acre-feet/yr)	Volume (acre-feet/yr)
Single family	3,411	1,379.4	2	0.8	1,380.2
Multi-family	94	16.6	-	-	16.6
Commercial	141	237.0	4	6.7	243.7
Industrial	-	-	-	-	-
Institutional/governmental	-	-	9	15.1	15.1
Landscape	-	-	-	-	-
Agriculture (untreated)	393	4,280.3(1,2)	-	-	4,280.3
Other	-	-	-	43.4	43.4
Total (treated & untreated)	4,039	5,913.3	15	66.1	5,979.4
Total (treated only)	**3,646**	**1,633.0**	**15**	**66.1**	**1,699.1**

Notes: (1) Agricultural (untreated) water is metered using a subsurface orifice and is sold by the miner's inch.
(2) Agricultural (untreated) water demand does not include carriage and ditch losses. Losses are included for the treated water. Latent demand is included in the future projected demands.

4.4.3. Projected Water Use

Table 11 and Table 12 present the projected water use by customer categories for both metered and not metered use for 2015 and 2020, respectively.

Table 13 presents the projected metered water use by customer categories for both 2025 and 2030. The projected water demands are based upon the following parameters:

- Population Projections from Table 5
- 2015 Interim Target and 2020 Targets for gallons per capita per day
- Distribution of water use by category presented in Section 4.4
- Raw water agricultural usage based on the El Dorado County Water Agency Water Resource and Development Management Plan, December 2007 (Note that this does not reflect the District's 2005 Irrigation Ordinance, which limits agricultural usage to the 2003 demand)

Table 11 - Projected Water Deliveries, 2015

Water Use Sectors	2015				
	Metered		Not metered		Total
	# of Accounts	Volume (acre-feet/yr)	# of Accounts	Volume (acre-feet/yr)	Volume (acre-feet/yr)
Single family	3,748	1,683.5	2	0.9	1,684.4
Multi-family	103	23.3	-	-	23.3
Commercial	155	294.1	4	7.6	301.7
Industrial	-	-	-	-	-
Institutional/governmental	-	-	9	17.1	17.1
Landscape	-	-	-	-	-
Agriculture (untreated)	504	5,493.7(1,2)	-	-	5,493.7
Other	-	-	-	94.5	94.5
Total (treated & untreated)	4,510	7,494.6	15	120.1	7,614.7
Total (treated only)	**4,006**	**2,000.9**	**15**	**120.1**	**2,121.0**

Notes: (1) Agricultural (untreated) water is metered using a subsurface orifice and is sold by the miner's inch.
(2) Agricultural (untreated) water demand does not include carriage and ditch losses. Losses are included for the treated water. Latent demand is included in the future projected demands.

Table 12 - Projected Water Deliveries, 2020

Water Use Sectors	2020				
	Metered		Not metered		Total
	# of Accounts	Volume (acre-feet/yr)	# of Accounts	Volume (acre-feet/yr)	Volume (acre-feet/yr)
Single family	4,118	1,696.0	2	0.8	1,696.8
Multi-family	113	23.4	-	-	23.4
Commercial	170	296.3	4	7.0	303.3
Industrial	-	-	-	-	-
Institutional/governmental	-	-	9	15.7	15.7
Landscape	-	-	-	-	-
Agriculture (untreated)	616	6,707.1(1,2)	-	-	6,707.1
Other	-	-	-	97.5	97.5
Total (treated & untreated)	5,017	8,722.8	15	120.9	8,843.8
Total (treated only)	**4,401**	**2,015.7**	**15**	**120.9**	**2,136.7**

Notes: (1) Agricultural (untreated) water is metered using a subsurface orifice and is sold by the miner's inch.
(2) Agricultural (untreated) water demand does not include carriage and ditch losses. Losses are included for the treated water. Latent demand is included in the future projected demands.

Table 13 - Projected Water Deliveries, 2025 and 2030

Water Use Sectors	2025		2030	
	# of Accounts	Volume (acre-feet/yr)	# of Accounts	Volume (acre-feet/yr)
Single family	4,458	1,836.0	4,826	1,987.6
Multi-family	122	25.4	132	27.5
Commercial	187	320.8	205	347.3
Industrial	-	-	-	-
Institutional/governmental	-	-	-	-
Landscape	-	-	-	-
Agriculture (untreated)	727	7,920.5(1)	839	9,133.3(1)
Other	-	130.9	-	141.7
Total (treated & untreated)	5,494	10,233.6	6,002	11,637.4
Total (treated only)	**4,767**	**2,313.1**	**5,163**	**2,504.1**

Notes: (1) Agricultural (untreated) water demand does not include carriage and ditch losses. Losses are included for the treated water. Latent demand is included in the future projected demands.

4.5. Wholesaler Water Demand Projections

The District is a retail water provider that does not rely on a wholesale agency for any sources of water. The District does not serve as a wholesale water provider to any other agency. Therefore, the District is not required to share its water demand projections with any other agency.

The District does not supply any water for saline water intrusion barriers, groundwater recharge, or conjunctive use.

4.6. Low Income Housing Demand

The 2008 Housing Element Update of the El Dorado County General Plan states that 139 low or very low income housing is planned for the communities of Cool and Pilot Hill. The 2008 Housing Element Update does not distinguish between single and multi-family residences. Projections of low income housing water demand are based on 2.71 persons per household and 2010 UWMP water use targets of 182 gpcd in 2015 and 167 gpcd in 2020 and beyond.

Table 14 - Projected Low Income Housing Water Demand

Water Use Sector	Low Income Water Demands (acre-feet/yr)			
	2015	2020	2025	2030
Single-family residential	77	70	70	70
Multi-family residential				
Total	77	70	70	70

5.0 System Supplies

5.1. Source of Supply – Stumpy Meadows Surface Water Diversion

The primary source of water to GDPUD is the Stumpy Meadows Project, which includes storage facilities, diversion structures, and a conveyance system to the service area. The project was completed in 1962 using funds from a Public Law 984 Loan administered by the Mid-Pacific Region of the U.S. Bureau of Reclamation

5.1.1. Description of Watershed

Stumpy Meadows Reservoir is formed by a 162 foot-high rock and earth fill dam (Mark Edson Dam) on Pilot Creek. The normal operating level is at the spillway crest at elevation 4,262', with storage of 20,000 acre-feet and a surface area of 330 acres. The minimum pool elevation is 4,170' with a dead storage of 1,200 acre-feet, and a usable storage of about 18,800 acre-feet.

The outlet structure is a screened, 5' x 5' precast reinforced concrete intake tower with a sill elevation of 4132' (130' below the crest of the spillway). Water released from the reservoir is funneled through a 30" welded steel pipeline which discharges to atmosphere. Flows are controlled by a Howell-Bunger valve at the discharge end of that line, with the water being redirected into Pilot Creek. The catchment area of the watershed supplying the Stumpy Meadows project is approximately 15.1 square miles, ranging in elevation from 4,170 feet to 6,190 feet.

The spillway is an un-gated over pour section constructed in a horseshoe configuration. It discharges into a concrete chute which rejoins Pilot Creek approximately 500 feet below the toe of the dam.

Water is released into Pilot Creek and is re-diverted into the District's water supply system by Pilot Creek Diversion Dam, two miles downstream of Edson Dam, near the mouth of Mutton Canyon Creek. The Pilot Creek Diversion Dam is a 110' x 20' reinforced concrete structure which diverts water into the El Dorado Conduit. A 36" sluice gate controls the flow into an open concrete channel that provides the inlet to a 48" RCP conduit. The inlet structure is screened by a trash rack constructed of No. 8 rebar on 9" centers. The diversion is made into the El Dorado Conduit. The portion of the watershed above the diversion structure which is not included in the Stumpy Meadows Reservoir watershed is about 4.1 square miles.

Diversion structures along the conveyance system, the El Dorado Conduit, divert water from cross drainages between Mutton Canyon and Tunnel Hill. Some of the en-route drainage is also intercepted by the conveyance ditch. These en-route cross diversions provide minimal supplementary supply to the District's system, and drain, in total, approximately three square miles above Tunnel Hill.

The small watersheds tapped by the Stumpy Meadows Project below the reservoir are in a lower elevation region where snow accumulation and melt have a lesser impact on time-distribution of runoff, rendering the available water supply from these diversions less dependable and entirely secondary to the primary supply of the reservoir.

5.1.2. Yield Analysis

In order to determine the adequacy of the Georgetown water supply system, yield analyses were prepared. Sierra Hydrotech analyzed yield of the water supply system, in a report "Stumpy Meadows Project Safe Yield Analysis", June 1985, Revised 1986. This report described project yield delivered to the service area with deficiencies taken in a critically dry year. Analysis was by a computer model using a monthly reservoir operation simulation, including diversion and losses in the conveyance system. The State Department of Water Resources (DWR) re-analyzed project yield data with virtually the same results. Reference to project yield in this report refers to the results of the DWR re-analysis.

Definition of Yield

When used in conjunction with water supply projects, the term "yield" generally refers to an annual quantity of water that can be made available to the potential project service area on a specified delivery schedule. Since this is only a general definition, more specific descriptions are required to distinguish the different types of yield. In this report, two types of yield will be discussed.

- Safe Yield is defined as "the maximum quantity of water that can be made available without deficiency each and every year without any adverse effects and under hydrologic conditions similar to those in the historic record."

- Firm Yield is defined as "the maximum annual quantity of water that can normally be made available each year under historic hydrologic conditions. Exceptions are allowed in critical and some dry years when a deficiency may be imposed."

Based on available hydrologic data and operation studies performed by Sierra Hydrotech and DWR, 1975 through 1978 was determined to be the most critical hydrologic period for the Stumpy Meadows Project as configured, and has been used as the critical period for determining the firm yield of the source.

Stumpy Meadows Project Firm Yield

The objective of the firm yield analysis was to operate the Stumpy Meadows system for the period 1927 through 1983 for various levels of deficiencies in treated and untreated deliveries. The system was operated similarly to the safe yield analysis with the exception that during dry periods such as 1976 and 1977, deficiencies were applied to the water requirements.

"Firm yield" with projected water requirements used in this report represents a deficiency of 10 percent for treated water and 50 percent for untreated water in critically dry years. Firm yield values reflect the operational losses and water requirements. The firm yield of the 20,000 acre-foot Stumpy Meadows Reservoir is 12,200 acre-feet, which allows for critical dry year deficiencies in raw water and treated water deliveries. The firm yield meets both the treated water and untreated water demands through 2030 (total demand = 11,638 acre-feet).

5.1.3. Description of Domestic Water System

Raw water from Stumpy Meadows Reservoir is released down Pilot Creek, where it is diverted and conveyed through approximately 70 miles of supply ditch/conduits to Walton Lake, a raw water surface impoundment. Walton Lake supplies raw water to the Walton Lake Water Treatment Plant. The plant is located four miles east of Georgetown and has a production capacity of 3.0 million gallons per day. After treatment, water is pumped into the distribution system that serves Georgetown, portions of Greenwood, Kelsey and Garden Valley.

A system of pipes and open ditches conveys water to another 10 acre-foot surface water impoundment that serves the Auburn Lake Trails Water Treatment Plant and the western portion of the service area including Cool, Pilot Hill and portions of Greenwood. The plant is located in the Auburn Lake Trails subdivision and has a production capacity of 3.0 million gallons per day.

The District's treated water distribution system consists of eight generalized pressure zones, 11 treated water storage tanks, 200 miles of distribution mains and six water pumping stations.

The GDPUD water system is linear in nature, relying on Stumpy Meadows Reservoir to the east and the system of pipes and ditches to convey water down slope to the west to various places of use. The District operates several small regulating reservoirs; however, with a break or outage in the primary transmission system, the potential exists for water supply disruptions if the outage lasts for several days. Future water supply options should consider the ability to improve redundancy and the level of water service reliability, in addition to meeting projected water demands.

5.2. Existing and Planned Water Sources

The Stumpy Meadows Reservoir is the only existing and planned water source for the District. Table 15 presents the capacity of the District's water supply sources from 2010 through 2030.

Table 15 - Current and Projected Sources of Water

Water Supply Sources	Water Source Capacity, acre-feet/yr				
	2010	2015	2020	2025	2030
Wholesale water provider	0	0	0	0	0
Supplier produced groundwater	0	0	0	0	0
Supplier surface diversion-Stumpy Meadows Reservoir (1)	12,200	12,200	12,200	12,200	12,200
Transfers in or out	0	0	0	0	0
Exchanges in or out	0	0	0	0	0
Recycled Water	0	0	0	0	0
Desalinated Water	0	0	0	0	0
Other	0	0	0	0	0
Total	12,200	12,200	12,200	12,200	12,200

(1) Stumpy Meadows Reservoir has a storage capacity of 20,000 AF but its firm reliable yield is 12,200 AF which is the maximum annual quantity of water that can normally be made available each year under historic hydrologic conditions.

5.2.1. Potential Groundwater Sources

The District has no plans to use groundwater as a source of water to supplement the surface water source. For the following reasons, local ground water resources are not of adequate quality or quantity to be a viable augmenting resource.

On the western slope of El Dorado County, groundwater occurs primarily in hard rock. In the county as in other parts of the Sierra Nevada foothills, alluvium consisting of unconsolidated deposits of clay, silt, sand, and gravel laid down by flowing water occurs only in small areas too thin to provide a significant amount of storage. Thus the amount of usable groundwater is limited. A cooperative study entitled *Georgetown Divide Water Management Study* prepared by the Department of Water Resources describes water supply alternatives available to the Georgetown Divide area and includes a discussion of the groundwater situation on the western slope. The following is an example from that study:

> Many wells are drilled in hard crystalline rock that lies at or near the ground surface or under the thin layers of alluvium. In rock formations water moves through, and is stored in, fractures in the rock mass. The width of each fracture usually decreases with depth, causing diminished water flow and storage capacity. The amount of water that can be stored and transmitted in such fractures is generally small compared to the amount that can be held and conveyed in a porous alluvial aquifer. The survey showed that while many residential wells produced 4 to 10 gallons per minute (gpm), many had flow rates less than 1 gpm and some had gone dry. Other reports substantiate the limitation of groundwater as a dependable source of water for supplementing public water supply or augmenting surface water storage during droughts. In fact, the contrary may be true where users of groundwater may look to the Districts for service when their wells go dry during droughts. Surveys also indicate that groundwater quality, though satisfactory in most areas of the western slope, is often marginal. As future development occurs in areas beyond pipeline service, both quantity and quality of groundwater sources could be threatened.

5.2.2. Water Exchange or Transfer Opportunities

The District is geographically separated from its neighboring water purveyors by the three forks of the American River. Also, the District has no existing intertie facilities with neighboring water agencies to either exchange raw water or transfer treated water to supplement the District's existing water source. Consequently, there is no immediate mechanism for the transfer of water into or out of the District through a mutual aid agreement should the need arise. Furthermore, due to the isolated nature of the District's service area, it is not practical to construct any exchange or transfer facilities.

5.2.3. Desalinated Water Project Opportunities

The District does not have any opportunities to develop desalinated water due to its remote location from any ocean water, brackish water, or high salinity groundwater.

5.2.4. Recycled Water Opportunities

There is currently no recycled water being used in the District's service area and there are very limited opportunities in the area to use recycled water as there are no sewer systems on the Divide. However, the District is the managing entity for the on-site wastewater disposal systems in the Auburn Lake Trails Subdivision. Treatment from these systems is limited to septic tank treatment and disposal is mainly via leach fields. Development of a recycled water supply from the Auburn Lake Trails Subdivision disposal system is not practical.

Auburn Lake Trails Wastewater Disposal Systems

In 1984, as part of class action legal settlement, the District became the regulatory agency responsible for wastewater disposal within the 1,100 lot Auburn Lake Trails Subdivision in Cool, and the owner of the Community Disposal System (CDS) serving 139 smaller lots in the subdivision. The Auburn Lake Trails On-Site Wastewater Disposal Zone (OSWDZ or Zone) was formed on March 19, 1985. The purpose of the Zone is to preserve and protect the environment and public health through an approved management program for individual and small community waste disposal systems in lieu of an area-wide sewage collection, treatment, and disposal system. As set forth in the Resolution 84-6 the District "shall investigate, test, design, operate, monitor, inspect and if necessary, maintain and repair the On-Site Wastewater Disposal Systems within the Zone at the individual homeowner's expense" The Auburn Lake Trails Zone was one of the first of its type in the State and served as a model for other OSWDZ in the State and in the nation.

There are currently 997 developed lots within the Subdivision. The type of individual on-site wastewater disposal system utilized on a particular lot is dependent on site-specific soil conditions. Disposal systems currently utilized in the Subdivision are the conventional leach field, mound, pressure dosed, intermittent sand filter, and other alternative wastewater disposal systems.

The Community Disposal System (CDS) was used for the remaining 139 lots that could not support any of the previously mentioned systems. The CDS collects only septic tank effluent from each residential unit's septic tank. This partially treated wastewater flows by gravity or is pumped up to the effluent lift station. From the lift station, the effluent is pumped to a large tank for distribution to the leach fields. The wastewater effluent is not chemically treated prior to disposal. There are a total of 38 manholes, 13,360 feet of collection line, a lift station and wet well, and approximately 1,800 feet of force main all connected to the community leach fields. The lift station is equipped with an emergency generator and a failsafe electrical backup system. The community leach fields consist of approximately 11,600 lineal feet of leach line.

Presently, there are 134 homes connected to the CDS. An ultrasonic flow meter continuously monitors the wastewater flow to the CDS fields. Average dry weather wastewater flows from this CDS system have been about 22,000 gallons/day for the past five years. At build-out, it is anticipated that the wastewater flows will be approximately 32,000 gallons/day. This wastewater is not disinfected and is classified as primary wastewater.

Recycled Water Evaluation

In 2005, the Auburn Lake Trails property Owner's Association and the District evaluated the potential for utilizing recycled water from the CDS system to irrigate the POA golf course. The existing nine hole golf course presently uses treated District water for irrigation purposes and the average daily demand during the summer months is 100,000 gallons per day. It was determined that it was cost prohibitive at this time for the following reasons:

- The wastewater system did not produce sufficient water during the summer months to meet the water demands of the golf course.
- A small ultra-filtration/disinfection plant would need to be installed to meet the State's recycled water standards.

The District has continued to explore funding mechanisms to recycle this wastewater for beneficial uses.

5.3. Future Water Projects

At some point in the future, if the District continues to grow and the demand for domestic treated water and agricultural raw water increases, a supplemental water supply to the Stumpy Meadows Project will be necessary to meet District-wide demands. A supplemental water supply would also reduce the magnitude and the frequency of projected water supply deficiencies during a critical drought period.

5.3.1. Potential Water Supply Projects

Over the years, the District has investigated numerous water supply alternatives. The 1992 Department of Water Resources (DWR) report, "Georgetown Divide Water Management Study" evaluated a number of storage reservoir projects, pumping from the American River and diversion from the Rubicon River Project. More recent evaluations conducted by the District refined the various project configurations and cost estimates. The most recent study was performed in 2009 – "Options To Increase Water Supply." Table 16 presents a summary of the options considered to increase the District's water supply. Figure 3 presents a schematic of the District's existing water supply system along with several of the most viable water supply options for the future. Most of these future water supply projects are in the investigative stage at this time with no immediate plans for implementation. There are however, two County water supply initiatives, as described in the "2009 – Options to Increase Water Supply" study, in various stages of development that may provide water supply to the District via the North Fork American River Pumping Plant.

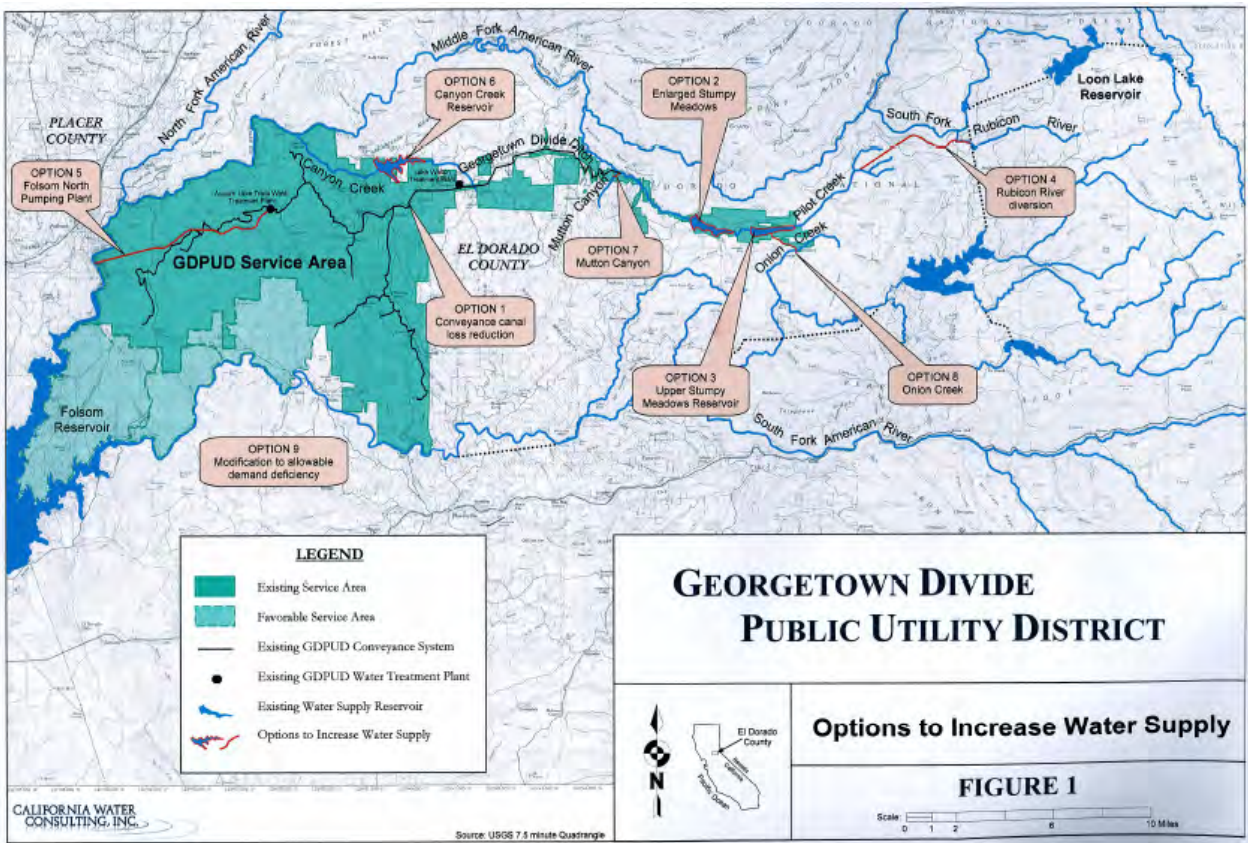

Figure 3 - Water Supply Options

Table 16 - Summary of Options to Increase Water Supply

Option Description	Additional Normal Year (1) Water Yield (acre-feet/yr)	Initial Cost ($ million)	Water Cost ($/acre-foot/yr)
Conveyance Canal Loss Reduction	670	11.5	1,200
Enlarge Stumpy Meadows Reservoir	250 to 1,000	(2)	(2)
Upper Stumpy Meadows Reservoir	3,200	(2)	(2)
Rubicon River Diversion	3,300 to 10,300	59.0	470 to 1,100
North Fork American River Pumping Plant	10,300	14.2	230
Canyon Creek Reservoir	6,100	108.3	1,200
Mutton Canyon Diversion	100	0.14	130
Onion Creek Diversion	50 to 300	2.2	500 to 3,000

(1) No information is available regarding the yield during dry years.
(2) No cost information has been developed for this option.

6.0 Water Shortage Reliability

6.1. Water Supply Management

The District has taken steps to improve water service reliability. The District has an ongoing capital improvement program to address system reliability that maximizes the available water supply in the future.

In addition to forecasting domestic water demands for the next 20 years, Table 11 through Table 13 also project an increase in raw water agricultural demand during that same time period. In an effort to plan for future domestic demands, the District has taken steps to control the rate of increase of agricultural water service. The District adopted Ordinance 2005-01 in 2005 which allows District staff to respond to reliability issues predicted by the General Plan estimations of growth in agricultural water service. New requests for agricultural service are evaluated each year based on available supply and will not be permitted unless there is sufficient capacity to meet the service requested. The irrigation season is generally from May 1 to October 1 of each year. A copy of the Ordinance is included in Appendix E.

The District's ongoing management practices and conservation programs to reduce losses in the water conveyance system by lining ditches with gunite, replacing ditches with pipelines, and improving operations that affect losses, will have a value in increasing the life of the present water supply. The District estimates that operational losses in the ditch conveyance system account for up to 3,000 acre-feet of water per year. Improved water supply efficiency will decrease the amount of water required from any of the water supply projects under consideration. However, conservation alone will not be sufficient to meet the long-term projected demands within the District's service area, and eventually, implementation of an additional water supply supplemental to the Stumpy Meadows Project will be necessary.

6.2. Water Supply Reliability

This section describes the reliability of the District's water supply and its vulnerability to seasonal or climatic shortages.

The District's only supply of water is surface water from the Stumpy Meadows Reservoir. Because this is a surface water supply, it is subject to significant reductions during dry years. However, there are no other legal, environmental or water quality limits on this source of supply. Options for additional water supply are presented in Table 16, but there are no current plans to implement any of these options.

The District's water supply is the Pilot Creek watershed which culminates in the Stumpy Meadows Reservoir. The average annual runoff is 22,370 acre-feet (AF). Reservoir capacity is 20,000 AF. The District monitors its supply by measuring the reservoir level on the second Tuesday in April each year. During a normal year the reservoir would be full at this time. The lowest reservoir level seen at this time was during 1977 when the reservoir's volume was only 11,060 AF. The District has elected to use the worst case single year condition from 1977 as the three-year condition to be conservative. Table 17 presents an estimate of the minimum water supply available during the next three years based on the driest three-year condition.

Table 17 - Supply Reliability During Worst-Case Three Year Dry Period

Water Supply Sources	Average / Normal Water Year Supply (acre-feet)	Single Dry Water Year Supply (acre-feet)	Multiple Dry Water Year Supply (acre-feet)		
		1977	2012	2013	2014
Stumpy Meadows Reservoir	20,000	11,060	11,060	11,060	11,060
Percent of Normal Year Water Supply:		55%	55%	55%	55%

6.2.1. Comparison of Supply and Demand

Table 18 through Table 20 present a comparison of the District's water demands and water supply for normal year, single dry year, and multiple dry years, respectively. Note that even though the total demand exceeds the supply during the worst case dry years by 5%, only 28% of the demand is for domestic water. The remaining 72% of the water demand is agricultural water. If these conditions were to occur, the District Board would address the situation by restricting the agricultural water use to the amount of water available.

Table 18 - Water Supply and Demand Comparison, Normal Year

	Water Volume (acre-feet/year)			
	2015	2020	2025	2030
Total Water Supply(1)	12,200	12,200	12,200	12,200
Total Water Demand	7,615	8,843	10,233	11,637
Difference (Supply – Demand)	4,585	3,357	1,957	563
Difference as % of Water Supply	+38%	+28%	+16%	+5%
Difference as % of Water Demand	+60%	+38%	+19%	+5%

(1) Stumpy Meadows Reservoir has a storage capacity of 20,000 AF but its firm reliable yield is 12,200 AF which is the maximum annual quantity of water that can normally be made available each year under historic hydrologic conditions.

Table 19 - Water Supply and Demand Comparison, Single Dry Year

	Water Volume (acre-feet/year)			
	2015	2020	2025	2030
Total Water Supply	11,060	11,060	11,060	11,060
Total Water Demand	7,615	8,843	10,233	11,637
Difference (Supply – Demand)	3,445	2,217	827	**(577)**
Difference as % of Water Supply	+31%	+20%	+7%	**-5%**
Difference as % of Water Demand	+45%	+25%	+8%	**-5%**

Table 20 - Water Supply and Demand Comparison, Multiple Dry Years

	Water Volume (acre-feet/year)			
	2015	**2020**	**2025**	**2030**
Total 3-Year Water Supply	33,180	33,180	33,180	33,180
Total 3-Year Water Demand	22,845	26,532	30,699	34,911
Difference (Supply – Demand)	10,335	6,648	2,481	**(1,731)**
Difference as % of Water Supply	+31%	+20%	+7%	**-5%**
Difference as % of Water Demand	+45%	+25%	+8%	**-5%**

6.2.2. Resource Maximization

The District maximizes their supply resource by planning their water deliveries based on the availability of water from the Stumpy Meadows reservoir each year. Priority is given to the domestic water customers and deliveries of raw agricultural water are evaluated each spring (mid-April) prior to the irrigation season (approximately from May 1 to October 1). Agricultural irrigation water is provided based on the water available that year.

6.3. Water Shortage Contingency Plans

The District has two water shortage contingency plans. The first plan provides emergency response to sudden water shortages or water quality emergencies. The second plan describes the District's staged response to address potential long-term water shortage conditions due to drought.

6.3.1. Water Supply Emergency Response Plan

The District's emergency response plan was prepared to respond to a sudden water shortage or water quality emergency such as might occur in the event of significant system damage from a major earthquake, or during a prolonged power outage, or in the event of a water quality emergency from bacteriological or chemical contamination of the water supply. Key provisions of the plan are summarized below:

Readiness

The District's primary emergency operations center would be created at the District office, at 6425 Main St. Georgetown CA. The District office is equipped with radios, telephones, telemetry equipment, emergency equipment, and supplementary documents and supplies. The emergency operations center would be the central point of coordination for government services, communications, and emergency public information.

Communication protocols have been established and damage evaluation procedures have been defined. In the immediate period following a major disaster, such as a fire, the District's initial task would be to evaluate the water supply system and to isolate breaks in order to minimize storage losses as quickly as possible.

The emergency operating center staffing would include the General Manager or his/her designee plus additional staff to help coordinate disaster control activities and communicate with the public. Other key District personnel would be assigned specific roles depending on the

magnitude of the emergency as well as the time of occurrence. On non-business days and after hours, the District maintains 24-hour response capability with the assignment of trained on-call workers, which can be summoned by calls from the District emergency phone service or the local Police and Fire Departments.

The District has assembled an inventory of equipment and spare parts, and maintains key vehicles in a "ready to respond" condition. The District also has arrangements with vendors for emergency backhoe and underground work, in the event there is more damage than the District's staff can manage. Crews would assemble at the District Office and be taken to the emergency work site by District personnel who would also be responsible for operating the valves to isolate the break and oversee the emergency repair work.

Response

The goal of the District's post disaster response actions is to maintain the water transmission and storage system intact and operational to the greatest extent possible. Emergency response protocols specify the leadership role of the on-call worker if the emergency occurs off-hours. The response plan is very specific with regard to operating protocols for the supply pumps and the monitoring of tank levels to ascertain the presence of significant leaks or pipeline breaks.

The repair or shut down work would be coordinated from the District Office and field crews would report progress to the emergency operations team. Regular progress reports would then be filed with the appropriate Police and/or Fire Department personnel.

6.3.2. Staged Response Plan

The District has in the past, and will continue in the future, to respond to water supply shortages on an individual basis as they develop. Generally, for droughts or any other long-term water supply shortage, the District implements a program of water conservation measures that will result in use restrictions proportional to the severity of the reductions needed. In the past, such use restrictions have been associated with droughts. Although the circumstances surrounding future droughts (or any other long-term supply shortages) may not be identical to the droughts that the District has faced in the past thirty-five years, the programs of voluntary and mandatory rationing developed in response to the increasingly severe actual or potential shortages in 1977-79 provide the District with its model for planning future responses to severe water shortages.

Table 21 outlines the four stages of rationing for water supply shortages of up to 50%. Stage 1 consists of voluntary measures and is an extension of the District's ongoing education and financial incentive programs to encourage water conservation. Stage 2 requires mandatory rationing of agricultural water in addition to voluntary conservation of domestic water. Stages 3 and 4 require mandatory rationing of both domestic and agricultural water. Mandatory rationing of domestic customers has never occurred in the past because of water conserved through mandatory reductions in agricultural use. The priority of domestic water over agricultural water is a long standing policy in the District and has been successfully used during periods of reduced water supply without noticeable long term impact on the community. No new agricultural accounts will be accepted during Stages of 3 and 4. However, the Board has the discretion to limit new agricultural customers at any time when it is deemed necessary. No new

domestic accounts will be accepted during Stage 3 unless the parcel has been assessed for improvements through a legal process; but during Stage 4, no new domestic accounts will be accepted. Potable water for street washing never occurs in the District's service area because there is no public entity to provide such a service.

Table 21 - Water Shortage Program Staged Response

	Stage One	Stage Two	Stage Three	Stage Four
Type of Program Domestic Agricultural	 Voluntary Voluntary	 Voluntary Mandatory	 Mandatory Mandatory	 Mandatory Mandatory
Conservation Goal	15%	16% - 25%	26% - 35%	36 - 50%
District Actions	• Initiate informational campaign • District Board has discretion to prohibit new agricultural accounts.	• Establish allocations • Ban wasteful water uses • Intensify leak detection • Intensify public education • District Board has discretion to prohibit new agricultural accounts	• Establish more stringent allocations • Require retrofits prior to review of hardship exemptions • Increase rates • District Board has discretion to prohibit new agricultural accounts • District Board has discretion to limit new domestic connections	• Reduce allocations further • Monitor use weekly, if necessary • End deliveries to landscape meters • Prohibit new agricultural connections • District Board has discretion to prohibit new domestic connections
Customer Actions	• Reduce water consumption	• Further reduce use • Comply with water waste ordinance	• Conform with allocations • Comply with landscape irrigation restrictions	• Conform with allocations • Monitor usage weekly or daily • No new landscaping
Penalties	• Education visit	• Excess use charges • Citations • Flow restriction • Shutoff	• Excess use charges • Citations • Flow restriction • Shutoff	• Excess use charges • Citations • Flow restriction • Shutoff

Table 22 presents examples of domestic water conservation methods that can be applied at each stage of the water supply shortage response.

Table 22 - Domestic Water Conservation Methods

Potential Water Conservation Methods	Stage When Method Takes Effect
Demand reduction program	1
Voluntary rationing	1
Incentives to reduce water consumption	1
Education Program	1
Percentage reduction by customer type	1
Use prohibitions	2
Plumbing fixture replacement	2
Mandatory rationing	2
Flow restriction	3
Restrict for only priority uses	3
Water shortage pricing	3
Reduce pressure in water lines	4
Restrict building permits	4
Per capita allotment by customer type	4

Historically, the amount of reservoir storage on April 15th has triggered rationing programs ranging from a voluntary to mandatory reduction goal for agricultural accounts of up to 50%. The reservoir levels in Table 23 present the trigger levels for the rationing stages and incorporate both supply and carry-over shortages. The reservoir level is automatically reviewed by the District Board of Directors in April prior to the release of irrigation water in May.

Table 23 - Water Supply Staged Response Trigger Levels

Stage	% Supply Shortage	Reservoir Level on 2nd Tuesday in April
1	15 to 25%	17,000 AF
2	25 to 35%	15,000 AF
3	35 to 50%	13,000 AF
4	50% +	10,000 AF

6.3.3. Mandatory Provisions to Reduce Water Use

The District adopted a “no waste” ordinance in 1982 which authorizes abatement procedures to curtail blatant water waste. According to the ordinance, the District may discontinue water service if such conditions are not corrected within five days after giving the customer written notice. If conditions warrant, the Board can enact more stringent measures to supplement the ordinance and will do what is required to ensure reasonable apportionment of water supplies during times of limited supply. The existing block rate schedule also provides the basis for penalizing excessive use. Additional tools for cases of flagrant waste include the installation of flow devices or termination of service.

6.3.4. Penalties or Charges for Excessive Use

The District’s existing Ordinance 82-1, Section 7.5, allows for the District to discontinue service in the event the wasteful condition is not corrected within 5 days. Typically, the District charges $25 for any violation of the ordinance. The District can establish penalties and charges above and beyond those that already exist as the water shortage stage increases.

6.3.5. Impacts on Revenue and Expenditures

The District has reserves established to respond to water shortage situations. Revenues are not expected to fluctuate significantly during a water shortage. Implementation of any stage of water rationing will not affect the minimum meter charge even though water usage will be reduced. The percentage increase in the increasing block rate schedule should be sufficient to compensate for the reduction in water sold. There will be no change in water cost to the District since the sole source of supply at this time is Stumpy Meadows Reservoir.

6.3.6. Mechanism for Monitoring Water Use

Since 99.8% of all Georgetown Divide Public Utility District customers are metered and the sources of supply are metered, the District is able to measure the effectiveness of any water shortage contingency plan that is implemented. The District collects sufficient data, in the normal course of operations, to determine actual reductions in sales, by user category, as compared to a given base year.

Normal Monitoring Procedure

In normal water supply conditions, production figures are recorded daily. Totals are reported monthly to the Operations Manager and incorporated into the water supply report.

Stage 1 and 2 Water Shortages

During a Stage l or 2 water shortage, daily production figures are reported to the Water Treatment Plant Supervisor. The Supervisor compares the weekly production to the target weekly production to verify that the reduction goal is being met. Weekly reports are then forwarded to the Operations Manager. Monthly reports are sent to the General Manager. If reduction goals are not met, the General Manager will notify the Board of Directors so that corrective action can be taken.

Stage 3 and 4 Water Shortages

During a Stage 3 or 4 water shortage, the procedure listed above will be followed, with the addition of a daily production report to the Operations Manager.

Disaster Shortage

During a disaster shortage, production figures will be reported to the Operations Manager hourly, and to the General Manager daily. Reports will also be provided to the Board of Directors and the El Dorado County Office of Emergency Services as necessary.

6.4. Water Quality Impacts on Reliability

The existing water quality of the District's surface water source continues to be excellent and therefore does not and should not affect the supply reliability between now and 2030. The District's 2010 Consumer Confidence Report is included in Appendix F. Stumpy Meadows Reservoir is a 20,000-acre reservoir located at an elevation of 4,262 feet. The Pilot Creek basin watershed supplying the Stumpy Meadows Reservoir is approximately 15.1 square miles in size, ranging in elevation from 4,170 ft. to 6,190 ft. Land uses within the watershed area located above the Walton Lake Water Treatment Plant are predominately forested, undeveloped and low density residential. Public access is very limited and much of the watershed is gated and locked.

7.0 Demand Management Measures

7.1. Introduction

The ethic of water conservation is a fundamental component of policy and operation at Georgetown Divide Public Utility District. As our Gold Rush era water system has evolved to meet the challenging needs and demands of the people it serves, the District is committed to promoting conservation and maximizing operational efficiency.

Demand Management Measures (DMMs) are mechanisms a water supplier can use to increase water conservation. Assembly Bill AB 1420 requires the implementation of 14 DMMs by water suppliers to be eligible for water grants or loans. The District has already implemented 11 of these DMMs. The remaining 3 DMMs do not apply to the District or are not economically feasible. Table 24 summarizes the DMMs and the District's implementation status. The remainder of this Section provides a detailed description of each DMM.

The Board of Directors will maintain full flexibility in funding the various water conservation programs listed in Table 24. As required by State law, the entire urban water management plan will be reviewed after five years.

Table 24 - District's DMM Implementation Status

DMM	DMM Description	Implemented?
A	Water Survey Programs for Single-Family and Multi-Family Residential Customers	Yes
B	Residential Plumbing Retrofits	Yes
C	System Audits, Leak Detection and Repair	Yes
D	Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections	Yes
E	Large Landscape Conservation Programs and Incentives	Yes
F	High-Efficiency Washing Machine Rebate Programs	No(1)
G	Public Information Programs	Yes
H	School Education Programs	Yes
I	Conservation Programs for Commercial, Industrial, and Institutional Accounts	Yes
J	Wholesale Agency Assistance Programs	No(2)
K	Conservation Pricing	Yes
L	Water Conservation Coordinator	Yes
M	Water Waste Prohibition	Yes
N	Residential Ultra-Low-Flush Toilet Replacement Programs	No(1)

(1) Implementation not economically feasible.
(2) Implementation not applicable to District.

7.2. Value of Water

To assess the benefits of the water conservation measures discussed below, the cost of treated water must be considered. In 2008, the District evaluated fiscal year 2007 costs to determine the cost of treated water. Table 25 presents a summary of the District's cost for treated water. Any cost-benefit analysis used to evaluate the economic feasibility of a DMM will use $5.31 per 1,000 gallons as the value of water.

Table 25 - Cost of Treated Water, 2007

Description	Allocation Basis	Cost
Source of Supply	28% of total consumption	$ 105,852
Transmission and Distribution – Raw Water	28% of total consumption	$ 208,521
Water Treatment	Total cost	$ 1,973,249
Transmission and Distribution – Treated Water	Total cost	$ 732,911
Customer Service	90% of total accounts	$ 264,226
	Total Treated Water Cost	**$ 3,284,759**
	Acre-feet Treated Water Delivered in 2007	1,900 AF
	Number of Treated Water Customers on June 30, 2007	3,565
	Treated Water Cost per 1,000 gallons	**$5.31 per 1,000 gallons**

7.3. DMM Implementation Status

7.3.1. DMM A – Residential Water Survey Program

Description

The District continually monitors customer usage in a proactive manner so that when usage trends higher, the customer can be notified. To accomplish this, the District's customer service staff performs regular analysis of customer water usage from meter data during each bimonthly billing cycle. The District's meter readers and billing clerks have been trained to check for unusual changes in water consumption by comparing past water usage with the current billing data when it is being collected or processed. Customers are notified by phone of any apparent anomalies and are offered assistance from District staff in checking for potential causes of the identified increases in water use. Customers are also offered water conservation kits that include faucet and showerhead flow restrictors, toilet displacement devices, and toilet leak tablets. These calls are logged and forwarded to the District's Water Conservation Coordinator.

In addition, the District Board enacted a leakage consideration policy in the 1980s to provide financial incentive to customers for prompt leak repairs. The policy is based on compassion for the customer, prompt repair of major leaks and payment for the chemicals and electricity to treat the water that was lost due to leakage. To qualify for leakage consideration, customers must repair the leak within 2 weeks of notification. District staff estimate the expected usage based upon the same billing cycle during the previous year to determine the amount of water lost due to leakage. Water use due to leakage beyond the expected usage is billed at a reduced rate of $2.25 per 1,000 cubic feet – as opposed to the current top tier rate of $2.21 per 100 cubic feet. Note that only one consideration may be granted to a customer every 10 years.

Effectiveness of DMM

Effectiveness of these surveys is measured by a customer's water usage reported in meter readings. The District continues to monitor customer usage following the initial contact to ensure that corrective actions were effective.

Per the California Urban Water Conservation Council (CUWCC), water conservation from this DMM is estimated to be 20 gallons per day for each customer contacted. On average, the District contacts 15 residential customers each bimonthly billing cycle for an estimated savings of 0.7 million gallons per year. This savings is equivalent to about 0.1% of the District's average daily water production or 0.3 gpcd.

Regardless of the savings, operations personnel have visited many residences and businesses regarding the increased water use. Numerous malfunctioning toilets, faucets and irrigation devices are discovered and repaired annually as a result of this program.

Schedule

This program is an historical program that has been used for the past 20 years. Considering the positive results of the existing program, the Georgetown Divide Public Utility District will continue to focus its water conservation work on efforts to contact high consumption residential users and assist them with reducing their water use. The District will continue to aggressively respond to all customer concerns regarding leaks and unusually high water usage.

Cost Benefit Analysis

Per the CUWCC, the residential water survey program should provide site-specific leak detection assistance along with a water conservation survey, water efficiency suggestions, and on-site inspection. The District does not believe that the additional cost of this level of implementation is beneficial.

As stated above, the water savings from a residential water survey program are about 20 gallons per day for each survey performed. Assuming that 3% (about 20 per bimonthly billing cycle) of the residential users in the District's service area were surveyed each year for the next 9 years, this would result in a total of nearly 1,100 surveys being performed. The total water savings after 9 years would be about 22,000 gallons per day or 0.2 gpcd. At the District's cost to treat water of $5.31 per 1,000 gallons, the "benefit" of this DMM is about $43,000 per year after 9 years of implementation. This is equivalent to a benefit of $39 per survey per year.

The District's costs to implement this DMM would include one-time costs to plan and develop the survey program and ongoing costs for performing the residential surveys. Table 26 presents a summary of these costs. Note that the CUWCC estimates the cost of implementing this DMM at $40 to $200 per survey. Due to the District's small size, it should be expected that the cost per survey should be at the high end of this range.

Table 26 - Cost Benefit Analysis for Residential Water Survey Program

DMM Implementation	District Cost	Annual Cost	Cost per Survey
Program Setup (100 hrs @ $90/hr)	$ 9,000	$ 1,000	$ 10
Survey (1.5 hr/survey @ $50/hr)	$162,000	$ 18,000	$ 150
		Total Cost Per Survey Performed	**$ 160**

This best management practice, per the CUWCC, requires annual surveys of at least 1.5% of the District's residential customers. The District's current practices contact twice as many customers each year.

Comparing the cost to implement the DMM and the benefits in terms of water cost savings, the costs outweigh the benefits by a factor of 4. Therefore, any additional effort toward implementation of this DMM is not economically practical.

7.3.2. DMM B – Residential Plumbing Retrofit

Description

Since 1992, all new and replacement plumbing fixtures sold in the state have been required to comply with applicable water conservation specifications. In 1991, the District's service area included about 2,400 residential customers.

The District's implementation of this DMM includes the distribution of water conservation kits free of charge to all customers. These water conservation kits included high-quality, 2.5 gpm or less showerheads, 2.2 gpm or less faucet aerators, toilet displacement devices and toilet tank leak detection tablets. Installation instructions and water conservation literature are included in each kit. Water conservation kits are available at the District's office upon request. Kits are offered directly to residential customers during the residential water survey (DMM A).

The water conservation kits are targeted for distribution to the 2,400 pre-1992 residential customers. This program is publicized in the District's Consumer Confidence Report that is distributed to each customer each year.

Effectiveness of DMM

Effectiveness of these water conservation kits on residential water use is difficult to quantify. Since 2006, the District has distributed 50 water conservation kits to its customers.

Per the CUWCC, water conservation from this DMM is estimated to be 12 gallons per day for each water conservation kit installed. Based on the number of kits distributed to date, this DMM has generated an estimated savings of 219,000 gallons per year. This savings is equivalent to less than 0.1% of the District's average daily water production or less than 0.1 gpcd.

Schedule

This program has been implemented since 2006. Considering the positive results of the existing program, the District will increase its efforts to advertise the availability of the water conservation kits in the annual Consumer Confidence Report.

7.3.3. DMM C – System Water Audits, Leak Detection and Repair

Description

The District conducts water audits at each billing cycle to determine the annual amount of un-metered water. Un-metered water is the difference between total water sales and total water production. Un-metered water includes both authorized and unauthorized uses. Authorized uses include water for un-metered water connections, fire-fighting and training, hydrant flushing, backwash water, construction water and other miscellaneous uses. Unauthorized uses include pipeline leaks, water meter inaccuracy, tank overflows, and stolen water. This un-metered, unauthorized use is classified as unaccounted-for water.

The District modified their billing software in 2011 to include residential (both single and multi-family), commercial, large landscape, and governmental/institutional. This will allow the District to track the water use for each individual sector in the future.

The District actively implements programs to reduce losses in both the treated and untreated water conveyance systems. The District's Board of Directors has approved a capital improvement program to assist in funding replacement of aging and inefficient facilities.

The District repairs all leaks in the distribution system as quickly as possible after they are detected. Even minor leaks are reported by the meter readers and are investigated and repairs are made.

Leak detection and pipe replacement are fundamental to the operation of the treated water system. Remote sensing at the storage tanks accelerates response capability and minimizes losses when leaks occur. Areas of recurring leakage are targeted for pipe replacement projects.

In addition, the District calibrates and/or replaces water meters when they are no longer operating within normal parameters. The purpose of this work is to a) enhance revenue by ensuring payment for all water sold, b) encourage conservation by ensuring that customers pay for all water delivered, and c) increase the agency's ability to account for its distributed water.

The District has also developed a water system pressure control program to reduce pressure and thereby reduce water use. The District operates with 8 pressure zones and forty-nine (49) pressure reducing stations at locations throughout the District's service area so as to reduce high static pressure in its system and at individual water connections. In addition, the District recommends customers install a pressure reducing valve on their service connection if the District's pressure at that location exceeds 60 psi. Pressure management is particularly important for the District because of the topographic variations in the service area. Reduced pressure helps conserve water by reducing flow through fixtures, which limits quantities lost when fixtures leak or when water is inefficiently applied.

Although not required by this UWMP, loss reduction in the raw water conveyance system is another major focus of the District's maintenance program. The annual budget routinely includes funding for a rehabilitation program of the raw water conveyance system. Over the years, sections of the ditch system have been replaced with pipeline and unlined ditches have been gunited, thus significantly reducing seepage losses from the ditch system. Over 20% of the untreated water conveyance system, which is in large part Gold Rush vintage, is now in pipe or concrete-lined ditch. When repairs are made to the raw water conveyance system, pipe is used whenever possible to reduce losses and avoid the maintenance requirements of ditches.

Effectiveness of DMM

The system audits are used to evaluate the effectiveness of the District's leak detection and repair program. The District's unaccounted-for water volume between 1999 and 2008 was about 2% of the overall treated water production. In addition, the unaccounted-for water volumes have not been higher than 3% in any recent year.

The CUWCC's best management practice for leak detection requires system audits when water losses (unaccounted-for water) exceed roughly 10% of an agency's total water production (the trigger is actually based on a more complicated scoring system from the American Water Works Association's Water Loss Audit software). Since the District typically operates with water losses

of 2%, the District's water savings from implementation of this DMM are estimated at 8% of their total water production or about 15 gpcd.

Note that these water use savings were achieved prior to 2005 and future savings from this DMM will be minimal. However, continued implementation of this DMM is required to maintain the current level of water conservation.

Schedule
This DMM was implemented prior to 2005. The District will continue its vigilance in reducing water losses with on-going programs to repair pipeline leaks as soon as they are discovered, replace old, less reliable pipelines, and upgrade older, potentially inaccurate, water meters.

7.3.4. DMM D – Metering with Commodity Rates

Description
Almost all (99.8%) of the District's domestic water connections are metered and all water is billed volumetrically. The District began installing water meters in 1961. Since 1982, treated water has been billed on an inclining block rate structure where the unit cost increases with the amount used, which penalizes inefficient water usage. The current rate structure is presented in DMM K.

The District currently has 15 unmetered connections. Most of these historical connections are along Main Street in Georgetown, where modification of the existing service for meter installation is difficult.

Effectiveness of DMM
The primary tool in promoting water conservation is the water meter. When there is a direct correlation between amount of water used and cost, people become aware and accountable, finding their own ways to conserve water. This practice is recognized as a sound urban water management practice.

The District's metering and rate structure has effectively promoted water conservation. Residential only water use in the District's service area averages approximately 158 gallons per person per day, much lower than the statewide average of 196 gallons per person per day (Source: California Urban Water Conservation Council, 2001-02 statewide mean).

Per the CUWCC, the water savings generated by the installation of water meters is about 25% of the total water use. For the District, these savings are equivalent to 400,000 gallons per day or about 40 gpcd. Note that the water use savings due to meter installation were achieved more than 30 years ago and future savings from this DMM will be minimal. However, continued implementation of this DMM is required to maintain the current level of water conservation.

Schedule
The District began implementation of this DMM prior to 2005. There are 15 older connections that are not metered, which represents approximately 0.2% of the total domestic accounts. It is anticipated that these connections will be retrofitted with meters by 2020 where practical and/or feasible.

7.3.5. DMM E – Large Landscape Conservation Programs and Incentives

Description

The District currently has several customers that could be considered large landscape domestic water users (four schools, two cemeteries and one nine-hole golf course). The District works with these domestic water users to identify conservation measures which would improve the irrigation efficiency of their landscaped areas. The District continues to provide economic incentives to customers through its rate structure to improve irrigation efficiency and conserve water.

All large landscape customers have dedicated meters and can monitor their irrigation usage. These meters improve efficiency and promote conservation by providing customers with detailed information on the water used to irrigate their property.

The District supported the modernization of the Auburn Lake Trails Property Owners Association golf course irrigation system. The Property Owners Association invested significant funds to modernize the irrigation system for the golf course. This system has resulted in a 50% decrease in water use between 2007 and 2010.

Two evaporation/weather stations were established with the support and cooperation of the Department of Water Resources and the Georgetown Divide Resource Conservation District. To promote water conservation through efficient application of irrigation water, the District publishes weather data in local newspapers weekly during the irrigation season. District staff is trained to assist in defining soil type, water holding capacity, and efficient irrigation scheduling for customers. The Conservation District has sponsored demonstrations and newspaper articles concerning development of effective irrigation schedules by using weather and soils data. In addition to the District's efforts, the El Dorado County Water Agency sponsors assistance to irrigators to insure optimal irrigation efficiency.

Effectiveness of DMM

Effectiveness is monitored by tracking the District's large landscape irrigation customer's water usage.

Between 2007 and 2010, water use has dropped by nearly 50% for these large users. This represents a water savings of about 37,000 gallons per day or about 4 gpcd. The current program that is in place is very flexible and has proven to be very effective.

Schedule

The District implemented this program in 2005.

The District will continue to work with its large landscape domestic customers to support all efforts to improve efficiency and encourage conservation. This small customer base (total of seven customers), allows the District to custom tailor a conservation program specific to its customer's needs and has been extremely effective in reducing water use for these purposes.

7.3.6. DMM F – High-Efficiency Washing Machine Rebate

Description

This DMM addresses the use of water-efficient washing machines to decrease water consumption. The District has already addressed this issue by providing economic incentives to reduce water consumption. The District's metering and rate structure provides incentive to conserve water and has proven to be successful.

Implementation of this DMM would require the District to offer financial incentives for the purchase of high-efficiency washing machines that use 40% less water per load. Costs to the District would include one-time costs to plan and develop the rebate program and ongoing costs for the advertising, administration, and the rebate itself.

Cost Benefit Analysis

Per the CUWCC, the water savings from the installation of a high-efficiency washing machine is about 100 gallons per week for each unit installed. Assuming that 1.5% of the residential users in the District's service area used the program each year for the next 9 years, this would result in a total of 450 high-efficiency washing machines being installed. The total water savings after 9 years would be approximately 6,500 gallons per day or 0.7 gpcd. At the District's cost to treat water of $5.31 per 1,000 gallons, the "benefit" of this DMM is about $13,000 per year after 9 years of implementation. This is equivalent to a benefit of $29 per unit per year.

The District's costs to implement this DMM would include one-time costs to plan and develop the rebate program and ongoing costs for the advertising, administration, and the rebate itself. Table 27 presents a summary of these costs. Note that the CUWCC estimates the cost of implementing this DMM at $400 to $1,000 per unit. Due to the District's small size, it should be expected that the cost per unit should be at the high end of this range.

Table 27 - Cost Benefit Analysis for High Efficiency Washing Machine Program

DMM Implementation	District Cost	Annual Cost	Cost per Unit Installed
Rebate Program Setup (100 hrs @ $90/hr)	$ 9,000	$ 1,000	$ 20
Rebate ($200 per unit)	$ 10,000	$ 10,000	$ 200
Administration (4 hrs/wk @ $50/hr)	$ 10,000	$ 10,000	$ 200
Advertising ($500 expenses per month)	$ 6,000	$ 6,000	$ 120
		Total Cost Per Unit Installed	**$ 710**

Comparing the cost to implement the DMM and the benefits in terms of water cost savings, the costs outweigh the benefits by a factor of 24.

Schedule

Based on the high cost to benefit ratio for this DMM, the District will not implement the high-efficiency washing machine rebate program at this time. The District's small staff and limited financial resources are too constrained to plan, develop and administer a program for washing

machine rebates and the potential benefits are not high enough to warrant the investment that would be required.

7.3.7. DMM G – Public Information Program

Description

The District has an on-going public information program and has conducted community outreach and public education activities. In the late 1970's and early 1980's the public information program efforts were aimed at motivating people to respond to the specific drought emergencies that were occurring, while in recent years the public information efforts have focused on general water conservation and wise water use.

The District's public information includes the following:

Presentations: District personnel speak at local schools, at local service clubs, neighborhood association meetings, etc. and are available to speak when requested. Additionally, District staff has conducted public tours at the water treatment plant facilities.

Brochures and Flyers: The District prepares and mails newsletters to all customers on an annual basis in conjunction with the annual consumer confidence report. The newsletters include articles and information on water conservation issues. In addition, the District has provided information on water conservation topics for inclusion in the Auburn Lake Trails "Trail Views" newsletter.

Water conservation messages are also routinely included in District communications with customers questioning bills or raising other related questions.

Water conservation flyers and brochures are kept at the reception desk in the District Office and made available to interested customers coming to pay bills or make inquiries.

In the event of a drought or pending drought the District uses general mailings, separate from the bimonthly billings, to announce water conservation programs to appeal to customers to reduce their water consumption. These efforts are supported with stepped-up public information initiatives using a variety of local media outlets.

The District has purchased and developed a number of pamphlets, flyers and information sheets containing water conservation information. These are available at the District office or can be mailed upon request. Appendix G presents several examples of the materials available to the District's customers. The following is a partial list of the brochures and leaflets that are currently available from the District:

- Homeowner's Guide to Onsite Sewage Disposal Systems (includes water conservation tips)
- California Water Facts – Conservation booklet
- El Dorado County Xeriscape Handbook – Introduction to drought tolerant gardens and landscaping

Usage Information: The District includes usage information on customer bills so that the customer can see how much water was used during the billing cycle.

Press Releases: Mandatory water conservation programs implemented by the District are announced with articles in local newspapers. In the event of a future drought, the District will again implement an active public relations effort to reinforce the need for active citizen participation in the conservation effort.

DMM Effectiveness

The District tracks the feedback regarding the information provided to the public. The District has no method to quantify the savings of this DMM but believes that this program is in the public's interest.

Schedule

The District implemented this DMM prior to 2005. The District will continue to provide public information services and materials to remind the public about water conservation and other water resource issues.

7.3.8. DMM H – School Education Program

Description

As part of the District's public information program, District personnel speak at schools to promote conscientious use of water resources. The District participates in school programs to the extent that staffing levels will allow. Presentations have been given each year to the local elementary schools. Additionally, District staff have conducted field trips at the water treatment plant facilities and assisted students with special projects involving water resources.

Effectiveness of DMM

The District tracks the feedback regarding the school presentations. The District has no method to quantify the savings of this DMM but believes that this program is in the public's interest.

Schedule

The District implemented this DMM prior to 2005. The District will continue to provide school education services to remind the students about water conservation and other water resource issues.

7.3.9. DMM I – Commercial, Industrial, and Institutional (CII) Conservation Programs

Description

The District has 141 commercial accounts as of 2010. There are no industrial or institutional accounts. In total, these customers account for about 14% of total water sales by volume. Most of the customers in this billing category are small retail businesses.

The District continually monitors commercial account usage in a proactive manner so that when usage trends higher, the customer can be notified. To accomplish this, the District's customer service staff performs regular analysis of customer water usage from meter data each bimonthly billing cycle. The District's meter readers and billing clerks have been trained to check for unusual changes in water consumption by comparing past water usage with the current billing data when it is being collected or processed. Customers are notified by phone of any apparent

anomalies and are offered assistance from District staff in checking for potential causes of the identified increases in water use. These calls are logged and forwarded to the District's Water Conservation Coordinator.

Effectiveness of DMM

Effectiveness of this program is measured by a customer's water usage reported in meter readings. The District continues to monitor customer usage following the initial contact to ensure that corrective actions were effective.

Per the California Urban Water Conservation Council (CUWCC), water conservation from this DMM is estimated to be 20% for each customer contacted. On average, the District contacts 3 commercial customers each bimonthly billing cycle for an estimated savings of 4,200 gallons per day. This savings is equivalent to about 0.3% of the District's average daily water production or 0.5 gpcd.

Regardless of the savings, operations personnel have visited many businesses regarding the increased water use. Numerous malfunctioning toilets, faucets and irrigation devices are discovered and repaired annually as a result of this program.

Schedule

This is an historical program that has been in place for more than 20 years. Considering the results of the existing program, the District will continue to focus its water conservation work on efforts to contact high consumption commercial users and assist them with reducing their water use. The District will continue to aggressively respond to all customer concerns regarding leaks and unusually high water usage.

Cost Benefit Analysis

Per the CUWCC, the CII conservation program should provide site-specific assistance including conservation measures such as installation of high efficiency toilets, dishwashers, ice machines, and washing machines. The District does not believe that the additional cost of this level of implementation is beneficial.

As stated above, the water savings from a CII conservation program are about 20% for each customer contacted. Assuming that the CUWCC required 1% of the commercial users in the District's service area were surveyed each year for the next 9 years, this would result in a total of 14 surveys being performed. The total water savings after 9 years would be about 5,000 gallons per day or 0.5 gpcd. At the District's cost to treat water of $5.31 per 1,000 gallons, the "benefit" of this DMM is about $10,000 per year after 9 years of implementation. This is equivalent to a benefit of $700 per survey per year.

The District's costs to implement this DMM would include one-time costs to plan and develop the survey program and ongoing costs for the performing the CII surveys. Table 28 presents a summary of these costs. Note that the CUWCC estimates the cost of implementing this DMM at $600 to $8,000 per survey. Due to the District's small size, it should be expected that the cost per survey should be at the high end of this range.

Table 28 - Cost Benefit Analysis for CII Water Conservation Program

DMM Implementation	District Cost	Annual Cost	Cost per Survey
Program Setup (100 hrs @ $90/hr)	$ 9,000	$ 1,000	$ 640
Survey (24 hrs/survey @ $50/hr)	$ 16,800	$ 1,200	$ 1,200
		Total Cost Per Survey Performed	**$ 1,840**

This best management practice per the CUWCC requires annual surveys of at least 1% of the District's residential customers. The District's current practices contact nearly four times as many customers each year.

Comparing the cost to implement the DMM and the benefits in terms of water cost savings, the costs outweigh the benefits by a factor of nearly 3. Therefore, any additional effort toward implementation of this DMM is not economically practical.

7.3.10. DMM J – Wholesale Agency Programs

The District is not a wholesale provider of water. Therefore, this DMM does not apply to the District and will not be implemented.

7.3.11. DMM K – Conservation Pricing

Description

Almost all (99.8%) of the District's domestic water connections are metered and the water is billed volumetrically. Since 1982, treated water has been billed on an inclining block rate structure where the unit cost increases with the amount used, which penalizes inefficient water usage.

In 2008, the District implemented a new water rate structure with increases in 2009 through 2011. The previous rate structure had been in place since July 1, 2006. The current minimum bi-monthly charges for domestic water are $47.14 (residential) and $50.32 (commercial) for water consumption up to 2,000 cubic feet (cf). Additional water beyond 2,000 cf is billed as follows:

- 2,001-4,000 cf: $1.38 per 100 cf
- 4,001-6,000 cf: $1.65 per 100 cf
- 6,001- 8000: $1.93 per 100 cf
- 8,001 and up: $2.21 per 100 cf

Effectiveness of DMM

The primary tool in promoting water conservation is the water meter. When there is a direct correlation between amount of water used and cost, people become aware and accountable, finding their own ways to conserve water. This practice is recognized as a sound urban water management practice.

The District's previous rate structures have effectively promoted water conservation. Residential water use in the District's service area averages approximately 158 gallons per person per day, much lower than the statewide average of 196 gallons per person per day (Source: California Urban Water Conservation Council, 2001-02 statewide mean).

Per the CUWCC, the water savings generated by implementation of commodity rates are estimated to be 10% to 50% of the increase in water rate for the average customer (e.g. a 10% water rate increase would generate 1% to 5% in water savings). Assuming a 30% savings, the District's 2008 water rate increase should generate water savings of 7% of the residential use and 20% of the commercial use. This is equivalent to about 140,000 gallons per day or 17 gpcd.

Schedule

The District began implementation of this DMM prior to 2005. Water meters were installed in the District's service area in the 1960's and an inclining block rate schedule has been in place since 1982.

The current rate structure was adopted in 2008 and implemented over three years (2009 – 2011). The District has no plans to increase rates further to promote water conservation.

7.3.12. DMM L – Conservation Coordinator

Description

The District has a very small staff. Over the past five years the Water Quality Division Operations Manager has taken on the responsibilities for a variety of water conservation related duties. As such, the Water Quality Division Operations Manager is the *de facto* Conservation Coordinator. The District's Conservation Coordinator coordinates and oversees all water conservation programs for the District.

Effectiveness of DMM

The District has no method to quantify the savings provided by this DMM but believes that this coordination and oversight effort is critical to the District's water conservation efforts.

Schedule

The District implemented this DMM in 2005. The District will continue to support the role of a water conservation coordinator to oversee its water conservation efforts.

7.3.13. DMM M – Water Waste Prohibition

Description

In response to the drought years of 1976-1977, the District Board of Directors passed an ordinance in 1982, which authorizes abatement procedures to curtail blatant water waste. According to the ordinance, the District may discontinue water service if such conditions are not corrected within five days after giving the customer written notice. If conditions warrant, the Board can enact more stringent measures to supplement the ordinance and will do what is required to ensure reasonable apportionment of water supplies during times of limited supply. A copy of this ordinance is provided in Appendix H.

Effectiveness of DMM
The District has no method to quantify the savings provided by this DMM but believes that enforcement of this ordinance is critical to the District's water conservation efforts.

Schedule
The District implemented this DMM prior to 2005. The District will continue enforce this ordinance to support the District's overall water conservation program.

7.3.14. DMM N – Residential Ultra-Low-Flush Toilets Replacement Programs

Description
El Dorado County provides a low flush toilet replacement program through the building permit process. The District adheres to this program and obtains results by requiring the replacement of inefficient toilets during remodel or new construction.

This DMM requires the replacement of existing high water-using toilets with ultra-low-flush (1.6 gallons or less) in single-family and multi-family residences. The replacement program can be in the form of rebates, distribution, or complete installation of ultra-low-flush toilets. Costs to the District to implement this DMM would include one-time costs to plan and develop the program and ongoing costs for the advertising, administration, and rebate/toilet/installation.

Cost Benefit Analysis
Per the CUWCC, the water savings from the installation of an ultra-low flush toilet are about 25 gallons per day for each residential unit installed. Assuming that 2.5% of the residential users in the District's service area used the program each year for the next 9 years, this would result in a total of 770 ultra-low-flush toilets being installed. The total water savings after 9 years would be about 19,250 gallons per day or 2.0 gpcd. At the District's cost to treat water of $5.31 per 1,000 gallons, the "benefit" of this DMM is about $38,000 per year after 9 years of implementation. This is equivalent to a benefit of $50 per unit per year.

The District's costs to implement this DMM would include one-time costs to plan and develop the program and ongoing costs for the advertising, administration, and the rebate/distribution/installation. For purposes of this evaluation, a rebate program was used since it should have the lowest cost. Table 29 presents a summary of these costs. Note that the CUWCC estimates the cost of implementing this DMM at $60 to $230 per unit. Due to the District's small size, it should be expected that the cost per unit should be at the high end of this range.

Table 29 - Cost Benefit Analysis for Ultra Low Flush Toilet Replacement Program

DMM Implementation	District Cost	Annual Cost	Cost per Unit Installed
Rebate Program Setup (100 hrs @ $90/hr)	$ 9,000	$ 1,000	$ 10
Rebate ($75 per unit)	$ 57,750	$ 6,400	$ 75
Administration (4 hrs/wk @ $50/hr)	$ 10,000	$ 10,000	$ 115
Advertising ($500 expenses per month)	$ 6,000	$ 6,000	$ 70
		Total Cost Per Unit Installed	**$ 270**

Comparing the cost to implement the DMM and the benefits in terms of water cost savings, the costs outweigh the benefits by a factor of more than 5.

Schedule

Based on the high cost to benefit ratio for this DMM, the District will not implement the ultra-low-flush toilet replacement program at this time. The District's small staff and limited financial resources are too constrained to plan, develop and administer a program for toilet replacement. In addition, the potential benefits are not high enough to warrant the investment that would be required.

Appendix A - Notice of Intent to Adopt UWMP to Coordinating Agencies

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
P.O. BOX 4240 PHONE (530) 333-4356
GEORGETOWN, CALIFORNIA 95634 FAX (530) 333-9442

Sent via e-mail and U.S Postal Service

May 5, 2011

Roger Trout
Director, Development Services Department
El Dorado County
2850 Fairlane Court, Building C
Placerville, CA 95667

Subject: Georgetown Divide Public Utility District 2010 UWMP Notice

Mr. Trout,

The Georgetown Divide Public Utility District is preparing its 2010 Urban Water Management Plan (UWMP). The UWMP is required to be submitted to the California Department of Water Resources every five years per water code 10610-10657. The law requires a water agency to notify the county in which it serves water that it will be updating its UWMP. The District is updating the UWMP for 2010 and intends to present its findings at a public hearing scheduled for July 12, 2011.

If you have any questions or comments please contact me at (530) 333-4356.

Sincerely,

Rebecca Siren

Rebecca Siren
Operations Manager, Water Quality Division
Georgetown Divide Public Utility District
6425 Main St
PO Box 4240
Georgetown, CA 95634

cc: Peterson, Brustad, Inc.

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
P.O. BOX 4240 PHONE (530) 333-4356
GEORGETOWN, CALIFORNIA 95634 FAX (530) 333-9442

Sent via e-mail and U.S Postal Service

May 12, 2011
Dave Eggerton, General Manager
El Dorado County Water Agency
3932 Ponderosa Road, Suite 200
Shingle Springs, CA 95682

Subject: Georgetown Divide Public Utility District 2010 UWMP Notice

Dear Mr. Eggerton,

The Georgetown Divide Public Utility District is preparing its 2010 Urban Water Management Plan (UWMP). The UWMP is required to be submitted to the California Department of Water Resources every five years per water code 10610-10657. This letter is written to notify El Dorado County Water Agency that the District is updating the UWMP for 2010. The District intends to present its findings at a public hearing in July.

If you have any questions or comments please contact me at (530) 333-4356.

Sincerely,

Rebecca Siren

Rebecca Siren
Operations Manager, Water Quality Division
Georgetown Divide Public Utility District
6425 Main St
PO Box 4240
Georgetown, CA 95634

cc: Peterson, Brustad, Inc.

Appendix B - Notice of Public Hearing

This space for the County Clerk's Filing Stamp

GEORGETOWN GAZETTE

PROOF OF PUBLICATION
(2015.5 C.C.P.)

Proof of Publication of:

STATE OF CALIFORNIA
County of El Dorado
I am a citizen of the United States and a resident of the County aforesaid; I'm over the age of eighteen years, and not a party to or interested in the above-entitled matter. I am a principal agent of and/or the publisher of the El Dorado Gazette, Georgetown Gazette & Town Crier, a newspaper of general circulation printed and published once each week in the town of Georgetown, Ponderosa Judicial District, County of El Dorado, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court to the County of El Dorado, State of California, under the date of April 3, 1970, Case Number 18589; that the notice, of which the attached is a printed copy (set in type no smaller than non-pareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

6/16, 6/23

All in the year 2011

I certify (or declare) under penalty of perjury that the foregoing is true and correct.
Dated at Placerville, California, this
day of **June 23, 2011**

T. Kennedy
Signature

NOTICE OF PUBLIC HEARING
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT BOARD OF DIRECTORS

URBAN WATER MANAGEMENT PLAN UPDATE

NOTICE IS HEREBY GIVEN that the Board of Directors of the Georgetown Divide Public Utility District will hold, in conjunction with the formal adoption of an update to the District's Urban Water Management Plan, an opportunity for the community to provide input on the District's urban water use target for compliance with the SBx7-7, also known as the Water Conservation Bill of 2009, and the District's planned methods for meeting its urban water use target. The Urban Water Management Plan describes and specifies the proposed urban water use targets and is available for public review after June 17, 2011 at 6425 Main Street, Georgetown, CA, 95634, Monday through Friday (except legal holidays) between the hours of 7:45 a.m. and 4:30 p.m. or online at www.gd-pud.org/publications/Studies & Reports.

The public hearing will be held on July 12, 2011 at 6425 Main Street, Georgetown, California, at 9:00 a.m., at which time and place all interested persons shall have the opportunity to present their comments and concerns to the Board of Directors. Persons wishing to comment can do so either in writing or in person. Written comments should be addressed to the Georgetown Divide Public Utility District, P.O. Box 4240, Georgetown, CA, 95634.

6/16, 6/23 **02533501**

Appendix C - Resolution to Adopt the Urban Water Management Plan

2011-05
RESOLUTION OF THE
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
TO ADOPT THE
URBAN WATER MANAGEMENT PLAN

WHEREAS, the California Legislature enacted Assembly Bill 797 (Water Code Section 10610 et seq., known as the Urban Water Management Planning Act) during the 1983-1984 Regular Session, and as amended subsequently, which mandates that every supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre feet of water annually, prepare an Urban Water Management Plan, the primary objective of which is to plan for the conservation and efficient use of water; and

WHEREAS, the District is an urban supplier of water providing water to over 3,500 customers and a population over 9,400, and

WHEREAS, the Plan shall be periodically reviewed at least once every five years, and that the District shall make any amendments or changes to its plan which are indicated by the review; and

WHEREAS, the Plan must be prepared by July 1, 2011, and after public review and hearing, filed with the California Department of Water Resources within thirty days of adoption; and

WHEREAS, the District has therefore, prepared and circulated for public review the Urban Water Management Plan on June 17, 2011, and a properly noticed public hearing regarding said Plan was held by the District on July 12, 2011, and

WHEREAS, the District will update and file said Plan with the California Department of Water Resources by August 12, 2011;

NOW THEREFORE, be it hereby resolved as follows:

1. 2010 Urban Water Management Plan is hereby adopted and ordered filed with the District Clerk;

2. The General Manager is hereby authorized and directed to file the 2010 Urban Water Management Plan with the California Department of Water Resources within 30 days after this date;

3. The General Manager is hereby authorized and directed to implement the Water Conservation Programs as set forth in the 2010 Urban Water Management Plan, which includes water shortage contingency analysis and recommendations to the District Board regarding necessary procedures, rules, and regulations to carry out effective and equitable water conservation and water recycling programs;

4. In a water shortage, the General Manager is hereby authorized to declare a Water Shortage Emergency according to the Water Shortage Stages and Triggers indicated in the Plan, and implement necessary elements of the Plan;

5. The General Manager shall recommend to the District Board of Directors additional regulations to carry out effective and equitable allocation of water resources.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT on the 12th day of July, 2011, by the following vote:

AYES: 5

NOES:

ABSENT:

ABSTAIN:

NORM KRIZL
President, Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

ATTEST:

HENRY N. WHITE, Clerk and ex officio
Secretary, Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

Appendix D - Completed DWR UWMP Checklist

Table I-2 Urban Water Management Plan checklist, organized by subject

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
PLAN PREPARATION				
4	Coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.	10620(d)(2)		Table 2
6	Notify, at least 60 days prior to the public hearing on the plan required by Section 10642, any city or county within which the supplier provides water that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. Any city or county receiving the notice may be consulted and provide comments.	10621(b)		Article 2.1, Appendix A
7	Provide supporting documentation that the UWMP or any amendments to, or changes in, have been adopted as described in Section 10640 et seq.	10621(c)		Appendix C
54	Provide supporting documentation that the urban water management plan has been or will be provided to any city or county within which it provides water, no later than 60 days after the submission of this urban water management plan.	10635(b)		Article 2.4, Appendix D
55	Provide supporting documentation that the water supplier has encouraged active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan.	10642		Article 2.2
56	Provide supporting documentation that the urban water supplier made the plan available for public inspection and held a public hearing about the plan. For public agencies, the hearing notice is to be provided pursuant to Section 6066 of the Government Code. The water supplier is to provide the time and place of the hearing to any city or county within which the supplier provides water. Privately-owned water suppliers shall provide an equivalent notice within its service area.	10642		Article 2.2, Appendix B
57	Provide supporting documentation that the plan has been adopted as prepared or modified.	10642		Article 2.2, Appendix C
58	Provide supporting documentation as to how the water supplier plans to implement its plan.	10643		Article 2.3

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
59	Provide supporting documentation that, in addition to submittal to DWR, the urban water supplier has submitted this UWMP to the California State Library and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. This also includes amendments or changes.	10644(a)		Article 2.3
60	Provide supporting documentation that, not later than 30 days after filing a copy of its plan with the department, the urban water supplier has or will make the plan available for public review during normal business hours	10645		Article 2.4
SYSTEM DESCRIPTION				
8	Describe the water supplier service area.	10631(a)		Article 3.2
9	Describe the climate and other demographic factors of the service area of the supplier	10631(a)		Article 3.3, Article 3.4
10	Indicate the current population of the service area	10631(a)	Provide the most recent population data possible. Use the method described in "Baseline Daily Per Capita Water Use." See Section M.	Article 3.5
11	Provide population projections for 2015, 2020, 2025, and 2030, based on data from State, regional, or local service area population projections.	10631(a)	2035 and 2040 can also be provided to support consistency with Water Supply Assessments and Written Verification of Water Supply documents.	Table 5
12	Describe other demographic factors affecting the supplier's water management planning.	10631(a)		Article 3.6
SYSTEM DEMANDS				
1	Provide baseline daily per capita water use, urban water use target, interim urban water use target, and compliance daily per capita water use, along with the bases for determining those estimates, including references to supporting data.	10608.20(e)		Article 4.1, Article 4.2
2	*Wholesalers:* Include an assessment of present and proposed future measures, programs, and policies to help achieve the water use reductions. *Retailers:* Conduct at least one public hearing that includes general discussion of the urban retail water supplier's implementation plan for complying with the Water Conservation Bill of 2009.	10608.36 10608.26(a)	Retailers and wholesalers have slightly different requirements	Article 4.3

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
3	Report progress in meeting urban water use targets using the standardized form.	10608.40		N/A
25	Quantify past, current, and projected water use, identifying the uses among water use sectors, for the following: (A) single-family residential, (B) multifamily, (C) commercial, (D) industrial, (E) institutional and governmental, (F) landscape, (G) sales to other agencies, (H) saline water intrusion barriers, groundwater recharge, conjunctive use, and (I) agriculture.	10631(e)(1)	Consider 'past' to be 2005, present to be 2010, and projected to be 2015, 2020, 2025, and 2030. Provide numbers for each category for each of these years.	Tables 9, 10, 11, 12
33	Provide documentation that either the retail agency provided the wholesale agency with water use projections for at least 20 years, if the UWMP agency is a retail agency, OR, if a wholesale agency, it provided its urban retail customers with future planned and existing water source available to it from the wholesale agency during the required water-year types	10631(k)	Average year, single dry year, multiple dry years for 2015, 2020, 2025, and 2030.	Article 4.5
34	Include projected water use for single-family and multifamily residential housing needed for lower income households, as identified in the housing element of any city, county, or city and county in the service area of the supplier.	10631.1(a)		Article 4.6
SYSTEM SUPPLIES				
13	Identify and quantify the existing and planned sources of water available for 2015, 2020, 2025, and 2030.	10631(b)	The 'existing' water sources should be for the same year as the "current population" in line 10. 2035 and 2040 can also be provided.	Table 15
14	Indicate whether groundwater is an existing or planned source of water available to the supplier. If yes, then complete 15 through 21 of the UWMP Checklist. If no, then indicate "not applicable" in lines 15 through 21 under the UWMP location column.	10631(b)	Source classifications are: surface water, groundwater, recycled water, storm water, desalinated sea water, desalinated brackish groundwater, and other.	Article 5.2.1
15	Indicate whether a groundwater management plan been adopted by the water supplier or if there is any other specific authorization for groundwater management. Include a copy of the plan or authorization.	10631(b)(1)		N/A
16	Describe the groundwater basin.	10631(b)(2)		N/A
17	Indicate whether the groundwater basin is adjudicated? Include a copy of the court order or decree.	10631(b)(2)		N/A

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
18	Describe the amount of groundwater the urban water supplier has the legal right to pump under the order or decree. If the basin is not adjudicated, indicate “not applicable” in the UWMP location column.	10631(b)(2)		N/A
19	For groundwater basins that are not adjudicated, provide information as to whether DWR has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition. If the basin is adjudicated, indicate “not applicable” in the UWMP location column.	10631(b)(2)		N/A
20	Provide a detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years	10631(b)(3)		N/A
21	Provide a detailed description and analysis of the amount and location of groundwater that is projected to be pumped.	10631(b)(4)	Provide projections for 2015, 2020, 2025, and 2030.	N/A
24	Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.	10631(d)		Article 5.2.2
30	Include a detailed description of all water supply projects and programs that may be undertaken by the water supplier to address water supply reliability in average, single-dry, and multiple-dry years, excluding demand management programs addressed in (f)(1). Include specific projects, describe water supply impacts, and provide a timeline for each project.	10631(h)		Table 16
31	Describe desalinated water project opportunities for long-term supply, including, but not limited to, ocean water, brackish water, and groundwater.	10631(i)		Article 5.2.3
44	Provide information on recycled water and its potential for use as a water source in the service area of the urban water supplier. Coordinate with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area.	10633		Article 5.2.4
45	Describe the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.	10633(a)		Article 5.2.4

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
46	Describe the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.	10633(b)		Article 5.2.4
47	Describe the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.	10633(c)		Article 5.2.4
48	Describe and quantify the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, indirect potable reuse, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses.	10633(d)		Article 5.2.4
49	The projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected.	10633(e)		N/A
50	Describe the actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.	10633(f)		N/A
51	Provide a plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.	10633(g)		N/A
WATER SHORTAGE RELIABILITY AND WATER SHORTAGE CONTINGENCY PLANNING [b]				
5	Describe water management tools and options to maximize resources and minimize the need to import water from other regions.	10620(f)		Article 6.1
22	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage and provide data for (A) an average water year, (B) a single dry water year, and (C) multiple dry water years.	10631(c)(1)		Article 6.2.1, Tables 18, 19, 20
23	For any water source that may not be available at a consistent level of use - given specific legal, environmental, water quality, or climatic factors - describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.	10631(c)(2)		Article 6.2
35	Provide an urban water shortage contingency analysis that specifies stages of action, including up to a 50-percent water supply reduction, and an outline of specific water supply conditions at each stage	10632(a)		Article 6.3.2

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
36	Provide an estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic sequence for the agency's water supply.	10632(b)		Table 17
37	Identify actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.	10632(c)		Article 6.3.1
38	Identify additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.	10632(d)		Article 6.3.2
39	Specify consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply.	10632(e)		Table 22
40	Indicated penalties or charges for excessive use, where applicable.	10632(f)		Article 6.3.4
41	Provide an analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.	10632(g)		Article 6.3.5
42	Provide a draft water shortage contingency resolution or ordinance.	10632(h)		Article 7.3.13, Appendix H
43	Indicate a mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.	10632(i)		Article 6.3.6
52	Provide information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments, and the manner in which water quality affects water management strategies and supply reliability	10634	For years 2010, 2015, 2020, 2025, and 2030	Article 6.4

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location
53	Assess the water supply reliability during normal, dry, and multiple dry water years by comparing the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. Base the assessment on the information compiled under Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.	10635(a)		Tables 18, 19, 20
DEMAND MANAGEMENT MEASURES				
26	Describe how each water demand management measures is being implemented or scheduled for implementation. Use the list provided.	10631(f)(1)	Discuss each DMM, even if it is not currently or planned for implementation. Provide any appropriate schedules.	Article 7.0
27	Describe the methods the supplier uses to evaluate the effectiveness of DMMs implemented or described in the UWMP.	10631(f)(3)		Articles 7.3.1 through 7.3.14, “Effectiveness of DMM”
28	Provide an estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the ability to further reduce demand.	10631(f)(4)		Articles 7.3.1 through 7.3.14, “Effectiveness of DMM”
29	Evaluate each water demand management measure that is not currently being implemented or scheduled for implementation. The evaluation should include economic and non-economic factors, cost-benefit analysis, available funding, and the water suppliers' legal authority to implement the work.	10631(g)	See 10631(g) for additional wording.	Tables 26 through 29
32	Include the annual reports submitted to meet the Section 6.2 requirements, if a member of the CUWCC and signer of the December 10, 2008 MOU.	10631(j)	Signers of the MOU that submit the annual reports are deemed compliant with Items 28 and 29.	N/A

a The UWMP Requirement descriptions are general summaries of what is provided in the legislation. Urban water suppliers should review the exact legislative wording prior to submitting its UWMP.

b The Subject classification is provided for clarification only. It is aligned with the organization presented in Part I of this guidebook. A water supplier is free to address the UWMP Requirement anywhere with its UWMP, but is urged to provide clarification to DWR to facilitate review.

Appendix E - District Ordinance 2005-01

ORDINANCE 2005-01

AN ORDINANCE ESTABLISHING RULES AND REGULATIONS FOR IRRIGATION SERVICE IN THE GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

BE IT ENACTED by the Board of Directors of the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT, County of El Dorado, State of California, as follows:

The rules and regulations for irrigation service within the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT ("District") are adopted by the Board of Directors of said District as hereinafter set forth.

SECTION 1. General Conditions:

(a) Control of System: District Works shall be under exclusive control and management of District personnel duly appointed by the Board of Directors.

(b) The District shall not be liable for interruption, shortage or insufficiency of irrigation water supply, or for any loss or damage occasioned thereby.

(c) The District shall not be liable for damage to person or property resulting directly or indirectly from privately owned conduits, meters or measuring devices.

(d) Irrigation water is used at the customer's own risk and the customer agrees to hold the District, its officers and employees free and harmless from liability and damages that may occur as the result of defective water quality, shortages, fluctuation in flow or pressure, interruptions in service or for failure to deliver water.

(e) Pumping of water by the customer is done at the customer's risk. The District assumes no liability for damage to pumping equipment or other damages as a result of turbulent water, shortages, excess of water or other causes.

(f) No purchaser of water from the District acquires a proprietary or vested right by reason of use. No purchaser acquires a right to resell water or to use for a purpose other than that for which it

was applied nor to use it on premises other than indicated on the application. The terms, conditions, priorities and allocation of irrigation service may be altered and amended by the Board of Directors. The District does not guarantee irrigation service customers the right to future service.

(g) The District expressly asserts the right to recapture, reuse and resell all waters originating from District Works.

(h) Ditchtenders and other agents of the District shall have access to all lands irrigated from its water system and to all conduits for the purpose of inspection, examination, measurements, surveys or other necessary purposes of the District with the right of installation, maintenance, control and regulation of all meters and other measuring devices, gates, turnouts and other structures necessary or proper for the measurement and distribution of water.

(i) No bridges, crossing, pipe or other structures shall be placed in or over a canal without written permission of the District. Maintenance of the canal crossings shall not be the District's responsibility but shall rest with the owner of the crossing. Where the owner fails to maintain the crossing, the District may perform the necessary repairs or removal at the expense of the owner. Notice of the District's intent will be given, if possible, to the owner prior to the work commencing.

(j) No rubbish, garbage, refuse, chemicals or animal matter from any source may be placed in or allowed to be emptied into any ditch, canal or reservoir of the District.

(k) District canals or reservoirs shall not be used for swimming or bathing.

(l) Livestock shall not be permitted to contaminate the water supply nor destroy or damage the canal system or use thereof. Property owners are liable for any damage due to livestock.

(m) No conveyance system shall cause a cross connection with the District's water system with any other source of water.

(n) No buildings, corrals or other structures, fences, trees, lines or bushes shall be permitted upon rights-of-way or use thereof be made in any way except by written authority of the District. Construction of

fences and/or gates is not permitted without written approval of the specifications by the General Manager.

(o) Violation of Rules and Regulations: Failure to comply with rules and regulations of the District shall be sufficient cause for terminating irrigation service as determined by the Board of Directors.

(p) Any person dissatisfied with any determination of the District management shall have the right to appeal to the Board of Directors.

(q) Amendments: The Board of Directors of the District may at their discretion alter, amend or add to these rules and regulations. The Board of Directors will follow applicable laws during this process.

SECTION 2. Application for an Irrigation Service Account:

(a) No irrigation service will be rendered until a complete application for an Irrigation Service Account has been approved and is on file at the office of the District. Applications will be accepted between January 1st and March 1st for the impending irrigation season. The application for service shall state that the customer agrees to abide by the terms and conditions for service as established in the Irrigation Ordinance.

(b) Applications will be approved where the District Works have sufficient capacity to meet service requested. Applications will be considered for approval utilizing the following priority system:

Priority 1.	Applications for Irrigation Service to parcels that received irrigation service during the immediate past irrigation season.
Priority 2.	Applications for Irrigation Service to parcels with the most recent active Irrigation Service Account during the previous ten (10) irrigation seasons
Priority 3.	New applications for irrigation service to parcels that have been made after the 2003 irrigation season with priority established by the earliest season applied for. Applications and priority are specific to the section of ditch the parcel is located near.

Competing applications within the same priority level, will be determined by public lottery.

(c) Applications for an increase to service will receive Priority 3 status for the requested increase.

(d) Applications must in all cases be signed by the holder of title to the property requesting irrigation service. If the property requesting irrigation service is leased, two months of charges must be paid in advance. The landowner of leased property shall be responsible for all charges or assessments.

(e) Applications for an Irrigation Service Account to benefit a parcel of land that is not adjacent to the District Works must be accompanied by a legally recorded easement that allows the conveyance of water to the parcel requesting irrigation service. The easement shall grant the District the right of ingress and egress for inspection, installation and maintenance purposes.

(f) New applications for Out-of-District Irrigation Service Accounts will not be approved by the Board of Directors. An existing Out-of-District Irrigation Service Account that is inactive for two or more years will be deleted from the District's accounts and the service will be permanently removed.

SECTION 3. Distribution of Water:

(a) The irrigation season shall generally be from May 1 through October 1 of each year. The Board of Directors shall consider changes to the irrigation season to respond to climactic conditions and may implement such changes by a majority vote.

(b) The District does not guarantee irrigation water under pressure from the District Works. Pressure requirements of the customer are the sole responsibility of the customer and the District shall not be liable for any damage to equipment used to provide pressure to the customer.

(c) Water is distributed under continuous flow. Water must be used continuously during all days and nights including holidays and Sundays and no allowances shall be made for failure to use water when it is made available. Failure to use water on schedule shall not entitle the customer to any rebate.

(d) Irrigation service is provided for the entire irrigation season. Customers shall pay for irrigation service for the entire irrigation season regardless of their interest or ability to use water.

(e) When interruptions to irrigation service due to failure of the District Works extend beyond five (5) days, proportionate adjustments for such water loss will be made.

(f) Irrigation customers shall pay a proportionate amount for irrigation service when the irrigation season is extended or shortened by the Board of Directors.

(g) Unauthorized connections or the taking of water in an amount greater than applied and paid for, by any means, is a misdemeanor under California Penal Code Section 498 and shall be subject to criminal prosecution under Section 498 and any other applicable laws. In addition, the District may bring a civil action for damages and may refuse future service to the parcel.

(h) Irrigation customers shall prevent any unnecessary or wasteful use of water. Should a customer permit wasteful use of water, the District may discontinue service if such condition is not corrected within five (5) days after giving the parcel owner written notice of intention to terminate service.

(i) No more than one parcel shall be served through each Irrigation Service Account except with the prior written approval of the Board of Directors. Any such approval shall be recorded against each parcel with the caveat that the agreement expires upon any change of ownership. Each Irrigation Service Account shall have independent service lines and sumps.

(j) The minimum irrigation service for each Irrigation Service Account shall be one miner's inch, from the open ditch system, and one-half miner's inch from the irrigation pipeline system. In the future, the District may consider reducing the minimum irrigation service to one-half miner's inch from the open ditch system and one-quarter miner's inch from the irrigation pipeline system.

(k) All pumped services shall utilize a sump provided by the customer and acceptable to the District.

(l) All Irrigation Service Accounts must have an appropriate measuring device which shall be installed by the District. The customer shall pay the cost thereof including costs of installation. The District shall approve the location of the measuring device.

(m) Customers receiving irrigation service who request a change in flow rate during the season shall be charged a fee set by the Board of Directors for the adjustment.

(n) Replacement of measuring devices shall be at the expense of the customer if the replacement is necessary due to abnormal wear or abuse.

(o) Alternate Boxes –The Board of Directors shall not approve any new applications for Alternate Boxes.

(p) Unusual costs incurred by the District to provide irrigation service shall be paid in full by the applicant or customer. An estimate of the expense shall be approved by the property owner prior to work commencing.

SECTION 4. Charges, Rates and Billings:

(a) The District will maintain a uniform rate schedule which may be changed from time to time upon action of the Board of Directors. The rate schedule, by reference, is attached hereto and made a part of these rules and regulations.

(b) Irrigation billings are made bi-monthly (every two months) in advance.

(c) All penalties shall be charged as outlined on the billings

(d) Disconnected irrigation service accounts shall pay a fee to re-establish service

(e) Irrigation service accounts requesting verification of flow will pay a fee if the delivered flow is within 10% of the contracted amount

SECTION 5. REPEAL

(a) Upon the effective date of this Ordinance 2005-__ all previously adopted Ordinances pertinent to the Rules and Regulations for

Irrigation Service will be superceded and repealed, including, but not limited to, Ordinance 79-2, 79-8, 87-1, and 04-01.

PASSED AND ADOPTED at a regularly held meeting of the Board of Directors of the GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT this tenth day of May, 2005.

AYES:	Bob Diekon, Norman Krizl, Doug Pickell, JoAnn Shepherd and Hy Vitcov
NOES:	None
ABSENT:	None

Bob Diekon, President
Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

ATTEST:

Henry N. White, Clerk and ex officio
Secretary, Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

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I hereby certify that the foregoing is a full, true, and correct copy of Ordinance 2005-01 duly and regularly adopted by the Board of Directors of the Georgetown Divide Public Utility District, El Dorado County, California, at a meeting duly held on the tenth day of May, 2005.

Henry N. White, Clerk and ex officio Secretary of the
Georgetown Divide Public Utility District

Appendix F - 2010 Consumer Confidence Report

Georgetown Divide Public Utility District

Domestic Water | Irrigation Service | On-Site Waste Disposal

1946~ 2011 Reflecting on the Past. Planning for the Future.

The Georgetown Divide Public Utility District is pleased to present our annual newsletter to our customers, which not only includes two documents mandated by the California Department of Public Health (1. Annual Water Quality Report /Consumer Confidence Report and 2. a State Notification Letter regarding the District's water treatment processes), but also provides an overview of GDPUD's projects and services. We have combined all information into one mailing to save on printing and mailing costs.

Dear GDPUD Customer,

Every year brings more opportunities for our District to meet the daily demands of providing safe, reliable water to our communities while forecasting water use to meet the needs of our future customers. This year is no different.

The District applied for water rights licensing of Stumpy Meadows in 2010. Stumpy stores 20,000 acre feet of water and is the source of the water for the Divide communities.

Photo by Roberta Long, 2006.

This year, in addition to meeting the daily maintenance and operational needs of our customers, we embarked upon an important task of applying to the State Water Resources Control Board for water rights for the Stumpy Meadows Project. The Stumpy Meadows Project was constructed between 1960 and 1962 and at that time, we obtained two water rights permits: one that allows the storage of water at Stumpy and the second that allows a direct diversion from Pilot Creek for delivery to meet our customers' needs.

The Board rightly anticipated then that we should continue to apply for the permit extensions every 10 years until such time that our communities have reached maximum water use capacity. We have reached this milestone, and have prepared this water rights licensing package not only so that we can maintain rights to our highest water use, but also to embed current environmental standards into our operational practices.

Stumpy Meadows spilled on December 19, 2010, only the fourth time it has spilled that early.

While water rights issues can be complicated, we want to assure you that your GDPUD Board works to bring the staffing and expertise necessary to meet the current and future water needs of our communities while anticipating and budgeting for ongoing maintenance of our facilities.

Most of our customers simply want to know that when they turn on a faucet, they will get safe, reliable water. For those of you who would like to know more about our budgets, reports and projects, we invite you to visit our website at www.gd-pud.org, or attend our meetings held on the second Tuesday of every month at 9:00 am at our District offices.

Mailing Address:PO Box 4240, Georgetown, CA 95634-4240/Physical Address: 6425 Main St.
Phone (530) 333-4356 www.gd-pud.org Fax (530) 333-9442

GDPUD 2010 News Briefs & Accomplishments

GDPUD staff carry out the vision and goals established by our Board of Directors.
Below are highlights of our 2010 accomplishments.

Hydroelectric Supply & Revenue. Both Tunnel Hill and Buckeye Hydroelectric Plants were in production for the full year, producing 3.6 million kiloWatt hours, which is enough electricity to power 300 homes for an entire year.

Buckeye Hydroelectric Plant

Residential & Commercial Domestic Water Service. We provided more than 554 million gallons of water to 3,571 residential and commercial customers in 2010.

GDPUD is providing FREE water conservation kits for homes built before 1992. Please stop by and pick up your kit today.

Irrigation Water. The District supplied nearly 5,000 acre feet of water to irrigation customers from May through September. If you are interested in providing input into irrigation policies and processes, please call the District office and ask to be placed on the Irrigation Committee and mailing list.

Wastewater Services. In 2010, we performed 1,313 wastewater inspections in the Auburn Lake Trails On-Site Wastewater Disposal Zone. In order to reduce the inflow and infiltration into the Community Disposal System (CDS) six leaking septic tanks were replaced in 2010. One homeowner took advantage of the District's no-interest loan for a year to help pay for the cost of this tank replacement.

The Board also adopted the State-mandated Sewer System Management Plan (SSMP) in August 2010, which outlines more stringent maintenance and inspection activities of the CDS to prevent sanitary sewer overflows. The SSMP was prepared by in-house staff, resulting in an approximate $50,000 savings to the District.

GDPUD customers have experienced no sewer overflows since 2005 due to the District's implementation of the septic tank leak detection and replacement program. This program has been instrumental in significantly reducing the inflow and infiltration into the CDS sewer collection system and in extending the collection system's life.

Black Oak Mine Tank Exterior

Facilities Maintenance. We recoated the interior and exterior of the Black Oak Mine water storage tank in 2010 and continued this maintenance on other tanks in 2011. The purpose of the coating is to maintain the integrity of the tanks and to prevent corrosion and pitting, which would eventually create holes in the tank that can lead to catastrophic failure of the tank.

The Black Oak Mine tank is a 300,000-gallon tank that serves Garden Valley and Greenwood. We estimated the price to be around $300,000, but were able to shop the market and negotiate a $128,000 price, saving significant ratepayer funds. The project was completed on schedule and within budget.

Auburn Lake Trails Water Treatment Plant Retrofit. GDPUD was able to secure a $200,000 grant from the El Dorado County Water Agency towards engineering and design cost for this project. Rather than construct a new plant, the Board voted in 2009 to retrofit the ALT plant, resulting in significant savings for the customers. The retrofit is at the 60% design stage, with final design expected to be complete in 2011 and construction final in 2013.

Fiscal. The California Society of Municipal Finance Officers awarded GDPUD an "Excellence in Budgeting" Award for its 2009-2010 operating budget. The award is based not only on the fact that GDPUD met all budget standards for municipal agencies, but also because the necessary fiscal detail was mixed well with written overviews, pictures and charts that make these complex budgets easier for the public to understand. The District's 2009-2010 budget was reduced by 3.35% from the previous year's budget. To view District budgets, audits and other details, go to our website at www.gd-pud.org.

Mailing Address: PO Box 4240, Georgetown, CA 95634 / Physical Address: 6425 Main Street
Phone (530) 333-4356 www.gd-pud.org Fax (530) 333-9442

Consumer Confidence Report 2010 Calendar Year (reported in 2011)

Dear Water User,

This report provides a snapshot of your water quality. We are pleased to report that in 2010, as in years past, your water met all US Environmental Protection Agency (EPA) and state drinking water health standards. The District vigilantly safeguards its water supplies and once again, our water system has not violated a maximum contaminant level or any other water quality standard. Included in these pages are details on where your water comes from, what it contains and how it compares to state standards. For additional information on water quality, customers may contact Becky Siren at GDPUD at (530) 333-4356.

About Contaminants

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. GDPUD is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Water Quality Rules Explained

In order to ensure that tap water is safe to drink, the EPA and CA Department of Public Health (CDPH) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. Department regulations also establish limits for contaminants in bottled water that must provide the same protection for public health.

Some People Are More Vulnerable

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA and Centers for Disease Control (CDC) guidelines on appropriate means to lessen risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline (1-800-426-4791).

Natural Materials Can Enter Water

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, reservoirs and canals. As water travels over the surface of the land it dissolves naturally-occurring minerals and in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity. Contaminants that may be present in source water include:

- Microbial contaminants, such as viruses and bacteria, that may come from septic systems, agricultural livestock operations, and wildlife.

Natural Materials Can Enter Water (cont.)

- Inorganic contaminants, such as salts and metals, that can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, mining, or farming.
- Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
- Organic chemical contaminants, including synthetic and volatile organic chemicals, that are byproducts of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, septic systems and agricultural application.
- Radioactive contaminants, which can be naturally occurring or be the result of oil and gas production and mining activities.

Watershed Health

Water Source Assessment

Source water protection is the primary barrier for providing safe drinking water. A contaminant that does not enter the water source does not need to be removed. An assessment of the district's drinking water source was completed in December 2002. The source is considered most vulnerable to the following activities for which no associated contaminants have been detected in the water supply: historic gas stations, historic mining operations, wastewater treatment systems, forest management activities, recreational use, storm drain and storm water discharges and illegal dumping. You may request a copy of the complete assessment or a summary at the GDPUD office or by contacting the CDPH District Engineer, at (916) 449-5600.

Your Water Supply

Your water originates in the Sierra, flows into Stumpy Meadows Reservoir and is transported through a Gold Rush-era canal system and pipes to the Walton Lake and Auburn Lake Trails water treatment plants.

The Walton Lake plant serves the communities of Georgetown, Garden Valley, Kelsey and Greenwood. The Auburn Lake Trails plant serves Auburn Lake Trails, Cool and Pilot Hill.

Both plants use a multi-barrier process to ensure the quality of your drinking water. Each plant uses liquid bleach to disinfect raw water before it undergoes treatment. The treatment process involves coagulation for the removal of fine particles, filtration using sand and anthracite, disinfection, and reduction of corrosivity through use of sodium carbonate. Treated water is stored in tanks and piped to customers.

GDPUD Consumer Confidence Report

2010 Calendar Year (Reported in 2011)

Primary Drinking Water Standards--Health Related

Parameters/ Constituents	Unit	MCL	PHG or (MCLG)	Your Water: Walton Lake WTP Service Area	Your Water: Auburn Lake Trails WTP Service Area	Meets Standards	Typical Source of Contaminant
Microbiological Primary Drinking Water Standards							
Turbidity	NTU	TT=1 NTU	0.1	0.22 highest (0.06 average)	0.31 highest (0.05 average)	YES	Soil runoff
		TT=95% of samples ≤ 0.3 NTU	n/a	100%	100%		
TURBIDITY NOTE: *Turbidity is a measurement of the cloudiness of the water or the level of suspended matter in the water. We monitor it because it is a good indicator of the effectiveness of our filtration system. High turbidity can hinder the effectiveness of disinfectants. In reporting turbidity, the highest single measurement and the lowest monthly percentage of samples meeting the turbidity limits are specified.*							
Total Coliform Bacteria (Total Coliform Rule) (weekly)		no more than one positive monthly sample	0	0	1	YES	Naturally present in the environment.
Fecal Coliform and E. Coli (Total Coliform Rule) (weekly)		A routine sample and a repeat sample are total coliform positive, and one of these is also fecal coliform or E. Coli positive	0	0	0	YES	Human and animal fecal waste
COLIFORM NOTE: *Coliforms are bacteria that are naturally present in the environment and are used as an indicator that other, potentially-harmful bacteria may be present.*							
Inorganic Chemicals- Source Water Results							
Aluminum	ppm	1.0	0.6	ND	ND	YES	**Note on Inorganic Chemicals**: The state does not require us to report undetected inorganic chemicals. These test results are included as a courtesy for our customers.
Antimony	ppm	6	20	ND	ND	YES	
Arsenic	ppb	10	0.004	ND	ND	YES	
Asbestos	fibers/L	7 MFL	(7 MFL)	ND	ND	YES	
Barium	ppm	1	2	ND	ND	YES	
Beryllium	ppb	4	1	ND	ND	YES	
Cadmium	ppb	5	0.07	ND	ND	YES	
Chromium	ppb	50	(100)	ND	ND	YES	
Copper	ppm	RAL=1.3	0.3	ND	ND	YES	
Cyanide	ppb	150	150	ND	ND	YES	
Fluoride	ppm	2	1	ND	ND	YES	
Lead	ppb	RAL=15	0.2	ND	ND	YES	
Mercury (inorganic)	ppb	2	1.2	ND	ND	YES	
Nickel	ppb	100	12	ND	ND	YES	
Nitrate (as Nitrate, NO^3)	ppm	45	45	ND	ND	YES	
Nitrite (as Nitrogen, N)	ppm	1	1	ND	ND	YES	
Perchlorate (2008)	ppb	6	6	ND	ND	YES	
Selenium	ppb	50	30	ND	ND	YES	
Thallium	ppb	2	0.1	ND	ND	YES	
Natural Radioactivity							
Gross Alpha Activity (2004)	pCi/L	15	0	ND	ND	YES	Erosion of natural deposits
Radium 226 & 228 (2004)	pCi/L	5	0	ND	ND	YES	Erosion of natural deposits
Uranium (2004)	pCi/L	20	0.5	ND	ND	YES	Erosion of natural deposits
Organic Chemicals							
Glyphosate (10/07)	ppm	700	900.0	ND	ND	YES	Runoff from herbicide use
Triclopyr (10/07)		NS	NS	ND	ND	YES	Runoff from herbicide use
Hexazinone (12/01)		NS	NS	ND	ND	YES	Runoff from herbicide use
Disinfection By-products, Disinfectant Residuals, and Disinfection Byproduct Precursors							
TTHMs (Total Trihalomethanes)	ppb	80	NA	25.3 running annual average 29.5 highest LRAA (21.0-32.0 range)	42.25 quarterly average 55.0 highest LRAA (28.0-68.0 range)	YES	By product of drinking water disinfection
Haloacetic Acids	ppb	60	NA	15.3 quarterly average 18.2 highest LRAA (9.6-20.1 range)	24.7 quarterly average 32.2 highest LRAA (16.3-33.8 range)	YES	By product of drinking water disinfection
Chlorine	ppm	MRDL = 4.0	MRDLG=4	0.74 average (0.58 to 0.92 range)	0.74 average (0.58 to 0.92 range)	YES	Drinking water disinfectant added for treatment

Definitions

MCL: Maximum Contaminant Level. The highest level of a contaminant that is allowed in drinking water. Primary MCL's are set as close to the PHG's (or MCLG's) as is economically and technologically feasible. Secondary MCL's are set to protect the odor, taste, and appearance of drinking water.

MCLG: Maximum Contaminant Level Goal. The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLG's are set by the U.S. Environmental Protection Agency.

MRDL: Maximum Residual Detection Limit. The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

MRDLG: Maximum Residual Detection Limit Goal. The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

NTU: Nephelometric Turbidity Units. A measurement of water clarity.

Primary Drinking Water Standard: MCL's for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.

PHG: Public Health Goal; The level of a contaminant in drinking water below which there is no known or expected risk to health. PHG's are set by the California Environmental Protection Agency.

RAL: Regulatory Action Level is the concentration of a contaminant which if exceeded, triggers treatment or other requirements that a system must follow.

ND: Non-Detected

NS: No Standard

NA: Not Applicable

ppm: parts per million

ppb: parts per billion

mg/L: milligrams per liter (1 mg/L = 1 ppm)

pCi/l: pico curies per liter

TOC: Total Organic Carbon

TT: Treatment Technique is a required process intended to reduce the level of a contaminant in drinking water.

LRAA: Locational Running Annual Average

Note to GDPUD Customers: Some samples, though representative, are more than a year old. The state allows us to monitor some constituents less than once per year because the concentration of these constituents does not change frequently.

Este informe contiene información muy importante sobre su agua beber.
Tradúzcalo o hable con alguien que lo entienda bien.

Mailing Address:PO Box 4240, Georgetown, CA 95634-4240/Physical Address: 6425 Main St.
Phone (530) 333-4356 www.gd-pud.org Fax (530) 333-9442

GDPUD Consumer Confidence Report

2010 Calendar Year (Reported in 2011)

Secondary Drinking Water Standards - Aesthetic

Parameters / Constituents	Unit	Secondary MCL	PHG or (MCLG)	Your Water		Meets Standards	Typical Source of Contaminant
				Walton Lake WTP Service Area	Auburn Lake Trails WTP Service Area		
Source water results							
Note: There are no PHG's or MCLG's for constituents with secondary drinking water standards because these are not health-based, but set on the basis of aesthetics.							
Aluminum	ppb	200		ND	ND	YES	Erosion of natural deposits; residual from some surface water treatment processes
Color	units	15 units		ND	ND	YES	Naturally occurring organic materials
Copper	ppm	1.0		ND	ND	YES	Internal corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives
Aggressive Index		NS		8.6 - 8.61 (slightly corrosive)	8.6 - 8.61 (slightly corrosive)	YES	Natural or industrially-influenced balance of hydrogen, carbon and oxygen in the water; affected by temperature and other factors.
Foaming Agents (MBAS)	ppb	500		ND	ND	YES	Municipal & industrial waste discharges
Iron	ppb	300		ND	240	YES	Leaching from natural deposits; industrial wastes
Manganese	ppb	50		12	ND	YES	Leaching from natural deposits
Methyl-tert-butyl ether (MTBE)	ppb	5		ND	ND	YES	Leaking underground storage tanks; discharge from petroleum and chemical factories.
Nitrate as NO_3	ppm	45		ND	ND	YES	Run-off and leaching from fertilizer use; leaching from sewage systems; erosion of natural deposits
Odor-Threshold	units	3		ND	1	YES	Naturally occurring organic materials
Silver	ppb	100		ND	ND	YES	Industrial discharges
Zinc	ppm	5		ND	ND	YES	Run-off/leaching from natural deposits;industrial wastes
Total Dissolved Solids (TDS)	ppm	1000		21	27	YES	Runoff/leaching from natural deposits
Specific Conductance (EC)	micromhos	1600		25	28	YES	Substances that form ions when in water; seawater influence
Chloride	ppm	500		0.70	0.73	YES	Run-off/leaching from natural deposits; seawater influence
Sulfate	ppm	500		0.5	ND	YES	Run-off/leaching from natural deposits' industrial wastes.
Additional Constituents							
Alkalinity as Calcium Carbonate	ppm	NS	NS	12	14	YES	Naturally occurring in water
Calcium	ppm	NS	NS	1.9	2.3	YES	Naturally occurring in water
Magnesium	ppm	NS	NS	ND	ND	YES	Naturally occurring in water
Potassium	ppm	NS	NS	ND	ND	YES	Naturally occurring in water
pH (daily treated water)	units	6.5-8.5	NS	8.15 average (8.07 - 8.14 range)	8.11 average (7.99 - 8.20 range)	YES	Naturally occurring in water
Sodium	ppm	NS	NS	1.4	1.4	YES	Sodium refers to the salt present in the water and is generally naturally occurring.
Total Hardness	ppm	NS	NS	7.6	9	YES	Naturally occurring in water, generally from magnesium and calcium.

How Data is Collected and Reported—The tables presented on these pages list all of the drinking water contaminants that were detected during the 2010 calendar year. The presence of these contaminants does not necessarily indicate that the water poses a health risk. Unless otherwise noted, the data presented in these tables was collected during 2010. The state requires us to monitor for certain contaminants less than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. During 2010, the district conducted monitoring for an additional 78 contaminants, none of which were detected in our water supplies. In addition, the state waived testing for more than 30 additional contaminants that are sometimes tested. Some of the data in this Consumer Confidence Report, though representative of water quality, is more than one year old.

PUBLIC NOTICE TO DISTRICT CUSTOMERS

OLDER WATER TREATMENT PROCESS DOES NOT MEET NEW STATE STANDARDS

Dear Customer,

The Georgetown Divide Public Utility District takes great pride in the high quality of the water we supply to our customers. In our many years of service, our water has always met or exceeded state and federal public health standards.

Even though our water continues to meet all of these standards, one of the methods in our water treatment process has become outdated under today's state standards. This is not surprising in a smaller, rural community where water treatment plants are older (the Auburn Lake Trails plant was built in 1971). It is financially challenging for a district with a small customer base to pay for millions of dollars in water system improvements.

Seven years ago, on February 9, 2004, the California Department of Public Health, Office of Drinking Water issued an administrative order (No. 01-09-04CO-002) that instructs the district to comply with state regulations regarding the filtration of drinking water. Printed here is the state's public notification message:

NOTIFICATION OF FAILURE TO COMPLY WITH DRINKING WATER TREATMENT STANDARDS

"The Georgetown Divide Public Utility District is providing this notice at the direction of the State of California Department of Public Health, Division of Drinking Water and Environmental Management (Department) to bring to your attention certain matters regarding the treatment of your drinking water supply.

The Department establishes standards for the quality of drinking water, including regulations for the quality of water supplies drawn from lakes and streams (i.e., surface water). If such water is inadequately treated, microbiological contaminants in the water may cause disease. Disease-causing organisms, if present, can cause symptoms including diarrhea, cramps, nausea, and possibly jaundice, and any associated headaches and fatigue. (These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water.)

Since it is infeasible to analyze treated water for all disease-causing organisms that may be present, the Department has established enforceable requirements (Surface Water Treatment Regulations) for treating surface water to reduce the risk of these adverse health effects. The regulations include specific criteria for filtering and disinfecting surface water to remove or destroy microbiological contaminants. Drinking water that is treated to meet these criteria is considered to be safe.

The District's Auburn Lake Trails Water Treatment Plant uses a filtration technology that is not among those listed in the Surface Water Treatment Regulations. Because the District has not demonstrated to the Department that its treatment plants provide a degree of treatment equivalent to the listed technologies, the plants are not considered to be in compliance with the Department's regulations. The District is currently working toward bringing its water treatment plants into compliance with the regulations or constructing new facilities that will comply with the regulations.

It is estimated that all improvements to the system will be made in 2013. The District will keep you informed on a regular basis of progress made to resolve this issue. If you have any questions regarding this notification, or our service, please call Becky Siren at GDPUD at (530) 333-4356."

District Summary

The district's water treatment plants were considered to be state of the art when they were built, but the "in-line filtration" technology does not meet current standards. Your Board of Directors wants to provide the best possible service to customers but is also very concerned about costs and resulting impacts on water rates.

The district is making significant progress in bringing its water treatment facilities into compliance with current regulations. A new filtration system was added in June 2005 at the Walton Lake Water Treatment Plant, which brings it into compliance with state standards.

The District is currently in the design phase for retrofitting the existing Auburn Lake Trails Water Treatment Plant to meet the state and federal surface water treatment standards and expects completion of the project in 2013.

In the meantime, you may consider your water safe to drink.

Water Bill Payment Options

Bi-monthly water bills are mailed in odd months (January, March, May, July, September and November), and cover service for the previous two months. Bills are due and payable the last day of the above-listed months. *(Ex: The bill you receive in early January covers service from November 1 – December 31 and is due upon receipt. The bill will be delinquent if not paid by January 31.)*

Those customers who would rather budget on a monthly basis can submit a payment of about half of a typical bill each month.

Be sure to include your customer number with your water payment or other correspondence, and mail to: PO Box 4240, Georgetown, CA 95634-4240.

Customers wishing to drop off payments after normal business hours may use the payment drop box located at the main office entry.

In an effort to reduce the financial burden on those customers whose bills remain unpaid for more than 30 days, the Board reduced the account delinquency fees from $25 to $12 per occurrence and the finance charges from 10 percent monthly to 1 percent bimonthly after the first 30 days. All other fees such as returned check charges, reconnection fees and payment collection fees remain the same. The new fees take effect August 2011. For a fee schedule, please visit our website at www.gd-pud.org under the publications drop-down menu.

Visit our website!

Please visit our website at www.gd-pud.org to download agendas, minutes, ordinances, publications and other important information.

Water Conservation Tips

Conserving water doesn't mean you should sacrifice your vegetable garden. By making small changes every day, you can reduce your water consumption sometimes by hundreds of gallons a month.

- Take shorter showers. A 5-minute shower uses 4-5 gallons versus 50 gallons for a bath.
- Shut off the water while brushing your teeth or shaving to save up to 500 gallons per month.
- Change your showerhead to a water-efficient one and use 750 gallons less water each month.
- Compost food and vegetables instead of using water to flush it down the garbage disposal.
- Run your dishwasher with full loads only. And if your clothes washer has a water level selector, be sure to check it before each wash to avoid overfilling with water.
- Keep a water pitcher in the refrigerator instead of running the faucet to get cold water.

GDPUD required to reduce water consumption by 20% by 2020

Even though GDPUD is considered a rural water agency, because we have more than 3,000 connections, we must comply with the state's mandate to prepare an Urban Water Management Plan (UWMP). Recently, the state added a new requirement for reducing water consumption by 20% by 2020 and asked water purveyors to update their Plans to reflect these conservation measures.

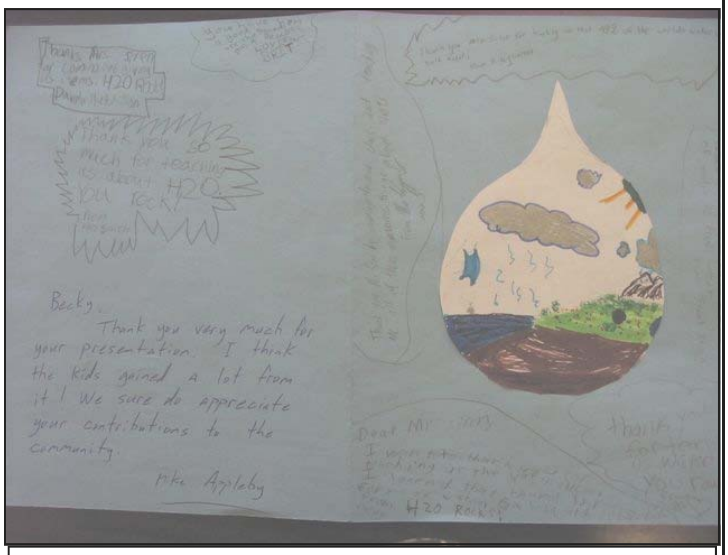
Thankfully, the Board anticipated the water reduction mandates several years ago and put several measures into place already, such as:

- Appointing a water conservation coordinator (Becky Siren) to help the District's customers implement conservation measures;
- Monitoring unaccounted water every billing cycle and identifying remedies;
- Offering water conservation kits to customers (call 333-4356 for your free kit!);
- Providing water education and conservation information to schools to reach our youngest customers (see photo below); and
- Passing an ordinance with a tiered rate structure (the more you conserve, the more you save!)

Many of our customers are conservation-minded and have implemented many water saving ideas. But we need everyone to practice water conservation to meet the requirements set by state law.

See information on this page for ways you can reduce water use, or check out other water conservation websites, such as www.h2ouse.com or www.wateruseitwisely.com.

(*Go online to www.gd-pud.org to download a copy of our Urban Water Management Plan.*)



Children from Georgetown School sent this note to Becky Siren to thank her for a presentation she gave regarding water conservation.

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
PO BOX 4240, GEORGETOWN, CA 95634-4240
OFFICE HOURS: M—F 7:45 AM—4:30 PM

PRSRT STD
U.S. POSTAGE
PAID
Permit #187
Placerville, CA 95667

Your GDPUD Board Members

The Board meets regularly on the second Tuesday of each month, at 9:00 am at the District offices, located at 6425 Main Street in Georgetown.

Your board members are:

- Norm Krizl, President
- Bonnie McLane, Vice President
- Bonnie Neeley, Treasurer
- Ray Griffiths, Director
- Kathy Otermat, Director

GDPUD Crews Maintain Water Quality and Reliability

Top Left: Crews repair 300 feet of pipe in an area that is geologically unstable. They shotcrete the head wall to prevent water seeping into the piped section.

Top Right: Come rain or...snow. GDPUD staffer Jack Bohn drives the Snow Cat up to Stumpy Meadows to check on the facilities. Staff member Kyle Madison is in the background.

Bottom Left: Crews make a repair band to fix a raw water pipe near ALT Water Treatment Plant. Jacob Walsh (L), Chris Barbour (R back) and Matt Sampson (R front) are the crew members.

Bottom right: Crew members Marty Ceirante (L) and Jason Smith complete a fix to a service line leak in Garden Valley, leaving a restored roadway

Visit our website at www.gd-pud.org to download agendas, minutes and other information.

Appendix G - Examples of Public Education Documentation

- California Water Facts
- Landscape Design
- Outdoor Water Conservation Checklist
- Ways to Save Water

CALIFORNIA

Water Facts

Compliments of:
Georgetown Divide PUD
P.O. Box 4240/6425 Main St.
Georgetown, CA 95634
(530) 333-4356

California Water Facts

This booklet was developed to help you identify your source of water, realize the importance of water in a semi-arid state and understand the competition for our most precious resource.

Much of California's water is stored as snow in the Sierra Nevada mountains.

When a person turns on the faucet, he or she may be tapping a water source close to home or one hundreds of miles away because of the complex web of water rights and delivery established long ago.

Where a community's water comes from depends largely on the foresight of its founders and the historic use of local lands and water. Some cities claimed water rights early to assure an adequate supply into the future.

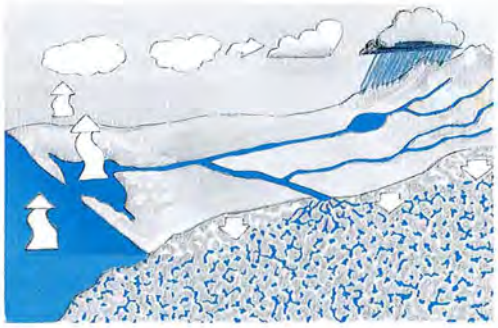
Other communities with plentiful surface water close to home failed to establish rights to those sources, and as a result, today do not have enough local water for their needs. Consequently, these communities must import water, sometimes over great distances, from state, federal or local water projects.

The mission of the Water Education Foundation, an impartial nonprofit organization, is to create a better understanding of water issues and help resolve water resource problems through educational programs.

Brochure produced with a grant from the U.S. Bureau of Reclamation, Mid-Pacific Region.
Cover texture photo courtesy of Roland Mills, Oasis Studios, Grass Valley, CA.
Brochure designed by Blue Cat Studio, Colfax, CA. revised June 2002

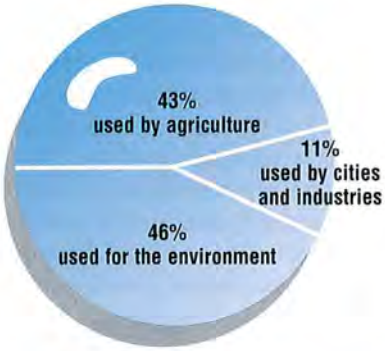
Rain and Snow

California receives about 193 million acre-feet of water each year as precipitation (rain and snow), but there is great variability between regions. Yearly precipitation on the North Coast is about 90 inches but only 2 inches in Death Valley.

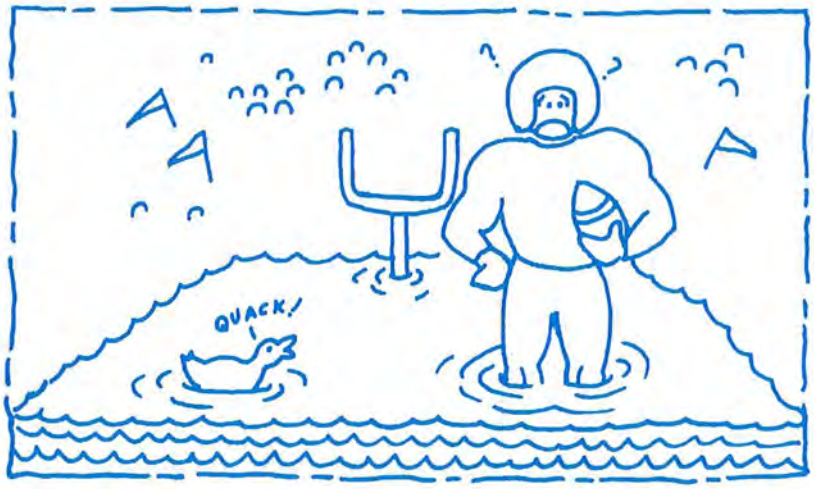


Precipitation can fall to the earth as rain, snow, sleet, hail or dew.

Much of this precipitation evaporates, leaving California with 78 million acre-feet in surface water supply (including Colorado River and Klamath River supplies). Of that water:



An acre-foot equals about 326,000 gallons, or enough water to cover an acre of land about the size of a football field, one foot deep. An average California household uses between one-half and one acre-foot of water per year for indoor and outdoor use.



Water Use

Surface Water

The water that runs into rivers, lakes and manmade reservoirs is called "surface water." Homes, farms and the environment use about 65.4 million acre-feet of surface water a year.

Irrigating an orchard (with groundwater).

Groundwater

We use about 12.5 million acre-feet of groundwater in an average year (about 30 percent of total statewide water use). In drought years, however, groundwater use increases to about 40 percent of total use. At present, California is overdrafting its groundwater supplies (extracting more water than is returned) by about 1.5 million acre-feet a year.

History

California's mild climate and abundant natural resources attracted early settlers, but water was the catalyst that allowed the semi-arid state to grow and prosper. Putting it to use required capturing the water and moving it from areas north of Sacramento, where nearly 75 percent of the state's rainfall occurs, to central and southern California, where 80 percent of the agricultural and urban use exists.

Large water development, storage and distribution projects transported the water, changing arid land to farmland and giving life to new cities and towns. Without these projects, much of the state would be different from what we see today.

Groundwater fills the pores (spaces) between rocks and other materials found beneath the earth's surface.

These projects, built from the 1930s to 1970s, helped make California the nation's leading producer of food and fiber, a major manufacturing center, the most populous state, and the eighth largest economy in the world.

Water Delivery

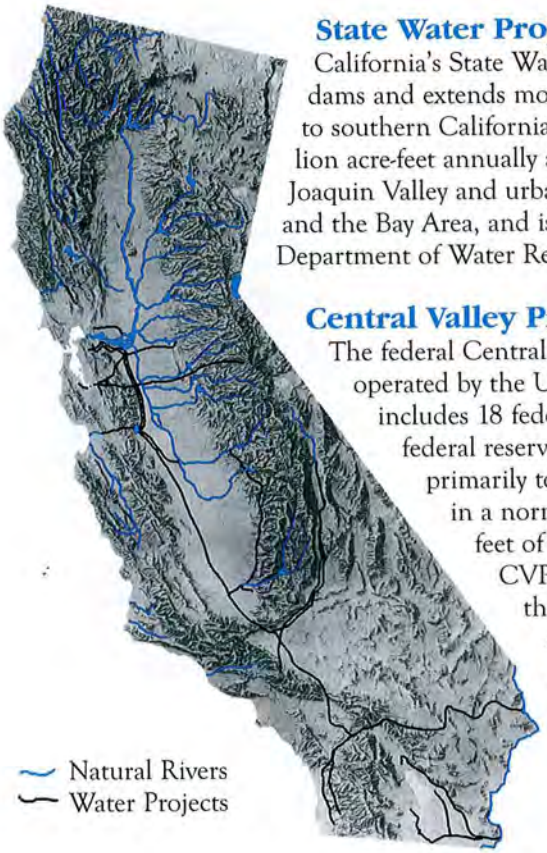
Water is free in California, but customers must pay for the cost of treating, pumping and transporting water and/or for building the dams, reservoirs and aqueducts needed to store and deliver the water.

There are over 1,000 local, state and federally owned and operated reservoirs in California. About 70 percent of California's annual water supply for urban and agricultural use is met by locally owned and operated dams, storage reservoirs and aqueducts. Examples are the Hetch Hetchy Reservoir in Yosemite National Park, which serves the city of San Francisco, and the Colorado River Aqueduct built by the Metropolitan Water District of Southern California, which brings Colorado River water to southern California.

There also are two major water projects, the State Water Project (SWP) and the federal Central Valley Project (CVP), that carry water from northern California to central and southern California users.

The Los Angeles Aqueduct, carrying water from the Owens Valley, helped the city grow from a population of 214,000 in 1905 to 3.8 million today.

The Water Projects



State Water Project

California's State Water Project (SWP) consists of 20 dams and extends more than 600 miles from northern to southern California. The SWP delivers about 3 million acre-feet annually and serves farmers in the San Joaquin Valley and urban users in southern California and the Bay Area, and is operated by the California Department of Water Resources.

Central Valley Project

The federal Central Valley Project (CVP), which is operated by the U.S. Bureau of Reclamation, includes 18 federal reservoirs and four state-federal reservoirs. The CVP was built primarily to irrigate the Central Valley, and in a normal year delivers 7 million acre-feet of water. About 90 percent of the CVP's water is used to irrigate more than 3 million acres of farmland – and the project also provides water to about 2 million urban consumers.

Major elements of California's water delivery system which transport water from areas of precipitation to areas of need.

A primary feature of the SWP is the 444-mile long California Aqueduct which transports water from the Sacramento-San Joaquin Delta south to the Los Angeles area. About 30 percent of SWP water is used by agriculture. About 20 million Californians – or two-thirds of the state – get part of their water from the SWP.

Environmental Protection

In the decades since construction of the state's major water projects, societal values have shifted in favor of environmental protection and enhancement. Beginning in the 1970s, elected officials recognized these values through passage of state and federal laws designed to protect the environment. These laws include the Endangered Species Act (ESA), Clean Water Act and legislation that protects many rivers as "wild and scenic." These laws have made it more difficult to develop traditional water projects.

Wetlands filter pollutants from water, store flood waters, recharge groundwater aquifers, and support migratory waterfowl.

While there remains broad general support for such environmental regulations, the restrictions they impose have sparked more criticism in recent years. The ESA, in particular, has required major changes in water project operations as officials try to protect several endangered species, including the winter-run chinook salmon.

Because more water is being used for environmental purposes, there often is less for traditional farming and municipal uses. This has heightened the competition for this precious resource.

A legal battle over Mono Lake, located in eastern Sierra Nevada, established that the public trust doctrine applies to water rights. The doctrine holds that natural resources are the property of all, and in 1994, Los Angeles was ordered to restrict its water diversions until the lake's level rises.

Alternative Water Sources

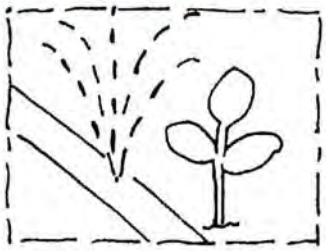
Officials estimate that by 2020, California's current population of 32 million will reach 47.5 million, and as the state grows, so will the demand for water. Officials are pursuing several options to stretch water supplies to meet demand. One way of stretching water supplies is through water conservation (see page 10).

Southern California leads the state in treating wastewater and reusing it to water golf courses, parks and landscapes or refill depleted groundwater basins.

Water recycling—the treatment and reuse of municipal wastewater—to irrigate fields, water golf courses and recharge groundwater aquifers is seen as a key way to "create" more water. By 2020, state officials say that water recycling programs could provide an additional 1 million acre-feet of water annually.

Converting salt water into fresh water—sea water desalination—was once commonly viewed as too expensive a source of drinking water. During the 1987-1992 drought, three coastal communities developed desalination plants to offset severe water shortages. New technology could lead to more desalination plants in the future.

Agriculture has increased use of drip irrigation and other methods to conserve water.



Water marketing or transfers—exchanging, leasing or selling water from one user to another—is slowly gaining support in California. Many concerns about third-party economic impacts, instream environmental water needs and legal constraints remain.

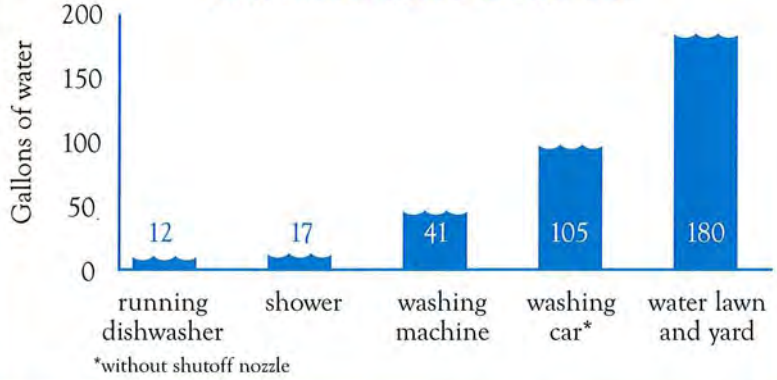
Water Trivia

The earth's water supply

Salt Water	97.2%
Fresh Water	2.8%
Groundwater	0.6%
Lakes and Streams	0.01%
Glaciers and Icecaps	2.2%
Water Vapor	0.001%

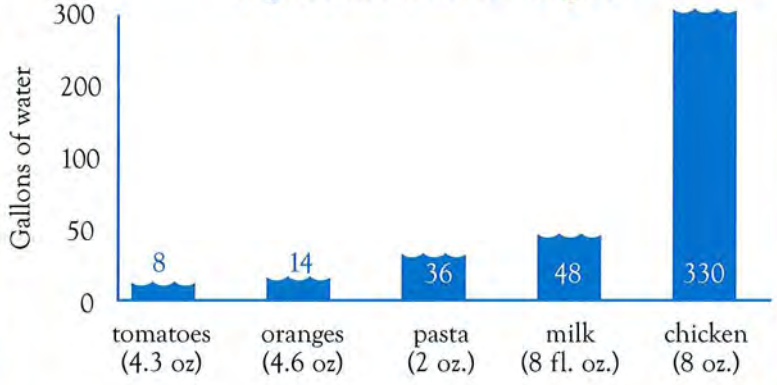
Amount of water contaminated by 1 quart of oil = 250,000 gallons

How much water do we use?



*without shutoff nozzle

How much water does it take to produce one serving of

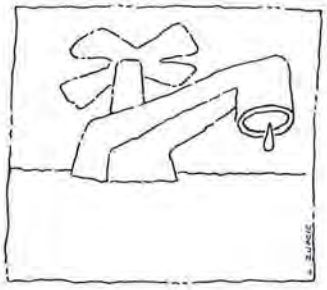


Saving Water At Home

With watering the yard, filling the swimming pool or hot tub and washing the car, outdoor water needs consume about half the water used in a typical single-family home. Xeriscape – landscaping with plants that use less water – has become a popular way for people to cut outdoor water use by as much as 50 percent.

Another approach is the use of landscape "water allowances." Customers have a set amount of water to use and can plant whatever they want—water rate charges encourage the use of water-efficient irrigation systems.

While half of residential water is used outdoors, big savings also can be made indoors – especially in the bathroom. A national study shows that the toilet accounts for 26.7 percent of the average household's indoor water use. A traditional toilet can be the biggest water-using fixture in the house, consuming about 3.6 gallons per flush. Ultra-low-flush toilets use about 1.5 gallons per flush. After the toilet, the biggest bathroom guzzler is the shower or bathtub. An eight-minute shower with a 2.2 gallon-per-minute showerhead can use 17 gallons of water. A bath, on the other hand, uses 24 gallons.

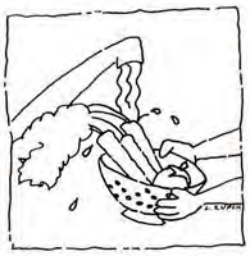


In the kitchen, a typical dishwasher uses between 8 and 15 gallons of water. New, water-efficient styles can use as little as 6 gallons per load. In the laundry room, a typical clothes washer uses 41 gallons per load. High-efficiency clothes washers reduce the average volume per load by 40 percent.

Per capita residential water use in California varies considerably, from about 290 gallons a day for Central Valley cities to about 150 gallons per day for some Central Coast communities.

Water Conservation Tips

Wash the car only with a bucket and hose equipped with a shutoff nozzle or at a commercial car wash that uses recycled water.



Do not leave the water running while brushing teeth, shaving, washing dishes, defrosting food or cleaning produce.

Do not over-water the lawn or allow water to run into the street.

Install an ultra-low flush toilet or toilet tank displacement bag.

Detect leaks and repair them within 48 hours.

Do not hose down sidewalks or driveways.

Wash only full loads of laundry and dishes.

Do not use the toilet to flush trash.

Only water outdoors in the early morning or evening.

Install a water-saving showerhead.

WATER EDUCATION FOUNDATION
717 K Street, Suite 317
Sacramento, CA 95814
Phone (916) 444-6240
Fax (916) 448-7699
Internet: www.watereducation.org

Item	Qty.	$ Amount
California Water Map, $10 ea.	____	_____
Water Awareness Guide, $3 ea.	____	_____
Layperson's Guide to California Water, $7 ea.	____	_____
Subscription to *Western Water*, $35/yr.	____	_____
Catalog	____	no charge
Subtotal		_____
Add 7.75% sales tax		_____
Shipping & handling		_____

Orders from $0-$10=$3.50; $10.01-$50=$6.50; $51.01-$100=$9.50; $100.01-$250=$12.50; $5250.01-$600=$25; over $600=call for charge

Total enclosed _____

Name _____

Company _____

Street Address _____

City/State/Zip _____

Credit card number for Visa, Mastercard or AmEx orders

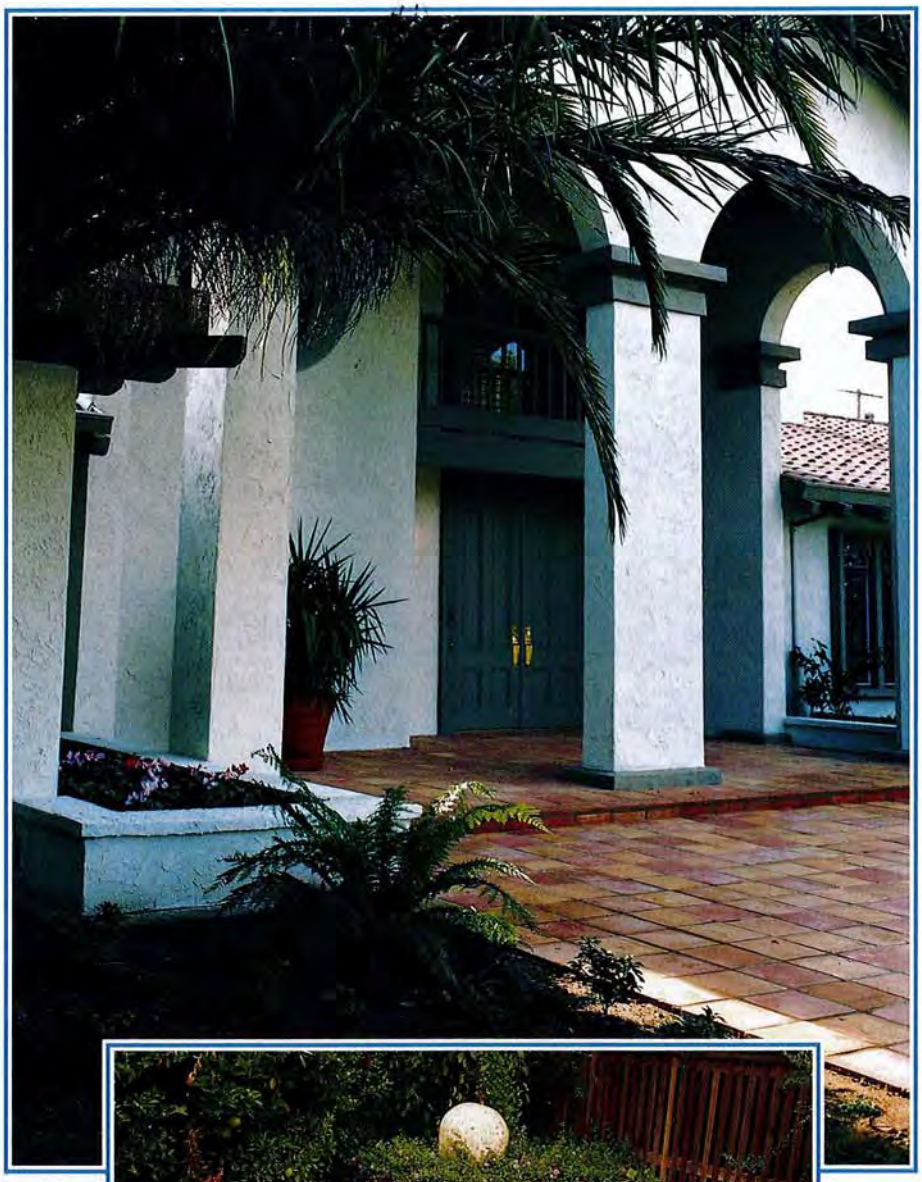
_____ exp. date _____

Signature _____

(Must be signed to process credit card order)

Return to the Water Education Foundation

LANDSCAPE DESIGN II



RE-DO YOUR LANDSCAPE
THE EASY AND EFFICIENT WAY

BEGINNING CONSIDERATIONS

WHY RE-DO YOUR LANDSCAPE?

Lifestyles are rapidly changing in our society, and landscapes are changing as well. Families are not interested in spending a great deal of time on the upkeep of their yards. On the other hand, they want green outdoor spaces for resting places, entertaining and family activities.

Whether you're doing it yourself or having it done, renovating your landscape can extend your living space, add new usage areas to your yard, help cut down on the time you spend on maintenance, and drastically reduce water use.

Almost half of the water used in a single-family home goes on the landscape. Low water-using landscapes can reduce landscape watering by half, often quite a savings on the monthly water bill.

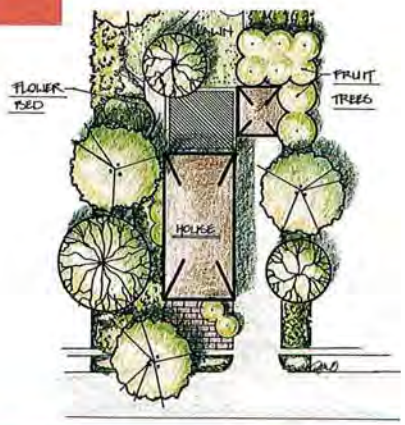
BEFORE YOU DIG IN

PLAN IT

You'll need to start with a master plan based upon your site and your requirements for your yard. Visits to botanical and demonstration gardens that emphasize water-efficient plants, irrigation systems and design can give you ideas to start out with.

First assess your site. Look at soil conditions, drainage, wind, sun, slopes and water-use areas. Next, assess your needs — what uses you will make of your outdoor space. Ask yourself these questions:

- What do you like most and least about your current landscape?
- How do you and your other family members plan to use the landscape and its new spaces? Relaxation? Outdoor cooking? Entertaining? Gardening? Swimming? Sports? Etc.?
- If you have children, what specific uses will they be growing into or out of?
- What about pets? Do you want them shut out or let into specific areas?
- Is there some particular landscape style (i.e., formal, Japanese, natural, etc.) you want to use? Is that style in keeping with the structure of your home?
- Is anyone in your family allergic to any plants or to bees?
- Does your site require any additional screening to ensure privacy?
- How much money have you budgeted for improvements?



SKETCH IT

Now use graph paper to draw up a model showing property boundary lines, house, fences, existing trees and shrubs and walkways. Also show the sun, soil, drainage and wind zones from your assessment. Most importantly, divide your existing landscape into low, moderate, and high water-use zones according to the following guidelines. (Your goal is to reduce the size of your high water-use areas while increasing the size of moderate to low water-use areas.)

- The highest water-use area of your yard is, in most cases, your lawn. Think about ways to reduce the size of your lawn by replacing it with areas of hardscape and less-thirsty groundcover, shrubs and trees. On your renovated landscape, your lawn can then be an oasis of green designed in the shape of a rounded, pool-like focal point, rather than a boring expanse.

- Moderate water-use areas include plants like groundcovers, annuals, vegetable gardens, and water-conserving plants with mulch. Such areas should be timer-watered or watered manually, as needed, using sprinkle or drip irrigation.

- Low water-use areas include *established* water-conserving trees and shrubs with mulch, and can be drip irrigated very infrequently once they are established.

- No water-use areas include hardscapes and some established native plants.

Once you have your "base map" completed, trace it and then draw in the new features you want your landscape to have (or have a professional do this). As you choose each element for your yard or patio, consider how it fits in with your total plan. Once you've got your plan, you can prioritize, in terms of your budget, how to go about completing the project. (This brochure includes a sample design which was completed in a three-year process.)

HOW TO RE-DO YOUR LANDSCAPE IN STAGES

CLEAR IT

Remove any unwanted structures and/or plants.

BUILD IT

A good overall plan for your project should include an irrigation system that can accommodate your landscape as it is now as well as the design of your renovated landscape. Install it using these guidelines:

- Use separate irrigation valves and timing schedules for areas of low, moderate, and high water use.
- Your high water-use lawn will be most water efficient if your sprinklers are on automatic timers.
- Moderate and low water-use areas should be irrigated using drip, ooze, or bubbler systems. (Your local do-it-yourself store, hardware store, or nursery should have brochures outlining how to install these.)
- Experts point out that *all* irrigation is more efficient on some type of automated timer — as long as you reset your timer as the seasons, and your yard's water requirements, change.
- Proper forethought will help you avoid having to figure out how to install a watering system *around* any new hardscapes you might add. (You can put PVC sleeves *under* them if you plan ahead.)

Next add in the hardscape areas that will help you reduce the size of your lawn. Use hardscapes like decking and walkways in conjunction with larger areas of low water-use plants. Hardscape materials include wood, flagstone, river stone, pavers and concrete.

PLANT IT

Planting just before or during the rainy season is best because it reduces transplant shock and allows the plants' roots to establish at greater depths so that summer drought is not as damaging. Remember that even non-thirsty plants require water until they are established.

It's important to group plants with similar watering, sun, and soil pH needs together. If you disperse low water-using plants with plants requiring more water, you may end up over-watering the less thirsty plants. If in doubt, ask a professional which plants "go together" in the different areas of your landscape.

When choosing plants, think in terms of their ultimate size. If you are concerned about the barren look of your landscape before it "grows in," and want more of an instant effect, consider planting fast-growing temporary plants with the permanent ones. As the permanent ones fill out, you can then remove the temporary ones.

Mulch, material added on top of the soil, buffers the soil from extreme temperatures, traps moisture and keeps water-robbing weeds down. Mulching materials include wood chips, fir bark, and fine gravel. To be efficient, mulch should be applied to a depth of two to six inches.

MAINTAIN IT

Water according to your plants' needs and adjust irrigation timers to match weather patterns. Contact your local water utility, county cooperative extension office, or nursery for tips on watering schedules in your particular area.

NEED HELP?

Many of the projects undertaken in a landscape renovation are well within the abilities of do-it-yourselfers. A little elbow grease and commitment can help you save on the costs of labor and leave more money for plants. But doing it yourself has disadvantages, too. A project that might take a few weeks in the hands of a landscape contractor can stretch into months or years if you only have weekends to devote to it. Remember, too, that certain design elements, like decking and irrigation systems, may require building permits. If the idea of doing it *all* yourself seems a little overwhelming, consider, at the very least, having designs drawn for you by a professional. You might also opt for finding a professional who will allow you to do some of the labor yourself. Also, many pros will do "consultation" visits, offering information to get you started.

HOW TO FIND A REPUTABLE PRO

If you do opt for working with a professional, you'll need to know how to select one.

There are two types of licensed professionals with whom you might want to deal on your renovation project: landscape architects, who usually design large outdoor spaces; and landscape contractors, who build landscapes. Landscape designers may have as much formal training as the licensed professionals, but have not obtained licensing as architects or contractors.

The California Landscape Contractors Association has several brochures on finding and hiring a qualified person to install your landscape. They will also send you a list of licensed contractors in your area and their specialties. You can then call for pricing information.

The California Council of Landscape Architects provides similar information.

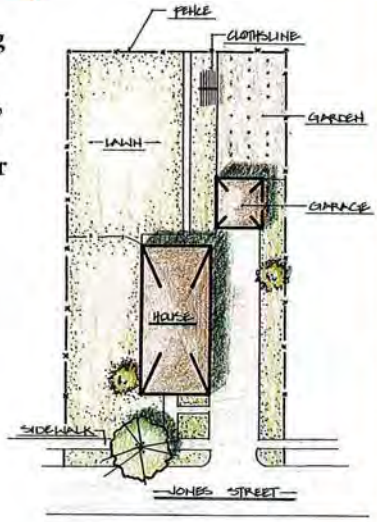
A local nurseryman can help with how-to advice, tell you which water-conserving plants will work in *your* area, and provide you with equipment, materials and plants. The California Association of Nurserymen has a certification program and can tell you which local nursery has certificated people available. (See the *RESOURCES* section of this brochure for the addresses of CLCA, CCLA, and CAN.)

A 3-YEAR PLAN

BEGIN...

By analyzing existing landscape with an eye toward function, aesthetics, and how to cut back on water usage.

Develop a plan designating the finished elements, hardscapes and plantings.



YEAR 1

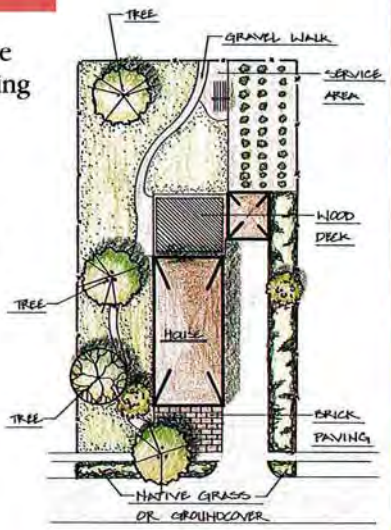
Install all hardscape and renovate existing irrigation.

Then add:

- Shade Trees
- Groundcover

Reduce:

- Lawn Areas



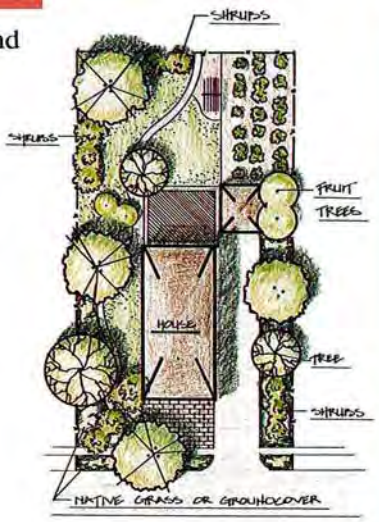
YEAR 2

Adjust irrigation, and add:

- More Shade Trees
- Shrubs
- Groundcover

Reduce:

- Lawn Areas



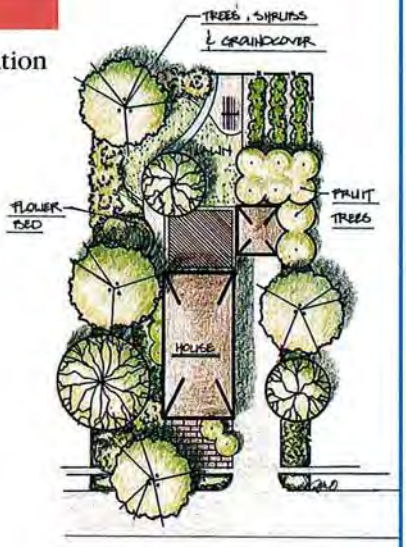
YEAR 3

Finely adjust irrigation and add more:

- Shade Trees
- Shrubs
- Groundcover

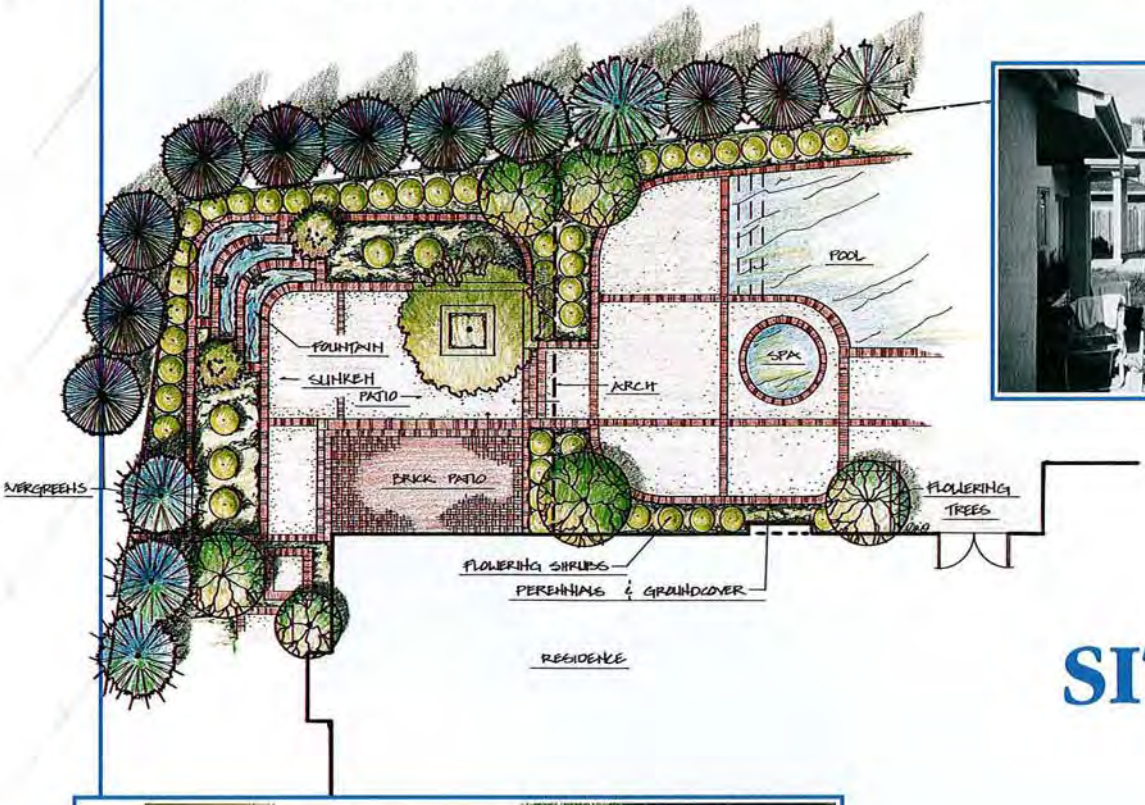
Further Reduce:

- Lawn Areas



FROM PUBLIC PATCH TO PRIVATE PARADISE

This long, narrow back yard had myriad problems: no privacy on the side yard, a view of a neighbor's house and an electric utility power station and major drainage problems. Renovated with no use of grass whatsoever, the yard is green, lush and colorful year-round. The fountain recirculates water and all irrigation is drip. The fence and extensive use of brick lend a French country feeling to the low-maintenance, functional yard.



BEFORE

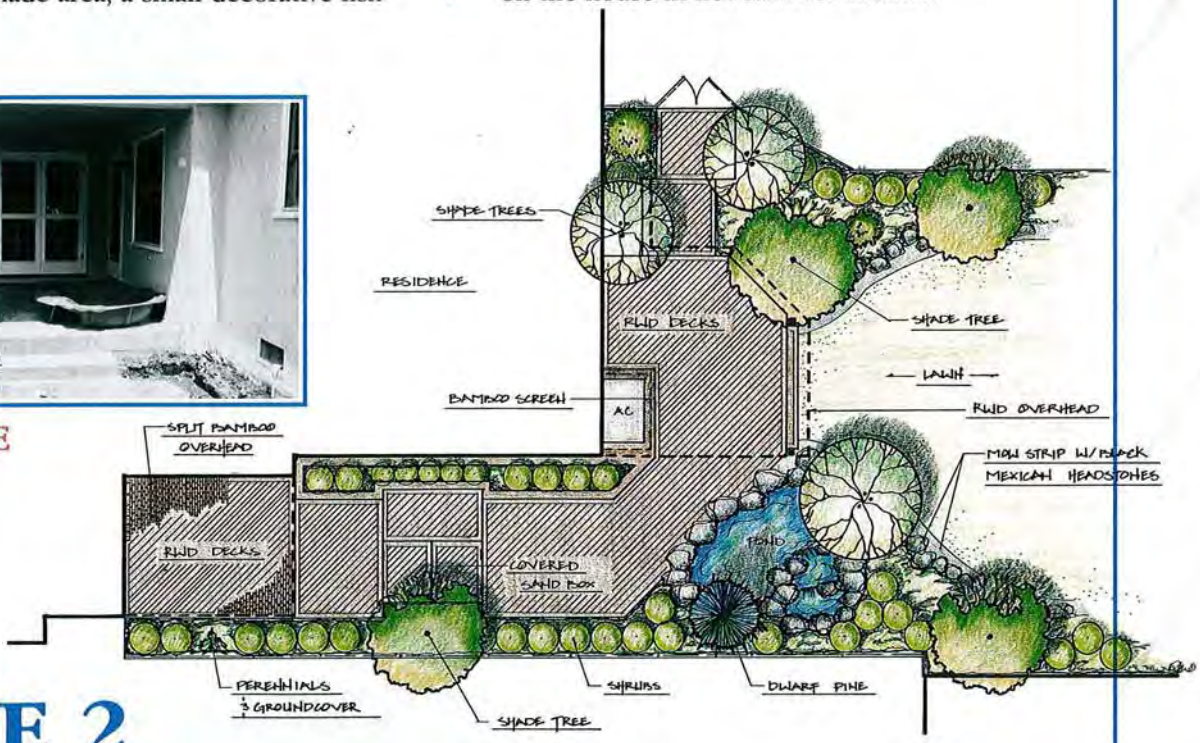
SITE 3

AFTER

FROM BORING 'BURB TO FUNLAND

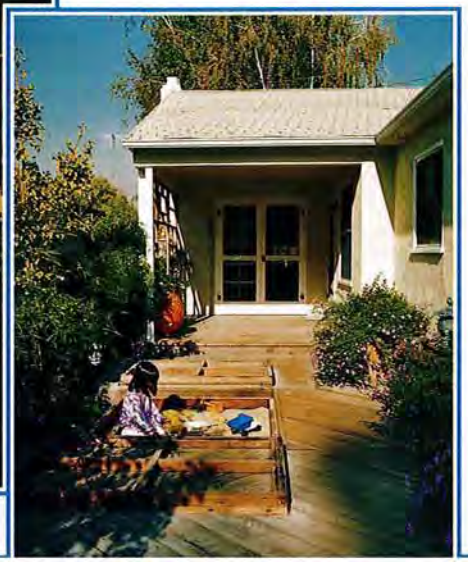
This existing back yard was all water-thirsty lawn with a small concrete pad. The space was re-designed with an oriental flavor and defined to provide for the many activities of an active young family. The addition of a large entertainment area, a shade area, a small decorative fish pond in which the children can wade, and a sand box that closes up to become part of the deck all serve to lower the yard's water requirements. An added bonus — the trellis overhead to the south reduces the heat load on the house in hot summer months.

BEFORE



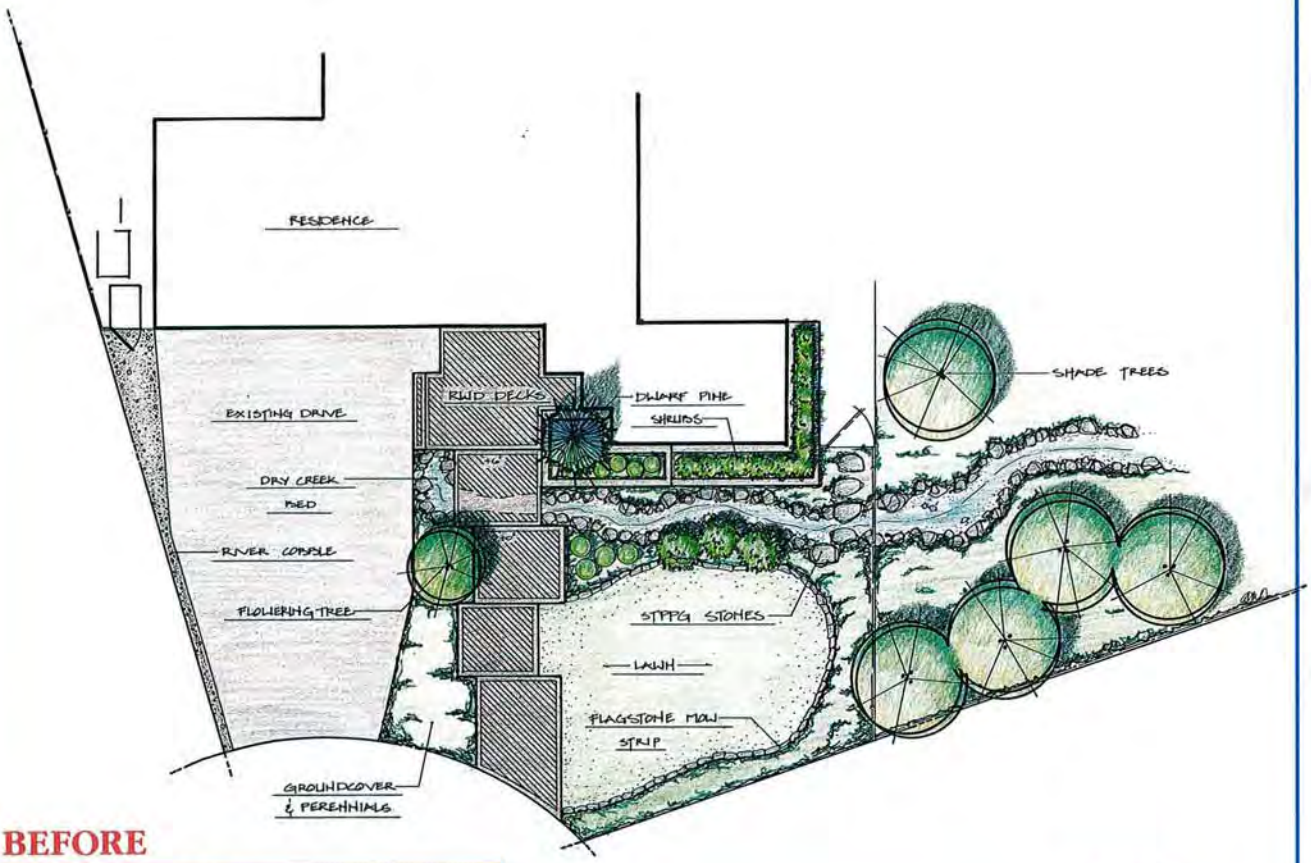
SITE 2

AFTER



FROM DULL AND DREARY TO VIVID VITAL

The goals of this renovation were to reduce the lawn area, solve a drainage problem and add color and interest. The renovation includes a much more extensive entry walkway with lighting and large redwood pads. A functional dry creekbed further reduces lawn area while non-thirsty perennial and groundcover plantings add color and interest. The use of plants native to the area and the overall design of the renovation combine to give a natural feeling to this water-efficient front landscape.



BEFORE

AFTER

SITE 1

WATER-SAVING PLANTS

THESE COMMON PLANTS NEED VERY LITTLE WATER AND CAN BE GROWN ALMOST ANYWHERE IN CALIFORNIA. This is just a sampling of plants: there are many others that will thrive in your local area.

GROUND COVERS

Yarrow
Manzanita
Snow in Summer
Chamomile
Indian Strawberry
Fleabane
Sulfur Flower
Coral Bells
Spreading Juniper
Evening Primrose
Lavender Cotton
Santolina
Thyme

PERENNIALS, ANNUALS, BULBS

Allium
Alyssum
Windflower
Thrift (Sea Pink)
Cosmos
Foxglove
Blanket Flower
Daylily
Iris
Lily
Daffodil
California Poppy
Rose Moss
Lamb's Ear

SHRUBS

Manzanita
Strawberry Tree
Sandhill Sage
Dusty Miller
Ceanothus
Rock Rose
Sunrose
Juniper
Mountain Mahogany
Smoke Tree
Oregon Grape
Toyon-Christmas Berry
Coffeeberry

TREES

Maidenhair Tree
Golden Rain Tree
Crape Myrtle
Holly Oak
Locust
Hackberry
Japanese Pagoda Tree
Chinese Flame Tree
Chinese Pistache
Western Redbud
Incense Cedar

GRASSES

Tall Fescues
Hybrid Bermudas
Saint Augustine
Zoysia

RESOURCES

- Your local cooperative extension office can offer answers to your specific gardening questions. Look under "County" in your telephone book white pages for their number.
- The California Landscape Contractors Association can help you find a licensed contractor in your area to help install your landscape. CLCA is located at:

  CLCA **Phone (916) 448-2522**
  2021 N St., Ste. 300
  Sacramento CA 95814

- The California Association of Nurserymen will help you find certified, knowledgeable people in your area who can help you choose plants, supplies and equipment.

  CAN **Phone (916) 928-3900**
  3947 Lennane Dr., Ste. 150
  Sacramento, CA 95834

- The UCD Cooperative Extension "Agricultural Publications Catalogue" lists many helpful publications on such topics as pruning, soils, fertilization, and irrigation. Many are free or can be purchased for a nominal amount. Order from:

  ANR Publications **Phone (510) 642-2431**
  University of California
  6701 San Pablo Ave.
  Oakland, CA 94608-1239

- *Sunset Magazine* has a packet of information about water efficient landscapes. Write:

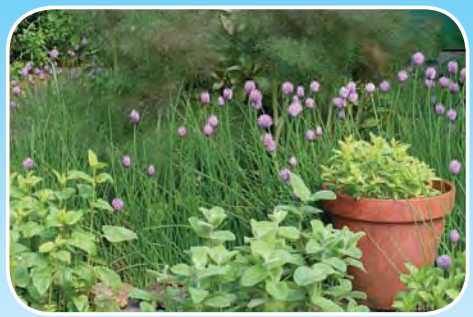
  Sunset Magazine
  80 Willow Road
  Menlo Park, CA 94025-3691

- Your local water agency or district should be able to provide you with information about plants and watering specific to your area.

For more copies and other information on water issues contact the Water Education Foundation.

WATER EDUCATION
717 K Street, Suite 517
Sacramento, CA 95814
(916) 444-6240
Internet: www.water-ed.org

Compliments of:
Georgetown Divide
Public Utility District
6425 Main Street
333-4356



Outdoor Water Conservation Checklist

FREE AND EASY IDEAS

- Water your lawn only when needed, 2-3 days a week at most. If you step on your lawn and the grass springs back, it does not need to be watered.
- Water early in the morning when temperatures and winds are at their lowest levels to reduce evaporation.
- Turn off your sprinklers when it rains. Rain sensors and shutoff switches are inexpensive and can be retrofitted to almost any system.
- See the indoor water conservation checklist for ways to capture otherwise wasted water to use for watering potted plants.
- Don't water the gutter. Runoff is wasteful and can carry pollutants to creeks.
- Check your irrigation monthly for:
  - ✓ Spray heads blocked by plant growth or clogged with debris
  - ✓ Poorly aimed nozzles/misaligned and tilted heads/incorrect arc (adjust at head)
  - ✓ Mixed heads (each station should only have one kind of head)
  - ✓ Overspray (adjust flow through the valve, use different nozzles, or adjust the flow control screw on the nozzle itself)
  - ✓ Broken heads (water leaks from the seal around the pop-up stem), broken parts (some expense)
  - ✓ Heads that weep even when off (due to a faulty valve or the lack of check valves)
  - ✓ Sunken heads in a lawn (may need taller risers or turf may need dethatching – some expense)
- Reset your irrigation timers four times a year as the seasons change. Most homeowners overwater each fall by 25% or more because they don't readjust at the end of September when solar radiation is already halfway to winter lows.
- Use a trigger nozzle on hoses so water won't run except when you intend it to.
- Teach children that hoses and sprinklers are not toys. Restrict or eliminate use of hose-end water toys.
- Use a broom to clean driveways and other hardscape.
- Schedule each individual zone in your irrigation system to account for the type of plant, sprinkler, sun exposure and soil type for the specific area. The same watering schedule rarely applies to all zones in the system.
- Remove dying plants and weeds that compete for available water.
- Maintain sharp blades on pruning shears and lawn mowers to reduce plant water loss.
- Aerate lawns and apply compost periodically to decrease compaction and improve penetration of water, air and nutrients into root zones. Lawns need aeration when water pools or runs off after only a few minutes of watering.
- Avoid installing water features. Even recycled water evaporates.

INEXPENSIVE OR MODERATE EFFORT REQUIRED

- Mulch flower and garden areas, as well as tree and shrub bases.
- Avoid planting turf or installing spray irrigation in areas that are difficult to water without runoff, such as isolated strips along sidewalks and driveways and on slopes.
- At least once a year, confirm that all irrigation systems are distributing water uniformly and inspect, repair, and/or adjust subsurface or drip watering systems.
- Immediately shut off irrigation system(s) and adjust whenever irrigation water falls or runs onto hard surfaces such as sidewalks, streets or driveways.
- Repair all leaks as soon as detected, including hose couplings.
- Plant drought-tolerant or low-water plants for landscaping.
- Cover pools, spas and other water features when not in use to minimize evaporation. A good pool cover will save energy by up to 90% and water by up to 70%, saving nearly 1,000 gallons of water per month.
- Seasonally check pools and spas for leaks, which can lose up to 1,000 gallons a day. Symptoms of leaks include water level drops over 2 inches per week in the summer (with automatic filling off) or increased need for chemicals.
- The more frequently swimming pool filters are cleaned, the less often you'll need to replace the pool water.

GOOD WATER SAVING INVESTMENTS

- Install a weather-based irrigation controller and efficient nozzles. Your local water agency may offer rebates.
- Reduce the amount of lawn you have, especially where it isn't used for play.
- Plant drought-tolerant and native plants.
- Employ a certified landscape-irrigation auditor to conduct a thorough and comprehensive check for efficiency of water application. He or she can inspect and tune your system to ensure optimal efficiency.
- Replace lawns with artificial turf.
- Determine specific water requirements for all existing landscape plants, and water accordingly. Plants with the same water needs should be planted and irrigated together so you don't have to overwater some to give the rest enough.
- Water all plants deeply but infrequently to encourage deeper, healthier rooting.
- Install drip irrigation for trees, shrubs, slopes and narrow spaces.
- Replace pool filters with newer water conserving models. A single back-flush with older models uses 180-250 gallons of water.
- Harvest water from rainfall for landscape irrigation purposes. Systems can range from rain barrels to underground cisterns.

Indoor Water Conservation Checklist

FREE AND EASY IDEAS

Kitchens

- Don't leave the faucet running while you rinse or wash dishes.
- Scrape food from dishes first, then rinse only as much as needed. Rinsing in a second sink or tub uses less water than rinsing under a faucet.
- Limit use of the garbage disposal. Save food scraps to run the garbage disposal only once, or save more water by composting.
- Operate the dishwasher only when it is fully loaded. Each dishwater cycle uses 9-25 gallons of water, depending on the model.
- Capture and use otherwise wasted water (waiting for water to warm or cool, vegetable or dish water). Soapy water is generally OK for watering plants as long as there is no bleach or borax.
- Keep a water bottle in the refrigerator for drinking instead of running tap water until cold.

Bathrooms

- Toilets use 27% of average indoor household water. Don't use toilets as waste baskets or ash trays.
- Showers use 17% of indoor water. Take shorter showers, five minutes or less. Turn shower water off except to wet before soaping, then again for rinsing.
- Cut down on bathtub use or fill the tub to a lower level.
- Capture the initial cold water in a bucket to water potted plants. Turn it all the way to hot until you get the temperature you want to decrease the wait.
- Faucets use 16% of indoor water. Only run water when actually using it.
- Turning off the tap while brushing your teeth or shaving can save more than 200 gallons of water each month.
- Rinse your razor in a partially filled sink instead of running the water.
- Teach children to turn water faucets off quickly and tightly after each use.

Laundry

- Clothes washers consume 22% of indoor water. Wash only full loads of laundry. Each washing cycle uses 20 – 40 gallons of water, depending on the model of the machine.
- Teach children to change into play clothes after school so that school clothes can be worn more than once before washing.

SOME EFFORT OR EXPENSE

- Leaks consume 14% of average indoor water use. Check for and repair toilet leaks, which can waste as much as 200 gallons a day.
  - ✓ Put food coloring in the tank and wait. If color shows in the bowl you have a leak.
  - ✓ Adjust or replace the flapper. If you hear the toilet running but color didn't appear in the bowl, adjust the float arm to below the overflow line.
  - ✓ If it still leaks, call a plumber.
- Check and repair faucet and pipe leaks. You can check your entire system by turning everything off and seeing if the water meter still shows flow.
- Install low-flow shower heads and faucet flow restrictors (aerators). You can purchase quality, low-flow fixtures for around $10 to $20 each and achieve water savings of 25%–60%.
- Replace older toilets with 1.28 gallons-per-flush high efficiency toilets.
- Install a circulating hot water system with a timer.
- Replace traditional clothes washers with new, energy- and water-conserving machines that use less than 27 gallons of water per load.
- Insulate hot water pipes. Running the "hot" line to clear cool water is wasteful.

WAYS TO SAVE WATER

ACTIVITY	NORMAL USE	CONSERVATION USE
SHOWER	Water Running 25 GALLONS	Wet down, soap up, rinse off 4 GALLONS
BRUSHING	Tap Running 10 GALLONS	Wet brush, rinse briefly 1/2 GALLON
TUB BATH	Full 36 GALLONS	Minimal Water level 10-12 GALLONS
SHAVING	Tap running 20 GALLONS	Fill basin 1 GALLON
DISHWASHING	Tap running 30 GALLONS	Wash and rinse in dishpans or sink 5 GALLONS
AUTOMATIC DISHWASHER	Full cycle 16 GALLONS	Short cycle 7 GALLONS
WASHING HANDS	Tap running 2 GALLONS	Fill basin 1 GALLON
TOILET FLUSHING	Depending on tank size 5-7 GALLONS	Using tank displacement device 4-6 GALLONS
WASHING MACHINE	Full cycle, top water level 60 GALLONS	Short cycle, minimal water level 27 GALLONS

DMK: 3/89

GEORGETOWN DIVIDE PUD

P.O. Box 4240
Georgetown, CA 95634
(530)333-4356

In the Home

Water is essential to each of us every day. But it's a limited resource, so we all need to rethink the way we use water on a daily basis. By following these water-saving tips inside your home, you can help save water every day, whether or not California is in a drought:

Laundry Room

- Use the washing machine for full loads only to save water and energy
- Install a water-efficient clothes washer

  Save: *16 Gallons/Load*

Kitchen

- Run the dishwasher only when full to save water and energy.
- Install a water- and energy-efficient dishwasher.

  Save: *3 to 8 Gallons/Load*
- Install aerators on the kitchen faucet to reduce flows to less than 1 gallon per minute.

Bathroom

- Install low-flow shower heads.

  Save: *2.5 Gallons*
- Take five minute showers instead of 10 minute showers.

  Save: *12.5 gallons with a low flow showerhead, 25 gallons with a standard 5.0 gallon per minute showerhead.*
- Fill the bathtub halfway or less.

  Save: *12 Gallons*
- Install a high-efficiency toilet.

  Save: *19 Gallons Per Person/Day*
- Install aerators on bathroom faucets.

  Save: *1.2 Gallons Per Person/Day*
- Turn water off when brushing teeth or shaving.

  Save: *Approximately 10 Gallons/Day*
- Don't use the toilet as wastebasket.

Outdoors

There are lots of ways to save water, but reducing the water you use outdoors can make the biggest difference of all. By making a few easy changes to the way we use water outside our homes – like watering lawns only when needed, adjusting sprinklers to avoid watering sidewalks and using a broom instead of a hose – you can save a significant amount of water every day.

Landscape

- Water early in the morning or later in the evening when temperatures are cooler.

  Save: *25 gallons / each time you water*

- Check your sprinkler system frequently and adjust sprinklers so only your lawn is watered and not the house, sidewalk, or street.

  Save: *15-12 gallons / each time you water*

- Choose a water-efficient irrigation system such as drip irrigation for your trees, shrubs, and flowers.

  Save: *15 gallons / each time you water.*

- Water deeply but less frequently to create healthier and stronger landscapes.
- Put a layer of mulch around trees and plants to reduce evaporation and keep the soil cool. Organic mulch also improves the soil and prevents weeds.

  Save: *20-30 gallons / each time you water / 1,000 sq. ft.*

- Plant drought-resistant trees and plants.

  Save: *30- 60 gallons / each time you water / 1,000 sq. ft.*

- Information about evapotranspiration (ET) and weather based irrigation controllers is available at: http://www.cuwcc.org. and www.cimis.water.ca.gov

Cleanup

- Use a broom to clean driveways, sidewalks and patios.

  Save: *8-18 gallons / minute*

- Wash cars/boats with a bucket, sponge, and hose with self-closing nozzle.

  Save: *8-18 gallons / minute*

Activities

- Teach children that the hose and sprinkler are not toys.
- Install a pool/spa cover to reduce evaporation and filter backwash.

  Save: *30 gallons / day*

- Test pool and spa water frequently and maintain appropriate chemical balances to avoid the need to drain it except for structural repairs. Check your pool and pool plumbing for leaks.

Appendix H - District Ordinance 82-1

ORDINANCE 82-1

AN ORDINANCE ESTABLISHING RATES, RULES AND REGULATIONS FOR WATER SERVICE BY AND WITHIN THE GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT AND REPEALING ORDINANCE NOS. 77-10, 79-1, AND 81-1 RELATING TO SUCH RATES, RULES AND REGULATIONS

WHEREAS, the public interest, convenience and necessity requires that the provisions of the following ordinances heretofore adopted by the Board of Directors of the Georgetown Divide Public Utility District be consolidated, changed in certain respects, to wit: Ordinance 77-10, An Ordinance Establishing Rates, Rules, and Regulations for Water Service By and Within the Georgetown Divide Public Utility District and Repealing Ordinance Nos. 72-4, 74-7, 75-2, 75-4, 76-3, 77-4 and 77-5 Relating to Such Rates, Rules and Regulations, adopted on October 13, 1977; Ordinance 79-1, An Ordinance Amending Ordinance 77-10, An Ordinance Establishing Rates, Rules and Regulations for Water Service By and Within the Georgetown Divide Public Utility District, and Repealing Ordinance Nos. 72-4, 74-7, 75-2, 75-4, 76-3, 77-4, and 77-5 Relating to Such Rates, Rules and Regulations, by Amending Article 16 Thereof Relating to Pipeline and Storage Benefit Charges, adopted on February 16, 1979; and Ordinance 81-1, An Ordinance Establishing Rates, Rules and Regulations for Water Service By and Within the Georgetown Divide Public Utility District, and Repealing Ordinance Nos. 77-10, and 79-1 Relating to Such Rates, Rules and Regulations, adopted on February 4, 1981;

NOW, THEREFORE, BE IT ENACTED by the Board of Directors of the Georgetown Divide Public Utility District, El Dorado County, California, as follows:

ARTICLE 1 - DEFINITIONS

For the purpose of this Ordinance, the terms used herein are defined as follows:

Sec. 1-1. Applicant is the person making application for water service and shall be the owner of premises to be served by the water facilities for which such service is requested, or his authorized agent.

Sec. 1-2. Board is the Board of Directors of the District.

Sec. 1-3. Building is any structure used for human habitation or a place of business, recreation or other purpose containing water facilities.

Sec. 1-17. Single Family Residential Premises means a lot or parcel of real property under one ownership which includes one or more separate single family residential structures.

Sec. 1-18. Commercial or Multi-Family Residential Premises means a lot or parcel of real property under one ownership which includes one or more apartment houses, motels, office buildings, commercial buildings, and structures of like nature.

Sec. 1-19. Public Fire Protection Service means the services and facilities of the entire water supply, storage, and distribution system of the District, including the fire hydrants affixed thereto, and the water available for fire protection, excepting house service connections and appurtenances thereto.

Sec. 1-20. Regular Water Service means water service and facilities rendered for normal domestic and commercial purposes on a permanent basis, and the water available therefor.

Sec. 1-21. Service Connection Charge means the benefit entitlement of the lot or parcel of real property to a connection from the water main line to the limits of the road or easements in which the pipelines are located.

Sec. 1-22. Service or Service Connection means the pipeline and appurtenant facilities such as the curb stop, curb cock or valve used to extend water service from a distribution main to premises, but exclusive of the meter and meter box. Where services are divided at the curb or property line to serve several customers, each such branch service shall be deemed a separate service.

Sec. 1-23. Single Family Unit means the water capacity normally needed to serve a single family residential unit or the equivalent water usage for buildings used for purposes other than single family residences. SFU means Single Family Unit.

Sec. 1-24. Street is any public highway, road, street, avenue, alley, way, easement, or right of way.

Sec. 1-17. Single Family Residential Premises means a lot or parcel of real property under one ownership which includes one or more separate single family residential structures.

Sec. 1-18. Commercial or Multi-Family Residential Premises means a lot or parcel of real property under one ownership which includes one or more apartment houses, motels, office buildings, commercial buildings, and structures of like nature.

Sec. 1-19. Public Fire Protection Service means the services and facilities of the entire water supply, storage, and distribution system of the District, including the fire hydrants affixed thereto, and the water available for fire protection, excepting house service connections and appurtenances thereto.

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Sec. 1-24. Street is any public highway, road, street, avenue, alley, way, easement, or right of way.

Sec. 1-25. Treatment Plant Connection Benefit Charge means a treatment plant capacity charge for benefits to a lot or parcel of real property under one ownership.

Sec. 1-26. Water Department means the Board of Directors of the District performing functions related to the District water service, together with the General Manager, the Water Superintendent, the Office Manager, and other duly authorized representatives.

ARTICLE 2 - GENERAL PROVISIONS

Sec. 2-1. Effective Area. Except as herein otherwise expressly provided, this ordinance shall apply to and be effective within the boundaries of the District.

Sec. 2-2. Rules and Regulations. The following rules and regulations respecting water construction and provision of water and connection to the water supply, storage, and distribution facilities of District are hereby adopted, and all work in respect thereto shall be performed as herein required and not otherwise.

Sec. 2-3. Purpose. This Ordinance is intended, among other things, to provide certain minimum standards, provisions, and requirements for design, methods of construction, and use of materials in water facilities and water service connections hereafter installed, altered, or repaired, and with respect thereto shall not apply retroactively, that is, in the event of an alteration or repair hereafter made, it shall apply only to the new materials and methods used therein.

Sec. 2-4. Short Title. This Ordinance shall be known and may be cited as "Georgetown Divide Public Utility District Water Ordinance."

Sec. 2-5. Words and Phrases. For the purpose of this Ordinance, all words used herein in the present tense shall include the future; all words in the plural number shall include the singular number; and all words in the singular number shall include the plural number.

Sec. 2-6. Pressure Conditions. All applicants for service connections or water service shall be required to accept such conditions of pressure and service as are provided by the distribution system at the

location of the proposed service connection, and to hold the District harmless from any damages arising out of low pressure or high pressure water service conditions or from any interruptions in service.

Sec. 2-7. Maintenance of Water Pressure and Shutting Down for Emergency Repairs. The Board shall not accept any responsibility for the maintenance of pressure and it reserves the right to discontinue service while making repairs, replacements, and connections or performing other work in the operation of the water system. Consumers dependent upon a continuous supply should provide emergency storage.

Sec. 2-8. Tampering with District Property. No one, except an employee or representative of the Board, shall at any time in any manner operate the curb cocks or valves, main cocks, gates or valves of the District's water system, or interfere with meters or their connections, street mains, or other parts of the water system.

Sec. 2-9. Penalty for Violation. For the failure of the customer to comply with all or any part of this Ordinance, and any ordinance, resolution, or order fixing rates and charges of this District, a penalty for which has not hereafter been specifically fixed, the customer's service shall be discontinued and the water shall not be supplied such customer until he shall have complied with the rule or regulation, rate or charge which he has violated, or in the event that he cannot comply with said rule or regulation, until he shall have satisfied the District that in the future he will comply with all the rules and regulations established by ordinance of the District and with all rates and charges of this District. In addition thereto, he shall pay the District the sum of Ten Dollars ($10.00) for renewal of his service.

Sec. 2-10. Ruling Final. All rulings of the Board shall be final. All rulings of the General Manager shall be final, unless appealed in writing to the Board within five (5) days. When appealed, the Board's ruling shall be final.

Sec. 2-11. Relief on Application. When any person, by reason of special circumstances, is of the opinion that any provision of this

Ordinance is unjust or inequitable as applied to his premises, he may make written application to the Board, stating the special circumstances, citing the provision complained of, and requesting suspension or modification of that provision as applied to his premises.

If such application be approved, the Board may, by resolution, suspend or modify the provision complained of, as applied to such premises, to be effective as of the date of the application and continuing during the period of the special circumstances.

Sec. 2-12. Relief on Own Motion. The Board may, on its own motion, find that by reason of special circumstances any provision of this regulation and ordinance should be suspended or modified as applied to a particular premises and may, by resolution, order such suspension or modification for such premises during the period of such special circumstances, or any part thereof.

Sec. 2-13. Separability. If any section, subsection, sentence, clause, or phrase of this Ordinance, or the application thereof to any person or circumstance is for any reason held to be unconstitutional or invalid, such decision shall not affect the validity of the remaining portions of this Ordinance of the application of such provision to other persons or circumstances. The Board hereby declares that it would have passed this Ordinance or any section, subsection, sentence, clause or phrase hereof irrespective of the fact that any one or more sections, subsections, sentences, clauses, or phrases be declared to be unconstitutional.

ARTICLE 3 - WATER DEPARTMENT

Sec. 3-1. Creation. A Water Department has been heretofore created comprising the Directors and the following positions, to wit: The General Manager, a Water Superintendent, a District Inspector, and an Office Manager. The same person may be appointed to any or all of said positions. They shall be appointed to serve at the pleasure of the Board. If the same person is appointed General Manager and any other position, then said person shall be known as the General Manager and shall assume

and execute all the duties and responsibilities of each of the positions to which he is appointed.

Sec. 3-2. Plumbing, Water Facility, Inspection, Compensation. The Board of said District shall employ the District Engineer or such other person as may be designated by the Board to perform the duties of inspecting the installation, connection, maintenance, and use of all water facilities in said District, to be known as the District Inspector. He shall receive, as compensation for his services for making inspections required to be made by the ordinances, orders, and regulations from time to time enacted and ordered by said Board, a sum to be fixed by the Board. He shall serve during the pleasure of the Board.

Sec. 3-3. General Manager. The General Manager shall have full charge and control of the maintenance, operation and construction of the water works and system. He shall, with the consent and approval of the Board, have authority to employ and discharge all employees and assistants. He shall prescribe the duties of employees and assistants. He shall perform such other duties as are imposed from time to time by the Board, and shall report to the Board in accordance with the rules and regulations adopted by the Board.

Sec. 3-4. Water Superintendent - Duties. The Water Superintendent shall regularly inspect all physical facilities related to the District's water system, to see that they are in good repair and proper working order, and to note violations of any water regulations.

Sec. 3-5. Engineer, Inspector or Water Superintendent - Supervision. The Engineer, Inspector or Water Superintendent shall supervise all repair or construction work authorized by the Board, and perform any other duties prescribed elsewhere in this Ordinance or which shall be hereafter prescribed by the Board.

Sec. 3-7. Office Manager. The position of Office Manager is hereby created. He shall have charge of the office of the District and of the billing for and collecting the charges herein provided. He

shall perform such other duties as shall be determined by the General Manager.

Sec. 3-8. Id. - Duties. The Office Manager shall compute, prepare, and mail bills as hereinafter prescribed, make and deposit collections, maintain proper books of account, collect, account for, and refund deposits, do whatever else is necessary or directed by the District Auditor to set up and maintain an efficient and economical bookkeeping system, and perform any other duties now or hereafter prescribed by the Board.

Sec. 3-9. Performance of Duties. The foregoing duties of Engineer, Inspector, Water Superintendent, and Office Manager may be performed by existing District personnel or by an additional employee or employees or agent thereof.

Sec. 3-10. Compensation. The General Manager, Engineer, Inspector, Water Superintendent, and Office Manager shall receive such compensation as is prescribed by the Board.

ARTICLE 4 - NOTICES

Sec. 4-1. Notices to Customers. Notices to a water customer from the District will normally be given in writing, and either delivered or mailed to him at his last known address. Where conditions warrant and in emergencies, the District may resort to notification either by telephone or messenger.

Sec. 4-2. Notices from Customers. Notice from the customer to the District may be given by him or his authorized representative in writing, at the District's operating office. Where conditions warrant and in emergencies, the customer may resort to notification either by telephone or messenger.

ARTICLE 5 - STANDARD DISTRICT SPECIFICATIONS

Sec. 5-1. Design and Construction Standards. Minimum standards for the design and construction of water facilities within the

District shall be in accordance with the applicable provisions of the ordinances, rules and regulations, and with the STANDARD DISTRICT SPECIFICATIONS for District heretofore or hereafter adopted by the District, copies of which are on file in the District office. The District or the District Engineer may permit modifications or may require higher standards where unusual conditions are encountered.

Two complete sets of "as built" drawings showing the actual location of all mains, valves, fire hydrants, house services, meters, if any, and appurtenances shall be filed with the District before final acceptance of the work.

ARTICLE 6 - APPLICATION FOR REGULAR WATER SERVICE - WHERE NO MAIN EXTENSION REQUIRED

Sec. 6-1 Application for Water Service. Applications for regular water service, where no main extension is required, shall be made on the form of application approved by the Board from time to time.

Sec. 6-2. Undertaking of Applicant. Such application shall signify the customer's willingness and intention to comply with this and other ordinances or regulations relating to water service and to make payment for water service required.

Sec. 6-3. Payment for Previous Service. An application shall not be honored unless payment in full has been made for water service previously rendered to the applicant by the District.

Sec. 6-4. Installation of Services. Water services will be installed at the location and of the size determined by the Water Department. Service installations will be made only to property abutting on public streets or abutting on such distribution mains as may be constructed in alleys or easements, at the convenience of the Water Department. Services installed in new subdivisions prior to the construction of streets or in advance of street improvement must be accepted by the applicant in the installed location.

Section 6-5. Service Connections. Service connections will be installed in accordance with applicable provisions of Article 8.

ARTICLE 7 - GENERAL USE REGULATIONS

Sec. 7-1. Number of Services per Single Family Residential Premises. The applicant may apply for as many services as may reasonably be required for his single family residential premises, provided that the pipeline system for each single family residence shall be independent of the other single family residences on said premises and that they shall not be inter-connected.

Sec. 7-2. Supply to Separate Single Family Residential Structures. Each single family residence for which the application for water service is hereafter made, shall have a separate service connection, including a separate meter.

Sec. 7-3. Supply to Separate Commercial or Multi-Family Residential Premises. Each separate commercial or multi-family residential building for which application for a separate water service is hereinafter made, shall have a separate service connection, including a separate meter. Application for water service for more than one commercial or multi-family residential building on one lot or parcel of real property under one ownership shall have a separate service connection, including a separate meter, for all of the buildings under one application for water service.

Sec. 7-4. Number of Services Per Commercial or Multi-Family Residential Premises. The applicant may apply for as many services as may reasonably be required for his commercial or multi-family residential premises. The pipeline system from each service shall be independent of the others and they may not be inter-connected. One service with sufficient equivalent single family unit capacity may provide all of the service to any or all of the structures on the commercial or multi-family residential premises.

Se. 7-5. Water Waste. No customer shall knowingly permit leaks or waste of water. Where water is wastefully or negligently used on a customer's premises, seriously affecting the general service, the

District may discontinue the service if such conditions are not corrected within five (5) days after giving the customer written notice.

Sec. 7-6. Responsibility for Equipment on Customer Premises. All facilities installed by the District on private property for the purpose of rendering water service shall remain the property of the District and may be maintained, repaired, or replaced by the Water Department without consent or interference of the owner or occupant of the property. The property owner shall use reasonable care in the protection of the facilities. No payment shall be made for placing or maintaining said facilities on private property. No persons shall place or permit the placement of any object in a manner which will interfere with the free access to a meter box or will interfere with the reading of a meter.

Sec. 7-7. Changes in Customer's Equipment. Customers making any material changes in the size, character, or extent of the equipment or operations utilizing water service, or whose change in operations results in a large increase in the use of water, shall immediately give the District written notice of the nature of the change, and, if necessary, amend their application.

Sec. 7-8. Damage to Water System Facilities. The customer shall be liable for any damage to the District-owned customer water service facilities when such damage is from causes originating on the premises by an act of the customer or his tenants, agents, employees, contractors, licensees, or permittees, including the breaking or destruction of locks by the customer or others on or near a meter, and any damage to a meter that may result from hot water or steam from a boiler or heater on the customer's premises. The District shall be reimbursed by the customer for any such damage promptly on presentation of a bill.

Sec. 7-9. Ground Wire Attachments. All persons are forbidden to attach any ground wire or wires to any plumbing which is or may be connected to a service connection or main belonging to the District unless such plumbing is adequately connected to an effective driven ground installation on the premises. The District will hold the customer

liable for any damage to its property occasioned by such ground wire attachments.

Sec. 7-10. Cross Connections. The customer must comply with the state and federal laws governing the separation of dual water systems or installations of backflow protective devices to protect the public water supply from the danger of cross-connections. Backflow protective devices must be installed as near the service as possible and shall be open to test and inspection by the Water Department. Plans for installation of backflow protective devices must be approved by the Water Department prior to installation.

In special circumstances, when the customer is engaged in the handling of especially dangerous or corrosive liquids or industrial or process waters, the District may require the customer to eliminate certain plumbing or piping connections as an additional precaution and as a protection of the backflow preventive devices.

As a protection to the customer's plumbing system, a suitable pressure relief valve must be installed and maintained by him, at his expense, when check valves or other protective devices are used. The relief valve shall be installed between the check valves and the water heater.

Whenever backflow protection has been found necessary on a water supply line entering a customer's premises, then any and all water supply lines from the District's mains entering such premises, buildings, or structures shall be protected by an approved backflow device, regardless of the use of the additional water supply line.

The double check valve or other approved backflow protection devices may be inspected and tested periodically for water tightness by the District. The devices shall be serviced, overhauled, or replaced whenever they are found defective and all costs of repair and maintenance shall be borne by the customer.

The service of water to any premises may be immediately discontinued by the District if any defect is found in the check valve

installation or other protective devices, or if it is found that dangerous unprotected cross-connections exist. Service will not be restored until such defects are corrected.

Sec. 7-11. Interruptions in Service. The District shall not be liable for damage which may result from an interruption in service from a cause beyond the control of the Water Department to make improvements and repairs. Whenever possible, and as time permits, all customers affected will be notified prior to making such shutdowns. The District will not be liable for interruption, shortage, or insufficiency of supply, or for any loss or damage occasioned thereby, if caused by accident, act of God, fire, strikes, riots, war, or any other cause not within its control.

Sec. 7-12. Ingress and Egress. Representatives from the Water Department shall have the right of ingress and egress to the customer's premises at reasonable hours for any purpose reasonably connected with the furnishing of water service.

ARTICLE 8 - METERS AND METERED SERVICE CONNECTIONS

Sec. 8-1. District Property. All services shall be metered. The service connection, whether located on public or private property, is the property of the District, and the District reserves the right to repair, replace and maintain it as well as to remove it upon discontinuance of service.

Sec. 8-2. Meters. When an application for service is granted under Article 6, the District will install the meter and meter box. A 5/8 x 3/4-inch meter will be furnished without charge. The applicant will pay a $60 fee for the cost of installation. If the applicant desires a larger meter, the applicant shall pay the difference in cost between a 5/8 x 3/4-inch meter and that requested plus installation cost.

Only duly authorized employees or agents of the District will be permitted to install a meter and meter box.

Sec. 8-3. Meter Installations. Meters will be installed at the curb or within the easement, and shall be owned by the District and installed and removed at its expense after payment of the charges established therefor. No rent or other charge will be paid by the District for a meter or other facilities, including housing and connections, located on a customer's premises. All meters will be sealed by the District at the time of installation, and no seal shall be altered or broken except by one of its authorized employees.

Sec. 8-4. Change in Location of Meters. Meters may be relocated only if approved by the Board upon application. All cost of relocation shall be borne by the applicant.

Sec. 8-5. Location of Meters. The District reserves the right to determine the location of meters with respect to the boundaries of the premises to be served. The installation including the meter, shall be the property of the District. The service between the meter and the building served by the installation shall be the property of the customer and shall be maintained by the customer at his expense.

Sec. 8-6. Size of Meter. The size of the meter shall be determined by the size of the service connection requested by the applicant. These sizes shall be as follows: 5/8 x 3/4-inch, 25 GPM; 1 inch, 50 GPM 1-1/2 inch, 100 GPM; 2 inch, 160 GPM; 3 inch, 350 GPM. GPM means gallons per minute.

Sec. 8-7. Curb Cock. Every service connection installed by the District shall be equipped with a curb cock or wheel valve. On metered services, the valve is to be on the customer's side of the service installation, as close as is practicable to the meter location. Such valve or curb cock is intended for the exclusive use of the District in controlling the water supply through the service connection pipe. If the curb cock or wheel valve is damaged by the consumer's use to an extent requiring replacement, such replacement shall be at the consumer's expense.

Sec. 8-8. Meter Tests - Deposit. If a customer desires to have the meter serving his premises tested, he shall first deposit Ten Dollars ($10.00). Should the meter register more than two percent (2%) fast, the deposit will be refunded, but should the meter register less than two percent (2%) fast, the deposit will be retained by the Water Department.

Sec. 8-9. Adjustment for Meter Errors - Fast Meters. If a meter, tested at the request of a customer pursuant to Sec. 8-8, is found to be more than two percent (2%) fast, the excess charges for the time service was rendered the customer requesting the test, or for a period of six months, whichever shall be the lesser, shall be refunded to the customer.

Sec. 8-10. Adjustment for Meter Errors - Slow Meters. If a meter, tested at the request of a customer pursuant to Sec. 8-8, is found to be more than twenty-five percent (25%) slow, in the case of domestic service, or more than five percent (5%) slow, for other than domestic services, the District may bill the customer for the amount of the undercharge based upon corrected meter readings for the period, not exceeding six months, that the meter was in use.

Sec. 8-11. Non-Registering Meters. If a meter is found to be not registering, the charges for service shall be at the minimum monthly rate or based on the estimated consumption, whichever is greater. Such estimates shall be made from previous consumption for a comparable period or by such other method as is determined by the Water Department and its decision shall be final.

ARTICLE 9 - BILLING

Sec. 9-1. Billing Period. The regular billing period will be monthly, bi-monthly, or quarterly at the option of the District. The District may bill such charges with other charges for services rendered by the District.

Sec. 9-2. Meter Reading. Meters will be read, as nearly

service will also be turned off for non-payment of bills rendered under Ordinance No. 71-3.

Sec. 10-2. Charges a Debt. Failure to receive a bill does not relieve an owner or consumer of liability. Any amount due shall be deemed a debt to the District, and any person, firm, or corporation failing, neglecting or refusing to pay said indebtedness shall be liable to an action in the name of the District in any court of competent jurisdiction for the amount thereof.

Sec. 10-3. Reconnection Charge. A reconnection charge of Ten Dollars ($10.00) plus penalties as provided in Sec. 11-1 will be made and collected prior to renewing service following a discontinuance.

Sec. 10-4. Unsafe Apparatus. Water service may be refused or discontinued to any premises where apparatus or appliances are in use which might endanger or disturb the service to other customers.

Sec. 10-5. Cross-Connections. Water service may be refused or discontinued to any premises where there exists a cross-connection in violation of state or federal laws or this Ordinance.

Sec. 10-6. Fraud or Abuse. Service may be discontinued, if necessary, to protect the District against fraud or abuse.

Sec. 10-7. Non-compliance with Regulations. Service may be discontinued for non-compliance with this or any other ordinance or regulation relating to the water service to customer by District.

Sec. 10-8. Continuing Liability. The customer shall be liable for minimum use charges whether or not any water is used. The property remains liable for water standby or facilities charges in any event.

ARTICLE 11 - COLLECTION BY SUIT

Sec. 11-1. Penalty. Rates and charges which are not paid on or before the day of delinquency shall be subject to a penalty of ten percent (10%) and thereafter shall be subject to a further penalty of one-half of one percent (1/2 of 1%) per month on the first day of each month following.

as possible, on the same day of each billing period. Bills for periods containing less than ninety percent (90%) of a full billing period will be prorated.

Sec. 9-3. Opening and Closing Bills. Opening and closing bills for less than the normal billing period shall be prorated both as to minimum charges and quantity blocks. If the total period for which service is rendered is less than one month, the bill shall not be less than the monthly minimum charge applicable. Closing bills may be estimated by the Water Department for the final period as an expediency to permit the customer to pay the closing bill at the time service is discontinued.

Sec. 9-4. Charges. All charges are due and payable at the office of the District on the date of mailing the bill to the property owner or his agent as designated in the application or otherwise, and delinquent 30 days after the Post Office cancellation date. Service may be discontinued without further notice if payment is not made by the delinquent date.

Sec. 9-5. Payment of Bills. Bills for metered water service shall be rendered at the end of each billing period. Flat rate service and all standby or facilities charges shall be billed in advance. Bills shall be payable on presentation. On each bill rendered by the District shall be printed substantially the following: "If this bill is not paid within thirty (30) days after the Post Office cancellation date, service may be discontinued. A reconnection charge and penalties will be made and collected prior to renewing service following a discontinuance. Delinquent standby or facilities charges can become a lien on your property and may be collected on the county tax rolls."

Sec. 9-6. Water Used Without Regular Application Being Made. A person taking possession of premises and using water from an active service connection, without having made application to the District for water service, shall be held liable for the water delivered from the date

of the last recorded meter reading, and if the meter is found inoperative, the quantity consumed will be estimated. If proper application for water service is not made upon notification to do so by the District, and if accumulated bills for service are not paid immediately, the service may be discontinued by the District without further notice.

Sec. 9-7. Damages Through Leaking Pipes and Fixtures. When turning on the water supply as requested and the house or property is vacant, the District will endeavor to ascertain if water is running on the inside of the building. If such is found to be the case, the water will be left shut off at the curb cock on the inlet side of the meter. The Board's jurisdiction and responsibility ends at the meter and the Board will, in no case, be liable for damages occasioned by water running from open or faulty fixtures, or from broken or damaged pipes beyond the meter.

Sec. 9-8. Damage to Meters. The Board reserves the right to set and maintain a meter on any service connection. The water consumer shall be held liable, however, for any damage to the meter due to his negligence or carelessness and, in particular, for damage caused by hot water or steam from the premises.

ARTICLE 10 - DISCONTINUANCE OF SERVICE

Sec. 10-1. Disconnection for Non-payment. Service may be discontinued for non-payment of bills on or after the thirtieth day following the date of Post Office cancellation. At least five (5) days prior to such discontinuance, the customer will be sent a final notice informing him that discontinuance will be enforced if payment is not made within the time specified in said notice. The failure of the District to send, or any such person to receive, said notice shall not affect the District's power hereunder. A customer's water service may be discontinued if water service furnished at a previous location is not paid for within the time herein fixed for the payment of bills. If a customer receives water service at more than one location and the bill for service at any one location is not paid within the time provided for payment, water service at all locations may be turned off. Water

Sec. 11-2. Suit. All unpaid rates and charges and penalties herein provided may be collected by suit.

Sec. 11-3. Costs. Defendant shall pay all costs of suit, including reasonable attorney fees, in any judgment rendered in favor of District.

ARTICLE 12 - PUBLIC FIRE PROTECTION

Sec. 12-1. Use of Fire Hydrants. Fire hydrants are for use by the District or by organized fire protection agencies pursuant to contract with the District. Other parties desiring to use fire hydrants for any purpose must first obtain written permission from the Water Department prior to use and shall operate the hydrant in accordance with instructions issued by the Water Department. Unauthorized use of hydrants will be prosecuted according to law.

Sec. 12-2. Moving of Fire Hydrants. When a fire hydrant has been installed in the location specified by the proper authority, the District has fulfilled its obligation. If a property owner or other party desires a change in the size, type, or location of the hydrant, he shall bear all costs of such changes, without refund. Any change in the location of a fire hydrant must be approved by the proper authority.

Sec. 12-3. Water Pressure and Supply. The District assumes no responsibility for loss or damage due to lack of water or pressure, either high or low, and merely agrees to furnish such quantities and pressures as are available in its general distribution system. The service is subject to shutdowns and variations required by the operation of the system.

ARTICLE 13 - SPECIAL PROVISIONS

Sec. 13-1. Pools and Tanks. When an abnormally large quantity of water is desired for filling a swimming pool or for other purposes, arrangements must be made with the District prior to taking such water. Water to be used for other than domestic purposes, such as

swimming pools and tanks, will be supplied only through a meter and filter system approved by the State Board of Health. All meters, lines, checks, filters, and appurtenances are to be furnished and installed by customer, under the supervision of the Water Superintendent. The system is to be open for inspection by the Water Superintendent at all times.

Permission to take water in unusual quantities will be given only if it can be safely delivered through the District's facilities and if other consumers are not inconvenienced thereby.

Sec. 13-2. Responsibility for Equipment. The customer shall, at his own risk and expense, furnish, install, and keep in good and safe condition all equipment that may be required for receiving, controlling, applying, and utilizing water, and the District shall not be responsible for any loss or damage caused by the improper installation of such equipment or the negligence or wrongful act of the customer or of any of his tenants, agents, employees, contractors, licensees, or permittees in installing, maintaining, operating, or interfering with property caused by faucets, valves, and other equipment that are open when water is turned on at the meter, either originally or when turned on after a temporary shutdown.

Sec. 13-3. Service Connections. The service connections, extending from the water main to the boundary of the road or public easement right of way in which the water main is situate, and the meter, meter box, and curb cock or wheel valve, shall be maintained by the District. All pipes and fixtures extending or lying beyond the boundary of said road or easement right of way shall be installed and maintained by the owner of the property.

ARTICLE 14 - RATES

Sec. 14-1. Rate Resolution. Charges for the use of water within Improvement District shall be prescribed by the Board by resolution, which may be amended from time to time within the limits established by any bond proceedings. Such resolution shall be on file in the

office of the Secretary and copies thereof shall be available on request.

Sec. 14-2. Special Charges. At the time of making a new service connection to the District water system from any parcel of land and/or an increase in the size of an existing service connection to said water system from any parcel of land the special charges which are applicable thereto pursuant to the provisions of Articles 15, 16 and 17 of this Ordinance shall be paid prior to the making thereof. Payment of such charges shall entitle such parcel only to the limited benefits covered by the charges paid, and thereafter water service to such parcel shall remain subject to all of the provisions of said Articles 15, 16 and 17. The portions of such charges which represent treatment plant benefit charges and pipeline and storage benefit charges, respectively, shall be placed in the special funds, respectively, and used only for the special purposes, respectively, provided in said Articles 15 and 16.

Sec. 14-3. Payment of Special Charges By Special Assessments. In the event the Board has heretofore included or hereafter includes any parcels of land within the boundaries of an improvement district formed for the purpose of acquiring, constructing and financing by special assessments, in whole or in part, water facilities to serve such parcels, the confirmation and levy by the Board of an assessment in the proceedings to form such improvement district shall constitute payment of the special charges applicable to such parcels, respectively, pursuant to the provisions of Articles 15, 16 and 17 of this Ordinance insofar as and to the extent that the individual assessments levied on such parcels, respectively, include amounts for the special charges provided for in said Articles 15, 16 and 17.

Sec. 14-4. Payment of special charges for parcels of land outside of improvement districts, as provided for and contemplated by Articles 15, 16 and 17 of this Ordinance, either by special assessments levied in other improvement districts or otherwise, shall confer on such

parcels only the limited rights of service and use in the facilities of the improvement district to which such charges relate as are covered by said special charges so paid.

ARTICLE 15 - TREATMENT PLANT BENEFIT CHARGES

Sec. 15-1. Georgetown-Buckeye Treatment Plant. Any parcel for which a treatment plant benefit charge has not been assessed or otherwise paid for in an amount sufficient (at the rate applicable thereto at the time of any assessment or payment for such benefit) to cover the single family unit capacity attributable to a new connection to the portion of the District water system regularly served by the treatment plant constructed in the proceedings for Georgetown-Buckeye Water Improvement District, Assessment District 1971-1, and/or an increase in the size of an existing connection to said portion of said water system shall pay, prior to receiving such new connection or such increase in size of an existing connection, the amount of $250.00 for each unpaid for single family unit capacity attributable to such connection or increase in size of connection, on the basis of the following table:

Size of Connection	Attributable Capacity
5/8 x 3/4 inch	1 single family unit
1 inch	2 single family units
1-1/2 inch	5 single family units
2 inch	10 single family units
3 inch	20 single family units

All such treatment plant connection benefit charges collected pursuant to this Ordinance shall be placed in a special fund entitled "Treatment Plant Benefit Charges - Georgetown-Buckeye Treatment Plant". The proceeds of said fund shall be credited annually or at such other periods as the Board may prescribe by resolution upon the assessments levied upon all of the parcels of property within the boundaries of Georgetown-Buckeye Water Improvement District, Assessment District 1971-1, until the total amount of treatment plant benefit charges assessed and collected under this section of this Ordinance or Ordinance No. 75-2 (An

Ordinance Providing for Water Service by the Georgetown Divide Public Utility District to Parcels of Land Outside the Boundaries of Georgetown-Buckeye Water Improvement District, Assessment District 1971-1, and Establishing Rates, Rules and Regulations Therefore; and Amending Section 15-1 and Deleting Article 20 of Ordinance No. 72-4, An Ordinance Establishing Rates, Rules and Regulations for Water Service by the Georgetown Divide Public Utility District Within the Boundaries of Georgetown-Buckeye Water Improvement District, Assessment District 1971-1), or Ordinance No. 76-3 (An Ordinance Amending Section 15-1 of Ordinance No. 72-4 (As said Section Was Amended by Ordinance No. 75-2), Entitled An Ordinance Establishing Rates, Rules, and Regulations for Water Service by the Georgetown Divide Public Utility District Within the Boundaries of Georgetown-Buckeye Improvement District, Assessment District 1971-1) or Ordinance 77-10 (An Ordinance Establishing Rates, Rules and Regulations for Water Service by and Within the Georgetown Divide Public Utility District, and Repealing Ordinance Nos. 72-4, 74-7, 75-2, 75-4, 76-3, 77-4, 77-5, Relating to Such Rates, Rules and Regulations) shall equal $43,569.26. Thereafter, the proceeds from treatment plant benefit charges assessed and collected under said ordinances (in excess of said $43,569.26) shall be accumulated and used only for expansion and/or improvements of the treatment plant constructed in the proceedings for Georgetown-Buckeye Water Improvement District, Assessment District 1971-1.

Sec. 15-2. Auburn Lake Trails Treatment Plant. Any parcel of land for which a treatment plant benefit charge has not been assessed or otherwise paid for in an amount sufficient (at the rate applicable thereto at the time of any assessment or payment for such benefit) to cover the single family unit capacity attributable to a new connection to the portion of the District water system regularly served by the treatment plant constructed in the proceedings for Improvement District No. U-1, and/or an increase in the size of an existing connection to said portion

of said water system shall pay, prior to receiving such new connection or such increase in size of an existing connection, the amount of $350.00 for each unpaid for single family unit capacity attributable to such connection or increase in size of connection, on the basis of the following table:

Size of Connection	Attributable Capacity
5/8 x 3/4 inch	1 single family unit
1 inch	2 single family units
1-1/2 inch	5 single family units
2 inch	10 single family units
3 inch	20 single family units

All such treatment plant benefit charges collected pursuant to this section of this Ordinance or Ordinance No. 77-4 (An Ordinance Establishing Rates, Rules, and Regulations for Water Service by the Georgetown Divide Public Utility District Within the Boundaries of Greenwood Water Improvement District, Assessment District 1977-1) or Ordinance No. 77-10 (An Ordinance Establishing Rates, Rules and Regulations for Water Service By and Within the Georgetown Divide Public Utility District, and Repealing Ordinance Nos. 72-4, 74-7, 75-2, 75-4, 76-3, 77-4 and 77-5 Relating to Such Rates Rules and Regulations) shall be placed in a special fund entitled "Treatment Plant Benefit Charges - Auburn Lake Trails Treatment Plant" and used only for expansion and/or improvement to said treatment plant.

ARTICLE 16 - PIPELINE AND STORAGE BENEFIT CHARGES

Sec. 16-1. Amount. Prior to connection to the District water system of any building located within the District, except buildings within Improvement Districts U-1 or U-2, and for which pipeline and storage benefit charges were not assessed for such building in the proceedings for a water improvement district or otherwise paid for in the amount applicable thereto at the time of any assessment or payment for such benefit, said charges shall be paid in the amounts of: Pipeline - $300.00 per building; Storage - $350.00 per building. Notwithstanding the foregoing provisions of this section, said pipeline charge shall be deemed paid for the first such building connected or to be connected to the District water system for each separate parcel of land which existed at the time of construction of the water main to which such building is connected, if the owner of such parcel shared in the cost of said water main by

payment of all or a portion of the cost of said main.

Sec. 16-2. Special Funds. All pipeline and storage benefit charges collected pursuant to this Ordinance or Ordinance No. 72-4 (An Ordinance Establishing Rates, Rules, and Regulations for Water Service by the Georgetown Divide Public Utility District Within the Boundaries of Georgetown-Buckeye Water Improvement District, Assessment District 1971-1), 75-4 (An Ordinance Establishing Rates, Rules, and Regulations for Water Service by the Georgetown Divide Public Utility District Within the Boundaries of Garden Valley Water Improvement District, Assessment District 1975-1), 77-4 (An Ordinance Establishing Rates, Rules, and Regulations for Water Service by the Georgetown Divide Public Utility District Within the Boundaries of Greenwood Water Improvement District, Assessment District 1977-1), and Ordinance 77-10 (An Ordinance Establishing Rates, Rules, and Regulations for Water Service by and Within the Georgetown Divide Public Utility District, and Repealing Ordinance Nos. 72-4, 74-7, 75-2, 75-4, 76-3, 77-4, and 77-5 Relating to Such Rates, Rules, and Regulations) shall be placed in separate special funds, one such fund for each water improvement district or separate area within a water improvement district. The names of each of said funds shall include the designation "Pipeline Benefit Fund" and "Storage Benefit Fund" and the name of the water improvement district or separate area within a water improvement district. The "Pipeline Benefit Charge" and the "Storage Benefit Charge" collected for a building shall be placed in the fund for the water improvement district or the separate area within a water improvement district within which is the water main to which the building is connected.

Monies in each of said funds, respectively, shall be used only for maintenance and/or extension of water mains, and/or maintenance and/or expansion or construction of storage facilities of benefit to parcels of land served by the acquisitions and improvements made for the water improvement districts or separate areas within a water improvement district, the names of which are included in the names of such funds.

ARTICLE 17 - SERVICE CONNECTION CHARGES

Sec. 17-1. Amount. Prior to the making of a new connection or increasing the size of an existing connection to the District water system for which a service connection charge has not been paid, by special

assessment therefore in proceedings for a water improvement district, or otherwise, a service connection charge shall be paid. The amount thereof shall be (a) the actual costs of constructing a new or larger service line from the water distribution main to the boundary of the road easement in which such main is located, if same is required, or (b) the amount set forth in the following table for the size of the new connection or the size to which an existing connection is increased, to wit:

Size of Service Connection	Meter Capacity (GPM)	Amount of Charge
5/8 x 3/4 inch	25	$350.00
1 inch	50	$365.00
1-1/2 inch	100	$430.00
2 inch	160	$480.00

whichever is larger.

ARTICLE 18 - NON-ADJACENT PARCELS TO IMPROVEMENT DISTRICT PIPELINE

Sec. 18-1. The owners of all parcels of land included within a water improvement district which are not adjacent to a road or public easement in which a pipeline constructed pursuant to the proceedings for such district is situate will be responsible for providing, at the cost and expense of the owners of such parcels, the necessary water lines from their parcel to the service lines provided for their respective parcels at the limits of the road or public easement in which the pipeline which will serve said parcels is situate; provided, however, that if necessary and upon request, the District shall condemn at the cost and expense of the owner or owners requesting the same the requisite easements for such service lines.

ARTICLE 19 - APPORTIONMENT OF ASSESSMENT IN EVENT OF DIVISION OF LAND SUBJECT HERETO

Sec. 19-1. In the event any parcel of land assessed in improvement district proceedings conducted by the Board is thereafter divided into two or more separate parcels, the assessment on such parcel shall be assigned to the separate parcels as follows:

(a) Where there is one existing service connection to such parcel, to the separate parcel served by the existing service connection;

(b) Where there are two or more existing service connections to such parcel, to the separate parcel or parcels served by said existing connections; and

(c) Where there are no existing service connections to such parcel, to the separate parcel which is nearest the pipeline constructed in the proceedings.

Sec. 19-2. Notwithstanding the foregoing, the assessment can be made to a different one of the separate parcels than above specified where the choice is between one of two or more separate parcels all of which or none of which have existing connections therefrom, either as appropriate in the judgement of the Engineer or as agreed to be the owner or owners of the separate parcels involved in such choice.

Sec. 19-3. Engineering, administrative, legal and other costs of apportionment of assessments upon division of parcels of land shall be borne by the owner of the parcel before division or to the new parcel or parcels to which the assessment is assigned.

ARTICLE 20 - MODIFICATION OF CHARGES

Sec. 20-1. Where the division of parcels of land or use of land for industrial, commercial, subdivision or residential projects require more than an equivalent 10 single family unit (SFU) water capacity demand for service, the Georgetown Divide Public Utility District reserves the right to modify the foregoing charges to accurately reflect the financial implications of said parcel division or use, by reason of the potential for major influence on the capacity operation and service availability of any of the facilities serving any existing water improvement district. Said modification of charges shall be made by the District Board of Directors based upon information provided by the District Engineer and staff relative to all applicable water costs and present and future water service demands.

ARTICLE 21 - REPEAL

Sec. 21-1. Ordinance Nos. 77-10, 79-1 and 81-1, the full titles and dates of adoption of which are set forth in the preamble of this Ordinance, are hereby repealed and shall be of no further force and effect; provided only that the monies in the special funds designated in any of said ordinances shall be placed in the corresponding special funds provided for in the Ordinance.

ARTICLE 22 - EFFECTIVE DATE

Sec. 22-1. Adoption and Effective Date. This Ordinance shall take effect thirty (30) days after its passage. At least one week before the expiration of said thirty days, copies thereof shall be posted in three public places within the Improvement District, and it shall be published once in the Georgetown Gazette and Town Crier, a newspaper of general circulation published in the District.

* * * * * * * * * * *

PASSED AND ADOPTED at a regularly held regular meeting of the Board of Directors of GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT on this 14th day of April, 1982.

AYES: Directors Robert E. Flynn, John C. Lampson, Fred G. DeBerry, and Arthur E. Smoot.

NOES: None.

ABSENT: Director Lee J. Hoddy.

ROBERT E. FLYNN, President
Board of Directors
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

ATTEST:

CHARLES F. GIERAU, Clerk and ex officio Secretary of the Board of Directors thereof.

(SEAL)

I hereby certify that the foregoing is a full, true and correct copy of Ordinance No. 82-1, duly and regularly adopted by the Board of Directors of the Georgetown Divide Public Utility District, El Dorado County, California, on April 14, 1982, 1982.

CHARLES F. GIERAU, Clerk of the
GEORGETOWN DIVIDE PUBLIC
UTILITY DISTRICT

(SEAL)

WATER SYSTEM RELIABILITY STUDY
FOR
GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT

November 2002

Submitted To: Georgetown Divide
Public Utility District
P.O. Box 4240
Georgetown, CA 95634

Submitted By: KASL Consulting Engineers, Inc.
7777 Greenback Lane, Suite 104
Citrus Heights, CA 95610

CONSULTING KASL ENGINEERS

WATER SYSTEM RELIABILITY STUDY FOR GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

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WATER SYSTEM RELIABILITY STUDY FOR GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

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CONSULTING KASL ENGINEERS

WATER SYSTEM RELIABILITY STUDY FOR GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

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TECHNICAL APPENDICES

1. Treated Water System Maps (21 Sheets)

2. Raw Water System maps (22 Sheets)

3. Ditch System Capacity Calculations (9 Sheets)

EXHIBITS
(included in Back Pockets of Study)

1. Auburn Lake Trails Watre System
   Proposed Network Reliability Improvements

2. Walton Lakes Water System
   Proposed Network Reliability Improvements (1 of 2)

3. Walton Lakes Water System
   Proposed Network Reliability Improvements (2 of 2)

WATER SYSTEM RELIABILITY STUDY FOR GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

I INTRODUCTION

PURPOSE AND SCOPE

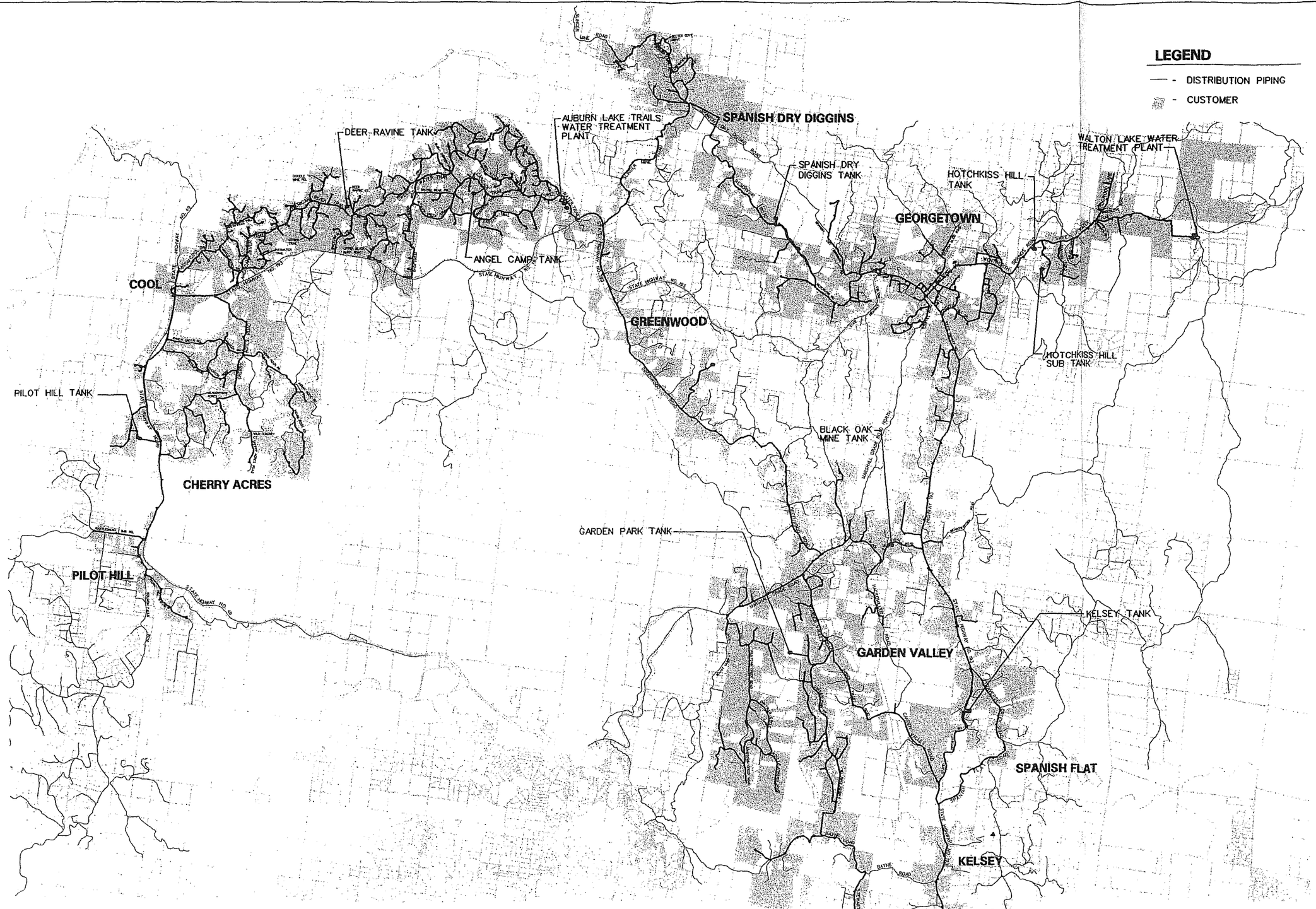
The Georgetown Divide Public Utility District (GDPUD) owns and operates raw water storage and delivery systems and treated water storage, pumping and distribution facilities which serve the El Dorado County communities of Georgetown, Cool, Pilot Hill, Auburn Lake Trails, Greenwood, Garden Valley, Kelsey and surrounding rural areas. Water is supplied from GDPUD's Stumpy Meadows Reservoir. Raw water is delivered to irrigation services and to water treatment plants through a system of open ditches and closed conduits. GDPUD water treatment plants, supplied by the GDPUD ditch system, include the Walton Lakes Water Treatment Plant and the Auburn Lake Trails Water Treatment Plant.

The scope of this Reliability Study includes the mapping and evaluation of some 70 miles of the GDPUD open ditch and raw water piped delivery network and over 200 miles of GDPUD treated water distribution facilities. The purpose of this study is to identify and prioritize repairs, upgrades and measures for both the raw water and treated water systems which should be conducted by GDPUD to reliably meet customer water demands.

This Reliability Study has been funded by a grant obtained by GDPUD from the California Department of Water Resources.

STUDY AREA LOCATION

The GDPUD water service area is located in north-central El Dorado County. The GDPUD treated water system map is presented in **Figure I-1**. The GDPUD ditch system map is presented in **Figure I-2**. The study area begins at the Pilot Creek Diversion Dam located approximately 11 miles east of Georgetown at elevation ±3780 and extends to the community of Kelsey, approximately 8 miles south of Georgetown at elevation ±2020 and to the community of Pilot Hill, approximately 12.5 miles southwest of Georgetown at elevation ±1300.

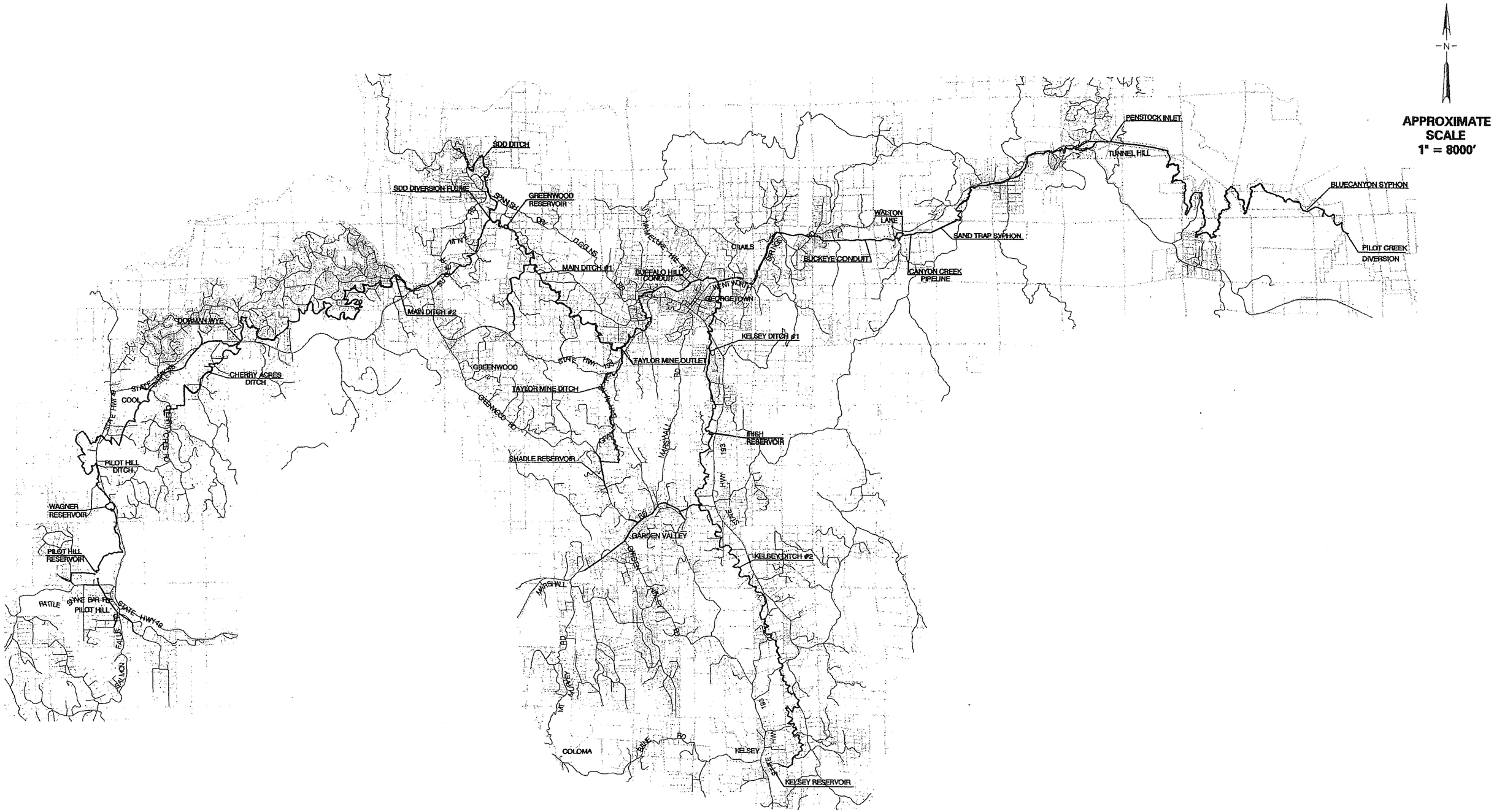


GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

WATER SYSTEM MAP

FIGURE I-1

KASL
7777 Greenback Lane
Suite 104
Citrus Heights, CA 95610
Tel. (916) 722-1600
Fax (916) 722-4505
CIVIL - WATER RESOURCES - SURVEYING



GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

DITCH WATER SYSTEM MAP

FIGURE I-2

KASL
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Tel. (916) 722-1800
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RELIABILITY STUDY OVERVIEW AND ORGANIZATION

This Reliability Study has been conducted as a joint effort between GDPUD engineering, management and field operations staff and KASL Consulting Engineers. GDPUD conducted the grants administration and project management. Public reports and presentations were provided during the course of this study by GDPUD staff and by KASL to advise the GDPUD Board of Directors and the public of the progress of this study. Specific tasks conducted by KASL for this Reliability Study included:

- System Inventory / Data Collection
- Water Demand Projections
- Performance and Design Standards
- Systems Analysis
- Alternative Feasibility Analysis
- Reliability Study Report

Findings and Recommendations of this Reliability Study Report are summarized in Section II of this report and are also included in the GDPUD Ditch System Maps and Treated Water Network Reliability Exhibits which are submitted as exhibit attachments to this Reliability Study.

System Inventory and Data Collection (Section III)

GDPUD raw water and treated water delivery, pipeline and distribution facilities were mapped using Global Positioning System (GPS) technology. The results of this mapping effort are summarized in Section III. GPS gathered coordinates and elevations were mapped at 1" = 400 scale. The system mapping conducted for the raw water and treated water systems were prepared compatible with countywide Geographic Information System (GIS) maps prepared by El Dorado County. Coordinating the GPS system mapping horizontal control used for this Reliability Study with the GIS control system used by El Dorado County allowed the location and alignment of GDPUD raw water and treated water facilities to be "layered onto" the road and parcel base maps prepared by El Dorado County. The raw water and treated water system maps prepared for GDPUD for the Reliability Study are discussed in Section III and are submitted as exhibit attachments.

Water Demands (Section IV)

This Reliability Study uses GDPUD water demand data available for the period of 1996 through 2001. Water demand information available for some 3000 domestic water services and provided in two-month demand (meter reading) increments were evaluated and quantified. Presented in Section IV of this study are the results of this analysis. GIS information available from El Dorado County including land use descriptions and zoning codes were applied to each parcel to identify GDPUD services by land use and by acreage. Average day demands and maximum day demands were then calculated

by land use category. Land Use categories included residential small acreage, residential medium acreage, residential large acreage, agricultural, commercial, industrial and public use. Demands were also identified by GDPUD region and zone. For the purpose of this Reliability Study the GDPUD treated water distribution service area was divided into three regions:

- Garden Valley / Kelsey
- Walton Lakes / Georgetown / Spanish Dry Diggins
- Auburn Lake Trails / Cool / Pilot Hill

As further described in Section IV these regions have been further divided into some 24 pressure zone sub-regions.

Water demands of the raw water delivery and distribution system have also been divided into three sections. These correspond to the principal ditch segments of the GDPUD raw water system which are:

- Upcountry Ditch
- Main Ditch / Pilot Hill Ditch
- Kelsey Ditch

Raw water demands and ditch design flows for each segment were determined from GDPUD raw water meter data collected at the Tunnel Hill Measuring Flume and the Buckeye Measuring Flume and from water treatment plant demands at Walton Lakes and Auburn Lake Trails.

Performance and Design Criteria (Section V)

As part of the scope of this Reliability Study, improvement standards have been prepared for GDPUD water treatment, storage, distribution and service facilities. Recommended improvement standards together with standard drawings have been submitted to GDPUD. Recommended GDPUD Water System Improvement Standards are summarized in Section V. These are compared to EID and PCWA Improvement Standards.

Design and performance criteria for the raw water ditch conveyance system and for raw water conveyance structures (culverts, pipelines, etc.) are also presented in Section V.

System Analysis (Section VI)

The raw water conveyance system was analyzed in the field with GDPUD ditch system operators. Findings, the performance of specific ditch systems and the history of repairs and maintenance were then reviewed with GDPUD engineering operations staff. Each section of the open conveyance ditch system was "pre-marked" ahead of GPS survey crews. Previous ditch repairs, known or suspected loss areas, high

maintenance segments, low freeboard areas, ditch segments which had been lined or replaced with closed conduits, ditch structures and ditch appurtenances, were identified in the field so that the location and limits of these features could be included in the raw water system mapping.

After the initial raw water system mapping was conducted, a field check of the mapped ditch segments was performed. Each of the ditch sections was again reviewed in the field with the ditch operators. The significance and conditions of previous repair areas, the significance of known or suspected loss areas, areas of known or suspected instability and the accuracy of the initial mapping effort was checked. Corrections to the raw water system maps were made to more accurately reflect the ditch system improvements and conditions. Revised ditch system maps were also submitted to GDPUD engineering and operations staff for review.

Open channel flow analysis was conducted for each segment of the open ditch. With ditch slope and typical ditch cross section determined in the field the capacity of each ditch segment to carry design flows with at least the minimum freeboard allowance was determined. The capacity of each closed conduit and the capacity of each culvert crossing was also checked. Details of these calculations and capacity determinations are included in Section VI. Recommended raw water conveyance measures to improve system reliability are discussed in Section VII.

To evaluate the treated water transmission and distribution system WaterCad distribution system modeling software developed by Haestad Methods was used. The GDPUD water distribution systems were created from the field mapping conducted as part of the system inventory and data acquisition task and from available GDPUD water system improvement plans. Once the water system networks were created from the field mapping, pipe diameters, junctions and system parameters (water storage tank and water surface elevations, pump characteristics, PRV settings, normally open and closed valves, etc.) were reviewed with GDPUD staff. The network models developed for the Walton Lakes System and the Auburn Lake Trails System were then calibrated. Steady static pressure readings were conducted in the field and compared to pressure readings predicted by the network models for demands typical of the period that field measurements were taken. Adjustments to the models were then made to accurately reflect measured field conditions. Fire hydrant flow tests were then performed throughout the Auburn Lake Trails and Walton Lakes Systems. Actual fire hydrant flows and pressures were compared to results predicted by the network models. Adjustments, as necessary, were made to pipe roughness and network system parameters. Fire hydrant tests were repeated until close correlation between actual and predicted results were achieved. Once the GDPUD treated water networks were accurately modeled and calibrated the ability of the existing distribution systems to reliably meet existing maximum day demands, maximum day plus a 5% increase in demands, maximum day plus a 10% increase in demands and maximum day plus fire flow demands were tested. The result of this analysis is included in Section VI. Recommended treated water system measures to improve system reliability are described in Section VIII.

Ditch System Reliability Measures (Section VII)

Measures recommended to enhance ditch system reliability and performance are described in Section VII of this Reliability Study. These were reviewed with GDPUD staff and prioritized. Ditch system modifications proposed for public health and safety are assigned the highest priority. Measures which increase system reliability and help ensure the supply for raw water to GDPUD water treatment plants are assigned a higher priority than modifications proposed downstream of water treatment supply intakes. Measures designed to ensure the continued delivery of existing raw water flows and to reduce conveyance losses are assigned a higher priority than measures suggested to enhance capacity.

Treated Water System Reliability Measures (Section VIII)

Measures recommended to enhance the treated water system reliability and performance are described in Section VIII of this Reliability Study. System improvements to reliably meet maximum day demands and to reliably meet maximum day plus fire flow demands were evaluated using the WaterCad network analysis. Water distribution system loops to provide alternative or enhanced water delivery paths, replacement of critical water mains with larger diameter pipe or with parallel mains and the replacement of old pipe section which have poor hydraulic sections with new, smooth, pipe are typical of network alternatives considered to improve system reliability. The benefits realized with each alternative were compared on the basis of costs, feasibility and performance. Recommended reliability measures, together with the prioritization of improvements were reviewed with GDPUD staff.

ACKNOWLEDGEMENTS

As previously noted this Reliability Study was conducted as a joint effort of the Georgetown Divide Public Utility District and KASL Consulting Engineers. KASL gratefully acknowledges GDPUD management, engineering and field operations personnel for their valuable assistance and participation in this study including:

Henry White	-	General Manager
Steven Gau	-	Operations Manager
Pete Hereford	-	Supervisor / Distribution
Don Schwagel	-	Ditch Superintendent
John Simons	-	Ditch Superintendent
Jack Bohn	-	Ditch Superintendent
Kelly Kawashima	-	Administrative Assistant
Delores Barron	-	Administrative Assistant
Marie Davis	-	Past General Manager

II SUMMARY

The findings and recommendations of the GDPUD Network Reliability Study are summarized in this section.

PURPOSE

The purpose of this Study is to identify and prioritize repairs, upgrades and measures to ensure that GDPUD raw water and treated water distribution and storage networks reliably meet customer demands. This Reliability Study shall serve as the basis for the implementation of cost effective raw water and treated water improvements. It is intended that this Study assist GDPUD in developing a Capital Improvements Program so that reliability measures can be budgeted and scheduled. It is intended that this Study serve as the basis for low interest construction loans and water system improvement grant applications available from State and Federal agencies.

The analysis and recommendations presented herein help prioritize the completion of remedial work. Design and operational criteria and system demands are developed so that GDPUD engineering and operations staff can effectively proceed with structural and non-structural upgrades and repairs and effectively utilize available maintenance and improvement funds. This Study also provides the necessary network model development, demands and criteria to help GDPUD staff evaluate proposed extensions or modifications to the existing distribution systems.

SCOPE

The scope of this Reliability Study includes the mapping and evaluation of approximately 70 miles of the GDPUD raw water delivery and raw water storage network and approximately 200 miles of the GDPUD treated water pumping, storage and distribution system. The scope of this Study does not include evaluation of the Stumpy Meadows Reservoir and does not include evaluation of the Walton Lakes Water Treatment Plant or the Auburn Lake Trails Water Treatment Plant.

SYSTEMS INVENTORY AND MAPPING

To effectively evaluate the condition and performance of both the raw water and treated water systems, inventory and mapping of existing distribution and storage facilities was conducted. Both the raw water and treated water networks were mapped using GPS technology. Mapping was conducted at 1" = 400' scale. A survey control network was established within and around the GDPUD service area. This network permitted mapping accuracy to ±1 foot, both horizontal and vertical. The GPS mapping

conducted for this Study takes advantage of the GIS mapping recently conducted by El Dorado County. GPS-gathered data was best fit to the County's parcel and roadway mapping.

Reduced size, GDPUD treated water system maps (21 sheets) completed for this Study are included in the Appendix. Network maps are prepared for storage and distribution systems served by the Auburn Lake Trails (ALT) Water Treatment Plant and by the Walton Lakes (WL) Water Treatment Plant. The treated water distribution system mapping completed for this Study includes pipe alignment, size and junctions, water storage tank elevations, pump station operating characteristics and pressure reducing valve set points. The system mapping conducted for the GDPUD treated water systems is a compilation of field surveys, as-builts, water system improvement plans and GDPUD-supplied operations information. The water system maps, prepared so that computer network modeling and analysis could be conducted, also provide a valuable data and inventory resource tool for GDPUD engineering and operations staff.

Reduced size, GDPUD raw water system maps (22 sheets) completed for this Study are included in the Appendix. Ditch system maps are prepared for the Upcountry (UC), Main / Pilot Hill (PH) and Kelsey (K) ditch systems. The raw water system maps include the location, alignment, slope and capacity of each raw water ditch and pipeline segment. The location and limits of existing ditch system improvements (piped sections, lining, culverts, wastegates, structures) are shown. Highlighted on the maps are priority repair areas recommended as part of this Study. The raw water mapping provides an accurate inventory of the main ditches, lateral ditches and irrigation pipelines. Similar to the treated water system mapping, raw water system maps were best fit to the El Dorado County parcel and road base maps. Full size and half size reduction ditch system maps prepared for this Study have been provided to GDPUD. While the ditch system maps were prepared to evaluate the performance and condition of the raw water delivery system they also serve as a valuable resource for the ongoing operation and maintenance of the GDPUD raw water system.

WATER SYSTEM DEMANDS

For the purpose of this Study GDPUD treated water system demands were determined by region, by pressure zone and by land use. A summary of demand results for residential land uses, by region, is as follows:

GDPUD Average Day and Maximum Day Residential Water Demands (gallons per day / unit) by Region

Land Use	Garden Valley / Kelsey		Walton Lakes, Georgetown, Spanish Dry Diggins		ALT / Cool / Pilot Hill	
	Avg. Day	Max. Day	Avg. Day	Max. Day	Avg. Day	Max. Day
Small Acreage Residential	295	750	360	915	435	1045
Medium Acreage Residential	425	1070	390	990	510	1225
Large Acreage Residential	475	1200	450	1140	550	1320

The average and maximum day residential water demands presented above compare well with El Dorado Irrigation District Standard Water Demands for the EID Central Region.

Water demand findings for residential, agricultural, commercial, industrial and public land uses and for each of the 24 pressure zones identified for the GDPUD water service area are presented in Tables IV-1, IV-2 and IV-3 of this Study. Average day and maximum day water demand findings were used to calibrate the network model and to conduct the system analysis.

Ditch design flows are also presented in Section IV. A summary of peak summer time ditch flows, by segment is as follows:

GDPUD DITCH DESIGN FLOWS

GDPUD Ditch Section	Design Flows (cfs)
Upcountry	
Above Tunnel Hill	32 to 35
Tunnel Hill to Walton Lakes	32 to 35
Walton Lakes to Crails	27 to 30

Main / Pilot Hill	
Main Ditch No. 1	16 to 20
Main Ditch No. 2	12.5 to 16.5
Pilot Hill Ditch	3 to 12
Kelsey	
Kelsey Ditch No. 1	8 to 10
Kelsey Ditch No. 2	3 to 8
Spanish Dry Diggins	2 to 3
Taylor Mine	3 to 5
Cherry Acres	2 to 3

In Section IV ditch design flows are further segmented into specific ditch segments. Ditch design flows are compared to ditch capacity determinations.

PERFORMANCE AND DESIGN CRITERIA

Prior to the preparation of this Reliability Study, GDPUD had no formally defined performance and operation criteria for either the treated water or the raw water system. Recommended Water System Improvement Standards have been prepared as part of this Study and submitted to the District. Performance and design criteria included in these Standards for treated water system demands, fire flows, treated water storage, transmission mains and design pressures are presented in Section V. These include:

RECOMMENDED PERFORMANCE AND DESIGN CRITERIA

Fire flows:	500 gpm per hydrant for Single Family and Duplex Residential land use areas Min. 20 psi delivery pressure
Treated Water Storage:	Min. Capacity, 250,000 gallons
Fire Storage Reserve:	4 hours of design fire flow
System Peaking Storage:	20% of the total daily fire flow
Emergency Storage:	Min. of 4 hours under maximum day demands
Transmission Main Size:	Min. 8-inch diameter mains to deliver max. day demands at less than 10 ft/sec.

Transmission Main Material:	PVC C-900 or C 905, CL 150 / 200 or DIP CL 200 min.
Design Pressures:	Not less than 35 psi and not more than 115 psi at the meter
Min. Pipe Cover:	3 feet
Raw Water Storage:	Not less than 50 ac-ft available to Walton Lakes and Auburn Lake Trails Water Treatment Plants
Ditch System Culvert and Pipe Criteria:	Per Table V-2
Min. Allowable Ditch Freeboard:	1 to 2 feet for Upcountry Ditch; 6 inches to 1 foot for other GDPUD ditches

SYSTEMS ANALYSIS

Treated Water

Treated water distribution models were developed for both the Auburn Lake Trails water system and the Walton Lakes treated water system. The network models were calibrated to ensure that model results accurately simulate actual conditions. With the assistance of local fire departments static pressure calibrations and flow test calibrations were completed for both systems.

Maximum Day Demands

Under maximum day demands, systems analysis using the Auburn Lake Trails model identified 9 pipe junctions, demand or fire hydrant nodes with pressures below the 35 psi minimum criteria. Within the Walton Lakes system, network analysis identified a total of 7 pipe junctions, demand or fire hydrant nodes with pressures below 35 psi during maximum day demand conditions.

Maximum Day Plus Fire Flows

Both the Auburn Lake Trails and Walton Lakes distribution systems were evaluated under maximum day plus 500 gpm fire flow conditions. Within the Auburn Lake Trails service area maximum day plus fire flow design criteria could not be met at 11 hydrant locations (out of 275 total). Under these test conditions either the minimum required flow could not be delivered with a minimum of 20 psi residual at the hydrant or the fire flow plus maximum day demands caused unacceptably low pressures somewhere in the system.

There are approximately 250 fire hydrants within the Walton Lakes system. Maximum day demands plus a 500 gpm fire flow was evaluated at each hydrant. At some 60 hydrant locations either the residual pressure at the hydrant dropped below 20 psi or unacceptably low pressures occurred somewhere within the distribution zone during the simulated test condition.

Storage Tank Capacities

Within the Auburn Lake Trails system, the Deer Ravine Tank is under capacity. With the Walton Lakes system, the Garden Park and Hotchkiss Hill Sub Tanks are under capacity.

Ditch System

Based on the analysis of field conditions, system performance, capacity and design criteria, the following segments of the ditch system include features which require priority reliability improvement measures.

LOCATION OF DITCH PRIORITY RELIABILITY MEASURES

Ditch	Segment
Upcountry Ditch (6 locations)	▪ Structure #1 to Structure #2 ▪ Structure #2 to Structure #3 ▪ Structure #3 to Structure #4 ▪ Structure #5 to Structure #6 ▪ Balderstan Wastegate to Sand Trap Siphon ▪ Buckeye Conduit to Shroeder Conduit
Main Ditch #1 (7 locations)	▪ Buffalo Hills Conduit to Spanish Dry Diggins Rd. ▪ Spanish Dry Diggins Rd. to Taylor Mine Outlet ▪ Taylor Mine Outlet to Cabin Wastegate ▪ Cabin Wastegate to Growlersberg Wastegate ▪ Growlersberg Wastegate to Summers Wastegate ▪ Summers Wastegate to Spools Wastegate ▪ Spools Wastegate to Jackass Wastegate
Main Ditch #2 (3 locations)	▪ Blue Heron Falls to Kaiser Siphon ▪ Kaiser Siphon to ALT Water Treatment Plant ▪ Willow Creek Wastegate to Baldridge Wastegate

Pilot Hill Ditch (4 locations)	▪ Doman Wye to Knickerbocker Creek ▪ Lovejoy Wastegate to Nagle Wastegate ▪ Nagle Wastegate to Capecroft Wastegate ▪ Wagner Reservoir to Wagner Reservoir Wastegate
Kelsey Ditch # 1 (4 locations)	▪ The Crails to St. James Wastegate ▪ St. James Wastegate to State Highway 193 ▪ Forest View Dr. Falls to Irish Res. Wastegate ▪ Stark Wastegate to Kelsey Reservoir

Priority reliability measures on the Upcountry Ditch typically include replacement of unstable ditch sections with piping. Priority measures on the Main / Pilot Hill Ditch typically include repair of sections with cribwalls and berm improvements. Priority measures on the Kelsey Ditch typically include gunnite lining of high loss areas. Specific reliability measures recommended for each segment of the ditch system are included in Section VII of this Study.

Raw Water Storage

Currently raw water storage capacity upstream of the GDPUD Water Treatment plants is approximately 33.9 ac-ft. A minimum of 50 ac-ft is recommended. Construction of new raw water storage reservoirs was evaluated. Expansion of existing raw water storage ponds was also evaluated and recommended as follows:

GDPUD RAW WATER STORAGE

Reservoir	Existing Capacity (ac-ft)	Expanded Capacity (ac-ft)
Walton Lakes	14.0	24.7
Greenwood	14.3	24.4
Auburn Lake Trails	5.6	9.6
Totals	33.9	58.7

DITCH SYSTEM RELIABILITY MEASURES

Priority ditch system reliability measures recommended for the ditch system are summarized in **Table II-1** of this Study. These are also highlighted on the Ditch System Maps included in the Appendix of this Study. It is recommended that these measures be conducted over the next 5 years. Estimated costs are projected ahead to the mid point of the 2003 – 2008 implementation period. Maintenance, access and second

priority reliability measures are also identified for this Study. These are itemized in Table VII-2 of this study but are not repeated in this Summary. "Second-tier" measures include SCADA instrumentation and control systems for the ditch flows and reservoir levels and the purchase of a second narrow track excavator.

TREATED WATER RELIABILITY IMPROVEMENTS

Priority treated water system reliability measures are summarized in **Table II-2** for Auburn Lake Trails and in **Table II-3** for Walton Lakes. These tables are also included in Section VIII of this Study. Treated water reliability measures are assigned a priority of 1 to 4. It is recommended that the first priority measures be completed over the next five years with the second, third and fourth priority measures completed within a 5 to 10, 10 to 15 and 15 to 20 year schedule. Highest priority Auburn Lake Trails system improvements include:

- ALT 1B — Supply Greenwood Road from Walton Lakes
- ALT 4A1 — Replace treated water golf course supply with raw water supply
- ALT 9 — Construct second Deer Ravine Tank (600,000 gallon capacity)

Highest priority Walton Lakes measures include:

- WL 2 — Fain Lane Line Extension
- WL 4B — Remove Quiet Place Check Valve
- WL 3A — Bayne Road Line Extension
- WL 15 — Whitney Creek Pressure Reducing Station
- WL 20 — Garden Park Line Replacement
- WL 21 — Hancock Road Tank Tie

Water treatment system reliability measures for both Auburn Lake Trails and for Walton Lakes are included as Exhibit attachments to this Study. These have been placed in the back pocket of this Study.

TABLE II-1

SUMMARY OF PRIORITY RELIABILITY MEASURE RECOMMENDATIONS GDPUD DITCH SYSTEM

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Upcountry Ditch	Structure #1 to Structure #2 (UC-5)	• Construct retaining walls / slope stabilization for downslope levee at "the Narrows" • Widen access road from 6 feet to 10 feet • Replace 250 feet of open ditch with 48" pipe	$548,000
Upcountry Ditch	Structure #2 to Structure #3 (UC-4)	• Provide 1 foot of additional freeboard for 400 feet of ditch	$72,000
Upcountry Ditch	Structure #3 to Structure #4 (UC-4)	• Replace 500 LF of ditch with 48" pipe	$305,000
Upcountry Ditch	Structure #5 to Structure #6 (UC-4)	• Replace 500 LF of ditch with 48" pipe	$305,000
Upcountry Ditch	Balderston Wastegate to Sand Trap Siphon (UC-2)	• Provide 1 foot of additional freeboard, 1000 feet of lined and unlined section of ditch	$111,000
Upcountry Ditch	Walton Lake (UC-2)	• Dredge Walton Lake to restore holding capacity to approx. 25.0 acre-feet • Provide bypass piping during dredging	$496,000
Upcountry Ditch	Buckeye Conduit to Shroeder Conduit (PH-7)	• Provide 1 foot of additional freeboard for approximately 1100 feet of lined ditch	$85,000
		Subtotal, Upcountry Ditch	$1,922,000

TABLE II-1 (cont.)

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Main / Pilot Hill Ditch (Main Ditch #1)	Buffalo Hills Conduit to Spanish Dry Diggins Rd. (PH-7)	• Provide 6 inches of additional freeboard for approximately 500 feet of unlined ditch	$60,000
Main / Pilot Hill Ditch (Main Ditch #1)	Spanish Dry Diggins Rd. to Taylor Mine Outlet (PH-7)	• Gunnite line approximately 2500 feet of ditch or improve ditch with crib walls and 6" of additional freeboard	$305,000
Main / Pilot Hill Ditch (Main Ditch #1)	Taylor Mine Outlet to Cabin Wastegate (PH-7)	• Construct crib wall improvements at 3 locations • Replace 500 feet of deteriorated lining with new lining • Provide 6 inches of additional freeboard, 500 feet of ditch • Replace Cabin Wastegate	$186,000
Main / Pilot Hill Ditch (Main Ditch #1)	Cabin Wastegate to Growlersberg Wastegate (PH-7)	• Replace 1800 feet of lined ditch with new lining	$200,000
Main / Pilot Hill Ditch (Main Ditch #1)	Growlersberg Wastegate to Summers Wastegate (PH-7)	• Provide crib wall repairs at 3 locations	$11,000
Main / Pilot Hill Ditch (Main Ditch #1)	Summers Wastegate to Spools Wastegate (PH-7)	• Repair 600 feet of ditch with crib walls and 6 inches of additional freeboard	$93,000
Main / Pilot Hill Ditch (Main Ditch #1)	Spools Wastegate to Jackass Wastegate (PH-5)	• Provide crib wall repairs at 2 locations	$7,500

TABLE II-1 (cont.)

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Main / Pilot Hill Ditch (Main Ditch #1)	Jackass Wastegate to Greenwood Reservoir (PH-5)	• Dredge Greenwood Reservoir to provide capacity of ±24.4ac-ft	$416,000
Main / Pilot Hill Ditch (Main Ditch #2)	Blue Heron Falls to Kaiser Siphon (PH-5)	• Gunnite line 600 feet of existing ditch	$84,000
Main / Pilot Hill Ditch (Main Ditch #2)	Kaiser Siphon to ALT Water Treatment Plant (PH-4)	• Dredge ALT raw water storage reservoir to provide capacity of ±9.6 ac-ft • Provide bypass piping during dredging	$198,000
Main / Pilot Hill Ditch (Main Ditch #2)	Willow Creek Wastegate to Baldridge Wastegate (PH-4)	• Repair with crib walls, 5 ditch sections damaged by cattle • Place 3000 lineal feet of cattle control fencing	$80,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Doman Wye to Knickerbocker Creek (PH-3)	• Remove and replace 2-18" CMP and 24" STL culverts with 42x29 CMPA or 36" CMP	$22,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Lovejoy Wastegate to Nagle Wastegate (PH-2)	• Gunnite line approximately 400 feet of ditch • Replace Nagle Wastegate	$81,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Nagle Wastegate to Capecroft Wastegate (PH-2)	• Provide crib wall; repair, ±50 feet in length, one location	$4,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Wagner Reservoir to Wagner Reservoir Wastegate (PH-1)	• Gunnite line ±250 foot ditch section	$28,000
		Subtotal, Main / Pilot Hill Ditch	$1,775,500

TABLE II-1 (cont.)

Ditch System	Segment (Map Sheet #) [1]	Description	Estimated Cost [2]
Kelsey Ditch (Kelsey Ditch #1)	The Crails to St. James Wastegate (K-4)	• Remove and replace 2-15" PVC pipes at two locations; total ±800 lineal feet, replace with min. 30" pipe or 42"x29" CMPA • Place trash racks (Grizzlies) at upstream end of new pipes	$136,000
Kelsey Ditch (Kelsey Ditch #1)	St. James Wastegate to State Highway 193 (K-4)	• Remove and replace 18" CMP culvert, replace with 42"x29" CMPA or 42" CMP	$8,000
Kelsey Ditch (Kelsey Ditch #1)	Forest View Dr. Falls to Irish Res. Wastegate (K-3)	• Gunnite line approximately 600 lineal feet of ditch	$75,000
Kelsey Ditch (Kelsey Ditch #2)	Black Oak Siphon to Dukes Wastegate (K-2)	• Gunnite line approximately 400 lineal feet of ditch	$51,000
Kelsey Ditch (Kelsey Ditch #2)	Dukes Wastegate to State Highway 193 (K-2)	• Gunnite line approximately 1000 lineal feet of ditch (total two locations)	$125,000
Kelsey Ditch (Kelsey Ditch #2)	Mellows Wastegate to Kelsey Flume (K-1)	• Gunnite line approximately 800 lineal feet of ditch (total two locations)	$95,000
Kelsey Ditch (Kelsey Ditch #2)	Kelsey Flume to Stork Wastegate (K-1)	▪ Gunnite line approximately 400 lineal feet of ditch	$48,000

TABLE II-1 (cont.)

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Kelsey Ditch (Kelsey Ditch #2)	Stork Wastegate to Kelsey Reservoir (K-1)	• Gunnite line approximately 800 lineal feet of ditch (total two locations) • Reconstruct Stork Wastegate	$120,000
		Subtotal, Kelsey Ditch	$563,000
		Estimated Total, All Priority Measures	$4,260,500

(1) Refer to Ditch System Map Sheets included in the Appendix of this Study
(2) Costs are based on ENRCC = 7000 projected for mid-point of 2003 – 2008 Priority Measure Schedule

GDPUD WATER SYTEM RELIABILITY MEASURES

AUBURN LAKE TRAILS SERVICE AREA

CONSULTING KASL ENGINEERS
7777 Greenback Ln #104
Citrus Heights, CA 95610
Tel 916/722-1800
Fax 916-722-4595
"We take engineering personally"

SUMMARY OF COSTS

6-Nov-02

	3% PER YEAR INCREASE, ENR-CCI	6,481	6,800	7,880	9,140	10,600
Measure #	**Description**	**Amount**	**Priority**			
			1	**2**	**3**	**4**
ALT-1A	GREENWOOD RD FEED FROM WL	$ 308,000	$ 324,000			
ALT-1B	GREENWOOD RD MAIN REPLACEMENT	$ 833,000				$ 1,363,000
ALT-2	ANGEL CAMP CT. BOOSTER PUMP	$ 102,000			$ 144,000	
ALT-3	HIGHWAY 193 CROSS TIE-BRINKS LN REPLACE	$ 267,000			$ 377,000	
ALT-4A	GRAVITY RAW WATER FOR GOLF COURSE	$ 413,000	$ 434,000			
ALT-4B	DIGGER TREE CT TO WESTVIEW TRL TIE	$ 40,000		$ 49,000		
ALT-5	INDIAN ROCK ROAD MAIN REPLACEMENT	$ 66,000			$ 94,000	
ALT-6	CHERRY ACRE ROAD PRV-CROSS TIE	$ 160,000		$ 195,000		
ALT-7	CATECROFT ROAD MAIN REPLACEMENT	$ 209,000			$ 295,000	
ALT-8A	HWY 49-PILOT HILL LOOP	$ 387,000				$ 633,000
ALT-8B	SALMON FALLS ROAD MAIN REPLACEMENT	$ 514,000			$ 725,000	
ALT-9	SECOND DEER RAVINE TANK, 0.6 MG	$ 1,965,000	$ 2,062,000			
ALT-10	CHERRY HILLS TANK, 0.4 MG	$ 787,000			$ 1,110,000	
TOTAL, CURRENT COSTS		**$ 6,051,000**				
PROJECTED FUTURE COSTS			**$ 2,820,000**	**$ 244,000**	**$ 2,745,000**	**$ 1,996,000**

Table II-2

Summary

GDPUD WATER SYSTEM RELIABILITY MEASURES

WALTON LAKES SERVICE AREA

CONSULTING KASL ENGINEERS
7777 Greenback Ln #104
Citrus Heights, CA 95610
Tel 916/722-1800
Fax 916-722-4595
"We take engineering personally"

SUMMARY OF COSTS 6-Nov-02

	3% PER YEAR INCREASE, ENR-CCI	6,481	6,800	7,880	9,140	10,600
Measure #	**Description**	**Amount**	**Priority**			
			1	**2**	**3**	**4**
WL-1	CITABRIA LN LOOP TIE	$ 92,000		$ 112,000		
WL-2	FAIN LANE EXTENSION	$ 364,000	$ 382,000			
WL-3	BUFFALO HILL RD LINE REPLACEMENT	$ 96,000			$ 136,000	
WL-4 A	QUIET PLACE LOOP TIE	$ 59,000				$ 97,000
WL-4 B	QUIET PLACE REMOVE CHECK VALVE	$ 5,000	$ 6,000			
WL-5	HOLLOWAY DR LINE REPLACEMENT	$ 74,000			$ 105,000	
WL-6	LONGVIEW LANE LINE REPLACEMENT	$ 270,000			$ 381,000	
WL-7	RESERVOIR RD, SDD, HWY 193 REPLACEMENTS	$ 917,000		$ 1,115,000		
WL-8	SILENT MEADOW LN LINE REPLACEMENT	$ 127,000			$ 180,000	
WL-9	SANROMO ROAD LINE REPLACEMENT	$ 531,000				$ 869,000
WL-10	BLACK OAK MINE RD PROPOSED IMPROVEMENT	$ 59,000				$ 97,000
WL-11	GREENWOOD ROAD MAIN REPLACEMENT	$ 208,000		$ 253,000		
WL-12	TRAVERSE CREEK RD. LINE REPLACEMENT	$ 454,000				$ 743,000
WL-13A	BAYNE ROAD LINE EXTENSION	$ 405,000	$ 425,000			
WL-13B	BAYNE ROAD TANK	$ 1,350,000		$ 1,642,000		
WL-14	LAZY BROOK TRAIL LINE REPLACEMENT	$ 128,000				$ 210,000
WL-15	WHITNEY CT. PRESSURE REDUCING STATION	$ 108,000	$ 114,000			
WL-16	OAK LANE LINE REPLACEMENT	$ 151,000			$ 213,000	
WL-17	SHASTA RD. LINE REPLACEMENT	$ 109,000				$ 179,000
WL-18	TALMALPAIS RD. LINE REPLACEMENT	$ 110,000			$ 156,000	
WL-19	PIKES PEAK CIR. LINE REPLACEMENT	$ 64,000			$ 91,000	
WL-20	GARDEN PARK LINE REPLACEMENT	$ 97,000	$ 102,000			
WL-21	HANCOCK ROAD TANK TIE	$ 113,000	$ 119,000			
WL-22	GARDEN PARK TANK PROPOSED IMPROVEMENTS	$ 836,000		$ 1,017,000		
WL-23	HOTCHKISS HILL SUB TANK ADDITION	$ 444,000			$ 627,000	
WL-24	TRAVERSE CREEK RD. BOOSTER PUMPS	$ 62,000			$ 88,000	
WL-25	CHRYSLER CIR & ROLLER COASTER REPLACEMENT	$ 570,000				$ 933,000
	TOTAL, CURRENT COSTS	**$ 7,803,000**				
	PROJECTED FUTURE COSTS		**$ 1,148,000**	**$ 4,139,000**	**$ 1,977,000**	**$ 3,128,000**

Table II-3

Summary

III INVENTORY / DATA COLLECTION

In this section of the Reliability Study the mapping of existing GDPUD raw water and treated water systems is summarized.

GPS MAPPING AND CONTROL

The scope of this task included accurate mapping of existing GDPUD raw water and treated water facilities using GPS technology. GPS-gathered coordinates and elevations were mapped at 1" = 400 scale for both the raw water and treated water systems. The base maps prepared for the GDPUD facilities as part of this task were, for the most part, compatible with the countywide GIS mapping conducted by El Dorado County. The GPS-gathered information was "best fit" to the parcel and roadway GIS mapping conducted by the County and with few exceptions, good agreement between the GPS data compiled for this project and the County's base maps was obtained.

To obtain accurate longitude, latitude and elevation data for each data point five control points were established within and around the GDPUD service area. With the location and elevations of these base control points established the GPS data collected at each point along the ditch or along GDPUD treated water mains was calibrated using Real Time Kinetic (RTK) surveys. A horizontal and vertical accuracy of ± 1 foot was obtained using this control system. Supplemental field surveys were conducted in areas where adequate GPS coverage could not be obtained. This occurred in areas of dense tree cover and in areas along the GDPUD ditch where topography prevented adequate satellite access. Over 5000 data points were collected in the raw water and treated water mapping effort.

DISTRICT SUPPLIED DATA

Field data was supplemented by GDPUD supplied improvement plans available for the treated water and raw water delivery systems. GDPUD improvement plans were used to determine the material, age and size of treated water main improvements (valves, hydrants, pipelines, PRV's, tanks, etc.).

The alignment and location of raw water conduits were plotted on the raw water ditch system map. The location of physical facilities, valves, pipeline inlets and outlets, etc. were determined in the field to verify that the improvement plans accurately reflected as-built conditions.

DISTRICT MAPPING ASSISTANCE

Ditch system appurtenances important to the mapping of existing GDPUD facilities were pre-marked. GDPUD ditch superintendents together with KASL engineering staff "flagged" the location of ditch structures, ditch culverts, lined sections, cribwalls, old repairs, low berms, fence crossings, waste gates and flumes. The location

and limits of these facilities were then included in the ditch system mapping. In addition, GDPUD ditch superintendents identified the location and alignment of raw water pipelines constructed to serve GDPUD irrigation customers remote from the ditch system. The location and alignment of the ditch pipeline appurtenances have also been included in the raw water mapping effort.

GDPUD treated water system appurtenances shown on District-supplied maps were located in the field. Where valves, hydrants, PRV's and tanks shown on District maps could not be located GDPUD staff provided assistance to KASL engineering and surveying crews to determine as-built locations. GDPUD treated water base maps include information on tank elevations, normal and minimum water levels, booster pump operating characteristics and the normal operating range of pressure reducing valves. This District-supplied information was needed to complete the network modeling of the treated water systems.

TREATED WATER SYSTEM MAPPING

GDPUD treated water system maps (21 sheets) prepared for this Reliability Study are included in the appendix of this report. Over 200 miles of treated water pipelines are mapped. Treated water improvements served by the Auburn Lake Trails (ALT) Water Treatment Plant are shown on the "ALT" plan sheets. These improvements include the ALT treated water booster pumps, Angels Camp Tank, Deer Ravine Tank and Pilot Hill Tank. The ALT water treatment plant has a capacity of 2.3 MGD. Maximum day deliveries as high as 2.2 MGD have been recorded. The ALT water system maps and GPS data were imported into the WaterCad model to conduct the ALT network analysis. As further discussed in Section VI, the ALT network model developed from this mapping effort includes some 28 PRV's, over 850 pipeline segments and over 650 demand, pipeline junction and fire hydrant nodes.

Treated water improvements served by the Walton Lakes (WL) Water Treatment Plant are shown on the "WL" plan sheets. WL treated water network improvements include the Walton Lake Tank, Hotchkiss Hill Tanks, Black Oak Mine Tank, Spanish Dry Diggins Tank, Garden Park Tank and Kelsey Tank. The capacity of the WL Water Treatment Plant is 2.3 MGD. A maximum day production of 1.8 MGD has been recorded for this facility. The WL water system maps and GPS data were imported into the WaterCad model to conduct the WL network analysis. The WL network model includes over 20 PRV's, over 800 pipeline segments and over 800 demand, pipeline junction and fire hydrant nodes. The WL system includes the community of Georgetown and the older portions of the GDPUD service area. Facilities of the WL treated water distribution system are, in general, older than the ALT system. As further discussed herein more extensive measures are needed to improve the reliability of the WL system than the newer ALT system.

RAW WATER SYSTEM MAPPING

GDPUD raw water system maps (total 23 sheets) prepared for this Reliability Study are also presented in the appendix. The GDPUD ditch system is divided into 3 distinct segments; the Upcountry Ditch, the Main / Pilot Hill Ditch System and the Kelsey Ditch.

The Upcountry Ditch System encompasses some 16.4 miles of open ditch and raw water conduits and includes the Buckeye Conduit, Canyon Creek Conduit, Sand Trap Siphon, Tunnel Hill, Bacon Canyon Pipe, Pilot Creek Pipeline, Buckeye Flume and Tunnel Hill Flume. The Upcountry Ditch is divided nearly equally into segments upstream of the Tunnel Hill Outlet (±8.12 miles) and downstream of the Tunnel Hill Outlet (±8.12 miles). The Upcountry Ditch begins at the Pilot Creek Diversion Dam and is the main supply line for the GDPUD system. All of the water which is delivered to the GDPUD Water Treatment Plants and all of the water which eventually reaches GDPUD irrigation services must be conveyed via the Upcountry Ditch. The Walton Lakes Water Treatment Plant is located downstream of the Canyon Creek Conduit and upstream of the Buckeye Conduit. Over the years several miles of open ditch segments within the Upcountry Ditch System have been replaced with closed conduits. Approximately 47% of the total Upcountry conveyance system is now piped.

The Main / Pilot Hill Ditch System including Main Ditch No. 1, Main Ditch No. 2, Pilot Hill Ditch and the Spanish Dry Diggins Ditch totals approximately 28.2 miles in length. Water is delivered to the Auburn Lake Trails Water Treatment Plant via the Main / Pilot Hill Ditch System. Not included in the above total is approximately 1 mile of Knickerbocker Creek. Downstream of Dorman Wye and the Cherry Acres Ditch Diversion, the Pilot Hill Ditch flows into and "shares" the Knickerbocker Creek Channel. The Pilot Hill Ditch is then diverted from Knickerbocker Creek upstream of Cherry Acres Road. There are approximately 4 miles of pipeline which are tributary to the Main / Pilot Hill Ditch. These include the Croft, Pilot Hill Estates and Pilot Hill pipelines.

The Kelsey Ditch System including Kelsey Ditch No. 1, Kelsey Ditch No. 2 and the Taylor Mine Ditch encompasses some 15.6 miles. Tributary to the Kelsey Ditch are the Kelsey, Cunningham, Garden Valley, Greenwood and Greenwood Road pipelines. These pipelines add approximately 6 miles to the Kelsey raw water delivery system.

The features, performance, capacities and suggested reliability improvements for each of the GDPUD ditches are described in Section VI of this Study.

IV WATER SYSTEM DEMANDS

Domestic water system demands and design flows in the GDPUD ditch system are summarized in this section of the Reliability Study.

DOMESTIC WATER SYSTEM DEMANDS

Domestic water demand history was obtained from GDPUD for some 3100 domestic water customers. Demand data available for the period from 1996 through 2001 was evaluated. Water system demands in the form of 2 month meter readings were first reduced to average day demands for each period and then to annual average demand for the 6-year data period. Water service customers were identified by assessors parcel number. With GIS information available from El Dorado County, the acreage, land use code and zoning code of each GDPUD water service customer was determined. Water service customers in older sections of the GDPUD service area have different water service demands than GDPUD customers located in newer developments. Residential parcels with small acreages have different demands than residential parcels with larger acreage. Customers served by the Walton Lakes Water Treatment Plant have different maximum day demand characteristics than customers served by the Auburn Lake trails Water Treatment Plant. To accurately model the demand characteristics of the GDPUD service area and to efficiently apply these demands to the network modeling, domestic water system demands were calculated by region, by pressure zones within each region and by land use.

Water Demands by Region

The GDPUD service area was first divided into regions. For this Reliability Study these regions have been identified as:

- Garden Valley / Kelsey Region
- Walton Lakes / Georgetown / Spanish Dry Diggins Region
- Auburn Lake Trails / Cool / Pilot Hill Region

The Garden Valley / Kelsey Region and the Walton Lakes/ Georgetown/ Spanish Dry Diggins Region are served by the Walton Lakes Water Treatment Plant. The Auburn Lake Trails / Cool / Pilot Hill Region is served by the Auburn Lake Trails Water Treatment Plant.

Garden Valley / Kelsey

Located in the southeast portion of the GDPUD service area this region encompasses some 20,000 acres. Approximately 815 parcels are now served by GDPUD in this region.

Pressure zones within each region were defined by a water storage tank, booster pump or a pressure reducing station. As part of the network modeling task, demands within each pressure zone were specifically assigned based on the water demands calculated from the GDPUD demand data. Pressure zones identified for the Garden Valley / Kelsey Region are as follows:

- Kelsey
- Garden Park
- Marshall Grade
- Water Willow
- Irish Lane
- Traverse Creek
- Garden Valley

Average day and maximum day domestic water demands are presented later in this section by region, by pressure zone and by land use. Average day and maximum day domestic demands for residential parcels in the Garden Valley / Kelsey Region were determined to be:

Average Day and Maximum Day
Domestic Water Demands
Garden Valley / Kelsey Region

Land Use	Avg. Day Demand (gpd / parcel)	Max. Day Demand (gpd / parcel)
Small Ac. Residential	295	750
Medium Ac. Residential	425	1070
Large Ac. Residential	475	1200

Maximum day demands were determined from maximum day treatment plant flow records. From the Walton Lakes Treatment Plant the maximum day factor was calculated at 2.54 times the average day demand.

As further discussed in this Reliability Study, average day water demands are included in the systems analysis for the purpose of conducting calibration runs. Maximum day water demands are used to evaluate system reliability. Each of the GDPUD regions and pressure zones are evaluated in Section VI of this Study under maximum day demands and under maximum day plus fire flow demand criteria.

Walton Lake / Georgetown / Spanish Dry Diggins

This region is located in the central and northeastern portion of the GDPUD Service Area. It encompasses some 17,850 acres, approximately 835 GDPUD service parcels and 8 pressure zones. For the purpose of this Study, pressure zones have been designated as:

- Fools Canyon
- Walton Lake
- Hotchkiss Hill
- Georgetown East
- Georgetown West
- Spanish Dry Diggins Tank
- Spanish Dry Diggins South
- Spanish Dry Diggins North

Each of these zones has been evaluated separately as part of the Walton Lakes / Georgetown / Spanish Dry Diggins Region. Domestic water demands by land use for each of these zones are also presented later in this section of this Reliability Study. As discussed above each of these zones is defined by a reservoir, tank or pressure reducing station. In general, average day and maximum day residential land use water demands for this region are summarized as follows:

Average Day and Maximum Day
Domestic Water Demands
Walton Lakes / Georgetown / Spanish Dry Diggins Region

Land Use	Avg. Day Demand (gpd / parcel)	Max. Day Demand (gpd / parcel)
Small Ac. Residential	360	915
Medium Ac. Residential	390	990
Large Ac. Residential	450	1140

Auburn Lake Trails / Cool / Pilot Hill Region

This region is served by the Auburn Lake Trails Water Treatment Plant. It currently encompasses some 32,900 acres and some 1435 service parcels. For this Study nine pressure zones have been identified in this region. These are:

- Black Ridge
- ALT East / Greenwood

- ALT Central
- Indian Rock
- ALT West
- Cool / Cherry Acres
- Meadowview
- EXT 82A
- Old Pilot Hill

Demand summaries for each of the land uses in each of these pressure zones are presented later in this section of this Reliability Study. In general, average day and maximum day residential land use domestic water demands for this region can be summarized as follows:

Average Day and Maximum Day
Water Demands
Auburn Lake Trails / Cool / Pilot Hill Region

Land Use	Avg. Day Demand (gpd / parcel)	Max. Day Demand (gpd / parcel)
Small Ac. Residential	435	1045
Medium Ac. Residential	510	1225
Large Ac. Residential	550	1320

For this region the maximum day factor applied was 2.40 based on Auburn Lake Trails Water Treatment Plant production records available for the period of 1996 to the present.

Comparison of GDPUD and EID Residential Water Demands

To evaluate the water demand findings determined for this Reliability Study and presented herein a comparison of GDPUD demands, by region, to El Dorado Irrigation District (EID) residential demand standards was conducted.

EID Standard Water Demands in effect for the EID "Central Region" are used for this comparison since this EID region (which includes the communities of Lotus, Coloma, Diamond Springs, Pleasant Valley, Placerville) most closely matches the characteristics of the GDPUD service area.

A summary comparison of average annual GDPUD demands and EID Standards is as follows:

Summary Comparison of EID Central Water Demand Studies and GDPUD Average Day Residential Water Demands				
Land Use	EID Central Avg. Annual Demand Standards (gpd / unit)	GDPUD Avg. Annual Demand Results by Region (gpd / unit)		
		Garden Valley/ Kelsey	Walton Lakes/ Georgetown	ALT / Cool/ Pilot Hill
Small Acreage Residential	375	295	360	435
Medium Acreage Residential	550	425	390	510
Large Acreage Residential	880	475	450	550

A summary comparison of EID maximum day residential demand standards and GDPUD Service Area findings is as follows:

Summary Comparison of EID Central Water Demand Studies and GDPUD Maximum Day Residential Water Demands				
Land Use	EID Central Max. Day Demand Standards (gpd / unit)	GDPUD Max. Day Demand Results by Region (gpd / unit)		
		Garden Valley/ Kelsey	Walton Lakes/ Georgetown	ALT / Cool/ Pilot Hill
Small Acreage Residential	750	750	915	1045
Medium Acreage Residential	1100	1070	990	1225
Large Acreage Residential	1760	1200	1140	1320

As presented above there is good correlation between the average annual and maximum day water demand findings for residential parcels within the GDPUD Service Area and the water demand standards in effect for the EID Central Zone.

Water Demands by Land Use

For each region and for each pressure zone within the GDPUD service area water demands by land use were determined. As previously discussed, land use data by parcel was available from the El Dorado County GIS database. From this database parcel acreage, use description, use codes and land use ones were determined by parcel. Water demands for each GDPUD region and pressure zone were determined, by land use, as follows:

- Small Acreage Residential (less than 1 acre)
- Medium Acreage Residential (1 to 5 acres)
- Large Acreage Residential (over 5 acres)
- High Density Residential (apts., mobile home parks, condominiums)
- Agricultural
- Commercial
- Industrial
- Public Use

The domestic water demand findings of this Reliability Study are summarized by region, pressure zone and land use in **Table IV-1** for the Garden / Kelsey Region, in Table **IV-2** for the Walton Lakes / Georgetown / Spanish Dry Diggins Region and in Table **IV-3** for the Auburn Lake Trails / Cool / Pilot Hill Region.

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TABLE IV-1
GDPUD DOMESTIC WATER
DEMAND SUMMARY
GARDEN VALLEY / KELSEY REGION

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS (1)
Pressure Zone: Kelsey				
Residential				
- Small Acreage (< 1 acre)	280	140-430	710	7
- Medium Acreage (1-5acres)	360	100-950	910	28
- Large Acreage (>5 acres)	400	100-1300	1020	27
- High Density	2720	2720	6910	1
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	100	100	250	1
Unknown	---	---	---	---
Pressure Zone: Garden Park				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	440	100-2330	1120	172
- Large Acreage (>5 acres)	440	100-1600	1120	19
- High Density	---	---	---	---
Agricultural	750	200-1140	1910	4
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---
Pressure Zone: Marshall Grade				
Residential				
- Small Acreage (< 1 acre)	320	320	810	1
- Medium Acreage (1-5acres)	540	140-1900	1370	90
- Large Acreage (>5 acres)	640	120-4640	1630	76
- High Density	---	---	---	---
Agricultural	310	160-560	790	5
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	--	---

TABLE IV-1 (cont.)

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS [1]
Pressure Zone: Water Willow				
Residential				
- Small Acreage (< 1 acre)	200	200	510	1
- Medium Acreage (1-5acres)	480	110-1290	1220	42
- Large Acreage (>5 acres)	430	110-2060	1090	14
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---
Pressure Zone: Irish Lane				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	400	400	1020	1
- Large Acreage (>5 acres)	420	190-830	1070	5
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---
Pressure Zone: Traverse Creek				
Residential				
- Small Acreage (< 1 acre)	230	130-320	580	7
- Medium Acreage (1-5acres)	370	100-1970	940	46
- Large Acreage (>5 acres)	520	110-3010	1320	42
- High Density	---	---	---	---
Agricultural	470	250-750	1190	3
Commercial	---	---	---	---
Industrial	830	830	2110	1
Public Use	600	600	1520	1
Unknown	---	---	---	---

TABLE IV-1 (cont.)

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS (1)
Pressure Zone: Garden Valley				
Residential				
- Small Acreage (< 1 acre)	430	120-1220	1090	13
- Medium Acreage (1-5acres)	360	100-1470	910	92
- Large Acreage (>5 acres)	460	110-1340	1170	48
- High Density	---	---	---	---
Agricultural	480	120-760	1220	3
Commercial	420	120-910	1070	7
Industrial	---	---	---	---
Public Use	210	210	530	1
Unknown	8940	820-17050	22710	2

Notes:

(1) Parcels within very low demand data (100 gpd or less) were not included in average day demand determinations

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TABLE IV-2
GDPUD DOMESTIC WATER
DEMAND SUMMARY
WALTON LAKE / GEORGETOWN / SPANISH
DRY DIGGINS REGION

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS (1)
Pressure Zone: Fools Canyon				
Residential				
- Small Acreage (< 1 acre)	460	1190-850	1170	3
- Medium Acreage (1-5acres)	480	120-1270	1220	39
- Large Acreage (>5 acres)	610	230-2040	1550	15
- High Density	---	---	---	---
Agricultural	360	360	910	1
Commercial	400	400	1020	1
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	300	300	790	1
Pressure Zone: Walton Lake				
Residential				
- Small Acreage (< 1 acre)	280	120-530	710	21
- Medium Acreage (1-5acres)	300	120-750	760	49
- Large Acreage (>5 acres)	300	120-730	760	20
- High Density	7400	7400	18800	1
Agricultural	950	950	2410	1
Commercial	520	520	1320	1
Industrial	---	---	---	---
Public Use	1830	590-3070	4650	2
Unknown	230	230	580	1
Pressure Zone: Hotchkiss Hill				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	280	100-640	710	6
- Large Acreage (>5 acres)	290	290	740	1
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	--	---

TABLE IV-2 (cont.)

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS [1]
Pressure Zone: Georgetown East				
Residential				
- Small Acreage (< 1 acre)	350	100-1580	890	25
- Medium Acreage (1-5acres)	390	110-1110	990	67
- Large Acreage (>5 acres)	490	140-1950	1240	19
- High Density	600	450-750	1520	2
Agricultural	4720	380-9050	11990	2
Commercial	220	220	560	1
Industrial	670	620-730	1700	2
Public Use	2170	420-3910	5510	2
Unknown	230	230	580	1
Pressure Zone: Georgetown West				
Residential				
- Small Acreage (< 1 acre)	350	100-1430	890	103
- Medium Acreage (1-5acres)	370	100-1600	990	180
- Large Acreage (>5 acres)	440	110-1420	1120	40
- High Density	610	250-1630	1550	5
Agricultural	340	100-750	860	5
Commercial	730	150-5030	1850	23
Industrial	1220	1220	3100	1
Public Use	470	250-680	1190	2
Unknown	4200	140-23640	10670	6
Pressure Zone: Spanish Dry Diggins Tank				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	480	170-780	1220	2
- Large Acreage (>5 acres)	480	120-1350	1220	17
- High Density	---	---	---	---
Agricultural	340	190-590	860	3
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---

TABLE IV-2 (cont.)

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS (1)
Pressure Zone: Spanish Dry Diggins South				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	350	350-130-920	890	1
- Large Acreage (>5 acres)	440	---	1120	3
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---
Pressure Zone: Spanish Dry Diggins North				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	460	120-1680	1190	84
- Large Acreage (>5 acres)	540	110-3570	1370	23
- High Density	---	111	---	---
Agricultural	10	10	30	1
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	600	600	1520	1

Notes:

(1) Parcels with very low consumption data (100 gpd or less) were not included in average day demand determinations

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TABLE IV-3
GDPUD DOMESTIC WATER
DEMAND SUMMARY
AUBURN LAKE TRAILS / COOL / PILOT HILL

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS (1)
Pressure Zone: Black Ridge				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	---	---	---	---
- Large Acreage (>5 acres)	410	140-990	980	8
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---
Pressure Zone: Alt East Greenwood				
Residential				
- Small Acreage (< 1 acre)	370	100-1140	890	171
- Medium Acreage (1-5acres)	420	100-1550	1010	270
- Large Acreage (>5 acres)	540	100-2660	1300	81
- High Density	640	460-820	1540	2
Agricultural	460	460	1100	1
Commercial	420	160-1000	1010	6
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	610	140-4640	1460	19
Pressure Zone: Alt Central				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	420	110-2030	1010	85
- Large Acreage (>5 acres)	510	150-960	1220	12
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	140	140	340	1

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TABLE IV-3 (cont.)

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS [1]
Pressure Zone: Indian Rock				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	450	160-980	1080	7
- Large Acreage (>5 acres)	460	240-1030	1100	4
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	520	520	1250	1
Pressure Zone: Alt West				
Residential				
- Small Acreage (< 1 acre)	450	110-2090	1080	119
- Medium Acreage (1-5acres)	430	130-1210	1030	89
- Large Acreage (>5 acres)	420	100-880	1010	10
- High Density	---	---	---	---
Agricultural	660	660	1580	1
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	260	260	620	1
Unknown	370	890	300-450	2
Pressure Zone: Cool / Cherry Acres				
Residential				
- Small Acreage (< 1 acre)	430	100-1140	1030	127
- Medium Acreage (1-5acres)	560	100-2530	1340	131
- Large Acreage (>5 acres)	770	240-2580	1850	29
- High Density	1400	1400	3360	1
Agricultural	1260	230-4860	3020	6
Commercial	2700	1380-4410	6480	3
Industrial	0	0	0	1
Public Use	6260	6260	15020	1
Unknown	610	140-1430	1460	10
Pressure Zone: Meadowview				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	610	220-1440	1460	23
- Large Acreage (>5 acres)	650	100-1990	1560	32
- High Density	---	---	---	---
Agricultural	---	---	---	---
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	---	---	---	---

TABLE IV-3 (cont.)

LAND USE	AVE DAY (GPD)	RANGE (GPD)	MAX DAY (GPD)	# of PARCELS (1)
Pressure Zone: Ext 82A				
Residential				
- Small Acreage (< 1 acre)	---	---	---	---
- Medium Acreage (1-5acres)	490	160-1500	1180	11
- Large Acreage (>5 acres)	650	210-2820	1560	19
- High Density	---	---	---	---
Agricultural	140	140	340	1
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	---	---	---	---
Unknown	500	230-820	1200	3
Pressure Zone: Old Pilot Hill				
Residential				
- Small Acreage (< 1 acre)	490	270-940	1180	5
- Medium Acreage (1-5acres)	680	100-2010	1630	29
- Large Acreage (>5 acres)	540	180-1830	1300	15
- High Density	3260	690-7650	7820	3
Agricultural	240	240	580	1
Commercial	---	---	---	---
Industrial	---	---	---	---
Public Use	1960	1960	4700	1
Unknown	---	---	---	---

Notes:

(1) Parcels with very low demand data (100 gpd or less) were not included in average day demand calculations.

DITCH DESIGN FLOWS

GDPUD measures releases from Stumpy Meadows Reservoir and measures ditch flows at measuring flumes located near the outlet from Tunnel Hill and at the outlet from Buckeye Conduit. Flows measured below Tunnel Hill most accurately reflect water conveyed in the GDPUD ditch system. These flows include water diverted from Pilot Creek at the Pilot Creek Diversion Dam and side water that is captured at the Bacon Creek Diversion Dam and at structures 1 through 7 located upstream of Tunnel Hill. In spring and early summer the District is normally permitted to collect sidewater from Bacon Creek Diversion Dam and from Structures 1 through 7. To maintain flows in Pilot Creek, restrictions are imposed on GDPUD from collecting sidewater during summer and fall months. In 2002, for example, GDPUD was not permitted to collect sidewater from structures 3 through 7 after August 1. Summertime flow measured at the Tunnel Hill outlet typically vary from 29 to 33 cfs. Since 1996, GDPUD has recorded flow measurements at the Tunnel Hill outlet. To date, the maximum daily flow recorded at this location is approximately 35 cfs.

The measuring flume at the Buckeye Conduit outlet is located downstream of Walton Lakes and reflects diversions to the Walton Lakes Water Treatment Plant. The maximum rated capacity of the Walton Lake Water Treatment Plant is 2.3 MGD (3.55 cfs). According to plant operating data, the maximum day water production at Walton Lake was approximately 1.8 MGD (2.8 cfs). Summer time flows measured at the Buckeye Outlet typically range from 24 to 26 cfs. These measured flows are consistent with the Tunnel Hill flow measurements less the summer time water treatment demands at Walton Lake Treatment Plant. Since 1966, maximum daily flows up to approximately 30 cfs have been recorded at the Buckeye Outlet.

Downstream of the Buckeye and Schroeder Conduits, flows are diverted to Main Ditch #1 and to Kelsey Ditch #1. The District does not currently maintain flow measuring facilities at this diversion point (known as "the Crails"). Based on operating experience approximately 1/3 of the flow delivered from the Buckeye Conduit is diverted to the Kelsey Ditch with approximately 2/3 of the flow diverted to the Main Ditch. For the purposes of this Reliability Study and consistent with the ditch flow data available a current design flow of 8 to 10 cfs is assigned to the upper section of the Kelsey Ditch System and a current design flow of 18 to 20 cfs is assigned to the upper section of the Main Ditch #1.

Water is diverted from the Main Ditch System to serve the Auburn Lake Trails (ALT) Water Treatment Plant. Downstream of this diversion point, water flows via the GDPUD ditch system to irrigation and raw water sources in Cool, Pilot Hill and Cherry Acres. The Kelsey Ditch System serves irrigation and raw water demands along Highway 193, Greenwood Road, Garden Valley and Kelsey.

A summary of raw water ditch design flows is presented in **Table IV-4**. In Section VI, the capacity of each section of the GDPUD ditch system shall be evaluated with respect to these current design flows. Current design flows presented in Table IV-4 provide a 10% to 15% range to allow for short term surges, changes in the flow released at Stumpy Meadows and entering the Pilot Creek Diversion Dam, the capture of sidewater at locations such as the Bacon Creek Diversion Dam, Upcountry Structures #1 through #7 and the miscellaneous capture of flows throughout the ditch system.

The range of ditch flows presented in Table IV-4 allows for diversion and losses along the ditch system. Main Ditch / Pilot Hill Ditch design flows take into account releases to the Taylor Mine Ditch, the ALT Water Treatment Plant, Cherry Acres Ditch and the Pilot Hill Estates and Pilot Hill Pipelines. The ALT Water Treatment Plant has a maximum rated capacity of approximately 2.3 MGD. The maximum day production recorded for this plant is approximately 2.2 MGD (3.40 cfs). Ditch design flows presented herein for Main Ditch No. 2 and the Pilot Hill Ditch downstream of the ALT Water Treatment Plant take into account these water treatment plant demands. Kelsey Ditch design flows take into account diversions to the Garden Valley and Greenwood Pipelines and other demands such as the Cunningham Pipeline.

Ditch design flows must also provide for losses due to leaks, evapotranspiration, and evaporation. Under normal operating conditions, net losses in the Upcountry Ditch Section are relatively small. Losses due to evapotranspiration, evaporation and leaks are offset with inflows from the Bacon Creek Diversion Dam and sidewater structures #1 through #7. The daily ditch flows recorded at the Tunnel Hill measuring flume are comparable to the ditch flows recorded upstream at the Pilot Creek Diversion Point. When Walton Lakes Water Treatment Plant demands are taken into account the daily ditch flows measured at the Buckeye Flume compare reasonably well with the ditch flows measured at Tunnel Hill. Flows into the Buckeye conduit are also regulated by changes in storage at Walton Lake.

Ditch flows are estimated but not measured with a flow metering device in either the Main Ditch / Pilot Hill Ditch or the Kelsey Ditch. Losses in these ditch systems must therefore be estimated. Based on operating experience and typical ditch performance the net loss in ditch flows in the Main / Pilot Hill Ditch and Kelsey Ditch Systems are estimated at 25% of the total design flows. For the Main Ditch / Pilot Hill Ditch System, a 5 cfs loss is included in the ditch design flows. For the Kelsey Ditch a 2.5 cfs loss is included in the ditch design flows.

The ability of existing GDPUD ditch, culvert and piped sections to reliably convey the design flows presented in Table IV-4 is discussed in Section VI of this Study.

TABLE IV-4

GDPUD
RAW WATER DITCH
DESIGN FLOWS

GDPUD Ditch Section	Current Design Flows (cfs)
Upcountry Ditch	
Pilot Creek Div. Dam to Tunnel Hill Outlet	32 to 35
Tunnel Hill Outlet To Walton Lake Water Treatment Plant	32 to 35
Walton Lake Water Treatment Plant to The Crails	27 to 30
Main / Pilot Hill Ditch	
Main Ditch No. 1, Crails to Taylor Mine Ditch	18 to 20
Main Ditch No. 1, Taylor Mine Ditch to Greenwood / Spanish Dry Diggins Ditch	16 to 17.5
Main Ditch No. 2, Spanish Dry Diggins Ditch to ALT Water Treatment Plant	15 to 16.5
Main Ditch No. 2 ALT Water Treatment Plant To Cherry Acres Ditch	12.5 to 14
Pilot Hill Ditch, Cherry Acres Ditch to Nagle Wastegate	8 to 12

TABLE IV-4 (cont.)

GDPUD
RAW WATER DITCH
DESIGN FLOWS

GDPUD Ditch Section	Current Design Flows (cfs)
Pilot Hill Ditch, Nagle Wastegate to Wagner Res.	5 to 8
Pilot Hill Ditch, Wagner Res. to Pilot Hill Res.	3 to 5
Kelsey Ditch	
Kelsey Ditch No. 1, Crails to Black Oak Mine Siphon / Garden Valley Pipeline	8 to 10
Kelsey Ditch No. 2, Garden Valley Pipeline to Chicken Flat Wastegate	5 to 8
Kelsey Ditch No. 2, Chicken Flat Wastegate to Kelsey Reservoir	3 to 5
Spanish Dry Diggins Ditch	2 to 3
Taylor Mine Ditch	3 to 5
Cherry Acres Ditch	2 to 3
Garden Valley / Greenwood Pipeline	2 to 3
Pilot Hill Pipeline	2 to 3
Pilot Hill Estates Pipeline	1 to 2
Greenwood Road Pipeline	1 to 2

V PERFORMANCE AND DESIGN CRITERIA

In this section of this Reliability Study recommended improvement standards are presented for GDPUD treated water storage and distribution facilities. Design criteria and improvement standards are also presented for the GDPUD raw water ditch system.

DESIGN CRITERIA – TREATED WATER SYSTEMS

As part of the scope of this Reliability Study, recommended water system Improvement Standards have been submitted to GDPUD. Performance and design criteria included within these Improvement Standards are summarized herein.

Regulatory Standards

Compliance with the following regulatory standards, including all updates and changes, should be included in the design of GDPUD treated water systems.

- United Stated Public Health Service (USPHS) Drinking Water standards and the Environmental Public Agency (EPA) Standards.
- California Safe Drinking Water Act, Laws and Standards of the state of California, Department of health Services, Public Water Supply Branch.
- The Porter-Cologne Water Quality Control Act and the California Regional Water Quality control Board, Central valley Region
- Ordinances of the County of El Dorado
- Uniform Fire Code and Local Fire Ordinances

Domestic Water System Demands

For new single family residential developments, it is recommended that average daily water demands be based on the following:

Design Population per Living Unit

- Developments of 100 living units and less; 3.5 persons per unit
- Developments of greater than 100 living units; 3.0 persons per unit

Average Per Capita Daily Flow Requirement

- Forested, Residential Developments (approximately above 3,000 ft. elevation), 200 gallons per person per day.
- Urban and Non-forested Residential Developments (approximately below 3,000 ft. elevation), 250 gallons per person per day.

These average daily demand values are consistent with the water demand findings included in Section IV of this Reliability Study.

Commercial and Industrial Uses

Since water demands for commercial and industrial uses vary widely, design demands should be based on the specific flow requirements of the proposed developments.

Schools

The larger demand, as determined from one of the two following methods, should be assumed for schools.

- The entire school area shall be assumed a single family zoning with minimum sized lots assumed.
- Flow shall be based on ultimate design student population plus administration, teaching and operating personnel.

Maximum Day Demands

Maximum day demands should be determined by multiplying average day demands by a factor of 2.0. this multiplier is consistent with the maximum day demand findings included in Section IV of this Reliability Study.

Peak Hourly Demands

Peak hourly demands should be determined by multiplying average day demands by a factor of 3.0

Fire Flows

The fire protection district with jurisdiction (El Dorado County Fire Protection District, Garden Valley Fire Department, Georgetown Fire Protection District, California Department of Forestry, etc.) should set fire flow requirements. In the absence of requirements from the local or county fire protection district, the following minimum design requirements are recommended:

- Single Family and Duplex Residential – 500 gpm from a single hydrant
- Townhouse, Apartment, Multiple Residential units – 1000 gpm from two hydrants
- Commercial and Industrial – based on Uniform Building Code Standards but not less than 1500 gpm from two hydrants

Treated Water Storage

Water storage tank capacity should be at least equal to the sum of the fire storage reservation, plus allowance for system peaking plus allowance for emergency reserve. The minimum storage tank capacity should be 250,000 gallons

Fire Storage Reservation

The fire storage reservation should be no less than the product of the minimum design fire flow and the design fire duration. The minimum design fire duration should be four (4) hours but may be increased by the fire protection district with jurisdiction. In residential areas the minimum fire storage reservation should be 120,000 gallons.

System Peaking Storage

Water storage tanks should provide not less than twenty (20) percent of the total maximum daily flows assuming a 24-hour pumping rate. Per 100 residential units, each with a maximum day demand of 1500 gallons per unit per day, the system peaking storage provided should be not less than 30,000 gallons.

Emergency Storage

Water storage tanks should provide emergency storage capacity in excess of fire storage and system peaking storage requirements. Emergency storage equivalent to a four hour demand under maximum day demands is recommended as the emergency storage reservation. Per 100 residential units, emergency storage equivalent to 25,000 gallons is recommended.

Treated Water Storage Transmission Mains

Recommended water storage transmission main design criteria and performance standards are as follows:

Pipe Material

- PVC C-900 or C-905, CL 150/200
- DIP CL 200 minimum

Pipe Size

- 8 inch diameter minimum
- Transmission main should be sized to deliver maximum daily demands at velocities not greater than 10 feet per second

Pressure

Transmission mains should be suitable for working pressures as high as 200 psi

Minimum Cover

3 feet minimum cover is recommended for water transmission mains

Treated Water Distribution Lines

Pipe Material

It is recommended that treated water distribution lines be constructed of the same material as the transmission mains; either PVC C-900 or C-905, CL 150/200 or DIP, CL 200 minimum.

Pipe Size

An 8-inch diameter minimum size is recommended for distribution lines, however, for short (less than 500 foot long) dead end water mains, a 6-inch diameter main may be adequate if not more than one fire hydrant is supplied from this distribution line.

Flow Data

Distribution lines should be sized to deliver the larger of:

- Maximum hourly flows or
- Maximum day demands plus fire flows

Distribution lines should be sized to deliver the design flow rate at velocities not greater than 10 feet per second.

Design Pressures

For municipal service the allowable working pressure within the distribution system should not exceed 150 psi under maximum day demand conditions. The minimum service pressure should not be below 35 psi at the meter and the maximum service pressure should not exceed 115 psi at the meter. The distribution system should be sized to provide fire flows plus maximum day demands at not less than 20 psi.

Main Line Valves, Blow-Off Assemblies and Air Release Valves

Main line valves should be installed at not more than 1800 foot intervals on transmission mains. Air release valves should be installed at all pipeline summits at 1,500 – 3,000 foot intervals and at both ends of long horizontal runs of pipe. Pipeline

blow-offs should be installed at all major low points. Whenever practical, a fire hydrant should be used for blow-off valves. A summary of recommended treated water standards and design criteria is presented in **Table V-1**. A performance comparison of proposed GDPUD standards and existing EID and PCWA standards is also presented in Table V-1.

DESIGN CRITERIA – RAW WATER SYSTEMS

Raw Water Storage

The storage of raw water is a high priority public health and systems control safety feature of the GDPUD ditch water system. Raw water storage located upstream of the Walton Lake Water Treatment Plant and the ALT Water Treatment Plant should provide adequate storage to meet treated water demands should a ditch failure occur. Based on GDPUD repair records, ditch failures upstream of Tunnel Hill have occurred which have reduced or temporarily eliminated the flow of raw water into downstream ditch sections for periods of up to 10 days. Upcountry Ditch failures are much more likely to occur during winter rain and snow periods than during the summer. For the purpose of this Reliability Study, existing and proposed GDPUD raw water storage reservoirs upstream of water treatment plants shall be evaluated with respect to a winter time ditch failure period of 15 to 20 days.

Planned ditch system repairs are typically conducted after the irrigation season ends in October, and weather permitting, may continue until mid November. For the purpose of this study it shall be assumed that any planned ditch repair work which requires more than 2 weeks (14 days) to repair will include provisions for bypassing the ditch flow with temporary piping and pumping facilities during longer repair periods.

GDPUD water treatment plant production records for Walton Lakes and for ALT for the period of 1994 – 2002 indicate that for the 5 month period of November through March Walton Lake WTP now produces an average of 0.38 million gallons per day (MGD) of treated water. Similarly, "winter" month treated water demands at ALT average 0.40 MGD. During the October and early November ditch maintenance periods, average daily water demands at Walton Lakes are currently 0.56 MGD. At ALT, water demands in October - November are typically 0.62 MGD.

To meet average daily winter time emergency ditch failure conditions, the raw water storage upstream of Walton Lakes equivalent to the average daily demands at Walton Lakes and Auburn Lake trails over a 15 to 20 (winter) day period should be provided. This storage demand is equivalent to 11.7 to 15.6 MG or 36 to 48 acre-feet. To meet the winter time emergency storage demands upstream of ALT, raw water storage equivalent to 6 to 8 MGD (18.5 to 25 acre-feet) should be provided. To permit fall maintenance work, it is recommended that raw water storage upstream of Walton Lakes equivalent to 16.5 MG or 50.8 acre-feet be available. To meet fall maintenance criteria upstream of ALT, 8.7 MG or 26.7 acre-feet of raw water storage should be available.

TABLE V-1
RECOMMENDED GDPUD DESIGN CRITERIA AND PERFORMANCE STANDARDS

IMPROVEMENT STANDARD COMPARISON TABLE – WATER DESIGN CRITERIA

GDPUDSPEC SECTION	DESIGN ITEM	RECOMMENDED GDPUD STANDARDS (2002)	PCWA STANDARDS (1993)	EID STANDARDS (1993)
SECTION 1002- REGULATORY STDS.	Agency Compliance	1. United States Public Health Service (USPHS) drinking water stds (DWS) 2. Environmental Public Agency (EPA) stds. 3. California Safe Drinking Water Act, 4. Department of Health Services 5. Porter-Cologne Water Quality Control Act 6. California Regional Water Quality Control Board 7. Ordinances of the County of El Dorado 8. Uniform Fire Code and Local Fire Ordinances	1. Laws and Stds. Of the State of California, Department of Public Health relating to Domestic Water Supply 2. Standards of Minimum Requirements for Safe Practice in the Production and Delivery of Water for Domestic Use 3. Title 17, Chapter V, Sections 7583-7622, California Administrative Code, regarding cross-connections 4. All applicable Ordinances, Rules and Regulations for all local agencies, cities, fire districts, etc…	1. Ordinances, requirements and applicable stds. Of governmental Agencies having jurisdiction within the Districts service area shall be Observed. 2. Uniform Plumbing Code 3. Municipal Code of the County of El Dorado 4. Road encroachment regulations of County of El Dorado 5. CALTRANS Std. Specifications 6. Regulations and Policy's adopted by board of directors of El Dorado Irrigation District
SECTION 1005- CALCULATIONS	Hydraulic Analysis	Computer Analysis Required for Proposed distribution system w/either Haested Methods or EPANET software	Shall be supplied to Agency upon request	Water System analysis shall be performed taking into consideration both existing and future development.
	Formulas	Use Hazen-Williams Formula	NA	Use Hazen-Williams Formula
	C - Values	For new system Use C-value of 140 or per manufacturer, whichever is lower. For existing system use C-value of 120	NA	Size (inches) / Existing Main / Proposed Main 4&6 / 100 / 110 8&10 / 110 / 120 12-18 / 115 / 130 Note: C-values have accounted for minor losses.
SECTION 1006 – MUNICIPAL FLOW	Design Population per Living Unit	3.0-3.5	NA	NA
	Avg Per Capita daily flow	200-250 gal/day	NA	NA
	Avg. Daily Flow (ADF)	(Sum of Design Pop.) x (Avg per capita daily flow)	NA	See Table 3-1: Mean Annual Water Demands Based on Land use Category and Geographic Region around District. Average Day Demand (ADD) - 160-922 gal/dwelling unit/day
	Max Daily Flow/Peak Daily	2 x ADF	- Use 1.5 gpm per connection for new medium to high density land use w/ 5/8"x3/4" meters. - Use 3.0gpm for large lot projects of 1-acre or more per lot - For Commercial/Industrial contact Engineering Department	2.5xADD gpm for – Low Density Residential (Western Region) 2.0x ADD - Medium/High Density Residential Commercial and Industrial 1.5xADD-Multiple Family 4.5xADD- Parks, Schools, Golf Courses
	Max Hourly Flow/ Peak Hour	3 x ADF	NA	5.0xADD-Low Density Residential 4.5xADD-Medium/High Density (Western & Central Region) 3.5xADD- Medium/High Density (Eastern Region) 2.5xADD-Multiple Family Mobile Home, Commercial/Industrial 4.5xADD-Parks, Schools, Golf Courses
SECTION 1007- FIRE FLOW	Fire Flow	500 gpm –Single Family 1000gpm-Townhouse 1500 gpm-Commercial Industrial-As determined by Fire protection district	Local Fire Protection Authority to Determine: -Max allowable velocity=7.0ft/sec -Residual Pressure at Peak Day+Fire must be greater than 20 psi	Fire District governs Fire Flow Requirements
SECTION 1008 SOURCE	Water Quality	EPA Drinking Water Act & State and County Health Departments	NA	NA
	Testing	Public Health Service Chemical Tests (including Heavy Metals), dissolved O_2, turbidity, temperature, bacteriological (including fecal coliform), pH, organics, radioactivity, pesticides, herbicides, etc…	NA	NA

TABLE V-1
RECOMMENDED GDPUD DESIGN CRITERIA AND PERFORMANCE STANDARDS

IMPROVEMENT STANDARD COMPARISON TABLE – WATER DESIGN CRITERIA

GDPUDSPEC SECTION	DESIGN ITEM	RECOMMENDED GDPUD STANDARDS (2002)	PCWA STANDARDS (1993)	EID STANDARDS (1993)
	Reliability	Geologic, Hydrological, and Meteorological to prove adequate supply in driest years on record	NA	NA
SECTION 1009 TREATMENT PLANT AND PUMPING STATION DESIGN	Pumping Units	100% Redundancy, Shall provide Max day design flow w/largest pump out of service	NA	NA
	Facilities	Paved Access, Lighting, and fencing, Toilet and Sink,	NA	NA
	Treatment Requirements	Must Meet DOHS Stds.	NA	NA
	Chlorinating	Gas or Liquid; Not less than 30 min. contact time @ max day & DOHS requirements	NA	NA
	Chlorinating Analyzer	7-Day, Programmable Circular chart recorder alarmed to stop production	NA	NA
	Turbidity	Recorded continuously and alarmed to stop production	NA	NA
	SCADA	Compatible w/ district	NA	NA
	Flow Meter	7-day, programmable circular chart recorder	NA	NA
	Electrical	Auxiliary power required - Monitor status of auxiliary power generation equip.	NA	NA
	Design Flow	Max Daily Flow- or Max Hourly w/ Fire (if no storage)	NA	NA
SECTION 1010 STORAGE FACILITIES	Storage Facility Capacity	Sum of Fire Storage reservation + system peaking + emergency reserve Min=250,000 gal	NA	NA
	Fire Storage Reservation (FSR)	Fire Flow * Duration Min duration is 4 hours	NA	NA
	System Peaking Storage (SPS)	20% of total maximum daily flows	NA	NA
	Emergency Storage (ES)	4-hour duration w/ Max daily flow	NA	NA
	Over-Flow Piping	Sized to pass max incoming flow rate w/4" of Head	NA	NA
SECTION 1011 TRANSMISSION MAINS	Pipe Material	C-900/C-905, PVC CL 150/200 or DIP CL 200	PVC, Ductile Iron, or Steel Pipe w/ minimum pressure rating of 150psi	12" and smaller – PVC, AWWA C900 CL150/200 or Ductile Iron larger than 12" – Ductile Iron CL 250, 300, 350
	Design Flow Rate	Max Daily Flow	Max Daily + Fire Flow	Higher of the two: 1. Peak Hour 2. Max Day + Fire
	Velocity	Max 10 fps	7 fps	10fps
	Minimum Diameter	8"	12"	6"
	Design Pressure	Min=Required Flow to Storage facility, Max=200psi	35 psi Min and 100 psi Max for service connection Minimum peak hour pressure = 30psi Minimum during periods of coincident peak day and fire flow shall not be less than 20 psi. Services w/ 80psi or more should have pressure regulator set to 60psi max. Services w/25psi should have individual hydropneumatic tank maintained by owner.	Max=150psi, Min=40psi, Min Emergency=20psi w/ half full reservoir
	Minimum Cover	3-feet	30"	3-feet in unpaved areas, 30" from subgrade to top of pipe in paved areas 60" in areas above the 5000' elevation
	Locator Wire	For all non-metallic pipe No. 12AWG copper wire Type UF insulation: Looped inside valves/vaults/risers: Grounded @ end of pipe run	No.10 gage insulated copper wire complete w/ epoxy splice kit, 6" over all pipe Provide Continuity Testing before final approval	No. 10 A.W.G. Insulated copper wire - installed on non-metallic pipe and non-bonded pipe

TABLE V-1
RECOMMENDED GDPUD DESIGN CRITERIA AND PERFORMANCE STANDARDS

IMPROVEMENT STANDARD COMPARISON TABLE – WATER DESIGN CRITERIA

GDPUDSPEC SECTION	DESIGN ITEM	RECOMMENDED GDPUD STANDARDS (2002)	PCWA STANDARDS (1993)	EID STANDARDS (1993)
SECTION 1011 TRANSMISSION MAINS	Valves, Blow-offs, and Air Release	Valves spaced 1/per 1800lf, ARV's at end of lines and every 1500-3000 ft, BO's fire hydrant valve preferred	BO's:Required @ low spots and dead ends, fire hydrant maybe substituted for BOV, locate in street 3' from curb and gutter, design BO for 2.5fps velocity: for 8" & 10" use min 4" BOV, for 12" and larger use 6" BOV, 2"BOV @ end of line for future service 4"BOV shall be above ground wharf type & 6"BOV shall be fire hydrant ARV's: Combination air/vacuum release valves (AVRV) at all high points and every 1000' on flat runs and between valved sections of pipe - 1"AVRV on lines up to 12" - 2"AVRV for lines 14-18" - 3" AVRV for lines 20 to 30" for lines larger than 30" shall be as directed by agency or engineer For In-line valves see distribution main	ARV"s: Required at all significant high points BO's: Required at low spots and at dead-ends of lines 2" and 4" assemblies or fire hydrant acceptable Sizing criteria provided: 6"-2"BO, 8"-4"BO, 10"-4"BO, 12"-4"BO, larger than 12" special design. Valves: In-line valves required at a minimum of every 1000' of pipe Except for lines 10" and larger, where valves shall be @ intervals of 100 ft. per inch of pipeline diameter. - Valves shall be the same nominal size as pipeline - Valves shall be able to handle high static pressures - 12" and smaller shall be resilient seated gate valves 12" and larger shall be butterfly valves
SECTION 1012 DISTRIBUTION MAINS	Pipe Material	C-900/C-905, PVC CL 150/200 or DIP CL 200	PVC, Ductile Iron, or Steel Pipe w/ minimum pressure rating of 150psi	12" and smaller – PVC, AWWA C900 CL150/200 or Ductile Iron larger than 12" – Ductile Iron CL 250, 300, 350
	Service Mains	NA	- 5/8", ¾", and 1" meters shall be served w/ 1" service piping - 1" shall be copper or polyethylene - 1.5-2" shall be copper or PVC: 2" and larger shall have buried GV @ main - 3"- PVC - Place near property lines (not in driveways)	1-2" polyethylene tubing CTS, AWWA C901 3" and greater – PVC Schedule 40
	Easements	See Section 600 - minimum width shall be 15' for lines less than 12" or 3 times the depth of line, whichever is greater - pipe location – prefer centerline of easement - Etc… (see section 600)	NA	Shall be accessible by conventional maintenance vehicles traveling over all weather relatively level surfaces. Width – for 18" in DIA. 20' Wide Pipe Location – 5' offsets from easement centerline Easement Location – On one property and not obstructed by walls, trees or permanent improvements unless otherwise approved Easement Provisions-Exclusive, non-exclusive, and or irrevocable offer of easement dedication
	Horizontal & Vertical Curves	NA	Joints laid in accordance w/ manufacturers recommendations	PVC: Deflection of joints not allowed, can bend pipe to the following minimum radius': 4"-190', 6"-200', 8"-250', 10"&12"-fittings required DIP: Max deflection for MJ joints 6-12" -4° or 260 ft radius, 14-18" - 3° or 345 ft. radius.
	Design Flow Rate	Higher of the following 2: 1. Max Hourly Flow Rate 2. Fire Flow Demand + Max Daily Flow	Design Q=Peak Day + Fire	Higher of the two: 1. Peak Hour Max Day + Fire
	Velocity	Max velocity not to exceed 10fps	7 fps	10 fps
	Design Pressure	Not to exceed 150psi Municipal Service Pressure Min=35psi Max=115psi Min w/Fire Flow=20psi	35 psi Min and 100 psi Max for service connection Minimum peak hour pressure = 30psi Minimum during periods of coincident peak day and fire flow shall not be less than 20 psi. Services w/ 80psi or more should have pressure regulator set to 60psi max. Services w/25psi should have individual hydropneumatic tank maintained by owner.	Max=150psi, Min=40psi, Min Emergency=20psi w/ half-full reservoir.

TABLE V-1
RECOMMENDED GDPUD DESIGN CRITERIA AND PERFORMANCE STANDARDS

IMPROVEMENT STANDARD COMPARISON TABLE – WATER DESIGN CRITERIA

GDPUDSPEC SECTION	DESIGN ITEM	RECOMMENDED GDPUD STANDARDS (2002)	PCWA STANDARDS (1993)	EID STANDARDS (1993)
	Min Line Size	6-inches to 8-inch	6"	6": 4-inches if cul-de-sac w/ no more than 8-3/4" services, no longer than 500 feet, and no fire hydrant connections
SECTION 1012 DISTRIBUTION MAINS	In-Line Valves	Distribution System shall have sufficient number of valves such that no single shut down will result in removing from service more than 500 feet of pipe in school, commercial, industrial, or multiple family dwelling areas, or greater than 900 feet in other districts. - No more than 2 fire hydrants out of service - Locate valves in street intersections or on prolongation property lines	Design distribution system w/ enough valves that no single shut-down will result close down more than 1000 feet of transmission line or 500' in other areas. No more than 2-fire hydrants removed from service at once. - 10" and smaller shall be gate valve type - 12" and larger shall be butterfly type - 16" and larger valve shall have min 2" bypass - locate valves in street intersections or property lines - 3-valve min on tees - 4-valve min on crosses - All valves shall be flanged - See More Detail for all valves Section 1.4	In-line valves required at a minimum of every 1000' of pipe Except for lines 10" and larger, where valves shall be @ intervals of 100 ft. per inch of pipeline diameter. - Valves shall be the same nominal size as pipeline - Valves shall be able to handle high static pressures - 12" and smaller shall be resilient seated gate valves - 12" and larger shall be butterfly valves
	Water Meters	Required on all services	5/8"x3/4" to 2": - Shall be in conformance w/ AWWA C700 - Manufactured by Sensus, Schlumberger or equal - Positive Displacement: rotating disc or oscillating piston - Etc… see section 1.4.9.1 3" and Larger - Shall be in conformance w/ AWWA C702 - Manufactured by Sensus or equal - Must have bypass piping: 3"w/2"bypass, 4"w/2", 6" w/4", 8"w/4"	Required on each new single family dwelling unit -No service line less than 1" Dia. -No meter smaller than ¾" -Polyethelene service tubing shall be min 160psi -Positive-displacement piston or disc-type Meter Sizing and Type Table 3-9 provided Service line sizing Table 3-11 and Head loss Tables also provided Table 3-10 and 3-12.
	ARV's/BO's	ARV's: Required at significant high points, Sizing criteria provided BO's: Fire hydrants preferred, dead end runs and low spots, capable of draining pipe in 2 to 4 hours, over 10" requires specially designed BO assembly.	BO's: Required @ low spots and dead ends, fire hydrant maybe substituted for BOV, locate in street 3' from curb and gutter, design BO for 2.5fps velocity: for 8" & 10" use min 4" BOV, for 12" and larger use 6" BOV, 2"BOV @ end of line for future service 4"BOV shall be above ground wharf type & 6"BOV shall be fire hydrant ARV's: Combination air/vacuum release valves (AVRV) at all high points and every 1000' on flat runs and between valved sections of pipe - 1"AVRV on lines up to 12" - 2"AVRV for lines 14-18" - 3" AVRV for lines 20 to 30" - for lines larger than 30" shall be as directed by agency or engineer	ARV's: Required at all significant high points BO's: Required at low spots and at dead-ends of lines 2" and 4" assemblies or fire hydrant acceptable Sizing criteria provided: 6"-2"BO, 8"-4"BO, 10"-4"BO, 12"-4"BO, larger than 12" special design.
	Minimum Cover	3-feet	30"	3-feet in unpaved areas, 30" from subgrade to top of pipe in paved areas 60" in areas above the 5000' elevation
	Locator Wire	For all non-metallic pipe No. 12AWG copper wire Type UF insulation: Looped inside valves/vaults/risers: Grounded @ end of pipe run	No.10 gage insulated copper wire complete w/ epoxy splice kit, 6" over all pipe Provide Continuity Testing before final approval	No. 10 A.W.G. Insulated copper wire - installed on non-metallic pipe and non-bonded pipe
	Separation	10' from parallel sewers and 12" higher	1. 24" min. separation from water line unless sewer 2. 10' min from sewers 3. Crossing-minimum 1' clearance-all sewer crossings shall conform to California State Health department regulations 4. Written application to district to install facilities in common trench.	Per California Code of Regulations: 1. 10 feet from sewers (if less, see Dwg W07) 2. Crossing- minimum 1 foot clearance 4. No common trenches allowed 5. 25' from cesspools, septic tanks, leach fields and seepage pits.

A summary of recommended raw water storage based on current demands, historic failures and ditch maintenance is as follows:

GDPUD
RAW WATER EMERGENCY AND MAINTENANCE
STORAGE CRITERIA
TO MEET EXISTING TREATED
WATER DEMANDS

Location	Ditch Failure Storage [1] (ac-ft)	Ditch Repair Storage [2] (ac-ft)	Recommended Min. Raw Water Storage (ac-ft)
Upstream of Walton Lakes & ALT Water Treatment Plant	36 to 48	51	50
Upstream of ALT Water Treatment Plant	18.5 to 25	26.7	25

(1) Based on a ditch failure resulting in no supply for a 15 to 20 day period during winter months.
(2) Based on a 2 week ditch repair project conducted between Oct. 1 - Nov. 15.

In Section VI of this Study, existing raw water storage capacities are evaluated with respect to the above criteria. Currently, raw water storage upstream of the Walton Lake Water Treatment Plant is limited to the Walton Lakes Reservoir. Raw water storage upstream of the ALT Water Treatment Plant is now provided at Greenwood Reservoir and at the Auburn Lake Trails Water Treatment Plant Reservoir.

Downstream of GDPUD water treatment plants, raw water storage is used to respond to fluctuations in daily irrigation demands. These raw water storage ponds may also be used to sustain demands during those periods during the irrigation season when ditch sections must be temporarily shut down for maintenance or repair.

Ditch Structures

Ditch structures include culverts, piped sections, and wastegates. Adequate culvert capacity is critical since in many locations culverts have been placed which are undersized or of inappropriate pipe material. In **Table V-2** is presented culvert recommendations based on an average ditch slope and hydraulic grade level of 0.002 ft./ft. (0.2%) and a Mannings "N" roughness co-efficient of 0.024. Corrugated metal pipe arches (CMPA) are recommended for culverts. As an alternative to CMPA, corrugated metal pipe (CMP) or high density polyethylene (HDPE) pipe may be used. The CMPA structure is preferred because the lower profile of the "squash pipe" is a better fit for the trapezoidal ditch section. Recommended minimum "round" culvert structures (CMP or HDPE) are also presented in Table V-2.

In Section VI of this Study culverts which have been placed within the GDPUD ditch system shall be compared to the CMPA and CMP recommendations presented in Table V-2. Future culverts which are proposed within the ditch at proposed driveways and new roadway crossings should be placed consistent with the recommendations presented in Table V-2.

Culverts should be constructed with tapered (smooth) inlet and outlet sections. Concrete, cobble or sack-crete should be placed at the upstream end. Culverts should be furnished with flared end sections for both upstream and downstream sections.

Recommended ditch repairs may include replacement of unstable or inadequate ditch sections with piped sections. For gravity flow pipelines, a number of pipe options are available including HDPE pipe, pre-cast concrete, concrete cylinder, lined and coated ductile iron and coated steel pipe. For the purpose of this study, HDPE or concrete pipe with a Mannings "N" of 0.015 is assumed. Piped sections with capacities adequate to meet design ditch flow for the various segments of the GDPUD ditch system are also presented in Table V-2.

Piped sections should be constructed with tapered inlet and outlet sections which are concrete or gunnite lined. A concrete headwall with a debris rack ("grizzley") should be installed at the piped inlet.

While the ditch serves mainly to deliver water to GDPUD customers, it also acts as a drain gutter which collects runoff and discharges this flow to controlled locations. Discharge points, or "wastegates", have been constructed at periodic locations along the ditch. In upper ditch sections sidewater collection structures #1 through #7 are also designed to serve as wastegates for the release of excess flow. In other ditch locations separate structures are provided to waste or discharge excess winter runoff. Structures #1 through #7 located in the Upcountry Ditch Section are constructed of reinforced concrete with metal slide gates. These have been in service for at least 40 years. A few of the wastegates below Tunnel Hill are also concrete construction however, most of

TABLE V-2

CULVERT AND PIPE CRITERIA FOR GDPUD DITCH SECTIONS

GDPUD Ditch Section	Design Flow (cfs)	Recommended Min. CMPA [1] (span x rise, in.)	Recommended Min. Culvert Size (in) CMP or HDPE [2]	Recommended Min. Pipe Size (in.) [3] HDPE or Concrete
Upcountry Ditch				
Pilot Creek Div. Dam to Tunnel Hill Outlet	35	71 x 47	54	48
Tunnel Hill Outlet To Walton Lake Water Treatment Plant	35	71 x 47	54	48
Walton Lake Water Treatment Plant to The Crails	30	66 x 51	54	42
Main / Pilot Hill Ditch				
Main Ditch No. 1, Crails to Taylor Mine Ditch	20	60 x 46	48	42
Main Ditch No. 1, Taylor Mine Ditch to Spanish Dry Diggins	17.5	57 x 38	48	36

TABLE V-2 (cont.)

CULVERT AND PIPE CRITERIA FOR GDPUD DITCH SECTIONS

GDPUD Ditch Section	Design Flow (cfs)	Recommended Min. CMPA [1] (span x rise, in.)	Recommended Min. Culvert Size (in) CMP or HDPE [2]	Recommended Min. Pipe Size (in.) [3] HDPE or Concrete
Main Ditch No. 2, Spanish Dry Diggins Ditch to ALT Water Treatment Plant	16.5	57 x 38	48	36
Main Ditch No. 2 ALT to Cherry Acres Ditch	14	49 x 33	42	36
Pilot Hill Ditch, Cherry Acres Ditch to Nagle Wastegate	12	49 x 33	42	36
Pilot Hill Ditch, Nagle Wastegate to Wagner Res.	8	35 x 24	36	30
Pilot Hill Ditch, Wagner Res. to Pilot Hill Res.	5	35 x 24	36	24

TABLE V-2 (cont.)

CULVERT AND PIPE CRITERIA FOR GDPUD DITCH SECTIONS

GDPUD Ditch Section	Design Flow (cfs)	Recommended Min. CMPA (1) (span x rise)	Recommended Min. Culvert Size (in) CMP or HDPE (2)	Recommended Min. Pipe Size (in.) (3) HDPE or Concrete
Kelsey Ditch				
Kelsey Ditch No. 1, Crails to Black Oak Mine Siphon	10	42 x 29	42	30
Kelsey Ditch No. 2, Black Oak Mine to Chicken Flat Wastegate	8	35 x 24	36	24
Kelsey Ditch No. 2, Chicken Flat Wastegate to Kelsey Reservoir	5	35 x 24	36	24

(1) Slope = 0.002
N = 0.024
Pipe Flow 50% to 75% Fill

(2) Slope = 0.002
N = 0.025
Pipe Flow = 50% to 75% Fill

(3) Slope = 0.002
N = 0.015
Pipe Flow 50% to 75% Fill

the wastegates within the GDPUD System are constructed with wood. These require replacement every 10 to 15 years.

Where wastegates have been constructed in intervals of 3500 to 5000 feet, adequate control of runoff flows has typically been provided. In areas where the wastegate interval exceeds this spacing the ditch operators have difficulty in keeping runoff contained in the ditch until the next wastegate release point. Where runoff flows exceed ditch capacity damage to the ditch section can occur. Where construction equipment access is possible it is recommended that new and replacement wastegates be constructed of concrete. Alternative concrete and metal (slide) wastegate configurations are presented in **Figures V-1 and V-2**.

Ditch Section

The ditch section geometry impacts the flow characteristics, the ease of operation and maintenance, capacity and access. While it is recognized that there are few segments within the GDPUD ditch system which meet all of the characteristics of the design ditch presented in **Figure V-3**, when ditch maintenance and ditch repairs are conducted it is important that reconstruction efforts be directed to achieving the design ditch section as a goal. Ditch section criteria includes freeboard, minimum bottom width and side slopes.

Freeboard

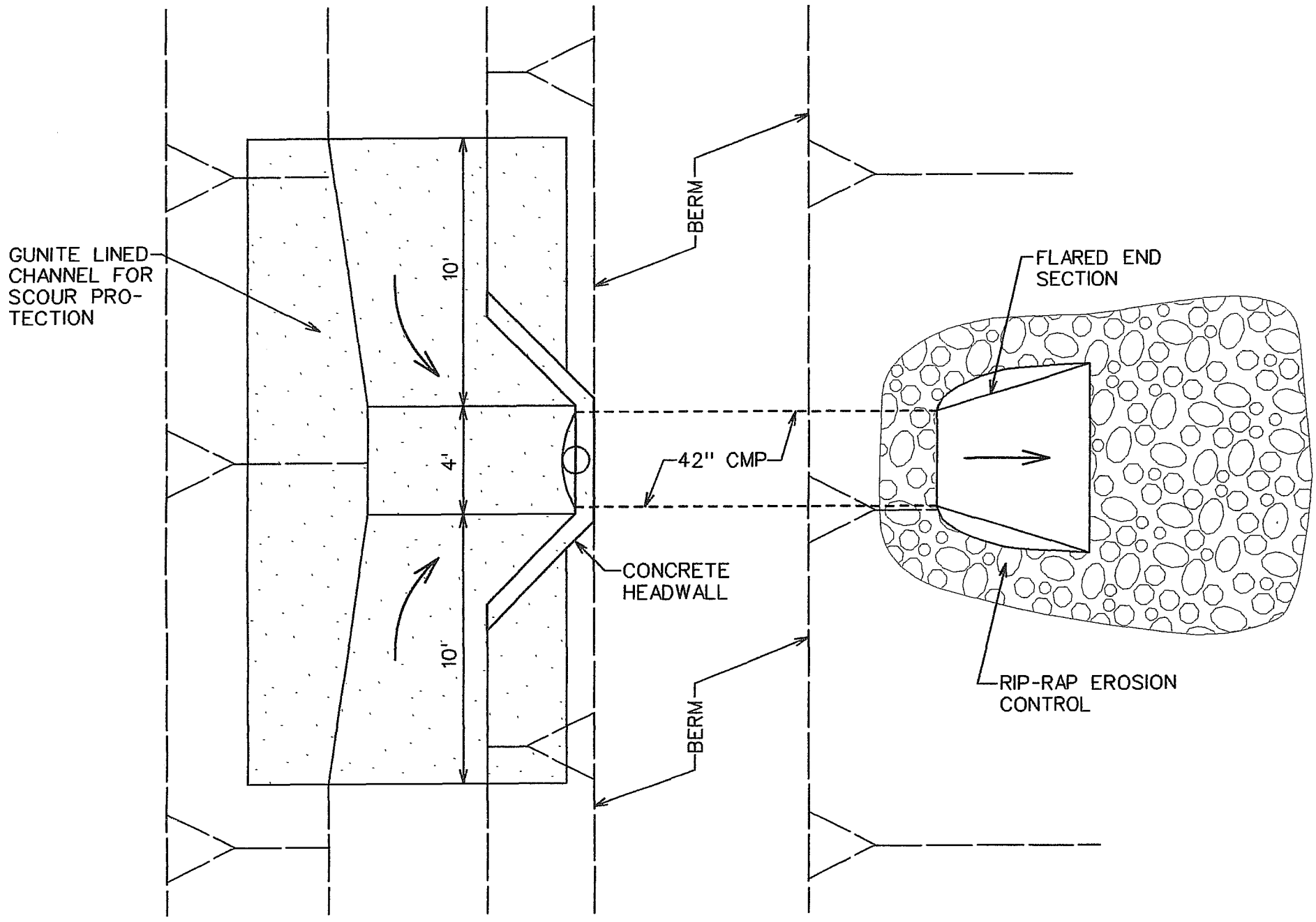
The design capacity of the GDPUD ditch system is evaluated in Section VI, in part, on the basis of allowable freeboard, or "clearance" between the normal maximum operating water level in the ditch and the top of the ditch section. Operating the ditch above these levels typically results in increased losses. Upper sections of the ditch are irregular and are compromised by roots and burrowing animals. Allowable freeboard provides for backwater at inlets to culverts and pipes without over-topping the ditch section.

The allowable freeboard recommended to be included in the reconstruction and repair of GDPUD ditch sections and included in the analysis of existing system ditch capacity is as follows:

TABLE V-1
RECOMMENDED GDPUD DESIGN CRITERIA AND PERFORMANCE STANDARDS

IMPROVEMENT STANDARD COMPARISON TABLE – WATER DESIGN CRITERIA

GDPUDSPEC SECTION	DESIGN ITEM	RECOMMENDED GDPUD STANDARDS (2002)	PCWA STANDARDS (1993)	EID STANDARDS (1993)
SECTION 1012 DISTRIBUTION MAINS	Line Location	6' from ROW CL or easement of 15'	3' from lip of gutter	5' from Edge of Pavement or 3' from lip of gutter:
SECTION 1013 FIRE PROTECTION	Hydrant Type	Dry Barrel w/2-hose one pumper outlet types and 6" Riser pipe	Dry or Wet Barrel per detail SA016 and 0017 Min Dia=Looped 6" feed or 8" feed min.	Dry barrel type w/ 4.5" and 2-21/2" hose nozzles
	Spacing	Single Family: not to exceed 500 feet Townhouse/Commercial/Industrial: not to exceed 300 feet	Per direction of local Fire District	Per direction of local Fire District
SECTION 1016 CREEK CROSSINGS	Material Requirement	DIP under full creek width plus 10 feet either side	NA	NA
	Encasement/Other Specifics	Concrete Encasement Required	NA	- Concrete Encasement w/ reinforcement (per detail W25)- Protect Pipe 10-feet beyond top of banks - Pipelines to cross upstream of hydraulic structures (i.e. bridges, culverts, etc.) - Cross perpendicular to flow line of creek



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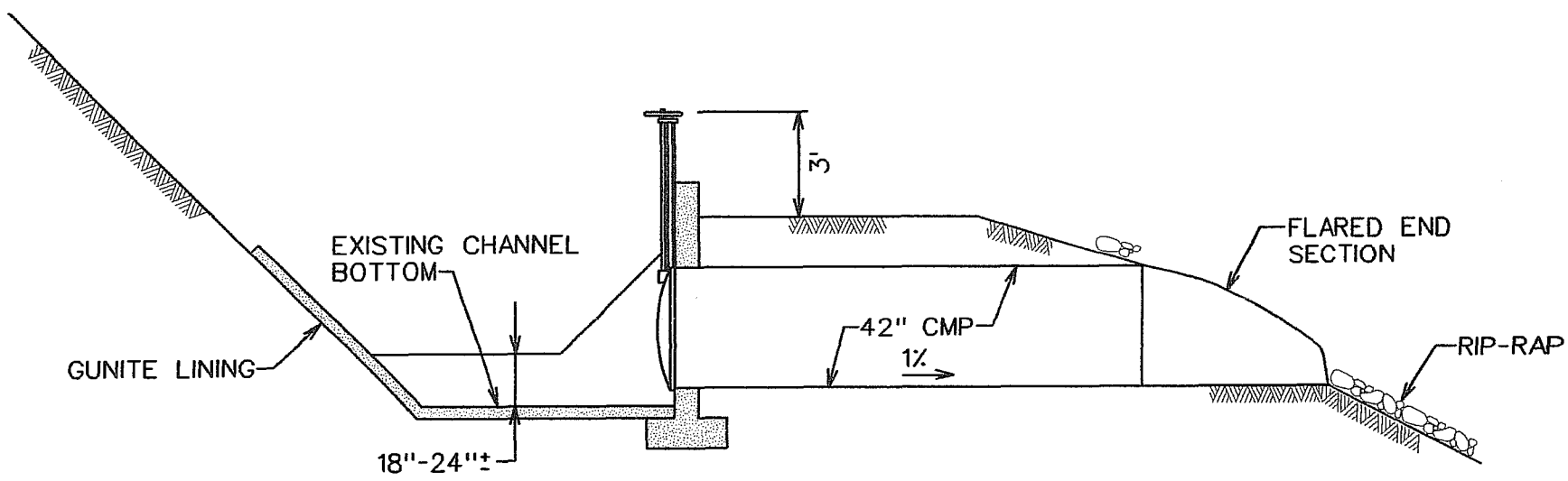
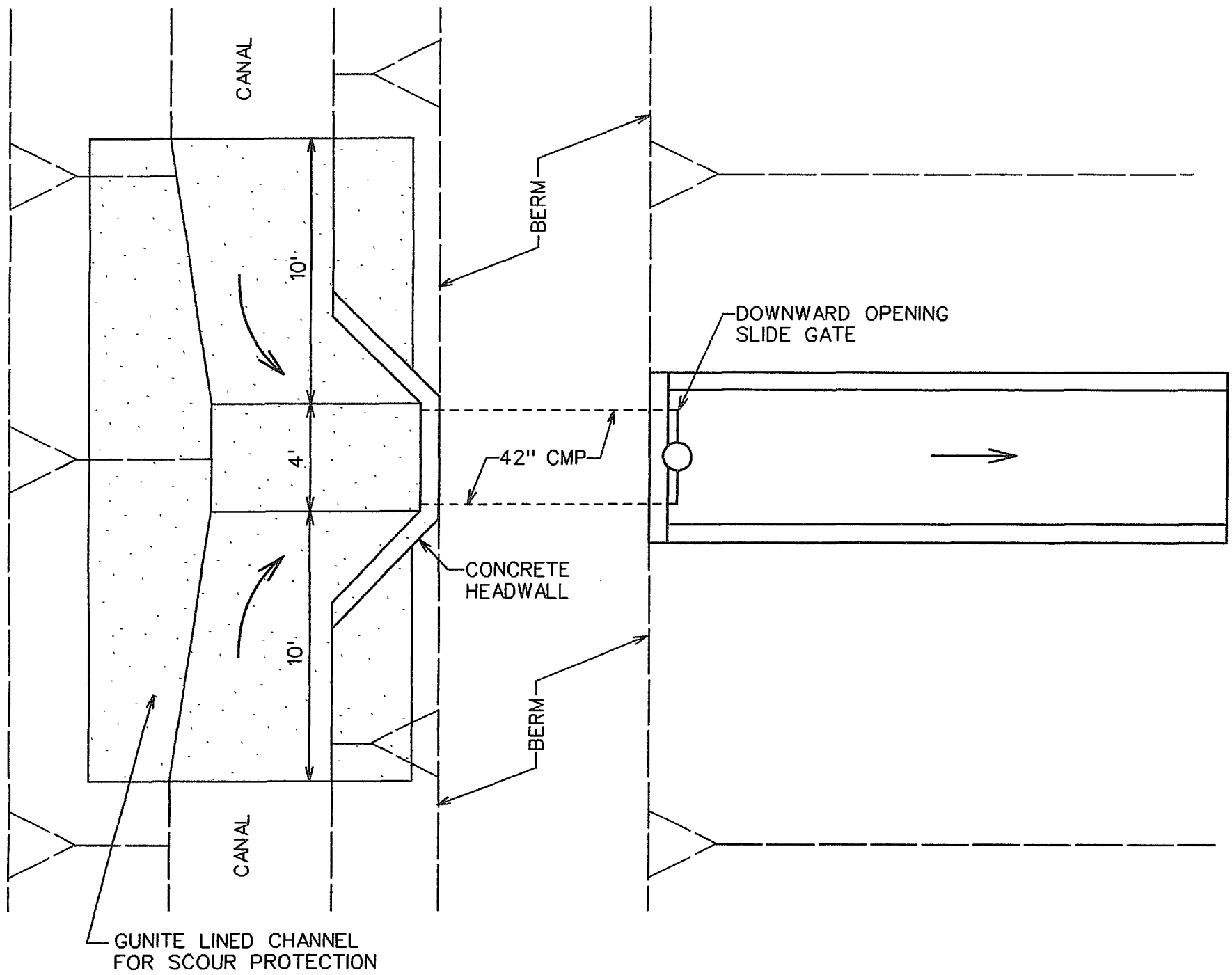


SECTION

WASTE GATE WITH CANAL GATE

SCALE: 1"=5'



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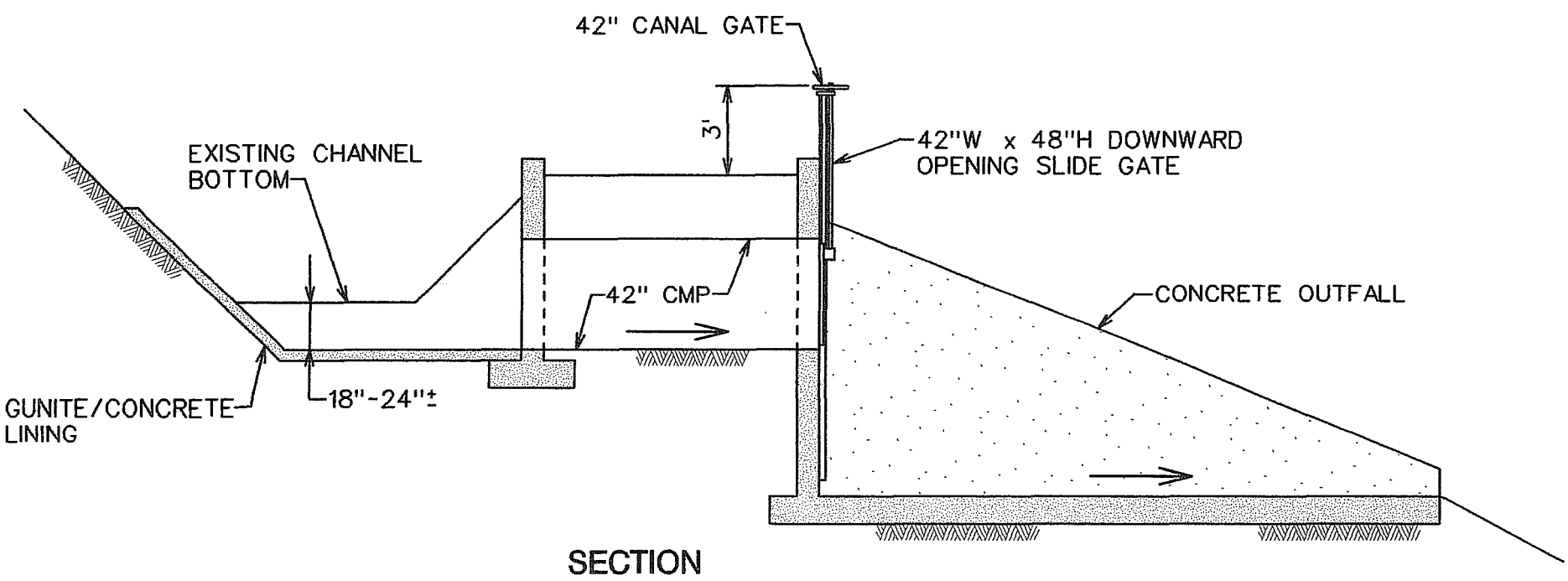
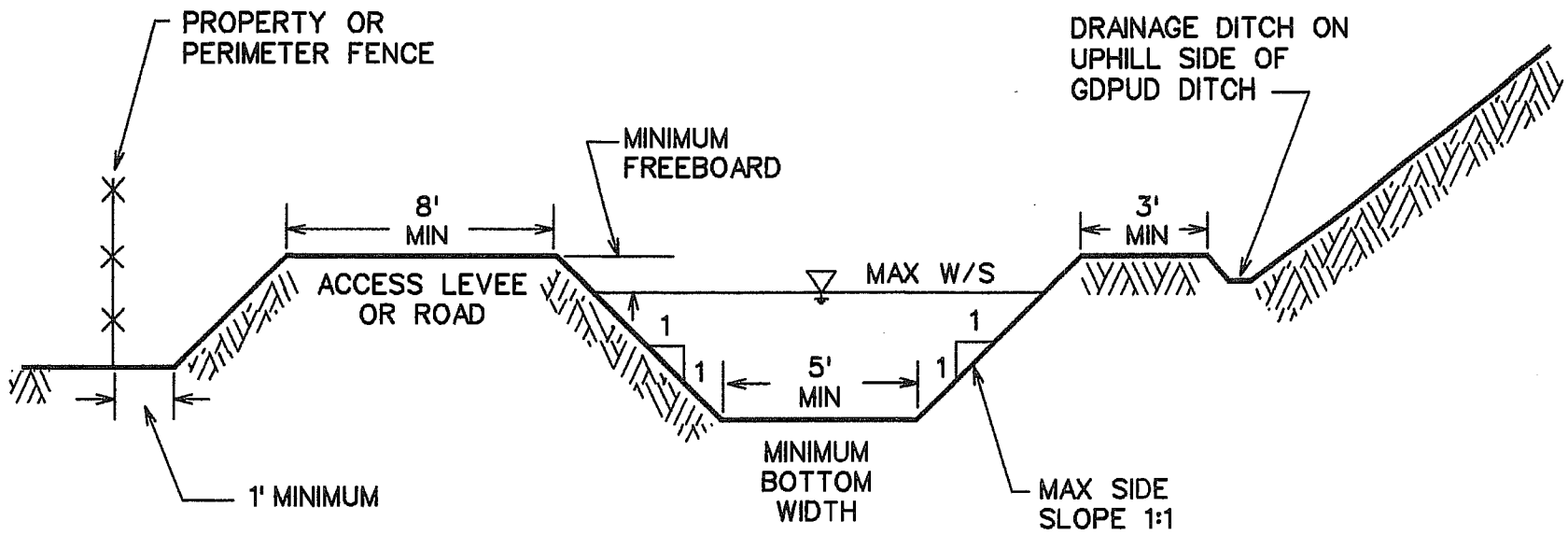


SECTION

WASTE GATE WITH ADJUSTABLE OVERFLOW WEIR

SCALE: 1"=5'

FIGURE 7.9



GDPUD DESIGN DITCH SECTION

NO SCALE

ALLOWABLE FREEBOARD

UPCOUNTRY DITCH
- U/S OF TUNNEL HILL.....2 FT
- TUNNEL HILL OUTLET TO THE CRAILS.....1 FT

MAIN DITCH No. 1
- THE CRAILS TO GREENWOOD/SDD.....0.5-1* FT

MAIN DITCH No. 2
- GREENWOOD/SDD TO DORMAN SIPHON.....0.5-1* FT

PILOT HILL DITCH
- DORMAN SIPHON TO PILOT HILL RES.....0.5 FT

KELSEY DITCH No. 1
- THE CRAILS TO BLACK OAK MINE.....1 FT

KELSEY DITCH No. 2
- BLACK OAK MINE TO KELSEY RES.....0.5 FT

TAYLOR MINE DITCH.....1 FT

CHERRY ACRES DITCH.....1 FT

SPANISH DRY DIGGINS DITCH.....0.5 FT

*WHERE POSSIBLE, A 1 FOOT MINIMUM FREEBOARD SECTION SHOULD BE PROVIDED IN MAIN DITCH No. 1 AND MAIN DITCH No. 2

FIGURE V-3

GDPUD
RAW WATER DITCH MINIMUM
ALLOWABLE FREEBOARD CRITERIA

GDPUD Ditch Sections	Minimum Allowable Freeboard (ft.)
Upcountry Ditch, Upstream of Tunnel Hill	2
Upcountry Ditch, Tunnel Hill Outlet to The Crails	1
Main Ditch No. 1 The Crails to Greenwood / SDD	0.5 to 1*
Main Ditch No. 2 Greenwood / SDD to Dorman Siphon	0.5 to 1*
Pilot Hill Ditch Dorman Siphon to Pilot Hill Res.	0.5
Kelsey Ditch No. 1 The Crails to Black Oak Mine	1.0
Kelsey Ditch No. 2 Black Oak Mine to Kelsey Res.	0.5
Taylor Mine Ditch	1.0
Cherry Acres Ditch	1.0
Spanish Dry Diggins Ditch	0.5

* Where possible, a 1 foot minimum freeboard section should be provided in Main Ditch No. 1 and Main Ditch No. 2.

Minimum Bottom Width and Side Slopes

To allow access for the District maintenance equipment a minimum ditch bottom width of 5 feet should be maintained. This ditch section criteria should be achievable in all areas of the GDPUD raw water ditch system except for the lower sections of the Kelsey Ditch (Kelsey Ditch No. 2 downstream of the Chicken Flat Wastegate) and at the

downstream ends of the smaller distribution ditches; Spanish Dry Diggins, Taylor Mine and Cherry Acres.

Wherever possible a ditch side slope of 1:1, or flatter, should be provided for unlined ditch sections. Ditches located in rocky sections may be constructed with steeper side slopes.

Access and Access Control

For maintenance access a ditch levee width of not less than 8 feet wide should be provided on one side of the ditch. Wherever possible diversion ditches should be provided on the upstream side of the ditch to divert runoff to specific discharge points (wastegates, culverts, drainage swales).

To allow continued operation and maintenance of the ditch system, property fences which cross the ditch section should be installed with a minimum 8-foot wide metal or prefabricated gate. Gates may be secured with GDPUD approved locks. Property line and livestock fences should not be permitted within the ditch section to the maintained toe of the ditch levee. Minimum recommended fence clearances are shown in Figure V-3.

The District should install access control fences outside the toe of the levee slope as necessary to prevent livestock from accessing the ditch section. Without appropriate fencing livestock damage the ditch section, creating losses and increased ditch maintenance costs. Control of livestock access to the ditch is particularly critical in ditch conveyance areas upstream of the Walton Lakes and Auburn Lake Trails Water Treatment Plants.

VI SYSTEMS ANALYSIS

In this section of the Reliability Study the hydraulic network modeling used to simulate the GDPUD treated water systems and the field measurements and hydraulic calculations used to evaluate the GDPUD raw water systems are described. Systems analysis findings are summarized.

TREATED WATER SYSTEM

Network Model

The WaterCad water distribution modeling software developed by Haestad Methods was used to analyze the GDPUD treated water distribution and storage systems. Using this software network models were developed for both the Auburn Lake Trails treated water system and the Walton Lakes treated water system. Network distribution models are mathematical representations of real physical systems. The WaterCad models permit the input of actual physical characteristics as well as loading conditions and boundary information. Field files created from the GPS mapping of the distribution system were input to the WaterCad models. The GPS data provided the actual locations, alignments and elevations of treated water pipes, valves and appurtenances. Water distribution maps created from the field information and used in the network modeling are appended to this report.

Average annual and maximum day water demands determined for each pressure zone served by the Auburn Lake Trails and Walton Lakes systems were also input to the models. Demands were placed at pipe junctions and demand nodes. Fire flows were evaluated at each fire hydrant. Average day and maximum day demands were assigned to pipe junctions and demand nodes consistent with the demand data determined for each pressure zone. By determining the demands (or loading) within each pressure zone loading conditions included in the models reflected actual demands on the Auburn Lake Trails and Walton Lakes systems.

Treated water pipe diameters and pipe material information was available from GDPUD improvement plans. Physical data together with pipe roughness coefficients appropriate for the age and the material of the pipe were input to the models.

Model Development and Review

Water distribution system maps developed for the network models were reviewed with GDPUD staff. Operating data for tanks, PRV's and pump stations was obtained from GDPUD. This information provided the boundary data which must also be included in the network models to produce accurate simulation results.

Model Calibration

Calibration testing of network models ensures that the results provided by the model bear close resemblance to reality. Calibration involves making corrections and adjustments to the model until observed pressures and flow rates are in reasonable agreement with computer-predicted performance over a wide range of operating conditions. Network calibration guidelines published by the American Water Works Association (AWWA) were used in this study. For planning studies AWWA suggests that at least 10% of the system nodes be tested for static pressure and that the pressure readings at these nodes be within 5 psi of the pressures predicted by the network model. For flow test calibrations the network model should predict flows within 10% of the actual values and within 5 psi of the actual pressure.

Static Pressure Calibration Test Results

Static pressure readings at fire hydrants were available for the study area from the El Dorado County Fire Protection District, the Garden Valley Fire Department and the Georgetown Fire Protection District. These pressure tests were conducted by the fire districts in either 2000 or 2001. Assuming average day demands, the network models were checked for pressures predicted at selected fire hydrant nodes. Static readings were within 5 psi of the predicted results at some 70 hydrant nodes checked within the Auburn Lake Trails system and were within the 5 psi criteria for some 40 hydrant locations checked within the Walton Lakes system. To further confirm these static pressure results, static pressure readings were conducted in November 2001 and January 2002 by KASL engineering staff for the Auburn Lake Trails system. Some 50 static pressure tests were conducted. The actual water system demands were determined for the days that static pressure tests were taken. The network model demands were then adjusted to closely approximate actual demands. Static pressures predicted by the model were within the 5 psi tolerance for all of the Auburn Lake Trails static pressures measured in the field.

Similarly, in February and March 2002 some 70 fire hydrant locations were tested for static pressure within the Walton Lakes system. Again, actual water demands for the dates that static pressure tests were conducted were determined with GDPUD. The Walton Lakes network model was run with demands adjusted to closely approximate the actual demands for the test days. Static pressures predicted by the model were within the 5 psi tolerance for all of the Walton Lakes static pressure test locations.

Flow Test Calibration Results

A total of 21 Auburn Lake Trails system fire hydrants were flow tested by KASL Consulting Engineers and the El Dorado County Fire Protection District in November 2001 and February 2002. Seven hydrants flow tested in November 2001 were re-tested in February 2002. Eighteen (18) of the 21 hydrant flow tests were within 5 psi of the

measured residual pressure and within 10% of the measured flows predicted by the network model. Fire hydrant flow test results were provided to GDPUD staff. Poorly operating pressure reducing valve(s) or a partially closed valve(s) are possible reasons that measured results at the three hydrants did not closely match the pressures and flows predicted by the network model.

A total of 16 Walton Lakes system hydrants were flow tested by KASL Consulting Engineers in February 2002. Follow up fire hydrant flow tests were conducted in March 2002. KASL was assisted by the Garden Valley Fire Department and the Georgetown Fire Protection District in the completion of these tests. For all but one of the 16 fire hydrants tested the actual pressures and flows measured were within 5 psi of the pressure and within 10% of the flow predicted by the network model.

Auburn Lake Trails and Walton Lake static pressure and fire hydrant flow test results were provided to GDPUD. Based on the results of both the static pressure and fire flow field tests it was determined that the Auburn Lake Trails and the Walton Lakes network models were adequately calibrated and produce results which closely approximate actual conditions within these systems. Systems analysis using the calibrated models was then initiated.

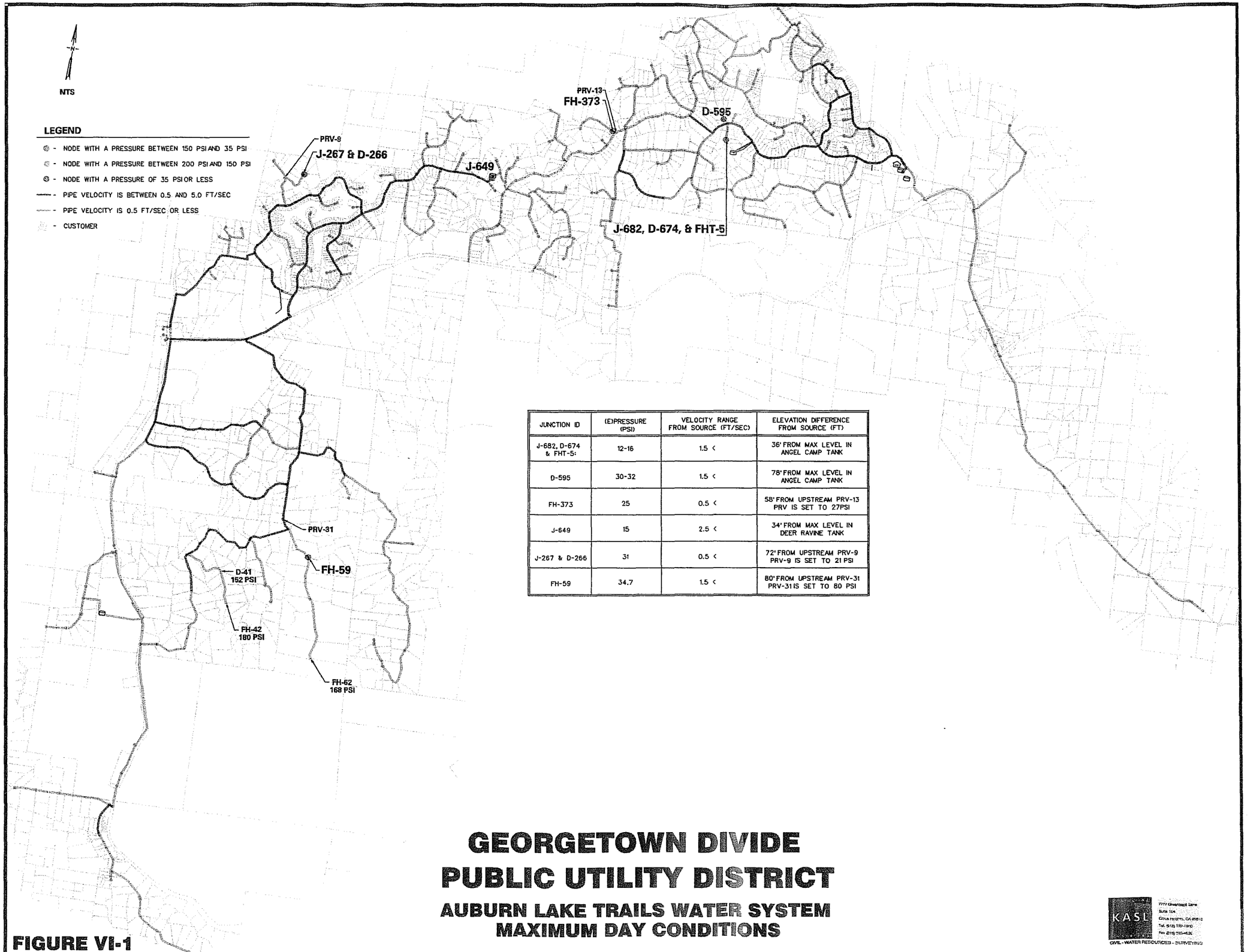
Model Results – Maximum Day Demands

Auburn Lake Trails Distribution System

In **Figure VI-1** is summarized the network analysis results for maximum day demand conditions within the Auburn Lake Trails system. Maximum day demands were evaluated at ±650 pipe junctions (J-nodes), demand nodes (D-nodes), and fire hydrant (FH-nodes) locations within the Auburn Lake Trails distribution system. Water treatment plant operations were included in the model. Maximum day demands were distributed through the ±850 pipelines, 3 tanks, water treatment plant, pump stations and 28 PRV's that comprise the Auburn Lake Trails system. As discussed in Section V of this Reliability Study distribution pressures should be between 35 psi and 150 psi. Reliability measures were evaluated for pressures which fell below 35 psi.

Under maximum day demand conditions, there were 9 nodes found that operate below 35 psi. The locations of these nodes are highlighted in Figure VI-1. Three of these nodes; J-682, D-674 and FHT-5 are located on Angels Camp Court near Angels Camp Tank. Under maximum day demands operating pressures at these nodes range from 12 to 16 psi. The elevation at these nodes is within 36 feet of the high water elevation at Angels Camp Tank.

Node D-595 is located on Hotchkiss Court opposite Cascade Trail from Angels Camp Court. This node is within 78 feet of the high water elevation at Angels Camp Tank and operates between 30 and 32 psi. To improve the pressures at these locations either a booster pump and pressure tank are needed to serve properties in close proximity to the Angels Camp Tank or the operating level at the tank must be raised.



JUNCTION ID	(E)PRESSURE (PSI)	VELOCITY RANGE FROM SOURCE (FT/SEC)	ELEVATION DIFFERENCE FROM SOURCE (FT)
J-682, D-674 & FHT-5	12-16	1.5 <	36' FROM MAX LEVEL IN ANGEL CAMP TANK
D-595	30-32	1.5 <	78' FROM MAX LEVEL IN ANGEL CAMP TANK
FH-373	25	0.5 <	58' FROM UPSTREAM PRV-13 PRV IS SET TO 27PSI
J-649	15	2.5 <	34' FROM MAX LEVEL IN DEER RAVINE TANK
J-267 & D-266	31	0.5 <	72' FROM UPSTREAM PRV-9 PRV-9 IS SET TO 21 PSI
FH-59	34.7	1.5 <	80' FROM UPSTREAM PRV-31 PRV-31 IS SET TO 80 PSI

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AUBURN LAKE TRAILS WATER SYSTEM MAXIMUM DAY CONDITIONS

FIGURE VI-1

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The pump at the water treatment plant could also be increased in head with an altitude valve placed at the Angels Camp Tank. With this alternative the existing inlet / outlet piping configuration at the tank would also need to be changed or else water would be "trapped" in the tank.

At FH 373 the existing maximum day demand pressure is 25 psi. This hydrant is located near the intersection of Big Nugget Trail and Sweetwater Trail. The pressures at this location are controlled by PRV-13 which is set to open at 27 psi. The downstream affects of increasing the operating set point at this PRV to 37 psi were evaluated. It was determined that this option caused unacceptably high pressures in other areas of the distribution system.

According to the network model results, Node J-649 operates at 15 psi under maximum day demands. This node is located on American River Trail between Wagon Wheel Court and Sweetwater Trail. The elevation at this node is within 34 feet of the maximum water level in Deer Ravine Tank. Either a booster pump station is needed to serve properties in close proximity to the tank or the operating level at Deer Ravine Tank must be raised to improve operating conditions.

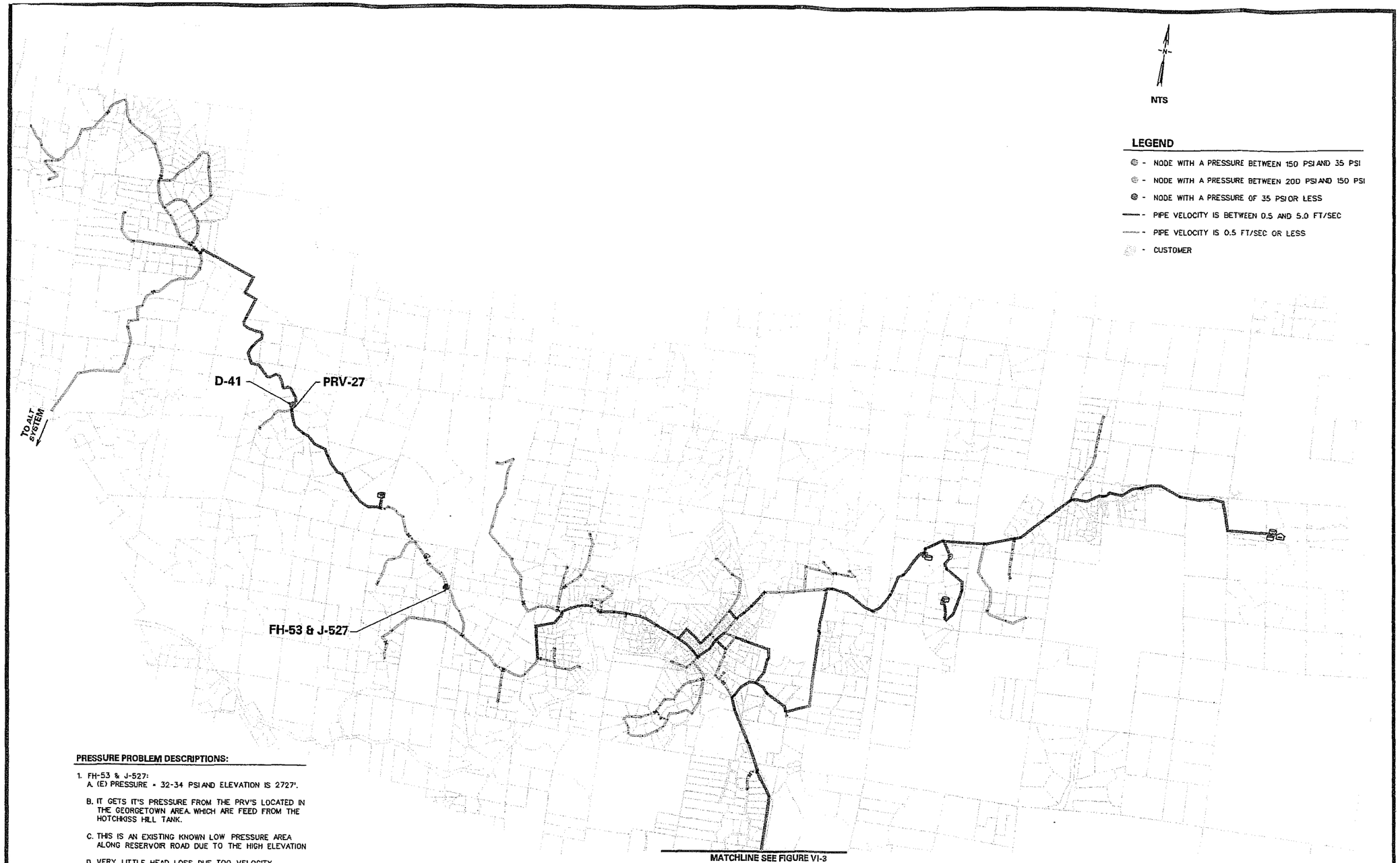
Nodes J-267 and D-266 are located on Brown Bar Court downstream of PRV-9 which is located near the intersection of Shirt Tail Trail and Brown Bar Court. Maximum day operating pressures of 31 psi are predicted by the network model at these nodes. PRV-9 is set to open at 21 psi. The downstream affects of increasing the set point of this PRV to 25 psi must be evaluated with respect to other nodes downstream of PRV-9 which may be "over-pressurized" by increasing the PRV set point.

FH-59 is located in Cherry Acres near the intersection of Cherry Acres Road and Cherry Acres Circle. This hydrant is located downstream of PRV-31 which is set to open at 80 psi. High pressures at D-41 (152 psi) and FH-42 (180 psi) were also found below PRV-31. Increasing the set point at PRV-31 to improve pressure at FH-59 is not a good alternative considering the high pressures which already exist downstream of this valve.

Improvements recommended to improve ALT systems reliability under maximum day demands are described in Section VIII of this Study.

Walton Lakes Distribution System

In **Figure VI-2 and VI-3** are summarized the network analysis results for maximum day demand conditions with the Walton Lakes treated water system. The Walton Lakes Treatment Plant was included in the model. Similar to the analysis conducted for Auburn Lake Trails, maximum day demands were evaluated at the ±700 pipe junctions, junction demand nodes and fire hydrant locations within the Walton Lakes system. The low pressure nodes found typically occur in the higher elevation areas of the system.



PRESSURE PROBLEM DESCRIPTIONS:

1. FH-53 & J-527:
   A. (E) PRESSURE = 32-34 PSI AND ELEVATION IS 2727'.

   B. IT GETS IT'S PRESSURE FROM THE PRV'S LOCATED IN THE GEORGETOWN AREA. WHICH ARE FEED FROM THE HOTCHKISS HILL TANK.

   C. THIS IS AN EXISTING KNOWN LOW PRESSURE AREA ALONG RESERVOIR ROAD DUE TO THE HIGH ELEVATION

   D. VERY LITTLE HEAD LOSS DUE TOO VELOCITY.

2. D-41:
   A. (E) PRESSURE = 34 PSI AND ELEVATION IS 2548'.

   B. IT GETS IT'S PRESSURE FROM PRV-27 THAT'S SET AT 35 PSI AND FEED FROM THE SOD TANK

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WALTON LAKES WATER SYSTEM
MAXIMUM DAY CONDITIONS

FIGURE VI-2

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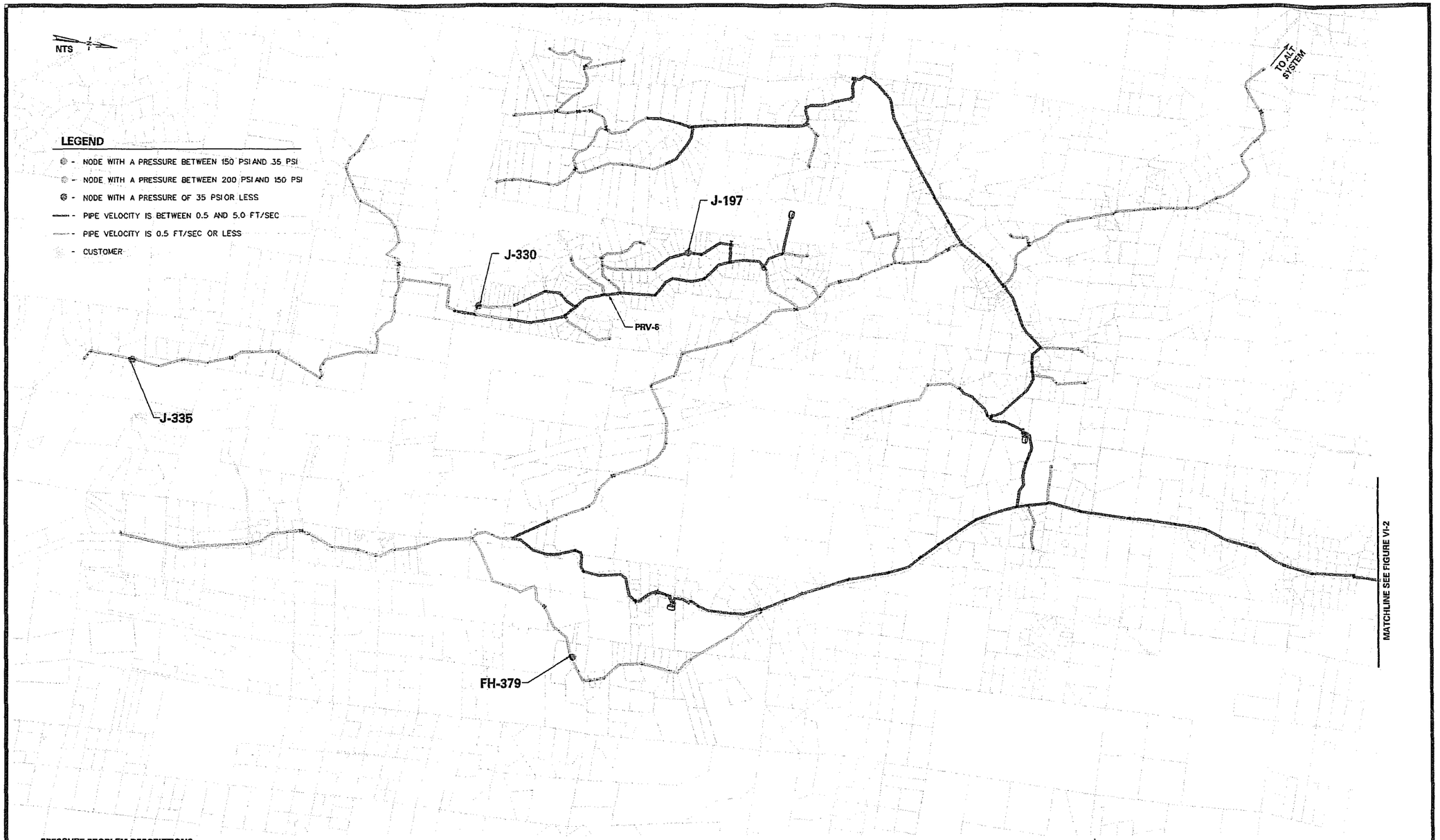

PRESSURE PROBLEM DESCRIPTIONS:

1. J-330:
   A. (E) PRESSURE = 34 PSI AND ELEVATION IS 1925'.
   B. IT GETS IT'S PRESSURE FROM PRV-8 WHICH IS SET TO A 2006 HGL.
   C. THIS IS A HIGH ELEVATED AREA.
   D. VERY LITTLE HEAD LOSS DUE TOO VELOCITY.
2. J-197:
   A. (E) PRESSURE = 33 PSI AND ELEVATION IS 2095'.
   B. IT GETS IT'S PRESSURE FROM THE GARDEN PARK TANK HGL= 2182'
   C. THIS IS A HIGH ELEVATED AREA.
   D. VERY LITTLE HEAD LOSS DUE TO VELOCITY.
3. FH-379:
   A. (E) PRESSURE = 32 PSI AND ELEVATION IS 2417'.
   B. IT GETS IT'S PRESSURE FROM THE PRESSURE SUSTAINING VALVE AT THE KELSEY TANK SET TO AN HGL OF 2482'
   C. THIS IS A HIGH ELEVATED AREA.
   D. VERY LITTLE HEAD LOSS DUE TO VELOCITY.
4. J-335:
   A. (E) PRESSURE = 29 PSI AND ELEVATION IS 1934'.
   B. IT GETS IT'S PRESSURE FROM PRV-8 SET TO AN HGL OF 2006
   C. THIS IS A HIGH ELEVATED AREA AND EXTREMELY DISTANT FROM THE PRESSURE SOURCE.
   D. VERY LITTLE HEAD LOSS DUE TO VELOCITY.

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

WALTON LAKES WATER SYSTEM
MAXIMUM DAY CONDITIONS

FIGURE VI-3

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Fire Hydrant 53 (FH-53) and Junction Node J-527 shown in Figure VI-2 are high elevation nodes located along Reservoir Road in the Georgetown West Zone. This is a known low pressure area which is served by pressure created from the Hotchkiss Hill Tank. Pressures in Georgetown West are inspected by several PRV valves. The cost of installing a booster pump and pressure tank at the Spanish Dry Diggins Tank together with a separate "high pressure line" to serve the low pressure zone along Reservoir Road was also evaluated.

Demand Node D-41 is located in the Spanish Dry Diggins Pressure Zone. Pressures at this node are controlled by the setting of PRV-27. The impacts of adjusting the setting at PRV-27 can be evaluated with the network model. Low pressures at D-41 could be resolved by a booster pump and pressure tank at the Spanish Dry Diggins (SDD) Tank together with a high pressure line parallel to the existing low pressure line which is served by the SDD tank.

Nodes D-41, FH-53 and J-527 are in close proximity to the Greenwood Reservoir. If a new treatment plant with a clearwell tank at ± elevation 2450 was located at the Greenwood Reservoir adequate pressure would be available to correct these low pressure nodes.

Low pressure nodes J-330, J-197 and J-335 shown in Figure VI-3 are located in the Garden Park Zone. Node J-330 is located on Pikes Peak Circle and is served by the Garden Park Tank and PRV-8. Node J-335 is located at the extreme southern end of the system on Stewart Mine Road. It is also served by the Garden Park Tank with pressures controlled by PRV-8. There is a significant range in elevations downstream of PRV-8. Increasing the setting at this PRV to serve the higher elevation nodes could result in unacceptably high pressures at the low elevation nodes. Separate high pressure and low pressure mains were evaluated for this area, as well as connection to the existing main in State Highway 193 which is served by the higher elevation Kelsey Tank.

J-197 is located on McKinley Court at elevation 2095 and is served by the Garden Park Tank HGL of 2182. While a booster pump and pressure tank would resolve this low pressure problem this solution is not considered cost effective.

FH-379 is located in the Traverse Creek Zone and is served by the pressure sustaining valve located at the Kelsey Tank. This is the only low pressure node identified for the Kelsey Tank service area. A booster pump and pressure tank would not be cost effective to resolve this low pressure area.

Improvements recommended to improve Walton Lakes system reliability under maximum day demands are presented in Section VIII of this Study.

Model Results – Maximum Day Demands Increased by 5%; Maximum Day Demands Increased by 10%

After completing the system analysis with maximum day demands, the Auburn Lake Trails and the Walton Lakes systems were evaluated with maximum day demands increased by 5% and with maximum day demands increased by 10%. No additional low pressure nodes were identified in either the Auburn Lake Trails system or in the Walton Lakes system with these percentage increases in maximum day demands.

Model Results – Maximum Day Demands Plus 500 GPM Fire Flow

Auburn Lake Trails

In **Figure VI-4** is presented a summary of "failed" fire hydrant test locations within the ALT system under maximum day demands plus 500 gpm fire flow. With maximum day demands already included in the modeled demands, delivery of a 500 gpm fire flow was tested at each of the ±275 fire hydrants within the ALT system. At a minimum, a 500 gpm fire flow with a 20 psi residual pressure is needed to satisfy the minimum operating criteria. In addition, positive pressures must be maintained throughout the ALT distribution system with maximum day plus fire flow demands. Maximum day demand plus fire flows at 11 locations within ALT failed to meet this criteria.

Test fire hydrant 5 (FHT-5) is located on Angels Camp Court within close proximity to Angel Camp Tank. Low pressures at this hydrant were previously discussed under maximum day demands.

Four of the "failed" ALT hydrants, FH-321, 660, 657 and 665 are located along Greenwood Road and are fed by a single, non-looping, 6-inch diameter main. With a 500 gpm fire flow to FH-321 some 1200 feet of the 8" diameter Greenwood Road main has flow velocities of 5 to 6.5 feet per sec. To avoid high friction head losses, flow velocities within supply pipelines should be maintained at 5 ft. / sec. or less. To improve pressures to the Greenwood Road hydrants the Greenwood Road main must be increased in size or be served by the higher pressures available from the Walton Lakes Plant. Conditions along Greenwood Road would improve with the relocation of the ALT Treatment Plant to Greenwood Reservoir.

Fire hydrant 631 (FH-631) is located at the end of Brinks Lane south of Upper Black Rock Road. This hydrant is fed by 6" diameter mains located on Lois Lane and Brinks Lane with pipe velocities in excess of 6.5 feet / sec. These pipes are connected to the 6-inch diameter main located in Upper Black Rock Road. Replacing these small diameter mains with minimum 8-inch diameter mains or connecting the mains which terminate on Upper Black Rock Road, Sweetwater Trail and Tegra Road with a main along State Highway 193 would improve maximum day and maximum day plus fire flow pressures to acceptable levels.

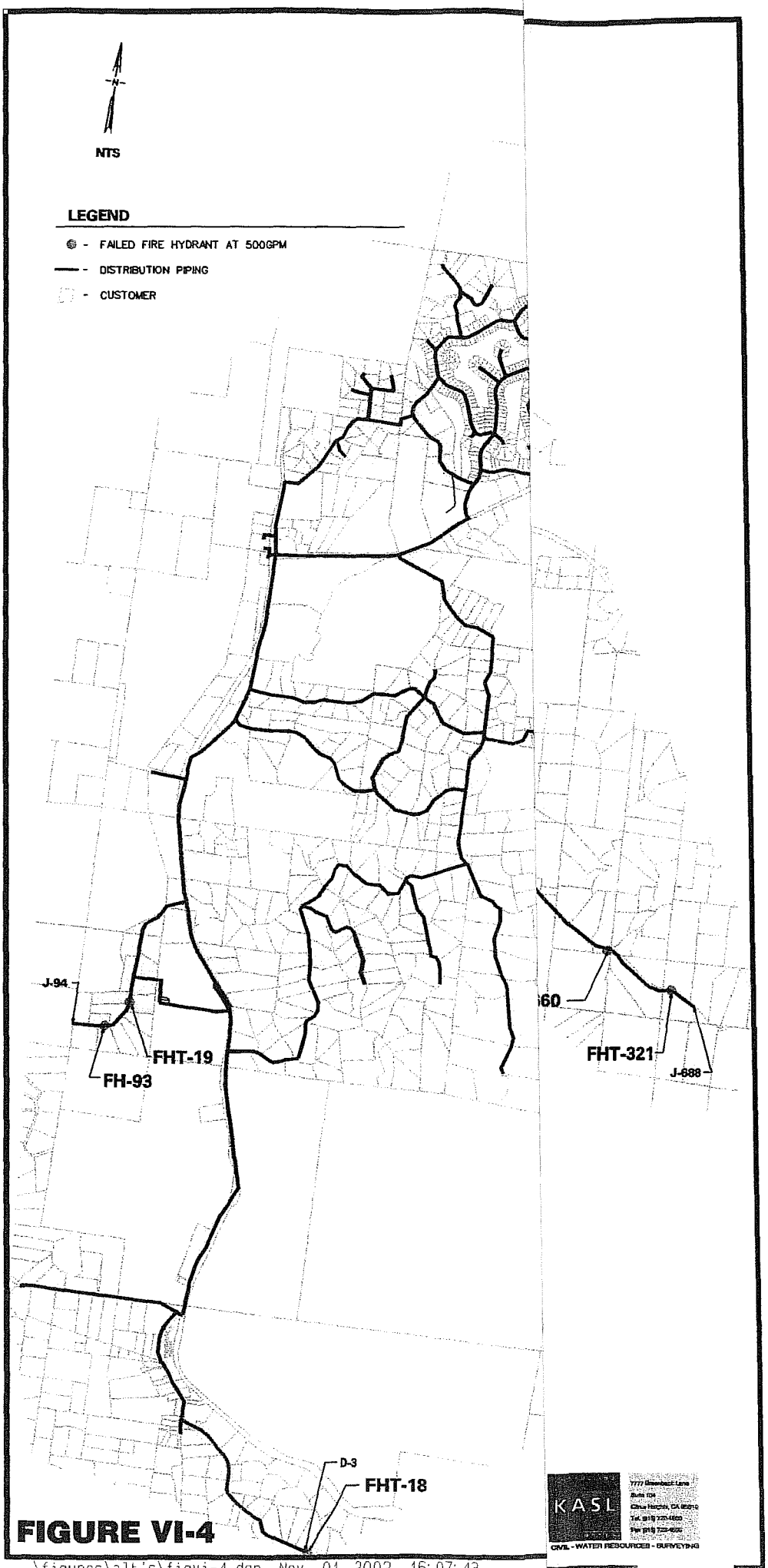

FIGURE VI-4

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Fire hydrant 643 (FH-643) is also located in the Upper Black Rock Road / Tegra Road area. With maximum day plus 500 gpm flows at FH-643 high velocities occur at the two 4-inch diameter mains which connect the pipeline in Tegra Road with the pipeline in Hidden Gold Trail. The main in Hidden Gold Trail south of Brown Bear Trail could also be replaced with a larger main. Again, connecting the Tegra Road, Upper Black Rock and Sweetwater Trail mains with a new main along Highway 193 would result in acceptable pressures under maximum day plus fire flow conditions.

Fire hydrant 93 (FH-93) and test fire hydrant 19 (FHT-19) are located on Capecroft Lane in the western end of the ALT System, west of the Pilot Hill Tank. Pipeline velocities above 5 feet per second occur in the 6-inch diameter Capecroft Lane main west of State Highway 49 when 500 gpm fire flows are delivered to FH-93.

Test fire hydrant 13 (FHT-13) is located in Cherry Acres east of Indian Rock Road. When fire flows are delivered to this hydrant, pipe velocities in excess of 5 ft. / sec. occur in ± 6000 feet of the 6-inch diameter Indian Rock Road main. Either this main must be increased in size or the Indian Rock Road connected to the main in Cherry Acres Road to improve fire hydrant flows and pressures.

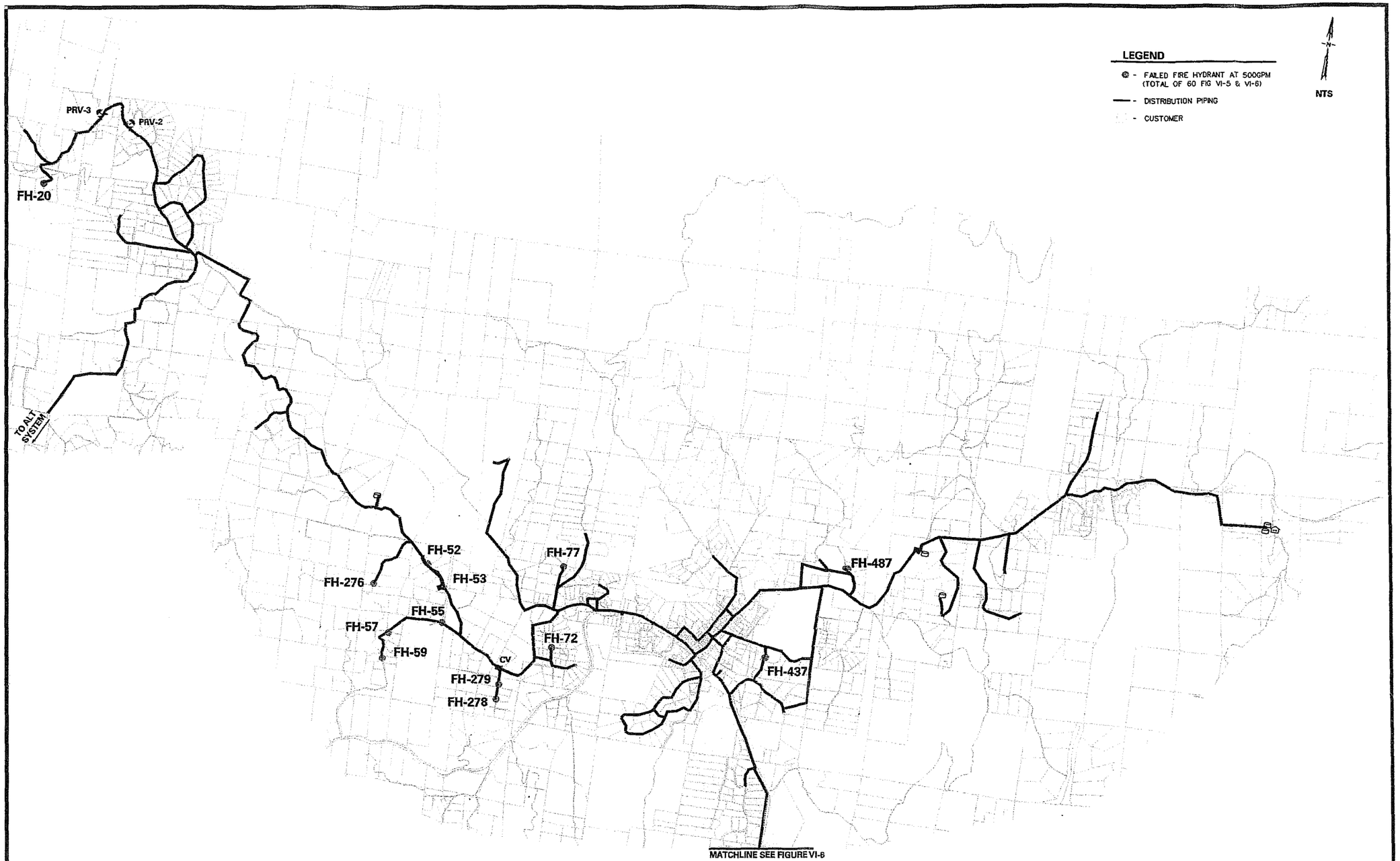
FHT-18 is located in Pilot Hill at the southwest limit of the ALT System. When 500 gpm are delivered to this location pipe velocities in excess of 5 ft / sec. occur in ±6000 feet of 6-inch diameter main on Pilot Hill Road and Meadow Craft Lane. To improve the performance of hydrants in the area, existing mains in Salmon Falls Road, Pilot Hill Road and Meadow Craft Lane must be improved to 8-inch diameter or a parallel main placed on State Highway 49 south of Rattlesnake Bar Road.

ALT system improvements recommended to improve reliability under maximum day plus fire flow demands are presented in Section VIII of this Study.

Walton Lakes

There are some 250 fire hydrants within the Walton Lakes system. A maximum day plus 500 gpm fire flow was evaluated at each hydrant. At some 60 Walton Lakes system hydrant locations either a residual pressure of 20 psi could not be maintained or pressures within the distribution zone dropped below zero with a hydrant flowing at 500 gpm. Conditions are not described herein for each failed case. System conditions and limitations common to "multiple" or "area" failure are summarized in this study. In **Figure VI-5** and **Figure VI-6** is presented a summary of hydrant locations which did not meet the system reliability criteria.

Fire hydrant 107 (FH-107) is located on Greenwood Road near Greybar Mine Road. With maximum day demands and a 500 gpm fire flow at FH 107 pipe velocities between 5 and 6.5 feet per second are predicted for some 7500 feet of 6" water main constructed in Greenwood Road north of Marshall Grade Road. With fire flow demands at FH 107, three nodes located near this hydrant (±1500 feet) would experience



GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

WALTON LAKE WATER SYSTEM
MAXIMUM DAY CONDITIONS PLUS 500 GPM FIRE FLOW

FIGURE VI-5

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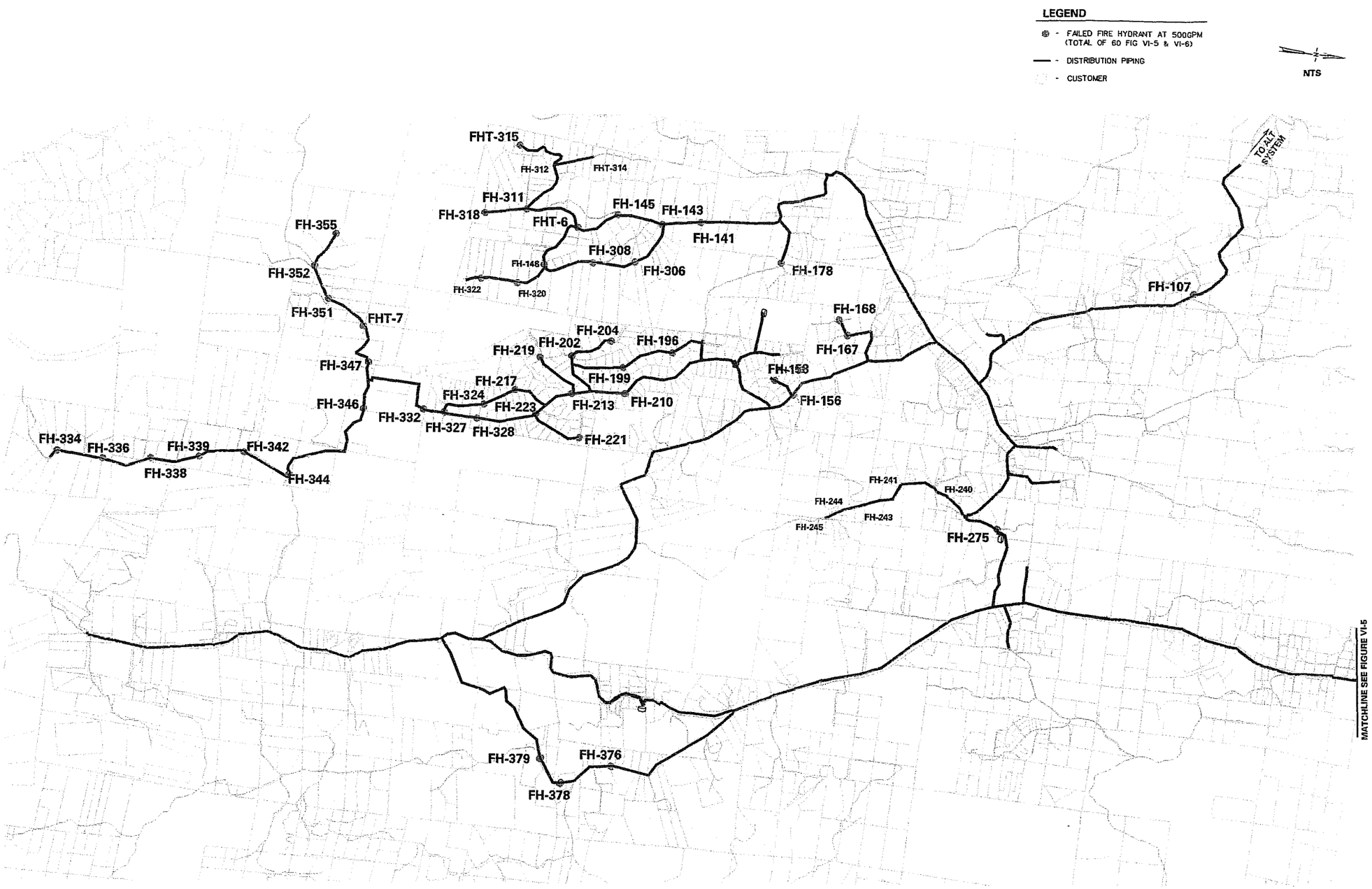

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

WALTON LAKE WATER SYSTEM
MAXIMUM DAY CONDITIONS PLUS 500 GPM FIRE FLOW

FIGURE VI-6

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pressures below 35 psi. To correct this deficiency either the 6" diameter Greenwood main must be replaced with a larger diameter pipeline or the Greenwood Road area must be served by two points of supply. This could be accomplished with the new treatment plant sited at Greenwood Reservoir with service from the Sliger Mine Road and an 8" diameter water main constructed in Greenwood Road north of this location.

Failed conditions found at fire hydrant 336 (FH-336) are representative of similar failures predicted at FH-334, FH-338, FH-339, FH-342 and FH-344, FH-346, FH-347, FH-351, FH-352, FH-355 and FHT-7 all located on Stewart Mine Road or Bayne Road. With a 500 gpm flow at FH-336, the WaterCad model identified some 21 nodes with negative pressures. These negative pressures were predicted at locations along Stewart Mine Road, Bayne Road, Pikes Peak Drive and Garden Park Drive. High velocities were also predicted in pipelines on Garden Park Drive and on Pikes Peak Drive.

With widespread failures a number of system improvements were evaluated to correct these system deficiencies. These included:

1.) Replace the 4 inch mains located in Pikes Peak Drive and in Garden Park Drive with larger (min. 8 inch diameter) pipelines.
2.) Replace the 6 inch diameter connection located between Pikes Peak Drive and Bayne Road with larger (min. 8 inch diameter) pipeline.
3.) Provide a second "source" of supply to this area by connecting the main at Stewart Mine Road and Bayne Road with a new main on Bayne Road east to State Highway 193. This connection would allow the Stewart Mine Road / Bayne Road parcels to be served by both the Garden Park Tank and the Kelsey Tank. A PRV would be needed with the second source of supply to allow the higher pressure Kelsey tank system to feed the lower pressure Garden Park Tank system.
4.) Replumb the Garden Park Tank with separate inlet and outlet piping and an altitude valve on the Garden Park Tank. This will allow the Garden Park Tank to better serve the Garden Park area and improve the efficiency of the water supply system.

The failed conditions found at fire hydrant 322 (FH-322) are representative of similar failures predicted at FHT-6, FH-141, FH-143, FH-145, FH-148, FH-306, FH-308 and FH-320 all located in the Roller Coaster Drive, Chrysler Circle, Johnston Creek Road area. With a 500 gpm fire flow at FH-322, the WaterCad Model predicted 10 nodes with negative pressures and determined that pipelines located in Johnston Creek Road, Chrysler Circle and Roller Coaster Road would deliver flows with velocities in excess of 5 ft. / sec.

To correct these deficiencies alternative improvements include:

1.) Replace 6" main in Johnston Creek Road with minimum 8" diameter main.
2.) Replace 4" mains in Chrysler Circle and in Roller Coaster Road with minimum 8" diameter mains.
3.) Provide alternative "source" of supply for this area by providing a connection to mains located in Garden Park Drive or in Bayne Road. Water distribution mains in Garden Park Drive and in Bayne Road must also be increased in size to at least 8-inch diameter for these improvements to be effective.

The failed conditions found at fire hydrant 315 (FH-315) are believed to be representative of similar failures predicted at FH-311, FH-312, FH-314 and FH-318, all located in the Lazy Brook Trail and Lynx Ridge service areas. Predicted conditions with fire hydrant flows at FH- 315 include 7 nodes with negative pressures and 14 nodes with pressures less than 35 psi.

To correct these deficiencies possible improvements include:

1.) Replace 4 inch diameter main in Lazy Brook Trail with minimum 8 inch diameter main.
2.) Replace 6 inch diameter main located in Lazy Brook Trail with minimum 8 inch diameter main.
3.) Implement improvements described above for FH-322.

The failed conditions evaluated for fire hydrant 379 (FH-379) are representative of similar failures predicted at FH-378 also located along Traverse Creek Road. With fire flows at FH-379, high pipe velocities are predicted for some 6500 feet of pipeline in Traverse Creek Road east of Highway 193. Negative pressures are predicted at two nodes. Pressures below 35 psi are predicted at two nodes located along Traverse Creek Road. Improvements evaluated to correct these deficiencies included:

1.) Replace the 6" diameter pipe in Traverse Creek Road / Spanish Flat Road with a minimum 8" diameter pipeline.
2.) Install booster pumps.

The failed condition identified by the network model for fire hydrant 168 (FH-168), located on Superior Court is also representative of a similar failure predicted at FH-167. With a fire flow at FH-168 negative node pressures are predicted at two locations with high pipeline velocities anticipated in the 4" & 6" diameter mains located on Garden Valley Road, Oak Lane, Towzen Drive and Superior Court. To correct deficiencies these pipelines should be replaced with minimum 8 inch diameter pipelines.

Fire hydrant 158 (FH-158) is located in Whitney Court west of Garden Valley Road. Fire flows tested at this location result in high pipeline velocities in over 10,000 feet of 6" diameter main constructed in Garden Valley Road. Existing pipelines must be

replaced with larger diameter mains. Replacing a normally closed valve with a PRV shall also be evaluated.

Fire hydrant 20 (FH-20) is the only predicted failed condition in the Walton Lakes System, west of the Spanish Dry Diggins Tank. Maximum day plus fire flow conditions at this location result in high pipeline velocities in the Sliger Mine Road main west and north of Edgewater Drive. The Sliger Mine Road main downstream of Edgewater Drive is 6 inches in diameter. To correct this deficiency this main should be replaced with a minimum 8-inch diameter pipeline.

The failure predicted at fire hydrant 57 (FH-57), Longview Drive, is believed representative of similar failures predicted at FH-52, 53, 55, 59 and 276. All of these hydrants are located along Reservoir Road, Silent Meadow Road and Longview Lane south and east of Spanish Dry Diggins Tank. Fire flows at FH-57 result in negative pressures at 3 nodes and pressures of 35 psi or less at 10 nodes. The water main in Longview Drive is 6 inch diameter. Replacement with an 8 inch diameter main was evaluated.

Failed fire hydrant 72 (FH-72) is located at Quiet Plane and Lasita Way. Mains which serve the hydrant are 6 inch diameter and pipeline velocities exceed 5 ft. / sec. under fire flow demands. Looping the 6 inch Quiet Place main back to the main in Reservoir Road and replacing the Reservoir Road main with a minimum 8 inch diameter main was evaluated to resolve this deficiency. The benefits of removing an existing check valve located in Reservoir Road shall be evaluated.

Failures at fire hydrant 437 (FH-437) are isolated to the area near Harkness St. and Birch Hill Court. Placement of an 8-inch main to connect the main at Harkness with the 12-inch main located along Fain Lane would resolve this isolated deficiency.

High velocities in the 6 inch diameter mains located in Eaton Road and Veterans Way and low pressures at 4 nodes are predicted with maximum day demands plus fire flows to fire hydrant 487 (FH-487). Replacement of the 6 inch diameter mains in Eaton and Veterans with an 8 inch main and the looping of these mains back to the Wentworth Springs Road mains via Citabra Lane would resolve this deficiency.

System reliability measures recommended to correct maximum day and maximum day plus fire flow deficiencies in both the ALT and Walton Lakes systems are summarized in Section VIII.

Water Storage Tank Capacities

Existing GDPUD water storage tanks were evaluated with respect to the storage tank performance and design criteria recommendations presented in Section V. To meet the Fire Storage Reservation (FSR), System Peaking Storage (SPS) and Emergency Storage (ES) requirements presented in Section V the following Auburn Lake Trails tank volumes are required:

Comparison of Auburn Lake Trails System Storage Tank Volumes with Recommended Design Criteria

Tank	Recommended Min. Volume, (FSR + SPS + ES) gallons	Storage Volume Provided, gallons	Notes
Angels Camp	420,600	500,000	Tank is adequately sized
Deer Ravine	596,100	250,000	Tank is undersized.
Pilot Hill	165,000	470,000	Tank is oversized

Similarly, a capacity analysis of Walton Lakes system tanks is as follows:

Comparison of Walton Lakes Storage Tanks with Recommended Design Criteria

Tank	Recommended Min. Volume, (FSR + SPS + ES) gallons	Storage Volume Provided, gallons	Notes
Hotchkiss Hill	377,300	500,000	Tank is adequately sized
Spanish Dry Diggins	183,900	200,000	Tank is adequately sized
Black Oak Mine	269,000	300,000	Tank is adequately sized
Garden Park	285,000	200,000	Tank is undersized
Kelsey	169,600	214,000	Tank is adequately sized
Walton Lakes Clearwells	361,410	600,000	Tanks are adequately sized
Hotchkiss Hill Sub Tank	121,600	60,000	Tank is undersized

As summarized above, the Deer Ravine Tank and the Garden Park Tank are inadequately sized. The Hotchkiss Hill Sub tank, while undersized, serves a limited area and therefore the capacity limits at this location are less significant than at the Deer Ravine Tank and the Garden Park Tank.

Extended Period Simulations

To confirm the evaluation of existing tank capacities presented above, extended period maximum day demand simulations were conducted for each GDPUD tank. With the network models, extended period simulations allow evaluation of tank levels over a 24 hour maximum day period. Predicted tank levels can be compared to the levels (volumes) that should be available in the tank for fire storage reserve, emergency storage and system peaking storage. Under maximum day demands tank levels may drop into the system peaking storage (SPS) but should not fall below the level reserved for fire and emergency storage (FSR + ES).

A summary of the extended period simulation results for each GDPUD tank is as follows:

Angels Camp Tank Tank levels fall within the SPS limits but do not drop below minimum ES + FSR requirements. The Angels Camp Tank is adequately sized.

Deer Ravine Tank Adequate volume is not provided for FSR + ES. This tank always operates below the minimum FSR + ES requirement. The Deer Ravine Tank is undersized.

Pilot Hill Tank Under maximum day conditions, the minimum hydraulic grade line is well above the FSR + ES + SPS level. The Pilot Hill Tank has more than adequate capacity.

Hotchkiss Hill Tank Tank levels operate within SPS levels under maximum day demands but do not drop below minimum FSR + ES requirements. The Hotchkiss Hill Tank is adequately sized.

Spanish Dry Diggins Tank levels do not drop below minimum FSR + ES requirements. The Spanish Dry Diggins Tank is adequately sized.

Black Oak Mine Tank level drops to minimum FSR + ES requirement. The volume of the Black Oak Mine Tank is marginally adequate.

Kelsey Tank Tank levels are well above the minimum FSR + ES requirement. The Kelsey Tank has adequate volume.

Garden Park Under maximum day demands, levels in the Garden Park Tank almost drop to the FSR limit and are below the FSR + ES minimum requirement. The Garden Park Tank does not have adequate storage volume.

Hotchkiss Hill Sub Tank Adequate volume is not provided in this tank to meet minimum fire flow requirements.

In Section VIII of this study recommended storage tank improvements are proposed at Deer Ravine and Garden Park to improve system reliability.

DITCH SYSTEM

The GDPUD raw water ditch system was evaluated in this Reliability Study on the basis of performance, condition and capacity. The performance and condition of each segment of the ditch system were reviewed in the field with GDPUD ditch operators. High maintenance areas, high loss areas, previous repair areas, lined and piped sections were mapped. These features are included in the ditch system maps presented in the Appendix of this study.

Ditch flowline elevations and cross sections were measured throughout the GDPUD system. The capacity of each ditch section was determined using open channel flow equations, ditch slope, cross sectional area and assumed "roughness" (Mannings "N" coefficients). Minimum allowable freeboards, as presented in Section V of this study, were also applied to determine ditch segment capacities. The capacity of culverts placed in the ditch and the capacity of piped segments were determined based on partially full pipe flow, the available pipe slope, Mannings "N" appropriate for the culvert or pipe material and the depth of flow through the culvert or pipe. Allowable head loss was assumed to be one-half of the available freeboard.

A summary of ditch, culvert and piped segment capacities is presented in the Appendix of this study. The capacity of each segment of the GDPUD ditch system with respect to the design flows presented in Section V is summarized in **Figure VI-7**. Figure VI-7 (14 sheets) is presented at the end of this section of this Reliability Study. Based on the ditch design criteria and ditch design flows recommended in this study, adequate ditch capacity is available in all segments of the ditch system with the exception of:

- Upcountry Ditch, Balderston Wastegate to Sand Trap Siphon
- Upcountry Ditch, Buckeye Conduit to Shroeder Conduit
- Main Ditch #1, Spanish Dry Diggins Road to Spools Wastegate
- Kelsey Ditch #1, Forest View Drive to Irish Reservoir Wastegate
- Kelsey Ditch #2, Irish Reservoir Wastegate to Twin Pine Siphon

Upcountry Ditch

Pilot Creek Pipeline

Findings: The Pilot Creek Pipeline is a 48 inch diameter concrete pipe constructed some 3900 lineal feet from the Pilot Creek Diversion Dam to the Bacon Canyon Pipe. Adequate capacity is available. The pipeline does not normally require maintenance except for the periodic checking and maintenance of vent structures. The ditch operator also needs to access the Pilot Creek Diversion Dam along this route. There is no vehicle access available along this section of the pipeline.

Recommendations: An all-weather vehicle access, a minimum of 10 feet wide, is needed along the Pilot Creek Pipeline to maintain the operation of the pipeline and to access the Pilot Creek Diversion Dam.

Bacon Creek Pipeline

Findings: The Bacon Creek Pipeline is a 48 inch diameter concrete pipe constructed some 3000 feet in length. The pipeline begins at the connection of the 12-inch diameter Bacon Creek Pipeline and ends with the first open ditch section of the Upcountry Ditch. In 1993 GDPUD extended this pipeline some 1800 feet to improve system reliability. The section of the ditch replaced with pipe was susceptible to slides and unstable soils conditions. Limited vehicle access is available along the Bacon Canyon Pipeline.

Recommendations: Improved all-weather vehicle access is needed along approximately 1500 feet of the Bacon Canyon Pipeline.

Bacon Canyon Pipeline to Structure #1

Findings: This section of the Upcountry Ditch has adequate capacity to meet design flows. The existing ditch section has a capacity of approximately 35.9 cfs. Immediately upstream of Structure #1 an 860 lineal foot section of the ditch has been replaced with a 48 inch diameter Corrugated Metal Pipe. Future pipe replacements for this section of the ditch should be 48 inch diameter concrete, HDPE or similar. Future culverts placed in this section of the ditch should be 71 x 47 CMPA or 54" CMP.

Structure #1 to Structure #2

Findings: Within this reach there are 7 sections of pipelines varying in length from 80 to approximately 2250 feet. Ditch sections have been repaired with pipeline in 1993 and again in 2000. The ditch capacity meets with design flow criteria only when the allowable freeboard is reduced to 1.5 feet. A portion of this segment includes "The Narrows". This is an abandoned section of ditch levee approximately 250 lineal feet in length. During the past 10 years the levee roadway has been reduced from

approximately 10 feet in width to less than 6 feet in width with slope failures occurring on the downhill side of the ditch and access road. Since this section of the access road is no longer safe for vehicle travel, GDPUD have created a temporary bypass road around The Narrows using old logging trails located above the ditch section.

Previous ditch repairs using 48" concrete pipe provide adequate conveyance capacity. Pipeline repairs using 48" CMP represent restrictions to flow. Future ditch replacement in this section should use 48" concrete or HDPE pipe. Future culverts should be 71 x 47 CMPA or 54" CMP.

Recommendations: Provide roadway stabilization at the "Narrows" using retaining walls or gabions. Replace the ±250 foot long open ditch section with 48" concrete or HDPE pipe. Because of its importance to the continued supply of water to the rest of the GDPUD system this is a priority repair item.

Structure #2 to Structure #3

Findings: Similar to the previous reach, the segment between Structure #2 and Structure #3 includes several ditch sections which have been replaced with pipeline. According to the Ditch Operator sections of this ditch were replaced with pipe in the 1970's. A repair with pipe replacement was also completed in 2000. Piped sections are concrete, composite or CMP. Adequate conveyance capacity is available with the concrete and composite pipes. The 48" diameter CMP pipes represent restriction to flow and should not be used for future pipe repairs in this section of ditch.

Adequate capacity is available with the existing ditch section and slope except for a ±400 foot long section of ditch located approximately 400 feet upstream of Structure #3. Freeboard improvements which would raise the road levee section by approximately 1 foot are needed in this area.

This segment of the ditch is located below an area known as "The Landing". In 2002 significant logging activity was observed in this area. The logging activity together with slides that have been observed below the ditch and recent repairs to replace unstable ditch sections suggests that additional ditch replacement with piping will be warranted. It is recommended that the District plan on replacing that ±800 foot long section of ditch located approximately 1800 feet upstream of Structure #3.

Recommendations: Provide additional freeboard for approximately 400 feet of existing ditch. Replace approximately 800 feet of ditch with 48" concrete or HDPE pipe.

Structure #3 to Structure #4

Findings: This is a short (±2200 foot long) segment. Most of this segment is open ditch. Downstream of Structure #3 a 100-foot long 48" diameter CMP was placed as a ditch repair in 2000. Immediately downstream of this repair there exists a ±500 foot long section of ditch which appears to be unstable. Saturated levee conditions

have been observed and this segment of ditch is located in a known slide area. Immediately upstream of Structure #4 there also exists a known slide area above the open ditch.

Recommendations: The ±500 foot long unstable ditch section located immediately downstream of Structure #3 should be replaced with a 48" diameter concrete or HDPE pipe as a priority repair. The District should also schedule for replacement the ±500 foot section of ditch located immediately upstream of Structure #4.

Structure #4 to Structure #5

Findings: In response to slide damage in this segment ditch sections were replaced with pipe in 1986 and 1997. The District also replaced a section of unstable ditch with the "Big Cut". While the Big Cut eliminated a problem area of the ditch and reduced the overall ditch length the new ditch section constructed did not include adequate access. Maintenance, especially ditch cleaning and vegetation removal along the levee is restricted along the Big Cut because of poor access.

Recommendations: Widen the Big Cut area to provide for a minimum 8 foot wide ditch access road along one side.

Structure #5 to Structure #6

Findings: This reach of the GDPUD Upcountry Ditch is mostly open ditch. There is one, ±50-foot long 48" CMP placed approximately 300 feet downstream of Structure #5. The CMP is under capacity. An unstable ditch section has been identified approximately 400 feet downstream of Structure #5. This is a priority repair area. Slides were observed above the ditch in this area during the 1986 storms however, no ditch sections were piped in this segment at that time.

Recommendations: Replace the 48" CMP and a section of ditch approximately 400 feet downstream of this CMP with a 48" diameter concrete or HDPE pipe. This work should be considered a priority repair by the District.

Structure #6 to Structure #7

Findings: Portions of this section of ditch are lined and there is one, 30-foot long section of 42" diameter concrete pipe. According to the Ditch Operator the segment between Structure #6 and Structure #7 is stable with no obvious problem areas. Capacity slightly exceeds the design flow in this reach.

Structure #7 to Tunnel Hill

Findings: Most of this segment consists of a 36-inch concrete pipe. Slopes are good (±1% compared to slopes of 0.2% or less for most of the Upcountry Ditch System) and adequate capacities are available in both the piped and open ditch sections.

Tunnel Hill

Findings: Access to the Tunnel Hill section of the ditch was not available for this study. No findings or recommendations are presented for this segment of the Upcountry system.

Penstock Inlet / Penstock Bypass to Tree House Lane

Findings: Beginning at the Tunnel Hill Outlet this section of the Upcountry Ditch falls rapidly along the Penstock Bypass Ditch to the crossing of Wentworth Springs Road. Slopes continue to be moderate from Wentworth Springs Road to Tree House Lane. With the moderate slopes and ditch sections available ditch capacities are adequate in this segment. This Tunnel Hill Flow Measuring Flume is located downstream of Wentworth Springs Road. Approximately 200 feet of lined ditch has been placed near the flume. Gauge readings at the flume are recorded manually.

Maintenance access along the ditch is adequate upstream of Homewood Drive. Between Homewood Drive and Tree House Lane, access is poor. Heavy vegetation growth has occurred within the ditch and along levee sections in the ±2600-foot long ditch segment between Homewood Drive and Tree House Lane.

Culverts ranging in size from 36" to 48" diameter have been placed for driveway and roadway crossings in this area. Because of the moderate to steep ditch slopes available these have not resulted in significant restrictions to flow. Future culvert crossings should be not less than 66 x 51 CMPA or 54" CMP.

Recommendations: Provide minimum 8-foot wide access for ditch maintenance and vegetation clearing from Homewood Drive to Tree House Lane (2600 feet). Install continuous flow monitoring and recording equipment at the Tunnel Hill Measuring Flume.

Tree House Lane to Balderston Wastegate

Findings: This is a moderately sloping ditch section with adequate ditch cross sections. Adequate capacity is available provided that the ditch can be kept clear of vegetation. Access is particularly poor upstream and downstream of Rock Creek Road and upstream and downstream of Mt. Cedar Road. To provide clearing and maintenance improved access should be provided in these areas. This section crosses numerous property lines with fences and no access gates. There are a number of

culverts placed in this section for driveway and road crossings. These are either 48" CMP or 57 x 38 CMPA. With the ditch slope available these structures have adequate capacity.

Recommendations: Provide improved ditch maintenance with minimum 8-foot access one side. Replace cross fences with access gates. Future culverts placed in this area should be not smaller than 57" x 38" CMPA or 48" CMP.

Balderston Wastegate to Sand Trap Siphon

Findings: The capacity of this section of the ditch is limited by available freeboard. During summertime operations, ditch flows were observed within a few inches of the top of the ditch. This was observed in both lined and unlined sections.

Recommendations: Provide 1 foot of additional freeboard along low freeboard areas located downstream of Balderston Road to the Sand Trap Siphon. This section is approximately 3300 feet in length. It is estimated that freeboard improvements are needed for approximately 1000 feet of ditch in this area.

Sand Trap Siphon / Canyon Creek Conduit

Findings: These are 30-inch diameter concrete pipes which were constructed by the District to replace high maintenance ditch sections. The Sand Trap Siphon is approximately 2500 feet in length. The Canyon Creek Conduit is approximately 2300 feet long. With the hydraulic grade line along these pipe routes adequate capacity is available to provide design flows. The pipelines do not require extensive maintenance, however, vegetation must be cleared to maintain to access to pipeline appurtenances including air release valves and blow off valves. Immediately upstream of the Sand Trap Siphon there exists a potential raw water reservoir site with capacity of 7 to 10 acre-feet. The benefits of developing this site for raw water storage will be evaluated later in this section of this study.

Recommendations: Maintain access along pipeline routes for periodic inspection and maintenance of pipeline appurtenances.

Buckeye Conduit

Findings: The Buckeye Conduit is a 30 inch concrete cylinder pipe constructed from the Walton Lake Outlet and extending some 10,300 feet to the outlet at the Buckeye hydroelectric power plant. With the hydraulic grade lines available, adequate capacity is provided in this pipeline to meet design flows. In general, this pipeline is constructed along property lines and along easement areas. Long reaches are inaccessible for periodic inspection and for maintenance of pipe appurtenances.

Recommendations: Provide and maintain access along pipeline routes for periodic maintenance and inspection.

Buckeye Conduit to Schroeder Conduit

Findings: This section includes the Buckeye Flow Measuring Flume. Similar to the Tunnel Hill Flume daily gauge readings are recorded by hand at this location. The existing ditch is lined in the vicinity of the flume. In 1999 gunite lining was also completed upstream of the Wentworth Springs Road crossing. The capacity of the ditch is limited by available freeboard and slope. To improve capacity an additional 1 foot of freeboard is needed along approximately 1500 feet of ditch beginning approximately 1100 feet upstream of the Wentworth Springs Road crossing. The 36" CMP constructed for the ditch crossing at Wentworth Springs Road is under-sized. Future culverts and road crossings provided in this segment of the ditch should be 66 x 51 CMPA or 54" CMP.

Recommendations: Provide continuous monitoring and recording of the flow measurements at the Buckeye Measuring Flume. Provide an additional 1 foot of freeboard for approximately 1100 feet of existing ditch.

Schroeder Conduit

Findings: The Schroeder Conduit consists of some 3235 lineal feet of 36 inch diameter concrete cylinder pipe. The pipeline parallels Wentworth Springs Road from Hotchkiss Hill Road to the discharge of the conduit at the Crails. With the available hydraulic grade lines and this pipe diameter and material, adequate capacity is provided to meet design flows. While pipe access can, typically, be achieved from Wentworth Springs Road, clearing is needed to periodically inspect and maintain pipe appurtenances including blow off valves and air relief valves.

Recommendations: Provide clearing and maintain access along pipeline routes for periodic pipe inspection and maintenance.

Main / Pilot Hill Ditch

Main Ditch No. 1, Crails to Buffalo Hills Conduit

Findings: This section of Main Ditch No. 1 has moderate slopes and adequate capacity to meet design flows. It is located in a heavily vegetated area with no maintenance access provided. At the Crails flow from the Upcountry District is diverted to the Main Ditch and to the Kelsey Ditch. Flows are estimated but not measured. There is a potential raw water storage site located along this reach of the ditch. This site is located on land owned by the GDPUD which once served as a raw water storage reservoir for a water treatment plant at Georgetown. The benefits of constructing a raw water storage reservoir in this location will be discussed later in this section of this Reliability Study.

Recommendations: Provide minimum 8-foot wide access and vegetation clearing for 1000 foot section located downstream of Crails. Provide measuring flume or flow meter to measure flow to the Main Ditch. Alternatively, a flow measuring device could be provided on the Kelsey Ditch with the difference in flows measured at Buckeye and measured at Kelsey assumed for the flow to the Main Ditch.

Buffalo Hills Conduit (Illinois Canyon Pipe)

Findings: This is a 24" diameter ductile iron pipe approximately 4900 feet in length. The pipe size, material and hydraulic grade line available provide adequate capacity to deliver design flows. Similar to other pipelines constructed by the District to replace ditch sections, this pipeline is located along property lines and easement areas. Access is needed to provide periodic pipeline inspection of maintenance of pipeline appurtenances.

Recommendations: Provide and maintain access along pipeline route for periodic pipe inspection and maintenance.

Buffalo Hills Conduit to Spanish Dry Diggins Road

Findings: Approximately 1300 lineal feet of the ditch is gunnite-lined. The condition of this lining ranges from fair to good. A 500-foot section upstream of Spanish Dry Diggins Road was lined in 2001 but has limited available freeboard. This section cannot provide 6" to 12" of freeboard at design flows.

Recommendations: A minimum of 6 inches of additional freeboard should be provided so that the ditch in this area can operate with a depth of approximately 1-1/2 feet with 1 foot of freeboard. A bottom ditch width of 7 feet is recommended. This is a priority repair area to allow continued delivery of raw water to the ALT Treatment Plant and to GDPUD irrigation services.

Spanish Dry Diggins Road to Taylor Mine Outlet

Findings: This section of the Main Ditch is constructed at very flat slopes (less than 0.2%). This condition together with the limited freeboard available has resulted in numerous crib wall repairs and low freeboard areas along 2500 feet of this segment of the ditch beginning at Spanish Dry Diggins Road and continuing to Lasita Place. With the present ditch section and minimal slopes, design flows cannot be conveyed with 6" to 12" of freeboard.

Downstream of Lasita Place there are two additional isolated crib wall repair areas. In addition, at approximately midway between Lasita Place and the Taylor Mine Outlet there exists an undersized CMP culvert which is a restriction to flow and capacity.

Recommendations: The existing ditch segment between Spanish Dry Diggins and Lasita Place should be gunnite-lined. A minimum ditch section with a 7-foot wide

bottom width and a minimum depth of 2-1/2 feet is recommended. This would allow a flow depth of 18 inches with 12 inches of freeboard. This is a priority repair. New crib wall sections, each ±40 feet in length, should be installed to replace the two old crib wall sections downstream of Lasita Place. New driveway and roadway crossings in this section of the ditch should be installed with a 60 x 46 CMPA or a 48" CMP.

Taylor Mine Outlet (and Flume) to Cabin Wastegate

Findings: This section of the Main Ditch is also constructed with very flat (< .2%) slopes. The existing ditch section together with the flat slopes does not permit the ditch to carry design flow with at least 6" to 12" of freeboard. While the first 2000 feet of this segment has been lined the last 500 feet of lining is in poor condition with large holes and cracks. This lining should be replaced. From the end of the existing lining to the Cabin Wastegate there are previous crib wall repairs. Typically, the ditch at Cabin Wastegate operates with less than 6 inches of freeboard. The Cabin Wastegate is scheduled to be replaced.

Recommendations: Approximately 500 feet of the existing lined section should be replaced with new lining from approximately 1500 to approximately 2000 feet downstream of the Taylor Mine Outlet. Construct 3 sections of crib wall approximately 40 feet long each, at three locations within 600 feet (upstream) of Cabin Wastegate. Provide freeboard improvements from the end of the lined section to Cabin Wastegate. This is a priority repair item. Construct enhanced ditch with minimum 6-foot bottom width and minimum 2 foot 9 inches deep section to provide not less than 12 inches of freeboard and 1 foot 9 inches of operating depth at design flows. Replace Cabin Wastegate.

Cabin Wastegate to Growlersberg Wastegate

Findings: This segment of the Main Ditch is lined, however much of the lining is old (over 20 years) and in poor condition. Ditch slopes are very flat. The existing ditch section together with the flat slopes are not adequate to carry design flows with adequate freeboard. There are a number of low freeboard and repair areas in this segment which were identified during field investigations.

Recommendations: Remove and replace existing lining with a new lined section for the 1800 foot segment between the Cabin Wastegate and the Growlersberg Wastegate. The minimum ditch section should include a 6 foot wide bottom and a 2 foot 9 inch depth (1 - 9 inch water operating depth) or a 7 foot bottom with a 2 foot 3 inch depth (1 - 3 inch water operating depth). This is a priority repair item. The fence at Growlersberg must be replaced with an access gate and security lock.

Growlersberg Wastegate to Summers Wastegate

Findings: The ditch is piped through a portion of the Growlersberg Conservation Camp. Downstream of the piped section there are three areas which require crib wall

repair and replacement. Further downstream there is an old lined section which was constructed with expansion joints. The construction method used has extended the useful life of the lining since it is still providing good service. While this section of ditch was constructed with relatively flat slopes lack of adequate freeboard can be permitted in this area since the ditch lining is in good condition. Downstream of a falls section (and immediately upstream of the Summers Wastegate and Flume) there is also a ±600 foot long section of lining. This lining was placed in 1991 and is in fair to good condition.

Recommendations: Provide crib wall repair or replacement to three, ±40 foot long sections.

Summers Wastegate to Spools Wastegate

Findings: Within 600 feet (downstream) of Summers Wastegate field investigations identified 5 repair areas. The existing ditch section and the flat slopes also do not permit the ditch segment to convey design flows with adequate freeboard. Upstream of Silent Meadow Lane leaks were observed through an old lined section. Downstream of Silent Meadow Lane there is also a lined section which is constructed with very flat slopes. This section can not convey design flow with adequate freeboard.

Recommendations: Beginning at Summers Wastegate repair the first 600 feet of ditch with crib walls and increased freeboard. This is a priority repair. The final ditch section should include not less than a 7-foot bottom width and not less than a 2 foot, 3 inch depth. Replace old lining with a new lined section for ±3200 lineal feet upstream of Spools Wastegate. New lined section should provide not less than 6 feet of bottom width and not less than 2-1/2 feet of depth.

Spools Wastegate to Jackass Wastegate

Findings: Three repair areas are identified in this segment of the ditch. Two are located in unlined areas and one is located in an area which was lined approximately 20 years ago. This segment continues to be flat with slopes less than 0.2%. With the section available and the flat gradient, this section of the ditch can not convey design flows with adequate freeboard.

Recommendations: Replace lined section for approximately 600 feet downstream of Spools Wastegate. Final lined section should provide not less than a 5 foot bottom width with not less than 2-1/2 feet of depth. Provide crib wall repairs at two locations, 40 feet in length and 100 feet in length. Replace 900-foot long lined section downstream of Cougar Lane. Provide levee improvements for approximately 1000 feet of ditch between lined sections.

Jackass Wastegate to Greenwood Reservoir

Findings: This segment has improved slope and capacity. Two repair areas each approximately 100 feet in length were identified downstream of Falstaff Road. The

Jackass Wastegate was re-constructed with reinforced concrete sidewalls and steel gates in 1977.

Greenwood Reservoir is a critical raw water storage reservoir of the GDPUD system. Reservoir capacity and modifications to increase capacity are discussed later in this section of this study.

Recommendations: Two ditch sections, each ±100 feet in length should be repaired with crib wall construction. Recommendations regarding Greenwood Reservoir are included under "Raw Water Storage".

Greenwood Reservoir to SDD Diversion Flume

Findings: This is a lined section which is in fair to good condition. Ditch capacities are limited by slope and section but there are no known repair areas or known leaks in this segment. To convey design flows, the ditch must operate with limited freeboard.

Recommendations: Freeboard enhancement may be needed in this segment of the ditch in the future.

SDD Diversion Flume to Blue Heron Way Falls

Findings: The ditch falls rapidly through this segment. Because of the elevation difference available this ditch section has capacity well in excess of design flows. No significant leaks or losses are known to occur in this segment. There is significant vegetation growth in this area which should be cleaned to maintain access.

Recommendations: Conduct vegetation removal to maintain access along the ditch.

Blue Heron Way Falls to Kaiser Siphon

Findings: Ditch slopes in the area are also well above the minimum required to maintain flows. There are, however, numerous fence crossings on the ditch which hinder operator access. Low berm area and old crib wall repair areas were identified from 500 to 1500 feet downstream of Blue Heron Way. Upstream of the Kaiser Wastegate and the Kaiser Siphon are two significant repair areas which extend some 600 feet along the ditch.

Recommendations: Replace fence crossings with GDPUD approved gates in 7 locations. Provide ditch lining 500 feet to 1500 feet downstream of Blue Heron Way. Lined sections should be constructed with bottom width not less than 5 feet and a ditch depth not less than 2 feet. Provide ditch lining 200 to 800 feet upstream of Kaiser Wastegate and Siphon. Minimum finished ditch section should be the same as

described above for the lined section below Blue Heron Way. This is a priority repair area.

Kaiser Pipeline and Kaiser Siphon

Findings: The Kaiser Pipeline is a 24 inch diameter Reinforced Plastic Mortar (RPM) pipe (Techite) placed by the District in the early 1970's. This pipeline connects to the Kaiser Siphon, a 24-inch diameter steel pipeline placed prior to the upstream pipeline. The two piped sections convey raw water some 4200 feet from the Kaiser Wastegate across State Highway 193. Hydraulic gradient and pipe diameter are adequate to convey 25 cfs which exceeds the design flows. Access along the pipeline must be maintained to permit periodic inspection and maintenance of system blowoffs, air relief valves and drains. According to District records portions of the pipeline which cross State Highway 193 to the discharge are Techite. Maintenance on the Kaiser Pipeline / Kaiser Siphon has been limited to replacing one section of the steel pipeline with plastic pipe.

Recommendations: While this conduit has provided reliable service, periodic repairs should be anticipated in the future. At a minimum, access along the pipeline and vegetation clearing must be maintained. The Kaiser Pipeline has been in place since the early 1970's. Replacement of this critical pipeline element with HDPE, pressure rated plastic (PVC 905) or concrete pipe should be included in the District's long term planning.

Kaiser Siphon to Ford Siphon

Findings: This is a short section of open ditch. There is adequate fall and ditch cross section to convey design flows. There are no known leaks or repair areas in this section of the ditch.

Ford Siphon

Findings: This is a ±250 foot long section of 36-inch diameter concrete pipe. Raw water flows are conveyed back across State Highway 193 to Auburn Lake Trails with this conduit. The Ford Siphon includes a drain / blowoff which must be periodically maintained.

Recommendations: Maintenance access to the drain / blowoff must be maintained for periodic access and repair.

Ford Siphon to ALT Water Treatment Plant

Findings: This section includes lined areas and a 30-inch diameter concrete pipe constructed under Rita Court. The capacities of the open ditch and piped section are adequate to convey design flows. Existing ditch lining is in good to very good condition. Access is hindered by two fence crossings.

Recommendations: Replace existing fence crossings with GDPUD approved gates.

ALT Water Treatment Plant to Campground Wastegate

Findings: The ALT Water Treatment Plant raw water storage reservoir is an important feature of the ditch supply system. Recommendations to improve capacity are included in this section of this Reliability Study. There is a metering flume on the ditch downstream of the ALT Plant. The flume is currently not used. Most of the ditch along this segment is unlined. Lined sections which have been constructed are rated fair to good, with some sections rated very good. Ditch slopes are relatively flat (±0.2%) but with the cross section provided, adequate capacity is available to convey design flows. There are numerous culverts placed for roadway and driveway crossings. These are typically 48" or 54" CMP, 57 x 38 CMPA or 49 x 33 CMPA. These are adequate to provide conveyance without restricting ditch flow. There are a number of fence crossings in this area. Those without gates should be replaced with GDPUD approved gates. Significant drainage flows enter the ditch at a point approximately 900 feet upstream of the second crossing of Cascade Lake Trails.

Recommendations: A metering device should be installed downstream of the ALT Water Treatment Plant. Install at the existing metering flume or replace the existing flume with a meter which continuously monitors and records flow. Replace ditch fence crossings with gates. If new culverts are placed for driveways or road crossings, they should be 49 x 33 or 57 x 38 CMPA. The ditch segment between the ALT Treatment Plant and the ALT Campground Wastegate is 13,000 feet in length. This is too long to provide adequate flow control during winter periods. It is recommended that a new wastegate be installed at the drainage inlet area located approximately 1000 feet upstream of Cascade Trail. It is recognized that permits from regulatory agencies are required to implement this feature. Provide improved access along the ditch in the vicinity of the ALT Campground. Vegetation clearing and levee widening from ±1500 feet downstream of the ALT Campground is recommended.

Campground Wastegate to Willow Creek Wastegate

Findings: This is another relatively flat section, however, adequate section and slope and capacity are available to meet design flows. Similar to the previous section there are isolated sections of lined ditch. Lined sections within 2500 feet (downstream) of Campground Wastegate are in fair to good condition. Approximately 1 mile downstream of the Campground Wastegate is an older lined section (20 to 25 years) which is in poor condition and should be replaced. This lined area is located approximately 500 to 1500 feet upstream of an area where the ditch parallels Cascade Trail. Excessive drainage flow enters the ditch in this area. Approximately 1500 feet upstream of the Willow Creek Wastegate the ditch crosses through cattle pasture land. There are numerous areas within the pasture in which cattle have damaged the ditch. Fencing is needed in this area to control access. The Campground Wastegate and the

Willows Creek Wastegate are separated by a distance of some 9600 feet. Approximately 800 feet upstream of the Willow Creek Wastegate is an area which receives excessive drainage flows.

Recommendations: It is recommended that a new wastegate be constructed in the drainage area below Cascade Trail. Construct lined ditch improvements upstream of the new wastegate some 1800 feet to replace old lining in poor condition. The lined ditch should provide a section with a minimum bottom width of 5 feet and a ditch depth not less than 2-1/2 feet. New culverts placed in this area should not be smaller than 49 x 33 CMPA or 48" CMP. Place livestock fence to control cattle access to the ditch. Approximately 1500 feet of livestock fencing is required upstream of Willow Creek Wastegate. Provide ditch lining approximately 800 feet upstream of the Willow Creek Wastegate in the area which receives widespread drainage inflow. Continue the lining to Willow Creek Wastegate.

Willow Creek Wastegate to Baldridge Wastegate

Findings: Downstream of the Willow Creek Wastegate is another area which receives widespread drainage flows. Drainage seeps upstream and downstream of the ditch were observed for a distance of some 500 feet. It is suspected that this wet area near the Willow Creek Wastegate is a high loss area. Approximately 900 feet downstream of the Willow Creek Wastegate the ditch again crosses cattle pasture area. Along the next 3000 feet there are several locations where cattle have damaged the levee sections creating low berm areas and ditch losses.

Recommendations: Downstream of the Willow Creek Wastegate provide ditch lining in the unstable saturated discharge areas. Construct some 3000 lineal feet of livestock control fencing where the ditch crosses pasture land. Repair with crib walls 5 locations each ±40 feet in length which have been damaged by cattle. Place GDPUD approved gates at existing fence crossings. If new culverts are placed in this ditch segment they should be 49 x 33 CMPA or larger.

Baldridge Wastegate to Bogus Wastegate

Findings: This section includes the Baldridge Pipe and several lined ditch sections. This existing piped, lined and unlined sections have adequate slope section and capacity to convey design flows. Lined sections are in fair to good condition. No repair or significant loss areas were identified in this segment. There are several fences which cross the ditch section. These should be replaced with GDPUD approved gates. Downstream of Upper Black Rock Road the ditch parallels pasture land separated from the ditch by fencing but which releases significant drainage into the ditch. This section of the ditch is currently lined.

Recommendations: Provide GDPUD approved gates at 8 cross fences located along this segment of this ditch. New culverts placed in the segment should be 49 x 33 CMPA or larger.

Bogus Wastegate to Dorman Wye

Findings: This section of the ditch has moderate slopes. The existing slope and ditch section provide capacity in excess of design flows.

Pilot Hill Ditch

Dorman Wye to Knickerbocker Creek

Findings: At Dorman Wye ditch flows are divided between the Cherry Acres Ditch and the Pilot Hill Ditch. Downstream of the Dorman Wye the Pilot Hill Ditch crosses State Highway 193 again with two, 18 inch CMP culverts. It is believed that one of these culverts is blocked. There is a 24-inch diameter steel culvert located at a driveway crossing downstream of this location. There is heavy vegetation growth along this segment of the ditch.

Recommendations: Replace two existing 18" CMP culverts at State Highway 193 and the 2 inch steel pipe located downstream of this location with a 42 x 29 CMPA or a 36" CMP. Remove vegetation and provide maintenance access along ditch.

Knickerbocker Creek to Pear Orchard Wastegate

Findings: There is adequate capacity in this ditch segment to convey design flows. No repair or loss areas were identified. This segment of the ditch, typical of much of the Pilot Hill Ditch, is hindered by vegetation growth.

Recommendations: Provide minimum 8 foot wide access for ditch inspection and control of vegetation. New culverts placed in the segment should be minimum 42 x 29 CMPA or 36" CMP. Install GDPUD approved gates at existing fence crossings.

Pear Orchard Wastegate to Therekel Wastegate

Findings: Adequate capacity is available in this segment to convey design flows. One repair area was identified.

Recommendations: Provide minimum 8 foot wide access for ditch inspection and control of vegetation. New culverts placed in this segment should be minimum 42 x 29 CMPA or 36" CMP. Conduct repairs with 40 foot section of crib wall improvements.

Therekel Wastegate to State Highway 49

Findings: This section is characterized by numerous cross fences and poor access. Adequate capacity is available in this segment to convey design flows,

however, poor access does not allow proper maintenance and the cleaning of vegetation. Two, 18" culverts have been placed for ditch flows at Grand Fir Circle.

Recommendations: Provide minimum 8-foot wide areas for ditch inspection and control of vegetation. Place GDPUD approved access gates to replace cross fences at 18 locations along this segment. Replace the two, 18 inch culverts at Grand Fir Circle with minimum 42 x 29 CMPA or 36" CMP.

State Highway 49 to Lovejoy Wastegate

Findings: This is a short ditch segment with adequate capacity to convey design flows. Vegetation clearing and adequate maintenance access needed especially in the vicinity of the Lovejoy Wastegate.

Recommendations: Provide minimum 8-foot wide clearing for access and vegetation control. New culverts placed in this segment should be 42 x 29 CMPA or 36" CMP, minimum.

Lovejoy Wastegate to Nagle Wastegate

Findings: This is a flat section of ditch with limited capacity. However available capacity does exceed design flows in this lower section of the Pilot Hill Ditch System. West of Northside School there is a ±500 foot long repair area. Saturated and unstable conditions make repairs with cribwalls unsuitable. The Nagle Wastegate, an old wastegate of wood construction, is scheduled to be rebuilt in 2002.

Recommendations: Provide minimum 8 foot clearance for access and vegetation clearing. New culverts placed in this segment should be minimum 42 x 29 CMPA or 36" CMP. Repair 500 foot long ditch segment west of Northside School with ditch lining. Reconstruct Nagle Wastegate as a reinforced concrete structure with metal slide gates.

Nagle Wastegate to Capecroft Wastegate

Findings: GDPUD staff have recently completed ditch improvements in this area. A wooden flume was reconstructed and a culvert replaced in this area in 2002. Ditch slopes are flat in this segment and capacities are limited but exceed current design flows for this lower section of the Pilot Hill Ditch. One repair area was identified approximately 250 to 300 feet downstream of Nagle Wastegate.

Recommendations: Provide cribwall repair for approximately 50 feet of leaking ditch sections 250 to 300 feet downstream of Nagle Wastegate.

Capecroft Wastegate to Wagner Reservoir

Findings: There are several fences which cross the ditch downstream of Capecroft Lane. These hinder access and impede maintenance. The ditch flows parallel to State Highway 49 for some 1200 feet before discharging to Wagner Reservoir. This section is heavily choked with vegetation. The ditch is constructed with adequate slope in this area.

Recommendations: Replace cross fences with minimum 8-foot wide gates installed with GDPUD approved locks. Clear vegetation growth along ditch. Maintain clearance by providing adequate access along the ditch.

Wagner Reservoir to Wagner Reservoir Wastegate

Findings: Wagner Reservoir is a GDPUD regulatory reservoir which helps control flows in the lower Pilot Hill Ditch system. The operators report no significant deficiencies with the reservoir. It appears to be adequately sized. Downstream of the reservoir ditch access is limited. There is a significant loss area located approximately 1000 feet downstream of the Wagner Reservoir and approximately 200 feet upstream of the Wagner Wastegate. The District has attempted to repair this section with cribwalls.

Recommendations: Wagner Reservoir should be periodically checked for siltation. Conduct maintenance dredging as required. Monitor and repair, as necessary, Wagner Reservoir outlet gates. Provide vegetation clearing and maintenance access for ditch section downstream of the reservoir. Construct approximately 250 feet of ditch lining to repair leaking sections upstream of Wagner Wastegate.

Wagner Wastegate to Bayley House Wastegate

Findings: Ditch slopes in this section are good and there are fewer obstructions to access. GDPUD crews are able to periodically clear and maintain this area with the narrow track excavators and crews. Three repair areas, each ±50 to 100 feet in length were identified.

Recommendations: Conduct cribwall repairs at three locations, each ±50 to 100 feet in length.

Bayley House Wastegate to Pilot Hill Reservoir

Findings: This is the last open ditch section of the Pilot Hill System. Slopes and capacities are adequate. Except for the area immediately upstream of Pilot Hill Reservoir, maintenance access is available.

Recommendations: Replace fence crossing upstream of Pilot Hill Reservoir with minimum 8-foot wide gate and GDPUD approved lock.

Kelsey Ditch System

The Crails to St. James Wastegate

Findings: This segment of the Kelsey Ditch passes through and adjacent to GDPUD school and recreation areas. Most of this segment has already been lined or piped. Lined sections are in good condition. At two locations totaling some 800 feet the ditch has been replaced with two, 15-inch diameter PVC pipes. These pipes are not large enough to carry the ditch design flows and are frequently clogged with debris. Play and sports equipment from the school and park areas float down the canal and become lodged in these small diameter pipes.

Recommendations: The two segments which were previously improved with the small diameter pipe should be replaced with minimum 30 inch diameter HDPE or concrete pipes or a 42" x 29" CMPA section. Typical of all piped sections on the ditch the piped inlets should be constructed with trash racks (grizzlies).

St. James Wastegate to State Highway 193

Findings: Upstream of Prospect Hill Drive this segment of the ditch is lined. Approximately 100 lineal feet of this lining has been damaged, however, and should be replaced. Downstream of Prospect Hill Drive there are 4 fence crossings which inhibit access and maintenance. The capacity of this segment of the ditch is adequate to carry design flows except for an 18-inch CMP culvert which has been placed at a crossing some 400 feet downstream of Prospect Hill Drive.

Recommendations: Replace with new lining approximately 100 feet of ditch located upstream of Prospect Hill Drive. Replace fence crossings with minimum 8-foot wide gates and GDPUD approved locks. Replace the 18-inch CMP culvert with a 42" x 29" CMPA or 42" CMP.

State Highway 193 to (Forest View Drive) Falls

Findings: This segment is not lined but is constructed with adequate slope and capacity. Existing culverts placed in the ditch are of adequate capacity to carry the design flows. One fence crossing and one repair area were identified within this segment.

Recommendations: Replace fence crossing with minimum 8-foot wide gates and GDPUD approved locks. Provide ±100 feet of cribwall and freeboard improvements at ditch repair area located approximately 600 feet downstream of State Highway 193 crossing.

Falls to Irish Reservoir Wastegate

Findings: Downstream of the Florallan Road crossing there is a ±600 foot long segment of ditch which has known leaks. Ditch soils in this area are more sandy and loamy than clay. Leaks surface several feet below the ditch. Cribwall repairs in the material and in the section of ditch have not been successful. Downstream of the Hope Mountain Road crossing there is a known repair area. This segment of this ditch has been fenced off by property owners and access is difficult. Adjacent to Shamrock Lane there exists approximately 150 feet of low berm area which impacts the capacity of this segment.

Recommendations: Approximately 600 feet of existing ditch located downstream of Florallan Road should be gunnite-lined. It is recommended that the lined section should be at least 5 feet, 6 inches wide with a minimum depth of 2 feet. This is a known loss area and a priority repair. The low freeboard area located along Shamrock Lane should also be improved with a ditch section not less than 5 feet, 6 inches wide and not less than 2 feet deep. Approximately 100 feet of cribwall and berm improvements are recommended for the repair area located downstream of Hope Mountain Road. Existing fence crossings at 6 locations should be replaced with minimum 8-foot wide gates and GDPUD approved locks.

Kelsey Ditch No. 2

Irish Reservoir Wastegate to Twin Pines Siphon

Findings: Most of this segment is unlined. There are several low berm areas located 1500 to 3000 feet downstream of Irish Reservoir which impact ditch capacity. This segment of the ditch crosses through pastureland. To prevent the ditch from damage, fences are needed along the ditch with gunnite-lined sections provided at cattle crossings. To protect the ditch, GDPUD has previously placed cribwalls at cattle crossings. After these have been placed the cattle create a new crossing and damage a new section of ditch upstream or downstream of the cribwall repairs. A ±400 foot long repair area was identified beginning 200 feet downstream of Irish Reservoir.

Recommendations: Approximately 1500 feet of cattle access control fencing is recommended for this segment. At four locations, each approximately 100 feet in length, the existing unlined ditch should be constructed with a gunnite-lined section to provide controlled cattle crossings. A 400-foot section of unlined ditch beginning approximately 200 feet downstream of Irish Reservoir should be lined. The lined section should be constructed with not less than a 5 foot, 6 inch wide bottom width and a 2 foot depth or, alternatively, a 6 foot, 6 inch wide bottom with not less than an 18-inch depth. There are 10 fence crossings in this segment which should be replaced with minimum 8-foot wide gates and GDPUD approved locks.

The last ±2000 feet of ditch upstream of the Twin Pines Siphon is lined. Of this lined segment approximately 1200 feet is in poor condition and should be repaired or replaced. Existing seeps surface below this lined section of the ditch.

Irish Reservoir is a shallow regulating reservoir with little capacity. Maintenance dredging of this reservoir is recommended.

Twin Pines Siphon to Black Oaks Siphon

Findings: This segment includes the 24-inch diameter Twin Pine Siphon and an older lined section upstream of the Black Oaks Siphon. Upstream of the Black Oaks Siphon is the Clark Hill Wastegate and the discharge to the Greenwood Road and the Garden Valley pipelines.

Recommendations: The ±600-foot long section of lined ditch located between the siphons is in poor to fair condition. This lined section should be scheduled for repair and / or replacement. There are two fence crossings in this ditch segment which should be replaced with minimum 8-foot wide gates and GDPUD approved locks.

Black Oaks Siphon to Dukes Wastegate

Findings: Immediately downstream of Black Oaks Siphon some 300 feet of ditch was gunnite-lined in 2001 to control leaks. The remainder of this ditch segment is unlined with numerous fence crossings. Three repair areas were identified within this reach. The most significant of these is located approximately 1200 feet upstream of Dukes Wastegate. The Cunningham pipe begins approximately 400 feet upstream of the ditch crossing of Fair Pines Lane.

Recommendations: Repair with gunnite lining approximately 400 lineal feet of ditch located approximately 1200 feet upstream of Dukes Wastegate. This is a known leak and a priority repair area.

Provide gunnite-lined ditch repairs for two other, ±400 foot long segments, one located downstream of Happy Trails Lane and one located upstream of Fair Pines Lane. Replace fence crossings in 11 locations with minimum 8-foot wide gates and GDPUD approved locks.

Dukes Wastegate to State Highway 193

Findings: A total of 7 repair areas were identified for the reach of the Kelsey No. 2 ditch. Two of these segments with a total length of some 1000 feet are known loss areas. Repairs in this segment of the ditch must be conducted with lining. Cribwall repairs have proven ineffective as the soil is sandy and loamy with relatively high permeability rates. The previously lined sections in the segment are in fair to good condition.

Recommendations: Provide, as a priority repair, ditch lining for some 1000 feet of unlined ditch with known and observed leaks. Schedule for repair the lining of an additional 5 areas with a total length of 1500 feet. There is a 120-foot length section of 15-inch PVC placed in the ditch approximately 800 feet upstream of the State Highway 193 crossing. This small diameter PVC pipe is a maintenance problem and restricts ditch capacity. It should be replaced with a minimum 24-inch diameter HDPE or concrete pipe, a 36-inch CMP or a 35" x 24" CMPA. There are two other short segments (±30 feet long) of 18-inch steel and 18" CMP / 20" steel pipe placed at driveway crossings. These should also be replaced with 35" x 24" CMPA or 36" CMP.

State Highway 193 to Chicken Flat Wastegate

Findings: Nearly all of this ditch segment has been replaced with 15 inch PVC low pressure, (irrigation Class 100) pipe. The plastic pipe was placed in the ditch section and partially covered. Typically, minimum cover suggested for this pipe is 30 inches.

Since this pipe was not placed with adequate bedding, backfill and cover and since some sections of the pipe are exposed, pipe sections have been damaged by traffic, debris and UV degradation. Because this segment is located at the lower end of Kelsey Ditch No. 2 design flows are lower and the capacity of the 15 inch pipe matches or nearly matches design flows.

Recommendations: While the 15-inch PVC pipe provides adequate capacity the District should schedule replacement of this pipe with 24" diameter HDPE or 36" diameter CMP. A repair area is located near the downstream limit of the 15 inch PVC pipe. This existing open ditch section should be replaced with gunnite lining or extension of the piping improvements. As outlined above piping options include a 24" HDPE, 36" CMP or 35" x 24" CMPA.

Chicken Flat Wastegate to Mellows Wastegate

Findings: This ditch segment provides adequate service and capacity.

Mellows Wastegate to Kelsey Flume

Findings: Two significant loss areas were identified for this segment of the Kelsey No. 2 ditch. The first is located immediately downstream of Mellows Wastegate. The second is located approximately 1200 feet upstream of the Kelsey Siphon. Three low berm repair areas were also noted. Previous repairs in this segment of this ditch have typically consisted of gunnite lining or the replacement of ditch sections with piping.

Recommendations: Gunnite line approximately 800 feet of ditch (total two locations) at the two known loss areas for this segment. These are priority repairs. The three low berm areas could be repaired by providing a minimum ditch bottom width of 3-1/2 feet and a ditch depth of two feet.

Kelsey Flume Siphon to Stork Wastegate

Findings: Three repair areas were identified in this reach. Two are located within 400 feet of the outlet of the Kelsey Flume Siphon. These are not as significant as the repair area located approximately 200 feet upstream of Stork Wastegate. This is a known loss area.

Recommendations: Gunnite line approximately 400 feet of ditch upstream of Stork Wastegate. Schedule for ditch lining an additional 400 feet of ditch located 200 to 600 feet downstream of the Kelsey Siphon outlet.

Stork Wastegate to Kelsey Reservoir

Findings: The existing Stork Wastegate is of wood construction and has exceeded its useful life. It should be replaced with a new reinforced concrete facility with steel wastegates. Two ditch repair areas were identified in this last Kelsey Ditch No. 2 segment. These are known loss areas. There is a ±200 foot section of 15 inch diameter PVC partially exposed pipe which was placed in the ditch approximately 1200 feet downstream of the Stork Wastegate.

Recommendations: Gunnite line approximately 800 feet of ditch to repair the known loss areas. These are priority repairs. Replacement of the Stork Wastegate with a reinforced concrete facility should also be conducted as a priority repair. The District should schedule replacement of the exposed 15 inch PVC pipe with a buried 18 inch HDPE pipe or 24 inch CMP or a 28" x 20" CMPA.

Spanish Dry Diggins Ditch

Spanish Dry Diggins Flume to End

Findings: This is a minor ditch of the GDPUD ditch system. Most of the old ditch sections have been replaced with 15" to 24" pipe. The exiting piped and open ditch sections, in general, provide adequate capacity and service. Two repair areas were identified. One is located approximately 400 feet upstream of the Shelter Cove Drive crossing and is located approximately 200 feet downstream of Shelter Cove Drive.

Recommendations: Since most of the repairs and improvements to the Spanish Dry Diggins Ditch have been accomplished by piping ditch sections it is recommended that the repair located upstream of Shelter Cove Drive be completed with approximately 100 feet of 18" HDPE, 24" CMP or 28 x 20 CMPA. Similarly it is recommended that the repair downstream of Shelter Cove Drive be completed with 200 feet of 18" HDPE, 24" CMP or 28 x 20 CMPA.

Taylor Mine Ditch

Taylor Mine Outlet to Stradle Reservoir

Findings: Similar to Spanish Dry Diggins Ditch, Taylor Mine Ditch is also a minor ditch of the GDPUD system. Similar to Spanish Dry Diggins, Taylor Mine Ditch is tributary to the Main / Pilot Hill Ditch System and serves only irrigation water customers. Approximately 2/3 of the Taylor Mine Ditch has already been piped or lined. Capacity is adequate. Existing wastegates are in good condition. One low berm area was identified. There are 8 fence crossings on this ditch segment.

Recommendations: There are a number of different pipe materials and sizes which have been used on the Taylor Mine Ditch. It is recommended that future pipe installations use 18" HDPE, 24" CMP or 28 x 20 CMPA. The low berm area located downstream of the last Graybar Mine Road crossing should be replaced with a ±100 foot long piped section. Replace the 8 fence crossings of the ditch with a minimum 8-foot wide gate and GDPUD approved lock.

Cherry Acres Ditch

Dorman Wye to End

Findings: Similar to the Taylor Mine and Spanish Dry Diggins ditches, the Cherry Acres Ditch is a minor ditch tributary to the Main / Pilot Hill Ditch network. The Cherry Acres Ditch serves only irrigation customers. Adequate capacity is available to meet demands. Culvert and piped sections are adequately sized. There is one section of 14" diameter steel pipe which, because of slope, has adequate capacity, but because of limited diameter and condition should be replaced. There are 21 fence crossings on the Cherry Acres ditch. Because of poor access, maintenance of the Cherry Acres Ditch is difficult. Vegetation growth is particularly heavy along the first ±2500 feet of the ditch beginning at Dorman Wye. Four repair areas were identified. These are of limited scope and could be corrected with piping or cribwalls. GDPUD has previously lined approximately 2000 feet of the Cherry Acres Ditch with satisfactory results.

Recommendations: Replace the ±200-foot long section of 14" diameter steel pipe located upstream of Cramer Court with an 18" HDPE, 24" CMP or 28 x 20 CMPA pipe. Provide ±40-foot long cribwall repairs and berm improvements at two locations upstream of Cramer Court, one location downstream of Cramer Road and one location upstream of Wawona Way. Replace the 21 fence crossings with minimum 8-foot wide gates and GDPUD approved locks.

Raw Water Storage

Existing Storage Capacity

In the event of a ditch failure and during periods of ditch maintenance GDPUD must rely on the raw water storage provided by the Walton Lakes, Greenwood and Auburn Lake Trails Reservoirs to supply the Auburn Lake Trails and the Walton Lakes Water Treatment Plants (WTP). In Section V of this Study raw water storage criteria to meet emergency and maintenance conditions was developed. Not less than 50 acre-feet of raw water storage should be provided upstream of the water treatment plants with not less than 25 acre-feet provided upstream of the Walton Lakes WTP and not less than 25 acre feet provided upstream of the Auburn Lake Trails WTP. Based on existing reservoir surface areas, normal operating depth, estimated useable depths and the siltation which has likely occurred in all three reservoirs, the estimated current available capacity of each reservoir is as follows:

EXISTING RAW WATER STORAGE CAPACITY AVAILABLE

Reservoir	Approx. Surface Area (ft^2)	Approx. Max. Useable Depth (ft.)	Approx. Average Useable Depth (ft.)	Approx. Storage Capacity (ac-ft)
Walton Lakes	215,000	8.5	2.8	14.0
Greenwood	250,000	7.5	2.5	14.3
Auburn Lake Trails	105,000	7.0	2.3	5.6
			Estimated Total (ac-ft)	33.9

Additional raw water storage could be developed by constructing new raw water storage reservoirs or by improving the capacity of existing reservoirs.

Construction of New Raw Water Storage Reservoirs

Ideally raw water storage should be provided along the raw water supply ditch upstream of both the Walton Lakes and the Auburn Lake Trails Water Treatment Plants. Using this criteria, raw water storage would be available to serve both plants. Storage should be provided downstream of Tunnel Hill since the ditch sections upstream of Tunnel Hill are most susceptible to major failures and long term outages. The best

apparent site for a new reservoir upstream of Walton Lakes is located along Balderston Road near the inlet to the Sand Trap Siphon. A relatively level and open site in the vicinity of the ditch section replaced by the Sand Trap Siphon was evaluated. It was estimated that a reservoir with a surface area of approximately 60,000 square feet could be reasonably developed at this location. With a useable storage depth of up to 10 feet a raw water storage reservoir of approximately 7 to 10 acre-feet could be developed at this site. Based on cost, site acquisition, environmental and operations criteria it was determined that development of a new raw water storage reservoir at this location was not a good alternative.

A potential raw water storage site is located on GDPUD-owned property (APN 061-140-37) near the beginning of the Main / Pilot Hill Ditch System. This site is located north and east of Beam Field and encompasses the old Georgetown Reservoir. Preliminary topographic surveys were conducted of this site and it was determined that a reservoir with a storage capacity of approximately 19.8 acre-feet could be developed at this location. While this site could be developed at reasonable construction costs and with no acquisition costs its location downstream of Walton Lakes limits its value to supplementary storage for Auburn Lake Trails. Should the District construct a new water treatment plant with expanded capacity at Greenwood Reservoir, additional raw water storage at the Georgetown site would be of greater benefit.

Expansion of Existing Raw Water Storage Capacity

Increasing the useable depth of Walton Lakes from approximately 8-1/2 feet to approximately 10 feet could increase the available storage at this site from approximately 14.0 acre-feet to approximately 24.7 acre-feet. Similarly, increasing the available storage capacity of Greenwood Reservoir from approximately 14.3 acre-feet to approximately 24.4 acre-feet could be accomplished by increasing the useable water storage depth from 7-1/2 feet to 8-1/2 feet. The useable water storage depth at the Auburn Lake Trails Reservoir could also be increased to approximately 8 feet and storage capacity increased to approximately 9.6 acre-feet. In 1980, GDPUD conducted limited sediment removal from Walton Lakes. At that time approximately 4000 yd^3 (2.5 ac-ft) of sediment was removed from Walton Lakes. This work was conducted on a limited budget basis. After 20 years this amount of sediment together with additional dredging and excavation could be conducted to expand the existing capacity of this reservoir.

The estimated expanded capacity of the existing reservoirs is as follows:

EXPANDED RAW WATER STORAGE CAPACITY AVAILABLE

Reservoir	Approx. Surface Area (ft^2)	Approx. Max. Useable Depth (ft.)	Approx. Avg. Useable Depth (ft)	Approx. Storage Capacity (ac-ft)
Walton Lakes	215,000	10.0	5.0	24.7
Greenwood	250,000	8.5	4.25	24.4
Auburn Lake Trails	105,000	8.0	4.0	9.6
			Estimated Total (ac-ft)	58.7

The raw water storage that would be available from these expanded reservoirs would satisfy emergency and maintenance storage criteria developed for this Study.

GDPUD Ditch System Capacities and Design Flows
Up Country Ditch System
Pilot Creek Diversion to Structure #3

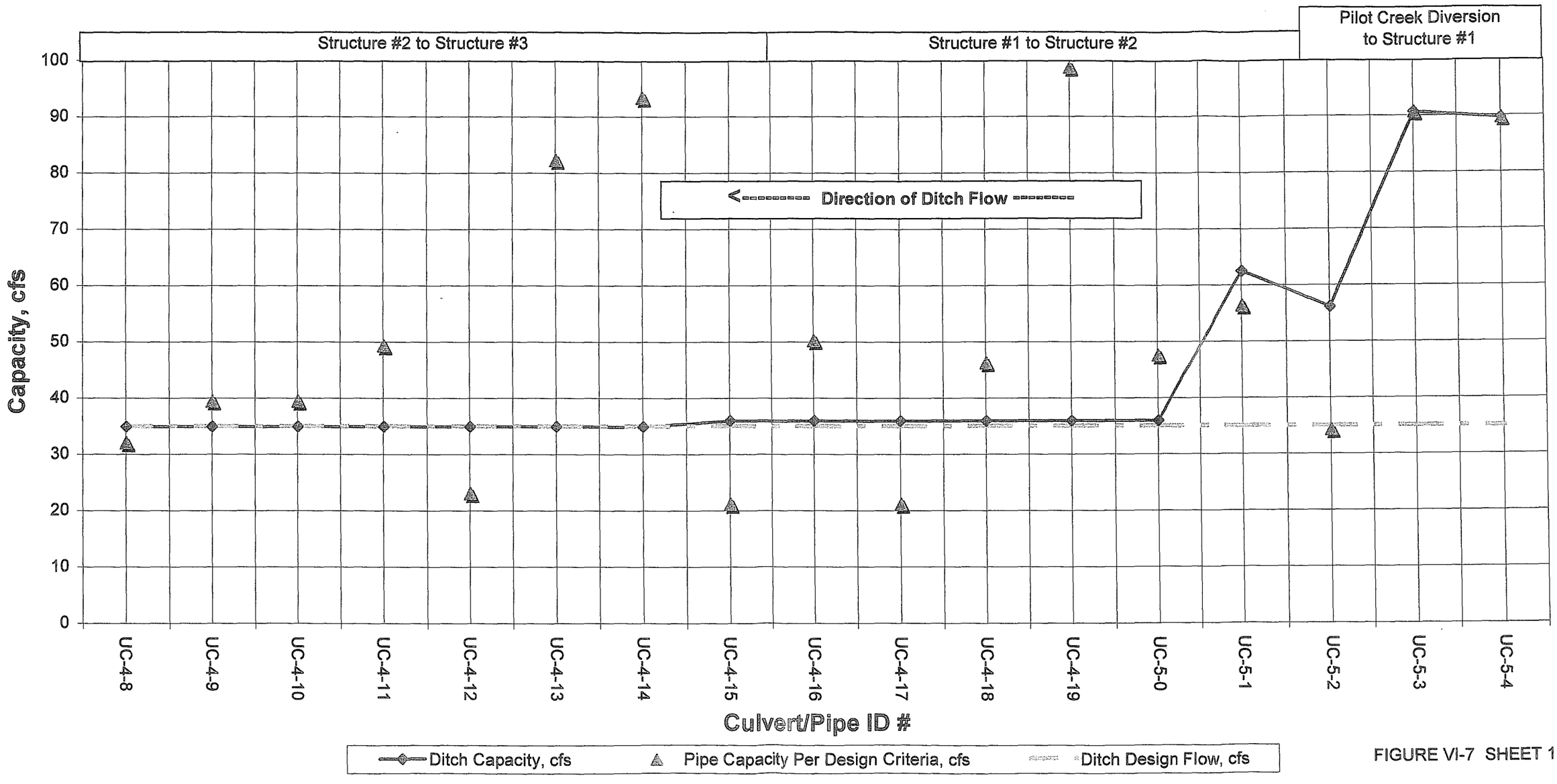

FIGURE VI-7 SHEET 1

GDPUD Ditch System Capacities and Design Flows
Up Country Ditch System
Structure #3 to Tunnel Hill Inlet

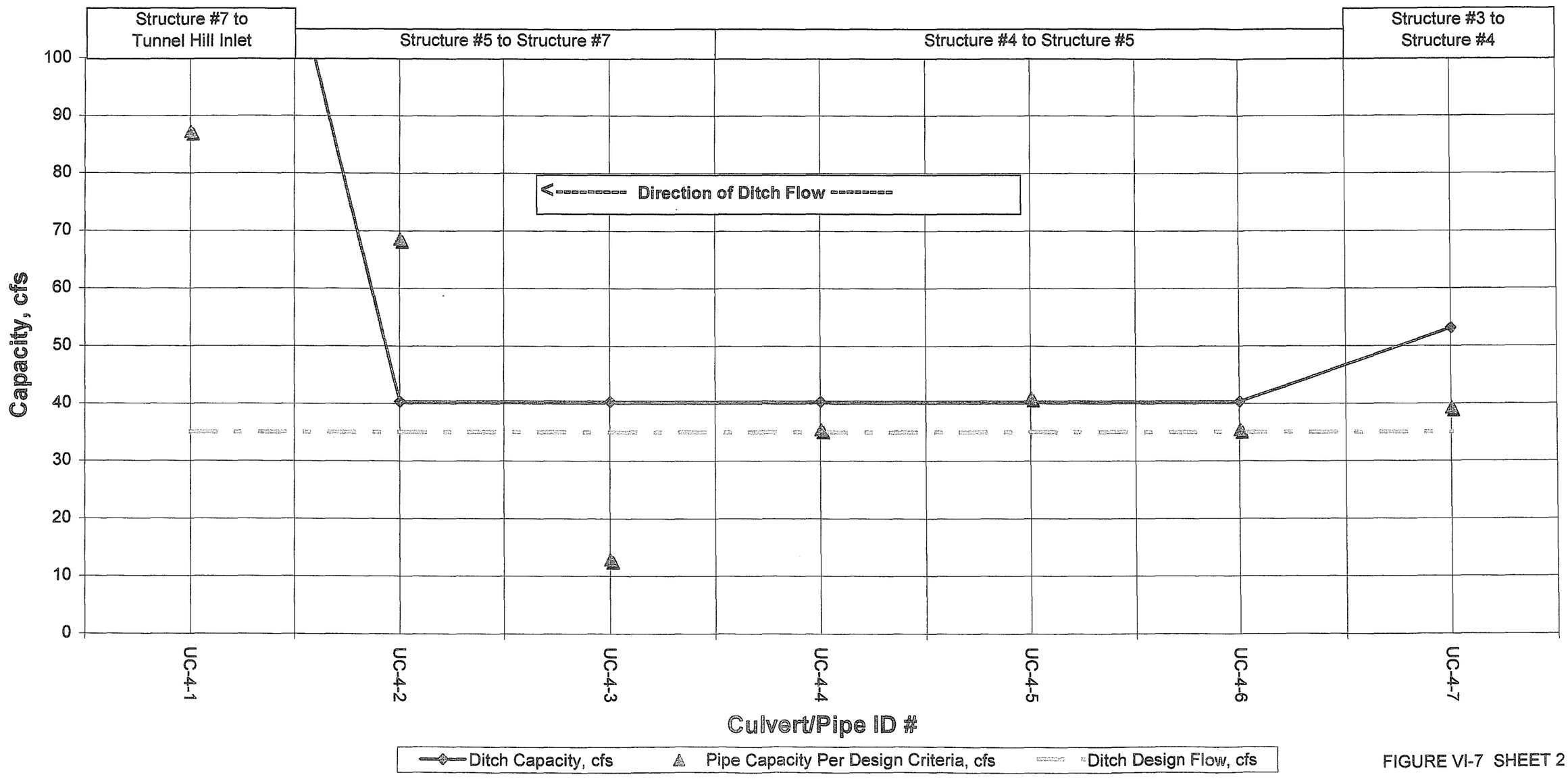

FIGURE VI-7 SHEET 2

GDPUD Ditch System Capacities and Design Flows
Up Country Ditch System
Penstock Inlet to Balderston Wastegate

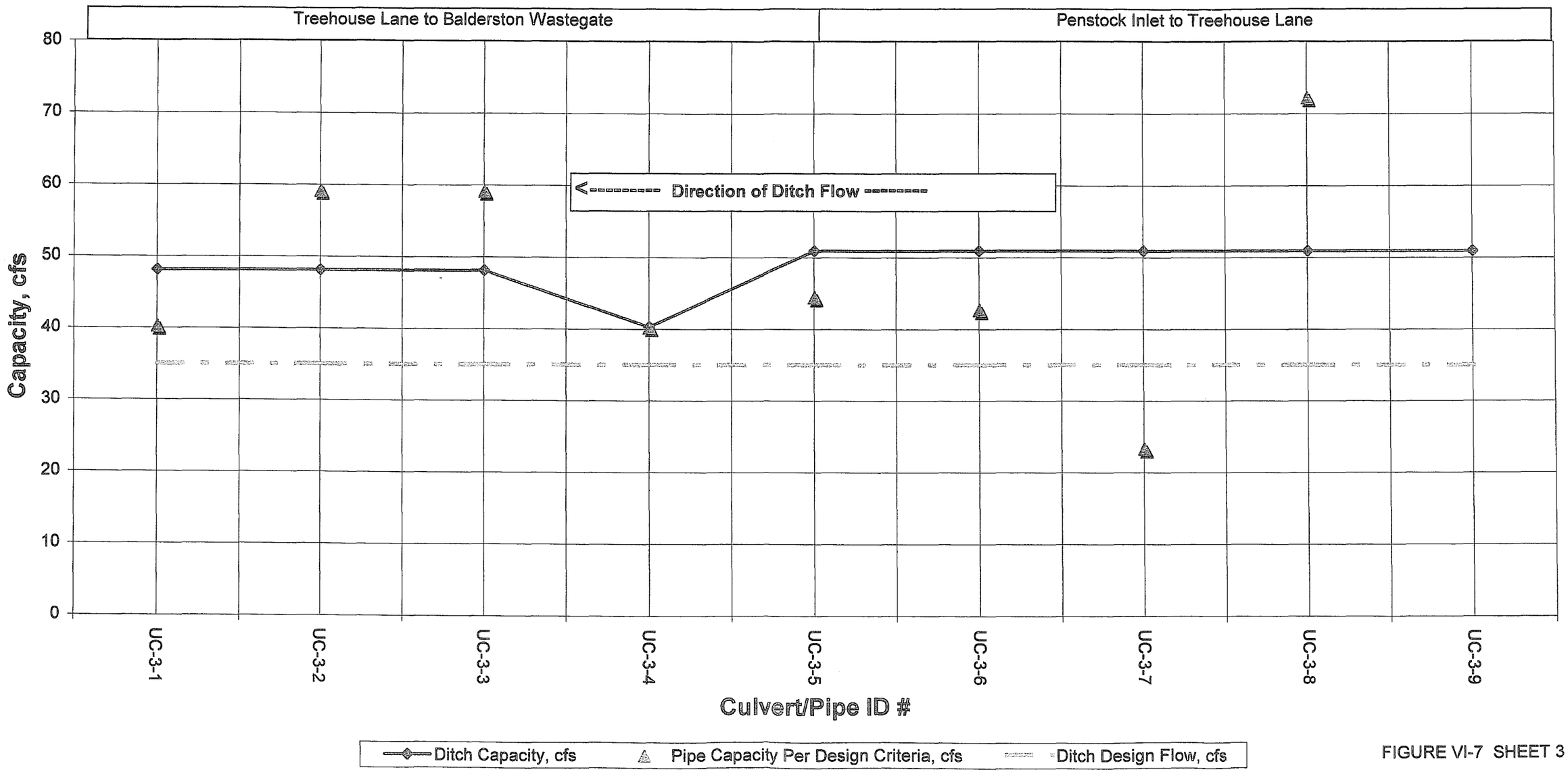

FIGURE VI-7 SHEET 3

GDPUD Ditch System Capacities and Design Flows
Up Country Ditch System
Balderston Wastegate to the Crails

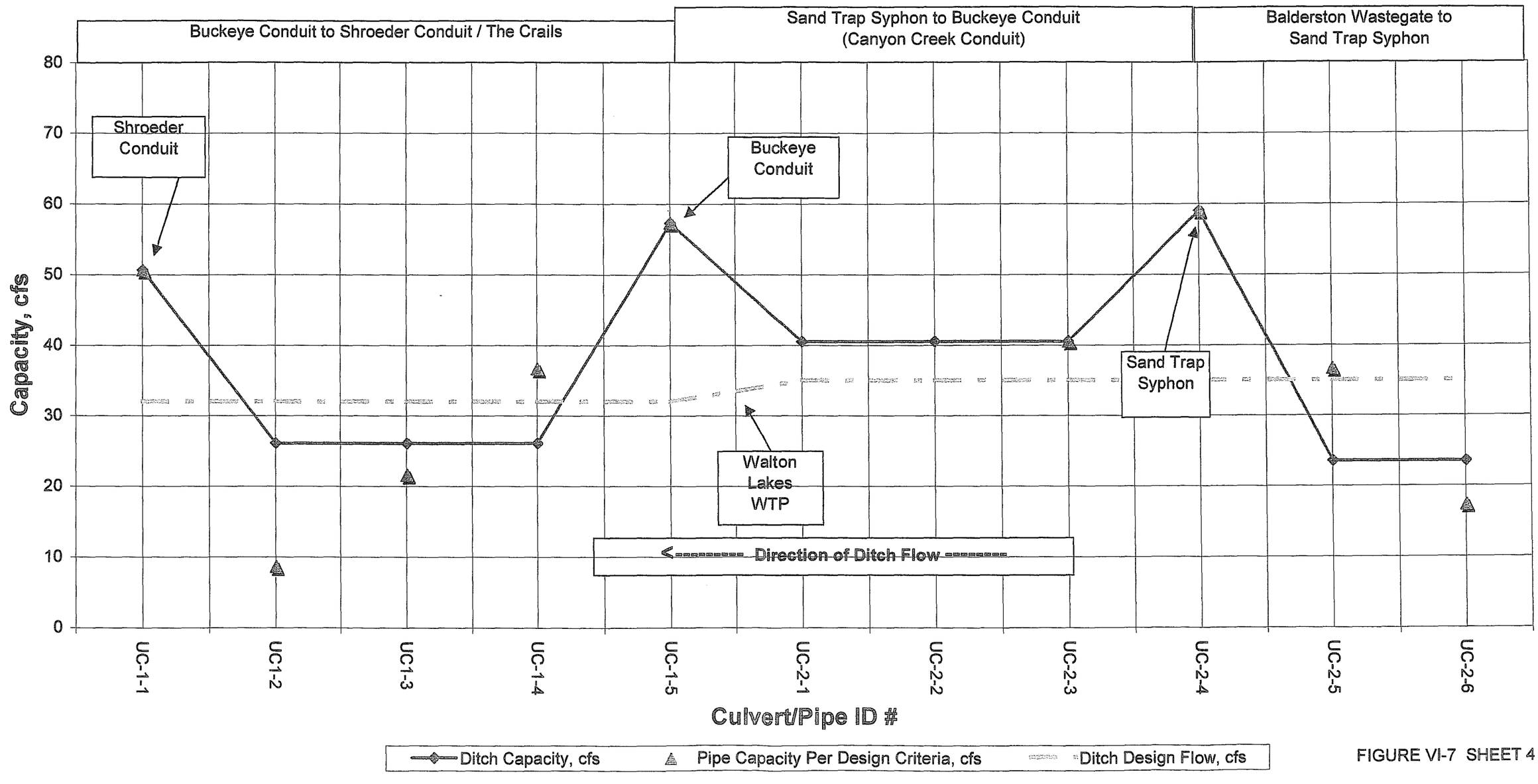

FIGURE VI-7 SHEET 4

GDPUD Ditch System Capacities and Design Flows
Main/Pilot Hill Ditch System
Main Ditch #1

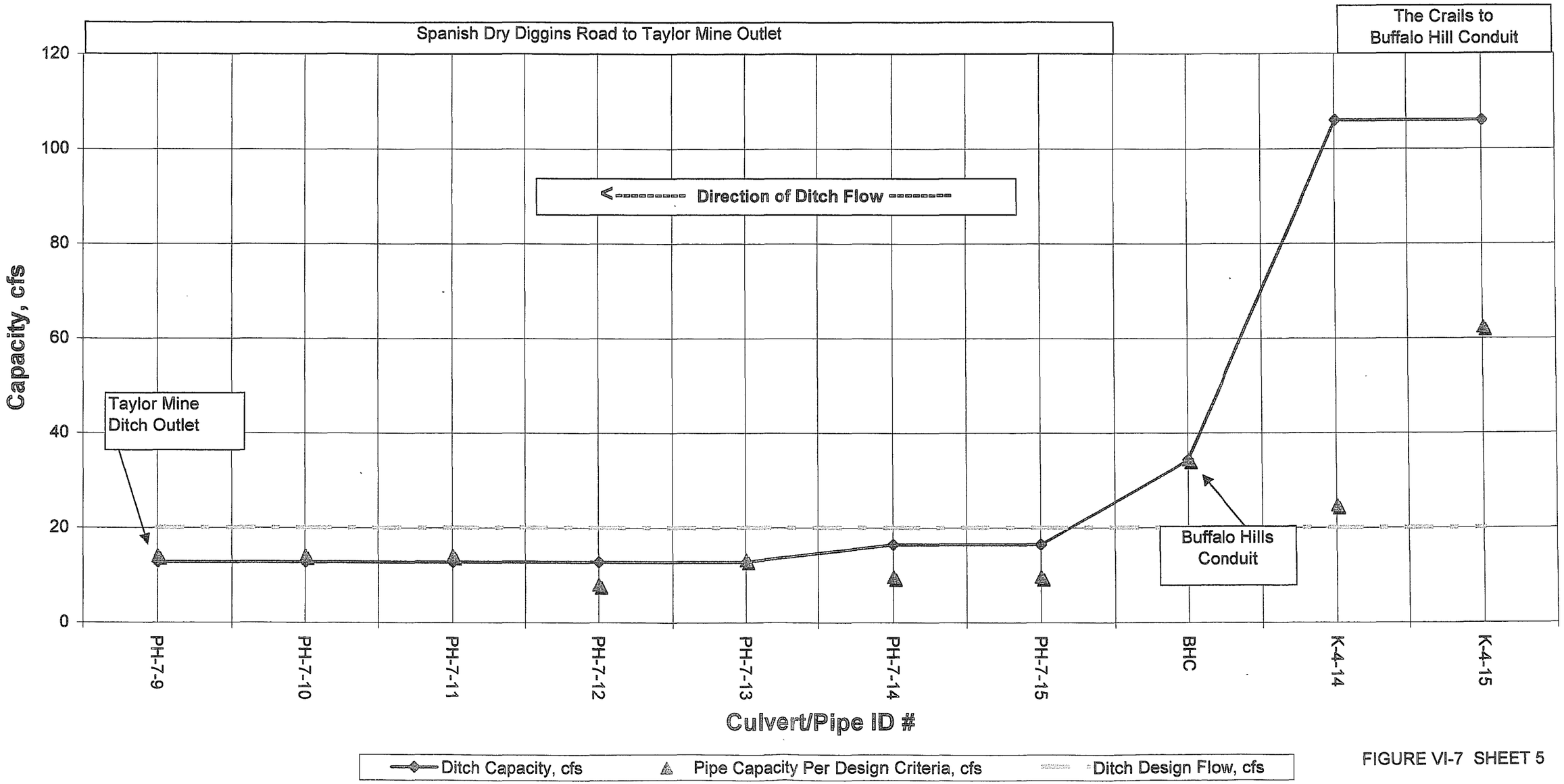

FIGURE VI-7 SHEET 5

GDPUD Ditch System Capacities and Design Flows
Main/Pilot Hill Ditch System
Main Ditch #1
Taylor Mine Outlet to SDD Diversion Flume

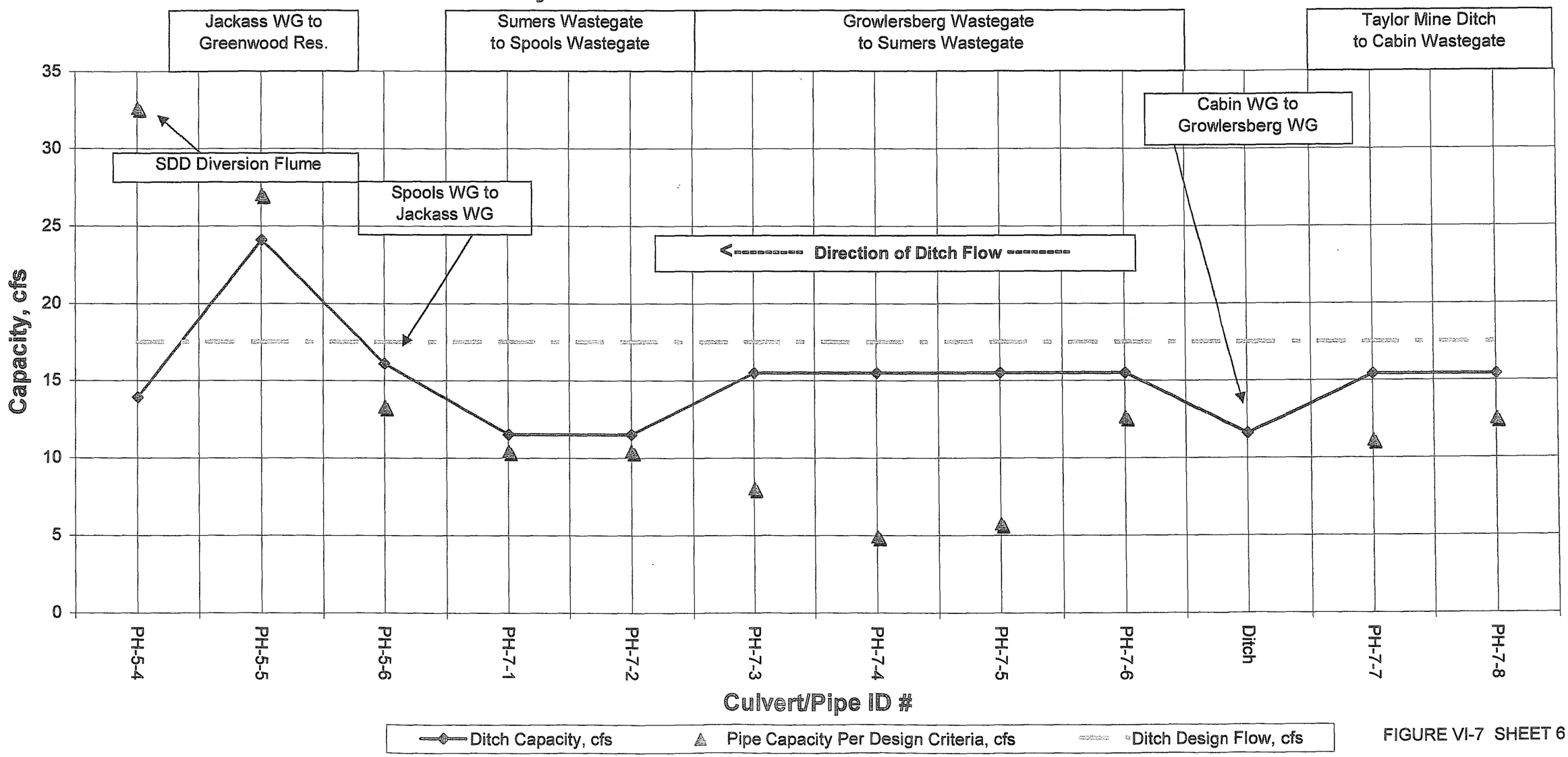

FIGURE VI-7 SHEET 6

GDPUD Ditch System Capacities and Design Flows
Main/Pilot Hill Ditch System
Main Ditch #2
Spanish Dry Diggins Diversion Flume to Dorman Wye

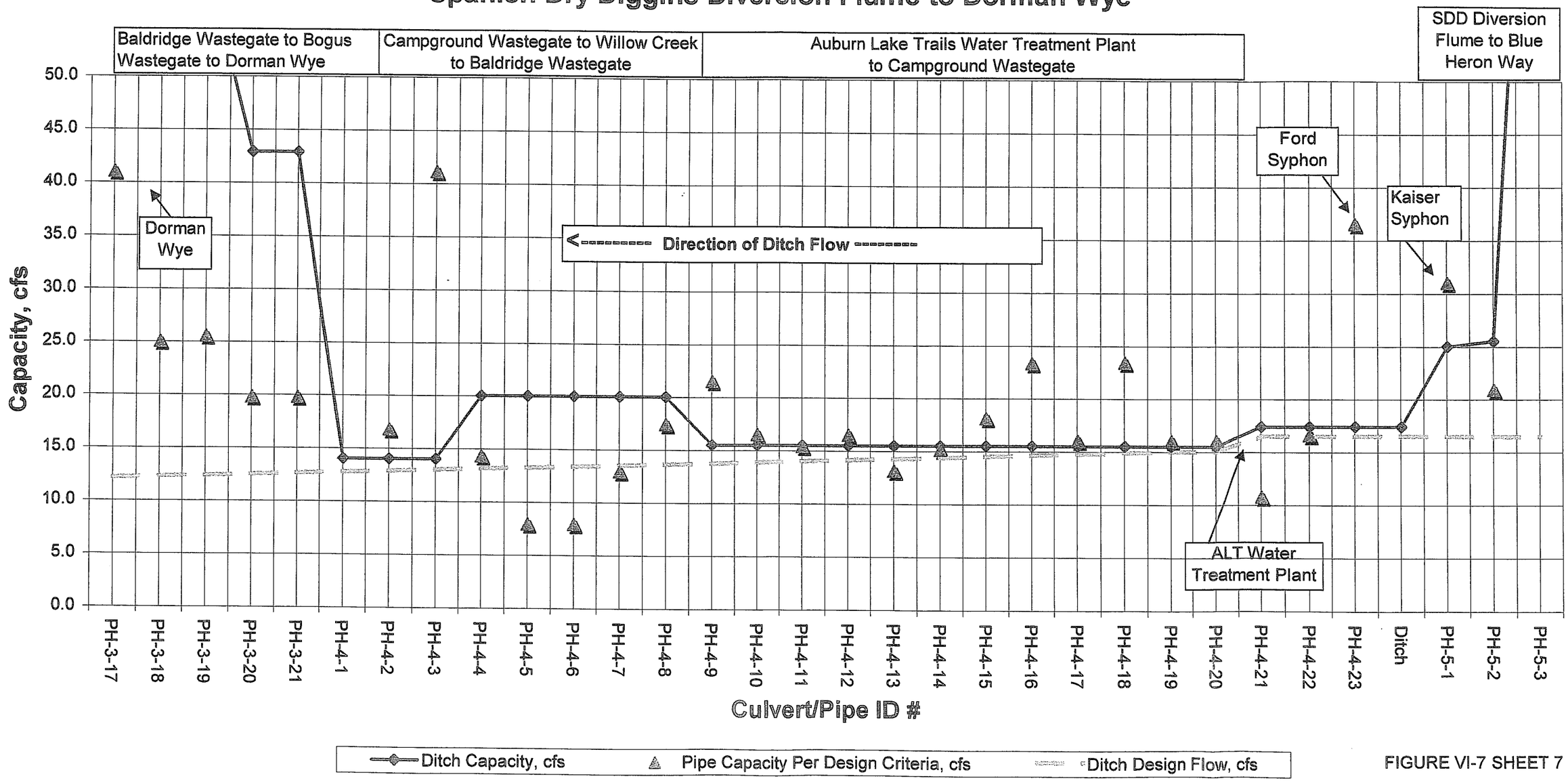

FIGURE VI-7 SHEET 7

GDPUD Ditch System Capacities and Design Flows
Main/Pilot Hill Ditch System
Pilot Hill Ditch
Dorman Wye to the Pilot Hill Reservoir

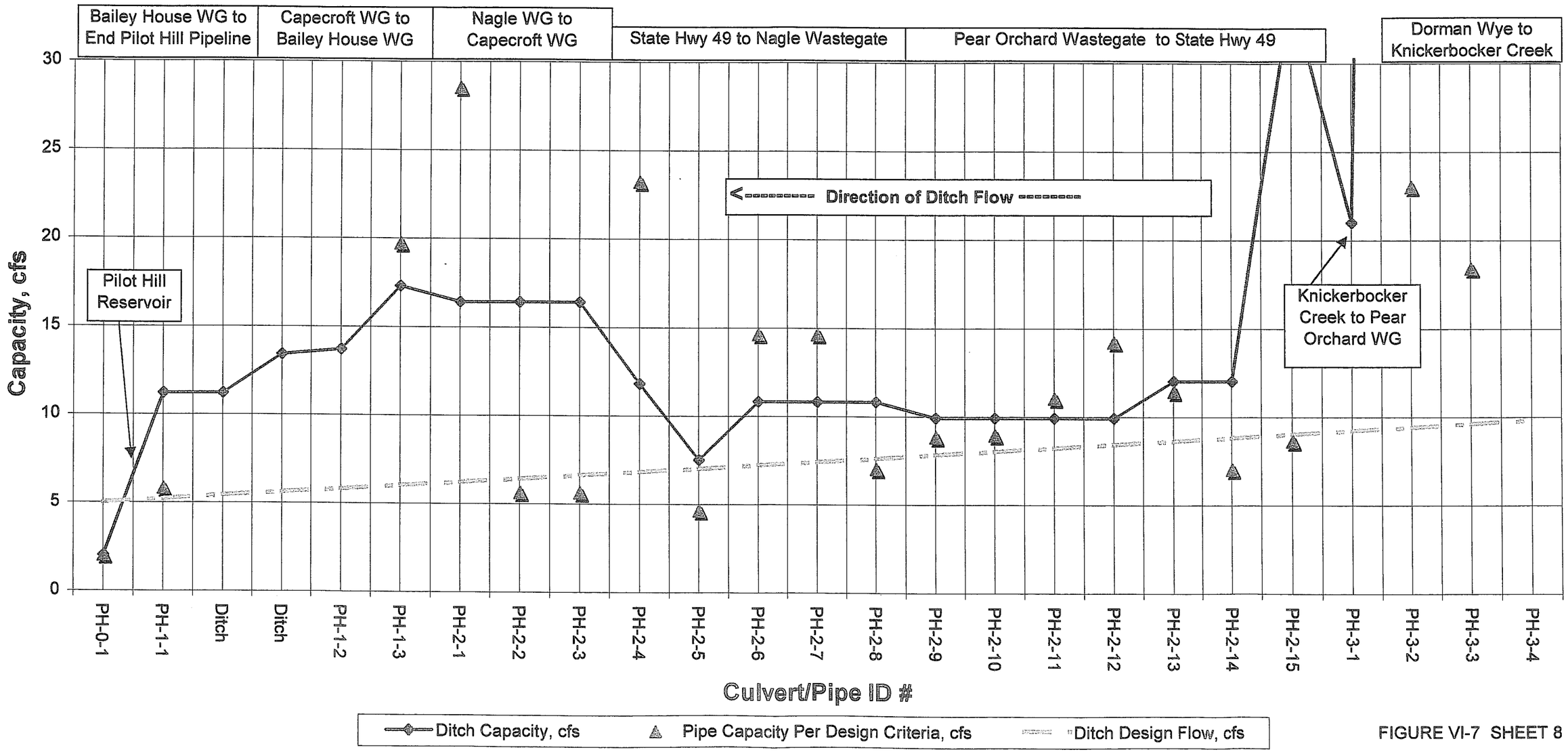

FIGURE VI-7 SHEET 8

GDPUD Ditch System Capacities and Design Flows
Main/Pilot Hill Ditch System
Spanish Dry Diggins Ditch
SDD Diversion Flume to End SDD Ditch

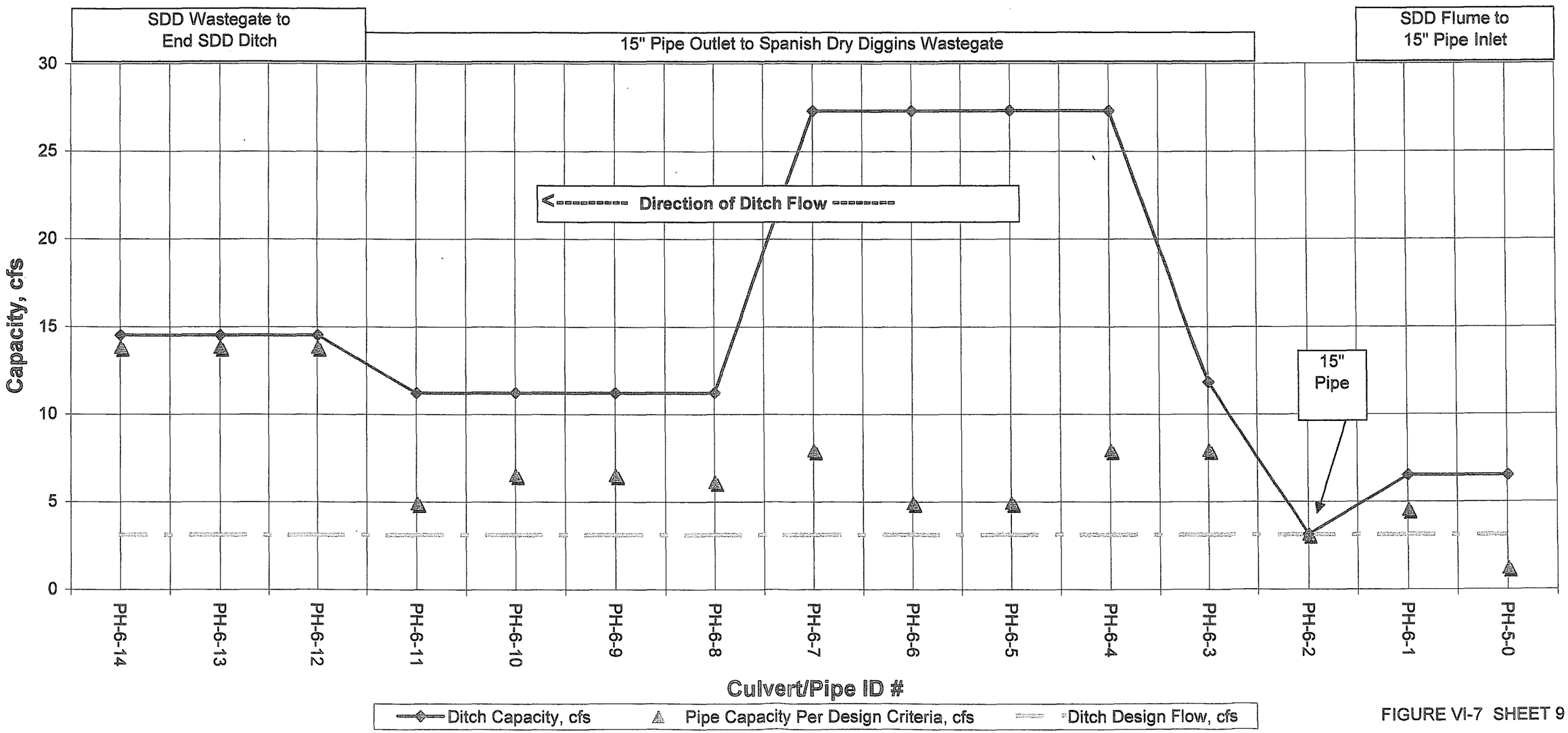

FIGURE VI-7 SHEET 9

GDPUD Ditch System Capacities and Design Flows
Main/Pilot Hill Ditch System
Cherry Acres Ditch
Dorman Wye to End of Cherry Acres Ditch

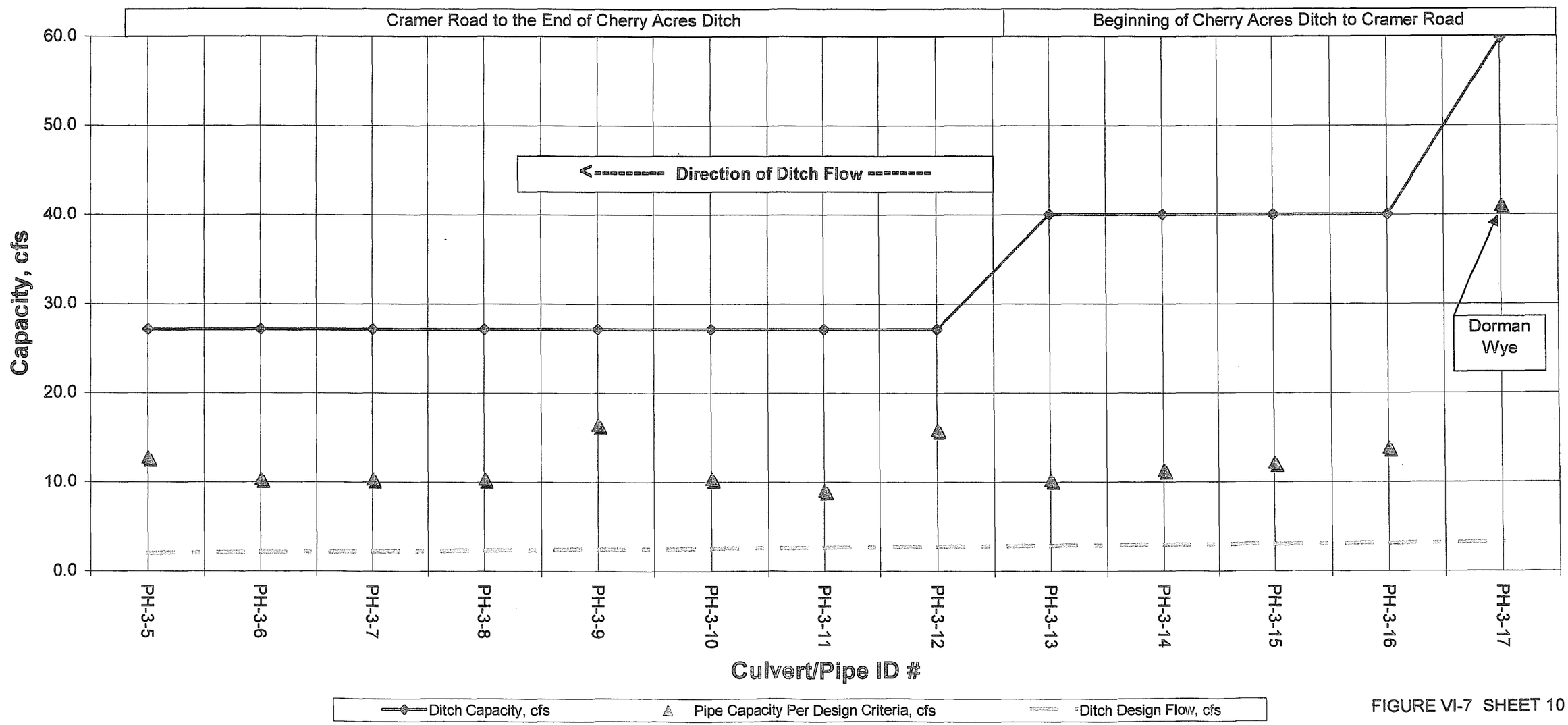

FIGURE VI-7 SHEET 10

GDPUD Ditch System Capacities and Design Flows
Kelsey Ditch System
Kelsey Ditch #1
The Crails to Irish Reservoir Wastegate

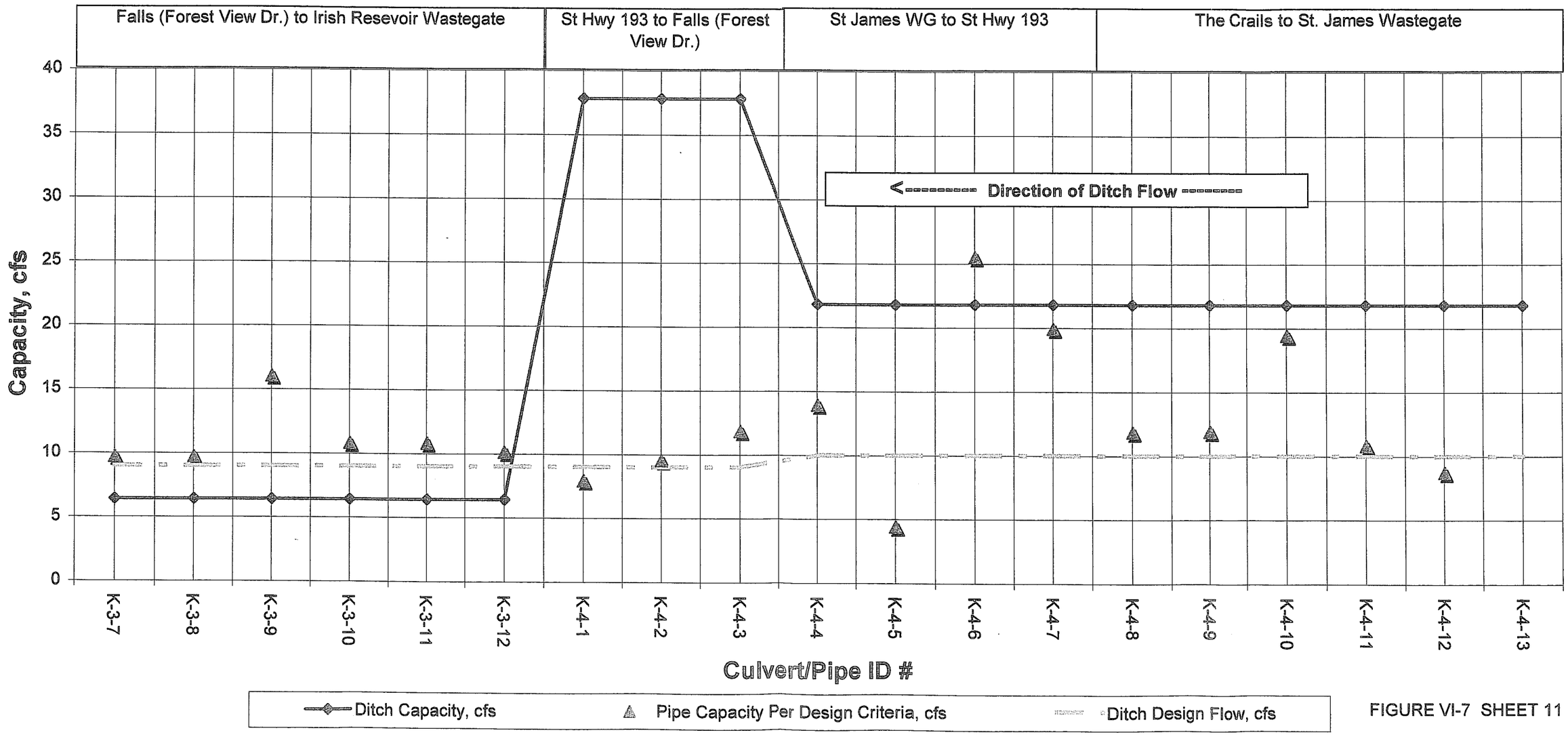

FIGURE VI-7 SHEET 11

GDPUD Ditch System Capacities and Design Flows
Kelsey Ditch System
Upper Kelsey Ditch #2
Irish Reservoir Wastegate to Chicken Flat Wastegate

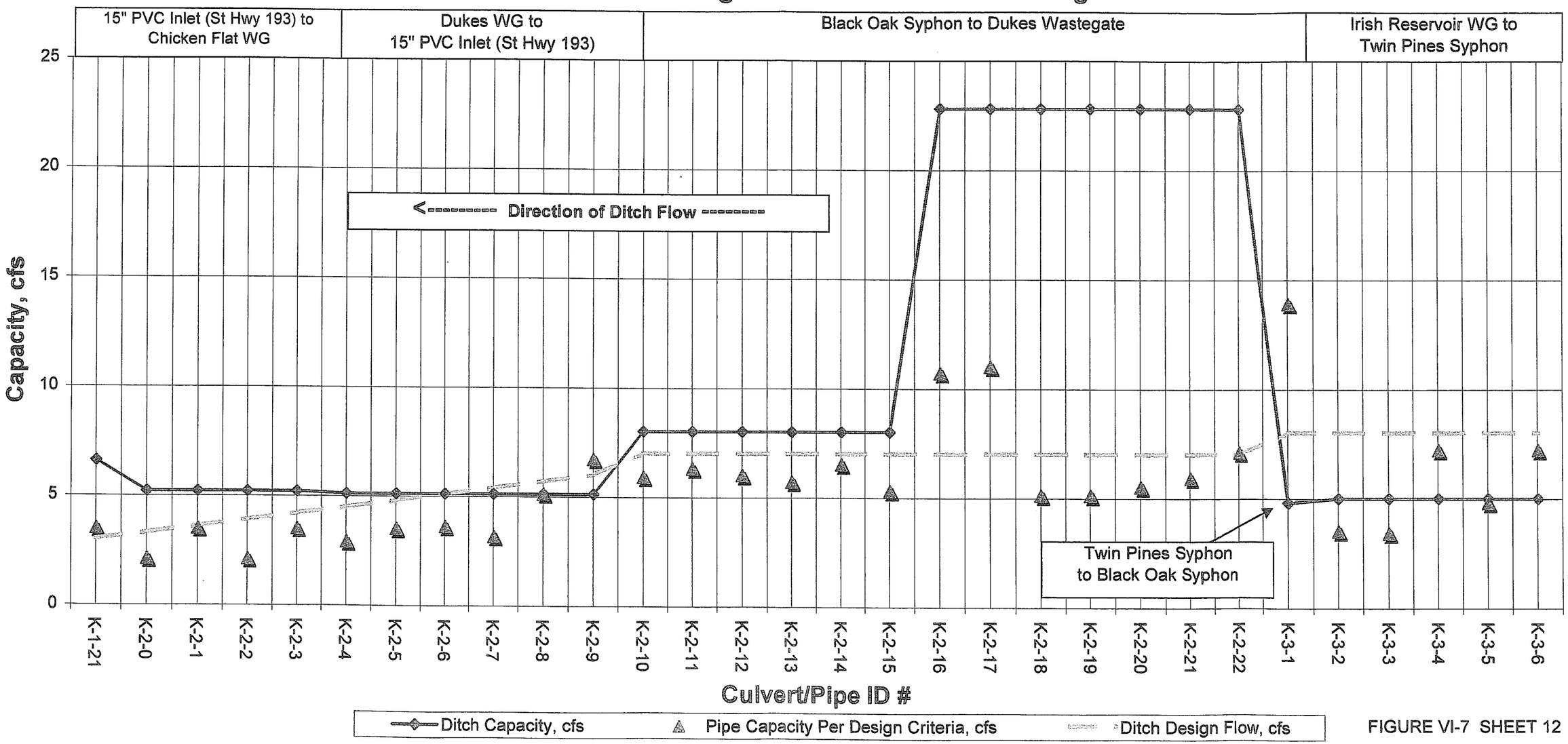

FIGURE VI-7 SHEET 12

GDPUD Ditch System Capacities and Design Flows
Kelsey Ditch System
Lower Kelsey Ditch #2
Chicken Flat Wastegate to Kelsey Reservoir

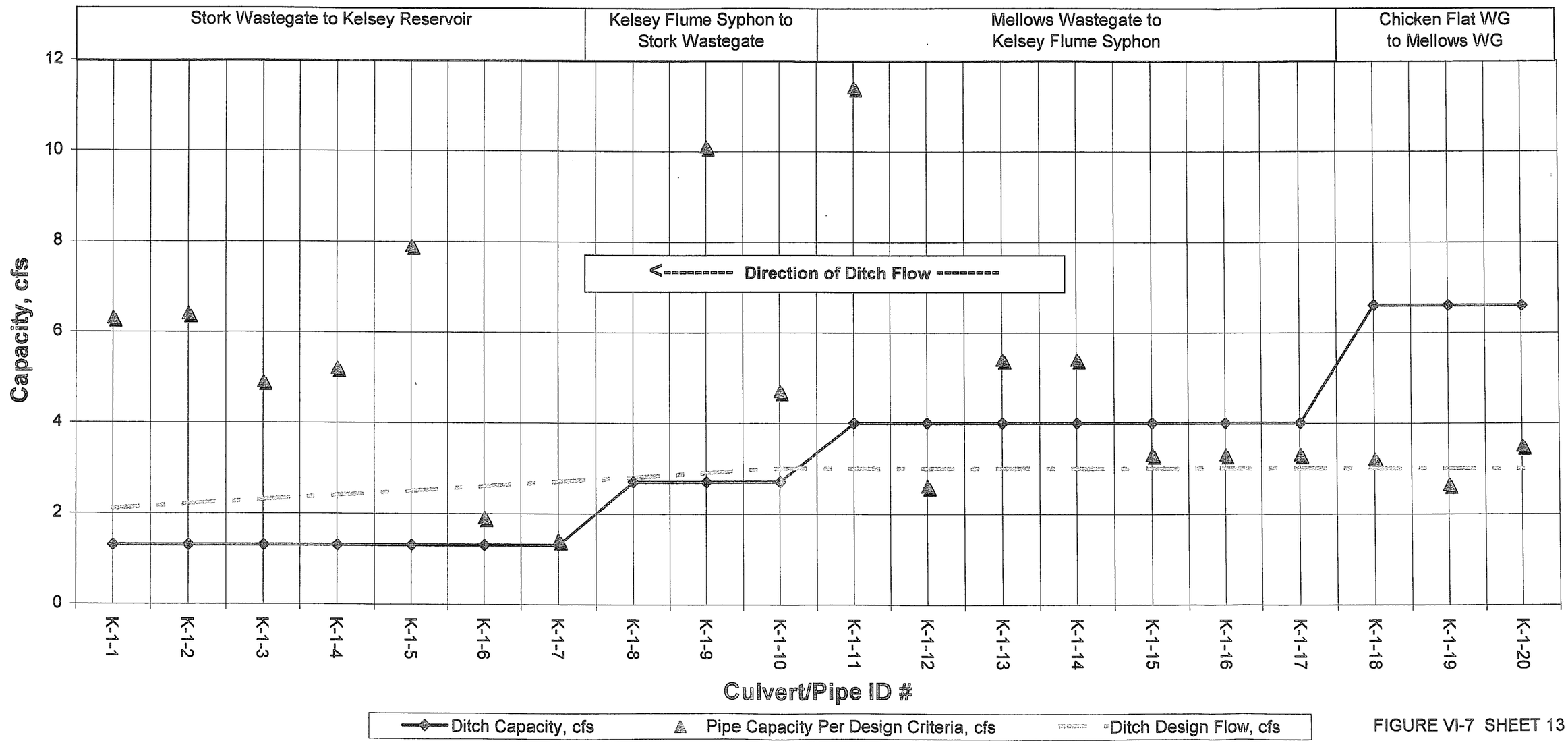

FIGURE VI-7 SHEET 13

GDPUD Ditch System Capacities and Design Flows
Kelsey Ditch System
Taylor Mine Ditch
Taylor Mine Outlet to End Greenwood Road Pipeline

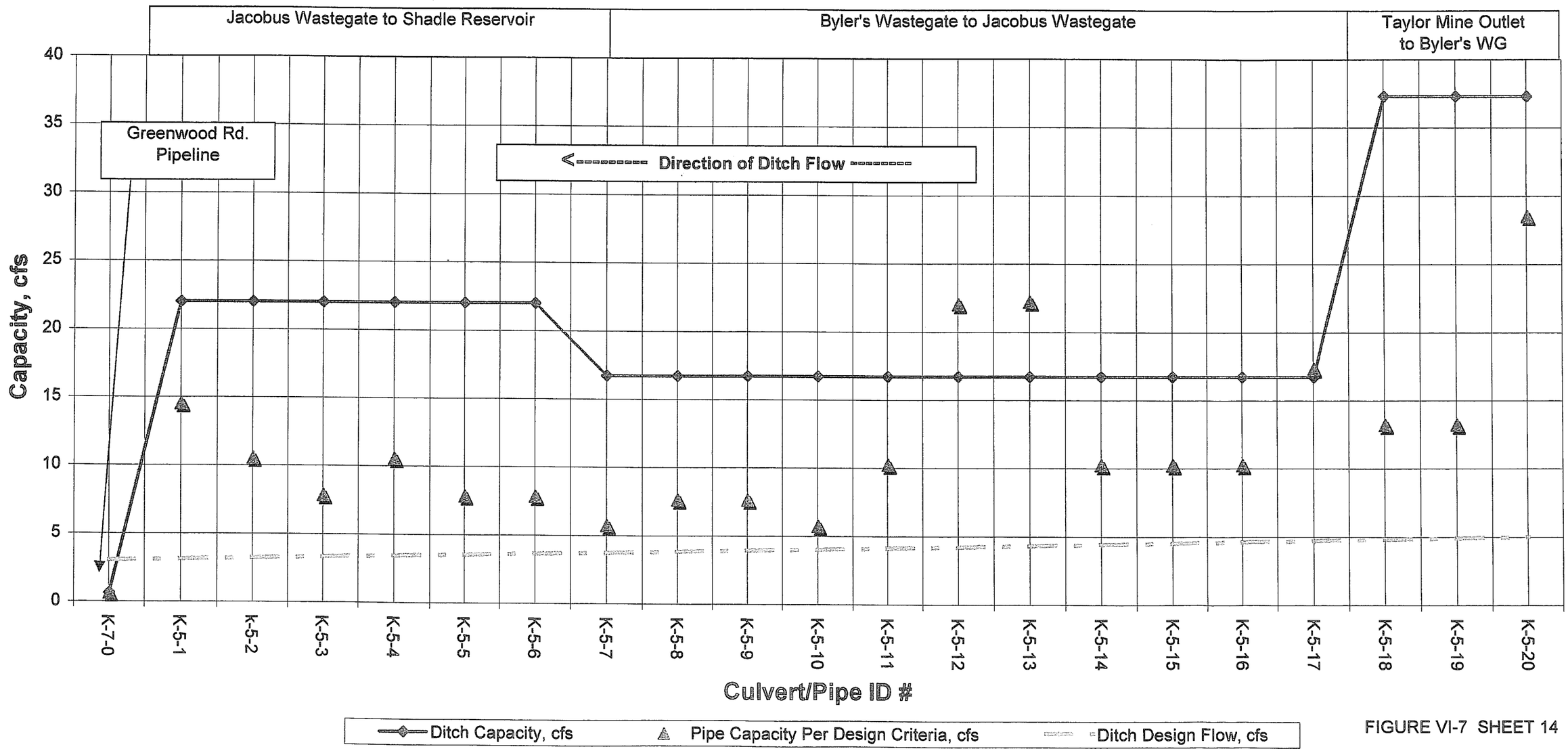

FIGURE VI-7 SHEET 14

VII RECOMMENDED DITCH SYSTEM RELIABILITY MEASURES

In this section of the Reliability Study measures recommended to improve ditch system reliability are presented and prioritized.

PRIORITY RELIABILITY MEASURES

Priority ditch system reliability measures are summarized in **Table VII-1**. Priority measures are identified by ditch segment and are cross-referenced to the raw water (ditch) maps presented in the Appendix of this Study. Priority repair areas are highlighted on the ditch system maps. Measures to improve the stability of Upcountry and Main / Pilot Hill Ditch improvements upstream of the Walton Lakes and Auburn Lake Trails water treatment plants have been assigned a higher priority than measures discussed in Section VI of this Study to improve ditch facilities downstream of treatment plant raw water supply points Ditch stability and loss reduction measures have been assigned a higher priority than ditch capacity improvements.

Enlargement of the raw water storage facilities at Walton Lakes, Greenwood and Auburn Lake Trails to meet emergency and maintenance supply criteria are high priority reliability measures. Replacement of unstable sections of the Upcountry Ditch system with piping are high priority measures. Repair of Main / Pilot Hill Ditch Systems upstream of the Auburn Lake Trails Water Treatment Plant with gunnite lining and cribwalls to control leaks and to reliably deliver design flows are assigned a high priority. Reduction of losses at known leak areas are assigned a high priority. These loss reduction measures include repairs along the Kelsey Ditch System as well as repairs on the Upcountry Ditch and Main / Pilot Hill Ditch

Implementation Schedule and Estimated Costs

It is recommended that the priority reliability measures presented in Table VII-1 be scheduled for implementation over the next 5 years (2003 – 2008). The estimated costs presented in Table VII-1 assume that current unit costs would be inflated, on average, to projected 2005 - 2006 costs. This would be the approximate midpoint of the recommended 5-year implementation period. Current costs are projected ahead using Engineering News Construction Costs (ENRCC) indices. The current (late 2002) ENRCC applicable to Northern California is approximately 6500. An ENRCC index of 7000 is used to estimate projected costs.

The total estimated cost of the priority ditch system reliability measures is $4,260,500. Priority Upcountry Ditch costs are estimated at $1,922,000, or 45% of this total. Main / Pilot Hill Ditch costs are estimated at $1,775,000 (42%) and Kelsey Ditch costs are estimated at $563,000 (13%).

TABLE VII-1

SUMMARY OF PRIORITY RELIABILITY MEASURE RECOMMENDATIONS GDPUD DITCH SYSTEM

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Upcountry Ditch	Structure #1 to Structure #2 (UC-5)	• Construct retaining walls / slope stabilization for downslope levee at "the Narrows" • Widen access road from 6 feet to 10 feet • Replace 250 feet of open ditch with 48" pipe	$548,000
Upcountry Ditch	Structure #2 to Structure #3 (UC-4)	• Provide 1 foot of additional freeboard for 400 feet of ditch	$72,000
Upcountry Ditch	Structure #3 to Structure #4 (UC-4)	• Replace 500 LF of ditch with 48" pipe	$305,000
Upcountry Ditch	Structure #5 to Structure #6 (UC-4)	• Replace 500 LF of ditch with 48" pipe	$305,000
Upcountry Ditch	Balderston Wastegate to Sand Trap Siphon (UC-2)	• Provide 1 foot of additional freeboard, 1000 feet of lined and unlined section of ditch	$111,000
Upcountry Ditch	Walton Lake (UC-2)	• Dredge Walton Lake to restore holding capacity to approx. 25.0 acre-feet • Provide bypass piping during dredging	$496,000
Upcountry Ditch	Buckeye Conduit to Shroeder Conduit (PH-7)	• Provide 1 foot of additional freeboard for approximately 1100 feet of lined ditch	$85,000
		Subtotal, Upcountry Ditch	$1,922,000

TABLE VII-1 (cont.)

Ditch System	Segment (Map Sheet #) [1]	Description	Estimated Cost [2]
Main / Pilot Hill Ditch (Main Ditch #1)	Buffalo Hills Conduit to Spanish Dry Diggins Rd. (PH-7)	• Provide 6 inches of additional freeboard for approximately 500 feet of unlined ditch	$60,000
Main / Pilot Hill Ditch (Main Ditch #1)	Spanish Dry Diggins Rd. to Taylor Mine Outlet (PH-7)	• Gunnite line approximately 2500 feet of ditch or improve ditch with crib walls and 6" of additional freeboard	$305,000
Main / Pilot Hill Ditch (Main Ditch #1)	Taylor Mine Outlet to Cabin Wastegate (PH-7)	• Construct crib wall improvements at 3 locations • Replace 500 feet of deteriorated lining with new lining • Provide 6 inches of additional freeboard, 500 feet of ditch • Replace Cabin Wastegate	$186,000
Main / Pilot Hill Ditch (Main Ditch #1)	Cabin Wastegate to Growlersberg Wastegate (PH-7)	• Replace 1800 feet of lined ditch with new lining	$200,000
Main / Pilot Hill Ditch (Main Ditch #1)	Growlersberg Wastegate to Summers Wastegate (PH-7)	• Provide crib wall repairs at 3 locations	$11,000
Main / Pilot Hill Ditch (Main Ditch #1)	Summers Wastegate to Spools Wastegate (PH-7)	• Repair 600 feet of ditch with crib walls and 6 inches of additional freeboard	$93,000
Main / Pilot Hill Ditch (Main Ditch #1)	Spools Wastegate to Jackass Wastegate (PH-5)	• Provide crib wall repairs at 2 locations	$7,500

TABLE VII-1 (cont.)

Ditch System	Segment (Map Sheet #) [1]	Description	Estimated Cost [2]
Main / Pilot Hill Ditch (Main Ditch #1)	Jackass Wastegate to Greenwood Reservoir (PH-5)	• Dredge Greenwood Reservoir to provide capacity of ±24.4ac-ft	$416,000
Main / Pilot Hill Ditch (Main Ditch #2)	Blue Heron Falls to Kaiser Siphon (PH-5)	• Gunnite line 600 feet of existing ditch	$84,000
Main / Pilot Hill Ditch (Main Ditch #2)	Kaiser Siphon to ALT Water Treatment Plant (PH-4)	• Dredge ALT raw water storage reservoir to provide capacity of ±9.6 ac-ft • Provide bypass piping during dredging	$198,000
Main / Pilot Hill Ditch (Main Ditch #2)	Willow Creek Wastegate to Baldridge Wastegate (PH-4)	• Repair with crib walls, 5 ditch sections damaged by cattle • Place 3000 lineal feet of cattle control fencing	$80,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Doman Wye to Knickerbocker Creek (PH-3)	• Remove and replace 2-18" CMP and 24" STL culverts with 42x29 CMPA or 36" CMP	$22,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Lovejoy Wastegate to Nagle Wastegate (PH-2)	• Gunnite line approximately 400 feet of ditch • Replace Nagle Wastegate	$81,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Nagle Wastegate to Capecroft Wastegate (PH-2)	• Provide crib wall; repair, ±50 feet in length, one location	$4,000
Main Ditch / Pilot Hill Ditch (Pilot Hill Ditch)	Wagner Reservoir to Wagner Reservoir Wastegate (PH-1)	• Gunnite line ±250 foot ditch section	$28,000
		Subtotal, Main / Pilot Hill Ditch	$1,775,500

TABLE VII-1 (cont.)

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Kelsey Ditch (Kelsey Ditch #1)	The Crails to St. James Wastegate (K-4)	• Remove and replace 2-15" PVC pipes at two locations; total ±800 lineal feet, replace with min. 30" pipe or 42"x29" CMPA • Place trash racks (Grizzlies) at upstream end of new pipes	$136,000
Kelsey Ditch (Kelsey Ditch #1)	St. James Wastegate to State Highway 193 (K-4)	• Remove and replace 18" CMP culvert, replace with 42"x29" CMPA or 42" CMP	$8,000
Kelsey Ditch (Kelsey Ditch #1)	Forest View Dr. Falls to Irish Res. Wastegate (K-3)	• Gunnite line approximately 600 lineal feet of ditch	$75,000
Kelsey Ditch (Kelsey Ditch #2)	Black Oak Siphon to Dukes Wastegate (K-2)	• Gunnite line approximately 400 lineal feet of ditch	$51,000
Kelsey Ditch (Kelsey Ditch #2)	Dukes Wastegate to State Highway 193 (K-2)	• Gunnite line approximately 1000 lineal feet of ditch (total two locations)	$125,000
Kelsey Ditch (Kelsey Ditch #2)	Mellows Wastegate to Kelsey Flume (K-1)	• Gunnite line approximately 800 lineal feet of ditch (total two locations)	$95,000
Kelsey Ditch (Kelsey Ditch #2)	Kelsey Flume to Stork Wastegate (K-1)	• Gunnite line approximately 400 lineal feet of ditch	$48,000

TABLE VII-1 (cont.)

Ditch System	Segment (Map Sheet #) (1)	Description	Estimated Cost (2)
Kelsey Ditch (Kelsey Ditch #2)	Stork Wastegate to Kelsey Reservoir (K-1)	• Gunnite line approximately 800 lineal feet of ditch (total two locations) • Reconstruct Stork Wastegate	$120,000
		Subtotal, Kelsey Ditch	$563,000
		Estimated Total, All Priority Measures	$4,260,500

(1) Refer to Ditch System Map Sheets included in the Appendix of this Study
(2) Costs are based on ENRCC = 7000 projected for mid-point of 2003 – 2008 Priority Measure Schedule

MAINTENANCE, ACCESS AND SECOND PRIORITY RELIABILITY MEASURES

Maintenance, access and second priority reliability measures are presented in **Table VII-2**. Included are reliability recommendations discussed in Section VI which are not already listed in Table VII-1. Access measures to improve operations and to keep maintenance problems from escalating into reliability issues are included in this "second-tier" of reliability measures. Replacement of additional Upcountry Ditch segments with piped improvements are included in this group of measures. Replacement of cross fences with access gates is proposed. The installation of additional flow monitoring and flow measuring equipment is included in this group of measures.

Second priority measures recommended in Table VII-2 include minor cribwall repair, ditch lining and piping on the Main / Pilot Hill Ditch downstream of the Auburn Lake Trails Water Treatment Plant, on the Kelsey Ditch and on the Taylor Mine, Spanish Dry Diggins and Cherry Acres ditches.

Second priority measures include replacement or repair of existing ditch lining in poor condition and the repair or replacement of GDPUD waste gates in place throughout the GDPUD ditch system. Wood-constructed waste gates equipped with stop logs should be replaced with reinforced concrete structures equipped with metal slide or canal gates. New waste gates proposed at two locations on Main Ditch No. 2 downstream of the Auburn Lake Trails Water Treatment Plant are proposed.

Second priority measures include the replacement of selected undersized culverts and the replacement of small diameter, partially exposed PVC pipe located in the Kelsey Ditch system. Second priority measures include the construction of access control fencing in selected areas of the Main / Pilot Hill and Kelsey ditches.

Schedule and Estimated Costs

It is recommended that the maintenance access and second priority reliability measures recommended herein be scheduled over the next 20-year period. An ENRCCI index of 8000 is assumed. This would provide a ±25% inflation of current costs.

As presented in Table VII-2 the total estimated cost of these second-tier measures is $7,029,000. Of this total approximately $1,787,000 is estimated for the Upcountry Ditch (25% of total), $3,534,000 is estimated for the Main / Pilot Hill Ditch (50% of total) and $1,308,000 is estimated for the Kelsey Ditch (19% of total). Estimated Cherry Acres Ditch and Spanish Dry Diggins Ditch costs are included in the Main / Pilot Hill Ditch total. Taylor Mine Ditch measures are included in the Kelsey Ditch total. Costs associated with ditch system maintenance equipment (small track excavators) and SCADA control systems ($400,000) are applicable to all the GDPUD ditch systems. These costs are included in the total cost estimate but not the Ditch subtotals.

TABLE VII-2

SUMMARY OF MAINTENANCE, ACCESS, AND SECOND PRIORITY RELIABILITY MEASURE RECOMMENDATIONS GDPUD DITCH SYSTEM

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Upcountry Ditch	Bacon Creek Pipeline (UC-5)	• Improve access along ±1,500 linear feet of pipeline to provide a 10-foot wide all-weather vehicle access road	$314,000
Upcountry Ditch	Structure #1 to Structure #2 (UC-4)	• Provide 1 foot of additional freeboard, ±200 ft of unlined section of ditch	$12,000
Upcountry Ditch	Structure #2 to Structure #3 (UC-4)	• Replace ±800 feet of ditch with 48" concrete or HDPE pipe	$492,000
Upcountry Ditch	Structure #3 to Structure #4 (UC-4)	• Schedule to replace ±500 feet of ditch with 48" concrete or HDPE pipe	$349,000
Upcountry Ditch	Structure #4 to Structure #5 (UC-4)	• Widen the Big Cut area to provide an 8-foot wide ditch access road along one side of ditch	$123,000
Upcountry Ditch	Penstock Inlet/Bypass to Tree House Lane (UC-3)	• Provide improved ditch maintenance with minimum 8-foot access on one side (±2600 ft) • Replace cross fences with access gates and locks (±5 locations) • Install continuous flow monitoring and recording equipment at the Tunnel Hill Measuring Flume	$177,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) [1]	Description	Estimated Cost [2]
Upcountry Ditch	Tree House Lane to Balderston Wastegate (UC-3)	• Provide improved ditch maintenance with minimum 8-foot access on one side (±5600 ft) • Replace cross fences with access gates and locks (±10 locations)	$209,000
Upcountry Ditch	Sand Trap Siphon Canyon Creek Conduit (UC-2)	• Maintain access along pipeline routes for maintenance and inspection (± 5000 ft.)	($10,000 / year) [3]
Upcountry Ditch	Buckeye Conduit (UC-2)	• Maintain access along pipeline route for maintenance and inspection (±10,000 ft.)	($20,000 / year) [3]
Upcountry Ditch	Buckeye Conduit to Schroeder Conduit (UC-1)	• Replace 36" CMP at Wentworth Springs Road with 66"x51" CMPA or 54" CMP • Provide continuous flow monitoring and recording equipment at the Buckeye Measuring Flume.	$49,000
Upcountry Ditch	Schroeder Conduit (UC-1)	• Maintain access along pipeline route for maintenance and inspection (± 3250 ft.)	($6,500 / year) [3]
Main / Pilot Hill Ditch (Main Ditch #1)	The Crails to Buffalo Hills Conduit (K-4)	• Provide ditch maintenance and vegetation clearing with minimum 8-foot access on one side ditch, 1000 feet • Provide measuring flume and flow meter to measure flow to the Main Ditch	$80,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) [1]	Description	Estimated Cost [2]
Main / Pilot Hill Ditch (Main Ditch #1)	Buffalo Hills Conduit (PH-7)	• Maintain access along pipeline route for maintenance and inspection (± 4900 ft.)	($9,800 / year) [3]
Main / Pilot Hill Ditch (Main Ditch #1)	Spanish Dry Diggins Rd. to Taylor Mine Outlet (PH-7)	• Construct two new ±40 foot crib wall sections to replace old crib wall sections	$10,000
Main / Pilot Hill Ditch (Main Ditch #1)	Cabin Wastegate to Growlersberg Wastegate (PH-7)	• Replace fence crossing with GDPUD approved gate and lock	$6,000
Main / Pilot Hill Ditch (Main Ditch #1)	Summers Wastegate to Spools Wastegate (PH-5)	• Replace ±3200 linear feet of old lining for with new lining	$414,000
Main / Pilot Hill Ditch (Main Ditch #1)	Spools Wastegate to Jackass Wastegate (PH-5)	• Replace ±1500 linear feet of old lining for with new lining (2 locations) • Provide berm improvements for approximately 1000 feet of ditch between lined sections.	$243,000
Main / Pilot Hill Ditch (Main Ditch #1)	Jackass Wastegate to Greenwood Reservoir (PH-5)	• Repair ±200 feet of ditch section with crib wall construction (2 locations)	$20,000
Main / Pilot Hill Ditch (Main Ditch #2)	SDD Diversion Flume to Blue Heron Way Falls (PH-5)	• Conduct vegetation removal to maintain access along the ditch (±3300 ft.)	($6,600 [3] / year)

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Main / Pilot Hill Ditch (Main Ditch #2)	Blue Heron Way Falls to Kaiser Siphon (PH-5)	• Replace fence crossings with GDPUD approved gates (7 locations) • Gunnite line approximately 500 feet of existing ditch	$103,000
Main / Pilot Hill Ditch (Main Ditch #2)	Kaiser Pipeline and Kaiser Siphon (PH-5)	• Maintain access and vegetation clearing along pipeline and siphon route for maintenance and inspection (± 4150 ft.) • Replace pipeline segment with HDPE, pressure rated plastic (PVC 905) or concrete pipe	$203,000 ($8,300 / year) (3)
Main / Pilot Hill Ditch (Main Ditch #2)	Ford Siphon to ALT Water Treatment Plant (PH-4)	• Replace existing fence crossings with GDPUD approved gates (3 locations)	$11,000
Main / Pilot Hill Ditch (Main Ditch #2)	ALT Water Treatment Plant to Campground Wastegate (PH-4)	• Replace existing fence crossings with GDPUD approved gates (±5 locations) • Install flow metering device downstream of ALT Water Treatment Plant • Construct new wastegate • Improve access along the ditch in the vicinity of the ALT Campground • Provide vegetation clearing and levee widening from ±1500 feet downstream of the ALT Campground	$172,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Main / Pilot Hill Ditch (Main Ditch #2)	Campground Wastegate to Willow Creek Wastegate (PH-4)	• Replace existing fence crossings with GDPUD approved gates (±3 locations) • Construct new wastegate • Construct lined ditch improvements ±1800 feet • Place ±1500 feet of livestock fencing • Gunnite line approximately 800 feet of ditch	$433,000
Main / Pilot Hill Ditch (Main Ditch #2)	Willow Creek Wastegate to Baldridge Wastegate (PH-4)	• Replace existing fence crossings with GDPUD approved gates and locks (±5 locations) • Gunnite line approximately 500 feet of ditch	$83,000
Main / Pilot Hill Ditch (Main Ditch #2)	Baldridge Wastegate to Bogus Wastegate (PH-3)	• Replace 8 existing fence crossings with GDPUD approved gates	$30,000
Main / Pilot Hill Ditch (Pilot Hill Ditch)	Dorman Wye to Knickerbocker Creek (PH-3)	• Provide access and vegetation clearing along ditch (±3300 ft.)	$162,000
Main / Pilot Hill Ditch (Pilot Hill Ditch)	Knickerbocker Creek to Pear Orchard Wastegate (PH-3)	• Provide 8 foot access and vegetation clearing along ditch (±1950 ft.) • Replace existing fence crossings with GDPUD approved gates (±3 locations)	$107,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) [1]	Description	Estimated Cost [2]
Main / Pilot Hill Ditch (Pilot Hill Ditch)	Pear Orchard Wastegate to Therekel Wastegate (PH-2)	• Provide an 8-foot access and vegetation clearing along ditch (±2900 ft.) • Conduct repairs with a 40-foot section of crib wall improvements	$93,000
Pilot Hill Ditch	Therekel Wastegate to State Hwy 49 (PH-2)	• Provide an 8 foot access and vegetation clearing along ditch (±5,300 ft.) • Replace 10 existing fence crossings with GDPUD approved gates • Replace two 18" culverts with minimum 42"x29" CMPA or 36" CMP	$304,000
Pilot Hill Ditch	State Hwy 49 to Lovejoy Wastegate (PH-2)	• Provide an 8 foot access and vegetation clearing along ditch (±1100 ft.) • Replace existing fence crossings with GDPUD approved gates and locks (2 locations)	$41,000
Pilot Hill Ditch	Lovejoy Wastegate to Nagle Wastegate (PH-2)	• Provide an 8 foot access and vegetation clearing along ditch (±5400 ft.) • Replace existing fence crossings with GDPUD approved gates and locks (2 locations)	$174,000
Pilot Hill Ditch	Capecroft Wastegate to Wagner Reservoir (PH-2)	• Provide an 8 foot access and vegetation clearing along ditch (±2200 ft.) • Replace fence crossings with approved gates and locks (±3 locations)	$119,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Pilot Hill Ditch	Wagner Reservoir to Wagner Reservoir Wastegate (PH-1)	• Provide an 8 foot access and vegetation for ditch section downstream of reservoir (±1300 ft.) • Dredge reservoir as necessary • Monitor and repair reservoir outlet gates as necessary	$156,000
Pilot Hill Ditch	Wagner Reservoir Wastegate to Bayley House Wastegate (PH-1)	• Construct 3 crib wall repairs, each ±50 to ±100 feet in length	$22,000
Pilot Hill Ditch	Bayley House Wastegate to Pilot Hill Reservoir (PH-1)	• Replace existing fence crossing with 8-foot wide minimum GDPUD approved gate and lock	$4,000
Kelsey Ditch	St. James Wastegate to State Hwy 49 (K-4)	• Replace existing fence crossings with 8-foot wide minimum GDPUD approved gates and locks (±4 locations) • Replace old lining with 100 lineal feet of gunnite lining	$30,000
Kelsey Ditch	State Hwy 49 to (Forrest View Dr.) Falls (K-4)	• Replace existing fence crossing with 8-foot wide minimum GDPUD approved gate and lock (one location) • Provide ±100 feet of cribwall and berm improvements	$14,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Kelsey Ditch	(Forrest View Dr.) Falls to Irish Res. Wastegate (K-3)	• Improve low freeboard condition for ±250 feet of ditch section • Provide ±100 feet of cribwall and berm improvements • Replace existing fence crossings with 8-foot wide minimum GDPUD approved gates and locks (6 locations)	$44,000
Kelsey Ditch	Irish Res. Wastegate to Twin Pines Siphon (K-3)	• Place ±1500 lineal feet of cattle control fencing • Gunnite line approximately 800 feet of ditch (total 5 locations including 4 cattle crossings) • Replace 1200 feet of lined ditch with new lining • Conduct maintenance and silt removal at Irish Reservoir • Replace existing fence crossings with GDPUD approved 8-foot wide minimum gates and locks (10 locations)	$302,000
Kelsey Ditch	Twin Pines Siphon to Black Oaks Siphon (K-3)	• Repair or replace 600 feet of lined ditch • Replace fence crossings with GDPUD approved 8-foot wide minimum gates and locks (2 locations)	$44,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) [1]	Description	Estimated Cost [2]
Kelsey Ditch	Black Oaks Siphon to Dukes Wastegate (K-2)	• Repair ±800 gunnite-lined ditch sections (2 locations) • Replace existing fence crossings with GDPUD approved 8-foot wide minimum gates and locks (11 locations)	$90,000
Kelsey Ditch	Dukes Wastegate to State Hwy 193 (K-2)	• Repair ±1500 gunnite-lined ditch sections (5 locations) • Remove and replace ±120 feet of 15" PVC pipe, replace with a 24" HDPE, 36" CMP, or 35"x24" CMPA • Replace an 18" and 18"/20" steel culverts, replace with 35"x24" CMPA or 36" CMP	$115,000
Kelsey Ditch	State Hwy 193 to Chicken Flat Wastegate (K-2/K-1)	• Replace exposed sections of 15" PVC with 24" HDPE or 36" CMP (±2000 feet) • Replace ±150 feet of open ditch with gunnite-lined ditch or extend piping improvements with 24" HDPE, 36" CMP, or 35"x24" CMPA	$269,000
Kelsey Ditch	Mellows Wastegate to Kelsey Flume (K-1)	• Repair ±200 feet of low berm areas along ditch (total three locations)	$10,000
Kelsey Ditch	Kelsey Flume Siphon to Stork Wastegate (K-1)	• Gunnite line approximately 800 lineal feet of ditch (total two locations)	$99,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Kelsey Ditch	Stork Wastegate to Kelsey Reservoir (K-1)	• Replace ±200 feet of exposed sections of 15" PVC with a buried 18" HDPE, 24" CMP or 28"x20" CMPA	$31,000
Spanish Dry Diggins Ditch	SDD Flume to End (PH-6)	• Replace ±300 feet of ditch with 18" HDPE, 24" CMP, or 28"x20" CMPA (total two locations)	$46,000
Taylor Mine Ditch	Taylor Mine Outlet to Shadle Reservoir (K-5)	• Replace ±100 of low berm area ditch with piped section • Replace existing 8 fence crossings with GDPUD approved 8-foot wide minimum gates and locks	$45,000
Overall	Overall	• Purchase a second excavator (Takeuchi Model TB 135 Compact Excavator)	$50,000
Overall	Overall	• Install SCADA remote transmitting units (RTU's) at four flow meter locations • Install monitoring equipment (pressure transducers or ultrasonic sensors) and SCADA RTU's at 3 reservoirs • Furnish automatic control valves or weirs at Stumpy Meadows and at Walton Lakes • Install Central Processing Unit for SCADA receiving station at GDPUD	$350,000

TABLE VII-2 (cont.)

Ditch System	Segment (Plan Sheet #) (1)	Description	Estimated Cost (2)
Upcountry Ditch	Overall	• Replace wastegates with new reinforced concrete wastegates (2 locations)	$62,000
Pilot Hill Ditch	Overall	• Replace wastegates and flumes with new reinforced concrete structures (15 locations)	$498,000
Kelsey Ditch	Overall	• Replace wastegates with new reinforced concrete wastegates (7 locations)	$215,000
		Estimated Total, Maintenance, Access and Second Priority Measures (3)	$7,029,000

Subtotal, Upcountry Ditch	=	$1,787,000 (25% of total)
Subtotal, Main / Pilot Hill Ditch (4)	=	$3,534,000 (50% of total)
Subtotal, Kelsey Ditch (5)	=	$1,308,000 (19% of total)
Subtotal, Other Items	=	$ 400,000 (6% of total)

(1) Refer to Ditch System Map Sheets included in the Appendix of this Study
(2) Costs are based on ENRCC = 8000
(3) Total does not include annual maintenance costs
(4) Cherry Acres and Spanish dDy Diggins costs included with Main / Pilot Hill Ditch
(5) Taylor Mine Ditch costs included with Kelsey Ditch

SCADA Instrumentation and Control

Currently releases from Stumpy Meadows are manually controlled. Levels in Walton Lakes are used to judge whether releases at Stumpy Meadows should be increased or decreased. There is a lag time of several hours between adjustments made at the Stumpy Meadows discharge structure and measurable changes in the levels of Walton Lakes. Flows from the Walton Lakes Reservoir are also manually controlled. An increase or decrease in the flow released from Walton Lakes is based on observed levels in downstream reservoirs (Greenwood, Auburn Lake Trails, Wagner, Pilot Hill, Kelsey), seasonal demands and operator experience. Ideally, releases from Walton Lakes are maintained at rates which meet treatment plant and irrigation customer demands without spills (overflows) at the downstream regulating reservoirs. Again, there are several hours of lag time between the adjustments made at Auburn Lake Trails and changes in the levels of downstream regulating reservoirs.

To improve system reliability and control, automatic flow metering and recording equipment is proposed in this Reliability Study at the existing Stumpy Meadows, Tunnel Hill and Buckeye measuring flumes. Furthermore, a new flow measuring device, with automatic flow metering and recording equipment is proposed downstream of the Crails (either on the Main / Pilot Hill Ditch or on the Kelsey Ditch). It is recommended that flow data from these metering devices be transmitted, via SCADA, to a central receiving station located at GDPUD offices in Georgetown. To provide automatic control of flows released from Stumpy Meadows and from Walton Lakes it is recommended that water surface elevations at the Walton Lakes Reservoir and water surface elevations at one reservoir on the Kelsey Ditch System (e.g. Kelsey Reservoir) and one reservoir on the Main / Pilot Hill Ditch System (e.g. Auburn Lake Trails, Wagner or Pilot Hill Reservoir) also be continuously monitored. Reservoir levels would be monitored by ultrasonic units or pressure transducers with limits which would maintain reservoirs between acceptable high and acceptable low levels. The reservoir level information would also be transmitted, by SCADA, to GDPUD central offices at Georgetown. A central processing unit (CPU) located at Georgetown would then process the flow and level information received from the remote transmitters (RTU's) and convert this information to signals which are transmitted to automatic control valves (or weirs) located at Stumpy Meadows and at Walton Lakes. The control signals would automatically actuate the position of the release valves or weirs to increase or decrease the releases from Stumpy Meadows and from Walton Lakes. Flows measured at the Buckeye flume would provide feedback control for the Walton Lakes releases. Flows measured at either the Stumpy Meadows or the Tunnel Hill flumes would provide feedback control for the Stumpy Meadows releases. A sudden decrease in flows measured at Tunnel Hill could be used to alert the operators of problems (ditch failure) in the Upcountry system. The estimated cost to install automatic control valves at Stumpy Meadows and Walton Lakes together with level control monitors, level and flow remote transmitting units (7 total) and a central processing unit is estimated at $350,000.

Ditch Maintenance Equipment

Currently the District owns and operates one narrow track (compact) excavator. It is recommended that during the next few years the District purchase a second excavator. The existing excavator is in demand by all three ditch superintendents. One unit can not meet all of the existing or projected demands. The existing excavator has been extremely beneficial in improving ditch maintenance and operations. With the replacement of cross fences with access gates, additional areas of the ditch will be available for maintenance by the excavator.

A Takeuchi Model TB 135 Compact Excavator similar to the unit now owned by GDPUD currently retails at approximately $40,000. Assuming purchase of a second unit within the next 5 years, $50,000 has been included in the proposed maintenance, access and second priority measure cost estimate.

VIII RECOMMENDED TREATED SYSTEM RELIABILITY MEASURES

In this section of the Reliability Study recommended measures to improve the reliability of the treated water system are summarized. The GDPUD distribution system is divided into two major service areas. Treated water customers are served either from the Walton Lakes Water Treatment Plant or the Auburn Lake Trails Water Treatment Plant.

The reliability measures recommended will improve the distribution systems so that they deliver maximum day demands and a minimum of 500 gallons per minute (gpm) fire flow to any one fire hydrant.

Under maximum day demands the ability of the existing Auburn Lake Trails and Walton Lake networks to maintain pressures within acceptable limits has been evaluated by the network modeling. Reliability measures recommended herein are proposed to resolve low-pressure deficiencies under these conditions. Network modeling has also been used to evaluate the capacity of each system to deliver not less than 500 gpm to each hydrant together with maximum day demands. Reliability measures identified herein are proposed to resolve the low flow or low-pressure deficiencies which occur under maximum day plus fire flow conditions. Low pressure and inadequate fire flows are indicators of system deficiencies. Correction measures address the cause, not just the deficiency indicated by the model.

The following reliability measures are not ranked in any particular order. Prioritization of reliability measures and a summary of costs are presented later in this section of the study.

AUBURN LAKE TRAILS TREATED WATER SYSTEM

ALT-1A Greenwood Road Feed from Walton Lake

This reliability measure would the remove the Greenwood Road area that is now being served by the Auburn Lake Trails (ALT) treatment plant and allow the area to be served from the Walton Lake treatment plant. The ALT treatment plant is at capacity during maximum days. This measure would remove some of the demand currently on the ALT treatment plant and shift it to the Walton Lake treatment plant which has more available capacity than the ALT treatment plant.

The measure includes the installation of 2,900 feet of 8-inch diameter pipe to replace existing 6-inch pipe between Blackridge Road and junction 688. This measure also includes the installation of a pressure reducing station just north of Blackridge Road. Approximately 1,900 feet of pipe on Blackridge Road would be replaced with a higher pressure rated pipe. The existing pump station serving the upper portion of

Blackridge could be eliminated because the pressure would be increased on Blackridge Road. The switch over to the Walton Lake system would be completed by closing a main line valve on Highway 193 south of Sliger Mine Road and opening a normally closed valve near junction 688.

ALT-1B Greenwood Road Main Replacement

This reliability measure would allow the Greenwood Road service area to remain on the ALT distribution system and increase the fire flow to the hydrants along the road. The measure would require the replacement of the existing 6-inch water line from Slinger Mine Road to Junction 688 with approximately 14,500 feet of 8-inch minimum water line. Included would be the installation of additional fire hydrants to improve the fire protection for the area.

ALT-2 Angel Camp Court Booster Pump

The fire hydrant on Angel Camp is only 36 feet lower than the high water level of the Angel Camp Tank. When the tank is full the pressure at the hydrant is only 15 psi and as the level in the tank lowers the pressure at the hydrant is reduced. To correct this problem this measure recommends installing a booster pump for the line serving Angel Camp Court. The booster pump would be of sufficient size to allow a minimum fire flow of 500 gpm during the maximum day demand.

ALT-3 Highway 193 Cross Tie-Brinks Line Replacement

The fire hydrants on Brinks Lane and Bud's Alley cannot provide 500 gpm during maximum day demands. Both of the hydrants are located on long dead-end lines. These lines were extended from the ALT subdivision south to serve lots outside of ALT. The dead-end lines can be connected with measure ALT-3. Looping the dead-ends provides two directions of supply. The measure would install approximately 4,500 feet of 8-inch main, valves and additional fire hydrants.

ALT-4 Gravity Raw Water for Golf Course

The ALT golf course is irrigated with treated domestic water. Under maximum day conditions, the golf course requires 250,000 gallons per day. At maximum day demands the ALT water treatment plant is at approximately 95% of its maximum capacity. The golf course is using treated domestic to water the course that could be used to serve approximately 250 single family dwelling units at 1,000 gallons per day.

This reliability measure would replace the treated water being used to irrigate the golf course with untreated ditch irrigation water. This measure would install 6,800 feet of 6-inch water line from a diversion point at the ditch just upstream of the Dorman Wye, then westerly along Highway 193 and then northwesterly to a pond on the golf course.

ALT-5 Indian Rock Road Main Replacement

A long dead-end 6-inch line serves the fire hydrant on White Horse Road from Indian Rock Road. The existing line is not adequate to provide 500-gpm fire flow during the maximum day demand. This reliability measure would replace approximately 1,200 feet of 6-inch main with 8-inch main water line.

ALT-6 Cherry Acre Road PRV-Cross Tie

The fire hydrant ant the end of Cherry Acre Road is located on one of the longest dead-end lines in either the Walton Lake or Auburn Lake Trails systems. Instead of replacing the water line in Indian Rock Road with a main larger enough to provide adequate flows, it would be more economical to connect the Indian Rock Road dead-end with the Cherry Acres dead-end. Both of these dead-ends are at the southern end of the Cherry Acres area. Connecting them together would provide a looped system and a second feed source for each.

The reliability measure would install 2,400 feet of 8-inch main together with a pressure reducing station, pressure relief station and related valving.

ALT-7 Capecroft Road Main Replacement

The fire hydrants on Capecroft Road are old style wharf hydrants. The main serving the area is not adequate to supply maximum day demands plus 500 gpm fire flows. The existing fire hydrants are widely spaced and would not provide adequate fire protection. The reliability measure would replace the existing 6-inch main with 8-inch diameter water main and add fire hydrants for adequate fire protection.

ALT-8A Highway 49-Pilot Hill Loop

The Pilot Hill service area is located in the southwest corner of the ALT service area. Pilot Hill is served by a main that dead-ends in Pilot Hill. It is not practical at this time to loop the line that provides water to Pilot Hill but it would be practical to loop the main service in Pilot Hill. Reliability measure 8A provides a loop to the service main in Pilot Hill. A single main would still serve the new looped service mains from the north along Highway 49 to the intersection of Highway 49 and Meadow View Road.

The measure would install approximately 7,500 feet, valves and fire hydrants south along Highway 49 from the Rattlesnake Bar Road intersection to then cross-country to Meadow Croft Lane. This reliability measure would encounter fewer existing buried utilities than the proposed measure ALT-8B.

ALT-8B Salmon Falls Road Main Replacement

This reliability measure would provide the same level of service as ALT-8A except that the distribution system within Pilot Hill would not be a looped system. The measure would replace the existing distribution main with approximately 7,200 feet of 8-inch diameter main, valves and additional fire hydrants. This measure would be a more difficult to install than ALT-8A because water services would have to be maintained as construction proceeded.

ALT-9 Second Deer Ravine

The existing Deer Ravine Tank is 250,000-gallon capacity. The tank was probably of adequate size to serve the western ALT system when it was installed. Because the ALT system has been extended west to Cool, southerly to the Cherry Hills, Indian Rock and Meadow View areas and southerly to the Pilot Hill area the tank is no longer of adequate size to serve the maximum day demand and have any reserve for fire flows or emergency storage. During a maximum day in 2001, approximately 595,000 gallons was served through the tank.

Reliability measure ALT-9 proposed to install a second tank at Deer Ravine. The tank would be a minimum of 600,000 gallons to provide for maximum day demand, fire and emergency storage.

ALT-10 Cherry Hills Tank

This reliability measure would provide water storage for the Cherry Acres, Indian Rock and Meadow View areas that not rely on the storage at Deer Ravine. The measure would install a 400,000-gallon capacity tank in the Cherry Hills area.

Reliability Measures Estimated Costs and Priorities

Reliability measure costs are estimated and summarized. This cost summary is shown on **Table VIII-1.** Cost estimates were first prepared based on current costs. Reliability measures were separated into four priorities. Each priority period represents approximately a five-year period. Current costs were inflated for future costs using the Engineering News Record – Construction Cost Index (ENR-CCI). The Engineering News Record established the Construction Cost Index in 1913 to track labor and material costs in 20 large cities. The index is updated every three months and historical data is available.

The reliability measures were prioritized based on what measure would result in the best improvement to the distribution system. Issues considered in establishing priorities included:

GDPUD WATER SYTEM RELIABILITY MEASURES

AUBURN LAKE TRAILS SERVICE AREA

CONSULTING KASL ENGINEERS

7777 Greenback Ln #104
Citrus Heights, CA 95610
Tel 916/722-1800
Fax 916-722-4595
"We take engineering personally"

SUMMARY OF COSTS 6-Nov-02

	3% PER YEAR INCREASE, ENR-CCI	6,481	6,800	7,880	9,140	10,600
Measure #	**Description**	**Amount**	**Priority**			
			1	**2**	**3**	**4**
ALT-1A	GREENWOOD RD FEED FROM WL	$ 308,000	$ 324,000			
ALT-1B	GREENWOOD RD MAIN REPLACEMENT	$ 833,000				$ 1,363,000
ALT-2	ANGEL CAMP CT. BOOSTER PUMP	$ 102,000			$ 144,000	
ALT-3	HIGHWAY 193 CROSS TIE-BRINKS LN REPLACE	$ 267,000			$ 377,000	
ALT-4A	GRAVITY RAW WATER FOR GOLF COURSE	$ 413,000	$ 434,000			
ALT-4B	DIGGER TREE CT TO WESTVIEW TRL TIE	$ 40,000		$ 49,000		
ALT-5	INDIAN ROCK ROAD MAIN REPLACEMENT	$ 66,000			$ 94,000	
ALT-6	CHERRY ACRE ROAD PRV-CROSS TIE	$ 160,000		$ 195,000		
ALT-7	CATECROFT ROAD MAIN REPLACEMENT	$ 209,000			$ 295,000	
ALT-8A	HWY 49-PILOT HILL LOOP	$ 387,000				$ 633,000
ALT-8B	SALMON FALLS ROAD MAIN REPLACEMENT	$ 514,000			$ 725,000	
ALT-9	SECOND DEER RAVINE TANK, 0.6 MG	$ 1,965,000	$ 2,062,000			
ALT-10	CHERRY HILLS TANK, 0.4 MG	$ 787,000			$ 1,110,000	
TOTAL, CURRENT COSTS		**$ 6,051,000**				
PROJECTED FUTURE COSTS			**$ 2,820,000**	**$ 244,000**	**$ 2,745,000**	**$ 1,996,000**

Table VIII-1

Summary

1. Looping of dead-ends, where possible.
2. Additional storage, for peak day, fire flows and emergencies
3. Conservation of treated water.

The current cost estimates shown on Table VIII-1 were based on an ENR-CCI value of 6,481. To estimate future cost were increased by three percent per year to the midpoint of each five-year priority period. The future ENR-CCI index was then used to estimate reliability measure future costs.

The Auburn Lake Trails reliability measures recommended herein are graphically represented on system maps included in the back pockets of this study. The map for the Auburn Lake Trails system is titled Figure 1, Auburn Lake Trails - Reliability Improvements.

WALTON LAKES TREATED WATER SYSTEM

WL-1 Citabria Lane

The fire hydrant at the North end or Citabria Lane will not flow 500 gpm during a maximum day because a long single line feeds it from Wentworth Spring Road, along Tiger Lane and Veterans Way to Citabria Lane. This WL-1 reliability measure will loop the line by installing approximately 1,200 feet of 8-inch water line from Wentworth Springs Road along Citabria Lane with connection to the existing main feeding the hydrant.

WL-2 Fain Lane Extension

This reliability measure would create multiple loops for the water distribution system serving the Georgetown Townsite, provide a second by-pass around the Georgetown Townsite and correct the flow to a hydrant located south of Harkness Street. The reliability measure would install approximately 1,600 feet of 8-inch main from Fain Lane westerly to Harkness Street and 3,300 feet of 12 inch main extending from the existing 12 inch pipe on Fain Lane southerly then westerly to Highway 193 to connect with the existing main just north of Cedar Drive.

WL-3 Buffalo Hill Road Line Replacement

The fire hydrant at the end of the Buffalo Hill Court water line will not flow 500 gpm during maximum day. 6-inch and 4-inch mains serve the fire hydrant. The WL-3 reliability measure would replace the line along Buffalo Hill Road and Buffalo Hill Court with new 8-inch main approximately 1,500 feet in length. Additional fire hydrants are proposed to improve the fire service in the area.

WL-4A & 4B Quiet Place

The fire hydrant near the intersection of Quiet Place and Lasita Way will not flow 500 gpm during maximum day demands. Reliability measure 4B would remove the check valve in Reservoir Road near Holloway Drive that prevents water in the Reservoir Tank from flowing easterly on Reservoir Road. Reliability measure 4A would install approximately 900 feet for 8-inch main from the intersection of Quiet Place and Lasita Way north along Quiet Place and connect to the existing 10-inch main in Reservoir Road creating a loop.

WL-5 Holloway Drive Line Replacement

The two hydrants on Holloway Drive do not flow 500 gpm during maximum day demands because the hydrants are served with a 4-inch main that is not large enough to supply the needed flow. The WL-5 reliability measure includes the replacement of the 4-inch main on Holloway Drive with 8-inch main to the last hydrant; a distance of approximately 1,000 feet. To ensure the flow the recommendations discussed in WL-7 would also need to be completed.

WL-6 Longview Lane Line Replacement

The hydrants along Longview Lane, which is served from Reservoir Road, will not provide 500 gpm during maximum day. Because it is not economical or practical to loop the main on Longview Lane the main would need to be increased in size to provide 500 gpm during maximum day demand. This reliability measure would include the installation of approximately 4,000 feet of 8-inch minimum. GDPUD should consider installation of a 10-inch main if Longview Lane is to be extended.

WL-7 Reservoir Road, Spanish Dry Diggings, Hwy 193 Line Replacement

Measure WL-7 is one of the more extensive and expensive reliability measures recommended for Walton Lakes. This measure would improve service and fire flows from the four-way stop at Main Street and Highway 193, westerly along Highway 193 to Spanish Dry Diggins Road and Reservoir Road. The reliability measure would include:

1. Enlarging the existing 6-inch pipe to 10-inch along Reservoir Road between Longview Lane and Spanish Dry Diggins Road.
2. Enlarging the existing 8-inch main along Spanish Dry Diggins to 10-inch between Reservoir Road and Highway 193.
3. Enlarging the existing 8-inch main to 10-inch along highway 193 between Spanish Dry Diggins Road and Main Street.
4. Looping along Highway 193 between South Street and Main Street with and 8-inch water line.

This measure would include the installation of approximately 10,500 feet of 10-inch pipe and 850 feet of 8-inch pipe with additional valves and fire hydrants.

WL-8 Silent Meadow Lane Line Replacement

The existing line installed in Silent Meadow Lane is 4-inches in diameter and is not adequate to deliver 500 gpm plus maximum day demand. The WL-8 measure would replace the existing 4-inch pipe with 8-inch pipe to correct the flow deficiency. The measure includes the installation of approximately 2,200 feet of new 8-inch main together with additional valves and fire hydrants.

WL-9 Sanromo Road Line Replacement

Because of the long dead-end on Sliger Mine Road in the northwest corner of the system, the distribution system cannot deliver 500 gpm fire flow to the end of Sanromo Road. The WL-9 reliability measure would replace approximately 8,200 feet of existing 6-inch pipe with 8-inch pipe and provide valves and additional fire hydrants. Looping the system to improve flows is not a practical option for this alternative.

WL-10 Black Oak Mine Road Proposed Reliability Measure

The fire hydrant near the Black Oak Mine Road tank cannot deliver 500 gpm at 20 psi primarily because the hydrant is only 35 feet lower than the high water level of the tank. The highest pressure at the fire hydrant is only 15 psi when the tank is full and then drops as the tank water elevation lowers. This reliability measure would install a new 8-inch line approximately 200 feet directly from the tank outlet main to the hydrant and construct a fire booster pump station that would supply a minimum of 500 gpm to the hydrant when flow is sensed at the hydrant lateral.

WL-11 Greenwood Road Main Replacement

To improve the flow along Greenwood Road sufficiently to allow the fire hydrant at the intersection of Greenwood Road and Conifer Lane to flow at 500 gpm during maximum day would require the upgrading of the existing pipe along Greenwood Road from Marshall Road to Esperanza Lane. A 10-inch diameter main is recommended. The measure would install approximately 2,600 feet of 10-inch main, valves and additional hydrants.

WL-12 Traverse Creek Road Line Replacement

Fire hydrants in the middle of the Traverse Creek Road loop are not capable of providing 500 gpm during maximum day. While the line is looped the length of 6-inch main causes too much resistance to flow during maximum day demands. To correct this deficiency it would be necessary to replace a portion the existing water line serving

Traverse Creek Road. The reliability measure would replace approximately 6,300 feet of 6-inch main with new 8-inch main together with valves and additional fire hydrants.

The WL-12 reliability measure is required to implement measure WL-24, which would install a booster pump on this line.

WL-13A Bayne Road Line Extension

The suggested Bayne Road proposed reliability measures provides the greatest single system benefit of any measures recommended for the Walton Lake distribution system. The Bayne Road reliability measure would tie together two extremely long dead-end distribution lines of the Walton Lake system and provide a loop for the southern end of the distribution system. The reliability measure would improve the fire flow capabilities of some 21 hydrants. The reliability measure would construct an 8-inch main from Highway 193 along Bayne Road to the intersection of Stewart Mine Road. The reliability measure would provide stub outs for a future tank(s) located just off Bayne Road (see WL-13B). The reliability measure would install approximately 5,500 feet of 8-inch main together with valves, fire hydrants, pressure reducing station and pressure relief station. The reliability measure should also acquire the tank sites for the future tanks.

WL-13B Bayne Road Tank

This reliability measure would further strengthen the southern end of the Walton Lake distribution system by installing a tank(s) near the intersection of Bayne Road and Highway 193. The south end of the Walton Lake distribution system does not have local storage for backup in the event of a line break along Highway 193. The installation of a tank(s) would make the southern end of the distribution system less vulnerable to upstream line breaks. It would also provide much needed storage in the southern end of the system. The reliability measure would install one 500,000-gallon tank with provisions for a second tank sometime in the future. Pipe and valves would be included to connect to the Bayne Road reliability measure, WL-13A.

WL-14 Lazy Brook Trail Proposed Reliability Measures

The fire hydrant at the end of Lazy Brook Trail cannot deliver 500 gpm during maximum day demand. To correct this problem it is recommended that the existing water line along Lazy Brook Trail be replaced from Lynx Ridge Road to the end of the existing water main. The reliability measure would install approximately 2,200 feet of 8-inch main, valves and additional fire hydrants to improve fire protection for the area.

WL-15 Whitney Court Proposed Reliability Measures

The Whitney Court reliability measures include the replacement of a normally closed valve on Green Valley Road just north of Whitney Court with a pressure reducing station. This valve is normally closed and prevents water from being delivered south on Green Valley Road from Marshal Road. The water that is delivered to the Whitney Court area is delivered from the south end of Green Valley Road from Highway 193. The installation of a pressure reducing valve would allow for a looped delivery to the Whitney Court area. In addition the existing 4-inch water line cannot deliver the 500-gpm fire flow. This line would be replaced with approximately 1,100 feet of 8-inch main.

The installation of the pressure reducing station will greatly improve the water service to the Garden Park Drive area.

WL-16 Oak Lane Proposed Reliability Measures

The existing 4-inch water line serving Oak Lane is too small to deliver the needed 500 gpm fire flows during maximum day demands. The solution would be to replace the existing water line with approximately 2,600 feet of 8-inch water main.

WL-17 Shasta Road Line Replacement

The water line installed on Shasta Road is a 4-inch line and is too small to deliver the maximum daily flow and 500 gpm fire flow. The reliability measure would replace the existing line with approximately 1,700 feet of 8-inch main, valves and additional hydrants for fire protection. Also recommended as part of this reliability measure is the completion of measure WL-13 and the pressure reducing station recommended in WL-15.

WL-18 Tamalpais Road Line Replacement

The existing 4-inch line serving Tamalpais Road is too small to deliver the needed maximum day demand and the 500 gpm fire flow. The reliability measure would replace the existing line with approximately 1,700 feet of 8-inch main and install new fire hydrants. Reliability measure WL-13 or WL-20 and the pressure reducing station of WL-15 should be completed in advance of or at the same time as this measure.

WL-19 Pikes Peak Circle Line Replacement

The mains in Pikes Peak Circle do not have adequate capacity to provide fire flows. The measure would replace approximately 1,000 feet of 4-inch main from the intersection of Pikes Peak Circle and Garden Valley Road south toward Bayne Road with an 8-inch diameter main. To complete the water supply WL-19 measure the

proposed measure WL-13 would also need to be installed. The pressure reducing station portion of WL-15 would need to be installed for WL-19 to be effective.

WL-20 Garden Park Line Replacement

There are six fire hydrants in the Garden Park area that cannot deliver the 500 gpm fire flow during maximum day. The water supply to this area of the distribution system could be greatly improved by providing a second source of water from the Garden Park tank. The reliability measure would include installing a new 8-inch main from the Garden Park tank and tying into the distribution system on Hancock Road. This would provide a two-source supply from the Garden Park tank. The measure would install approximately 1,700 feet of 8-inch main together with valves and additional fire hydrants. The pressure reduction station portion of WL-15 would also need to be completed to improve this water supply measure.

WL-21 Hancock Road – Garden Park Tank Tie

This measure is similar to WL-20 but would deliver water from the Garden Park tank to the Johntown Creek Road area via a tie at the westerly end of Hancock Road. The Johntown Creek Road area is served by a single source from Marshall Road. The area is vulnerable to outages caused by a line break as far upstream as the intersection of Marshall Road and Garden Valley Road. This measure would include the installation of approximately 1,700 feet of 8-inch main from the Garden Park tank easterly to Bee Hive Court and along Bee Hive Court to the intersection of Hancock Road. Additional hydrants would also be installed.

WL-22 Garden Park Tank Addition

This measure includes installation of an additional 250,000-gallon tank next to the existing Garden Park Tank. This reliability measure would bolster the fire flow storage and emergency storage for the area. If the WL-21 reliability measure is completed additional storage would also be needed for the Johntown Creek Road service area. Minor piping and valving would be needed for this reliability measure. A fire hydrant would be installed near the tank to provide a drafting point for fire truck pumpers.

WL-23 Hotchkiss Hill Subdivision Tank Addition

The Hotchkiss Hill Subdivision tank is not adequate to provide fire flow and emergency storage. The tank should be replaced with a minimum tank of 250,000-gallons to provide the storage needed. The tank would probably need to occupy the existing site because the area is limited in size and available tank sites.

WL-24 Traverse Creek Road Booster Pump

For the most southerly fire hydrant on Traverse Creek Road to deliver 500 gpm during maximum day demand a fire flow booster pump needs to be installed. In addition, the WL-12 reliability measure (Traverse Creek Road Line Replacement) needs to be completed to provide adequate supply water for the booster pump.

WL-25 Chrysler Circle and Roller Coaster Replacements

The Chrysler Circle and Roller Coaster Road distribution system consists of 4-inch diameter water mains. These mains are not large enough to deliver maximum day demands and 500 gpm fire flows. The reliability measure would replace these distribution mains with approximately 9,100 feet of 8-inch mains, valves and add several fire hydrants. To be effective this reliability measure would need to be made after the WL-21 reliability measure.

Reliability Measures Estimated Costs and Priorities

Walton Lakes reliability measure costs are estimated and summarized. This cost summary is shown on **Table VIII-2.** Cost estimates were first prepared based on current costs. Reliability measures were separated into four priorities. Each priority period represents approximately a five-year period. Current costs were inflated for future costs using the Engineering News Record – Construction Cost Index (ENR-CCI). The Engineering News Record established the Construction Cost Index in 1913 to track labor and material costs in 20 large cities. The index is updated every three months and historical data is available.

The reliability measures were prioritized based on what measure would result in the best improvement to the distribution system. Issues considered in establishing priorities included:

1. Looping of dead-ends, where possible.
2. Additional storage, for peak day, fire flows and emergencies
3. Conservation of treated water.

The current cost estimates shown on Table VIII-2 were based on an ENR-CCI value of 6,481. To estimate future costs, current costs were increased by three percent per year to the midpoint of each five-year priority period. The future ENR-CCI index was then used to estimate reliability measure future costs.

The Walton Lake reliability measures recommended herein are graphically represented on system maps included in the back pockets of this study. The map for the Walton Lakes system is entitled Figure 2, Walton Lakes - Reliability Improvements 1 of 2 and Figure 3, Walton Lakes – Reliability Improvements 2 of 2.

GDPUD WATER SYSTEM RELIABILITY MEASURES

WALTON LAKES SERVICE AREA

CONSULTING KASL ENGINEERS
7777 Greenback Ln #104
Citrus Heights, CA 95610
Tel 916/722-1800
Fax 916-722-4595
"We take engineering personally"

SUMMARY OF COSTS 6-Nov-02

	3% PER YEAR INCREASE, ENR-CCI	6,481	6,800	7,880	9,140	10,600
Measure #	**Description**	**Amount**	**Priority**			
			1	**2**	**3**	**4**
WL-1	CITABRIA LN LOOP TIE	$ 92,000		$ 112,000		
WL-2	FAIN LANE EXTENSION	$ 364,000	$ 382,000			
WL-3	BUFFALO HILL RD LINE REPLACEMENT	$ 96,000			$ 136,000	
WL-4 A	QUIET PLACE LOOP TIE	$ 59,000				$ 97,000
WL-4 B	QUIET PLACE REMOVE CHECK VALVE	$ 5,000	$ 6,000			
WL-5	HOLLOWAY DR LINE REPLACEMENT	$ 74,000			$ 105,000	
WL-6	LONGVIEW LANE LINE REPLACEMENT	$ 270,000			$ 381,000	
WL-7	RESERVOIR RD, SDD, HWY 193 REPLACEMENTS	$ 917,000		$ 1,115,000		
WL-8	SILENT MEADOW LN LINE REPLACEMENT	$ 127,000			$ 180,000	
WL-9	SANROMO ROAD LINE REPLACEMENT	$ 531,000				$ 869,000
WL-10	BLACK OAK MINE RD PROPOSED IMPROVEMENT	$ 59,000				$ 97,000
WL-11	GREENWOOD ROAD MAIN REPLACEMENT	$ 208,000		$ 253,000		
WL-12	TRAVERSE CREEK RD. LINE REPLACEMENT	$ 454,000				$ 743,000
WL-13A	BAYNE ROAD LINE EXTENSION	$ 405,000	$ 425,000			
WL-13B	BAYNE ROAD TANK	$ 1,350,000		$ 1,642,000		
WL-14	LAZY BROOK TRAIL LINE REPLACEMENT	$ 128,000				$ 210,000
WL-15	WHITNEY CT. PRESSURE REDUCING STATION	$ 108,000	$ 114,000			
WL-16	OAK LANE LINE REPLACEMENT	$ 151,000			$ 213,000	
WL-17	SHASTA RD. LINE REPLACEMENT	$ 109,000				$ 179,000
WL-18	TALMALPAIS RD. LINE REPLACEMENT	$ 110,000			$ 156,000	
WL-19	PIKES PEAK CIR. LINE REPLACEMENT	$ 64,000			$ 91,000	
WL-20	GARDEN PARK LINE REPLACEMENT	$ 97,000	$ 102,000			
WL-21	HANCOCK ROAD TANK TIE	$ 113,000	$ 119,000			
WL-22	GARDEN PARK TANK PROPOSED IMPROVEMENTS	$ 836,000		$ 1,017,000		
WL-23	HOTCHKISS HILL SUB TANK ADDITION	$ 444,000			$ 627,000	
WL-24	TRAVERSE CREEK RD. BOOSTER PUMPS	$ 62,000			$ 88,000	
WL-25	CHRYSLER CIR & ROLLER COASTER REPLACEMENT	$ 570,000				$ 933,000
	TOTAL, CURRENT COSTS	**$ 7,803,000**				
	PROJECTED FUTURE COSTS		**$ 1,148,000**	**$ 4,139,000**	**$ 1,977,000**	**$ 3,128,000**

Table VIII-2

Summary

WATER SYSTEM RELIABILITY STUDY
FOR
GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT

TECHNICAL APPENDICES

November 2002

Submitted To: Georgetown Divide
Public Utility District
P.O. Box 4240
Georgetown, CA 95634

Submitted By: KASL Consulting Engineers, Inc.
7777 Greenback Lane, Suite 104
Citrus Heights, CA 95610

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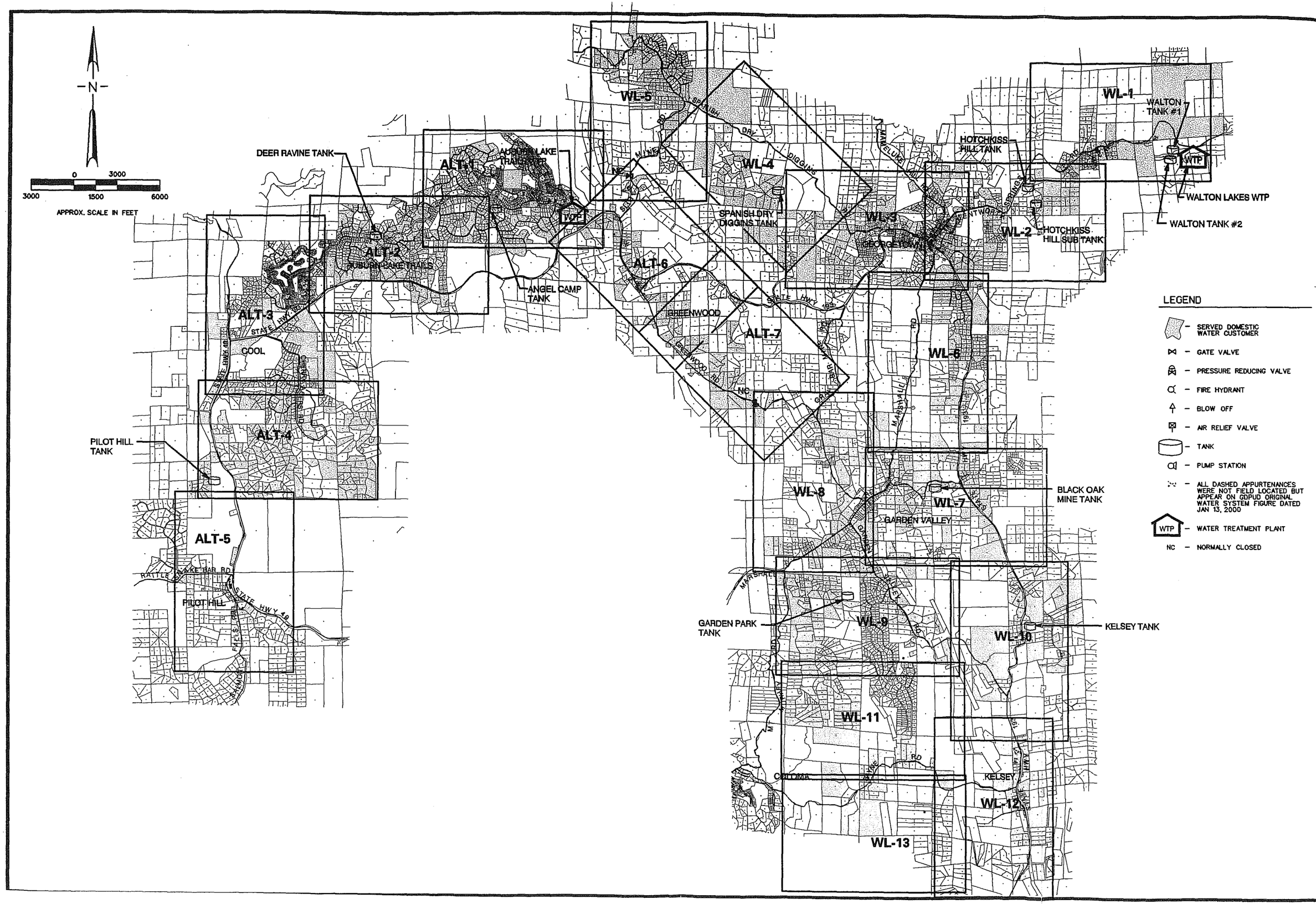
EL DORADO COUNTY
WATER AGENCY



KASL

SHEET INDEX

APPROX. SCALE 1"=2000'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV :

DATUM :

BENCH MARK :

DESCRIPTION :

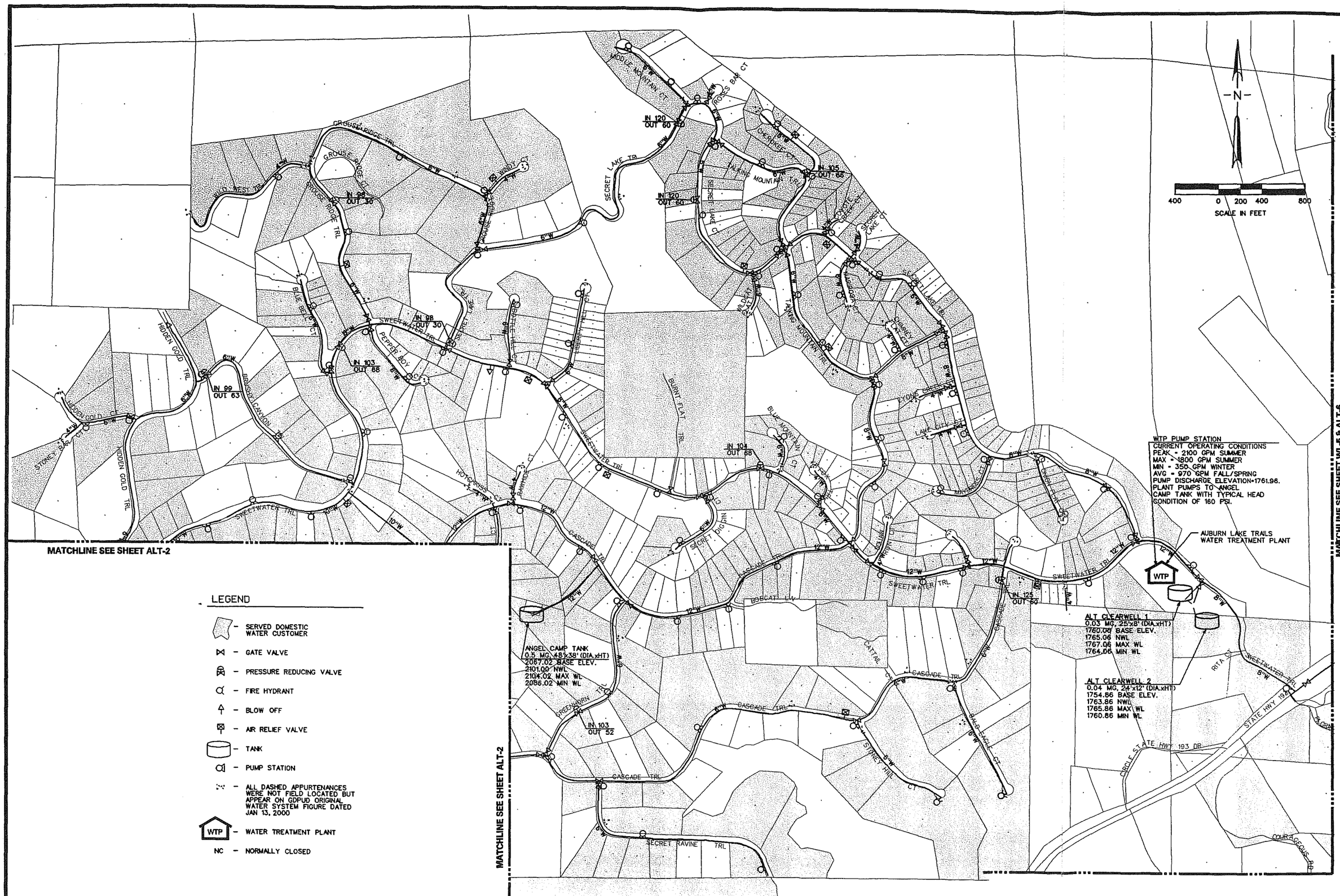
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET 1 OF 21



LEGEND

- SERVED DOMESTIC WATER CUSTOMER
- GATE VALVE
- PRESSURE REDUCING VALVE
- FIRE HYDRANT
- BLOW OFF
- AIR RELIEF VALVE
- TANK
- PUMP STATION
- ALL DASHED APPURTENANCES WERE NOT FIELD LOCATED BUT APPEAR ON GDPUD ORIGINAL WATER SYSTEM FIGURE DATED JAN 13, 2000
- WTP – WATER TREATMENT PLANT
- NC – NORMALLY CLOSED

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AUBURN LAKE TRAILS EAST

APPROX. SCALE

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MATCHLINE SEE SHEET ALT-1

MATCHLINE SEE SHEET ALT-3

MATCHLINE SEE SHEET ALT-1

LEGEND

- SERVED DOMESTIC WATER CUSTOMER
- GATE VALVE
- PRESSURE REDUCING VALVE
- FIRE HYDRANT
- BLOW OFF
- AIR RELIEF VALVE
- TANK
- PUMP STATION
- ALL DASHED APPURTENANCES WERE NOT FIELD LOCATED BUT APPEAR ON GDPUD ORIGINAL WATER SYSTEM FIGURE DATED JAN 13, 2000
- WTP – WATER TREATMENT PLANT
- NC – NORMALLY CLOSED

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GDPUD-WATER PROJECTS\AUBURN LAKE TRAILS

AUBURN LAKE TRAILS CENTRAL/WEST

APPROX. SCALE

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DATE: 10/06/2002

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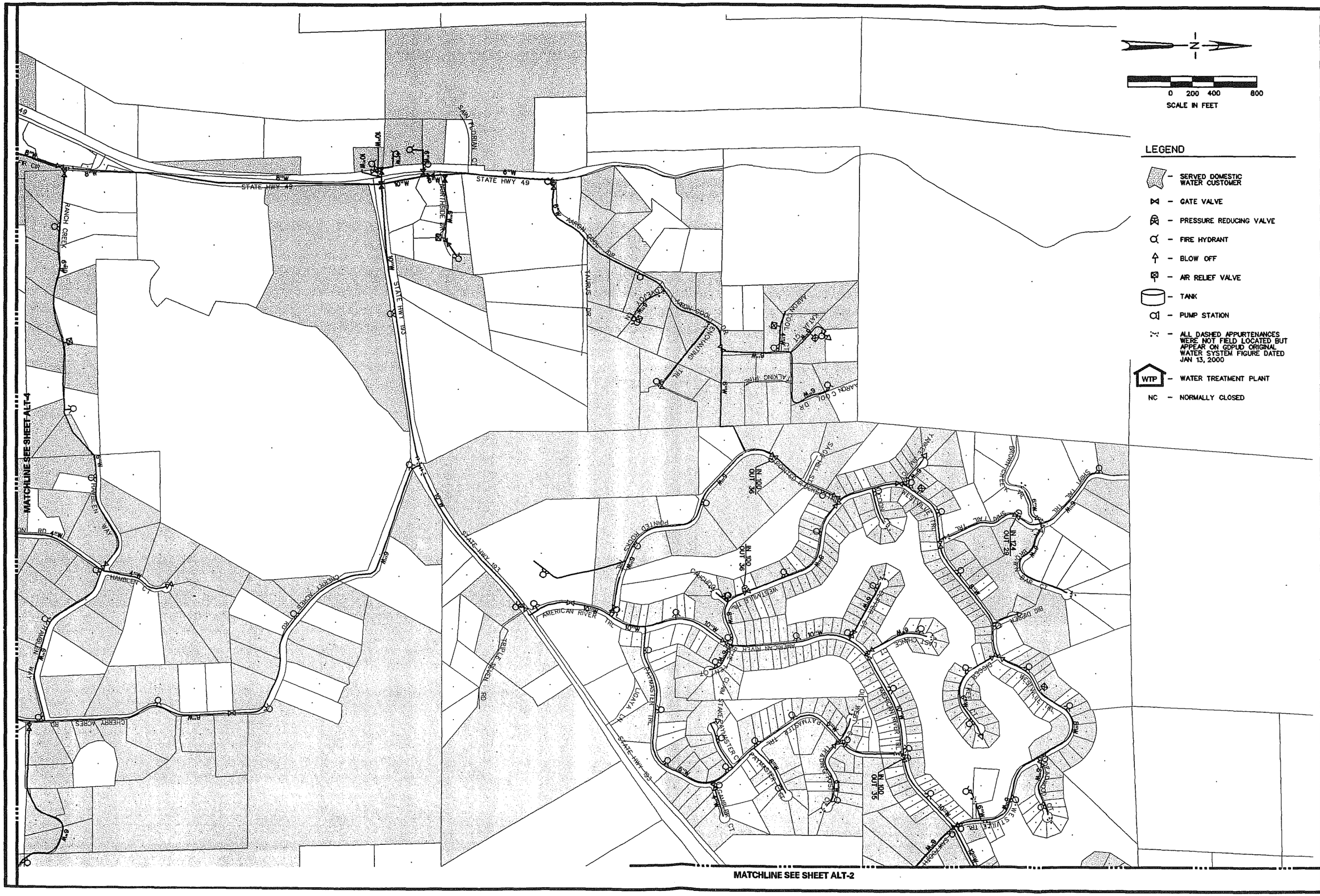

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ABURN LAKE TRAILS WEST, COOL/CHERRY

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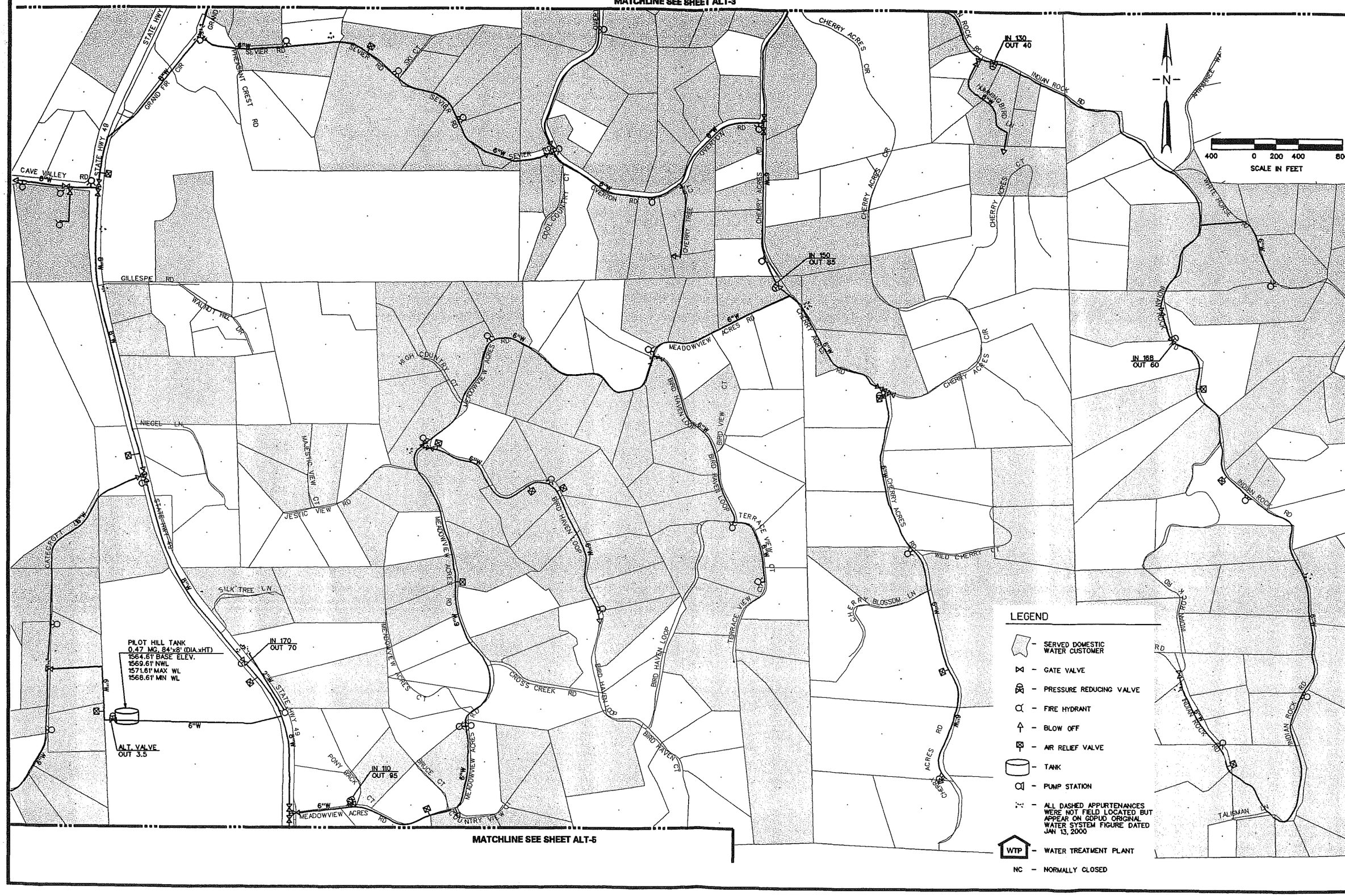

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COOL/CHERRY, MEADOWVIEW, INDIAN ROCK, EXT. 82A ZONES

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EL DORADO COUNTY, CALIFORNIA

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LEGEND

- SERVED DOMESTIC WATER CUSTOMER
- GATE VALVE
- PRESSURE REDUCING VALVE
- FIRE HYDRANT
- BLOW-OFF
- AIR RELIEF VALVE
- TANK
- PUMP STATION
- ALL DASHED APPURTENANCES WERE NOT FIELD LOCATED BUT APPEAR ON GDPUD ORIGINAL WATER SYSTEM FIGURE DATED JAN 13, 2000
- WTP – WATER TREATMENT PLANT
- NC – NORMALLY CLOSED

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ABURN LAKE TRAILS PILOT HILL

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AUBURN LAKE TRAILS ALT/EAST GREENWOOD

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AUBURN LAKE TRAILS ALT/EAST GREENWOOD/BLACK RIDGE

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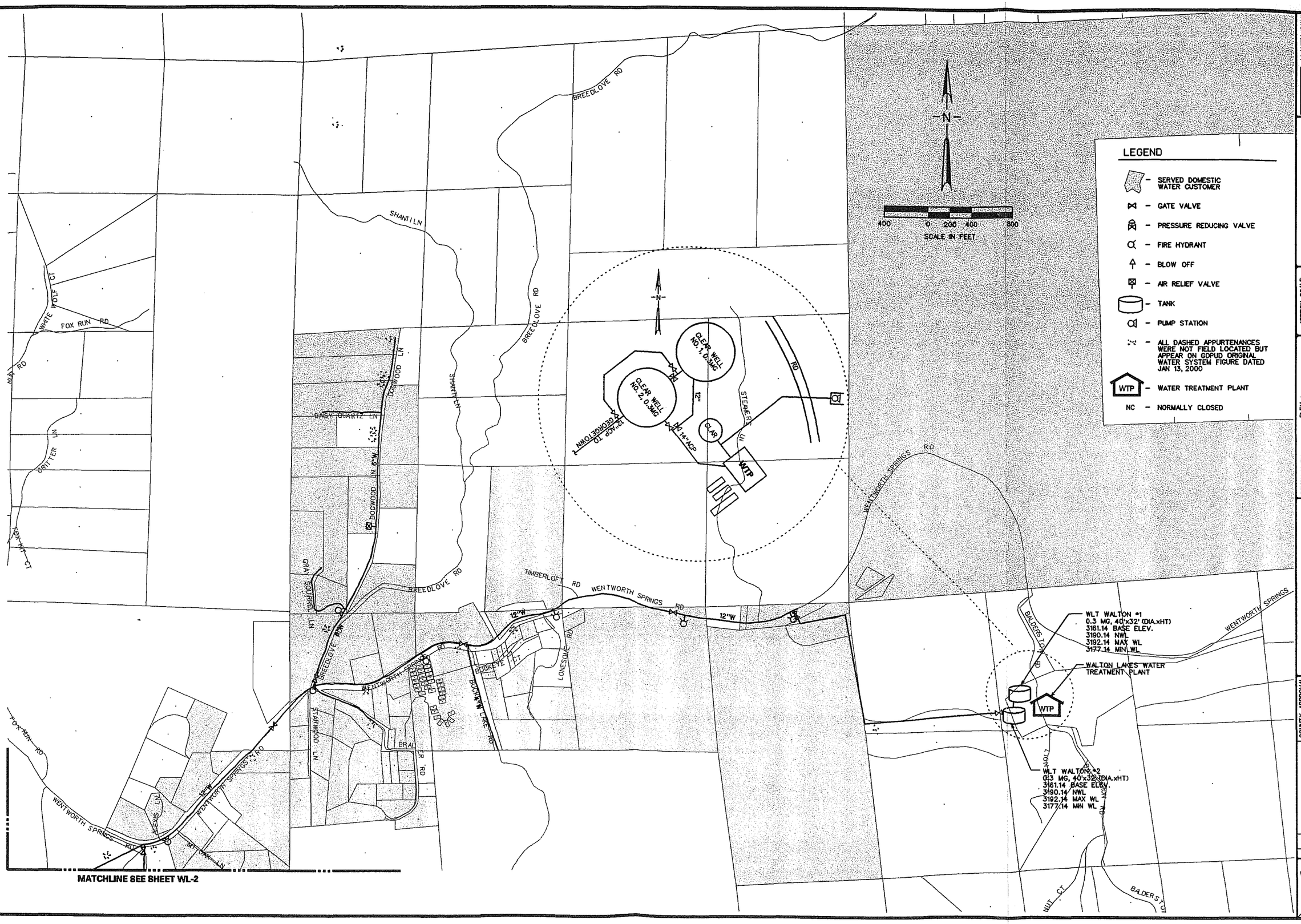

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WALTON LAKES
GEORGETOWN

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DATE: NOV. 2002

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GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

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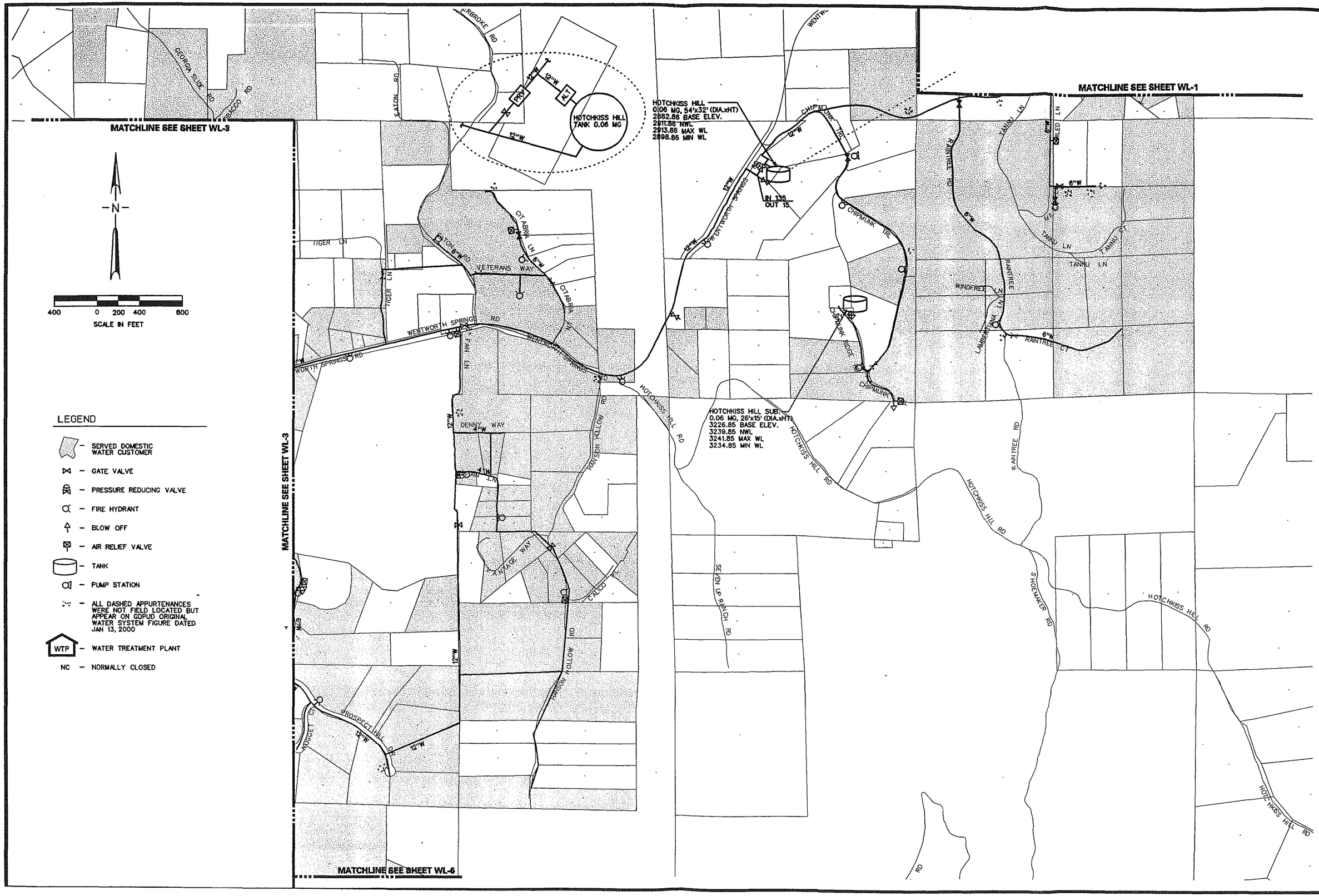

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WALTON LAKES GEORGETOWN

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DATE: NOV. 2002

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EL DORADO COUNTY, CALIFORNIA

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WALTON LAKES GEORGETOWN

APPROX. SCALE

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GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

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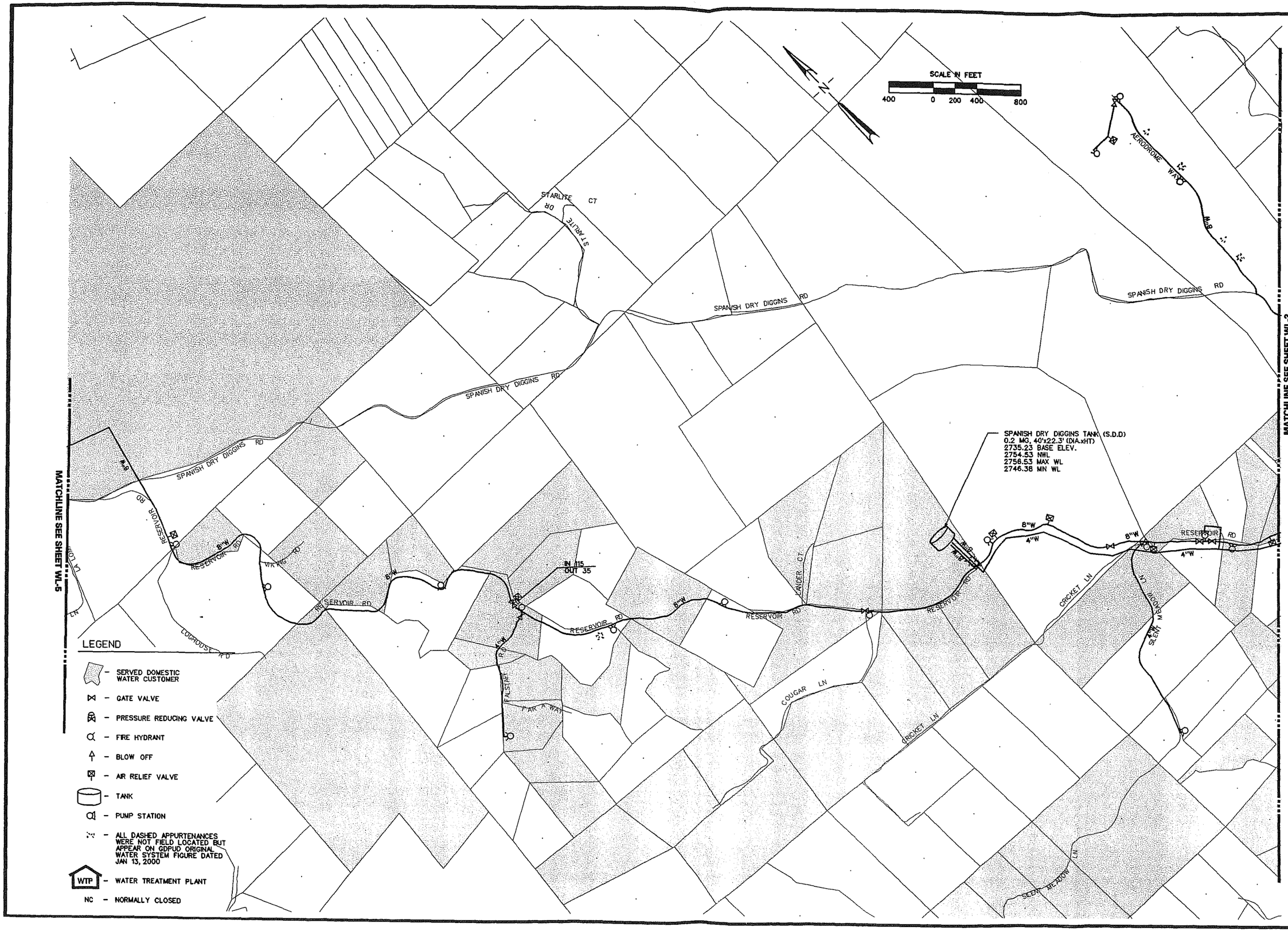

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WALTON LAKES
GEORGETOWN

APPROX. SCALE

JOB. NO. 2865-02

DATE: NOV. 2002

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GEORGETOWN DIVIDE
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EL DORADO COUNTY, CALIFORNIA

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WALTON LAKES GEORGETOWN

APPROX. SCALE

JOB. NO. 2805-02

DATE: NOV. 2002

BENCH MARK : ELEV :

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GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

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LEGEND

- SERVED DOMESTIC WATER CUSTOMER
- GATE VALVE
- PRESSURE REDUCING VALVE
- FIRE HYDRANT
- BLOW OFF
- AIR RELIEF VALVE
- TANK
- PUMP STATION
- ALL DASHED APPURTENANCES WERE NOT FIELD LOCATED BUT APPEAR ON GDPUD ORIGINAL WATER SYSTEM FIGURE DATED JAN 13, 2000
- WTP - WATER TREATMENT PLANT
- NC - NORMALLY CLOSED

MATCHLINE SEE SHEET WL-7

MATCHLINE SEE SHEET WL-3

MATCHLINE SEE SHEET WL-2

MARSHALL RD
MARSHALL RD
MARSHALL RD
MARSHALL RD
LEATON MINE RD
AVALON DR
BACKBERRY LN
UNNAMED RD
STATE HWY 193
STATE HWY 193
STATE HWY 193
STATE HWY 193
10"W
10"W
10"W
10"W
IN 145
OUT 85
IN 140
OUT 35-50
SHADROCK LN
HOPE MOUNTAIN RD
TOOLS CANYON RD
TOOLS CANYON RD
VAN CT
GUN SMOKE RD
FLORALAN CT
FLORALAN RD
CEDAR CT
CEDAR DR
CEDAR DR
CEDAR DR
FOREST VIEW DR
FOREST VIEW DR
PINE COVE DR
BEAR CREEK RD
BEAR CREEK RD
BEAR CREEK HEIGHTS RD
ELMWOOD DR
WILD SPRING CT
SHOEMAKER RD

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WALTON LAKES
GEORGETOWN

APPROX. SCALE
JOB. NO. 2885-02
DATE: NOV. 2002

BENCH MARK :
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PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

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REVISION

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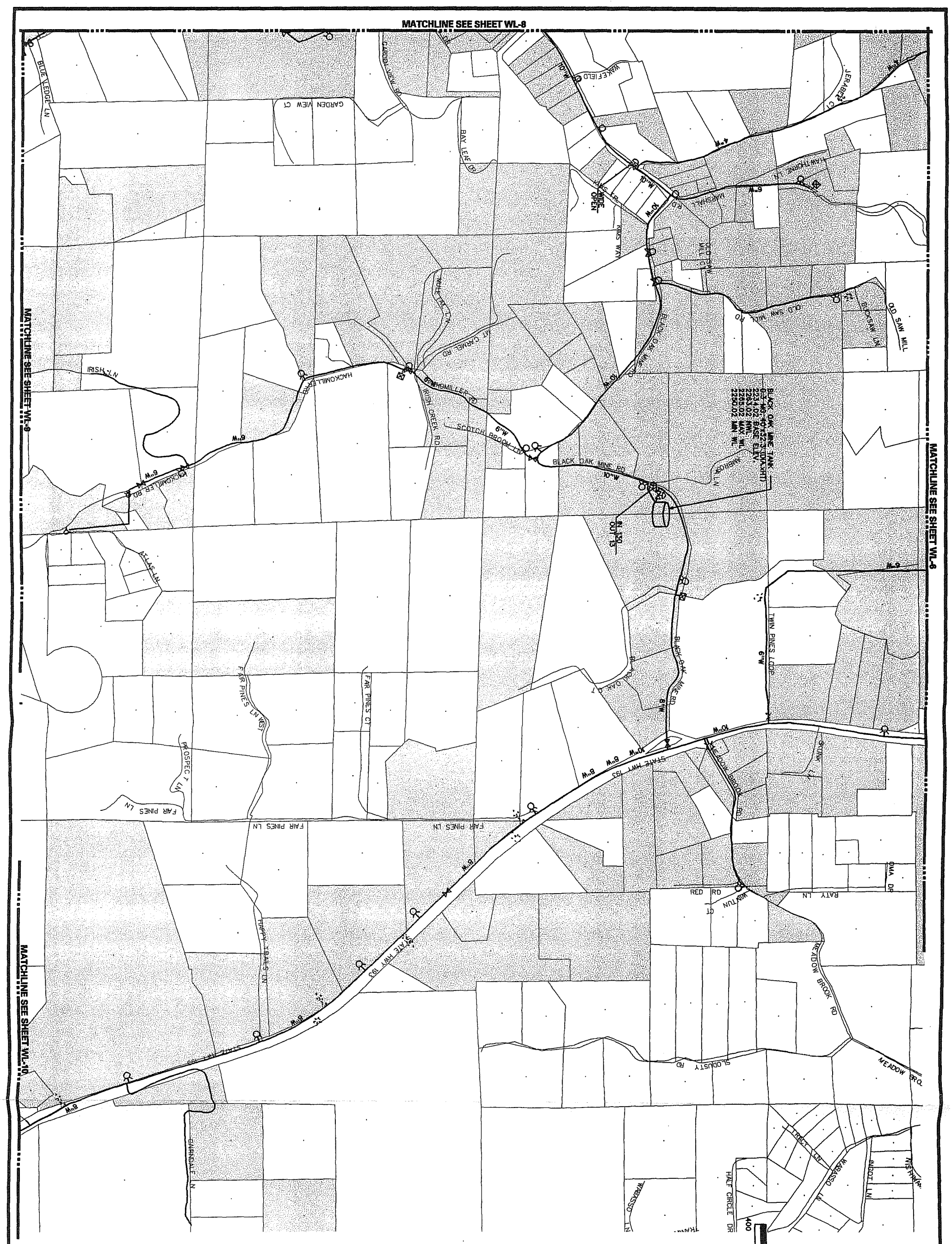

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SHEET WL-7 OF 21

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

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DESCRIPTION :

APPROX. SCALE

JOB. NO. 2895-02

DATE: NOV. 2002

WALTON LAKES GEORGETOWN

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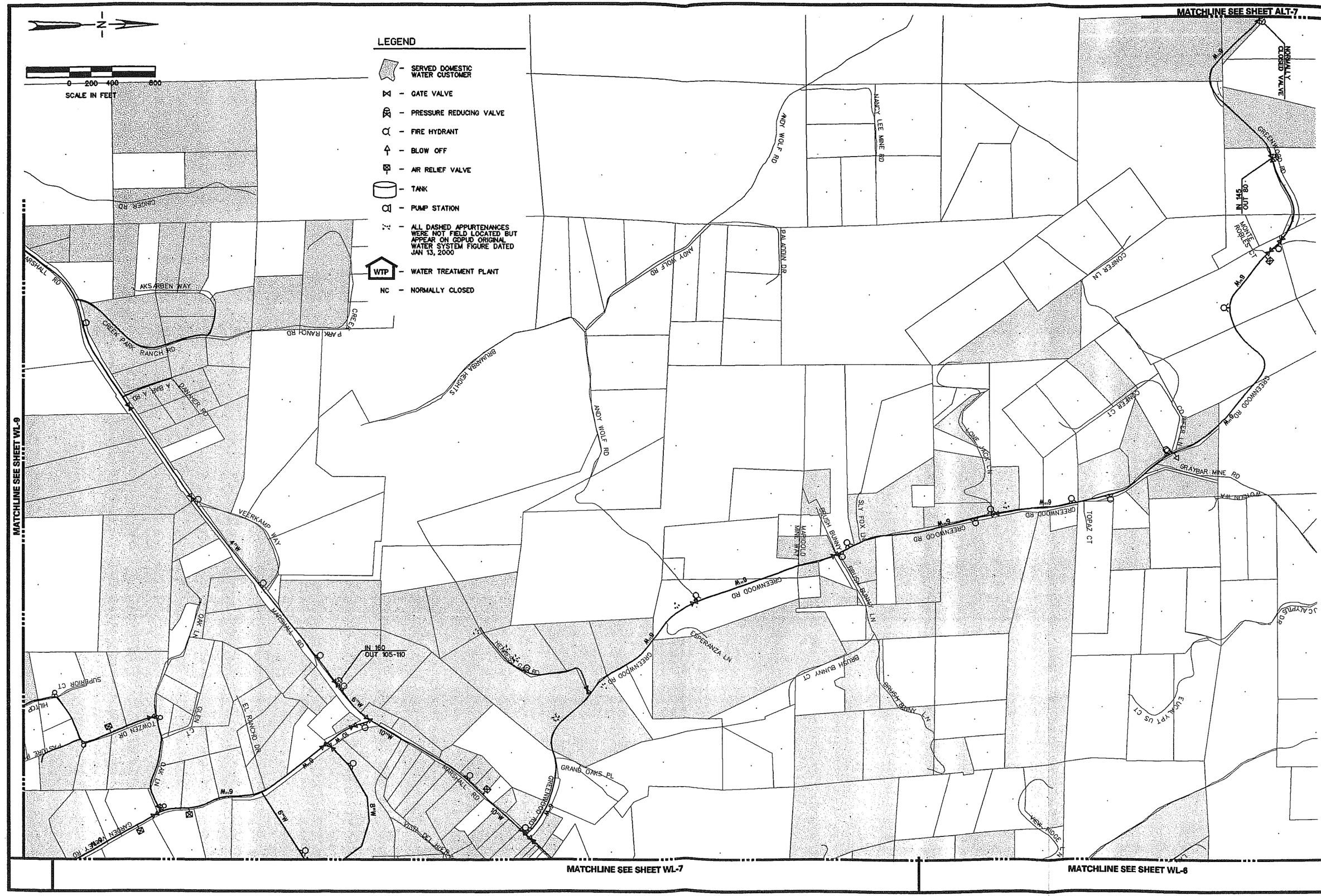

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WALTON LAKES GEORGETOWN

APPROX. SCALE
JOB. NO. 2895-02
DATE: NOV. 2002

BENCH MARK :
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ELEV :
DATUM :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET WL-8 OF 21

MATCHLINE SEE SHEET WL-8

MATCHLINE SEE SHEET WL-7

MATCHLINE SEE SHEET WL-11

MATCHLINE SEE SHEET WL-10

LEGEND

- SERVED DOMESTIC WATER CUSTOMER
- GATE VALVE
- PRESSURE REDUCING VALVE
- FIRE HYDRANT
- BLOW OFF
- AIR RELIEF VALVE
- TANK
- PUMP STATION
- ALL DASHED APPURTENANCES WERE NOT FIELD LOCATED BUT APPEAR ON GDPUD ORIGINAL WATER SYSTEM FIGURE DATED JAN 13, 2000
- WTP – WATER TREATMENT PLANT
- NC – NORMALLY CLOSED

-N-

400 0 200 400 800

SCALE IN FEET

KASL

WALTON LAKES GARDEN VALLEY

APPROX. SCALE

JOB. NO. 2805-02

DATE: MAY 2002

BENCH MARK : ELEV :

DESCRIPTION : DATUM :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

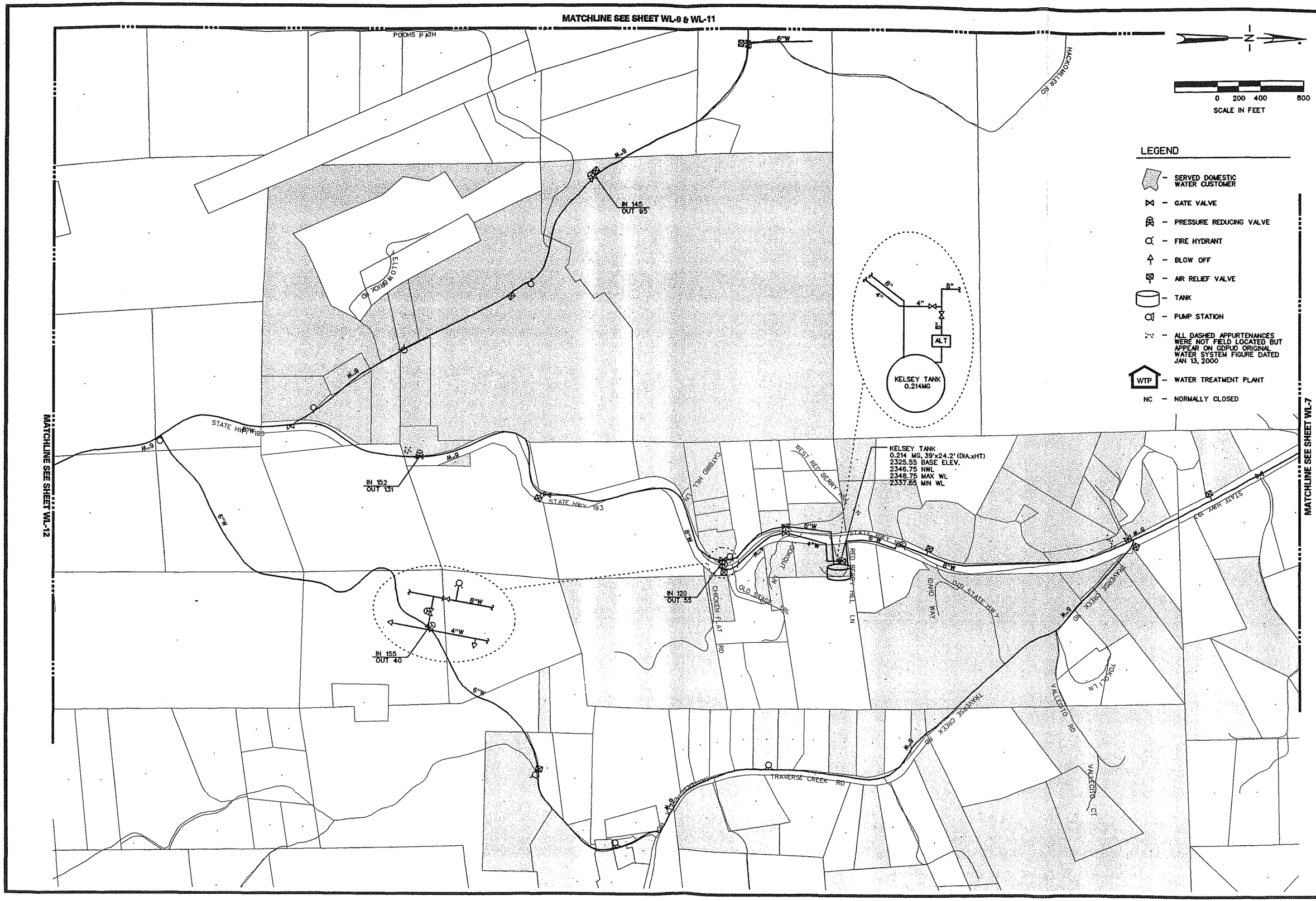
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET WL-9 OF 21



KASL

WALTON LAKES
GEORGETOWN

APPROX. SCALE

JOB. NO. 2895-02

DATE: NOV. 2002

BENCH MARK :

DESCRIPTION :

ELEV :

DATUM :

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL	
APPROVED BY	DATE

NO.	DESCRIPTION

REVISION

SHEET
WL-10
OF
21

MATCHLINE SEE SHEET WL-9

MATCHLINE SEE SHEET WL-10

MATCHLINE SEE SHEET WL-12

MATCHLINE SEE SHEET WL-13

KASL
CIVIL • WATER RESOURCES • SURVEYING

WALTON LAKES
GARDEN VALLEY

APPROX. SCALE

JOB. NO. 2895-02

DATE: NOV. 2002

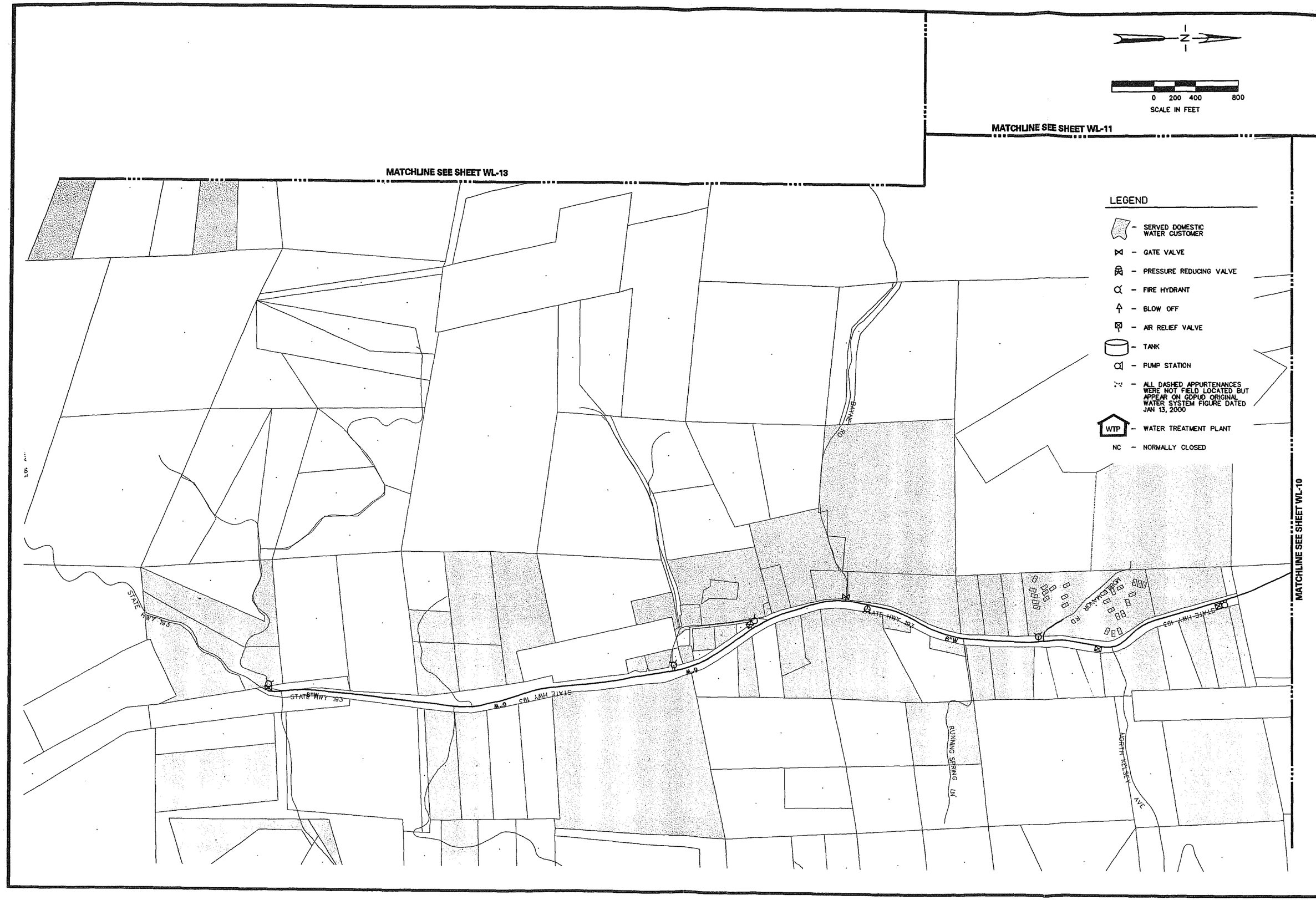
BENCH MARK :
ELEV :
DESCRIPTION :
DATUM :

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET
WL-11
OF
21



KASL

CIVIL · WATER RESOURCES · ENVIRONMENTAL

WALTON LAKES GEORGETOWN

APPROX. SCALE

JOB. NO. 2895-02

DATE: NOV. 2002

BENCH MARK :

DESCRIPTION :

ELEV :

DATUM :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET WL-12 OF 21

KASL

WALTON LAKES GARDEN VALLEY

APPROX. SCALE

JOB. NO. 2895-02

BENCH MARK :
ELEV :
DATUM :
DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

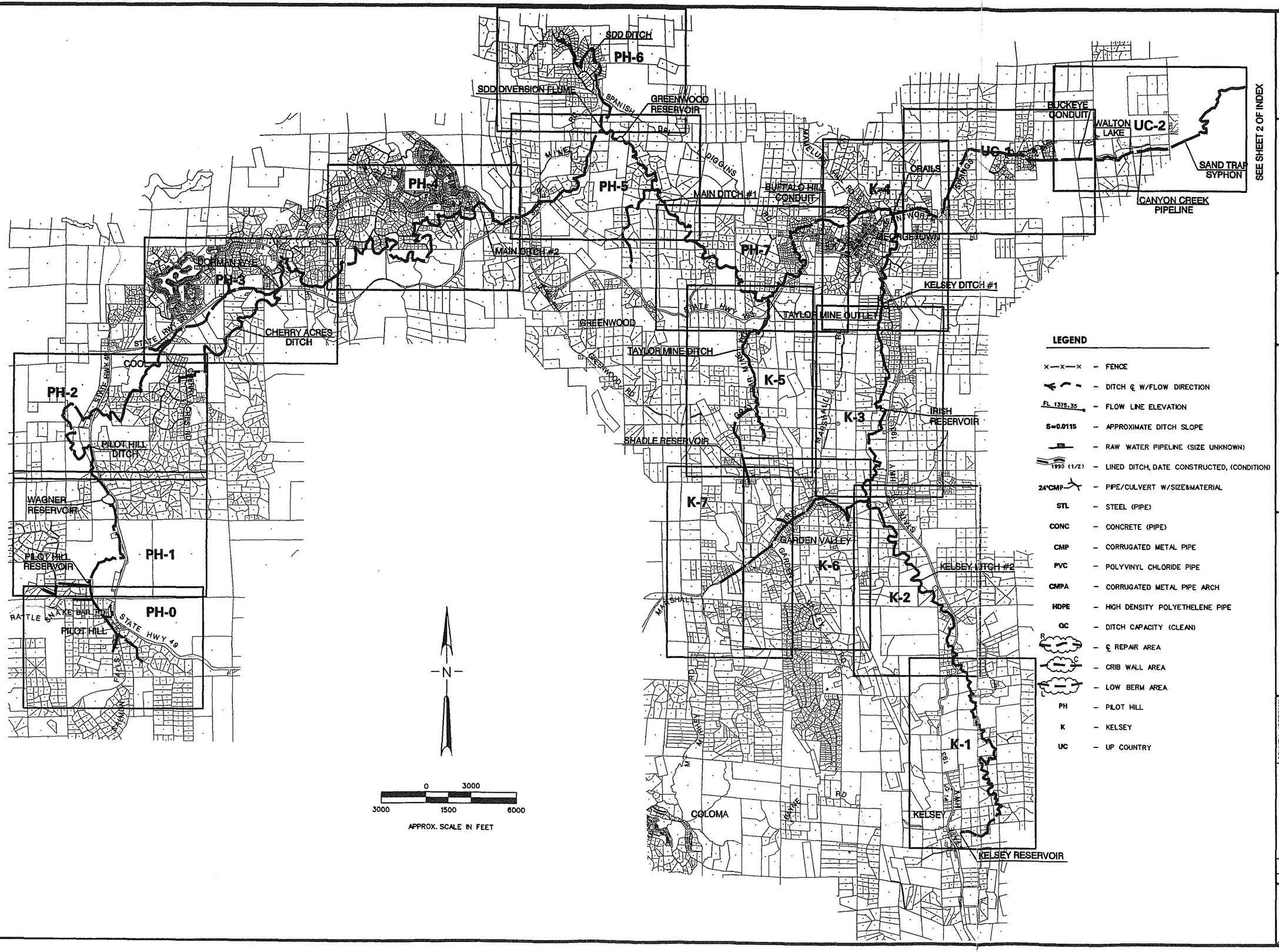
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET WL-13 OF 21



KASL
CIVIL • WATER RESOURCES • LAND DEVELOPMENT

GDPUD DITCH WATER SHEET INDEX

APPROX. SCALE 1"=400'
JOB. NO. 2895-02
DATE: NOV. 2002

BENCH MARK : ELEV : ____
DESCRIPTION : DATUM : ____

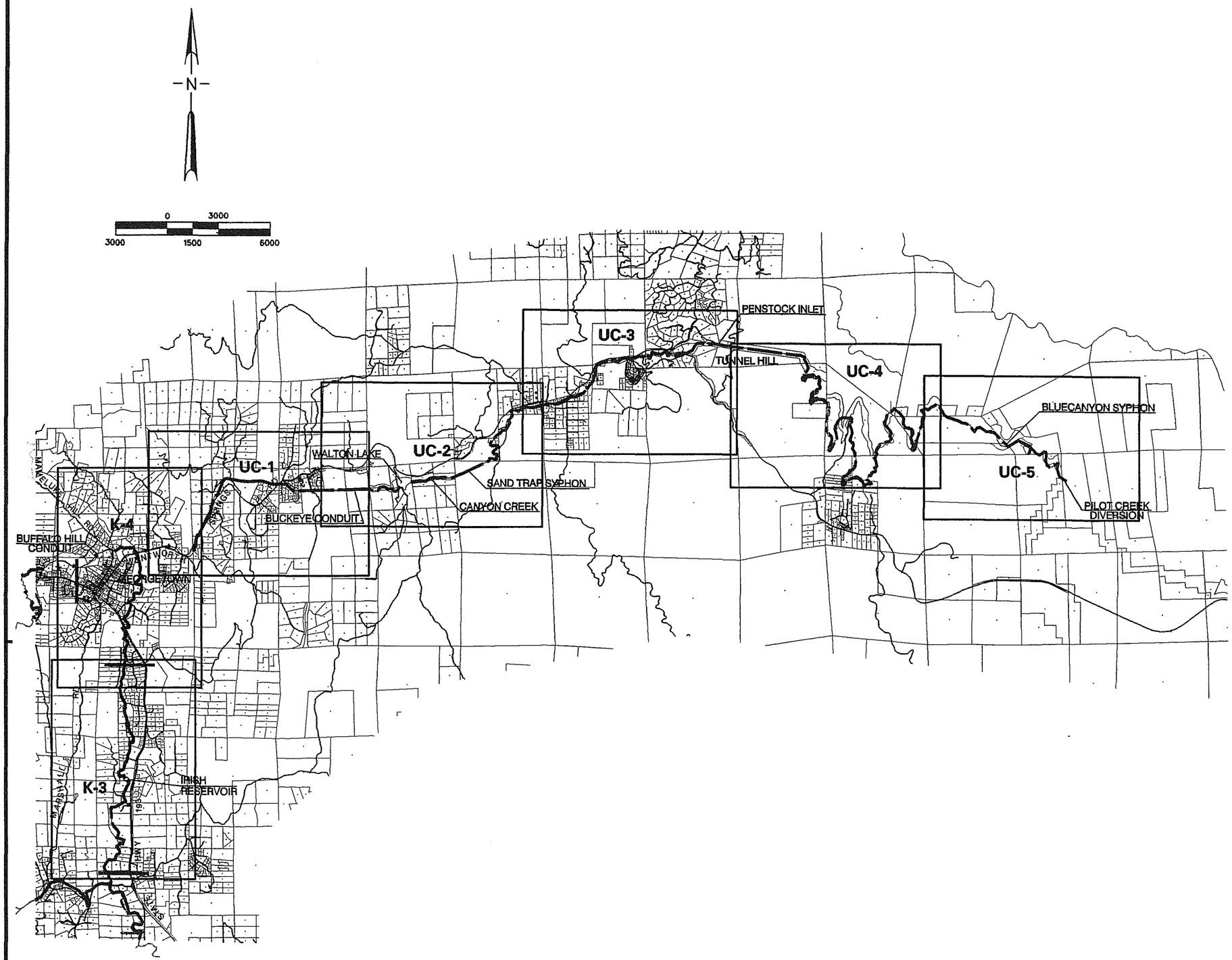
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET 1 OF 22



LEGEND

×—×—×	– FENCE
	– DITCH ℄ W/FLOW DIRECTION
FL 1375.35	– FLOW LINE ELEVATION
S=0.0115	– APPROXIMATE DITCH SLOPE
RW	– RAW WATER PIPELINE (SIZE UNKNOWN)
1990 (1/2)	– LINED DITCH, DATE CONSTRUCTED, (CONDITION)
24"CMP	– PIPE/CULVERT W/SIZE&MATERIAL
STL	– STEEL (PIPE)
CONC	– CONCRETE (PIPE)
CMP	– CORRUGATED METAL PIPE
PVC	– POLYVINYL CHLORIDE PIPE
CMPA	– CORRUGATED METAL PIPE ARCH
HDPE	– HIGH DENSITY POLYETHELENE PIPE
QC	– DITCH CAPACITY (CLEAN)
R	– ℄ REPAIR AREA
C	– CRIB WALL AREA
L	– LOW BERM AREA
PH	– PILOT HILL
K	– KELSEY
UC	– UP COUNTRY

KASL

GDPUD DITCH WATER SYSTEM INDEX

APPROX. SCALE 1"=3000'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV : ____

DATUM : ____

BENCH MARK : ____

DESCRIPTION : ____

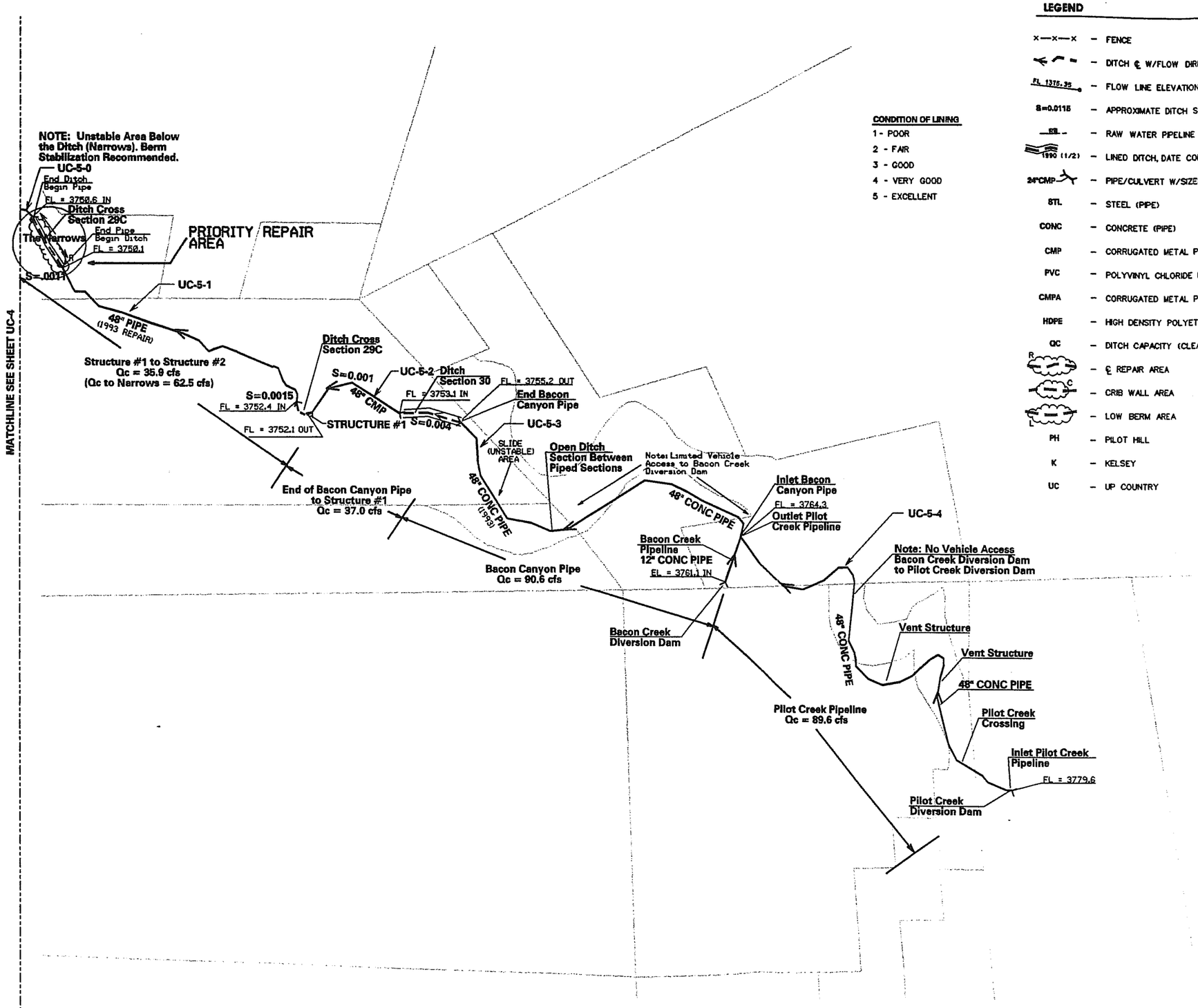
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET 2 OF 22



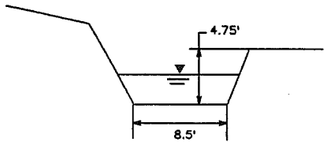
CONDITION OF LINING

1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT

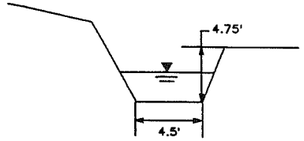
LEGEND

x—x—x	– FENCE
	– DITCH ℄ W/FLOW DIRECTION
FL 1376.35	– FLOW LINE ELEVATION
S=0.0115	– APPROXIMATE DITCH SLOPE
RW	– RAW WATER PIPELINE (SIZE UNKNOWN)
1990 (1/2)	– LINED DITCH, DATE CONSTRUCTED, (CONDITION)
24"CMP	– PIPE/CULVERT W/SIZE&MATERIAL
STL	– STEEL (PIPE)
CONC	– CONCRETE (PIPE)
CMP	– CORRUGATED METAL PIPE
PVC	– POLYVINYL CHLORIDE PIPE
CMPA	– CORRUGATED METAL PIPE ARCH
HDPE	– HIGH DENSITY POLYETHELENE PIPE
QC	– DITCH CAPACITY (CLEAN)
R	– ℄ REPAIR AREA
C	– CRIB WALL AREA
L	– LOW BERM AREA
PH	– PILOT HILL
K	– KELSEY
UC	– UP COUNTRY

Note: GIS Base maps provided by El Dorado County were prepared from a "best fit" of recorded maps. The GPS data collected by KASL for the location of the ditch is more accurate than the county base data and may not align with the county base maps in all areas.



DITCH CROSS SECTION 29C
N.T.S.



DITCH CROSS SECTION 30
N.T.S.

KASL

Pilot Creek to Str No.1/Str No.2

UP COUNTRY DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV : ____

DATUM : ____

BENCH MARK : ____

DESCRIPTION : ____

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

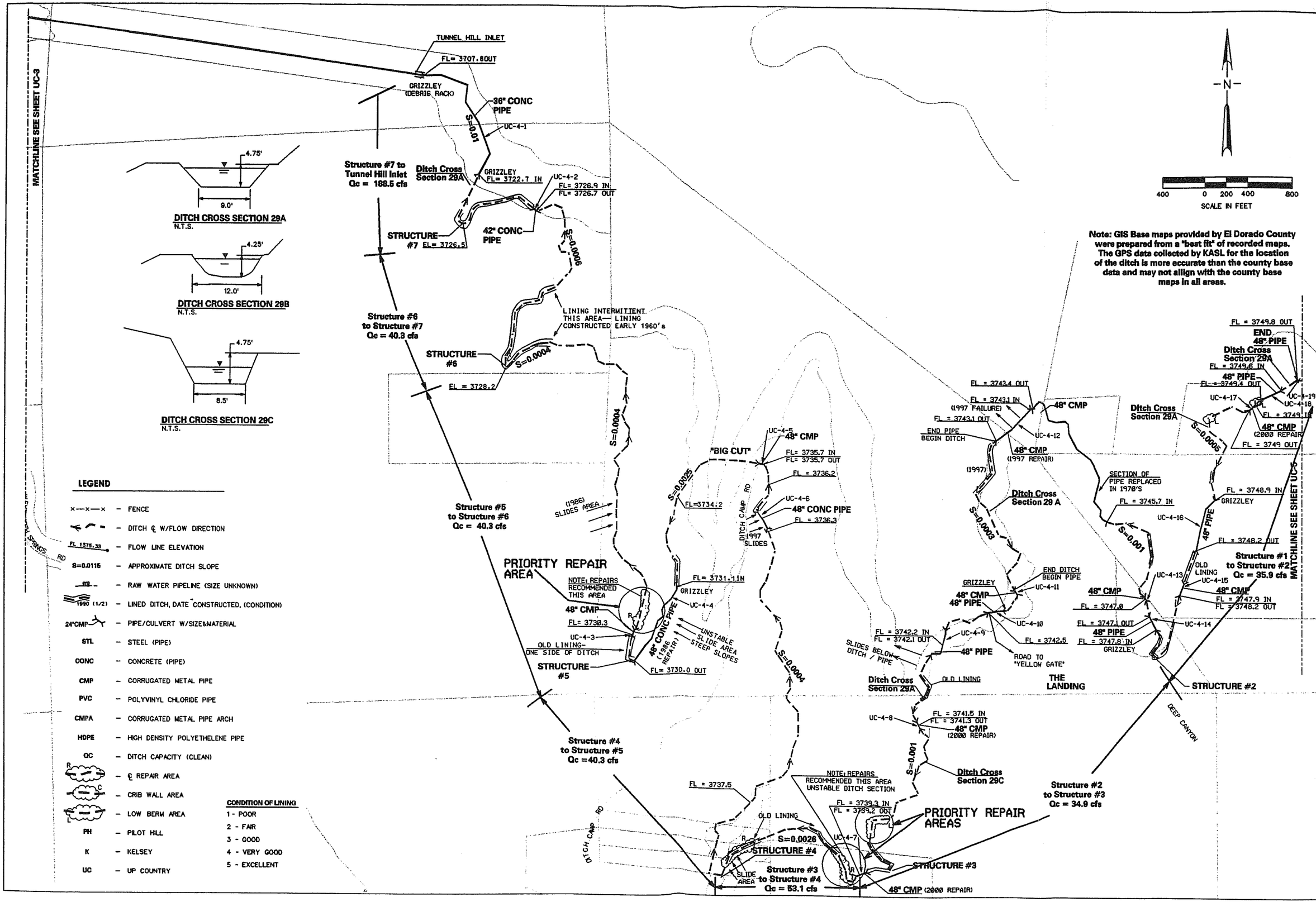
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET **UC-5** OF **22**



KASL

STR#1/STR#2 TO TUNNEL HILL

UP COUNTRY DITCH SYSTEM

APPROX. SCALE 1"=400'

JOB. NO. 2895-02

DATE: JAN. 2002

ELEV : ____

DATUM : ____

BENCH MARK : ____

DESCRIPTION : ____

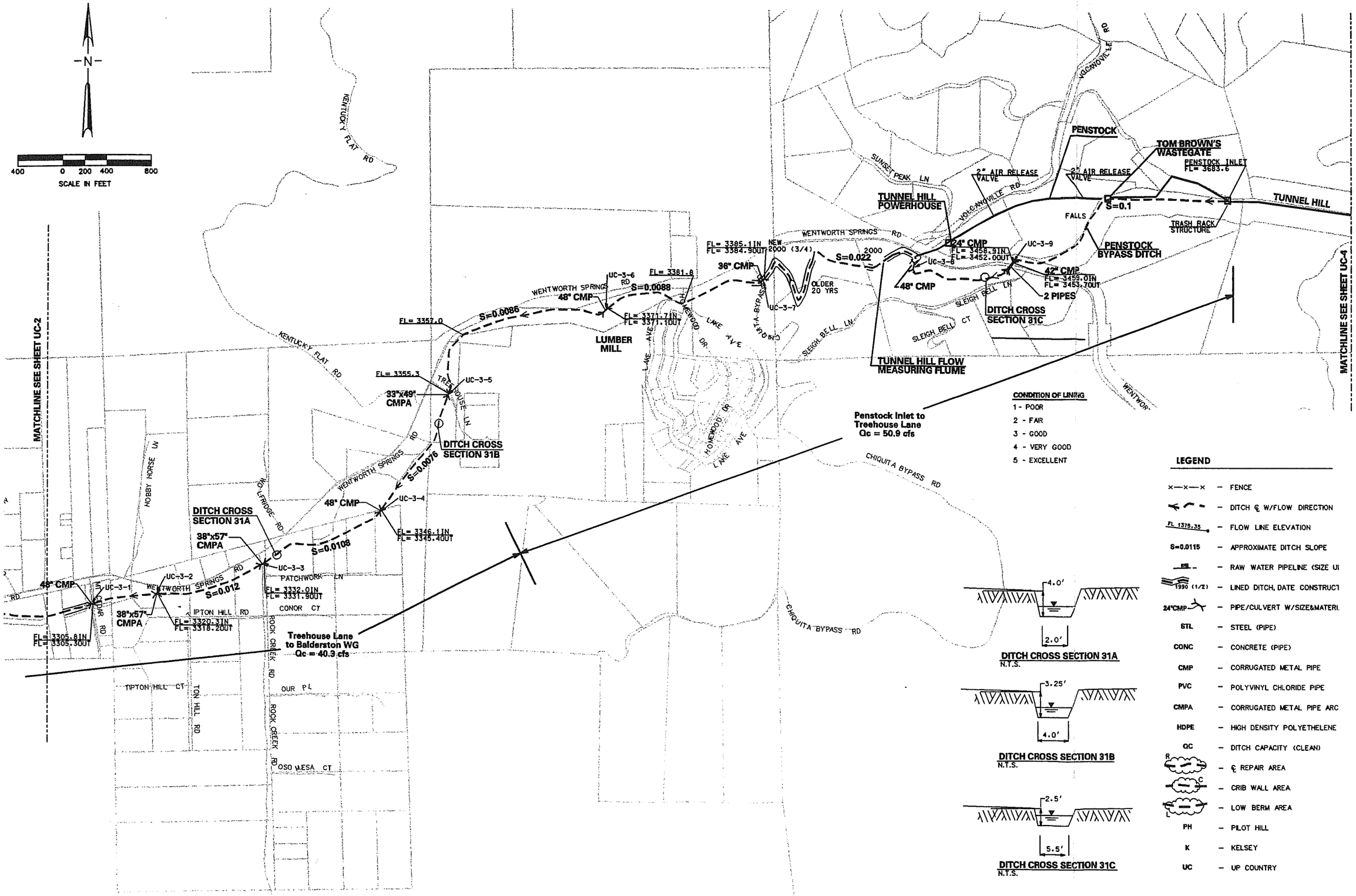
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED	BY	DATE

REVISION

SHEET UC-4 OF 22



KASL
CIVIL - WATER RESOURCES - ENVIRONMENTAL

TUNNEL HILL TO MT. CEDAR RD.

UP COUNTRY DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV :
DATUM :

BENCH MARK :
DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

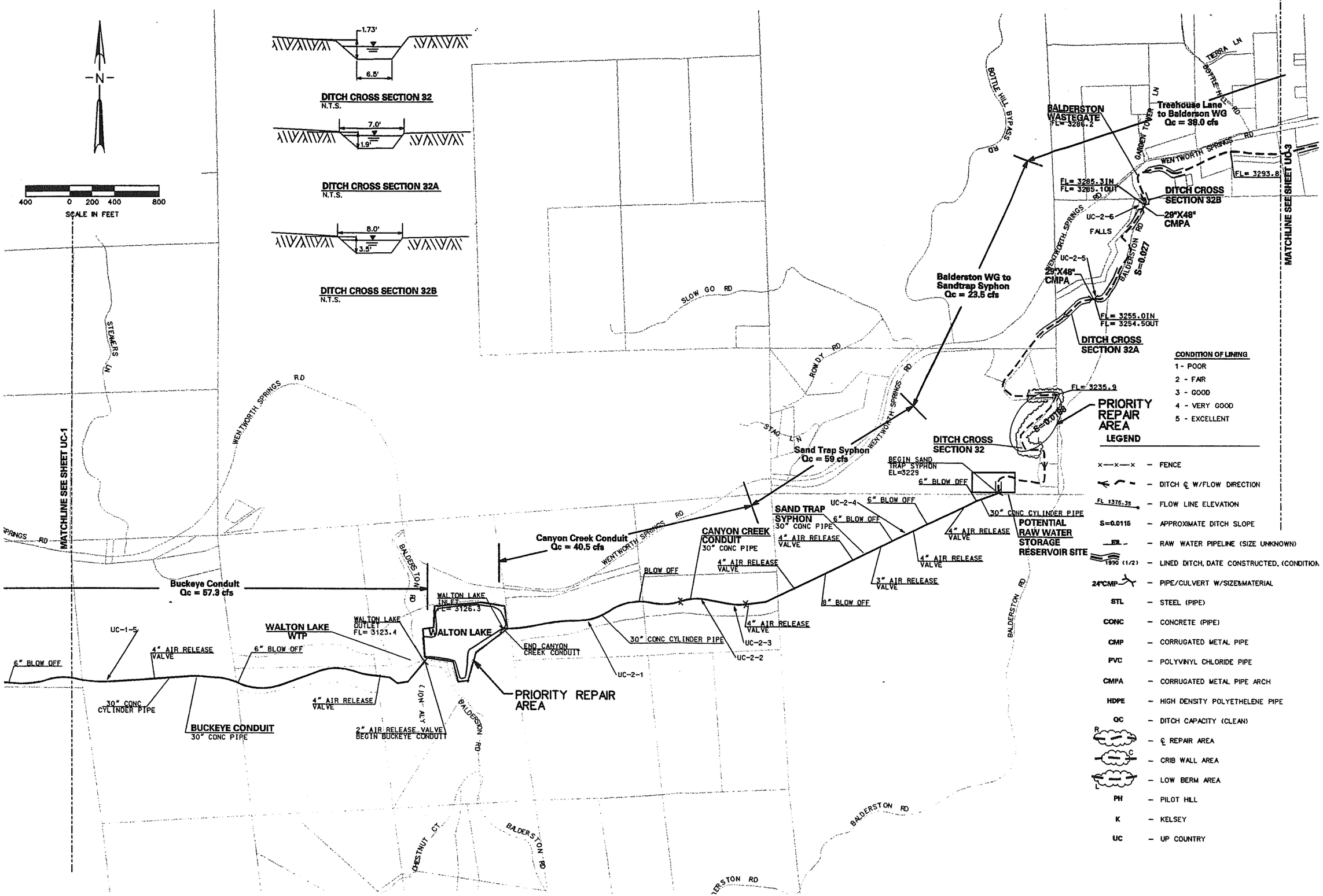
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET UC-3 OF 22



KASL

MT. CEDAR ROAD TO BUCKEYE CONDUIT

UP COUNTRY DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2995-02

DATE: NOV. 2002

ELEV :

DATUM :

BENCH MARK :

DESCRIPTION :

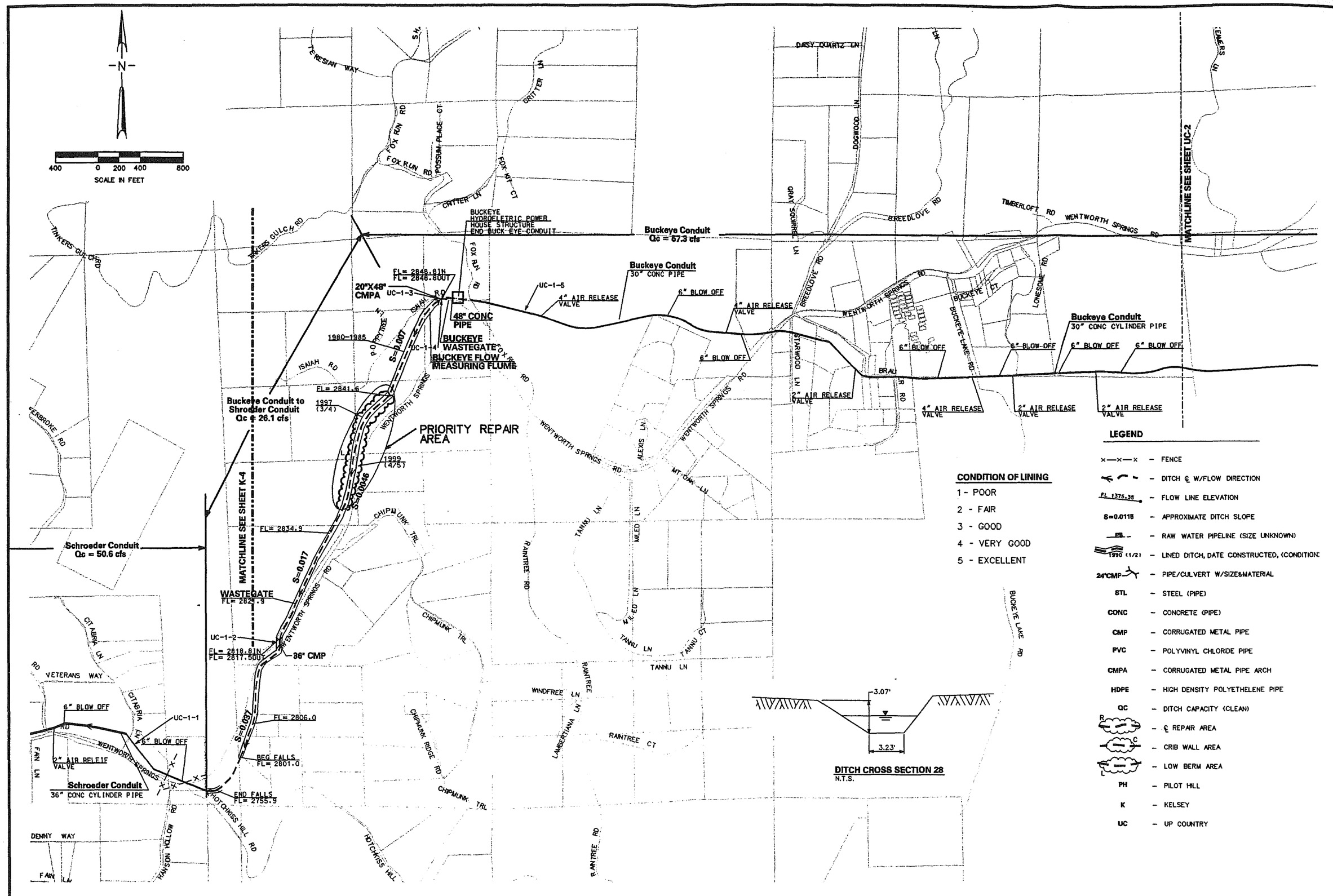
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET UC-2 OF 22



KASL

BUCKEYE CONDUIT TO SCHROEDER CONDUIT

UP COUNTRY DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV : ____

DATUM : ____

BENCH MARK :

DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

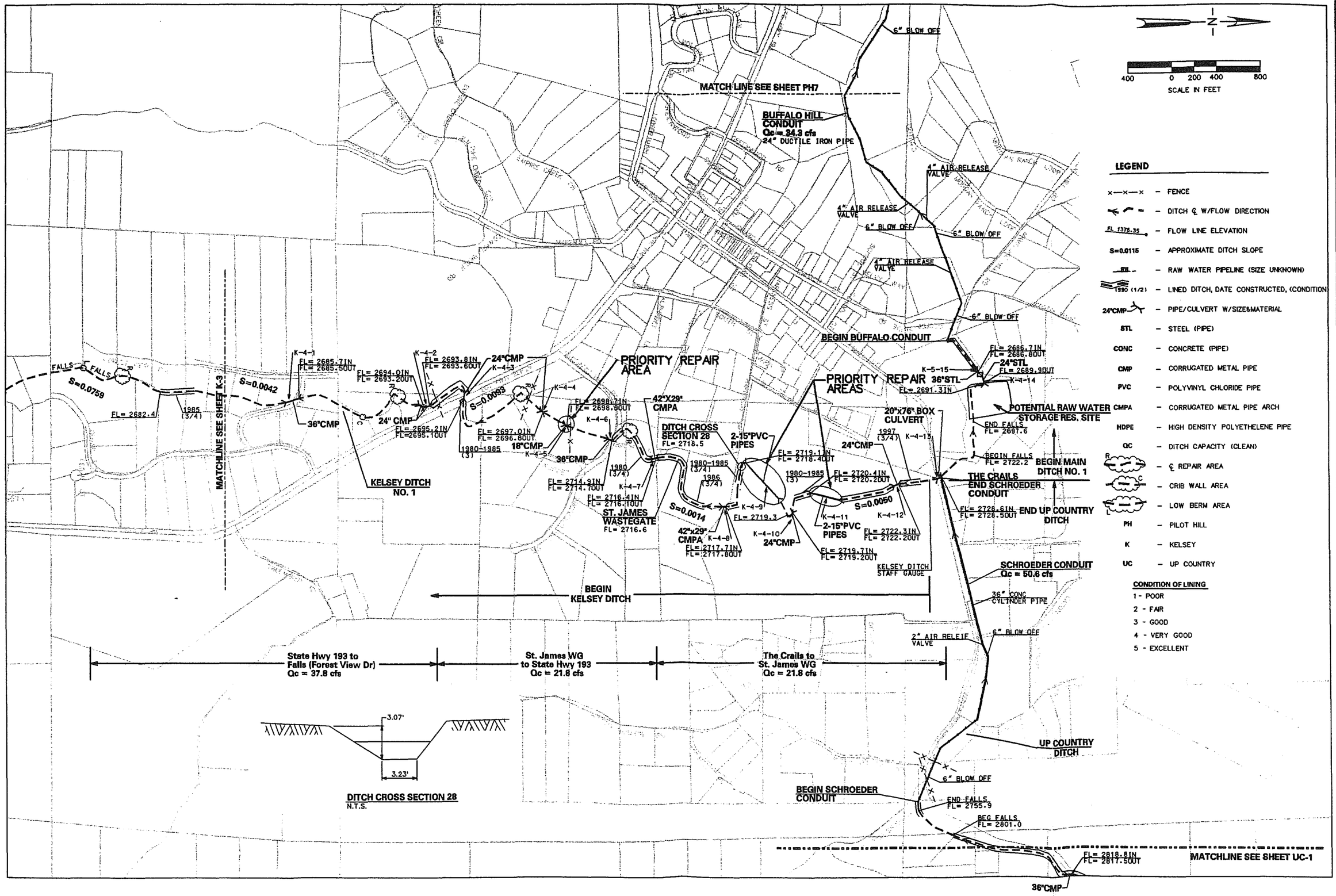
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET UC-1 OF 22



KASL
CIVIL - WATER RESOURCES - SURVEYING

END - UP COUNTRY DITCH
BEGIN - KELSEY DITCH AND MAIN DITCH NO. 1

APPROX. SCALE 1"=800'
JOB. NO. 2895-02
DATE: NOV. 2002

ELEV :
DATUM :
BENCH MARK :
DESCRIPTION :

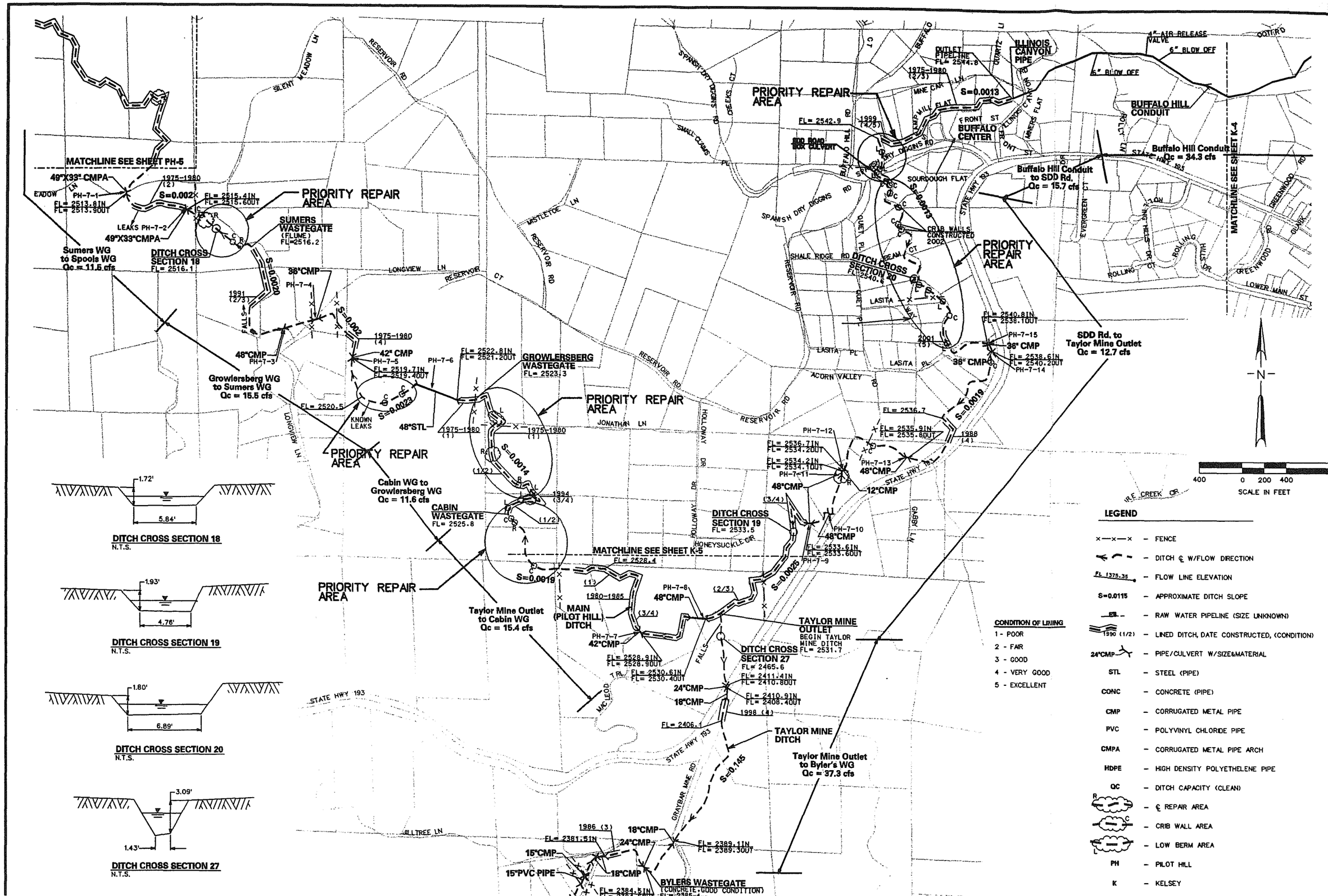
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET K-4 OF 22



KASL

MAIN DITCH NO. 1
BUFFALO HILL TO SUMERS WG

MAIN / PILOT HILL DITCH SYSTEM

APPROX. SCALE 1"=800'
JOB. NO. 2885-02
DATE: NOV. 2002

ELEV :
DATUM :
BENCH MARK :
DESCRIPTION :

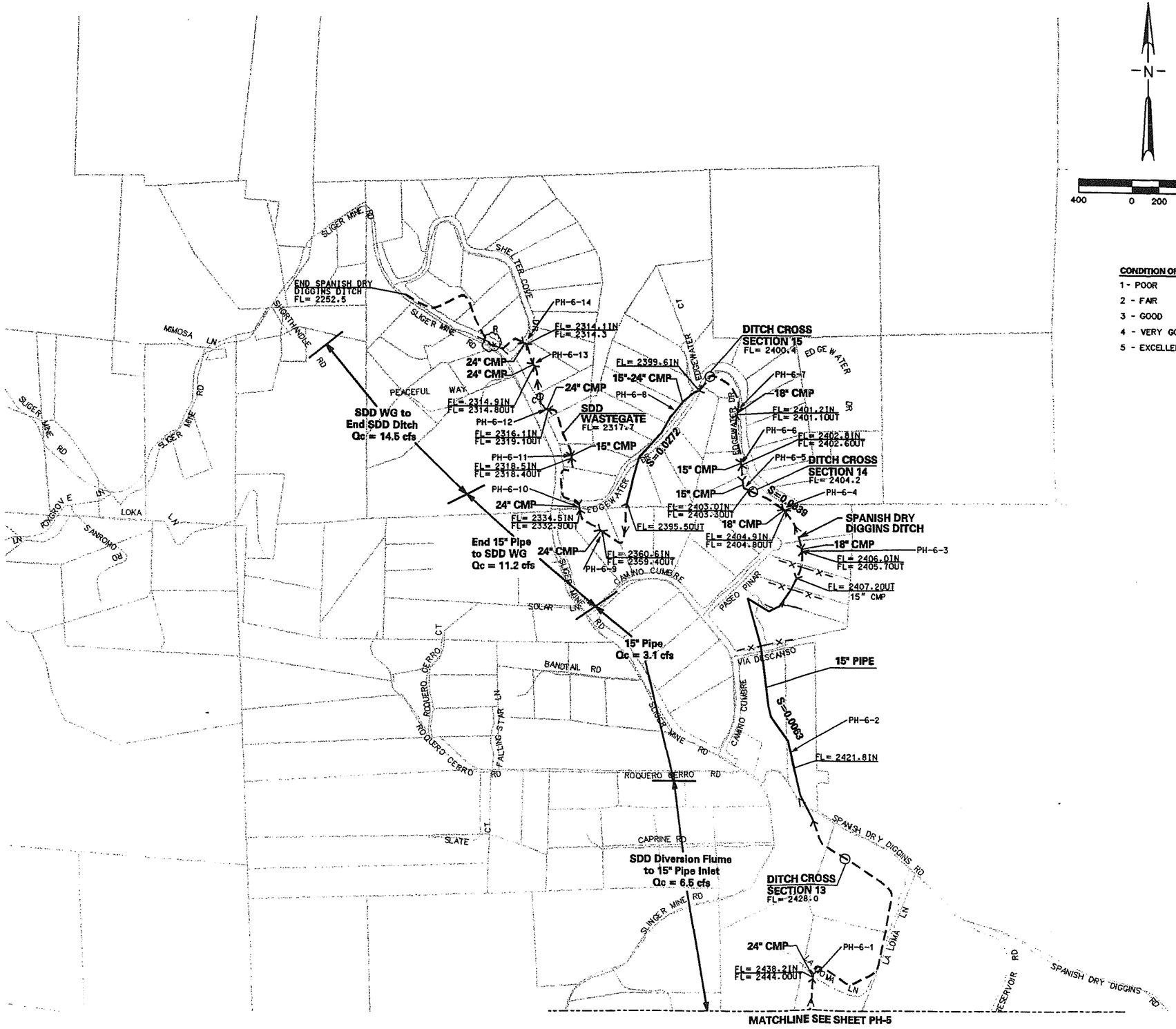
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

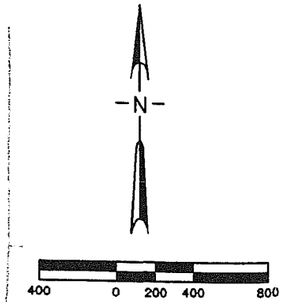
EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET PH-7 OF 22



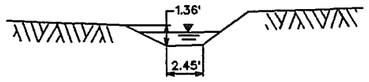


CONDITION OF LINING

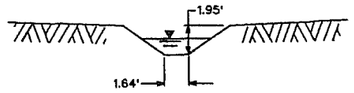
1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT

LEGEND

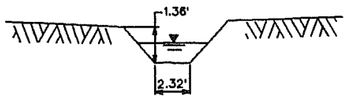
x—x—x	–	FENCE
	–	DITCH ℄ W/FLOW DIRECTION
FL 1375.35	–	FLOW LINE ELEVATION SCALE IN FEET
S=0.0115	–	APPROXIMATE DITCH SLOPE
RW	–	RAW WATER PIPELINE (SIZE UNKNOWN)
1990 (1/2)	–	LINED DITCH, DATE CONSTRUCTED, (CONDITION)
24"CMP	–	PIPE/CULVERT W/SIZE&MATERIAL
STL	–	STEEL (PIPE)
CONC	–	CONCRETE (PIPE)
CMP	–	CORRUGATED METAL PIPE
PVC	–	POLYVINYL CHLORIDE PIPE
CMPA	–	CORRUGATED METAL PIPE ARCH
HDPE	–	HIGH DENSITY POLYETHELENE PIPE
QC	–	DITCH CAPACITY (CLEAN)
R	–	℄ REPAIR AREA
C	–	CRIB WALL AREA
L	–	LOW BERM AREA
PH	–	PILOT HILL
K	–	KELSEY
UC	–	UP COUNTRY



DITCH CROSS SECTION 13
N.T.S.



DITCH CROSS SECTION 14
N.T.S.



DITCH CROSS SECTION 15
N.T.S.

KASL
CIVIL - WATER RESOURCES - SURVEYING

SPANISH DRY DIGGINS DITCH
MAIN/PILOT HILL DITCH SYSTEM

APPROX. SCALE 1"=800'
JOB. NO. 2695-02
DATE: NOV. 2002

ELEV :
DATUM :
BENCH MARK :
DESCRIPTION :

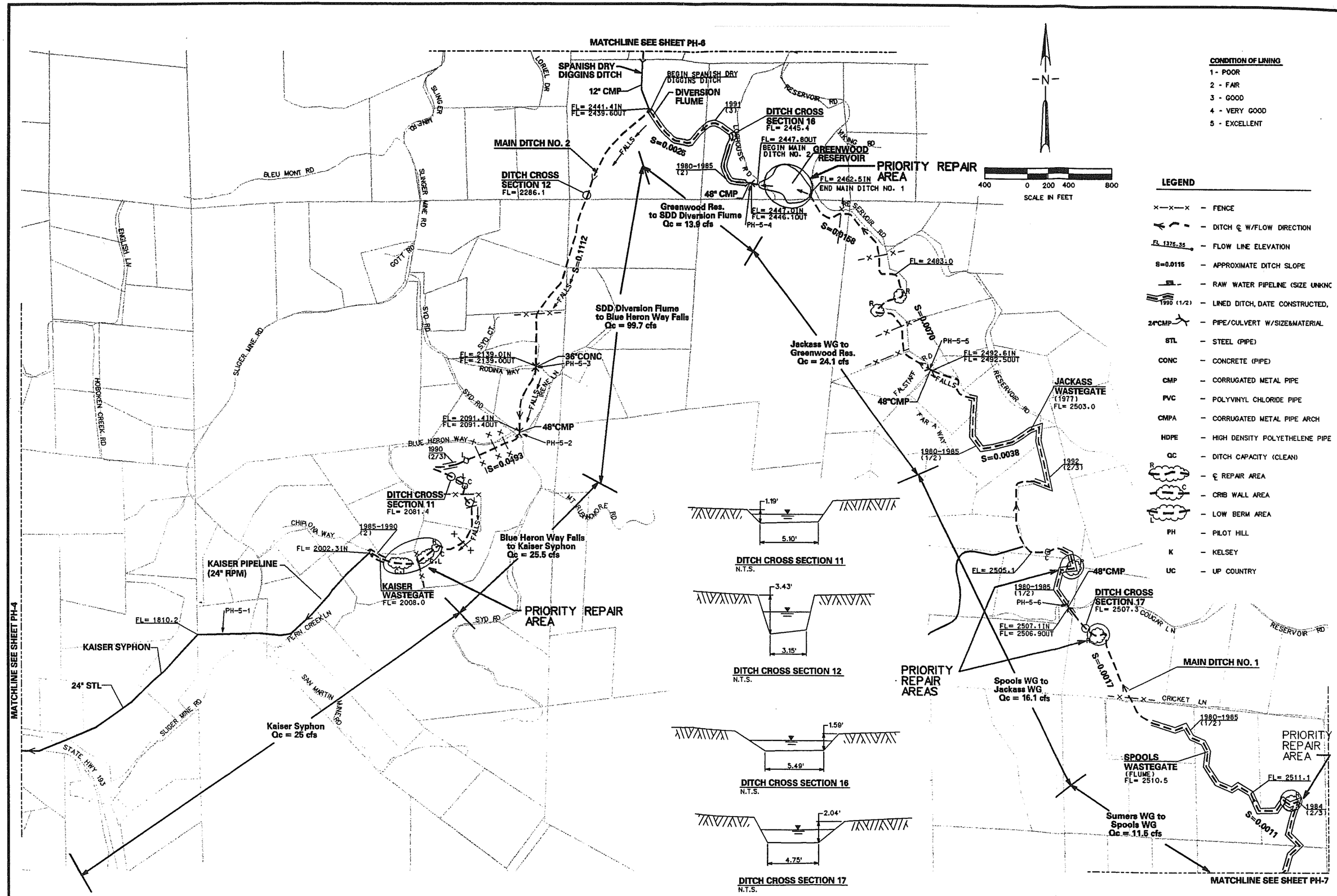
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET PH-6 OF 22



KASL

END MAIN DITCH NO. 1
MAIN DITCH NO. 2
GREENWOOD RES.
TO KAISER SYPHON
MAIN/PILOT HILL DITCH SYSTEM

APPROX. SCALE 1"=800'
JOB. NO. 2895-02
DATE: NOV. 2002

ELEV : ____
DATUM : ____

BENCH MARK :
DESCRIPTION :

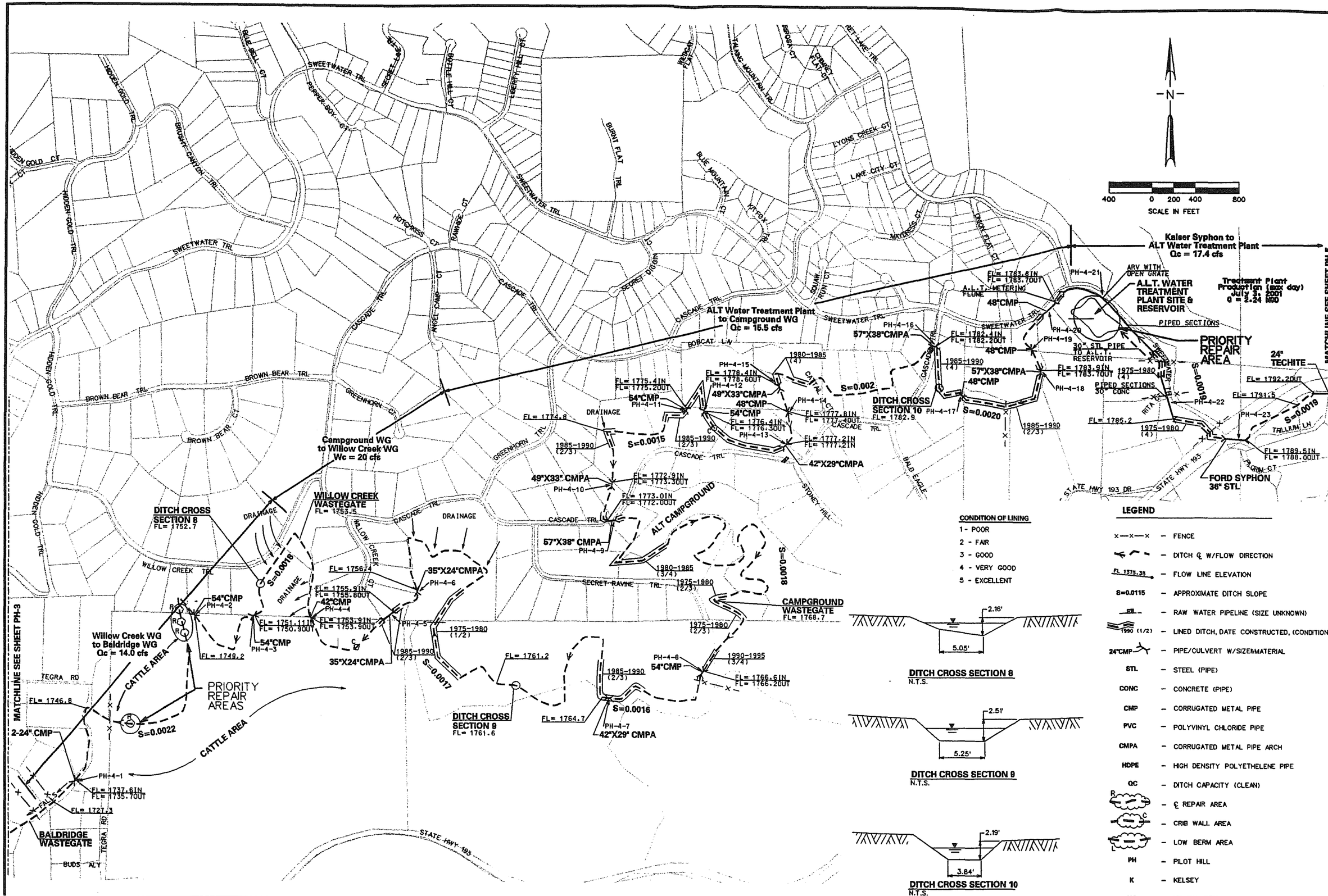
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET PH-5 OF 22



CONDITION OF LINING

1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT

DITCH CROSS SECTION 8
N.T.S.

DITCH CROSS SECTION 9
N.T.S.

DITCH CROSS SECTION 10
N.T.S.

LEGEND

x—x—x	FENCE
	DITCH ℄ W/FLOW DIRECTION
FL 1375.35	FLOW LINE ELEVATION
S=0.0115	APPROXIMATE DITCH SLOPE
STL	RAW WATER PIPELINE (SIZE UNKNOWN)
1990 (1/2)	LINED DITCH, DATE CONSTRUCTED, (CONDITION)
24"CMP	PIPE/CULVERT W/SIZE&MATERIAL
STL	STEEL (PIPE)
CONC	CONCRETE (PIPE)
CMP	CORRUGATED METAL PIPE
PVC	POLYVINYL CHLORIDE PIPE
CMPA	CORRUGATED METAL PIPE ARCH
HDPE	HIGH DENSITY POLYETHELENE PIPE
QC	DITCH CAPACITY (CLEAN)
R	℄ REPAIR AREA
C	CRIB WALL AREA
L	LOW BERM AREA
PH	PILOT HILL
K	KELSEY
UC	UP COUNTRY

KASL

MAIN DITCH NO. 2 FORD SYPHON TO BALDRIDGE WG

MAIN / PILOT HILL DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV : ____

DATUM : ____

BENCH MARK :

DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

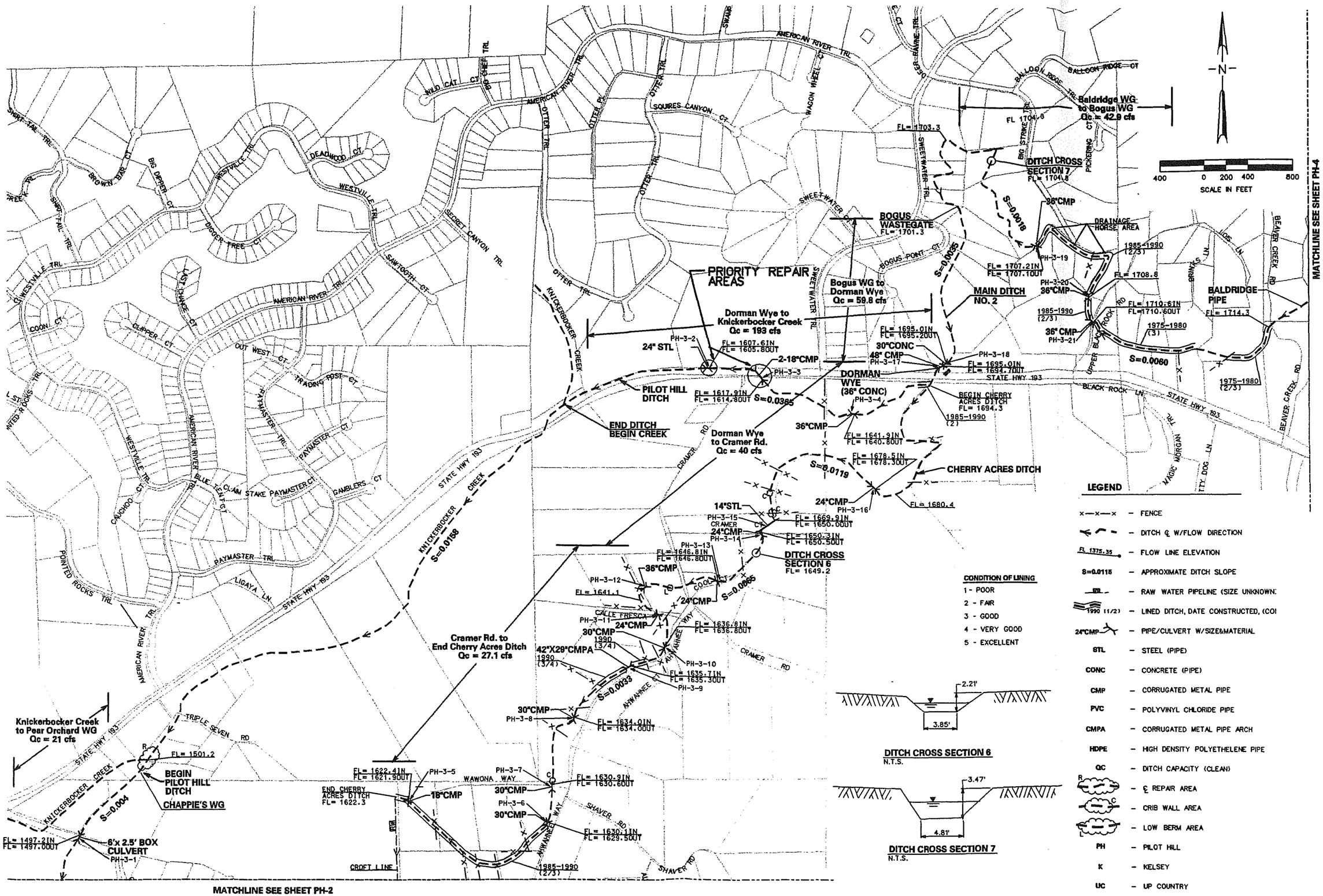
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET **PH-4** OF 22



END MAIN DITCH NO. 2
CHERRY ACRES DITCH
BEGIN PILOT HILL DITCH

MAIN / PILOT HILL DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: NOV. 2002

ELEV :

DATUM :

BENCH MARK :

DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL

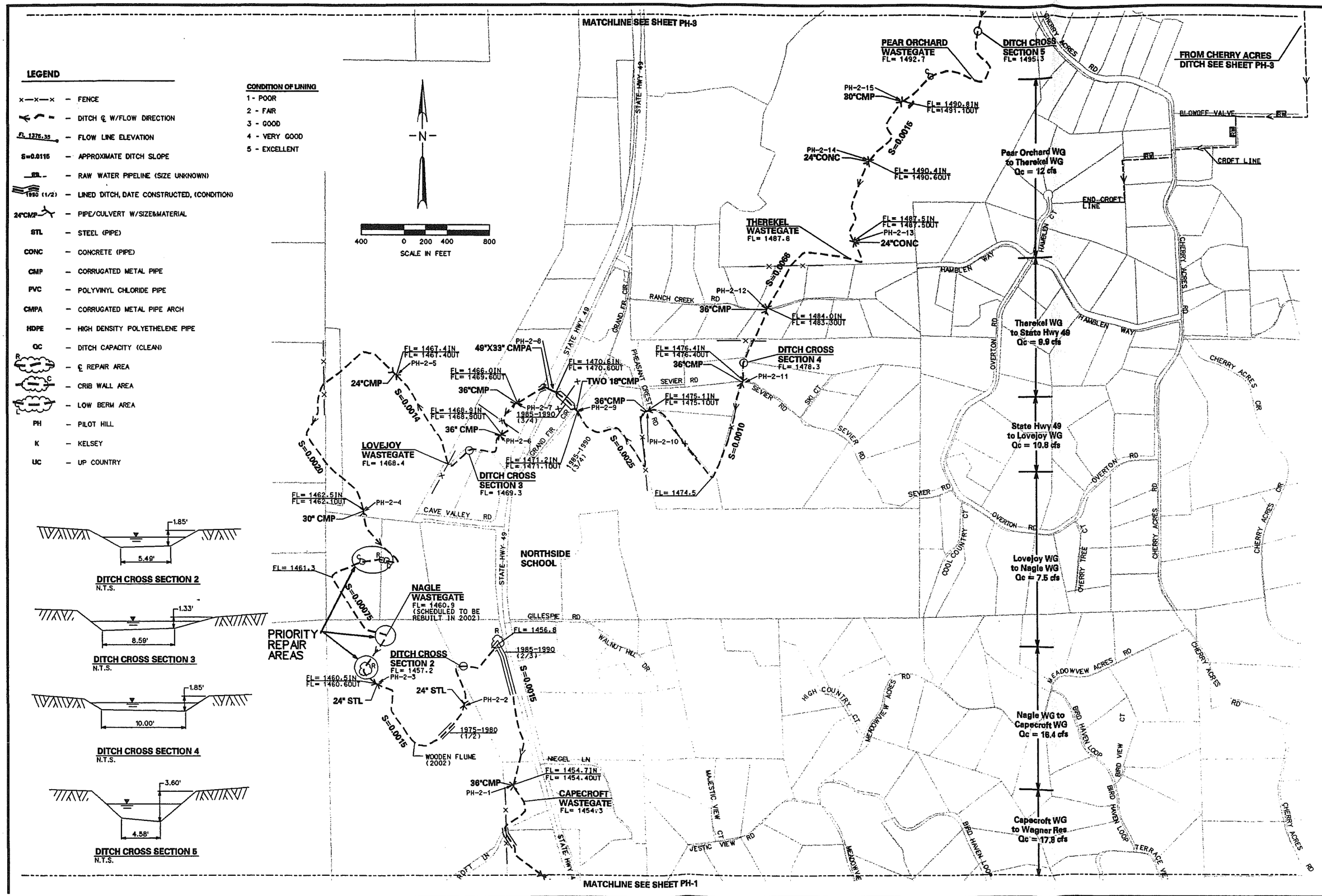
APPROVED BY DATE

DESCRIPTION

NO.

REVISION

SHEET PH-3 OF 22



KASL CIVIL · WATER RESOURCES · SURVEYING

PEAR ORCHARD WG TO CAPECROFT WG

PILOT HILL DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2695-02

DATE: NOV. 2002

ELEV : ——

DATUM : ——

BENCH MARK :

DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	REVISION

SHEET PH-2 OF 22

MATCHLINE SEE SHEET PH-2

Capecroft WG to Wagner Res. Qc = 17.3 cfs

Wagner Res. to Wagner Res. WG Qc = 13.7 cfs

Wagner Res. WG to Bailey House WG Qc = 13.4 cfs

Bailey House WG to Pilot Hill Res. Qc = 11.2 cfs

FL= 1426.61N
FL= 1425.8
24" CMP
PH-1-3

S=0.034

END DITCH WAGNER RES.
FL= 1374.7

WAGNER RESERVOIR

BEGIN DITCH WAGNER OUTLET

FL= 1375.41N
FL= 1373.60UT
48" CMP
PH-1-2

DITCH CROSS SECTION 1
FL=1349.4

S=0.0057

PRIORITY REPAIR AREA

WAGNER WASTEGATE
FL= 1346.9

S=0.0076

FL= 1326.5

S=0.0057

BAYLEY HOUSE WASTEGATE
FL= 1313.8

S=0.0034

PILOT HILL RES. WASTEGATE

24" CMP
PH-1-1

END PILOT HILL DITCH
FL= 1309.5

PILOT HILL RESERVOIR

PILOT HILL ESTATES PIPELINE

PH-0-1

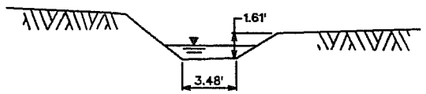
PILOT HILL PIPELINE

MATCHLINE SEE SHEET PH-0

SILK TREE LN
CATECROFT LN
CATECROFT
STATE HWY 49
MEADOWVIEW ACRES RD
MEADOWVIEW ACRES CT
MEADOWVIEW ACRES P.D.
CROSS CREEK RD
BIRD HAVEN LOOP
BIRD HAVEN CT
TERRACE VIEW CT
PONY BACK CT
BRUCE CT
COUNTRY VIEW CT
FINE TREE CIR
ACORN LN
OAK VIEW DR
OAK VIEW CT
ORCHARD CT
K SIDE CT

-N-

400 0 200 400 600
SCALE IN FEET



DITCH CROSS SECTION 1
N.T.S.

LEGEND

- ×—×—× – FENCE
- – DITCH ℄ W/FLOW DIRECTION
- FL 1375.35 – FLOW LINE ELEVATION
- S=0.0115 – APPROXIMATE DITCH SLOPE
- – RAW WATER PIPELINE (SIZE UNKNOWN)
- 1990 (1/2) – LINED DITCH, DATE CONSTRUCTED, (CONDITION)
- 24"CMP – PIPE/CULVERT W/SIZE&MATERIAL
- STL – STEEL (PIPE)
- CONC – CONCRETE (PIPE)
- CMP – CORRUGATED METAL PIPE
- PVC – POLYVINYL CHLORIDE PIPE
- CMPA – CORRUGATED METAL PIPE ARCH
- HDPE – HIGH DENSITY POLYETHELENE PIPE
- QC – DITCH CAPACITY (CLEAN)
- R – ℄ REPAIR AREA
- C – CRIB WALL AREA
- L – LOW BERM AREA
- PH – PILOT HILL
- K – KELSEY
- UC – UP COUNTRY

CONDITION OF LINING

1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT

KASL

CAPECROFT WG TO PILOT HILL RES.

MAIN / PILOT HILL

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

BENCH MARK : ELEV :
DESCRIPTION : DATUM :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET PH-1 OF 22

KASL

PILOT HILL PIPELINE
PILOT HILL ESTATES PIPELINE

PILOT HILL

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

ELEV : _____

DATUM : _____

BENCH MARK :

DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL	
APPROVED BY	DATE

NO.	DESCRIPTION

REVISION

SHEET **PH-0** OF **22**

Twin Pines Syphon to Black Oak Syphon
Qc = 4.8 cfs

Irish Res. WG to Twin Pines Syphon
Qc = 5.0 cfs

Falls (Forest View Dr.) to Irish Res. WG
Qc = 6.4 cfs

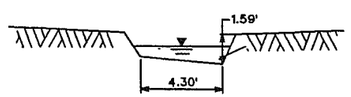
State Hwy 193 to Falls (Forest View Dr)
Qc = 37.8 cfs

CONDITION OF LINING
1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT

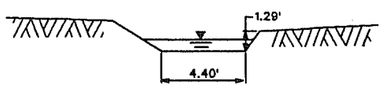
MATCHLINE SEE SHEET K-2

MATCHLINE SEE SHEET K-4

1980(1/2)
FL = 2375.7 OUT
TWIN PINES SYPHON
24" PVC
FL= 2377.9
K-3-1
S=0.0029
24"CMP
FL= 2377.2IN
FL=2380.10OUT
DITCH CROSS SECTION 22
FL= 2382.7
1980(3/4)
36"CMP
S=0.0025
FL= 2388.4
1980(1/2)
K-3-2
24"CMP
1980(2/3)
FL= 2380.8IN
FL= 2380.60UT
K-3-3
K-3-4
42"X29" CMPA
FL= 2384.9IN
FL= 2385.30UT
K-3-5
PASTURE AREA
KELSEY DITCH NO. 2
1980(2/3)
K-3-6
42"X29" CMPA
S=0.0028
FL= 2392.2
IRISH RES. WASTEGATE
FL= 2395.2
FL= 2443.4IN
FALLS
IRISH RESERVOIR
(SHALLOW RESERVOIR WITH LITTLE STORAGE CAPACITY)
24" CMP
FL= 2406.90UT
FL= 2514.2
K-3-7
FL= 2515.8
DITCH CROSS SECTION 21
FL= 2516.8
30"CONC
FL= 2518.5IN
FL= 2518.30UT
K-3-8
24" CMP
K-3-9
BEGIN FALLS
FL= 2555.7
K-3-10
24" CMP
24" CMP
K-3-11
S=0.0227
FL= 2556.1
FL= 2548.6IN
FL= 2546.90UT
END FALLS
FL= 2520.6IN
FL= 2520.30UT
KELSEY DITCH NO. 1
36"CMP
SEEPS
PRIORITY REPAIR AREA
FL= 2598.9
FALLS
S=0.0769
K-3-12
FL= 2562.4
FL= 2682.4
1985 (3/4)
STATE HWY 193
STATE HWY 193
STATE HWY 193
FOREST VIEW DR
CEDAR DR
CEDAR CT
FLORALAN CT
GUN SMOKE RD
COLS CANYON RD
BEAR CREEK RD
BEAR CREEK HEIGHTS RD
ELMWOOD DR
WELL SPRING CT
DAFFODIL LN
MEADOW BROOK RD
MEADOW BROOK RD
W. OPOSSO LN
OPOSSUM PATH
TRACY LN
WASSO LN
WINNISHM TRL
NUTT LN
RATY LN
OMA DR
SKUNK LN
TWIN PINES LOOP
SAW LN
SAW MILL
MARSHALL RD
MARSHALL RD
BLACKBERRY LN
UNNAMED RD
HOPE MOUNTAIN LN
SHAMROCK LN
HWY CT



DITCH CROSS SECTION 21
N.T.S.



DITCH CROSS SECTION 22
N.T.S.

LEGEND

x—x—x	FENCE
	DITCH ℄ W/FLOW DIRECTION
FL 1375.35	FLOW LINE ELEVATION
S=0.0115	APPROXIMATE DITCH SLOPE
STL	RAW WATER PIPELINE (SIZE UNKNOWN)
1990 (1/2)	LINED DITCH, DATE CONSTRUCTED, (CONDITION)
24"CMP	PIPE/CULVERT W/SIZE&MATERIAL
STL	STEEL (PIPE)
CONC	CONCRETE (PIPE)
CMP	CORRUGATED METAL PIPE
PVC	POLYVINYL CHLORIDE PIPE
CMPA	CORRUGATED METAL PIPE ARCH
HDPE	HIGH DENSITY POLYETHELENE PIPE
QC	DITCH CAPACITY (CLEAN)
R	℄ REPAIR AREA
C	CRIB WALL AREA
L	LOW BERM AREA
PH	PILOT HILL

KASL

END KELSEY DITCH NO. 1
KELSEY DITCH NO. 2 TO
BLACK OAK MINE ROAD

KELSEY DITCH SYSTEM

APPROX. SCALE 1"=800'
JOB. NO. 2895-02
DATE: NOV. 2002

ELEV :
DATUM :

BENCH MARK :
DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED	BY	DATE

REVISION

SHEET K-3 OF 22

LEGEND

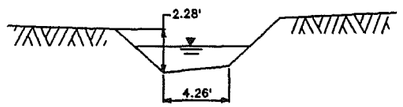
- FENCE
- DITCH ℄ W/FLOW DIRECTION
- FL 1378.35 – FLOW LINE ELEVATION
- S=0.0115 – APPROXIMATE DITCH SLOPE
- RAW WATER PIPELINE (SIZE UNKNOWN)
- 1990 (1/2) – LINED DITCH, DATE CONSTRUCTED, (CONDITION)
- 24"CMP – PIPE/CULVERT W/SIZE&MATERIAL
- STL – STEEL (PIPE)
- CONC – CONCRETE (PIPE)
- CMP – CORRUGATED METAL PIPE
- PVC – POLYVINYL CHLORIDE PIPE
- CMPA – CORRUGATED METAL PIPE ARCH
- HDPE – HIGH DENSITY POLYETHELENE PIPE
- QC – DITCH CAPACITY (CLEAN)
- R – ℄ REPAIR AREA
- C – CRIB WALL AREA
- L – LOW BERM AREA
- PH – PILOT HILL
- K – KELSEY
- UC – UP COUNTRY

CONDITION OF LINING

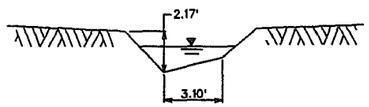
1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT

N

400 0 200 400
SCALE IN FEET



DITCH CROSS SECTION 23
N.T.S.



DITCH CROSS SECTION 24
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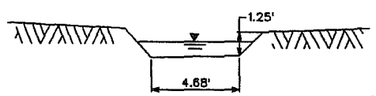

DITCH CROSS SECTION 25
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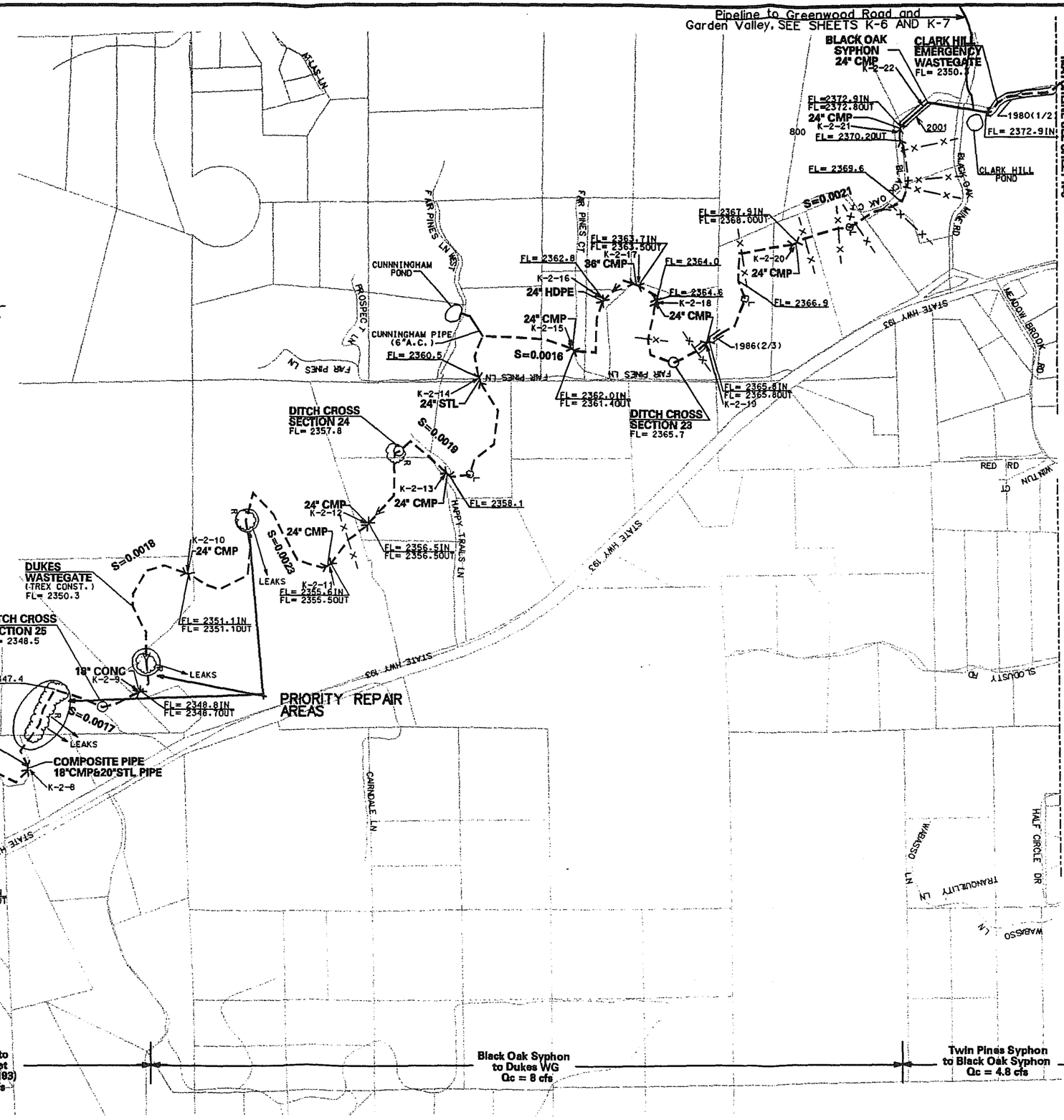


KASL

KELSEY DITCH NO. 2
BLACK OAK MINE TO STATE HWY 193

KELSEY DITCH SYSTEM

APPROX. SCALE 1"=800'
JOB. NO. 2985-02
DATE: NOV. 2002

ELEV :
DATUM :
BENCH MARK :
DESCRIPTION :

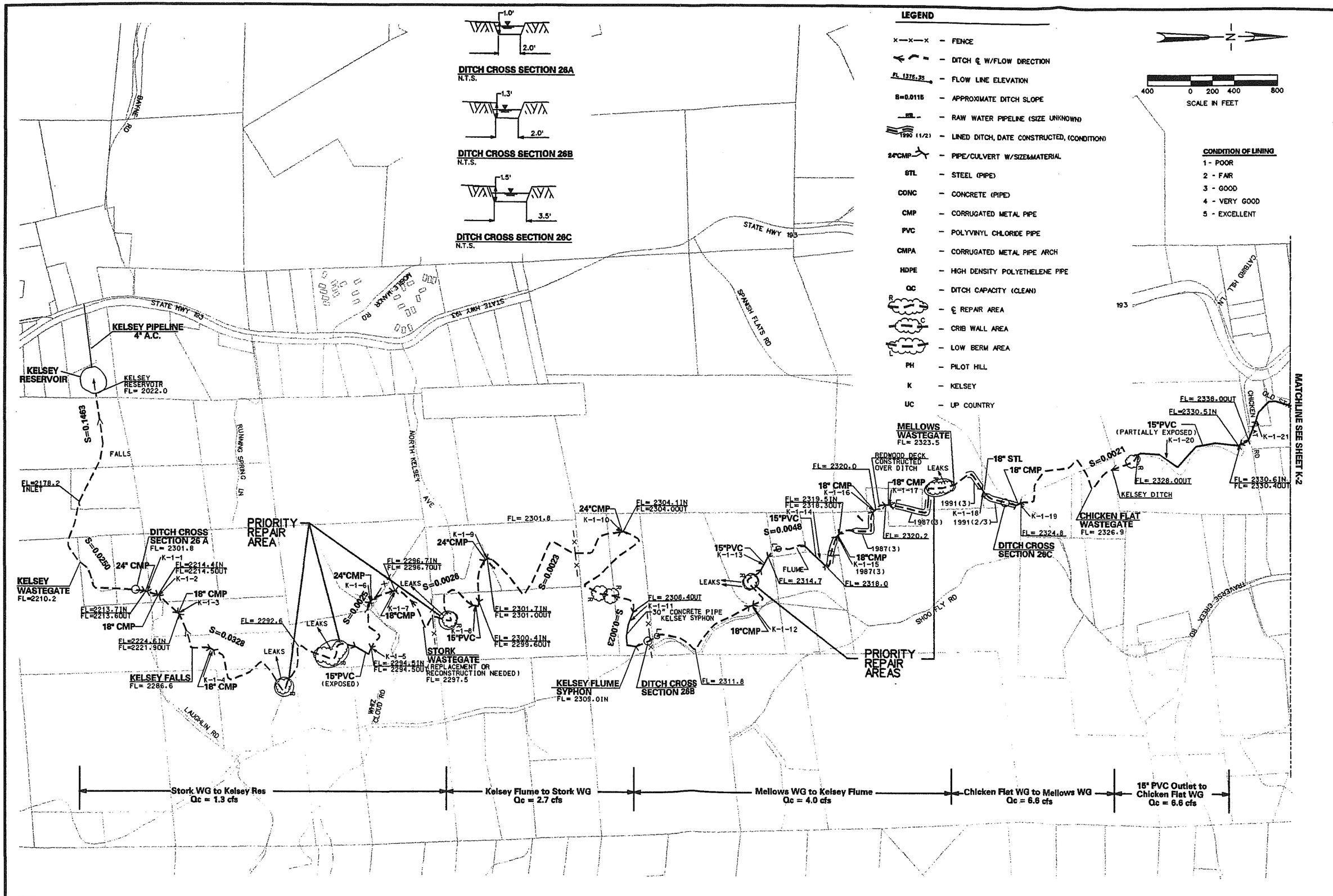
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET K-2 OF 22



KASL

KELSEY DITCH NO.2
HWY 193 TO KELSEY RES.

KELSEY DITCH SYSTEM

APPROX. SCALE 1"=500'

JOB. NO. 2695-02

DATE: NOV. 2002

ELEV :
DATUM :

BENCH MARK :
DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET K-1 OF 22

Jacobus WG to Shadle Res. Qc = 22 cfs

Byler's WG to Jacobus WG Qc = 16.7 cfs

Taylor Mine Outlet to Byler's WG Qc = 37.3 cfs

SCALE IN FEET 400 0 200 400 800

6" ACP Greenwood Road Pipeline

END PIPELINE

Shadle Res.

Outlet FL= 2175.3

Inlet

K-7-0

18" CONC FL= 2222.70UT

FALLS

K-5-1 K-5-2 K-5-3 K-5-4 K-5-5 K-5-6

18" CMP FL= 2238.7

S=0.019

15" PVC PIPE

15" PVC PIPE

DITCH SECTION END 15" PVC

BEGIN 15" PVC PIPE

FL= 2249.4IN

18"CMP

FL INLET 2232.7

JACOBUS WASTEGATE (CONCRETE, GOOD CONDITION)

FL=2264.5

18"CMP

1999(3/4)

FL=2267.9IN FL=2267.6OUT

15" PVC K-5-8

FL=2273.1OUT

FL=2272.6IN FL=2272.4OUT

DITCH SECTION

END 15" PVC

S=0.01

15" PVC K-5-9

FL=2282.0

BEGIN 15" PVC

FL=2295.4IN

18"CMP

FL=2322.0IN FL=2319.7OUT K-5-10

18"CMP K-5-11

FALLS

FL=2377.0IN FL=2376.8OUT

2001(4) K-5-12

24"CMP

FL=2379.4IN FL=2379.4OUT K-5-13 K-5-14

24"CMP PH-5-17

FL=2384.5IN FL=2384.5OUT

FL=2385.1

1985(2/3)

S=0.032

18" PVC FL=2380.4IN FL=2380.1OUT

15"CMP

K-5-15

18"CMP FL=2380.9IN FL=2380.8OUT K-5-16

18"CMP FL=2381.5IN FL=2380.9OUT

1986(3)

FL=2388.9

PH-5-18

BYLERS WASTEGATE (CONCRETE, GOOD CONDITION)

S=0.145

18"CMP

24" CMP 16" CMP FL=2406.1

K-5-19 K-5-20

FALLS

FL=2413.4IN FL=2409.9OUT

TAYLOR MINE DITCH

1998 (4)

DITCH CROSS SECTON 27 FL=2465.6

BEGIN TAYLOR MINE DITCH FL=2531.7

CABIN WASTEGATE

FL=2525.8

(1/2)

S=0.0019

MAIN PILOT HILL DITCH

1980-1985(1)

FL=2528.4

42"CMP

FL=2528.9IN FL=2528.9OUT

1980-1985(3/4)

FL=2530.4

48"CMP

TAYLOR MINE OUTLET

(2/3)

DITCH CROSS SECTION 19 FL=2533.5

(3/4)

S=0.0025

48"CMP

48"CMP

FL INLET 2536.7

MATCHLINE SEE SHEET PH-7

MATCHLINE SEE SHEET K-6

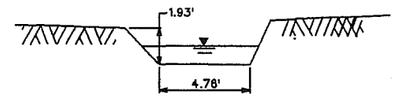
MATCHLINE SEE SHEET K-8

LEGEND

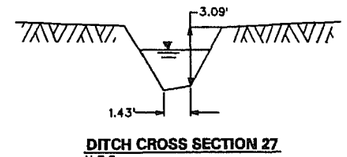
x—x—x	– FENCE
	– DITCH ℄ W/FLOW DIRECTION
FL 1375.35	– FLOW LINE ELEVATION
S=0.0115	– APPROXIMATE DITCH SLOPE
RWL	– RAW WATER PIPELINE (SIZE UNKNOWN)
1990 (1/2)	– LINED DITCH, DATE CONSTRUCTED, (CONDITION)
24"CMP	– PIPE/CULVERT W/SIZE&MATERIAL
STL	– STEEL (PIPE)
CONC	– CONCRETE (PIPE)
CMP	– CORRUGATED METAL PIPE
PVC	– POLYVINYL CHLORIDE PIPE
CMPA	– CORRUGATED METAL PIPE ARCH
HDPE	– HIGH DENSITY POLYETHELENE PIPE
QC	– DITCH CAPACITY (CLEAN)
R	– ℄ REPAIR AREA
C	– CRIB WALL AREA
L	– LOW BERM AREA
PH	– PILOT HILL
K	– KELSEY
UC	– UP COUNTRY

CONDITION OF LINING

1 - POOR
2 - FAIR
3 - GOOD
4 - VERY GOOD
5 - EXCELLENT



DITCH CROSS SECTION 19
N.T.S.



DITCH CROSS SECTION 27
N.T.S.

KASL

TAYLOR MINE DITCH

KELSEY DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: MAY 2002

ELEV :

DATUM :

BENCH MARK :

DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

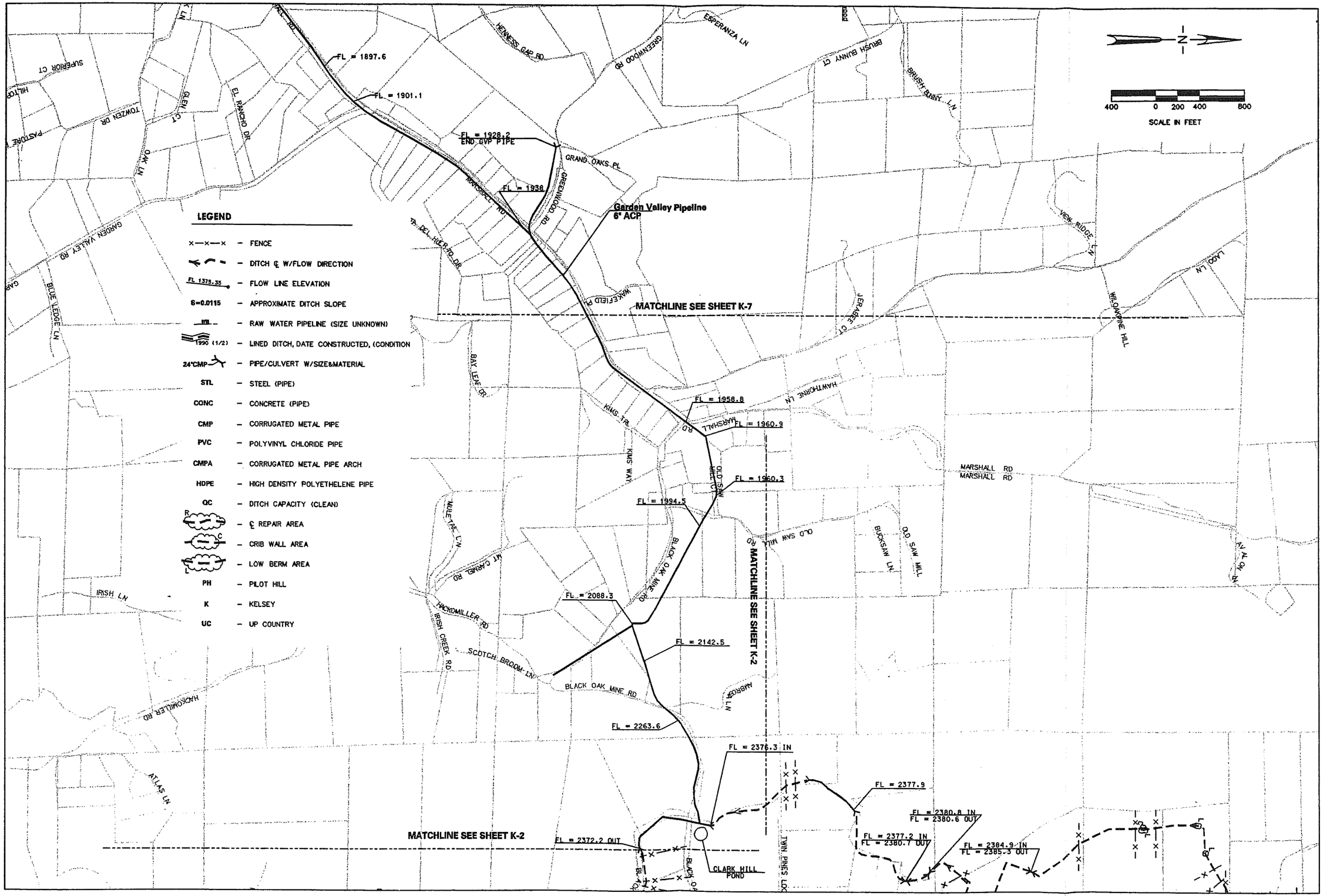
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET K-5 OF 22



KASL

GARDEN VALLEY PIPELINE

KELSEY DITCH SYSTEM

APPROX. SCALE 1"=800'

JOB. NO. 2895-02

DATE: NOV 2000

BENCH MARK : ELEV :

DESCRIPTION : DATUM :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

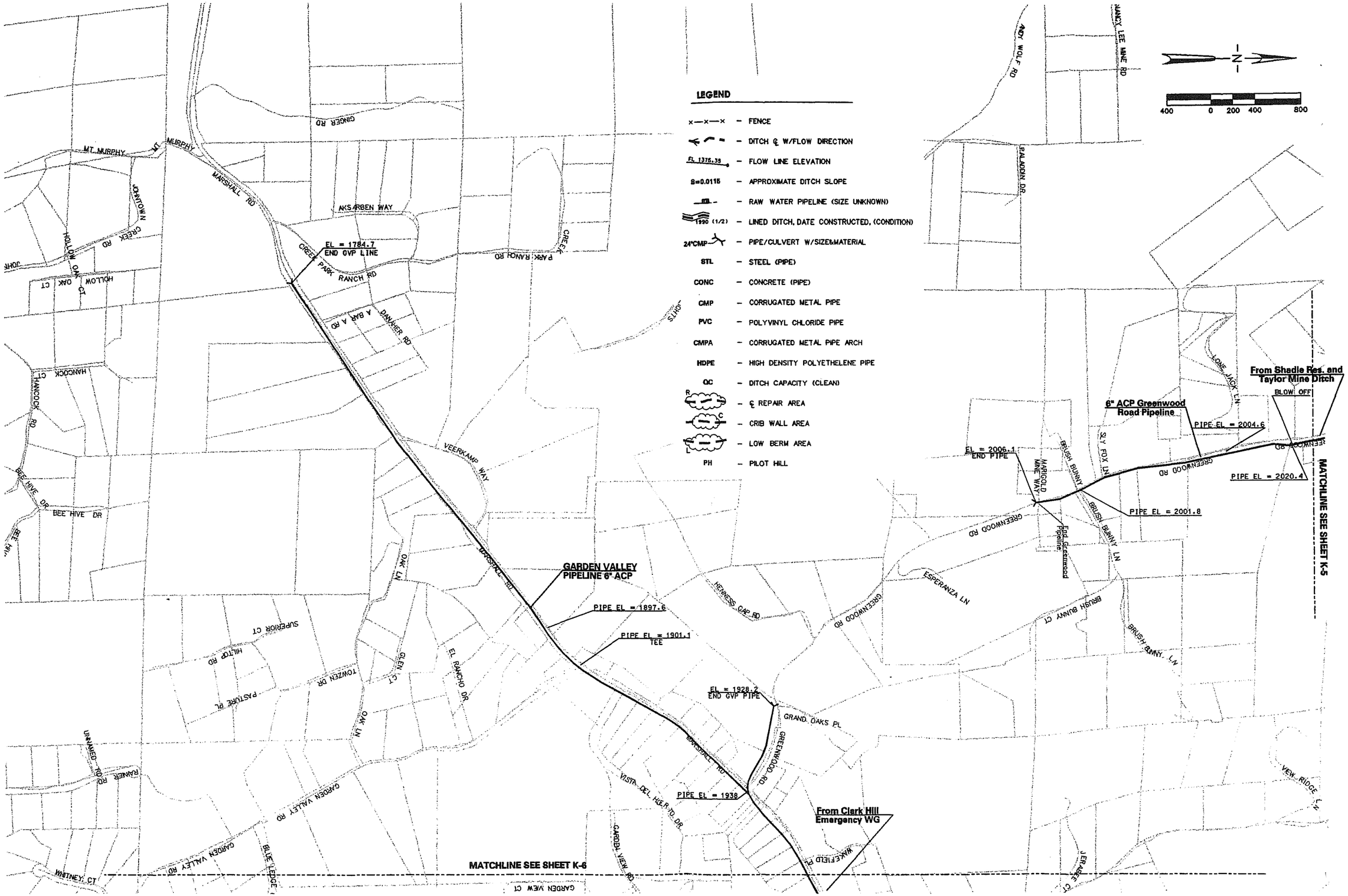
EL DORADO COUNTY, CALIFORNIA

COUNTY APPROVAL		
APPROVED BY	DATE	

NO.	DESCRIPTION	

REVISION

SHEET K-6 OF 22



KASL

GARDEN VALLEY PIPELINE
GREENWOOD RD. PIPELINE
KELSEY DITCH

APPROX. SCALE 1"=800'
JOB. NO. 2895-02

ELEV :
DATUM :
BENCH MARK :
DESCRIPTION :

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET K-7 OF 22

Summary of Ditch System Capacity Calculations
Up Country Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
UC-5	Pilot Creek Pipeline	3900	3779.6	3764.3	0.1496	-0.2588	n/a	n/a	n/a	n/a	n/a	UC-5-4	3900	0.0052	CONC	0.015	48	89.6
UC-5	Bacon Canyon Pipe	3000	3764.3	3755.9	0.1	-0.0013	n/a	n/a	n/a	n/a	n/a	UC-5-3	3000	0.0053	CONC	0.015	48	90.6
UC-5	End Bacon Canyon Pipe to Structure #1	1320	3755.9	3752.1	0.004	0.001	4.5	4.75	2	0.5	37	UC-5-2	860	0.0029	CMP	0.024	48	34.2
UC-4 / UC-5	Structure #1 to Structure #2	2880	3752.1	3750.6	0.002	0.0011	8.5	4.75	2	0.5	62.5	UC-5-1	2250	0.0023	PIPE	0.013	48	56.3
		3520	3750.6	3748 +/-	0.002	0.0005	4.5	4.75	1.5	0.5	35.9	UC-5-0	735	0.0056	CMP	0.024	48	47.5
												UC-4-19	160	0.005	PIPE	0.011	48	98.6
												UC-4-18	200	0.0011	PIPE	0.011	48	46.2
												UC-4-17	80	0.0011	CMP	0.024	48	21.1
												UC-4-16	520	0.0013	PIPE	0.011	48	50.2
												UC-4-15	120	0.0011	CMP	0.024	48	21.1
UC-4	Structure #2 to Structure #3	8900	3748 +/-	3740 +/-	0.001	0.0003	8.5	4.75	2	0.5	34.9	UC-4-14	155	0.0045	PIPE	0.011	48	93.3
												UC-4-13	30	0.0167	CMP	0.024	48	82.2
												UC-4-12	2050	0.0013	CMP	0.024	48	23.0
												UC-4-11	50	0.006	CMP	0.024	48	49.3
												UC-4-10	100	0.0008	PIPE	0.011	48	39.4
												UC-4-9	330	0.0008	PIPE	0.011	48	39.4
												UC-4-8	80	0.0025	CMP	0.024	48	32.0
UC-4	Structure #3 to Structure #4	2200	3740 +/-	3738 +/-	0.0168	0.0026	4.5	4.75	2	0.5	53.1	UC-4-7	100	0.0026	CMP	0.024	48	39.2
UC-4	Structure #4 to Structure #5	7300	3738 +/-	3730	0.0025	0.0004	8.5	4.75	2	0.5	40.3	UC-4-6	175	0.0012	CONC	0.015	48	35.4
												UC-4-5	55	0.0012	PIPE	0.013	48	40.9
												UC-4-4	840	0.0012	CONC	0.015	48	35.4
UC-4	Structure #5 to Structure #6	4200	3730	3728.2	0.0004	0.0004	8.5	4.75	2	0.5	40.3	UC-4-3	50	0.0004	CMP	0.024	48	12.8
UC-4	Structure #6 to Structure #7	2970	3728.2	3726.5	0.0067	0.0004	8.5	4.75	2	0.5	40.3	UC-4-2	30	0.0067	CONC	0.015	42	68.5
UC-4	Structure #7 to Tunnel Hill Inlet	1950	3726.5	3709.1	0.01	0.01	8.5	4.75	2	0.5	188.5	UC-4-1	1350	0.01	CMP	0.024	36	87.2
UC-4	Tunnel Hill	3800	3709.1	3683.6	0.0067	0.0067	n/a	n/a	n/a	n/a	n/a							

NOTES:
(1) Segments are identified by known landmarks, lengths and elevations are from field survey data.
(2) Typical cross sections and minimum slopes for each segment were used to compute the ditch flow capacities.
(3) Based on the minimum slope for segment, design freeboard and assumed "n" value = 0.035
(4) Culverts identified according to the ditch system plan drawing.
(5) The length, dimensions, friction coefficient, and slope of the culverts shown were used to find the Culvert Capacity using the PipeFlow program.
** Based on the "n" value of 0.08

Summary of Ditch System Capacity Calculations
Up Country Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
UC-3	Penstock Inlet to Treehouse Lane	8800	3683.6	3355.8	0.1	0.0086	6.5	2.5	1.25	0.5	50.9	UC-3-9	90	0.05	CMP	0.024	24+42	105.6
												UC-3-8	9	0.022	CMP	0.024	48	72.2
												UC-3-7	30	0.0088	CMP	0.024	36	23.2
												UC-3-6	50	0.012	CMP	0.024	48	42.6
												UC-3-5	15	0.0086	CMPA	0.024	33X49	44.4
UC-2 / UC-3	Treehouse Lane to Balderston WG	5800	3355.3	3286.2	0.0207	0.0076	4	3.25	1.5	0.5	40.3	UC-3-4	25	0.0076	CMP	0.024	48	40.2
							2	4	1.5	0.5	48.1	UC-3-3	30	0.0076	CMPA	0.024	38x57	59.1
												UC-3-1	20	0.0076	CMP	0.024	48	40.2
UC-2	Balderston WG to Sand Trap Syphon	4700	3286.2	3229	0.0273	0.0188	5	1.9	1	0.5	23.5	UC-2-6	36	0.0056	CMPA	0.024	29X48	17.3
												UC-2-5	20	0.025	CMPA	0.024	29X48	36.6
UC-2	Sand Trap Syphon	2500	3229	3155.8	0.675	0.0063	n/a	n/a	n/a	n/a	59	UC-2-4	2500	0.0065	CONC	0.015	30	59
UC-2	Canyon Creek Conduit	2300	3155.8	3126.3	0.354	0.0015	5.2	3.5	1	0.5	40.5	UC-2-3	1300	0.013	CONC	0.015	30	40.5
												UC-2-2	55	0.02	CONC	0.015	36	81.7
												UC-2-1	140	0.28	CONC	0.015	30	321
UC-1 / UC-2	Buckeye Conduit	10300	3123.4	2856	0.4329	-0.28	n/a	n/a	n/a	n/a	57.3	UC-1-5	10300	0.026	CONC	0.015	30	57.3
UC-1	Buckeye Conduit to Schroeder Conduit	5500	2856	2755.9	0.11	0.0046	6.5	1.73	0.5	0.25	26.1	UC-1-4	50	0.026	CMP	0.024	48	36.6
												UC1-3	30	0.0046	CMPA	0.024	33X49	21.6
												UC1-2	45	0.0046	CMP	0.024	36	8.6
UC-1	Schroeder Conduit	3235	2755.9	2726.5	0.037	0.0025	n/a	n/a	n/a	n/a	50.6	UC-1-1	3240	0.0102	STL	0.02	36	50.6
K-4	The Crails to St. James WG	3500	2728.6	2716.6	0.005	0.0014	3.23	3.07	1	0.5	21.8	K-4-13	25	0.005	CONC BOX	0.013	20x76	61
												K-4-12	40	0.005	CMP	0.024	24	8.7
												K-4-11	270	0.005	PVC	0.011	15+ 15	10.8
												K-4-10	20	0.025	CMP	0.024	24	19.4
												K-4-9	440	0.0061	PVC	0.011	15+15	11.9
												K-4-8	25	0.0014	CMPA	0.024	42x29	11.8
K-4	St. James WG to State Hwy 193	2600	2716.6	2695.2	0.0093	0.0014	3.23	3.07	1	0.5	21.8	K-4-7	30	0.004	CMPA	0.024	42x29	19.9
												K-4-6	40	0.005	CMP	0.024	36	25.5
												K-4-5	15	0.006	CMP	0.024	18	4.4
												K-4-4	15	0.013	CMP	0.024	24	13.9
K-4	State Hwy 193 to Falls (Forest View Dr.)	3900	2695.2	2598.9	0.0759	0.0042	3.23	3.07	1	0.5	37.8	K-4-3	50	0.0093	CMP	0.024	24	11.8
												K-4-2	110	0.006	CMP	0.024	24	9.5
												K-4-1	120	0.0042	CMP	0.024	36	24.3
K-4	Buffalo Hill Conduit to the Crails	1670	2728.5	2681.5	0.082	0.028	3.23	3.07	1	0.5	106	K-4-14	15	0.028	STL	0.02	24	24.6
												K-4-15	15	0.028	STL	0.02	36	62.3
K-4 / PH-7	Buffalo Hills Conduit	4920	2681.5	2543	0.35	-0.5	n/a	n/a	n/a	n/a	34.3	BHC	4920	n/a	DIP	0.017	24	34.3

Summary of Ditch System Capacity Calculations
Main/Pilot Hill Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
PH-7	Buffalo Hill Condult to Spanish Dry Diggins Rd	1800	2544.8	2542.9	0.0012	0.0012	6.89	1.8	0.5	0.25	15.7							
PH-7 / K-5	Spanish Dry Diggins Rd to Taylor Mine Ditch Outlet	7500	2542.9	2531.7	0.0025	0.0013	6.89	1.8	0.5	0.25	16.4	PH-7-15	20	0.0019	CMP	0.024	36	9.5
												PH-7-14	15	0.0019	CMP	0.024	36	9.5
							4.76	1.93	0.5	0.25	12.7	PH-7-13	20	0.0021	CMP	0.024	48	13.1
												PH-7-12	15	0.1667	CMP	0.024	12	7.9
												PH-7-11	40	0.0024	CMP	0.024	48	14
												PH-7-10	25	0.0024	CMP	0.024	48	14
Ph-7	Taylor Mine Ditch Outlet to Cabin WG	3100	2531.7	2525.8	0.0019	0.0019	4.76	1.93	0.5	0.25	15.4	PH-7-8	145	0.0019	CMP	0.024	48	12.5
												PH-7-7	30	0.0019	CMP	0.024	42	11.1
PH-7	Cabin WG to Growlersberg WG	1800	2525.8	2523.3	0.0014	0.0014	5.84	1.72	0.5	0.25	11.6							
PH-7	Growlersberg WG to Sumers WG	3700	2523.3	2516.2	0.0023	0.002	5.84	1.72	0.5	0.25	15.5	PH-7-6	400	0.0023	STL	0.02	48	12.6
												PH-7-5	50	0.0008	CMP	0.024	42	5.7
												PH-7-4	50	0.0008	CMP	0.024	36	4.9
												PH-7-3	20	0.001	CMP	0.024	48	8
PH-5 / PH-7	Sumers Wg to Spools WG	3800	2516.2	2510.5	0.0013	0.0011	5.84	1.72	0.5	0.25	11.5	PH-7-2	10	0.0011	CMPA	0.024	49x33	10.4
												PH-7-1	20	0.0011	CMPA	0.024	49x33	10.4
PH-5	Spools WG to Jackass WG	4800	2510.5	2503	0.0038	0.0017	4.75	2.04	0.5	0.25	16.1	PH-5-6	25	0.0017	CMP	0.024	48	13.3
PH-5	Jackass WG to Greenwood Res.	4100	2503	2447.8	0.0158	0.0038	4.75	2.04	0.5	0.25	24.1	PH-5-5	30	0.007	CMP	0.024	48	27
PH-5	Greenwood Res. To Spanish Dry Diggins Diversion Flume	1800	2447.8	2439.6	0.0025	0.0025	5.49	1.59	0.5	0.25	13.9	PH-5-4	30	0.03	CMP	0.024	48	32.6
PH-5	Spanish Dry Diggins Diversion Flume to Blue Heron Way (Falls)	3400	2439.6	2091.4	0.1112	0.0805	3.15	3.43	1	0.5	99.7	PH-5-3	15	0.0805	CONC	0.013	36	200
PH-5	Blue Heron Way (Falls) to Kaiser Syphon	2700	2091.4	2002.3	0.0493	0.0493	5.1	1.19	0.5	0.25	25.5	PH-5-2	25	0.0493	CMP	0.024	48	20.9
PH-5	Kaiser Syphon	4200	2002.3	1792.2	0.0500	0.05	n/a	n/a	n/a	n/a	25	PH-5-1	4200	0.05	STL	0.024	24	31

Summary of Ditch System Capacity Calculations
Main/Pilot Hill Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
PH-6	Spanish Dry Diggins Flume to 15" Pipe Inlet	3200	2421.8	2439.6	0.0056	0.0039	2.45	1.36	0.5	0.25	6.5	PH-5-0	460	0.0039	CMP	0.024	12	1.2
												PH-6-1	40	0.0056	CMP	0.024	24	4.5
PH-6	15" Pipe	1900	2421.8	2407.2	0.0063	0.0063	n/a	n/a	n/a	n/a	3.1	PH-6-2	1900	0.0077	CMP	0.024	15	3.1
PH-6	15" Pipe Outlet to Spanish Dry Diggins WG	4600	2407.2	2317.7	0.0272	0.0194	1.64	1.95	1	0.5	11.8	PH-6-3	20	0.0194	CMP	0.024	18	7.9
									0.50	0.25	27.3	PH-6-4	20	0.0194	CMP	0.024	18	7.9
												PH-6-5	110	0.0194	CMP	0.024	15	4.9
												PH-6-7	30	0.0194	CMP	0.024	18	7.9
							2.32	1.36	0.5	0.25	11.2	PH-6-8	1100	0.0272	CMP	0.024	15-24	6.1
												PH-6-9	20	0.0194	CMP	0.024	24	6.5
												PH-6-10	40	0.0194	CMP	0.024	24	6.5
												PH-6-11	20	0.0194	CMP	0.024	15	4.9
PH-6	Spanish Dry Diggins WG to End Spanish Dry Diggins Ditch	2000	2317.7	2252.5	0.0326	0.0326	2.32	1.36	0.5	0.25	14.5	PH-6-12	20	0.036	CMP	0.024	24	13.8
												PH-6-13	20	0.036	CMP	0.024	24	13.8
												PH-6-14	30	0.036	CMP	0.024	24	13.8
PH-4	Kaiser Syphon to Ford Syphon	800	1792.2	1789.5	0.0019	0.0019	3.84	2.19	0.5	0.25	17.4							
PH-4	Ford Syphon to A.L.T. Water Treatment Plant	2310	1789.5	1783.8	0.0019	0.0019	3.84	2.19	0.5	0.25	17.4	PH-4-23	190	0.0019	CONC	0.013	36	36.5
												PH-4-22	410	0.0019	CONC	0.013	30	16.6
												PH-4-21	1100	0.0019	STL	0.02	30	10.75
PH-4	A.L.T. Water Treatment Plant to Campground WG	13000	1783.8	1768.7	0.002	0.0015	3.84	2.19	0.5	0.25	15.5	PH-4-20	160	0.002	CMP	0.024	48	16
												PH-4-19	20	0.002	CMP	0.024	48	16
												PH-4-18	21	0.002	CMPA	0.024	57x38	23.4
												PH-4-17	15	0.002	CMP	0.024	48	16
												PH-4-16	35	0.0019	CMPA	0.024	57x38	23.3
												PH-4-15	30	0.0018	CMPA	0.024	49x33	18.1
												PH-4-14	10	0.0018	CMP	0.024	48	15.1
												PH-4-13	40	0.00175	CMPA	0.024	42x29	13.1
												PH-4-12	15	0.0015	CMPA	0.024	49x33	16.5
												PH-4-11	15	0.0015	CMP	0.024	54	15.4
												PH-4-10	40	0.0015	CMPA	0.024	49x33	16.5
												PH-4-9	70	0.0016	CMPA	0.024	57x38	21.5
PH-4	Campground WG to Willow Creek WG	9600	1768.7	1753.5	0.0018	0.0016	5.25	2.51	1	0.5	20	PH-4-8	40	0.0016	CMP	0.024	54	17.4
												PH-4-7	25	0.0016	CMPA	0.024	42x29	12.9
												PH-4-6	25	0.0017	CMPA	0.024	35x24	7.9
												PH-4-5	100	0.0017	CMPA	0.024	35x24	7.9
												PH-4-4	20	0.0018	CMP	0.024	42	14.3
PH-4	Willow Creek WG to Baldridge WG	5500	1753.5	1723.5	0.0022	0.0018	5.05	2.16	0.5	0.25	14	PH-4-3	20	0.011	CMP	0.024	54	41.1
												PH-4-2	10	0.0018	CMP	0.024	54	16.8
												PH-4-1	20	0.095	CMP	0.024	24+24	81

Summary of Ditch System Capacity Calculations
Main/Pilot Hill Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
PH-3 / PH-4	Baldridge WG to Bogus WG	6500	1723.5	1701.3	0.006	0.0018	4.81	3.47	1	0.5	42.9	PH-3-21	40	0.003	CMP	0.024	36	19.8
												PH-3-20	30	0.003	CMP	0.024	36	19.8
PH-3	Bogus WG to Beginning Cherry Acres Ditch (Dorman Wye)	1600	1701.3	1694.3	0.0035	0.0035	4.81	3.47	1	0.5	59.8	PH-3-19	20	0.005	CMP	0.024	36	25.5
												PH-3-18	20	0.0035	CONC	0.013	30	25
												PH-3-17	30	0.0035	CMP	0.024	48	41
PH-3	Beg. Cherry Acres Ditch (Dorman Wye) to Cramer Road	4600	1694.3	1643	0.0119	0.0065	3.85	2.21	0.5	0.25	40.0	PH-3-16	40	0.0119	CMP	0.024	24	13.8
												PH-3-14	30	0.008	CMP	0.024	24	11.3
												PH-3-13	20	0.0065	CMP	0.024	24	10.2
PH-3	Cramer Road to End Cherry Acres Ditch	5000	1643	1622.3	0.0033	0.0033	3.85	2.21	0.5	0.25	27.1	PH-3-12	25	0.005	CMP	0.024	36	15.8
												PH-3-11	15	0.005	CMP	0.024	24	9
												PH-3-10	20	0.0033	CMP	0.024	30	10.3
												PH-3-9	40	0.0033	CMPA	0.024	42x29	16.4
												PH-3-8	20	0.0033	CMP	0.024	30	10.3
												PH-3-7	40	0.0033	CMP	0.024	30	10.3
												PH-3-6	20	0.0033	CMP	0.024	30	10.3
												PH-3-5	10	0.05	CMP	0.024	18	12.7
PH-3	Dorman Wye to Knickerbocker Creek	3800	1694.3	1614.8	0.0365	0.0365	4.81	3.47	1	0.5	193.0	PH-3-4	30	0.027	CMP	0.024	36	62
												PH-3-3	100	0.031	CMP	0.024	18+18	18.4
												PH-3-2	20	0.0365	STL	0.02	24	23
PH-3	Knickerbocker Creek	5500	Not Evaluated (Creek)															
PH-3	Knickerbocker Creek to Pear Orchard WG	2200	1501.2	1492.7	0.004	0.004	4.58	3.6	1	0.5	21.0	PH-3-1	40	0.004	CONC	0.013	72x30	73.2

Summary of Ditch System Capacity Calculations
Main/Pilot Hill Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
PH-2	Pear Orchard WG to Therekel WG	2600	1492.7	1487.8	0.002	0.0015	4.58	3.6	0.5	0.25	**33.9**	**PH-2-15**	10	0.0015	CMP	0.024	30	**8.6**
					0.004	0.0015	10	1.85	0.5	0.25	**12****	**PH-2-14**	15	0.0015	CONC	0.013	24	**7**
												PH-2-13	10	0.004	CONC	0.013	24	**11.4**
PH-2	Therekel WG to State Hwy 49	5400	1487.8	1470.6	0.0066	0.001	10	1.85	0.5	0.25	**9.9****	**PH-2-12**	30	0.005	CMP	0.024	36	**14.2**
												PH-2-11	30	0.003	CMP	0.024	36	**11**
												PH-2-10	35	0.002	CMP	0.024	36	**8.9**
												PH-2-9	30	0.0033	CMP	0.024	15+15	**8.8**
		1400	1470.6	1468.4	0.0016	0.0016	8.59	1.33	0.5	0.25	**10.8**	**PH-2-8**	100	0.0016	CMPA	0.024	49x33	**7**
												PH-2-7	25	0.0016	CMP	0.024	36	**14.6**
												PH-2-6	20	0.0016	CMP	0.024	36	**14.6**
PH-2	Lovejoy WG to Nagle WG	5300	1468.4	1460.9	0.002	0.00075	8.59	1.33	0.5	0.25	**7.5**	**PH-2-5**	40	0.0014	CMP	0.024	24	**4.6**
							5.49	1.85	0.5	0.25	**11.8**	**PH-2-4**	20	0.02	CMP	0.024	30	**23.2**
PH-2	Nagle WG to Capecroft WG	4400	1460.9	1454.3	0.0015	0.0015	5.49	1.85	0.5	0.25	**16.4**	**PH-2-3**	15	0.0015	STL	0.02	24	**5.6**
												PH-2-2	15	0.0015	STL	0.02	24	**5.6**
												PH-2-1	15	0.02	CMP	0.024	36	**28.5**
PH-1 / PH-2	Capecroft WG to Wagner Res.	2300	1454.3	1375.4	0.034	0.034	3.48	1.61	0.5	0.25	**17.3*****	**PH-1-3**	20	0.04	CMP	0.024	24	**19.7**
PH-1	Wagner Res. to Wagner WG	1500	1375.4	1346.9	0.0051	0.0051	3.48	1.61	0.5	0.25	**13.7**	**PH-1-2**	25	.0.072	CMP	0.024	24	**52.0**
PH-1	Wagner WG to Bailey House WG	4900	1346.9	1313.8	0.0076	0.0057	3.48	1.61	0.5	0.25	**13.4**							
PH-1	Bailey House WG to Pilot Hill Res. WG	1200	1313.8	1309.4	0.0034	0.0034	3.48	1.61	0.5	0.25	**11.2**							
PH-1	Pilot Hill Res. WG to Pilot Hill Res.	100	1309.4	1304.4	0.0034	0.0034	3.48	1.61	0.5	0.25	**11.2**	**PH-1-1**	20	0.0034	CMP	0.024	24	**5.8**
PH-0	Pilot Hill Pipeline	6200	1304.4	1219.2	n/a	n/a	n/a	n/a	n/a	n/a	**2**	**PH-0-1**	6200	n/a			6	**2**

Summary of Ditch System Capacity Calculations
Kelsey Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
K-5	Taylor Mine Outlet to Byler's WG	2700	2531.7	2385.1	0.145	0.054	1.43	3.09	1	0.5	**37.3**	**K-5-20**	20	0.054	CMP	0.024	24	**28.5**
												K-5-19	90	0.054	CMP	0.024	18	**13.2**
												K-5-18	30	0.054	CMP	0.024	18	**13.2**
K-5	Byler's WG to Jacobus WG	4900	2385.1	2264.5	0.032	0.01	1.43	3.09	1	0.5	**16.7**	**K-5-17**	20	0.02	CMP	0.024	24	**17.3**
												K-5-16	75	0.032	CMP	0.024	18	**10.2**
												K-5-15	70	0.032	CMP	0.024	18	**10.2**
												K-5-14	10	0.032	CMP	0.024	18	**10.2**
												K-5-12	20	0.032	CMP	0.024	24	**22**
												K-5-11	30	0.032	CMP	0.024	18	**10.2**
												K-5-10	40	0.01	CMP	0.024	18	**5.7**
												K-5-9	1890	0.01	PVC	0.011	15	**7.6**
												K-5-8	20	0.01	PVC	0.011	15	**7.6**
												K-5-7	40	0.01	CMP	0.024	18	**5.7**
K-5	Jacobus WG to Shadle Reservoir	4400	2264.5	2175.3	0.0203	0.019	1.43	3.09	1	0.5	**22**	**K-5-6**	70	0.019	CMP	0.024	18	**7.8**
												K-5-5	100	0.019	CMP	0.024	18	**7.8**
												K-5-4	975	0.019	PVC	0.011	15	**10.5**
												K-5-3	105	0.019	CMP	0.024	18	**7.8**
												k-5-2	730	0.019	PVC	0.011	15	**10.5**
												K-5-1	75	0.019	CONC	0.013	18	**14.5**
K-7	Greenwood Road Pipeline	2800	2175.3	2058.7	0.04	0.04	n/a	n/a	n/a	n/a	**0.6**	**K-7-0**	2800	0.04	ACP	0.024	6	**0.6**

Summary of Ditch System Capacity Calculations
Kelsey Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
K-3	Falls (Forest View Dr.) to Irish Res. WG	6300	2598.9	2395.2	0.0759	0.0026	4.3	1.59	0.5	0.25	6.4	K-3-12	15	0.01	CMP	0.024	36	10.1
												K-3-11	20	0.0227	CMP	0.024	24	10.8
												K-3-10	25	0.0227	CMP	0.024	24	10.8
												K-3-9	25	0.01	CONC	0.013	30	16.0
												K-3-8	20	0.01	CMP	0.024	24	9.7
												K-3-7	25	0.01	CMP	0.024	24	9.7
K-3	Irish Res. WG to Twin Pines Syphon	6400	2395.2	2377.9	0.0029	0.0025	4.41	1.29	0.5	0.25	5.0	K-3-6	55	0.0026	CMPA	0.024	42x29	7.2
												K-3-4	50	0.0027	CMPA	0.024	42x29	7.2
												K-3-3	30	0.0027	CMP	0.024	24	3.4
												K-3-2	25	0.0028	CMP	0.024	24	3.5
K-3	Twin Pines Syphon to Black Oak Syphon	1800	2377.9	2372.9	0.0029	0.0023	4.41	1.29	0.5	0.25	4.8	K-3-1	570	0.0029	PVC	0.011	24	13.9
K-2	Black Oak Syphon to Dukes WG	12000	2372.9	2350.3	0.0023	0.0016	4.26	2.28	0.5	0.25	22.8	K-2-22	700	0.0024	CMP	0.024	24	7.1
												K-2-21	110	0.0023	CMP	0.024	24	5.9
												K-2-20	35	0.002	CMP	0.024	24	5.5
												K-2-19	20	0.0017	CMP	0.024	24	5.1
												K-2-18	50	0.0017	CMP	0.024	24	5.1
												K-2-17	40	0.0017	CMP	0.024	36	11
												K-2-16	15	0.0016	HDPE	0.011	24	10.7
							3.1	2.17	0.5	0.25	8	K-2-15	25	0.016	CMP	0.024	24	5.3
												K-2-14	40	0.0017	STL	0.02	24	6.5
												K-2-13	30	0.0019	CMP	0.024	24	5.7
												K-2-12	20	0.0021	CMP	0.024	24	6.0
												K-2-11	40	0.0023	CMP	0.024	24	6.3
												K-2-10	20	0.002	CMP	0.024	24	5.9
K-2	Dukes WG to 15" PVC Inlet (state hwy 193)	6500	2350.3	2337.9	0.0028	0.0017	4.68	1.25	0.5	0.25	5.1	K-2-9	15	0.006	CONC	0.013	18	6.7
												K-2-8	30	0.013	CMP	0.024	18	5.1
												K-2-7	15	0.0035	STL	0.02	18	3.2
												K-2-6	20	0.0035	CMP	0.024	24	3.6
												K-2-5	115	0.0022	PVC	0.011	15	3.5
												K-2-4	210	0.0022	CMP	0.024	24	2.9
K-2	15" PVC Inlet (state highway 193) to 15" PVC Outlet	650	2337.9	2336.1	0.0022	0.0017	4.68	1.25	0.5	0.25	5.1	K-2-3	210	0.0022	PVC	0.011	15	3.5
												K-2-2	50	0.0022	CMP	0.024	18	2.1
												K-2-1	370	0.0022	PVC	0.011	15	3.5
												K-2-0	30	0.0022	CMP	0.024	18	2.1

Summary of Ditch System Capacity Calculations
Kelsey Ditch System

Georgetown Divide Public Utility District

Ref. Sheet	Segment (1)	Segment Length (ft)	Upstream Elev. (ft)	Downstream Elev (ft)	Max Slope (ft/ft)	Min Slope (ft/ft)	Typical Ditch Width (ft)	Typical Ditch Depth (ft)	Minimum Allowable Freeboard (ft)	Maximum Allowable Backwater (ft)	Capacity for Ditch Segment (cfs) (2) (3)	ID# (4)	Pipe/Culvert Length (ft)	Slope (ft/ft)	Culvert Material	n value	Culvert Size (in)	Pipe/Culvert Capacity (cfs) (5)
K-1	15" PVC Outlet to Chicken Flat WG	4100	2337.3	2326.9	0.0021	0.0021	3.5	1.5	0.5	0.25	6.6	K-1-21	2200	0.0021	PVC	0.0150	15	3.5
K-1	Chicken Flat WG to Mellows WG	2200	2326.9	2323.5	0.0021	0.0021	3.5	1.5	0.5	0.25	6.6	K-1-20	1040	0.0021	PVC	0.011	15	3.5
												K-1-19	50	0.0021	CMP	0.024	18	2.6
												K-1-18	50	0.0021	STL	0.020	18	3.2
K-1	Mellows WG to Kelsey Flume Syphon	4500	2323.5	2309	0.0048	0.0048	2	1.3	0.5	0.25	4	K-1-17	50	0.0048	CMP	0.024	18	3.3
												K-1-16	40	0.0048	CMP	0.024	18	3.3
												K-1-14	250	0.0048	PVC	0.015	15	5.4
												K-1-13	145	0.0048	PVC	0.011	15	5.4
												K-1-12	40	0.0030	CMP	0.024	18	2.6
												K-1-11	410	0.0023	CONC	0.013	30	11.4
K-1	Kelsey Flume Syphon to Stork WG	5400	2309	2297.5	0.0026	0.0023	2	1.3	0.5	0.25	2.7	K-1-10	20	0.005	CMP	0.024	24	4.7
												K-1-9	30	0.0230	CMP	0.024	24	10.1
												K-1-8	95	0.0084	PVC	0.011	15	7.1
												K-1-7	20	0.0025	CMP	0.024	18	1.4
												K-1-6	35	0.0025	CMP	0.024	24	1.9
												K-1-5	140	0.0240	PVC	0.011	15	7.9
												K-1-4	40	0.0330	CMP	0.024	18	5.2
												K-1-3	20	0.0300	CMP	0.024	18	4.9
												K-1-2	20	0.0290	CMP	0.024	18	6.4
												K-1-1	30	0.0280	CMP	0.024	24	6.3
K-1	Stork WG to Kelsey Res.	7800	2297.5	2022	0.1463	0.0025	2	1	0.5	0.25	1.3							

SOIL SURVEY OF

El Dorado Area, California

United States Department of Agriculture
Soil Conservation Service and Forest Service
In cooperation with
University of California
Agricultural Experiment Station

Major fieldwork for this soil survey was done in 1965. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the area in 1965. This survey was made cooperatively by the Soil Conservation Service and Forest Service and the University of California Agricultural Experiment Station. It is part of the technical assistance furnished to the El Dorado County and Georgetown Divide Resource Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of the El Dorado Area are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the area in alphabetic order by map symbol and gives the capability classification of each. It shows the page where each soil is described and the page for the range site, woodland group, and wildlife group in which the soil has been placed. It also gives the Storie index rating for each soil.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions, the section "Use of the Soils for Crops," and the discussions of range sites and woodland groups.

Foresters and others can refer to the section "Woodland Uses of the Soils," where the soils of the area are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation, Morphology, and Classification of the Soils.

Newcomers in the area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the Area."

Cover: Pear orchards on Aiken and Cohasset soils. Sierra Nevada Range in background.

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SOIL SURVEY OF EL DORADO AREA, CALIFORNIA

BY JOHN H. ROGERS, SOIL SCIENTIST, SOIL CONSERVATION SERVICE

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE AND FOREST SERVICE, IN COOPERATION WITH UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

THE EL DORADO AREA is in the east-central part of California (fig. 1). It is in the western half of El Dorado County in the Central Sierra Nevada. The Area is mainly within the Cosumnes and American Rivers drainage basins and is made up of rolling foothills to steep mountainous slopes. It extends about 6 miles into the western side of the El Dorado National Forest. Placerville, the county seat of El Dorado County and the largest town in the El Dorado Area, has a population of about 6,000. The survey area has a total area of 539,065 acres.

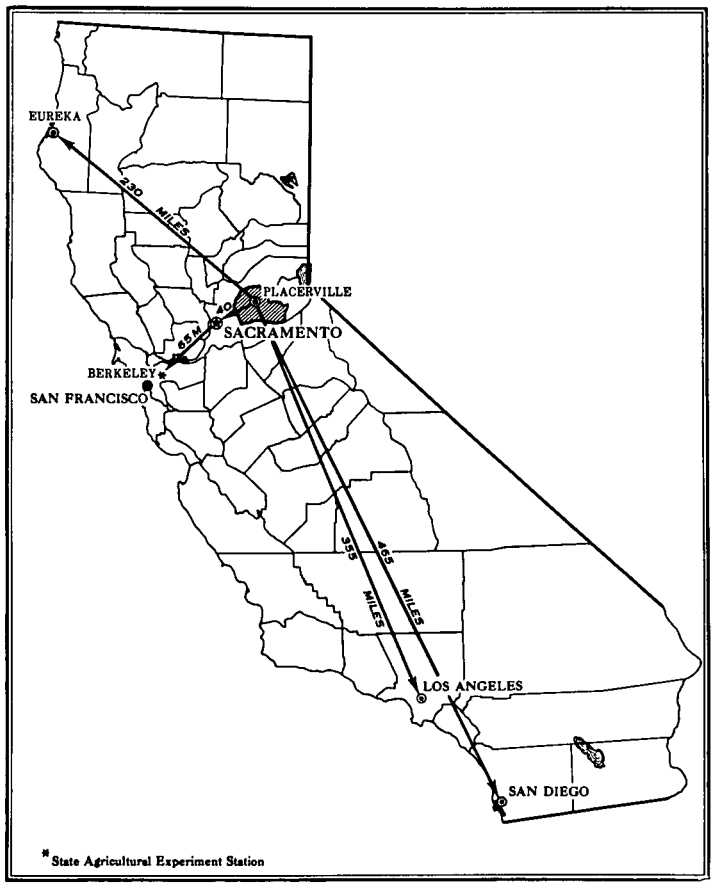

Figure 1.—**Location of the El Dorado Area in California.**

Farming is of considerable importance in the El Dorado Area, but the acreage used for crops has been reduced by urban expansion. The main crops are pears, apples, and irrigated pasture. Livestock is produced in the western part of the Area, where forage is abundant. Woodland crops are produced in the eastern part of the survey area.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the El Dorado Area, where they are located, and how they can be used. The soil scientists went into the Area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the kinds of plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase (*19*)[1] are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Aiken and Boomer, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For

[1] Italic numbers in parentheses refer to Literature Cited, p. 84.

example, Aiken loam, 3 to 9 percent slopes, is one of several phases within the Aiken series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, roads, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit shown on the soil map of the El Dorado Area is the soil complex. A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Boomer-Sites loams, 9 to 15 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Gullied land is a land type in the El Dorado Area.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and range, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the El Dorado Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

There are two main physiographic regions in the El Dorado Area, (1) the lower and middle foothills and (2) the mountainous uplands. The small alluvial areas are not shown on the general soil map. One or more soil associations are in each physiographic region. The soil associations have been grouped principally on the basis of soil differences that are related to differences in parent rock.

Texture given in the descriptive title of each of the associations is the texture of the surface layer. The brief description of the major soils in each association is that of the profile described as representative for the series being discussed.

The eight soil associations in the El Dorado Area are discussed in the following pages.

Soils of the Lower and Middle Foothills

The lower and middle foothills of the Sierra Nevada Range are in the western part of the El Dorado Area. They consist of rolling to steep hills that have a few conspicuous peaks. The elevation typically ranges from 500 to 3,500 feet. The annual precipitation ranges from 25 to 50 inches. Rock outcrops are common. Depth to bedrock ranges from 0 to more than 60 inches. The lower and middle foothills make up about 50 percent of the survey area.

There are five soil associations in the lower and middle foothills. The soils in these associations formed in material from weathered slates, schists, metabasic igneous rocks, acid igneous rocks, basic igneous rocks, and serpentine rocks. The plant cover is mainly grass and oak trees, but there are areas of brush and coniferous trees.

1. Auburn-Argonaut association

Well-drained silt loams and gravelly loams formed in material weathered from basic rocks and metasedimentary rocks

This association is in the southwestern part of the survey area at elevations of 500 to 1,800 feet. The soils are generally undulating to hilly, but they become steep to very steep in areas adjacent to the major streams and rivers. Rock outcrops are common. The annual average precipitation ranges from 25 to 35 inches. The vegetation consists mostly of grass and oak trees, but there are scattered areas of brush and Digger pine. The association occupies about 25 percent of the survey area.

Auburn soils make up about 75 percent of the association and Argonaut soils about 10 percent. The remaining 15 percent consists of Perkins soils, moderately deep variant; Sobrante and Whiterock soils; and scattered areas of Metamorphic rock land.

The Auburn soils have a surface layer of brown silt loam and a subsoil of reddish-yellow silt loam. The depth to bedrock ranges from 12 to 26 inches. These soils formed in material weathered from diabase, slates, and schist.

The Argonaut soils have a surface layer of strong-brown gravelly loam and gravelly silt loam and a subsoil of yellowish-red, yellowish-brown, and brown heavy clay and gravelly clay. The depth to bedrock ranges from 20 to 40 inches. These soils formed in material weathered from metaandesite.

Sobrante soils are scattered throughout the association. Perkins soils, moderately deep variant, are adjacent to drainageways in the Clarksville-Latrobe area. Whiterock soils are in two narrow belts, one west of Latrobe and the other in the southern part of the Mother Lode Belt.

The soils of this association are used mainly for range, watershed, and wildlife habitat. Some areas are used for woodland, pasture, hay, grain, and orchards.

2. Boomer-Auburn association

Well-drained silt loams and gravelly loams formed in material weathered from basic igneous rocks or metasedimentary rocks

This association is in the northwestern part of the survey area at elevations of 1,000 to 2,000 feet. The soils generally are undulating to hilly, but they are steep to very steep in areas adjacent to major streams and rivers. Slopes are 2 to 70 percent. Rock outcrops are common. The average annual precipitation is 25 to 50 inches. The vegetation typically consists of grass and oak trees and commercial stands of coniferous trees. The association occupies about 10 percent of the survey area.

Boomer soils make up about 50 percent of the association, and Auburn soils, about 40 percent. The remaining 10 percent consists of Argonaut and Sobrante soils and scattered areas of Metamorphic rock land.

The Boomer soils have a surface layer of yellowish-red gravelly loam and a subsoil of red gravelly clay loam, gravelly sandy clay loam, and very gravelly sandy clay loam. The depth to bedrock ranges from 24 to 52 inches. These soils formed in material weathered from diabase, slates, and schists.

The Auburn soils have a surface layer of brown silt loam and a subsoil of reddish-yellow silt loam. The depth to bedrock ranges from 12 to 26 inches. These soils formed in material weathered from diabase, slates, and schists.

The soils of this association are used mainly for range, water supply, wildlife habitat, and some commercial timber production. A few areas are used for pasture, hay, grain, or orchards.

3. Rescue association

Well-drained sandy loams formed in material weathered from basic rocks

This association is in small areas scattered throughout the western part of the survey area. It is at elevations of 1,000 to 2,500 feet. The soils are undulating to steep. The average annual precipitation is 25 to 35 inches. The vegetation is chamise brush and scattered areas of pine, oak, and grass. The association occupies about 5 percent of the survey area.

Rescue soils make up about 85 percent of the association. The remaining 15 percent consists of Loamy alluvial land, Argonaut soils, and soils of the Rescue series, clayey variant.

The Rescue soils have a surface layer of reddish-brown sandy loam and a subsoil of yellowish-red and reddish-yellow heavy sandy loam and sandy clay loam. The depth to weathered bedrock ranges from 40 inches to more than 60 inches. These soils formed in material weathered from gabbrodiorite rock. Stones and some rock outcrops are common.

Loamy alluvial land is adjacent to streams. Argonaut soils are along drainageways and on concave slopes. Rescue soils, clayey variant, are in wet swales and below seeps.

The soils of this association are used mainly for grazing, watershed, and wildlife habitat. Some small areas are used for hay, grain, and pasture.

4. Serpentine rock land-Delpiedra association

Excessively drained to somewhat excessively drained rock land and loams formed in material weathered from ultrabasic rocks

This association is mainly scattered throughout the lower and middle foothills, but two areas are in the mountainous uplands. Where elevations are 500 to 1,800 feet, the average annual rainfall is 25 to 35 inches. In the two areas in the mountainous uplands, where elevations are 500 to 3,200 feet, precipitation is 25 to 50 inches. This association is undulating to very steep. The vegetation consists of chamise, grasses, and scattered Digger pines. This association occupies about 5 percent of the survey area.

Serpentine rock land makes up about 85 percent of the association, and Delpiedra soils, about 10 percent. The remaining 5 percent consists of Auburn soils.

Serpentine rock land is in areas of highly resistant serpentine and other ultrabasic rock formations. Rock outcrops and stones occupy 50 to 90 percent of the surface area, and there is a thin mantle of soil material in crevices.

The Delpiedra soils have a surface layer of reddish-brown loam and a subsoil of reddish-brown and yellowish-red clay loam. The depth to bedrock ranges from 10 to 24 inches. These soils formed in material weathered from serpentine. Rock outcrops are common.

The soils of this association are used mainly for watershed, for wildlife habitat, and as a source of rock for roads. Delpiedra soils are grazed. Some areas are mined for chrome.

5. Auberry-Ahwahnee-Sierra association

Well-drained coarse sandy loams and sandy loams formed in material weathered from granitic rocks

This association is in two main areas, one in the vicinity of Gold Hill-Lotus and the other west of Aukum and extending north to near Oak Hill. The soils generally are gently rolling to hilly, but they are steep where they break into the major streams and rivers. In relation to the adjacent associations, this association has the appearance of being in a basin. These soils formed in material weathered from granodiorite. The surface is commonly broken by rock outcrops. The vegetation consists of grass and oak

trees and scattered pockets of commercial conifers. Elevations are 500 to 2,500 feet. The average annual rainfall is 25 to 35 inches. This association occupies about 5 percent of the survey area.

Auberry soils make up about 55 percent of the association; Ahwahnee soils, about 25 percent; and Sierra soils, about 10 percent. The remaining 10 percent consists of Chawanakee soils and Acidic rock land.

The Auberry soils have a surface layer of brown and light yellowish-brown coarse sandy loam and a subsoil of very pale brown, light yellowish-brown, and yellowish-brown coarse sandy clay loam and coarse sandy loam. The depth to weathered granodiorite bedrock ranges from 24 inches to more than 60 inches. These soils generally are gently rolling to hilly.

The Ahwahnee soils have a surface layer of very dark gray and grayish-brown coarse sandy loam and a subsoil of pale-brown and light yellowish-brown heavy coarse sandy loam. The depth to weathered granodiorite bedrock ranges from 24 to 40 inches. These soils are hilly to steep on sides of hills that break into the major drainageways.

The Sierra soils have a surface layer of brown sandy loam and a subsoil of mainly yellowish-red and red clay loam. The depth to weathered bedrock ranges from 40 inches to more than 60 inches. The largest area of the Sierra soils is in the southern part of the Aukum-Oak Hill block. These soils are rolling to steep.

The Chawanakee soils are hilly to steep on slopes that break into the major rivers.

The soils of this association are used mainly for annual range, watershed, and wildlife habitat. Some areas have been planted to dryland walnuts. In areas where irrigation water is available, these soils can be planted to pasture and deciduous orchards. Vineyards are being introduced on these soils. Timbered areas are harvested for wood products.

Soils of the Mountainous Uplands

The mountainous uplands of the Sierra Nevada are located in the eastern part of the El Dorado Area. They consist of tabular ridges and rolling to steep uplands that are deeply entrenched by rivers and streams that flow westward. Elevations range from 1,500 feet to more than 5,500 feet. Annual precipitation ranges from 35 inches to more than 60 inches, and much of it falls as snow. The soils are 15 inches to more than 60 inches deep to bedrock. Rock outcrops are common. The mountainous uplands make up about 50 percent of the survey area.

There are three associations in the mountainous uplands. The soils in these associations formed in material weathered from slates and schists, metabasic rocks, volcanic conglomerate, and granitic rocks. The plant cover is dominantly forests of conifers and hardwoods, and there are scattered areas of brush.

6. Holland-Musick-Chaix association

Well-drained coarse sandy loams and sandy loams formed in material weathered from granitic rocks

This association is in two main areas in the survey area, one in the Aukum-Grizzly Flat area and the other in the Mosquito area. The soils are gently rolling to hilly on uplands. The relief generally is smooth and the hills are rounded, but areas that adjoin river canyons are steep and, in places, precipitous. In relation to the surrounding topography, this association has the appearance of being in a basin. These soils formed in material weathered from granodiorite. Rock outcrops are common, especially where the soils are steeper. The vegetation consists of conifers and hardwoods. Elevations are 1,800 to 5,000 feet. Average annual precipitation is 35 to 60 inches. This association occupies about 10 percent of the survey area.

Holland soils make up about 35 percent of the association; Musick soils, about 20 percent; and Chaix soils, about 15 percent. The remaining 30 percent consists of Chawanakee, Hotaw, and Shaver soils and Acidic rock land.

The Holland soils have a surface layer of brown coarse sandy loam and sandy loam and a subsoil of strong-brown, brown, and yellowish-brown sandy clay loam. The substratum is pale-brown coarse sandy loam. The depth to weathered granitic bedrock ranges from 40 inches to more than 60 inches. The Holland soils are mainly rolling to steep.

The Musick soils have a surface layer of brown sandy loam and a subsoil of reddish-brown, red, and reddish-yellow sandy clay loam, clay loam, and sandy clay. The depth to weathered granitic bedrock is more than 48 inches. The Musick soils are mainly rolling to steep.

The Chaix soils have a surface layer of dark grayish-brown coarse sandy loam and a subsoil of brown coarse sandy loam. The substratum is pale-brown coarse sandy loam. The depth to weathered granitic rock ranges from 24 to 40 inches. These soils are mainly steep and have slopes that break into the rivers.

Chawanakee soils are hilly to steep and occupy areas that break into the major rivers. Hotaw soils are present throughout the association. Shaver soils are mainly in the Grays Corners-Aukum area. Acidic rock land is mainly steep and very steep and is on side slopes that break into the major rivers.

The soils in this association are used mainly for timber, water supply, and wildlife habitat. Some areas have been cleared and are used for grazing and dryland walnuts. In areas where irrigation water is available, deciduous orchards and pasture have been planted.

7. Cohasset-Aiken-McCarthy association

Well-drained cobbly loams and loams formed in material weathered from volcanic conglomerate

This association is in three main areas, the Volcanoville Ridge area east of Georgetown, the Camino-Pollock Pines area east of Placerville, and the Omo Ranch-Farnham Ridge area southeast of Placerville. The soils occupy broad, sloping, tabular ridges and the steep sides of these ridges. The vegetation consists of conifers and hardwoods. Elevations are 2,000 to 5,500 feet. Average annual precipitation is 35 inches to more than 60 inches at the higher elevations. Much of the precipitation falls as snow. This association occupies about 10 percent of the survey area.

Cohasset soils make up about 45 percent of the association; Aiken soils, about 20 percent; and McCarthy soils, about 20 percent. The remaining 15 percent consists of Crozier and Iron Mountain soils.

The Cohasset soils have a surface layer of brown and reddish-brown cobbly loam and a subsoil of reddish-

brown and yellowish-red cobbly loam and cobbly clay loam. The depth to andesitic conglomerate ranges from 40 inches to more than 60 inches. These soils are moderately sloping to strongly sloping on ridgetops and are steep on side slopes.

The Aiken soils have a surface layer of brown and reddish-brown loam and clay loam and a subsoil of yellowish-red and red clay loam and clay. The depth to weathered andesitic conglomerate is more than 48 inches. These soils are gently sloping to strongly sloping on broad ridgetops.

The McCarthy soils have a surface layer of dark grayish-brown and brown cobbly loam and a subsoil of strong-brown very cobbly loam. The depth of andesitic conglomerate ranges from 24 to 40 inches. These soils are steep on side slopes below areas of Aiken and Cohasset soils.

Crozier soils are present throughout this association. Iron Mountain soils are in patches on the ridgetops and in long, thin bands on the steep sides of ridges. Mapped with the Iron Mountain soils are rocky areas commonly called lava caps.

The soils in this association are used mainly for timber production, water supply, and wildlife habitat. In the Camino-Pollock Pines area, large acreages have been planted to pear and apple orchards.

8. *Mariposa-Josephine-Sites association*

Well-drained gravelly silt loams, silt loams, and loams formed in material weathered from metasedimentary rocks

This association is present throughout the eastern half of the survey area at elevations of 1,500 feet to more than 5,500 feet. The soils are rolling to steep on uplands that have sharp ridges. There are a few, wide, rolling valleys. The streams have entrenched in a herringbone pattern. Soils adjacent to the major rivers and streams commonly are rocky and very steep. The vegetation consists of conifers, hardwoods, and brush. The shallower soils tend to be brushy. The average annual precipitation ranges from 35 inches to more than 60 inches, and much of it falls as snow.

The soils in this association formed in vertically tilted slates and schists, and some metamorphosed basic rocks. Because of the early vertical uplifting of the parent rock and its mixed mineralogy and varying degree of metamorphism, these soils are quite variable within short horizontal distances. This association occupies about 30 percent of the survey area.

Mariposa soils make up about 50 percent of the association; Josephine soils, about 30 percent; and Sites soils, about 10 percent. The remaining 10 percent consists of Boomer, Diamond Springs, and Maymen soils and Metamorphic rock land.

The Mariposa soils have a surface layer of pink gravelly silt loam and a subsoil of reddish-yellow gravelly silt loam. The depth to bedrock ranges from 15 to 30 inches. These soils occupy narrow ridge crests and are very steep on side slopes. Rock outcrops and slate fragments are common.

The Josephine soils have a surface layer of yellowish-brown and reddish-yellow silt loam and a subsoil of reddish-yellow silty clay loam and yellow very gravelly silt loam. The depth to bedrock ranges from 40 to 60 inches. These soils are moderately sloping to very steep throughout the association. Rock outcrops and slate fragments are common.

The Sites soils have a surface layer of brown and reddish-brown loam and a subsoil of yellowish-red and red clay loam and clay. The depth to bedrock ranges from 40 inches to more than 60 inches. Rock outcrops and slate fragments are common.

Boomer soils are intermingled with Sites soils at the lower elevations. Diamond Springs soils are along the western fringe of the association. Maymen soils are mainly adjacent to the very steep soils that break into the major rivers and in the Slate Mountain area east of Georgetown.

The soils in this association are used mainly for timber, water supply, and wildlife habitat. Some areas have been cleared and planted to deciduous orchards.

Descriptions of the Soils

This section describes the soil series and mapping units of the El Dorado Area. The approximate acreage and proportionate extent of each mapping unit are given in table 1.

In the pages that follow, a general description of each soil series is given. Following each series description is a fairly detailed description of one mapping unit in the series. This detailed description is followed by brief descriptions of the rest of the mapping units. Miscellaneous land types, such as Acidic rock land and Loamy alluvial land, are described in alphabetic order along with other mapping units.

In each series description is a short, nontechnical description of a profile representative for the series. In the description of the first mapping unit is a more detailed description of the same profile, which can be used by scientists, engineers, and others in making highly technical interpretations. The descriptions of the rest of the mapping units tell mainly how these units differ from the one described in detail.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. At the end of the description of each mapping unit are listed the capability unit, woodland group, and range site, where applicable, in which the mapping unit has been placed. The page where each of these groups is described can be found readily by referring to the "Guide to Mapping Units."

Unless otherwise stated, the colors mentioned are for dry soils.

For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils are described. Many of the terms used in the soil descriptions and other parts of the survey are defined in the Glossary.

Acidic Rock Land

Acidic rock land (AcF) occurs in areas of granitic rock and on rhyolitic ridges. In areas of granitic rock, it is mainly steep to very steep and occupies the canyon walls of the American and Cosumnes Rivers. It is associated with the Chawanakee, Ahwahnee, Chaix, Shaver, and

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Acidic rock land	6, 407	1. 2
Ahwahnee coarse sandy loam, 9 to 15 percent slopes	486	. 1
Ahwahnee very rocky coarse sandy loam, 9 to 30 percent slopes	1, 468	. 3
Ahwahnee very rocky coarse sandy loam, 30 to 50 percent slopes	3, 887	. 7
Aiken loam, 3 to 9 percent slopes	1, 670	. 3
Aiken loam, 3 to 9 percent slopes, eroded	775	. 1
Aiken loam, 9 to 15 percent slopes	2, 920	. 5
Aiken loam, 9 to 15 percent slopes, eroded	1, 162	. 2
Aiken loam, 15 to 30 percent slopes	2, 690	. 5
Aiken cobbly loam, 3 to 30 percent slopes	972	. 2
Argonaut gravelly loam, 2 to 15 percent slopes	2, 304	. 4
Argonaut extremely stony loam, 15 to 30 percent slopes	542	. 1
Argonaut very rocky loam, 3 to 30 percent slopes	2, 304	. 4
Argonaut clay loam, 3 to 9 percent slopes	653	. 1
Argonaut loam, seeped variant	1, 203	. 2
Auberry coarse sandy loam, 5 to 9 percent slopes	946	. 2
Auberry coarse sandy loam, 9 to 15 percent slopes	1, 390	. 3
Auberry coarse sandy loam, 15 to 30 percent slopes	959	. 2
Auberry rocky coarse sandy loam, 5 to 15 percent slopes	2, 720	. 5
Auberry very rocky coarse sandy loam, 15 to 30 percent slopes	2, 829	. 5
Auberry very rocky coarse sandy loam, 30 to 50 percent slopes	3, 990	. 7
Auberry very rocky coarse sandy loam, moderately deep, 9 to 30 percent slopes	1, 235	. 2
Auburn silt loam, 2 to 30 percent slopes	15, 692	2. 9
Auburn very rocky silt loam, 2 to 30 percent slopes	63, 396	11. 8
Auburn very rocky silt loam, 30 to 50 percent slopes	28, 559	5. 3
Auburn extremely rocky silt loam, 3 to 70 percent slopes	7, 722	1. 4
Auburn cobbly clay loam, heavy subsoil variant, 9 to 50 percent slopes	607	. 1
Boomer gravelly loam, 3 to 15 percent slopes	1, 466	. 3
Boomer gravelly loam, 15 to 30 percent slopes	1, 773	. 3
Boomer very rocky loam, 3 to 30 percent slopes	4, 204	. 8
Boomer very rocky loam, 30 to 50 percent slopes	10, 361	1. 9
Boomer very rocky loam, 50 to 70 percent slopes	1, 925	. 4
Boomer-Sites loams, 9 to 15 percent slopes	593	. 1
Boomer-Sites loams, 15 to 30 percent slopes	1, 703	. 3
Boomer-Sites very rocky loams, 9 to 50 percent slopes	3, 559	. 7
Chaix very rocky coarse sandy loam, 9 to 50 percent slopes	4, 920	. 9
Chaix very rocky coarse sandy loam, 50 to 70 percent slopes	2, 381	. 4
Chawanakee very rocky coarse sandy loam, 9 to 50 percent clopes	2, 385	. 4
Cohasset sandy loam, 15 to 30 percent slopes	1, 055	. 2
Cohasset cobbly sandy loam, 9 to 50 percent slopes	1, 875	. 4
Cohasset loam, 3 to 9 percent slopes	752	. 1
Cohasset loam, 9 to 15 percent slopes	2, 882	. 5
Cohasset loam, 15 to 30 percent slopes	4, 983	. 9
Cohasset cobbly loam, 3 to 15 percent slopes	2, 414	. 5
Cohasset cobbly loam, 15 to 50 percent slopes	8, 160	1. 5
Crozier cobbly loam, 9 to 50 percent slopes	2, 521	. 5
Delpiedra very rocky loam, 3 to 50 percent slopes	1, 692	. 3
Diamond Springs very fine sandy loam, 3 to 9 percent slopes	247	. 1
Diamond Springs very fine sandy loam, 9 to 15 percent slopes	2, 948	. 6
Diamond Springs very fine sandy loam, 15 to 30 percent slopes	846	. 2
Diamond Springs very rocky very fine sandy loam, 3 to 50 percent slopes	2, 321	. 4
Diamond Springs gravelly sandy loam, grayish subsoil variant, 9 to 30 percent slopes	529	. 1
Diamond Springs gravelly sandy loam, grayish subsoil variant, 30 to 50 percent slopes	585	. 1
Gullied land	2, 430	. 6
Holland coarse sandy loam, 5 to 9 percent slopes	516	. 1
Holland coarse sandy loam, 9 to 15 percent slopes	3, 195	. 6
Holland coarse sandy loam, 15 to 30 percent slopes	3, 780	. 7
Holland rocky coarse sandy loam, 5 to 15 percent slopes	631	. 1
Holland very rocky coarse sandy loam, 15 to 50 percent slopes	7, 077	1. 3
Holland very rocky coarse sandy loam, 50 to 70 percent slopes	1, 332	. 3
Horseshoe gravelly sandy loam, 9 to 15 percent slopes	190	(1)
Horseshoe gravelly loam, 30 to 50 percent slopes	787	. 1
Hotaw very rocky coarse sandy loam, 15 to 50 percent slopes	3, 159	. 6
Iron Mountain very rocky sandy loam, 3 to 50 percent slopes	5, 527	1. 0
Josephine gravelly loam, 9 to 15 percent slopes	1, 968	. 4
Josephine gravelly loam, 15 to 30 percent slopes	4, 351	. 8
Josephine very rocky loam, 15 to 50 percent slopes	10, 639	2. 0
Josephine silt loam, 5 to 15 percent slopes	2, 505	. 5
Josephine silt loam, 15 to 30 percent slopes	12, 007	2. 2
Josephine silt loam, 30 to 50 percent slopes	3, 634	. 7
Josephine very rocky silt loam, 9 to 50 percent slopes	10, 953	2. 0
Josephine very rocky silt loam, 50 to 70 percent slopes	2, 985	. 6
Josephine-Mariposa gravelly loams, 15 to 30 percent slopes	1, 359	. 3
Loamy alluvial land	624	. 1
Mariposa gravelly silt loam, 3 to 30 percent slopes	5, 715	1. 1
Mariposa very rocky silt loam, 3 to 50 percent slopes	32, 853	6. 1
Mariposa very rocky silt loam, 50 to 70 percent slopes	25, 459	4. 7
Mariposa-Josephine very rocky loams, 15 to 50 percent slopes	21, 127	3. 9
Mariposa-Josephine very rocky loams, 50 to 70 percent slopes	5, 218	1. 0
Maymen very rocky loam, 15 to 70 percent slopes	8, 675	1. 6
McCarthy cobbly loam, 9 to 50 percent slopes	9, 496	1. 7
Metamorphic rock land	11, 677	2. 2
Mixed alluvial land	1, 058	. 2
Musick sandy loam, 9 to 15 percent slopes	2, 061	. 4
Musick sandy loam, 15 to 30 percent slopes	2, 296	. 4
Musick rocky sandy loam, 5 to 15 percent slopes	710	. 1
Musick very rocky sandy loam, 15 to 50 percent slopes	3, 183	. 6
Perkins gravelly loam, 3 to 30 percent slopes	201	(1)
Perkins gravelly loam, moderately deep variant, 2 to 5 percent slopes	967	. 2
Placer diggings	9, 108	1. 7
Rescue sandy loam, 2 to 9 percent slopes	3, 801	. 7
Rescue sandy loam, 9 to 15 percent slopes	740	. 1
Rescue sandy loam, 15 to 30 percent slopes	249	. 1

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Acres	Percent
Rescue very stony sandy loam, 3 to 15 percent slopes	6, 535	1. 2
Rescue very stony sandy loam, 15 to 30 percent slopes	2, 471	. 5
Rescue very stony sandy loam, 30 to 50 percent slopes	1, 155	. 2
Rescue extremely stony sandy loam, 3 to 50 percent slopes, eroded	10, 286	1. 9
Rescue clay, clayey variant	679	. 1
Serpentine rock land	18, 201	3. 4
Shaver coarse sandy loam, 5 to 9 percent slopes	288	. 1
Shaver coarse sandy loam, 9 to 15 percent slopes	1, 648	. 3
Shaver coarse sandy loam, 15 to 30 percent slopes	1, 813	. 3
Shaver rocky coarse sandy loam, 5 to 15 percent slopes	462	. 1
Shaver very rocky coarse sandy loam, 15 to 50 percent slopes	1, 635	. 3
Sierra sandy loam, 9 to 15 percent slopes, eroded	675	. 1
Sierra sandy loam, 15 to 30 percent slopes, eroded	356	. 1
Sierra rocky sandy loam, 5 to 15 percent slopes	343	. 1
Sierra very rocky sandy loam, 15 to 30 percent slopes	473	. 1
Sierra very rocky sandy loam, 30 to 50 percent slopes	833	. 2
Sites loam, 9 to 15 percent slopes	2, 789	. 5
Sites loam, 15 to 30 percent slopes	5, 407	1. 0
Sites loam, 30 to 50 percent slopes	1, 149	. 2
Sites stony loam, 30 to 50 percent slopes	782	. 2
Sites very rocky loam, 15 to 50 percent slopes	1, 912	. 4
Sites very rocky loam, 50 to 70 percent slopes	258	. 1
Sites clay loam, 9 to 15 percent slopes	1, 124	. 2
Sites clay loam, 15 to 30 percent slopes	2, 628	. 3
Sites clay loam, 30 to 50 percent slopes	461	. 1
Sobrante silt loam, 3 to 15 percent slopes	4, 870	. 9
Sobrante silt loam, 15 to 30 percent slopes	591	. 1
Sobrante very rocky silt loam, 3 to 30 percent slopes	960	. 2
Tailings	1, 798	. 3
Wet alluvial land	626	. 1
Whiterock gravelly silt loam, 3 to 50 percent slopes	3, 153	. 6
Reservoirs	7, 123	1. 3
Rivers	2, 770	. 5
Total	539, 065	100. 0

[1] Less than 0.05 percent.

Sierra soils. In the Pleasant Valley area, it occupies plateaus and escarpments of rhyolitic ridges along with soils of the Diamond Springs series, grayish subsoil variant.

About 60 percent of the area of this land type is bare rock. The remaining 40 percent has a thin mantle of soil. This land type is excessively drained. Runoff is very rapid, and the erosion hazard is very high, although there is little soil available to erode.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam and Sierra very rocky sandy loam that have slopes of more than 50 percent.

This land type is used for watershed and wildlife habitat. It has no farming value. Capability unit VIIIs–1 (18, 22); range site and woodland suitability group not assigned.

Ahwahnee Series

The Ahwahnee series consists of well-drained soils that are underlain by weathered granitic rocks at a depth of 24 to 40 inches. These are rolling to steep soils on foothills. Slopes are 9 to 50 percent. Elevations range from 500 feet to 2,500 feet. The average annual rainfall is 25 to 35 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses, forbs, and oaks, and there are scattered Digger and ponderosa pines. Ahwahnee soils are associated principally with Auberry, Sierra, and Auburn soils.

In a representative profile, the surface layer is very dark gray and grayish-brown, neutral and slightly acid sandy loam and coarse sandy loam about 8 inches thick. The subsoil is pale-brown and light yellowish-brown, slightly acid heavy coarse sandy loam. Weathered granodiorite occurs at a depth of about 26 inches.

Ahwahnee soils are used for annual range.

Ahwahnee coarse sandy loam, 9 to 15 percent slopes (AcC).—This soil is strongly sloping. Exposed bedrock occupies less than 5 percent of the surface.

Representative profile, 7 miles southwest of Pilot Hill, 0.1 mile east of the high-water mark on Folsom Reservoir, 0.1 mile southwest of the northeast corner of sec. 8, T. 10 N., R. 8 E.:

A11—0 to 2½ inches, very dark gray (N 3/0) sandy loam, black (N 2/0) when moist; massive; soft, friable, nonsticky and nonplastic; many very fine roots; many very fine tubular and interstitial pores; neutral; clear, smooth boundary.

A12—2½ to 8 inches, grayish-brown (10YR 5/2) coarse sandy loam, dark brown (10YR 3/3) when moist; massive; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine tubular pores; slightly acid; clear, smooth boundary.

B1—8 to 18 inches, pale-brown (10YR 6/3) heavy coarse sandy loam, dark yellowish brown (10YR 4/4) when moist; massive; hard, friable, slightly sticky and nonplastic; common fine and medium roots; common very fine tubular and interstitial pores and few fine tubular pores; slightly acid; clear, smooth boundary.

B2t—18 to 26 inches, light yellowish-brown (10YR 6/4) heavy coarse sandy loam, brown (7.5YR 4/4) when moist; massive; very hard, friable, slightly sticky and nonplastic; few fine and medium roots; common very fine tubular and interstitial pores; few thin clay films in pores and as bridges; slightly acid; abrupt, irregular boundary.

C—26 inches, weathered granodiorite that has many thin clay films in pores and as bridges.

Total thickness of the A horizon is about 6 to 10 inches. Depth to rock is 24 to 40 inches.

Included in mapping are small areas of Auberry coarse sandy loam, Sierra sandy loam, Auburn very rocky silt loam, and a soil that is similar to this Ahwahnee soil but has a paler surface layer.

478-431 O—74——2

Permeability of this Ahwahnee soil is moderately rapid. Surface runoff is medium, and the erosion hazard is moderate to high. The available water holding capacity is 3.5 to 5 inches. The effective rooting depth is 24 to 40 inches.

This soil is used for range. Capability unit IVe-1(18); range site 3; woodland suitability group not assigned.

Ahwahnee very rocky coarse sandy loam, 9 to 30 percent slopes (AdD).—In areas of this soil, rock outcrops occupy 5 to 25 percent of the surface.

Included in mapping are small areas of Auberry very rocky coarse sandy loam, Auburn very rocky silt loam, Chawanakee very rocky coarse sandy loam, Chaix very rocky coarse sandy loam, and Sierra very rocky sandy loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for range. Capability unit VIs-1(18); range site 3; woodland suitability group not assigned.

Ahwahnee very rocky coarse sandy loam, 30 to 50 percent slopes (AdE).—In areas of this soil, rock outcrops make up 5 to 25 percent of the surface.

Included in mapping are small areas of Auberry very rocky coarse sandy loam, Auburn very rocky silt loam, Chawanakee very rocky coarse sandy loam, Chaix very rocky coarse sandy loam, and Sierra very rocky sandy loam.

Surface runoff is rapid, and the erosion hazard is very high.

This soil is used for range and watershed. Capability unit VIIs-1(18); range site 3; woodland suitability group not assigned.

Aiken Series

The Aiken series consists of well-drained soils that are underlain by deeply weathered andesitic conglomerate at a depth of 4 feet or more. These soils are gently sloping to moderately steep on wide, smooth ridges and the sides of ridges. Slopes are 3 to 30 percent. Elevations range from 2,500 feet to 5,000 feet. The average annual precipitation, including snow, is 40 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Aiken soils are associated principally with Cohasset, Josephine, McCarthy, Musick, and Sites soils.

In a representative profile, the surface layer is brown and reddish-brown, medium acid loam and clay loam about 24 inches thick. The subsoil is red and yellowish-red, medium acid and strongly acid heavy clay loam and clay that extend to a depth of more than 72 inches.

Aiken soils are used for woodland and for deciduous fruit orchards.

Aiken loam, 3 to 9 percent slopes (AfB).—This soil is moderately sloping.

Representative profile, 8 miles northeast of Georgetown and 3 miles east of Volcanoville, 0.1 mile east and 0.45 mile south of the northwest corner of sec. 14, T. 13 N., R. 11 E.:

O1&O2—3 inches to 0, litter and duff.

A11—0 to 3 inches, brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure parting to strong, very fine, granular; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine and coarse roots; many very fine and fine interstitial and tubular pores; medium acid; abrupt, smooth boundary.

A12—3 to 9 inches, brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) when moist; massive parting to strong, very fine, granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots and common fine to coarse roots; many very fine and fine interstitial and tubular pores; medium acid; clear, smooth boundary.

A31—9 to 15 inches, brown (7.5YR 4/4) loam, dark reddish brown (5YR 3/3) when moist; strong, very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots and common fine, medium, and coarse roots; many very fine and fine interstitial and tubular pores; medium acid; clear, wavy boundary.

A32—15 to 24 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; strong, very fine, granular structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots, few medium and coarse roots; many very fine and fine interstitial and tubular pores; medium acid; clear, smooth boundary.

B1—24 to 35 inches, yellowish-red (5YR 4/6) heavy clay loam, dark reddish brown (2.5YR 3/4) when moist; weak, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots and few fine and coarse roots; many very fine and few fine tubular pores and many very fine interstitial pores; medium acid; clear, smooth boundary.

B21t—35 to 43 inches, red (2.5YR 5/6) clay, dark red (2.5YR 3/6) when moist; massive; hard, firm, sticky and plastic; few fine, medium, and coarse roots; common fine and medium tubular pores; many thin clay films in pores; strongly acid; clear, smooth boundary.

B22t—43 to 52 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) when moist; massive; hard, firm, sticky and plastic; few fine, medium, and coarse roots; common fine and medium tubular pores; many thin clay films in pores; strongly acid; clear, smooth boundary.

B31—52 to 62 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) when moist; moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; few very fine, fine, medium, and coarse roots; common fine and medium tubular pores; common thin clay films in pores and on ped faces; strongly acid; gradual, irregular boundary.

B32—62 to 72 inches, yellowish-red (5YR 5/8) clay, yellowish red (5YR 4/6) when moist; moderate, fine, angular blocky structure; hard, firm, sticky and plastic; few very fine, fine, medium, and coarse roots; common fine and medium tubular pores; common thin clay films in pores and on ped faces; strongly acid.

Depth to weathered andesitic conglomerate ranges from 4 feet to more than 10 feet, but a depth of 6 to 10 feet is most common. Total thickness of the A horizon is 15 to 30 inches. Texture of the B2t horizon ranges from heavy clay loam to clay.

Included in mapping are small areas of Cohasset loam, Aiken cobbly loam, and Iron Mountain very rocky sandy loam. A small area of a soil that has a sandy loam surface layer, on Barney Ridge southeast of Omo Ranch, also is included.

Permeability of this Aiken soil is moderately slow. Surface runoff is slow, and the erosion hazard is slight. The available water holding capacity is 7 to 10 inches. The effective rooting depth is 48 inches to more than 60 inches.

This soil is used for apple and pear orchards, pasture, and woodland. Capability unit IIe-1(22); range site not assigned; woodland suitability group 1.

Aiken loam, 3 to 9 percent slopes, eroded (AfB2).—This soil is similar to Aiken loam, 3 to 9 percent slopes, except that the surface layer is only 8 to 15 inches thick as a result of erosion. Most of the erosion took place before sprinkler irrigation and cover crops were used in the orchards.

Included in mapping are small areas of Cohasset loam and Aiken cobbly loam.

This soil is used for woodland, apple and pear orchards, and pasture. Capability unit IIe-1(22); range site not assigned; woodland suitability group 1.

Aiken loam, 9 to 15 percent slopes (AfC).—This soil is strongly sloping.

Included in mapping are small areas of Aiken cobbly loam and Cohasset loam.

The erosion hazard is slight to moderate, and runoff is slow to medium.

This soil is used for woodland, for pear and apple orchards, and for pasture. Capability unit IIIe-1(22); range site not assigned; woodland suitability group 1.

Aiken loam, 9 to 15 percent slopes, eroded (AfC2).—This soil is similar to Aiken loam, 3 to 9 percent slopes, except that the surface layer is only 8 to 15 inches thick as a result of erosion and the soil is more sloping. Most of the erosion occurred before sprinkler irrigation and cover crops were used in the orchards.

Included in mapping are small areas of Cohasset loam and Aiken cobbly loam.

The erosion hazard is slight to moderate, and runoff is slow to medium.

This soil is used for pear and apple orchards, irrigated pasture, and woodland. Capability unit IIIe-1(22); range site not assigned; woodland suitability group 1.

Aiken loam, 15 to 30 percent slopes (AfD).—This soil is similar to Aiken loam, 3 to 9 percent slopes, except that it is more sloping.

Included in mapping are small areas of Cohasset loam, Aiken cobbly loam, Iron Mountain very rocky sandy loam, McCarthy cobbly loam, Sites loam, and Musick sandy loam.

The erosion hazard is moderate, and runoff is medium.

This soil is used for woodland, apple and pear orchards, and irrigated pasture. Capability unit IVe-1(22); range site not assigned; woodland suitability group 2.

Aiken cobbly loam, 3 to 30 percent slopes (AgD).—This soil is similar to Aiken loam, 3 to 9 percent slopes, except that it is more sloping and 10 to 20 percent, by volume, of the soil mass is cobblestones. In a few small areas, there are scattered stones.

Included in mapping are small areas of Cohasset cobbly loam, Aiken loam, McCarthy cobbly loam, Iron Mountain very rocky sandy loam, Sites very rocky loam, and Musick very rocky sandy loam.

The erosion hazard is slight to moderate, and runoff is slow to medium. The available water holding capacity is 6.5 to 8 inches.

This soil is used mainly for woodland, but some areas are used for apple and pear orchards and for irrigated pasture. Capability unit IVe-1(22); range site not assigned; woodland suitability group 2.

Argonaut Series

The Argonaut series consists of well-drained soils underlain by metabasic or basic rocks at a depth of 20 to 40 inches (fig. 2). These soils are undulating to moderately steep on broad ridges. Slopes are 2 to 30 percent. Elevations generally range from 500 feet to 1,600 feet, but occasional areas are as high as 2,500 feet. The average annual rainfall is 25 to 35 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses, forbs, and areas of oaks, Digger pine, and brush. Wiregrass, sedges, and species of *Stipa* are found in some areas. Argonaut soils are associated principally with Auburn, Rescue, and Whiterock soils.

Figure 2.—**Profile of Argonaut gravelly loam, 2 to 15 percent slopes.**

In a representative profile, the surface layer is strong-brown, medium acid gravelly loam and gravelly silt loam about 7 inches thick. The subsoil is yellowish-red, yellowish-brown, and brown, medium acid and slightly acid heavy silt loam, clay, and gravelly clay. At a depth of about 30 inches is weathered metaandesite.

Argonaut soils are used for range and pasture.

Argonaut very rocky loam, 3 to 30 percent slopes (AmD).—This soil has slopes of dominantly less than 15 percent. Five to 25 percent of the surface has outcrops of bedrock.

Representative profile, 0.5 mile southwest of Latrobe and about 75 feet south of Latrobe Road, near the center of NE¼ sec. 16, T. 8 N., R. 9 E.:

A11—0 to 3 inches, strong-brown (7.5YR 5/6) gravelly loam, yellowish red (5YR 3/6) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular

and interstitial pores; medium acid; clear, smooth boundary.

A12—3 to 7 inches, strong-brown (7.5YR 5/6) gravelly silt loam, yellowish red (5YR 4/6) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores and few medium tubular pores; medium acid; clear, smooth boundary.

B1t—7 to 10 inches, yellowish-red (5YR 5/6) heavy silt loam, yellowish red (5YR 4/6) when moist; massive; hard, friable, slightly sticky and plastic; common very fine and fine roots; many very fine and fine tubular pores and few medium tubular pores; few thin films in pores; medium acid; abrupt, smooth boundary.

B21t—10 to 13 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/8) when moist; massive; very hard, firm, sticky and very plastic; few very fine roots; few fine tubular pores; many moderately thick clay films in pores; slightly acid; clear, smooth boundary.

B22t—13 to 27 inches, yellowish-brown and yellowish-red (7.5YR 5/4, 10YR 5/4, and 5YR 5/6) clay, brown and yellowish red (7.5YR 5/4, 10YR 5/3, and 5YR 4/6) when moist; massive; very hard, very firm, sticky and very plastic; few very fine roots; few fine tubular pores; many moderately thick clay films in pores; slightly acid; clear, wavy boundary.

B23t—27 to 30 inches, brown (7.5YR 4/4) gravelly clay, brown (7.5YR 4/4) when moist; massive; very hard, very firm, sticky and plastic; very few very fine roots; very few very fine pores; many moderately thick clay films in pores; slightly acid; abrupt, wavy boundary.

R—30 inches, weathered metaandesite.

The A horizon is strong brown to yellowish red or reddish brown in color, is slightly acid to medium acid, and contains common distinct mottles and black manganese stains in places. Total thickness of the A horizon is 6 to 12 inches. A stone lens or hard broken rock fragments generally are found between the A horizon and B horizon where the soil formed in metaandesite. Depth to the B21t horizon ranges from 10 to 20 inches. The depth to bedrock ranges from 20 to 40 inches.

Included in mapping are small areas of Auburn very rocky silt loam.

Permeability of this Argonaut soil is very slow. Surface runoff is slow to medium, and the erosion hazard is slight to moderate. The available water holding capacity is about 2.5 to 4.0 inches. The effective rooting depth for most plants is 20 to 30 inches, although the clay subsoil restricts root movement and available moisture.

This soil is used for range. Capability unit VIs–1(18); range site 1; woodland suitability group not assigned.

Argonaut gravelly loam, 2 to 15 percent slopes (AkC).—This soil is similar to Argonaut very rocky loam, 3 to 30 percent slopes, except that less than 5 percent of the surface has outcrops of bedrock.

Included in mapping are small areas of Auburn silt loam and Sobrante silt loam.

This soil is used for range. Occasional crops of hay and grain or irrigated pasture are grown. Capability unit IVe–3(18); range site 1; woodland suitability group not assigned.

Argonaut extremely stony loam, 15 to 30 percent slopes (AlD).—This soil is moderately steep. It formed in colluvium from metabasic rock and is underlain by slate. Three to 15 percent of the surface is covered with stones and boulders. The surface layer and upper part of the subsoil contain 20 to 50 percent, by volume, gravel, cobblestones, and stones. The depth to the underlying slate ranges from 24 to 40 inches.

Included in mapping are small areas of Auburn very rocky silt loam and Whiterock gravelly silt loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIs–1(18); range site 1; woodland suitability group not assigned.

Argonaut clay loam, 3 to 9 percent slopes (AnB).—This soil is similar to Argonaut very rocky loam, 3 to 30 percent slopes, except that it formed in material weathered from gabbrodiorite and has a slightly acid clay loam surface layer. In addition, less than 5 percent of the surface is exposed bedrock.

Included in mapping are small areas of Rescue sandy loam and Rescue clay, clayey variant.

This soil is used mainly for range. Small areas are used for irrigated pasture. Capability unit IVe–3(18); range site 1; woodland suitability group not assigned.

Argonaut Series, Seeped Variant

The Argonaut series, seeped variant, consists of poorly drained soils that are underlain by bedrock at a depth of 25 to 40 inches. These soils are nearly level to gently sloping on uplands and are in concave positions around spring and seep areas. Slopes are 0 to 5 percent. Elevations range from 1,800 feet to 4,000 feet. The average annual rainfall is 35 to 50 inches, average annual temperature is 54° F., and the frost-free season is 140 to 240 days. Vegetation consists of meadow grasses and sedges. Argonaut soils, seeped variant, are associated principally with Aiken, Cohasset, Holland, Josephine, Mariposa, and Sites soils.

In a representative profile, the surface layer is very dark grayish-brown and brown, slightly acid and medium acid loam about 8 inches thick. The subsoil is pale-brown and light olive-brown, medium acid to neutral silty clay loam and clay. Weathered gleyed slate is at a depth of about 32 inches.

Argonaut soils, seeped variant, are used for range and pasture.

Argonaut loam, seeped variant (AoB).—This soil has slopes of 0 to 5 percent.

Representative profile, 3 miles south of Georgetown, 0.7 mile south and 0.5 mile east of the northwest corner of sec. 23, T. 12 N., R. 10 E.:

A11—0 to 3 inches, very dark grayish-brown (10YR 3/2) loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

A12—3 to 8 inches, brown (10YR 5/3) loam, dark yellowish brown (10YR 3/4) when moist; moderate, medium, subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; common very fine and fine tubular pores; medium acid; gradual, wavy boundary.

B1t—8 to 17 inches, pale-brown (10YR 6/3) silty clay loam that has few, fine, distinct, yellowish-brown (10YR 5/4) mottles, dark yellowish brown (10YR 4/4) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common very fine roots; common very fine and fine tubular pores; few thin clay films on ped faces and in pores; medium acid; gradual, wavy boundary.

B21t—17 to 25 inches, light olive-brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) when moist and has many, medium, distinct, yellowish-brown (10YR 5/4) mottles when moist; moderate, medium, subangular blocky struc-

ture; very hard, firm, sticky and plastic; few fine roots; few fine tubular pores; common thin clay films on ped faces and in pores; slightly acid; gradual, wavy boundary.

B22t—25 to 32 inches, light olive-brown (2.5Y 5/4) clay that has common, fine, distinct, yellowish-brown (10YR 5/8) mottles when dry and when moist; weak, medium, prismatic structure; very hard, firm, sticky and plastic; no roots; few fine tubular pores; few thin clay films on ped faces and in pores; neutral; abrupt, wavy boundary.

C—32 inches, weathered gleyed slate.

Depth to weathered bedrock ranges from 25 to 40 inches. This soil formed in material weathered from acidic, basic, or metamorphic bedrock. The A horizon ranges from sandy loam to silt loam in texture. Total thickness of the A horizon is 6 to 10 inches. The B2t horizon ranges from heavy clay loam to clay.

Included in mapping are small areas of a soil that is similar to this Argonaut soil, except that it has a subsoil of loam to light clay loam. Also included are small areas of Wet alluvial land and Mixed alluvial land. In a few areas slopes range to about 15 percent.

Permeability of this Argonaut soil is very slow. Surface runoff is very slow to slow, and the erosion hazard is slight. The effective rooting depth is 25 to 40 inches for most roots, although some roots are restricted by the clay subsoil. This soil has a seasonal high water table at a depth of 20 to 40 inches in winter and spring that drops to a depth of more than 5 feet or disappears during summer and fall. The available water holding capacity is about 3.5 to 6 inches.

This soil is used for dryland and irrigated pasture. Capability unit IVw–2(18, 22); range site and woodland suitability group not assigned.

Auberry Series

The Auberry series consists of well-drained soils that are underlain by weathered granitic rocks, mostly at a depth of 40 inches to more than 60 inches. These soils are gently rolling to steep on foothills. Slopes are 5 to 50 percent. Elevations range from 700 to 1,800 feet. The average annual rainfall is 25 to 35 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses, forbs, oaks, and scattered ponderosa and Digger pines. Auberry soils are associated principally with Ahwahnee, Auburn, Holland, Musick, and Boomer soils.

In a representative profile, the surface layer is brown and light yellowish-brown, slightly acid coarse sandy loam about 13 inches thick. The upper part of the subsoil is very pale brown, light yellowish-brown, and yellowish-brown, slightly acid coarse sandy clay loam about 23 inches thick. The lower part of the subsoil consists of yellowish-brown, light yellowish-brown, and strong brown, slightly acid coarse sandy loam that grades to well-weathered granodiorite at a depth of 56 inches.

Auberry soils are used for range, woodland, pear and apple orchards, and irrigated pasture.

Auberry very rocky coarse sandy loam, 15 to 30 percent slopes (AtD).—This soil is moderately steep. Five to 25 percent of the surface has outcrops of bedrock.

Representative profile, 3.5 miles west of Coloma, 0.25 mile north of State Highway 49, and 1,300 feet north of the south quarter corner of sec. 2, T. 11 N., R. 9 E.:

A1—0 to 8 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 3/3) when moist; massive; slightly hard, friable, nonsticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

A3—8 to 13 inches, light yellowish-brown (10YR 6/4) coarse sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; common very fine and fine roots; many very fine and fine tubular and interstitial pores; few thin clay films as bridges and in pores; slightly acid; clear, smooth boundary.

B21t—13 to 18 inches, very pale brown (10YR 7/4) coarse sandy clay loam, dark brown (10YR 4/3) when moist; massive; very hard, friable, slightly sticky and plastic; common very fine and fine roots; many very fine and fine tubular and interstitial pores; many thin clay films as bridges and in pores; slightly acid; clear, smooth boundary.

B22t—18 to 25 inches, light yellowish-brown (10YR 6/4) coarse sandy clay loam, yellowish brown (10YR 5/4) when moist; massive; very hard, firm, slightly sticky and plastic; few very fine roots; many very fine and fine tubular and interstitial pores; many thin clay films as bridges and in pores; slightly acid; clear, smooth boundary.

B31—25 to 36 inches, yellowish-brown (10YR 5/4) light coarse sandy clay loam, brown (7.5YR 5/4) when moist; massive; very hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine, fine, and medium interstitial pores; common, yellowish-red (5YR 5/6), thin clay films as bridges; slightly acid; clear, smooth boundary.

B32—36 to 42 inches, light yellowish-brown (10YR 6/4) coarse sandy loam, brown (7.5YR 5/4) when moist; massive; very hard, firm, nonsticky and nonplastic; no roots observed; common fine and medium interstitial pores; common, strong-brown (7.5YR 5/6), thin clay films as bridges; slightly acid; clear, smooth boundary.

B33—42 to 56 inches, yellowish-brown and strong-brown (10YR 5/4, 7.5YR 5/6) light coarse sandy loam, strong brown (7.5YR 5/6) when moist; massive; very hard, very firm, nonsticky and nonplastic; no roots observed; few fine and medium interstitial pores; few thin clay films as bridges; slightly acid; clear, wavy boundary.

C—56 inches, yellow (10YR 7/6) well-weathered granodiorite, yellowish brown (10YR 5/4) when moist; few thin clay films as bridges.

Depth to weathered granodiorite ranges from 40 inches to more than 60 inches. The A horizon ranges from brown to pale brown in color. Texture of the A horizon generally is coarse sandy loam, but minor areas are sandy loam. Total thickness of the A horizon is 10 to 15 inches. The color of the B horizon ranges from brown to very pale brown, and its texture ranges from heavy sandy loam to sandy clay loam.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam, Sierra very rocky sandy loam, and Boomer very rocky loam.

Permeability of this Auberry soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is high. The available water holding capacity is 5 to 9 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used for range, woodland, and, in a few areas, pear and apple orchards. Capability unit VIs–1(18); range site 3; woodland suitability group 6.

Auberry coarse sandy loam, 5 to 9 percent slopes (ArB).—This soil is similar to Auberry very rocky coarse sandy loam, 15 to 30 percent slopes, except that less than 5 percent of the surface has rock outcrops.

Included in mapping are small areas of somewhat poorly drained soils, with or without a clay subsoil, in swale or seep positions. Also included are small areas of Ahwahnee coarse sandy loam and Sierra sandy loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for deciduous orchards and vineyards and for irrigated pasture. Capability unit IIIe-1(18); range site 3; woodland suitability group not assigned.

Auberry coarse sandy loam, 9 to 15 percent slopes (ArC).—This soil is similar to Auberry very rocky coarse sandy loam, 15 to 30 percent slopes, except that less than 5 percent of the surface has rock outcrops.

Included in mapping are small areas of Ahwahnee coarse sandy loam and Sierra sandy loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for deciduous orchards, walnuts, and vineyards and for irrigated pasture. Capability unit IVe-1(18); range site 3; woodland suitability group not assigned.

Auberry coarse sandy loam, 15 to 30 percent slopes (ArD).—This soil is similar to Auberry very rocky coarse sandy loam, 15 to 30 percent slopes, except that less than 5 percent of the surface has rock outcrops.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam, Sierra sandy loam, and Boomer gravelly loam.

Runoff is medium to rapid, and the hazard of erosion is moderate to high.

This soil is used mainly for range. A few areas remain in woodland. Some areas are used for deciduous orchards, walnuts, and irrigated pasture. Capability unit VIe-1(18); range site 3; woodland suitability group not assigned.

Auberry rocky coarse sandy loam, 5 to 15 percent slopes (AsC).—This soil is similar to Auberry very rocky coarse sandy loam, 15 to 30 percent slopes, except that 5 to 10 percent of the surface has rock outcrops.

Included in mapping are small areas of Ahwahnee coarse sandy loam and Sierra rocky sandy loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for range, pear and apple orchards, walnuts, and irrigated pasture. Capability unit IVe-7(18); range site 3; woodland suitability group not assigned.

Auberry very rocky coarse sandy loam, 30 to 50 percent slopes (AtE).—This soil is similar to Auberry very rocky coarse sandy loam, 15 to 30 percent slopes, except that it is more sloping.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam, Sierra very rocky sandy loam, Boomer very rocky loam, and Chawanakee very rocky coarse sandy loam.

Surface runoff is rapid, and the erosion hazard is very high.

This soil is used for range and woodland. Capability unit VIIs-1(18); range site 3; woodland suitability group 6.

Auberry very rocky coarse sandy loam, moderately deep, 9 to 30 percent slopes (AuD).—This soil is similar to Auberry very rocky sandy loam, 15 to 30 percent slopes, except that it is thinner and the depth to weathered granitic rock ranges from 24 to 40 inches.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam, Sierra very rocky coarse sandy loam, and Boomer very rocky loam.

The effective rooting depth is 24 to 40 inches. The available water holding capacity is 3 to 5 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

This soil is used for range and woodland. Capability unit VIs-1(18); range site 3; woodland suitability group 7.

Auburn Series

The Auburn series consists of well-drained soils that are underlain by hard metamorphic rocks at a depth of 12 to 26 inches. These soils are undulating to very steep on foothills. Slopes are 2 to 70 percent. Elevations range from 500 feet to 1,800 feet. The average annual rainfall is 25 to 35 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses, forbs, and oaks, and there are scattered areas of Digger pine and brush. Auburn soils are associated principally with Argonaut, Boomer, Sobrante, and Whiterock soils.

In a representative profile (fig. 3), the surface layer is brown, slightly acid silt loam about 3 inches thick. The subsoil is reddish-yellow, slightly acid silt loam. Weathered metabasic rock is at a depth of about 14 inches.

Auburn soils are used mainly for range. A few small areas are used for irrigated pasture.

Auburn very rocky silt loam, 2 to 30 percent slopes (AxD).—This soil is gently sloping to moderately steep. Outcrops of bedrock cover 5 to 25 percent of the surface.

Representative profile, 5 miles west of Shingle Springs, 2,000 feet west and 1,200 feet south of the northeast corner of sec. 7, T. 9 N., R. 9 E.:

A1—0 to 3 inches, brown (7.5YR 5/4) silt loam, dark reddish brown (5YR 3/3) when moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine and fine pores; slightly acid; clear, wavy boundary.

B2—3 to 14 inches, reddish-yellow (5YR 6/8) silt loam, dark reddish brown (5YR 3/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; slightly acid; abrupt, wavy boundary.

R—14 inches, weathered metabasic rock.

Depth to bedrock ranges from 12 to 26 inches. As much as 25 percent of the soil mass consists of gravel- and cobblestone-size rock fragments. The color of the A horizon ranges from reddish brown or brown to yellowish red. The texture is loam or silt loam. The total thickness of the A horizon is 3 to 10 inches. There is a slight increase in clay content in the B horizon. Reaction is slightly acid or neutral.

Included in mapping are small areas of Argonaut very rocky loam, Boomer very rocky loam, and Sobrante very rocky silt loam. In the Folsom Reservoir area, there is a soil similar to this Auburn soil that has a darker colored surface layer and formed on mica schist.

Permeability of this Auburn soil is moderate. Surface runoff is slow to medium, and the erosion hazard is slight to moderate. The available water holding capacity is 2 to 4 inches. The effective rooting depth is 12 to 26 inches.

This soil is used for range. A few small areas are used as irrigated pasture. Capability unit VIs-1(18); range site 1; woodland suitability group not assigned.

Auburn silt loam, 2 to 30 percent slopes (AwD).—This soil has slopes that are dominantly between 5 and 15 percent. It is similar to Auburn very rocky silt loam, 2 to 30

Figure 3.—**Profile of Auburn very rocky silt loam, 2 to 30 percent slopes.**

percent slopes except that less than 5 percent of the surface is exposed bedrock.

Included in mapping are small areas of Argonaut gravelly loam; Perkins gravelly loam, moderately deep variant; and Sobrante silt loam.

This soil is used for range, irrigated pasture, and some dryland hay and grain. Capability unit IVe-8(18); range site 1; woodland suitability group not assigned.

Auburn very rocky silt loam, 30 to 50 percent slopes (AxE).—This soil is steep in the more prominent foothills and slopes that drop into creek channels and drainageways.

Included in mapping are small areas of Boomer very rocky loam. In the Folsom Reservoir area, there is a soil similar to this Auburn soil that has a darker surface layer and formed from mica schist.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

This soil is used for range. Capability unit VIIs-1(18); range site 1; woodland suitability group not assigned.

Auburn extremely rocky silt loam, 3 to 70 percent slopes (AyF).—This soil has slopes that dominantly range from 15 to 50 percent. It is similar to Auburn very rocky silt loam, 2 to 30 percent slopes, except that 25 to 50 percent of the surface has rock outcrops and the depth to bedrock ranges from 12 to 20 inches.

Included in mapping are small areas of Metamorphic rock land.

The available water holding capacity of this Auburn soil is 2 to 4 inches. Surface runoff is slow to very rapid, and the erosion hazard is slight to very high. The effective rooting depth is 12 to 20 inches.

This soil is used for range. Capability unit VIIs-1(18); range site 1; woodland suitability group not assigned.

Auburn Series, Heavy Subsoil Variant

The Auburn series, heavy subsoil variant, consists of well-drained soils that are underlain at a depth of 8 to 27 inches by vertically tilted schists and slates of the Calaveras Formation. These soils are rolling to steep on foothills. Slopes are 9 to 50 percent. Elevations range from 1,000 feet to 1,700 feet. The average annual precipitation is 30 to 35 inches, average annual temperature is 59° F., and the frost-free season is 170 to 270 days. Vegetation is chamise brush and open areas of annual grass and oaks. Auburn soils, heavy subsoil variant, are associated principally with normal Auburn soils.

In a representative profile, the surface layer is light-brown, medium acid gravelly light clay loam about 4 inches thick. The subsoil is light yellowish-brown and pink, slightly acid cobbly and very cobbly clay loam about 23 inches thick. The parent material is slightly weathered Calaveras slate.

Auburn soils, heavy subsoil variant, are used for range and watershed.

Auburn cobbly clay loam, heavy subsoil variant, 9 to 50 percent slopes (AzE).—This soil is strongly sloping to steep.

Representative profile, 1.5 miles west of El Dorado, 0.3 mile west of U.S. Highway 50, and 0.1 mile east of the southwest corner of sec. 27, T. 10 N., R. 10 E.:

A1—0 to 4 inches, light-brown (7.5YR 6/4) gravelly light clay loam, reddish brown (5YR 4/4) when moist; massive; hard, friable, sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine tubular pores and few fine tubular pores; common thin clay films in pores and as bridges; medium acid; clear, smooth boundary.

B21t—4 to 13 inches, light reddish-brown (5YR 6/4) cobbly clay loam, yellowish red (5YR 4/6) when moist; massive; hard, friable, sticky and plastic; common very fine, fine, medium, and coarse roots; common very fine tubular pores and few fine tubular pores; many thin clay films in pores and as bridges; slightly acid; gradual, smooth boundary.

B22t—13 to 27 inches, pink (7.5YR 7/4) very cobbly clay loam, strong brown (7.5YR 5/6) when moist; massive; hard, friable, sticky and plastic; few fine roots and common medium roots; common very fine tubular pores and few fine tubular pores; many thin clay films in pores and as bridges; slightly acid; clear, irregular boundary.

R—27 inches, slightly weathered Calaveras slate.

Depth to parent material ranges from 8 to 27 inches. The A horizon ranges from light brown to yellowish red in color and from gravelly loam to gravelly light clay loam in texture. The thickness of the A horizon is 2 to 4 inches. The lower part of the B horizon is 50 to 80 percent fragments of slate that are 3 to 8 inches long. In many places the parent rock interrupts the B horizon.

Included in mapping are small areas of Auburn very rocky silt loam and Metamorphic rock land.

Permeability of this Auburn soil, heavy subsoil variant, is moderate. Surface runoff is medium to rapid, and the erosion hazard is moderate to high. The available water holding capacity is 1 to 3 inches. The effective rooting depth is 8 to 27 inches.

This soil is used for range and watershed. Capability unit VIIs-1(18); range site 1; woodland suitability group not assigned.

Boomer Series

The Boomer series consists of well-drained soils that are underlain by basic schists at a depth of 24 to 52 inches. These soils are undulating to very steep on uplands. Slopes are 3 to 70 percent. Elevations are 1,000 to 3,500 feet. The average annual precipitation is 35 to 50 inches, average annual temperature is 57° F., and the frost-free season is 170 to 270 days. Vegetation is mainly coniferous forest and annual grasses. Boomer soils are associated principally with Auburn and Sites soils.

In a representative profile, the surface layer is yellowish-red, medium acid gravelly loam about 13 inches thick. The subsoil is red, medium acid gravelly clay loam to very gravelly sandy clay loam about 39 inches thick. This is underlain by basic schist at a depth of about 52 inches.

Boomer soils are used for woodland and range.

Boomer very rocky loam, 30 to 50 percent slopes (BkE).—This soil is in the transition zone between areas of grass and oak trees and coniferous forest. Rock outcrops cover 5 to 25 percent of the surface.

Representative profile, 6 miles northwest of Coloma and 0.25 mile east of the west quarter corner of sec. 33, T. 12 N., R. 9 E.:

O1&O2—1 inch to 0, pine needles and decomposing litter.

A1—0 to 5 inches, yellowish-red (5YR 5/6) gravelly loam, dark reddish brown (5YR 3/4) when moist; moderate, medium and fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and common fine roots; many very fine tubular pores; medium acid; clear, smooth boundary.

A3—5 to 13 inches, yellowish-red (5YR 5/6) gravelly loam, dark reddish brown (5YR 3/4) when moist; moderate, medium subangular blocky structure and weak, medium and fine, granular structure; slightly hard, friable, sticky and plastic; many very fine and fine roots and common medium roots; many very fine and fine tubular and intersitial pores and few medium tubular pores; few thin clay films in pores; medium acid; clear, smooth boundary.

B21t—13 to 24 inches, red (2.5YR 4/6) gravelly clay loam, dark red (2.5YR 3/6) when moist; moderate, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine, fine, medium, and coarse roots; many very fine tubular and interstitial pores and few fine tubular pores; many thin clay films in pores; medium acid; clear, smooth boundary.

B22t—24 to 37 inches, red (2.5YR 4/8) gravelly sandy clay loam, dark red (2.5YR 3/6) and yellowish red (5YR 4/6) when moist; moderate, medium and fine, subangular blocky structure; hard, firm, sticky and plastic; few fine, medium, and coarse roots; many very fine tubular and interstitial pores and few fine tubular pores; many thin clay films in pores; medium acid; gradual, smooth boundary.

B31t—37 to 52 inches, red (2.5YR 4/6) very gravelly sandy clay loam, red (2.5YR 4/6) and yellowish red (5YR 4/6) when moist; massive; hard, firm, sticky and plastic; very few fine, medium, and coarse roots; few fine pores; many thin clay films as bridges and coating gravel; medium acid; clear, slightly wavy boundary.

R—52 inches, well-fractured schist that has dark-red (2.5YR 3/6) sandy clay loam in cracks, variable dark red (2.5YR 3/6), yellowish red (5YR 4/6), and strong brown (7.5YR 5/6) when moist; firm, sticky and slightly plastic; many thin clay films as bridges and coats on gravel; medium acid.

As much as 35 percent of the soil mass consists of gravel- and cobblestone-sized rock fragments. The A horizon is 10 to 15 inches thick and is brown to yellowish red in color. The B horizon is reddish brown to red and is medium acid or slightly acid. Depth to rock is 24 to 52 inches.

Included in mapping are small areas of Auburn silt loam and Sites loam.

Permeability of this Boomer soil is moderately slow. Surface runoff is rapid, and the erosion hazard is high. The available water holding capacity is 4 to 7 inches. The effective rooting depth is 24 to 52 inches.

This soil is used for range and woodland. Capability unit VIs-1(22); range site 2; woodland suitability group 5.

Boomer gravelly loam, 3 to 15 percent slopes (BhC).—This soil is similar to Boomer very rocky loam, 30 to 50 percent slopes, except that less than 5 percent of the surface has exposed rock outcrops.

Included in mapping are small areas of Auburn silt loam, Argonaut gravelly loam, and Sobrante silt loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used mainly for range and woodland. A few small areas are used for dryland or irrigated pasture, grain, and deciduous orchards. Capability unit IIIe-1(22); range site 2; woodland suitability group 4.

Boomer gravelly loam, 15 to 30 percent slopes (BhD).—This soil is similar to Boomer very rocky loam, 30 to 50 percent slopes, except that less than 5 percent of the surface has exposed rock outcrops.

Included in mapping are small areas of Auburn silt loam and Sobrante silt loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for range and woodland. A few areas are used for dryland and irrigated pasture and pear and apple orchards. Capability unit IVe-1(22); range site 2; woodland suitability group 4.

Boomer very rocky loam, 3 to 30 percent slopes (BkD).—This soil is similar to Boomer very rocky loam, 30 to 50 percent slopes, except that it is less sloping.

Included in mapping are small areas of Auburn very rocky silt loam, Argonaut very rocky loam, Sites very rocky loam, and Sobrante very rocky silt loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used for range, irrigated or dryland pasture, and woodland. Capability unit VIs-1(22); range site 2; woodland suitability group 4.

Boomer very rocky loam, 50 to 70 percent slopes (BkF).—This soil is adjacent to the major drainageways, and depth to the parent rock ranges from 24 to 40 inches.

Included in mapping are small areas of Auburn very rocky silt loam, Sites very rocky loam, and Metamorphic rock land.

Surface runoff is rapid, and the erosion hazard is high. The available water holding capacity is 4 to 6 inches for the 24- to 40-inch rooting depth.

This soil is used for woodland, range, and watershed. Capability unit VIIs-1(22); range site 2; woodland suitability group 6.

Boomer-Sites loams, 9 to 15 percent slopes (BpC).—These soils are rolling on uplands at elevations of about 2,000 feet to 3,500 feet. Boomer loam makes up about 55 percent of the complex. Slopes are convex. About 35 percent of this complex is Sites loam, which occupies plane and slightly concave toe slopes. About 10 percent of the complex is included areas of Mariposa gravelly silt loam and Josephine silt loam. Small areas near the Kelsey Lumber Company have a surface layer of clay loam.

The profile of the Boomer soil is similar to the one described for Boomer very rocky loam, 30 to 50 percent slopes, and the profile of the Sites soil is similar to the one described for Sites loam, 15 to 30 percent slopes.

Surface runoff is medium, and the erosion hazard is slight to moderate.

Soils in this complex are used for woodland and deciduous orchards. Capability unit IIIe-1(22); range site not assigned; woodland suitability group 4.

Boomer-Sites loams, 15 to 30 percent slopes (BpD).—These soils have a profile similar to the one described as representative for their respective series, but they are strongly sloping. Boomer soils make up 55 percent and Sites soils make up 35 percent of this complex. Included areas of Mariposa and Josephine soils make up the remaining 10 percent.

Surface runoff is medium, and the erosion hazard is moderate.

Soils of this complex are used for woodland and deciduous orchards. Capability unit IVe-1(22); range site not assigned; woodland suitability group 5.

Boomer-Sites very rocky loams, 9 to 50 percent slopes (BrE).—These soils have slopes of 9 to 50 percent, and 5 to 25 percent of the surface has rock outcrops and slate fragments. Otherwise, they have profiles similar to those described as representative for their respective series. Boomer soils make up 55 percent and Sites soils make up 35 percent of this complex. About 10 percent of the complex is included areas of Mariposa very rocky silt loam, Josephine very rocky loam, and Josephine very rocky silt loam.

Soils of this complex are used for woodland. Capability unit VIs-1(22); range site not assigned; woodland suitability group 5.

Chaix Series

The Chaix series consists of well-drained soils that are underlain by weathered granitic rock at a depth of 24 to 40 inches. These soils are rolling to very steep on mountainous uplands. Slopes are 9 to 70 percent. Elevations range from 2,000 feet to 4,000 feet. The average annual precipitation, including snow, is 35 to 50 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods, and there are scattered areas of brush. Chaix soils are associated principally with Chawanakee, Holland, and Shaver soils.

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In a representative profile, the surface layer is dark grayish-brown, slightly acid coarse sandy loam about 8 inches thick. The subsoil and substratum are brown and pale-brown, medium acid coarse sandy loam about 26 inches thick. The parent material is weathered granodiorite rock and is at a depth of about 34 inches.

Chaix soils are used for woodland.

Chaix very rocky coarse sandy loam, 9 to 50 percent slopes (CcE).—This soil is strongly sloping to steeply sloping. Rock outcrops cover 5 to 25 percent of the surface.

Representative profile in a wooded area, 3 miles north of Aukum, 0.4 mile west and 0.1 mile south of the northeast corner of sec. 35, T. 9 N., R. 11 E.:

O1&O2—2 inches to 0, litter and duff.

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; massive; soft, very friable, nonsticky and nonplastic; many very fine, medium, and coarse roots; many very fine and fine interstitial pores; slightly acid; clear, smooth boundary.

B2—8 to 18 inches, brown (10YR 5/3) coarse sandy loam, dark yellowish brown (10YR 3/4) when moist; massive; soft, very friable, nonsticky and nonplastic; many very fine, medium, and coarse roots; many very fine and fine interstitial pores; medium acid; clear, smooth boundary.

C1—18 to 34 inches, pale-brown (10YR 6/3) coarse sandy loam, brown (10YR 4/3) when moist; massive; soft, friable, nonsticky and nonplastic; common fine and medium roots; many very fine and fine interstitial pores; medium acid; clear, smooth boundary.

C2—34 inches, weathered granodiorite.

The A horizon ranges from dark grayish brown or brown to light gray in color. Reaction is medium acid to slightly acid. Texture is coarse sandy loam to sandy loam. The total thickness of the A horizon is about 3 to 8 inches. The B horizon ranges from very pale brown to brown in color. Reaction is medium acid to strongly acid.

Included in mapping are small areas of Chawanakee very rocky coarse sandy loam, Ahwahnee very rocky coarse sandy loam, Hotaw very rocky coarse sandy loam, and Mariposa very rocky silt loam.

Permeability of this Chaix soil is moderately rapid. Surface runoff is medium to rapid, and the erosion hazard is high. The available water holding capacity is 3 to 5 inches. The effective rooting depth is 24 to 40 inches.

This soil is used mainly for woodland. Capability unit VIIs-1(22); range site not assigned; woodland suitability group 6.

Chaix very rocky coarse sandy loam, 50 to 70 percent slopes (CcF).—This soil is adjacent to major rivers and streams.

Included in mapping are a few areas of a soil similar to this Chaix soil that is more than 40 inches deep over granodiorite bedrock. Small areas of Acidic rock land, Holland very rocky coarse sandy loam, and Mariposa very rocky silt loam also are included.

Surface runoff is rapid, and the erosion hazard is very high.

This soil is used for woodland and watershed. Capability unit VIIs-1(22); range site not assigned; woodland suitability group 6.

Chawanakee Series

The Chawanakee series consists of excessively drained soils that are underlain by weathered granitic rock at a depth of 10 to 24 inches. These soils are rolling to steep on

uplands. Slopes are 9 to 50 percent. Elevations range from 1,200 feet to 2,400 feet. The average annual precipitation, including snow, is 25 to 40 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly mixed coniferous forest, brush, and grass. Chawanakee soils are associated principally with Auberry, Ahwahnee, Shaver, and Holland soils.

In a representative profile, the surface layer is grayish-brown, slightly acid coarse sandy loam about 3 inches thick. The next layer, about 13 inches thick, is pale-brown and light brownish-gray, slightly acid coarse sandy loam. Weathered granitic rock is at a depth of about 16 inches.

Chawanakee soils are used for woodland and watershed.

Chawanakee very rocky coarse sandy loam, 9 to 50 percent slopes (ChE).—This soil is strongly sloping to steep. It is adjacent to the major drainageways. Outcrops of bedrock cover 5 to 25 percent of the surface.

Representative profile, 1.5 miles south of Somerset, 100 feet west of Mt. Aukum road, 1/8 mile south and 1/8 mile east of the northwest corner of sec. 19, T. 9 N., R. 12 E.:

O1&O2—1/2 inch to 0, pine litter and duff.

A1—0 to 3 inches, grayish-brown (10YR 5/2) coarse sandy loam, dark brown (10YR 3/3, 4/3) when moist; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; slightly acid; clear, smooth boundary.

AC—3 to 9 inches, pale-brown (10YR 6/3) coarse sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots and few coarse roots; many very fine and fine interstitial pores; slightly acid; clear, smooth boundary.

C1—9 to 16 inches, light brownish-gray (10YR 6/2) coarse sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many very fine and fine interstitial pores; slightly acid; abrupt, irregular boundary.

C2—16 inches, decomposed granodiorite.

Depth to weathered granodiorite ranges from 10 to 24 inches. Reaction is slightly acid to medium acid. Thickness of the A horizon is 3 to 6 inches.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam, Chaix very rocky coarse sandy loam, Acidic rock land, and Gullied land.

Permeability of this Chawanakee soil is moderately rapid. Surface runoff is medium to rapid, and the erosion hazard is moderate to high. The available water holding capacity is 1 to 3 inches. The effective rooting depth is 10 to 24 inches.

This soil is used for woodland and watershed. Capability unit VIIs-1(22); range site not assigned; woodland suitability group 7.

Cohasset Series

The Cohasset series consists of well-drained soils that are underlain by weathered andesitic conglomerate at a depth of more than 40 inches. These soils are gently sloping to strongly sloping on smooth ridges or are moderately steep to steep on sides of ridges. Slopes are 3 to 50 percent. Elevations range from 2,000 feet to 5,500 feet. The average annual precipitation, including snow, is 40 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Cohasset soils are associated principally with Aiken, McCarthy, Josephine, and Sites soils.

In a representative profile, the surface layer is brown and reddish-brown, slightly acid cobbly loam about 14 inches thick. The subsoil is reddish-brown and yellowish-red, medium acid cobbly heavy loam and cobbly clay loam about 32 inches thick. The parent rock is slightly weathered andesitic conglomerate, and it is at a depth of about 46 inches.

Cohasset soils are used for woodland and for deciduous fruit orchards.

Cohasset cobbly loam, 15 to 50 percent slopes (CoE).—This soil is strongly sloping to steep (fig. 4).

Representative profile, 0.5 mile north of Sly Park Guard Station and 0.7 mile northwest of intersection of Sly Park Road and Rainbow Trail (Sly Park Hills), 1,000 feet northeast of the west quarter corner of sec. 18, T. 10 N., R. 13 E.:

O1&O2—2 inches to 0, litter and duff.

A11—0 to 6 inches, brown (7.5YR 5/4, 4/4) cobbly loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular and subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

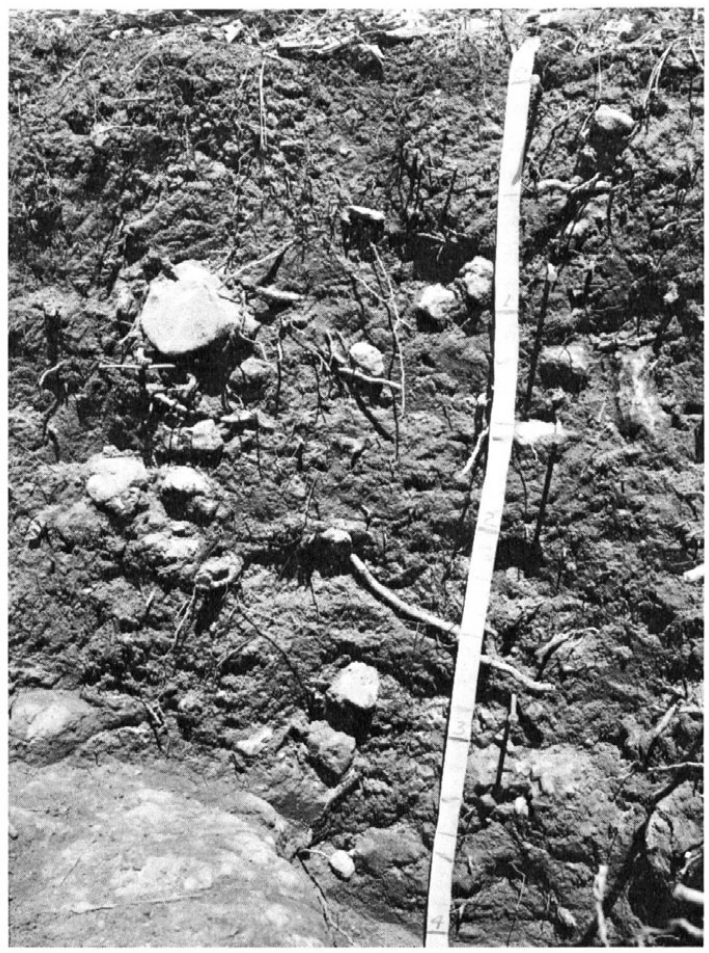

Figure 4.—**Profile of Cohasset cobbly loam, 15 to 50 percent slopes.**

A12—6 to 14 inches, reddish-brown (5YR 4/4) cobbly loam, dark reddish brown (5YR 3/4) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many very fine and fine tubular and interstitial pores; slightly acid; gradual, smooth boundary.

B1t—14 to 22 inches, reddish-brown (5YR 5/4) cobbly heavy loam, dark reddish brown (5YR 3/4) when moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many very fine and fine tubular and interstitial pores; few thin clay films in pores; medium acid; gradual, smooth boundary.

B2t—22 to 35 inches, yellowish-red (5YR 5/6) cobbly clay loam, dark reddish brown (5YR 3/4) when moist; massive; hard, slightly firm, sticky and plastic; many fine, medium, and coarse roots; common very fine and fine tubular and interstitial pores; many thin clay films in pores and as bridges; medium acid; gradual, smooth boundary.

B3t—35 to 46 inches, yellowish-red (5YR 5/6) cobbly heavy loam, reddish brown (5YR 4/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; common fine, medium, and coarse roots; common very fine and fine tubular and interstitial pores; common thin clay films in pores and as bridges; medium acid; clear, irregular boundary.

R—46 inches, slightly weathered andesitic conglomerate.

The A horizon is 10 to 30 percent cobblestones, and the B horizon is 20 to 35 percent cobblestones. The A horizon is slightly acid to medium acid in reaction. Total thickness of the A horizon is about 14 to 30 inches. The B horizon is medium acid to strongly acid and ranges from yellowish red to reddish yellow or reddish brown.

Included in mapping are small areas of Aiken cobbly loam, Crozier cobbly loam, McCarthy cobbly loam, Josephine very rocky silt loam, Sites very rocky loam, and Iron Mountain very rocky sandy loam.

Permeability of this Cohasset soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is moderate to high. The available water holding capacity is 6 to 10 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used for woodland. Capability unit VIe–1 (22); range site not assigned; woodland suitability group 2.

Cohasset sandy loam, 15 to 30 percent slopes (CkD).—This soil is on Barney Ridge near Omo Ranch. It contains less than 5 percent cobblestones. The surface layer is dark grayish-brown to brown, medium acid sandy loam. The subsoil is reddish-brown heavy loam.

Included in mapping are small areas of Cohasset cobbly loam, Cohasset cobbly sandy loam, McCarthy cobbly loam, and Aiken loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for woodland. Capability unit IVe–1 (22); range site not assigned; woodland suitability group 2.

Cohasset cobbly sandy loam, 9 to 50 percent slopes (ClE).—This soil is on Barney Ridge near Omo Ranch. The surface layer is dark grayish-brown to brown, medium acid cobbly sandy loam. The subsoil is reddish-brown heavy loam.

Included in mapping are areas of Cohasset sandy loam, Cohasset cobbly loam, McCarthy cobbly loam, and Iron Mountain very rocky sandy loam.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

The soil is used for woodland. Capability unit VIe–1 (22); range site not assigned; woodland suitability group 2.

Cohasset loam, 3 to 9 percent slopes (CmB).—This soil is similar to Cohasset cobbly loam, 15 to 50 percent slopes, except that it has less than 5 percent cobblestones in the profile.

Included in mapping are small areas of Aiken loam, Cohasset cobbly loam, Crozier cobbly loam, and McCarthy cobbly loam.

Surface runoff is slow to medium, and the erosion hazard is slight.

This soil is used for deciduous orchards and woodland. Capability unit IIe–1 (22); range site not assigned; woodland suitability group 1.

Cohasset loam, 9 to 15 percent slopes (CmC).—This soil is similar to Cohasset cobbly loam, 15 to 50 percent slopes, except that it has less than 5 percent cobblestones, by volume, throughout the profile.

Included in mapping are small areas of Aiken loam, Cohasset cobbly loam, Crozier cobbly loam, Sites loam, and Josephine loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for deciduous orchards and woodland. Capability unit IIIe–1 (22); range site not assigned; woodland suitability group 1.

Cohasset loam, 15 to 30 percent slopes (CmD).—This soil is similar to Cohasset cobbly loam, 15 to 50 percent slopes, except that it contains less than 5 percent cobblestones, by volume.

Included in mapping are small areas of Aiken loam, Cohasset cobbly loam, Crozier cobbly loam, McCarthy cobbly loam, Sites loam, and Josephine silt loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for deciduous orchards and woodland. Capability unit IVe–1 (22); range site not assigned; woodland suitability group 2.

Cohasset cobbly loam, 3 to 15 percent slopes (CoC).—This soil is similar to Cohasset cobbly loam, 15 to 50 percent slopes, except that it has a surface layer that is 10 to 20 percent cobblestones and a subsoil that is 10 to 25 percent cobblestones.

Included in mapping are small areas of Aiken cobbly loam, Cohasset loam, Crozier cobbly loam, McCarthy cobbly loam, and Iron Mountain very rocky sandy loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used mainly for woodland. Some areas are used for apple and pear orchards. Capability unit IIIe–1 (22); range site not assigned; woodland suitability group 1.

Crozier Series

The Crozier series consists of well-drained soils that are underlain by andesitic conglomerate at a depth of 24 to 40 inches. These soils are strongly sloping on ridges and moderately steep and steep on sides of ridges. Slopes are 9 to 50 percent. Elevations are 2,000 to 5,500 feet. The average annual precipitation, including snow, is 40 to 60 inches, average annual temperature is 55° F., and the frost-free

season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Crozier soils are associated principally with Aiken, Cohasset, and McCarthy soils.

In a representative profile, the surface layer is brown and reddish-brown, slightly acid and medium acid cobbly loam about 16 inches thick. The subsoil is yellowish-red, medium acid and strongly acid cobbly heavy loam and cobbly clay loam about 20 inches thick. The parent material, at a depth of about 36 inches, consists of weathered andesitic breccia.

Crozier soils are used for woodland.

Crozier cobbly loam, 9 to 50 percent slopes (CrE).—This soil occupies andesitic ridges and their side slopes.

Representative profile in a wooded area, 4 miles southeast of Placerville and 0.25 mile south of the northeast corner of sec. 27, T. 10 N., R. 11 E.:

O1&O2—1 inch to 0, litter and duff.

A1—0 to 10 inches, brown (7.5YR 4/4) cobbly loam, dark reddish brown (5YR 3/3) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

A3—10 to 16 inches, reddish-brown (5YR 4/4) cobbly loam, dark reddish brown (5YR 3/4) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular and interstitial pores; medium acid; clear, smooth boundary.

B1t—16 to 23 inches, yellowish-red (5YR 4/6) cobbly heavy loam, dark reddish brown (5YR 3/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine and fine tubular and interstitial pores; common thin clay films in pores and as bridges; medium acid; gradual, smooth boundary.

B2t—23 to 36 inches, yellowish-red (5YR 4/6) cobbly clay loam, dark reddish brown (5YR 3/4) when moist; massive; hard, friable, sticky and plastic; many medium and coarse roots; many fine and medium tubular pores; many thin clay films in pores and as bridges; strongly acid; clear, wavy boundary.

R—36 inches, andesitic breccia, weathered in upper few inches.

The A horizon is 10 to 30 percent cobblestones, and the B horizon is 20 to 35 percent cobblestones. The total thickness of the A horizon is about 7 to 16 inches. The color of the B horizon ranges from yellowish red to reddish brown in a hue of 5YR.

Included in mapping are small areas of Cohasset cobbly loam, McCarthy cobbly loam, and Iron Mountain very rocky sandy loam.

Permeability of this Crozier soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is moderate to high. The available water holding capacity is 3 to 6 inches. The effective rooting depth is 24 to 40 inches.

This soil is used mainly for woodland. Capability unit VIe–1(22); range site not assigned; woodland suitability group 5.

Delpiedra Series

The Delpiedra series consists of somewhat excessively drained soils that are underlain by hard serpentine rock at a depth of 10 to 24 inches. These soils are on foothills. Slopes are 3 to 50 percent. Elevations range from 500 to 1,800 feet. The average annual rainfall is 25 to 35 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses, forbs, brush, and Digger pine. Delpiedra soils are associated principally with Auburn and Rescue soils and Serpentine rock land.

In a representative profile, the surface layer is reddish-brown, slightly acid loam about 2 inches thick. The subsoil is reddish-brown and yellowish-red, slightly acid and neutral clay loam about 10 inches thick. The parent rock, at a depth of about 12 inches, is hard ultrabasic rock, mainly serpentine.

Delpiedra soils are used for annual range and watershed.

Delpiedra very rocky loam, 3 to 50 percent slopes (DeE).—This soil is gently sloping to steep. Outcrops of bedrock cover 5 to 25 percent of the surface.

Representative profile, 3 miles southwest of Lotus, on the right side of a dirt road, near the south sixteenth corner of the west section line of sec. 26, T. 11 N., R. 9 E.:

A1—0 to 2 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 2/2) when moist; weak, fine, granular structure and weak, fine, subangular blocky; slightly hard, friable, slightly plastic and nonsticky; many fine roots; slightly acid; abrupt, smooth boundary.

B21t—2 to 7 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (2.5YR 2/4) when moist; moderate, medium, subangular blocky structure; hard, firm, plastic and slightly sticky; few roots; many thin clay films in pores and on ped faces; slightly acid; gradual, smooth boundary.

B22t—7 to 12 inches, yellowish-red (5YR 4/6) clay loam, dark reddish brown (2.5YR 2/4) when moist; moderate, medium, subangular blocky structure; slightly hard, friable, plastic and sticky; few roots; many thin clay films in pores and on ped faces; neutral; abrupt, wavy boundary.

C—12 inches, fractured, partly decomposed serpentine.

Depth to bedrock ranges from 10 to 24 inches. Total thickness of the A horizon is about 2 to 8 inches. The B horizon ranges from heavy loam to clay loam in texture.

Included in mapping are small areas of Auburn very rocky silt loam and Serpentine rock land.

Permeability of this Delpiedra soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is slight to high. The available water holding capacity is 2 to 4 inches. The effective rooting depth is 10 to 24 inches.

This soil is used for range and watershed. Capability unit VIIs–1(18); range site 5; woodland suitability group not assigned.

Diamond Springs Series

The Diamond Springs series consists of well-drained soils that are underlain by fine-grained acid igneous rocks at a depth of 24 to 50 inches. These soils formed on mountainous uplands. Slopes are 3 to 50 percent. Elevations range from 1,200 to 2,000 feet. The average annual precipitation, including snow, is 30 to 40 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly grass and oak trees and coniferous forest. Diamond Springs soils are associated principally with Auberry, Auburn, and Boomer soils.

In a representative profile, the surface layer is pale brown and very pale brown, medium acid and very strongly acid very fine sandy loam and loam about 9 inches thick. The subsoil is very pale brown, very strongly acid clay loam about 19 inches thick. The substratum is white, very strongly acid clay loam and strongly acid coarse sandy clay

loam. The parent rock is fine-grained metamorphic acid igneous rock and is at a depth of about 40 inches.

Diamond Springs soils are used for deciduous orchards, woodland, and range.

Diamond Springs very fine sandy loam, 3 to 9 percent slopes (DfB).—This soil is moderately sloping.

Representative profile, 0.5 mile west of El Dorado, 75 feet east of Missouri Flat Road, 300 feet south of the railroad tracks, and 0.1 mile west and 0.15 mile south of the northeast corner of sec. 34, T. 10 N., R. 10 E.:

A11—0 to 3 inches, pale-brown (10YR 6/3) very fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular and interstitial pores; medium acid; abrupt, slightly wavy boundary.

A12—3 to 9 inches, very pale brown (10YR 7/3) loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots, many medium roots, and few coarse roots; many very fine and fine tubular pores and common medium tubular pores; very strongly acid; few krotovinas; clear, slightly wavy boundary.

B1t—9 to 14 inches, very pale brown (10YR 8/4) light clay loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable, sticky and plastic; common very fine and fine roots and many medium roots; many very fine and fine tubular pores and common medium tubular pores; common thin clay films in pores; very strongly acid; few krotovinas; clear, slightly wavy boundary.

B21t—14 to 20 inches, very pale brown (10YR 8/4, 7/4) clay loam, light yellowish brown (10YR 6/4) when moist; massive; hard, firm, sticky and plastic; few fine roots and common medium roots; many very fine and fine tubular pores and common medium tubular pores; many moderately thick clay films in pores and as bridges; very strongly acid; gradual, smooth boundary.

B22t—20 to 28 inches, very pale brown (10YR 8/4) clay loam, light yellowish brown (10YR 6/4) when moist; massive; very hard, firm, very sticky and plastic; few fine roots; common very fine pores and few fine pores; continous clay films, light brown (7.5YR 6/4) and reddish brown (5YR 4/4) to strong brown (7.5YR 5/6) when moist, moderately thick in pores and as bridges; very strongly acid; clear, wavy boundary.

C1—28 to 36 inches, white (10YR 8/2) clay loam, very pale brown (10YR 7/4) when moist; massive; very hard, firm, sticky and plastic; very few fine roots; common very fine and fine pores; many moderately thick clay films in pores and as bridges; very strongly acid; clear wavy boundary.

C2—36 to 40 inches, white (10YR 8/2) coarse sandy clay loam that has brownish-yellow (10YR 6/6) mineral grains, very pale brown (10YR 7/4) when moist; massive; very hard, firm, sticky and plastic; many moderately thick and thick clay films in fracture planes; strongly acid; clear, irregular boundary.

C3—40 inches, well-weathered metadacite with few clay films in rock fracture.

The A horizon is very pale brown to light brown very fine sandy loam to loam about 5 to 12 inches thick. The B horizon is very pale brown to yellowish-red and is strongly acid to very strongly acid. The texture of the B horizon ranges from sandy clay loam or clay loam to silty clay loam.

Included in mapping are small areas of Auberry coarse sandy loam and Boomer gravelly loam.

Permeability of this Diamond Springs soil is moderately slow. Surface runoff is medium, and the erosion hazard is slight to moderate. The available water holding capacity is 4 to 9 inches. The effective rooting depth is 24 to 50 inches.

This soil is used for pear and apple orchards, woodland, and limited range. Capability unit IIIe–1(22); range site not assigned; woodland suitability group 4.

Diamond Springs very fine sandy loam, 9 to 15 percent slopes (DfC).—This soil is similar to Diamond Springs very fine sandy loam, 3 to 9 percent slopes, except that it is more sloping.

Included in mapping are small areas of Auberry coarse sandy loam and Boomer gravelly loam.

The erosion hazard is moderate, and runoff is medium.

This soil is used for pear and apple orchards, woodland, and limited range. Capability unit IVe–1(22); range site not assigned; woodland suitability group 5.

Diamond Springs very fine sandy loam, 15 to 30 percent slopes (DfD).—This soil is similar to Diamond Springs very fine sandy loam, 3 to 9 percent slopes, except that it is more sloping.

Included in mapping are small areas of Auberry coarse sandy loam and Boomer gravelly loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland and limited range. Capability unit VIe–1(22); range site not assigned; woodland suitability group 6.

Diamond Springs very rocky very fine sandy loam, 3 to 50 percent slopes (DgE).—This soil is similar to Diamond Springs very fine sandy loam, 3 to 9 percent slopes, except that 5 to 25 percent of the surface is rock outcrops.

Included in mapping are small areas of Auberry very rocky coarse sandy loam and Boomer very rocky loam.

Surface runoff is medium to rapid, and the erosion hazard is slight to high.

This soil is used for woodland and limited range. Capability unit VIs–1(22); range site not assigned; woodland suitability group 6.

Diamond Springs Series, Grayish Subsoil Variant

The Diamond Springs series, grayish subsoil variant, consists of well-drained soils that are underlain by weathered rhyolitic tuff at a depth of 36 to 60 inches. These soils are strongly sloping to steep on mountainous uplands. Slopes are 9 to 50 percent. Elevations are 2,000 feet to 4,000 feet. The average annual precipitation is 35 to 50 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Diamond Springs soils, grayish subsoil variant, are associated principally with Cohasset and McCarthy soils.

In a representative profile, the surface layer is grayish-brown, slightly acid gravelly sandy loam about 5 inches thick. The subsoil is light brownish-gray and light-gray, slightly acid and medium acid loam and gravelly loam about 33 inches thick. The substratum is light-gray, strongly acid gravelly sandy loam that grades to weathered rhyolitic tuff at a depth of 48 inches.

Diamond Springs soils, grayish subsoil variant, are used mainly for woodland.

Diamond Springs gravelly sandy loam, grayish subsoil variant, 30 to 50 percent slopes (DmE).—This soil has steep slopes and is on the sides of rhyolitic ridges.

Representative profile in a wooded area, 2 miles south of Camino, ¼ mile north of the Stark Grade Road, 1½ miles

east of the Newton Road intersection, and 1/8 mile northeast of the south quarter corner of sec. 15, T. 10 N., R. 12 E.:

O1&O2—1 inch to 0, pine litter and duff.

A1—0 to 5 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) when moist; strong, fine and medium, granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots and common fine and medium roots; many very fine, fine, and medium interstitial pores; slightly acid; clear, smooth boundary.

B1—5 to 13 inches, light brownish-gray (10YR 6/2) loam, dark brown (10YR 4/3) when moist; weak, medium, granular structure; soft, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine and fine interstitial pores and common fine tubular pores; slightly acid; gradual, smooth boundary.

B21—13 to 25 inches, light-gray (10YR 7/2) loam, dark brown and brown (10YR 3/3, 5/3) when moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many very fine, fine, and medium roots; many very fine and fine interstitial pores and common tubular pores; medium acid; gradual, smooth boundary.

B22—25 to 38 inches, light-gray (10YR 7/2) gravelly loam, brown (10YR 4/3, 5/3) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine, fine, and medium roots; many very fine and fine interstitial pores and common fine tubular pores; medium acid; clear, smooth boundary.

C1—38 to 48 inches, light-gray (10YR 7/1) gravelly sandy loam, light yellowish brown and brown (10YR 6/4, 5/3) when moist; massive; hard, friable, sticky and slightly plastic; few fine and medium roots; many medium and coarse interstitial pores; strongly acid; gradual, smooth boundary.

C2—48 inches, light-gray (10YR 7/1), weathered rhyolitic tuff that has some manganese stains (crushes to gravelly sandy loam), light brownish gray (2.5Y 6/2) when moist; few fine and medium roots in fracture planes; very strongly acid.

The color of the A horizon ranges from gray to grayish brown. The thickness of the A horizon is 5 to 8 inches. The B horizon is light gray to white and is medium acid to strongly acid.

Included in mapping are small areas of Acidic rock land, McCarthy cobbly loam, Cohasset cobbly loam, and a shallow soil similar to this Diamond Springs soil, grayish subsoil variant, that formed in rhyolitic tuff.

Permeability of this Diamond Springs soil, grayish subsoil variant, is moderate. Surface runoff is medium to rapid, and the erosion hazard is high. The available water-holding capacity is 4 to 8 inches. The effective rooting depth is 36 to 60 inches.

This soil is used mainly for woodland. Capability unit VIe-1(22); range site not assigned; woodland suitability group 2.

Diamond Springs gravelly sandy loam, grayish subsoil variant, 9 to 30 percent slopes (DmD).—This soil occupies side slopes of rhyolitic ridges.

Included in mapping are small areas of McCarthy cobbly loam, Cohasset cobbly loam, and a similar but shallow soil that formed in rhyolitic tuff.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used for woodland. Capability unit IVe-1(22); range site not assigned; woodland suitability group 2.

Gullied Land

Gullied land (GuF) is steep to very steep and is on south-facing, granitic slopes that break into the Middle Fork of the Cosumnes River between Somerset and Coles Station. About 90 percent of the area has been cut by gullies and is severely eroded, and 10 percent is remnant pedestals of the original soils. This land type is associated with the Chawanakee, Shaver, Holland, and Musick soils. The erosion hazard is very high, and runoff is very rapid. The vegetation is dense stands of chamise, manzanita, and wedgeleaf ceanothus.

This land type is used for watershed and wildlife. It has no farming value. Capability unit VIIIs-1(18, 22); range site and woodland suitability group not assigned.

Holland Series

The Holland series consists of well-drained soils that are underlain by weathered granitic rocks at a depth of more than 40 inches. These soils are gently rolling to very steep on mountainous uplands. Slopes are 5 to 70 percent. Elevations range from 1,800 feet to 5,000 feet. The average annual precipitation, including snow, is 35 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Holland soils are associated principally with Aiken, Cohasset, Hotaw, Josephine, Musick, Shaver, and Sites soils.

In a representative profile, the surface layer is brown, medium acid coarse sandy loam and sandy loam about 21 inches thick. The subsoil is strong-brown, brown, and yellowish-brown, medium acid sandy clay loam about 24 inches thick. The substratum consists of pale-brown, medium acid coarse sandy loam underlain by slightly weathered granodiorite at a depth of about 59 inches.

Holland soils are used for woodland, pear and apple orchards, and, in a few areas, range.

Holland rocky coarse sandy loam, 5 to 15 percent slopes (HhC).—This soil is moderately sloping to strongly sloping. Rock outcrops cover 5 to 10 percent of the surface.

Representative profile, 1.25 miles northeast of Fair Play, 600 feet north of Slug Gulch Road, and 0.14 mile southwest of the center of sec. 27, T. 9 N., R. 12 E.:

A11—0 to 2 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine tubular and interstitial pores and few fine tubular pores; medium acid; clear, smooth boundary.

A12—2 to 10 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 3/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots and few fine and medium roots; many very fine tubular and interstitial pores and few fine tubular pores; medium acid; clear, smooth boundary.

A3—10 to 21 inches, brown (10YR 5/3) sandy loam, dark brown (7.5YR 3/4) when moist; massive; hard, very friable, slightly sticky and slightly plastic; common very fine roots and few fine and medium roots; many very fine tubular and interstitial pores; common fine tubular pores and few medium tubular pores; common thin clay films in pores and as bridges; medium acid; clear, slightly wavy boundary.

B21t—21 to 30 inches, strong-brown (7.5YR 5/6) sandy clay loam, dark brown (7.5YR 3/4) when moist; massive;

extremely hard, friable, sticky and slightly plastic; few very fine roots; common very fine and fine tubular pores; many thin clay films in pores and as bridges; medium acid; gradual, smooth boundary.

B22t—30 to 36 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) when moist; massive; extremely hard, firm, sticky and slightly plastic; very few very fine roots; common very fine tubular pores and few fine tubular pores; many thin clay films in pores and as bridges; medium acid; gradual, smooth boundary.

B3t—36 to 45 inches, yellowish-brown (10YR 5/4) sandy clay loam (near sandy loam), dark yellowish brown (10YR 4/4) when moist; massive; hard, firm, slightly sticky and slightly plastic; very few very fine roots; few very fine and fine tubular pores; common thin clay films in pores and as bridges; medium acid; clear, wavy boundary.

C1—45 to 59 inches, pale-brown (10YR 6/3) coarse sandy loam, brown (10YR 4/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; no roots observed; few thin clay films in pores; medium acid; abrupt, irregular boundary.

C2—59 inches, slightly weathered granodiorite.

A thin mantle of litter and duff is present in places. Depth to weathered bedrock ranges from 40 inches to more than 60 inches. The A horizon is brown to dark brown. The total thickness of the A1 horizon is 10 to 15 inches. The B2 horizon is heavy sandy loam to clay loam and is medium acid to strongly acid.

Included in mapping are small areas of Musick rocky sandy loam, Shaver rocky coarse sandy loam, and Josephine gravelly loam. Along the contacts between the granodiorite and slate, the parent material tends to weather to clay.

Permeability of this Holland soil is moderately slow. Surface runoff is medium, and the erosion hazard is moderate to high. The available water holding capacity is 5 to 8 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used for woodland, deciduous fruits and nuts, and, in a few areas, range. Capability unit IVe–7(22); range site not assigned; woodland suitability group 2.

Holland coarse sandy loam, 5 to 9 percent slopes (HgB).—This soil is similar to Holland rocky coarse sandy loam, 5 to 15 percent slopes, except that less than 5 percent of the surface is rock outcrops.

Included in mapping are small areas of Musick sandy loam, Shaver coarse sandy loam, Josephine gravelly loam, and Argonaut loam, seeped variant.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for deciduous fruits and nuts, woodland, and, in a few areas, range. Capability unit IIIe–1(22); range site not assigned; woodland suitability group 1.

Holland coarse sandy loam, 9 to 15 percent slopes (HgC).—This soil is similar to Holland rocky coarse sandy loam, 5 to 15 percent slopes, except that less than 5 percent of the surface is rock outcrops.

Included in mapping are small areas of Musick sandy loam, Shaver coarse sandy loam, and Josephine gravelly loam.

Surface runoff is medium, and the erosion hazard is moderate to high.

This soil is used for deciduous fruits and nuts, woodland, and, in a few areas, range. Capability unit IVe–1(22); range site not assigned; woodland suitability group 2.

Holland coarse sandy loam, 15 to 30 percent slopes (HgD).—This soil is similar to Holland rocky coarse sandy loam, 5 to 15 percent slopes, except that less than 5 percent of the surface is rock outcrops.

Included are small areas of Musick sandy loam, Shaver coarse sandy loam, and Josephine gravelly loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland, pear and apple orchards, and nuts. Capability unit VIe–1(22); range site not assigned; woodland suitability group 3.

Holland very rocky coarse sandy loam, 15 to 50 percent slopes (HkE).—This soil is similar to Holland rocky coarse sandy loam, 5 to 15 percent slopes, except that 5 to 25 percent of the surface is rock outcrops.

Included in mapping are small areas of Hotaw very rocky coarse sandy loam, Musick very rocky sandy loam, Shaver very rocky coarse sandy loam, Josephine very rocky loam, and Chawanakee very rocky coarse sandy loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIs–1 (22); range site not assigned; woodland suitability group 3.

Holland very rocky coarse sandy loam, 50 to 70 percent slopes (HkF).—This soil is adjacent to major drainageways. It is similar to Holland rocky coarse sandy loam, 5 to 15 percent slopes, except that 5 to 25 percent of the surface is rock outcrops.

Included in mapping are small areas of Hotaw very rocky coarse sandy loam, Musick very rocky sandy loam, Shaver very rocky coarse sandy loam, Chawanakee very rocky coarse sandy loam, and Josephine very rocky loam.

Surface runoff is rapid, and the erosion hazard is high.

This soil is used for timber. Capability unit VIIs–1(22); range site not assigned; woodland suitability group 6.

Horseshoe Series

The Horseshoe series consists of well-drained soils that are underlain by alluvium from mixed sources. Slopes are 9 to 50 percent. Elevations range from 2,500 to 3,500 feet. The average annual precipitation, including snow, is 45 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Horseshoe soils are associated principally with Mariposa, Josephine, Cohasset, Aiken, and Sites soils.

In a representative profile, the surface layer is reddish-brown and yellowish-red, slightly acid and medium acid gravelly loam about 15 inches thick. The upper part of the subsoil is yellowish-red, strongly acid and very strongly acid gravelly heavy loam and gravelly clay loam about 35 inches thick. This is underlain by yellowish-red, very strongly acid very gravelly clay loam that extends to a depth of more than 60 inches.

Horseshoe soils are used mainly for woodland.

Horseshoe gravelly loam, 30 to 50 percent slopes (HsE).—This soil is on terrace remnants that break into the American River.

Representative profile in a wooded area, 8 miles east of Georgetown and 0.5 mile northeast of the east portal of

the new Georgetown ditch tunnel, near the east quarter corner of sec. 25, T. 13 N., R. 11 E.:

O1&O2—2 inches to 0, partially decomposed forest litter.

A1—0 to 3 inches, reddish-brown (5YR 5/4) gravelly loam, dark reddish brown (5YR 3/4) when moist; strong, very fine, granular structure; soft, very friable, nonsticky and slightly plastic; many very fine and few medium roots; many very fine pores; slightly acid; abrupt, smooth boundary.

A3—3 to 15 inches, yellowish-red (5YR 5/6) gravelly loam, dark red (2.5YR 3/6) when moist; moderate, very fine, granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; common fine roots and few medium and coarse roots; many very fine pores; medium acid; gradual, smooth boundary.

B1t—15 to 30 inches, yellowish-red (5YR 5/6) gravelly heavy loam, dark red (2.5YR 3/6) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots, few medium and coarse roots; many very fine pores; few thin clay films in pores; strongly acid; gradual, smooth boundary.

B2t—30 to 50 inches, yellowish-red (5YR 5/8) gravelly clay loam, yellowish red (5YR 4/8) when moist; massive; slightly hard, firm, slightly sticky and plastic; common very fine and fine roots and few medium and coarse roots; many very fine pores; thin, nearly continuous clay films in pores; very strongly acid; gradual, smooth boundary.

IIB3t—50 to 70 inches, yellowish-red (5YR 5/8) very gravelly clay loam, yellowish red (5YR 4/8) when moist; spotted with black stains; massive; hard, firm, slightly sticky and plastic; few roots; many very fine pores and few fine and medium pores; thin, nearly continuous clay films in pores; very strongly acid; clear, smooth boundary.

IIIC—70 to 72 inches, yellowish-red (5YR 5/8) gravelly heavy loam, yellowish red (5YR 4/8) when moist; massive; hard, firm, slightly sticky and slightly plastic; no roots; common very fine tubular pores; few thin clay films in pores; very strongly acid.

This soil formed in old river deposits, and in some places the parent material is stratified. The soil is 5 to 30 percent cobblestones and gravel, by volume. Total thickness of the A horizon is about 8 to 18 inches. Depth to the IIB3 horizon ranges from 50 inches to more than 60 inches.

Included in mapping are small areas of Mariposa very rocky silt loam and Josephine very rocky silt loam. Also included, along the American River, are some areas of soils that have slopes of 50 to 60 percent.

Permeability of this Horseshoe soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is high. The available water holding capacity is 8 to 10 inches. The effective rooting depth is more than 60 inches.

This soil is used for woodland. Capability unit VIe-1(22); range site not assigned; woodland suitability group 2.

Horseshoe gravelly sandy loam, 9 to 15 percent slopes (HrC).—This soil is on terrace remnants. The surface layer is light grayish-brown gravelly sandy loam that ranges from 5 to 10 inches in thickness. The subsoil is medium acid to strongly acid sandy clay loam to gravelly clay loam.

Included in mapping are small areas of Mariposa gravelly loam, Josephine silt loam, and Cohasset cobbly loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for woodland. A few areas have been cleared and are used for pasture. Capability unit IVe-1(22); range site not assigned; woodland suitability group 1.

Hotaw Series

The Hotaw series consists of well-drained soils that are underlain by weathered granitic rocks at a depth of 24 to 40 inches. These soils are hilly to steep on uplands. Slopes are 15 to 50 percent. Elevations range from 1,800 feet to 5,000 feet. The average annual precipitation is 35 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is coniferous forest and associated hardwoods. Hotaw soils are associated principally with Holland, Musick, and Shaver soils.

In a representative profile, the surface layer is grayish-brown, slightly acid coarse sandy loam about 12 inches thick. The subsoil is pale-brown, medium and coarse sandy loam and light-brown, strongly acid sandy clay loam about 23 inches thick. This is underlain by weathered coarse-grained acid igneous rock, mainly granodiorite, at a depth of about 35 inches.

Hotaw soils are used for woodland.

Hotaw very rocky coarse sandy loam, 15 to 50 percent slopes (HtE).—This soil is moderately steep to steep. Outcrops of bedrock cover 5 to 25 percent of the surface.

Representative profile in a wooded area, 0.5 mile east of Aukum and 0.1 mile northeast of the southwest corner of sec. 12, T. 8 N., R. 11 E.:

O1&O2—1 inch to 0, litter and duff.

A1—0 to 12 inches, grayish-brown (10YR 5/2) coarse sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, wavy boundary.

B1t—12 to 22 inches, pale-brown (10YR 6/3) heavy coarse sandy loam, brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine and fine tubular and interstitial pores; few thin clay films in pores; medium acid; clear, smooth boundary.

B2t—22 to 35 inches, light-brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 4/4) when moist; moderate, medium and coarse, subangular blocky structure; very hard, firm, sticky and slightly plastic; many fine and medium roots; common very fine and fine tubular pores; many moderately thick clay films on ped faces, in pores, and as bridges; strongly acid; clear, wavy boundary.

C—35 inches, weathered granodiorite.

The A horizon ranges from brown to grayish brown in color and from slightly acid to medium acid in reaction. Total thickness of the A horizon is 8 to 12 inches. The B horizon ranges from pale brown to light brown or reddish brown.

Included in mapping are small areas of Holland very rocky coarse sandy loam, Chawanakee very rocky coarse sandy loam, Chaix very rocky coarse sandy loam, and Josephine very rocky silt loam.

Permeability of this Hotaw soil is moderately slow. Surface runoff is medium to rapid, and the erosion hazard is high. The available water holding capacity is 4 to 8 inches. The effective rooting depth is 24 to 40 inches.

This soil is used for woodland. Capability unit VIs-1(22); range site not assigned; woodland suitability group 6.

Iron Mountain Series

The Iron Mountain series consists of excessively drained soils that are underlain by hard volcanic rock at a depth

of 5 to 20 inches. These soils are undulating on ridgetops and steep on side slopes. Slopes are 3 to 50 percent. Elevations range from 2,000 feet to 5,000 feet. The average annual precipitation, including snow, is 35 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly stunted conifers, hardwoods, shrubs, and annual grasses. Iron Mountain soils are associated principally with Aiken, Cohasset, and McCarthy soils.

In a representative profile, the soil is dark-brown, medium acid cobbly sandy loam about 12 inches thick. This is underlain by hard volcanic breccia.

Iron Mountain soils are used for watershed and wildlife habitat.

Iron Mountain very rocky sandy loam, 3 to 50 percent slopes (ImE).—This soil is gently sloping to steeply sloping. Exposed lava cap covers 25 to 40 percent of the surface.

Representative profile, 1.5 miles west of Sly Park Dam and 1,000 feet south of the north quarter corner of sec. 13, T. 10 N., R. 12 E.:

A11—0 to 5 inches, dark-brown (10YR 4/3) cobbly sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable, nonsticky and slightly plastic; common very fine and fine roots; many very fine and fine interstitial and tubular pores; medium acid; clear, wavy boundary.

A12—5 to 12 inches, dark-brown (10YR 4/3) cobbly sandy loam, dark brown (7.5YR 3/2) when moist; massive; soft, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine interstitial and tubular pores; medium acid; abrupt, smooth boundary.

R—12 inches, hard volcanic breccia.

Depth to bedrock ranges from 5 to 20 inches. The color of the A horizon ranges from dark grayish-brown to brown. Gravel, cobblestones, and stones make up 35 percent of the soil mass.

Included in mapping are small areas of McCarthy cobbly loam.

Permeability of this Iron Mountain soil is moderately rapid. Surface runoff is medium to rapid, and the erosion hazard is slight to high. The available water holding capacity is 0.5 to 2.0 inches. The effective rooting depth is 5 to 20 inches.

This soil is used for watershed and wildlife habitat. Capability unit VIIs–1(22); range site not assigned; woodland suitability group 7.

Josephine Series

The Josephine series consists of well-drained soils that are underlain by vertically tilted schists, slates, and contact metamorphic rocks at a depth of 40 to 60 inches. These soils are gently rolling to very steep on mountainous uplands. Slopes are 5 to 70 percent. Elevations range from 1,500 feet to 5,500 feet. The average annual precipitation, including snow, is 35 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods, and there are scattered areas of brush. Josephine soils are associated principally with Mariposa, Sites, Musick, Holland, and Cohasset soils.

In a representative profile, the surface layer is yellowish-brown and reddish-yellow, medium acid and strongly acid silt loam about 14 inches thick. The upper part of the subsoil is reddish-yellow, very strongly acid silty clay loam about 19 inches thick. The lower part of the subsoil is yellow, very strongly acid, very gravelly silt loam. This is underlain by slate at a depth of 50 inches.

Josephine soils are used mainly for woodland. A few areas are used for deciduous fruit orchards.

Josephine silt loam, 15 to 30 percent slopes (JtD).—This soil is moderately steep.

Representative profile, 2.5 miles south of the Georgetown Ranger Station, on the south side of Cove Hill Road, near the center of NE¼ sec. 18, T. 12 N., R. 11 E.:

O1&O2—1 inch to 0, duff and litter.

A1—0 to 4 inches, yellowish-brown (10YR 5/4) silt loam, brown (7.5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; many very fine tubular and interstitial pores and common fine tubular and intersitital pores; medium acid; abrupt, smooth boundary.

A3—4 to 14 inches, reddish-yellow (7.5YR 6/6) silt loam, yellowish red (5YR 4/6) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots and few coarse roots; many very fine tubular and interstitial pores and common fine tubular and interstitial pores; strongly acid; clear, slightly wavy boundary.

B21t—14 to 24 inches, reddish-yellow (7.5YR 6/6) silty clay loam, yellowish red (5YR 4/8) when moist; weak, medium, subangular blocky structure that appears massive in places; slightly hard, firm, slightly sticky and plastic; common very fine, fine, and medium roots and few coarse roots; common very fine and fine tubular pores; many thin clay films on ped faces and in pores; very strongly acid; clear, smooth boundary.

B22t—24 to 33 inches, reddish-yellow (7.5YR 7/6) silty clay loam, yellowish red (5YR 5/6) when moist; weak, medium, subangular blocky structure that appears massive in places; hard, firm, slightly sticky and plastic; few very fine, fine, and medium roots; common very fine and fine tubular pores; many thin clay films on ped faces and in pores; very strongly acid; gradual, smooth boundary.

B3t—33 to 50 inches, yellow (10YR 7/6) very gravelly silt loam, reddish yellow (7.5YR 6/8) when moist; massive; slightly hard, firm, slightly sticky and slightly plastic; very few very fine to medium roots; common very fine tubular pores, few thin clay films in pores; very strongly acid; abrupt, irregular boundary.

C—50 inches, light-gray (N 6/0), weathered, vertically tilted slate; strongly acid; some roots penetrate fractures.

Gravel and slate fragments make up less than 5 percent of the soil, by volume. The A horizon ranges from reddish-yellow and yellowish-brown to yellowish-red in color. Total thickness of the A horizon is 5 to 15 inches. The B horizon is reddish-yellow or yellowish-red to yellow and is medium acid to very strongly acid.

Included in mapping are small areas of Mariposa gravelly silt loam, Josephine gravelly loam, and Sites loam.

Permeability of this Josephine soil is moderate. Surface runoff is medium, and the erosion hazard is moderate. The available water holding capacity is 6 to 10 inches. The effective rooting depth is 40 to 60 inches.

This soil is used for woodland and deciduous orchards. Capability unit IVe–1(22); range site not assigned; woodland suitability group 2.

Josephine gravelly loam, 9 to 15 percent slopes (JrC).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that it is less sloping. Also, it has a surface layer of brown to reddish-brown, medium acid gravelly loam and a subsoil of red to reddish-brown, me-

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dium acid to strongly acid clay loam. The parent material is mica schist.

Included in mapping are small areas of Josephine silt loam, Sites loam, Mariposa gravelly silt loam, Musick sandy loam, and Holland coarse sandy loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for woodland and deciduous orchards. Capability unit IIIe-1 (22); range site not assigned; woodland suitability group 1.

Josephine gravelly loam, 15 to 30 percent slopes (JrD).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that it has a surface layer of brown to reddish-brown, medium acid gravelly loam and a subsoil of red to reddish-brown, medium acid clay loam.

Included in mapping are small areas of Josephine silt loam, Mariposa gravelly silt loam, Sites loam, Musick sandy loam, and Holland coarse sandy loam.

This soil is used for woodland and deciduous orchards. Capability unit IVe-1 (22); range site not assigned; woodland suitability group 2.

Josephine very rocky loam, 15 to 50 percent slopes (JsE).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that it has a surface layer of brown to reddish-brown, medium acid gravelly loam and a subsoil of red to reddish-brown, medium acid to strongly acid clay loam. The parent material is mica schist. About 5 to 25 percent of the surface is rock outcrops.

Included in mapping are small areas of Josephine very rocky silt loam, Mariposa very rocky silt loam, Sites very rocky loam, Musick very rocky sandy loam, and Holland very rocky coarse sandy loam.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

This soil is used for woodland. Capability unit VIs-1 (22); range site not assigned; woodland suitability group 2.

Josephine silt loam, 5 to 15 percent slopes (JtC).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that it is less sloping.

Included in mapping are small areas of Mariposa gravelly silt loam, Josephine gravelly loam, and Sites loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used for woodland and deciduous orchards. Capability unit IIIe-1 (22); range site not assigned; woodland suitability group 1.

Josephine silt loam, 30 to 50 percent slopes (JtE).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that it is more sloping.

Included in mapping are small areas of Mariposa very rocky silt loam, Josephine very rocky loam, and Sites loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This land is used for woodland. Capability unit VIe-1 (22); range site not assigned; woodland suitability group 2.

Josephine very rocky silt loam, 9 to 50 percent slopes (JuE).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that 5 to 25 percent of the surface is outcrops of bedrock.

Included in mapping are small areas of Mariposa very rocky silt loam, Josephine very rocky loam, and Sites very rocky loam.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

This soil is used for woodland. Capability unit VIs-1 (22); range site not assigned; woodland suitability group 2.

Josephine very rocky silt loam, 50 to 70 percent slopes (JuF).—This soil is similar to Josephine silt loam, 15 to 30 percent slopes, except that 5 to 25 percent of the surface is rock outcrops.

Included in mapping are small areas of Mariposa very rocky silt loam, Josephine very rocky loam, Maymen very rocky loam, and Sites very rocky loam.

Surface runoff is rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIIs-1 (22); range site not assigned; woodland suitability group 3.

Josephine-Mariposa gravelly loams, 15 to 30 percent slopes (JvD).—These soils are hilly on uplands. Josephine gravelly loam makes up about 60 percent of this complex and is on plane and slightly concave side slopes; Mariposa gravelly loam makes up about 35 percent and is on ridges and sharp breaks; and Boomer gravelly loam and Sites loam make up about 5 percent. There are a few small areas of included soils that have slopes of 3 to 15 percent.

The profile of the Josephine soil is similar to the one described for Josephine gravelly loam, 15 to 30 percent slopes, and the profile of the Mariposa soil is similar to the one described for Mariposa very rocky silt loam, 3 to 50 percent slopes.

Surface runoff is medium, and the erosion hazard is moderate.

The soils of this complex are used for woodland and deciduous orchards. Capability unit IVe-1 (22); range site not assigned; woodland suitability group 2.

Loamy Alluvial Land

Loamy alluvial land (LaB) consists of small areas of recent alluvium that have slopes of 2 to 5 percent and are adjacent to stream channels. The alluvium is variable in color and is stratified sandy loam, loam, and clay loam that, in places, becomes gravelly as depth increases. The depth to underlying rock is more than 48 inches.

This land type is moderately well drained. Surface runoff is slow to medium, permeability is moderate to moderately slow, and the erosion hazard is slight. The available water holding capacity is 8 to 10 inches. This land type occasionally is flooded by overflowing streams.

Loamy alluvial land is suitable for irrigated pasture and deciduous orchards if it is protected from overflow. Capability unit IIe-1 (18, 22); range site not assigned; woodland suitability group 1.

Mariposa Series

The Mariposa series consists of well-drained soils that are underlain at a depth of 15 to 30 inches by vertically tilted schists and slate and contact metamorphic rock. These soils are sloping or rolling to very steep on mountainous uplands. Slopes are 3 to 70 percent. Elevations range from 1,500 feet to 5,000 feet. The average annual

precipitation, including snow, is 35 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly mixed coniferous forest and associated hardwoods and brush. Mariposa soils are associated principally with Josephine, Maymen, and Sites soils.

In a representative profile, the surface layer is pink, medium acid gravelly silt loam about 8 inches thick. The subsoil is reddish-yellow, medium acid and strongly acid gravelly silt loam about 18 inches thick. This is underlain by schists or slate at a depth of about 26 inches.

Mariposa soils are used mainly for woodland and watershed. Small areas are used for range or pasture.

Mariposa very rocky silt loam, 3 to 50 percent slopes (MbE).—This soil has south- and west-facing slopes along narrow ridgetops. Outcrops of bedrock cover 5 to 25 percent of the surface.

Representative profile, 0.75 mile southeast of Kelsey and 1,000 feet northeast of the center of sec. 24, T. 11 N., R. 10 E.:

O1&O2—1 inch to 0, pine needles, duff, and partially decomposed litter.

A1—0 to 8 inches, pink (7.5YR 7/4) gravelly silt loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine and medium roots; many very fine pores and common fine pores; medium acid; clear, smooth boundary.

B1—8 to 15 inches, reddish-yellow (7.5YR 7/6) gravelly silt loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine pores, common fine pores, and few medium pores; few, thin, discontinuous clay films in pores; medium acid; clear, smooth boundary.

B2t—15 to 26 inches, reddish-yellow (7.5YR 6/6) gravelly heavy silt loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine pores and few fine pores; common, thin, continuous clay films, mainly in pores; strongly acid; abrupt, irregular boundary.

C&R—26 inches, yellow (10YR 7/6) weathered slate or schist, yellowish brown when moist; nearly vertically tilted cleavage planes.

The soil is 10 to 30 percent gravel-sized rock fragments, by volume. The soil colors are related to the bedding of the metamorphic rocks and commonly are variable within short horizontal distances. The A horizon is pink to brown in color, slightly acid to medium acid in reaction, and gravelly loam to gravelly silt loam in texture. The B horizon ranges from gravelly silt loam to gravelly clay loam.

Included in mapping are small areas of Josephine very rocky loam, Josephine very rocky silt loam, Sites very rocky loam, and Maymen very rocky loam.

Permeability of this Mariposa soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is slight to high. The available water holding capacity is 2 to 4 inches. The effective rooting depth is 15 to 30 inches.

This soil is used for woodland. Capability unit VIs–1 (22); range site not assigned; woodland suitability group 5.

Mariposa gravelly silt loam, 3 to 30 percent slopes (MaD).—This soil is similar to Mariposa very rocky silt loam, 3 to 50 percent slopes, except that less than 5 percent of the surface has outcrops of bedrock.

Included in mapping are small areas of Josephine silt loam, Josephine gravelly loam, and Sites loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used mainly for woodland. A few areas are used for range and irrigated pasture. Capability unit IVe–8(22); range site not assigned; woodland suitability group 5.

Mariposa very rocky silt loam, 50 to 70 percent slopes (MbF).—This soil is adjacent to the major rivers. In a few areas along the Middle Fork of the American River, slopes range up to 85 percent.

Included in mapping are small areas of Josephine very rocky silt loam, Josephine very rocky loam, Sites very rocky loam, Maymen very rocky loam, and Metamorphic rock land.

Surface runoff is rapid, and the erosion hazard is high.

This soil is used for woodland and watershed. Capability unit VIIs–1(22); range site not assigned; woodland suitability group 6.

Mariposa-Josephine very rocky loams, 15 to 50 percent slopes (McE).—These soils are hilly to steep on mountainous uplands. Mariposa very rocky loam makes up about 60 percent of this complex and occupies the ridges, the sharp breaks, and most of the south-facing and west-facing slopes. Josephine very rocky silt loam makes up about 35 percent and occupies concave slopes and most of the smoother north-facing and east-facing slopes. Inclusions of Sites very rocky loam make up about 5 percent.

The profile of the Mariposa soil is similar to the one described for Mariposa very rocky silt loam, 3 to 50 percent slopes, and the profile of the Josephine soil is similar to the one described for Josephine silt loam, 15 to 30 percent slopes.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

These soils are used for woodland. Capability unit VIs–1(22); range site not assigned; woodland suitability group 5.

Mariposa-Josephine very rocky loams, 50 to 70 percent slopes (McF).—These soils are very steep on mountainous uplands. This complex is about 55 percent Mariposa very rocky loam; about 35 percent Josephine very rocky silt loam; and about 10 percent inclusions of Sites very rocky loam, Boomer very rocky loam, and Maymen very rocky loam.

Surface runoff is rapid, and the erosion hazard is high.

These soils are used for woodland and watershed. Capability unit VIIs–1(22); range site not assigned; woodland suitability group 6.

Maymen Series

The Maymen series consists of excessively drained soils that are underlain by vertically tilted schists and slates at a depth of 6 to 16 inches. These soils are hilly to very steep on mountainous uplands. Slopes are 15 to 70 percent. Elevations range from 2,000 feet to 4,000 feet. The average annual precipitation, including snow, is 35 to 50 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly brush, and there are scattered areas of stunted conifers and hardwoods. Maymen soils are associated principally with Mariposa and Josephine soils.

In a representative profile, the surface layer is brown, light yellowish-brown, and reddish-yellow, strongly acid and very strongly acid gravelly loam and gravelly silt loam. This is underlain at a depth of about 9 inches by hard, vertically tilted slate.

Maymen soils are used for watershed and wildlife habitat.

Maymen very rocky loam, 15 to 70 percent slopes (MfF).—This soil is moderately steep to very steep. Outcrops of bedrock cover 5 to 25 percent of the surface.

Representative profile, 2 miles north of Slate Mountain Lookout, 0.45 mile south and 0.3 mile west of the northeast corner of sec. 25, T. 12 N., R. 11 E.:

O1&O2—1 inch to 0, litter from manzanita.

A11—0 to ¼ inch, brown (10YR 5/3) gravelly loam, brown (7.5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores and common fine tubular pores; strongly acid; abrupt, smooth boundary.

A12—¼ inch to 2 inches, light yellowish-brown (10YR 6/4) gravelly loam, strong brown (7.5YR 5/6) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium and coarse roots; many very fine tubular pores and common fine tubular pores; very strongly acid; clear, smooth boundary.

A13—2 to 9 inches, reddish-yellow (7.5YR 6/6) gravelly silt loam, strong brown (7.5YR 5/6) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common very fine and fine roots and few medium and coarse roots; many very fine tubular and interstitial pores; few clay films in pores; very strongly acid; abrupt, irregular boundary.

R—9 inches, hard slate.

The profile is brown, light yellowish brown, or reddish brown. The A horizon is strongly acid or very strongly acid gravelly loam or gravelly silt loam.

Included in mapping are small areas of Mariposa very rocky silt loam and Metamorphic rock land.

Permeability of this Maymen soil is moderate. Surface runoff is rapid, and the erosion hazard is high. The available water holding capacity is 1 to 2 inches. The effective rooting depth is 6 to 16 inches.

This soil is used for watershed. Capability unit VIIs-1(22); range site and woodland suitability group not assigned.

McCarthy Series

The McCarthy series consists of well-drained soils that are underlain by volcanic conglomerate and breccia at a depth of 24 to 40 inches. These soils are strongly sloping on ridges and are steep on side slopes. Slopes are 9 to 50 percent. Elevations range from 2,000 to 5,000 feet. Annual precipitation, including snow, is 35 to 60 inches, annual average temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods, and there are scattered areas of brush. McCarthy soils are associated principally with Cohasset, Aiken, and Iron Mountain soils.

In a representative profile, the surface layer is dark grayish-brown and brown, slightly acid cobbly loam about 10 inches thick. The subsoil is strong-brown, medium acid very cobbly loam about 28 inches thick. This is underlain by weathered andesitic conglomerate.

McCarthy soils are used for woodland.

McCarthy cobbly loam, 9 to 50 percent slopes (MhE).—This soil is on side slopes of andesitic ridges.

Representative profile, 1 mile west of Sly Park Dam and 0.25 mile north of the west quarter corner of sec. 18, T. 10 N., R. 13 E.:

O1&O2—3 inches to 0, litter and duff.

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) cobbly loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

A12—3 to 10 inches, brown (7.5YR 5/4) cobbly loam, dark reddish brown (5YR 3/3) when moist; moderate fine, granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

B2—10 to 24 inches, strong-brown (7.5YR 5/6) very cobbly loam, reddish brown (5YR 4/4) when moist; weak, fine, subangular blocky structure and moderate, fine, granular structure; slightly hard, friable, nonsticky and nonplastic; many fine roots and common coarse roots; many very fine and fine tubular and interstitial pores; medium acid; clear, wavy boundary.

B3—24 to 38 inches, strong-brown (7.5YR 5/6) very cobbly loam, yellowish red (5YR 4/6) when moist; massive; hard, slightly firm, slightly sticky and slightly plastic; common fine roots and many medium and coarse roots; common very fine and fine tubular and interstitial pores; medium acid; gradual, wavy boundary.

C2—38 inches, well-weathered andesitic conglomerate.

The profile is 10 to 50 percent cobblestones, and the weighted average is more than 35 percent. The A horizon is slightly acid to medium acid cobbly loam or cobbly sandy loam. The B horizon is medium acid to strongly acid very cobbly loam and very cobbly sandy loam.

Included in mapping are small areas of Iron Mountain very rocky sandy loam and Cohasset cobbly loam. In the Barney Ridge area are some areas of McCarthy soils that have a cobbly sandy loam surface layer. Slopes in places are as gentle as 5 percent and as steep as 60 percent.

Permeability of this McCarthy soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is moderate to high. The available water holding capacity is 3 to 6 inches. The effective rooting depth is 24 to 40 inches.

This soil is used for woodland. Capability unit VIe-1(22); range site not assigned; woodland suitability group 5.

Metamorphic Rock Land

Metamorphic rock land (MmF) is in areas of highly resistant schist and slate formations. Rock outcrops and stones occupy from 50 to 90 percent of the surface, and the rest has a thin mantle of soil material. This land type is mainly steep to very steep and occupies areas that break into the major drainageways. At the lower elevations, it is associated with Auburn soils, and at higher elevations it is associated with Maymen and Mariposa soils.

This land type is excessively drained. Surface runoff is very rapid, and the erosion hazard is slight to moderate.

Metamorphic rock land is used for watershed and wildlife habitat. It has no farming value. Capability unit VIIIs-1(18, 22); range site and woodland suitability group not assigned.

Mixed Alluvial Land

Mixed alluvial land (MpB) consists of small areas of recent mixed alluvium adjacent to stream channels. This material is variable in color and is stratified gravelly sandy loam, gravelly loam, and gravelly clay loam that grades into sand and gravel as depth increases. The depth to unrelated underlying rock is more than 36 inches. Permeability is moderately rapid to slow. This land type is moderately well drained to somewhat poorly drained. Surface runoff is slow to medium, and the erosion hazard is moderate. The land is subject to frequent flooding in winter.

Mixed alluvial land is used for pasture and range. Capability unit IVw–2(18, 22); range site not assigned; woodland suitability group 5.

Musick Series

The Musick series consists of well-drained soils that are underlain by acid igneous rocks at a depth below 48 inches. These soils are gently rolling to steep on mountainous uplands. Slopes are 5 to 50 percent. Elevations range from 2,000 to 5,000 feet. The average annual precipitation, including snow, is 35 to 60 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Musick soils are associated principally with Holland, Shaver, Aiken, and Sites soils.

In a representative profile, the surface layer is brown, medium acid sandy loam about 12 inches thick. The subsoil is variegated reddish-brown, red, reddish-yellow, and light-red, strongly acid sandy clay loam, clay loam, and sandy clay about 44 inches thick. The substratum consists of variegated light-red, red, and reddish-yellow, very strongly acid heavy sandy loam.

Musick soils are used for woodland and deciduous orchards.

Musick sandy loam, 15 to 30 percent slopes (MrD).—This soil is moderately steep.

Representative profile, 5.5 miles southwest of Somerset, 50 feet south of old Caldor Railroad right-of-way, and 35 feet north of the west quarter corner of sec. 19, T. 9 N., R. 13 E.:

O1&O2—3 inches to 0, pine litter and duff.

A1—0 to 6 inches, brown (10YR 5/3) sandy loam, dark brown (7.5YR 3/3) when moist; moderate, fine, granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; common very fine and fine tubular pores; medium acid; abrupt, slightly wavy boundary.

A3—6 to 12 inches, brown (7.5YR 5/4) heavy sandy loam, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and many medium and coarse roots; many very fine and fine tubular and interstitial pores; medium acid; clear, slightly wavy boundary.

B1t—12 to 18 inches, variegated reddish-brown and red (5YR 5/4, 2.5YR 5/6) light sandy clay loam, variegated yellowish red and red (5YR 4/6, 2.5YR 4/6) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and slightly plastic; common very fine and fine roots and many medium and coarse roots; many very fine and fine tubular and interstitial pores; common thin clay films as bridges and in pores; strongly acid; clear, smooth boundary.

B21t—18 to 28 inches, variegated red and reddish-yellow (2.5YR 5/8, 5YR 6/6) heavy clay loam near sandy clay, variegated red and yellowish red (2.5YR 4/6, 4/8; 5YR 5/6) when moist; weak, very coarse, prismatic structure; very hard, firm, sticky and plastic; common very fine, fine, medium, and coarse roots; common very fine and fine tubular pores; many moderately thick clay films on ped faces, as bridges, and in pores; strongly acid; gradual, smooth boundary.

B22t—28 to 42 inches, variegated light-red and reddish-yellow (2.5YR 6/8, 5YR 6/8) light sandy clay, variegated red and reddish yellow (2.5YR 4/8, 5YR 6/8) when moist; weak, very coarse, prismatic structure; very hard, firm, sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular pores; many moderately thick clay films on ped faces, as bridges, and in pores; strongly acid; gradual, smooth boundary.

B3—42 to 56 inches, variegated light-red, red, and reddish-yellow (2.5YR 6/8, 2.5YR 5/8, 5YR 6/8) heavy sandy loam, variegated red, light red, and reddish yellow (2.5YR 5/8, 2.5YR 6/8, 5YR 6/8) when moist; massive; hard, firm, nonsticky and nonplastic; few fine and medium roots; many very fine and fine tubular and interstitial pores; common thin clay films as bridges and in pores; very strongly acid; gradual, wavy boundary.

C—56 to 60 inches, variegated reddish-yellow (5YR 6/8, 7/8) sandy loam, variegated reddish yellow and light red (5YR 6/8, 2.5YR 6/8) when moist; massive; hard, firm, slightly sticky and slightly plastic; few moderately thick clay films; very strongly acid.

The A horizon generally is sandy loam, but it is silt loam in few minor areas that are highly micaceous. Total thickness of the A horizon is 10 to 20 inches. The B horizon is massive or has weak, prismatic to subangular blocky structure. Granitic rock is at a depth of 48 inches to more than 60 inches.

Included in mapping are small areas of Holland coarse sandy loam, Shaver coarse sandy loam, and Josephine gravelly loam.

Permeability of this Musick soil is moderately slow. Surface runoff is medium to rapid, and the erosion hazard is high. The available water holding capacity is 7 to 10 inches. The effective rooting depth is 48 inches to more than 60 inches.

This soil is used for woodland and deciduous orchards. Capability unit VIe–1(22); range site not assigned; woodland suitability group 3.

Musick sandy loam, 9 to 15 percent slopes (MrC).—This soil is similar to Musick sandy loam, 15 to 30 percent slopes, except that it is less sloping.

Included in mapping are small areas of Holland coarse sandy loam, Shaver coarse sandy loam, Josephine gravelly loam, and Argonaut loam, seeped variant. Some toe slopes and swale areas have soils with slopes of 5 percent.

Surface runoff is medium, and the erosion hazard is moderate to high.

This soil is used for deciduous orchards and woodland. Capability unit IVe–1(22); range site not assigned; woodland suitability group 2.

Musick rocky sandy loam, 5 to 15 percent slopes (MsC).—This soil is similar to Musick sandy loam, 15 to 30 percent slopes, except that 5 to 10 percent of the surface is outcrops of bedrock.

Included in mapping are small areas of Holland coarse sandy loam and Shaver coarse sandy loam.

Surface runoff is medium, and the erosion hazard is moderate to high.

This soil is used for deciduous orchards and woodland. Capability unit IVe–7(22); range site not assigned; woodland suitability group 2.

Musick very rocky sandy loam, 15 to 50 percent slopes (MtE).—In areas of this soil, rock outcrops occupy from 5 to 25 percent of the surface.

Included in mapping are small areas of Holland very rocky coarse sandy loam, Shaver very rocky coarse sandy loam, Chaix very rocky coarse sandy loam, and Josephine very rocky loam. In addition, along the major rivers, there are a few areas of soils that have slopes of as much as 70 percent.

This soil is used for woodland. Capability unit VIs-1(22); range site not assigned; woodland suitability group 3.

Perkins Series

The Perkins series consists of well-drained soils that are undulating to hilly on remnants of terraces. These soils formed in material that washed from mixed sources, and they are underlain by weathered granodiorite. Slopes are 3 to 30 percent. Elevations range from 700 to 800 feet. The average annual rainfall is 25 to 30 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses and forbs, and there are scattered areas of oaks. Perkins soils are associated principally with Auberry and Boomer soils.

In a representative profile, the surface layer is brown, slightly acid gravelly loam and cobbly heavy loam about 13 inches thick. The subsoil is yellowish-red, red, and strong-brown, slightly acid and neutral cobbly clay loam and cobbly light clay about 35 inches thick. The substratum is weathered granodiorite.

Perkins soils are used for annual range.

Perkins gravelly loam, 3 to 30 percent slopes (PeD).—This soil is in the Coloma-Lotus area.

Representative profile, 4 miles west of Coloma, 0.6 mile north of Highway 49, and 0.1 mile north of the west quarter corner of sec. 2, T. 11 N., R. 9 E.:

A11—0 to 4 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 3/4) when moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

A12—4 to 13 inches, brown (7.5YR 5/4) cobbly heavy loam, dark brown (7.5YR 3/4) when moist; massive, hard, friable, sticky and slightly plastic; common very fine roots; many very fine and fine tubular and interstitial pores; slightly acid; clear, smooth boundary.

B21t—13 to 35 inches, yellowish-red (5YR 5/6) cobbly clay loam, yellowish red (5YR 3/8) when moist; massive; very hard, slightly firm, sticky and plastic; common very fine roots; many fine interstitial and few fine tubular pores; many thin clay films in pores and as bridges; slightly acid; gradual, smooth boundary.

B22t—35 to 48 inches, variegated yellowish-red, red, and strong-brown (5YR 4/6, 2.5YR 4/6, 7.5YR 4/6) cobbly light clay, dark red and yellowish red (2.5YR 3/6, 5YR 4/6) when moist; massive; very hard, firm, sticky and plastic; very few roots; common fine interstitial pores; many moderately thick clay films in pores and as bridges; neutral.

C—48 inches, weathered granodiorite.

This soil in places lies on unconforming granodiorite rock that is at a depth ranging from 48 inches to more than 60 inches. Gravel and cobblestones make up 5 to 15 percent, by volume, of the A horizon and 20 to 25 percent, by volume, of the B horizon. The A horizon is brown to reddish brown and is massive or has granular structure. Total thickness of the A horizon is 10 to 15 inches.

Included in mapping are small areas of Auberry coarse sandy loam and Placer diggings.

Permeability of this Perkins soil is slow. Surface runoff is medium, and the erosion hazard is slight to moderate. The available water holding capacity is 6 to 9 inches. The effective rooting depth is 48 to 60 inches or more.

This soil is used for range. Capability unit IVe-3(18); range site 2; woodland suitability group not assigned.

Perkins Series, Moderately Deep Variant

The Perkins series, moderately deep variant, consists of moderately well drained soils that formed in medium-textured alluvium underlain by unrelated rock at a depth of 24 to 40 inches. These soils are nearly level to gently sloping on stream terraces. Slopes are 2 to 5 percent. Elevations range from 450 to 700 feet. The average annual rainfall is 23 to 25 inches, average annual temperature is 62° F., and the frost-free season is 170 to 270 days. Vegetation is annual grasses and forbs. Perkins soils, moderately deep variant, are associated principally with Auburn, Argonaut, and Whiterock soils.

In a representative profile, the surface layer is brown and reddish-brown, slightly acid gravelly loam and clay loam about 17 inches thick. The upper part of the subsoil is reddish-brown, slightly acid very gravelly sandy clay loam. At a depth of 33 inches, the subsoil is unrelated pale-olive, mildly alkaline sandy clay. Depth to unrelated rock is about 37 inches.

Perkins soils, moderately deep variant, are used mainly for range.

Perkins gravelly loam, moderately deep variant, 2 to 5 percent slopes (PgB).—This soil has gentle slopes (fig. 5).

Representative profile, 2 miles south of Clarksville, 0.25 mile west of Latrobe Road, and 0.25 mile west of the southeast corner of sec. 14, T. 9 N., R. 8 E.:

Ap—0 to 4 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 3/4) when moist; massive; hard, friable, nonsticky and nonplastic; many very fine roots; many very fine and fine pores; slightly acid; abrupt, smooth boundary.

A1—4 to 12 inches, reddish-brown (5YR 4/4) gravelly heavy loam, dark reddish brown (5YR 3/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores and few fine and medium pores; slightly acid; clear, smooth boundary

A3—12 to 17 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores and few fine and medium pores; few thin clay films in pores; slightly acid; abrupt, smooth boundary.

B21t—17 to 25 inches, reddish-brown (5YR 5/4) very gravelly sandy clay loam, dark red (2.5YR 3/6) when moist; massive; hard, firm, slightly sticky and plastic; few very fine roots; common very fine pores; many moderately thick clay films as bridges and in pores; slightly acid; gradual, smooth boundary.

B22t—25 to 33 inches, reddish-brown (5YR 5/4) very gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; massive; hard, firm, slightly sticky and plastic; very few very fine roots; common very fine pores; many moderately thick clay films as bridges and in pores; slightly acid; abrupt, wavy boundary.

IIB23—33 to 37 inches, pale-olive (5Y 6/3) sandy clay, olive (5Y 5/3) when moist; massive; very hard, very firm; clay films fill all voids; mildly alkaline; slightly effervescent; abrupt, wavy boundary.

Figure 5.—**Profile of Perkins gravelly loam, moderately deep variant, 2 to 5 percent slopes.**

IIR—37 inches, fractured hard greenstone.

Gravel and cobblestones are present throughout the profile and increase to make up 50 to 60 percent of the B horizon by volume. B2t horizon is reddish brown to yellowish red and generally lies abruptly on unrelated pale-olive soil material. The unrelated soil material generally has weathered to sandy clay or clay and contains some lime in places.

Included in mapping are small areas of Auburn silt loam, Argonaut gravelly loam, and Whiterock gravelly silt loam.

Permeability of this Perkins soil is moderately slow. Surface runoff is slow, and the erosion hazard is slight. The available water holding capacity is 4 to 6 inches. The effective rooting depth is 24 to 40 inches.

This soil is used for range. Capability unit IIIe-8(18); range site 2; woodland suitability group not assigned.

Placer Diggings

Placer diggings (PrD) consists of areas of stony, cobbly, and gravelly material, commonly in beds of creeks and other streams, or of areas that have been placer mined and contain enough fine sand or silt to support some grass for grazing. The material that makes up this land type is derived from a mixture of rocks and commonly is stratified or poorly sorted. In some areas where slopes are steep, the material consists of fines from stamp mills or tailings from placer mining. The depth of the soil material is variable, ranging from 6 inches to more than 5 feet. Areas in streambeds frequently are flooded during the rainy season. Natural drainage varies from place to place.

The vegetation is variable, but it generally consists of grass, browse, oak, and a few conifers. Alder, willow, cottonwood, or maple generally are along the edges of areas adjacent to streams.

This land type has some value for grazing and for wildlife habitat, and it provides watering places for livestock. Capability unit VIIs-1(18, 22); range site 6; woodland suitability group not assigned.

Rescue Series

The Rescue series consists of well-drained soils that are underlain by gabbrodiorite rocks at a depth of more than 40 inches. These soils are undulating to steep in the foothills. Slopes are 2 to 50 percent. Elevations range from 1,000 feet to 2,500 feet. The average annual rainfall is 25 to 35 inches, average annual temperature is 57° F., and the frost-free season is 170 to 270 days. Vegetation is mainly chamise, annual grasses, and scattered pines. Rescue soils are associated principally with Auburn, Argonaut, and Sobrante soils.

In a representative profile, the surface layer is reddish-brown, medium acid and slightly acid sandy loam about 10 inches thick. The subsoil is yellowish-red and reddish-yellow, slightly acid heavy sandy loam and sandy clay loam about 24 inches thick. The underlying material is reddish-yellow, slightly acid coarse sandy loam and very pale brown, slightly acid loamy coarse sand.

Rescue soils are used for annual range, perennial pasture, irrigated pasture, and forage crops.

Rescue sandy loam, 2 to 9 percent slopes (ReB).—This soil is moderately sloping.

Representative profile, 4 miles west of Rescue, on the east side of Deer Valley Road, near the center of the NE¼SE¼ sec. 19, T. 10 N., R. 9 E.:

A1—0 to 5 inches, reddish-brown (5YR 5/4) sandy loam, dark reddish brown (5YR 3/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and common fine roots; many very fine tubular and interstitial pores and few fine tubular pores; medium acid; clear, smooth boundary.

A3—5 to 10 inches, reddish-brown (5YR 4/4) sandy loam, dark reddish brown (5YR 3/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and common fine roots; many very fine tubular and interstitial pores and few fine tubular pores; few thin clay films in pores; slightly acid; clear, slightly wavy boundary.

B1t—10 to 14 inches, yellowish-red (5YR 4/6) heavy sandy loam, yellowish red (5YR 3/6) when moist; massive; hard, friable, sticky and plastic; common very fine and fine roots; common very fine tubular pores; many thin clay films in pores and as bridges; slightly acid; gradual, smooth boundary.

B2t—14 to 26 inches, yellowish-red (5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) when moist; massive; extremely hard, firm, sticky and plastic; few fine, medium, and coarse roots; few very fine and fine tubular

pores; many moderately thick clay films in pores; slightly acid; gradual, smooth boundary.

B3t—26 to 34 inches, reddish-yellow (5YR 6/8) heavy sandy loam, variegated reddish brown and reddish yellow (5YR 4/4, 6/6) when moist; massive; extremely hard, firm, sticky and plastic; very few fine, medium, and coarse roots; few very fine tubular and interstitial pores; many thin clay films in pores and as bridges; slightly acid; clear, slightly wavy boundary.

C1—34 to 55 inches, reddish-yellow (5YR 7/8) coarse sandy loam, yellowish red (5YR 5/6) when moist; massive; very hard, firm, slightly sticky and slightly plastic; very few fine, medium, and coarse roots; few very fine tubular and interstitial pores; few thin clay films in pores and as bridges; slightly acid; clear, slightly wavy boundary.

C2—55 to 66 inches, very pale-brown (10YR 7/4) loamy coarse sand, strong brown (7.5YR 5/6) when moist; massive; slightly hard, firm, nonsticky and nonplastic; very few fine, medium, and coarse roots; few very fine tubular and interstitial pores; slightly acid; gradual, wavy boundary.

C3—66 inches, weathered gabbrodiorite.

Thickness of the A horizon ranges from 6 to 10 inches. The A horizon is reddish brown to yellowish red.

Included in mapping are small areas of Argonaut clay loam and Rescue clay, clayey variant.

Permeability of this Rescue soil is moderately slow. Surface runoff is slow to medium, and the erosion hazard is slight to moderate. The available water holding capacity is 4 to 7 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used for range, dryland pasture, irrigated pasture, and forage crops. Capability unit IIIe-1(18); range site 2; woodland suitability group not assigned.

Rescue sandy loam, 9 to 15 percent slopes (ReC).—This soil is similar to Rescue sandy loam, 2 to 9 percent slopes, except that it is more sloping.

Included in mapping are small areas of Argonaut clay loam.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for range and dryland pasture. Capability unit IVe-1(18); range site 2; woodland suitability group not assigned.

Rescue sandy loam, 15 to 30 percent slopes (ReD).—This soil is similar to Rescue sandy loam, 2 to 9 percent slopes, except that it is more sloping.

Included in mapping are small areas of Argonaut clay loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for range and pasture. Capability unit VIe-1(18); range site 2; woodland suitability group not assigned.

Rescue very stony sandy loam, 3 to 15 percent slopes (RfC).—This soil is similar to Rescue sandy loam, 2 to 9 percent slopes, except that 1 to 3 percent of the surface is covered with stones. Because the stones are small enough to be removed, this soil can be cultivated.

Included in mapping are small areas of Argonaut clay loam.

Surface runoff is slow to medium, and the erosion hazard is slight to moderate.

This soil is used for range and pasture. Most areas under brush cover are subject to slight erosion. Capability unit VIs-1(18); range site 2; woodland suitability group not assigned.

Rescue very stony sandy loam, 15 to 30 percent slopes (RfD).—This soil is similar to Rescue sandy loam, 2 to 15 percent slopes, except that 1 to 3 percent of the surface is covered with stones.

Included in mapping are small areas of Argonaut clay loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for range, pasture, and some woodland. Large areas are covered with chamise. Capability unit VIs-1(18); range site 2; woodland suitability group 5.

Rescue very stony sandy loam, 30 to 50 percent slopes (RfE).—This soil is similar to Rescue sandy loam, 2 to 9 percent slopes, except that 1 to 3 percent of the surface is covered with stones.

Included in mapping are small areas of Boomer very rocky loam.

Surface runoff is rapid, and the erosion hazard is high.

This soil is used for annual range and woodland. Large areas are covered by chamise brush. Capability unit VIIs-1(18); range site 2; woodland suitability group 5.

Rescue extremely stony sandy loam, 3 to 50 percent slopes, eroded (RgE2).—This soil has stones on 3 to 15 percent of its surface. The thickness of the surface layer is only 3 to 8 inches.

Included in mapping are small areas of Metamorphic rock land and Serpentine rock land.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

This soil is used mainly for watershed. Almost all of it is covered with chamise brush. Capability unit VIIs-1(18); range site 2; woodland suitability group 5.

Rescue Series, Clayey Variant

The Rescue series, clayey variant, consists of poorly drained soils that are underlain by basic igneous rock at a depth of more than 40 inches. These soils are nearly level in wet drainageways and swales. Elevations are 500 to 1,500 feet. The average annual precipitation is 25 to 35 inches, average annual temperature is 59° F., and the frost-free season is 170 to 270 days. Vegetation consists of reeds, sedges, meadow grasses, and a few willows. Rescue soils, clayey variant, are associated principally with Auburn soils and normal Rescue soils.

In a representative profile, the surface layer is mottled, very dark gray and black, slightly acid and mildly alkaline clay about 23 inches thick. The upper part of the substratum is mottled, very dark grayish-brown, mildly alkaline clay about 13 inches thick. Below this, the substratum is mottled, dark grayish-brown, mildly alkaline clay loam that grades to weathered basic igneous rock at a depth of about 48 inches.

Rescue soils, clayey variant, are used for hay and irrigated pasture.

Rescue clay, clayey variant (Rk).—This soil has slopes of less than 2 percent.

Representative profile in native meadow, about 4.5 miles west of Rescue and 0.3 mile south and 0.3 mile west of the northeast corner of sec. 30, T. 10 N., R. 9 E.:

A11—0 to 15 inches, very dark gray (N 3/0) clay, black (N 2/0) when moist; strong, medium, angular blocky structure; very hard, firm, sticky and very plastic; many very fine roots and few medium roots; many

very fine and fine tubular and interstitial pores; many moderately thick organic films in pores and on ped faces; slightly acid; gradual, smooth boundary.

A12—15 to 23 inches, black (10YR 2/1) clay, black (10YR 2/1) when moist; common, medium, distinct, grayish-brown (10YR 5/2) mottles, very dark grayish-brown (10YR 3/2) when moist; massive; very hard, firm, sticky and very plastic; common very fine and fine roots and few medium roots; common fine tubular pores; many moderately thick organic films in pores; mildly alkaline; gradual, smooth boundary.

C1g—23 to 36 inches, very dark grayish-brown (2.5Y 3/2) clay, very dark grayish brown (2.5Y 3/2) when moist; common, medium, prominent, white (10YR 8/1) mottles, common, medium, distinct, and strong brown (7.5YR 5/6) when moist; massive; very hard, firm, sticky and very plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; common thin clay films in pores; mildly alkaline; diffuse, smooth boundary.

C2g—36 to 48 inches, dark grayish-brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; many, medium, distinct, brown (10YR 5/3) mottles, many, medium, prominent, and yellowish brown (10YR 5/6) when moist; massive; hard, firm, sticky and plastic; very few, very fine and fine, medium roots; many fine interstitial pores; mildly alkaline; gradual wavy boundary.

C3—48 inches, weathered basic igneous rock.

Depth to bedrock is more than 40 inches and generally is more than 48 inches. In places there is 2 to 4 inches of loamy overwash covering the clay surface layer. Total thickness of the A horizon is 10 to 25 inches. The C horizon is very dark grayish brown to dark gray and is neutral or mildly alkaline.

Included in mapping, about 1 mile west of Rescue, is a soil that is similar to this Rescue soil, clayey variant, except that the surface layer is dark reddish-brown clay loam, the subsoil is grayish-brown, mottled clay, and the soil is somewhat poorly drained. Also included are small areas of Rescue sandy loam, Auburn gravelly silt loam, Delpiedra very rocky loam, and Loamy alluvial land.

The water table fluctuates between depths of 18 and 36 inches from winter to early in summer. Most of the wetness is because of springs and seeps from higher lying, adjacent areas. This soil generally is channeled, but lateral movement of water into the channels is slow. Permeability is slow. Surface runoff is slow, and the erosion hazard is none to slight. The available water holding capacity is 6 to 10 inches. The effective rooting depth is 40 inches to more than 60 inches, although the fine texture and the height of the water table do not favor the development of an extensive root system below a depth of about 25 to 30 inches.

This soil is used for hay and irrigated pasture. Capability unit IIIw–5(18); range site and woodland suitability group not assigned.

Serpentine Rock Land

Serpentine rock land (SaF) is in areas of highly resistant serpentine and other ultrabasic rock formations. Rock outcrops and stones make up from 50 to 90 percent of the surface, and there is a thin mantle of soil. This land type is undulating to very steep. At lower elevations it is associated with Delpiedra soils.

Included with this miscellaneous land type, above an elevation of 1,000 feet, are small, scattered areas of a soil that has a surface layer of reddish-brown, slightly acid loam and a subsoil of reddish-brown and yellowish-red, neutral very gravelly heavy clay loam and clay. Depth to hard bedrock ranges from 10 to 24 inches.

This land type is excessively drained. Surface runoff is very rapid, and the erosion hazard is slight to moderate.

Serpentine rock land is used for watershed and wildlife habitat. It has no farming value. Capability unit VIIIs–1(18, 22); range site and woodland suitability group not assigned.

Shaver Series

The Shaver series consists of well-drained soils that are underlain by granitic rocks at a depth of more than 40 inches. These soils are gently rolling to steep on mountainous uplands. Slopes are 5 to 50 percent. Elevations range from 2,000 feet to 4,000 feet. The average annual precipitation, including snow, is 35 to 50 inches, average annual temperature is 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and associated hardwoods. Shaver soils are associated principally with Holland, Musick, and Chaix soils.

In a representative profile, the surface layer is dark grayish-brown, brown, and yellowish-brown, medium acid coarse sandy loam about 30 inches thick. The subsoil is yellowish-brown, medium acid coarse sandy loam. The parent rock, at a depth of about 51 inches, is well-weathered granodiorite.

Shaver soils are used mainly for woodland, deciduous fruits, and nuts. Some areas are used for range.

Shaver coarse sandy loam, 9 to 15 percent slopes (SbC).—This soil is strongly sloping.

Representative profile, 3 miles south of Somerset, 25 feet west of the Fair Play Road, and 0.3 mile northwest of the center of sec. 30, T. 9 N., R. 12 E.:

O1&O2—1½ inches to 0, litter and duff, mainly pine needles and oak leaves.

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots and common fine roots; many very fine tubular and interstitial pores and common fine tubular and interstitial pores; medium acid; clear, smooth boundary.

A12—6 to 15 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 3/3) when moist; massive; soft, very friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; common very fine and fine tubular and interstitial pores; medium acid; gradual, smooth boundary.

A13—15 to 30 inches, yellowish-brown (10YR 5/4) coarse sandy loam, dark brown (10YR 3/3) when moist; massive; soft, friable, nonsticky and nonplastic; common fine and medium roots; many very fine and fine interstitial pores and common very fine and fine tubular pores; medium acid; gradual, smooth boundary.

B2—30 to 51 inches, yellowish-brown (10YR 5/4) coarse sandy loam, brown (10YR 4/3) when moist; massive; soft, friable, nonsticky and nonplastic; common fine, medium, and coarse roots; many very fine and fine interstitial pores and common very fine and fine tubular pores; medium acid; gradual, smooth boundary.

C—51 inches, well-weathered granodiorite.

Depth to weathered granodiorite is more than 40 inches. The texture of the A and B horizons ranges from coarse sandy loam to sandy loam. Total thickness of the A horizon is 20 to 30 inches. The B horizon is brown to yellowish brown.

Included in mapping are small areas of Holland coarse sandy loam, Musick sandy loam, and Shaver rocky coarse sandy loam.

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Permeability of this Shaver soil is moderately rapid. Surface runoff is medium, and the erosion hazard is moderate to high. The available water holding capacity is 4 to 7 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used for deciduous fruits and nuts, range, and woodland. Capability unit IVe-1(22); range site not assigned; woodland suitability group 2.

Shaver coarse sandy loam, 5 to 9 percent slopes (SbB).—This soil is similar to Shaver coarse sandy loam, 9 to 15 percent slopes, except that it is less sloping.

Included in mapping are small areas of Holland coarse sandy loam, Musick sandy loam, Shaver rocky coarse sandy loam, and Argonaut loam, seeped variant.

Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for deciduous fruits and nuts, woodland, and range. Capability unit IIIe-1(22); range site not assigned; woodland suitability group 1.

Shaver coarse sandy loam, 15 to 30 percent slopes (SbD).—This soil is similar to Shaver coarse sandy loam, 9 to 15 percent slopes, except that it is more sloping.

Included in mapping are small areas of Holland coarse sandy loam, Musick sandy loam, and Chaix very rocky coarse sandy loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIe-1 (22); range site not assigned; woodland suitability group 3.

Shaver rocky coarse sandy loam, 5 to 15 percent slopes (ScC).—This soil is similar to Shaver coarse sandy loam, 9 to 15 percent slopes, except that 5 to 10 percent of the surface is exposed outcrops of bedrock.

Included in mapping are small areas of Holland coarse sandy loam, Musick sandy loam, and Chaix very rocky coarse sandy loam.

This soil is used for woodland, deciduous fruits, nuts, and very limited range. Capability unit IVe-7(22); range site not assigned; woodland suitability group 2.

Shaver very rocky coarse sandy loam, 15 to 50 percent slopes (SdE).—This soil is similar to Shaver coarse sandy loam, 9 to 15 percent slopes, except that 5 to 25 percent of the surface is exposed outcrops of bedrock.

Included in mapping are small areas of Holland very rocky coarse sandy loam, Musick very rocky sandy loam, Chaix very rocky coarse sandy loam, Ahwahnee very rocky coarse sandy loam, Mariposa very rocky loam, and Josephine very rocky loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIs-1 (22); range site not assigned; woodland suitability group 3.

Sierra Series

The Sierra series consists of well-drained soils that are underlain by granitic rocks at a depth of 40 inches to more than 60 inches. These soils are gently rolling to steep on foothills. Slopes are 5 to 50 percent. Elevations range from 1,000 feet to 2,000 feet. The average annual rainfall is 30 to 35 inches, average annual temperature is 60° F., and the frost-free season is 170 to 270 days. Vegetation is annual grasses and forbs and scattered areas of hardwoods and conifers. Sierra soils are associated principally with Auberry, Ahwahnee, Holland, and Musick soils.

In a representative profile, the surface layer is brown, medium acid sandy loam about 7 inches thick. The subsoil is about 65 inches thick. In sequence from the top, the upper 15 inches is brown and yellowish-red, medium acid loam. The next 22 inches is yellowish-red and red, slightly acid clay loam. The next 14 inches is red, slightly acid sandy clay loam. The lower part is light-red, slightly acid sandy clay loam that extends to a depth of 72 inches.

Sierra soils are used for range, pasture, deciduous orchards, vineyards, and woodland.

Sierra sandy loam, 9 to 15 percent slopes, eroded (SfC2).—This soil is strongly sloping. Erosion has removed 3 to 7 inches of the surface layer (fig 6).

Representative profile, 3 miles west of Aukum and 0.2 mile east of the center of sec. 8, T. 8 N., R. 11 E.:

A1—0 to 7 inches, brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 3/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine tubular and interstitial pores; medium acid; clear, smooth boundary.

B11t—7 to 13 inches, brown (7.5YR 5/4) loam, reddish brown (5YR 4/4) when moist; moderate, medium and coarse, subangular blocky structure; hard, firm, slightly sticky and plastic; many very fine and fine roots; many very fine and fine tubular pores and common medium tubular pores; common thin clay films on ped faces and in pores; medium acid; gradual, smooth boundary.

B12t—13 to 22 inches, yellowish-red (5YR 5/6) heavy loam, yellowish red (5YR 3/6) when moist; moderate, medium and coarse, subangular blocky structure; very hard, firm, sticky and plastic; common very fine and fine roots; many very fine and fine tubular pores and common medium tubular pores; common thin clay films on ped faces and in pores; medium acid; gradual, smooth boundary.

B21t—22 to 30 inches, yellowish-red (5YR 4/6) clay loam, dark red (2.5YR 3/6) when moist; moderate, medium and coarse, subangular blocky structure; very hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine medium tubular pores; many moderately thick clay films on ped faces and in pores; slightly acid; gradual, smooth boundary.

B22t—30 to 44 inches, red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) when moist; moderate, medium and coarse, subangular blocky structure; very hard, firm, slightly sticky and plastic; few very fine and fine roots; common very fine, fine, and medium tubular pores; many moderately thick clay films on ped faces and in pores; slightly acid; gradual, smooth boundary.

B31t—44 to 58 inches, red (2.5YR 5/8) light sandy clay loam, red (2.5YR 4/8) when moist; massive; very hard, slightly firm, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine tubular and interstitial pores; common thin clay films in pores and as bridges; slightly acid; gradual, smooth boundary.

B32—58 to 72 inches, light-red (2.5YR 6/8) light sandy clay loam, red (2.5YR 4/8) when moist; massive; very hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine tubular and interstitial pores; common thin clay films in pores and as bridges; slightly acid; gradual, smooth boundary.

B33—72 to 80 inches, yellowish-red (5YR 5/8) light sandy clay loam, red (2.5YR 4/6) when moist; massive; hard, firm, slightly sticky and slightly plastic; no roots observed; common very fine and fine tubular and interstitial pores; common thin clay films in pores and as bridges; slightly acid.

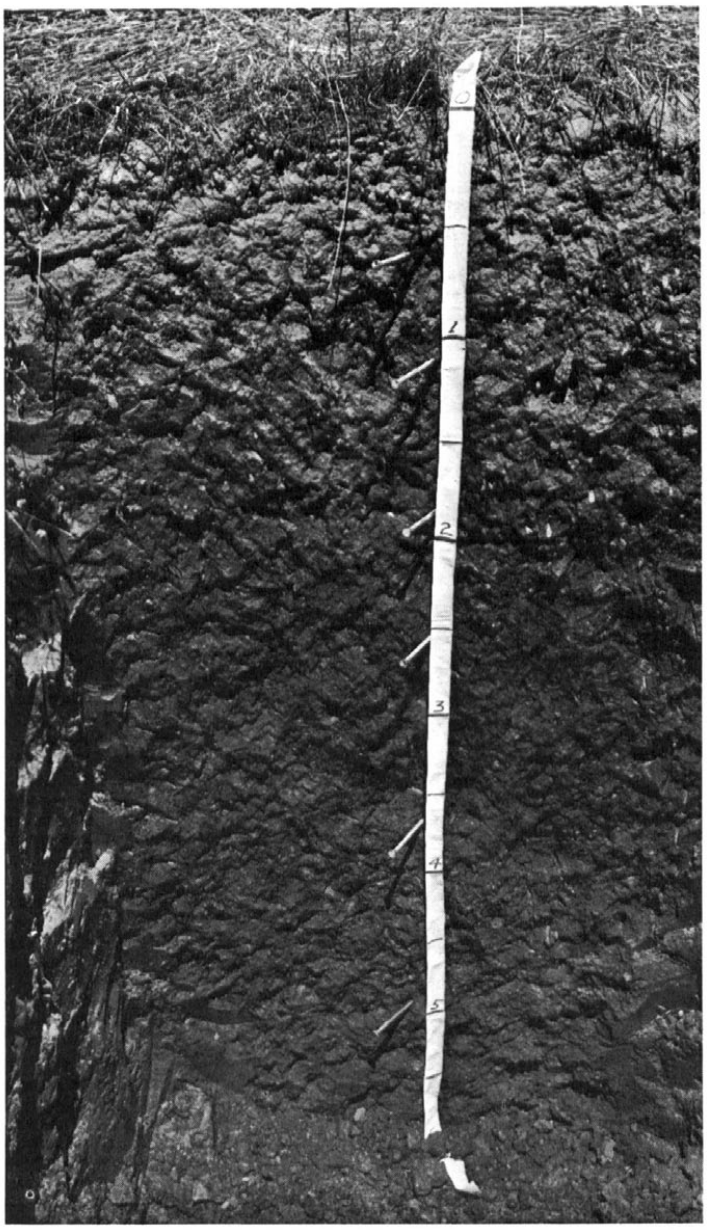

Figure 6.—**Profile of Sierra sandy loam, 9 to 15 percent slopes, eroded.**

Depth to weathered parent rock ranges from 40 inches to more than 60 inches. The A horizon averages from 6 to 9 inches in thickness and is brown to strong brown coarse sandy loam to light loam. The B2 horizon is massive or subangular blocky sandy clay loam to clay loam.

Included in mapping are small areas of Sierra sandy loam that has slopes of 3 to 9 percent, Auberry coarse sandy loam, Ahwahnee coarse sandy loam, Musick sandy loam, and Argonaut loam, seeped variant.

Permeability of this Sierra soil is moderately slow. Surface runoff is medium, and the erosion hazard is moderate. The available water holding capacity is 6 to 10 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used mainly for annual range. Small areas are used for deciduous orchards, vineyards, and irrigated pasture. Capability unit IVe–1(18); range site 3; woodland suitability group not assigned.

Sierra sandy loam, 15 to 30 percent slopes, eroded (SfD2).—This soil is similar to Sierra sand loam, 9 to 15 percent slopes, eroded, except that it is more sloping.

Included in mapping are small areas of Auberry coarse sandy loam, Ahwahnee very rocky coarse sandy loam, and Musick sandy loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used mainly for range. Some areas are used for deciduous orchards. Capability unit VIe–1(18); range site 3; woodland suitability group not assigned.

Sierra rocky sandy loam, 5 to 15 percent slopes (SgC).—This soil is similar to Sierra sandy loam, 9 to 15 percent slopes, eroded, except that outcrops of bedrock make up 5 to 10 percent of the surface area and the surface layer is 9 to 16 inches thick and is grayish brown to brown.

Included in mapping are small areas of Auberry coarse sandy loam, Ahwahnee very rocky coarse sandy loam, Musick rocky sandy loam, and Argonaut loam, seeped variant.

This soil is used for range. Capability unit IVe–7(18); range site 3; woodland suitability group not assigned.

Sierra very rocky sandy loam, 15 to 30 percent slopes (ShD).—This soil is similar to Sierra sandy loam, 9 to 15 percent slopes, eroded, except that the surface is 5 to 25 percent rock outcrops and the surface layer is 9 to 16 inches thick and is grayish-brown to brown.

Included in mapping are small areas of Ahwahnee very rocky coarse sandy loam, Auberry very rocky coarse sandy loam, Musick very rocky sandy loam, Holland very rocky coarse sandy loam, and Josephine very rocky silt loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for range and woodland. Capability unit VIs–1(18); range site 3; woodland suitability group 5.

Sierra very rocky sandy loam, 30 to 50 percent slopes (ShE).—This soil is similar to Sierra sandy loam, 9 to 15 percent slopes, eroded, except that the surface is 5 to 25 percent rock outcrops and the surface layer is 9 to 16 inches thick and is grayish-brown to brown.

Included in mapping are small areas of Auberry very rocky coarse sandy loam, Ahwahnee very rocky coarse sandy loam, Musick very rocky sandy loam, and Josephine very rocky silt loam.

Surface runoff is rapid, and the erosion hazard is very high.

This soil is used for range and woodland. Capability unit VIIs–1(18); range site 3; woodland suitability group 6.

Sites Series

The Sites series consists of well-drained soils that are underlain by vertically tilted metasedimentary and metabasic rocks at a depth of 40 inches to more than 60 inches. These soils are rolling to very steep on mountainous uplands. Slopes are 9 to 70 percent. Elevations range from 2,000 to 5,000 feet. The average annual precipitation, including snow, is 35 to 60 inches, average annual temperature is about 55° F., and the frost-free season is 140 to 240 days. Vegetation is mainly coniferous forest and asso-

ciated hardwoods. Sites soils are associated principally with Josephine, Mariposa, Aiken, and Musick soils.

In a representative profile, the surface layer is brown and reddish-brown, slightly acid and medium acid loam about 14 inches thick. The upper part of the subsoil is yellowish-red, medium acid clay loam, and red strongly acid clay about 39 inches thick. The lower part of the subsoil is light-red, very strongly acid clay loam that is underlain at a depth of 69 inches by weathered schist and slate.

Sites soils are used for woodland and for deciduous orchards.

Sites loam, 15 to 30 percent slopes (SkD).—This soil is moderately steep.

Representative profile, 5 miles east of Placerville, 1,000 feet north of Blakely Reservoir, and 1,000 feet northwest of the southeast corner of sec. 1, T. 10 N., R. 11 E. (fig. 7):

O1&O2—3 inches to 0, pine needles, duff, and partially decomposed litter.

A11—0 to 7 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/3) when moist; strong, fine and medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many fine and medium tubular and interstitial pores; slightly acid; clear, smooth boundary.

A12—7 to 14 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/3) when moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and coarse roots; common very fine and fine tubular and interstitial pores and many medium tubular and interstitial pores; medium acid; clear, smooth boundary.

B1t—14 to 21 inches, yellowish-red (5YR 4/6) clay loam, reddish brown (5YR 4/4) when moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots and many medium and coarse roots; common very fine and medium tubular and interstitial pores; common thin clay films in pores and on ped faces; medium acid; clear, smooth boundary.

B21t—21 to 29 inches, red (2.5YR 5/6) clay, red (2.5YR 4/6) when moist; strong, medium and coarse, subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; common very fine and medium tubular and interstitial pores; many thin clay films in pores and on ped faces; strongly acid; gradual, smooth boundary.

B22t—29 to 53 inches, red (2.5YR 5/8) clay, red (2.5YR 4/8) when moist; strong, medium and coarse, angular and subangular blocky structure; hard, firm, sticky and plastic; few fine and common medium roots; common very fine and medium tubular pores; continuous, moderately thick clay films in pores and on ped faces; strongly acid; gradual, smooth boundary.

B3t—53 to 69 inches, light-red (2.5YR 6/8) clay loam, red (2.5YR 4/8) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and medium roots; few fine tubular pores; many moderately thick clay films in pores and on ped faces; contains reddish-yellow (5YR 6/8), highly weathered parent material; very strongly acid; clear, irregular boundary.

R—69 inches, weathered schist and slate.

Depth to weathered slate and schist ranges from 40 inches to more than 60 inches. The A horizon ranges from 10 to 15 inches in thickness and from brown, reddish-brown, and yellowish-brown to red in color. It has granular or subangular blocky structure. The B2t horizon ranges from medium acid to very strongly acid and is silty clay, heavy clay loam, or clay.

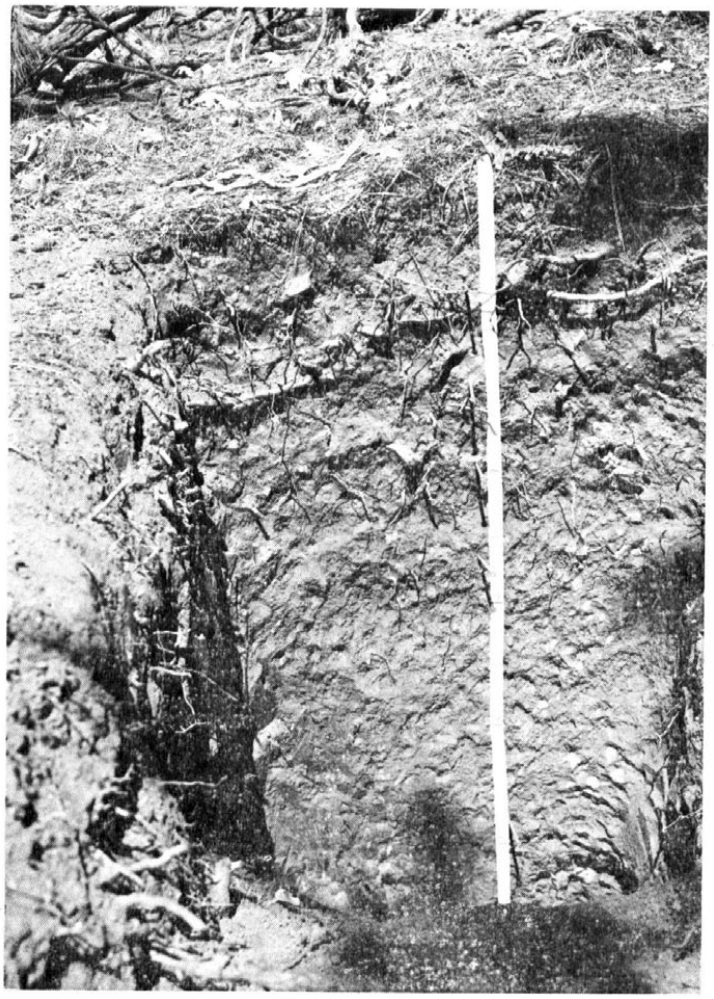

Figure 7.—**Profile of Sites loam, 15 to 30 percent slopes.**

Included in mapping are small areas of Mariposa gravelly silt loam, Josephine silt loam, Josephine gravelly loam, Aiken loam, and Boomer gravelly loam. Also included are small areas where depth to bedrock is 36 to 40 inches.

Permeability of this Sites soil is moderately slow. Surface runoff is medium, and the erosion hazard is moderate. The available water holding capacity is 5 to 10 inches. The effective rooting depth is 40 inches to more than 60 inches.

This soil is used for woodland and deciduous orchards. Capability unit IVe-1 (22); range site not assigned; woodland suitability group 2.

Sites loam, 9 to 15 percent slopes (SkC).—This soil is similar to Sites loam, 15 to 30 percent slopes, except that it is less sloping.

Included in mapping are small areas of Mariposa gravelly silt loam, Josephine silt loam, Josephine gravelly loam, Aiken loam, and Boomer gravelly loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used for woodland and deciduous orchards. Capability unit IIIe-1 (22); range site not assigned; woodland suitability group 1.

Sites loam, 30 to 50 percent slopes (SkE).—This soil is similar to Sites loam, 15 to 30 percent slopes, except that it is more sloping.

Included in mapping are small areas of Boomer gravelly loam, Mariposa very rocky silt loam, Josephine silt loam, and Josephine gravelly loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIe–1 (22); range site not assigned; woodland suitability group 2.

Sites stony loam, 30 to 50 percent slopes (SoE).—This soil has stones and coarse fragments that make up 15 to 35 percent, by volume, of the upper 30 inches of the profile. The profile, as a whole, is 10 to 20 percent stones. Depth to parent rock generally is more than 5 feet.

Included in mapping are small areas of Josephine silt loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIe–1 (22); range site not assigned; woodland suitability group 2.

Sites very rocky loam, 15 to 50 percent slopes (SrE).—This soil is similar to Sites loam, 15 to 30 percent slopes, except that rock outcrops make up 5 to 25 percent of the surface area.

Included in mapping are small areas of Boomer very rocky loam, Mariposa very rocky silt loam, Josephine very rocky silt loam, and Josephine very rocky loam.

Surface runoff is medium to rapid, and the erosion hazard is moderate to high.

This soil is used for woodland. Capability unit VIs–1 (22); range site not assigned; woodland suitability group 2.

Sites very rocky loam, 50 to 70 percent slopes (SrF).—This soil is similar to Sites loam, 15 to 30 percent slopes, except that rock outcrops make up 5 to 25 percent of the surface area.

Included in mapping are small areas of Boomer very rocky loam, Mariposa very rocky silt loam, Josephine very rocky silt loam, and Josephine very rocky loam.

Surface runoff is rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIIs–1 (22); range site not assigned; woodland suitability group 3.

Sites clay loam, 9 to 15 percent slopes (SsC).—This soil is similar to Sites loam, 15 to 30 percent slopes, except it has a surface layer of clay loam about 12 inches thick.

Included in mapping were small areas of Josephine silt loam, Mariposa gravelly silt loam, and Sites loam.

Surface runoff is medium, and the erosion hazard is slight to moderate.

This soil is used for woodland and deciduous orchards. Capability unit IIIe–1(22); range site not assigned; woodland suitability group 4.

Sites clay loam, 15 to 30 percent slopes (SsD).—This soil is similar to Sites loam, 15 to 30 percent slopes, except that the surface layer is clay loam about 12 inches thick.

Included in mapping are small areas of Josephine silt loam and Mariposa gravelly silt loam.

This soil is used for woodland and deciduous orchards. Capability unit IVe–1(22); range site not assigned; woodland suitability group 5.

Sites clay loam, 30 to 50 percent slopes (SsE).—This soil is similar to Sites loam, 15 to 30 percent slopes, except that the surface layer is clay loam about 10 inches thick.

Included in mapping are small areas of Josephine silt loam, Sites loam, and Mariposa very rocky silt loam.

Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used for woodland. Capability unit VIe–1 (22); range site not assigned; woodland suitability group 5.

Sobrante Series

The Sobrante series consists of well-drained soils that are underlain by fine-grained metamorphic rocks at a depth of 22 to 36 inches. These soils are undulating to hilly and are in the foothills. Slopes are 3 to 30 percent. Elevations range from 800 to 1,800 feet. The average annual temperature is 60° F., average annual rainfall is 25 to 35 inches, and the frost-free season is 170 to 270 days. Vegetation is chiefly annual grasses and forbs, and there are scattered oaks. Sobrante soils are associated principally with Auburn, Argonaut, and Boomer soils.

In a representative profile, the surface layer is reddish-brown, medium acid silt loam about 5 inches thick. The subsoil is yellowish-red, slightly acid silt loam and light clay loam about 19 inches thick. The substratum is well-weathered basic schist about 6 inches thick. Bedrock is at a depth of 30 inches.

The Sobrante soils are used mainly for range. A few small areas are used for irrigated pasture and deciduous orchards.

Sobrante silt loam, 3 to 15 percent slopes (SuC).—This soil is gently sloping to strongly sloping (fig. 8).

Representative profile, 2½ miles south of Shingle Springs, 200 feet west of French Creek Road, and 200 feet south of the north quarter corner of sec. 19, T. 9 N., R. 10 E.:

A1—0 to 5 inches, reddish-brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; massive; slightly hard and hard, friable, slightly sticky and slightly plastic; many micro and very fine roots; common very fine, fine, and medium tubular and interstitial pores; medium acid; clear, smooth boundary.

B1—5 to 11 inches, yellowish-red (5YR 4/6) silt loam, yellowish red (5YR 3/6) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; many very fine and fine tubular pores; few thin clay films in pores; slightly acid; clear, smooth boundary.

B2t—11 to 24 inches, yellowish-red (5YR 5/6) light clay loam near silty clay loam, dark red (2.5YR 3/6) when moist; moderate, medium, subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; common very fine tubular pores and many fine and medium tubular pores; many thin clay films in pores and on ped faces; slightly acid; clear, wavy boundary.

C—24 to 30 inches, soft, well-weathered basic schist; slightly acid.

R—30 inches hard basic schist; pockets of slightly weathered material.

The A horizon is reddish brown to strong brown, is slightly acid to medium acid, and ranges from 3 to 9 inches in thickness. The B horizon ranges from reddish brown to yellowish red and from silt loam and light clay loam to light silty clay loam.

Included in mapping are small areas of Auburn silt loam, Argonaut gravelly loam, and Boomer gravelly loam.

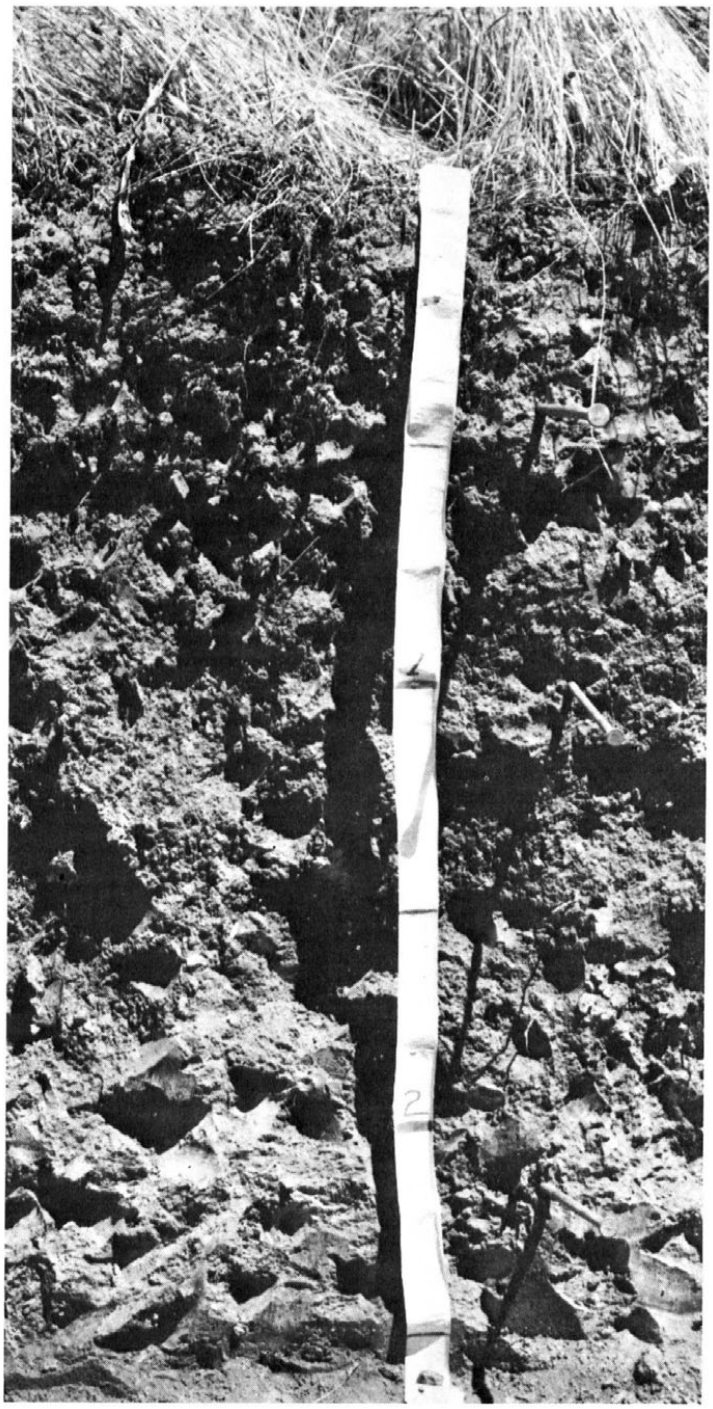

Figure 8.—**Profile of Sobrante silt loam, 3 to 15 percent slopes.**

Permeability of this Sobrante soil is moderate. Surface runoff is slow to medium, and the erosion hazard is slight to moderate. The available water holding capacity is 4 to 7 inches. Effective rooting depth is 22 to 36 inches.

This soil is used mainly for range. Small areas are used for pasture and deciduous orchards. Capability unit IIIe–8(18); range site 2; woodland suitability group not assigned.

Sobrante silt loam, 15 to 30 percent slopes (SuD).—This soil is similar to Sobrante silt loam, 3 to 15 percent slopes, except that it is more sloping.

Included in mapping are small areas of Auburn silt loam and Boomer gravelly loam.

The erosion hazard on this Sobrante soil is moderate. Surface runoff is medium.

This soil is used for range and for pasture. Capability unit IVe–8(18); range site 2; woodland suitability group not assigned.

Sobrante very rocky silt loam, 3 to 30 percent slopes (SwD).—This soil is similar to Sobrante silt loam, 3 to 15 percent slopes, except that it is more sloping and rock outcrops make up 5 to 25 percent of the surface area.

Included in mapping are small areas of Auburn very rocky silt loam, Argonaut very rocky loam, and Boomer very rocky loam.

This soil is used for range. Capability unit VIs–1(18); range site 2; woodland suitability group not assigned.

Tailings

Tailings (TaD) consists of cobbly and stony tailings from dredge mining and hydraulic mining and in hard-rock mine dumps. All the soil material either has been washed away, as in hydraulic mining, or has been buried, as in dredge mining or mine dumps. Surface runoff is slight, and the erosion hazard is none to slight.

This land type is used for watershed and wildlife habitat. It has no farming value. Capability unit VIIIs–1(18, 22); range site and woodland suitability group not assigned.

Wet Alluvial Land

Wet alluvial land (WaB) consists of small areas of recent alluvium adjacent to stream channels. The alluvium is stratified sandy loam, loam, and clay that generally become gravelly as depth increases. Depth to underlying rock is more than 48 inches.

This land type is somewhat poorly drained. The water table is at a depth of 2 to 3 feet in winter and spring but drops to a depth of 4 feet or more late in summer and in fall. Permeability is moderate to moderately slow. Surface runoff is slow, and the erosion hazard is slight. This land type occasionally is flooded. The available water holding capacity is 8 to 10 inches.

This land type is used for irrigated pasture and dryland pasture. Capability unit IIw–2(18, 22); range site and woodland suitability group not assigned.

Whiterock Series

The Whiterock series consists of excessively drained soils that are underlain by slate at a depth of 5 to 12 inches. These soils are undulating to steep on foothills. Slopes are 3 to 50 percent. Elevations range from 450 to 1,500 feet. The average annual rainfall is 23 to 30 inches, annual average temperature is 61° F., and the frost-free season is 170 to 270 days. Vegetation is mainly annual grasses, forbs, and a few areas of oak or brush. Whiterock soils are associated principally with Auburn, Argonaut, and Mariposa soils.

In a representative profile, the surface layer is pale-brown and white, medium acid and strongly acid gravelly silt loam about 5 inches thick. The next layer is white, strongly acid cobbly silt loam. This is underlain at a depth of 8 inches by hard slate.

Whiterock soils are used for range and watershed.

Whiterock gravelly silt loam, 3 to 50 percent slopes (WhE).—This soil is gently sloping to strongly sloping (fig. 9). As much as 2 percent of the surface is outcrops of slate.

Representative profile, 3 miles west of Latrobe, 1/8 mile east of the Sacramento County Line, and 1/8 mile south of Latrobe Road, near the west section line of sec. 19, T. 8 N., R. 9 E.:

A11—0 to 1 inch, pale-brown (10YR 6/3) gravelly silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular and interstitial pores; medium acid; abrupt, smooth boundary.

A12—1 to 5 inches, white (10YR 8/2) gravelly silt loam, brown (10YR 4/3) when moist; massive; hard, friable, nonsticky and slightly plastic; common very fine and fine roots; many very fine and fine tubular pores; strongly acid; clear, smooth boundary.

AC—5 to 8 inches, white (10YR 8/2) cobbly silt loam, brown (10YR 5/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine tubular pores; strongly acid; abrupt, wavy boundary.

R—8 inches, hard slate.

A few, thin, vertical slabs of outcropping bedrock are in most areas. Cobblestones make up 0 to 20 percent of the AC horizon.

Figure 9.—**Profile of Whiterock gravelly silt loam, 3 to 50 percent slopes.**

Included in mapping are small areas of Metamorphic rock land, Auburn silt loam, and Argonaut extremely stony loam. In some included areas along the Mother Lode belt, the surface layer is only slightly acid.

Permeability of this Whiterock soil is moderate. Surface runoff is medium to rapid, and the erosion hazard is slight to high. The available water holding capacity is 0.5 to 1.5 inches. The effective rooting depth is 5 to 12 inches.

This soil is used for range. Capability unit VIIs-1(18); range site 4; woodland suitability group not assigned.

Use and Management of the Soils

This section discusses use of the soils for crops and gives estimated yields and soil management practices. It also discusses use of the soils for range, woodland, wildlife habitat, and engineering.

Use of the Soils for Crops

The main crops that are grown in the survey area are discussed in the paragraphs that follow. Table 2 gives the acreage of fruit and nut crops. The statistics are for the year 1968 and are compiled from the El Dorado County Agricultural Commissioner's report.

TABLE 2.—*Acreage of fruit and nut crops*

Crop	Bearing	Nonbearing
Pears	2, 220	245
Apples	500	76
Walnuts	260	150
Cherries	66	15
Peaches	11	----------
Plums	28	----------
Grapes	10	8
Total	3, 095	494

Most of the commercial fruit and nut crops are grown under irrigation at elevations of less than 4,000 feet. Pears, apples, and walnuts are the main fruit and nut crops grown. Small acreages are used for cherries, peaches, plums, and grapes. Most walnuts are dryfarmed, but they need supplemental irrigation for establishment.

The pear industry was severely affected in 1959 by an insect-spread disease called pear decline. In 1958 there were 3,700 acres of bearing pears; by 1965, the acreage was reduced to about 2,000 acres. Improved management and resistant root stock have slowed pear decline, and at present there are about 2,200 acres in bearing pear trees and 245 acres in nonbearing pear trees.

Most of the areas west of State Highway 49 are used for pasture and range. There are about 5,240 acres of irrigated pasture. Most of the irrigated pasture is in small parcels. About 9,000 acres have been planted to perennial grasses and legumes.

Small, scattered acreages of barley, oats, milo, and sudan are grown. Most of these crops are used for hay and silage.

Most areas higher than 2,500 feet in elevation are used for woodland and are harvested for lumber. The acreage of commercial Christmas trees is increasing.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most common crops. The groups are made according to the limitations of the soils when used for common crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the soils are grouped at three levels, the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in the El Dorado Area.)

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in the El Dorado Area.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, clayey, or stony; and *c*, used in only some parts of the United States but not in the El Dorado Area, shows that the chief limitation is climate that is too cold or too dry.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils.

Capability units in California in classes I through IV are given Arabic numbers that suggest the chief kind of limitation responsible for placement of the soil in the capability class and subclass. For this reason, some of the units within the subclasses are not numbered consecutively, and their symbols are a partial key to some of the soil features. Except for class I, the numerals used to designate units within the classes and subclasses are these:

0. A limitation caused by sand and gravel in the substratum. (Not used in the El Dorado Area.)
1. An actual or potential erosion hazard.
2. A limitation of wetness caused by poor drainage or flooding.
3. A limitation caused by slow to very slow permeability of the subsoil or substratum.
4. A limitation caused by coarse soil texture or excessive gravel. (Not used in the El Dorado Area.)
5. A limitation caused by a fine textured or very fine textured surface soil.
6. A limitation caused by salt or alkali. (Not used in the El Dorado Area.)
7. A limitation caused by cobblestones, stones, or rock outcrops.
8. A limitation caused by nearly impervious bedrock or hardpan that limits the effective rooting depth.
9. A limitation caused by low fertility or by toxicity. (Not used in the El Dorado Area.)

Soils in classes V through VIII are given the single, nonconnotative Arabic number 1. The management of soils in these classes when used for range or woodland is given in the sections "Use of the Soils for Range" and "Woodland Uses of the Soils," respectively.

Land resource areas

In the El Dorado Area, capability classification is further refined by designating the land resource area in which the soils in a unit occur. A land resource area is a broad geographic area that has a distinct combination of climate, soils, management needs, and cropping systems. The 48 conterminous States in the Nation have been divided into 156 land resource areas. Parts of two of these areas are in the El Dorado Area.

It is necessary to make assumptions that affect management in a land resource area if soils are to be placed consistently in capability units. In the paragraphs that follow, those land resource areas that have parts within the El Dorado Area are described so that local farming can be related to the resource areas. Following the description of each resource area is a list of those conditions typical of the area that guided placement of the soils in capability classes and units.

Land resource area 18.—This land resource area is in the lower and middle foothills of the Sierra Nevada. It is located in the western quarter of El Dorado County, extend-

ing from the Sacramento County line to near Placerville. The soils are rolling to very steep, and the area is dissected by rivers and streams that flow westerly into the Great Central Valley.

Elevations range from about 500 feet to about 2,500 feet. The average annual rainfall is 23 to 35 inches. The frost-free season is 170 to 270 days.

The major properties that limit use of soils in this resource area are steep slopes, shallowness to bedrock, coarse fragments in the profile, low available water holding capacity, and rock outcrops.

The soils in this land resource area are placed in capability units on the assumption that—

1. Irrigation water is available, or will be available when plans for future water development are realized. No attempt has been made to exclude tracts that might not be possible to irrigate because of location.
2. Rainfall is adequate for dryfarmed crops commonly grown in the area.
3. A moderately high level of management is used.
4. The major uses of soils in the area are for range, hay, irrigated pasture, dryland pasture, and deciduous fruits and nuts. Some vineyards are being introduced.

Land resource area 22.—This land resource area makes up part of the Sierra Nevada. It extends easterly from the eastern boundary of land resource area 18, near Placerville, to the eastern boundary of the El Dorado Area. It is characterized by hilly to very steep soils on mountainous uplands and by occasional, broad, tabular ridgetops and deeply entrenched rivers and streams. Elevations range from about 2,000 to 5,000 feet. The average annual precipitation is 35 to 60 inches, and a large part of its falls as snow. The frost-free season is 140 to 240 days.

The major properties that limit use of the soils in this resource area are low temperatures in winter, steep slopes, shallowness to bedrock, coarse fragments in the profile, low available water holding capacity, and rock outcrops.

The soils in this land resource area are placed in capability units on the assumption that—

1. Irrigation water is available, or will be available when plans for future water development are realized. No attempt has been made to exclude tracts of land that might not be possible to irrigate because of location.
2. A moderately high level of management is used.
3. The major uses of soils in the area are for woodland, deciduous fruits and nuts, and some irrigated pasture. Some vineyards are being introduced.

Management by capability units

In the following pages, the capability units in the El Dorado Area are described and suggestions for use and management of the soils are given. Soil series names are mentioned in each capability unit, but this does not mean that all mapping units of the series are in that particular unit. The soils in each unit are listed in the "Guide to Mapping Units" at the back of the survey.

In the following descriptions of the capability units, the available water holding capacity applies to the effective rooting zone, or the depth to which plant roots generally penetrate.

478-431 O—74——6

CAPABILITY UNIT IIe-1(18)

This unit consists only of Loamy alluvial land. This miscellaneous land type has slopes of 2 to 5 percent. Permeability is moderate to moderately slow, and drainage is moderately good. The effective rooting depth is about 48 inches. Available water holding capacity is 8 to 10 inches. Tillage is easy.

This land type is used for range, dryland pasture, and some alfalfa, irrigated pasture, and deciduous orchards. Crops respond well to applications of nitrogen and phosphorus fertilizers.

This land type generally is irrigated by sprinkler systems and, to a lesser extent, by the furrow method. Some surface smoothing can be done, but extensive leveling may expose unfavorable soil material. In places small levees or channel alinement may be required to prevent minor flooding.

CAPABILITY UNIT IIe-1(22)

This unit consists of well drained to moderately well drained soils that have slopes of 0 to 9 percent. These soils are in the Aiken and Cohasset series. Also in the unit is the land type Loamy alluvial land. Permeability of the subsoil is moderate. The effective rooting depth is 40 inches to more than 60 inches. Available water holding capacity is 6 to 10 inches. Runoff is slow to medium, and the erosion hazard is slight. The soils are easy to work.

These soils are used mainly for woodland. A few areas are used for apple and pear orchards. The soils are well suited to apple and pear orchards in areas where water is available for irrigation. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation should be done by sprinklers. Erosion can be controlled by tilling across the slope and by using cover crops in orchards during winter.

CAPABILITY UNIT IIw-2(18, 22)

This unit consists only of Wet alluvial land. This miscellaneous land type is more than 48 inches deep, is somewhat poorly drained, and has slopes of less than 6 percent. It is in narrow tracts on small, scattered alluvial fans and flood plains along streams. Permeability of the subsoil is moderate to moderately slow. Available water holding capacity is 8 to 10 inches. The water table is at a depth of 2 to 3 feet during winter and spring, but it is at a depth of 4 feet or more during summer. Some areas are subject to occasional flooding or overflow that generally is not damaging. These areas generally are channeled by streams.

This land type is used for range, irrigated pasture, and dryland pasture. Where it is protected from overflow, it can be used for deciduous fruits, mainly pears. Crops respond to applications of nitrogen and phosphorus fertilizers.

Care is required in irrigating to prevent raising the water table above its present level, particularly in areas where deeper rooted crops are grown. Crop residue should be disked into the soil to maintain good tilth. In places small levees or channel alinement may be required to help prevent minor flooding.

CAPABILITY UNIT IIIe-1(18)

This unit consists of well-drained soils that have slopes of 2 to 9 percent. These soils are in the Auberry and Rescue series. Permeability of the subsoil is moderate to moderately slow. Available water holding capacity is 4 to 9

inches. Runoff is medium, and the hazard of erosion is slight to moderate. The soils are easy to work.

These soils are used for range and for some pear and apple orchards. A few areas are used for vineyards, dryland pasture, irrigated pasture, or forage crops (fig. 10). Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers or furrows on the contour. Cover crops help to control erosion during the rainy season. Orchards should be planted across the slope. Adequate outlets are needed safely to dispose of runoff water.

CAPABILITY UNIT IIIe-1(22)

This unit consists of well-drained soils that have slopes of 3 to 15 percent. These soils are in the Aiken, Boomer, Cohasset, Diamond Springs, Holland, Josephine, Shaver, and Sites series. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting depth is 24 inches to more than 60 inches. Available water holding capacity is 4 to 10 inches. Runoff is slow to medium, and the erosion hazard is slight to moderate. Except for Cohasset cobbly loam, 3 to 15 percent slopes, the soils are easy to work.

These soils are used mainly for woodland. A few areas are used for range, pears, apples, and nuts. In areas where irrigation water is available, these soils are suited to pears, apples, walnuts, vineyards, and pasture. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers. Tillage should be across the slopes. Growing cover crops in orchards and vineyards in rainy seasons helps to control erosion. Residue from cover crops should be returned to the soil. Cultivation should be limited to the control of weeds.

CAPABILITY UNIT IIIe-8(18)

This unit consists of moderately well drained and well drained soils that have slopes of 2 to 15 percent. These soils are in the Perkins series, moderately deep variant, and the Sobrante series. Permeability in the subsoil is moderately slow to moderate. The effective rooting depth is 22 to 40 inches. Available water holding capacity is 4 to 7 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate. These soils are easy to work.

These soils are used for range, dryland and irrigated pasture, fruit trees, and some forage crops. Crops respond to applications of nitrogen and phosphorus fertilizers.

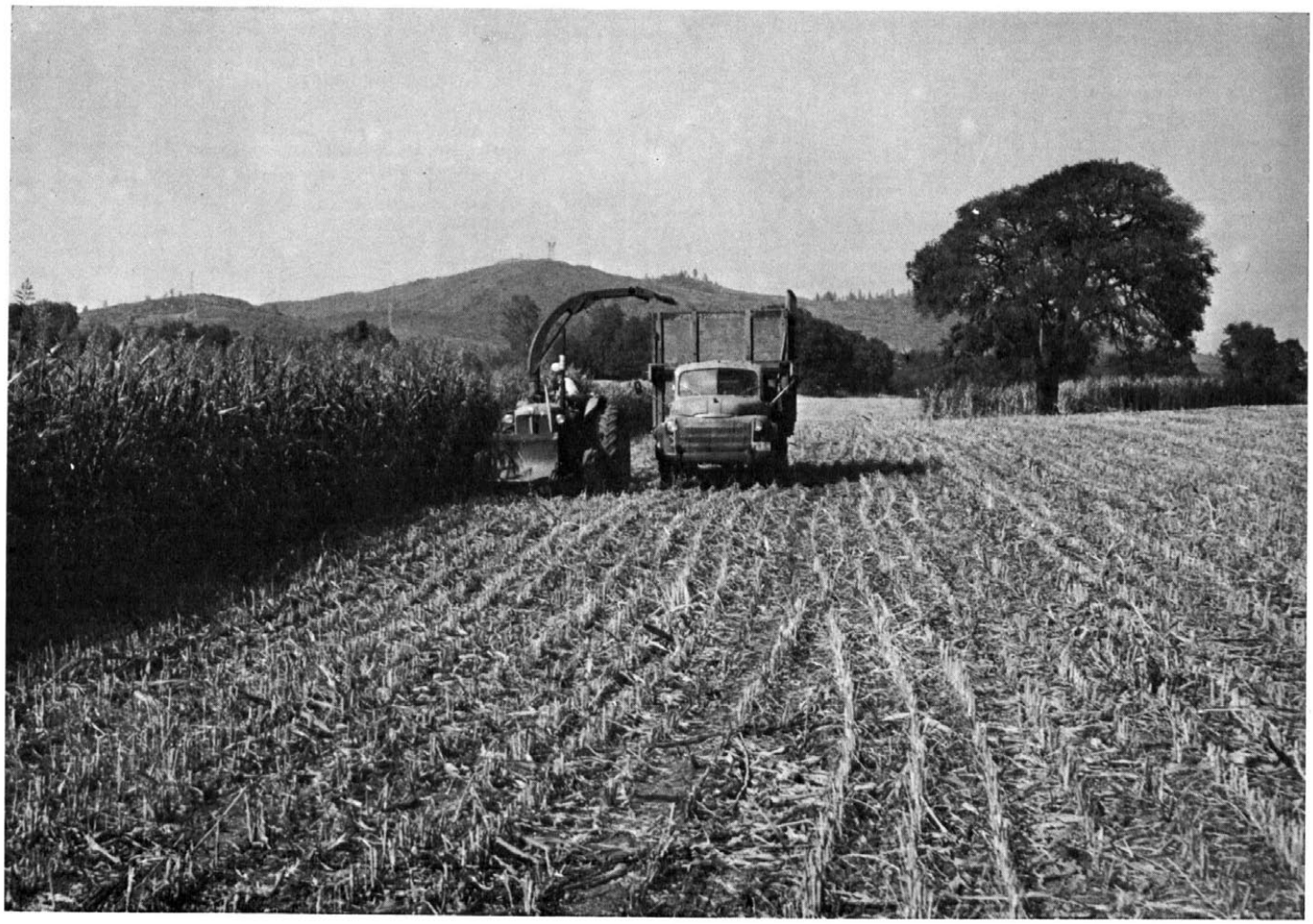

Figure 10.—**Chopping sudan-milo hybrid for silage on Rescue sandy loam, 2 to 9 percent slopes.**

The use of green-manure crops and crop rotation and the return of crop residue to the soil help to control erosion, improve soil tilth, increase water infiltration, and improve fertility. Green-manure crops can be grown in rotation with grain and forage crops. All tillage should be on the contour or across the slope.

Irrigation water should be applied by sprinklers. Cover crops grown in orchards and vineyards help to control sheet erosion during the rainy season.

CAPABILITY UNIT IIIw-5(18)

Rescue clay, clayey variant, is the only soil in this unit. This soil is poorly drained, has slow permeability, and occupies concave areas. Slopes are 0 to 2 percent. The wetness problem is aggravated by springs and seeps. Depth to the water table ranges from 18 to 36 inches. Available water holding capacity is 6 to 10 inches. Channeling is the only erosion problem.

This soil is used for pasture, meadow, and volunteer hay. Areas that are drained and protected from overflow can be used for small grain. Crops respond to applications of nitrogen and phosphorus fertilizers.

Drainage is very difficult because of the slowly permeable subsoil and the lack of drainage outlets. Care should be exercised to avoid the formation of deep gullies that reduce forage production.

CAPABILITY UNIT IVe-1(18)

This unit consists of well-drained soils that have slopes of 9 to 15 percent. These soils are in the Ahwahnee, Auberry, Rescue, and Sierra series. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting depth is 24 inches to more than 60 inches. Available water holding capacity is 3.5 to 10 inches. Runoff is medium, and the hazard of erosion is moderate. The soils are easy to work.

These soils are used primarily for range. Some areas are irrigated and used for pasture; walnut, pear, and apple orchards; forage crops; and vineyards. The soils are well suited to these crops if irrigation water is available. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers. Orchards and vineyards should be planted across the slopes, and cover crops should be maintained during the rainy season.

Grain cut for hay can be grown 1 year and followed by 4 years of pasture. All tillage should be on the contour. On long slopes, stripcropping and diversion terracing are needed.

CAPABILITY UNIT IVe-1(22)

This unit consists of well-drained soils that have slopes of 3 to 30 percent. These soils are in the Aiken, Boomer, Cohasset, Diamond Springs, Holland, Horseshoe,, Josephine, Mariposa, Musick, Shaver, and Sites series and in the Diamond Springs series, grayish subsoil variant. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting depth is 24 inches to more than 60 inches. Available water holding capacity is 4 to 10 inches. Runoff is slow to medium, and the erosion hazard is slight to high. The soils are easy to work.

These soils are used primarily for woodland and some range. Some areas are used for walnuts and as pasture. In areas where irrigation water is available, these soils are well suited to pears, apples, walnuts, and pasture. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers. Permanent cover crops should be used in orchards. All farming operations should be on the contour.

CAPABILITY UNIT IVe-3(18)

This unit consists of well drained and moderately well drained soils that have slopes of 2 to 30 percent. These soils are in the Argonaut and Perkins series. Permeability in the subsoil is slow to very slow. The effective rooting depth is 20 inches to more than 60 inches. Available water holding capacity is 2.5 to 9 inches. Runoff is medium, and the erosion hazard is slight to moderate. The soils are difficult to cultivate because they contain coarse fragments.

These soils are used for range. They are suitable for hay and grain or for irrigated pasture. If these soils are cropped, a cover of grasses and legumes should be grown 4 years out of 5. The use of crop residue, cross-slope tillage, and stripcropping on long slopes reduces runoff and helps to control erosion.

Irrigation water should be applied by sprinklers. Water should be applied slowly to prevent saturating the soil that overlies the slowly and very slowly permeable clay subsoil.

CAPABILITY UNIT IVe-7(18)

This unit consists of well-drained soils that have slopes of 5 to 15 percent. Exposed rock outcrops cover 5 to 10 percent of the surface. These soils are in the Auberry and Sierra series. Permeability of the subsoil is moderate to moderately slow. The effective rooting depth is 40 inches to more than 60 inches. Available water holding capacity is 5 to 10 inches. Runoff is medium, and the erosion hazard is moderate. Rock outcrops make tillage of intertilled crops difficult but not impracticable.

These soils are used primarily for range. Some walnut, pear, and apple orchards and pasture are grown in areas where irrigation water is available. The soils are well suited to vineyards. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers. Tillage should be across the slope to control erosion. Cover crops should be grown during the rainy season.

CAPABILITY UNIT IVe-7(22)

This unit consists of well-drained soils that have slopes of 5 to 15 percent. These soils are in the Holland, Musick, and Shaver series. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting depth is 40 inches to more than 60 inches. Available water holding capacity is 4 to 10 inches. Runoff is medium, and the erosion hazard is moderate to high. About 5 to 10 percent of the surface is outcrops of bedrock that make tillage difficult but not impracticable.

The soils in this unit are used mainly for woodland. Some areas are used for pear, apple, and nut orchards in areas where irrigation water is available, or for limited range. These soils are well suited to vineyards, and a few areas are used for vineyards. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers. Tillage should be on the contour. Cover crops should be grown in orchards and vineyards during the rainy season.

CAPABILITY UNIT IVe-8(18)

This unit consists of well-drained soils of the Auburn and Sobrante series. These soils have slopes of 2 to 30 percent. Permeability of the subsoil is moderate. The effective rooting depth is 12 to 36 inches. Available water holding capacity is 2 to 7 inches. The erosion hazard is slight to moderate. The soils are somewhat difficult to work.

These soils are used mainly for range. A few small areas are used for irrigated or dryland pasture. Hay or grain is suitable. Crops respond to applications of nitrogen and phosphorus fertilizers.

Irrigation water should be applied by sprinklers. Tillage should be across the slope. Cover crops should be maintained in orchards and vineyards.

Grain should be grown 1 year in every 5. All crop residue should be returned to the soil to maintain good tilth.

CAPABILITY UNIT IVe-8(22)

Mariposa gravelly silt loam, 3 to 30 percent slopes, is the only soil in this unit. This soil is well drained. Permeability of the subsoil is moderate. The effective rooting depth is 15 to 30 inches. Available water holding capacity is 2 to 4 inches. Runoff is medium, and the erosion hazard is slight to moderate. Gravel makes the soil somewhat difficult to work.

This soil is used mainly for woodland. A few areas are used for range and irrigated pasture. The soil is not well suited to dryland farming. Deciduous fruit crops, mainly apples, are marginally suited to this soil.

Irrigation water should be applied lightly and frequently by sprinklers because of slope and the low available water holding capacity. Tillage should be on the contour, and cover crops should be grown during the rainy season to control erosion. Crops respond to applications of nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IVw-2(18, 22)

This unit consists of Argonaut loam, seeped variant, and Mixed alluvial land along streams and swales. Drainage is moderately good to poor. These soils are subject to frequent flooding and channeling. Permeability in the subsoil of the Argonaut soil is very slow. Permeability of Mixed alluvial land is moderately rapid to slow. The effective rooting depth ranges from 25 inches to more than 60 inches. Available water holding capacity is 3 to 6 inches. Erosion hazard is slight to moderate.

These soils are used for pasture, for native meadow, and, in land resource area 22, for woodland. Where drained and protected from overflow, these soils can be used for small grain.

Channel improvements, dikes, or levees may be necessary in some areas before permanent crops can be grown. These soils can be improved by drainage.

CAPABILITY UNIT VIe-1(18)

This unit consists of well-drained soils that have slopes of 2 to 30 percent. These soils are in the Auberry, Rescue, and Sierra series. Permeability of the subsoil is moderate to moderately slow. The effective rooting depth is 12 inches to more than 60 inches. The available water holding capacity is 2 to 10 inches. Runoff is slow to rapid, and the erosion hazard is slight to high.

These soils are used mainly for range. A few areas are used for woodland. Where irrigation water is available, apples, pears, and pasture are grown to a limited extent.

Irrigation water should be applied by sprinklers.

Orchards should be planted on the contour, and permanent cover crops should be maintained to prevent erosion. All farming operations should be done across the slope.

CAPABILITY UNIT VIe-1(22)

This unit consists of well-drained soils that mainly have slopes of 15 to 50 percent but in a few areas have slopes as gentle as 9 percent. These soils are in the Cohasset, Crozier, Diamond Springs, Holland, Horseshoe, Josephine, McCarthy, Musick, Shaver, and Sites series and in the Diamond Springs series, grayish subsoil variant. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting depth is 24 inches to more than 60 inches. Available water holding capacity is 3 to 10 inches. Runoff is medium to rapid, and the erosion hazard is moderate to high. These soils are difficult to work.

These soils are used for woodland and for limited range. If irrigation water is available, if permanent cover is maintained, and if irrigation water is applied by sprinklers, the soils that have slopes of less than 30 percent are suitable for pears and apples. All areas of these soils need to be protected from fires or from uses that leave the surface bare.

CAPABILITY UNIT VIs-1(18)

This unit consists of well-drained soils that have slopes of 3 to 30 percent. These soils are in the Ahwahnee, Argonaut, Auberry, Auburn, Rescue, Sierra, and Sobrante series. Permeability of the subsoil is moderately rapid to very slow. The available water holding capacity is 2 to 10 inches. Runoff is slow to rapid, and the erosion hazard is slight to high. About 5 to 25 percent of the surface is outcrops of bedrock and 1 to 3 percent is covered by stones, making tillage of intertilled crops impractical.

These soils are used for range and some woodland.

Rock outcrops, stones, and rolling to hilly slopes make these soils better suited to grazing than to most other uses. Firebreaks and trails should be maintained along roads. Seeding of perennial or annual grasses and legumes may be desirable if the plant cover is deteriorated. Forage plants grown on these soils respond well to applications of ammonium phosphate surface fertilizers. Adequate plant residue must be left at the end of grazing if maximum forage production is to be maintained.

CAPABILITY UNIT VIs-1(22)

This unit consists of well-drained soils that have slopes of 3 to 50 percent. These soils are in the Boomer, Diamond Springs, Holland, Hotaw, Josephine, Mariposa, Musick, Shaver, and Sites series. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting depth is 15 inches to more than 60 inches. Available water holding capacity is 2 to 10 inches. Runoff is medium to rapid, and the erosion hazard is slight to high. About 5 to 25 percent of the surface is outcrops of bedrock that make tillage of intertilled crops impractical.

These soils are used for mainly woodland. A few areas are used for range.

These soils are well suited to woodland. Firebreaks should be maintained along access roads. Areas that have been cleared or burned over tend to come back in brush and, unless properly managed, produce little forage for domestic livestock. These soils respond favorably to seeding of adapted range grasses and to fertilization of these grasses.

CAPABILITY UNIT VIIs-1 (18)

This unit consists of well-drained to excessively drained soils that have slopes of 15 to 70 percent and a few areas where slopes are as gentle as 3 percent. The soils of this unit are in the Ahwahnee, Argonaut, Auberry, Auburn, Delpiedra, Rescue, Sierra, and Whiterock series and in the Auburn series, heavy subsoil variant. Also included is the land type Placer diggings. Permeability of the subsoil is moderately rapid to very slow. The effective rooting depth is 5 inches to more than 60 inches. Available water holding capacity is 0.5 to 10 inches. Runoff is slow to very rapid, and the erosion hazard is slight to very high. Fertility is moderate to very low. These soils are very rocky or extremely rocky, and 5 to 50 percent of the surface is rock outcrops. In some areas 1 to 15 percent of the surface is covered by stones. Other areas have as much as 80 percent slate fragments in the profile.

These soils are used chiefly for range, wildlife habitat, and watershed. Selected areas are used for woodland. Adequate plant residue should remain after grazing to maintain maximum production and to control erosion. Seeding of annual grasses and legumes is limited to critical areas of accidental burns.

CAPABILITY UNIT VIIs-1 (22)

This unit consists of well-drained to excessively drained soils that have slopes of 3 to 70 percent. These soils are in the Boomer, Chaix, Chawanakee, Holland, Iron Mountain, Josephine, Mariposa, Maymen, and Sites series. Also included is the land type Placer diggings. Permeability of the subsoil is moderately rapid to moderately slow. The effective rooting zone is 5 inches to more than 60 inches. Available water holding capacity is 0.5 to 10 inches. Runoff is medium to rapid, and the erosion hazard is slight to very high. About 5 to 25 percent of the surface is exposed bedrock.

These soils are used for woodland, wildlife habitat, and watershed. A few areas are used for range.

To reduce erosion, these soils should be protected from fire by use of firebreaks. Brushy areas furnish browse and cover for wildlife.

CAPABILITY UNIT VIIIs-1 (18, 22)

This unit consists of Acidic rock land, Gullied land, Metamorphic rock land, Serpentine rock land, and Tailings. All of these land types except Tailings have slopes of 30 to 75 percent. Tailings has slopes of less than 15 percent. Acidic rock land, Gullied land, and Tailings are more erodible than the other land types in this unit, and they produce more sediment and debris in lower lying areas.

These land types are used for watershed and wildlife habitat. They have no value for farming. Protecting the areas from fire helps to prevent erosion and subsequent sedimentation of the rivers.

Storie index rating [2]

The soils of the survey area are listed in alphabetic order and are rated according to the Storie index (*16*) in the "Guide to Mapping Units." This index expresses numerically the relative degree of suitability, or value, of a soil for general intensive farming. The rating is based on soil characteristics only. It does not take into account other factors, such as availability of water for irrigation, climate, and distance from markets, that might determine the desirability of growing specific crops in a given locality. For these reasons, the index in itself cannot be considered an index for land valuation.

Four factors that represent the inherent characteristics and qualities of the soil are considered in the index rating. Each factor is rated or evaluated separately in terms of percentage of the ideal, or 100 percent. The factors are:

Factor A, Profile characteristics.—Factor A expresses relative suitability of a profile for the growth of plant roots. Soils that have deep permeable profiles are rated 100 percent. Those that have a dense clay layer or a hardpan or are shallow over bedrock are rated less than 100 percent. The rating depends upon the extent to which root penetration is limited.

Factor B, Texture of the surface soil.—Factor B is rated according to the texture of the surface soil, which affects the ease of tillage and the capacity of the soil to hold water. The moderately coarse and medium textures—fine sandy loam, loam, and silt loam—are the most desirable and are rated 100 percent. The coarser and finer textures, such as sand and clay, are rated less than 100 percent.

Factor C, Slope.—Factor C is particularly important if the soil is irrigated. The amount of water that runs off a soil and its susceptibility to erosion are influenced by the slope of the soil. Smooth, nearly level or very gently sloping soils are rated 100 percent. The rating decreases as the slope increases.

Factor X, Other conditions.—Factor X is used to evaluate any limitations to use of the soil, such as poor drainage or a high water table, erosion, salts or alkali, low fertility, acidity, or unfavorable microrelief. If more than one limitation exists, the values of each are multiplied together to get the X factor.

The index rating of a soil is obtained by multiplying the four factors A, B, C, and X; thus, any one factor may dominate or control the final rating. For example, a soil may have an excellent profile justifying a rating of 100 percent for factor A, excellent texture of the surface soil justifying 100 percent for factor B, a smooth, nearly level surface justifying 100 percent for factor C, but a strong accumulation of salts or alkali that would give a rating of 20 percent for factor X. Multiplying these four ratings gives an index rating of 20 for this soil. The strong accumulation of salts or alkali dominates, makes the soil unproductive for crops, and justifies the low index rating of 20.

Soils are placed in grades according to their suitability for farming use as shown by their Storie index ratings. The six grades and their range in index ratings are—

[2] By GORDON L. HUNTINGTON, lecturer in soil morphology, Department of Soils and Plant Nutrition, University of California, Davis, California.

	Index rating
Grade 1	80 to 100
Grade 2	60 to 80
Grade 3	40 to 60
Grade 4	20 to 40
Grade 5	10 to 20
Grade 6	Less than 10

Soils of grade 1 have few or no limitations that restrict their use for crops. Soils of grade 2 are suitable for most crops, but they have minor limitations that narrow the choice of crops and have few special management needs. Grade 3 soils are suited to a few crops or to special crops and require special management. Grade 4 soils are severely limited for crops. If used for crops, they require careful management. Grade 5 soils are not suited to cultivated crops but can be used for pasture and range. Grade 6 consists of soils and land types that generally are not suited to farming.

Estimated Yields and Soil Management Practices

Yield estimates and management practices given in this survey are based on observations made by the soil scientists who surveyed the El Dorado Area, on information furnished by farmers, and on suggestions furnished by crop specialists in the Soil Conservation Service. Federal and county census records and crop data also were reviewed and considered. More information was available for some soils than for others. If little or no information was available for a particular soil, yield estimates were made by comparison with similar soils. The range and woodland sections contain yield information on soils used for range and forest.

Table 3 gives yields of the principal irrigated crops grown on soils in the survey area under optimum management. This is the level of management under which, according to experience, field trials, and research findings, the highest returns could be expected at the present time.

Some important limitations should be kept in mind when using the yield estimates in table 3. First, the figures are estimates or predictions; second, the figures are averages that may be expected over a period of years. In any given year, the yield may be considerably higher or lower than the average.

The information on yields and management practices provided in this part of the soil survey will be most useful and helpful immediately upon release of this survey. New developments in crops, plant breeding, control of insects and diseases, use of fertilizer, tillage, irrigation, and drainage, will date some of the information on management. Newer and better practices can always be substituted, and the State and Federal farm advisory services are always ready to provide the latest information available.

Management commonly practiced for most crops grown in the El Dorado Area includes proper tillage operations and control of insects and weeds. Under an optimum level of management, the best adapted and most desirable known varieties of crops are grown. Harvesting, pruning, tillage, irrigation, and other management practices are performed at the proper time or season. Management by capability units is discussed in the section "Capability Grouping."

TABLE 3.—*Estimated average acre yields of principal crops*

[Only the soils that are widely used for crops are listed. Dashes indicate that the soil is not suited to the specific crop or that no yield data are available]

Soil name	Irrigated crops			Dryland walnuts
	Apples	Pears	Pasture	
	Tons	*Tons*	*Animal-unit-months* [1]	*Pounds*
Ahwahnee coarse sandy loam, 9 to 15 percent slopes	--------	--------	10	850
Aiken loam, 3 to 9 percent slopes	25	25	12	--------
Aiken loam, 3 to 9 percent slopes, eroded	25	25	12	--------
Aiken loam, 9 to 15 percent slopes	25	25	12	--------
Aiken loam, 9 to 15 percent slopes, eroded	25	25	12	--------
Aiken loam, 15 to 30 percent slopes	20	20	12	--------
Aiken cobbly loam, 3 to 30 percent slopes	25	25	11	--------
Argonaut gravelly loam, 2 to 15 percent slopes	--------	--------	14	--------
Argonaut clay loam, 3 to 9 percent slopes	--------	--------	14	--------
Argonaut loam, seeped variant	--------	--------	12	--------
Auberry coarse sandy loam, 5 to 9 percent slopes	--------	20	16	1,300
Auberry coarse sandy loam, 9 to 15 percent slopes	--------	20	16	1,300
Auberry coarse sandy loam, 15 to 30 percent slopes	--------	20	14	1,000
Auberry rocky coarse sandy loam, 5 to 15 percent slopes	--------	20	14	1,200
Auburn silt loam, 2 to 30 percent slopes	--------	--------	14	--------
Boomer gravelly loam, 3 to 15 percent slopes	--------	18	14	--------
Boomer gravelly loam, 15 to 30 percent slopes	--------	18	14	--------
Boomer-Sites loams, 9 to 15 percent slopes	20	20	12	--------
Boomer-Sites loams, 15 to 30 percent slopes	20	20	12	--------
Cohasset sandy loam, 15 to 30 percent slopes	20	20	12	--------
Cohasset loam, 3 to 9 percent slopes	25	25	12	--------
Cohasset loam, 9 to 15 percent slopes	25	25	12	--------

See footnote at end of table.

TABLE 3.—*Estimated average acre yield of principal crops*—Continued

Soil name	Irrigated crops			Dryland walnuts
	Apples	Pears	Pasture	
	Tons	*Tons*	*Animal-unit-months* [1]	*Pounds*
Cohasset loam, 15 to 30 percent slopes	20	20	12	--------
Cohasset cobbly loam, 3 to 15 percent slopes	25	25	11	--------
Diamond Springs very fine sandy loam, 3 to 9 percent slopes	18	18	10	--------
Diamond Springs very fine sandy loam, 9 to 15 percent slopes	18	18	10	--------
Diamond Springs gravelly sandy loam, grayish subsoil variant, 9 to 30 percent slopes	20	20	12	--------
Holland coarse sandy loam, 5 to 9 percent slopes	25	25	12	1,000
Holland coarse sandy loam, 9 to 15 percent slopes	20	20	12	1,000
Holland coarse sandy loam, 15 to 30 percent slopes	20	20	11	900
Holland rocky coarse sandy loam, 5 to 15 percent slopes	20	20	11	900
Horseshoe gravelly sandy loam, 9 to 15 percent slopes	--------	--------	--------	--------
Josephine gravelly loam, 9 to 15 percent slopes	25	25	12	--------
Josephine gravelly loam, 15 to 30 percent slopes	20	20	12	--------
Josephine silt loam, 5 to 15 percent slopes	25	25	12	--------
Josephine silt loam, 15 to 30 percent slopes	20	20	12	--------
Loamy alluvial land	--------	--------	16	--------
Mariposa gravelly silt loam, 3 to 30 percent slopes	15	15	10	--------
Mixed alluvial land	--------	--------	12	--------
Musick sandy loam, 9 to 15 percent slopes	20	20	12	1,000
Musick sandy loam, 15 to 30 percent slopes	20	20	11	900
Musick rocky sandy loam, 5 to 15 percent slopes	20	20	11	900
Perkins gravelly loam, 3 to 30 percent slopes	--------	--------	16	--------
Perkins gravelly loam, moderately deep variant, 2 to 5 percent slopes	--------	--------	14	--------
Rescue sandy loam, 2 to 9 percent slopes	--------	--------	14	--------
Rescue sandy loam, 9 to 15 percent slopes	--------	--------	14	--------
Rescue very stony sandy loam, 3 to 15 percent slopes	--------	--------	12	--------
Rescue clay, clayey variant	--------	--------	14	--------
Shaver coarse sandy loam, 5 to 9 percent slopes	20	20	--------	1,000
Shaver coarse sandy loam, 9 to 15 percent slopes	20	20	--------	1,000
Shaver coarse sandy loam, 15 to 30 percent slopes	20	20	11	900
Shaver rocky coarse sandy loam, 5 to 15 percent slopes	20	20	11	900
Sierra sandy loam, 9 to 15 percent slopes, eroded	--------	20	16	1,300
Sierra sandy loam, 15 to 30 percent slopes, eroded	--------	20	14	1,000
Sierra rocky sandy loam, 5 to 15 percent slopes	--------	20	14	1,200
Sites loam, 9 to 15 percent slopes	25	25	12	1,000
Sites loam, 15 to 30 percent slopes	20	20	12	1,000
Sites clay loam, 9 to 15 percent slopes	20	20	12	--------
Sites clay loam, 15 to 30 percent slopes	20	20	12	--------
Sobrante silt loam, 3 to 15 percent slopes	--------	18	14	--------
Sobrante silt loam, 15 to 30 percent slopes	--------	18	14	--------
Wet alluvial land	--------	--------	14	--------

[1] Animal-unit-months is a term used to express the carrying capacity of pasture. It is the amount of forage or feed required to maintain one animal, or 1,000 pounds of live weight, for a period of 30 days without injury to the pasture plants. An acre of pasture that provides 30 days of grazing for two animals has a carrying capacity of 2 animal-unit-months.

The following paragraphs discuss the management practices that were assumed when the yields for the crops specified in table 3 were estimated.

Irrigated apples.—About 50 to 100 pounds of nitrogen is applied during February. Excess nitrogen prior to harvesting interferes with coloring of the fruit. Potassium is usually adequate. About 500 pounds of phosphorus per acre is applied if phosphorus deficiencies develop. A fall application of zinc foliage spray may be used. Magnesium sulfate foliage spray occasionally is applied if deficiency symptoms are severe the previous season.

Irrigation and cover crops are the same as those used for pears, except that no legumes are used in the cover crop.

Irrigated pears.—These trees use 100 pounds of nitrogen per acre applied in the middle of February. About 50 to 100 additional pounds are applied during the first or second irrigation if the crop is heavy or lacks shoot vigor. In areas where orchards have a permanent sod cover, the amount of fertilizer applied generally is increased by 50 percent. Phosphorus and potassium are applied at rates of 500 pounds as symptoms or tissue analysis indicate. Agricultural borax is applied every 5 years at a rate of 50 pounds per acre. Zinc foliage sprays are used when deficiency symptoms are observed.

Irrigation water is applied at a rate of 0.25 to 0.35 inch per hour by sprinklers. A total of 3.5 to 5.5 inches of water is applied at each irrigation. Irrigation frequency is every 12 to 14 days during July and August. Approximately 3½ acre-feet of water is used during the year.

Permanent sod cover consists of 3 pounds of innoculated

White Dutch clover or 3 pounds of narrowleaf trefoil and 5 pounds of bromegrass or 4 pounds of creeping red fescue per acre. This cover crop is kept mowed, using a rotary mower during spring and summer through harvestings.

Annual cover crops used in areas where slopes are more gentle are 30 pounds of barley seed and 20 pounds of horsebeans per acre.

Irrigated pasture.—A combination of legumes and grasses is planted on a well-prepared seedbed. A combination of 3 pounds of narrowleaf trefoil or 2 pounds of Ladino clover and 1 pound of Salina strawberry clover with 5 pounds of Akaroa orchardgrass, 8 pounds of Alta fescue, or 8 pounds of Goars fescue per acre is used. Legume seed is innoculated before seeding. Nitrogen is applied at 30 to 40 pounds per acre, along with 15 pounds of phosphorus. Irrigation water is applied by sprinklers at a rate of 0.25 inch to 0.35 inch per acre. At the peak consumptive-use season of July and August, irrigation water is applied every 8 to 12 days. Approximately 4 acre-feet of water is used during the year.

Dryland walnuts.—About 100 pounds of nitrogen is applied late in January or early in February. About 50 pounds of agricultural borax per acre may be used if symptoms indicate the need.

Use of the Soils for Range [3]

The livestock industry in the El Dorado Area has undergone considerable change in the past decade. The 1968 El Dorado Area Agricultural Commissioner's Report estimates that there were 11,500 head of cattle, including calves, in the survey area that year. This same report lists an estimated 7,800 head of sheep and lambs. There are also several small flocks of Angora goats in the survey area, totaling about 1,000 head. A 1960 report (*23*) lists 12,700 head of cattle and 7,500 head of sheep and lambs in the Area.

Water development projects have eliminated the need of high mountain summer range for some operators. Subdivisions have taken large acreages formerly used for winter and early spring grazing in the western part of the survey area. As the population of the Area increases, grazing land will be reduced.

Most of the cattle are in herds of cows and calves that graze the lower foothills in winter and early in spring. Some operators use Federal grazing permits in summer or take their cattle to other parts of the State. Some operators transport them out of the State for summer feed. A few keep their stock in the survey area all year and use irrigated and dryland pastures and range in summer. There are many small, part-time cattle operations that depend on irrigated and dryland pastures for feed. Most of these are of the stocker-feeder type.

About 40 percent of the El Dorado Area is used for range. More than half of this acreage is Auburn soils. The Auberry, Boomer, Rescue, Sobrante, and Whiterock soils are the other important forage producers. They are mainly at elevations of about 450 feet in the western part of the survey area and extend eastward to elevations of 1,500 to 1,800 feet. At elevations between 1,200 and 1,800 feet, there is a gradual transition from grass and grass-oak to timber. Generally, the soils used for range are too steep, too shallow, or too rocky for cultivated crops. Large acreages that formerly were used for hay and grain now are used for grazing. Also, fairly large acreages along stream channels, in parks and meadows, and on shallow, stony ridgetops within timbered areas have some value for grazing. Some soils at elevations of about 1,800 feet have been cleared of trees and are used for forage. These soils produce poor quality forage and are not placed in range sites.

Most of the important range forage plants in the El Dorado Area are introduced. The original forage plants were a mixture of perennials and annuals, but the introduced plants are mostly cool-weather annuals. These annuals take advantage of soil moisture while it is there, produce seed, and mature by the time the moisture is gone. They furnish highly nutritious feed in spring when they are green and growing, but after maturity their nutritional value is low.

The forage-producing plants in the survey area are grouped into three classes: desirable, less desirable, and undesirable. Livestock graze selectively. They seek out the more palatable and nutritious plants. If grazing is not carefully regulated, the better, more desirable plants are weakened or eliminated because they are not allowed to produce seed. Less desirable plants then increase. If grazing pressure is continued, the second-choice plants also are thinned out or eliminated, and undesirable, unpalatable plants take their place or the soil is left bare.

Experience of ranchers and studies by research workers show that if only part of the current yearly growth of grass is grazed, damage to the more desirable plants is slight and higher production is attained. This vegetative material left at the end of the grazing season—

1. Serves as a mulch that increases intake rate and storage of water in the soil. The more water stored in the soil, the better the growth of plants for grazing.
2. Protects the soil from water erosion.
3. Reduces year-to-year fluctuation in forage production; plants make more efficient use of soil moisture.
4. Holds moisture near the surface after the first rains in fall so that seeds can germinate and get off to an early start.
5. Provides a reserve of feed for years when growing conditions are unfavorable.

In addition to managing the forage so that needed amounts of residue are left, there are range improvement practices that can materially increase production. These include trees and brush removal, fertilization, and seeding suitable grasses and legumes, or a combination of these practices. Sound management requires that grazing use be adjusted from season to season, according to the amount of forage produced. Because of the growth habits of annual forage plants, it is very difficult to properly utilize all the forage when it is most nutritious. If the forage is used as dry feed in summer or held for early feed in fall, protein supplements are needed by the livestock. Maintaining adquate reserves of feed and forage permits proper use of vegetation.

[3] By ROCHE D. BUSH, range conservationist, Soil Conservation Service.

Range sites

Range sites are kinds of land that produce significantly different kinds or amounts of vegetation. Each site has a different potential for production of forage and presents different management problems. The rangeland in the El Dorado Area has been grouped into six range sites. The descriptions of the range sites that follow include a brief description of the soils that make up the sites; a listing of the most desirable, less desirable, and undesirable forage plants; the acreage of the sites; and the estimated production of each site. The range site in which each soil has been placed is indicated in the "Guide to Mapping Units" at the back of this survey.

SITE 1: SHALLOW LOAMY

This range site consists of gently rolling to steep soils in the Argonaut and Auburn series and Auburn series, heavy subsoil variant. It is the most extensive site in the survey area. It occupies approximately 122,000 acres, beginning at the county line on the west and extending eastward to the vicinity of the communities of El Dorado and Cool. Elevations generally range from 500 to 1,600 feet but are as much as 2,000 feet in a few areas. The average annual rainfall ranges from 22 to 35 inches. Slopes are 3 to 50 percent, but 70 percent of the site has slopes of less than 30 percent.

The soils in this site have a surface layer that is mainly clay loam, silt loam, extremely stony loam, loam, or gravelly loam. These soils are 12 to 30 inches deep over bedrock. They are well drained and moderately well drained. The available water holding capacity is 2 to 5 inches, and the permeability is very slow to moderate. Runoff is medium to rapid, and the hazard of erosion is slight to very high. Rock outcrops cover 0 to 50 percent of the surface but do not impede livestock movement or decrease forage production, except in a few areas.

This site has a plant cover mainly of open grass or grass and oak, and there is some brush and Digger pine. The oak and brush tend to increase as the elevation and rainfall increase from west to east. Some areas have dense stands of oak and brush.

Where this site is producing at its maximum, approximately 70 percent of the plant cover is soft chess, wild oats, burclover, filaree, and other desirable species, including remnant perennial grasses that grow in the open or under the trees.

Approximately 20 percent of the vegetation is ripgut brome, annual fescues, annual lupines, and other less desirable plants. The remaining 10 percent consists of nitgrass, silver hairgrass, tarweed, popcornflower, turkeymullein, Medusahead, or other undesirable plants.

The soils in this site are well suited to adapted annual grasses and legumes. Forage plants respond to applications of nitrogen, phosphorus, and sulfur fertilizers. Repeated applications of phosphorus fertilizer are needed to maintain good stands of legumes.

About 8,500 acres in this site has been mapped as extremely rocky. Also, on about 600 acres the soils are moderately deep and have a cobbly clay loam surface layer. In these areas livestock movement is somewhat restricted and production is reduced because of the amount of rock outcrops and cobblestones on the surface.

Where needed, removal of trees and brush increases production on this site, except in the extremely rocky areas.

Total air-dry production is 3,000 pounds per acre in favorable years and 1,000 pounds in unfavorable years.

SITE 2: LOAMY

This range site consists of gently rolling to steep soils in the Boomer, Perkins, Rescue, and Sobrante series. It occupies approximately 62,000 acres and is above the lower foothills in the western part of the survey area. The soils of this site are intermingled at higher elevations with the soils of site 1 (fig. 11). Elevations generally range from 450 to 3,500 feet but are typically 1,000 to 1,600 feet. The average annual rainfall ranges from 25 to 50 inches but is typically 25 to 35 inches. Slopes range from 3 to 70 percent, but less than 2 percent of the site has slopes of more than 50 percent.

The soils in this site have a surface layer that is mainly loam, gravelly loam, cobbly loam, very stony sandy loam, silt loam, or sandy loam. These soils are 22 inches to more than 60 inches deep over bedrock or sediments. They are well drained and moderately well drained. The available water holding capacity is 4 to 9 inches, and the permeability is moderately slow to moderate. Runoff is slow to rapid, and the hazard of erosion is slight to very high. Rock outcrops and stones cover 0 to 25 percent of the surface but do not impede livestock movement or decrease forage production.

About 10,000 acres of the Rescue soils in this site is extremely stony. In this area livestock movement is restricted and total herbage production is reduced by 35 to 40 percent because of the stones on the surface.

This site typically has a grass and oak cover, and there is some brush and Digger pine. Some areas have dense stands of brush. Where the site is producing at its maximum, approximately 70 percent of the plant cover is soft chess, wild oats, burclover, filaree, and other desirable plants, including remnant perennials that grow in the open or under the trees.

Approximately 20 percent of the vegetation is ripgut brome, annual fescues, annual lupines, and other less desirable plants. The remaining 10 percent is nitgrass, silver hairgrass, tarweed, popcornflower, turkeymullein, Medusahead, or other undesirable plants.

Where an adequate seedbed can be prepared, the soils in this site are suited to Hardinggrass. The Rescue sandy loams are particularly well suited. All the soils are suited to adapted annual grasses and legumes. Forage plants respond to applications of nitrogen, phosphorus, and sulfur fertilizers. Repeated applications of phosphorus fertilizer are needed to maintain good stands of legumes on all soils in this site.

Where needed, removal of trees and brush increases production on this site, except in the extremely stony areas.

Total air-dry production is 3,500 pounds per acre in favorable years and 1,200 pounds in unfavorable years, except on the extremely stony soils. On these soils the yields are 2,200 pounds in favorable years and 900 pounds in unfavorable years.

SITE 3: GRANITIC

This range site consists of gently rolling to steep soils in the Ahwahnee, Auberry, and Sierra series. This site occu-

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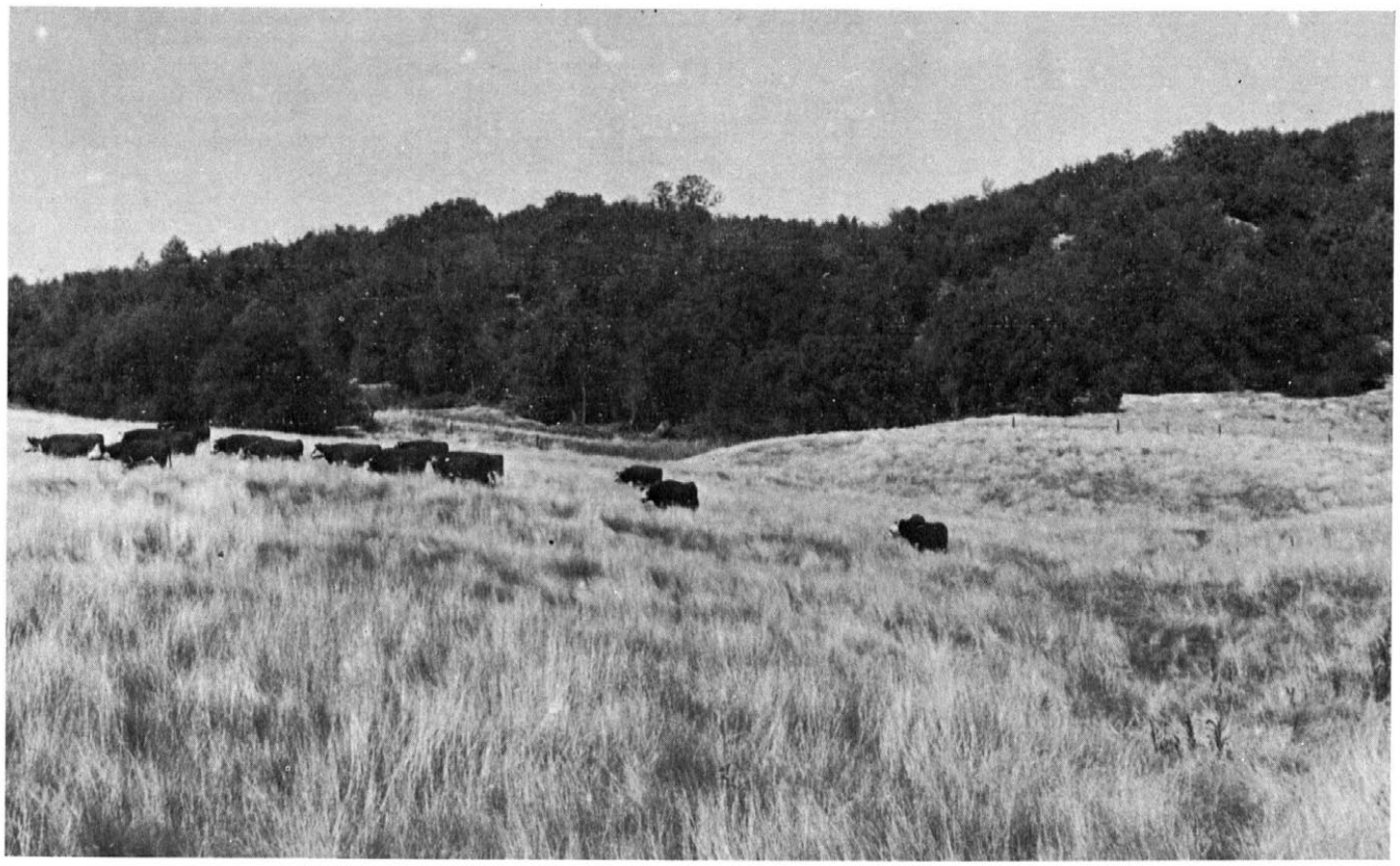

Figure 11.—**Cattle grazing on Sobrante silt loam, 3 to 15 percent slopes, in range site 2. In the background is an area of Auburn very rocky silt loam, 2 to 30 percent slopes, in range site 1.**

pies approximately 23,000 acres. It is in two rather large areas. One of these begins at Cold Springs and extends in a northwesterly direction, and Coloma is about in the center. The second area extends northward from the Amador County line west of Aukum to the Oak Hill area. Elevations range from 500 to 2,500 feet. The average annual rainfall ranges from 25 to 35 inches. Slopes are 5 to 50 percent, but more than two-thirds of the site has slopes of less than 30 percent.

The soils in this site have a surface layer of sandy loam or coarse sandy loam and are 24 inches to more than 60 inches deep to granitic bedrock. These soils are well drained. The available water holding capacity is 3 to 10 inches, and the permeability is moderately slow to moderately rapid. Runoff is medium to rapid and erosion hazard is moderate to very high. Rock outcrops cover 0 to 25 percent of the surface but do not impede livestock movement or decrease forage production appreciably.

This site typically has a plant cover of open grass or grass and oak. In the area north of the Amador County line to Oak Hill, Ponderosa pine also is present.

Where this site is producing at its maximum, about 70 percent of the plant cover is soft chess, wild oats, filaree, and other desirable plants, including remnant perennial grasses. Only a little burclover is present on this site, but other annual clovers thrive during favorable years.

Approximately 20 percent of the vegetation is ripgut brome, annual fescues, mouse barley, annual forbs, and other less desirable plants. The remaining 10 percent is fiddleneck, tarweed, Klamathweed, dogtail, nitgrass, turkeymullein, and other undesirable plants.

The Sierra soils in this site are well suited to Hardinggrass in areas where adequate seedbed can be prepared. All soils in this site are suited to annual grasses and legumes. Forage plants respond to applications of nitrogen, phosphorus, and sulfur fertilizers. Repeated applications of phosphorus and sulfur fertilizers are necessary to maintain good stands of introduced legumes.

Where needed, removal of trees and brush increases production on this site.

Total air-dry production is 3,500 pounds per acre in favorable years and 1,000 pounds in unfavorable years.

SITE 4: VERY SHALLOW LOAMY

Whiterock gravelly silt loam, 3 to 50 percent slopes, is the only soil in this range site. This site occupies about 3,100 acres. It is in small, scattered areas intermingled with areas of site 1 at the western end of the survey area and the southern one-fourth of the Mother Lode Belt. The topography is rolling to steep. Slopes are 3 to 50 percent but dominantly are less than 30 percent. Elevations range from 450 to 1,500 feet. The average annual rainfall is 23 to 30 inches.

The soil in this site has a surface layer of gravelly silt

loam that is 5 to 12 inches thick over slate. The available water holding capacity is 0.5 to 1.5 inches, and the vegetation dries early in spring or during periods of extended drought in winter. Drainage is excessive. Runoff is medium to rapid, and the erosion hazard is slight to moderate.

This site typically has a plant cover of open grass and, in some areas, scattered stands of blue oak, Digger pine, and thickets of brush. Where this site is producing at its maximum, approximately 70 percent of the plant cover is soft chess, filaree, and other desirable plants. The site also supports wild oats and burclover in areas where the soil is slightly deeper.

About 20 percent of the vegetation is red brome, mouse barley, annual fescues, annual lupines, and other less desirable plants. The remaining 10 percent is nitgrass, silver hairgrass, owlclover, goldfield, popcornflower, and other undesirable plants.

The soil in this site is not suitable for seeding, fertilizing, or brush removal.

Total air-dry production is 1,500 pounds per acre in favorable years and 500 pounds in unfavorable years.

SITE 5: SERPENTINE

Delpiedra very rocky loam, 3 to 50 percent slopes, is the only soil in this range site. This site occupies about 1,700 acres. It is in thin bands oriented in a north-south direction and scattered throughout the survey area between elevations of 500 and 1,800 feet. The topography is undulating to steep. The average annual rainfall is 25 to 35 inches.

The soil in this site has a surface layer of loam and is 10 to 24 inches deep to serpentine rock. The available water holding capacity is 2 to 4 inches. Runoff is medium to rapid, and the erosion hazard is slight to high. Permeability is moderate. Rock outcrops cover 2 to 25 percent of the surface.

This site typically has a plant cover of brush or brush and grass, and there is some Digger pine. Chamise, yerba santa, toyon, and deerbrush are the dominant brush species.

Where this site is producing at its maximum, about 50 percent of the plant cover is soft chess, filaree, and other desirable plants. It also includes remnants of needlegrass and squirreltail. There is little or no burclover.

Approximately 35 percent of the understory is red brome, mouse barley, annual lupines, large amounts of annual fescues, and other less desirable plants. The remaining 15 percent is owlclover, goldfield, brodiaea, popcornflower, vinegarweed, and other undesirable plants.

Plants grown on this soil do not respond to applications of fertilizer. Clearing and seeding are not feasible.

Total air-dry production is 1,200 pounds per acre in favorable years and 400 pounds in unfavorable years.

SITE 6: PLACER DIGGINGS

Only Placer diggings is in this range site. This land type consists of variable soil material in stream channels and swales. About 9,000 acres is in this site, and it is present throughout the survey area. The areas are long and narrow, and most of them are small. They are near, and in many places within, areas of cobbly riverwash and mine tailings. Slopes generally are less than 9 percent.

The soil material in this site consists of debris left by placer mining. As a result, the material is a mixture of various soil materials and the surface is scarred and uneven. All areas contain some fine soil material that supports plant growth. The soil material is shallow to deep, and in many places it is underlain by coarse sand or gravel. Drainage and permeability are variable. Areas in streambeds are subject to flooding in winter.

Vegetation on this site varies. Many areas support a dense stand of trees and brush that have an understory of annual and perennial forbs and grasses. In some areas annual grasses and forbs are dominant. The main trees and brush plants are willow, alder, cottonwood, blackberry, wild rose, poison-oak, live oak, and white oak, none of which generally adds much to the usable forage. Desirable grasses and forbs, which furnish most of the forage on this site, are bluegrass, blue wildrye, mountain brome, sedges, soft chess, annual clovers, and filaree. Stinging nettle, horehound, wormwood, deergrass, curly dock, wiregrass, and other undesirable plants also are present.

Total air-dry production is extremely variable within short distances, depending on the soil materials present. Areas of this site are generally too narrow and soil material too variable for reseeding. Yields would not justify the cost of fencing and other management needs. Furthermore, because of annual flooding, the erosion hazard is severe if the areas are left unprotected in winter. Applying fertilizer is not feasible.

Small areas that have dense stands of trees and brush probably could be thinned and use of the site improved. The expense of clearing for increased yields alone would not be justified, because intensive practices that prevent regrowth of brush are required.

The total air-dry production is about 2,500 pounds per acre in favorable years and 1,000 pounds in unfavorable years.

Woodland Uses of the Soils [4]

Forests are among the important resources of the El Dorado Area. They supply raw material for one of the major industries, recreation for many people, food and cover for many kinds of wildlife, and protection for watersheds. They also form a backdrop for much of the outdoor beauty in the survey area.

There are approximately 317,000 acres of soils available for growing commercial forests in the survey area. This is about 57 percent of the total area. Approximately 64,000 acres are in the El Dorado National Forest.

Trees grow on most of the soils, but commercial conifers grow mainly on specific kinds of soil. The most widespread species of the commercial conifers is ponderosa pine. Others of commercial importance are sugar pine, white fir, incense-cedar, and Douglas-fir. Digger pine, knobcone pine, and other noncommercial conifers also grow in the survey area. California black oak and canyon live oak grow throughout the survey area. California black oak grows on soils suited to commercial conifers and commonly is in association with them. Several other noncommercial species of oak are present, including interior live oak, blue oak, and California white oak. Cottonwoods, willows, alders, bigleaf maple, Oregon ash, and other hardwoods grow along streams.

[4] By MILTON B. EDWARDS, woodland conservationist, Soil Conservation Service.

Woodland suitability groups

To assist woodland owners in planning use of their soils, the soils of the El Dorado Area have been placed in seven woodland suitability groups. Each group consists of soils that have similar characteristics, show similar response to management, and have similar limitations for the production of wood crops. For each group, ratings are given according to similarities of site quality, erosion hazard, equipment limitations, pest and disease hazards, windthrow hazard, and manageability. These are discussed in the paragraphs that follow. Each woodland suitability group is described, and factors that affect management of each group are discussed. Soils that have not been placed in a woodland suitability group are not suited to that use or are better suited to other uses. The woodland suitability group in which each soil has been placed is indicated in the "Guide to Mapping Units" at the back of this soil survey.

Site quality is a measure of the productivity of a soil for growing trees and is expressed as site index. In this survey it refers to site quality for ponderosa pine. Studies show that associated conifers on similar soils have about the same relationship in height and age as ponderosa pine (*5*). Site index for ponderosa pine is based on the height attained by the average dominant and codominant trees at 100 years of age (*10*).

The ratings used for site quality in this survey are high, medium, and low. The rating *high* means that the site index is more than 115; *medium*, that it ranges from 75 to 115; and *low*, that it is less than 75. Average production of wood in board feet per acre per year, over a 100-year period, for fully stocked, even-aged, unmanaged stands of trees growing on soils that have a site quality rating of high should be 700 board feet (International log rule, ⅛-inch kerf) or more. Under the same conditions, average annual production for trees growing on soils that have a site quality rating of medium should be between 300 and 700 board feet per acre. For soils that have a site quality rating of low, production would be less than 300 board feet per acre per year. Management should increase net production but experimental data indicating how much it would be increased are lacking.

In the El Dorado Area, effective depth of the soils is the most important soil factor affecting site quality. The effective depth is the depth to bedrock or to any other layer that prevents or restricts penetration of roots. Texture has some influence on effective depth if it affects permeability enough to prevent penetration of roots or to restrict drainage. Generally, moderate amounts of stones, cobblestones, or gravel in the profile have little effect on growth of trees, particularly if the soil is deep. In soils that are extremely stony or extremely cobbly, however, the rate of growth diminishes in proportion to the content of coarse fragments. Experimental data on this point are lacking, but it is obvious that a large volume of rock fragments in the rooting zone reduces the volume of soil available to hold water and to provide nutrients for the trees. At lower elevations, lack of precipitation reduces growth rates. By reducing the area available for trees, rock outcrops reduce wood production.

The hazard of erosion refers to the potential hazard of erosion of the soils. The length and steepness of slope, texture, and stability of the soil aggregates are considered in rating the erosion hazard. If soils are kept under a protective cover of forest litter and duff, they generally do not erode. Consequently, the soils are rated according to their susceptibility to erosion if the cover is removed through fire, logging, trampling by animals, or other disturbances. The susceptibility of forest soils to erosion if they are cultivated is not considered in rating erosion hazard in this section. Erosion hazard is rated as none or slight, moderate, high, or very high.

Equipment limitation refers to the characteristics of the soils that restrict or prevent the use of equipment that commonly is used in tending and harvesting trees. For example, Aiken loam, 3 to 9 percent slopes, has few equipment limitations except when it is wet. When this soil is wet, and this could be 6 months in a year, heavy equipment mires down. Tree-planting machines can be used on this soil, however, at carefully selected times. Steep slopes and large boulders on the surface increase the limitation to use of equipment; presence of sand or gravel decreases the limitation. Equipment limitation is rated slight, moderate, or severe.

The hazards of pests and disease depend on many properties and qualities of the soil, most of which are not well understood. Depth, texture, wetness, and inherent fertility are probably the four most important factors. Observations indicate that on wet soils, or on shallow soils that have rock outcrops, pests and diseases make the greatest inroads. The hazard of pests and disease is rated slight, moderate, or severe.

The hazard of windthrow generally is not serious, except on shallow soils derived from slate, shale, schist, volcanic breccia, or granitic material. It is rated slight, moderate, or severe.

Ratings for manageability are based on a summarization of all the qualities of a soil for growing and managing forest trees, including the qualities already listed. Manageability is rated high, medium, or low.

The ratings assigned are based on the best data available and on the judgment of qualified soil scientists, soil conservationists, and woodland conservationists. The ratings are subject to change as more information becomes available.

WOODLAND SUITABILITY GROUP 1

This group consists of soils in the Aiken, Cohasset, Holland, Horseshoe, Josephine, Shaver, and Sites series and Loamy alluvial land. These soils are gently sloping to rolling or strongly sloping. They are deep and very deep and have a surface layer of coarse sandy loam to silt loam. Some of the soils are gravelly or cobbly.

All the soils in this group are of high site quality. The erosion hazard is only slight, but equipment limitations are moderate to severe. Pest and disease hazards are slight, and the hazard of windthrow is slight. The soils are highly adaptable to management.

These soils are the best in the survey area for woodland. They are suitable for very intensive management. Seedlings become established fairly easily after logging if a seed source is near, and they grow rapidly to maturity. Economic returns can be expected at an early age. Thinning and pruning can be done even after the trees have become fairly large. Logging is fairly easy, but in low or level areas equipment is likely to bog down in wet weather. At times there may be enough snow on the ground to hinder or prevent the use of equipment.

Locating and building roads is fairly easy. Except on the cobbly and gravelly soils, roads built on soils in this group need to be graveled for year-round use. Roads and skid trails should be protected from runoff water. Main roads require bridges, ditches, and culverts. Temporary and minor roads should be outsloped, and the grades should be sloped downward toward the water-course for a short distance on both sides of creeks or draws. Grades of unsurfaced roads should not exceed 8 percent on the Holland and Shaver soils, 10 percent on the Josephine and Sites soils, and 12 percent on the Aiken, Horseshoe, and Cohasset soils and on Loamy alluvial land.

Fire is relatively easy to control on these soils, chiefly because of easy access and the dominantly gentle slopes. Areas where trees have been removed by fire or other causes can be prepared for planting fairly easily. Planting can be done by machine.

WOODLAND SUITABILITY GROUP 2

This group consists of soils in the Aiken, Cohasset, Holland, Horseshoe, Josephine, Mariposa, Musick, Shaver, and Sites series and in the Diamond Springs series, grayish subsoil variant. These soils are gently sloping to steep. They are deep and very deep and have a surface layer of coarse sandy loam to silt loam. Some of the soils are gravelly, cobbly, rocky, or very rocky.

All the soils in this group are of high site quality. The erosion hazard is moderate. Equipment limitations range from slight to severe but are mostly severe. Pest and disease hazards are slight to moderate, and the hazard of windthrow is slight to moderate. Adaptability of these soils to management ranges from poor to high but is mostly moderate.

These soils are suitable for intensive management. Seedlings become established easily after logging if a seed source is near, and they grow rapidly to maturity. Trees grow rapidly, and economic returns can be expected at an early age. Thinning and pruning can be done even after the trees have become fairly large. Because of steeper slopes, however, logging is more difficult than on soils in group 1, and it may be impractical in wet weather.

Locating and building roads is fairly difficult. Except on the gravelly and cobbly soils, roads built on soils in this group need to be graveled for year-round use. Roads and skid trails should be protected from runoff water. Main roads require bridges, ditches, and culverts. Temporary and minor roads should be outsloped, and the grades should be sloped downward toward the watercourse for a short distance on both sides of creeks or draws. Grades of unsurfaced roads should not exceed 8 percent on the Diamond Springs soils, grayish subsoil variant, and the Holland, Musick, and Shaver soils; 10 percent on the Josephine and Sites soils; and 12 percent on the Aiken and Cohasset soils.

Fire is difficult to control where slopes are steep. Areas where trees have been removed by fire or other causes can be prepared for planting only with difficulty. If planting is to be done by machines, terracing is necessary where slopes are steeper (fig. 12). Terraces should be outsloped slightly.

WOODLAND SUITABILITY GROUP 3

This group consists of soils in the Holland, Josephine, Musick, Shaver, and Sites series. These soils are moderately steep or very steep. They are deep and very deep and have a surface layer of coarse sandy loam to silt loam. Some of the soils are gravelly or rocky.

All the soils in this group are of high site quality. The erosion hazard is high, and equipment limitations are severe. Pest and disease hazards are slight to moderate but are typically slight. The hazard of windthrow is slight to moderate. These soils are mostly moderately adaptable to mangement, but some are poorly adaptable.

These soils are excellent forest soils, but because of steep slopes, they are only suitable for moderately intensive management. Seedlings become established fairly easily after logging if a seed source is near. Trees grow rapidly, and economic returns can be expected at an early age. Thinning and pruning can be done even after the trees have become fairly large.

Locating and building roads is difficult, but most of them do not need to be graveled, except in a few areas, for year-round use. Roads and skid trails should be protected from runoff water. Main roads require bridges, ditches, and culverts. Temporary and minor roads should be outsloped, and the grades should be sloped downward toward the watercourse for a short distance on both sides of creeks or draws. Grades of unsurfaced roads should not exceed 8 percent on the Holland, Musick, and Shaver soils, and 10 percent on the Josephine and Sites soils.

Fire is difficult to control because of slope. Areas where trees have been removed by fire or other causes can be prepared for planting only with difficulty. If planting is done by machines, terracing is necessary. Terraces should be outsloped slightly.

WOODLAND SUITABILITY GROUP 4

This group consists of soils in the Boomer, Diamond Springs, and Sites series. These soils are gently sloping to moderately steep. They are deep and moderately deep and have a surface layer of very fine sandy loam to clay loam. Some of the soils are gravelly, cobbly, or very rocky.

The soils in land resource area 18 that are included in this woodland suitability group require onsite investigation to determine adaptability for woodland management.

All the soils in this group are of medium site quality. The erosion hazard is slight, but equipment limitations are slight to severe. Pest and disease hazards are moderate, and the hazard of windthrow is slight to moderate. These soils are moderately adaptable to management.

These soils are suitable for moderately intensive management. Trees grow at a moderate rate. Thinning should be done at an early age, and trees should be pruned before they reach a diameter of 15 inches at chest height. Damage from insect pests can be expected but should not be excessive except in extremely dry years. Logging is fairly easy, but in low or level areas heavy equipment is likely to bog down in wet weather.

Locating and building roads is fairly easy. In some places they must be graveled for year-round use. Roads and skid trails should be protected from runoff water. Main roads require bridges, ditches, and culverts. Temporary and minor roads should be outsloped, and the grades should be sloped downward toward the watercourse for a short distance on both sides of creeks and drains. Grades of unsurfaced roads should not exceed 8 percent on the Diamond Springs soils, 10 percent on the Sites soils, and 12 percent on the Boomer soils.

Figure 12.—**Josephine silt loam, 15 to 30 percent slopes, being terraced for machine planting of ponderosa pine after a fire.**

Fire is relatively easy to control, chiefly because of easy access and the dominantly gentle slopes. Areas where trees have been removed by fire or other causes can be prepared for planting fairly easily. Planting can be done by machines on most of these soils without terracing. Where the slopes are steeper, terracing is necessary. Terraces should be outsloped slightly.

WOODLAND SUITABILITY GROUP 5

This group consists of soils in the Boomer, Crozier, Diamond Springs, Josephine, Mariposa, McCarthy, Rescue, Sierra, and Sites series and Mixed alluvial land. These soils are gently sloping to steep. They are deep and moderately deep and have a surface layer of coarse sandy loam to silt loam. Some of the soils are gravelly, very stony, extremely stony, cobbly, or very rocky.

All the soils in this group are of medium site quality. The erosion hazard is moderate. Equipment limitations are mostly severe but in some areas are moderate. Pest and disease hazards are moderate, and the hazard of windthrow is moderate. The soils are moderately adaptable to management.

These soils are suitable for moderately intensive management, but management is more difficult where slopes are steeper. Growth rates are moderate. Thinning should be done at an early age, and trees should be pruned before they reach a diameter of 15 inches at chest height. Damage from insect pests can be expected on some soils in most years but should not be excessive except in extremely dry years. Logging is difficult where slopes are steep, and in wet weather logging may be impractical.

Locating and building roads is fairly difficult. Only on a few soils in this group do roads need to be graveled for year-round use. Roads and skid trails should be protected from runoff water. Main roads require bridges, ditches, and culverts. Temporary and minor roads should be outsloped, and the grades should be sloped downward toward the watercourse for a short distance on both sides of creeks or draws. Grades of unsurfaced roads should not exceed 8 percent on the Diamond Springs and Sierra soils, 10 percent on the Mariposa, Josephine, and Sites soils, and 12 percent on the Boomer, Crozier, McCarthy, and Rescue soils and on Mixed alluvial land.

Fire is difficult to control where slopes are steep. Areas where trees have been removed by fire or other causes can be prepared for planting only with difficulty. If planting is done by machines, terracing is necessary where slopes are steeper. Terraces should be outsloped slightly. Because of cobblestones and rocks in some soils, planting by machine may be impractical.

WOODLAND SUITABILITY GROUP 6

This group consists of soils in the Auberry, Boomer, Chaix, Diamond Springs, Holland, Hotaw, Josephine,

Mariposa and Sierra series. These soils are moderately sloping to very steep. They are deep to shallow and have a surface layer of coarse sandy loam to silt loam. Most of the soils are very rocky.

All the soils in this group are of medium site quality. The erosion hazard is high and very high, and the equipment limitations are severe. Pest and disease hazards are moderate to severe, and the hazard of windthrow is moderate. The soils are moderately to poorly adaptable to management.

These soils are suitable for moderately intensive management, but management practices can be applied only with considerable difficulty. Growth rates are moderate, and economic returns from these soils cannot be expected to be so great or to be achieved so soon as those from soils in groups 1, 2, and 3. Thinning should be done at an early age, and trees should be pruned before they reach a diameter of 15 inches at chest height. Damage from insect pests and disease can be expected but should not be excessive except in extremely dry years. Logging is difficult and is almost impossible in wet weather.

Locating and building roads is difficult, but only in places do roads need to be graveled for year-round use. Roads and skid trails should be protected from runoff water. Main roads require bridges, ditches, and culverts. Temporary and minor roads should be outsloped, and the grades should be sloped downward toward the watercourse for a short distance on both sides of creeks or draws. Grades of unsurfaced roads should not exceed 8 percent on the Auberry, Chaix, Diamond Springs, Holland, Hotaw, and Sierra soils; 10 percent on the Josephine and Mariposa soils; and 12 percent on the Boomer soils.

Fire is difficult to control where slopes are steep. Areas where trees have been removed by fire or other causes can be prepared for planting only with difficulty. If planting is to be done by machines, terracing is necessary. Terraces should be outsloped. On the cobbly or very rocky soils, planting by machine is not feasible.

WOODLAND SUITABILITY GROUP 7

This group consists of soils in the Auberry, Chawanakee, and Iron Mountain series. These soils are gently sloping to very steep. They range from very shallow to moderately deep but are typically shallow. They have a surface layer of coarse sandy loam to loam and are very rocky.

All the soils in this group are of low site quality. The erosion hazard is slight to severe. Equipment limitations range from slight to severe but are mostly severe. Pest and disease hazards are severe, and the hazard of windthrow is severe. These soils are poorly adaptable to management.

Growth rates are low. Extensive management practices, such as fire protection, insect pest and disease control, protection from overgrazing, and control of erosion, are needed.

Wildlife [5]

Hunting and fishing are important in the economy of the El Dorado Area. As the population of California increases and the amount of wildlife habitat decreases, the value of hunting and fishing will increase.

Reservoirs, ponds, and streams in the survey area provide habitat for various fish, including rainbow trout, brown trout, black bass, and bluegill. They also provide habitat for a few wood ducks, mallards, and mudhens. Canada geese use the larger reservoirs during winter. The water areas at higher elevations and in areas where the water temperature rarely rises above 70° F. during summer are well suited to trout. At lower elevations where water is warm, the water areas are well suited to bass, bluegill, and channel catfish.

Production of fish in a pond or reservoir is dependent upon the fertility of the water it contains, which is influenced significantly by the fertility of the soils in the watershed and, to some extent, by the soil at the bottom of the pond or reservoir. Ponds on infertile soils produce less fish per acre. In general, the water areas in the survey area have good potential for economic return from fish production and from outdoor recreation, such as swimming, boating, camping, and picnicking.

In the El Dorado Area, black-tailed deer, valley quail, and trout are the most important wildlife species. Bear, raccoon, opossum, mourning dove, mountain quail, band-tailed pigeon, rabbit, gray squirrel, bass and bluegill, and wood duck also are important. These animals occupy a wide variety of habitats that are dependent upon the kinds of soil and the availability of water and suitable plants. The soils influence the quality of a habitat for any particular species, including the food and cover that characterize specific wildlife habitats.

The soils in the survey area have been placed in four wildlife suitability groups. Suitability of the wildlife groups for various kinds of plants is shown in table 4. Also shown in this table is suitability of the various plants listed for use by stated kinds of wildlife. The wildlife groups are discussed in the pages that follow. The soils in each group can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

WILDLIFE SUITABILITY GROUP 1

This group consists of soils in the Aiken, Auberry, Cohasset, Diamond Springs series, grayish subsoil variant, Holland, Horseshoe, Josephine, Mariposa, Musick, Perkins series, moderately deep variant, Shaver, Sierra, and Sites series and of Loamy alluvial land and Wet alluvial land. These soils are present throughout the survey area, but most of them are above an elevation of 2,000 feet. This group occupies approximately 140,000 acres. Most of the soils are deep, well drained, and on uplands, but included are small areas of moderately well drained to somewhat poorly drained alluvial land. The surface layer ranges from coarse sandy loam to clay loam. Many areas of these soils have rock outcrops and coarse fragments in the profile. Slopes are 3 to 70 percent.

The vegetation consists mainly of oak and grass, and there are scattered ponderosa pines at the lower elevations. Coniferous forest and associated hardwoods are at the higher elevations.

The soils in this group have no limitations for habitat development except where slopes are more than 30 percent. Water can be impounded on these soils where dam sites exist.

[5] By WENDELL MILLER, State biologist, Soil Conservation Service.

TABLE 4.—*Suitability of specified plants for wildlife groups of soils and for specified kinds of wildlife*

[An Arabic number 1 means the plant named is suited to the wildlife group or has high value for the kind of wildlife; 2 means suitability of the plant is fair to marginal for the wildlife group or kind of wildlife; dashes in the columns mean that the plant is not suited to soils of the wildlife group or its suitability is not known, or that the plant seldom is used by the particular kind of wildlife or its use is not known]

Plant	Wildlife group and rating				Kind of wildlife and rating								
	1	2	3	4	Black-tailed deer	California quail	Mountain quail	Dove	Band-tailed pigeon	Gray squirrel	Rabbit	Bear	Wood duck
Alfalfa	1	[1] 2	------	------	1	2	------	------	------	------	1	------	------
Alta fescue	1	1	2	------	1	------	------	------	------	------	1	2	------
Barley	1	1	------	------	1	1	------	2	1	------	1	2	1
Blackberries, wild	2	2	1	------	2	1	1	------	1	------	1	1	------
Black walnut	1	2	------	------	------	------	------	2	2	1	------	1	2
Buckbrush (*Ceanothus cuneatus*)	1	1	------	2	1	2	1	------	2	------	1	2	------
Burclover	1	1	------	------	1	1	2	------	------	------	1	------	------
Chamise	2	1	------	2	1	2	2	------	------	------	2	------	------
Clover, subterranean	1	1	------	------	1	1	2	------	------	------	1	------	------
Coffee berry	2	1	------	2	2	2	1	----	1	------	2	1	2
Deerbrush (*Ceanothus integerrimus*)	1	2	------	2	1	2	1	------	2	----	1	2	------
Filaree	2	1	------	2	2	1	1	2	------	------	1	------	------
Hardinggrass	1	[2] 2	------	------	2	1	1	2	------	------	1	------	------
Lemon ceanothus	2	1	------	2	1	2	1	------	2	------	1	2	------
Manzanita	1	1	------	2	2	2	1	------	1	------	2	1	2
Multiflora rose	1	2	1	------	------	1	------	------	------	------	1	------	------
Narrowleaf trefoil	1	2	2	------	1	2	------	2	------	------	2	------	------
Oak, black	1	1	------	------	1	2	2	------	1	1	------	1	1
Oak, blue	1	1	------	------	1	2	2	1	1	1	------	1	1
Oak, live	1	1	------	------	1	1	1	2	1	1	------	1	1
Oak, valley	1	2	2	2	1	2	2	1	1	1	------	1	1
Pine, Digger	------	2	------	1	------	2	2	------	2	1	------	1	1
Pine, ponderosa	1	[1] 2	------	------	------	2	1	------	1	1	------	1	------
Pyracantha	1	2	2	------	------	1	------	------	1	------	1	1	------
Ryegrass, annual	1	2	------	------	1	2	2	------	------	------	1	------	------
Ryegrass, perennial	1	2	------	------	1	2	2	------	------	------	1	2	------
Soft chess (Blando brome)	1	1	------	2	1	2	2	------	------	------	1	------	------
Spanish clover (deervetch)	2	1	------	2	1	1	1	2	------	------	2	------	------
Toyon	2	1	------	------	2	2	1	------	1	------	2	1	------
Turkeymullein	2	1	------	2	------	1	1	1	------	------	------	------	------
Vetch, Lana	1	1	------	2	1	1	1	1	2	------	1	------	2
Vetch, purple	1	1	------	2	1	1	1	1	2	------	1	------	2
Wildoats	1	1	------	------	2	2	2	2	------	------	2	------	2

[1] Not suited on Argonaut and Auburn soils.
[2] Not suited on Auburn soils.

Deer present serious depredation problems in orchards and vineyards on these soils. They come in from the timber and brushland areas around the orchards. The most effective method of control is use of deer-proof fencing. Quail and many songbirds are present where there is suitable cover.

WILDLIFE SUITABILITY GROUP 2

This group consists of soils in the Ahwahnee, Argonaut, Auberry, Auburn, Boomer, Chaix, Chawanakee, Cohasset, Crozier, Delpiedra, Diamond Springs, Holland, Hotaw, Josephine, Mariposa, McCarthy, Perkins, Rescue, Sierra, Sites, and Sobrante series. These soils are present throughout the survey area. This group of soils is the largest in the area and occupies approximately 321,000 acres. The soils are shallow to deep, moderately well drained to excessively drained, and on uplands. The surface layer ranges from coarse sandy loam to loam. Some of the soils are gravelly, cobbly, stony, rocky, or very rocky. Slopes are 3 to 70 percent. The available water holding capacity is low to moderate.

The vegetation at lower elevations is mainly oak, grass, and brush. At the higher elevations, the vegetation is coniferous forest, associated hardwoods, and brush. The Auburn and Argonaut soils are not suited to coniferous trees.

Soils in this group present slight to moderate limitations to habitat development where slopes are less than 30 percent and severe limitations where slopes are more than 30 percent. Water can be impounded on most of these soils where suitable dam sites exist.

Because of the large areas of brush on these soils, they are well suited to browse and cover for deer. Population of deer ranges from 10 to 30 per square mile. Extensive stands of mature brush are not so productive as smaller stands of new brush interspersed with grass and other cover. Irrigated pastures and other irrigated crops attract large numbers of deer and need to be protected by use of deer-proof fences to prevent depredation by deer. Quail and nongame birds are abundant where suitable cover and food exist. The leasing of hunting rights on this habitat has a good potential for economic return to landowners.

WILDLIFE SUITABILITY GROUP 3

This group consists of soils in the Argonaut series, seeped variant, and the Rescue series, clayey variant, and of Mixed alluvial land. These soils are present in small scattered areas, and there is only about 3,000 acres in the survey area. The soils are poorly drained to somewhat poorly drained and generally are in swales and concave areas below seeps and springs. The surface layer ranges from loam to clay.

The vegetation on these soils consists of water-loving plants, such as wiregrass, sedges, and cattails. Deer feed on the green plants in summer, and the heavy cover provides nesting habitat for blackbirds and other nongame species. Because of the wetness, these soils commonly provide a good source of water for wildlife and ideal locations for fishponds. Drier areas are suitable for planting cover for quail, such as wild blackberries and multiflora rose. Care must be taken, however, to prevent these plants from becoming too numerous.

WILDLIFE SUITABILITY GROUP 4

This group consists of soils in the Auburn series, and Auburn Series, heavy subsoil variant, Iron Mountain, Maymen, and Whiterock series and of Acidic rock land, Gullied land, Metamorphic rock land, Placer diggings, Serpentine rock land, and Tailings. These soils are scattered throughout the survey area and occupy about 75,000 acres. They consist mainly of various types of rock land and mined areas, and the soils are either very shallow or are rocky.

The soils and land types in this group are severely limited for wildlife habitat development. The vegetation is mainly annual grasses, brush, and Digger pine, and there are some barren areas. These soils are used mainly as marginal habitat for deer, quail, doves, and such nongame birds as meadowlarks and blackbirds. The potential for water impoundment on these soils is extremely variable and depends on position and local conditions, which must be investigated onsite.

Engineering Uses of the Soils [6]

Engineering deals with soil as either a structural material or a foundation material upon which structures are built or as a building material itself. Much of the information in this subsection is in tables 5, 6, and 7. These tables are based on fieldwork done by soil scientists of the Soil Conservation Service. Although the purpose of the field surveys was to obtain soil characteristics important to farming, many of these same soil characteristics also are important to engineering. Therefore, the soil survey is useful to many branches of engineering, to builders, and to other nonfarm users. Some of the terms used by soil scientists differ from those used by engineers. These and other special terms are defined in the Glossary at the back of this survey.

The interpretations and information contained in this soil survey are not specific enough for all engineering purposes and should not be used in place of detailed investigations of the site. They are useful, however, in planning more detailed engineering field surveys to determine the in-place condition of the soils at the site of the proposed engineering structure. As a rule, the soil data in this survey apply to the developed soil and the underlying layers to a depth of about 5 feet.

[6] R. A. MILLER, argicultural engineer, Soil Conservation Service, helped to prepare this section.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of Highway Officials (AASHO) (*1*, *13*). In this system soil materials are classified in seven principal groups. The groups range from A–1 (gravelly soils that have high bearing capacity, the best soils for road fill) to A–7 (clayey soils that have low strength when wet, the poorest soils for road fill). Within each group the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best materials to 20 for the poorest. The group index number for the soils tested is shown in parentheses after the soil group symbol in table 5.

Some engineers prefer to use the Unified soil classification system (*13*, *24*). In this system soil materials are identified as coarse grained, 8 classes; fine grained, 6 classes; and highly organic.

Engineering test data

Engineering test data for three of the extensive soils in the survey area are given in table 5. The soils were tested in the laboratory of District III, California State Division of Highways. The data in this table show the moisture density, mechanical analyses, liquid limit, plasticity index, and the classification of the samples according to the system of the American Association of State Highway Officials (AASHO) and the Unified system. Additional engineering test data of seven soils important to this area are given in the Soil Survey of the Amador Area, California (*21*). These soils are the Aiken, Ahwahnee, Auburn, Josephine, Musick, Sierra, and Sites, and they are similar to the same soil series mapped within the El Dorado Area.

The relation of moisture content and the density to which a soil can be compacted are important for engineering purposes. If soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that, the density decreases with an increase in moisture content. The moisture content at which the maximum dry density is obtained is the optimum moisture content.

Mechanical analysis shows the relative proportions of the different sized particles in the soil material. The size and proportions of the particles affect the behavior of soil material when it is used for engineering purposes.

The tests for liquid limit and plastic limit, or Atterberg values, measure the effect of water on consistency of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil material changes from a plastic to a liquid state. The plasticity index is the numerical difference between liquid limit and plastic limit. It indicates the range in moisture content within which a soil material is in a plastic condition.

TABLE 5.—*Engineering*

[Tests performed by District III, California Division of Highways, in accordance with

Soil name and location	Parent material	Report No.	Depth	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
			Inches	*Lb. per cu. ft.*	*Percent*
Boomer:					
NE. corner of NW¼SW¼ sec. 33, T. 12 N., R. 9 E. (Modal).	Basic schist.	61–2882	0–5	116	16
		61–2874	24–37	114	16
		61–2872	37–52	130	10
Holland:					
NE¼SW¼ sec. 27, T. 9 N., R. 12 E. (Modal)	Granodiorite.	61–2871	2–10	121	13
		61–2868	21–30	126	12
Rescue:					
NE¼SE¼ sec. 19, T. 10 N., R. 9 E. (Modal)	Gabbrodiorite.	61–2875	0–5	133	11
		61–2870	14–26	124	14
		61–2877	34–55	140	10

[1] Based on AASHO Designation: T 99–57, Method A (*1*) and California Division of Highways test method No. 216E.

[2] Mechanical analyses according to AASHO Designation: T 88. Results by this procedure frequently may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser

TABLE 6.—*Estimated*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series in the first column

Soil series and map symbols	Depth to bedrock	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
Acidic rock land: AaF. Properties too variable to be estimated.	*Feet*	*Inches*			
Ahwahnee: AcC, AdD, AdE	2.0–3.5	0–8	Coarse sandy loam	SM	A–2
		8–26	Heavy coarse sandy loam	SM	A–2
		26	Weathered granodiorite.		
Aiken: AfB, AfB2, AfC, AfC2, AfD, AgD	4.0–5.0	0–15	Loam	ML	A–4 or A–5
		15–35	Clay loam	CL	A–6 or A–7
		35–72	Clay	MH	A–7
Argonaut: AkC, AlD, AmD	1.5–3.5 (2.0–4.0 in AlD)	0–10	Gravelly loam and gravelly silt loam.	SM	A–4
		10–30	Clay	MH or CH	A–7
		30	Metaandesite.		

See footnote at end of table.

test data

standard procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis [2]									Atterberg values		Classification	
Percentage passing sieve—							Percentage smaller than—		Liquid limit	Plasticity	AASHO [3]	Unified [4]
1 inch	¾ inch	⅜ inch	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.005 mm.	0.002 mm.				
-------	100	92	84	75	55	45	16	7	39	10	A-4(2)	SM
-------	-------	-------	100	84	47	33	20	14	46	22	A-2-7(2)	SC
100	99	84	69	53	34	22	13	8	37	19	A-2-6(1)	SC
-------	-------	-------	100	98	77	45	18	9	31	(5)	A-4(2)	SM
-------	-------	-------	----------	100	80	41	29	19	30	11	A-6(1)	SC
-------	-------	-------	100	97	73	47	18	8	27	7	A-4(2)	SM-SC
-------	-------	-------	100	98	76	54	33	23	30	23	A-6(9)	CL
-------	-------	-------	100	93	61	30	9	6	28	(5)	A-2-4(0)	SM

than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on AASHO Designation: M145-49 (*1*).

[4] Based on the Unified soil classification system (*24*).

[5] Nonplastic..

properties of the soils

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for of this table. The symbol < means less than]

Coarse fragments greater than 3 inches	Percentage passing sieve—				Atterberg values		Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity (uncoated steel)
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Liquid limit	Plasticity					
							Inches per hour	*Inches per inch of soil*	*pH value*		
0	100	85-100	40-50	20-30	10-20	(1)	2. 00-6. 30	0. 11-0. 13	6. 1-7. 3	Low-------	Low.
0	100	85-100	50-60	25-35	20-30	0-10	2. 00-6. 30	0. 13-0. 15	6. 1-6. 5	Low-------	Low.
0 (15-30 in AgD)	100	95-100	75-85	50-60	35-50	0-10	0. 63-2. 00	0. 15-0. 17	5. 6-6. 0	Low-------	High.
0 (15-30 in AgD)	100	95-100	90-95	70-80	35-50	15-30	0. 63-2. 00	0. 17-0. 19	5. 6-6. 0	Moderate---	High.
0 (15-30 in AgD)	100	95-100	90-95	75-85	50-60	15-30	0. 2-0. 63	0. 15-0. 17	5. 1-5. 5	Moderate---	High.
0 (20-30 in AlD)	75-90	65-85	60-80	35-50	10-20	0-10	0. 63-2. 00	0. 10-0. 12	5. 6-6. 5	Low-------	Moderate.
0 (20-30 in AlD)	100	70-90	65-85	65-80	50-65	20-35	<0. 06	0. 14-0. 16	6. 1-6. 5	High-------	High.

TABLE 6.—*Estimated properties of*

Soil series and map symbols	Depth to bedrock	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Argonaut—Continued					
AnB	2. 0–3. 5	0–11	Clay loam	CL	A–6
		11–40	Clay	MH or CH	A–7
		40	Gabbrodiorite.		
Argonaut, seeped variant: AoB	2. 0–3. 5	0–8	Loam	ML or CL	A–4
		8–17	Silty clay loam	CL	A–7
		17–32	Clay	MH or CH	A–7
		32	Slate.		
Auberry: ArB, ArC, ArD, AsC, AtD, AtE, AuD.	3. 5–5. 0+ (2.0–3.5 in AuD).	0–13	Coarse sandy loam	SM	A–2
		13–36	Coarse sandy clay loam	SC	A–4 or A–6
		36–56	Coarse sandy loam	SM	A–2
		56	Granodiorite.		
Auburn: AwD, AxD, AxE, AyF	1. 0–2. 0	0–14	Silt loam	ML or CL	A–4
		14	Metamorphic rock.		
Auburn, heavy subsoil variant: AzE	0. 5–2. 0	0–27	Cobbly clay loam and very cobbly clay loam.	SC	A–6
		27	Slate.		
*Boomer: BhC, BhD, BkD, BkE, BkF, BpC, BpD, BrE. For properties of Sites soil in BpC, BpD, and BrE, refer to SkC, SkD, SkE, SoE, SrE, SrF in the Sites series.	2. 0–4. 5	0–13	Gravelly loam	SM	A–4
		13–52	Gravelly clay loam and gravelly sandy clay loam.	SC	A–2
		52	Basic schist.		
Chaix: CcE, CcF	2. 0–3. 5	0–34	Coarse sandy loam	SM	A–2
		34	Granodiorite.		
Chawanakee: ChE	1. 0–2. 0	0–16	Coarse sandy loam	SM	A–2
		16	Granodiorite.		
Cohasset:					
CkD, ClE	3. 5–5. 0+	0–15	Sandy loam or cobbly sandy loam.	SM	A–2
		15–46	Loam or cobbly loam	SM or SC	A–4 or A–6
		46	Andesite.		
CmB, CmC, CmD, CoC, CoE	3. 5–5. 0+	0–14	Cobbly loam or loam	ML	A–4
		14–46	Cobbly clay loam or clay loam.	CL	A–7
		46	Andesite.		
Crozier: CrE	2. 0–3. 5	0–16	Cobbly loam	ML	A–4
		16–36	Cobbly clay loam	CL	A–6
		36	Andesite.		
Delpiedra: DeE	1. 0–2. 0	0–12	Clay loam	CL	A–6
		[1] 12	Serpentine.		
Diamond Springs: DfB, DfC, DfD, DgE	2. 0–4. 0	0–9	Very fine sandy loam and loam.	ML or CL	A–4
		9–40	Clay loam	ML	A–6
		40	Metadacite.		

See footnote at end of table.

the soils—Continued

Coarse fragments greater than 3 inches	Percentage passing sieve—				Atterberg values		Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity (uncoated steel)
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Liquid limit	Plasticity					
							Inches per hour	*Inches per inch of soil*	*pH value*		
0	100	95–100	85–95	70–80	30–40	15–25	0. 63–2. 00	0. 18–0. 20	6. 1–6. 5	Moderate	Moderate.
0	100	95–100	80–90	75–80	50–65	20–35	<0. 06	0. 14–0. 16	6. 1–6. 5	High	High.
0	95–100	80–90	70–80	50–60	15–25	0–10	0. 63–2. 00	0. 13–0. 15	5. 6–6. 5	Low	High.
0	100	95–100	90–95	70–90	40–50	15–30	0. 20–0. 63	0. 18–0. 20	5. 6–6. 0	Moderate	High.
0	100	100	95–100	70–90	50–65	20–35	<0. 06	0. 14–0. 16	6. 1–7. 3	High	High.
0	100	85–95	60–70	25–35	(1)	(1)	2. 00–6. 30	0. 11–0. 13	6. 1–6. 5	Low	Low.
0	100	90–100	80–90	40–50	20–30	5–15	0. 63–2. 00	0. 14–0. 16	6. 1–6. 5	Moderate	Moderate.
0	100	85–95	60–70	25–35	(1)	(1)	2. 00–6. 30	0. 11–0. 13	6. 1–6. 5	Low	Low.
0–15	90–100	85–95	75–85	70–80	20–30	5–10	0. 63–2. 00	0. 16–0. 20	6. 1–7. 3	Low	Low.
20–40	75–85	55–70	50–65	35–50	30–40	10–20	0. 63–2. 00	0. 08–0. 10	5. 6–6. 5	Low	Low.
0–10	80–90	70–80	50–70	40–50	30–40	5–10	0. 63–2. 00	0. 15–0. 17	5. 6–6. 5	Low	Low.
0–10	65–90	50–85	30–50	25–35	35–50	15–25	0. 2–0. 63	0. 15–0. 17	5. 6–6. 5	Moderate	Moderate.
0	90–100	75–85	50–60	25–35	(1)	(1)	2. 00–6. 30	0. 10–0. 12	5. 1–6. 5	Low	Low.
0	90–100	75–85	40–50	25–35	(1)	(1)	2. 00–6. 30	0. 10–0. 12	5. 6–6. 5	Low	Low.
0–30	85–95	80–90	55–65	25–35	10–20	(1)	2. 00–6. 30	0. 10–0. 12	5. 6–6. 5	Low	Moderate.
0–35	85–95	75–85	55–65	35–50	30–40	5–20	0. 63–2. 00	0. 14–0. 18	5. 1–6. 0	Moderate	Moderate.
0–30	85–95	80–90	75–85	50–60	10–20	0–10	0. 63–2. 00	0. 13–0. 17	5. 6–6. 5	Low	Moderate.
0–35	90–100	85–95	75–85	65–75	40–50	15–25	0. 63–2. 00	0. 14–0. 18	5. 1–6. 0	Moderate	Moderate.
10–30	95–100	85–95	70–80	60–70	20–30	5–10	2. 00–6. 30	0. 13–0. 15	5. 6–6. 5	Low	Moderate.
20–35	95–100	85–95	75–85	65–75	30–40	15–25	0. 63–2. 00	0. 14–0. 18	5. 1–6. 0	Low	Moderate.
0–5	95–100	90–95	75–85	70–80	30–40	10–20	0. 63–2. 00	0. 16–0. 18	6. 1–7. 3	Moderate	Moderate.
0	100	95–100	80–90	60–75	20–30	5–10	0. 63–2. 00	0. 13–0. 16	4. 5–6. 0	Low	High.
0	100	100	80–90	70–80	30–40	10–20	0. 20–0. 63	0. 17–0. 19	4. 5–5. 5	Low	High.

TABLE 6.—*Estimated properties of*

Soil series and map symbols	Depth to bedrock	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Diamond Springs, grayish subsoil variant: DmD, DmE.	3. 0–5. 0	0–5	Gravelly sandy loam	SM	A–2
		5–25	Loam	ML	A–4
		25–48	Gravelly loam and gravelly sandy loam.	SM or SC	A–4
		48	Rhyolitic tuff.		
Gullied land: GuF. Properties too variable to be estimated.					
Holland: HgB, HgC, HgD, HhC, HkE, HkF	3. 5–5. 0+	0–21	Coarse sandy loam	SM	A–4
		21–45	Sandy clay loam	SC	A–6
		45–59	Coarse sandy loam	SM	A–4
		59	Granodiorite.		
Horseshoe: HrC, HsE	5. 0	0–30	Gravelly loam (gravelly mucky loam surface layer in places).	CL	A–6
		30–50	Gravelly clay loam	CL	A–6
		50–70	Very gravelly clay loam	GC	A–6
Hotaw: HtE	2. 0–3. 5	0–22	Coarse sandy loam	SM	A–4
		22–35	Sandy clay loam	SC	A–6
		35	Granodiorite.		
Iron Mountain: ImE	0. 5–2. 0	0–12	Cobbly sandy loam	SM	A–2
		12	Andesite.		
Josephine: JrC, JrD, JsE, JtC, JtD, JtE, JuE, JuF, JvD.	3. 5–5. 0	0–14	Silt loam (gravelly loam in places).	ML or CL	A–4
		14–33	Silty clay loam	CL	A–6
		33–50	Very gravelly silt loam	GM	A–1 or A–2
		50	Slate.		
Loamy alluvial land: LaB. Properties too variable to be estimated.					
*Mariposa: MaD, MbE, MbF, McE, McF. For properties of the Josephine soils in McE and McF, refer to the Josephine series.	1. 5–2. 5	0–26	Gravelly silt loam	SM or ML	A–4
		26	Slate.		
Maymen: MfF	0. 5–1. 5	0–9	Gravelly loam	SM or SC	A–4
		9	Slate.		
McCarthy: MhE	2. 0–3. 5	0–38	Very cobbly loam	SC or SM	A–4
		38	Andesite.		
Metamorphic rock land: MmF. Properties too variable to be estimated.					
Mixed alluvial land: MpB. Properties too variable to be estimated.					
Musick: MrC, MrD, MsC, MtE	4. 0–5. 0+	0–12	Sandy loam	SM	A–4
		12–42	Heavy clay loam and sandy clay.	SM or ML	A–7
		42–60	Sandy loam	SM	A–4
Perkins: PeD	4. 0–5. 0+	0–13	Gravelly loam and cobbly loam.	SM or SC	A–4 or A–6
		13–46	Cobbly clay loam and cobbly clay.	SC or CL	A–6
		46	Weathered granodiorite.		

See footnote at end of table.

the soils—Continued

Coarse fragments greater than 3 inches	Percentage passing sieve—				Atterberg values		Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity (uncoated steel)
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Liquid limit	Plasticity					
							Inches per hour	*Inches per inch of soil*	*pH value*		
0	80–90	60–75	40–50	20–30	(1)	(1)	2. 00–6. 30	0. 09–0. 11	6. 1–6. 5	Low	Low.
0	95–100	90–100	80–90	60–75	20–30	5–10	0. 63–2. 00	0. 15–0. 17	5. 6–6. 5	Low	Moderate.
0	80–90	70–80	50–70	35–50	10–30	5–10	0. 63–6. 30	0. 10–0. 14	5. 1–6. 0	Low	Moderate.
0	100	90–100	70–80	40–50	25–35	(1)	2. 00–6. 30	0. 10–0. 12	5. 6–6. 0	Low	Low.
0	100	95–100	75–85	40–50	25–35	10–20	0. 20–0. 63	0. 14–0. 16	5. 1–6. 0	Moderate	Moderate.
0	100	90–100	60–70	40–50	25–35	(1)	2. 00–6. 30	0. 10–0. 12	5. 6–6. 0	Low	Low.
0–10	85–95	70–90	60–85	50–60	20–30	10–20	0. 63–2. 00	0. 13–0. 15	5. 1–6. 5	Low	Low.
0–10	85–95	70–90	65–90	55–65	30–40	20–30	0. 63–2. 00	0. 15–0. 17	4. 5–5. 5	Moderate	Moderate.
10–20	45–55	40–50	40–50	35–45	40–50	20–30	0. 63–2. 00	0. 08–0. 10	4. 5–5. 0	Low	Moderate.
0	100	90–100	70–80	40–50	25–35	0–10	2. 00–6. 30	0. 10–0. 12	5. 6–6. 5	Low	Low.
0	100	95–100	75–85	40–50	25–35	10–20	0. 20–0. 63	0. 14–0. 16	5. 1–6. 0	Moderate	Moderate.
10–20	75–95	65–90	45–65	25–35	20–30	0–10	2. 00–6. 30	0. 08–0. 10	5. 6–6. 0	Low	Low.
0	95–100	95–100	80–90	70–80	20–30	0–10	0. 63–2. 00	0. 16–0. 18	5. 1–6. 0	Low	Moderate.
0	100	95–100	85–95	75–85	30–40	20–30	0. 63–2. 00	0. 16–0. 18	4. 5–6. 0	Moderate	Moderate.
0–5	35–45	30–40	25–40	20–35	20–30	0–5	0. 63–2. 00	0. 07–0. 09	4. 5–5. 0	Low	Moderate.
0	60–90	55–85	50–80	40–70	20–30	0–5	0. 63–2. 00	0. 12–0. 14	5. 1–6. 5	Low	Low.
0–5	60–90	50–80	45–65	35–50	10–20	0–10	0. 63–2. 00	0. 12–0. 14	4. 5–5. 5	Low	Low.
15–65	70–80	65–75	55–70	35–50	20–30	5–10	0. 63–2. 00	0. 10–0. 12	5. 1–6. 5	Low	Moderate.
0	100	95–100	80–90	40–50	30–40	0–10	2. 00–6. 30	0. 12–0. 14	5. 6–6. 0	Low	Low.
0	100	95–100	80–90	45–60	40–50	10–20	0. 20–0. 63	0. 16–0. 18	5. 1–5. 5	High	High.
0	100	95–100	75–85	35–45	30–40	0–10	0. 63–2. 00	0. 11–0. 13	4. 5–5. 0	Low	Low.
5–15	75–85	70–80	55–65	40–50	20–30	5–15	0. 63–2. 00	0. 12–0. 14	6. 1–6. 5	Low	Low.
20–25	85–95	80–90	60–70	40–60	30–40	15–25	0. 06–0. 20	0. 15–0. 17	6. 1–7. 3	High	High.

TABLE 6.—*Estimated properties of*

Soil series and map symbols	Depth to bedrock	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Perkins, moderately deep variant: PgB	2. 0–3. 5	0–12	Gravelly loam	SM or SC	A–4
		12–37	Very gravelly sandy clay loam.	GC	A–2
		37	Metabasic rock.		
Placer diggings: PrD. Properties too variable to be estimated.					
Rescue: ReB, ReC, ReD, RfC, RfD, RfE, RgE2.	3. 5–5. 0+	0–10	Sandy loam	SM or SC	A–4
		10–34	Sandy clay loam	SC or CL	A–6
		34–66	Weathered gabbrodiorite.		
Rescue, clayey variant: Rk	3. 5–5. 0+	0–40	Clay	CH	A–7
Serpentine rock land: SaF. Properties too variable to be estimated.					
Shaver: SbB, SbC, SbD, ScC, SdE	3. 5–5. 0+	0–51	Coarse sandy loam	SM	A–2
		51	Granodiorite.		
Sierra: SfC2, SfD2, SgC, ShD, ShE	3. 5–5. 0+	0–22	Sandy loam and loam	ML	A–4
		22–44	Clay loam	CL	A–6 or A–7
		44–72	Sandy clay loam	SC or CL	A–6
Sites: SkC, SkD, SkE, SoE, SrE, SrF	3. 5–5. 0+	0–14	Loam and stony loam	ML	A–4
		14–21	Clay loam	ML or CL	A–4 or A–6
		21–53	Clay	CL	A–7
		53–69	Clay loam	ML or CL	A–4 or A–6
		69	Schist.		
SsC, SsD, SsE	3. 5–5. 0+	0–12	Clay loam	ML or CL	A–4 or A–6
		12–70	Clay	CL	A–7
Sobrante: SuC, SuD, SwD	2. 0–3. 0	0–11	Silt loam	ML or CL	A–4
		11–24	Clay loam	CL	A–6
		24	Basic schist.		
Tailings: TaD. Properties too variable to be estimated.					
Wet alluvial land: WaB. Properties too variable to be estimated.					
Whiterock: WhE	0. 5–1. 0	0–8	Gravelly silt loam	SM	A–4
		8	Slate.		

[1] Nonplastic.

the soils—Continued

Coarse fragments greater than 3 inches	Percentage passing sieve—				Atterberg values		Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity (uncoated steel)
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Liquid limit	Plasticity					
							Inches per hour	*Inches per inch of soil*	*pH value*		
0–5	75–85	70–80	55–65	40–50	20–30	5–10	0. 63–2. 00	0. 12–0. 14	6. 1–6. 5	Low	Low.
10–20	40–50	30–40	25–35	15–25	20–30	10–20	0. 20–0. 63	0. 08–0. 10	6. 1–7. 8	Low	Low.
0–15 (0 in ReB, ReC, ReD)	100	90–100	65–75	40–50	20–30	5–10	0. 63–2. 00	0. 12–0. 14	5. 6–6. 5	Low	Low.
0	100	95–100	70–80	45–55	30–40	20–30	0. 20–0. 63	0. 15–0. 17	6. 1–6. 5	Moderate	Moderate.
0	100	100	90–100	75–95	50–60	30–40	0. 06–0. 20	0. 16–0. 18	6. 1–7. 8	High	High.
0	100	85–95	40–50	25–35	(1)	(1)	2. 00–6. 30	0. 10–0. 12	5. 6–6. 0	Low	Low.
0	100	95–100	85–95	60–70	25–40	5–10	0. 63–2. 00	0. 15–0. 17	5. 6–6. 0	Low	Low.
0	100	95–100	75–85	65–75	35–45	15–25	0. 20–0. 63	0. 18–0. 20	6. 1–6. 5	Moderate	Moderate.
0	100	90–95	75–85	45–55	25–35	10–20	0. 20–0. 63	0. 14–0. 16	6. 1–6. 5	Moderate	Moderate.
0 (15–35 in SoE)	90–100	80–95	60–70	50–65	20–35	0–10	0. 63–2. 00	0. 14–0. 16	5. 6–6. 0	Low	Moderate.
0 (15–35 in SoE)	90–100	85–95	80–90	60–70	25–35	5–15	0. 63–2. 00	0. 16–0. 18	5. 6–6. 0	Low	Moderate.
0 (5–10 in SoE)	100	95–100	80–95	70–85	40–50	20–30	0. 20–0. 63	0. 15–0. 17	4. 5–6. 0	Moderate	High.
0 (5–10 in SoE)	90–100	85–95	80–90	60–70	25–35	5–15	0. 20–0. 63	0. 16–0. 18	4. 5–5. 0	Low	Moderate.
0	90–100	85–95	80–90	60–70	25–35	5–15	0. 63–2. 00	0. 16–0. 18	5. 6–6. 0	Low	Moderate.
0	100	95–100	80–95	70–85	40–50	20–30	0. 20–0. 63	0. 15–0. 17	4. 5–5. 5	Moderate	High.
0	100	95–100	80–90	70–80	20–30	0–10	0. 63–2. 00	0. 18–0. 20	5. 6–6. 5	Low	Low.
0	95–100	90–95	80–90	70–80	30–40	10–20	0. 63–2. 00	0. 18–0. 20	6. 1–6. 5	Moderate	Moderate.
0–30	55–70	50–65	40–55	35–50	25–35	0–10	0. 63–2. 00	0. 12–0. 14	5. 1–6. 0	Low	Low.

TABLE 7.—*Estimated engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in for referring to other series in

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Road location
Acidic rock land: AaF. Interpretations not made; properties too variable.				
Ahwahnee: AcC, AdD, AdE.	Fair to poor: mostly sandy loam; rock outcrops.	Poor for sand: 20 to 30 percent fines. Unsuitable for gravel: 15 to 25 percent gravel.	Good	Cut and fill slopes are easily eroded; moderate to high potential frost action; rock outcrops on steeper slopes.
Aiken: AfB, AfB2, AfC, AfC2, AfD, AgD.	Fair: loam over clay loam; clay at depth of 35 inches.	Unsuitable: more than 50 percent fines.	Fair to poor: A-4, A-5, A-6, or A-7.	Bare slopes are erodible; moderate potential frost action; moderately slow permeability; on broad, gently rolling ridgetops.
Argonaut: AkC, AlD, AmD, AnB.	Poor: clay at depth of 10 inches.	Unsuitable: mostly more than 50 percent fines.	Fair to poor: A-4, A-6, or A-7.	Rock outcrops cover from 5 to 25 percent of surface; moderate potential frost action; very slow permeability; on undulating to hilly uplands.
Argonaut, seeped variant: AoB.	Poor: clay at depth of 17 inches.	Unsuitable: more than 50 percent fines.	Fair to poor: A-4 or A-7.	Small spring and seep areas occur in slightly sloping areas; drainageways and waterways needed.
Auberry: ArB, ArC, ArD, AsC, AtD, AtE, AuD.	Fair to poor: coarse sandy clay loam at depth of 13 inches. AsC: rocky. AtD, AtE, AuD: very rocky.	Poor for sand: limited amount of material; 25 to 50 percent fines. Unsuitable for gravel: 0 to 15 percent gravel.	Good to poor: A-2, A-4, or A-6.	Bare slopes easily eroded; rock outcrops occupy up to 25 percent of surface; slight potential frost action; moderate permeability; on gently rolling uplands.
Auburn: AwD, AxD, AxE, AyF.	Poor: silt loam 1 to 2 feet deep over bedrock. AxD, AxE: very rocky. AyF: extremely rocky.	Unsuitable: more than 50 percent fines.	Fair: A-4	Up to 50 percent outcrops of amphibolite schist; shallow over bedrock; moderate to high potential frost action; moderate permeability; bare slopes are erodible.
Auburn, heavy subsoil varient: AzE.	Poor: cobbly and very cobbly clay loam; cobbly subsoil.	Unsuitable for sand: limited sand. Poor to unsuitable for gravel: 50 to 80 percent slate fragments.	Poor: A-6	Moderate to high potential frost action; moderate permeability; subsoil very cobbly.
*Boomer: BhC, BhD, BkD, BkE, BkF, BpC, BpD, BrE. For properties of Sites soils in BpC, BpD, BrE, refer to the Sites series.	Fair: gravelly loam over gravelly clay loam. BkD, BkE, BkF, BrE: very rocky.	Poor to unsuitable for sand: 25 to 50 percent fines. Poor to unsuitable for gravel: 20 to 50 percent gravel.	Good to fair: A-2 or A-4.	Slight to high potential frost action; moderate permeability; up to 50 percent of the soil mass consists of gravel-sized fragments; rock outcrops cover from 0 to 25 percent of the surface; undulating to steep.

interpretations of the soils

such mapping units may have different properties and limitations, and for this reason, it is necessary to follow carefully the instructions the first column of this table]

Soil features affecting—Continued			Soil limitations for septic tank filter fields	Hydrologic soil group
Water retention		Irrigation		
Embankments	Reservoir areas			
Moderate shear strength; semipervious to impervious when compacted; slight to medium compressibility; moderate stability; low to moderate resistance to piping.	High seepage rate; underlying granitic rock is weathered, fractured, and fairly porous.	Low available water holding capacity; rapid intake rate; 9 to 50 percent slopes. AdD, AdE: very rocky.	Severe: 2.0 to 3. 5 feet to bedrock; slopes are more than 15 percent in places.	C.
Low shear strength; semipervious when compacted; medium compressibility; low stability; low to moderate resistance to piping.	Moderately slow permeability; deep, weathered bedrock.	High available water holding capacity; moderate intake rate; 3 to 30 percent slopes. AgD: cobbly.	Severe: moderately slow permeability; slopes are more than 15 percent in places.	B.
Low shear strength; impervious when compacted; medium to high compressibility; low stability; cracks when dry.	Very slow permeability	Moderate available water holding capacity; slow intake rate; 2 to 30 percent slopes. AlD: extremely stony. AmD: very rocky.	Severe: very slow permeability; slopes are more than 15 percent in places.	D.
Low shear strength; impervious when compacted; medium compressibility; low stability; cracks when dry.	Very slow permeability	Moderate available water holding capacity; moderate intake rate; 0 to 5 percent slopes.	Severe: very slow permeability; poorly drained; bedrock.	D.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; low to moderate resistance to piping.	Moderately slow permeability; underlying bedrock is strongly weathered.	Moderate available water holding capacity; moderate intake rate; 5 to 50 percent slopes. AsC: rocky. AtD, AtE, AuD: very rocky.	Severe: moderately slow permeability.	B (ArB, ArC, ArD, AsC, AtD, AtE). C (AuD).
Low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; moderate to low stability; cracks when dry; moderate resistance to piping.	Moderate permeability, which varies according to degree of fracturing of parent material; shallow over bedrock.	Low available water holding capacity; moderate intake rate; 2 to 70 percent slopes. AxD, AxE: very rocky. AyF: extremely rocky.	Severe: 1 to 2 feet to bedrock; slopes are more than 15 percent in many places.	D.
Moderate shear strength; semipervious to impervious when compacted; medium compressibility; moderate stability.	Moderate permeability; weathered slate at shallow depth.	Low available water holding capacity; moderate intake rate; 9 to 50 percent slopes.	Severe: slopes; 0.5 to 2.0 feet to bedrock.	D.
Moderate shear strength; impervious when compacted; slight to medium compressibility; moderate stability; moderate resistance to piping.	Moderate permeability; underlain by fractured bedrock	Low available water holding capacity; moderately rapid intake rate; 3 to 70 percent slopes. BkD, BkE, BkF, BrE: very rocky.	Severe: slopes; 2.0 to 4.5 feet to bedrock.	B (More than 40 inches to bedrock). C (24 to 40 inches to bedrock).

TABLE 7.—*Estimated engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Road location
Chaix: CcE, CcF	Fair: coarse sandy loam.	Fair to poor for sand: 25 to 35 percent fines. Unsuitable for gravel: 15 to 25 percent gravel.	Good	Rolling to very steep on uplands; 24 to 40 inches to well-weathered granitic rock; 5 to 25 percent of surface contains rock outcrops; high erosion hazard.
Chawanakee: ChE	Poor: coarse sandy loam; weathered bedrock at depth of 16 inches; very rocky.	Poor for sand: limited amount of material; 25 to 35 percent fines. Unsuitable for gravel: 15 to 25 percent gravel.	Good	Bare slopes are easily erodible; moderate to high potential frost action; moderately rapid permeability; shallow over decomposed bedrock; contains 5 to 25 percent rock outcrops.
Cohasset: CkD, ClE	Fair to poor: sandy loam or cobbly sandy loam over loam or cobbly loam; bedrock at depth of 40 inches to more than 60 inches; very rocky.	Poor to unsuitable for sand: 25 to 50 percent fines. Unsuitable for gravel: 10 to 25 percent gravel; 0 to 35 percent cobblestones.	Good to poor: A-2, A-4, or A-6.	Slight to high potential frost action; moderate permeability; soils contain 0 to 35 percent cobblestones; moderately sloping to steep on side slopes.
CmB, CmC, CmD, CoC, CoE.	Fair to poor: cobbly loam or loam over cobbly clay loam or clay loam; bedrock at depth of 40 inches to more than 60 inches.	Unsuitable for sand: more than 50 percent fines. Unsuitable for gravel: 5 to 20 percent gravel; 0 to 35 percent cobblestones.	Fair to poor: A-4 or A-7.	Moderate to very high potential frost action; moderate permeability; moderately sloping on ridgetops and steep on side slopes of andesitic ridges; 0 to 35 percent cobblestones.
Crozier: CrE	Fair: cobbly loam over cobbly clay loam; bedrock at depth of 24 to 40 inches.	Unsuitable for sand: more than 60 percent fines. Unsuitable for gravel: 5 to 15 percent gravel; 10 to 35 percent cobblestones.	Fair to poor: A-4 or A-6.	Moderate to very high potential frost action; moderate permeability; strongly sloping to steep on side slopes of andesitic ridges; shallow over hard conglomerate bedrock.
Delpiedra: DeE	Poor: clay loam; bedrock at depth of 10 to 24 inches; very rocky.	Unsuitable: more than 70 percent fines.	Poor: A-6	Moderate to high potential frost action; moderate permeability; shallow over serpentine bedrock; 2 to 25 percent of surface is covered with rock outcrops.
Diamond Springs: DfB, DfC, DfD, DgE.	Fair: very fine sandy loam and loam over clay loam; bedrock at depth of 24 to 50 inches. DgE: very rocky.	Unsuitable: more than 60 percent fines.	Fair to poor: A-4 or A-6.	Moderate to high potential frost action; moderately slow permeability; bare slopes are erodible; on ridges and side slopes.
Diamond Springs; grayish subsoil variant: DmD, DmE.	Fair: gravelly loam, loam, and gravelly sandy loam; bedrock at depth of 36 to 60 inches.	Unsuitable for sand: 20 to 75 percent fines. Unsuitable for gravel: 0 to 40 percent gravel.	Good to fair: A-2 or A-4.	Slight to high potential frost action; moderate permeability; steep on side slopes of rhyolitic ridges; highly erodible.

interpretations of the soils—Continued

Soil features affecting—Continued			Soil limitations for septic tank filter fields	Hydrologic soil group
Water retention		Irrigation		
Embankments	Reservoir areas			
Moderate shear strength; impervious when compacted; slight to medium compressibility; moderate stability; too steep for embankments; moderate resistance to piping.	Moderately rapid permeability; underlain by deeply weathered bedrock.	Moderate available waterholding capacity; moderately rapid intake rate; 9 to 70 percent slopes; very rocky.	Severe: slopes; 2.0 to 3.5 feet to bedrock at depth of 24 to 40 inches.	C.
Moderate shear strength; semipervious when compacted; very slight compressibility; moderate stability; moderate resistance to piping.	Moderately rapid permeability; shallow over weathered bedrock.	Low available water holding capacity; moderately rapid intake rate; 9 to 50 percent slopes; very rocky.	Severe: slopes; 1 to 2 feet to bedrock.	C.
Moderate shear strength; semipervious to impervious when compacted; very slight compressibility; moderate stability: low to moderate resistance to piping.	Moderate permeability; generally too steep for water storage.	Moderate to high available water holding capacity; moderate intake rate; 9 to 50 percent slopes. ClE: cobbly.	Severe: slopes	B.
Moderate shear strength; semipervious to impervious when compacted; medium compressibility; moderate to high stability; moderate to high resistance to piping.	Moderate permeability; generally too steep for water storage.	Moderate to high available water holding capacity; moderate intake rate; 3 to 50 percent slopes. CoC, CoE: cobbly.	Moderate for CmB: slopes. Severe for all other units: slopes.	B.
Low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; low to moderate stability; low to moderate resistance to piping.	Moderate permeability; too steep for water storage.	Moderate available water holding capacity; moderate intake rate; 9 to 50 percent slopes; cobbly.	Severe: slopes; 2.0 to 3.5 feet to bedrock at depth of 24 to 40 inches.	C.
Low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; low to moderate stability; moderate shrink-swell potential.	Moderate permeability; 10 to 24 inches to decomposed bedrock.	Low available water holding capacity; moderate intake rate; 3 to 50 percent slopes; very rocky.	Severe: 1 to 2 feet to bedrock; slopes are more than 10 percent in most places.	D.
Low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; low to moderate stability; low to moderate resistance to piping.	Moderately slow permeability.	Moderate available water holding capacity; moderate intake rate; 3 to 50 percent slopes. DgE: very rocky.	Severe: moderately slow permeability; slopes are more than 10 percent in many places; 2 to 4 feet to bedrock.	C.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; low to moderate resistance to piping.	Moderate permeability; generally too steep for water storage.	Moderate available water holding capacity; moderate intake rate; 9 to 50 percent slopes.	Severe: slopes	B.

TABLE 7.—*Estimated engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Road location
Gullied land: GuF. Interpretations not made; properties too variable.				
Holland: HgB, HgC, HgD, HhC, HkE, HkF.	Fair: coarse sandy loam over sandy clay loam; bedrock at depth of 40 inches to more than 60 inches. HhC: rocky. HkD, HkF: very rocky.	Unsuitable for sand: 40 to 50 percent fines. Unsuitable for gravel: 0 to 10 percent gravel.	Good to poor: A-4 or A-6.	Slight to high potential frost action; moderately slow permeability; highly erodible; rock outcrops cover 0 to 25 percent of surface; hilly to very steep.
Horseshoe: HrC, HsE.	Fair: gravelly sandy loam and gravelly loam over gravelly clay loam; very gravelly clay loam at depth of 50 inches.	Unsuitable for sand: 35 to 65 percent fines. Poor to unsuitable for gravel: 10 to 60 percent gravel.	Poor: A-6	Slight to moderate potential frost action; moderate permeability; profile contains 5 to 30 percent gravel and cobblestones rolling to very steep on terraces formed from old river deposits.
Hotaw: HtE	Fair: coarse sandy loam over sandy clay loam; bedrock at depth of 24 to 40 inches; very rocky.	Unsuitable for sand: 40 to 50 percent fines. Unsuitable for gravel: 0 to 10 percent gravel.	Fair to poor: A-4 or A-6.	Slight to high potential frost action; moderately slow permeability; rock outcrops cover 5 to 25 percent of the surface; 2 to 3½ feet deep to deeply weathered granitic rock; rolling to steep; high erodibility.
Iron Mountain: ImE.	Poor: cobbly sandy loam; 5 to 20 inches deep to bedrock; very rocky.	Unsuitable for sand: limited amount of material; 25 to 35 percent fines. Unsuitable for gravel: 10 to 35 percent gravel; 10 to 20 percent cobblestones.	Good	Slight to moderate potential frost action; moderately rapid permeability; shallow over hard cemented conglomerate bedrock; 35 percent of soil mass consists of gravel and cobblestones.
*Josephine: JrC, JrD, JsE, JtC, JtD, JtE, JuE, JuF, JvD. For properties of Mariposa part of JvD, see Mariposa series.	Fair: gravelly loam, silt loam, and silty clay loam over very gravelly silt loam; bedrock at depth of 3½ to 5 feet. JuE, JuF: very rocky.	Poor to unsuitable for sand: 25 to 85 percent fines. Poor to unsuitable for gravel: 5 to 70 percent gravel; 0 to 5 percent cobblestones.	Good to poor: A-2, A-4, or A-6.	Moderate to high potential frost action; moderate permeability; road cuts are erodible; 0 to 25 percent rock outcrops.
Loamy alluvial land: LaB. Interpretations not made; properties too variable.				
*Mariposa: MaD, MbE, MbF, McE, McF. For properties of Josephine part of McE, McF, see Josephine series.	Poor: gravelly silt loam; bedrock at depth of 15 to 30 inches. MbE, MbF, McE, McF: very rocky.	Unsuitable for sand: 40 to 70 percent fines. Poor to unsuitable for gravel: 15 to 45 percent gravel.	Fair: A-4	Moderate to very high potential frost action; moderate permeability; rock outcrops are common; gravel makes up 15 to 45 percent of soil mass; rolling to very steep; erodible.

interpretations of the soils—Continued

Soil features affecting—Continued			Soil limitations for septic tank filter fields	Hydrologic soil group
Water retention		Irrigation		
Embankments	Reservoir areas			
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; low to moderate resistance to piping.	Moderately slow permeability; bedrock is deeply weathered.	High available water holding capacity; moderately rapid intake rate; 5 to 70 percent slopes. HhC: rocky; HkD, HkF: very rocky.	Severe: moderately slow permeability; slopes are more than 10 percent in many places.	B.
Moderate to low shear strength; semipervious to impervious when compacted; slight compressibility; moderate to low stability.	Moderate permeability; parent material is stratified; steep.	High available water holding capacity; moderate intake rate; 9 to 50 percent slopes.	Severe: slopes	B.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; low to moderate resistance to piping.	Moderately slow permeability; 2 to 3½ feet to deeply weathered granitic bedrock.	Moderate available water holding capacity; moderately rapid intake rate; 15 to 50 percent slopes; very rocky.	Severe: moderately slow permeability; slopes are more than 15 percent.	C.
Moderate shear strength; semipervious to impervious when compacted; very slight compressibility; moderate stability; low to moderate resistance to piping.	Moderately rapid permeability; bedrock is impervious.	Low available water holding capacity; moderately rapid intake rate; 3 to 50 percent slopes; very rocky.	Severe: 5 to 20 inches to bedrock; slopes in places.	D.
Very low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; moderate to low stability; moderate shrink-swell potential; low to moderate resistance to piping.	Moderate permeability; bedrock is fractured and vertically tilted.	High available water holding capacity; moderate to moderately slow intake rate; 5 to 70 percent slopes. JuE, JuF: very rocky.	Moderate where slopes are 5 to 10 percent. Severe where slopes are 10 to 70 percent.	B.
Low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; low to moderate stability; moderate to high resistance to piping.	Moderate permeability; 15 to 30 inches to bedrock; bedrock is fractured and vertically tilted.	Moderate available water holding capacity; moderate intake rate; 3 to 70 percent slopes, MbE, MbF, McE, McF: very rocky.	Severe: slopes; 15 to 30 inches to bedrock.	C.

TABLE 7.—*Estimated engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Road location
Maymen: MfF	Poor: gravelly loam; bedrock at depth of 6 to 16 inches; very rocky.	Unsuitable for sand: 35 to 50 percent fines. Unsuitable for gravel: 20 to 50 percent gravel; 0 to 50 percent cobblestones.	Fair: A-4	Moderate to high potential frost action; moderate permeability; shallow over bedrock; 20 to 50 percent of soil volume is gravel; 5 to 25 percent rock outcrops; hilly to very steep on uplands.
McCarthy: MhE	Poor: very cobbly loam; bedrock at depth of 24 to 40 inches.	Unsuitable for sand: 35 to 50 percent fines. Poor for gravel: 25 to 35 percent gravel; 15 to 65 percent cobblestones.	Fair: A-4	Slight to moderate potential frost action; moderate permeability; profile contains 15 to 65 percent cobblestones; road cuts erodible.
Metamorphic rock land: MmF. Interpretations not made; properties too variable.				
Mixed alluvial land: MpB. Interpretations not made; properties too variable.				
Musick: MrC, MrD, MsC, MtE.	Poor: sandy loam over heavy clay loam and sandy clay. MsC: rocky. MtE: very rocky.	Unsuitable: 35 to 60 percent fines.	Fair to poor: A-4 or A-7.	Gently rolling to very steep on uplands; 0 to 25 percent rock outcrops; high erodibility.
Perkins: PeD	Poor: gravelly loam and cobbly loam over cobbly clay loam and cobbly clay.	Poor to unsuitable for sand: 40 to 60 percent fines. Poor to unsuitable for gravel: 10 to 30 percent gravel; 5 to 25 percent cobblestones.	Fair to poor: A-4 or A-6.	Slight to moderate potential frost action; slow permeability; gravel and cobblestones make up 10 to 50 percent of the soil profile; on terraces above valley floor.
Perkins, moderately deep variant: PgB.	Poor: gravelly loam over very gravelly sandy clay loam; bedrock at depth of 30 to 40 inches.	Poor for sand: 15 to 50 percent fines. Poor to unsuitable for gravel: 20 to 70 percent gravel; 0 to 20 percent cobblestones.	Good to fair: A-2 or A-4.	Moderate potential frost action; moderately slow permeability; below depth of 12 inches, 60 to 70 percent of soil volume is gravel; drainageways necessary; nearly level to gently sloping on gravelly stream terraces.
Placer diggings: PrD. Interpretations not made; properties too variable.				
Rescue: ReB, ReC, ReD, RfC, RfD, RfE, RgE2.	Fair: sandy loam and sandy clay loam; bedrock at depth of 40 inches to more than 60 inches. RfC, RfD: very stony. RgE2: extremely stony.	Unsuitable for sand: 40 to 55 percent fines. Unsuitable for gravel: 0 to 10 percent gravel; 0 to 15 percent stones.	Good to poor: A-2, A-4, A-6.	Slight to high potential frost action; moderately slow permeability; 1 to 15 percent of the surface is covered with stones; undulating to steep; erodible.

interpretations of the soils—Continued

Soil features affecting—Continued			Soil limitations for septic tank filter fields	Hydrologic soil group
Water retention		Irrigation		
Embankments	Reservoir areas			
Moderate shear strength; semipervious to impervious when compacted; medium compressibility; moderate stability; shallow over bedrock; low to moderate resistance to piping.	Moderate permeability; 6 to 16 inches to vertically tilted slate bedrock.	Low available water holding capacity; moderate intake rate; 15 to 70 percent slopes; very rocky.	Severe: 0.5 to 1.5 feet to bedrock; slopes.	D.
Moderate shear strength; semipervious to impervious when compacted; very slight compressibility; moderate stability.	Moderate permeability; material is very cobbly.	Low to moderate available water holding capacity; moderate intake rate; 9 to 50 percent slopes; cobbly.	Severe: slopes; 2.0 to 3.5 feet to bedrock.	C.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; high shrink-swell potential; moderate to high resistance to piping.	Moderately slow permeability; underlying bedrock is deeply weathered.	High available water holding capacity; moderately rapid intake rate; 5 to 50 percent slopes. MsC: rocky. MtE: very rocky.	Severe: moderately slow permeability; slopes are more than 10 percent in places.	C.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; high shrink-swell potential.	Slow permeability; clay layer rests on weathered granodiorite.	High available water holding capacity; moderate intake rate; 3 to 30 percent slopes.	Severe: slow permeability; slopes are 10 to 30 percent in places.	C.
Moderate to high shear strength; impervious when compacted; slight compressibility; moderate to high stability.	Moderately slow permeability; clay layer rests on bedrock.	Moderate available water holding capacity; moderate intake rate; 2 to 5 percent slopes.	Severe: moderately slow permeability.	C.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability.	Moderately slow permeability; bedrock is deeply weathered granitic material.	Moderate to high available water holding capacity; moderately rapid intake rate; 3 to 50 percent slopes. RfC, RfD, RfE: very stony; RgE2: extremely stony.	Severe: moderately slow permeability; slopes are 10 to 50 percent in many places.	B.

TABLE 7.—*Estimated engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Road location
Rescue, clayey variant: Rk.	Poor: clay	Unsuitable: more than 75 percent fines.	Poor: A-7	Subject to infrequent flooding; high water table during winter season; beside slow-flowing creeks; drainageways and watercourses needed.
Serpentine rock land: SaF. Interpretations not made; properties too variable.				
Shaver: SbB, SbC, SbD, ScC, SdE.	Fair: coarse sandy loam, bedrock at depth of 40 inches to more than 60 inches. ScD: rocky. SdE: very rocky.	Fair to poor for sand: 25 to 35 percent fines. Unsuitable for gravel: 5 to 15 percent gravel.	Good	Slight to high potential frost action; moderately rapid permeability; road cuts very erodible; 0 to 25 percent of the surface is rock outcrops; deeply weathered granitic bedrock; gently sloping to steep.
Sierra: SfC2, SfD2, SgC, ShD, ShE.	Fair: sandy loam and loam over clay loam and sandy clay loam. SgC: rocky. ShD, ShE: very rocky.	Unsuitable: mostly more than 50 percent fines.	Fair to poor: A-4, A-6, or A-7.	Moderate to high potential frost action; moderately slow permeability; 5 to 25 percent rock outcrops in places; deeply weathered granitic bedrock; hilly; highly erodible.
Sites: SkC, SkD, SkE, SoE, SrE, SrF, SsC, SsD, SsE.	Poor: loam and clay loam over clay; bedrock at depth of 40 inches to more than 60 inches. SoE: stony. SrE, SrF: very rocky.	Unsuitable for sand: more than 50 percent fines. Unsuitable for gravel: mostly 0 to 20 percent gravel. SoE: 5 to 35 percent stones.	Fair to poor: A-4, A-6, or A-7.	Slight to high potential frost action; moderately slow permeability; bedrock is vertically tilted slates; rock outcrops and slate fragments occupy 0 to 25 percent of soil surface.
Sobrante: SuC, SuD, SwD.	Fair: silt loam over clay loam; bedrock at depth of 22 to 36 inches. SwD: very rocky.	Unsuitable: more than 70 percent fines.	Fair to poor: A-4 or A-6.	Moderate to high potential frost action; moderate permeability; 22 to 36 inches to hard bedrock; rock outcrops cover 0 to 25 percent of the surface.
Tailings: TaD. Interpretations not made; properties too variable.				
Wet alluvial land: WaB. Interpretations not made; properties too variable.				
Whiterock: WhE	Poor: gravelly silt loam; bedrock at depth of 5 to 12 inches.	Unsuitable: 5 to 12 inches to bedrock.	Fair: A-4	Slight to high potential frost action; moderate permeability; very shallow soils underlain by hard slate; occasional rock outcrops.

interpretations of the soils—Continued

Soil features affecting—Continued			Soil limitations for septic tank filter fields	Hydrologic soil group
Water retention		Irrigation		
Embankments	Reservoir areas			
Low to very low shear strength; impervious when compacted; medium to very high compressibility; low to very low stability; high shrink-swell potential.	Slow permeability; broad, nearly level on bottom land.	Moderate available water holding capacity; slow intake rate; 0 to 2 percent slopes.	Severe: slow permeability; poorly drained.	D.
Moderate shear strength; semipervious when compacted; very slight compressibility; low stability; highly erodible; high resistance to piping.	Moderately rapid permeability; high seepage loss because of very porous underlying material.	Moderate available water holding capacity; rapid intake rate; 5 to 50 percent slopes. ScD: rocky. SdE: very rocky.	Moderate for SbB: slopes; 3.5 to 5 feet to bedrock. Severe for all other units; slopes.	B.
Low to moderate shear strength; semipervious to impervious when compacted; medium compressibility; moderate to low stability; moderate to low resistance to piping.	Moderately slow permeability, but underlying bedrock is deeply weathered and porous.	High available water holding capacity; moderate intake rate; 5 to 50 percent slopes.	Severe: moderately slow permeability; slopes in places.	B.
Low to moderate shear strength; semipervious to impervious when compacted; slight to medium compressibility; low to moderate stability; low to moderate resistance to piping.	Moderately slow permeability, but bedrock is fractured vertically tilted slates and schists.	High available water holding capacity; moderate to slow intake rate; 9 to 70 percent slopes. SoE: stony. SrE, SrF: very rocky.	Severe: moderately slow permeability; slopes in places.	B.
Moderate to low shear strength; impervious when compacted; medium compressibility; moderate to low stability; low to moderate resistance to piping.	Moderate permeability; 22 to 36 inches to hard bedrock.	Moderate available water holding capacity; moderate intake rate; 3 to 30 percent slopes. SwD: very rocky.	Severe: slopes; 2 to 3 feet to bedrock.	C.
Moderate shear strength; semipervious to impervious when compacted; slight compressibility; moderate stability; very shallow to rock; moderate resistance to piping.	Moderate permeability, depending on amount of fracturing of bedrock; 5 to 12 inches deep to bedrock.	Low available water holding capacity; rapid intake rate; 3 to 50 percent slopes.	Severe: 0.5 to 1.0 foot to bedrock; slopes in places.	D.

Engineering properties

Table 6 lists the soils in the survey area, lists the map symbols for each mapping unit, and gives estimates of soil properties significant to some engineering work. It also gives the textural classification of the U.S. Department of Agriculture and estimates of the Unified classification and the AASHO classification. In addition, estimates of the Atterberg values, permeability (*17*), available water holding capacity, reaction, shrink-swell potential, and corrosivity are given. The estimates are based partly on examinations made in the field, partly on results of test data shown in table 5, and partly on information on soils from other survey areas. Since the estimates are mainly for typical soils, some variations from these values should be anticipated. More information on the range of properties and qualities of the soils can be obtained in other parts of this survey.

Depth to bedrock is of interest to the engineer. Generally, the soils are shallow to underlying bedrock in the western part of the survey area and are increasingly deeper to the east.

The available water holding capacity, expressed in inches per inch of soil depth, is the capacity of a soil to retain water that can be readily absorbed by plants. It is the estimated amount of moisture held in soil between field capacity and the permanent wilting point of plants.

None of the soils in the survey area are saline or alkali to an extent that would affect their use for engineering.

The column showing reaction gives the estimated acidity or alkalinity of the soil expressed in pH value. A pH value of more than 7.3 indicates the soil is alkaline (basic), a pH value of less than 6.6 indicates an acid soil, and a pH value between 6.6 and 7.3 indicates a neutral soil.

The degree of limitations indicated for the soils in the columns in table 6 giving shrink-swell potential and corrosivity (untreated steel) are low, moderate, and high.

Shrink-swell potential refers to the change in volume of the soil material that results from a change in content of moisture. It is estimated on the basis of the kind and amount of clay in the soil layers. In general, soils that have a high content of clay have high shrink-swell potential, and coarser textured soils that contain less clay have a low shrink-swell potential. The soil that contains the most clay generally shrinks and swells the most, but in some soils the kind of clay in the soil may be more important than the amount.

Much damage to building foundations, roads, and other structures is caused by the shrinking and swelling of soils as they become dry or wet. Soils that have a low shrink-swell potential are suitable for building sites if other factors are favorable. As the shrink-swell potential increases, the soil is increasingly less suitable for buildings and roads. More detailed investigation of a site is needed where the soils have moderate or high shrink-swell potential. If large housing developments are placed on soils that have moderate or high shrink-swell potential, applying large amounts of water to lawns, shrubs, and other plants could cause ground water to accumulate in the subsurface and cause land slippage. Land slippage is particularly a hazard on the steeper slopes.

The ratings for corrosivity (*23*) in table 6 are based strictly on soil characteristics. Most materials used in construction, such as metal and concrete, corrode or deteriorate when buried in soil. The rate at which a material deteriorates depends largely upon the physical, chemical, and biological characteristics of the soil, and a given material corrodes more rapidly in some soils than in others. The corrosion probability generally is greater for extensive installations that intersect soil boundaries or soil horizons than for installations in one kind of soil or soil horizon. The range of characteristics between the layers in the profile of some soils is wide. As a result, the depth that a pipe or other structural material is buried can affect the degree of corrosion. A soil that has a more strongly developed subsoil, for example, has a different corrosivity rating for structural material laid near the surface than for such material laid just above or in the subsoil layer.

Construction of buildings and of pavements, fill and compaction operations, adding material to the surface soil, and other measures that alter soil permeability increase the probability of corrosion. In addition, mechanical agitation or excavation that results in nonuniform mixing of soil horizons is likely also to increase the probability of corrosion. Corrosivity, particularly for steel pipes or other structures, is also likely to be increased by electrical leaks from underground cables and by electrical charges resulting from dissimilar metal composition. Other factors likely to increase corrosivity are the quality of water used for watering plants, differences in the water content along conduits or structures, and the adding of fertilizer and of large amounts of organic matter.

Several soil characteristics affect the rate of corrosion of untreated steel. The most important of these are (1) electrical resistance to flow of current, (2) total acidity, (3) soil drainage, and (4) soil texture.

Engineering interpretations

Estimated engineering interpretations are listed in table 7. Each soil is given a broad relative rating as to its suitability as a source of topsoil, sand and gravel, and road fill. The criterion used in rating suitability as a source of sand and gravel was that these materials would be used as concrete aggregate with a minimum of preparation. The soil features that affect the use of the soils as sites for roads, embankments, reservoir areas, and irrigation are discussed.

The soils in the Area are highly susceptible to erosion when exposed on embankment faces and outslopes. At the lower elevations in the western part of the survey area, soils that are shallow over bedrock present problems in constructing roadways and laying pipelines. In these areas the construction and operation of septic tanks and of beds for the disposal of effluent also are complicated by the shallow depth to bedrock. The location of roads is difficult because of the steeply sloping rocky ridges separated by narrow, deep stream channels. Because of the numerous rock outcrops of tilted and fractured slate and schist, dam foundations and reservoirs may require special treatment to prevent excessive seepage. Flooding does not appear to be a limitation except in scattered areas located adjacent to stream courses. The need for agricultural drainage, other than disposal of surface water, is minor.

The factors considered for interpretating the soil limitations for septic tank filter fields are depth to bedrock, slope, permeability, percolation rate, water table, soil drainage, and flooding hazard. Assumptions were based on the amount of filter material, diameter of the lines, and

the depth of the earth cover. The ratings are moderate and severe.

Hydrologic soil groups are used in watershed planning to estimate runoff from rainfall. Soil properties and qualities are considered that influence the minimum rate of infiltration obtained for a bare soil after prolonged wetting. These properties are depth to seasonally high water table, intake rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The influence of ground cover is treated independently, not in hydrologic soil groupings. The soils have been classified into four groups:

Group A consists of soils that have a high infiltration rate when thoroughly wetted. These soils have a high rate of water transmission and low runoff potential. They are deep, are well drained or excessively drained, and consist chiefly of sand, gravel, or both. No soils in the El Dorado Area are in group A.

Group B soils have a moderate infiltration rate when thoroughly wetted. These soils have a moderate rate of water transmission and moderate runoff potential. They are moderately deep or deep, are moderately well drained or well drained, and are medium textured to moderately coarse textured.

Group C soils have a slow infiltration rate when thoroughly wetted. These soils have a slow rate of water transmission and high runoff potential. They have a layer that impedes downward movement of water, or they are moderately fine textured or fine textured and have a slow infiltration rate.

Group D soils have a slow infiltration rate when thoroughly wetted. The rate of water transmission is very slow, and runoff potential is very high. In this group are (1) clay soils that have high shrink-swell potential, (2) soils that have a permanent high water table, (3) soils that have a claypan or clay layer at or near the surface, and (4) soils that are shallow over nearly impervious material.

Formation, Morphology, and Classification of the Soils [7]

In this section the factors that affect the formation of the soils in the El Dorado Area are discussed and important processes in the morphology of the soils are described. Then the classification of the soils by higher categories is given.

Factors of Soil Formation

Soil is a natural formation on the surface of the earth in which plants grow; it is composed of organic and mineral material (*18*). Soils differ in their appearance, composition, management requirements, and productivity in different localities or even within short distances in the same locality. The factors that cause soils to differ are: (1) the relief, or lay of the land, and drainage; (2) the physical and chemical composition of the parent material; (3) the climate under which the soil material has accumulated and existed since accumulation; (4) the biological activity, including plant and animal life in and on the soil; and (5) the length of time the forces of formation have acted on the soil material. Each soil is affected by all five factors, but the relative effect and importance of each varies from one soil to another.

Relief

The survey area is drained by deeply entrenched streams that flow in a westerly direction to form V-shaped canyons. There are remnant ridges of andesite that are tabular and slope slightly to the west. The areas of metamorphic rocks are complex and steep, and there are many narrow ridges that lie in a northwesterly direction and have a dendritic drainage pattern. The relief is less rugged in the foothills. The areas of gabbrodiorite and granodiorite are smooth and rounded. Some areas of granodiorite appear as if they were in a basin, because they are rimmed by more resistant metamorphic rocks. There are a few alluvial bottoms and terraces along present-day and Tertiary streams. Most of these areas have been mined for gold.

Parent material

Parent material exerts one of the strongest influences on soil formation in the survey area. Most of the soils are on uplands and formed in place in material weathered from metamorphic rock, granitic rock, or andesitic conglomerate.

Following is a list of the types of parent material in the survey area and the soils formed on them.

Type of parent material	*Soil series*
Stratified mixed alluvium (Recent.)	Loamy alluvial land; Mixed alluvial land; Perkins; Perkins, moderately deep variant.
Stratified mixed alluvium (Teritary river gravels.)	Horseshoe.
Andesitic conglomerate (Merhrten Formation.)	Aiken; Cohasset; Crozier; McCarthy.
Welded tuff breccia (Merhrten Formation.)	Iron Mountain.
Granodiorite and mica schist	Ahwahnee; Auberry; Chaix; Chawanakee; Holland; Hotaw; Musick; Shaver; Sierra.
Gabbrodiorite	Rescue; Rescue, clayey variant.
Metadacite	Diamond Springs.
Serpentine	Delpiedra.
Slate (Mariposa Group.)	Mariposa; Whiterock.
Metamorphosed volcanic rock greenstone, amphibolite schist. (Amador Group.)	Argonaut; Auburn; Boomer; Rescue, clayey variant; Sobrante.
Schists and slates (Calaveras Group.)	Argonaut, seeped variant; Auburn; Auburn, heavy subsoil variant; Boomer; Josephine; Mariposa; Maymen; Sites.
Rhyolitic tuff (Valley Spring Formation.)	Diamond Springs, grayish subsoil variant.

Metamorphic rocks generally are not easily weathered. They commonly form shallow, gravelly soils that have many outcrops. The metamorphic rocks are fine grained and form soils that have a surface texture of loam and silt loam. Some of these soils are low in mineral nutrients, probably because the sediments from which these rocks formed were previously weathered in an earlier erosion cycle. For example, the Josephine soils contain fewer mineral nutrients than the adjacent Cohasset soils, which formed in material from andesitic rock.

[7] By GRANT M. KENNEDY, soil scientist, Soil Conservation Service.

At the lower elevations, amphibolite schist, greenstone, and schists and slates of the Calaveras Formation form the Auburn soils. The Auburn soils are shallow silt loams that have many rock outcrops. The Calaveras and Mariposa Formations are folded so that they are vertically tilted. The bedding planes of schists and slates are exposed at the surface of these formations. The variability in the composition of these strata is reflected in the difference between the soils within short horizontal distances. The depth and other soil characteristics change rapidly. Examples are Mariposa, Josephine, and Sites soils.

The soils that formed on andesitic conglomerate are in the Aiken, Cohasset, Crozier, and McCarthy series. The andesitic conglomerate is deeply weathered, especially in the Aiken soils because this material is porous and weathers easily. The andesite is moderately fine grained and forms soils that have a surface layer of loam and sandy loam. If the parent rock is welded tuff breccia, the rock is hard, massive, and nonporous and shows only slight signs of weathering. The shallow soils that formed on this parent material are in the Iron Mountain series.

Soils underlain by granitic rocks occupy places where the overlying rocks were stripped away and the Sierra Nevada batholith is exposed. These are soils of the Auberry, Holland, Musick, Shaver, and Sierra series. The parent rock is weathered to a considerable depth, and the soils are 3½ feet to more than 5 feet deep. The weathered rocks contain many angular coarse grains of sand, mainly quartz, that form soils that have a surface layer of coarse sandy loam. The abrasive action of the grains of sand carried by runoff water accounts for the susceptibility of these soils to erosion. The rounded topography and the depth of the soils indicate that geologic erosion also is relatively rapid.

Narrow bands of ultrabasic rocks, mainly serpentine, underlie some areas. The ultrabasic rocks contain a large amount of magnesium in relation to the amount of calcium. Consequently, the Delpiedra soils are very low in fertility.

The relationship of parent material to soil patterns show up on the general soil map at the back of this survey. The major difference between groups of soil associations is parent material, and many of the soil boundaries are closely related to the boundaries between different geologic formations.

Climate

Climate has a marked influence on soil formation. Heat and moisture strongly influence the kind and amount of vegetation that grows, the rate at which organic matter decomposes, the rate at which minerals weather, and the rate at which material moves from some soil horizons and accumulates in others.

Temperature and precipitation in the survey area vary according to elevation. In the western part of the area, near the Sacramento County line, the elevation is about 500 to 700 feet. The precipitation there is about 23 to 25 inches, and the average annual temperature is 60° F. The precipitation increases and the temperature decreases regularly with an increase in elevation. At an elevation of 5,000 feet, the annual precipitation is 50 to 60 inches and the average annual temperature is 55°. At an elevation of more than 3,000 feet, much of the precipitation falls as snow.

Summers in the survey area are hot and dry, and winters are cool and moist. There is no appreciable rainfall in summer, except for a few thundershowers in the mountains. Significant rainfall generally starts early in fall, reaches a maximum in midwinter, and stops late in spring.

The content of organic matter in the soils is highest at high elevations, where the climate is cool and moist. At elevations of more than 4,800 feet, growth is not so rapid as at lower elevations, because of cool temperatures and the short growing season. Nevertheless, the soils are high in content of organic matter because the roots of the plants are generally coarse and the cool temperatures do not favor rapid decomposition.

At intermediate elevations, the soils have a moderate content of organic matter even though decomposition is rapid. The rainfall is abundant, and the temperatures are moderate. The vegetation is abundant, and large amounts of plant residue are returned to the soil.

At lower elevations, the soils contain a small amount or organic matter. The vegetation consists mainly of annual grasses and forbs. Even though the soils are dry in summer and early in fall, the warm and moist weather in spring and late in fall favors rapid decomposition of the very fine grass roots.

Rainfall in the survey area is sufficient to leach the soils of lime and other water-soluble material. Surplus water in the soil during the wettest season ranges from 11 inches to more than 30 inches (*2*). The surplus water is retained by the soil, percolates through it, or is lost through runoff. Surface runoff, however, does not cause major loss of water in the area. Thus, even at low elevations there is enough rainfall to leach the soils of carbonates and soluble salts. Evidences of leaching are the absence of lime in most soil profiles, the presence of clay films at considerable depths within many of the soils or within the weathered rock, and the consistent or decreasing pH value as depth increases.

Between elevations of 2,000 and 5,000 feet, the soils appear to undergo the most intensive weathering because they are still moist when they are warm in summer. In general, the soils at these elevations have a thicker profile and a redder, finer textured Bt horizon than soils at higher or lower elevations. Examples are the Aiken, Musick, and Sites soils. At lower elevations lack of moisture when the soils are warm limits the rate of weathering. On the other hand, cooler temperatures at the higher elevations, along the eastern boundary of the survey area, slow chemical reactions and thus also limit weathering.

The Argonaut soils seem to be an exception. These soils occur at the lower elevations but have a Bt horizon of clay associated with rapid weathering. There are two reasons for this. First, there is some translocation of clay from the A horizon to the B horizon. Second, these soils formed on relatively massive rocks where slopes are gentle and commonly concave. The bedrock is impermeable, and the relief is such that water is trapped above the bedrock. These soils stay moist longer in summer, and the rock weathers in place to clay.

Biological activity

The vegetation from the western boundary of the survey area eastward consists, in progression, of (1) grass, (2) oak and grass intermingled in places with brush, (3) oak and grass that are transitional to coniferous forest,

and (4) coniferous forest. The pattern of vegetation has been affected somewhat because of changes caused by fires, grazing practices, clearing, and short periods of cultivation.

Soils such as the Auburn and Sobrante formed under grass and under oak and grass. They have a thin A horizon about 3 to 9 inches thick and contain a relatively low amount of organic matter. Most of these soils have been used for grazing for more than 100 years. The amount of plant residue left after grazing each year varies greatly according to grazing practices and seasonal growth. Under average grazing, yearly additions of organic residue to the soils are estimated to be between 400 and 1,500 pounds per acre of stems and leaves and an equivalent weight of roots. Thus, about 800 to 3,000 pounds of organic matter is returned to the soil each year, mainly in the A horizon. Most of the soils contain between 1 and 2 percent organic matter in the A horizon; thus, between 30,000 and 60,000 pounds would accumulate in the upper 9 inches of the soils in 20 to 40 years if no decomposition occurred. There is no evidence to indicate that the organic-matter content of the soils is increasing. Consequently, it is assumed that micro-organisms cause the decomposition of the annual additions of organic matter.

Near Shingle Springs on some of the Rescue soils, there are extensive areas of brush. The soils in these areas are susceptible to erosion. The brush cover does not adequately protect the soil from erosion, because brush has few fine surface roots even though the overstory is thick. Also, grass does not grow well enough under brush to leave a residue. Consequently, erosion is active under the brush. Additions of organic matter to the soils therefore are low, and the relatively coarse roots probably account for a carbon-nitrogen ratio of 15 to 18 in comparison to less than 15 under grass.

Soils in the transition zone between areas of oak and grass and areas of coniferous forest have an A horizon that is somewhat thicker and is higher in content of organic matter than soils at lower elevations.

The soils that formed under coniferous forest have a mat of litter and duff from ½ inch to more than 6 inches thick. Such material is acid and contributes to the acidity of the soils. The roots of the trees follow cracks and fracture planes in the parent rock and help to alter the rocks. Roots in the upper 2 or 3 feet of the soil make up more than 20 percent of the total volume in places, and their growth and decomposition make the soil more porous. The Aiken, Musick, and Sites soils formed under forest and have a carbon-nitrogen ratio that exceeds 20.

Burning has also influenced the soils in many ways. Man and lightning are the main causes of fires. Repeated burning depletes the organic matter and thus influences the characteristics of the surface soil. Fire upsets the ecological balance, and different plant communities result. Thus, one of the soil-forming factors is altered by fire.

Time

The geologic age of the parent rock is not necessarily related to the age of the soils. None of the soils in the survey area show signs of being old. Because of slope, geologic erosion progresses at about the same rate as the soils form.

The oldest soils in the survey area are those in relatively undissected areas, and the youngest soils are those on narrow steep divides, on very steep slopes, or in other areas that are subject to erosion. The Aiken soils formed from remnants of the volcanic plain as tabular ridges and are considered to be the oldest soils. Younger soils formed in materials that were exposed after the volcanic plains were dissected or stripped away by erosion.

An example of the sequence of soil formation in the survey area is illustrated by the Maymen, Mariposa, Josephine, and Sites soils. The Maymen soils are on narrow ridge crests or adjacent steep slopes. These soils are very shallow to shallow over hard bedrock and lack a B2t horizon. The Mariposa soils are on broader divides and less erodible side slopes than Maymen soils. They are shallow to moderately deep and have a weak B2t horizon. The Josephine soils are on long, stable slopes or lower, gently sloping divides. They are deep and have a distinct B2t horizon of clay loam. The Sites soils are in the most stable positions on the landscape and have a B2t horizon of red clay. Some of the differences in the accumulation of silicate clays in these soils, however, may be related to the degree of weatherability of the stratified parent rock.

Morphology of the Soils

Because the influence of the soil-forming factors varies greatly within the survey area, many different kinds of soil have formed. Many soils in the area have several prominent horizons, some have only one horizon, and others have several faint horizons. Soils that have prominent horizons may occur adjacent to those that have less distinct horizons. The processes that have had the greatest influence in forming the different soil horizons are (1) weathering of parent materials, (2) accumulation of organic matter, (3) formation and translocation of clays, and (4) the influence of iron oxides.

Some of the distinguishing features of the soils formed from bedrock are related to the degree of weathering of the parent material. For example, where weathering has been slight, the soils have few horizons and generally have distinguishing features that come from their parent material. The soils of the Whiterock series are slightly weathered. They have thin, indistinct horizons, and their pale color, silt loam texture, and strongly acid reaction are related to the underlying Mariposa slates. As weathering increases, horizon differences are less directly related to the parent material but are products of alteration. The deep Aiken soils have a subsoil of red clay, and their horizons contrast strongly with the underlying brownish-yellowish andesitic conglomerate.

In all soils of the survey area, enough organic matter has accumulated on the surface to form an A1 horizon. This horizon ranges from thin, faint, and pale in color to thick, distinct, and dark in color. At the lower elevations the soils have an A1 horizon that is about 3 to 8 inches thick and contains about 2 percent or less organic matter. Organic matter does not accumulate in large quantities, because of warm temperatures. In the eastern part of the survey area, cooler temperatures and higher rainfall prevail and the A1 horizon is thicker, darker, and higher in content of organic matter. The Aiken soils have a thick, dark A1 horizon that has about 6 percent organic matter in the upper 15 inches.

The translocation of silicate clay minerals has taken place in many soils in the Area. The clay films on ped faces and in root channels, as well as colloidal bridges between the sand grains, indicate the movement of clay minerals from the A horizon to the B2t horizon. The Auburn soils have little or no translocated clay. The Musick soils have large amounts of translocated clay, and there is 20 percent more clay in the B2t horizon than in the A1 horizon. Evidence of clay movement is the many, moderately thick, continuous clay films in the Bt horizon.

Iron affects the color of many soils. In well-drained soils, iron is oxidized and produces yellow and red colors. Where the iron has been translocated in the profile, the colors are more intense, as in the Aiken, Musick, and Sites soils. The translocation of iron is greatest in soils at elevations of 2,000 to 4,000 feet. Here, the temperatures favor a high degree of weathering, and a considerable amount of water percolates through the soil. Forest litter on the surface produces organic acids that help to release iron from downward migration. This increase is indicated in the redder color of the B2t horizon in such soils as the Aiken and Sites soils. The reduction of iron is not an important process in the area, but it does take place in such poorly drained soils as Rescue clay, clayey variant. This gives rise to black, gray, and blue-green colors. This process is called gleying.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*18*) and was later revised. The system currently used was adopted by the National Cooperative Soil Survey in 1965 (*20*). It is under continual study (*15*).

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 8 shows the classification of each soil series of the El Dorado Area by family, subgroup, and order, according to the current system. The classes in the current system are briefly described in the following paragraphs. Following these descriptions, the soil orders represented in the El Dorado Area are discussed.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. The exceptions, Entisols and Histosols, occur in many different climates. Five soil orders are represented in the survey area—Alfisols, Entisols, Inceptisols, Mollisols, and Ultisols.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders have a narrower climatic range than the orders. The criteria for suborders chiefly reflect the presence or absence of waterlogging or soil differences that result from the climate or vegetation.

GREAT GROUP: Each suborder is divided into great groups according to the presence or absence of genetic horizons and the arrangement of these horizons.

SUBGROUP: Each great group is subdivided into subgroups. One of these subgroups represents the central (typic) segment of the great group, and the others, called intergrades, contain those soils that have properties of soils in another group, suborder, or order.

FAMILY: Each subgroup is divided into families, primarily on the basis of properties important to the growth of plants. Among the properties considered are texture, mineralogy, reaction, soil temperature, and thickness of horizons.

SERIES: The series consists of a group of soils that formed from a particular kind of parent material and that have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, consistence, reaction, and mineralogical and chemical composition.

Soil orders in the area

Five soil orders are represented in the survey area—Alfisols, Entisols, Inceptisols, Mollisols, and Ultisols. These soil orders are discussed in the following paragraphs.

Alfisols are soils that lack a mollic epipedon and have an argillic horizon. These soils have base saturation greater than 35 percent at a depth of 50 inches below the top of the argillic horizon or in the subhorizon above a lithic contact. All the Alifisols in this survey area are seasonally dry for 60 consecutive days or more in most years except for the Argonaut series, seeped variant. None of these soils has a 15 percent clay increase within 1 inch of the upper boundary of the argillic horizon. Many of the Alfisols in the survey area have some properties that are similar to those of Mollisols and Ultisols.

The Ahwahnee, Argonaut, Delpiedra, Perkins, Rescue, and Sobrante soils and the Perkins soils, moderately deep variant, have an argillic horizon with a base saturation of 75 percent or more and an ochric epipedon with a moist color value of 3.5 or darker, and they have more than 1.2 percent organic matter in the upper 4 inches of the surface layer. Laboratory data for the Rescue soils are given in the table in the section "Laboratory Analyses." These data show that the organic carbon in the upper 4 inches of the surface layer is high enough to be equivalent to more than 1 percent organic matter. All of these soils are classified in the subgroup Mollic Haploxeralfs, but they differ at the family level. The Ahwahnee soils have a coarse-loamy argillic horizon. The Argonaut and Perkins soils have a

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Ahwahnee	Coarse-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols.
Aiken	Clayey, kaolinitic, mesic	Xeric Palehumults	Ultisols.
Argonaut	Fine, mixed, thermic	Mollic Haploxeralfs	Alfisols.
Argonaut, seeped variant.	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Auberry	Fine-loamy, mixed, thermic	Ultic Haploxeralfs	Alfisols.
Auburn	Loamy, mixed, thermic	Ruptic-Lithic Xerochrepts	Inceptisols.
Auburn, heavy subsoil variant.	Loamy-skeletal, mixed, thermic	Ruptic-Lithic-Xerochreptic Haploxeralfs.	Alfisols.
Boomer	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols.
Chaix	Coarse-loamy, mixed, mesic	Dystric Xerochrepts	Inceptisols.
Chawanakee	Loamy, mixed, mesic, shallow	Dystric Xerochrepts	Inceptisols.
Cohasset	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols.
Crozier	Fine-loamy, mixed, mesic	Xeric Haplohumults	Ultisols.
Delpiedra	Loamy, serpentinitic, thermic, shallow	Mollic Haploxeralfs	Alfisols.
Diamond Springs	Fine-loamy, mixed, mesic	Typic Haploxerults	Ultisols.
Diamond Springs, grayish subsoil variant.	Ashy, mesic	Typic Vitrandepts	Inceptisols.
Holland	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols.
Horseshoe	Fine-loamy, mixed, mesic	Xeric Haplohumults	Ultisols.
Hotaw	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols.
Iron Mountain	Loamy, mixed, mesic	Lithic Ultic Haploxerolls	Mollisols.
Josephine	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols.
Mariposa	Fine-loamy, mixed, mesic	Ruptic-Lithic-Xerochreptic Haploxerults.	Ultisols.
Maymen	Loamy, mixed, mesic	Dystric Lithic Xerochrepts	Inceptisols.
McCarthy	Loamy-skeletal, mixed, mesic	Dystric Xerochrepts	Inceptisols.
Musick	Clayey, kaolinitic, mesic	Ultic Haploxeralfs	Alfisols.
Perkins	Fine, mixed, thermic	Mollic Haploxeralfs	Alfisols.
Perkins, moderately deep variant.	Loamy-skeletal, mixed, thermic	Mollic Haploxeralfs	Alfisols.
Rescue	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols.
Rescue, clayey variant.	Fine, montmorillonitic, noncalcareous, thermic	Typic Haplaquolls	Mollisols.
Shaver	Coarse-loamy, mixed, mesic	Pachic Ultic Haploxerolls	Mollisols.
Sierra	Fine-loamy, mixed, thermic	Ultic Haploxeralfs	Alfisols.
Sites	Clayey, kaolinitic, mesic	Xeric Haplohumults	Ultisols.
Sobrante	Fine-loamy. mixed, thermic	Mollic Haploxeralfs	Alfisols.
Whiterock	Loamy, mixed, acid, thermic	Lithic Xerorthents	Entisols.

fine argillic horizon. The Delpiedra soils have a loamy argillic horizon and are serpentinitic. The Rescue and Sobrante soils have a fine-loamy argillic horizon. The Perkins soils, moderately deep variant, have more than 35 percent gravel, by volume, in the argillic horizon and are considered to be loamy-skeletal.

The Auberry, Boomer, Cohasset, Josephine, Musick, and Sierra soils have an ochric epipedon and an argillic horizon with a base saturation of less than 75 percent in some part. The Boomer soils have a base saturation of less than 75 percent in the upper part of the argillic horizon. All of these soils are classified in the subgroup Ultic Haploxeralfs, but they differ at the family level. They all have a fine-loamy argillic horizon. The Auberry and Sierra soils are in the thermic temperature zone, the Boomer, Cohasset, Josephine, and Musick soils are in the mesic temperature zone.

The Holland and Hotaw soils are also classified as Ultic Haploxeralfs. They differ from Auberry, Boomer, and Sierra soils in having an umbric epipedon instead of an ochric epipedon. The Holland and Hotaw soils differ at the series level.

The Auburn series, heavy subsoil variant, has an ochric epipedon and an argillic horizon that is interrupted by bedrock and also contains more than 35 percent coarse fragments. These soils are classified in the subgroup Ruptic-Lithic-Xerochreptic Haploxeralfs.

The Argonaut series, seeped variant, is never dry for 60 consecutive days. These soils have an ochric epipedon and an argillic horizon. They are classified in the subgroup Typic Hapludalfs.

Entisols are soils without natural genetic horizons. They are generally recently formed, so that not enough time has elapsed to form soil horizons, or they formed in materials that are resistant to weathering. The Entisols have few morphological features.

The Whiterock soils are shallow gravelly silt loams that formed on hard metasedimentary rock. They have an ochric epipedon and lithic contacts of hard metasedimentary rock within 12 inches of the surface. They are seasonally dry for 60 consecutive days or more in most years. The Whiterock soils are classified in the subgroup Lithic Xerorthents.

Inceptisols are soils that have one or more diagnostic horizons that formed in the early stages of weathering. They do not have significant eluviation or illuviation. Except for darkening of the epipedon, they lack prominent morphological features. The conductivity of the saturated extract is less than 1 millimho at 25° C.

The Auburn, Chaix, Chawanakee, Maymen, and Mc-

Carthy soils and the Diamond Springs soils, grayish subsoil variant, are Inceptisols. All of these soils are seasonally dry for 60 consecutive days or more in most years.

The Auburn soils are shallow silt loams that formed on hard metabasic rock. They have a pale ochric epipedon and a redder cambic horizon. The cambic horizon is interrupted by ledges of bedrock. There also is a lithic contact to hard rock within 12 to 26 inches of the surface. The Auburn soils are classified in the subgroup Ruptic-Lithic Xerochrepts.

The Chaix soils are moderately deep coarse sandy loams that formed in material weathered from granitic rocks. They have an ochric epipedon and a cambic horizon. The base saturation is less than 60 percent within 30 inches of the surface. The Chaix soils are classified in the subgroup Dystric Xerochrepts.

The Chawanakee soils are similar to the Chaix soils, but they differ in being shallow to weathered granitic rock. They have a paralithic contact at a depth of 10 to 24 inches. The Chawanakee soils also are classified in the subgroup Dystric Xerochrepts.

The Diamond Springs soils, grayish subsoil variant, are deep gravelly loams that formed in material weathered from rhyolitic tuff. They have an ochric epipedon, a cambic horizon, and more than 60 percent vitric volcanic ash or other vitric pyroclastic material in the silt, sand, and gravel fractions. These soils are classified in the subgroup Typic Vitrandepts.

The Maymen soils are shallow gravelly loams that formed in material weathered from hard metasedimentary rock. They have an ochric epipedon, a cambic horizon, and lithic contacts within 6 to 16 inches of the surface. The base saturation also is less than 60 percent. The Maymen soils are classified in the subgroup Dystric Lithic Xerochrepts.

The McCarthy soils are moderately deep cobbly loams that formed on andesitic rock. They have a dark-colored surface layer that is less than 10 inches thick and a cambic horizon. The base saturation also is less than 60 percent within 30 inches of the surface. The McCarthy soils are classified in the subgroup Dystric Xerochrepts.

Mollisols are soils that have a soft to slightly hard, dark-colored surface horizon that has more than 1 percent organic matter and more than 50 percent base saturation. This dark-colored surface horizon is called a mollic epipedon.

The Iron Mountain and Shaver soils and the Rescue soils, clayey variant, are classified as Mollisols. The Iron Mountain and Shaver soils are seasonally dry for 60 consecutive days or more in most years. The Rescue soils, clayey variant, are saturated with water for a part of the year and show characteristics of wetness.

The Iron Mountain soils are shallow soils that formed in material weathered from hard volcanic breccia. They have a mollic epipedon that lies abruptly on lithic contacts within 5 to 20 inches of the surface. They have a base saturation of less than 75 percent above the lithic contact. The Iron Mountain soils are classified in the subgroup Lithic Ultic Haploxerolls.

The Rescue soils, clayey variant, are deep, wet, fine-textured soils that formed in material weathered from basic rock. They have a mollic epipedon and lack an argillic horizon. They are classified in the subgroup Typic Haplaquolls.

The Shaver soils are deep coarse sandy loams that formed in material weathered from granitic rock. They have a mollic epipedon that is more than 20 inches thick, a cambic horizon, and a base saturation of less than 75 percent throughout the upper 30 inches of the soil. The Shaver soils are classified in the subgroup Pachic Ultic Haploxerolls.

Ultisols are highly weathered soils that formed under a humid climate. They all have an argillic horizon. The base saturation is less than 35 percent at a depth of 50 inches below the top of the argillic horizon. In the survey area, all Ultisols are seasonally dry for 60 consecutive days or more in summer between depths of 7 and 20 inches in most years.

The Aiken soils are considered to be the oldest soils in the survey area. They have a thick, dark umbric epipedon. They have an argillic horizon that is more than 50 inches thick, they have less than 10 percent weatherable minerals in the 20- to 200-micron fraction in the upper 40 inches of the argillic horizon, and they have more than 1.5 percent organic matter in the upper 6 inches of the argillic horizon. The Aiken soils are classified in the subgroup Xeric Palehumults.

The Crozier soils formed in parent material similar to that in which the Aiken soils formed, but they are not so weathered. They have an umbic epipedon and an argillic horizon that is more than 1.5 percent organic matter in the upper 6 inches, but they have more than 10 percent weatherable minerals in the 20- to 200-micron fraction in the upper 40 inches and are less than 50 inches thick. The Crozier soils are classified in the subgroup Xeric Haplohumults. The soils differ at the series level.

The Horseshoe and Sites soils also are classified in the subgroup Xeric Haplohumults. Their epipedon is variable. Sites soils have an umbric epipedon. Horseshoe soils have an ochric epipedon because it is too thin to be umbric. The argillic horizon has more than 1.5 percent organic matter in the upper 6 inches, is thicker than 50 inches, and has more than 10 percent weatherable minerals of the 20- to 200-micron fraction in the upper 40 inches. These soils differ at the family and series level. The Horseshoe soils have a fine-loamy argillic horizon. The Sites soils have a clayey, kaolinitic argillic horizon.

The Diamond Springs and Mariposa soils have less than 1.5 percent organic matter in the upper 6 inches of the argillic horizon. The Diamond Springs soils are classified in the subgroup Typic Haploxerults. The Mariposa soils have an argillic horizon that is interrupted by ledges of bedrock. They are classified in the subgroup Ruptic-Lithic-Xerochreptic Haploxerults.

Laboratory Analyses

Three of the important soils in the El Dorado Area were sampled for laboratory analyses, and the data are presented in table 9. Each soil was sampled at two places, but only the modal profile for the survey area is given in the table. Additional laboratory analyses on the Ahwahnee, Aiken, Argonaut, Auburn, Josephine, Mariposa, Musick, Sierra, and Sites soils can be found in the soil survey of the Amador Area, California (*21*).

The methods and procedures used to obtain the laboratory analyses reported are as follows: All samples were collected from pits. Fragments larger than 1 inch were discarded. Samples were air dried, crushed with a rubber-tipped pestle, and then screened through a 2-millimeter, round-holed sieve. After they had been rubbed relatively clean, the coarse fragments larger than 2-millimeters in diameter were weighed to determine the percentage of gravel and were then discarded. The material that passed through the sieve was thoroughly mixed, and subsamples of this were used for the laboratory analyses. Methods used in obtaining the data are described in the paragraphs that follow. All results in table 9 are expressed on an ovendry basis.

Particle-size distribution.—Separation of particles into size classes and ranges of diameters for data on particle-size distribution were made by pipette and sieve analyses. After treatment of the sample to remove organic matter and soluble salts, particles were dispersed with sodium hexametaphosphate and mechanical shaking (*8*, *9*).

Reaction.—Soil reaction, expressed in pH value, was obtained by glass electrode pH meter using 1 : 1 soil-water and soil-potassium chloride saturated pastes (*11*, *14*).

Organic carbon.—The percentage of organic carbon was determined by acid-dichromate digestion and ferrous sulfate titration, a modification of the Walkley-Black method (*11*).

C/N ratio.—The C/N ratio was determined by dividing the percentage of organic carbon by the percentage of nitrogen (*3*).

Free iron oxide.—The percentage of free iron oxide was determined by the dithonite reduction method (*7*).

Bulk density.—Bulk density, expressed in grams per cubic centimeter, was determined on core samples of the size of 4.7 by 3.5 centimeters. The samples were taken with the Salinity Laboratory modified Uhland core samples (*14*). The bulk density is presumed to be equal to the horizon density at field moisture.

Moisture retention.—Moisture retained at a tension of 15 atmospheres was determined by using the pressure membrane apparatus on the fragmented samples (*22*). Moisture retained at 15 atmospheres pressure corresponds fairly closely to the permanent wilting point.

Cation exchange capacity.—The cation exchange capacity was determined by saturating the samples with sodium by mixing the samples with a solution of sodium acetate. The amount of exchangeable sodium displaced by ammonium acetate extraction represents the cation exchange capacity. The exchangeable sodium was determined by flame analysis (*6*).

Extractable cations.—The extractable cations, calcium, magnesium, sodium, and potassium, were extracted with neutral, normal ammonium acetate. Calcium was precipitated as an oxalate and titrated, magnesium was determined gravimetrically as magnesium pyrophosphate, and sodium and potassium were analyzed by flame photometer. Extractable acidity, or exchangeable hydrogen, was displaced from the soil with triethanolamine and barium chloride at pH 8.2 (*11*, *22*).

Base saturation.—The percent base saturation (table 9) was determined by dividing the sum of the extractable bases by the cation exchange capacity and multiplying the result by one hundred.

General Nature of the Area

This section describes the physiography, relief, and drainage and the geology and geomorphic history of the survey area. It also gives some important facts about the development, water supply, and climate.

Physiography, Relief, and Drainage

The El Dorado Area is in the western part of the Central Sierra Nevada. It is dominated by steeply dipping, faulted and folded metamorphic rocks that have been intruded by several types of igneous rocks. Overlying the bedrock in many places are mantles of river gravel and volcanic debris.

The ascent from the Central Valley is gentle, and the average slope through a west-to-east transect is about 5 percent. In general, the trend of the ridges and rock formations is northwest by southeast. Drainage is generally toward the southwest, and the drainage channels have cut through geologic formations and followed the westward tilting of the Sierran fault block. The headward parts of the major streams and rivers are more deeply gouged by river canyons and drainageways than the rolling foothills, where river cutting is less. Typically, the folded and faulted areas of metamorphic rocks are steep and angular, the granitic areas are rounded and smooth and have a basin-like apearance, and the volcanic areas are flat topped and smooth.

The survey area is drained mainly by the Middle and South Forks of the American River and the Cosumnes River. These rivers join the Sacramento River in Sacramento County and flow into the San Francisco Bay. There are many major perennial streams in these major drainage areas.

Geology and Geomorphic History

The El Dorado Area is in the Sierra Nevada geomorphic province. It is on the western slope of the Sierra Nevada. Early in geologic time, in the late Paleozoic period, this area was covered by a vast inland sea in which large amounts of various kinds of sediments were deposited (*4*). The sediments of this sea were uplifted and folded to form the metamorphic rocks of the Calaveras Group.

Later, in the Late Jurassic period, the sea advanced over the Area again. Sediments and volcanic rocks were deposited in this sea. These sediments formed the Amador Group. The fine-grained marine deposits that followed formed the Mariposa Formation. Intense folding and metamorphism followed the retreat of the sea again. As a result, nearly continuous belts of vertically tilted rocks with ridges that extend generally northwestward were formed. The fine-grained sedimentary rocks were changed to slate; the siliceous sediments to quartzites and metacherts; the volcanic rocks to amphibolite schists and greenstone; and the calcareous ooze to crystalline limestone.

The Area was then intruded by ultrabasic rocks, most of which were altered to serpentine. Soon thereafter a sequence of granitic-type rocks was emplaced on a major scale, beginning with the more basic gabbrodiorite and followed by the more acid granodiorite. During all that time, the survey area sloped more gently westward than

TABLE 9.—*Laboratory analyses*

[Analyses by Soil Survey

Soil and sample number	Depth	Horizon	Particle-size distribution							
			Very coarse sand (2.0–0.1 mm.)	Coarse sand (1.0–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	0.2–0.02 mm.
	Inches		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Boomer gravelly loam: S61-Calif-9-3.	0–5	A1	6.9	14.1	5.7	9.0	5.1	39.4	19.8	23.0
	5–13	A3	5.0	11.8	4.9	8.5	5.4	39.5	24.9	22.4
	13–24	B21t	5.1	13.5	5.1	7.6	4.3	31.4	33.0	18.4
	24–37	B22t	10.7	22.7	6.2	7.9	3.9	20.2	28.4	14.8
	37–52	B31t	19.6	21.0	4.9	5.3	2.8	20.4	26.0	10.6
Holland coarse sandy loam: S61-Calif-9-5.	0–2	A11	7.6	19.6	9.2	18.4	7.6	26.4	11.2	28.2
	2–10	A12	7.0	18.5	8.5	20.0	8.2	25.4	12.4	28.5
	10–21	B1	4.5	19.5	8.2	19.3	8.0	25.1	15.4	27.5
	21–30	B21t	6.3	17.7	6.8	16.6	6.8	24.1	21.7	24.4
	30–36	B22t	5.1	17.6	7.5	17.1	6.5	21.7	24.5	22.5
	36–45	B3t	6.2	18.7	8.8	18.6	7.2	20.4	20.1	23.8
	45–54	C1	8.8	21.3	10.6	20.7	7.3	17.7	13.6	24.4
Rescue sandy loam: S61-Calif-9-1.	0–5	A1	6.8	16.1	8.1	16.1	9.0	29.8	14.1	29.1
	5–10	A3	7.7	16.2	8.4	15.0	8.5	29.1	15.1	27.3
	10–14	B1t	9.2	18.6	6.8	12.0	7.4	25.7	20.3	21.8
	14–26	B2t	9.4	12.1	4.2	13.3	8.6	21.3	31.1	23.6
	26–34	B3t	10.1	10.6	5.9	21.1	11.7	20.4	20.2	31.6
	34–55	C1	13.9	13.8	7.6	25.0	12.2	17.3	10.2	35.5
	55–66	C2	23.0	14.8	7.2	24.5	11.0	15.2	4.3	33.4

it does today, although the crest of the Sierra Nevada was approximately in its present location. Then the surface of the folded sedimentary and volcanic rocks was lowered throughout a long period of erosion. Large areas of the granitic batholith were exposed.

The volcanic activity began in the Sierra Nevada in the late Eocene period. Rhyolitic ash fell at the lower elevations, and at the higher elevations both flows and ash falls were deposited. These ash falls and flows formed the Valley Springs Formation. This choked the stream channels, and the drainage system was completely changed. Following the rhyolitic emissions, the volcanoes began to discharge andesitic materials, mostly mudflows, dust, and some lava flows. These flows formed the Mehrten Formation. A volcanic plain was formed that again choked the streams, and new drainageways were formed. The Logtown Ridge, from the Amador County line to near Placerville, blocked the westward movement of the andesitic material. East of the Logtown Ridge, only the prominent peaks remained as islands above the volcanic plain. The geologic activity of this time marked the beginning of the present landforms and had a strong influence in forming the soil patterns of the survey area (*12*).

In early Pleistocene times, there was a major uplift of the Sierra Nevada. This was caused by faulting along the eastern flank of the mountains. The western slope was uniformly tilted upwards. The west-flowing rivers and streams in the newly uplifted area removed much of volcanic debris and cut deep canyons into the underlying material. This left long, tabular volcanic ridges and exposed Tertiary river gravel, rhyolitic tuff, and granitic and metamorphic rocks.

Development

In 1848 gold was discovered on the South Fork of the American River at Coloma, California. News of this discovery started the Gold Rush, which was probably the most rapid migration of a large number of people in the history of this country. Previously, the Sierra Nevada foothills had been unattractive to settlers and had been entered only by hunters, trappers, and a transcontinental expedition or two.

The Gold Rush marked the beginning of settlement and development in and around Placerville. Gold was the first desire of the new arrivals; few thought of other occupations. Poor transportation facilities and high prices for even the simpler necessities, however, soon led an increasing number of individuals to engage in farming and lumbering. With the passage of the years, these two occupations became more and more important.

By 1863, more acres of land were under cultivation in El Dorado County than have been at any time since. A large additional acreage also was used for hay and forage for livestock. It was not until 1883 that fruit production became important, at which time the area around Placerville was described as one continuous orchard.

Livestock generally continued a steady rise (*25*). Growing of grain decreased in the early 1920's. The trend then was away from general ranching and toward fruit grow-

of three representative soils

Laboratory, Riverside, California]

Particle-size distribution—Continued		Reaction		Organic carbon	Nitrogen	C/N ratio	Free iron oxide	Bulk density	Moisture held at tension of 15 atmospheres	Cation exchange capacity (Na)	Extractable cations (Meq. per 100 grams of soil)					Base saturation
0.02–0.002 mm.	Coarse fragments (greater than 2 mm.)	Water (1:1 ratio)	KCl (1:1 ratio)								Ca	Mg	H	Na	K	
Percent	*Percent*	*pH*	*pH*	*Percent*	*Percent*		*Percent*	*Gm./cc.*	*Percent*							*Percent*
26.5	26	6.6	5.4	2.52	0.137	18.4	7.6	1.28	12.8	26.9	11.9	6.1	8.2	0.2	0.9	70
27.4	21	6.2	4.7	.99	.056	17.7	8.5	1.37	13.2	20.4	9.7	6.0	9.1	.2	.6	65
21.4	31	5.9	4.4	.60	.036	16.7	8.7	1.47	16.8	27.7	11.7	7.1	8.7	.2	.3	69
13.6	40	5.8	4.0	.26	.015	------	6.2	1.53	16.9	36.0	7.2	12.6	7.7	.2	.2	72
15.4	64	6.1	4.1	.10	------	------	5.5	------	13.7	24.3	14.3	11.7	5.9	.2	.2	82
16.3	0	6.0	5.0	2.77	.203	13.6	.7	------	7.0	14.6	5.8	1.1	6.0	.2	.8	57
16.6	0	5.9	4.6	1.08	.085	12.7	.9	1.57	5.8	9.7	3.5	.8	5.4	.2	.7	49
16.6	0	6.0	4.5	.36	.033	10.9	1.1	1.54	6.8	9.1	3.1	1.0	3.9	.2	.4	55
16.0	0	6.1	4.6	.18	.019	------	1.5	1.80	9.9	11.5	4.5	1.8	3.8	.2	.3	64
15.4	0	6.3	4.7	.10	------	------	1.5	1.86	10.5	11.3	4.7	2.4	3.3	.2	.2	69
15.0	0	6.5	4.7	.07	------	------	1.0	1.89	10.6	11.9	4.8	2.6	2.5	.2	.1	76
12.5	0	6.6	4.7	.06	------	------	.5	------	7.8	9.1	4.7	2.3	2.0	.2	.1	79
19.3	8	6.4	5.0	1.21	.094	12.9	3.6	1.75	7.5	14.1	7.8	2.5	4.5	.1	.2	70
19.1	5	6.4	5.0	.77	.057	13.5	4.1	1.78	7.9	14.2	8.3	2.8	4.0	.2	.2	74
18.3	4	6.4	4.9	.41	.034	12.1	4.4	1.81	10.0	18.1	9.7	3.9	4.0	.2	.1	78
14.8	4	6.5	5.0	.26	.024	------	4.0	1.86	13.9	23.4	11.0	5.8	4.1	.2	.1	81
14.1	6	6.6	4.7	.14	------	------	2.3	1.98	10.7	19.6	8.7	5.0	3.0	.3	.1	83
9.9	6	6.6	4.5	.07	------	------	1.3	1.87	6.6	16.4	7.1	4.1	2.3	.2	.1	83
8.9	14	6.7	4.4	.02	------	------	.9	1.78	4.4	14.5	6.6	3.6	1.8	.2	.1	85

ing. A half century after the discovery of gold, a specialized one-crop system of farming, based on shipment of fresh pears and other deciduous fruits to eastern markets, was developing.

Prior to 1915, pears were packed on the ranches, but the Placerville Fruitgrowers Association, a cooperative, was formed in that year and greatly facilitated the packing and shipping of fruit. About 80 percent of the plantings of fruit trees are Bartlett pears.

The development of this Area as a fruit growing and shipping point was favored by several circumstances. During the height of gold mining, an extensive system of ditches was constructed to provide adequate supplies of water for the hydraulic, placer, and other mining operations. The system of ditches and the water rights were taken over by the orchardists, and these provided the irrigation used in the vicinity of Placerville, Coloma, Camino Ridge, Georgetown, Penobscot, Cool, and Pilot Hill. Since that time the Georgetown Divide Public Utility District and the Lotus-Coloma Ditch Company were formed, and the El Dorado Irrigation District took the place of the El Dorado Corporation and improved old facilities and constructed new ones.

The soils and the climate in the survey area are favorable for fruit production. The irregular relief of the western foothills of the Sierra Nevada provides unexcelled air drainage. The wide range in elevation, from about 1,500 feet in the western part to nearly 4,000 feet at Pollock Pines on Camino Ridge, provides a later and more extended marketing season and assures less competition from other producing areas. Adequate transportation facilities, both railroads and highways, permit the shipping of fruit to all parts of the country.

Water Supply [8]

Water development in the El Dorado Area began with the influx of people in the days of the Gold Rush. A long history of expenditures in time and money to bring water from available sources in mountain lakes and river bottoms for use on high ridges is shown in the minor ditches that even today provide a good part of the water used in the El Dorado Area. In the past 20 years, there has been a marked upswing in water resources development. At this time there is a temporary surplus of water available in the Area.

With the decline in gold mining at the turn of the century, water was used increasingly for farming. Mining ditches that served the more productive farmlands now provide water service to areas that have greater farming potential. Those systems that served areas of poorer potential are no longer used.

The American and Cosumnes Rivers generally divide the El Dorado Area for purposes of water service into the Georgetown Ridge, Placerville Ridge, and Somerset and Fair Play service areas in the Cosumnes River Basin. In each of these areas distance from existing distribution facilities is a major element that determines cost.

[8] By Harry Dunlop, manager, El Dorado Irrigation District.

The water service areas in the El Dorado Area are discussed in the following paragraphs.

Georgetown Ridge service area.—Water service in this area generally is provided by a public district, the Georgetown Divide Public Utility District. Recent construction of Stumpy Meadows Reservoir and enlargement of the district's canal system provide the Georgetown Ridge with a water supply that is greater than that presently used. Stumpy Meadows Reservoir has adequate water for double the present farm use on the Georgetown Ridge.

Placerville Ridge service area.—During World War II, and for about a decade after it, lack of water was a factor that limited farm production on the Placerville Ridge. Construction of the Sly Park Unit of the Central Valley Project in 1955 removed this limitation. The El Dorado Irrigation District provides most of the water service to farms in the Placerville Ridge area. Because of the availability of water from Sly Park, and because of limitations in the capacity of the distribution system, the district constructed a piped distribution system, which was completed in 1963. This district can now provide piped water service to a major part of Placerville Ridge west to Shingle Springs. Existing supplies from Sly Park and other sources are adequate to irrigate an additional 2,500 acres.

Somerset and Fair Play service areas (Cosumnes River Basin).—Water for irrigated farming generally is not available in this area. Water that is used for irrigation normally comes from irrigation reservoirs constructed on individual ranches. However, the entire Cosumnes River Basin has been the subject of an intensive study by the U.S. Bureau of Reclamation. It is anticipated that in due time facilities proposed in reports on the Cosumnes River Division will be constructed. This will provide water for irrigated farming in the Somerset and Fair Play service areas.

Areas outside the water districts have little water available for irrigation. The sources of water are springs, shallow wells, and small reservoirs. The supply of water in these areas is critical after a series of dry years.

Climate [9]

The El Dorado Area is an Area of abundant sunshine in summer, moderate to heavy precipitation in winter, and wide temperature ranges. The Area is subject to strong flows of marine air from the Pacific Ocean in winter, which result in heavy precipitation, particularly at intermediate levels in the mountains. At high elevations much of the precipitation falls as snow, providing a water supply that lasts into summer. Precipitation in summer is light and generally is limited to a few scattered thundershowers.

Temperatures range from very warm in summer near the Sacramento Valley to very cold in some of the high mountain areas during midwinter. All of the survey area experiences freezing temperatures at some time during the year.

The Sierra Nevada Range plays a dominant role in determining the climate of the El Dorado Area. Differences in elevation affect both temperatures and precipitation. On the western slopes of the mountains, precipitation tends to increase with elevation up to about 6,000 feet but decreases slowly above that level. Temperature also decreases with elevation, except that some of the valleys are cooler than the slopes above them at night because of cold-air drainage.

The average annual temperature in the El Dorado Area ranges from above 60° F. at the lower elevations to about 55° at the higher elevations toward the east. The average minimum temperatures in January decrease from about 36° at the lower elevations to about 30° at the higher elevations. Minimum temperatures are affected by local differences in the terrain. Placerville, which is at the bottom of a narrow valley, has a lowest temperature of 8°, while the Placerville Institute of Forest Genetics, which is on a nearby ridgetop, has a lowest temperature of 16°.

Average maximum temperatures in July are in the 90's, and they range from about 90° at the higher elevations to nearly 95° at the lower elevations. The highest temperatures recorded range from 107° to 114°.

The growing season, which is the interval between the last temperature of 32° or lower in spring and first in fall, ranges from 150 to 275 days. The average date of the last freezing temperature in spring is about the first of March at the lower elevations and about the last of April at the higher elevations. In fall the average date of the first freezing temperature ranges from the last of October in the cooler parts of the survey area to the first of December in the warmer parts. The growing season also is affected by local variations in terrain. The average length of the growing season is shown in figure 13.

Precipitation in the driest part of the survey area, the southwest corner, is about 23 inches. Precipitation at the upper end of the Area toward the east, on the other hand, averages about 50 inches per year (fig. 14).

[9] By ROBERT ELFORD, climatologist for California, National Weather Service, U.S. Department of Commerce.

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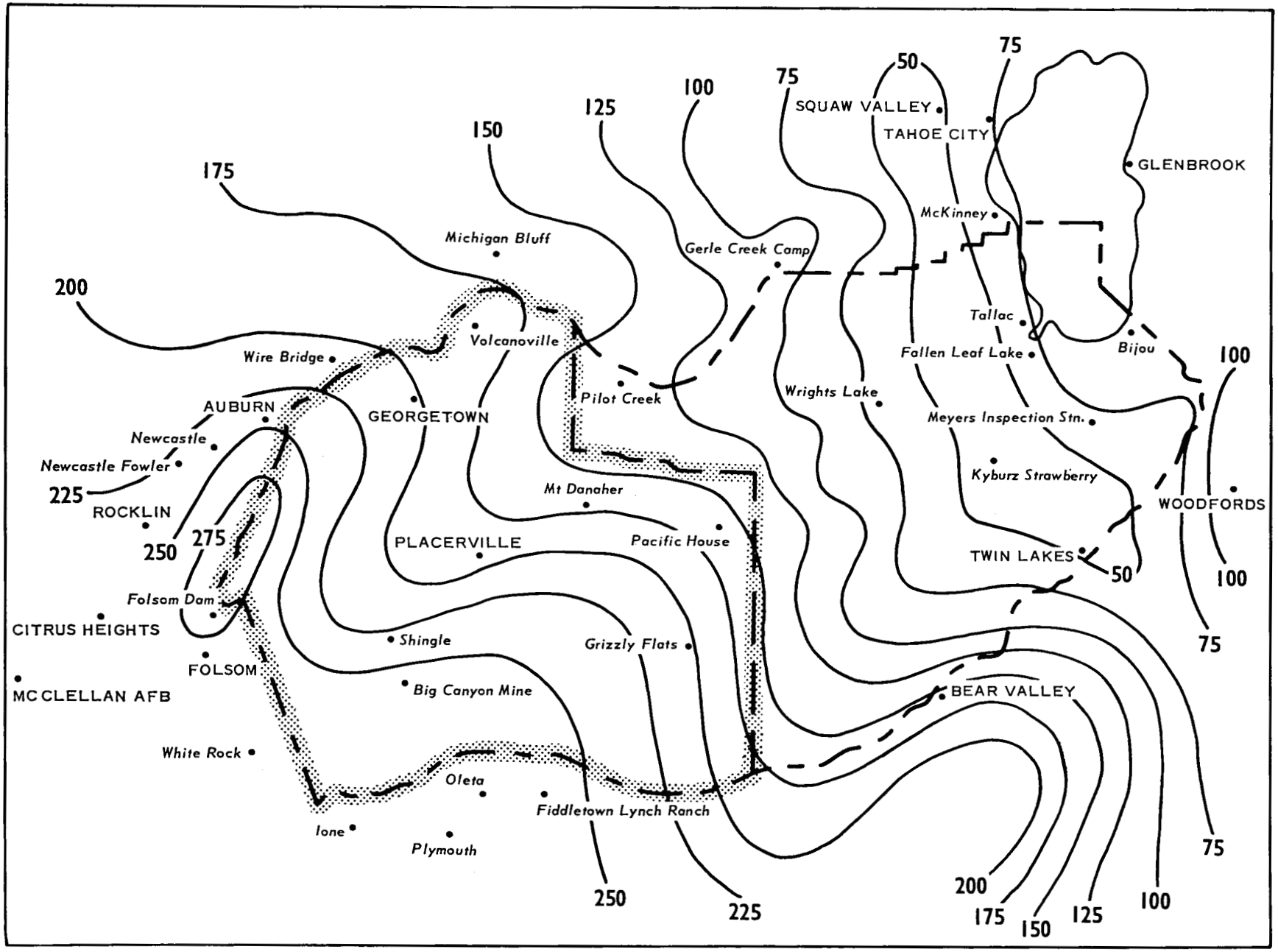

Figure 13.—Average length of growing season.

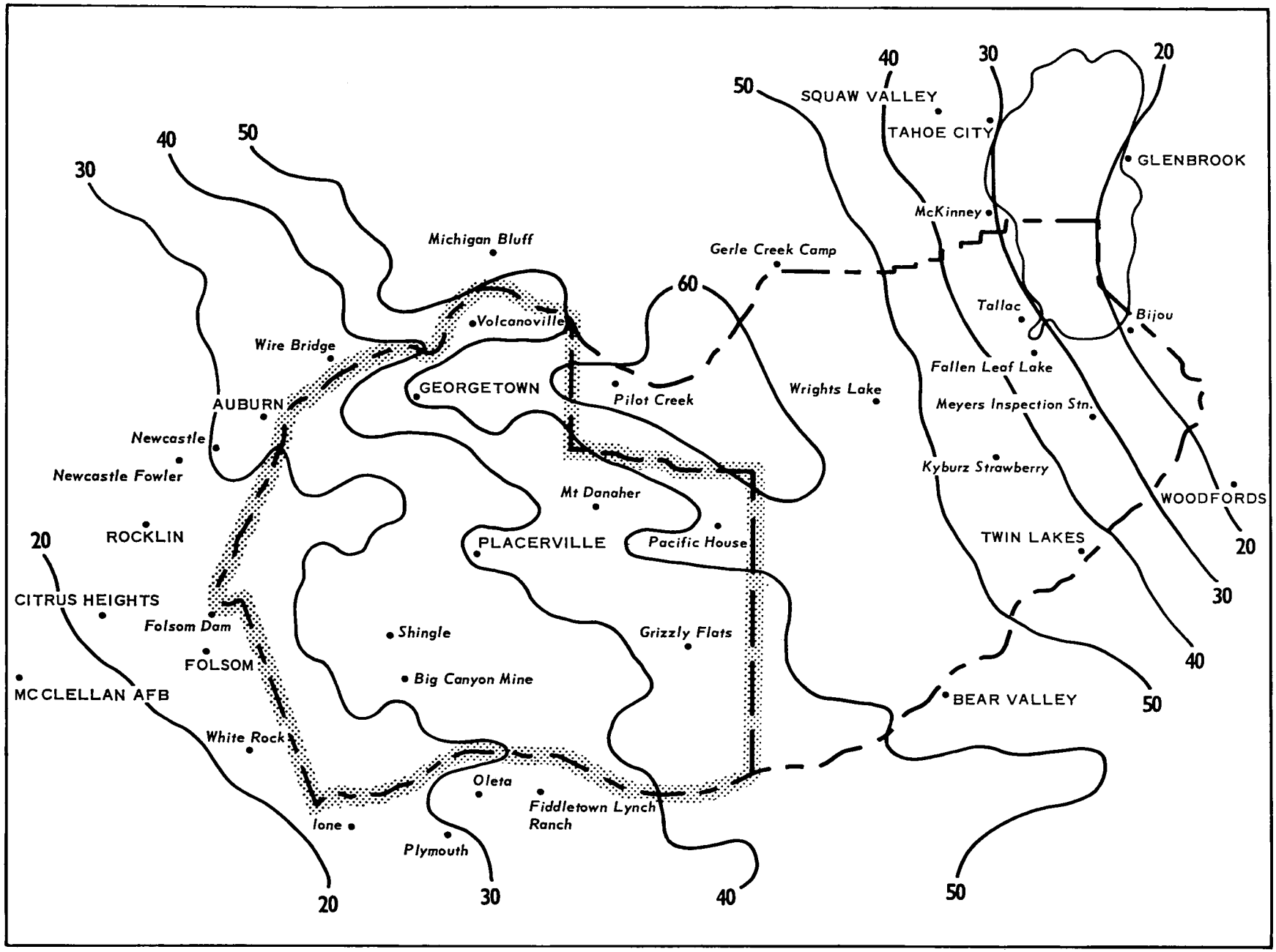

Figure 14.—**Average annual precipitation.**

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Glossary

Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where it flows out onto a level plain or meets a slower stream.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity (also termed available moisture holding capacity or available water holding capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregrate. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage, altered. Changes in drainage commonly as the result of reclamation through artificial drainage or irrigation, but also because of natural deepening of the stream channels, the filling of depressions, or from wetness caused by seepage from drainage ditches or irrigation channels.

Drainage, natural. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil. Opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized:

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in some soils commonly have mottlings at a depth below 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Effective rooting depth. Depth to a claypan, bedrock, or any other layer in the soil that would stop or would hinder the penetration of roots. It is the depth of soil readily penetrated by roots. Depth classes are: *Very deep*, more than 60 inches; *deep*, 40 to 60 inches; *moderately deep*, 20 to 40 inches; *shallow*, 10 to 20 inches; and *very shallow*, less than 10 inches.

Effervescence. The fizz observed when dilute hydrochloric acid is applied to a soil containing free carbonates. The amount of effervescence is divided into four classes—*very slightly ef-*

fervescent, slightly effervescent, strongly effervescent, and *violently effervescent.*

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and physical condition of the soil are favorable. For the purpose of this survey, fertility is based on the content of organic matter as follows: *Very low,* less than 0.6 percent; *low,* 0.6 to 1.2 percent, *moderate,* 1.2 to 2.0 percent; *high,* 2.0 to 4.0 percent; *very high,* more than 4.0 percent.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substances.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residue.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R horizon.—Consolidated rock beneath the soil. The rock generally underlies a C horizon but may be immediately beneath an A or B horizon.

Igneous rock. A rock produced by the cooling of melted mineral material, such as granite, andesite, diorite, and basalt.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation commonly used in this survey area are:

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Leaching. The removal of soluble materials from the soil by percolating water.

Leveling (of land). The reshaping, or modification of the soil surface to a planned grade to permit uniform distribution of irrigation water without erosion or to provide proper surface drainage.

Lime. Chemically, lime is calcium oxide, but as the term is commonly used, it is also calcium carbonate and calcium hydroxide. Agricultural lime refers to ground limestone, hydrated lime, or burned lime, with or without magnesium minerals.

Metamorphic rocks. Rocks of any origin that have been completely changed physically by pressure, heat, and movement. Such rocks are nearly always crystalline. Examples: Mica schist and serpentine.

Microrelief. Minor surface irregularities of the land, such as low mounds or pits.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils generally indicates poor aeration and lack of drainage.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are:

	Inches per hour
Very slow	Less than 0.06
Slow	0.06–0.20
Moderately slow	0.20–0.63
Moderate	0.63–2.00
Moderately rapid	2.00–6.30
Rapid	6.30–20.0
Very rapid	More than 20.0

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. In words, the degree of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. As a soil separate, the individual rock or mineral fragments in soils range from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be any mineral composition. As a soil textural class, soil material that contains 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. A rock largely composed of particles deposited from suspension in water. The chief sedimentary rocks are conglomerate, from gravel; sandstone, from sand; shale, from clay; and limestone, from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sands have been consolidated into sandstone.

Silt. As a soil separate, individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil material that is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil or layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to

flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

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