COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

Feasibility Report

JN 95191

October 2016

With December 2016 Erratum

Prepared By:

County of El Dorado

Community Development Agency - Transportation Division

Tahoe Engineering Unit

Errata Sheet for the Country Club Heights Erosion Control Project Feasibility Report CIP 95191.

The Country Club Heights Erosion Control Project Feasibility Report (Report) was released by El Dorado County (County) in October 2016 for public and agency review. Since that time the County has received both public and agency comments on the Report, held a public meeting on November 6, 2016, and have completed additional site visits. The Report has been updated to reflect the comments received. These updates do not substantially modify the analysis of the document, but instead identify additional problem areas and potential solutions. Changes to the text are noted with underline (for added text) or strikeout type (for deleted text).

Updates to the Report include:

- Section 3.5 (page 14) – updated text to reflect use of Bailey Land Capability data as opposed to Sinclair Land Capability data. Figure 7 (page 15) was updated to reflect this change as well.
- Figure 17 (page 28) – updated to include additional problem areas identified by the public and County maintenance. Includes:
    - Ponding issues on Tamoshanter Drive (near Meadowvale Drive), Meadowvale Drive (between Pebble Beach Drive and Thunderbird Drive), and Skyline Drive (at Elks Club Drive).
- Section 8.1 (page 42 and 43) – updated language regarding:
    - Alternatives for addressing existing gunite wall at the Meadowvale Drive location
    - Clarification of funding for resurfacing of Elks Club Drive.
- Figure 18 (page 45) – updated to reflect following changes:
    - Shorted new channels into the meadow system off of Boca Raton Drive to reflect that constructed improvements will be on parcel 033-22-305 and not on parcel 033-22-304.
    - Added channel to Tamoshanter Drive (at Meadowvale Drive)
    - Relocated proposed CSP Inlets from 1) Yqui Street to Skyline Drive at Elks Club Drive and 2) one on Thunderbird Drive to Meadowvale Drive (between Pebble Beach Drive and Thunderbird Drive).
    - The updates made will result in a net zero in terms of additional improvements
- Figure 19 (page 46) – updated to reflect the following changes:
    - Shorted new channels into the meadow system off of Boca Raton Drive to reflect that constructed improvements will be on parcel 033-22-305 and not on parcel 033-22-304.
    - Added channel to Tamoshanter Drive (at Meadowvale Drive)
    - Relocated proposed CSP Inlets from Cherry Hills Circle to Skyline Drive at Elks Club Drive The updates made will result in a net zero in terms of additional improvements
- Section 9.1 (page 53) – Updated Fundability discussion.
- Section 9.2 (page 54) – Updated to reflect current funding positions for both Alternatives.
- Appendix E – updated to include summary of comments received.

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1.0 Introduction

This Feasibility Report (Report) has been developed pursuant to the Storm Water Quality Improvement Committee (SWQIC) guidelines for erosion control projects (ECP) in the Lake Tahoe Basin and has been prepared by the County of El Dorado Community Development Agency, Transportation Division (Transportation). This Report includes an analysis of the existing conditions and an analysis of potential alternatives for the Country Club Heights Erosion Control Project (Project).

The Project is bounded by Highway 50 to the west, Southern Pines Drive, Crystal Air Drive, and Skyline Drive to the south, Crystal Air Drive and Elks Club Drive to the east, and the subdivision boundaries to the north (Figure 1). The Upper Truckee River traverses the northwest corner of the Project boundary. The Project is within the Tahoe Regional Planning Agency's (TRPA) Plan Area Statements 119 (Country Club Meadow) and 120 (Tahoe Paradise Meadowvale). The Project area is identified in TRPA's Environmental Improvement Project (EIP) list as project number 01.01.01.0021 (formally No. 189) and is located within the TRPA designated Priority 2 Watershed 44 (Upper Truckee River).

In 2011 Transportation requested and received a portion of the funds from the USFS necessary to develop the Planning, Environmental, and Preliminary Engineering documents. In 2013 Transportation requested and received Site Improvement funding from the USFS to construct improvements which will address the identified water quality issues within the Project area.

Runoff from the Project area is conveyed toward the Upper Truckee River which is tributary to Lake Tahoe. The partial connectivity between Lake Tahoe and the Project area results in a high to moderate potential to deliver fine sediment to Lake Tahoe. Implementation of this Project will augment the existing storm drain and infiltrating systems in order to better meet current ECP goals and objectives. The County is currently preparing an Initial Study to assess the Project's potential effects on the environment and significance of those effects.

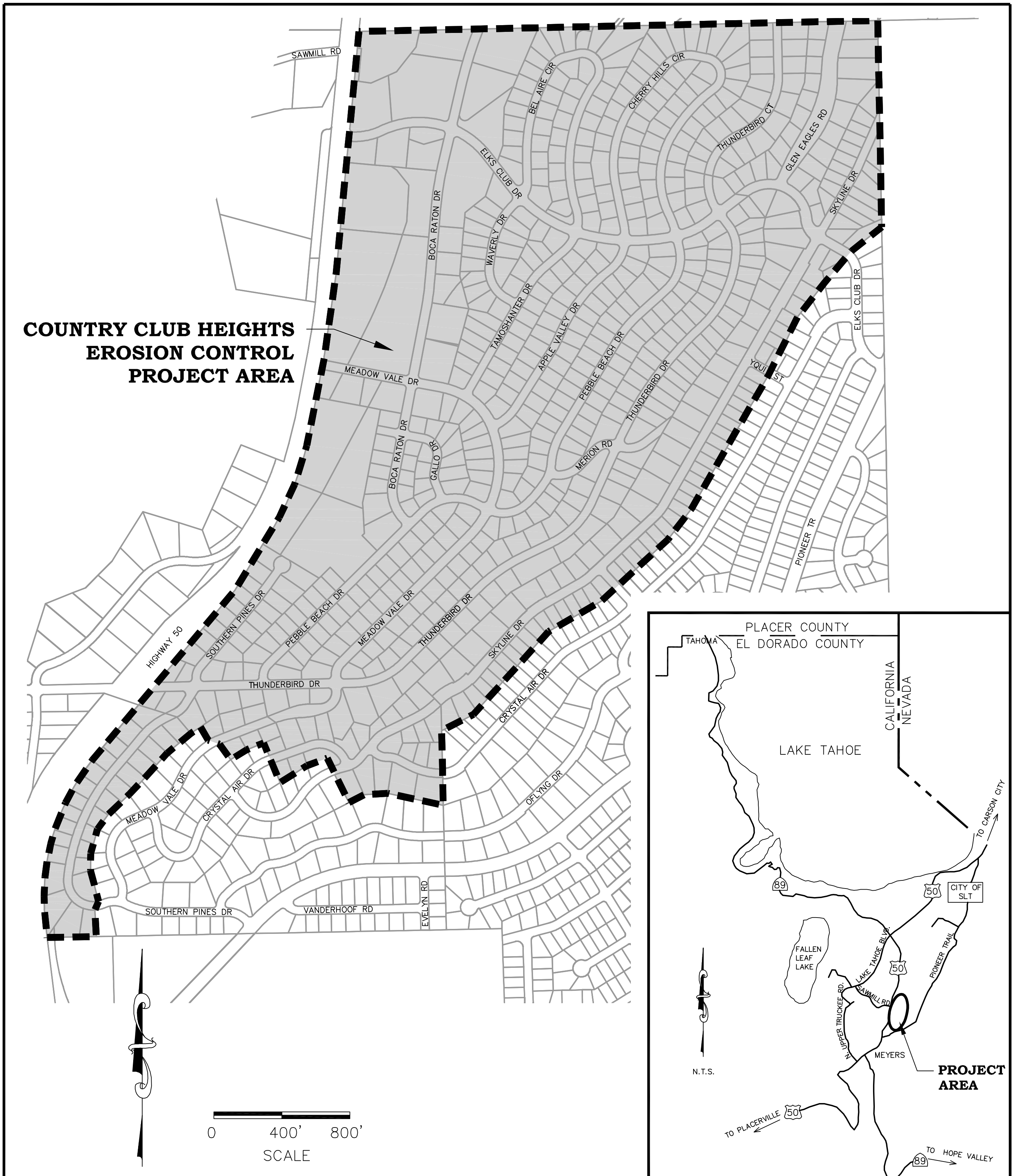
This Report will provide background on existing information concerning the Project area and provide an understanding of how Transportation identifies potential water quality, erosion control, and storm water hydrologic and pollution problems. Transportation utilized the CTC's Preferred Design Approach (PDA) guidelines,[1] the SWQIC process,[2] and the County of El Dorado Drainage Manual[3] to develop this Report.

2.0 Project Overview

The primary problems to be addressed with this Project are defined under CTC guideline categories as Source Control (SC), Hydrologic Design (HD), or Treatment (T). These categories include, but are not limited to, the following sub-categorically defined areas:

1. Untreated discharge of storm water runoff and snow melt via tributaries into Lake Tahoe.
2. Eroding cut slopes and roadside ditches along the County rights-of-way (ROW).
3. Sediment accumulation along roads with subsequent discharge into watercourses.
4. Poor surface runoff water quality.
5. Sediment migrating from private parcels to County ROW.

To discuss the Project and obtain agency and public input, a project development team (PDT) meeting with agency and utility company staff will be held in October 2016 and a request for public comment sent out shortly thereafter.



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

LOCATION MAP

FIGURE 1

DATE: 10/2016 | PROJECT NO.: 95191 | BY: ALD

2.1 Tahoe Basin Goals and Objectives

The five key milestones within the development of storm water and erosion control goals and objectives within recent Tahoe regulatory history include:

1. Pursuant to the requirements of Section 208 of the Clean Water Act, the TRPA prepared a Water Quality Management Plan (208 Plan) in 1978 for the Lake Tahoe Basin and revised the plan in 1988.[4] The 208 Plan identifies erosion, runoff, and disturbance resulting from development, such as subdivision roads, as primary causes of the decline of Lake Tahoe's water quality. The 208 Plan also mandates that capital improvement projects such as this Project be implemented to bring all County roads into compliance with Best Management Practices (BMPs) by the year 2008.
2. In the early 1980's, the Lahontan Regional Water Quality Control Board (Lahontan) adopted a Basin Plan that also mandated that BMPs be implemented within the Tahoe Basin to protect the water quality of Lake Tahoe and its tributaries (see Chapter 5 of the Basin Plan).
3. In 1987, the CTC completed a report entitled, "A Report on Soil Erosion Control Needs and Projects in the Basin," that further identified specific project areas for BMP retrofit.
4. In 1997, TRPA developed a Basin-wide EIP that defined various projects in need of BMP retrofits. This list of projects with assigned project numbers was also linked to the 1987 CTC Report.
5. In 2011 the Total Maximum Daily Load (TMDL) was adopted by Lahontan. One of the requirements of the TMDL is for local California jurisdictions within the Lake Tahoe Basin to take appropriate measures to decrease pollutant loading to Lake Tahoe from urbanized areas.

2.2 Project Goals and Objectives

The overall goal of this Project is to improve the water quality of runoff to Lake Tahoe and its tributaries by reducing erosion and sediment transport originating from the Country Club Heights Project Area.

The Project goals and extent could be expanded during the Project Development Process - Scoping Phase to accommodate the Project Development Team (PDT) endorsed Work Plan. The Project objectives represent physical conditions that can be measured to assess the success of the Project in achieving the Project goals. The Project will conform to the Preferred Design Approach as detailed in the SWQIC process.

The Project goals and objectives are as follows:

Goals		Objectives
1.	Reduce the amount of very fine inorganic sediment by 12%, fine inorganic sediment by 25%, and coarse inorganic sediment by 33% from the urbanized watershed bounded by the Project boundary or to the maximum extent practicable prior to discharging into Lake Tahoe. Very fine sediment is defined as	Stabilize eroding slopes with County approved slope stabilization (Source Control) BMPs; Stabilize eroding channels/ditches with County approved channel or road treatment source control BMPs; Utilize various County approved sediment trapping BMPs (CMP inlets,

	particles with a diameter of 20 microns or less (<20 µm), fine sediment is defined as particles which pass a #200 sieve (<74 µm), and coarse sediment is defined as particles retained on or greater than the #200 sieve (>74 µm).	infiltration, sediment basins, etc.) to capture sediment from impervious surfaces and eroding areas; Capture de-icing abrasives tracked in from local roads and highways to prevent discharge to watercourses; and, Define and increase the sweeping frequency within the ROW as funding and resources are available. Current County sweeping frequency is a minimum of once per year.
2.	Reduce the 25-year, 1-hour storm surface water volume from the urbanized watershed bounded by the Project boundary by 33% or to the maximum extent practicable prior to discharging into Lake Tahoe.	Utilize County ROW and publicly owned parcels to capture, store, and infiltrate a portion of the 25-year, 1-hour volume, which are at main discharge points within the watersheds; and, Utilize various County approved infiltration and storage BMPs prior to discharging into the Upper Truckee River.
3.	Reduce the 25-year, 1-hour storm surface water peak flow from the urbanized watershed bounded by the Project boundary by 33% or to the maximum extent practicable prior to discharging into Lake Tahoe.	Utilize County ROW and publicly owned parcels to detain, spread, and infiltrate the storm water within the watershed prior to discharging into the Upper Truckee River without violating drainage laws; and Utilize various storm water drainage systems, which increase the time of concentration and reduce the peak discharge to the main discharge points into Lake Tahoe.
4.	Complete a BMP Retrofit Watershed Master Plan which will include private BMP development as part of the Project Delivery Process (PDP). Achieve 25% participation with the private homeowners within the limits of the Project.	Utilize the TRPA Home Landscaping Guide for evaluating and developing BMP solutions for each driveway within the limits of the Project area; and Coordinate the private BMP's design within ROW with the Tahoe Resource Conservation District (TRCD)/Natural Resources Conservation District (NRCS).

2.3 Measures of Progress

TRPA is now using performance measures (PM) to monitor the effectiveness of the key thresholds associated with the Environmental Improvement Program (EIP). This Project (EIP

No. 01.01.01.0021) has two (2) separate performance measures with corresponding definitions:

5 - Miles of Road Treated

The amount of city, county, state, and federal roads that are retrofitted or obliterated to reduce stormwater pollution through capital improvements. Operations and maintenance activities are captured by other PMs. This PM is reported in three categories of treatment priority based on water quality risk. Treating high-priority roads reduces stormwater pollution and cost-effectively improves the clarity of Lake Tahoe.

6 - Miles of Street Sweeping

Miles of city, county, and state roads that are swept to reduce stormwater pollution during each EIP reporting year as part of regular operations and maintenance procedures. Capital stormwater infrastructure improvement activities are captured by other PMs. Sweeping streets reduces a major source of pollutants in stormwater runoff that flows to Lake Tahoe and works toward reducing clarity loss.

The performance measures for this Project are shown in Table 1.

Table 1 – Performance Measures

PM	PM Indicator	PM Unit of Benefit
5	Road Priority	Miles Retrofitted
6	Sweeper Type	Miles Swept

2.4 General Site Description

The Project is located in the south section of the Lake Tahoe Basin within portions of Sections 20, 21, 28, and 29, Township 12 North, Range 18 East, Mount Diablo Meridian.

The total Project area is approximately 270 acres and encompasses County of El Dorado ROW as well as County, CTC, USFS, and privately owned residential lots. Subdivisions within the Project area include Country Club Heights Unit Nos. 1, 2, 3, 4 and portions of Country Club Heights Unit No. 5 and Tahoe Paradise Unit No. 48. Improvements within the Project area include paved County roads ranging between approximate widths of 25-feet to 40-feet within ROW that varies in width between 50-feet to approximately 100-feet, unpaved roads, rock and concrete slope protection, timber and concrete block retaining walls, dike, storm drain systems, sediment basins, check dams, channels, and overhead and underground utilities. Portions of the paved County roads may not be centered within the ROW.

Within the Project area approximately 44% of the parcels are owned by the County, CTC, or the USFS. The majority of the privately owned parcels have been developed with single-family residences.

Urban development within the Project area resulted in concentrated storm water flows from the County ROW and developed parcels to be directed via dike, roadside ditch, and storm drain pipe toward the State ROW or onto forested open space prior to runoff reaching the Upper Truckee River. Infiltrating channels with rock check dams and vegetated detention basins were constructed as part of the 1987 Erosion Control Projects in the South Tahoe

Basin and the 1994 Southern Pines Drive S.E.Z. Restoration Project which provide additional water quality treatment as well as peak flow and volume reduction.

3.0 Existing Site Characteristics

3.1 Topography

As presented on Figure 2, the approximate elevation range of the Project area is 273 feet (from 6,258 to 6,531 feet above mean sea level (NGVD 1929)). Project area topography consists of gently sloping to steep terrain with typical slopes ranging from 3% to 30% with some areas exceeding 60% as shown on Figure 3.

3.2 Geology

A preliminary review of regional geology within the Project area has shown that this geomorphic unit has flat to moderate slopes and moderate to steep slopes, weathered rock outcrops, and two main geologic map units as shown on Figure 4.[5] Characteristics of these map units are described below.[6]

Flood Plain Deposits (Holocene) (Qfp)

Gravely to silty sand and sandy to clayey silt. Locally includes lacustrine and delta deposits. In part may be Pleistocene.

Older Glacial Deposits (Pleistocene) - Pre-Tahoe Deposits; Till (Qog)

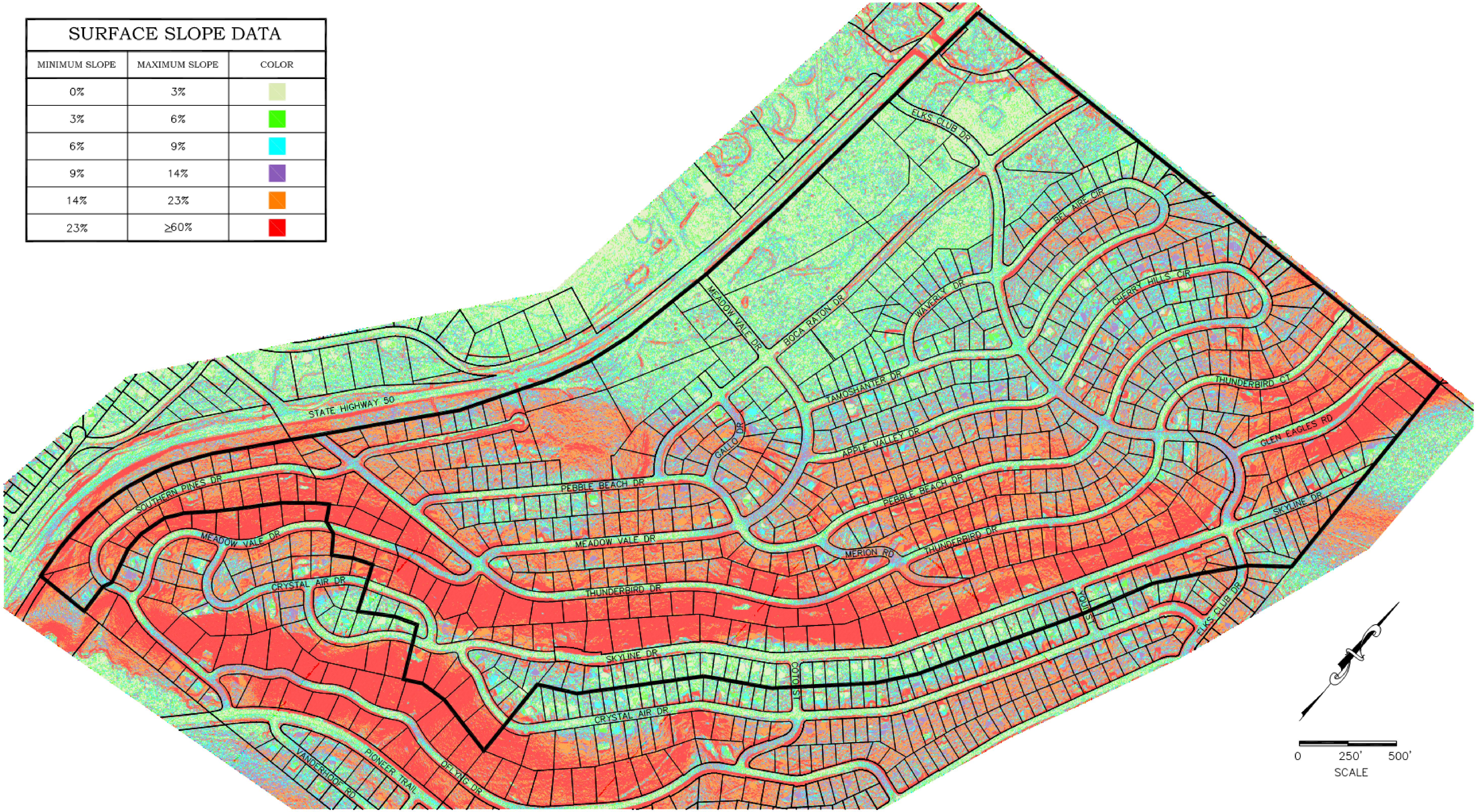
Deeply weathered bouldery deposits generally without morainal form; surface granitic boulders are weathered with stained, pitted and knobby surface; granitic boulders within the deposit are decomposed. Locally may include outwash deposits.

LEGEND

- CONTOUR (5' INTERVAL)
- COUNTY OR CALTRANS RIGHTS-OF-WAY OR PROPERTY LINE
- PROJECT BOUNDARY

COUNTY OF EL DORADO COMMUNITY DEVELOPMENT AGENCY TRANSPORTATION DIVISION	COUNTRY CLUB HEIGHTS EROSION CONTROL PROJECT TOPOGRAPHIC MAP	FIGURE 2
	DATE: 10/2016 PROJECT NO.: 95191 BY: ALD	

SURFACE SLOPE DATA		
MINIMUM SLOPE	MAXIMUM SLOPE	COLOR
0%	3%	
3%	6%	
6%	9%	
9%	14%	
14%	23%	
23%	≥60%	

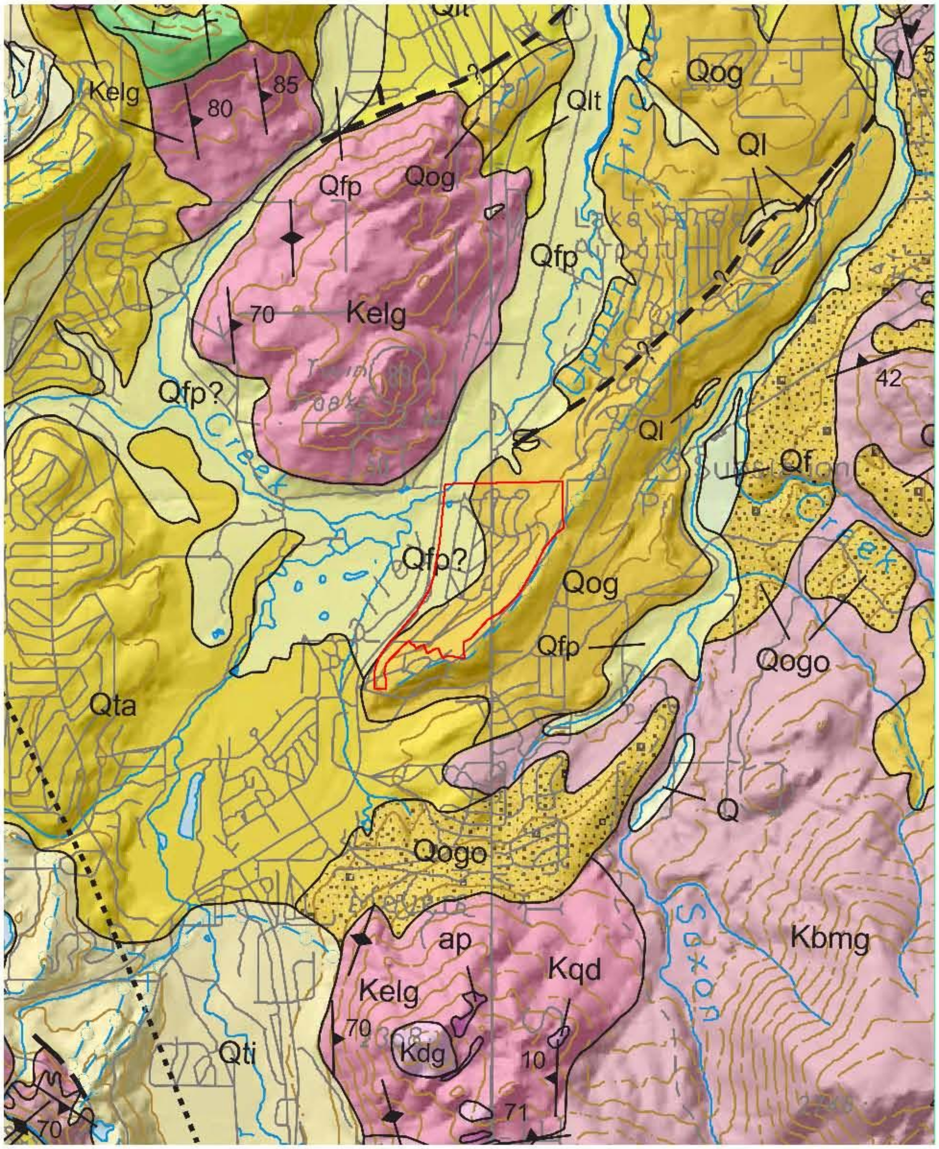


LEGEND

PROPERTY LINE OR COUNTY OR CALTRANS RIGHTS-OF-WAY

PROJECT BOUNDARY

COUNTY OF EL DORADO COMMUNITY DEVELOPMENT AGENCY TRANSPORTATION DIVISION	COUNTRY CLUB HEIGHTS EROSION CONTROL PROJECT SLOPE MAP	FIGURE 3
	DATE: 10/2016 · PROJECT NO.: 95191 · BY: ALD	



LEGEND

Qfp	Flood-plain deposits (Holocene)
Ql	Lake deposits (Holocene)
Q	Alluvium (Holocene and Pleistocene)
Qf	Alluvial fan deposits (Holocene and Pleistocene)
Qlt	Lacustrine terrace deposits (Pleistocene)

Tahoe glacial deposits (Pleistocene)

Qta	Till

Older glacial deposits - pre-Tahoe deposits (Pleistocene)

Qog	Till
Qogo	Outwash deposits

Granitic rocks

Kelg	Echo Lake granodiorite (Cretaceous)
Kbmg	Bryan Meadow granodiorite (Cretaceous)

Project Boundary

Fault - solid where well located; dashed where approximately located; short dash where inferred; dotted where concealed; queried where continuation or existence is uncertain. Ball and bar on downthrown side. *(The age and location of the faults in the lake bottom and cutting Quaternary deposits should be considered preliminary interpretations.)*

Glacial moraine crest.

Strike and dip of metamorphic and igneous foliation and cleavage.

45 Foliation or cleavage

Vertical foliation or cleavage

0 2500' 5000'

SCALE

NOTE: ONLY THOSE GEOLOGIC REFERENCES CLOSEST TO THE PROJECT AREA ARE SHOWN IN THE LEGEND

EL DORADO COUNTY CALIFORNIA

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB ESTATES EROSION CONTROL PROJECT

GEOLOGY MAP

FIGURE 4

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3.3 Hydrology

The United States Geological Survey (USGS) has divided the Tahoe Basin into 110 hydrologic basins and intervening areas contributing to outflow from Lake Tahoe.[7] The majority of the Project area is located within USGS hydrologic basin 73 with a small portion at the northeast within USGS hydrologic basin 72. Basin 73 has a drainage area of 56.5 square miles and is defined as the Upper Truckee River at Mouth. The watershed drains into the Upper Truckee River from the subdivisions through established storm drains, surface channels, and detention basins. Basin 72 has a drainage area of 41.2 square miles and is defined as Trout Creek at Mouth. The watershed drains into Saxon Creek from the subdivisions through established storm drains, surface channels, and detention basins. The USGS basins are depicted in Figure 5.

Runoff flowing throughout the Project area is directed toward drainage facilities within County and Caltrans ROW before reaching the Upper Truckee River. Transportation has divided the Project area into six primary watersheds using topographic mapping based on LiDAR developed in 2013[8] and field surveys. Watershed A, on the southwest end of the Project area, is the smallest of the five watersheds and drains into a channel toward Caltrans ROW. Watershed B drains into a channel and basin constructed within the Southern Pines Drive ROW as part of the 1994 Southern Pines Drive S.E.Z. Restoration Project. Overflow is conveyed toward Highway 50 via pipe and channel. Watershed C drains into a channel on private and public parcels below Pebble Beach Road and Boca Raton Drive. Any runoff not infiltrated is conveyed toward Highway 50 via sheetflow. Watersheds D and E drain into channels and a basin constructed within the Boca Raton Drive ROW as part of the 1987 Erosion Control Projects in the South Tahoe Basin Project. Overflow is conveyed toward the Upper Truckee River via pipe and channel. Watershed F, along the east and northeast portions of the Project area, drains into a channel on publicly owned parcels conveying runoff toward the Upper Truckee River beyond the Project boundary.

A comprehensive hydrological analysis of the Project area is found in Section 4.

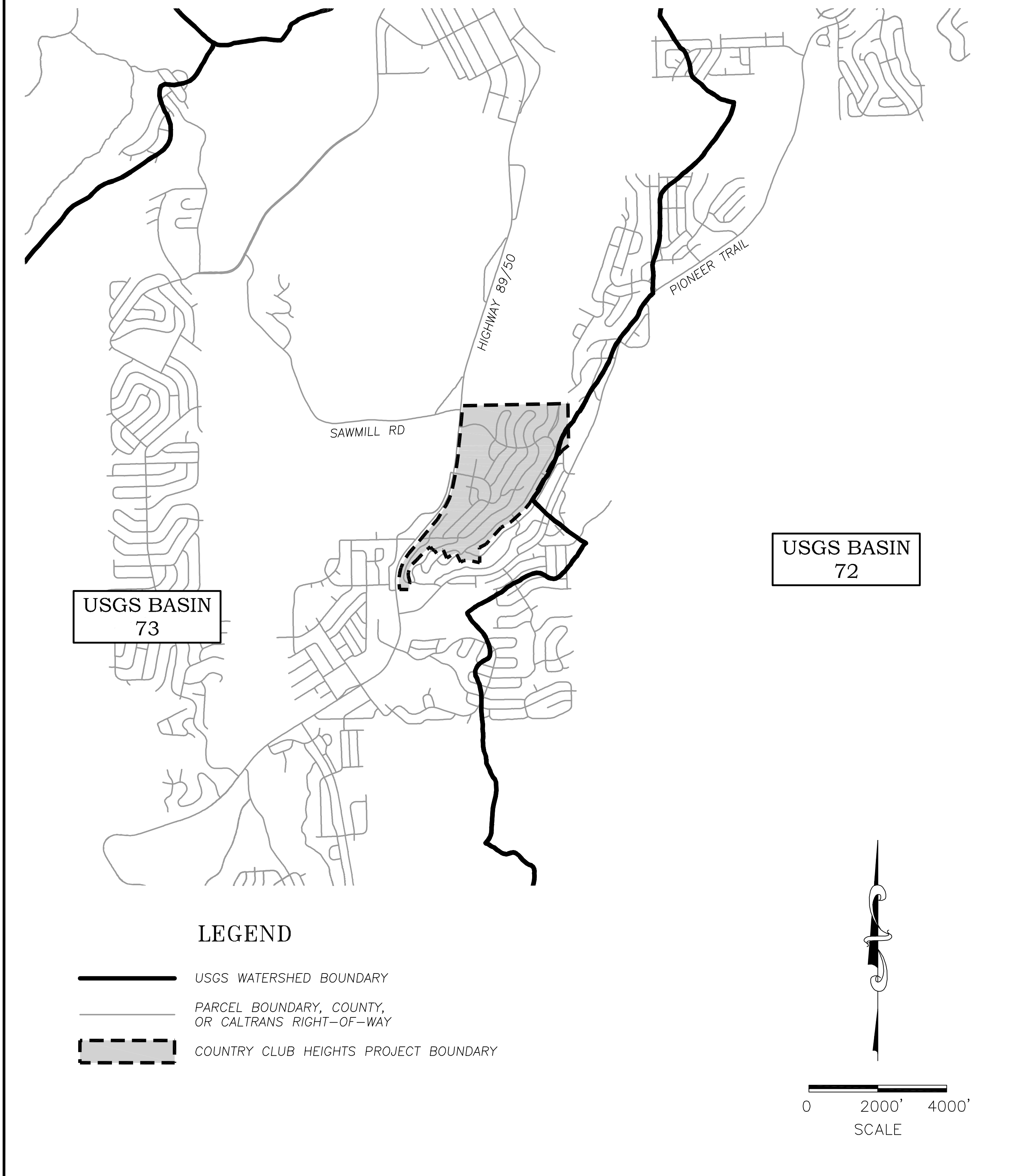
3.4 Soils

The 2007 NRCS soil survey data for the County of El Dorado Tahoe Basin Area was used to determine the primary soils units within the Project area.[9] The soils found within the Project boundary are presented on Figure 6 and are described below.

- Tahoe complex, 0 to 2 percent slopes (7041). This soil consists of very deep, very poorly drained alluvium. Average total available water in the top five feet of soil is 9.2 inches. There are hydric soils in this unit. Hydrologic soil group is C/D and runoff class is very high. Water table is present within the soil profile.
- Celio loamy coarse sand, 0 to 5 percent slopes (7431). This soil consists of deep, somewhat poorly drained alluvium and glacial outwash. Average total available water in the top five feet of soil is 1.7 inches. There are no hydric soils in this unit. Hydrologic soil group is A/D and runoff class is high. Water table is present within the soil profile.
- Christopher loamy coarse sand, 0 to 9 percent slopes (7441). This soil consists of very deep, somewhat excessively drained glacial outwash. Average total available water in the top five feet of soil is 6.6 inches. There are no hydric soils in this unit. Hydrologic soil group is A and runoff class is low. Water table is not present within the soil profile.
- Christopher loamy coarse sand, 9 to 30 percent slopes (7442). This soil consists of very deep, somewhat excessively drained glacial outwash. Average total available water in the

top five feet of soil is 6.6 inches. There are no hydric soils in this unit. Hydrologic soil group is A and runoff class is medium. Water table is not present within the soil profile.

- Gefo gravelly loamy coarse sand, 2 to 9 percent slopes (7451). This soil consists of very deep, somewhat excessively drained alluvium and glacial outwash. Average total available water in the top five feet of soil is 3.5 inches. There are no hydric soils in this unit. Hydrologic soil group is A and runoff class is very low. Water table is not present within the soil profile.
- Jabu coarse sandy loam, 0 to 9 percent slopes (7461). This soil consists of very deep, very well drained glacial outwash. Average total available water in the top five feet of soil is 5.4 inches. There are no hydric soils in this unit. Hydrologic soil group is A and runoff class is low. Water table is present within the soil profile.
- Jabu coarse sandy loam, 9 to 30 percent slopes (7462). This soil consists of very deep, very well drained glacial outwash. Average total available water in the top five feet of soil is 6 inches. There are no hydric soils in this unit. Hydrologic soil group is A and runoff class is low. Water table is present within the soil profile.
- Marla loamy coarse sand, 0 to 5 percent slopes (7471). This soil consists of very deep, poorly drained alluvium. Average total available water in the top five feet of soil is 6.8 inches. There are hydric soils in this unit. Hydrologic soil group is A/D and runoff class is very high. Water table is present within the soil profile.
- Meeks gravelly loamy coarse sand, 0 to 5 percent slopes, stony (7481). This soil consists of deep and very deep to weakly cemented glacial till and is well drained or somewhat excessively drained. Average total available water in the top five feet of soil is 2.9 inches. There are no hydric soils in this unit. Hydrologic soil group is A and runoff class is negligible. Water table is not present within the soil profile.
- Ubaj sandy loam, 0 to 9 percent slopes (7541). This soil consists of very deep colluvium and/or alluvium outwash and is moderately well drained. Average total available water in the top five feet of soil is 8.4 inches. There are no hydric soils in this unit. Hydrologic soil group is B and runoff class is medium. Water table is present within the soil profile.



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

USGS WATERSHED MAP

FIGURE 5

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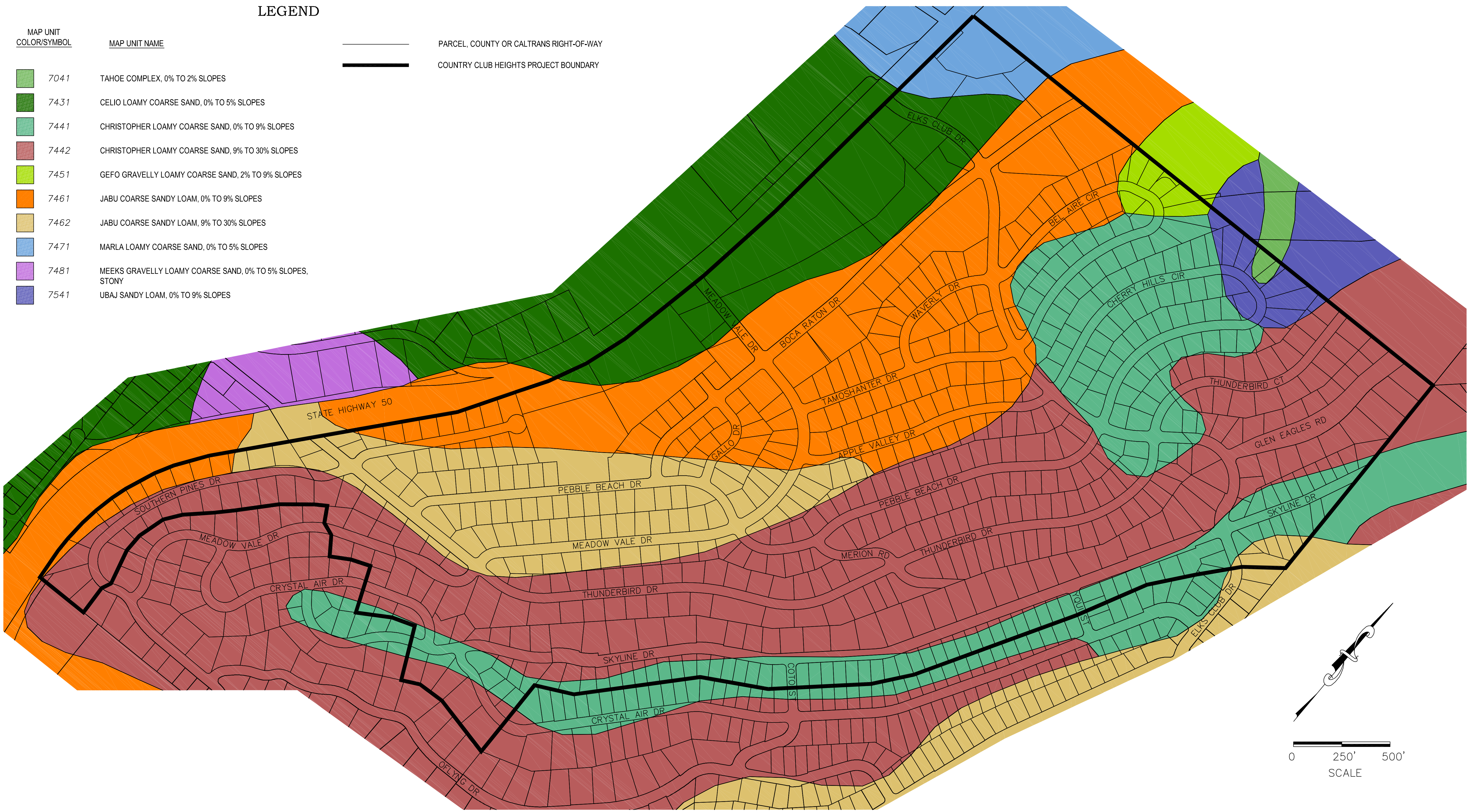

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

SOILS MAP

FIGURE 6

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3.5 Land Capability

All the lands within the Tahoe Basin are divided into seven classes based on soil types, potential for erosion, and other related characteristics.[10] Lands with a ranking of 1 have the highest potential for erosion and 7 the lowest. Level 1 is also subdivided into three categories: 1a – least tolerance for use; 1b – poor natural drainage in a stream environmental zone (SEZ); and 1c – fragile flora and fauna. There are four land capability classes within the Project boundary as shown on Table 2 and Figure 7. The Land capability groups were based on TRPA Bailey ~~Sinclair~~ Land Capability data. A request for Verification of Land Capability by TRPA staff will be forwarded shortly for those areas where work is proposed.

Table 2 – Area Distribution by Land Capability Class

Land Capability Class	Percent
1b	~~41.4~~ 20%
4	~~35.3~~ 43%
5	~~14.5~~ 27%
6	~~8.8~~ 9%

3.6 Land Use

The majority of the Project boundary lies within the TRPA Plan Area Statement (PAS) 120 – Tahoe Paradise Meadowvale, with the balance falling within PAS 119 – Country Club Meadow (Figure 7). The land use classification for PAS 120 is residential, the management strategy is mitigation, and the special designation is none. The land use classification for PAS 119 is recreational, the management strategy is mitigation, and the special designation is scenic restoration area.

Within PAS 120, the existing use is residential at a density of one single family dwelling per parcel. The planning area is approximately 30 percent built out. PAS 119 is primarily classified as 1B - SEZ with the dominate feature being the Upper Truckee River. Homes in this PAS are often located within SEZs.[11]

3.7 Biological Resources

3.7.1 Wetlands

Jurisdictional waters of the U.S. are classified into multiple types based on topography, edaphics (soils), vegetation, and hydrologic regime. Primarily, the U.S. Army Corps of Engineers establishes two distinctions: Wetland and non-wetland waters of the U.S. Non-wetland waters are commonly referred to as other waters.

Transportation retained NCE to determine the presence of jurisdictional wetlands. NCE noted the presence of features that appear to conform to the definition of waters of the U.S. per Section 404 of the federal Clean Water Act. A final report describing their findings has been submitted to the U.S. Army Corps of Engineers for a permit. The determinations will be taken into account when finalizing the preferred alternative design.

LEGEND

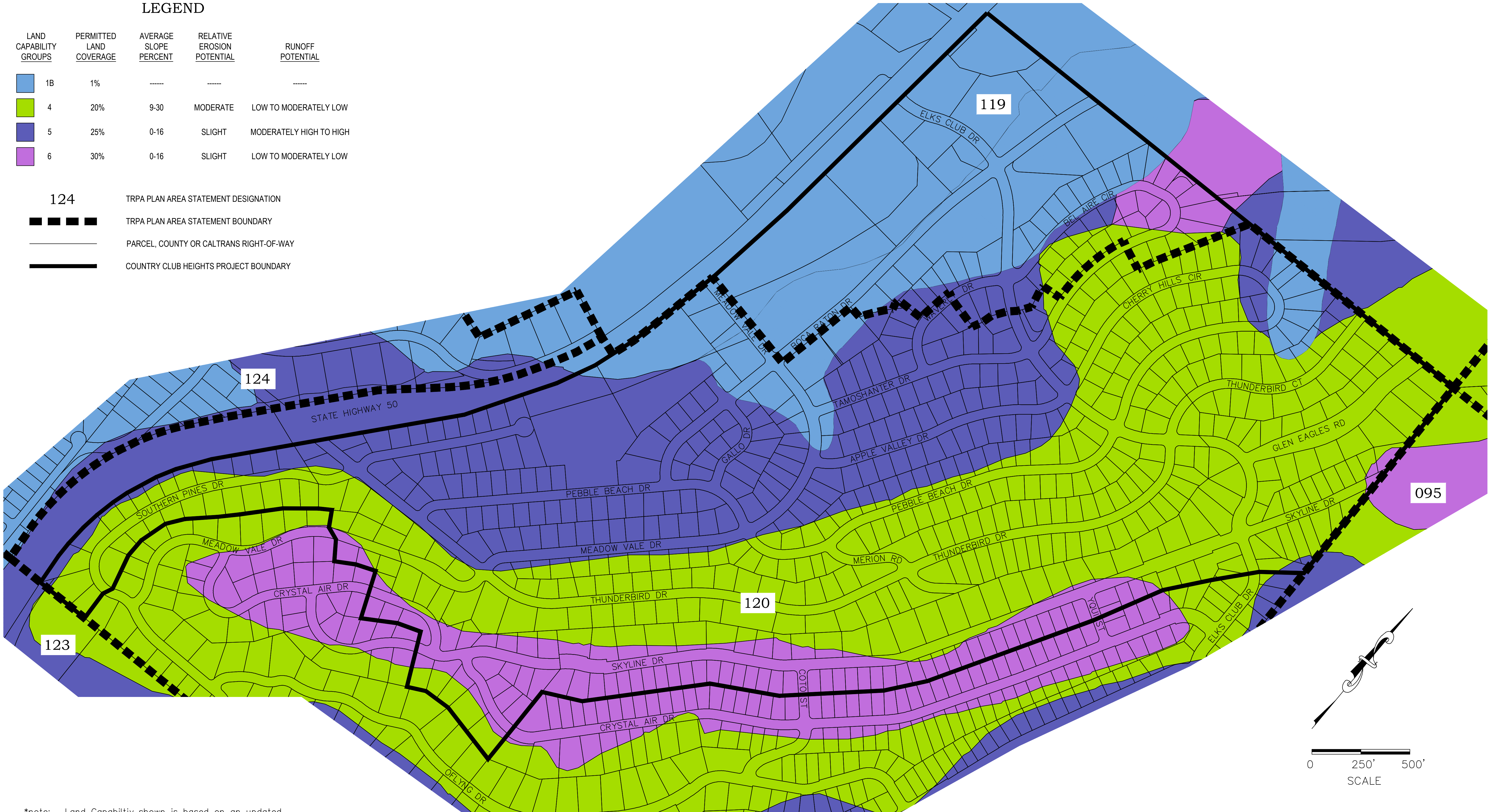
LAND CAPABILITY GROUPS	PERMITTED LAND COVERAGE	AVERAGE SLOPE PERCENT	RELATIVE EROSION POTENTIAL	RUNOFF POTENTIAL
1B	1%	------	------	------
4	20%	9-30	MODERATE	LOW TO MODERATELY LOW
5	25%	0-16	SLIGHT	MODERATELY HIGH TO HIGH
6	30%	0-16	SLIGHT	LOW TO MODERATELY LOW

124 TRPA PLAN AREA STATEMENT DESIGNATION

TRPA PLAN AREA STATEMENT BOUNDARY

PARCEL, COUNTY OR CALTRANS RIGHT-OF-WAY

COUNTRY CLUB HEIGHTS PROJECT BOUNDARY



*note: Land Capabiltiy shown is based on an updated Sinclair boundary for the SEZ. This is not to be used for individual parcel evaluations.

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

LAND USE AND LAND CAPABILITY MAP

FIGURE 7

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3.7.2 Vegetation

Transportation retained NCE to perform a review of published documents and inventory and conducted a field inspection to determine special status plant species, vegetation classifications, and invasive/noxious weed species within a one-half mile radius of the Project area. However, a final report describing their findings has not been completed at the time of this Report. The findings will be taken into account when finalizing the preferred alternative design.

3.7.3 Fish and Wildlife

Transportation retained NCE to perform a review of published documents and inventory and conducted a field inspection to identify special status wildlife species and habitat within and adjacent to the Project area. However, the final report describing their findings has not been complete at the time of this Report. The findings will be taken into account when finalizing the preferred alternative design.

3.8 Cultural Resources

Transportation retained NCE to perform a review of published documents and inventory and, if necessary, conduct a field inspection to determine the location and extent of previous archaeological inventories in and near the Project area. However, the final report describing their findings has not been complete at the time of this Report. The findings will be taken into account when finalizing the preferred alternative design.

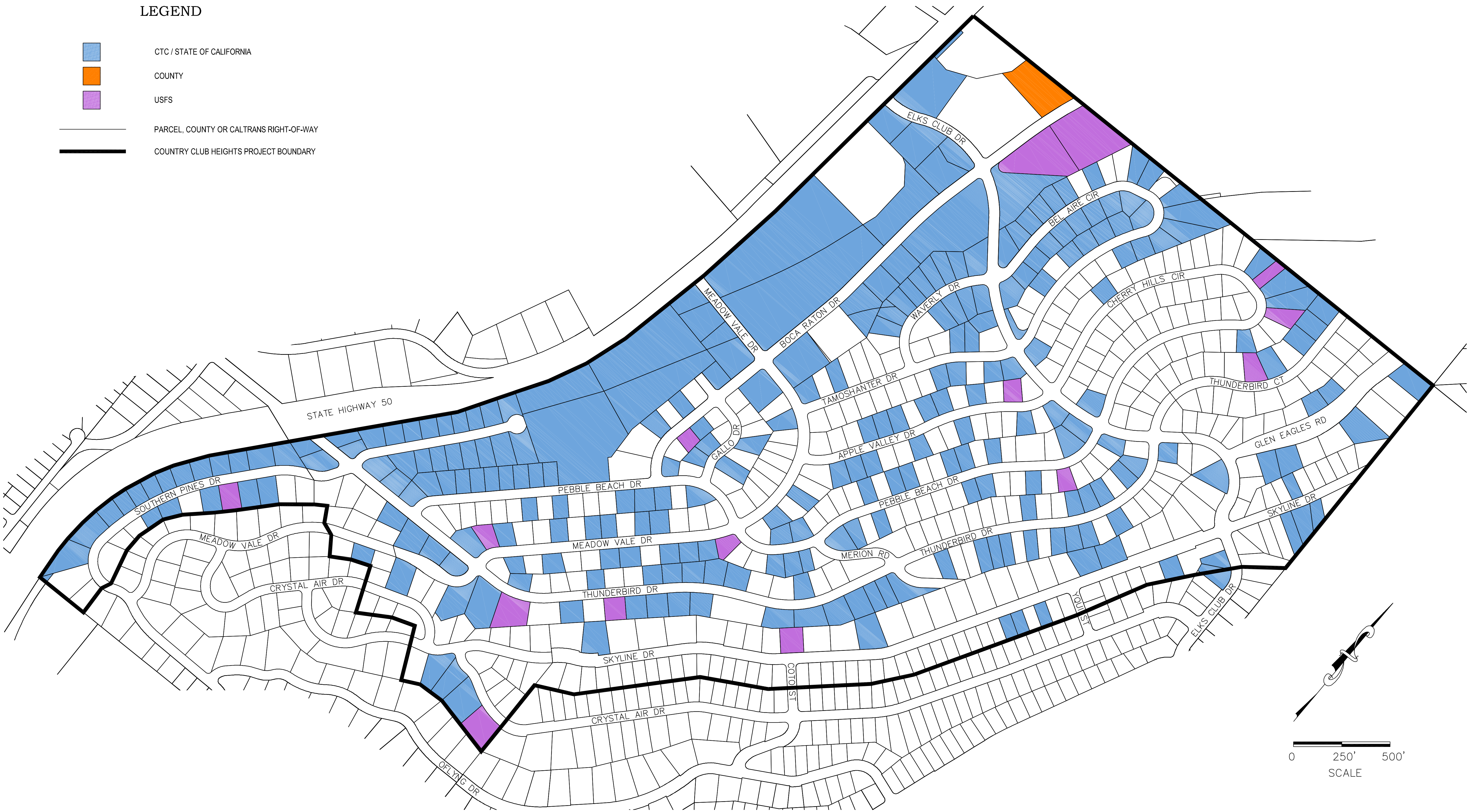
3.9 Property Network

The Project property network was developed from GIS data, ROW and recorded subdivision maps, and field survey. The property network depicts County and Caltrans road ROW, and property lines. The purpose of the property network is to depict a close representation of the subdivisions for planning purposes and is utilized for many of the figures throughout this Report.

Figure 8 depicts the Project area which is comprised of 371 private lots and 290 public lots owned by the County, CTC, and USFS. Where necessary, Transportation will begin the process of ROW acquisition for easements, special use permits, and license agreements for any affected parcels during the development of the preferred design alternative.

3.10 Utilities

Numerous underground and overhead utilities are within the Project area. The Existing Utilities Map (Figure 9) was developed from available record information and shows the approximate location and utility type. Utility owners are listed in Table 3.



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

PUBLIC PROPERTY MAP

FIGURE 8

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COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

EXISTING UTILITIES MAP

FIGURE 9

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Table 3 – Utility Owner List

Utility Type	Owner	Owner Address	Contact
Telephone	AT&T	12824 Earhart Ave Auburn, CA 95602	Astrid Willard
Electricity	Liberty Energy	933 Eloise Avenue S. Lake Tahoe, CA 96150	Andrew Gregorich
Water & Sewer	STPUD	1275 Meadow Crest Dr S. Lake Tahoe, CA 96150	Steve Caswell
Cable Television	Charter Communications	9335 Prototype Dr Reno, NV 89521	Anthony Lefanto
Natural Gas	Southwest Gas	1740 D Street, Unit No. 4 S. Lake Tahoe, CA 96150	Chris Peters

3.11 Driveway and Private BMP Inventory

A driveway and private BMP inventory was not completed for this Project.

3.12 Maintenance

During the winter months, the County's Tahoe Maintenance and Operations removes snow by plowing within and adjacent to the Project limits on an as-needed basis. Snow is plowed along every street within the Project area with snow storage occurring on the shoulders and at the ends of streets or cul-de-sacs where stacked snow does not interfere with driveway access.

Road maintenance activities in the winter are primarily limited to snow removal. To improve vehicle traction during icy conditions, road abrasives are applied as required throughout the Project area. Sweeping of streets and vactoring of storm drain systems is currently the only method of collecting sediment generated by road abrasives, naturally occurring sediment, or sediment tracked into the Project area.

4.0 Existing Hydrology

4.1 Watershed Characteristics

Transportation has divided the Project area into 6 watersheds as shown on Figures 10 and Figure 11. Runoff is conveyed through the watersheds via pipe, sheetflow, roadside ditches, AC swales, and AC dike. At specific points of interest, the watersheds have been divided into sub-watersheds. The watershed limits do not reflect flows through the existing channels and basins in the Southern Pines Drive and Boca Raton Drive ROW since the focus of the Project is to reduce peak flow and volume and increase water quality benefits upstream of these facilities.

The hydrologic characteristics of the Project area were analyzed in accordance with techniques outlined in the County of El Dorado Drainage Manual (Drainage Manual).[12] The Drainage Manual includes precipitation information through 1989. Since that time, additional updates have been completed for the precipitation record including an update of the precipitation Mean Annual Precipitation Map.[13]

Watershed A is approximately 7.5 acres. Runoff flows along Southern Pines Drive to a CMP inlet. The structure's outlet pipe conveys the runoff across the street to an AC apron and vegetated swale which directs flows toward Highway 50.

Watershed B is approximately 18.4 acres and is divided into 8 sub-watersheds which drain to the channel and basin constructed within the Southern Pines Drive ROW. Sub-watersheds B1 through B6 convey flows to the southern end of the channel while sub-watersheds B7 and B8 drain toward the middle section of the channel. Overflow from the basin is conveyed via pipe and channel toward Highway 50.

Watershed C is approximately 24.5 acres and is divided into 8 sub-watersheds. Watershed C ultimately drains into a channel below Pebble Beach Road and Boca Raton Drive. The steeper, upper reach of this channel is on private property and is partially incised. The lower portion is on flatter terrain within CTC parcels. This reach previously flowed toward Highway 50 but was redirected away from the highway and armored with seed, blanket, and rock check dams. Any runoff not infiltrated is conveyed toward Highway 50 via sheetflow.

Watersheds D and E drain into the channels and basin constructed within the Boca Raton Drive ROW. Watershed D is approximately 76.5 acres and is divided into 22 sub-watersheds. Sub-watersheds D1 through D15 drain to the southern end of the channel while sub-watersheds D16 through D22 drain toward the middle section of the channel located south of Elks Club Drive. Watershed E is approximately 14.4 acres and is divided into 7 sub-watersheds which generally convey runoff along the north side of Elks Club Drive. Currently, this runoff confluences with that of watershed D within the Boca Raton Drive channel; however, the watershed limits as shown stop short of this confluence in order to correlate with proposed future improvements. Overflow from the Boca Raton Drive basin is conveyed via pipe and channel toward the Upper Truckee River which crosses the northwest corner of the Project boundary.

Watershed F is approximately 30.4 acres and is divided into 13 sub-watersheds. Sub-watersheds F1 through F12 drain into a well vegetated channel running parallel with Cherry Hills Circle. At the north end of Cherry Hills Circle, this channel diverts away from the road onto a USFS parcel. Sub-watershed F13 drains into a pipe which outlets adjacent to the USFS channel conveying the runoff from sub-watersheds F1 through F-12. Runoff from the sub-watershed F13 pipe eventually confluences with the USFS channel and the combined flows continue beyond the Project boundary toward the Upper Truckee River.

LEGEND

- PROJECT AREA
- WATERSHED ID / AREA IN ACRES (F 30.4)
- WATERSHED BOUNDARY
- SUB-WATERSHED / AREA IN ACRES (F13 2.9)
- SUB-WATERSHED BOUNDARY
- FLOWPATH
- NODE DESIGNATION (28)
- EXISTING PIPE AND CMP INLET
- COUNTY AND CALTRANS ROW AND/OR PROPERTY LINES

0 150' 300'
SCALE

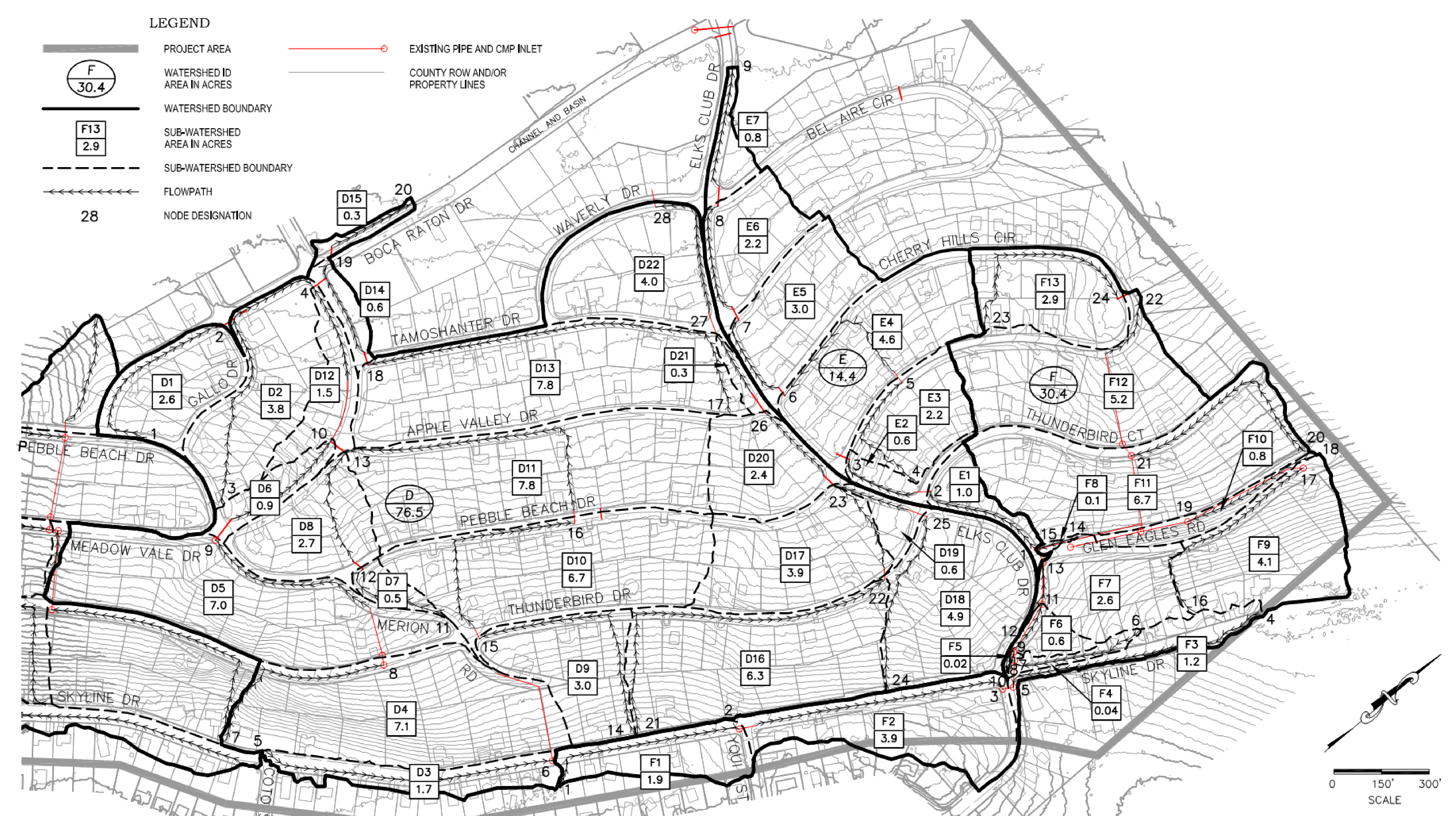
COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

WATERSHED MAP

FIGURE 10

DATE: 10/2016	PROJECT NO.: 95191	BY: ALD



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

WATERSHED MAP

FIGURE 11

DATE: 10/2016 | PROJECT NO.: 95191 | BY: ALD

4.2 Storm Frequency

Transportation utilizes the Drainage Manual as a guide for hydrologic and hydraulic design within the Tahoe Basin. The Drainage Manual requires that drainage facilities be designed to safely convey storm water runoff from an event with an average recurrence interval of 100-years for areas greater than 100 acres, and an average recurrence interval of 10-years for areas less than 100 acres without the headwater depth exceeding the pipe barrel height.[14]

The TRPA Code of Ordinances stipulates an infiltration requirement for the 20-year, 1-hour storm runoff volume.[15] The TRPA Code of Ordinances also states that drainage conveyance shall be designed for at least a 10-year, 24-hour storm and that drainage conveyance through an SEZ shall be designed for a minimum 50-year storm. The Lahontan Water Quality Control Plan states that the "design storm" for storm water control facilities in the Lake Tahoe Basin is the 20-year, 1-hour storm event.[16]

Considering that the individual watersheds within the Project area are less than 100 acres, the Project design hydrologic storm frequency is defined as the 25-year, 1-hour rain event. SEZ is found within 5 of the 6 defined watersheds. The areas identified for improvement needs as part of this Project are included in those 5 watersheds (B, C, D, E, and F). Therefore, any conveyance improvements within the SEZ will be designed to meet the 50-year storm requirement. For evaluation of hydraulic conveyance in other locations, the Project design storm frequency is defined as the 10-year event with the storm duration equal to the time of concentration.[17] In addition, Transportation will analyze hydraulic conveyance of the peak runoff for the 100-year, 24-hour return period storm event.

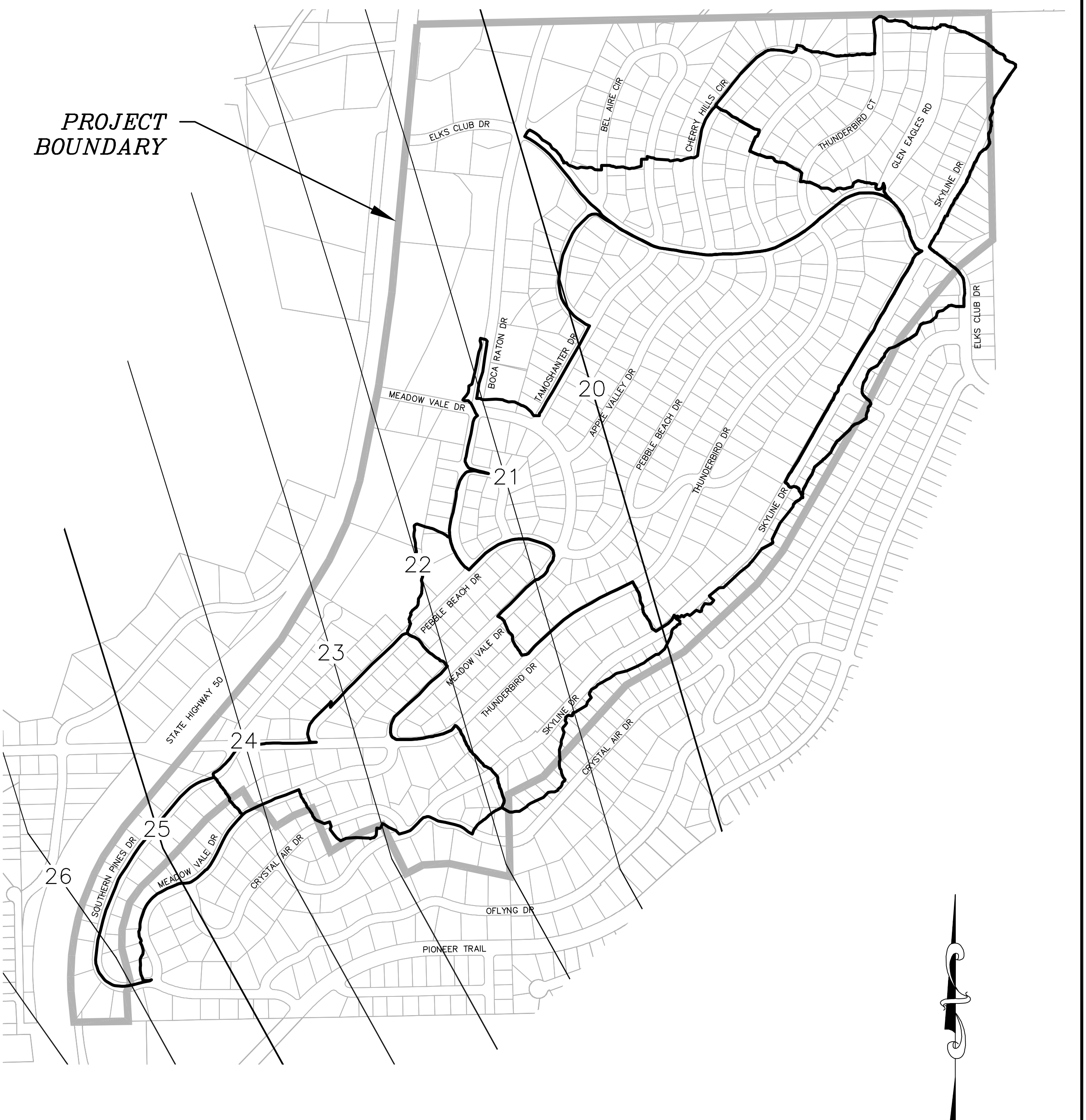
4.3 Precipitation Values

Mean annual precipitation (MAP) for the Project watersheds are 25 inches for watershed A, 23 inches for watershed B, 21 inches for watershed C, and 20 inches for watersheds D, E, and F (Figure 12). As shown on Figures 13 through 16, for a MAP of 25 inches, the 1-hour rainfall depth is equal to 0.79 inches for the 25-year return period. For a MAP of 23 inches, the 1-hour rainfall depth is equal to 0.725 inches for the 25-year return period. For a MAP of 21 inches, the 1-hour rainfall depth is equal to 0.66 inches for the 25-year return period. For a MAP of 20 inches, the 1-hour rainfall depth is equal to 0.63 inches for the 25-year return period.[18]

The TRPA Code of Ordinances stipulates that an average rain intensity of 1-inch per hour can be used for the 20-year, 1-hour storm for water quality evaluation.[19] The Lahontan Water Quality Control Plan states that for the Mammoth Lakes area, the 1-hour design storm is equal to 1 inch of rainfall.[20] Based on the location of the Project, the Project design rainfall intensity for the 1-hour storm is accepted as that ranging from 0.79 inches to 0.63 inches to represent a storm event with a return period of 25 years.

4.4 Hydrologic Methods

The objective of the hydrologic analysis is to estimate the peak flow and runoff volumes for the 10-year, 6-hour; 25-year, 1-hour; and 100-year, 24-hour storm events. For the Project, two hydrologic techniques were used; the Rational Method and the Unit Hydrograph. An Excel spreadsheet was used to calculate peak flows and velocities using the Rational Method and the computer program, HEC-HMS, version 3.5, was used to calculate peak flows and volumes using the Unit Hydrograph Method. The results from these analyses were accepted to represent peak flow and volumes, without the presence of base flow.



26 MEAN ANNUAL PRECIPITATION, INCHES PER YEAR

PROJECT WATERSHED BOUNDARIES

REFERENCE: REPORT ON EL DORADO COUNTY DESIGN RAINFALL BY JIM GOODRIDGE, 2008

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

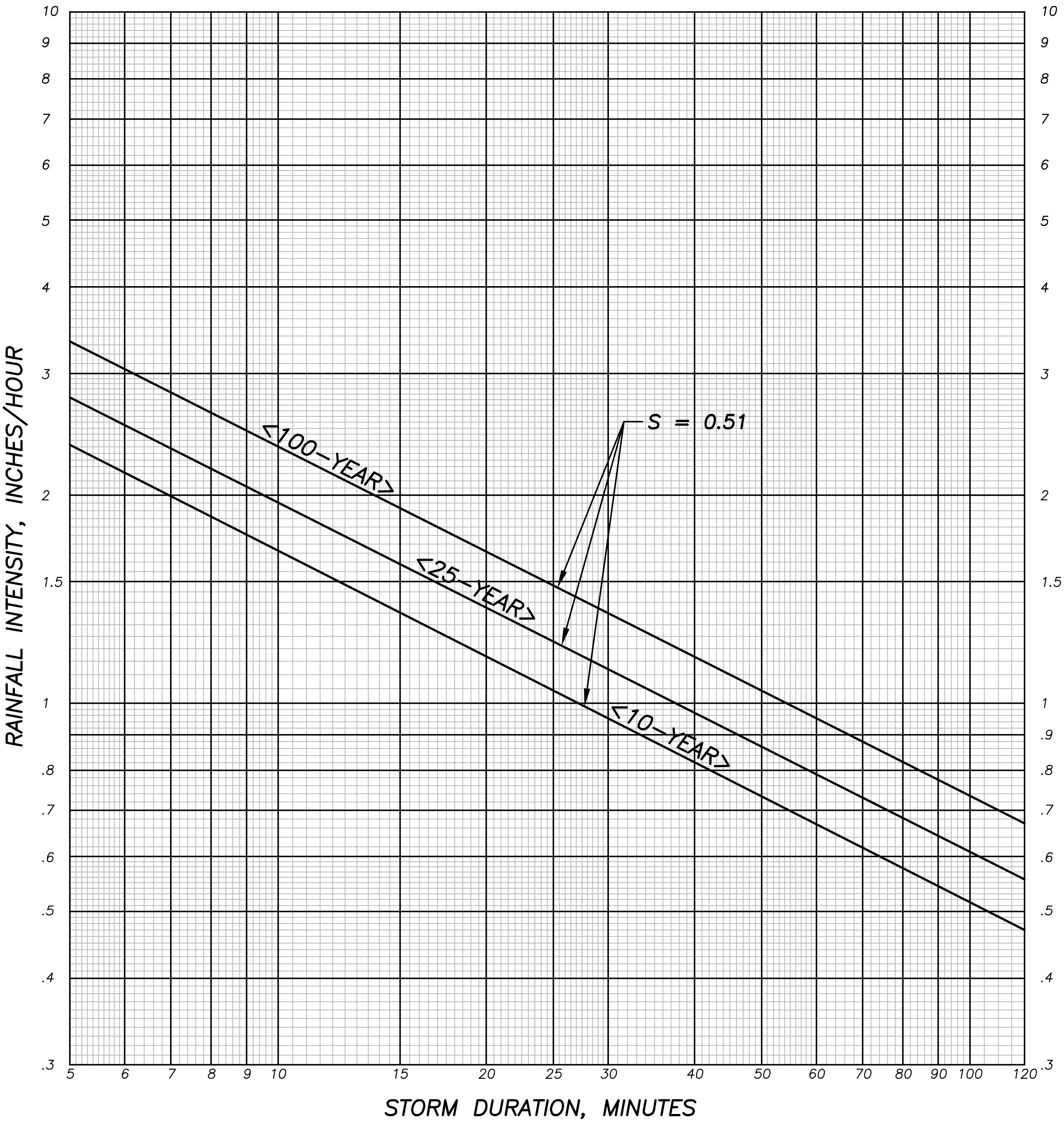
COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

MEAN ANNUAL RAINFALL MAP

FIGURE 12

DATE: 10/2016 | PROJECT NO.: 95191 | BY: ALD

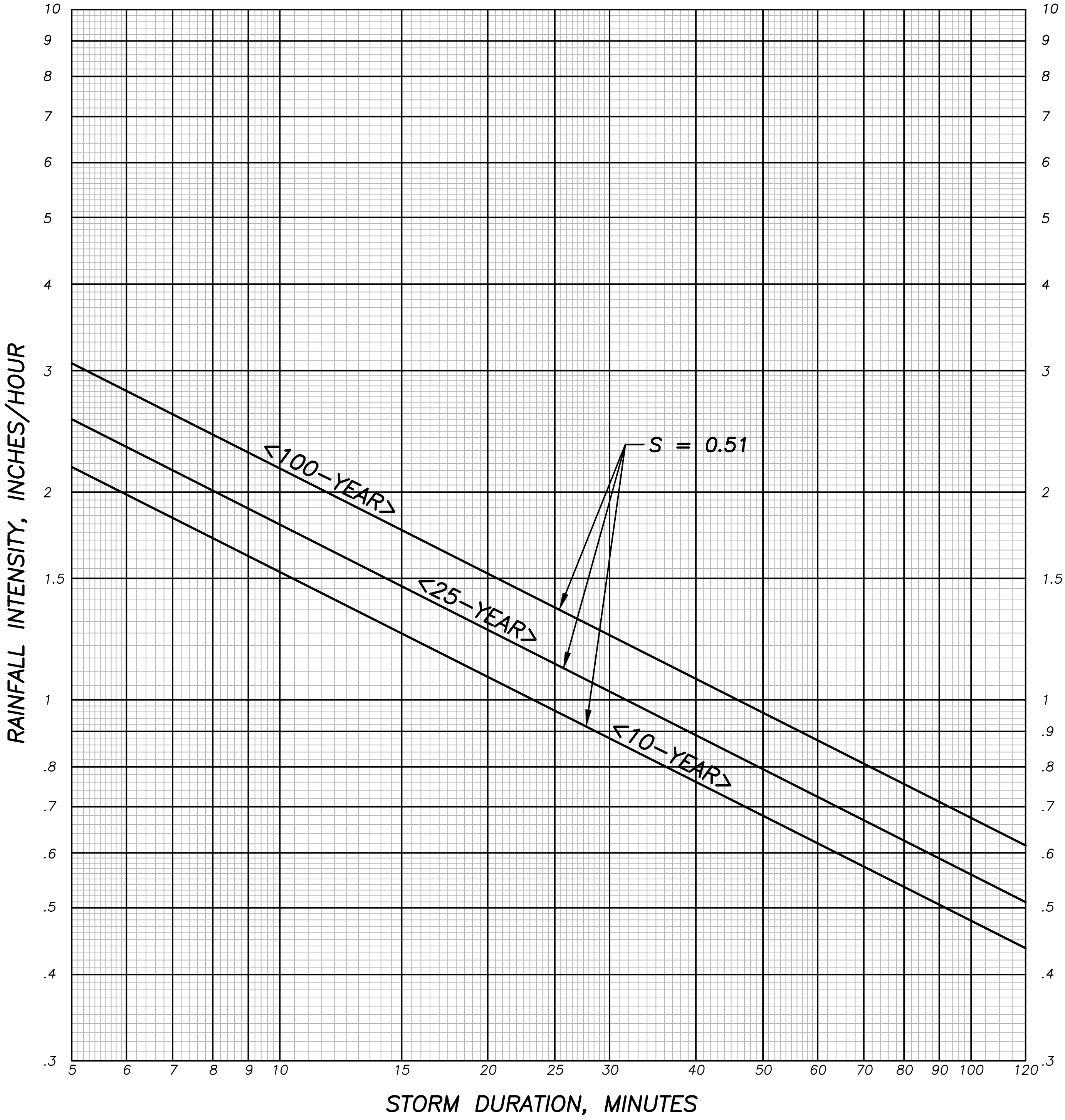
RAINFALL INTENSITY–DURATION–FREQUENCY CURVE



SOURCE: COUNTY OF EL DORADO DRAINAGE MANUAL, 1995
UPDATED FROM EL DORADO COUNTY DESIGN RAINFALL, GOODRIDGE 2008
MEAN ANNUAL RAINFALL – REVISED ISOHYET 25 INCHES

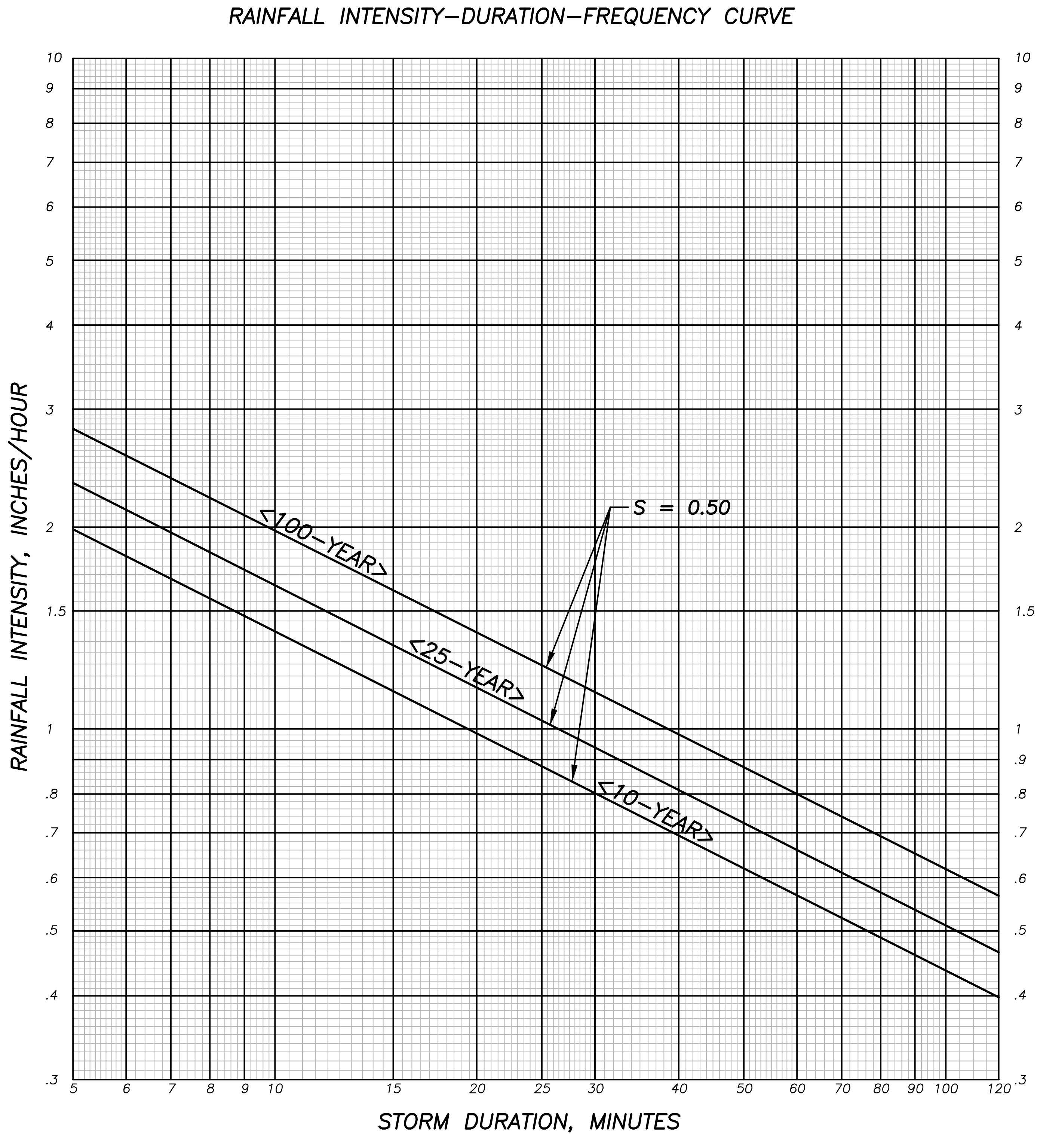
COUNTY OF EL DORADO COMMUNITY DEVELOPMENT AGENCY TRANSPORTATION DIVISION	COUNTRY CLUB HEIGHTS EROSION CONTROL PROJECT RAINFALL INTENSITY-DURATION-FREQUENCY CURVES	FIGURE 13
DATE: 10/2016	PROJECT NO.: 95191	BY: ALD

RAINFALL INTENSITY—DURATION—FREQUENCY CURVE



SOURCE: COUNTY OF EL DORADO DRAINAGE MANUAL, 1995
UPDATED FROM EL DORADO COUNTY DESIGN RAINFALL, GOODRIDGE 2008
MEAN ANNUAL RAINFALL — REVISED ISOHYET 23 INCHES

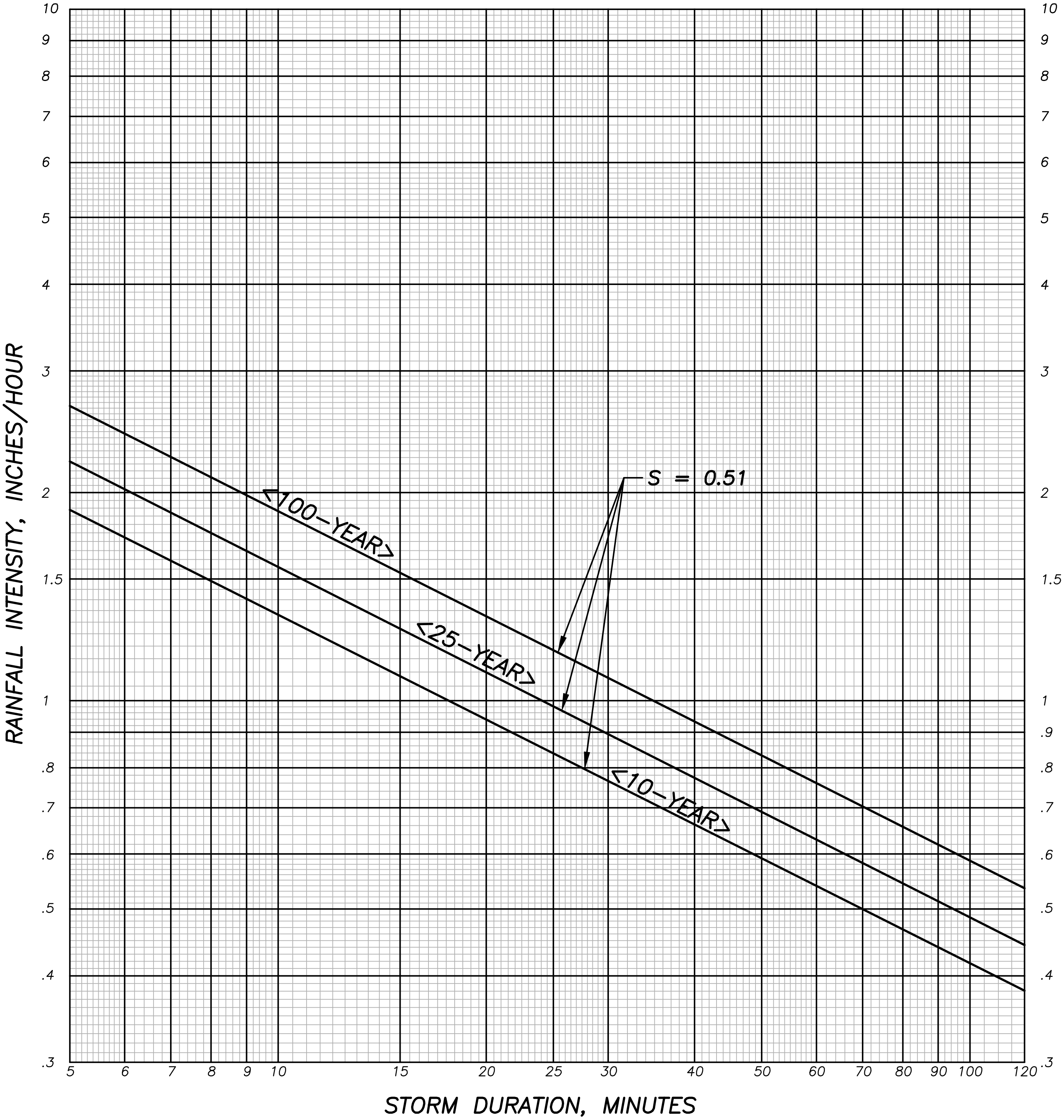
COUNTY OF EL DORADO COMMUNITY DEVELOPMENT AGENCY TRANSPORTATION DIVISION	COUNTRY CLUB HEIGHTS EROSION CONTROL PROJECT RAINFALL INTENSITY-DURATION-FREQUENCY CURVES	FIGURE 14
	DATE: 10/2016 · PROJECT NO.: 95191 · BY: ALD	



SOURCE: COUNTY OF EL DORADO DRAINAGE MANUAL, 1995
UPDATED FROM EL DORADO COUNTY DESIGN RAINFALL, GOODRIDGE 2008
MEAN ANNUAL RAINFALL — REVISED ISOHYET 21 INCHES

COUNTY OF EL DORADO COMMUNITY DEVELOPMENT AGENCY TRANSPORTATION DIVISION	COUNTRY CLUB HEIGHTS EROSION CONTROL PROJECT RAINFALL INTENSITY-DURATION-FREQUENCY CURVES	FIGURE 15
	DATE: 10/2016 | PROJECT NO.: 95191 | BY: ALD	

RAINFALL INTENSITY–DURATION–FREQUENCY CURVE



SOURCE: COUNTY OF EL DORADO DRAINAGE MANUAL, 1995
UPDATED FROM EL DORADO COUNTY DESIGN RAINFALL, GOODRIDGE 2008
MEAN ANNUAL RAINFALL – REVISED ISOHYET 20 INCHES

COUNTY OF EL DORADO COMMUNITY DEVELOPMENT AGENCY TRANSPORTATION DIVISION	COUNTRY CLUB HEIGHTS EROSION CONTROL PROJECT RAINFALL INTENSITY-DURATION-FREQUENCY CURVES		FIGURE 16
	DATE: 10/2016	PROJECT NO.: 95191	BY: ALD

The Project area was divided into 6 watersheds which drain toward Highway 50 and the Upper Truckee River. The watersheds were further divided into sub-watersheds in order to estimate the peak flow and volume at specific drainage structures and treatment locations.

For this hydrologic analysis, the land within the sub-watersheds was considered connected to the point of interest (e.g., an outfall) when computing the total watershed hydrology and no bulking factor was applied.

A ROW only hydrologic analysis was also completed to determine the County's portion of the storm runoff from the 25-year, 1-hour event. This analysis included only the impervious surfaces from within the County road ROW. Outside ROW connectivity was not considered as part of the ROW only analysis.

4.4.1 Rational Method

The Rational Method was used to calculate the peak discharge from the Project area. This method relies on four input variables and was calculated using equation 1:[21]

$$Q = C \cdot C_f \cdot I \cdot A \qquad (1)$$

Where *Q* is peak discharge in cubic feet per second (cfs), *C* is the runoff coefficient, *Cf* is the runoff coefficient frequency adjustment factor, *I* is the rainfall intensity in inches per hour, and *A* is the area of the watershed in acres. For the Project area, an unadjusted runoff coefficient *C* of 0.1 was selected based on the drainage area being unimproved. For the Project design rainfall return periods of 10 and 25 years, a runoff coefficient frequency adjustment factor *Cf* of 1.0 was applied to the runoff coefficient and for the 100 year design rainfall return period, an adjustment factor *Cf* of 1.0 x 1.25 was applied.[22] The rain intensity *I* of the design storm was calculated using the estimated time of concentration *Tc* and the area *A* of the sub-watershed.

The flow paths for the Project watersheds were segregated into overland sheet flow, shallow concentrated flow, and, where applicable, channel flow and curb and gutter. The times of concentration were calculated for each watershed to determine the time required for runoff to travel from the hydraulically most distant part of the watershed to the outfall. For this Project area, the overland-flow roughness coefficient was estimated to be 0.40 based on Woods with light underbrush.

The travel time for sheetflow was calculated using the kinematic-wave equation and is presented as equation 2:[23]

$$T_t = 0.007 \frac{(n \cdot L)^{0.8}}{P^{0.5} \cdot S^{0.4}} \qquad (2)$$

Where T_t is sheetflow time of travel in hours, *n* is overland-flow roughness coefficient, *L* is length of overland flow in feet (300 foot maximum), *P* is rainfall depth in inches, and *S* is land slope in feet per feet.

The velocity of shallow flow over unpaved surfaces was estimated based on equation 3:[24]

$$V_U = 16.1345 \cdot S_O^{0.5} \qquad (3)$$

Where V_U is flow velocity in feet per second and S_0 is land slope in feet per foot.

The velocity of shallow flow over paved surfaces was estimated based on equation 4:[25]

$$V_P = 20.3283 \cdot S_O^{0.5} \qquad (4)$$

Where V_P is flow velocity in feet per second and S_0 is land slope in feet per foot.

The times of concentration for shallow flow over unpaved and paved surfaces were calculated by dividing the flow path length by the velocity. The watershed time of concentration for each of these flow path segments was summed to determine the total time. In all cases, a 6 minute initial time of concentration was used.

Input parameters and output results for the Rational Method are contained in Appendix B.

4.4.2 Unit Hydrograph Method (HEC-HMS)

The Unit Hydrograph Method is commonly used for determining the peak flow (Q) and the hydrograph from relatively large watersheds (up to 10 sq. mi.). Transportation used the unit hydrograph for an entire watershed tributary to its outflow as well as at specific drainage structures and treatment locations. This method was used to determine the peak runoff rates for the Project watersheds.

The program requires input parameters and variables such as a Basin Model, Meteorological Model, and a Control Storm. The Basin Model parameters include: input of the drainage area, lag time, percent impervious, initial abstraction I_a, and any base flow information. The lag time is the product of 0.6 multiplied by the time of concentration derived from the Rational Method.[26] The impervious coverage was estimated using field survey data and existing aerial topographic maps for each watershed. The initial abstraction was calculated using equation 5:[27]

$$I_a = 0.2\left(\frac{1000}{RI} - 10\right) \tag{5}$$

With the runoff index (RI) being equivalent to a weighted curve number (CN). For the Meteorological Model, the Soil Conservation Services (SCS) method was chosen with a Type 1A storm, per the Drainage Manual.[28]

Output results for HEC-HMS are contained in Appendix B.

4.5 Hydrologic Results

Based on the results of the Rational Method, the peak discharge for the main watersheds is presented in Table 4. The peak discharge at points of interest within each main watershed is presented in Table 5.

Table 4 – Main Watershed Characteristics & Peak Flow Summary (Rational)

Main WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
		C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
A	7.5	0.2	11	1.9	2.7	3.2	4.8	15
B (B1-B6)	13.6	0.3	36	0.9	2.9	3.4	5.1	21
B (B7-B8)	4.8	0.3	20	1.3	1.3	1.5	2.3	19
C	24.5	0.3	36	0.9	4.6	5.4	8.2	20
D (D1-D15)	54.1	0.3	60	0.6	7.5	8.8	13.3	20

Main WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
		C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
D (D16-D22)	22.4	0.2	44	0.7	3.0	3.5	5.3	14
E	14.4	0.3	49	0.7	2.5	3.0	4.5	25
F (F1-F12)	27.6	0.3	54	0.7	4.3	5.0	7.6	22
F (F13)	2.8	0.3	47	0.7	0.5	0.5	0.8	20

Notes:
1. For 100-year events, value increased by 25%.
2. Only 25-year event is listed here.

Table 5 – Points of Interest Peak Flow Summary (Rational)

Main WS	Sub WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
			C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
A	A1	7.5	0.2	11	1.9	2.7	3.2	4.8	15
B	B1	1.6	0.3	30	1.0	0.5	0.5	0.8	29
	B1-B2	1.8	0.4	32	1.0	8.6	0.7	1.0	33
	B3	0.9	0.3	9	1.9	0.5	0.5	0.8	26
	B1-B5	8.7	0.3	33	1.0	2.0	2.4	3.6	22
	B1-B6	13.6	0.3	36	0.9	2.9	3.4	5.1	21
	B7	4.7	0.2	13	1.6	1.5	1.8	2.7	17
	B8	0.1	0.9	7	2.2	0.1	0.2	0.2	97
	B7-B8	4.8	0.3	20	1.3	1.3	1.5	2.3	19
C	C1	4.2	0.4	19	1.2	1.7	2.0	3.0	37
	C2	4.4	0.2	50	0.7	0.6	0.7	1.1	15
	C3	3.1	0.2	8	1.8	1.1	1.3	2.0	17
	C1-C4	16.8	0.3	53	0.7	2.7	3.2	4.8	21
	C5	4.5	0.3	33	0.9	0.9	1.1	1.6	22
	C6	0.2	0.3	27	1.0	0.0	0.0	0.1	22
	C7	1.2	0.3	33	0.9	0.2	0.3	0.4	19
	C1-C7	22.6	0.3	3.5	0.9	4.5	5.3	7.9	21

Main WS	Sub WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
			C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
	C1-C8	24.5	0.3	36	0.9	4.6	5.4	8.2	20
D	D1	2.6	0.3	8	1.7	1.3	1.6	2.3	30
	D2	3.9	0.2	44	0.7	0.6	0.7	1.0	16
	D3	1.7	0.5	12	1.4	1.1	1.3	1.9	53
	D3-D4	8.8	0.3	30	0.9	1.7	2.0	3.0	19
	D3-D5	15.8	0.2	33	0.9	2.6	3.0	4.6	16
	D7	0.5	0.3	7	1.9	0.2	0.3	0.4	22
	D7-D8	3.2	0.3	9	1.7	1.3	1.5	2.3	22
	D9	3.0	0.2	39	0.8	0.5	0.5	0.8	16
	D9-D10	9.7	0.2	43	0.8	1.5	1.8	2.6	18
	D7-D11	20.7	0.3	54	0.7	2.9	3.4	5.1	18
	D3-D11	37.4	0.3	54	0.7	5.2	6.1	9.2	18
	D1-D12	45.4	0.3	56	0.7	6.4	7.5	11.3	19
	D13	7.8	0.3	18	1.2	2.0	2.3	3.5	20
	D13-D14	8.4	0.3	20	1.1	2.1	2.5	3.7	21
	D1-D14	53.8	0.3	56	0.7	7.6	9.0	13.5	20
	D1-D15	54.1	0.3	60	0.6	7.5	8.8	13.3	20
	D16	6.3	0.2	39	0.8	0.8	0.9	1.4	10
	D18	4.9	0.2	36	0.8	0.7	0.8	1.2	12
	D16-D19	15.7	0.2	40	0.8	2.0	2.4	3.6	12
	D16-D20	18	0.2	41	0.8	2.6	2.8	4.2	13
	D16-D21	18.5	0.2	42	0.8	2.4	2.9	4.3	13
	D16-D22	22.5	0.2	44	0.7	3.0	3.5	5.3	14
E	E1	1.0	0.4	7	1.9	0.6	0.7	1.1	39
	E1-E2	1.6	0.4	8	1.7	1.0	1.2	1.8	42
	E3	2.2	0.3	40	0.8	0.4	0.4	0.7	19

Main WS	Sub WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
			C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
	E3-E4	6.8	0.3	45	0.7	1.1	1.3	2.0	21
	E1-E4	8.4	0.3	45	0.7	1.6	1.8	2.7	25
	E1-E5	11.4	0.3	46	0.7	2.1	2.5	3.7	25
	E1-E6	13.7	0.3	47	0.7	2.4	2.8	4.3	24
	E1-E7	14.4	0.3	49	0.7	2.5	3.0	4.5	25
F	F1	1.9	0.4	27	0.9	0.5	0.6	1.0	32
	F1-F2	5.8	0.3	32	0.9	1.4	1.6	2.4	28
	F3	1.2	0.6	48	0.7	0.4	0.5	0.7	58
	F4	0.4	0.5	21	1.1	0.2	0.2	0.3	45
	F5	0.02	0.5	6	2.0	0.0	0.0	0.0	46
	F6	0.6	0.4	7	1.9	0.3	0.4	0.6	33
	F7	2.7	0.3	7	1.9	1.1	1.2	1.9	18
	F8	0.06	0.5	10	1.5	0.0	0.1	0.1	52
	F9	4.1	0.2	34	0.8	0.6	0.7	1.0	13
	F10	0.8	0.4	11	1.5	0.4	0.5	0.8	40
	F11	6.8	0.3	38	0.8	1.2	1.4	2.0	19
	F1-F12	27.6	0.3	54	0.7	4.3	5.0	7.6	22
	F13	2.9	0.3	47	0.7	0.5	0.5	0.8	20

Notes:
1. For 100-year events, value increased by 25%.
2. Only 25-year event listed here.

Based on the results of the HEC-HMS model, the peak discharge and volumes for the 25-year, 1-hour storm for the main watersheds are presented in Table 6.

Table 6 – Main Watershed Peak Flow Summary [25-yr, 1-hr] (Unit Hydrograph)

WS	Area (acres)	Area (sq mi)	Q Peak (cfs)	Volume (ac-ft)	Volume (ft^3)
A	7.5	0.0116754832	2.2	0.0755	3,289
B (B1-B6)	13.6	0.0212966483	2.8	0.1715	7,471
B (B7-B8)	4.8	0.0074996865	1.2	0.0549	2,391

WS	Area (acres)	Area (sq mi)	Q Peak (cfs)	Volume (ac-ft)	Volume (ft^3)
C	24.5	0.0382646361	4.5	0.2706	11,787
D (D1-D15)	54.1	0.0843947300	6.8	0.5586	24,333
D (D16-D22)	22.4	0.0350735268	2.5	0.1690	7,362
E	14.4	0.0225123070	2.6	0.1858	8,093
F (F1-F12)	27.6	0.0430939189	4.2	0.3182	13,861
F (F13)	2.8	0.0044618784	0.4	0.0304	1,324

The peak discharge based on the Rational Method is greater than the results from the HEC-HMS model. The differences can be attributed to the different parameters required for the calculations. For watersheds less than 100 acres, Transportation utilizes the Rational Method results for analyzing existing and proposed storm drain systems. The Unit Hydrograph modeling provides the runoff volumes required for confirming compliance with permitting requirements and analyzing existing and proposed infiltration/detention systems.

HEC-HMS was also used for the ROW only analysis. A summary of the results are found in Table 7.

Table 7 – ROW Only Peak Flow Summary [25-yr, 1-hr] (Unit Hydrograph)

WS	Area (sq mi)	Q Peak (cfs)	Depth (inches)	Volume (ac-ft)	Volume (ft^3)
A ROW	0.0009852613	1.0	0.79	0.0415	1,808
B ROW	0.0038570492	3.6	0.73	0.1491	6,495
C ROW	0.0047203591	1.5	0.66	0.0606	2,640
D ROW	0.0138063899	11.2	0.63	0.4639	20,207
E ROW	0.0036012824	2.9	0.63	0.1210	5,271
F ROW	0.0071327325	5.8	0.63	0.2396	10,437

4.6 Hydrologic Validation

Hydrologic validation will be performed once the selection of the alternative has been finalized.

5.0 Existing Hydraulics

The intent of the hydraulic analysis is to confirm whether or not the existing storm drain systems are adequate for conveyance of the calculated runoff and to confirm whether conditions at each inlet accommodate that runoff. Pipe locations and elevations for the analysis were derived from topographic mapping based on LiDAR[29] and recent field survey data available at the time of this Report. To generate a more accurate representation of the system's dynamics with less extrapolation a field survey would be required.

There are a number of pipes, inlets, channels, and basins within the Project area (Exhibits 1a and 1b, Appendix B). These facilities were installed as subdivision infrastructure, maintenance upgrades, or as part of previous erosion control projects. Most of the conveyance facilities direct runoff toward the infiltrating channels and basins in the Southern Pines Drive and Boca Raton Drive ROW. The hydraulic analysis does not include these channels and basins but is limited to the storm drain systems upslope of these facilities.

5.1 Pipe Characteristics

The pipe systems within the Project area are comprised of 12", 15", 18", 21", 24", and 30" diameter CMP, 15"x21" and 13"x17" arch CMP, and 18" and 21" diameter smooth wall HDPE. Pipe conditions range from fair to poor. The Manning's roughness coefficient (n) of the existing CMP and HDPE pipes was estimated to be 0.024 and 0.012, respectively.[30] In some locations, sediment deposition limits the capacity of the pipe and outlet conveyance systems.

5.2 Shoulder Characteristics

Most of the roads within the Project area were constructed with runoff being conveyed by AC dike, AC swales, or vegetated/dirt swales on one side of the street and on the opposite side, sheetflow conveys runoff away from the paved road surface onto dirt shoulders or vegetation. In some locations, erosion and sediment deposition is evident within the shoulders.

5.3 Hydraulic Methods

For circular pipes, the full capacity of the pipe was calculated using the Manning's equation which is presented as equation 6:[31]

$$Q = 0.463 \cdot \frac{D^{8/3} \cdot S_f^{\ 1/2}}{n} \qquad (6)$$

Where Q is discharge in cfs, D is pipe diameter in feet, S_f is slope of the energy grade line in feet/feet, and n is Manning's roughness coefficient.

The hydraulic capacity of the existing pipes was compared to the results of the hydrologic analysis for the design storm.

5.4 Hydraulic Results

The Drainage Manual requires that drainage facilities be designed to safely convey storm water runoff from an event with an average recurrence interval of 100-years for areas greater than 100 acres and an average recurrence interval of 10-years for areas less than 100 acres without the headwater depth exceeding the pipe barrel height.[32] The drainage areas generating runoff through the subdivisions are all less than 100 acres; therefore, according to the Drainage Manual, the 10-year, 6-hour Rational Method peak would be an acceptable design storm. In Section 4.2 of this Report, however, the 25-year, 1-hour rain event was determined to be the design storm for this Project and was used to analyze the hydraulic capacity of the existing pipes. The results of this analysis are located in Appendix B. Table 8 contains a summary of the existing pipes, inflows, and capacities.

Table 8 – Existing Pipe Characteristics [25-yr, 1-hr] (Rational)

WS	Pipe ID	Pipe Size / Material	Inlet / Outlet Facility	Q Capacity (cfs)	Q 25-yr,1-hr	% Capacity
A	1508	18” CMP	CMP Inlet / Channel	8.6	3.2	37%
B	1504	18” CMP	CMP Inlet / Channel	6.5	0.5	8%
	1505	18” CMP	CMP Inlet / Channel	6.6	0.5	8%
	1496	18” CMP	CMP Inlet / Channel	2.6	2.4	92%
	1499	21” CMP	CMP Inlet / CMP Inlet	14.9	3.4	23%
	1494	18” CMP	Channel / CMP Inlet	10.6	1.8	17%
	1495	18” CMP	CMP Inlet / Channel	20.7	1.5	7%
C	1489/1490	18” CMP	CMP Inlet / CMP Inlet	28.8	2.0	7%
	1491	18” CMP	Channel / Channel	22.0	1.9	9%
	1492/1493	18” CMP	Channel / Channel	14.7	2.4	16%
	1483	18” CMP	CMP Inlet / CMP Inlet	23.8	1.1	5%
	1484	18” CMP	CMP Inlet / CMP Inlet	8.1	1.1	14%
	1485/1486	18” CMP	CMP Inlet / CMP Inlet	22.4	1.4	6%
	1487	18” CMP	CMP Inlet / Channel	8.2	5.3	64%
D	1337	18” CMP	Channel / Channel	10.1	1.6	15%
	1410/1411	18” CMP	CSP Inlet / Channel	24.0	1.3	5%
	1389/1390	18” CMP	CSP Inlet / Channel	21.8	2.0	9%
	1380	15” CMP	CSP Inlet / Channel	6.5	3.0	46%
	1366	18” CMP	Channel / Channel	6.9	0.3	4%
	1365	12” CMP	Channel / Channel	4.4	0.5	12%
	1367	18” CMP	Channel / Channel	7.0	1.8	25%
	1379A	18” CMP	Channel / Channel	13.0	3.4	26%
	1379B	18” CMP	Channel / Channel	16.1	6.1	38%
	1376	18” CMP	Channel / Channel	2.2	7.5	337%
	1371	18” CMP	Channel / Channel	11.4	2.3	20%
	1375	15”x21” ACMP	Channel / Channel	3.8	9.0	234%
	1364	12” CMP	Channel / Channel	3.9	0.9	32%
	1363	18” CMP	Channel / Channel	13.7	0.8	6%
	1368	12” CMP	Channel / Channel	4.8	2.4	50%

WS	Pipe ID	Pipe Size / Material	Inlet / Outlet Facility	Q Capacity (cfs)	Q 25-yr,1-hr	% Capacity
	1369	18” CMP	Channel / Channel	15.0	2.8	19%
	1370	13”x17” ACMP	Channel / Channel	8.0	2.9	36%
	1372	24” CMP	Channel / Channel	23.9	3.5	15%
E	2638	18” CMP	Conc. Inlet / Channel	9.5	0.7	8%
	2639	18” HDPE	Channel / Channel	19.2	1.2	6%
	1362	15” CMP	Channel / Channel	4.5	0.4	10%
	1360	21” HDPE	Channel / Channel	35.1	1.8	5%
	2640	12” CMP	Channel / Channel	3.9	2.5	63%
	1358	24” CMP	Channel / Channel	17.2	2.8	16%
F	1387	18” CMP	CSP Inlet / Channel	0.8	0.6	80%
	1391	21” CMP	CSP Inlet / CSP Inlet	12.7	1.6	13%
	1392	21” CMP	CSP Inlet / CSP Inlet	14.7	1.8	12%
	1393	21” CMP	CSP Inlet / CSP Inlet	28.6	1.9	7%
	1394	21” CMP	CSP Inlet / CSP Inlet	25.4	1.9	7%
	1395	21” CMP	CSP Inlet / CSP Inlet	25.9	2.0	8%
	1396	24” CMP	CSP Inlet / CSP Inlet	32.9	2.5	8%
	1397	24” CMP	CSP Inlet / Pipe	7.1	2.5	35%
	1382	18” CMP	CSP Inlet / CSP Inlet	5.9	0.7	12%
	1383	21” CMP	CSP Inlet / SDMH	9.8	0.9	10%
	1385/1398	24” CMP	SDMH / CSP Inlet	56.9	3.2	6%
	1399/1400	30” CMP	CSP Inlet / Channel	72.6	4.4	6%
	1361	12” CMP	Channel / Channel	4.8	0.5	11%

The results in Table 8 do not reflect potential head pressure or inlet structure capacities. There are two pipes that do not appear to convey the design storm peak runoff. The pipes are located at the intersection of Boca Raton Drive and Meadow Vale Drive where the terrain is flat and both pipe slopes are less than 0.5%. Work is proposed for this location and the inlet/outlet conditions and pipe capacities will be further analyzed during design of the preferred alternative.

6.0 Storm Water Quality and Loading Summary

6.1 Water Quality Monitoring

The current water quality effluent objectives for runoff from the Project area are based on TRPA and Lahontan water quality limits as presented in Table 9.[33] One of the goals of this Project is to meet these water quality limits by providing source control, hydrologic design, and treatment BMPs within the Project area for the 25-year, 1-hour runoff event.

Table 9 – TRPA and Lahontan Water Quality Limits

Constituent	Surface Waters		Infiltration Systems	
	Lahontan	TRPA	Lahontan	TRPA
Total Nitrogen as N	0.5 mg/l		5 mg/l	
Dissolved Nitrogen as N		0.5 mg/l		5 mg/l
Total Phosphate as P	0.1 mg/l		1 mg/l	
Dissolved Phosphate as P		0.1 mg/l		1 mg/l
Total Iron	0.5 mg/l		4 mg/l	
Dissolved Iron		0.5 mg/l		4 mg/l
Turbidity	20 NTU		200 NTU	
Suspended Sediment		250 mg/l		
Grease & Oil	2 mg/l	2 mg/l	40 mg/l	40 mg/l

6.2 Groundwater and Percolation

Groundwater levels and soil percolation rates within the Project area will be evaluated for the proposed basin on the CTC parcel at the intersection of Boca Raton Drive and Meadow Vale Drive. The findings will be taken into account when finalizing the preferred alternative design.

6.3 Storm Water Loading Estimates

The load analysis for this report was taken from the County Baseline Pollutant Load Estimate Report (2011)[34]. The analysis was completed using the Pollutant Load Reduction Method (PLRM) developed by NHC.[35] This method utilizes the PLRM model to estimate average annual pollutant loads from the individual Project watersheds based on the following factors: watershed size, slope, land uses, road condition, shoulder condition, estimated connectivity of the roadway section, roadway maintenance practices, and number of private BMP's installed.

For planning purposes, the six watersheds were grouped into three urban planning catchment s (UPC) (Table 10). The Project area is typically only sanded by the County in the steeper portions of the roadways as part of routine County snow removal operations. The loading associated with the abrasives will be taken into consideration as part of the project design for CSP inlets and needed infrastructure requirements, but increased load contributed for this portion of the analysis will not be considered. Therefore loading generated from sanding operations was not taken into consideration as part of this analysis.

Table 10 – Annual Pollutant Load (PLRM) – Existing Condition

UPC	WS	Area (acres)	Volume (Acre-Ft / Year)	TSS[1] (lbs/yr)	FSP[1] (lbs/yr)	TP[1] (lbs/yr)	TN[1] (lbs/yr)
71	E, F	43.8	11.65	4988	2611	15	74

UPC	WS	Area (acres)	Volume (Acre-Ft / Year)	TSS[1] (lbs/yr)	FSP[1] (lbs/yr)	TP[1] (lbs/yr)	TN[1] (lbs/yr)
72[2]	D, E	118.8	27.66	11589	6101	36	175
73[2]	A,B,C	109.3	29.13	13387	7121	38	192

1. Based on Characteristic Runoff Concentrations as a funtion of land use.
2. Includes watershed ares between highway 50 and Boca Raton.

The watersheds used in the baseline report covered a larger area and only approximate those mapped as part of this report. In addition, the pollutant load values shown in Table 10 were caluclated using PLRM V1, where as the County the County is currently updating the baseline load using PLRM v2. The County will analyze the effect each of the proposed alternatives has on the estimated Annual Pollutant Load using PLRM v2. A detailed analysis of the estimated average annual pollutant load will be completed as part of the Final Design Report.

7.0 Existing Conditions

7.1 Problem Areas

Figure 17 depicts the problem areas within the Project boundary. Many of the road shoulders and slopes in the Country Club Heights Project area have been stabilized with rock and AC swales, timber and masonry block retaining walls, rock and gunite slope protection, and vegetation. However, bare and eroding shoulders and slopes can be found in numerous locations throughout the subdivisions and some of the rock slope protection sites are failing due to the rock being small and rounded. At one location on Meadow Vale Drive, a 12-foot high section of gunite slope protection has buckled.

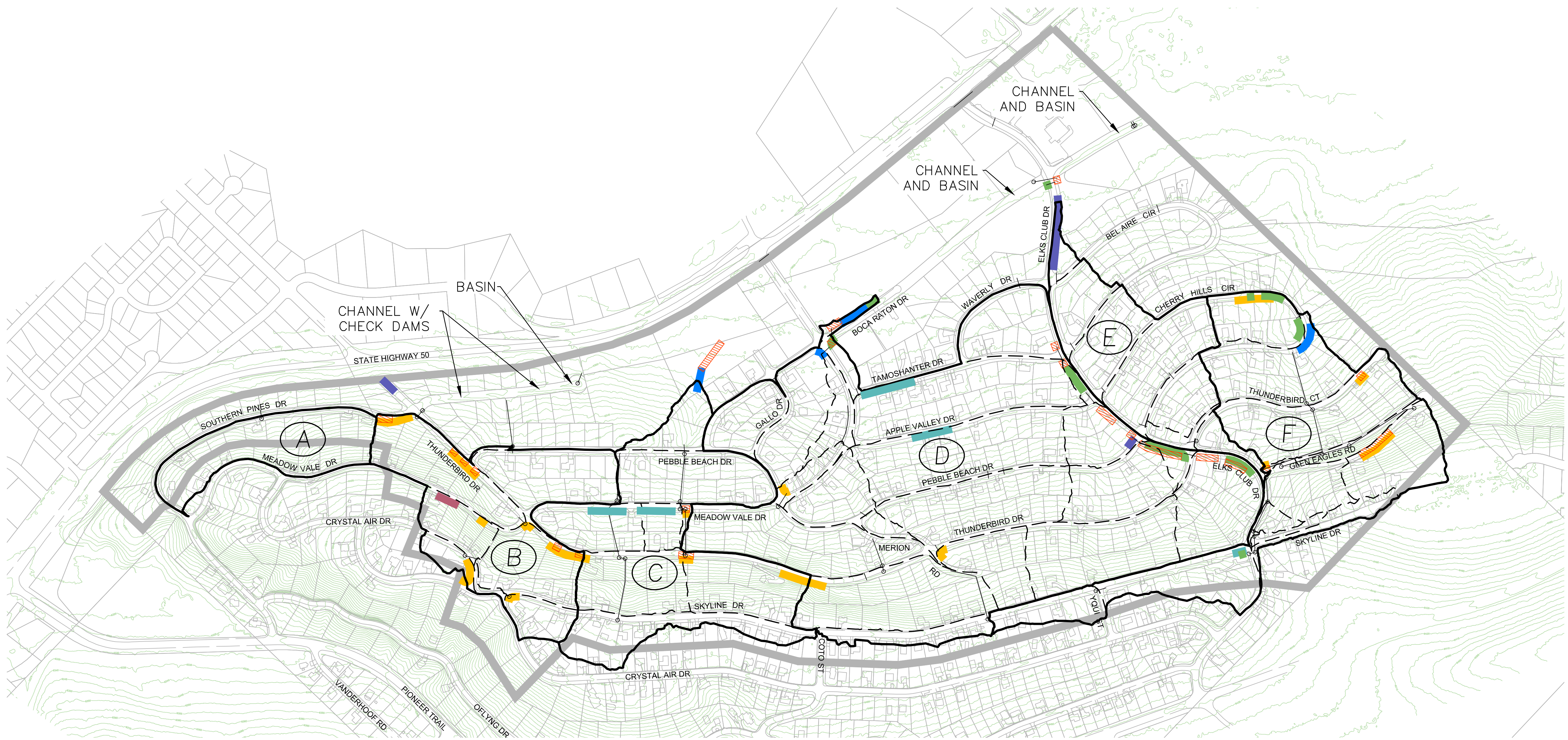
Many of the roads within the Project area were constructed with AC dike or integrated AC swales. In some locations the AC dike is missing or separated from the pavement surface, impacting conveyance capacity. In other locations the AC dike or swale is covered or filled with sediment and rock from eroding cut slopes, forcing runoff into the travel lane. Due to multiple AC pavement overlays on the steeper portion of Elks Club Drive, the depth of the AC swales on the north side of the road has increased, resulting in a safety hazard for drivers and cyclists. In the flatter reach of Elks Club Drive, between Bel Aire Circle and the Boca Raton Drive ROW, vegetation has broken through the AC swales impacting water quality and impeding conveyance.

Ponding is evident on the east side of the road shoulder of Apple Valley Drive. During the winter, icing along this stretch creates hazardous conditions for residents.

With the exception of the infiltrating channels and basins east of Highway 50 in the Southern Pines Drive and Boca Raton Drive ROW, runoff from the Project area receives minimal infiltration or treatment. The direct connectivity between the Project area and the Upper Truckee River results in a high potential to deliver fine sediment to Lake Tahoe.

7.2 Opportunities and Constraints

Within the Project area there are opportunities to provide source control where erosion is evident, hydrologic design where conveyance is insufficient, and treatment of runoff and the reduction of sediment. With implementation of these measures, the reduction of runoff volume and coarse, fine, and very fine sediment from the Project area is feasible.



LEGEND

PROJECT BOUNDARY	ERODING OR INCISED CHANNEL
COUNTY ROW, CALTRANS ROW, OR PROPERTY LINES	IMPAIRED GUNITE SLOPE PROTECTION
CONTOUR	ERODING SHOULDER
EXISTING CMP I OR DI	ERODING SLOPE
EXISTING PIPE	PONDING LOCATION
WATERSHED ID	IMPAIRED ASPHALT
WATERSHED BOUNDARY	SEDIMENT ACCUMULATION
SUB-WATERSHED BOUNDARY	

0 300' 600'
SCALE

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

PROBLEM AREA MAP

FIGURE 17

DATE: 10/2016 | PROJECT NO.: 95191 | BY: ALD

8.0 Formulating Alternatives

In order to satisfy the goals of the Project, two alternatives were formulated to mitigate specific erosion and storm water runoff water quality problems within the Project area. A third "do nothing" alternative will not satisfy the Project goals or objectives and is therefore not considered a viable alternative for discussion in this Section.

The two mitigating alternatives were developed using the BMP categories of source control, hydrologic design, and treatment of runoff. Many BMPs satisfy more than one category. Appendix C contains detailed BMP toolbox sheets for each specific facility and treatment proposed.

Important design considerations in formulating the alternatives were ROW constraints, availability of suitable publicly owned parcels, existing underground utilities, capital costs of the proposed improvements, relative cost vs effectiveness of the proposed improvements, and the relatively high cost of easement acquisition on private property. Suitable BMPs chosen for consideration for the Project alternatives include:

Revegetation

Revegetation is a source control mitigation measure. In order for revegetation to be successful as a soil stabilization BMP, the characteristics of the application needs to be tailored to the specific conditions of each site. These characteristics should include selection of a soil stabilization material and developing an appropriate plan for the growth of vegetation. Revegetation alone is not expected to be successful for all areas of bare soil. This is primarily due to the dryness of some sites, granitic characteristics of the soil, and the depth to groundwater.

Rock Slope Protection

Rock slope protection is a successful source control mitigation alternative which has been used extensively within the Project area as elements of other erosion control projects. The costs, benefits, and limitations have been established and demonstrated on past projects. This alternative has a long design life, is resilient to snow removal activities, and is successful in stabilizing eroding slopes.

Rock-Lined Channel

Rock-lined channels are a proven source control, hydrologic design, and treatment alternative for conveying runoff, stabilizing roadside ditches, and treating runoff. The suspended sediments settle into the voids between the rock and portions runoff is infiltrated into the in situ soils beneath the channel. Rock-lined channels have been constructed on numerous erosion control projects, including those previously constructed within the Project area.

Seed and Blanket Channel

When located in the correct environment, seed and blanket channels are a proven source control, hydrologic design, and treatment alternative for conveying runoff, stabilizing roadside ditches, and treating runoff. Once established, suspended sediments are stabilized within the root system and the runoff is infiltrated into the in situ soils beneath the channel. Seed and blanket channels have been constructed on numerous erosion control projects with varying degrees of success, primarily due to location.

Sediment Basin

A sediment basin meets the criteria for hydrologic design and treatment BMP through conveyance, the reduction of sediment, the reduction of runoff volume through infiltration, the reduction of peak flow through detention and infiltration, and treatment of runoff through infiltration. The reduction in peak flow is based on the infiltration rate of the sediment basin bottom, the runoff volume, and the volume of infiltration storage. For the reduction of suspended coarse and fine sediment in runoff, the sediment basin relies on gravitational settling of particles that are denser than water. For very fine particles suspended in runoff, the settling time is such that capture by a sediment basin requires the design and operation is in a first flush configuration. The distance from the bottom of the sediment basin to groundwater and the rate of infiltration of the in situ soils is a factor in determining suitable basin locations.

CSP Inlets

As a conveyance structure, the CSP inlet meets the criteria for hydrologic design and is a proven means of treatment through infiltration. Reduction of suspended sediment, the reduction of runoff volume and peak flow, and the treatment of runoff is dependent on the infiltration rate of the in situ soils, the runoff volume, and the volume of infiltration storage. The distance from the bottom of the infiltrating facility to groundwater and the rate of infiltration of the in situ soils is a factor in determining suitable CSP inlet locations.

Aggregate Base

Aggregate base meets the criteria for source control, hydrologic design, and treatment BMP and is an economic technique for stabilizing eroding soil adjacent to a paved road, can be used to redirect flow, and is permeable. The typical use of aggregate base as a BMP includes excavation adjacent to the road surface and replacing this material with washed, poorly graded angular gravel. The aggregate base provides a wearing surface and reduces erosion from rain or concentrated flow. With the infiltration capacity of the in situ soil beneath the aggregate base, this alternative provides a reduction in runoff peak flow and volume as well as treatment by means of infiltration. For the Project, aggregate base would be used as a source control alternative providing shoulder stabilization.

8.1 Alternatives

The two alternatives formulated to address the erosion, hydrologic, and treatment deficiencies within the Project area are described below.

Alternative 1

Figure 18 depicts the facilities and treatments proposed for Alternative 1. Conditions requiring source control include bare and eroding shoulders, eroding slopes, areas of sediment deposition, failing rock and gunite slope protection, and eroding or incised channels. For the eroding shoulders, stabilization will consist of compacted aggregate base, rock or seed with blanket roadside channels, and rock bowls or dissipators at pipes. For the slopes, rock slope protection and revegetation are proposed. For the failing rock slope protection, replacement of the existing rock with heavier, angular rock is proposed. Where the gunite slope protection is failing, in-kind replacement is proposed, however, Transportation will ~~hire a consultant~~use available resources to perform an in-depth evaluation which may result in more extensive stabilization techniques than in-kind replacement. The two eroding or incised channels will be stabilized with seed with blanket or rock, if velocities are too great for blanket. Depending on availability, salvaged sod could be used to replace the seed and blanket material.

To improve hydrologic conveyance, seven new pipes are proposed to replace existing pipes that are either damaged or undersized and one new pipe is proposed at a new conveyance location. The inlets and outlets of the pipes will be connected to CSP inlets or stabilized with rock bowls or flared-end sections with rock dissipators. The deep AC swales along the north side of Elks Club Drive will be replaced with more shallow AC swales providing safer roadway conditions and allow County Maintenance staff to clean the swales with a sweeper. In the flatter reach of Elks Club Drive, between Bel Aire Circle and the Boca Raton Drive ROW, impaired AC swale will be replaced with new AC swale that directs runoff onto the adjacent CTC parcels. Ponding within the road shoulder of Apple Valley Drive will be minimized with the interception of runoff from Pebble Beach Drive, above. These flows will be conveyed via channel across publicly owned parcels to Apple Valley Drive south of the ponding location. Runoff would then be conveyed south in a roadside channel to the pipe at the Apple Valley Drive and Meadow Vale Drive intersection.

To intercept and treat a portion of the runoff currently reaching the channels and basins in the Southern Pines Drive and Boca Raton Drive ROWs, surface flow from upper area watersheds will be conveyed into 22 infiltrating CSP inlets that also have the capacity to store sediment. Some CSP inlets will replace older inlets that currently do not provide infiltration or storage. An additional CSP inlet will be installed at the pipe inlet on the north end of Cherry Hills Circle in order to capture sediment and treat runoff before flows cross the subdivision boundary toward the Upper Truckee River. Treatment and sediment capture will also be provided through an infiltrating sediment basin proposed on a CTC parcel at the Boca Raton Drive and Meadow Vale Drive intersection and infiltrating channels directing runoff to re-water areas on CTC parcels from Boca Raton Drive and Elks Club Drive.

No conveyance or treatment is proposed for watershed A as storm runoff from this watershed will be treated by the Meyers SEZ and Erosion Control Project to be constructed in 2017.

A total of 9 public parcels are proposed for use with Alternate 1.

Alternative 2

Figure 19 depicts the facilities and treatments proposed for Alternative 2. Alternative 2 is a reduction in scope from that shown in Alternative 1.

The work proposed along Elks Club Drive in Alternative 1 is much more comprehensive than that shown in Alternative 2. The County's Tahoe Maintenance and Operations is proposing to grind and resurface Elks Club Drive within approximately 5 years. Funding to include this work as part of this Project was applied for but not granted. The proposed grades and elevations of the roadway are not known at this time. Installing the south CSP inlets, shoulder stabilization measures, and the upper road AC swale R&R as part of this Project could result in these improvements not functioning integrally with the future roadway. Therefore, most of these items have been omitted from Alternative 2. The elements retained are those that we believe could be installed or constructed without impacting the future work. The resurfacing of Elks Club Drive will be completed at such time when funding is available.

The conditions requiring source control remain the same as that outlined in Alternative 1, but the proposed source control areas have been reduced from 31 locations depicted in Alternative 1 to 24 locations. For the remaining eroding shoulders, stabilization will consist of compacted aggregate base, rock or seed with blanket roadside channels, and rock bowls or dissipators at pipes. Eroding slope locations were reduced because they were found to be beyond the County ROW on private property or conditions were found to be not as compromised as other locations. For the remaining eroding slopes, rock slope protection and revegetation are proposed. For the failing rock slope protection, replacement of the existing rock with heavier, angular rock is proposed. Where the gunite slope protection is failing, in-kind replacement is proposed, however, Transportation will ~~hire a consultant~~use available resources to perform an in-depth evaluation which may result in more extensive stabilization techniques than in-kind replacement. The two eroding or incised channels will be stabilized with seed with blanket or rock, if velocities are too great for blanket. Depending on availability, salvaged sod could be used to replace the seed and blanket material.

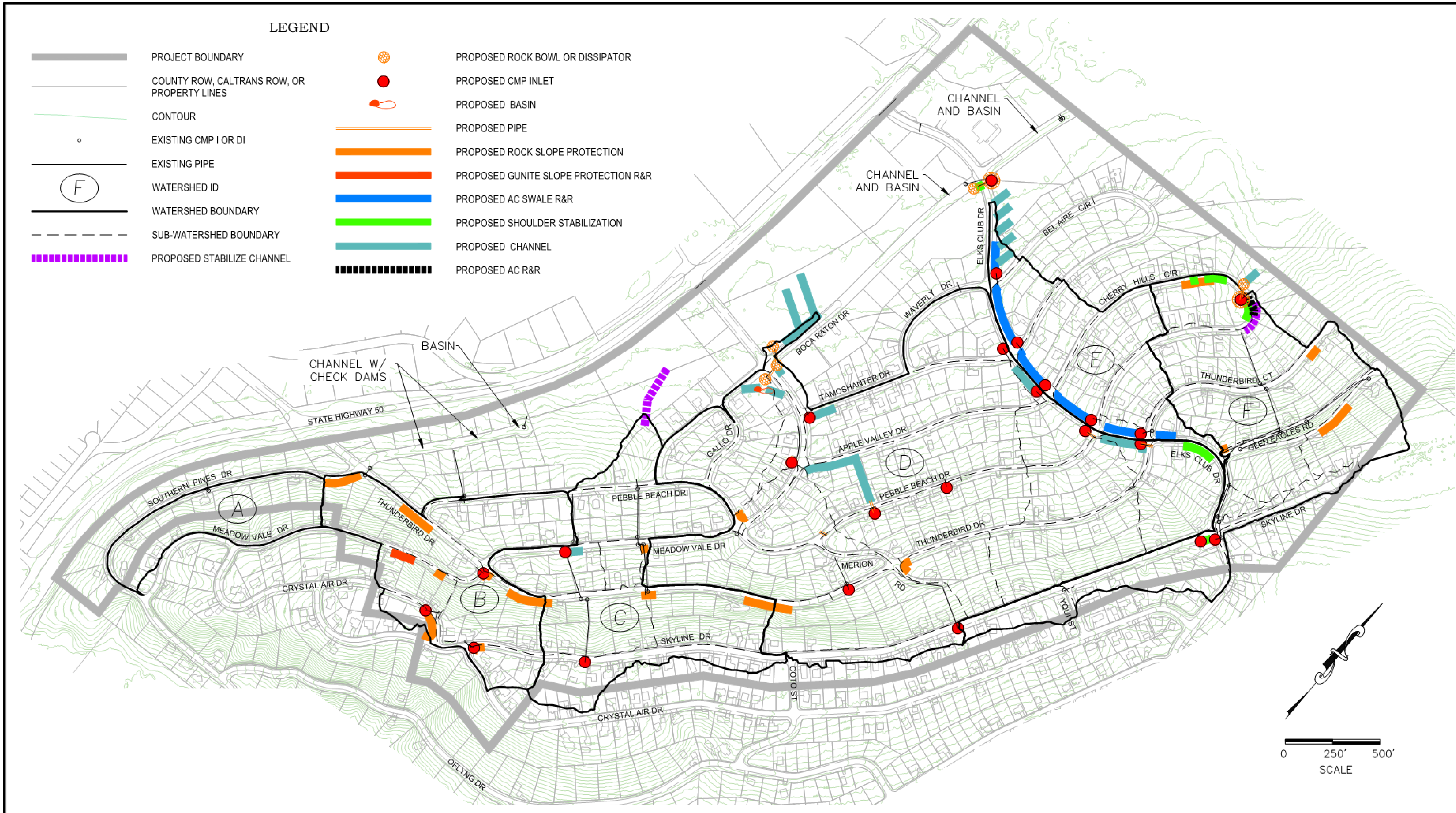
To improve hydrologic conveyance, four new pipes are proposed to replace existing pipes that are either damaged or undersized. This is a reduction from the eight pipes proposed in Alternative 1. The inlets and outlets of the pipes will be connected to CSP inlets or stabilized with rock bowls and flared-end sections with rock dissipators. In the flatter reach of Elks Club Drive, between Bel Aire Circle and the Boca Raton Drive ROW, impaired AC swale will be replaced with new AC swale that directs runoff onto the adjacent CTC parcels.

To intercept and treat a portion of the runoff currently reaching the channels and basins in the Southern Pines Drive and Boca Raton Drive ROWs, surface flow from the upper area watershed will be conveyed into six infiltrating CSP inlets that also have the capacity to store sediment. This is a reduction from the 22 inlets proposed in Alternative 1.

Treatment and sediment capture will also be provided through an infiltrating sediment basin proposed on a CTC parcel at the Boca Raton Drive and Meadow Vale Drive intersection and infiltrating channels directing runoff to re-water areas on CTC parcels from Boca Raton Drive and Elks Club Drive.

No conveyance or treatment is proposed for watershed A as storm runoff from this watershed will be treated by the Meyers SEZ and Erosion Control Project to be constructed in 2017.

A total of 7 public parcels are proposed for use with Alternate 1.



COUNTY OF EL DORADO
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COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

ALTERNATIVE 1

FIGURE 18

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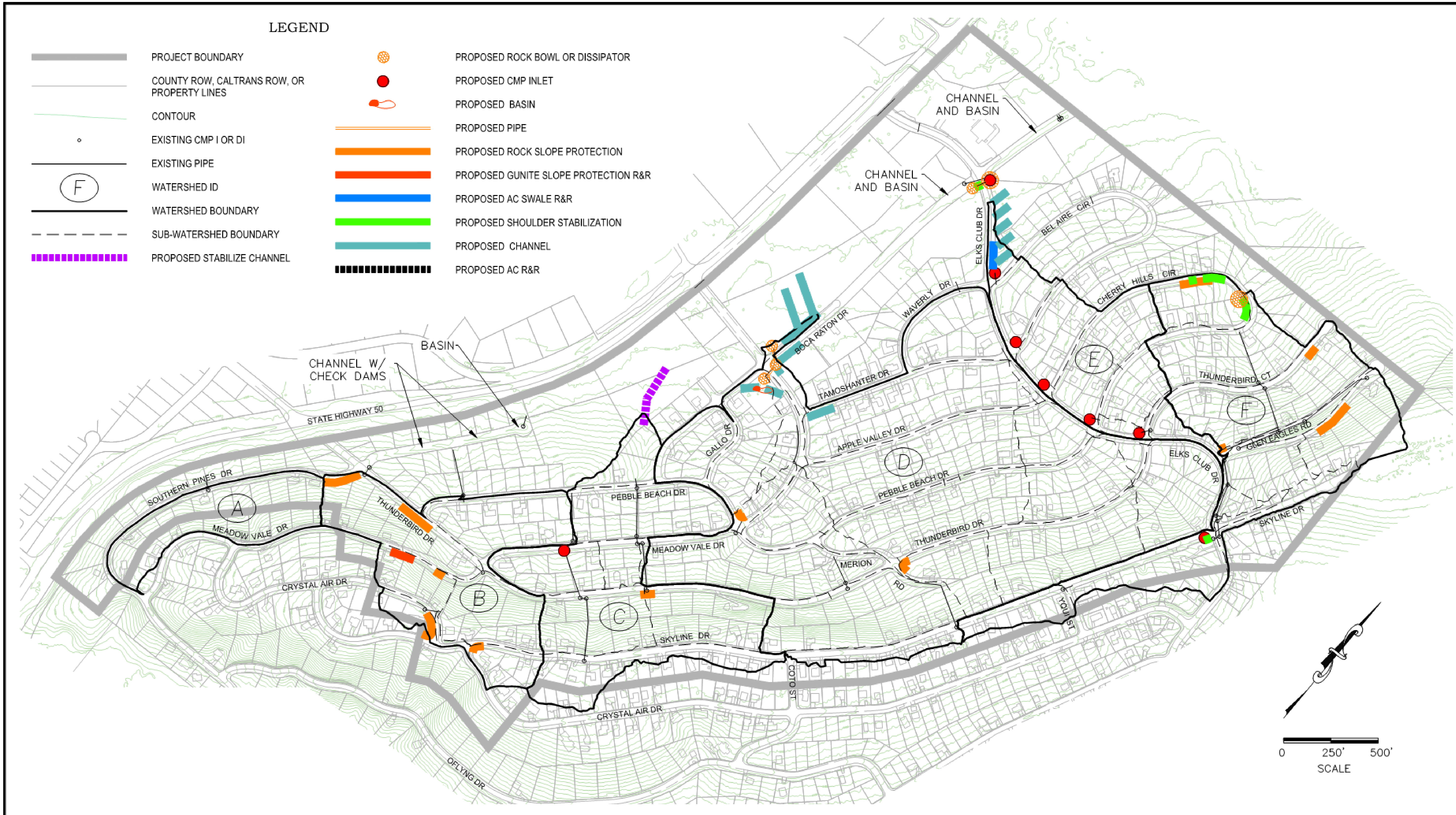

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

COUNTRY CLUB HEIGHTS
EROSION CONTROL PROJECT

ALTERNATIVE 2

FIGURE 19

DATE: 10/2016	PROJECT NO.: 95191	BY: ALD

8.2 Alternative Unit Costs for Meeting Goals

The costs to satisfy the goals of the Project were calculated on a unit cost basis for each alternative in order to evaluate and compare each alternative's relative benefit and are presented in Appendix C. For this analysis the capital costs for each facility were based on bid summaries from Transportation's erosion control and air quality projects within the Lake Tahoe Basin constructed between 2010 and 2015. Maintenance costs were not considered within this Report, however, the maintenance costs will be a factor during the evaluations. The unit costs of each alternative were calculated for the cost to provide source control, the cost to reduce and treat runoff volume and peak flow, and the cost to reduce sediment.

The unit cost to reduce runoff volume, peak flow, and sediment was calculated by assuming that treatment will be provided by each alternative at an annual frequency of 22 storm events per year for the design life of the alternative. The basis for this treatment frequency is the mean annual precipitation at the Project site divided by the 1-inch per hour design storm event. The effectiveness of each BMP was determined by estimating the storage volume, determining the infiltration volume for a 1-hour duration based on an assumed 1.25 feet per hour infiltration rate, and estimating the runoff total suspended sediment concentration based on an assumed 150 mg/L.

The estimate of the cost to reduce runoff volume and peak flow assumes that runoff is directed to each BMP throughout the design storm event. The calculation of the cost to reduce sediment assumes that each treatment alternative is maintained throughout the design life and operated in a first flush configuration which results in complete reduction of suspended sediment from the runoff. These conditions will not be satisfied for most storm events experienced during the design life of each BMP; however, since the purpose of this analysis is to evaluate the relative effectiveness of each BMP, these assumptions are accepted for this alternatives comparison.

Calculation of BMP Unit Costs

Source control unit cost was calculated using equation 7:

$$C_C = \frac{U_{bmp}}{D} \qquad (7)$$

Where C_C is the unit cost of source control in \$/square feet, U_{bmp} is the unit construction cost of the BMP in \$/square feet, and D is the design life in years.

The volume reduction unit cost was calculated by equation 8:

$$C_V = \frac{U_{bmp} / (D \cdot F)}{V_I + V_S} \qquad (8)$$

Where C_V is the unit cost of the reduction in runoff volume in \$/cubic feet, F is the annual frequency of storm events, V_I is the volume of infiltration in one hour per unit in cubic feet, and V_S is the volume of storage per unit in cubic feet.

The peak flow reduction unit cost was calculated by equation 9:

$$C_P = \frac{U_{bmp} / (D \cdot F)}{V_I / 3600} \qquad (9)$$

Where C_P is the unit cost of the reduction in peak flow in $/cfs.

The total suspended sediment concentration reduction unit cost was calculated by equation 10:

$$C_S = 16{,}017 \cdot \frac{U_{bmp} / (D \cdot F)}{(V_I + V_S) \cdot C_i} \qquad (10)$$

Where C_S is the unit cost of the reduction of sediment in runoff in $/pounds and C_i is the concentration of total suspended sediment in mg/L.

BMP Unit Costs

The relative unit costs for source control and the reduction in runoff volume, peak flow, and sediment is presented in Table 11. These relative unit costs are presented as one tool for evaluating the relative cost efficiency of the alternatives considered in this analysis and does not represent a complete evaluation of each alternative's overall effectiveness. In addition, depending on site conditions, some BMPs are more appropriate than others for source control, hydrologic design, and treatment of runoff, irrespective of the unit costs. This variable is not represented in the unit cost analysis.

Table 11 – BMP Unit Costs

BMP	Unit	Unit Costs			
		Reduce Volume (per ft^3)	Reduce Peak (per cfs)	Reduce Sediment (per lb)	Source Control (per ft^2)
CSP Inlet	EA	$0.23	$2779.39	$24.25	N/A
Sediment Basin	EA	$0.02	$183.27	$2.09	N/A
Aggregate Base	SF	$0.01	$43.64	$1.29	$0.33
AC Swale R&R	LF	N/A	N/A	N/A	$1.16
AC Pavement	SF	N/A	N/A	N/A	$0.80
Rock-Lined Channel	LF	$0.04	$128.00	$3.80	$0.98
Rock Dissipator/Bowl	SF	$0.03	$96.00	$2.85	$0.73
Seed and Blanket Chnl[1]	LF	$0.02	$74.18	$2.20	$0.57
Revegetation	SF	NA	NA	NA	$0.10
Rock Slope Protection	SF	NA	NA	NA	$0.57
Sweeping	---	NA	NA	$0.05	NA

1. Seed and blanket channel is the assumed improvement for the proposed "stabilize channel" shown on Figures 18 and 19.

CMP Inlets, sediment basins, rock-lined channels, seed and blanket channels, and rock dissipators or bowls all perform satisfactorily in volume and peak flow reduction and treatment of runoff. The most cost efficient means of satisfying the reduction in volume, peak flow, and suspended sediment goals of the Project are with the sediment basin, seed and blanket channel, and rock dissipators or bowls. However, a sediment basin is limited in that it requires a fairly large footprint and is not suitable for all site conditions. The seed and blanket channel is limited in that it is not suitable for all site conditions and is not suitable for detention.

Revegetation and aggregate base are practical and inexpensive means of source control but are not suitable for all site conditions. Rock-lined channels and seed and blanket channels provide source control at a higher cost but also provide multiple benefits which offset the unit cost increase.

For the collection of sediment, sweeping costs per pound recovered are significantly less expensive than all other BMPs. The effectiveness of removing fines (<125 microns) with sweeping is in question.[36]

9.0 Evaluating Alternatives

If designed and maintained properly, Alternatives 1 and 2 should meet the objectives of this Project. Alternative 3, the "do nothing" alternative, will not meet the Project objectives and therefore is not included in this evaluation. However, ongoing sweeping of the impervious surfaces within the County ROW will continue to reduce the amount of sediment which is available for suspension in runoff thereby reducing the sediment load. The Preferred Alternative will be outlined in the Preferred Alternative Memorandum and will be selected based on the evaluation of the two mitigating alternatives and the degree to which each meets the objectives of the Project.

9.1 Alternatives Summary

Alternative 1 reflects a complete, comprehensive plan and provides mitigation measures for those areas within the Project area currently without adequate source control, hydrologic design, and treatment.

Alternative 2 proposes a reduction in scope from that shown in Alternative 1 due to potential conflicts and constraints.

Both alternatives propose slope and road shoulder stabilization, infiltrating CSP inlets, pipe replacement, rock dissipators and rock bowls, seed and blanket channels, and a sediment basin at the intersection of Meadow Vale Drive and Boca Raton Drive. Implementing this combination of source control, hydrologic design, and treatment elements is a necessary component of the Project.

Reduction of Coarse, Fine, and Very Fine Sediments

The reduction of coarse, fine, and very fine sediments by 33%, 25%, and 12%, respectively, is one of the goals of the Project. Table 12 reflects the anticipated reduction in sediment from each facility. The reduced sediment was calculated by assuming that reduction will be provided by each facility at an annual frequency of 22 storm events per year for the design life of the facility. The basis for this treatment frequency is the mean annual precipitation at the Project site divided by the 1-inch per hour design storm event. The effectiveness of each BMP was determined by estimating the storage volume and estimating the runoff total suspended sediment concentration based on an assumed 150 mg/L.

Table 12 – Anticipated Load Reduction Per Storm Event

BMP	Unit	Reduced Sediment Load (lbs)
CSP Inlet	EA	0.2812
Sediment Basin	SF	0.0304
Aggregate Base	SF	0.0117
AC Swale R&R	LF	N/A
AC Pavement	SF	N/A
Rock-Lined Channel	LF	0.0351
Rock Dissipator/Bowl	SF	0.0117
Seed and Blanket Channel[1]	LF	0.0351
Revegetation	SF	0.0008
Rock Slope Protection	SF	0.0008

1. Seed and blanket channel is the assumed improvement for the proposed "stabilize channel" shown on Figures 18 and 19.

Taking the values from Table 12 and the proposed facilities from Figures 18 and 19, the total potential sediment load reduction per storm event from Alternative 1 would be 292 lbs. and from Alternative 2, 228 lbs. Using the unit costs from Table 11, the cost per pound of sediment load reduction per storm event for each alternative would be $759 and $491, respectively.

Reduction in Runoff Volume and Peak Flow

Reduction in total runoff volume and peak discharge leaving the site from a 1-inch/hour storm by 33% is a goal of the Project. Table 13 reflects the anticipated reduction in volume and peak flow from each facility. The reduced runoff volume and peak flow was calculated by assuming that treatment will be provided by each facility at an annual frequency of 22 storm events per year for the design life of the facility. The basis for this treatment frequency is the mean annual precipitation at the Project site divided by the 1-inch per hour design storm event. The effectiveness of each BMP was determined by estimating the storage volume and determining the infiltration volume for a 1-hour duration based on 1.25 feet per hour infiltration rate.

Table 13 – Anticipated Volume and Peak Reduction Per Storm Event

BMP	Unit	Reduced Volume (ft^3)	Reduced Peak (cfs)
CSP Inlet	EA	30.03	0.0025
Sediment Basin	SF	3.25	0.0003
Aggregate Base	SF	1.25	0.0003
AC Swale R&R	LF	N/A	N/A

BMP	Unit	Reduced Volume (ft^3)	Reduced Peak (cfs)
AC Pavement	SF	N/A	N/A
Rock-Lined Channel	LF	3.75	0.0010
Rock Dissipator/Bowl	SF	1.25	0.0003
Seed and Blanket Chnl[1]	LF	3.75	0.0010
Revegetation	SF	0.08	0.0000
Rock Slope Protection	SF	0.08	0.0000

1. Seed and blanket channel is the assumed improvement for the proposed "stabilize channel" shown on Figures 18 and 19.

Capital Costs

Rough Order of Magnitude (ROM) cost estimates, prepared for each of the Project Alternatives, can be found in Appendix D. The quantities for each alternative were tabulated based on the proposed improvements shown on Figures 18 and 19. The unit costs for each facility were based on bid summaries from Transportation's erosion control and air quality projects within the Lake Tahoe Basin constructed between 2010 and 2015. Table 14 presents a summary of the ROM construction cost estimates for each of the alternatives.

Table 14 – Alternative ROM Construction Cost Estimate Summary

	Alt-1	Alt-2
Mobilization	$ 45,000	$ 35,000
Traffic Control	$ 20,000	$ 20,000
Sweeping	$ 17,500	$ 12,500
Trench Excavation & Safety	$ 7,000	$ 7,000
Install & Maintain Temp BMPs	$ 20,000	$ 16,000
Remove & Dispose CMP Inlet	$ 9,900	$ -
Remove CMP	$ 18,000	$ 11,025
CMP Inlet	$ 103,500	$ 27,000
18" HDPE Pipe	$ 50,600	$ 26,950
Sediment Basin	$ 17,000	$ 17,000
AC Swale R&R	$ 110,490	$ 12,615
AC Pavement R&R	$ 8,400	$ 8,400
Rock-Lined Channel	$ 58,960	$ -
Seed & Blanket Channel	$ 84,150	$ 68,850
Gunite Slope Protection R&R	$ 80,000	$ 80,000
Rock Slope Protection	$ 316,200	$ 210,800
Rock Bowl/Rock Dissipator	$ 5,200	$ 4,550
AB Shoulder Stabilization	$ 12,050	$ 3,550
Misc Grading	$ 440	$ 440

	Alt-1	Alt-2
Revegetation (Basin)	$ 3,000	$ 3,000
Revegetation (General)	$ 18,000	$ 12,000
California Conservation Corps	$ 6,000	$ 4,200
Project Sign	$ 2,000	$ 2,000
Subtotal	$1,013,390	$ 582,880
Contingency Percentage	20%	20%
Contingency	$ 202,680	$ 116,580
Total	**$1,216,070**	**$ 699,460**

Planning and Design Costs

Planning and design costs include costs associated with the preparation of environmental documentation and plans and specifications up to the 100% stage. The level of detail and effort necessary for the planning and design for Alternative 1 would be greater than that for Alternate 2; therefore, the planning and design costs for Alternative 1 would be greater.

Operations and Maintenance Costs

The new facilities and treatments for Alternative 1 are greater in number than that for Alternate 2; therefore, the operations and maintenance costs for Alternative 1 would be greater.

It is anticipated that each mitigating measure will be relatively inexpensive to operate and maintain.

Design Life

The design life is defined as the number of years the project is expected to function adequately without new construction. The design life for the components of both alternatives is similar due to the nature of each alternative being functionally and structurally the same.

ROW Acquisition

It is anticipated that all work will be performed within the County ROW or publicly owned parcels. A total of 9 public parcels are proposed for use with Alternate 1 and a total of 7 public parcels are proposed for use with Alternate 2. License Agreements will be obtained from the CTC for this work. The proposals for Alternatives 1 and 2 are such that the costs for preparation and processing of these documents will be similar with either alternative.

Impacts to Existing Utilities

Impacts to existing utilities include costs associated with removals or relocations. Potential impacts to existing utilities are greater with Alternative 1.

Disturbance

Disturbance is defined as new temporary and/or new permanent earth disturbance. Work proposed in paved locations and areas exhibiting erosion or other forms of existing disturbance is not considered to be creating new disturbance. Work proposed in areas previously disturbed but restored as well as undisturbed areas is considered new disturbance.

With the work proposed on the CTC parcels along Elks Club Drive, Boca Raton Drive, and the intersection of Boca Raton Drive and Meadow Vale Drive, both alternatives will likely cause new disturbance. Alternative 2 is a reduction in scope from Alternative 1; therefore, Alternative 2 will create less disturbance overall.

Aesthetics

Aesthetics represent the appearance of the completed Project. Each alternative is comprised of similar erosion mitigation techniques which have equivalent aesthetic characteristics.

Constructability

Constructability reflects the ease of construction of each alternative. The proposals for Alternatives 1 and 2 are such that constructability aspects are similar.

Groundwater Impacts

Groundwater impacts reflect the potential for positive or negative effects to existing groundwater flow patterns, or mixing polluted surface water with groundwater. For the treatment of runoff, both alternatives rely on infiltrating structures, channels, and a sediment basin. Any potential impact to groundwater quality will be similar with either alternative.

Impervious Surfaces

An impervious surface is a surface that does not allow infiltration of surface water. There is no change in impervious surface area with either alternative.

Road Sand/Cinders

Road sand/cinders are introduced sediments from County operations. The County's Tahoe Maintenance and Operations routinely applies road sands/cinders within the Project area. The volume of road sand/cinder captured in the proposed facilities will be greater with Alternative1.

Manmade Nutrient Sources

Manmade nutrient sources are from private lands and utilities such as lawn fertilizers and wastewater pipes. The collection, conveyance, and treatment of manmade nutrients are not goals for this Project. For this reason the alternatives were not formulated specifically to address manmade nutrients.

Public Safety

There will be no changes to public safety following implementation of either alternative.

Wildlife Habitat

Impacts to wildlife habitat within uplands and SEZs with thriving native vegetation is currently being studied. However, it is anticipated there will be no changes to wildlife habitat as a result of the implementation of either alternative.

Vector Control

During mosquito breeding season, water that is standing for 72 hours or longer could facilitate mosquito production. Both alternatives will be designed and constructed in a manner that standing water will be present for less than 72 hours.[37]

Permitability

The length of time required to obtain the construction permits for Alternatives 1 and 2 will likely be the same considering that the proposed facilities for each alternative are similar.

Fundability

Fundability considers the number of agencies needed for funding each alternative and the requirements each alternative must meet to receive that funding. The Project currently is underfunded to construct Alternatives 1 or 2, though there are available funds that can be applied within the scope of Alternative 2.

Alternative 1 proposes work far beyond the scope of Alternative 2. With approximately $430,000 (less contingency) separating Alternative 1 from Alternative 2, the number of funding sources for construction of Alternative 1 would need to be expanded.

9.2 Alternatives Evaluation Summary and Recommendations

The County has looked at the existing conditions in the Project area to identify problems and analyzed potential solutions to address the problems noted. The alternatives selected by the County were those that the County determined will meet the Project goals and objectives.

Implementing Alternative 1 ensures that the Project goals and objectives will be met to the maximum extent practicable. This alternative will mitigate water quality issues not currently addressed with the existing drainage systems and will stabilize areas that are beginning to become a detriment to water quality. At an estimated cost of $1,013,390, Alterative 1 is outside the range of current secured funding and available grant funds that could be applied for at this time.

Implementing Alternative 2 will also meet the goals and objectives for the Project to the maximum extent practicable. Although smaller in scope than Alternative 1, this alternative will still mitigate water quality issues not currently addressed with the existing drainage systems and will stabilize areas that are beginning to become a detriment to water quality. At an estimated cost of $582,880, Alternative 2 is within range of the current secured funding and potentially available grant funding that the County is applying for.

Implementation of Alternative 3 will not meet the goals and objectives for the Project as it does not provide any source control, hydrologic, or water quality benefits. Without these benefits, sediment from eroding slopes and shoulders will continue to obstruct conveyance facilities, impede the ability of the infiltrating channel and basin systems to infiltrate and treat runoff, and impact the water quality of the Upper Truckee River.

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