



TROUT UNLIMITED

APPENDIX K: SPROUL CREEK WATER DEMAND ANALYSIS

Prepared by:

Trout Unlimited

Prepared for:

California Trout North Coast Region
North Coast Regional Water Quality Control Board
and
State Water Resources Control Board
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SEPTEMBER 1, 2017

Introduction

Sproul Creek is a tributary to the South Fork Eel River located in southern Humboldt County. It flows north, entering the South Fork Eel River about 2.3 miles downstream from Benbow Dam. Sproul Creek drains a watershed of approximately 23.98 square miles. The majority of the watershed is dominated by redwood and mixed hardwood forests. Elevations range from 310 feet at the mouth of Sproul Creek to 1,000 feet at the headwaters. Sproul Creek currently supports five salmonid species, including Coho and Chinook salmon, and steelhead trout.

Like watersheds throughout coastal California, the Mediterranean climate of the Sproul Creek watershed results in the majority of the rainfall and streamflow occurring during the rainy half of the year. Streams recede gradually through the spring and summer, and some reaches become intermittent by late summer. This creates naturally harsh conditions for juvenile salmonid species, which must persist through at least one summer in freshwater streams before migrating to the ocean: the receding flow results in receding habitat, food supply, and chemical transport (as well as less dissolved oxygen and higher temperature) through the season.

Like many parts of rural northern California, many small cultivations of marijuana have appeared in the Sproul Creek watershed over the past two decades. These operations require water through the summer season, and because the climate results in no rainfall during this period, people must obtain water from ambient sources to meet water needs. Surface water is often utilized via instream diversions, or storage of water into reservoirs in winter for use in summer, to meet dry-season water needs. Depending on where, how, and when this water is obtained, diversions of water for human uses



could adversely affect an already low rate of streamflow, further reducing the habitat and associated biophysical properties important for fish survival.

This report examines the water needs in several key tributaries and areas in the Sroul Creek watershed to determine how the magnitude of water need varies in different parts of the watershed. Those areas with particularly high water needs may be suitable areas of focus to improve streamflow and restore aquatic ecosystems through water storage projects.

Methods

Human water needs are commonly met through diversion from springs or streams, groundwater extraction and in some cases involve storage in reservoirs. Direct diversions from streams or pumping groundwater from an adjacent shallow aquifer can appreciably reduce streamflow and the amount and quality of instream habitat available for over-summering salmonids. To assess how human water needs have the potential to influence flow conditions and how these vary spatially throughout the watershed, we digitized land-use and estimated the quantity of human water needs in each of our focus study areas (Figure K-1).

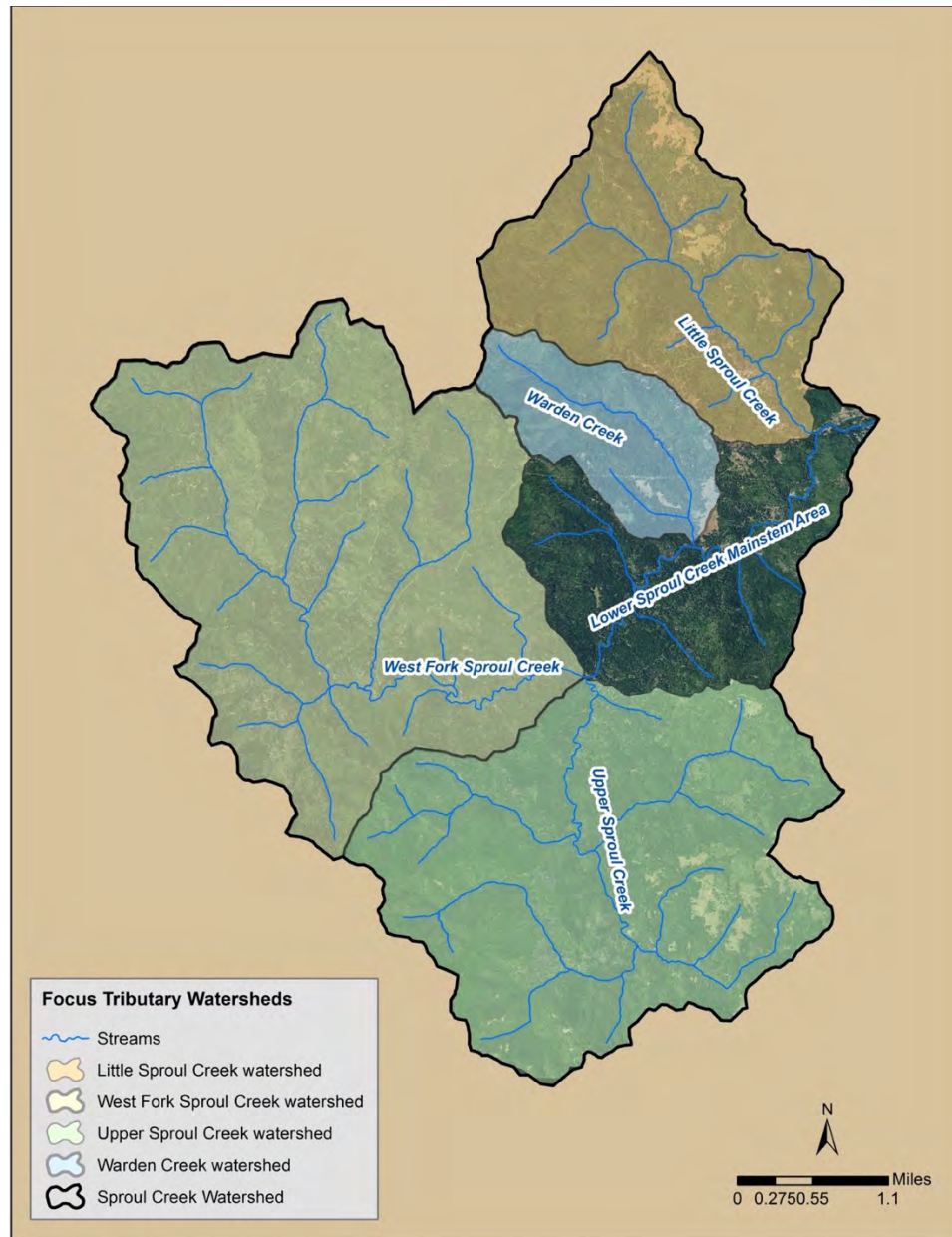


Figure K-1. Focus watersheds and areas in the Sproul Creek watershed.

Digitization of Human Development

We hand-digitized features of human development, including marijuana cultivation, building structure locations, and reservoirs, using aerial imagery in ArcMap to model the human development footprint. Marijuana cultivation and reservoirs were mapped as polygons; residences and other structures were mapped as points. We used each of these features to develop an assessment of total human water need in several regions of the Sproul Creek watershed. We estimated water need using the following rules:

- **Residential.** We identified all building structures in the Sproul Creek watershed as either residential or residential storage (e.g., garage or shed) resulting in a total of 27 residences. For all those identified as residential we assigned a standard water use value of 355 gallons per day

per structure for a five-month summer period (152 days), and 155 gallons per day for a seven-month winter period (213 days). These summer and winter values are based on regional water use estimates. The values also account for considerably greater water use in summer than in winter (a 130% increase in summer), which is a common feature for water use in California.

- ***Marijuana.*** We used our spatially-based dataset of marijuana grows to estimate water use and to estimate the total water need of indoor and outdoor marijuana grows. Estimates of water use for marijuana were based on 6 gallons per plant per day from June through October (based on numbers described by Bauer *et al.*, 2015).

We then calculated the water need associated with each of the above water uses, in addition to the annual and dry-season water needs for each of the following portions of the Sproul Creek watershed (Figure K-1):

- *Little Sproul Creek*
- *West Fork Sproul Creek*
- *Upper Sproul Creek*
- *Warden Creek*
- *Mainstem Sproul Creek*

Water Rights

The Electronic Water Rights Information Management System (eWRIMS) database lists water rights on file with the State Water Board throughout the state of California. For the Sproul Creek watershed, eWRIMS lists 2 domestic registrations, 1 stock pond registration, and 27 riparian claims (Table 1).

Table 1. List of water rights in the Sproul Creek watershed, from the eWRIMS database.

Application Number	WR Type	Diversion begin date	Diversion end date	Total Days	Diversion Rate (cfs)	WR Face Value Amount (AF)	Volume of Storage (AF)	Comments
S025258	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0005	0.199	0.921	Riparian
D032343	Registration Domestic	10/16/2011	7/14/2012	272	0.0000	0.000	0.000	
S024096	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0012	0.442	0.000	Riparian
S016637	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0003	0.106	0.000	Riparian
S025140	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0007	0.258	0.000	Riparian
S024841	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0002	0.086	0.044	Riparian
S024680	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0008	0.292	0.114	Riparian
S024838	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0018	0.644	0.092	Riparian
S016636	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0000	0.006	0.000	Riparian
S024908	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0008	0.304	0.077	Riparian
S024810	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0004	0.150	0.095	Riparian
S024847	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0023	0.855	0.037	Riparian
S024741	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0005	0.200	0.009	Riparian
D032360	Registration Domestic	10/9/2011	9/30/2012	357	0.0003	0.110	0.110	
S025440	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0002	0.074	0.000	Riparian
C003068	Stockpond	10/1/2011	9/30/2012	365	0.0005	0.200	0.200	
S025007	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0003	0.110	0.019	Riparian
S024813	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0004	0.140	0.099	Riparian
S024848	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0023	0.855	0.004	Riparian
S024893	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0002	0.080	0.028	Riparian
S016327	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0049	1.780	0.000	Riparian
S025259	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0003	0.107	0.921	Riparian
S025712	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0037	1.350	0.157	Riparian
S024811	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0004	0.150	0.095	Riparian
S025222	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0006	0.203	0.086	Riparian
S024840	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0001	0.020	0.015	Riparian
S025710	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0022	0.809	0.037	Riparian
S024846	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0010	0.350	0.506	Riparian
S025254	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0005	0.199	0.921	Riparian
S024845	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0010	0.350	0.602	Riparian

Results

Marijuana cultivation is the most visible and accessible form of human water use in the Sproul Creek watershed; however, the rural residences and the growing forest also significantly contribute to the watershed's water need. In the Sproul Creek watershed we documented 27 residential structures, 2.4 acres of outdoor grows, and 0.9 acres of indoor grows (Figure K-2). Within the watershed we estimate that there are approximately 4,686 marijuana plants being grown both indoors and outdoors. In the sections below, we describe the amount of water needed in each focus region, and within the total Sproul Creek watershed.

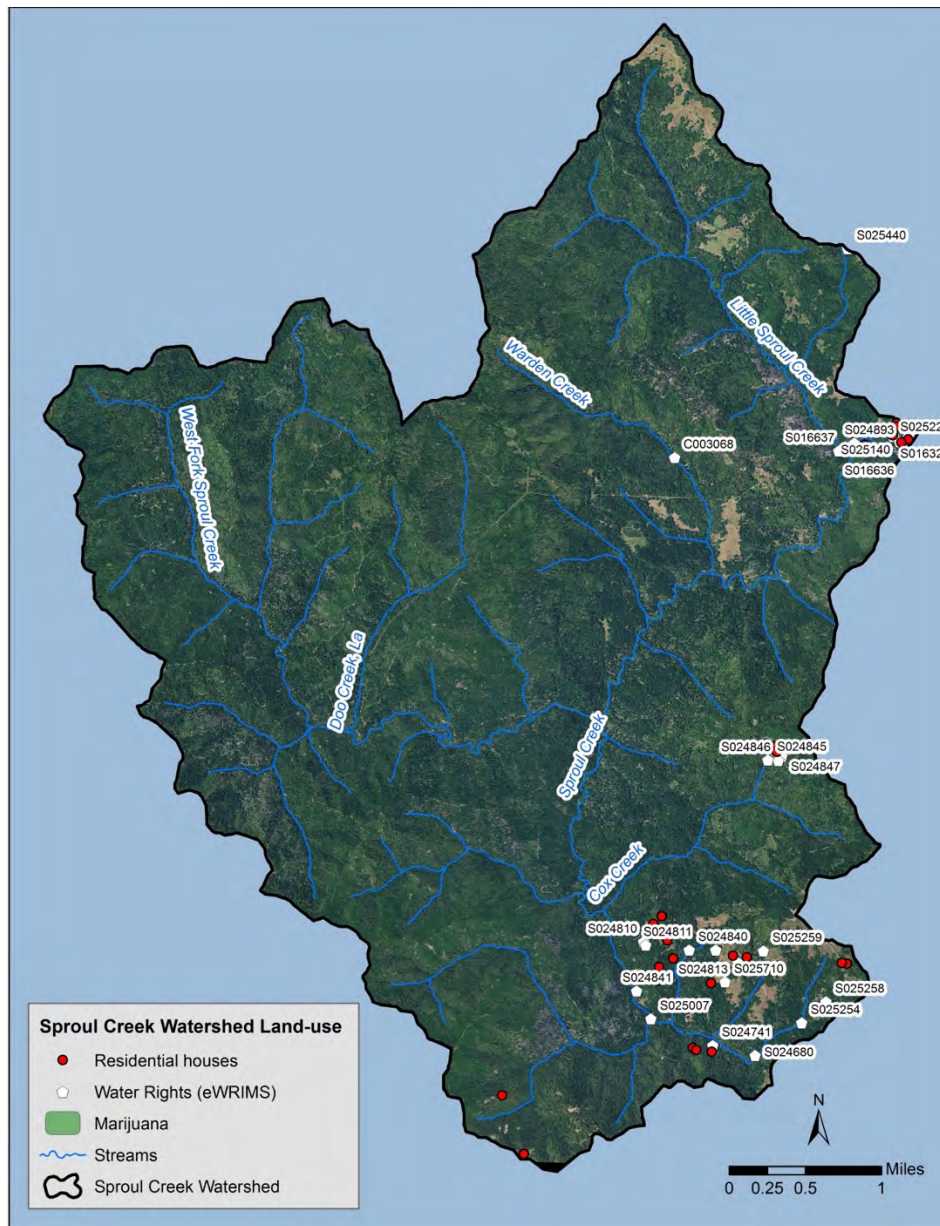


Figure K-2. Land-use in the Sproul Creek watershed.

Little Sproul Creek

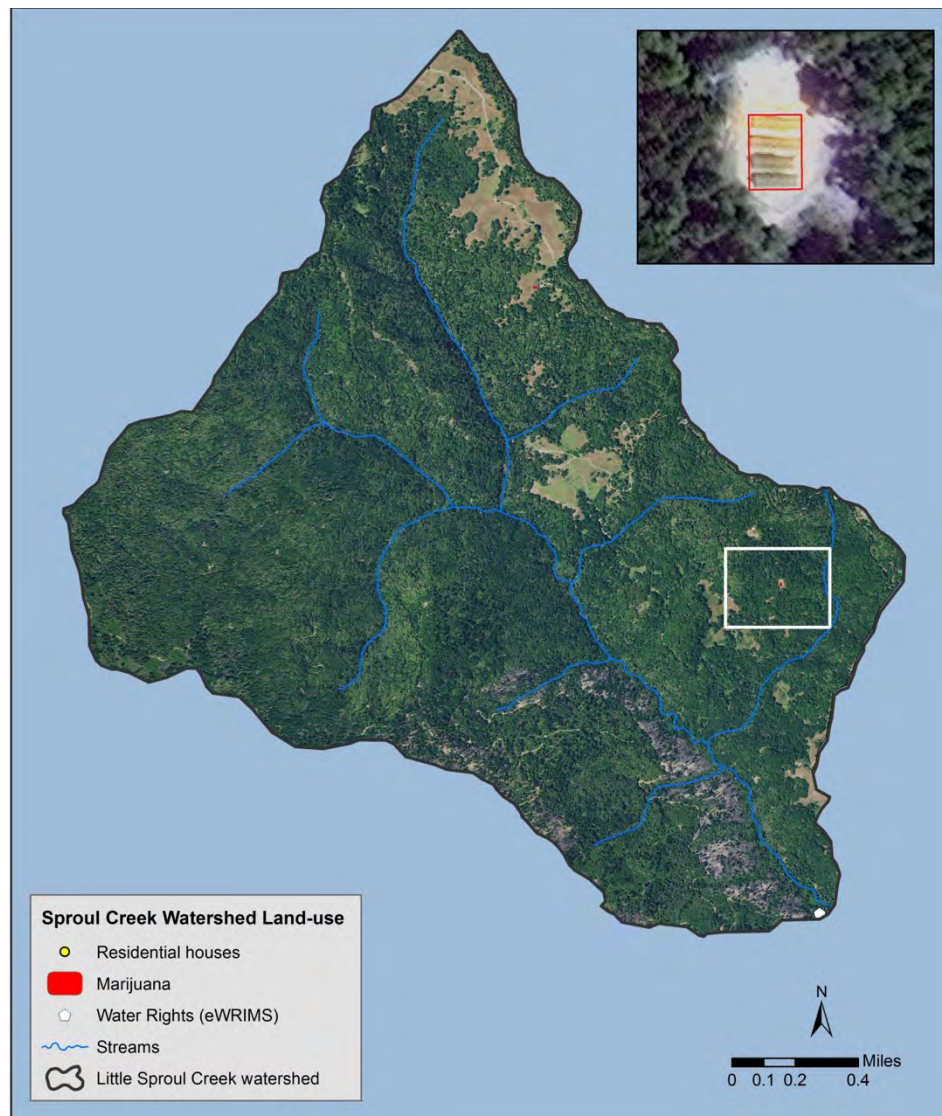


Figure K-3. Land-use in the Little Sproul Creek watershed.

Little Sproul Creek consists of about 1.8 stream miles and flows southeasterly, entering Sproul Creek about 0.5 miles upstream from the South Fork Eel River confluence. The Little Sproul Creek watershed drains a basin of approximately 2,483 acres. It consists primarily of undeveloped forested land and a few small marijuana grows. The marijuana grows in this watershed have no associated water right. Tables K-2a and K-2b describe the details of the water needs in the Little Sproul Creek watershed. Based on these figures, we estimate the total annual human water need for the Little Sproul Creek watershed is 0.75 acre-feet.

Table K-2a and K-2b. Little Sproul Creek marijuana cultivation and water needs.

Agriculture						Structures
Marijuana (acres)	Outdoor Plants	Outdoor Area (acres)	Indoor Plants	Indoor Area (acres)	Total Plants	Residential
0.156	29	0.089	242	0.067	271	0

Annual Water Use			Summer Water Use	
Annual Pot Water (6 GPD per plant)	Annual Pot Water AF/YR	Annual Residential Water AF/YR	Summer Residential Water AF/YR	Summer Pot Water Use AF/Yr
243,900	0.749	0.000	0.000	0.749

West Fork Sproul Creek

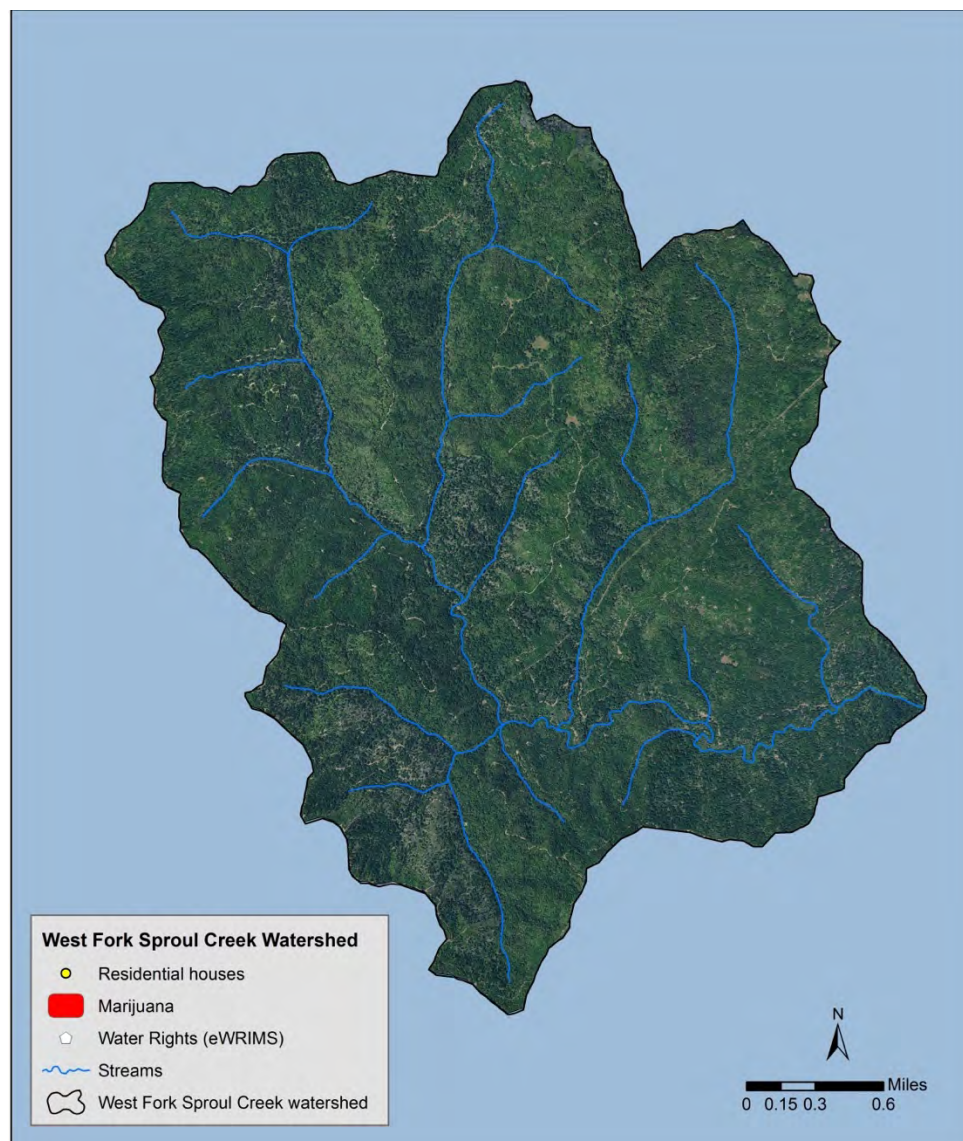


Figure K-4. Land-use in the West Fork Sproul Creek watershed.

West Fork Sproul Creek (Figure K-4) consists of about 5.1 stream miles and flows southeasterly, entering Sproul Creek about four miles upstream from the South Fork Eel River. The West Fork Sproul Creek watershed drains a basin of approximately 5,430 acres. It consists primarily of undeveloped forested land. Due to the absence of any agriculture or residences, we estimate that there is no human water need in the West Sproul Creek watershed.

Upper Sproul Creek

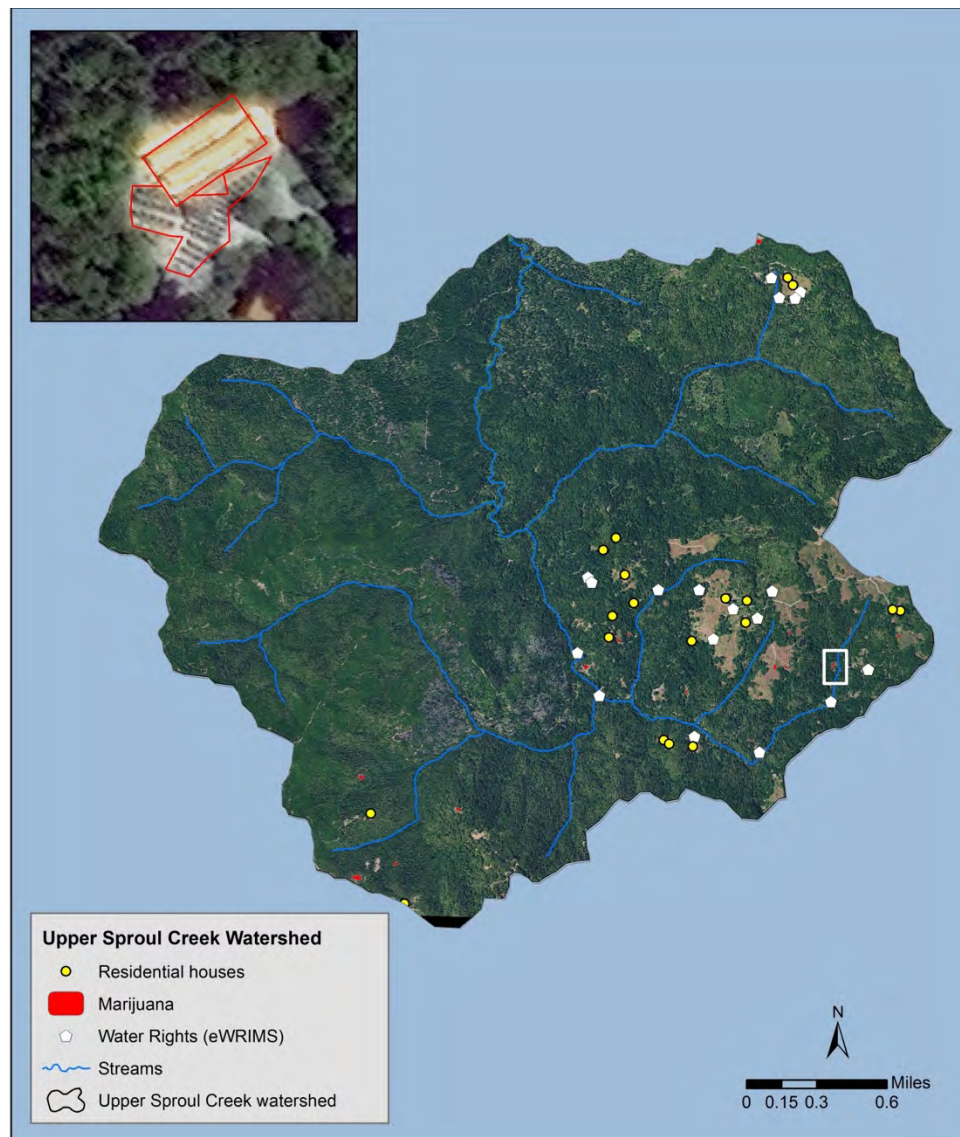


Figure K-5. Land-use in the Upper Sproul Creek watershed.

The Upper Sproul Creek watershed drains a basin of approximately 4,436 acres (Figure K-5). It consists primarily of undeveloped forested land, rural residences, and several marijuana grows. The Upper Sproul Creek watershed has the highest concentration of marijuana cultivation and water needs. We digitized 2.3 acres of outdoor marijuana grows, 0.9 acres of indoor marijunana grows and 20 rural residents. Based on these figures, we estimate the total annual human water need for the Little Sproul Creek watershed is 8.3 acre-feet. During the dry season, we estimate that human water need is 7.3 acre-feet (Table K-3a and K-3b).

Table K-3a and K-3b. Upper Sproul Creek marijuana cultivation and water needs.

Agriculture						Structures
Marijuana (acres)	Outdoor Plants	Outdoor Area (acres)	Indoor Plants	Indoor Area (acres)	Total Plants	Residential
3.134	906	2.261	3,167	0.872	4,073	20

Annual Water Use			Summer Water Use	
Annual Pot Water (6 GPD per plant)	Annual Pot Water AF/YR	Annual Residential Water AF/YR	Summer Residential Water AF/YR	Summer Pot Water Use AF/Yr
3,665,700	11.250	5.339	3.312	11.250

Warden Creek



Figure K-6. Land-use in the Warden Creek watershed.

Warden Creek consists of about 1.8 stream miles and flows southeasterly, entering Sproul Creek about 2.5 miles upstream from the South Fork Eel River confluence (Figure K-6). The Warden Creek watershed drains a basin of approximately __ acres. It consists primarily of undeveloped forested land. Due to the absence of any agriculture or residences, we estimate that there is no human water need in the Warden Creek watershed.

Lower Mainstem Sproul Creek Area

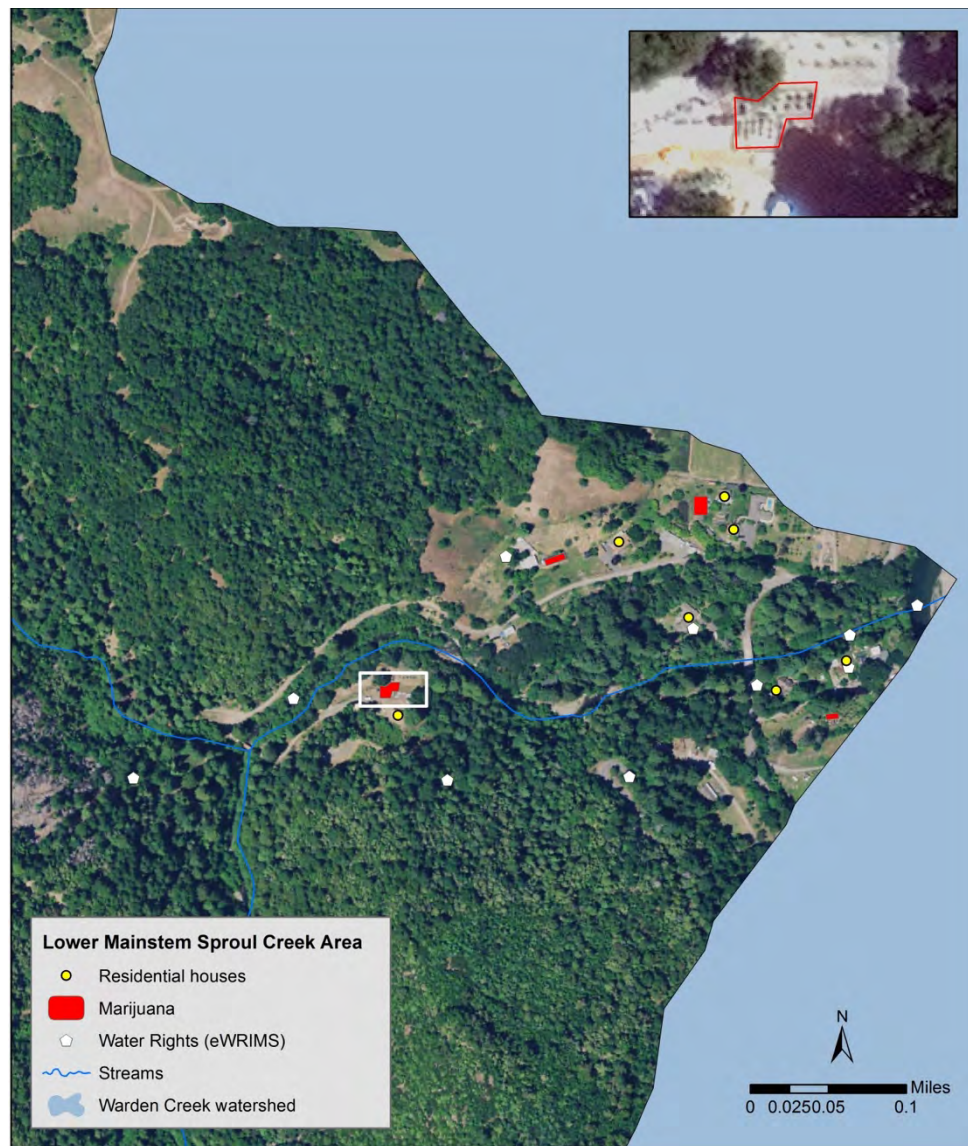


Figure K-7. Land-use in the Lower Mainstem Sproul Creek watershed.

The Lower Mainstem Sproul Creek Area lies at the bottom of the watershed, above the confluence with the South Fork Eel River (Figure K-7). This area consists primarily of undeveloped forested land, rural residences, and several marijuana grows. Based on these figures, we estimate the total annual human water need for the mainstem Sproul Creek watershed is 2.8 acre-feet. We estimate that human water need is 2.1 acre-feet during the dry season (Table K-4a and K-4b)

Table K-4a and K-4b. Lower Mainstem Sproul Creek Area marijuana cultivation and water needs.

Agriculture						Structures
Marijuana (acres)	Outdoor Plants	Outdoor Area (acres)	Indoor Plants	Indoor Area (acres)	Total Plants	Residential
0.2	46	0.1	296	0	342	7

Annual Water Use			Summer Water Use	
Annual Pot Water (6 GPD per plant)	Annual Pot Water AF/YR	Annual Residential Water AF/YR	Summer Residential Water AF/YR	Summer Pot Water Use AF/Yr
307,800	0.9	1.9	1.2	0.9

Total Sproul Creek Watershed Water Need

In the Sproul Creek watershed we digitized 3.5 acres of marijuana grows and 27 residential houses. Using these numbers we estimate that the total annual human water need for the watershed is approximately 20.15 AF per year, and the total human water need during the dry season is approximately 17.41 AF. Table K-5 shows the areas of marijuana cultivation, total structure counts and water use (annual and summer) for each focus watershed/area.

Table K-5. Marijuana cultivation and water needs by focus watershed/area and for the entire Sproul Creek watershed.

Watershed	Agriculture						Structures	Annual Water Use					Summer Water Use	
	Total Marijuana (acres)	Outdoor Plants	Outdoor Area (acres)	Indoor Plants	Indoor Area (acres)	Total Plants	Residential Houses	Annual Pot Water (6 GPD per plant)	Annual Marijuana Water Use AF/YR	Annual Residential Water Use AF/YR	Total Annual water Need	Summer Residential Water Use AF/YR	Summer Marijuana Water Use AF/Yr	Total Summer water Need
Little Sproul Creek	0.16	29	0.09	242	0.07	271	0	243,900	0.75	0.00	0.75	0.00	0.75	0.75
West Fork Sproul Creek	0.00	0	0.00	0	0.00	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Upper Sproul Creek	3.13	906	2.26	3,167	0.87	4,073	20	3,665,700	11.25	5.34	16.59	3.31	11.25	14.56
Warden Creek	0.00	0	0.00	0	0.00	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Mainstem Sproul Area	0.19	46	0.11	296	0.00	342	7	307,800	0.94	51.87	2.81	1.16	0.94	2.10
Sproul Creek Watershed	3.48	981	2.46	3,705	0.94	4,686	27	4,217,400	12.94	7.21	20.15	4.47	12.94	17.41

Marijuana water use makes up 64% of the total annual water use and 74% of the total summer human water use (Figures K-8a and K-8b). Out of the focus watersheds/areas, the Upper Sproul Creek watershed has the largest areas of marijuana cultivation, concentration of rural residences, and largest human water need in the watershed (Figures K-9a and K-9b).

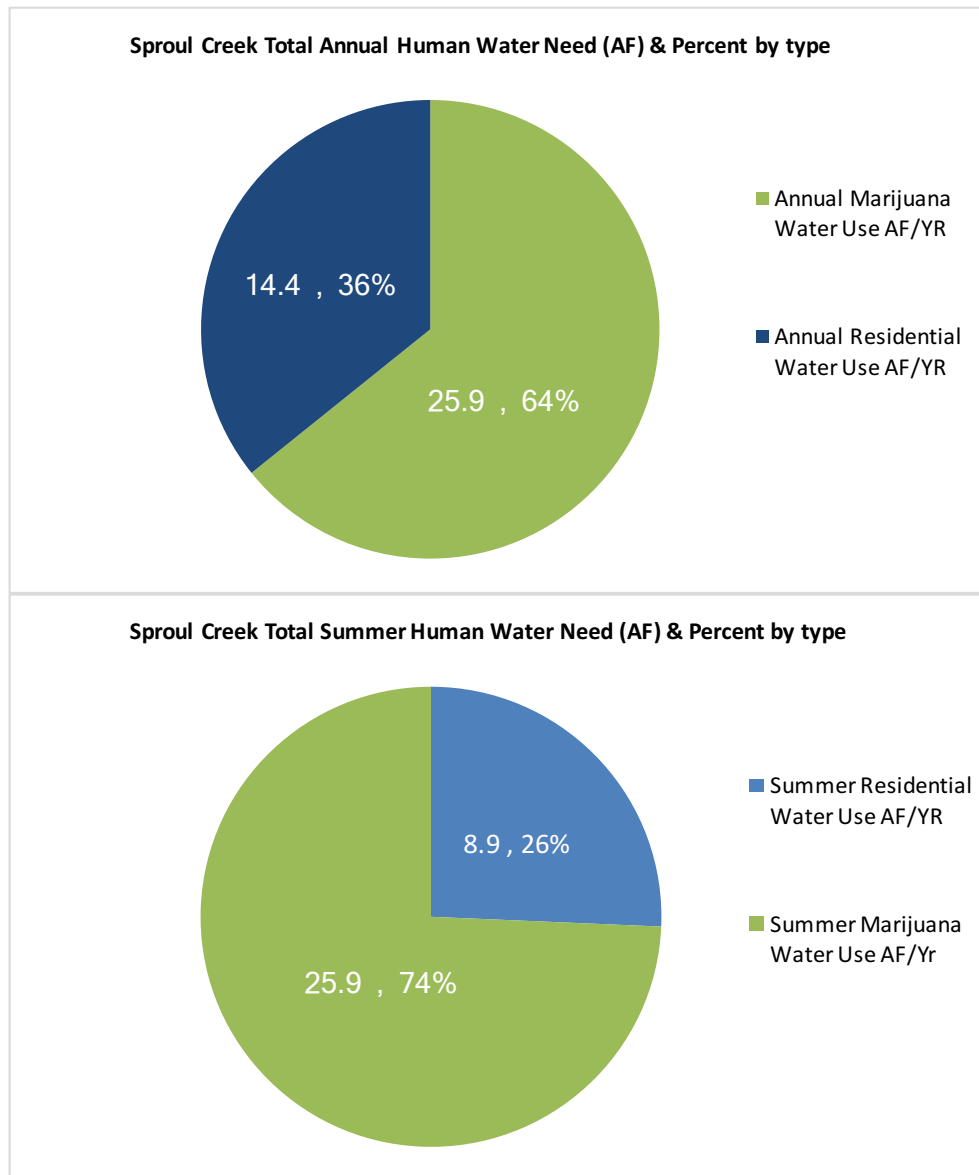


Figure K-8a and K-8b. Sproul Creek human water use by type in AF and by percent, annually and during the dry season (summer).

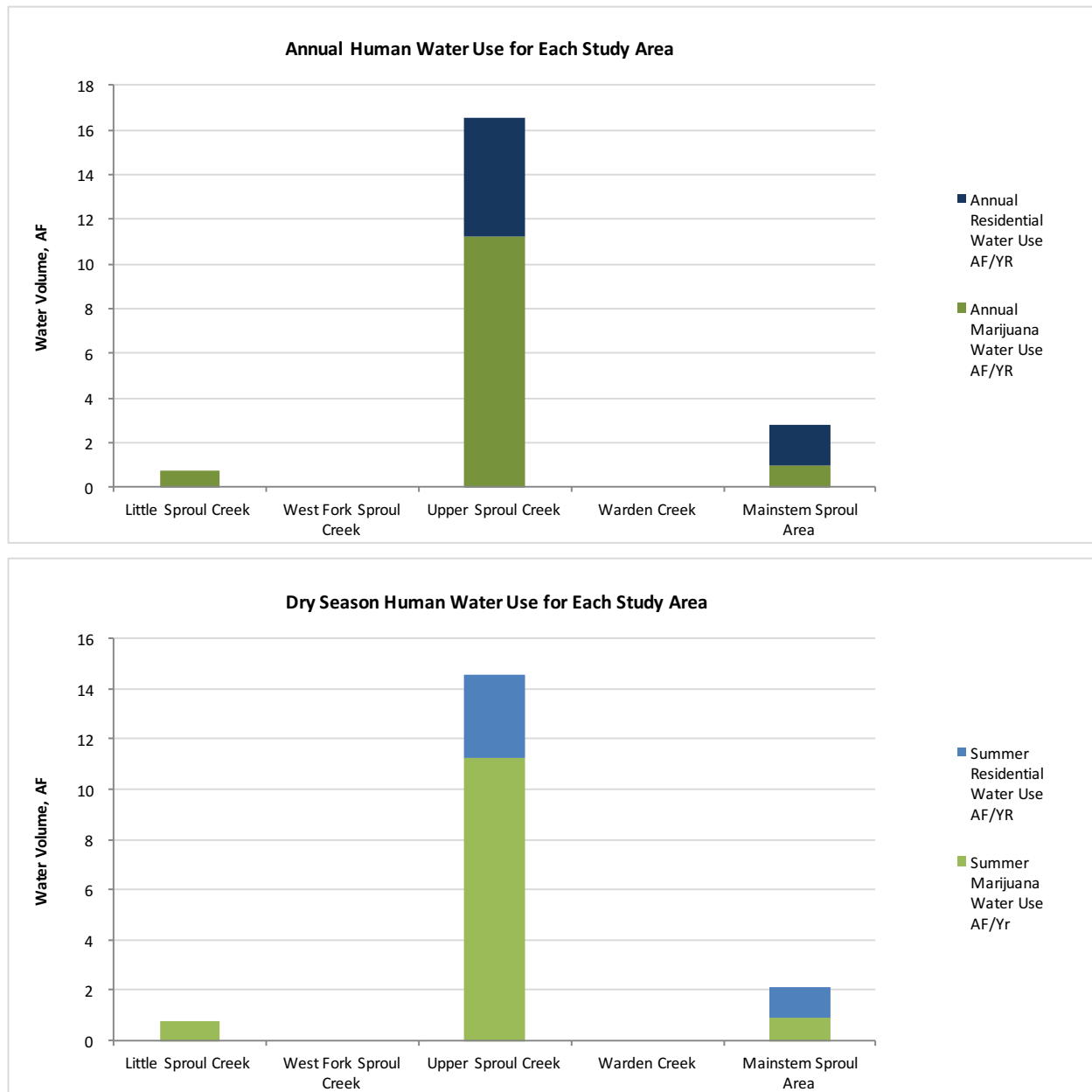


Figure K-9a and K-9b. Human water use by type and by focus watershed/area annually and during the dry season (summer).

Water Need vs Discharge

Annual and summer discharge for Sproul Creek was calculated by scaling discharge from the USGS gauge at Bull Creek to the Sproul Creek watershed, data provided by Cal Trout. On an annual basis and during the dry season the watershed has enough discharge to meet all human water needs (Figure K-10a and K-10b). Annual human water demand is approximately 0.04% of the total average annual discharge and summer human water demands take up approximately 1.38% of the total average summer discharge. During one of the driest month of the year (September), the total dry season monthly human water need is approximately 5.73% of the total average monthly discharge (Figure K-11).

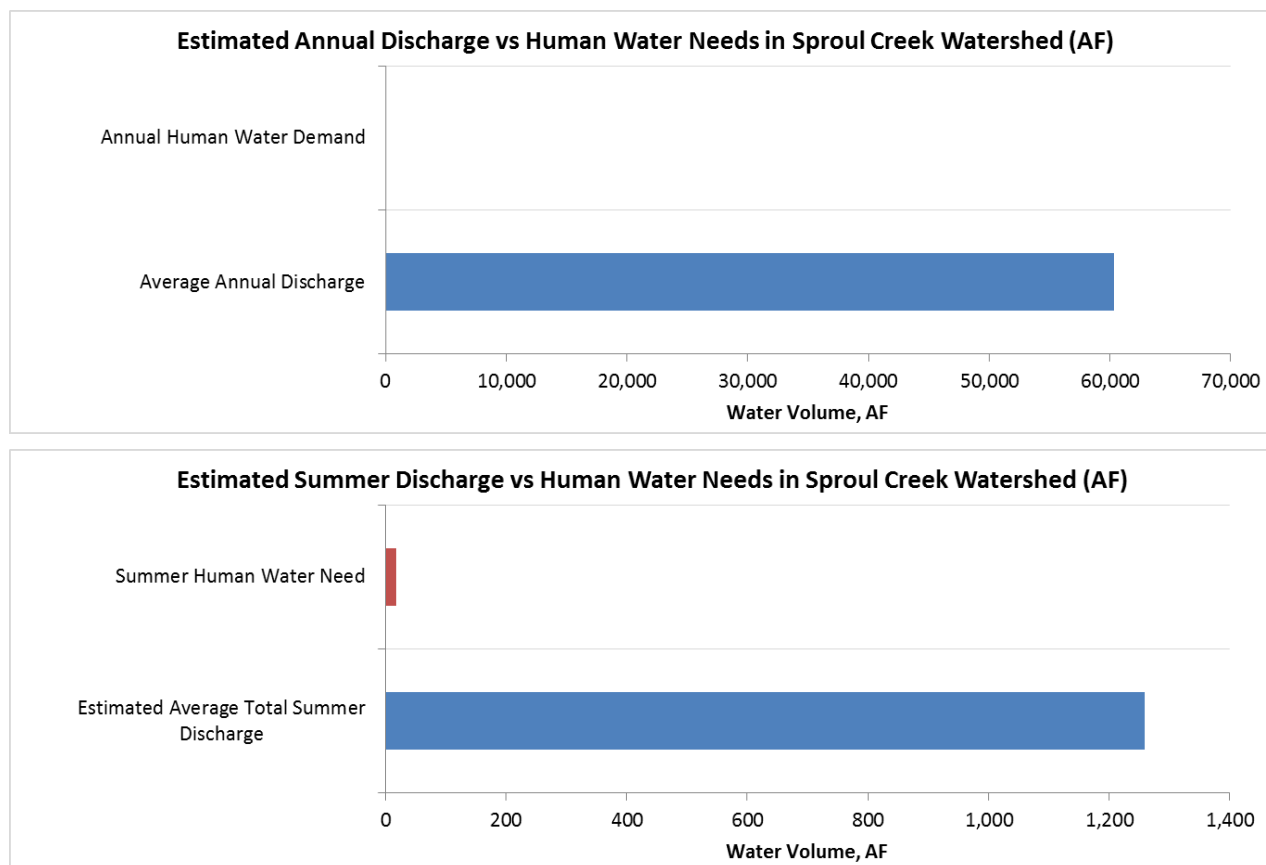


Figure K-10a and K-10b. Estimated annual and summer discharge compared to human water needs in the Sproul Creek watershed.

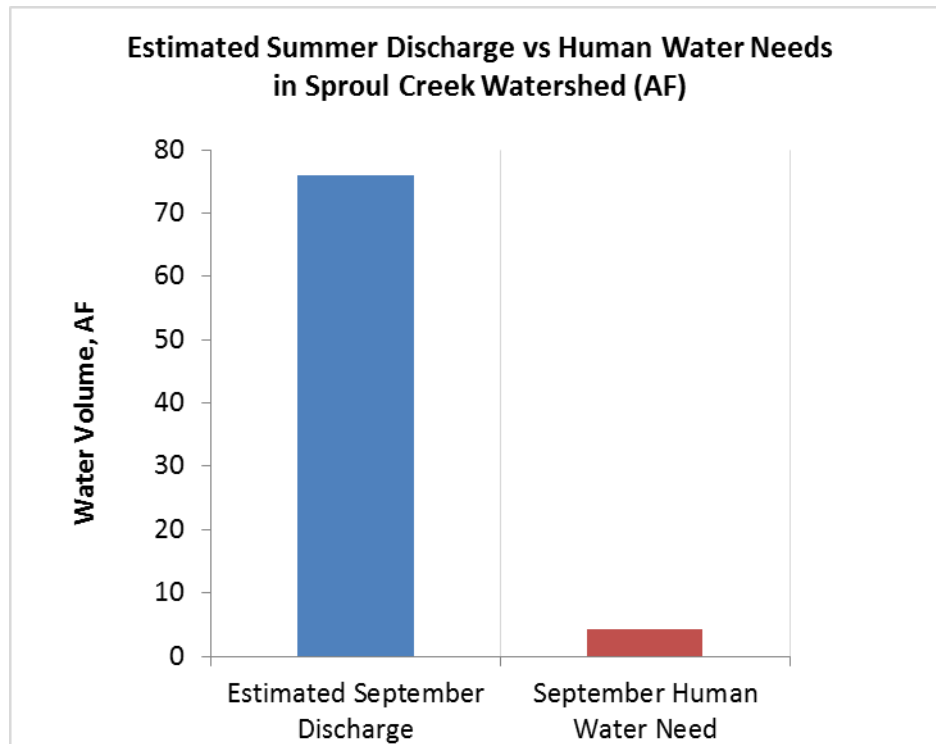


Figure K-11. Estimated summer discharge compared to human water needs during the month of September.

Opportunities for Water Storage in the Upper Sproul Creek Watershed

Similar to many watersheds in Coastal California, understanding the timing and availability of water sources and supply in the Sproul Creek watershed is fundamental to managing the resource effectively. Our analysis shows that on an annual basis the watershed receives enough rainfall and has enough discharge to meet all human water needs; however, the timing of water need could be better aligned with the availability of water. There are 27 riparian water right holders in the watershed that have the right to divert water from abient sources of water on a continuous basis 365 days per year. We recommend working with the landowners whom hold riparian water rights in the Upper Sproul Creek watershed to alter the timing of their diversions from year-round to winter storage (Figure K-12). In particular we recommended focusing outreach efforts and water storage projects, at first, on the water rights clustered in the upper portion of the watershed, to have the greatest benefit on enhancing streamflows. The water rights we recommend prioritizing outreach to first are heighted in Table K-6.

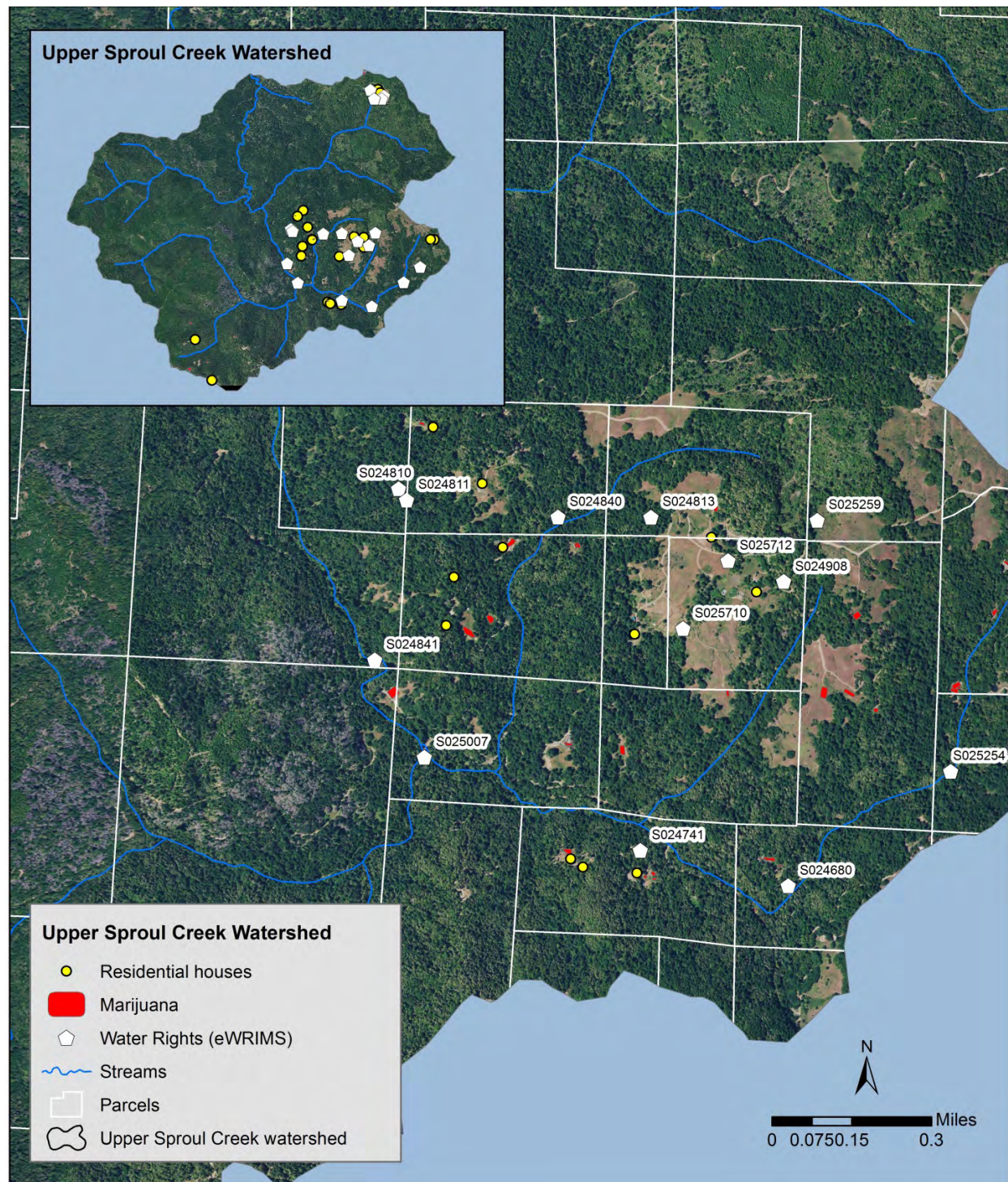


Figure K-12. Riparian water right holders in the Upper Sproul Creek Watershed.

Table K-6. Priority water right holders that may offer opportunities for water storage projects.

Application Number	WR Type	Diversion begin date	Diversion end date	Total Days	Diversion Rate (cfs)	WR Face Value Amount (AF)	Volume of Storage (AF)	Comments
S025258	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0005	0.199	0.921	Riparian
D032343	Registration Domestic	10/16/2011	7/14/2012	272	0.0000	0.000	0.000	
S024096	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0012	0.442	0.000	Riparian
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S024741	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0005	0.200	0.009	Riparian
D032360	Registration Domestic	10/9/2011	9/30/2012	357	0.0003	0.110	0.110	
S025440	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0002	0.074	0.000	Riparian
C003068	Stockpond	10/1/2011	9/30/2012	365	0.0005	0.200	0.200	
S025007	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0003	0.110	0.019	Riparian
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S025259	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0003	0.107	0.921	Riparian
S025712	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0037	1.350	0.157	Riparian
S024811	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0004	0.150	0.095	Riparian
S025222	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0006	0.203	0.086	Riparian
S024840	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0001	0.020	0.015	Riparian
S025710	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0022	0.809	0.037	Riparian
S024846	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0010	0.350	0.506	Riparian
S025254	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0005	0.199	0.921	Riparian
S024845	Statement of Div and Use	10/1/2011	9/30/2012	365	0.0010	0.350	0.602	Riparian

Conclusions

This study analyzes human water needs in the Sproul Creek watershed on a sub-watershed scale, and provides insights to focus areas where water management could be improved. In the overall study area, on an annual basis approximately 64 percent of all human water needs is needed for marijuana cultivation and 36 percent is needed for residential purposes. Marijuana comprises the largest water need within the watershed but these areas greatly lack water storage, indicating the largest potential to reduce summer water use and restore streamflow. Water storage projects in these areas would significantly reduce human water needs in their associated watersheds. Additionally, small scale domestic storage tanks could benefit summer flows especially in areas where residential homes are clustered. In addition, implementing water storage projects would not only benefit streamflow but could also greatly serve landowners by providing water security in a region where summer water supply can be variable.