Paired Watershed Study to Track Soil Moisture and Alluvial Water Response Before and After Brush Treatments in the Gila Watershed Region, New Mexico

FINAL REPORT, 2014

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Grant Soil & Water Conservation District, 3082 32nd St. Bypass, Ste. C, Silver City NM 88061

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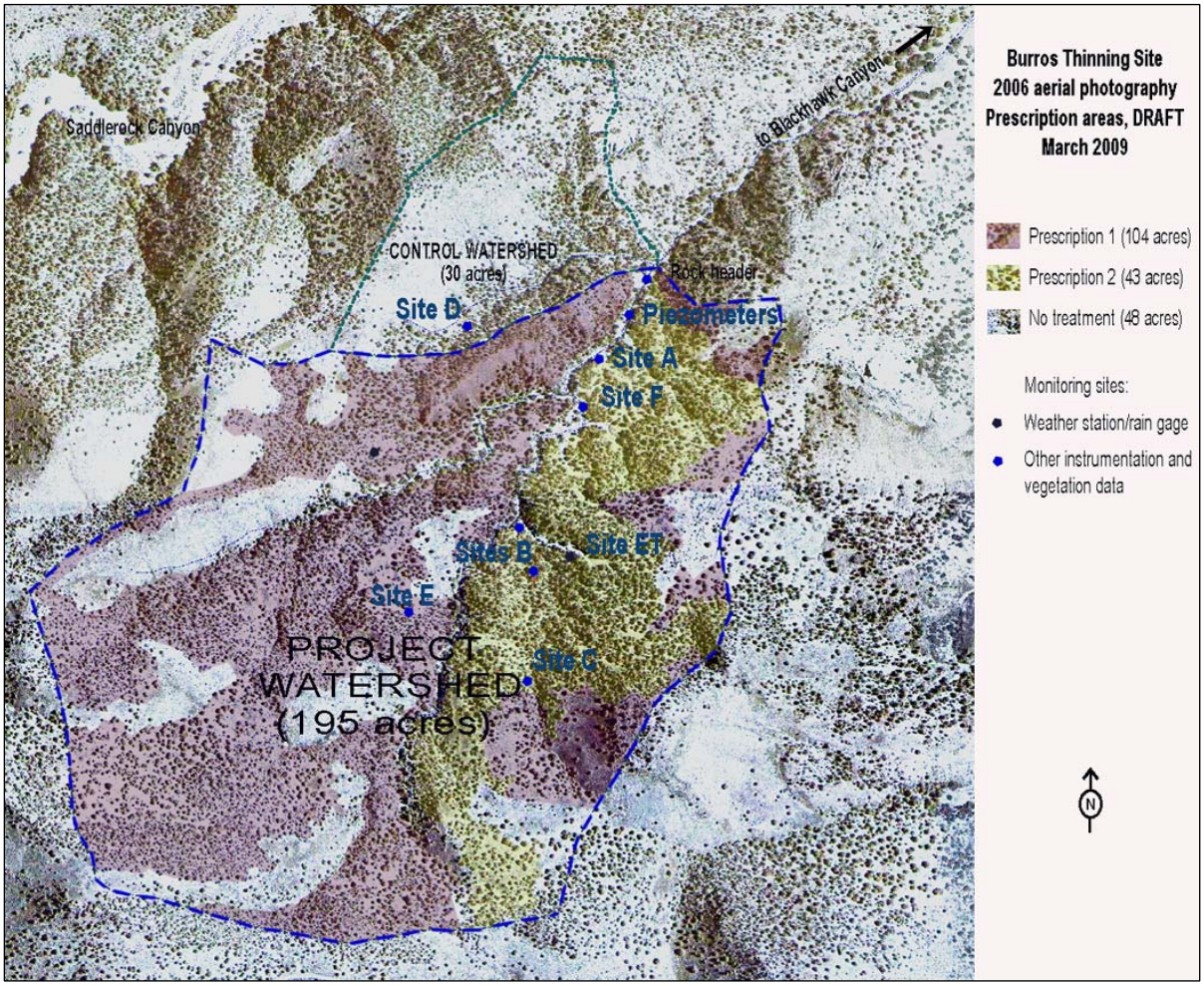
This project encompasses two study areas, in the Burro Mountains and at Stiver Canyon in the Gila River headwaters. This report is accompanied with a CD containing all data collected June 2013-June 2014 at the Burros study site. Data from the project's inception in 2007 were included with the annual reports for project years 2008 through 2011. Project year reports for 2012 and 2013 provided data and summaries for each of those project years.

Fuel thinning treatments at the Burros site were completed in the fall of 2010, following three years of baseline data collection.

Baseline data collection at the Stiver site was suspended in the summer of 2013, as continued restrictions in funding for the Gila National Forest further delayed burning or thinning treatments originally planned at the site. The Silver Fire in the summer of 2013, which burned more than 138,000 acres to the south of the Stiver project area, diverted additional resources from the Black Range and Silver City Ranger Districts. Discussions with Black Range staff regarding potential site treatments will resume in 2015.

BURRO MOUNTAINS STUDY AREA



The Burro Mountains study area, between Blackhawk and Saddlerock Canyons, is shown on the map above. The original soil moisture instrumentation in the study area in the Burros Mountains was replaced in late August, 2010, just prior to thinning treatments at the site. A second round of replacements was conducted this project year, February–April 2014, to replace aging sensors before loss of calibration. Monumented vegetation transects at the site will be re-sampled in early October, 2014, during early vegetation dormancy following the monsoon season. Sensors and other instruments were downloaded in the fall of 2013 and at least monthly from January through June of 2014 . Table 1 summarizes the data collection sites and continuous data collected since study inception in November 2007. Soil moisture data collection sites, identified by letters, are shown on the map above. The map also shows thinning treatment zones established in conjunction with Gila National Forest staff. Treatments were completed between September and December 2010. Graphs on the report CD present the data collected from September 2010 through June 2014.

Table 1. Data collected at the Burro Mountains project area since project start, November 2007.

	Soil moisture sites (15-min data) [1]							
	A	**B1**	**B2**	**C**	**E**	**F**	**D1 (control)**	**D2 (control)**
Dates	11/2007 - 5/2009	11/2007- 6/2014	11/2007- 7/2013	11/2007- 5/2011	5/2008- 3/2011	5/2008- 6/2014	12/2007- 4/2013	6/2012- 9/2013
	5/2011-8/2013		2/2014- 6/2014	11/2011- 11/2012	10/2011- 6/2012			2/2014- 6/2014
	2/2014-6/2014			4/2013- 6/2014	4/2013- 6/2014			

	Vegetation			Soil samples	Climate [2]		Groundwater
	Point	**Biomass**	**Richness**				**Levels, temperature**
Dates	4/2008	3/2009	11/2008	11/2007, 8/2008	11/2007- 6/2014	6/2010- 6/2014	11/2007-6/2014
Sites	A, B1, C, E, ET	A, B1, C, E	C, F	A, B2, C	rain gauge, Barologger	ET	above and below spring/seep

[1] Soil moisture sites are labeled on the map on page 3.
[2] Rain gauge and Barologger data are continuous precipitation and ambient temperature data, respectively. Site ET is the weather station. Continuous weather station data include precipitation (100ths inch), temperature, wind speed, RH, and solar radiation.

Data sets

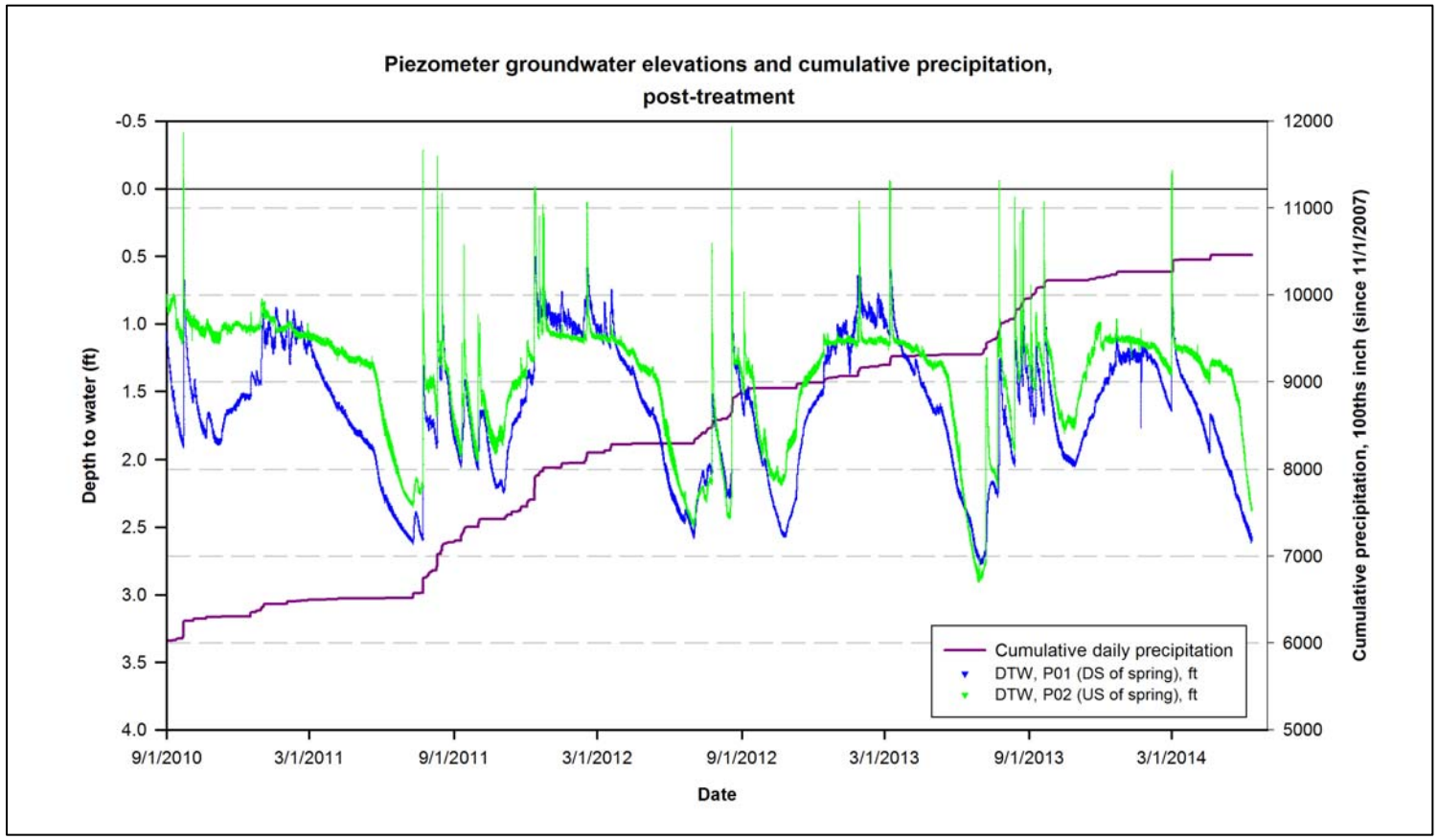
Alluvial groundwater

The most recent data downloaded from the two site piezometers were collected in June 2014. Piezometer data are recorded at 30-minute intervals and checked against manual water level measurements made during site visits. Variance between all manual measurements and levels recorded by transducer was < 0.2 ft for the period. All piezometer data collected since 2010 are graphed on the next page, and all data collected since project inception in November 2007 are included on the CD containing this report. Graphs of data collected since the project start are plotted in previous reports. Water level and temperature data are continuous throughout the study period to date.

Recording soil moisture sensors

All original soil moisture sensors in the Burro Mountains project area were replaced in August-October 2010 and again in February-April 2014. The initial replacement of sensors within the treatment areas (August 2010) provided a brief period during which data continuity could be checked prior to thinning treatment. In fact, soil moisture levels recorded by the sensors dropped after replacement; most recovered to earlier levels after rainfall in early September, 2010. The drop in recorded levels is likely because the soil contact with each sensor is lessened during replacement; although the soil around each new sensor was tamped down as well as possible, we did not "water" the sensors as during initial placement. However, data recorded by a few sensors suggested that soil contact with those sensors remained inconsistent for an extended period after placement. During sensor replacement work in 2014, we again “watered” the spot in which each sensor was placed to try to improve soil–sensor contact. Consequently, these data will have to be reviewed and soil moisture levels that were artificially elevated by watering the sensors during placement will be discarded.

Soil moisture data, as throughout the study period, were recorded at 15-min time steps (see graphs pp. 8-11 and on the report CD). The resulting data sets were evaluated for sensor errors (i.e., during frozen soil conditions) and damage. Obviously invalid data were removed. A number of sensors were damaged by rodents during the interim between fall of 2013 and the first 2014 site visit. Damage to the sensor wiring can drain the microstation datalogger batteries, causing loss of data (Sites A and B2). The installation at Site D2 was completely destroyed, probably by a bear, during the interim period; the microstation was badly damaged. It was replaced and the site was reconstructed in early February. At Site E, repeated testing and replacement of sensors produced short intervals of normal data, followed by weeks of inconsistent and unreliable data. All sensors and the Hobo datalogger at Site E were replaced in



Post-treatment alluvial groundwater levels at the two Burro Mountain site piezometers, and cumulative precipitation at the site since November 2007.

April 2014, which appears to have resolved the problem. Managing the data gaps that have developed over time at some sites are discussed in the Data Evaluation section below.

The final data download for the current project period was on June 11.The graphs on the following pages and included on this report CD show the resulting data sets since thinning treatments in 2010. Site locations are shown on the map on p.3.

Soil temperature and climate data

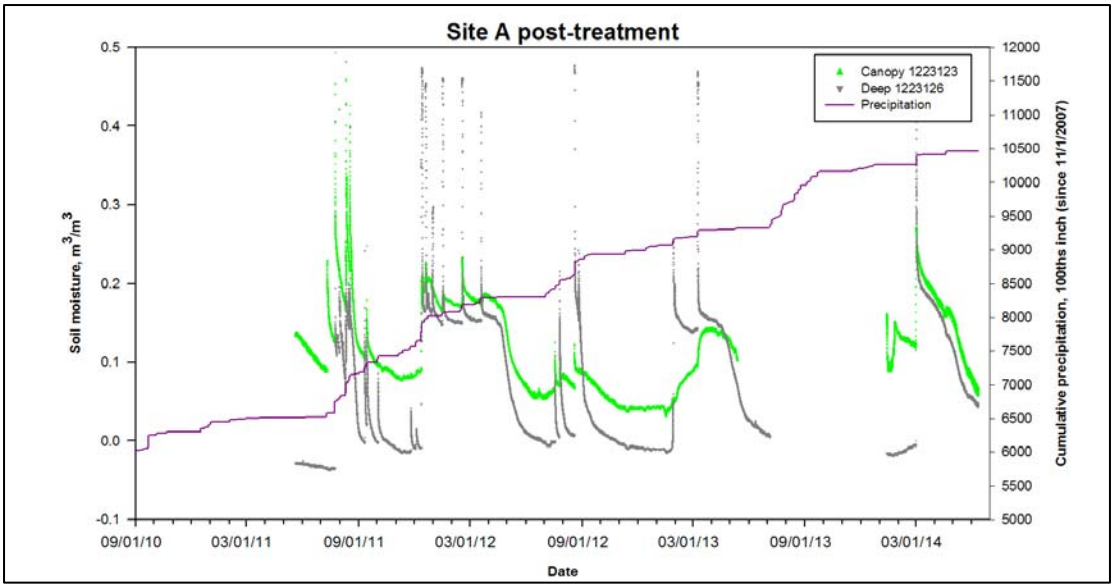
Continuous hourly soil and ambient temperatures, relative humidity, wind speed, solar radiation level, and precipitation data are collected by the weather station. All weather station data collected since weather station construction in mid-2010 are included on the report CD. The Barologger at the piezometer installation site collects ambient temperature and barometric pressure data, also included on the report CD. Climate data are supplied to the New Mexico Climate Center at NM State University for development of an ET model for the site. If possible, an update on this work will be included in the report on evaluation of data through summer, 2014, to be completed in October 2014 (see section below).

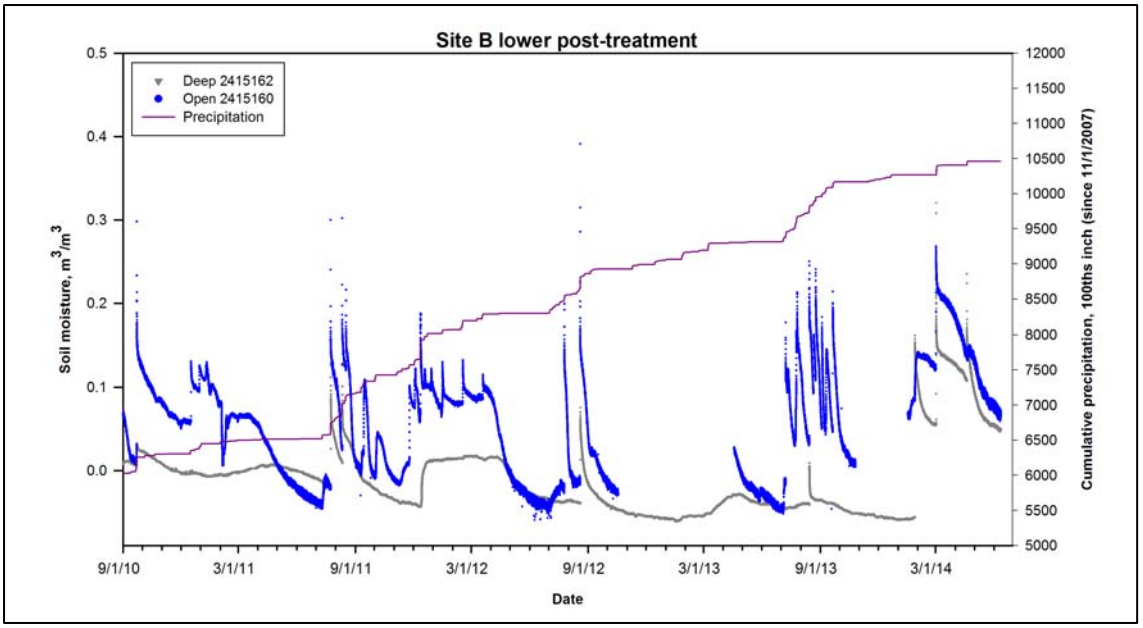
Vegetation transects and biomass plots

Detailed ground and canopy cover data were collected throughout the project area (Table 1) by March of 2009, during periods when vegetation was dormant or near-dormant. All vegetation data, graphs, and photos from each measurement site were included with the final report for 2009.

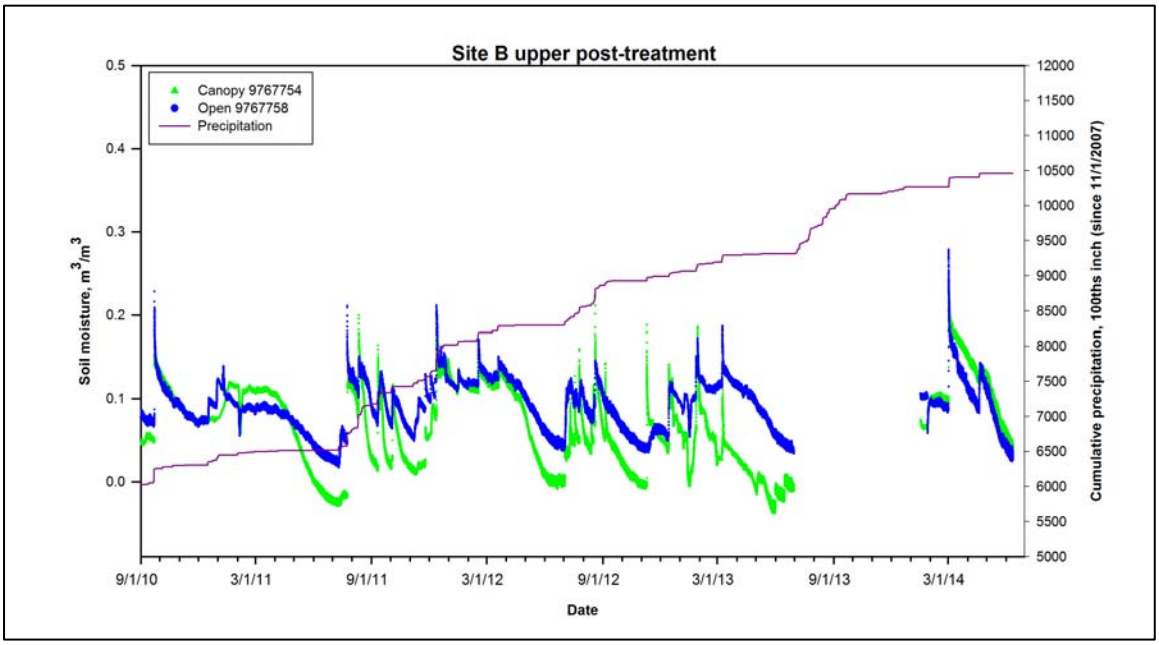
The vegetation transects along which point and biomass plot data were collected are permanent monumented. Re-sampling has been scheduled for October 2014 in order to 1) document vegetation response to treatment and 2) provide representative vegetation data against which estimates of evapotranspiration can be calibrated (NMSU Climate Center).

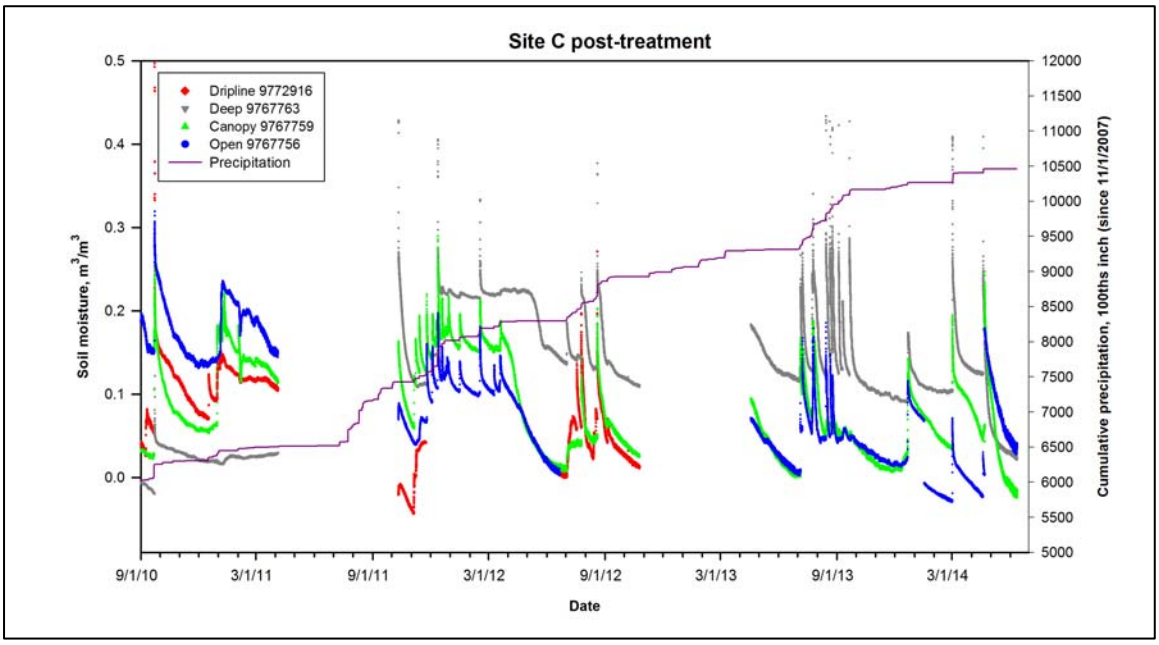
By scheduling the work for October, we hope to capture vegetation results following at least one monsoon period in which total rainfall at the site might more nearly resemble conditions during the baseline period of 2007–2010. During the study period, the worst effects of the continuing regional drought coincided almost exactly with the post-treatment period beginning in October 2010. During the 35-month baseline data collection period through September 2010, total precipitation at the site was more than 62 inches, nearly 1.8 inches/month on average. Over the 44 months since (through May 2013), total precipitation was just over 42 inches, < 1 inch per month average. Reduced rainfall during the monsoon months of August–September was a large part of the difference. In 2008–2010, rainfall during those two months averaged 7.2 inches; from 2011–2013, it averaged 4.6 inches, less than 64% of the previous period's average.



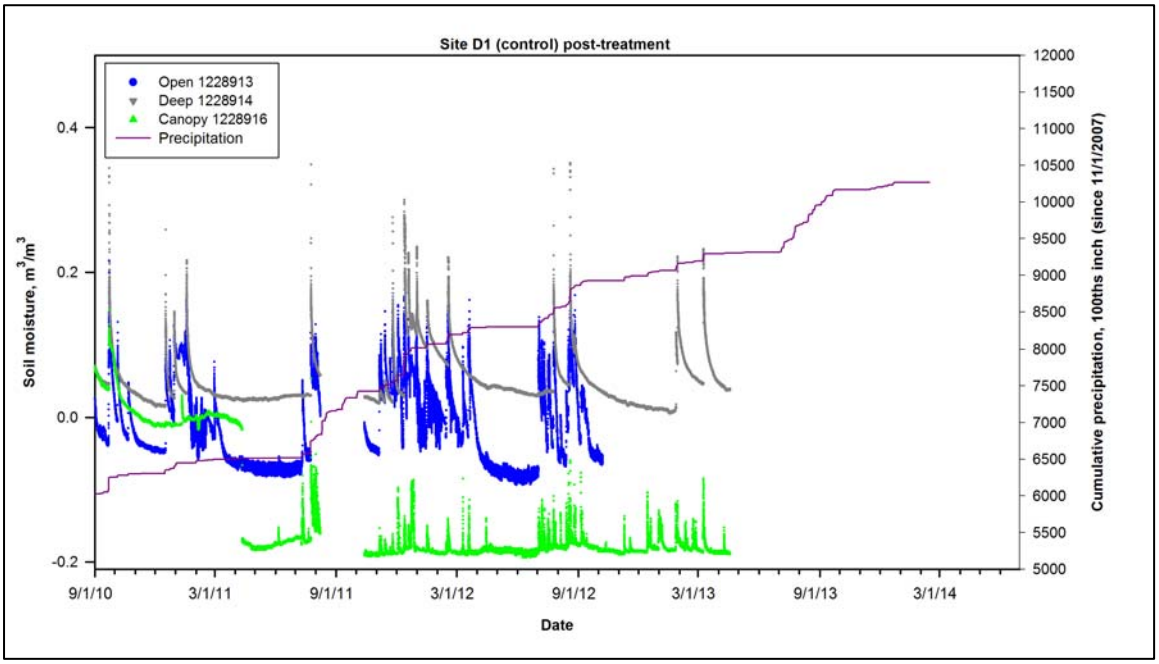


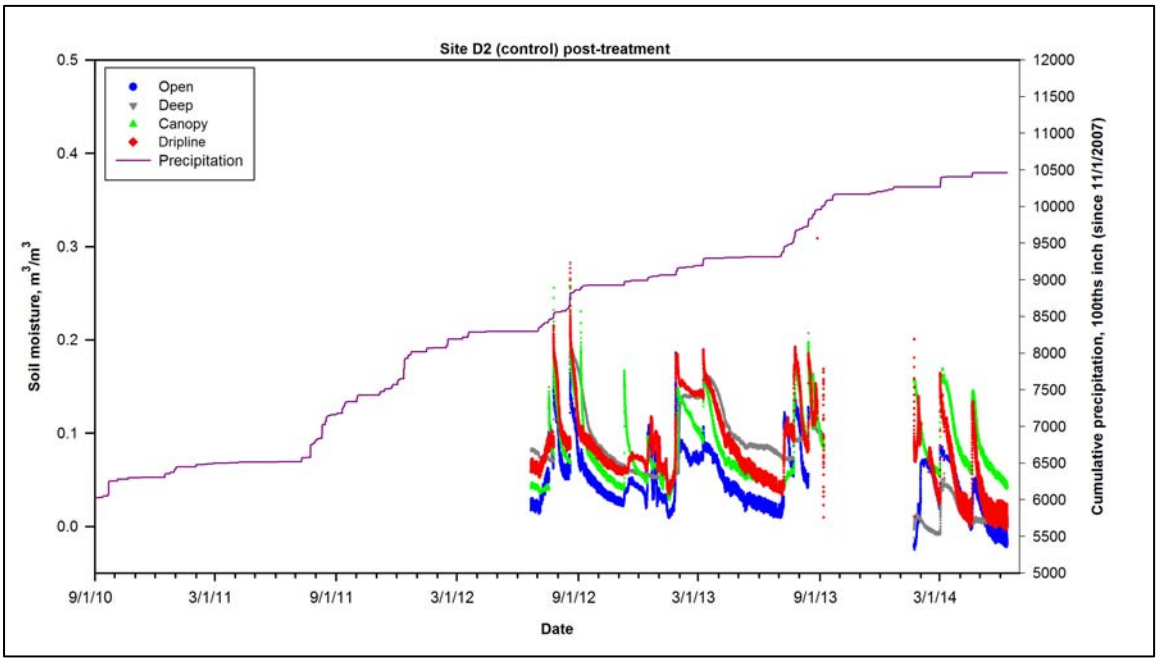
Site A (top) and lower Site B soil moisture data recorded, post-treatment.



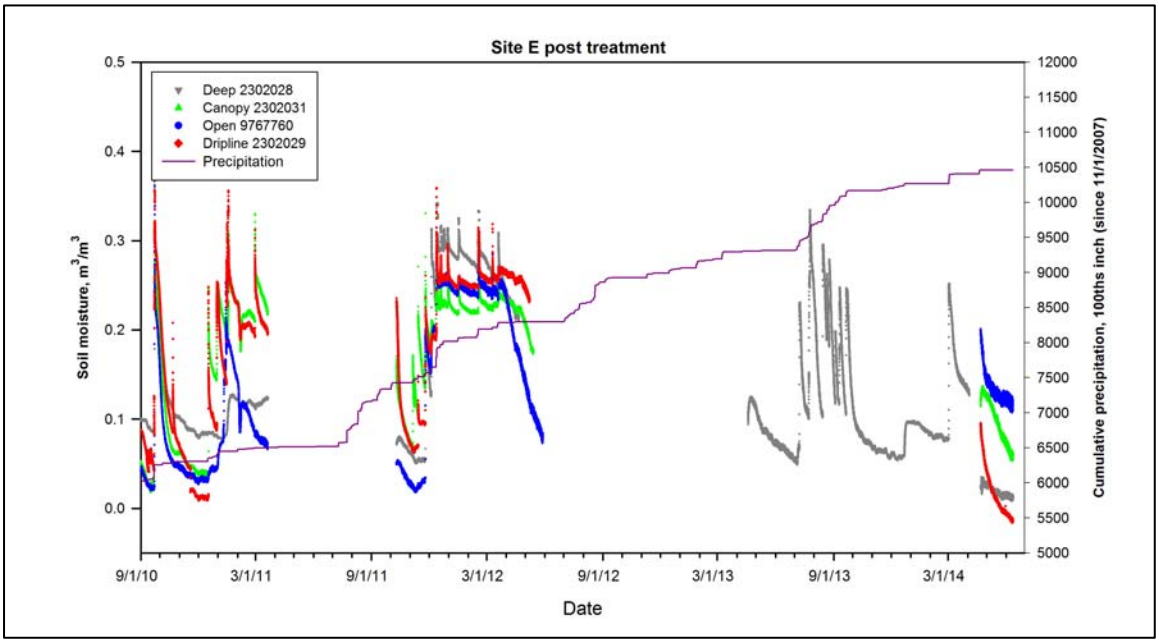


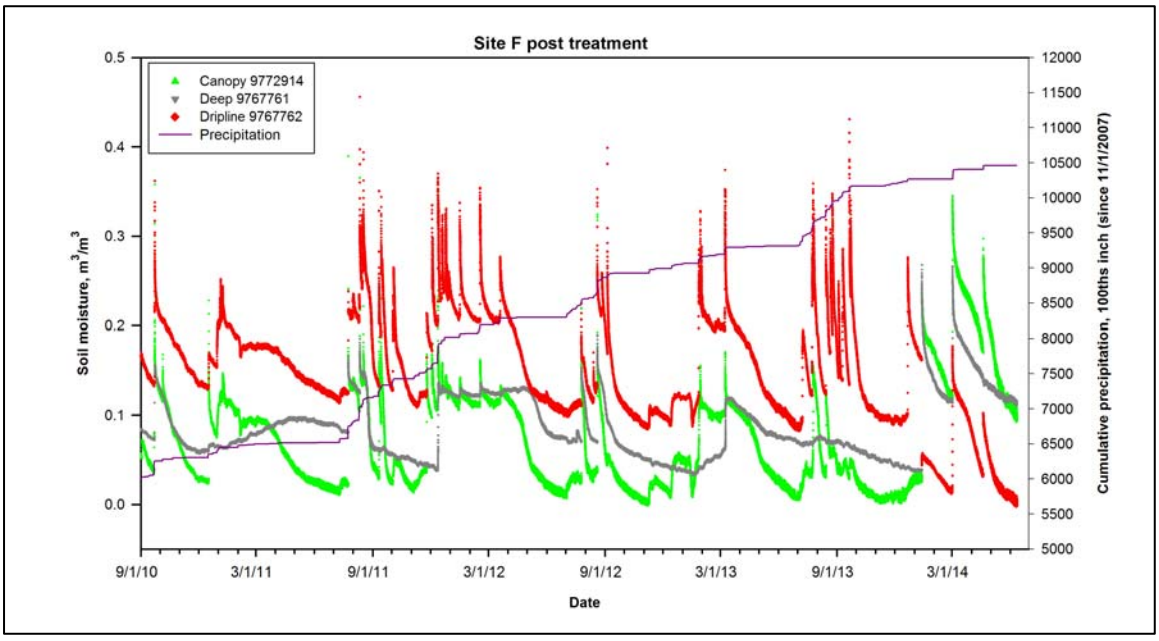
Upper Site B (top) and Site C soil moisture data recorded, post-treatment.





Control Sites D1 and D2 soil moisture data recorded post-treatment.





Site E (top) and Site F soil moisture data recorded post-treatment.

Treatment effects evaluation, October 2014

The contrast in climatic conditions since 2010 has made meaningful comparison of pre- and post-thinning soil moisture and alluvial groundwater response at the Burro Mountains site difficult. However, by late monsoon of 2014, four years will have elapsed since the thinning treatments were conducted. Evaluation of treatment effects, even under conditions of limited moisture, would provide useful information for project participants and others. Therefore, a full report of methods and evaluation of results will be completed and provided to the Grant SWCD following the 2014 monsoon period. The methods section will identify the data used in the evaluation, in order to compensate for data gaps and sensor replacement effects. Soil moisture data will first be evaluated for similarity of soil moisture levels among sites and sensor placements. The data analysis will seek to combine data from as many sensors of each type (placement) as possible, in order to increase the robustness of the data set's applicability across the project area. Complete evaluation of the soil moisture, vegetation, and alluvial groundwater data will examine 1) long-term trends pre- and post-treatment; 2) rates of soil moisture and alluvial groundwater recession following significant precipitation events; and 3) implications of rates of recession for retention of soil moisture and groundwater across the site, pre- and post-treatment. Report completion is scheduled for October 2014.

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