Appendix:
Water Recharge and Runoff

Conservation Indicator: Water Resources
The water systems above and below ground—streams, rivers, ponds, vernal pools, lakes and reservoirs, and ground water basins—are the veins of life support for the upland habitats and rare landscapes that comprise the Conservation Lands Network. The CLN 1.0 recognized that a whole-watershed is necessary for the successful conservation of riparian and fish habitat. Therefore, Water Resources are defined in the CLN 1.0 Progress Report as the important streams, riparian habitat, and associated upland areas that support healthy native fish populations and ensure watershed functionality. **Water Resource Progress Metrics** include additional stream miles of protected aquatic and riparian habitat, and watershed functions measured by rates of recharge and runoff.

Annual Hydrologic Cycle:
The hydrologic response of a piece of land is a function of precipitation, temperature, topography, soil depth/texture, and bedrock permeability. The Bay Area Mediterranean climate alternates between cool rainy winters and warm dry summers. Winter precipitation is partitioned into soil moisture storage, below-surface recharge, surface water runoff, and evapotranspiration over the course of the water year (October-September). Only after sufficient precipitation can saturated soils produce groundwater recharge and surface runoff. Evapotranspiration and vegetation growth increase in spring with warming temperatures, drawing down soil water, and runoff and recharge drop to zero. All available soil water is depleted during summer, vegetation goes dormant, and a cumulative water deficit develops. Slow release of winter recharge maintains stream base flow in the dry season. Total stream discharge is a combination of immediate runoff and the slower release of shallow groundwater.

These hydrologic processes have been modeled across the Bay Area using the Basin Characterization Model (Flint and Flint 2012). The Terrestrial Biodiversity Climate Change Collaborative (TBC3) project produced fine-scale (18-acre grid) maps of 30-year average recharge and runoff for the recent (1981-2010) time period. All subsequent mentions of recharge and runoff refer to this 30-year average.

“Recharge” is water that permeates the surface, drains below the rooting zone and becomes shallow and deep groundwater. Recharge is precious in our climate, and is an obvious benefit of conservation lands and other open space. Maximum rates of recharge are determined by bedrock permeability. Shallow recharge is the sole natural source of stream flow during the dry season, and many Bay Area communities depend on deep well water. When land is developed, recharge decreases and runoff increases as impervious surfaces and hydrologic modifications divert potential recharge.

“Runoff” is short-term surface stream flow, and occurs during storms when the soils are at water capacity. (Imagine a sponge, when it is full of water.) Runoff occurs on shallower soils more rapidly than on deeper soils. Large runoff events fill reservoirs and

flood creeks. Impervious surfaces and storm-water infrastructure create flashier runoff with downstream consequences.

Evapotranspiration strongly correlates with vegetation productivity and, in combination with water deficit, largely determines potential vegetation structure and composition. For example, rangeland productivity fluctuates strongly with annual evapotranspiration.

The Bay Area's steep precipitation gradients, jumbled geology, and diverse soils intermingle and create complex hydrologic landscapes. Coastal-inland precipitation gradients and rain shadows are apparent at broader scales. On local scales, recharge and runoff are nearly mirror images across bands of permeable and impermeable bedrock, and from deep valley to shallow mountain soils. View and download the Recharge and Runoff maps at www.bayarealands.org.

CLN 1.0 Progress Report metrics and methodology for understanding recharge and runoff values across the 10-County landscape:

The TBC3 fine-scale hydrologic data sets of the Bay Area (TBC3 2013) were created to be used for climate change assessments, planning, and adaptation. The availability of historical baseline data and alternative climate futures is a breakthrough for integrating hydrology data into the Conservation Lands Network. A subset of these data are available through the CLN Explorer.

This metric addresses the contribution of the CLN to water resources by answering the following questions:

- How many acre-feet of annual recharge and runoff are generated by protected lands, lands within the CLN network, other lands, and converted lands as of 2013?
- What were the approximate increments in protection since 2010?
- How are the protected and unprotected water resources distributed across the region?

The key metrics calculated are total acre-feet, and the fraction of recharge and runoff provided by the CLN at scales ranging from the whole region (10 counties), mountain ranges (Landscape Units), and watersheds (Hydrologic Area).

Data were extracted by CLN 1.1 basemap class, Landscape Unit, and Hydrologic Area and summarized in pivot tables. Both tables and graphs are provided, with initial emphasis on the regional scale.

Subregional Analysis of Recharge and Runoff: by Hydrologic Area
Hydrologic Areas (HAs) from California's watershed map (Calwater 2.2.1) were used to sub-regionalize the outputs from the regional recharge and runoff analysis shown in Chapter 5 of the CLN 1.0 Progress Report. Because of great differences in scale of acre-ft, the HAs displayed here are organized first by the set of the largest (>200,000 ac-ft recharge+runoff), and then the smaller HAs were grouped by geographic regions (Santa Cruz Mountains, East Bay, Marin-Sonoma Coast, and North Bay). Each HA has a recharge column and a runoff column for comparison.

Figure: Recharge/Runoff by Hydrologic Area: Largest Watersheds

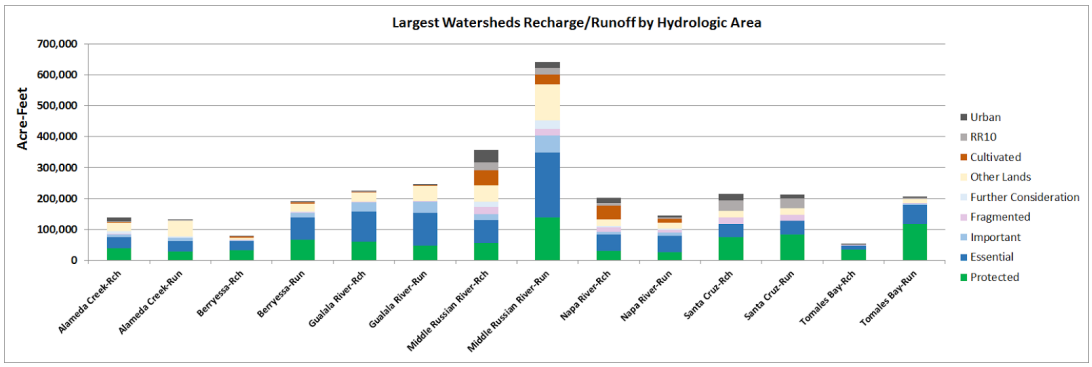

Figure: Recharge/Runoff by Hydrologic Area: Marin-Sonoma Coast

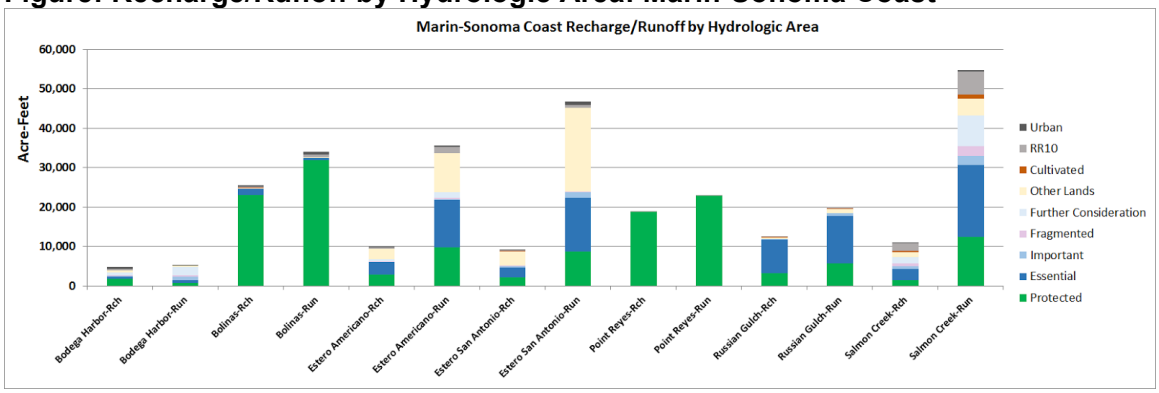

Figure: Recharge/Runoff by Hydrologic Area: North Bay

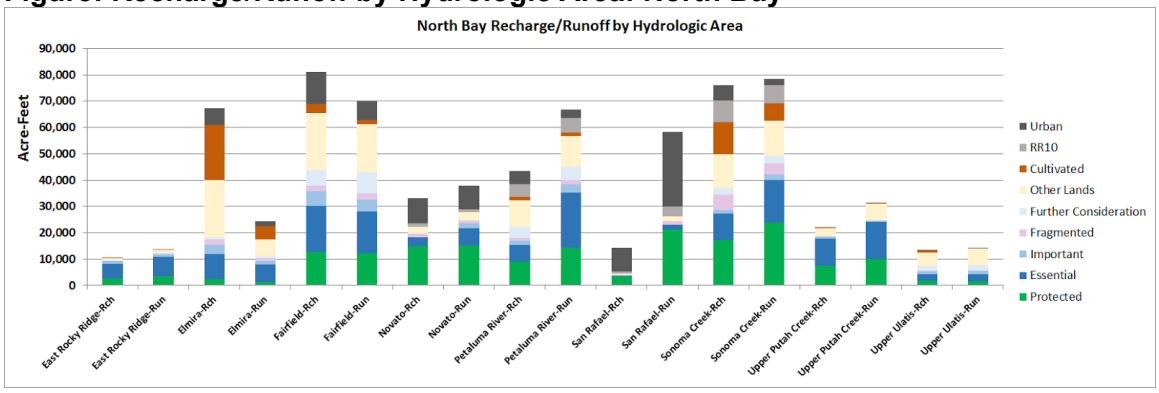

Figure: Recharge/Runoff by Hydrologic Area: East Bay

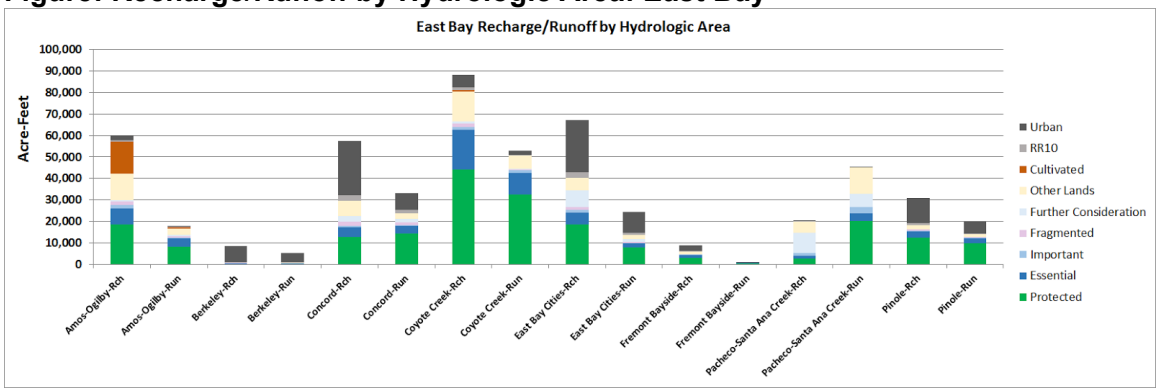

Figure: Recharge/Runoff by Hydrologic Area: Santa Cruz Mountains