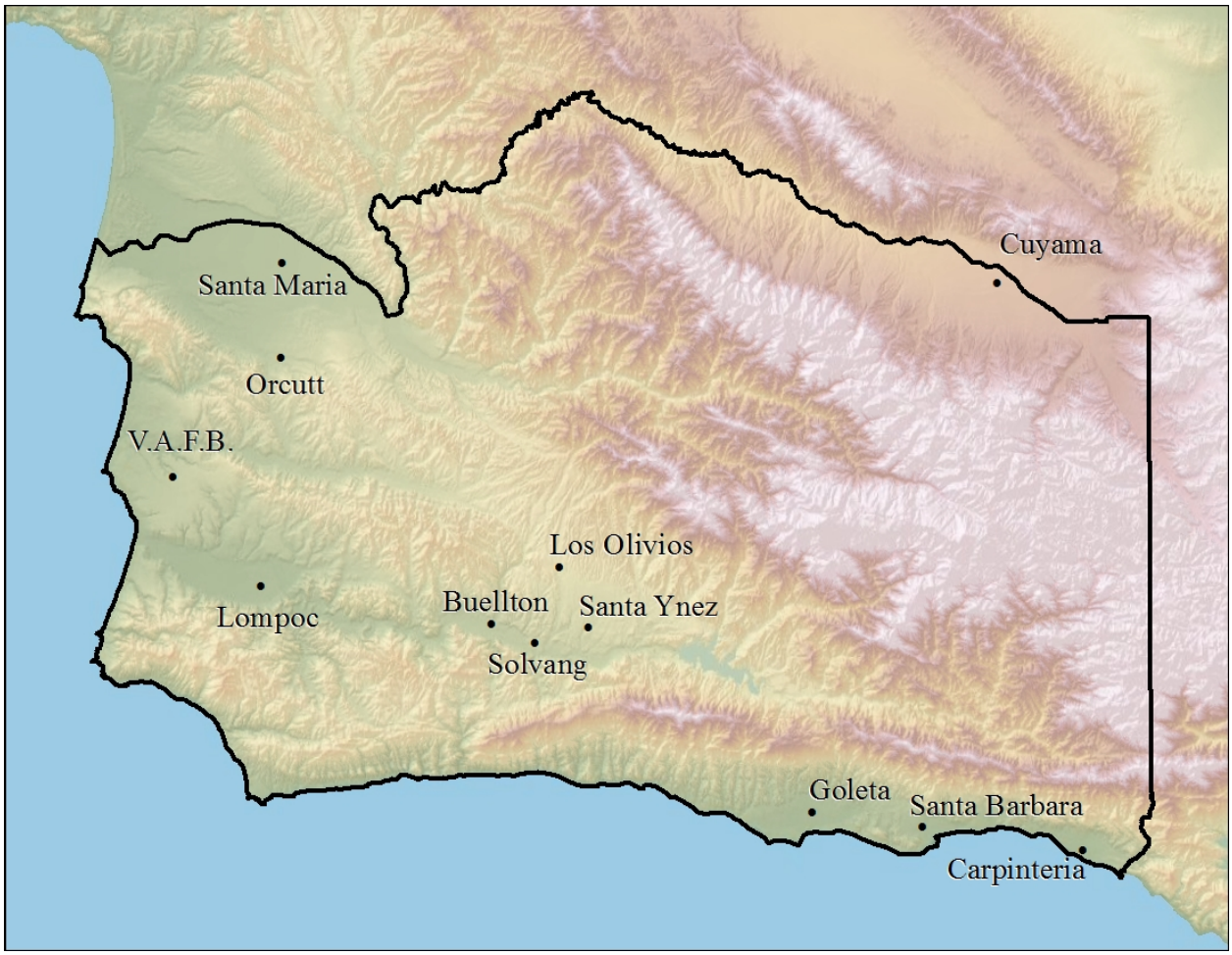
Potential Acreage in Santa Barbara County for Compost Application on Rangeland



November 2016

United States Department of Agriculture
Natural Resources Conservation Service

Prepared for the Cachuma Resource Conservation District with funding from NRCS.

Methods & Results

We conducted a spatial analysis of relevant data to provide a coarse estimate of the amount of land in Santa Barbara County suitable for compost application projects. Only mainland portions of Santa Barbara County were analyzed (no offshore islands), totaling approximately 1,636,825 acres (Figure 1). The primary purpose of this document is to provide a rough market potential or feasibility for compost application projects in mainland portions of Santa Barbara County.

We established the following parameters to identify suitable areas:

1. land must have a slope of <25%[1] in order to allow access by compost-spreading equipment and
2. existing vegetation must be dominated by herbaceous ground cover (grasses, forbs, etc.).
3. all acres must be at least 100 feet away from riparian or wetland areas.

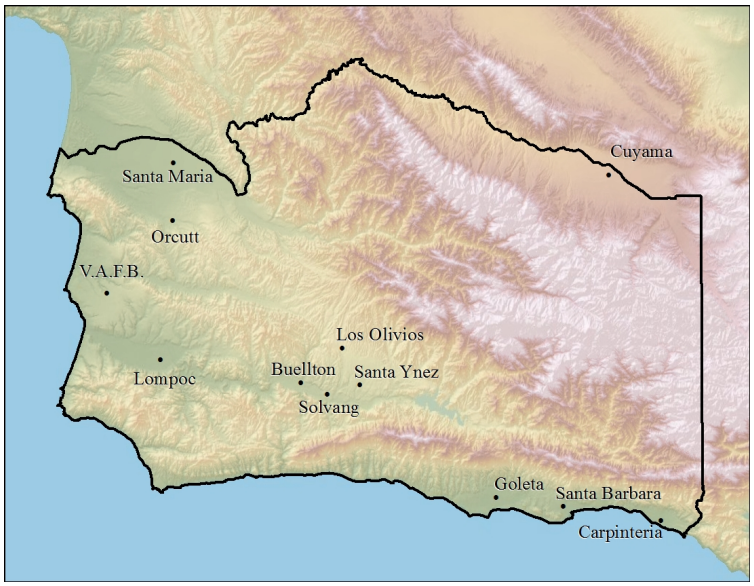


Figure 1. Figure showing the approximately 1,636,825 acres of mainland portions of Santa Barbara County (black outline) included in this analysis.

This document describes the procedures we used to calculate suitable areas and further categorizes that acreage by land ownership (e.g., private lands, federal and state lands, etc.). We also calculated the potential amount of carbon that could be captured through the rangeland improvements associated with compost application along with estimates of the potential for improved soil water holding capacity. Finally, we calculated the potential amount of compost material that would be required to treat all eligible lands. We hope these estimates will be of use to organizations considering the feasibility of launching new programs that seek to implement compost application projects in grassland areas of Santa Barbara County.

[1] 25% slope was recommended by Jeffrey Creque of the Carbon Cycle Institute as being an acceptable threshold for safely operating the machinery necessary to apply compost. Individual field analysis would have to be completed to ensure operator safety on a property-by-property basis. Compost is commonly applied to steeper slopes using blower equipment and manually-operated hose.

Slope Analysis

To obtain the slope estimates, we acquired 30-m resolution Digital Elevation Models (DEMs) from the U.S. Geological Service[2]. The DEMs were then converted into slope classes, showing areas with slopes <25% and areas with slopes >25%. Only the areas with slopes <25% were used to identify potential land areas suitable for compost application projects[1].

Our analysis showed that approximately 732,981 acres of Santa Barbara County had slopes <25%, which was approximately 45% of our study area (Figure 2).

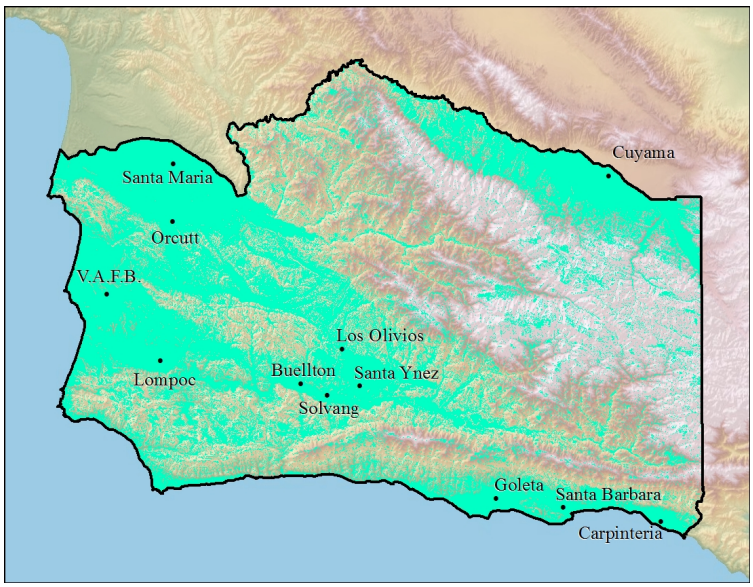


Figure 2. Figure showing the portions of Santa Barbara County with slopes <25% (turquoise shading-approximately 732,981 acres).

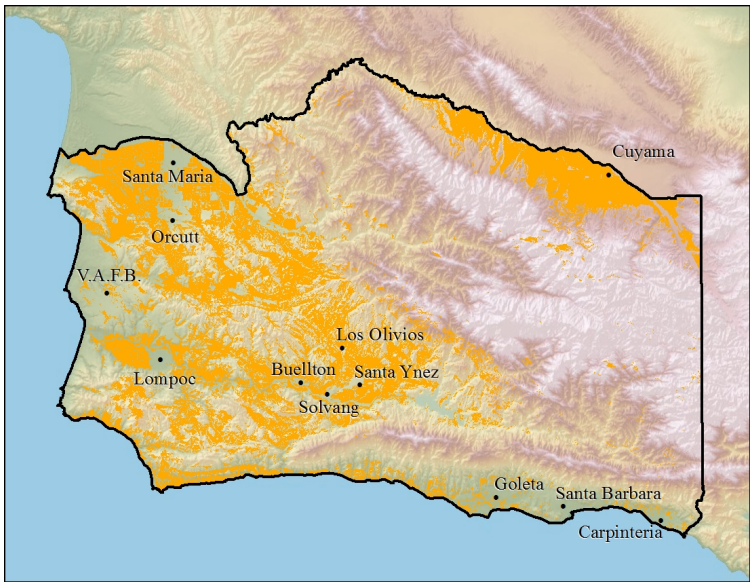


Figure 3. Figure showing the approximate locations of herbaceous-dominated acres in Santa Barbara County (bright orange shading-384,374 acres). These areas were dominated by annual grasslands and pasture.

Vegetation Analysis

We derived vegetative land cover classes using CalVEG layers for the central and southern coastal areas of California[3]. We filtered out all classes dominated by unsuitable criteria (shrubs, trees, developed areas, etc.) to leave only herbaceous-dominated grassland, pasture and cropland areas.

Approximately 384,374 (23%) of the county was dominated by herbaceous vegetation (Figure 3). This included all annual and perennial grasslands, croplands, and pasture designations. Annual grasslands and pasture accounted for approximately 96% of these areas while croplands and perennial grassland accounted for only about 4% (Table 1).

[2] USGS DEM data for Santa Barbara County, California downloaded from the USDA/NRCS GeoSpatialDataGateway: https://gdg.sc.egov.usda.gov/GDGOrder.aspx.

[3] Santa Barbara County contains two regions of the CalVEG coverage: Zone 6: Central Coast and Zone 7: South Coast. Data obtained from: http://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192

Table 1. Table showing the breakdown of herbaceous acres in Santa Barbara County.

Land Cover Classification	Acres	% of Total
Annual Grassland	281,125	73.14%
Cropland	15,816	4.11%
Pasture	86,674	22.55%
Perennial Grassland	759	0.20%
Totals:	***384,374***	

Wetlands Analysis

We also chose to remove acres that were close to riparian and other wetland types. We obtained the most recent version of the National Wetlands Inventory (NWI) from the U.S. Fish and Wildlife Service for the state of California[4]. The current NWI dataset is "a more comprehensive dataset (NWI Version 2) that is inclusive of all wetlands and surface water features". We clipped this layer to just the mainland portions of Santa Barbara County and buffered this polygon layer by 100 feet to create an area of exclusion around important wetland features (Figure 4). We did this to avoid the risk, if any, of negatively impacting local water quality with compost application projects[5]. Table 2 summarizes the wetland types included as well as the acreages removed as potential areas for compost application (100 foot buffers around NWI features).

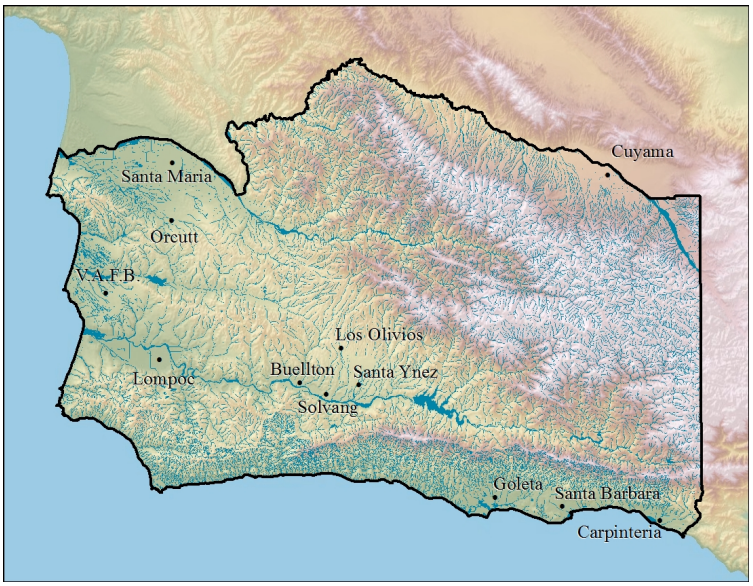


Figure 4. *Figure showing the 100 foot buffers around wetland areas in the mainland portions of Santa Barbara County.*

Table 2. *Table showing the breakdown of wetland types and acreages with a 100 foot buffer in mainland portions of the County of Santa Barbara. >*

Wetland Type	Acres	% of Total
Riverine	176,180	66.92%
Freshwater Forested/Shrub Wetland	59,529	22.61%
Freshwater Emergent Wetland	11,093	4.21%
Estuarine and Marine Wetland	5,266	2.00%
Lake	4,856	1.84%
Freshwater Pond	3,749	1.42%
Estuarine and Marine Deepwater	2,580	0.98%
Totals:	***263,253***	

[4] National Wetlands Inventory Dataset obtained from the USFWS website: https://www.fws.gov/wetlands/Data/Data-Download.html and was obtained on 7/18/2016.

[5] Compost use presents minimal, if any risk to surface waters, and has been used safely in wetland restoration and other habitat improvement projects for many years. Additional information can be found here: https://prrp.memberclicks.net/assets/docs/Organics/reforestation%20wetlands%20restoration%20habitat%20revitalization.pdf

Potential Compost Application Project Area

We then combined the above results to show only those lands with <25% slopes, herbaceous land cover, and at least 100 feet from wetland features to calculate the total number of acres that could possibly receive compost treatments.

Combining the slope, vegetation layers, and wetland buffers, we found 269,588 acres of land dominated by herbaceous vegetation with slopes <25% and at least 100 feet from wetlands (Figure 5). This was approximately 16% of the study area.

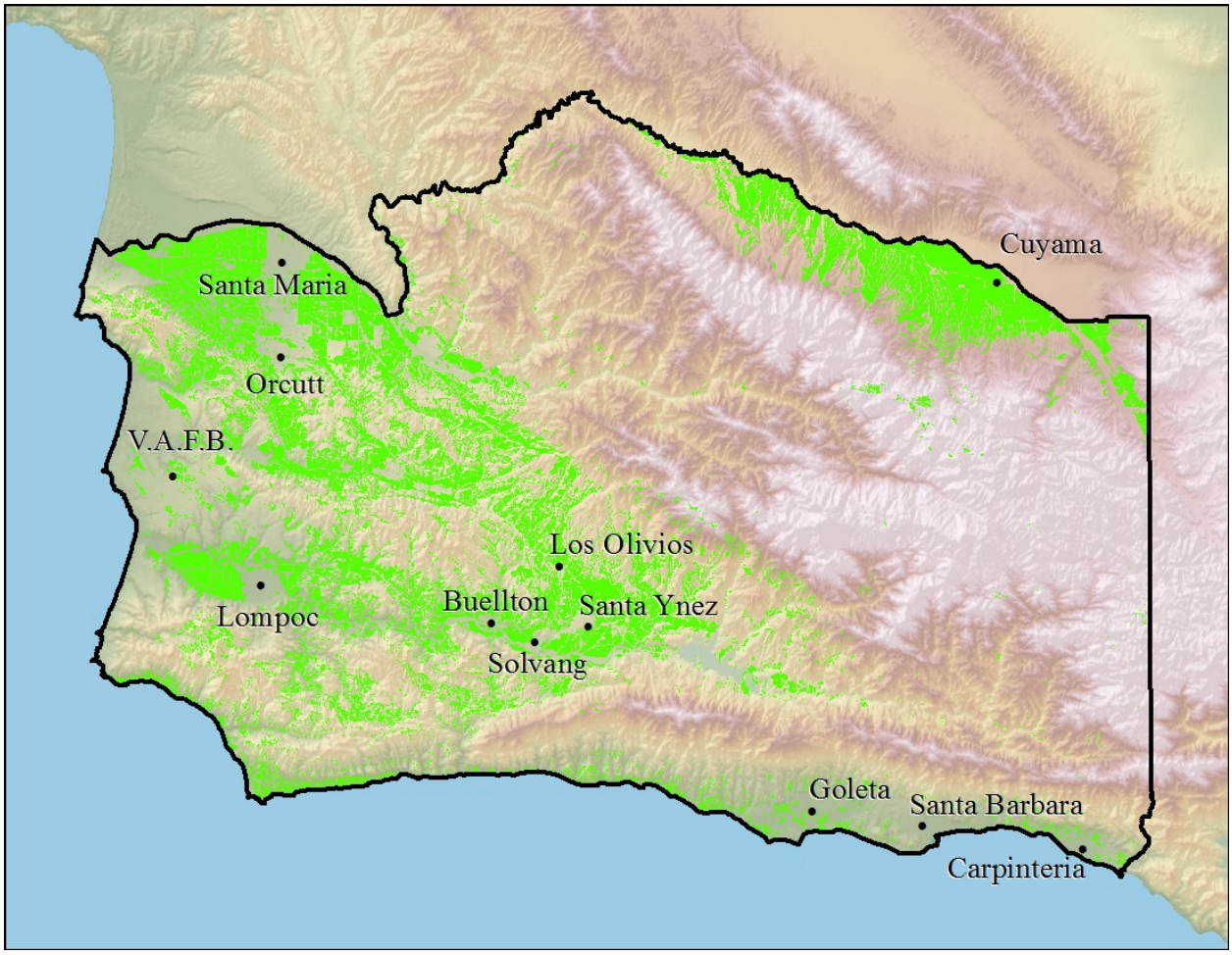


Figure 5. Map showing the potential areas suitable for compost applications. All areas shown in bright green have slopes <25%, are dominated by herbaceous vegetation, and are at least 100 feet from open water or wetland areas (approximately 269,588 acres or 16% of the total study area).

Private and Public Lands Summary

We further refined the results by identifying lands that were privately owned as well as those owned and managed by federal and state governments. To determine land ownership, we used parcel data provided by the Santa Barbara County Planning Department.

The majority of the mainland portions of Santa Barbara County were privately owned (822,742 or about 50% of the study area). Federally-owned lands comprised approximately 748,117 (46%) of the study area while only about 1% was owned by the state of California. The <3% (45,321 acres) of remaining lands were owned by local or county governments, municipalities, or other tax-exempt organizations.

Overwhelmingly, the acres of land with suitable criteria for compost application projects were privately owned (Table 3 and Figure 6). Of the 269,588 acres of land dominated by herbaceous vegetation with slopes <25% and at least 100 feet from wetland features, 242,759 acres (90%) were on private property. Federally-owned land accounted for about 7% of the total potential acres (19,546 acres), while state-administered lands only contained about 1% of these areas (2,450 acres). The remaining 4,833 (2%) acres occurred on lands owned by other local government entities. It is interesting to note that while private and federal ownership figures were nearly equal in the county, the amount of land suitable for compost application projects were dramatically higher on private lands.

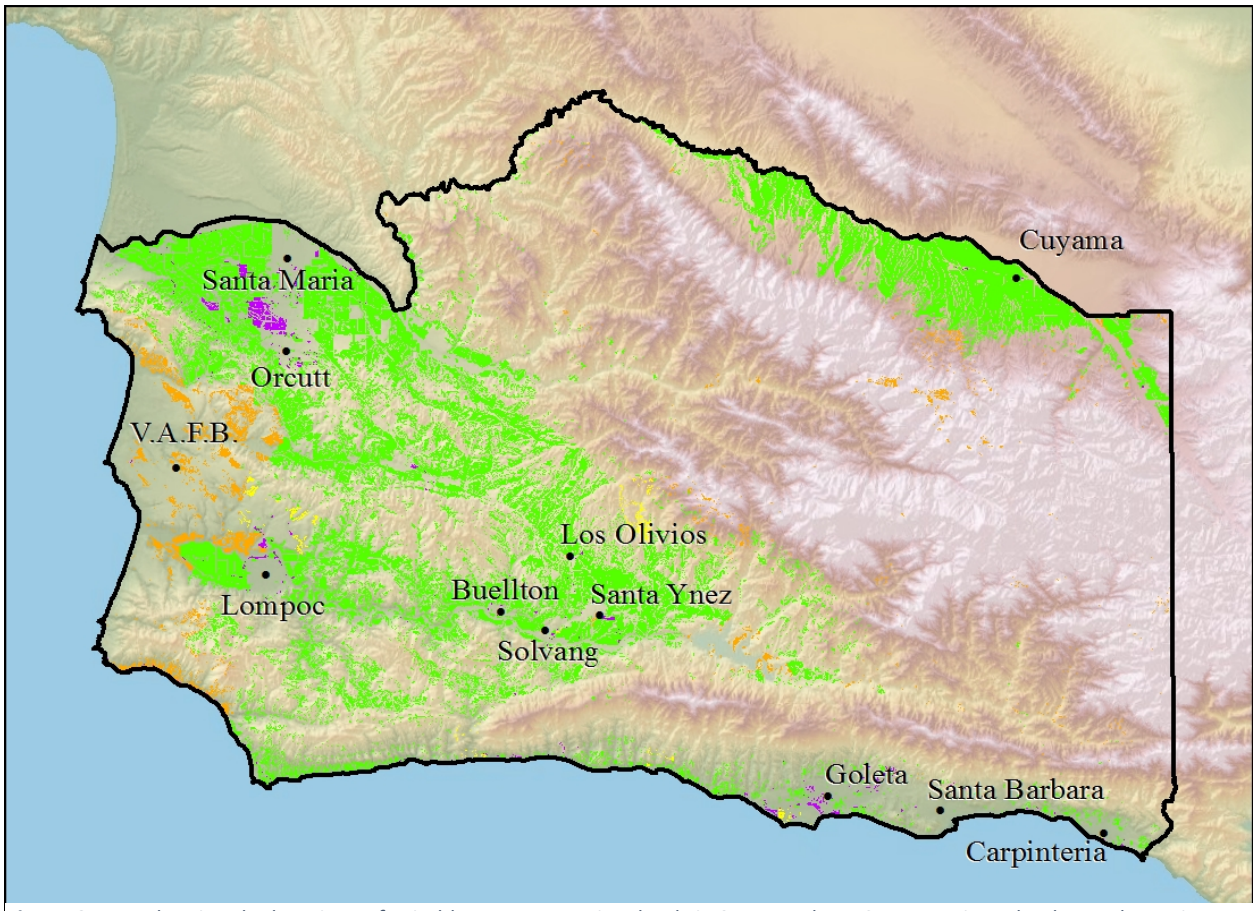


Figure 6. Map showing the locations of suitable compost project lands in Santa Barbara County. Private lands are shown in bright green (90% of total potential areas), federal lands in orange (7%), state lands in yellow (1%), and local government lands in purple (2%).

Potential Carbon Sequestration and Water Holding Capacity Benefits

Research conducted on northern California rangelands by the Silver Lab at the University of California at Berkeley has shown significant and long lasting increases in forage production, soil carbon, and soil water holding capacity in response to a single ½-inch compost application on grazed sites in both coastal and foothill rangelands (Ryals and Silver 2013[6]). Forage production increased by approximately 40% and 70%, respectively. Likewise, soil water holding capacity increased by nearly 25%, while soil carbon increased by about 0.4 tons (1.468 $MTCO_2e$[7]) per acre per year. These changes have persisted across six years of data collection and ecosystem models suggest this improvement will continue for at least 20-30 years in response to the single compost application. Theoretically, this will result in ongoing improved forage and improved soil water holding capacity. We used these figures to compute the potential amount of soil carbon sequestration on an annual as well as a long-term cumulative basis (twenty years). As a note of interest, more recent research (Ryals et al 2015[8]) suggests that a compost application rate of ¼-inch might be as effective as the ½-inch rate used in the study mentioned above. Throughout the rest of this document, we therefore assume an application rate of ¼-inch per acre. This would allow for the treatment of more acreage using the more conservative application rate.

NRCS suggests that a 1% increase in soil organic matter (SOM) results in an increase in soil water holding capacity of approximately 1 acre inch, or 27,152 gallons of increased soil water storage capacity per acre. A 1% increase in SOM represents roughly 20,000 pounds (10 short tons) of organic matter, or 5 short tons of organic carbon. We used these parameters to estimate the increase in soil water holding capacity, expressed in Acre Feet.

Table 3 shows the total potential for carbon sequestration and improved water holding capacity across all potential grassland areas of Santa Barbara County. Private lands alone could sequester up to 97,104 metric tons of carbon (356,370 metric tons CO2e) as soil organic material annually. Over a twenty year period, this would amount to nearly two million tons of carbon (7.1 million metric tons CO2e) removed from the atmosphere. Similarly, increased water holding capacity on private lands could add an additional 1,780 Acre Feet of water annually to the soils in these area. While this amounts to a relatively small amount per acre (about 0.1 inches each year), the cumulative effect of such projects would have a significant impact on soil water levels should drought conditions persist into the future. By year 20, treated private lands could store over 35,000 Acre Feet of additional water annually. This is equivalent to roughly 28% of the average storage capacity of Cachuma Reservoir[9]. Estimates for soil carbon storage and water holding capacities are also reported for federal, state, and other government-owned lands.

[6] Ryals, R. and W. L. Silver. 2013. Effects of organic matter amendments on net primary productivity and greenhouse gas emissions in annual grassland ecosystems. Ecological Applications 23:46-59.

[7] $MTCO_2e$ stands for metric tons of carbon dioxide equivalents (2,200 pounds).

[8] Ryals, R., M.D. Hartman, W.J. Parton, M.S. DeLonge, & W.L. Silver. 2015. Long-term climate change mitigation potential with organic matter management on grasslands. Ecological Applications 25(2): 531-545.

[9] http://cosb.countyofsb.org/uploadedFiles/pwd/Water/Cachuma%20Storage%2025%20yrs%201986-2011.pdf

Table 3. Summary table showing annual and projected twenty-year increase of soil carbon sequestration and water holding capacity for privately owned as well as areas administered by federally, state, and other government agencies with a 1/4-inch of compost application. All acres have slopes <25%, are dominated by herbaceous vegetation, and at least 100 feet from riparian or wetland areas.

			Annual Estimates			20-Year Estimates		
Ownership	**Acres**	**% of Total**	**Potential Metric Tons of Carbon Sequestered Annually**	**Potential $MTCO_2e$ of Carbon Sequestered Annually**	**Increased Water Holding Capacity (Acre Feet) Annually**	**Potential Metric Tons of Carbon Sequestered Over 20 Years**	**Potential $MTCO_2e$ of Carbon Sequestered Over 20 Years**	**Increased Water Holding Capacity (Acre Feet) by Year 20**
Private	242,759	90%	97,104	356,370	1,780	1,942,072	7,127,404	35,608
Federal	19,546	7%	7,818	28,694	143	156,368	573,871	2,867
State	2,450	1%	980	3,597	18	19,600	71,932	359
Other	4,833	2%	1,933	7,095	35	38,664	141,897	709
Totals:	***269,588***	***100%***	**107,835**	***395,755***	***1,977***	***2,156,704***	***7,915,104***	***39,544***

Estimating the Amount of Compost Needed

To estimate the amount of compost needed to treat all the potential acreage suitable to receive it, we assumed that a single ¼-inch compost application would require 35 cubic yards of material per acre (approximately 17.5 tons). Our estimated compost needs are summarized in Table 4.

Table 4. Summary of the amount of compost needed to treat private and public lands in Santa Barbara County.

Ownership	**Acres**	**Estimated Tons of Compost Needed**	**Estimated Cubic Yards of Compost Needed**
Private	242,759	4,248,283	8,496,565
Federal	19,546	342,055	684,110
State	2,450	42,875	85,750
Other	4,833	84,578	169,155
Totals:	***269,588***	***4,717,790***	***9,435,580***

Conclusions

Compost application projects are widely recognized as an effective means of increasing carbon capture and are being actively considered as a way to reduce atmospheric CO_2 levels. The results of this study suggest that there is ample opportunity to pursue such projects in Santa Barbara County. Approximately 16% of the county consists of grassland/cropland-dominated ecosystems with slopes that could accommodate compost spreading equipment.

Furthermore, the vast majority of these areas appear to be privately owned. This suggests that future projects that seek to implement compost application projects should develop programs that involve private landowners. Organizations such as the Cachuma Resource Conservation District are in an excellent position to actively engage landowners for participation in such projects.

While admittedly a coarse estimate, this study suggests that there is ample opportunity to continue exploring compost application projects at a large scale. Some of the key findings are summarized here:

- We estimate that there are approximately 269,588 acres of land potentially suitable for compost application in Santa Barbara County.
- The vast majority are located on private lands (242,759 acres or 90% of the potential area)
- Federally-administered lands accounted for only 7% (19,546 acres), while lands owned by the state of California accounted for <1% (2,450 acres). The remaining 2% (4,833 acres) of potentially-treatable areas are owned by other local government agencies.
- Private lands receiving a single ¼-inch application of compost have the potential to sequester an estimated 97,104 metric tons of carbon (356,370 metric tons CO2e) per year. Over a twenty year period, this would amount to nearly two million metric tons of carbon (7.1 million metric tons CO2e) removed from the atmosphere.
- Water holding capacity increases on privately-owned treated acres could amount to 1,780 Acre Feet annually, with an additional 35,608 Acre Feet stored annually across all treated private acreage by year 20.
- Assuming it would require 35 cubic yards of compost (17.5 short tons) for ¼-inch of compost application across all 242,759 private acres, it would require an estimated 8,496,565 cubic yards (4,248,283 short tons) of compost to treat all of the potential private acres.

It should be noted that this analysis was done at a very coarse scale of resolution. Completing detailed compost application projects would need to be refined at an individual ranch scale. Important factors we did not account for in this study include avoiding sensitive soils (serpentine, etc.), special-status species, or actual soil status. Clearly, individual plans would need to consider these and other factors at a finer scale to ensure compliance with local regulations and other conservation goals. As an example, if more detailed soils analysis showed a large proportion of sensitive soils types, these areas would be excluded from compost application. Similarly, if additional data showed that certain portions of the property already had high levels of soil organic matter (approximately 4% for rangeland areas or 8% for croplands), these areas would likely not respond significantly to application of compost and would be excluded as well. It is possible that our model could be refined to reflect at least some of these factors and therefore be revised and improved over time. Similarly, as new research is conducted and yields new insights into carbon sequestration and water holding capacity rates, some of the parameters and

assumptions we used in these analyses could be improved to reflect more local data to improve our estimates.

While it is clear that there is a considerable opportunity for the widespread application of compost across Santa Barbara County private (and possibly even public) lands, there are two key factors that could possibly limit any future programs. These will need to be researched in more detail to gain a clearer view of the full program potential and include:

1. the ability of organizations to mobilize and enroll private landowners in such programs by communicating the importance and benefits of compost application projects and
2. the supply of compost available for county-wide projects

It is very likely that these might prove more of a limiting factor than identifying suitable lands. Even if a small portion of the potential areas identified in this report are treated with compost, it would still require a large amount of compost material. Additional research into the amount, quality, and types of compost now available in the county should be completed to ascertain a fuller understanding of the market opportunity as it exists today.