GAVIOTA DISTRICT
CARBON MANAGEMENT PLAN

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PREPARED BY

CACHUMA RESOURCE CONSERVATION DISTRICT

AND

LEGACYWORKS group

Prepared By:

Anna Olsen
Cachuma Resources Conservation District
920 East Stowell Road
Santa Maria, CA 93454
(805) 868-4013

Jessica Elliott
LegacyWorks Group
521 Santa Barbara Street
Santa Barbara, CA
(805) 845-7113

Funded By:
Gaviota Coastal Conservancy

Advised By:
Gaviota Agricultural Project
Guner Tautrim
Sharyn Main
Allegra Roth
Marc Chytilo
Ana Citrin
Chet Work
Katherine Anderson
Doug Kern
Anna Olsen
Sigrid Wright

With additional contributions by:
Teddy Travers
Paul van Leer

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Executive Summary

The Gaviota District Carbon Management Plan is a regional carbon farm plan that is meant to serve multiple producers in one area in order to describe what carbon farming is, what its benefits are and how it can be implemented in this specific place. The goal of the plan is to provide information to landowners in the District to expedite their ability to increase their operation's resilience in the midst of a changing climate by implementing carbon farming practices while simultaneously leveraging funding currently available to do so.

Maintaining the rural, agricultural character of the Gaviota Coast is important to local residents as well as for the public at large. The Gaviota Coast is one of the last undeveloped stretches of coastline in Southern California and is home to a plethora of endemic species that reside within the confluence of two bioregions. The effects of a rapidly changing climate is just the latest threat to this unique landscape. Increasing the resilience of our working lands to withstand longer droughts, more extreme wind and rain events and increased temperatures- just some of the expected challenges that we are already seeing unfold around us- is an urgent need. Fortunately, agricultural and working lands, if managed in specific ways, can serve as a powerful climate change mitigation tool drawing carbon out of the atmosphere and sequestering it into biomass and soil and at the same time, increasing productivity, soil health and water-holding capacity, biodiversity and a slew of other ecosystem services that improve a producer's bottom line.

Landowners hold the key to these natural climate solutions and should be empowered to act now. As consensus around climate science continues to grow, more and more funding is becoming available to assist producers in deploying carbon farming practices on their lands. Moreover, groups of producers operating in concert in a specific local area opens up even more funding opportunities for large scale carbon offset projects that corporations and communities are now seeking to implement to achieve carbon neutrality goals.

This regional carbon farm plan will detail the opportunities and technical resources available to the District and serve as a stepping stone to ramp up implementation of various carbon farming practices. With grazing and perennial cropland dominating the current operations in the District, compost application to both cropland and grazed grassland, livestock integration and prescribed grazing, cover cropping in alleyways, establishing hedgerows and windbreaks and mulching are priority practices that can be readily implemented quickly.

The Gaviota Coast Conservancy (GCC), the Cachuma Resource Conservation Service (CRCD) and other partners that have helped bring this regional plan into fruition will be encouraging producers to get in touch with them to discuss what incorporating carbon farming practices would look like for their specific operation and what resources are available to provide technical and grant application assistance. State and federal monies are available and technical service providers want to help. Producers should start by simply contacting the GCC and CRCD today!

INTRODUCTION

The subject site, the Gaviota Coast planning area (the "Site", the "Gaviota District" or the "Gaviota Coast"), is approximately 158 square miles (101,199 acres) of land, including 76 miles of coastline, located in southwestern Santa Barbara County west of Goleta, California (County, 2016). Refer to the Site Location Map in Appendix A. The Gaviota Coast is one of the last undeveloped stretches of coastline in southern California and is known as a biodiversity hotspot encompassing an ecological transition zone between southern and northern California. The area is dominated by open spaces nestled between the Pacific Ocean, the Los Padres National Forest and the Santa Ynez Mountains. Land use in the District consists of agricultural and grazing lands, recreational areas, residential properties, protected spaces and oil and gas development. The Gaviota District also houses the County's landfill.

There has been a long-lived concerted effort to preserve the ecological and agricultural integrity of the Gaviota Coast, while also balancing the various land use interests that value all that the area has to offer. The Gaviota Coast Conservancy (GCC) has been an important steward of this process advocating for the preservation of the area's rural character and endemic resources under continued threat of urban sprawl and industrialization. In June of 2018 the GCC settled a lawsuit against the County that forbade the County from expanding the Tajiguas Landfill but allowed them to go forward with the Tajiguas Resource Recovery Project (TRRP), their plan to extend its life span. The TRRP will employ a sorter to separate recyclables and organic material from co-mingled refuse collection and process the latter through an industrial-scale anaerobic digester. Both of these facilities will be allowed to continue to operate after the dump reaches its storage capacity. Carbon dioxide and methane will be captured in the digestor to create electricity and the digestate produced will be in a stable form for use as landfill cover or potentially as a compost feedstock. Although speculation remains as to the characteristics of the digestate that will be produced (e.g. possible contamination due to lack of source-separation, production of phytotoxic acids in anaerobic conditions, etc.), it has the potential to be a meaningful resource for the County's working lands if handled thoughtfully. The digestate itself can then become a feedstock for making a high quality compost that would be acceptable for use as a soil amendment to improve productivity, increase water holding capacity and sequester atmospheric carbon (Bell et al, 2014). The settlement establishes an academic research protocol to confirm and refine compost quality, and makes available 4,000 tons of compost annually for ten years at market rates for use on the Gaviota Coast, where transportation costs will be low.

As part of the settlement agreement, the GCC has funding available to assist landowners in enhancing agricultural sequestration of carbon and implementing regenerative agricultural practices such as compost application on working lands in the District. The Cachuma Resource Conservation District (CRCD) is uniquely poised to assist the Conservancy in this endeavor due to its long standing track record of working with landowners to provide education and technical assistance to achieve successful long-term resource conservation outcomes. The CRCD also has an existing carbon farming initiative with the same goals underway throughout Santa Barbara County for individual farms and ranches. This District-wide carbon management plan will:

- identify and to the extent possible quantify opportunities to enhance on-farm carbon capture in terrestrial plant biomass and soil organic matter on natural and working lands,
- determine the assets and barriers around implementation of these opportunities,
- reach out to landowners in the District that would be interested in applying these practices, and
- identify potential funding sources to assist in the cost of their implementation.

Sequestering carbon from the atmosphere into biomass and soils, a principle on which regenerative agriculture is based, is a critical solution to both global warming mitigation and to increasing the resiliency of our natural and working lands in the face of a changing climate. Implementing practices that enhance on-farm carbon capture can not only maintain but strengthen and enhance the adaptability of the incredible ecosystem that is the Gaviota Coast and serve as a critical step towards preserving this community's way of life. Importantly, each practice that will be discussed herein that sequesters carbon into the landscape has multiple co-benefits such as reducing erosion, creating habitat and increasing biodiversity. As we will show, like planting dense stands of trees and shrubs, compost application to grazed grasslands can sequester considerable amounts of carbon per acre while increasing productivity, extending the grazing season and increasing soil water holding capacity. The TRRP could serve to resolve a barrier to large scale implementation of this practice: an inexpensive, local, high-quality compost supply. Other carbon sequestering practices such as prescribed grazing, planting pollinator habitat via hedgerows and using biochar also present powerful opportunities to solve challenges with weed and fuel load management, pests, and costs of various inputs. The Gaviota Coast hosts a community of respected land stewards who are ready and willing to put such practices into place and this plan will serve as a roadmap to guide their efforts.

The Carbon Cycle and Global Climate Change

Scientific Context

Since the mid-1700s when the Industrial Revolution began, vast amounts of carbon in the form of fossil fuels that took millions of years to accumulate in the Earth's crust have been extracted, burned, and released into the atmosphere in the form of carbon dioxide. Land management practices such as clearing land through burning and conventional industrial farming have also moved an increased amount of carbon from the terrestrial pool to the atmospheric pool. The effects from this significant transfer of carbon from land and plant matter to the thin layer of air that surrounds our planet in a relatively short window of time are being observed and documented today.

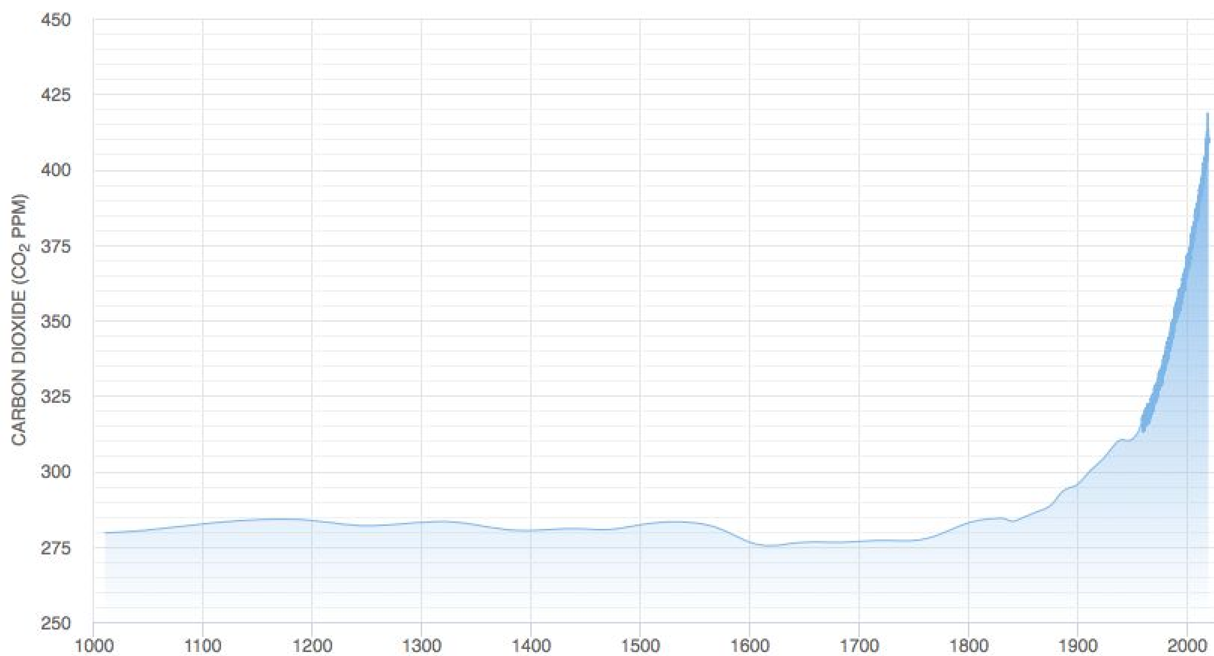

Figure 1. Global Atmospheric Carbon Dioxide Record from Law Dome, Antarctica Ice Cores

Graphic source: D.M. Etheridge, L.P. Steele, R.L. Langenfelds, R.J. Francey, J.-M. Barnola and V.I. Morgan. 1998. Historical CO2 records from the Law Dome DE08, DE08-2, and DSS ice cores. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. presented at http://www.co2.earth/co2-ice-core-data

Apart from anthropogenic effects, carbon naturally moves around through its various reservoirs in the air, ocean and land as part of the global carbon cycle.

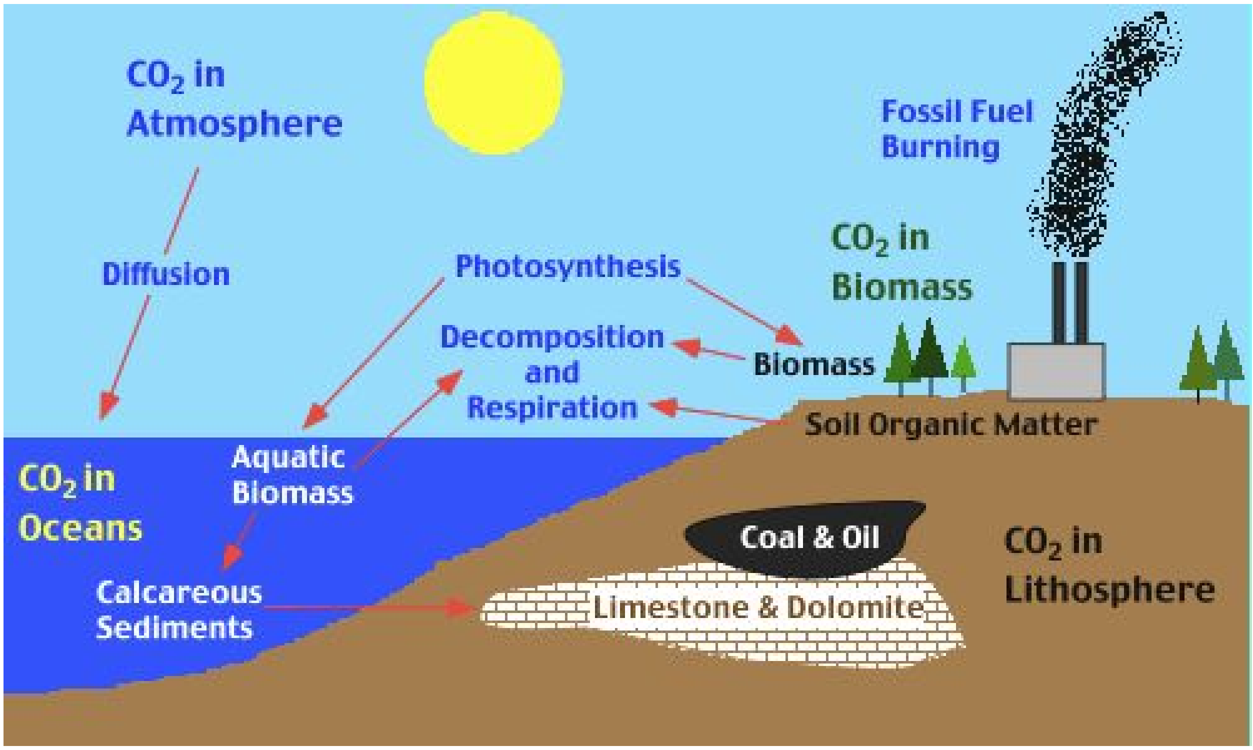

Figure 2. Diagram of the Sources, Sinks, and Processes of the Global Carbon Cycle

Graphic from Indiana University. http://www.indiana.edu/~geol105b/1425chap8.htm

The ocean and land plants have taken up about 55% of the extra carbon people have put in the atmosphere and eventually will take up most of it (not without harmful effects such as ocean acidification), but as much as 20% may remain in the atmosphere for many thousands of years (NASA, 2019). This is significant because carbon dioxide (CO_2) is considered the most important greenhouse gas for controlling the Earth's temperature. CO_2 absorbs a wide range of energy including infrared energy (heat) emitted by the Earth itself and re-emits it back to the Earth, heating its surface and essentially acting as a catalyst that causes a vicious cycle of further warming (NASA, 2019).

Although the Earth's climate has cycled between warming and cooling periods with evidence of glacial retreat and advance, the rate at which the current warming is occurring is roughly ten times faster than the average rate of previous ice age recovery warming (NASA, 2019a).

Carbon dioxide takes decades to begin its warming effect, so we have not yet felt the total impact of much of the carbon that has already been emitted. We will see an average global temperature increase of at least 1° to 1.5° C (1.8° to 2.7° F) even if we stop all emissions tomorrow. While that may not seem like much, to put it in perspective, at the coldest part of the last ice age the average global temperature was only 6° C colder than in recent years (Toensmeier, 2016).

In the 136-year record of tracking average global surface temperature, 18 of the 19 warmest years have occurred since 2001, with 1998 being the exception and 2016 ranking as the warmest (NASA 2019b). We have already begun to see the effects of a rapidly warming climate, such as increases in the occurrence of extreme weather events, sea level rise, warming and acidification of the oceans, shrinking ice caps and decreased snow cover (NASA 2019a). Scientists have reached the consensus that global climate change – not just progressive warming of the Earth's surface (global warming) - but the severe disruptions of weather patterns including record breaking heat waves, long-term drought, increasingly extreme super storms, and 100-year floods and snow falls in consecutive years are the new norm. The recently published *Special Report on Global Warming of 1.5°C* by the Intergovernmental Panel on Climate Change in October 2018 and the *National Climate Assessment Report Vol. 2* by the U.S. government in November 2018 conclude that the predicted effects of climate change are happening faster than anticipated and efforts to address them must ramp up now to have an impact.

Regulatory Context

The Paris Agreement that was negotiated at the United Nations Climate Change Conference in December 2015 marked an unprecedented political recognition of the risks of climate change and a consensus to address those risks and their causes. The agreement established a goal of limiting global temperature rise this century well below 2° C (~3.6° F) above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5° C (UNFCCC, 2015). The two-degree threshold was thought to represent a tipping point above which irreversible climate change would ensue but the specific number for that tipping point and whether or not we've already triggered it is arguable.

California has been a leader in addressing climate change with its pioneering Global Warming Solutions Act of 2006 also known as Assembly Bill No. 32 or AB 32. This bill established a statewide greenhouse gas (GHG) emissions limit equivalent to the statewide GHG emissions levels in 1990 to be achieved by 2020. California is on track to meet the goal of AB 32 as a result of implementing a comprehensive set of programs focused on energy efficiency and renewable energy, cleaner vehicles and fuels, putting a price on carbon through a cap-and-trade system and managing farms, rangelands, forests and wetlands so they store more carbon. In April 2015, Governor Jerry Brown issued Executive Order B-30-15 which set an interim GHG emissions reduction target of 40% below 1990 levels by 2030 to increase the likelihood of success in reaching the ultimate target of 80% reduction by 2050.

The Need for Land Based Sequestration

However, the data shows that even if we stop all emissions in the next decade, keep remaining stores of fossil fuels in the ground and transition to 100% renewable energy, global temperatures will continue to rise. To have a chance of reversing these trends we must actively drawdown, or sequester, carbon out of the atmosphere (Toensmeier, 2016). Project Drawdown, founded by Paul Hawken in 2014, is a coalition of researchers, scientists, policy makers, business leaders and others that identified, measured and modeled the 100 most substantive solutions to reverse global warming. Several agricultural and grazing practices made their list including: silvopasture (ranked 9th), regenerative agriculture (11th), afforestation (15th), conservation agriculture (16th), tree intercropping (17th), managed grazing (19th), farmland restoration (23rd), multi-strata agroforestry (28th), perennial biomass (51st), composting (60th) and nutrient management (65th) (Hawken, 2017). These practices and others can transition agriculture and grazing from being culprits to solutions as over one third of the Earth's land area is utilized as agricultural and grazing lands (World Bank, 2019).

While adding carbon to the oceans and atmosphere creates problems, building soil and land-based carbon generates significant benefits, benefits that are needed now more than ever. Professor Ratan Lal, Director of Ohio State University's Carbon Management and Sequestration Center (C-MASC) estimates that at least 50% of the carbon in the earth's soils has been released into the atmosphere as carbon dioxide over the past few hundred years – approximately 80 billion tons (Hawken, 2017). An estimated 4.4 billion tons of carbon have been lost from soils in the United States as a result of farming practices. Conventional agricultural activities, overgrazing and deforestation are the main causes of soil degradation and resulting decreased productivity (NRCS, 2016). The Natural Resources Conservation Service, formerly named the Soil Conservation Service, was created in 1935 amid the occurrence of the Dust Bowl to address these concerns. Franklin D. Roosevelt made conservation of soil and water resources a national priority in the New Deal administration, stating that "a nation that destroys its soil destroys itself". Several writers including Lowdermilk, Montgomery, Lindert, Hyams, Carter and Dale have documented the decline of civilizations throughout history in parallel with the destruction of their soil (USDA, 2011). Climate change science aside, our agricultural land desperately needs to be replenished with carbon.

Soil organic carbon is a vital constituent of healthy soil because it serves as the main source of energy for soil microorganisms that digest minerals and make them bio-available to plant roots. Organic carbon compounds bind mineral particles together to create soil aggregates which stabilize soil structure making it more resistant to erosion, but porous enough to allow air, water and plant roots to move through the soil. Needed carbon enters the soil through the decomposition of plant and animal residues, root exudates, living and dead microorganisms and soil biota, and is concentrated in the top layers of the soil. Practicing no-till crop management, applying manure and compost, and planting cover crops compensate for soil carbon loss from harvesting and microbial consumption/respiration.

Many of today's solutions to climate change are technological, from methane digesters and wind turbines to electrical vehicles and stack scrubbers, however ecological solutions are equally important. Farmers and ranchers are one of the communities that are disproportionately bearing the brunt of the effects of climate change, but as stewards of large swaths of land they can also offer a solution through the ways they manage their land and foster resiliency. Changing how we grow our food, graze animals and manage forests and riparian areas not only helps pull carbon out of the atmosphere, but also revitalizes our soils and increases productivity. Healthy soil can in turn retain more water and naturally create its own fertility, improving nutritional content and disease resistance, thereby creating healthier plants and animals. Creating resilient and thriving landscapes in turn produces vibrant and thriving communities thus ensuring the next generation's niche as good land stewards. This report looks at ways additional carbon can be sequestered into the terrestrial carbon pool through various land management practices to achieve these myriad benefits.

What is Carbon Farming?

Carbon Farming is newer terminology to describe the intentional implementation of certain farming practices that increase carbon capture from the atmospheric store and sequester that carbon in the terrestrial store.

The Marin Carbon Project defines carbon farming as follows:

"Carbon farming involves implementing practices that are known to improve the rate at which carbon dioxide is removed from the atmosphere and converted to plant material and/or soil organic matter. Carbon farming is successful when carbon gains resulting from enhanced land management and/or conservation practices exceed carbon losses." (Marin Carbon Project, 2013)

Dr. Rattan Lal, the director of the Carbon Management and Sequestration Center at Ohio State University, defines carbon farming with an explicit link to carbon offset monetization:

"a system of increasing carbon in terrestrial ecosystems for adaptation and mitigation of climate change, to enhance ecosystem goods and services, and trade carbon credits for economic gains." (Toensmeier, 2016)

Sequestration of carbon in the agricultural context is accomplished in three main ways:

1. Via photosynthesis where plants convert sunlight, water and atmospheric carbon dioxide into carbohydrates such as sugars, starches and cellulose, and exude carbon compounds into the soil through their roots. Additional carbon is stored in the terrestrial pool as plant parts decompose and become incorporated into the soil as soil organic matter and eventually the more stable humus, and when subsurface microbial and fungal communities made of carbon are allowed to populate and thrive;
2. By minimizing soil disturbance such as through plowing and tilling which releases carbon from the soil via oxidation and erosion;
3. By reducing greenhouse gas emissions from mechanized equipment and synthetic fertilizers.

Carbon farming practices that sequester carbon and/or reduce greenhouse gases include:

- Cover cropping and reducing areas of bare ground by planting plants, particularly woody, perennial crops that store more carbon (plants not only convert atmospheric carbon to biomass via photosynthesis but improve soil health which increases productivity, stores additional carbon in the subsoil and reduces carbon loss via erosion);
- Increasing biomass density through intercropping and multi-strata cropping in cropland areas, establishing hedgerows and windbreaks, planting trees, increasing the occurrence of perennial species and via riparian restoration;

- Applying biochar and compost to soils to increase organic matter content, enhance the subsurface microbial community, improve soil structure and nutrient cycling, and replace the need for GHG-emitting synthetic fertilizers;
- Practicing no-till management to avoid oxidation of soil carbon, soil erosion and disruption of the subsurface microbial community;
- Managing grazing to increase plant productivity and assist in annual to perennial grass conversion;
- Incorporating trees into grazing lands via silvopasture.

These practices, among others, are not only agricultural climate change solutions, they also create healthier nutrient and water cycles, increase productivity and improve resiliency to pests and disease. Carbon farming practices are part of the current Regenerative Agricultural movement, which seeks to mimic nature and natural systems as much as possible to restore and promote the long-term health of the land. To regenerate is to give life to and all life is made of carbon. This requires whole systems thinking and an all-inclusive view of the ecosystem being managed. At scale, carbon farming can contribute to the drawdown of carbon from the atmosphere and the reversal of climate change (Smallwood 2017).

Implementing carbon farming practices requires a capital investment, whether it is purchasing plant stock, compost, or fence line, or transitioning to a new management practice requiring new equipment such as no-till. Many farmers and ranchers are already struggling to make ends meet and stay on their land facing increased development pressure, labor shortages, and economic and climate instability. The ability to quantify the carbon sequestration potential of each practice a landowner proposes to implement is what makes a carbon farm plan different from other conservation plans. This quantification of the critical ecosystem services that landowners provide to the surrounding landscape and broader community by implementing carbon farming practices that draw carbon out of the atmosphere and increase the resiliency and adaptability of the land in the face of climate change, provides them with one potential vehicle by which to be monetarily compensated for making these capital investments and preserving our agricultural and working lands.

The Carbon Farming Planning Process

The carbon farming planning process is based on the existing Natural Resources Conservation Service (NRCS) conservation planning process, but is organized around the theme of carbon sequestration. The process starts with an overall inventory of natural resource conditions and then identifies and maps opportunities for enhanced carbon capture and reduction of greenhouse gas emissions. In the NRCS planning process, potential resource concerns such as soil erosion or overgrazing are evaluated by a set of criteria to determine whether they warrant the application of a specifically defined conservation practice such as cover cropping or prescribed grazing. The overall resource concern in a carbon farm plan is the need to sequester more carbon at the site in both the soil and biomass and reduce activities that result in a loss of carbon. The producer’s goals overall are to maintain the sustainability of the farm or ranch and its ecosystem services - to simultaneously work the land to generate a financial return while regenerating the landscape and serving as a net carbon sink.

NRCS Conservation Practice Standards (CPSs) provide the specification needed in order to facilitate the quantification of carbon sequestration potential. The acreage of each CPS recommended for a site can then be plugged into the online COMET-Planner tool developed by the University of Colorado in partnership with NRCS to provide approximate greenhouse gas mitigation potentials. An implementation plan is then created based on a prioritization of the various conservation practices identified taking into account the property owner's goals and financial and/or logistical constraints and available funding opportunities. Monitoring and documentation of the implemented practices, including documentation of baseline conditions before the practices are implemented, allow for the tracking of changes over time and subsequent adjustments and updates to the plan. Carbon Farm Plans leverage existing and trusted networks of financial and technical resources to de-risk the transition to regenerative agriculture.

Existing Land Use & Land Cover Types

The Gaviota Coast planning area is bounded by the City of Goleta to the east, Vandenberg Air Force Base to the west, the Los Padres National Forest and the Santa Ynez mountains ridgeline to the north and the Pacific Ocean to the south. It contains approximately[1]:

- **76,335 acres of private land** including residential neighborhoods, working agricultural and grazing lands, oil and gas facilities, The Dangermond Preserve (24,381 acres), UCSB's Las Varas Ranch (1,800 acres), and the Land Trust for Santa Barbara County held lands (3,627 acres) (77% of total District acreage),
- **15,705 acres of federal land** consisting of the U.S. Forest Service Los Padres National Forest (16% of total),
- **5,408 acres of state owned lands** including Gaviota State Park, El Capitan State Park and Refugio State Park (5% of total),
- **1,640 acres of county held land** including the 1,092-acre Baron Ranch, adjacent to the Tajiguas landfill (2% of total), and
- **597 acres of "other public" land** including small municipality holdings, road right-of-ways, etc. (1% of total)

[1]approximately 1,500 acres of the total district area are not included in the above breakdown due to incomplete classification data (blank spots) in the Santa Barbara parcel data layer.

The Nature Conservancy's 24,381-acre Dangermond Preserve constitutes 24% of the District's total acreage and 32% of its privately-held lands, underscoring the value of their potential role in increasing carbon sequestration in the District as a whole. Refer to the Overview Map in Appendix A.

The Santa Barbara County Conservation Blueprint delineates approximately 2,391 acres of cropland in the District categorized by: citrus and subtropicals (e.g. lemons and avocados), deciduous fruits and nuts, vineyards, young perennials, truck nursery and berry crops, grain and hay crops, and pasture. This dataset is derived from 2014 aerial photography from the National Agricultural Imagery Program administered by the USDA's Farm Service Agency (CBI, 2019). Although this data is now 6 years old and not a complete inventory of cropland currently cultivated in the District, it does show that the majority of the crop types are perennial orchards and where these operations are concentrated. Refer to the Agricultural Crop Map in Appendix A.

Habitat in the District includes annual grasslands, riparian corridors, oak woodlands, mixed conifer forest, coastal sage scrub and chaparral. Effective ecological sites for planning purposes are: hardwood rangeland and forested areas, annual rangeland, cropland and riparian areas.

Hardwood Rangeland and Forested Areas

Mixed conifer and hardwood forest/woodland cover characterize approximately 22,293 acres of the District while approximately 50,271 acres were categorized as shrub land cover type according to the CalVeg (Classification and Assessment with Landsat of Visible Ecological Groupings) map. Refer to the CalVeg map in Appendix A.

Intact woodlands and forests tend to be gradual accumulators of carbon and as such these areas of the site were generally excluded from this analysis with prioritization on annual rangelands, cropland and riparian areas. Establishing additional woodlands on rangeland and cropland areas via tree/shrub establishment, silvopasture, woody plantings, windbreaks/shelterbelts and hedgerows are discussed elsewhere in this report where a net benefit in terms of carbon sequestration (among other benefits) would occur from the conversion of areas with existing annual vegetation to perennial vegetation.

Annual Rangeland

In California, rangelands are dominated by non-native (naturalized) annual species with some areas including native grasses, forbs, shrubs and trees. Annual rangeland in much of California including on the Gaviota Coast is in less than ideal condition due to decades of continuous grazing activity by cattle and/or horses where animals are turned out on a large area and allowed to congregate in shaded areas and around water resources and overgraze their favorite plants. This has resulted in degraded soil conditions and less desirable plant composition. Typical resource concerns of historically grazed rangelands in Southern California can be magnified during extended drought periods like the one this region has recently experienced and include the following:

- soil erosion (sheet, rill, wind, gullies, bank);
- soil quality degradation (compaction, organic matter depletion, concentration of salts or other chemicals);
- insufficient water or excess water (ponding or flooding);
- water quality degradation (elevated temperature and/or excessive sediment, nutrients, pathogens, salts, or other contaminants in surface or groundwater);
- air quality impacts (emissions of particulate matter or greenhouse gases);
- degraded plant condition (inadequate plant productivity and health, undesirable structure and composition, excessive plant pest pressure, wildfire hazard/excessive biomass accumulation);
- inadequate habitat for fish and wildlife (quantity or quality of food, water, cover/shelter or habitat continuity and/or space); and
- livestock production limitation (inadequate feed and forage, shelter or water).

Management Objectives:

- increase carbon sequestration throughout the rangeland, increase the rate at which carbon is transferred from the atmospheric to terrestrial pool;
- increase forage productivity and carrying capacity;
- increase forage biodiversity particularly with native, perennial and/or drought-tolerant species;

- improve soil health so that it contains more organic matter, hosts a thriving microbial community, holds more water and demonstrates optimal structure (increased pore space, decreased erosivity, etc.);
- plant more trees to create more shade, reduce ambient and soil temperature, improve grazing distribution, hold more water onsite, increase habitat and sequester more carbon; and
- increase water storage onsite above and below ground.

Several carbon-sequestering conservation practices can be implemented in the Gaviota District to address these management objectives:

- application of compost to grazed grassland;
- prescribed grazing;
- range planting;
- tree/shrub establishment;
- silvopasture;
- prescribed fire;
- hedgerow establishment; and
- windbreak / shelterbelt establishment.

These practices and their carbon sequestration potential are discussed in more detail in the latter sections of this report. In general, practices that reduce or repair soil erosion, reduce the area of bare compacted soil, reduce trailing and provide grazed vegetation sufficient rest for adequate regrowth between grazing periods will tend to result in more overall forage production and more carbon sequestered in vegetation and soils over time. Grazing management strategies within this plan therefore include increasing field divisions to force uniform grazing of plant species and allow grazed vegetation longer rest periods to recover, restoring degraded areas, planting trees and increasing production through improved field rotation, compost applications and seeding. Implementing such practices will transition the landscape from the Southern California status quo of continuously grazed (over grazed) land dominated by European annual grasses and noxious plant species to a more diverse, humus-rich, tree-studded environment with more deep-rooted perennial species.

Cropland

Cropland on the Gaviota Coast is currently dominated by monocultures of either citrus or avocado orchards. However, crop types can be expected to change over time according to changing trends (e.g. wine grapes), policy (e.g. cannabis) and as a result of a rapidly changing climate. Although the District's working lands consist primarily of grazed rangeland, there has been a dramatic conversion from rangeland to vineyard cultivation in other areas of the County that wouldn't have been expected 10 years ago according to local landowners. Similarly, Santa Barbara County is now the State's top cannabis producer. (Mozingo, 2019).

The Gaviota Coast Plan states that 76% of the privately held land within the Gaviota Coast is enrolled under the Williamson Act, a voluntary program that restricts land use to agriculture, open space or recreational uses in exchange for substantially reduced property tax assessment. Landowners must demonstrate continuous agricultural production to retain their agricultural contract eligibility. (County, 2017). Carbon farming practices can be applied to various types of annual row crops and perennial crops such as orchards and vineyards, and can make whatever the desired crop type is at the time more productive and resilient.

Conventional agriculture, the dominant farming practice in the world today, treats the soil as a medium to which mineral fertilizers and chemicals are added. The soil is plowed, tilled, cultivated or disked two or more times a year. Herbicides clear the weeds, insect infestation is treated with pesticides and blight or rust is sprayed with fungicides. Lack of water is compensated for with irrigation which can cause salinization of the soils. The main sources of greenhouse gas emissions from cropland agriculture are carbon dioxide released from soils via tillage and generated by mechanized equipment, and nitrous oxide from the use of nitrogen fertilizers (CAST 2011). Tilling oxidizes carbon in the soil emitting it as carbon dioxide, destroys the soil structure, causes compaction and disrupts the subsurface microbial and fungal communities essential to soil and plant health. Carbon inputs via organic matter may be increased through higher plant residue inputs from more productive annual crops, intensified cropping frequency and cover cropping, inclusion of perennial crops, or through the application of mulch and/or compost. Nitrous oxide emissions from agricultural soil account for approximately 4.5 percent of total U.S. greenhouse gas emissions, with the most dominant source from the use of nitrogen fertilizers (EPA 2014). Improved nitrogen fertilizer management strategies include reducing the rate of nitrogen fertilizer applied, shifting timing of applications from the fall to the spring when it is most needed, planting nitrogen fixing plants and applying compost. In terms of carbon farming, the District is already ahead of the game, cultivating many perennial crops such as orchards and vineyards which sequester more carbon than annual crops and do not require tilling. Otherwise, resource concerns of the cropland land use in the District are somewhat typical of monocultures in southern California.

Typical resource concerns include:

- soil erosion (sheet, rill, wind, gullies, bank);
- soil quality degradation (compaction, organic matter depletion, concentration of salts or other chemicals);
- insufficient water or excess water (ponding or flooding);
- water quality degradation (elevated temperature and/or excessive sediment, nutrients, pathogens, salts, or other contaminants in surface or groundwater);
- air quality impacts (emissions of particulate matter or greenhouse gases);
- degraded plant condition (undesirable plant productivity and health, inadequate structure and composition, excessive plant pest pressure, wildfire hazard/excessive biomass accumulation);
- inadequate habitat for wildlife (quantity or quality of food, water, cover/shelter or habitat continuity and/or space);
- lack of biodiversity in crop monocultures
- overuse of synthetic nitrogen and associated nitrous oxide emissions and potential water contamination
- use of toxic chemicals to control weeds, pests and disease and decrease in pollinator species

- excessive weeds
- carbon dioxide emissions from portable mechanized equipment, pumps, etc.

Goals:

- increase biodiversity particularly with plants that provide habitat for pollinators, fix nitrogen in the soil and/or have symbiotic relationships with the crop in cultivation
- improve soil health so that it sequesters more carbon, contains more soil organic matter, holds more water, hosts a thriving microbial community, and provides enough nutrients to decrease or eliminate the need for synthetic fertilizer
- increase crop productivity
- decrease need for irrigation and synthetic inputs
- incorporate more climate-appropriate species suitable to the existing conditions of the natural environment in terms of naturally occurring amounts of moisture, seasons and temperatures
- enhance financial returns from cropland harvest
- increase resilience to drought and extreme weather
- experiment with new crop commodities that are adaptable to predicted changes in local climate (e.g. reduced chill days, longer more frequent droughts, etc.)

Several carbon-sequestering conservation practices can be implemented to address these resource concerns and respond to the producer's management goals.

Conservation practices that address these typical resource concerns include:

- cover cropping
- alley cropping
- hedgerow plantings
- windbreak/shelterbelt establishment
- application of compost and/or biochar
- mulching
- conversion of fallow areas with new cover crops and/or tree and shrub establishment
- decrease use of and/or improve fuel-efficiency of farm equipment and infrastructure
- multi-species grazing

These practices and their carbon sequestration potential are discussed in more detail in the latter sections of this report. In general, the focus would be on increasing the biodiversity in the cropland areas via alley cropping, intercropping or perimeter plantings, and amending soils with mulch, biochar and compost. These activities would nurture the subsurface microbial communities thereby reducing or eliminating the need for synthetic nitrogen fertilizer and augmenting the water-holding capacity and carbon sequestration in the soil.

Beneficial species of soil microbes such as bacteria, fungi, protozoa, nematodes and micro arthropods found naturally in healthy growing systems provide the mechanism by which nutrients are converted into their non-leachable, plant-available forms in the root zone of soil. Beneficial bacteria and fungi are needed to degrade any residual toxic chemicals in the growing environment and serve to tie-up nutrients so that they are not lost when water moves through the soil. Bacteria and fungi then need to be eaten by protozoa and nematodes to release those tied-up nutrients in a plant available form. If your soil is missing or deficient in any of these key players, the process will be impaired and key nutrients will be unavailable or deficient. If this is the case, the system needs to be jump-started to reestablish the natural set of organisms and thus reestablish normal nutrient cycling. One of the primary ways this is done is through the addition of a high-quality compost. Microbes and the diversity of larger organisms they support such as worms and insects also restructure the soil by creating air passageways and cavities that enable water and air to be retained within the soil, decreasing the demand for irrigation. Overall, if there is a healthy subsurface microbial community, plants have access to and thus contain their full complement of critical nutrients, boosting their health, nutritional value and resistance to pathogens, pests and disease. Maintaining a healthy population of 70 percent of beneficial microbes in soils and on plant surfaces will nurture a protective type of environment that will thwart any disease-causing organisms that may come along, simply by outcompeting them for food and space (Ingham, 2015).

Riparian

Numerous riparian corridors of varying sizes drain the steep front country terrain of the Santa Ynez Mountains emptying into the Pacific Ocean. They tend to be flashy and ephemeral, surging and draining quickly during rainfall events and then typically drying up at least in portions in the summer months. The largest drainages include Gaviota Creek, El Capitan Creek, Tajiguas Creek, Refugio Creek and Jalama Creek.

The construction of Highway 101 which runs perpendicular and across many of these drainages created barriers to migrating Southern California steelhead. Steelhead, members of the salmon family, are anadromous fish that hatch in freshwater, migrate to the ocean to mature, and then return to freshwater to spawn. This life cycle, when allowed to function, serves as a “nutrient pump” bringing nutrients and organic matter from the ocean into the watershed and contributing it to the ecosystem via direct consumption of fish and fish eggs by animals and via their excretions and decomposition. This nutrient and organic matter distribution increases both soil nutrients and riparian vegetation growth among other benefits. (Gende et al 2002)

Given the region’s steep topography, long history of cattle grazing, highway construction and its location in a semi-arid region of Southern California having recently experienced a historic drought, typical resource concerns and management objectives for the watersheds in the Gaviota District are as follows:

Typical resource concerns:

- stream incision and disconnection from floodplains, lowering of the water table;
- lack of surface and groundwater;
- flash flood prone morphology;
- man-made pinch points and flow restricting infrastructure
- undesirable plant species, lack of native riparian vegetation; and
- decreased water-holding capacity of soil.
- barriers to Steelhead migration

Management Objectives:

- slow the flow of surface water across the site and in the drainage areas;
- retain as much water as possible that falls or flows onto the site;
- increase the height of the water table;
- minimize evaporative loss from riparian corridors, drainages and catch basins;
- increase the water holding capacity of the soil;
- establish earthworks to spread, capture and/or store rainfall; and
- establish appropriate grazing strategies as it relates to riparian corridors.

Water availability is currently a limiting factor in the overall productivity of the region and will be necessary when establishing practices to increase carbon capture even if climate appropriate, drought-tolerant, resilient species are planted. Staging and strategic timing of practice implementation can reduce the burden on water resources in any one given year.

Additional opportunities to meet the above objectives include:

- installing gutters on all infrastructure to direct rainfall into holding tanks and/or infiltration basins;
- installing cisterns or other rainwater collection devices throughout properties;
- creating additional earthworks such as terraces, keylines, berms, pocket ponds and other rainwater harvesting techniques;
- using beaver mimicry to slow and retain water by building semi-permeable dams (aggradation devices also known as Beaver Dam Analogs or BDAs) out of natural materials where water is known to flow during rainfall events.

One significant factor in the drying of the West was the near eradication of the region's native hydrologic engineers – the beaver. As beaver dams decayed and washed away, wet beaver meadows were incised and subjected to drying and soil loss. Watersheds responded to the resulting changes in hydrology with flashier flood events, increased erosion and less water retention. Today, beavers are increasingly recognized as a keystone species playing a critical role in watershed dynamics where they are present, including benefitting native fish populations. Beaver ponds provide perennial pools and replenish aquifers, allowing groundwater to recharge streams and meadows in dry summers.

Evidence of beaver populations in Santa Barbara County coastal streams includes a Chumash pictograph of a beaver at Painted Rock in the Cuyama River watershed (Figure 3). The Barbareño and Ventureño Chumash are known to have had a Beaver Dance (Timbrook 2007), and Father Pedro Font, on the second de Anza Expedition in 1776, described coastal Chumash women wearing beaver capes (Lanman et al. 2013). Taken together, these facts suggest that beaver once ranged throughout Santa Barbara County. John Peabody Harrington reported beaver on Zanja de Cota Creek on or before 1900, however, the Santa Ynez River beaver were likely trapped out until re-introduction in the 1940s by the California Department of Fish and Game (Hensley 1946). The lower Santa Ynez River today has about a dozen California Golden (*Castor canadensis subauratus*) beaver dams.

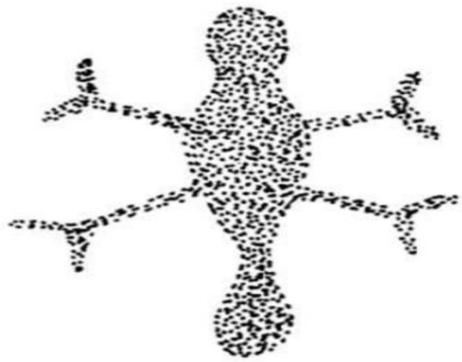

Figure 3. Image of Beaver Pictograph at Painted Rock Cave

(Lee and Horne, 1978)

While beavers are unlikely to return to the Gaviota Coast in the near term, opportunities for enhancing beaver habitat could be seized when designing and implementing riparian restoration efforts in order to facilitate the return of this keystone hydrological engineer to the ranch ecosystem. In the meantime, their behavior can be mimicked by building semi-permeable dams out of natural materials where water is known to flow during rainfall events. Beaver mimicry is increasingly being recognized as a way to restore watersheds and is being studied by The Nature Conservancy, the U.S. Forest Service-Pacific Southwest Research Station, Point Blue Conservation Science, Montana's Madison Conservation District, The Occidental Arts & Ecology Center and others.

Opportunities To Enhance On-Farm Carbon Capture

The NRCS has at least 30 established Conservation Practice Standards (CPSs) for various management practices associated with cropland cultivation, woody plantings, grazing lands and restoration that represent opportunities to enhance on-farm carbon capture and/or reduce GHG emissions. Although not an inclusive list of all of the available opportunities to implement carbon farming in the District, CPSs provide a valuable resource of readily accessible guidance documentation for practice descriptions and implementation. Refer to section IV of the NRCS Field Office Technical Guide for California available online at efotg.sc.egov.usda.gov for detailed information on each CPS. Because they are well-defined practices that producers have been utilizing for decades, there is a track record that demonstrates their success representing a lower risk for producers considering their adoption. NRCS also provides cost-sharing opportunities to assist producers with the cost of their implementation as discussed later in this report. Well-defined and studied CPSs provided an existing basis for the development of quantification methodology for their potential to increase carbon capture or reduce GHG emissions as cataloged in the online COMET-Planner tool.

<u>Cropland Management</u>

- Nutrient Management (CPS 590)
- Conservation Crop Rotation (CPS 328)
- Cover Crop (CPS 340)
- Stripcropping (CPS 585)
- Mulching (CPS 484)
- Combustion System Improvement (CPS 372)
- Residue and Tillage Management (CPS 329 & 345)

<u>Woody Plantings</u>

- Tree/Shrub Establishment – Farm Woodlot (CPS 612)
- Windbreak / Shelterbelt Establishment (CPS 380)
- Windbreak / Shelterbelt Renovation (CPS 650)
- Riparian Forest Buffer (CPS 391)
- Hedgerow Planting (CPS 422)
- Alley Cropping (CPS 311)
- Multi-story Cropping (CPS 379)

<u>Restoration of Disturbed Lands</u>

- Critical Area Planting (CPS 342)
- Riparian Restoration

<u>Cropland to Herbaceous Cover</u>

- Conservation Cover (CPS 327)
- Forage & Biomass Plantings - Full Conversion (CPS 512)
- Forage and Biomass Plantings (CPS 512)
- Herbaceous Wind Barriers (CPS 603)
- Vegetative Barriers (CPS 601)
- Riparian Herbaceous Cover (CPS 390)
- Contour Buffer Strips (CPS 332)
- Field Border (CPS 393)
- Filter Strip (CPS 393)
- Grassed Waterway (CPS 412)

<u>Grazing Lands</u>

- Range Planting (CPS 550)
- Silvopasture (CPS 381)
- Prescribed Grazing (CPS 528)
- Nutrient Management (CPS 590)

Practices other than the established NRCS CPSs that represent promising opportunities to increase carbon capture in the District should also be considered such as compost application to grazed grassland, the use of biochar, prescribed fire and marine permaculture (ocean farming of kelp and seaweed). All of the opportunities are described in turn below along with any co-benefits in terms of ecosystem services they provide other than increased carbon capture or reduced GHG emissions. Refer to Appendix B for a summary table of the potential annual carbon sequestration and GHG emission reduction potential per 100 acres and co-benefits of various practices. For reference, one metric ton of CO2 equivalent is equal to the amount sequestered by 1.2 acres of U.S. forest in one year or the GHG emissions from 0.2 passenger vehicles driven for one year.

Cropland Management

The following practices have been identified as opportunities to sequester carbon and/or decrease GHG emissions in areas of the District being utilized for cropland cultivation. Note that none of the practices in the Cropland to Herbaceous Cover category are discussed here under the assumption that it is unlikely most producers are interested in taking any existing cropland out of production.

Combustion System Improvement (CPS 372)
Implementation of this practice involves improving the fuel efficiency of farm equipment by either installing, replacing or retrofitting agricultural combustion systems and/or related components or devices. Besides tractors, this practice also applies to portable, mobile and self-propelled equipment including sit down and pull-behind mowers. On the Gaviota Coast, diesel generators used to power off-grid water wells could be targeted for this practice. Co-benefits other than a reduction in GHG emissions include overall improved air quality (decreased smell and noxious fumes) and decreased fuel costs. One metric ton of CO2 equivalent could be avoided per year if this practice was implemented on 42 acres.

Conservation Crop Rotation (CPS 328)
The definition of this CPS is “a planned sequence of crops grown on the same ground over a period of time (i.e. the rotation cycle)”. Implementation of this practice involves decreasing the fallow frequency or adding perennial crops to rotations occurring in existing annually-planted cropland. Co-benefits include reduced erosion, increased soil health and organic matter content, reduced water quality degradation due to excess nutrients, improved soil moisture efficiency, reduced concentration of salts and other chemicals, reduced plant pest pressures, feed and forage for domestic livestock, food and cover habitat for wildlife, including pollinator forage and nesting. One metric ton of CO2 equivalent could be sequestered per year for every 2 acres where this practice was implemented.

Cover Crop (CPS 340)
NRCS defines this practice as “crops including grasses, legumes and forbs for seasonal cover and other conservation purposes”. Implementation scenarios for this conservation practice are to add a legume or non-legume seasonal cover crop to irrigated or non-irrigated cropland. Typically cover crops are planted after the harvest of an annual crop to re-establish nutrients (e.g. nitrogen) in the soil and to cover the soil with a planted crop to reduce soil erosion and degradation (e.g. surface crust formation) that would occur on a field of bare soil. Cover crops also provide a source of fuel for the soil microbial community to continue providing its contributions to the soil ecosystem as previously described. Other co-benefits of this practice include promoting biological nitrogen fixation, reducing water quality degradation by

utilizing excessive soil nutrients, suppression of excessive weed pressures and breaking pest cycles, improved soil moisture use efficiency, increasing biodiversity, reducing erosion and minimization of soil compaction. Adding a legume seasonal cover crop to just one acre of irrigated or non-irrigated cropland can sequester one metric ton of CO2 equivalent per year. One and a half acre or 2.2 acres would be required to sequester a like amount if adding a non-legume seasonal cover crop to irrigated or non-irrigated cropland respectively.

Mulching (CPS 484)

NRCS defines this practice as "applying plant residues or other suitable materials to the land surface". Co-benefits include conservation of soil moisture, decreased irrigation costs, reduced energy use associated with irrigation, decreased soil erosion, improved soil health and reduced airborne particulates. One metric ton of CO2 equivalent could be sequestered for every 2.5 acres that are mulched. Some producers are currently utilizing this practice to reduce irrigation needs and control weeds although unfortunately the mulch that the County offers free of charge is often contaminated with pieces of plastic and other bits of trash. There may be an opportunity to partner with local fire departments to receive alternative sources of mulched material that they process as part of their fire fuels management activity.

Nutrient Management Plan (CPS 590)

This practice has to do with "managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments" according to the NRCS CPS.

Implementation choices for this conservation practice in COMET-Planner include:

- improving nitrogen fertilizer management on irrigated or non-irrigated croplands by either
  - reducing the fertilizer application rate by 15%,
  - using nitrification inhibitors or
  - using slow release fertilizers, or
- replacing synthetic nitrogen fertilizer on irrigated or non-irrigated croplands with either
  - beef feedlot manure
  - chicken broiler manure
  - chicken layer manure
  - compost with carbon to nitrogen ratios of either 10, 15, 20 or 25
  - dairy, sheep swine or other manure.

Ideally, we would want to replace the use of synthetic fertilizer inputs and so the option to apply compost with a C:N of 20 was chosen as the most appropriate option as dairies, feedlots or other large sources of manure are not located at a convenient distance from the site. Co-benefits of this practice include reducing nutrient runoff, decreasing fertilizer costs, improving air quality, improving soil structure and water holding capacity and stimulating the subsurface microbial community to increase natural nutrient cycling processes. One metric ton of CO2 equivalent could be sequestered for every 2 acres of irrigated cropland where this practice is applied.

Residue and Tillage Management – No-Till (CPS 329)

NRCS defines this practice as "limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year round". Implementation choices for this selection have to do with various scenarios of transitioning from intensive till or reduced till to no till or strip till on irrigated or non-irrigated cropland. Co-benefits of this practice include reducing sheet, rill and wind erosion and excessive sediment in surface waters, reducing tillage-induced particulate emissions, maintaining or increasing soil health and organic matter content, increasing plant-available moisture, reducing energy use and providing food and escape cover for wildlife. One metric ton of CO_2 equivalent could be sequestered for every 2.5 acres of irrigated cropland that is transitioned from intensive till to no till or strip till.

Residue and Tillage Management – Reduced Till (CPS 345)

This practice has to do with transitioning from intensive till to reduced till on irrigated or non-irrigated cropland. Similar co-benefits would be realized as in a transition to no-till but to a lesser degree. One metric ton of CO_2 equivalent could be sequestered for every 6 acres of irrigated cropland that is transitioned from intensive till to reduced till.

Stripcropping (CPS 585)

NRCS defines this practice as "growing planned rotations of erosion-resistant and erosion-susceptible crops or fallow in a systematic arrangement of strips across a field". Implementation scenarios for this conservation practice in the COMET-Planner tool involves adding a perennial cover grown in strips with either irrigated or non-irrigated annual crops. Co-benefits of this practice include reducing sheet and rill erosion, reducing wind erosion, reducing excess nutrients in surface waters, reducing sediment and pesticide transport to surface waters and improving plant productivity and health. One metric ton of CO_2 equivalent could be sequestered for every 4 acres of irrigated or non-irrigated cropland where stripcropping is implemented.

Biochar

The use of biochar as a soil amendment represents one of the practices that is still being studied and lacks a robust body of academic research, but should nonetheless be considered. The IPCC rates biochar application as having high global mitigation potential being moderately easy to adopt by farmers. The UN Convention to Combat Desertification is promoting the use of biochar to help restore degraded land. (Toensmeier, 2016) Biochar is also among the 100 solutions to reverse global warming identified by Project Drawdown (Hawken, 2017).

Biochar refers to biomass-derived charcoal and is formed by burning biomass in the absence of oxygen. Its porous structure provides extensive surface area that then serve as binding sites for nutrients, hold water and provide habitat for vital microorganisms making it particularly useful in tropical and sandy soils where nutrients are easily leached away. Moreover, it carries a negative electrical charge that can pull in positively charged elements such as calcium and potassium, and it reduces soil acidity caused by nitrogen fertilizers. Biochar is incorporated into agricultural soils to increase carbon sequestration, improve fertility and boost yields. A meta-analysis of multiple studies found an average crop yield increase of roughly 15% in biochar-amended soils. Biochar retains and renders stable most of the carbon present in its biomass feedstock, persisting in soils for 100 to 1,000 years. In the Amazon, historical use of biochar, also referred to as terra preta (literally “black earth” in Portuguese), has persisted to the present day in rich fertile soils as deep as 2 meters (Toensmeier, 2016). This 6.5 to 7-foot layer of topsoil represents approximately 150-500 tons of carbon per hectare to a depth of one meter (Hawken, 2017). In ancient Amazonian society, virtually all waste was organic and disposed of by either burning or burying. Buried organic wastes were baked without exposure to air beneath a layer of soil. This process, known as pyrolysis, produced the charcoal soil amendment rich in carbon (Hawken, 2017). The more modern preferred method to create biochar is gasification, a higher temperature pyrolysis that results in more completely carbonized biomass. As it is heated, gas and oil separate from carbon-rich solids and the output is twofold: fuels that can be used for energy and biochar for soil amendment (Hawken, 2017).

Woody Plantings

The following practices have been identified as opportunities to sequester carbon and/or decrease GHG emissions in areas of the District where woody plantings could be established.

Alley Cropping (CPS 311)

Conservation Practice Standard 311 defines alley cropping as “trees or shrubs planted in sets of single or multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products”. Co-benefits of this practice include enhancing microclimatic conditions to improve crop or forage quality or quantity, reducing surface water runoff and erosion, improving soil health by increasing utilization and cycling of nutrients, enhance wildlife and beneficial insect habitat, increasing crop diversity, and decreasing offsite movement of nutrients or chemicals. Unfortunately this conservation practice does not have an implementation scenario in COMET-Planner for Santa Barbara County and therefore no quantification value. However, the Stripcropping CPS values above could be utilized as a conservative estimation given the similarity between these two practices.

Hedgerow Planting (CPS 422)

Hedgerow Planting is defined in Conservation Practice Standard 422 as “establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose”. Implementation scenarios in COMET-Planner are to either replace a strip of *cropland* with one row of woody plants or replace a strip of *grassland* with one row of woody plants. The CDFA Healthy Soils Incentive Program (HSP) specifies further implementation requirements such as inclusion of pollinator-friendly shrubs and perennial wildflowers, a combination of cool and warm season perennial species, a density of ≥200 plants/acre, row width of ≥ 8 feet, and average height ≥ 3 feet at maturity, although the carbon sequestration value of the practice in the HSP version of COMET Planner is the same as the original COMET-Planner tool of 8 metric tons of carbon dioxide equivalent per acre per year.

Besides increasing carbon storage in biomass and soils at the site, planting hedgerows will also create habitat, increase plant diversity, attract pollinators, and may act as a screen for privacy. They are often referred to as living fences because of their ability to provide boundary delineation and contour guidelines.

There are several opportunities throughout the District to establish hedgerow plantings including:

- along perimeter and interior fence lines;
- along the perimeters or boundaries of various man made or natural features;
- along the perimeter of cultivated croplands; and
- in a series of rows on-contour along steeper slopes to build natural terraces, stabilize the soil, reduce erosion, and slow and spread rainfall.

Multi-story Cropping (CPS 379)

NRCS defines multi-story cropping as "existing or planted stands of trees or shrubs that are managed as an overstory with an understory of woody and/or non-woody plants that are grown for a variety of products". Unfortunately, this conservation practice does not have an implementation scenario in COMET-Planner for Santa Barbara County and therefore no quantification value. This is likely due to the inherent diversity in how it could be implemented. Multi-story cropping is a signature carbon farming practice however as it increases net carbon storage in plant biomass and soil, improves soil quality by increasing utilization and cycling of nutrients and maintaining or increasing soil organic matter, and improves crop diversity by growing mixed but compatible crops having different heights on the same area as described in the NRCS CPS.

The "food forest" illustrated below is an example of a multi-story cropping system (multi-strata agroforestry) consisting of various food-bearing trees and shrubs. The goal is to mimic a woodland ecosystem with companion plantings of edible trees, shrubs, perennials and annuals grown in a succession of layers. Fruit and nut trees are typically the canopy (overstory), while vines, berry shrubs and edible ground plantings make up the understory.

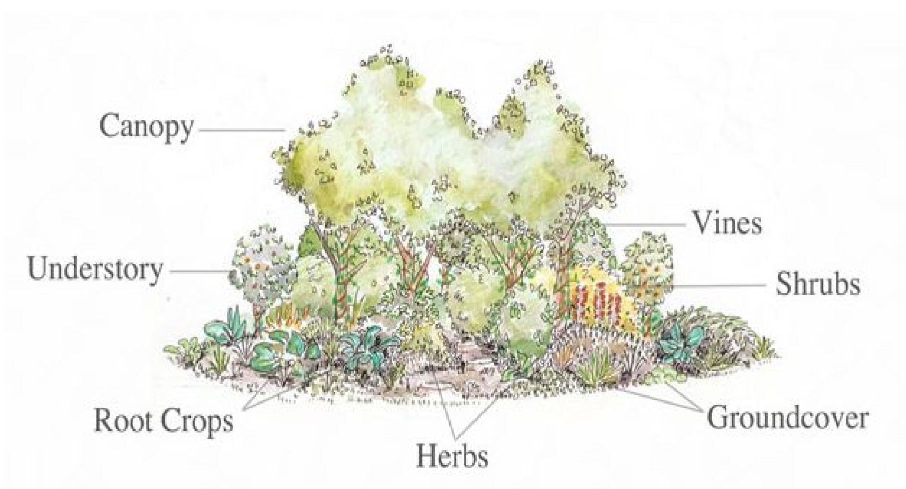

Figure 4. Diagram of a Food Forest

Source of graphic: https://www.onecommunityglobal.org/food-forest/ (Aug. 2017)

With orchards being the dominant crop type in the District, there is ample opportunity to experiment with this practice on portions of acreage in cultivation that can be scaled if proven to be successful and if it meets the individual producer's goals.

Riparian Forest Buffer (CPS 391)

The definition of this Conservation Practice Standard is "an area predominantly [of] trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies". Implementation scenarios in COMET-Planner are to replace a strip of cropland or grassland near watercourses or water bodies with woody plants. Co-benefits of this practice besides sequestering carbon from the atmosphere and increasing carbon storage in plant biomass and soils include: improving habitat by lowering or maintaining water temperatures and providing a source of detritus and large woody debris, reducing excess amounts of sediment, nutrients and pesticides in surface runoff and shallow groundwater flow, reducing the amount of pesticide drift and restoring riparian plant communities. One metric ton of CO2 equivalent could be sequestered for every 0.5 acre this practice is established.

Tree/Shrub Establishment (CPS 612)

NRCS defines this practice as "establishing woody plants by planting seedlings or cuttings, by direct seeding, and/or through natural regeneration". Implementation choices for this practice in the COMET-Planner tool include conversion of *annual cropland* or *grassland* to a farm woodlot. One metric ton of CO2 equivalent could be sequestered for every 0.03 acre this practice is established with 19 metric tons of CO2e being sequestered per acre per year.

There are many factors that go into selecting appropriate species for a given farm, not the least of which are the producer's goals and their willingness to take risks in experimenting with different species that may require new market establishment. If we are to expect a warmer, drier climate, producers may look to what is growing successfully in other places already under those climatic conditions. Considering the potential for reduced chill hours will be important for orchard crop species selection. NRCS' *California eVegGuide*, Eric Toensmeier's *The Carbon Farming Solution: A Toolkit of Perennial Crops and Regenerative Agriculture Practices for Climate Change Mitigation and Food Security*, and Gary Paul Nabhan's *Growing Food in a Hotter, Drier Land: Lessons from Desert Farmers on Adapting to Climate Uncertainty* are among various resources that offer particular species recommendations to consider.

Windbreak/Shelterbelt Establishment (CPS 380) or Renovation (CPS 650)

Windbreaks and shelterbelts are defined as "single or multiple rows of trees or shrubs in linear configurations", a definition very similar to hedgerows. Essentially, windbreaks are a type of hedgerow used for the specific purpose of controlling wind, air quality, noise and visual resources. They tend to be taller than hedgerows and consisting of a less diverse arrangement of species. The Gaviota Coast is an area known to get particularly windy due to its geology and geographic location. Prevailing winds typically flow from the northwest and therefore windbreaks are useful in locations perpendicular to that direction to stop or slow the wind before it enters the site. Co-benefits of this practice include: protecting vulnerable plants from wind related damage, providing shelter for animals, people and structures, establishing a barrier to intercept airborne particulate matter, chemicals and orders, and reducing soil erosion. Implementation scenarios in COMET-Planner are to either replace a strip of *cropland* with one row of woody plants or replace a strip of *grassland* with one row of woody plants. The CDFA Healthy Soils Incentive Program specifies a row width of ≥ 8 feet, although the carbon sequestration value of the practice in the HSP version of COMET Planner is the same as the original COMET-Planner tool of 8 metric tons of CO_2 equivalent per acre per year. One metric ton of CO_2 equivalent could be sequestered for every 0.07 acre this practice is established.

Grazing Lands

The following practices have been identified as opportunities to sequester carbon and/or decrease GHG emissions in areas of the District being utilized as grazing lands.

Prescribed Grazing (CPS 528)

The NRCS CPS for Prescribed Grazing defines the practice as "managing the harvest of vegetation with grazing and/or browsing animals with the intent to achieve specific ecological, economic, and management objectives". Implementation choices in COMET-Planner for this practice are grazing management to improve *irrigated pasture condition*, or to improve *rangeland or non-irrigated pasture condition*. One metric ton of CO_2 equivalent could be sequestered for every 18 acres of irrigated pasture or 104 acres of rangeland or non-irrigated pasture this practice is applied. Co-benefits include:

- Improving or maintaining desired species composition, structure, and/or vigor of plant communities including increasing annual to perennial grass conversion;
- Improving or maintaining quantity and/or quality of forage;
- Improving or maintaining surface and/or subsurface water quality and/or quantity;
- Improving or maintaining riparian and/or watershed function;
- Reducing soil erosion and maintaining or improving soil health;
- Improving or maintaining the quantity, quality, or connectivity of food and/or cover available for wildlife; and
- Managing fine fuel loads

In contrast to prescribed grazing, a standard cattle grazing practice referred to as continuous grazing is where livestock are turned out on a very large area and allowed to go after their favorite plant species closest to their water supply. Eventually the stock water area gets denuded and compacted from animals congregating there, and the favored plant species disappear because they get overgrazed and are not allowed to grow enough to either establish their seed head or transfer enough carbohydrate storage to its root system through photosynthesis. Over time, this results in a less favorable forage composition, decreased productivity, poor distribution and soil degradation.

Prescribed grazing is actively managing the timing and duration livestock are present in a particular area, the efficiency at which available forage in that area is consumed and how long the area is rested and allowed to recover subsequent to being grazed. Managed grazing of domesticated animals seeks to imitate what migratory herds of herbivores do on wildlands. They move more quickly across a landscape, in a cluster for protection against predators, consuming different grass species uniformly, and incorporating their defecation into the soil with their hooves while their tracks create pockets for rainwater catchment. Then they continue on their migration and the area is allowed a significant resting period.

To implement this practice existing pasture delineations would be divided into smaller sections using permanent or temporary fencing, and cattle would be forced to graze the area more uniformly before moving onto the next section as a group. The frequency at which the cattle are rotated from one section to the next will be dependent on observing stubble height and maintaining sufficient residual dry matter. How long the area is subsequently rested will be dependent on the season and rate of regrowth. Some sections may only be grazed once per year to provide an extended rest period. Stock water resources will need to be provided in each section and often become the limiting factor for implementation of this practice.

Although the body of research on high intensity short duration cattle grazing is still being developed, ranchers who use managed grazing report that capacity to stock cattle on the land increased by 200 to 300 percent on farms with more intensive rotations, native grasses re-established themselves crowding out less desirable species, perennial streams that once went dry returned, and the behavior of cattle changed. Rather than staying for a prolonged period of time on stubbly, overgrazed rangeland, the cattle moved quickly and in the process ate a diversity of plants including protein-rich weeds thus reducing or eliminating the need for weed control. Managed-grazing experimentation is occurring worldwide as a movement and ranchers are establishing networks to share learnings. The results seem to improve when grazing is rapid and intense and rest periods are longer. As the protein and sugars of grasses improve and more carbon sugars are fed to the microbes in the soil, the structure and water holding capacity of the soil improves. Practitioners report that their soils can soak up several inches of rain per hour where previously hardened soils would pond and erode with just small amounts of rainfall (Hawken, 2017).

Other ruminants such as sheep and goats can be managed on rangelands and in shrublands via prescribed grazing as well, each having its own set of traits that can serve different purposes. Goats tend to be browsers preferring leaves, twigs, vines and shrubs whereas sheep are grazers preferring grass and shorter plants close to the ground. Both sheep and goats can also handle steeper terrain than cattle. Goats are useful for clearing fire fuels consisting of their forage preference and sheep can be used as an effective tool for controlling finer fuels, weeds, removing thatch and transitioning a plant community from non-native annuals to perennials. In Australia, sheep integration is part of typical vineyard management where they are used to graze vineyard understory during winter dormancy. Initial studies being carried out in northern California’s wine country by UC Davis show that soils in integrated sheep-vineyard systems had increased biological biomass, biodiversity and activity, higher plant available phosphorus and nitrogen content, and increased soil organic matter (Brewer, 2019).

Multi-species grazing can be considered a type of prescribed grazing where a variety of animals pass through an area. For example, cattle or sheep may make a pass to mow down grassed alleyways, followed by pigs to clean up any fallen and rotting fruit, followed by chickens to control the insect population in the area freshly fertilized with manure.

Range Planting (CPS 550)

The NRCS CPS for Range Planting defines it as the “establishment of adapted perennial or self-sustaining vegetation such as grasses, forbs, legumes, shrubs and trees”. Implementation of this practice in COMET-Planner involves seeding forages to improve rangeland condition. One metric ton of CO2 equivalent could be sequestered for every 1.5 acres of this practice is applied. Other than carbon sequestration, its co-benefits include: improving forage for livestock, improving forage, browse and cover for wildlife, increasing plant diversity, reducing erosion by wind and/or water and improving water quality and quantity. Specifically, the goal is to reduce the amount of bare ground and to increase the occurrence of certain plant species that have deeper rooting systems thereby sequestering more carbon and increasing resiliency during extended drought conditions. The impact of rain drops falling onto bare soil is so significant that it can break up the soil aggregates at the surface into smaller pieces that then fill in the air spaces and create a crust at the surface that then precludes water from infiltrating. For optimal carbon storage, species shall be selected that will increase site biomass such as longer-rooted perennials, and reduce the frequency of carbon releases caused by wildfire events by selecting less flammable perennial plants appropriate for the District.

Nutrient Management (CPS 590)

Similar to the cropland context, this practice has to do with "managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments" according to the NRCS CPS but the implementation scenario is to replace synthetic nitrogen fertilizer on managed pasture.

Implementation choices for this conservation practice in COMET-Planner include:

- replacing synthetic nitrogen fertilizer on managed irrigated or non-irrigated pasture with either
    - beef feedlot manure
    - chicken broiler manure
    - chicken layer manure
    - compost with carbon to nitrogen ratios of either 10, 15, 20 or 25
    - dairy, sheep swine or other manure.

The option to apply compost with a C:N of 20 was chosen as the most appropriate option as dairies, feedlots or other large sources of manure are not located at a convenient distance from the site. Co-benefits of this practice include reducing nutrient runoff, decreasing fertilizer costs, improving air quality, improving soil structure and water holding capacity and stimulating the subsurface microbial community to increase natural nutrient cycling processes. One metric ton of CO2 equivalent could be sequestered for every 1.5 acres of irrigated pasture and 6.5 non-irrigated pasture this practice is applied to.

Silvopasture (CPS 381)

Silvopasture is defined in the NRCS Conservation Practice Standard as "establishment and/or management of desired trees and forages on the same land unit" and the implementation scenario in COMET-Planner is described as "tree/shrub planting on grazed grasslands". One metric ton of CO2 equivalent could be sequestered for every 0.8 acre this practice is applied according to the specifications in COMET-Planner. Co-benefits of silvopasture include: providing forage shade and/or shelter for livestock, improving livestock distribution, improving the productivity and health of trees/shrubs and forages, improving water quality and soil water holding capacity, reducing erosion, enhancing wildlife habitat, increasing biological diversity, improving soil quality, and providing for beneficial organisms and pollinators.

The management objective for silvopasture is not always to establish a timber crop in the form of densely planted, intensively managed trees, but can consist of simply adding trees to grazing lands in strategic areas either to serve as fodder banks or to mimic a natural oak savannah. Incorporating trees into grazing lands offers the opportunity for utilization of certain tree forages to supplement livestock feed. Tree species that are resilient, drought tolerant and able to provide commodities such as supplemental forage for livestock, fruit and or nuts should be considered. In addition, introducing multi-species grazing into multi-story cropping systems more closely mimics what occurs in a natural ecosystem where overall biodiversity above and below ground is increased and symbiotic and complementary relationships are able to occur between plants, animals and the soil microbiome.

As with most rangeland that has been grazed for decades, there is a lack of trees in what are likely the most heavily used areas: the easily accessible, flatter areas with decreased slope. This makes sense given that it would be difficult for saplings to establish themselves in overgrazed, compacted soil and without protection from grazing livestock. Where there has likely been less grazing activity over time - on the steeper slopes, on the more remote sections of grazed areas, and in areas where water collects at the bottoms of steeper canyons - trees remain. Any trees that are established in grazed areas would therefore require protection in the form of exclusion zones or tree guards as well as supplemental water during the first few summers.

Prescribed Burning

Prescribed fire, fire set deliberately to achieve management objectives, has been utilized by many indigenous cultures including the Chumash that once prospered along the Gaviota Coast. The devastating 2017/2018 wildfire season contributed to the calls made by proponents of this practice to reintroduce it after years of fire suppression had contributed to the build up of fuel loads in the State's forests and rangelands. Prescribed burning can have the net effect of reducing GHG emissions by reducing fuel loads thereby decreasing or avoiding the occurrence of large scale uncontrolled wildfires such as the Thomas Fire that would release more carbon emissions overall. Prescribed fire can also be used as a tool for controlling invasive species, enhancing native perennial grasses and improving biodiversity (Carlsen et al, 2016). Increasing annual to perennial grass conversion on the District's rangeland will sequester more carbon in the root systems, increase water holding capacity of the soil and improve resiliency during periods of drought.

Compost Application to Grazed Grassland

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). 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 metric tons (1.468 MTCO2e) 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. As a note of interest, more recent research suggests that a compost application rate of ¼-inch may be as effective as the ½-inch rate (Ryals et al 2015). A single ¼-inch compost application would require 35 cubic yards of material per acre.

NRCS suggests that a 1% increase in soil organic matter (SOM) in the top six inches of soil 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 4 shows an estimated potential for carbon sequestration and improved water holding capacity across all suitable grassland areas in the District. Suitable land consisted of all acres dominated by herbaceous vegetation, with slopes <25% and at least 100 feet from riparian or wetland areas. Refer to the Potential Compost Application Area Map in Appendix A. Private lands alone could sequester up to 4,296 metric tons (tonnes) of carbon (15,766 metric tons CO2e) annually. Over a twenty-year period, this would amount to 85,920 metric tons of carbon (315,326 metric tons CO2e) removed from the atmosphere. Similarly, increased water holding capacity on private lands could add an additional 79 acre-feet of water annually to the soils in these areas. While this amounts to a relatively small amount per acre, 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 1,575 acre-feet of additional water annually. Estimates for soil carbon storage and water holding capacities are also reported for federal, state and other government-owned lands.

Table 4. Projected Annual & 20-year Increase of Soil Carbon Sequestration & Water Holding Capacity After a 1/4" Application of Compost to Suitable Land in the Gaviota District

			Annual Estimates			20-Year Estimates		
Ownership	**Acres**	**% of Total**	**Potential Metric Tons of Carbon Sequestered Annually**	**Potential $MTCO_2e$ Sequestered Annually**	**Increased Water Holding Capacity (acre feet) Annually**	**Potential Metric Tons of Carbon Sequestered Over 20 Years**	**Potential $MTCO_2e$ Sequestered Over 20 Years**	**Increased Water Holding Capacity (acre feet) by Year 20**
Private	10,740	96%	4,296	15,766	79	85,920	315,326	1,575
Federal	0	0%	0	0	0	0	0	0
State	267	2%	107	392	2	2,136	7,839	39
County	31	0%	12	46	0	248	910	5
Other Public	152	1%	61	223	1	1,216	4,463	22
Totals:	**11,190**	**100%**	**4,476**	**16,427**	**82**	**89,520**	**328,538**	**1,641**

$MTCO_2e$ = Metric Tons of Carbon Dioxide equivalent
Suitable land included all acres in the County dominated by herbaceous vegetation, with slopes <25% and at least 100 feet from riparian or wetland areas.
¼" or ½" compost application = increase in soil carbon by 0.4 metric tons or 1.468 MTCO2e per acre per year (Ryals et al 2015)
Assumptions courtesy of Jeff Creque of Carbon Cycle Institute:
Conversion of MTCO2e to organic carbon based on the fact that one carbon dioxide molecule weighs 3.67 times that amount (1.468 MTCO2e per acre per year/3.67= 0.4 metric tons of organic carbon per acre per year).
To adjust for increases in above-ground carbon stock increases, soil carbon factor of 1 was used for compost application (0.4 metric tons of organic carbon per acre per year x 1 = 0.4 metric tons of soil organic carbon per acre per year).

Soil Organic Matter (SOM) is ~50% carbon by mass (0.4 metric tons of soil organic carbon x 2= 0.8 metric tons of SOM) 1 metric ton = 1.1 short tons (US Ton) (0.8 metric tons of SOM = 0.88 short tons of SOM) (0.88 short tons of SOM divided by 1 acre is 0.88 tons of SOM per acre increase) Tons of SOM per acre increase is then divided by 1012.7 tons for the weight of a 1-acre furrow slice to get percentage SOM increase per acre ((0.88/1012.7)*100= 0.09% SOM increase per acre) If each 1% increase in SOM = increase soil water holding capacity by 1 acre inch or 27,152 gallons per acre (per NRCS): (0.09% SOM increase per acre x 27,152 gallons per acre= 2,359.43 gallons per acre increase in soil water holding capacity) (2,359.43 gallons per acre x 1 acre treated= 2,359.43 gallons of increased soil water holding capacity) 1 acre-foot = 325,581 gallons (2,359.43 total gallons of increased soil water holding capacity / 325,581= 0.01 acre-foot annually) An acre of the plow layer, or acre-furrow slice (6.7 inches) volume is 24,394 cubic feet or 43,560 square feet x 0.56 feet (depth) Approximate bulk density of a silty loam= 1.33 grams/cubic centimeter 1 cubic inch = 16.3871 cc and 1 ounce = 28.3495 grams Therefore 1 cubic inch of soil weighs 0.77 ounces ((16.3871 x 1.33)/28.3495) 1 cubic foot = 1728 cubic inches so 0.77 x 1728= 1328.471 ounces 1 pound = 16 ounces so 1328.471/16= 83.029 lbs in 1 cubic foot of soil 1 acre-foot of soil weighs 43560 sq ft. / acre x 83.029= 3616762.31 pounds 1 acre-furrow slice weighs 3616762.31 lbs x 0.56 feet depth= 2025386.89 pounds or 1012.69345 tons 1 Acre foot = 325,581 gallons

The NRCS is still in the process of considering whether a Conservation Practice Standard for compost application to grazed grassland will be established or whether this practice may be included in the existing Nutrient Management or Mulching CPSs. NRCS in partnership with the Silver Lab and others are currently conducting several additional research trials throughout the state, including here in Santa Barbara County at the Chamberlin Ranch in the Santa Ynez Valley, to better understand and provide additional documentation on the effects of this practice in various locations. Though there have been positive results from initial studies in terms of increased soil carbon, productivity and water holding capacity, there are also concerns related to how plant species composition may be affected and the potential for nutrient leaching. As a precaution, this practice is limited to areas that are managed by grazing and application rates are typically ¼ of an inch or less.

The California Air Resources Board (CARB) developed quantification methodology for the greenhouse gas benefits of this practice so that it could be included in the suite of practices funded by the California Department of Food and Agriculture's (CDFA) Healthy Soils Incentive Program in 2017. The CARB quantification methodology is currently housed in a specific version of COMET-Planner developed for use as part of the 2018 Healthy Soils Program and is based on calculations made by the DeNitrification-DeComposition model, a biogeochemical model used to simulate the impacts of compost application on carbon sequestration, nitrous oxide emissions and methane emissions. Note that Ryals and Silver report increased ecosystem photosynthetic gain of carbon in response to compost application whereas CDFA and the CA Air Resources Board (CARB) base their estimation on avoided emissions associated with diversion from landfills of the organics that produced the compost, or, the carbon in the compost itself though the numbers are similar and it is hard to tell from their protocol which approach they actually used (Creque, 2019). The application rate used by CDFA/CARB is 4.7 dry tons (approximately 6 – 8 wet tons) per acre, essentially a very light dusting (Gravuer 2016). This application rate was developed under the guidance of the Environmental Farming Act Science Advisory Panel and is discussed in greater detail in a compost application white paper commissioned by the CDFA entitled *Compost Application Rates for California Croplands and Rangelands for a CDFA Healthy Soils Incentives*

Program. Implementation scenarios in the CDFA COMET-Planner are application of compost with a carbon to nitrogen ratio greater than 11 to either grazed grassland or grazed irrigated pasture. One metric ton of CO2 equivalent could be sequestered for every 0.25 acre of grazed grassland or irrigated pasture this practice is applied. Co-benefits include increased productivity, increased soil water holding capacity and related extended grazing season/increased forage availability.

Restoration of Disturbed Lands

The following practices have been identified as opportunities to sequester carbon and/or decrease GHG emissions through the restoration of disturbed lands.

Critical Area Planting (CPS 342)

The NRCS CPS defines this practice as "establishing permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal seeding/planting methods". The CPS further specifies that this practice applies to highly disturbed areas such as construction areas, active or abandoned mines and other areas degraded by human activities or natural disasters. In the Gaviota District, land currently being utilized for oil and gas development that may be transitioning out of this use due to a lessening of our dependence on fossil fuel resources may represent an example of where this practice may be applicable.

The implementation scenario in COMET-Planner is specified as restoring highly distrubed areas by planting permanent vegetative cover. One metric ton of CO2 equivalent could be sequestered for every 0.5-acre where this practice is applied. Co-benefits of this practice are reducing erosion, establishing or improving habitat, controlling invasive species, improving the subsurface microbial community, soil structure and nutrient cycling.

Riparian Restoration

This practice is described in COMET-Planner as restoring degraded streambanks by planting woody plants. One metric ton of CO2 equivalent could be sequestered for every 0.6-acre where this practice is applied. Co-benefits of this practice are reducing erosion, establishing or improving habitat, controlling invasive species, improving water flow, and improving the subsurface microbial community, soil structure and nutrient cycling.

Forest Management

Although forests are generally gradual accumulators of carbon, actively managing dead or decadent stands of biomass to control wildfire risk through targeted applications of the prescribed grazing, prescribed fire and biochar conversion could result in a net sequestration of carbon compared to the emissions produced from an uncontrolled wildfire such as the Thomas Fire that Santa Barbara County recently experienced in 2017. In terms of carbon sequestration, sustainable forestry practices can improve the rate at which carbon is accumulated in forests by harvesting some of the older trees before they start to decay and release carbon, and replacing them with younger trees that have higher rates of carbon uptake.

Marine Permaculture

Although this plan focuses on opportunities to enhance carbon sequestration on the terrestrial landscape, marine permaculture, ocean farming of kelp and seaweeds, should at least be mentioned given the Gaviota Coast District's 76-mile coastline. Blue carbon is the term for this underwater primary productivity that is gaining attention as another way to draw down carbon from the atmosphere and sequester it in biomass and on the ocean floor. Historical maps show that a river of kelp existed up and down California's coast including in the Santa Barbara Channel. Due to changes in management practices such as kelp harvesting and the removal of sea otters, an uncontrolled increase in the purple sea urchin population and warming of the ocean waters, the occurrence of kelp has been drastically reduced. Restoring these underwater ocean forests not only sequesters carbon but re-establishes habitat and creates food for other species of algae, invertebrates and fish. Kelp grows incredibly fast, up to two feet per day, taking up carbon dioxide via photosynthesis. Most of the carbon sequestered by this macroalgae is sent to the deep sea either in the form of dissolved carbon or in the form of plant detritus which eventually sinks to the seafloor (Hurlimann, 2019). Macroalgae sequesters about 634 million metric tons of carbon dioxide per year, greater than the emissions of Australia, the world's 13th largest emitter. While 10% of this is buried in coastal sediments with a risk of anthropogenic reversals, about 90% is exported to the deep sea representing a storage pool with more permanence (Cage, 2018). Harvested kelp can be used for a variety of products including as cropland fertilizer and to supplement livestock feed. Initial studies show that adding seaweed to livestock feed can improve digestion and reduce livestock methane emissions (Hawken, 2017). Though faced with cumbersome permitting challenges, at least one aquaculture farm off Santa Barbara County is currently operating (Hope Ranch Mussels) with another one undergoing final permit issuance (PharmerSea). SeaTrees is an example organization currently regenerating kelp forests off the coast of Palos Verdes, California.

Quantification of Carbon Sequestration Potential

Estimation methods used for most GHG sources in COMET-Planner rely on advanced methods, such as process-based modeling in DAYCENT (daily time-step biogeochemical model), DNDC (Denitrification-Decomposition model) and California-specific empirical calculations to determine the long-term impacts of conservation practices on carbon sequestration, nitrous oxide emissions and methane emissions. Approximate carbon sequestration and greenhouse gas emission reductions are presented in megagrams (1,000,000 grams) or tonnes of carbon dioxide equivalent per year, where:

Tonnes = Metric Tons = Megagrams = 1,000,000 grams

Carbon dioxide equivalent is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. Carbon dioxide equivalents are used in COMET-Planner to allow users to compare emissions reductions of carbon dioxide, nitrous oxide and methane in standardized units.

Emission reduction coefficients were largely derived using a sample-based approach and model runs in COMET-Farm, which utilizes USDA entity-scale greenhouse gas inventory methods. Coefficients were generalized by multi-county regions defined by USDA Major Land Resource Areas. Emissions estimates represent field emissions only, including those associated with soils and woody biomass as appropriate, and do not include off-site emissions, such as those from transportation, manufacturing, processing, etc.

Each emission reduction is calculated using the following equation:

Emission reduction = Area (acres) * Emission Reduction Coefficient (ERC)

Each practice has been assigned an emission reduction coefficient, the largest of which correspond to the woody plantings category of practices with Tree/Shrub Establishment (conversion to Farm Woodlot) at 19 metric tons of CO2 equivalent per acre per year, and Hedgerow Planting and Windbreak/Shelterbelt Establishment each at 8 metric tons of CO2 equivalent per acre per year being the highest by far.

Cropland Inventoried by the Santa Barbara Co. Blueprint Atlas

The Santa Barbara County Conservation Blueprint Atlas was utilized to obtain a rough estimation of total acres and type of cropland in the District. All cropland identified is on private land. This is not a complete data set and would require further ground-truthing to improve accuracy but it gives us a place to start playing with some estimation scenarios.

Cropland Inventory from Santa Barbara County Conservation Blueprint Atlas for the Gaviota District

Crop Type	Acres	Perimeter (linear feet)
Citrus and Subtropical	2,198	717,572
Deciduous Fruits & Nuts	18	9,840
Vineyard	2	3,263
Young Perennial	52	14,900
Perennials Subtotal	**2,270**	**745,575**
Truck Nursery & Berry Crops	16	5,754
Pasture	37	9,590
Grain & Hay Crops	68	16,942
Total	**2,391**	**777,861**

Crop type and acreage data from Santa Barbara County Conservation Blueprint Crop Layer, April 2019. Note that all cropland inventoried above is on private land and none was shown to exist on public lands in the District.

Perennial Cropland

According to the cropland data layer in the Atlas, most of the cropland in cultivation consists of orchards and other perennials and totals approximately 2,270 acres for citrus and subtropicals, deciduous fruits and nuts, vineyards, and young perennials.

Since perennial crops typically have somewhat similar management practices in contrast to annual row crops, we combined the acreage to apply the same suite of potential practices to determine potential increases in carbon sequestration that could be realized. These should be considered very rough estimates given that the specific management practices currently employed for each of these acres were not ascertained. If we assumed typical management practices consisting of: fertilizing, spraying herbicides, pesticides and/or fungicides, and weed wacking, mowing and/or tilling between planted rows are being employed on all of these acres without accounting for the portion that are not being managed this way and/or already have some of the recommended practices being employed, we could arrive at a rough estimation for total increased carbon sequestration potential. The table below lists recommended practices with assumptions applied to the total acreage as follows: ⅓ of the total acreage accounts for planted rows, ⅔ of the total acreage accounts for alley rows, hedgerows could be planted around the perimeters of every field and windbreaks could be planted in addition to hedgerows on ¼ of the total perimeter area.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions by Practice for Perennial Cropland

Management Practice	Acres	Metric Tons CO_2 Equivalent per year	Increased Water Holding Capacity (gallons) annually
In planted rows:			
Nutrient Management (CPS 590) - replace synthetic N fertilizer with compost (C/N of 20) to planted rows of perennials, orchards and vineyards	2,270 x ⅓ = 757	213	342,342
Mulching (CPS 484)- add mulch to cropland	2,270 x ⅓ = 757	156	125
In between planted rows:			
Cover Crop (CPS 340)- add legume seasonal cover crop to irrigated cropland	2,270 x ⅔ = 1,513	797	640,485

Residue & Tillage Management (CPS 329)- intensive till to no till on irrigated cropland	2,270 x ⅔ = 1,513	393	631,645
Combustion System Improvement (CPS 372)- improved farm equipment fuel efficiency	2,270 x ⅔ = 1,513	18	NA
Prescribed Grazing (CPS 528)- grazing management to improve irrigated pasture condition (to represent multi-species grazing in alley rows)	2,270 x ⅔ = 1,513	48	77,147
Perimeter:			
Hedgerow Planting (CPS 422)- replace a strip of grassland with one row of woody plants	745,575 linear ft. x 8-foot width**= 5,964,600 sq. ft. /43,560 sq. ft. per acre = 137	1,120*	900,054
Windbreak Establishment - replace a strip of grassland with one row of woody plants	745,575 linear ft. x ¼ = 186,394 linear ft x 8-foot width**= 1,491,152 sq. ft. /43,560 sq. ft. per acre = 34	280*	225,013
	Total	**3,025**	**2,816,811**
	GHG equivalent	642 passengers cars driven for one year	
*Per CDFA version of Comet Planner **Per CDFA 2018 Healthy Soils Program practice requirement GHG equivalent is from the EPA's GHG Equivalencies Calculator https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator			

Truck Nursery & Berry Crops

Besides the perennial crops (citrus and subtropicals, deciduous fruits and nuts, vineyards, and young perennials) identified in the Gaviota District's cropland data layer in the Atlas, Truck Nursery & Berry Crops, Pasture, and Grain and Hay Crops were also inventoried. Insufficient information was found on the Truck Nursery & Berry Crops designation and it is expected that their management could vary (e.g. annual strawberries are managed much differently than perennial blueberries). The term Truck Nursery typically refers to potted plants or those grown in greenhouses and trucked to other areas for planting. Because of this inherent variability, management practices were not applied to the 16 acres in the District mapped to contain Truck Nursery & Berry Crops, however hedgerows and windbreaks could be planted directly adjacent. The table below quantifies the carbon sequestration potential for these practices being applied to the Truck Nursery and Berry Crops crop type identified in the District.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions by Practice for Truck Nursery & Berry Crops

Management Practice	Acres	Metric Tons CO_2 Equivalent per year	Increased Water Holding Capacity (gallons) annually
Additional data required to apply potential cropland management practices to these crop type categories.	16	-	-
Perimeter:			
Hedgerow Planting (CPS 422)- replace a strip of grassland with one row of woody plants	5,754 linear ft. x 8-foot width**= 46,032 sq. ft. /43,560 sq. ft. per acre = 1.06 acre	9*	7,233
Windbreak Establishment - replace a strip of grassland with one row of woody plants	5,754 linear ft. x ¼ = 1,439 linear ft x 8-foot width**= 11,508 sq. ft. /43,560 sq. ft. per acre = 0.3 acre	2*	1,607
	Total	**11**	**8,840**
	GHG equivalent	2.3 passengers cars driven for one year	
*Per CDFA version of Comet Planner **Per CDFA 2018 Healthy Soils Program practice requirement GHG equivalent is from the EPA's GHG Equivalencies Calculator https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator			

Pasture

The Santa Barbara County Conservation Blueprint Atlas identified 37 acres of Pasture in the District. The table below shows the carbon sequestration potential if the following practices were applied to irrigated pastures: application of a light dusting of compost to the surface, prescribed grazing, range planting, silvopasture, hedgerows and windbreaks.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions by Practice for Pasture

Management Practice	Acres	Metric Tons CO_2 Equivalent per year	Increased Water Holding Capacity (gallons) annually
Compost Application to Grazed, Irrigated Pasture (compost with C/N >11)	37	160	88,607
Prescribed Grazing (CPS 528)- grazing management to improve irrigated pasture condition	37	1	1,607
Range Planting (CPS 550)- seeding forages to improve rangeland condition	37	13	10,447
Silvopasture (CPS 381)- tree/shrub planting on grazed grasslands	37	24	19,287
Perimeter:			
Hedgerow Planting (CPS 422)- replace a strip of grassland with one row of woody plants	9,590 linear ft. x 8-foot width**= 76,720 sq. ft. /43,560 sq. ft. per acre = 1.8	15*	12,054
Windbreak Establishment - replace a strip of grassland with one row of woody plants	9,950 linear ft. x ¼ = 2,398 linear ft x 8-foot width**= 19,184 sq. ft. /43,560 sq. ft. per acre = 0.44	4*	3,214
	Total	**217**	**135,216**
	GHG equivalent	46.1 passengers cars driven for one year	

*Per CDFA version of Comet Planner
**Per CDFA 2018 Healthy Soils Program practice requirement
GHG equivalent is from the EPA's GHG Equivalencies Calculator
https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Grain & Hay Crops

For the 68 acres of Grain & Hay crops inventoried by the Atlas, the following practices could be applied: compost application, combustion system improvement, conservation crop rotation, hedgerows and windbreaks.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions by Practice for Grain & Hay Crops

Management Practice	Acres	Metric Tons CO_2 Equivalent per year	Increased Water Holding Capacity (gallons) annually
Compost Application to Annual Crops (compost with C/N >11)	68	280	450,027
Combustion System Improvement (CPS 372)- improved farm equipment fuel efficiency	68	1	NA
Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations	68	18	NA
Perimeter:			
Hedgerow Planting (CPS 422)- replace a strip of grassland with one row of woody plants	16,942 linear ft. x 8-foot width**= 135,536 sq. ft. /43,560 sq. ft. per acre = 3.1	25*	20,090
Windbreak Establishment - replace a strip of grassland with one row of woody plants	16,942 linear ft. x ¼ = 4,235.5 linear ft x 8-foot width**= 33,884 sq. ft. /43,560 sq. ft. per acre = 0.78	6*	4,822
	Total	**330**	**474,939**
	GHG equivalent	70.1 passengers cars driven for one year	
*Per CDFA version of Comet Planner **Per CDFA 2018 Healthy Soils Program practice requirement GHG equivalent is from the EPA's GHG Equivalencies Calculator https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator			

Suitable Acres of Rangeland

An estimate of the suitable acreage for compost application to grazed rangeland was calculated by combining the amount of land in the District that had <25% slope, herbaceous land cover and were at least 100 feet from all wetland types. If we were to assume that all of the recommended practices for grazed rangeland could be implemented on those acres without taking into account the portion thereof that may be implementing some of these practices already or the additional acreage in the 25% - 40% slope to which prescribed grazing, range planting and silvopasture could be implemented, we could arrive at a rough estimation for increased carbon sequestration that could be achieved.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions by Practice for Acreage Suitable for Compost Application to Grazed Rangeland

Grazing Lands Practices	Acres	Metric Tons CO_2 Equivalent per year	Increased Water Holding Capacity (gallons) annually
Compost Application to Grazed Grassland (compost with C/N >11)	11,190	48,600*	26,797,655
Prescribed Grazing (CPS 528) - grazing management to improve rangeland or non-irrigated pasture condition	11,190	57	91,613
Range Planting (CPS 550) - seeding forages to improve rangeland condition	11,190	3,800	3,053,754
Silvopasture (CPS 381) - tree/shrub planting on grazed grasslands	11,190	7,340	5,898,567
	Total	**59,797**	**35,841,589**
	GHG equivalent	12,696 passengers cars driven for one year	
*Per CDFA version of Comet Planner GHG equivalent is from the EPA's GHG Equivalencies Calculator https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator			

Agricultural Operations of Producers Interviewed

Representatives from three ranches in the District were interviewed to get a sense of which crops were being grown in the region and typical management practices being employed. The table below provides an estimation for potential increases in annual carbon sequestration if certain practices were implemented on the acreage they manage.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions for an Example Suite of Practices Applied to Agricultural Operations of Producers Interviewed

<table>
<tr><th>Commodity</th><th>Acres</th><th>Potential Practice Implementation</th><th>Metric tons CO_2 Equivalent per year</th><th>Increased Water Holding Capacity (gallons) annually</th></tr>
<tr><td>Avocados</td><td>747</td><td rowspan="3">Nutrient management via compost application, cover crop between rows, mulching, combustion system improvement, residue and tillage - no till management between rows, prescribed grazing in alley rows**</td><td rowspan="3">1476</td><td rowspan="3">2,124,814</td></tr>
<tr><td>Lemons</td><td>30</td></tr>
<tr><td>Cherimoyas</td><td>10</td></tr>
<tr><td>Cattle grazing</td><td>2,341</td><td>Range planting, silvopasture, prescribed grazing, compost application to grazed grassland</td><td>12,516* (10,200 metric tons from 6-8 tons/acre compost application alone)</td><td>7,497,914</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">13,079</td></tr>
<tr><td colspan="3">GHG equivalent</td><td colspan="2">2,777 passenger cars driven for one year</td></tr>
<tr><td colspan="5">*Per CDFA version of Comet Planner
**Same management assumptions applied as to perennial crop estimates above for entire District
GHG equivalent is from the EPA's GHG Equivalencies Calculator
https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator</td></tr>
</table>

Various Practices on a Targeted Number of Acres

Another way to consider quantifying the potential for increased carbon sequestration is to determine an annual goal to implement a practice or suite of practices on a targeted number of acres such as 100 or 500 acres for example. If the District established an annual goal to implement the following recommended practices on 200 acres every year, a total of 2,009 metric tons of carbon could be sequestered.

Potential Annual Carbon Sequestration and/or GHG Emissions Reductions by Practice if Applied to 200 New Acres in the District Each Year

Practice	Acres	Metric metric tons CO_2 Equivalent per year	Increased Water Holding Capacity (gallons) annually
Cropland Management Practices			
Nutrient Management via compost (C/N>11) application to planted rows of perennials, orchards and vineyards	200	870*	1,398,298
Mulching - add mulch to croplands	200	41	33
Cover crop - add legume seasonal cover crop to irrigated cropland	200	106	85,184
Residue & Tillage Management - reduced till to no till or strip till on non-irrigated cropland	200	20	32,145
Combustion System Improvement - improved farm equipment fuel efficiency	200	2	NA
Prescribed Grazing - grazing management to improve rangeland or non-irrigated pasture condition	200	1	1,607
Grazing Lands Practices			
Compost Application to Grazed Grassland (compost with C/N >11)	200	870*	478,957
Prescribed Grazing (CPS 528) - grazing management to improve rangeland or non-irrigated pasture condition	200	1	1,607
Range Planting (CPS 550) - seeding forages to improve rangeland condition	200	68	54,646

Silvopasture (CPS 381) - tree/shrub planting on grazed grasslands	200	130	104,471
	Total	**2,009**	**2,156,948**
	GHG equivalent	427 passenger cars driven for one year	

*from CDFA version of Comet Planner
GHG equivalent is from the EPA's GHG Equivalencies Calculator
https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Assets & Needs

The following assets and needs have been identified to aid in successfully implementing a regional carbon management plan.

Assets

Working Lands & Willing Landowners

The primary asset required to expand use of these practices are working lands in the Gaviota District that are owned or managed by people who are willing to implement new management practices. Knowledge sharing between multi-generational landowners among each other via a program such as the local Rancher to Rancher Program is incredibly meaningful in terms of reducing risk and embracing change required to overcome our current generation's and future generation's challenges. Many current generation farmers and ranchers recognize the need for change, are open to new ways of doing things, are self-educating through the multitude of resources available online, and are experimenting with practices first at smaller scales - learning by doing in their particular locales.

Technical Expertise & Partners

In addition to practitioner knowledge, technical expertise is another essential asset and is available to the District via the CRCD, the NRCS Santa Maria office, University of California Cooperative Extension Ventura office serving Santa Barbara County, and various qualified individual consultants and Technical Service Providers (TSPs). A wide array of local partners who are engaged in similar efforts focused on carbon drawdown and ecological resilience are also available for collaboration including: UCSB, Santa Barbara Botanical Garden, Land Trust for Santa Barbara County, White Buffalo Land Trust, Kiss the Ground, Soil Carbon Coalition, Carbon Cycle Institute, California Rangeland Trust, The Nature Conservancy's Dangermond Preserve, Community Environmental Council, Cuyama Lamb contract graziers, Santa Barbara Organics, Santa Barbara Natives, local fire agencies, CA Coastal Conservancy, Santa Barbara County Community Services Department Sustainability Division and LegacyWorks Group.

Momentum Around Agricultural Climate Change Solutions, Carbon Neutrality Goals & Demand Creation

Now that people across the globe are starting to see and feel the effects of climate change that scientists have long forewarned us about manifest themselves, there is a notable uptick in momentum around solutions that will mitigate their effects. Carbon farming and regenerative agriculture are now being discussed in such mainstream publications as The New York Times (April 2018 cover article "Can Dirt Save the Earth?") and Forbes Magazine (December 2018 article "How Investing in Regenerative Agriculture Can Help Stem Climate Change Profitably" and June 2019 article "Indigo CEO: Agriculture Can Reverse Climate Change And Livestock Farming Has An Important Role"). The year 2015 was declared The International Year of Soils by the United Nations General Assembly. California rolled out its state-wide Healthy Soils Initiative in 2017 in recognition of the role of soil health. In 2018, The Rodale

Institute established the Regenerative Organic Certification which allows producers to leverage this designation in creating value-added products. In March 2019, General Mills, one of the nation's largest manufacturers and marketers of branded consumer foods pledged to advance regenerative agricultural practices on 1 million acres of farmland by 2030 (Spiegel 2019). Other corporations, small businesses, education institutions and individuals are now growing conscious of their carbon footprint and looking for ways to neutralize their contribution to the problem. Locally, County and City government, UCSB, the oil and gas industry and others are committed to offsetting their carbon emissions. All of this creates demand for the implementation of practices articulated in this plan, a critical asset for making their initial capital investment economical.

Needs

The needs that have been identified for successful deployment of this plan include: upfront capital, equipment and quality supplies of organic inputs.

Upfront Capital

Much of the available funding for practice implementation is distributed on a reimbursement basis requiring farmers and ranchers on tight budgets to come up with the initial capital investment to purchase new supplies and labor. Upfront capital in the form of low interest short-term loans and grant programs that front the full cost of the practices are needed.

Grant Application Assistance

Grant application assistance is currently both an asset and a need. The CRCD, the NRCS Santa Maria office, the University of California Cooperative Extension and others are available to assist producers in finding and/or securing resources to implement practices. The California Department of Food and Agriculture has also started funding technical assistance grants for technical service providers such as Resource Conservation Districts and nonprofits alongside their roll outs of their Healthy Soils Program grant opportunities knowing that they will be able to distribute more funding if producers have help in applying for the grants. That said, there is still more demand for grant application assistance than supply.

Equipment

Another need is for new specialized equipment that is required for certain recommended practices such as reduced and no-till tillage management where a no-till seed drill is then required for planting. Compost windrow turners and spreaders are other examples of equipment that could be shared among producers via establishment of local equipment sharing programs.

Quality Supplies of Organic Soil Amendments

Quality supplies of organic matter such as mulch, compost and biochar represent another need for implementing this plan. Although the County has an adequate amount of mulch being produced at their transfer stations that is available for producers to pick up free of charge, it is often contaminated with plastics and weed seeds. Better source separation, education and screening is needed to improve the quality of this material. Collaborating with fire districts undertaking fuel management operations presents an opportunity in the shorter term to provide mulch to producers that contains less contaminants.

Quality volumes of compost are also needed to deploy one of the practices identified in this plan that could be brought to scale the quickest. Many producers simply lack the quantity of feedstock necessary to make enough compost to supply their needs. Making a high-quality compost is also not a trivial endeavor. Care must be taken in combining feedstocks to create an appropriate carbon to nitrogen ratio, monitoring temperature, and supplying correct amounts of air and moisture to piles. Engel & Grey of Santa Maria, Agromin of Ventura and other local certified facilities listed on CalRecycle's website represent local assets in terms of compost supply but may not be able to keep up with an increased County or even District-wide demand. It's also expensive. If the digestate produced from the TRRP's anaerobic digester can create a quality feedstock for producers to make their own compost or a finished compost supply, it could fulfill this critical need. The CRCD and NRCS are available to provide landowners interested in making their own on-farm compost including via small-scale vermiculture operations with resources and technical assistance to do so.

Similarly, although there are some local suppliers of biochar including Blue Sky Biochar, Agromin and Cool Terra all of Ventura County, they are limited and expensive. Mobile Biochar Production Units represent another equipment sharing opportunity among vineyard and orchard landowners and/or partnership opportunity with local forest managers.

Barriers

The following barriers to successfully implementing a carbon management plan have been identified.

Economic

The primary barrier to implementing recommended practices is the lack of capital and lack of available loan vehicles to aid in upfront costs such as compost supplies, plant material, and equipment as discussed above. Many producers have expressed interest in dividing pastures for shorter duration higher intensity grazing for example but simply do not have the resources to buy additional stock water infrastructure, fencing and labor to establish smaller paddocks and move livestock on a more frequent basis.

Moreover, conventional agriculture has a long history of being subsidized which has misrepresented the actual costs of food production and skewed commodity pricing. Artificially low prices drive overproduction and overproduction then keeps prices low. The external costs generated by conventional agricultural practices including topsoil and habitat loss, use of cancer-causing biocides, and pollinator species endangerment are also not realized in the price of conventionally produced products. This causes the price of local, grass-fed, organic or otherwise responsibly-produced products to appear artificially inflated.

Another difficulty is the longer-term return cycle for some of these practices such as tree planting that takes an extended period of time for a financial gain to be realized from the initial investment. With more and more farmers leasing land these days there is less incentive to make long term investments in soil health for example if there is no security in the term of their operation on a particular piece of land.

Regulatory

Land use restrictions in local planning documents, an overburdensome permitting process and labor and housing shortages represent barriers related to the current regulatory environment that may stifle successful implementation of a District-wide carbon management plan on working lands.

Other Barriers

Several other factors could serve as barriers:

- Landowner's high regard for privacy;
- Lack of consumer education about where and how their food is produced;
- Difficulty in establishing new markets for new "climate-friendly" or locally-appropriate products;
- Perceived or real risk adversity among producers operating on tight budgets;
- Lack of funding for new research trials and innovation;
- Lack of an existing robust body of academic research on particular practices;
- Lack of inexpensive, broadly-accepted carbon offset verification methodology;
- Artificially low and inconsistent pricing of carbon offset credits;
- Time-consuming and complicated application process for various funding sources.

Funding Opportunities

Existing and potential funding opportunities to assist producers with the cost of implementing various carbon farming practices, or to get compensated for doing so, are outlined below. This is certainly not an exhaustive list and new opportunities, particularly in the fields of carbon credit trading and ecosystem service payments, will continue to emerge as the world responds to the ever more urgent need to address the root causes and impacts of climate change.

NRCS Environmental Quality Incentives Program

Commonly referred to as EQIP, the NRCS Environmental Quality Incentives Program is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water and related natural resources on agricultural land. Willing landowners that meet the eligibility requirements with suitable acreage should be encouraged to participate in this program in order to implement NRCS CPSs under their purview to benefit from the technical services they provide including engineering plans and specifications and to lessen the financial burden of the capital investment. This program can also assist with infrastructure improvements such as roads, fencing and stock water installation that support conservation practices.

California Climate Investments

The State's portion of the Cap-and-Trade auction proceeds are deposited in the Greenhouse Gas Reduction Fund and used to further the objectives of the California Global Warming Solutions Act of 2006 (AB 32). California Climate Investments is a statewide initiative that allocates billions of dollars received from the auction proceeds to programs that reduce greenhouse gas emissions, strengthen the economy and improve public health and the environment—particularly in disadvantaged communities. To date, more than $9B have been appropriated to state agencies implementing GHG emissions reduction programs and projects. Funding programs are categorized into three priority areas: transportation and sustainable communities, clean energy and energy efficiency, and natural resources and waste diversion. There are several programs highlighted below that are either available directly to producers or that would require their partnership in order to be implemented. These include:

The Funding Agricultural Replacement Measures for Emission Reductions Program

The Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program provides funding through local air districts for the purchase of cleaner agricultural harvesting equipment, heavy-duty trucks, agricultural pump engines, tractors, and other equipment used in agricultural operations. The statewide FARMER program received $132 million in fiscal year 2018-19 and is administered locally by the Santa Barbara Air Pollution Control District (APCD).

The APCD administers two funding opportunities as part of the Clean Air Grants Program funded by the California Air Resources Board's Carl Moyer Program, Community Air Protection Program, FARMER Program, Voluntary NOx Remediation Measure Program, and California Department of Motor Vehicles surcharge revenue:

- Clean Air Grants for Agricultural Engines
    - assists in the cost of replacing agricultural stationary diesel engines
    - maximum grant award of $150,000 per project or 80% of eligible reimbursement, whichever is less.

- Clean Air Grants for Off-Road Equipment
    - assists in the cost of replacing off-road equipment such as diesel powered tractors, dozers, forklifts, loaders, excavators, scrapers, agricultural utility terrain vehicles, ground support equipment, etc.
    - maximum grant award of $150,000 per project or 80% of eligible reimbursement, whichever is less.

Healthy Soils Program

California's Healthy Soils Initiative is a collaboration of state agencies and departments, led by the California Department of Food and Agriculture (CDFA) to promote the development of healthy soils on

California's farm and ranchlands. The State originally allocated $7.5M from the Greenhouse Gas Reduction Fund (state cap and trade proceeds aka California Climate Investments) to fund the initiative with the authorization of the 2016 Budget Act. The California Department of Food and Agriculture disbursed funds during the late summer/fall of 2017 with a second round in the Spring of 2018 through what is now being called the Healthy Soils Program (HSP) via two competitive grant programs: The Healthy Soils Program Incentive Program and the Healthy Soils Program Demonstration Program. An estimated $3.75M was allocated through the Incentives Program to provide financial assistance for implementation of agricultural management practices that sequester soil carbon and reduce greenhouse gas emissions. The maximum grant award was $50,000 and the grant term was for a period of 3 years. An estimated $3M was allocated to projects that monitor and demonstrate to farmers and ranchers in California, specific management practices in agriculture that sequester carbon, improve soil health and reduce atmospheric greenhouse gases.

CDFA was then appropriated $10M from the California Drought, Water, Parks, Climate, Coastal Protection and Outdoor Access for all Act of 2018, and another $5M from the California Climate Investments authorized by the Budget Act of 2018 to fund a 2018 round of the HSP Incentives Program and HSP Demonstration Projects. The maximum grant award for this round of funding was increased to $75,000. With this round of funding, the HSP reimbursement rate for compost application to grazed grassland was $50 per ton which covered the full estimated cost of practice implementation here in Santa Barbara County based on quotes received:

Cost Per Ton	
Certified organic compost delivered in SB County[1]	$38/wet ton
Spreading[2]	$11/ton
Total Cost/Ton Delivered and Spread	$49/ton
Cost Per Acre	
Per acre application rate required for HSP	6-8 tons/acre
Cost per ton delivered and spread	$49/ton
Total Cost Per Acre	$294-$392/acre
HSP 2018 Payment Rate	
Payment per ton	$50/ton
Per acre application rate required for HSP	6-8 tons/acre
Total Payment Per Acre	$300-$400/acre

[1]Price provided by Agromin (for organic compost) and Engel & Gray (not organic, but STA-certified)

[2]Price provided by Premier Ag

Future funding to this program and subsequent requests for proposals should be monitored as most recently, Governor Gavin Newsom showed his support for the State's Climate Smart Agriculture programs by increasing the allocation to the Healthy Soils Program from $15M to $28M in his state budget for fiscal year 2019-20 which was approved by the California legislature on June 13, 2019. Applications for this current round of funding are due in April and June 2020 for the Demonstration and Incentives grants respectively. With each round of funding the CDFA continues to make improvements to the program including increasing the maximum award from $75,000 to $100,000 and simplifying the application process.

National Fish & Wildlife Foundation Monarch Butterfly and Pollinators Conservation Fund

NFWF solicits proposals to fund projects that protect, conserve and increase habitat for the monarch butterfly and other at risk native insect pollinators. The Pollinator Fund will award up to $1.6M in grant in 2019 for habitat improvement and technical assistance for private working lands. Priority is given to projects on or adjacent to working lands, important monarch butterfly overwintering sites and US Forest Service and Bureau of Land Management lands.

Western SARE

Western Sustainable Agriculture Research and Education (SARE) is a program of the U.S. Department of Agriculture that according to their website "functions through competitive grants implemented cooperatively by farmers, ranchers, researchers and ag professionals to advance farm and ranch systems that are profitable, environmentally sound and good for communities". Western SARE provides grants in these categories: Research & Education Grants, Professional Development Program Grants, Farmer/Rancher Grants, Professional and Producer Grants, Graduate Students Grants in Sustainable Agriculture and Research to Grass Roots Grants.

Carbon Offset Market Opportunities

American Carbon Registry

The American Carbon Registry (ACR), founded in 1996, is a nonprofit enterprise of Winrock International and is the first private voluntary greenhouse gas registry in the world. ACR oversees the registration and verification of carbon offset projects for both the voluntary carbon market and California's regulated carbon market. ACR follows approved carbon accounting protocols and issues offsets on a transparent registry system. They publish standards, methodologies, protocols and tools for greenhouse gas accounting. Each offset represents the reduction or removal of one metric ton of carbon dioxide. They only register project-based carbon offset tons that are real, permanent and independently verified.

CAPCOA

The California Air Pollution Control Officers Association (CAPCOA) is a non-profit association of the air pollution control officers from all 35 local air quality agencies throughout California and runs a California-based greenhouse gas credit exchange called GHG Rx. The GHG Rx is a registry and information exchange for greenhouse gas emissions reduction credits generated from projects within

California. The GHG Rx facilitates communication between those who create the credits, potential buyers and funding organizations. It provides a low cost forum for buying and selling high quality greenhouse gas reduction credits for CEQA mitigation, implementing local Climate Action Plans and other voluntary actions. Projects are developed pursuant to protocols approved by the CAPCOA Board. Several protocols have been approved including Methodology for Compost Additions to Grazed Grasslands allowing it to become part of the CAPCOA GHG Rx. Compost application projects should consider utilizing CAPCOA GHG Rx and implementing this protocol in order to generate marketable credits to reduce overall costs of practice implementation.

Large-scale Carbon Offset Project Demand

Currently, the global carbon offset market is dominated by big players and large scale projects. For example, The Land Life Company is funded by companies like Shell and Lyft who want to either offset their emissions or contribute to climate change solutions for public relations reasons. Land Life Company carries out their funder's goals by restoring degraded lands by planting trees at scale (typically 10,000 trees minimum per project). The Climate Trust and Indigo Ag are other examples of companies that are compensating producers for implementing carbon-sequestering practices at scale. This carbon management plan being executed at the District-wide scale opens the opportunity for a group of Gaviota producers to be eligible for larger scale offset project demand.

Emerging Local Carbon Offset Market Opportunities

This regional carbon management plan, along with carbon farm plans that have been written for specific producers in the County, are key building blocks in an emerging effort to create a local boutique carbon offset market here in Santa Barbara County, with the Gaviota Coast positioned to be an initial roll out area. This emerging market will bring together producers who sequester carbon by implementing the practices described in this plan with carbon offset credit buyers including education institutions, businesses, nonprofits and citizens who want to offset their carbon footprint beyond what they can achieve through direct emission reductions efforts to achieve low, no, or net negative carbon footprints. LegacyWorks Group and an array of partners are currently initiating a collaborative effort to engage a number of local organizations, institutions and businesses to design and pilot the market in the coming years. We envision this local carbon offset market serving as a source of funding that can, alongside other funding sources, provide capital, including the critical upfront capital needed to implement practices identified in this plan. UCSB and other research institutions will be key partners to develop appropriate yet not overburdensome verification protocols and undertake research to refine the COMET projections for carbon sequestration potential in our local system. With a successful launch focused on carbon in the first phase of this market development process, the partners hope to layer other ecosystem services on top of the market structure to enable payment to producers for the co-benefits that are generated through practices identified herein including groundwater recharge, restoration of native vegetation, pollinator health and more.

While the Gaviota Coast is host to producers that have the potential to supply carbon offset credits through practice implementation, the University of California Santa Barbara represents a key player on the demand side with their commitment to the UC Carbon Neutrality Initiative. As they seek to achieve carbon neutrality by 2025, they will need to look to carbon offsets to balance emissions that they simply cannot yet avoid such as utilization of current transportation infrastructure and plane travel. Landholders in the District with a concrete plan for how additional carbon could be sequestered on their properties presents an exciting opportunity to meet both parties' goals and ensure these offsets are administered locally.

Similarly, in May of 2015 the County Board of Supervisors adopted the County of Santa Barbara Energy and Climate Action Plan which established a goal of reducing GHG emissions in the unincorporated county by 15% below 2007 levels by 2020. According to their 2017 Progress Report, the County and community were behind in implementing many of the report's emission reduction measures including carbon farming and GHG emissions were trending in the wrong direction. As of 2016 GHG emissions remained 14% above 2007 levels and as of 2017 only 50% of their emissions reduction measures were on track to meet the 2020 goal. GHG emissions from the County's agricultural sector were estimated to be 90,348 and 119,360 metric tons of carbon dioxide equivalent in 2007 and 2016 respectively. The primary reason for this 32% increase was reported to be from increased fertilizer use (County 2017a). Directing County funding to the implementation of this plan could target the reported cause of increased emissions from the ag sector and move the County in the right direction towards achieving its goal.

Next Steps

The next steps to take are for the Gaviota Coast Conservancy, the Cachuma Resource Conservation District and all of the partners who were responsible for making this regional carbon farm plan happen, to commence or ramp up an outreach phase to producers in the District. Outreach may consist of mailers, workshops, flyers, presentations, networking and direct contact through existing relationships to introduce and share the Plan. Producers are encouraged to contact the CRCD for a consultation regarding what their specific needs or interests are (e.g. grant writing assistance, more information about a particular practice, technical assistance regarding resource concerns or practice implementation, etc.). Producers that are employing these practices are encouraged to host workshops or presentations to demonstrate what they have done to others. This regional plan provides important context for the what, why and how of carbon farming that can now expedite the creation of site-specific carbon farm plans for individual properties. The site-specific plans can reference the regional plan but be simplified to include only a practice layout map and an implementation plan showing timing, cost estimates and carbon sequestration potential. This documentation can then also be used for and is often required by grant applications. The goal is to get more carbon farming practices implemented across the District in a shorter period of time to take advantage of current funding opportunities available and to dramatically improve the resilience of this special place in the near term.

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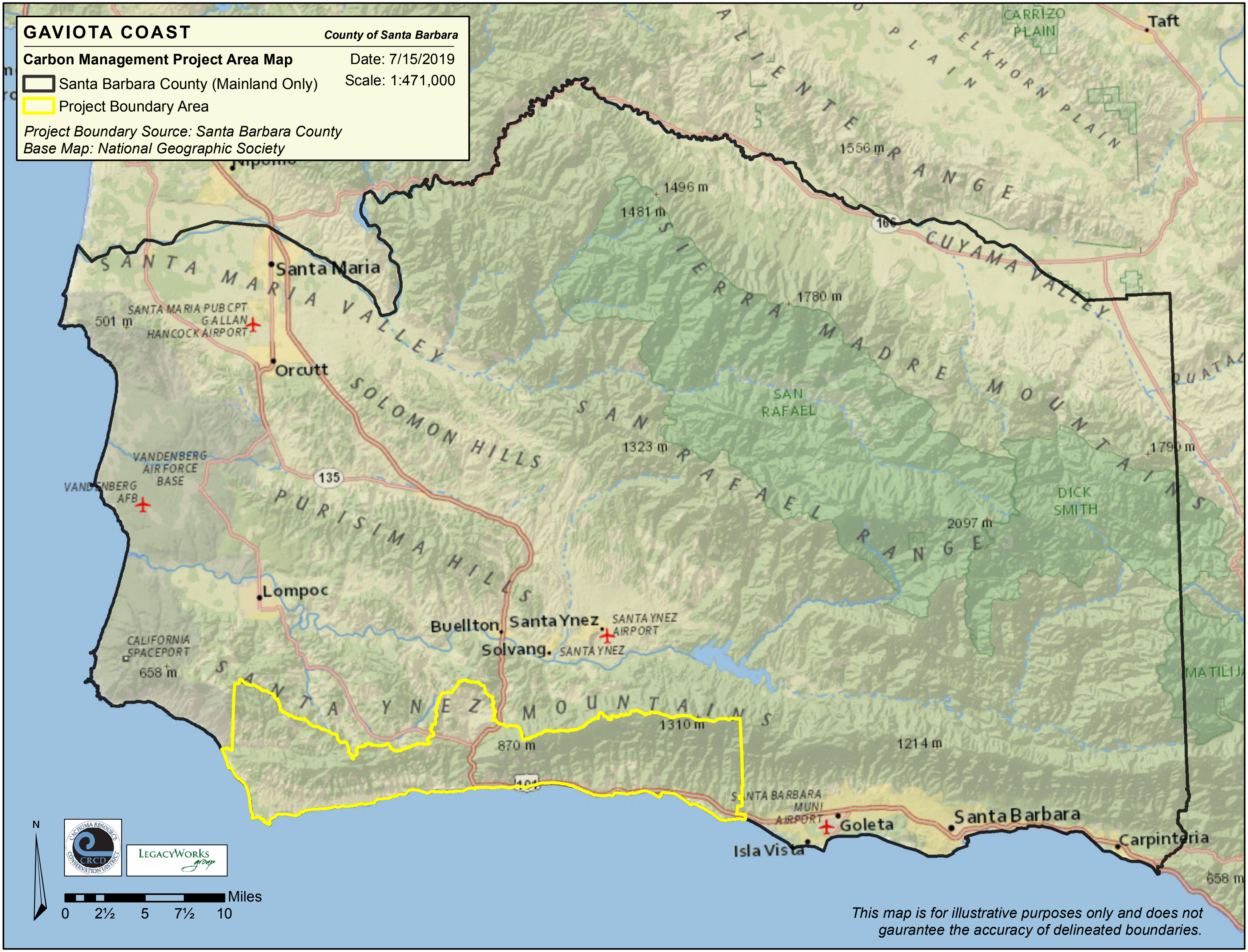
APPENDIX A - Maps


GAVIOTA COAST
County of Santa Barbara
Carbon Management Project Area Map
Date: 7/15/2019
Santa Barbara County (Mainland Only)
Scale: 1:471,000
Project Boundary Area
Project Boundary Source: Santa Barbara County
Base Map: National Geographic Society
Taft
CARRIZO PLAIN
ELKHORN PLAIN
CALIENTE RANGE
CUYAMA VALLEY
166
1556 m
1496 m
1481 m
1780 m
SIERRA MADRE MOUNTAINS
SAN RAFAEL
SAN RAFAEL RANGE
1323 m
1790 m
2097 m
DICK SMITH
MATILIJA
Santa Maria
SANTA MARIA VALLEY
SANTA MARIA PUB CPT GALLAN HANCOCK AIRPORT
501 m
Orcutt
SOLOMON HILLS
135
VANDENBERG AIR FORCE BASE
VANDENBERG AFB
PURISIMA HILLS
Lompoc
Buellton
Santa Ynez
SANTA YNEZ AIRPORT
Solvang
SANTA YNEZ
CALIFORNIA SPACEPORT
658 m
SANTA YNEZ MOUNTAINS
1310 m
870 m
1214 m
101
SANTA BARBARA MUNI AIRPORT
Goleta
Isla Vista
Santa Barbara
Carpinteria
658 m
N
CRCD
CACHUMA RESOURCE CONSERVATION DISTRICT
LegacyWorks group
0 2½ 5 7½ 10 Miles
This map is for illustrative purposes only and does not gaurantee the accuracy of delineated boundaries.

GAVIOTA CARBON MANAGEMENT PLAN
County of Santa Barbara
Overview Map
Data Sources: Land Ownership & Parcels: Santa Barbara County, Streams: National Hydrology Dataset
Project Boundary
Parcels
Named Stream
Unnamed Stream
County of Santa Barbara Lands
State Lands
Federal Lands
Dangermond Preserve Boundary
Land Trust for Santa Barbara County Easements
Aerial Imagery: 2017 DigitalGlobe
0
1
2
3
4
Miles
N
Date: 5/9/2019
Scale: 1:37,000
LegacyWorks group
CACHUMA RESOURCE CONSERVATION DISTRICT CRCD
This map is for illustrative purposes only and does not gaurantee the accuracy of delineated boundaries.
Rancho Dos Vistas
Gaviota State Park
Arroyo Hondo Preserve
Baron Ranch
El Capitan Beach State Park
Refugio Beach State Park

GAVIOTA CARBON MANAGEMENT PLAN
County of Santa Barbara
Overview Map
Data Sources: Land Ownership & Parcels: Santa Barbara County, Streams: National Hydrology Dataset
Project Boundary
Parcels
Named Stream
Unnamed Stream
County of Santa Barbara Lands
State Lands
Federal Lands
Dangermond Preserve Boundary
Land Trust for Santa Barbara County Easements
Aerial Imagery: 2017 DigitalGlobe, Topographic Imagery: National Geographic Society
0
1
2
3
4
Miles
N
Date: 5/9/2019
Scale: 1:37,000
This map is for illustrative purposes only and does not gaurantee the accuracy of delineated boundaries.
Rancho Dos Vistas
Gaviota State Park
Arroyo Hondo Preserve
Baron Ranch
El Capitan Beach State Park
Refugio Beach State Park


GAVIOTA CARBON MANAGEMENT PLAN
County of Santa Barbara
Land Cover & Vegetation Map
Project Boundary (Modified NRCS Santa Barbara Coastal Hydrologic Unit)
Parcels (Santa Barbara County)
Named Stream (National Hydrology Dataset)
Unnamed Stream
Aerial Imagery: 2017 DigitalGlobe
0 1 2 3 4 Miles
N
Date: 5/9/2019
Scale: 1:37,000
LegacyWorks group
CACHUMA RESOURCE CONSERVATION DISTRICT CRCD
This map is for illustrative purposes only and does not gaurantee the accuracy of delineated boundaries.
Legend: Land Cover
Data Source: CALVEG (2010), USDA/USFS-Pacific Southwest Region
Shrub (50,271 +/- Acres)
Herbaceous (26,701 +/- Acres)
Hardwood forest/woodland (21,734 +/- Acres)
Barren (819 +/- Acres)
Urban (565 +/- Acres)
Mixed conifer & hardwood forest/woodland (559+/- Acres)
Water (338 +/- Acres)
Agriculture (47 +/- Acres)

GAVIOTA CARBON MANAGEMENT PLAN
County of Santa Barbara
Agricultural Crop Map
Project Boundary (Modified NRCS Santa Barbara Coastal Hydrologic Unit)
Parcels (Santa Barbara County)
Named Stream (National Hydrology Dataset)
Unnamed Stream
Aerial Imagery: 2017 DigitalGlobe
Miles
0
1
2
3
4
N
Date: 5/9/2019
Scale: 1:37,000
LegacyWorks group
CACHUMA RESOURCE CONSERVATION DISTRICT
CRCD
This map is for illustrative purposes only and does not gaurantee the accuracy of delineated boundaries.
Legend: Agricultural Crops
Data Source: Santa Barbara County Conservation Blueprint Atlas
CITRUS & SUBTROPICAL (2,195 +/- Acres)
IDLE (208 +/- Acres)
GRAIN & HAY CROPS (68 +/- Acres)
YOUNG PERENNIAL (51 +/- Acres)
PASTURE (37 +/- Acres)
DECIDUOUS FRUITS & NUTS (18 +/- Acres)
TRUCK NURSERY & BERRY CROPS (16 +/- Acres)
VINEYARD (2 +/- Acres)


GAVIOTA CARBON MANAGEMENT PLAN
County of Santa Barbara
Potential Compost Application Area Map
Project Boundary (Modified NRCS Santa Barbara Coastal Hydrologic Unit)
Parcels (Santa Barbara County)
Named Stream (National Hydrology Dataset)
Unnamed Stream
Aerial Imagery: 2017 DigitalGlobe
0 1 2 3 4 Miles
N
Date: 5/9/2019
Scale: 1:37,000
LegacyWorks group
Cachuma Resource Conservation District CRCD
This map is for illustrative purposes only and does not gaurantee the accuracy of delineated boundaries.
Legend: Compost Application Areas
Potential Compost Application Area (11,190 +/- Acres)
Data Source: LegacyWorks Group*
* Potential compost application layer was created using the following parameters and data sources:
Slope less than 25% (10-m Digital Elevation Models)
Herbaceous vegetation type (CALVEG)
>100 feet from all wetland types (National Wetlands Inventory)

APPENDIX B

Potential Annual Carbon Sequestration & GHG Emissions Reductions Per 100 Acres and Co-Benefits of Various Practices

Cropland Management Practices	Tonnes CO2 Equivalent per 100 acres per year	Co-benefits
Combustion System Improvement (CPS 372) - improved farm equipment fuel efficiency	1	Increased air quality, decreased fuel costs
Conservation Crop Rotation (CPS 328) - decrease fallow frequency or add perennial crops to rotations	26	Increased soil nutrients, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity
Cover Crop (CPS 340) - add legume or non-legume seasonal cover crop to irrigated or non-irrigated cropland	52 irrigated, 36 non-irrigated	Increased soil nutrients, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity
Mulching (CPS 484) - add mulch to croplands	21	Increased soil water holding capacity, decreased evaporation, decreased soil temperature, decreased erosion, weed control
Nutrient Management (CPS 590) - replace synthetic N fertilizer with compost (CN ratio 15) on irrigated croplands	24	Reduced costs due to reduced application rates, decreased potential for fertilizer run-off, decreased demand of synthetic fertilizer and related fossil fuel use in production process
Residue and Tillage Management - No-Till (CPS 329) - reduced till to no till or strip till on irrigated cropland	18	Decreased compaction, increased air quality, decreased fuel costs, increased soil microbiology

Residue and Tillage Management - No-Till (CPS 329) - intensive till to no till or strip till on irrigated cropland	26	Decreased compaction, increased air quality, decreased fuel costs, increased soil microbiology
Residue and Tillage Management - Reduced-Till (CPS 345) - intensive till to reduced till on irrigated cropland	10	Decreased compaction, increased air quality, decreased fuel costs, increased soil microbiology
Stripcropping (CPS 585) - add perennial cover grown in strips with irrigated or non-irrigated annual crops	4 irrigated, 14 non-irrigated	Decreased erosion, increased soil nutrients, increased soil microbiology, increased biodiversity
Estimated tonnes of CO2e from COMET-Planner.		

Woody Planting Practices	**Tonnes CO2 Equivalent per 100 acres per year**	**Co-benefits**
Hedgerow Planting (CPS 422) - replace a strip of grassland with 1 row of woody plants	820	Increased pollinator habitat, potential for associated decreased use of pesticides and therefore decreased costs, increased soil nutrients, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity
Multi-story Cropping (CPS 379)	Not reported in COMET-Planner	Increased soil nutrients, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity
Riparian Forest Buffer (CPS 391) - replace a strip of grassland near watercourses or water bodies with woody plants	177	Increased soil nutrients, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity

Tree / Shrub Establishment (CPS 612) - conversion of grasslands to a farm woodlot	1889	Increased soil nutrients, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity, increased shade, decreased ambient temperature, assists in restoring onsite water cycling
Windbreak / Shelterbelt Establishment (CPS 380) - replace a strip of grassland with 1 row of woody plants	820	Decreased erosion, decreased soil water evaporation, increased biodiversity, increased soil nutrients, increased soil microbiology, increased soil water holding capacity, increased shade, decreased ambient temperature, assists in restoring onsite water cycling
Estimated tonnes of CO2e from COMET-Planner.		

Grazing Lands Practices	**Tonnes CO2 Equivalent per 100 acres per year**	**Co-benefits**
Nutrient Management (CPS 590) - replace synthetic N fertilizer with compost (CN ratio 15) on managed irrigated or non-irrigated pasture	39 irrigated, 9 non-irrigated	Increased soil microbiology, increased soil water holding capacity
Prescribed Grazing (CPS 528) - grazing management to improve irrigated pasture condition	3	Decreased erosion, improved plant composition, increased soil fertility, increased soil water holding capacity
Prescribed Grazing (CPS 528) - grazing management to improve rangeland or non-irrigated pasture condition	<1 for 100 acres (5 for 1000 acres)	Decreased erosion, improved plant composition, increased soil fertility, increased soil water holding capacity
Range Planting (CPS 550) - seeding forages to improve rangeland condition	34	Improved plant composition, increased soil fertility, decreased erosion, increased soil microbiology, increased soil water holding capacity, increased biodiversity

Silvopasture (CPS 381) - tree/shrub planting on grazed grasslands	66	Increased soil water holding capacity, decreased evaporation, decreased soil temperature, decreased erosion, increase biodiversity, increased soil microbiology
Compost (C/N >11) application to grazed grassland	430*	Increased productivity, increased water holding capacity, increased soil microbiology
Estimated tonnes of CO2e from COMET-Planner. *value is from the CDFA version of COMET-Planner used for the Healthy Soils Program funding.		

Restoration of Distributed Land Practices	**Tonnes CO2 Equivalent per 100 acres per year**	**Co-benefits**
Critical Area Planting (CPS 342) - restore highly disturbed areas by planting permanent vegatative cover	105	Decreased erosion, increased habitat, increased soil nutrients, increased soil microbiology, increased soil water holding capacity, increased biodiversity
Riparian Restoration - restore degraded riparian areas by planting woody plants	99	Decreased erosion, increased habitat, increased soil nutrients, increased soil microbiology, increased soil water holding capacity, increased biodiversity
Estimated tonnes of CO2e from COMET-Planner.		