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WESTCARB afforestation pilot projects in Shasta County, California



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# WESTCARB AFFORESTATION PILOT PROJECTS IN SHASTA COUNTY, CALIFORNIA

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***Winrock International***

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Arnold Schwarzenegger
*Governor*

# WESTCARB AFFORESTATION PILOT PROJECTS IN SHASTA COUNTY, CALIFORNIA

PIER PROJECT REPORT

*Prepared For:*

**California Energy Commission**
Public Interest Energy Research Program

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# Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Energy Commission) conducts public interest research, development, and demonstration (RD&D) projects to benefit the electricity and natural gas ratepayers in California. The Energy Commission awards up to $62 million annually in electricity-related RD&D, and up to $12 million annually for natural gas RD&D.

The PIER program strives to conduct the most promising public interest energy research by partnering with RD&D organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Environmentally Preferred Advanced Generation
- Energy-Related Environmental Research

*WESTCARB Afforestation Pilot Projects in Shasta County, California* is a report for the West Coast Regional Carbon Sequestration Partnership – Phase II (contract number MR-06-03L, work authorization number MR-045), conducted by Winrock International. This report is submitted in fulfillment of deliverable #10, "Paper Summarizing Results from Shasta County Afforestation Pilot Activity." The information from this project contributes to PIER's Energy-Related Environmental Research program.

For more information on the PIER Program, please visit the Energy Commission's Web site at www.energy.ca.gov/pier or contact the Energy Commission at (916) 654-5164.

# Table of Contents


**ABSTRACT** ..... **8**

**EXECUTIVE SUMMARY** ..... **9**

**1.0 INTRODUCTION** ..... **13**

1.1 BACKGROUND AND OVERVIEW ..... 13
1.2 PROJECT OBJECTIVES ..... 14
1.3 REPORT ORGANIZATION ..... 14

**2.0 IDENTIFICATION OF PLANTING SITES** ..... **14**

2.1 COMPILE DATA ON EXISTING PLANTINGS ..... 14
2.2 SET CRITERIA FOR WESTCARB PILOT PROJECTS ..... 15
2.3 LANDOWNER OUTREACH AND EDUCATION ..... 16
2.4 IDENTIFIED PLANTING SITES ..... 17

**3.0 TREE PLANTING METHODS** ..... **18**

3.1 CONTRACT SEED AND SEEDLINGS ..... 18
3.2 PLANNING FOR TREE PLANTING ..... 19
*3.2.1 Site-specific plans* ..... *19*
*3.2.2 Prepare NEPA documentation* ..... *19*
*3.2.3 Draft and negotiate landowner agreements* ..... *20*
3.3 BASELINE CARBON STOCKS ..... 20
3.4 SITE PREPARATION, PLANTING, AND EARLY MAINTENANCE ..... 21
3.5 BIOMASS ENERGY ..... 22
3.6 PLANTING DATA COLLECTION ..... 23
*3.5.1 Data on costs* ..... *23*
*3.5.2 Modeling carbon accumulation* ..... *24*
*3.5.3 Evaluation of early performance of afforestation pilots* ..... *24*

**4.0 DETAILS OF AFFORESTATION PILOTS** ..... **25**

4.1 RED RIVER FORESTS PARTNERSHIP ..... 25
4.2 BROOKS WALKER JR, ET AL ..... 29
4.3 HENDRIX-PHILLIPS TREE FARM ..... 32
4.4 GOOSE VALLEY RANCH ..... 35
4.5 LAMMERS PROPERTIES ..... 40
4.6 FRASE PROPERTY ..... 44
4.7 KLOEPPEL PROPERTY ..... 48
4.8 SIVADAS PROPERTY ..... 51
4.9 EILERS PROPERTY ..... 55
4.10 WILSON PROPERTY ..... 59
4.11 LAKEY PROPERTY ..... 63
4.12 BUREAU OF LAND MANAGEMENT ..... 66

**5.0 SUMMARY OF PILOT PROJECTS** ..... **69**

**6.0 CONCLUSIONS AND RECOMMENDATIONS** ..... **72**

6.1 CONCLUSIONS ..... 72

6.2 RECOMMENDATIONS ..... 74
6.3 BENEFITS TO CALIFORNIA ..... 74

**7.0 REFERENCES ..... 76**

**ANNEX A: INVITATION AND AGENDA, WESTCARB SHASTA COUNTY LANDOWNER OUTREACH AND STAKEHOLDERS MEETING (OCTOBER 26, 2006) ..... 78**

**ANNEX B: SHASTA COUNTY LANDOWNER WILLINGNESS TO PARTICIPATE SURVEY ..... 81**

**ANNEX C: SITE-SPECIFIC PLANTING AND MAINTENANCE PLANS FOR WESTCARB AFFORESTATION PILOTS ..... 86**

**ANNEX D: ANNUAL LANDOWNER SURVEY FOR WESTCARB AFFORESTATION PROJECTS ... 107**

## Abstract

Afforestation was identified in Phase I of WESTCARB as a significant terrestrial carbon sequestration opportunity, both in Shasta County and at the state level for California, Oregon and Washington. This report summarizes work done under WESTCARB Phase II (2006-10) by Winrock International and its Shasta County partners, primarily the Western Shasta Resource Conservation District and WM Beaty and Associates, to implement afforestation pilot projects. Activities included refining land classification for afforestation potential; landowner outreach and formal surveys; setting criteria for selection and distribution of pilot plantings; developing site-specific planting and maintenance plans; negotiating landowner agreements; sourcing seed and growing seedlings in nurseries; taking baseline carbon stock measurements; collecting data on operational costs; conducting site preparation, planting and early maintenance; and modeling carbon accumulation. A total of twelve afforestation projects were implemented, totaling 476 acres. Initial survival rates were determined, and future growth and carbon stocks were modeled over a 100-year period.



Keywords: *Carbon, sequestration, afforestation, reforestation, forest, shrubland, rangeland, Shasta County*

# Executive Summary

*Introduction*

The West Coast Regional Carbon Sequestration Partnership (WESTCARB), led by the California Energy Commission, is one of seven US Department of Energy regional partnerships working to evaluate, validate and demonstrate ways to sequester carbon dioxide and reduce emissions of greenhouse gases linked to global warming. Based on analyses conducted in WESTCARB Phase I and related work for the California Energy Commission, afforestation[1] represents the largest single terrestrial carbon sequestration opportunity for Shasta County, for California, and across the WESTCARB region. Protocols, policies and programs to encourage afforestation may make a substantial contribution toward the greenhouse gas (GHG) emission reduction goals of California and other Western states. Meanwhile, afforestation may offer landowners near-term opportunities to participate in rapidly evolving GHG reporting registries, offset markets and other carbon "credit" sale opportunities under voluntary and regulated markets. WESTCARB Phase II included pilot afforestation projects to evaluate the actual potential to implement these projects.

*Purpose*

The purpose of this report is to provide a final update on the WESTCARB Phase II afforestation pilot projects in Shasta County, California. The report summarizes pilot locations, site preparation and planting methods, species, post-planting maintenance, costs, landowner interests and concerns, carbon measurement and monitoring plans, projected tree growth and levels of carbon sequestration. WESTCARB conducted afforestation pilots through cost-shared agreements with private landowners.

*Project Objectives*

The overall goal of WESTCARB Phase II is to validate and demonstrate the region's key carbon sequestration opportunities through pilot projects, methodology development, reporting, and market validation. WESTCARB research will facilitate informed decisions by policymakers, communities, and businesses on how to invest in carbon capture and storage

[1] The uses of the terms "afforestation" and "reforestation" differ across the US and internationally. In the US and under the USDOE revised 1605(b) guidelines for greenhouse gas reporting, "afforestation" is the establishment of new forests on lands that have not been forested for some considerable length of time, and is in essence a land-use change; "reforestation" is the re-establishment of forest cover, naturally or artificially, on lands that have recently been harvested or otherwise cleared of trees. In contrast, California state agencies and the California Climate Action Registry protocols generally use the term "reforestation" to mean the establishment of new forests on lands that have not been recently forested. Regardless of terminology, the practice being tested under WESTCARB is a land-use change activity that would qualify for carbon reporting in the State of California: *the establishment and subsequent maintenance of native tree cover on lands that were previously forested, but have had less than 10% tree canopy cover for a minimum time of ten years* (termed "reforestation" in California). In this report for consistency we use the term "afforestation."

technology development and deployment to achieve climate change mitigation objectives. The climate change mitigation opportunity presented here is afforestation.

The specific objectives of the Phase II Shasta County afforestation pilots are:

- Refine the Phase I economic analysis for afforestation with improved cost data;
- Gain on-the-ground experience to explore the feasibility, success and survival of afforestation projects;
- Refine carbon estimates for afforestation, using baseline measurements, proxy measurements in relevant species groups, and industry data;
- Gain experience with site preparation, seedling sourcing, planting techniques, post-planting maintenance treatments, and other considerations necessary to inform the efforts of land managers, landowners and businesses in replicating and expanding afforestation projects for climate change mitigation in California and the WESTCARB region;

*Project Outcomes*

Twelve landowner agreements for WESTCARB afforestation pilot projects were signed and implemented, totaling 476 acres (Table A). Projects range in size from 7 to 98 acres, and average 40 acres. Project baselines consisted of a variety of brush species, mostly in dense stands. Baseline carbon stocks ranged from zero, for a project that had recently burned in a wildfire, to 34 metric tons of carbon per acre, on a project with dense old-growth Manzanita. Projects were planted to ponderosa pine, mixed conifer stands, or native oaks. After 100 years, projections of net carbon stocks over 100 years on conifer plantings ranged from 53 t C/ac to 111 t C/ac. The native oak planting had projected net carbon stocks of 24 t C/ac after 100 years. Survival of planted conifer seedlings was high, despite limited rainfall in the year of planting. Project costs ranged from $354/ac to $1,880/ac.

**Table A. WESTCARB Shasta County Afforestation Pilot Project Summaries**

| Project | Acres | Cost/ac | Baseline C stocks (t/ac) | Species | Trees/ac planted | Projected net project C stocks after 100 years (t/ac) |
|---|---|---|---|---|---|---|
| **Red River Forests Partnership** | 98 | $832 | 21 | Ponderosa pine | 300 | 73 |
| **Brooks Walker** | 7 | $1,265 | 3 | Ponderosa pine & red fir | 300 | 100 |
| **Hendrix-Phillips Tree Farm** | 20 | $1,223 | 24 | Ponderosa pine | 300 | 67 |
| **Goose Valley Ranch** | 60 | $1,033 | 20 | Ponderosa pine, Douglas fir, incense cedar | 290 | 80 |
| **Lammers** | 50 | $858 | 15 | Ponderosa pine & Douglas fir | 249 | 74 |
| **Frase** | 43 | $600 | 0 | Ponderosa pine | 282 | 85 |
| **Kloeppel** | 51 | $899 | 10 | Ponderosa pine & Douglas fir | 314 | 198 |
| **Sivadas** | 46 | $778 | 44 | Ponderosa pine | 197 | 43 |
| **Eilers** | 20 | $354 | 0 | Ponderosa pine (18 acres) | 208 | 64 |
| | | | | Ponderosa pine & blue oak (2 acres) | 258 | 53 |
| **Wilson** | 14 | $1,300 | 31 | Ponderosa pine | 274 | 60 |
| **Lakey** | 60 | $482 | 0 | Ponderosa pine | 177 | 69 |
| **BLM** | 7 | $1,880 | 0 | Oak | 143 | 24 |

*Conclusions*

Landowners have a strong interest in afforestation projects, and are willing to provide cost-share for projects intended to increase carbon sequestration. There is a wide range of project costs and projected net project carbon stocks, depending on the baseline condition of the land, the accessibility of the project, the quality of the site, and the resulting tree growth. Projects

with high carbon stocks in the baseline do not result in positive net carbon stocks for 30 to 40 years after planting, and therefore may not be feasible on a strictly financial basis. However, sites with low carbon stocks in the baseline result in net positive results within the first 10 years, and sequester large amounts of carbon over the project lifetime. Those areas with high site quality result in large net increases in carbon stocks, although even in areas with poor site quality and limited rainfall, seedling survival was high, and projected carbon stocks can be significant.

*Recommendations*

WESTCARB states should continue to support efforts to explore the potential of afforestation to contribute to state GHG reduction goals. Many different afforestation project designs are conceivable, and can be replicated broadly elsewhere in California and the WESTCARB region. Afforestation can make a significant contribution to carbon sequestration, climate change mitigation and adaptation, and should be considered as part of the broad portfolio of strategies under consideration by the State of California (Climate Action Team and AB32) and analogous policy processes in other WESTCARB states.

Ongoing outreach and education is necessary to keep landowners informed about the opportunities to conduct afforestation for carbon sequestration, evolving carbon markets and climate change policies, and requirements for participation.

*Benefits to California*

Findings from the WESTCARB afforestation pilots have informed both voluntary efforts, such as those by Climate Action Reserve members interested in offsetting GHG emissions through forestry, and regulatory developments, such as the process now underway by the California Air Resources Board to design a GHG regulatory program under the California Global Warming Solutions Act of 2006 (AB32). The AB32 Market Advisory Committee, charged by Executive Order S-20-06 with advising the Air Resources Board on the design of a market-based compliance program under AB32, has recommended that such a program include offset projects provided such projects meet a series of stringent criteria ("real, additional, independently verifiable, permanent, enforceable, predictable, and transparent"), as well as meeting standards for rigorous accounting methods and environmental integrity (Market Advisory Committee 2007). Although debate remains over the role of offsets in GHG emission reduction programs, what sort of offset project types should be eligible, and the role of forestry within offset programs, afforestation projects like those being demonstrated under WESTCARB are perhaps the most likely to meet the Market Advisory Committee's quality criteria. Projects demonstrated to meet these criteria are likely to be attractive to landowners/carbon credit suppliers, to entities (companies, individuals, financial sector investors) purchasing offsets on the voluntary market, and to regulated entities seeking flexible compliance mechanisms to achieve GHG reductions.

# 1.0 Introduction

## 1.1 Background and overview

The West Coast Regional Carbon Sequestration Partnership (WESTCARB), led by the California Energy Commission, is one of seven US Department of Energy regional partnerships working to evaluate, validate and demonstrate ways to sequester carbon dioxide and reduce emissions of greenhouse gases linked to global warming. Terrestrial (forestry and land use) sequestration options being investigated include afforestation[2], improved management of hazardous fuels to reduce emissions from wildfires, biomass energy, and forest management. Shasta County, California and Lake County, Oregon were chosen for Phase II terrestrial sequestration pilot projects because of the diversity of land cover types present, opportunities to implement the most attractive terrestrial carbon activities identified in Phase I, and replication potential elsewhere in the WESTCARB region.

Earlier reports (Brown et al 2004; Brown et al 2007; Martin et al 2007a, 2007b; Martin *et al*. 2006) have presented the results of Winrock analyses of afforestation potential for California and for Shasta County. These analyses included suitability of lands classified as rangelands for afforestation, carbon sequestration potential, cost analyses (opportunity, conversion, measuring and monitoring, and maintenance costs), and carbon supply curves summarizing the area of land that might be afforested and resulting carbon sequestration at a range of prices for $CO_2$. Winrock concluded that afforestation represents the single largest terrestrial sequestration opportunity at the state level for California, Oregon and Washington (Brown et al 2004; Dushku et al 2005a, b; Brown et al 2006). For example, for California, it was found that at a price of <$5.50t $CO_2$, 345 million metric tons $CO_2$ could be sequestered on 2.7 million acres after 20 years and 3 billion metric tons $CO_2$ on 14.8 million acres after 40 years via afforestation of rangelands with native species (Brown et al 2004). Afforestation was also the single largest opportunity for Shasta County; at the same price, afforestation could sequester 65 million metric tons $CO_2$ on 331 thousand acres after 20 years and 87 million metric tons $CO_2$ on 346 thousand acres after 40 years (Brown et al 2007).

Moving beyond these initial analyses, in Phase II Winrock has worked with Shasta County landowners to implement afforestation pilot projects. The purpose of pilot projects was to validate and demonstrate Phase I findings, refine earlier analyses with more specific cost and

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[2] The uses of the terms "afforestation" and "reforestation" differ across the US and internationally. In the US and under the USDOE revised 1605(b) guidelines for greenhouse gas reporting, "afforestation" is the establishment of new forests on lands that have not been forested for some considerable length of time, and is in essence a land-use change; "reforestation" is the re-establishment of forest cover, naturally or artificially, on lands that have recently been harvested or otherwise cleared of trees. In contrast, California state agencies and the California Climate Action Registry protocols generally use the term "reforestation" to mean the establishment of new forests on lands that have not been recently forested. Regardless of terminology, the practice being tested under WESTCARB is a land-use change activity that would qualify for carbon reporting in the State of California: *the establishment and subsequent maintenance of native tree cover on lands that were previously forested, but have had less than 10% tree canopy cover for a minimum time of ten years* (termed "reforestation" in California). In this report for consistency we use the term "afforestation."

carbon data and explore the interests and concerns of landowners in conducting afforestation for carbon sequestration.

## 1.2 Project Objectives

The overall goal of WESTCARB Phase II was to validate and demonstrate the region's key carbon sequestration opportunities through pilot projects, methodology development, reporting, and market validation. Results from WESTCARB research will be able to facilitate informed decisions by policymakers, communities, and businesses on how to invest in carbon capture and storage technology development and deployment to achieve climate change mitigation objectives.

The specific objectives of the Phase II Shasta County afforestation pilots were to:

- Refine the Phase I economic analysis for afforestation with improved cost data;
- Gain on-the-ground experience to explore the feasibility, success and survival of afforestation projects;
- Refine carbon estimates for afforestation, using baseline measurements, proxy measurements in relevant species groups, and industry data;
- Gain experience with site preparation, seedling sourcing, planting techniques, post-planting maintenance treatments, and other considerations necessary to inform the efforts of land managers, landowners and businesses in replicating and expanding afforestation projects for climate change mitigation in California and the WESTCARB region.

## 1.3 Report Organization

The report is organized into six sections. Section 2 summarizes methods for compiling information on planting in Shasta County, CA and identifying plantings sites for the afforestation pilots. Section 3 provides information on the planting methods used for the pilots. Section 4 details and Section 5 summarizes the planting sites. Section 6 summarizes findings and recommendations.

# 2.0 Identification of Planting Sites

## 2.1 Compile data on existing plantings

Public and private interests were contacted to compile a list of reforestation projects planned in Shasta County between 2007 and 2009. The objective was to further our understanding of afforestation activities already underway in California. Other projects currently underway or planned, such as projects under the EQIP and CFIP programs, are not explicitly designed for carbon sequestration purposes but involve similar activities and potentially data for analysis. Information collected included: project status, county, ownership size, project size, legal location, responsible RPF, land use prior to project, elevation, slope, aspect, soil, vegetation prior to planting, project description, maintenance methods, planting density, costs, projected volume accumulation if available, and seedling survival/growth rates if known.

## 2.2 Set criteria for WESTCARB pilot projects

Winrock, Western Shasta RCD, and WM Beaty & Associates established the following general criteria for selecting landowners to proceed to site-specific afforestation plans and landowner agreements:

- The practice supported by WESTCARB funding should be eligible for carbon registries, reporting and markets, should landowners choose to do so. The eligibility criteria for the practice must fit within "reforestation" as defined by the Climate Action Reserve, and described as "the establishment and subsequent maintenance of native tree cover on lands that were previously forested, but have had less than 10% tree canopy cover for a minimum time of ten years[3]." Proposed sites must therefore have had less than 10% tree canopy cover for at least ten years at the start of the project.
- Participation in a WESTCARB afforestation pilot would not, however, be contingent on landowners' willingness to report the activity to the Registry or sell credits. Some requirements of the Registry protocols current at the time posed challenges to landowners. Notably, acceptance of a perpetual conservation easement was not made a pre-condition of participating in a WESTCARB afforestation pilot, and this requirement was eliminated in subsequent versions of the protocols. The decision whether or not to report afforestation projects to the Registry, and/or sell carbon credits, entails specific requirements and costs that were left to individual landowner decisions. Landowners would be educated and even encouraged to consider this process, but WESTCARB research results could be secured whether or not participating landowners choose to do so.
- Lands where afforestation was required under existing forest practice rules and regulations (e.g. re-stocking requirements) were not eligible. Such lands would not meet the regulatory additionality test of carbon markets/reporting systems. Lands that currently have a stocking violation under California PRC 4561 were also ineligible.
- Landowners had to be willing to allow periodic access by field teams to the afforested portion of their lands for measurement and monitoring.
- Landowners were asked to complete a brief annual survey and provide photo documentation as a means of documenting survival and performance of the afforestation pilot, for 10 years beginning with the year of planting.
- Landowners must have been willing to share costs of afforestation, in recognition of mutual benefits and to create a vested interest in maintenance of the projects. A general cost-sharing guideline of 75% WESTCARB /25% landowner was adopted, applied to

[3] The WESTCARB Shasta Afforestation pilot projects were chosen and initiated according to version 1.0 of the California Climate Action Registry (CCAR) Forest Project Protocols (FPP). The current version of the FPP is 3.2, which is administered by the Climate Action Reserve (CAR) and differs from version 1.0 in numerous areas. More information is available on the CAR website: http://www.climateactionreserve.org/how/protocols/adopted/forest/development/.

operational costs (site preparation, brush disposal, seed and seedlings, planting, seedling protection, and early maintenance treatments). Actual cost-sharing levels differed from 25% for various reasons, but 25% was to be the starting point for negotiations.

- WESTCARB funded 100% of other costs to secure research results and help build capacity of landowners. These costs included the initial analysis, landowner outreach, surveys, project plans etc. summarized here; Registered Professional Forester (RPF) supervision of the afforestation process; baseline carbon stock measurements and carbon accumulation modeling. Costs of reporting and certifying afforestation projects on carbon registries, and/or entering into market transactions, were at landowners' discretion and so 100% borne by landowners.
- A minimum size (acreage) for afforestation pilot projects was considered. A general guideline of at least 20 acres was adopted, for reasons of cost-effectiveness considering economies of scale in site preparation and planting. However this was applied as a flexible guideline. Smaller projects offering unique benefits were considered and accepted, particularly if near to a larger project so that equipment move-in/move-out costs could be reduced.
- The eventual "portfolio" of WESTCARB afforestation pilot projects was intended to include a diversity of land types and project types, and as broad a geographic distribution across the county as possible. Thus, an effort was made to include lands at low, medium and high elevations, lands suitable for oak, oak/conifer, and conifer afforestation projects, and representatives of the diversity of site conditions created by the elevation, slope, climatic, vegetation and other gradients within Shasta County. However, because a core WESTCARB objective is demonstration of projects with relevance to the county, state, and region as a whole, project selection considered not only uniqueness but also replication potential.

## 2.3 Landowner outreach and education

Model-based analyses of site suitability for growing trees, carbon potential or cost indicate only which rangelands within Shasta County might successfully be converted for carbon purposes, or where within the county the most attractive regions for afforestation opportunities might be located. Moving to actual afforestation pilot activities, it was necessary to identify specific landowners and assess their level of interest and potential concerns about planting forests on a portion of their lands. Landowners must weigh the benefits of planting forests and/or participating in evolving carbon markets against the costs and resulting obligations.

To begin this dialogue, Winrock worked with the Western Shasta Resource Conservation District (RCD) to host a Shasta County Landowner Outreach & Stakeholders Meeting in Anderson, CA, October 26, 2006. Invitations to this meeting were sent to landowners, land managers, ranchers, foresters and other Shasta County stakeholders through flyers, e-mails, regular mail, and outreach via the RCD's watershed groups throughout the county. The meeting invitation and agenda are included in **Annex A**.

Following the October 26 meeting, Western Shasta RCD conducted follow-up meetings with landowners, and coordinated outreach via the RCD's watershed groups and partner agencies. RCD staff met with the Shasta-Tehama Shedhead Watershed Coordinator Group, Sacramento River Area Conservation Forum, and individual landowners to discuss afforestation opportunities. To collect additional data and identify specific candidate landowners, a relatively simple but formal landowner survey was developed. The survey format is shown in **Annex B**. Over 400 letters were mailed to Shasta County landowners inquiring about interest in participating in afforestation, and 44 landowners participated in the formal survey.

Landowners indicated a considerable uncertainty and lack of information about evolving climate change policy, carbon markets, and income potential from these projects. To respond to this need, Winrock prepared a document "Talking Points for Shasta County Landowner Survey: Carbon Credit Revenue Potential from Afforestation" for the RCD's use in conversations with landowners. The intent was to provide landowners some sense of the magnitude of carbon sequestration (tons $CO_2$ or "credits") that afforestation on their lands could generate over time, the range of possible prices, and how carbon markets and policy are currently evolving. The "talking points" emphasized that it is not possible to predict with confidence the evolution of markets, future prices, or even future performance of an afforestation project on any given piece of land, and that actual revenues available from afforestation, along with timing of such revenues, will be the result of bilateral negotiations between offset buyers and sellers.

Following landowner survey results and desk review of potential projects, Beaty and Associates and the RCD met with 20 landowners on their property to assess the sites, discuss landowner goals and pilot project objectives, and determine if a project was feasible. These meetings were vital in not only determining project feasibility, but also to begin forming understanding and trust between landowner and those implementing projects.

## 2.4 Identified planting sites

Table 1 and Figure 1 show the size and location of the pilot projects, along with the species composition that was planted.

**Table 1. WESTCARB afforestation pilot projects**

| Project | Acres | Species Planted |
|---|---|---|
| Red River Forests Partnership | 98 | Ponderosa pine |
| Brooks Walker | 7 | Ponderosa pine & red fir |
| Hendrix-Phillips Tree Farm | 20 | Ponderosa pine |
| Goose Valley Ranch | 60 | Ponderosa pine, Douglas fir, incense cedar |
| Lammers | 50 | Ponderosa pine & Douglas fir |
| Frase | 43 | Ponderosa pine |
| Kloeppel | 51 | Ponderosa pine & Douglas fir |
| Sividas | 46 | Ponderosa pine |
| Eilers | 20 | Ponderosa pine & blue oak |
| Wilson | 14 | Ponderosa pine |
| Lakey | 60 | Ponderosa pine |
| BLM | 7 | Oak |

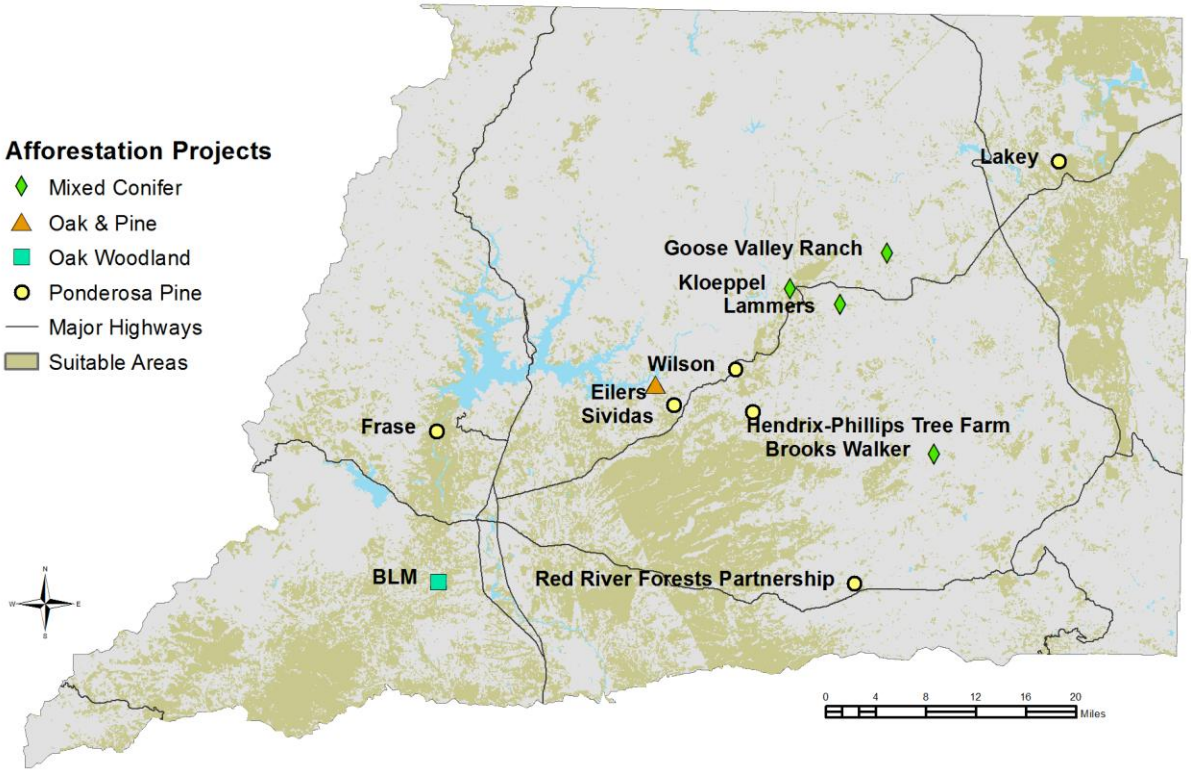


**Figure 1. WESTCARB afforestation projects**

# 3.0 Tree Planting Methods

## 3.1 Contract seed and seedlings

Generally, seedlings for conifer afforestation must be grown for at least a year prior to planting. Seed is purchased or collected, specific to the Seed Zone of the site to be planted, and delivered to a nursery for stratification[4], sowing, and growing under contract for a year or more. For example, for planting in spring 2008, seed and seedling arrangements with nurseries would need to be made in late fall 2006. This posed a significant implementation challenge. Due to contractual delays at the start of WESTCARB, the process of conducting landowner outreach and surveys, identifying specific sites, negotiating landowner agreements and drafting site-specific plans was only beginning in late 2006, at the same time seedlings should be planted in nurseries for successful spring 2008 planting. Because of the relatively long time required for site selection, landowner outreach and negotiation, specific afforestation pilot sites would be known and agreements signed by mid-2007 – at that point, too late to begin growing seedlings for spring 2008 planting (or, if seedlings were not specifically grown under contract for WESTCARB, to be guaranteed of adequate seedlings from nursery overstock).

[4] Stratification is the exposure of a seed to a cold, moist treatment to overcome dormancy and promote germination.

Under these circumstances, Winrock made arrangements in fall 2006 with a nursery to grow seedlings using seed from a Seed Zone covering the areas of Shasta County where it was reasonably likely willing landowners could be identified. This decision necessarily limited the geographic and elevation range of sites that could be considered for spring 2008 planting to those appropriate to the Seed Zone chosen. Arrangements were made with the California Department of Forestry & Fire Protection for improved ponderosa pine seed from Seed Zone 522, NSTIA lot 1N, and with Cal-Forest Nursery in Etna, California to grow 40,000 Ponderosa pine seedlings in Styro 6 blocks. Western Shasta RCD and WM Beaty & Associates, Inc. were ultimately able to identify willing landowners matching the Seed Zone and number of seedlings being grown for 2008 planting.

A second round of afforestation sites for 2009 planting had considerably more flexibility because the entire process of site identification, site-specific planning, and negotiation with landowners took place in 2007 prior to the time (late fall 2007) when appropriate seed had to be delivered to nurseries to begin growing for spring 2009 planting. These "Round Two" afforestation sites were more broadly distributed, in geographic location and elevation, representing a broader range of Seed Zones and site conditions.

Oak afforestation projects do not necessarily require this long lead-time because oaks can be successfully direct-seeded from acorns collected the previous fall, though not every season produces a viable acorn crop. There were two projects that included oak planting, both of which were initially planted in early 2009.

## 3.2 Planning for tree planting

### 3.2.1 Site-specific plans

Site-specific afforestation planting and maintenance plans have been developed by a Registered Professional Forester (WM Beaty & Associates) for each of the candidate afforestation sites. These site-specific plans include details of location, acres available and suitable for afforestation, road access, any easements, utilities or sensitive areas, soil types, precipitation, seed zone, slope, aspect, site class, current vegetation conditions, a step-by-step plan for site preparation, planting, chemical and mechanical treatments, and estimated costs.

Development of such a plan involves a substantial time investment including site visits by the RPF. However, without a site-specific plan and cost estimates, it is difficult to enter into specific negotiations on a landowner agreement. Therefore of the landowners initially contacted and the subset (44) who had active enough interest to participate in the formal survey, a further subset were chosen, based on the criteria above and their demonstrated willingness to consider a cost-shared afforestation agreement, to receive site-specific plans. These plans were then incorporated into landowner agreements described below. All the site-specific afforestation planting and maintenance plans developed are included in **Annex C**.

### 3.2.2 Prepare NEPA documentation

The WESTCARB Phase II terrestrial pilot activities in Shasta and Lake Counties in December 2006 received a determination by the US Department of Energy NEPA Examiner that "the

proposed action falls under one or more of the categorical exclusions listed in Appendix A or B of Subpart D of the DOE NEPA Implementing Procedures" (10 CFR Part 1021). However, the Shasta County afforestation pilot projects were excluded from this determination because at the time, specific sites had not been identified and it was not possible to make a determination on potential environmental impacts. Instead, USDOE requested to receive site-specific information on each afforestation pilot site as these were identified, in the format of the original USDOE Environmental Questionnaire provided for the project as a whole.

Winrock therefore, with assistance from Western Shasta RCD, prepared site-specific Environmental Questionnaires for each of the proposed afforestation pilot sites. These questionnaires describe the proposed project and any environmental impacts including land use, construction activities and/or operation, geological/soil conditions, vegetation and wildlife resources, socioeconomic and infrastructure conditions, historical/cultural resources, visual resources, atmospheric conditions/air quality, hydrologic conditions/water quality, soil and hazardous wastes, health/safety factors, and environmental restoration and/or waste management. In general, afforestation has minimal or positive environmental impacts; any significant impacts on soil conditions, vegetation and wildlife resources, or historical/cultural resources can be avoided and/or mitigated by simply flagging and avoiding sensitive areas, shifting project boundaries, or if necessary dropping the proposed afforestation pilot site in favor of another site without such potential impacts.

### 3.2.3 Draft and negotiate landowner agreements

Through the process of landowner outreach (>400 landowners) and formal surveys (44 landowners), a smaller number of landowners were identified who met the selection criteria described in section 2.2, were willing to share costs, and demonstrated continued commitment through multiple conversations and site visits, suggesting a high probability that they would be willing to commit to hosting a WESTCARB afforestation pilot project. For these landowners, site-specific afforestation planting and maintenance plans and cost estimates were incorporated into draft agreements provided to landowners for review and signing.

## 3.3 Baseline carbon stocks

Field crews composed of Winrock and Western Shasta RCD personnel implemented baseline carbon stock measurements on all WESTCARB afforestation pilots, prior to the removal of existing vegetation for site preparation. All of the sites which were cleared in summer/fall 2007 for spring 2008 planting were initially in various types of brush. Field crews visited each afforestation unit and established between five and eleven measurement plots at random distances and bearing from a starting point. Measurement plots were either of radius 2 m for very dense brush or 4 m for less dense brush. At each plot location, for each shrub originating within the plot radius, crews recorded number of stems, stem basal diameter, height, two crown diameters (N-S and E-W), and species.

A literature search revealed that no appropriate allometric equations exist to determine shrub biomass. It was concluded that conducting destructive sampling in the specific areas of the pilot project would yield the most accurate estimates of shrub carbon. In the field, individual shrubs

were randomly selected and the number of stems was counted and the basal diameter recorded for each stem, along with height, and canopy diameter in two directions. Approximate canopy volume was calculated using the volume formula for a cone and the height and average canopy diameter. The shrub was then cut at the base and the wet weight of the entire shrub was recorded. A representative subsample of each plant was bagged, weighed, and shipped to a laboratory for dry weight. Using the data gathered from this destructive sampling across a number of the pilot sites in Shasta County, regression equations for Manzanita shrubs and non Manzanita shrubs were developed using as predictors average basal area and canopy volume.

The regression equation for aboveground biomass of Manzanita ($r^2 = 0.91$, n=47) is:

$$y = 3.96 + 0.06(ABA) + 1.09(CV)$$

Where
Y = biomass in kilograms,
ABA = Average Basal Area, and
CV = Canopy Volume.

For non Manzanita shrubs – primarily Buckbrush, Whitethorn, and Deerbrush – the regression equation for aboveground biomass ($r^2$=0.65, n=53) is:

$$y = 5.52 + 0.60(CV)$$

Where
Y = biomass in kilograms, and
CV = Canopy Volume.

Because time constraints allowed relatively few measurement plots, the baseline carbon estimates have a high uncertainty. Based on the variability in the plots, in all cases additional measurement plots would have been required to attain a 90% confidence interval within 10% of the mean. While some projects may have required as few as 15 baseline plots, others would have required as many as 72, with most projects requiring more than 30. This number of plots would not have been cost-effective, or feasible without delaying site preparation, and this is likely to true of many shrublands. Based on the number of plots measured per site, the 90% confidence interval ranged from 14% of the mean to 26% of the mean. Because of this level of uncertainty, the upper bound of the 90% confidence interval was used as the estimate of baseline carbon stocks. This yields a conservative estimate of net carbon sequestration through afforestation, since it would tend to overestimate baseline carbon stocks.

## 3.4 Site preparation, planting, and early maintenance

The site-specific planting and maintenance plans for each WESTCARB afforestation pilot project included a series of steps spanning two years or more. Plans varied slightly by project, but in general involved:

- Purchase of seed from CAL FIRE or private inventories of Sierra Pacific Industries and W.M. Beaty & Associates, Inc. if CAL FIRE inventory did not include seed suitable for a particular zone, elevation, and species.
- Contract with nursery to stratify and sow seed and grow conifer seedlings.
- Mechanical site preparation to masticate or remove or reduce existing vegetation that would prevent establishment of trees due to physical access for planters as well as moisture, light or nutrient competition;
- Disposal of brush through pile-burning, or alternately grinding and removal to a biomass energy facility (see Section 3.5);
- Chemical site preparation either immediately before or immediately after planting;
- Lifting of seedlings at the nursery and cold storage until planting;
- Planting at 150 to 300 trees per acre;
- Where needed, installation of seedling protectors or netting;
- Where needed and feasible within the term of WESTCARB, post-planting follow-up chemical applications to control competing vegetation and promote seedling survival.

The 20-acre Eilers pilot involved afforestation with a mixture of conifer and oak species and the 7-acre BLM project involved strictly afforestation with oak species.

## 3.5 Biomass energy

Two different approaches to disposal of the existing brush were explored under the WESTCARB afforestation pilot projects:

1. Brush piling and burning. This is the conventional and often the only feasible approach for brush disposal in "brush-conversion" afforestation projects. In the context of a carbon sequestration project where the intent is to monitor and implicitly maximize GHG benefits, this approach basically emits immediately to the atmosphere all the carbon stocks of the baseline vegetation.

2. Grinding and removal to a biomass energy facility of the brush that is removed prior to planting. This alternative would still emit as $CO_2$ the carbon contained in the brush (simply at a different location, at the biomass plant rather than at the afforestation site), but would have a better overall GHG balance. Efficient and complete combustion at the biomass plant would likely release less non-$CO_2$ GHGs than pile-burning; and electricity generated from biomass would offset generation of electricity using fossil fuels reducing the net emission The choice of the baseload power alternative, and the assumed GHG intensity of that alternative, would affect the net GHG benefits of removing brush for biopower generation instead of the more conventional pile-burning.[5]

[5] For example, 1,100 pounds $CO_2e$ per megawatt-hour, for a relatively efficient combined cycle natural gas turbine plant, per the California Public Utilities Commission's Interim Greenhouse Gas Emissions Performance Standard (SB1368; see http://www.cpuc.ca.gov/static/energy/electric/climate+change/070411_ghgeph.htm); or a higher GHG

Under the afforestation pilot, both alternatives were explored. Grinding and removal for biomass energy production is unfortunately significantly more complex and costly than conventional pile-burning. The following represents the requirements for consideration of a site for biomass extraction:

A. There must be a sufficiently large project area, type and quantity (tons per acre) of brush to justify the move-in/out costs of additional equipment (excavator, tub grinder, chip van(s), and water truck).

B. The site must be close enough to a biomass energy facility to make removal cost-effective considering transport costs and the price of diesel fuel, and have suitable road access to and within the afforestation unit to allow chip vans and other equipment that may not be able to negotiate sharp turns or rough roads.

C. Because of additional temporary roads and landings required for the grinder and chip vans, the approach requires mitigation (post-grinding sub-soiling of temporary roads) and management of environmental impacts, which are easier if site topography is relatively flat.

D. Finally, the technique used for clearing, piling, and grinding must produce piles significantly freer of soil and debris than if the plan is pile-burning. Piles with a substantial amount of soil created through mechanical site preparation can be burned, effectively and in compliance with all necessary permits and air-quality regulations, but the same pile put into a grinder and transported to a biomass energy plant may cause problems for the life of the grinding equipment, combustion at the plant, or fugitive emissions at the plant. This problem can be partially mitigated by having a water truck (at added cost) to control fugitive emissions from roads and grinding at the project site, and from unloading at the biomass plant, but a pile with too much soil will still cause problems for fuel handling and combustion.

Because the approach is unconventional, unfortunately there are relatively few contractors with the equipment and expertise necessary to control all these variables, producing a clean afforestation site ready for planting, and clean fuel delivered to the plant, at reasonable cost. However, where possible the approach was considered in each of the pilot projects.

## 3.6 Planting data collection

### 3.5.1 Data on costs

Phase I economic analyses of afforestation relied on very general conversion cost estimates. These cost estimates were refined in Phase II by gathering information on real-world and site-specific estimates of conversion costs from each of the pilot projects (mechanical and chemical site preparation, brush disposal, seedling growing, planting, seedling protection, and post-planting early maintenance). Cost estimates for each of these steps in the process were prepared

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intensity if one assumes that megawatt-hours not available from biopower would have to be replaced by increased imports of coal-fired electricity.

by an RPF, including consulting California Forest Improvement Program (CFIP) cost guidelines for reforestation and estimating site-specific costs for each proposed site. These cost estimates were the basis for negotiating prices with the afforestation subcontractor. The final actual costs of implementing each project were used to develop a range of costs for afforestation projects in Shasta County.

### 3.5.2 Modeling carbon accumulation

Earlier Winrock analyses have suggested that afforestation with mixed conifer may be able to accumulate around 170 t C/ha (252 t $CO_2$/acre) over 40 years, while lower-elevation Shasta County rangelands suitable for afforestation primarily with oaks and foothill pine might produce carbon at 40 years in the range of 26-50 t C/ha (39-74 t $CO_2$/acre) (Brown et al 2007).

Clearly WESTCARB Phase II, lasting only through fall 2010, does not provide sufficient time for direct monitoring of carbon accumulation in the afforestation pilots. Only the initial success of the pilots, in terms of establishment and early survival, can be monitored directly. Therefore for each of the WESTCARB afforestation pilots, quantities of carbon accumulation into the future were projected using a growth model with data specific to that pilot site.

Growth of conifers and/or hardwoods on the pilot projects was modeled using the US Forest Service Forest Vegetation Simulator (FVS). FVS is an individual-tree, distance-independent growth and yield model (Dixon 2002). It has numerous geographic variants and allows the user to project growth using Jenkins equations (Jenkins *et al.,* 2003) or localized Forest Service equations. The Fire and Fuels Extensions (FFE) of FVS can be used to determine forest biomass and the tons of $CO_2$ sequestered in the forest over a project lifetime. Growth for each pilot project was modeled for a 100-year period, using the Inland California and Southern Cascades variant and Jenkins equations[6], and future carbon stores were determined using FFE.

### 3.5.3 Evaluation of early performance of afforestation pilots

WESTCARB Phase II allowed 2.5 years' monitoring (for afforestation projects planted in spring 2008) or 0.5 years (for spring 2010 plantings). For the 2008 plantings, this time frame made it possible to observe how projects fared over two winters and most of three growing seasons, including the ability to monitor the need for post-planting chemical weed control in 2009 and 2010. For the 2009 plantings, Phase II allowed observation of one winter and most of two growing seasons, while for the 2010 planting, only one growing season passed prior to project end. Based on information received from landowners and periodic assessment of the project areas, additional maintenance was conducted where funding was available. In the late summer of 2010, WM Beaty and Associates conducted surveys of survivorship on all of the pilot projects.

To extend the availability of monitoring data somewhat, WESTCARB landowner agreements request that all participating landowners complete annual surveys and photo documentation

[6] Specific carbon registries may have different requirements for which allometric biomass equations are allowed, but the Jenkins equations are commonly accepted as predictors of tree biomass (the Climate Action Reserve Protocols, v.3.2 do not allow the use of Jenkins equations, but the protocol version that was available at the initiation of these pilot projects (v.1.0) did allow their use).

for 10 years from the date of planting. These data will be compiled and archived at Western Shasta RCD, for analysis by WESTCARB partners or others pending availability of funding. The format of this annual survey is included in **Annex D**.

# 4.0 Details of Afforestation Pilots

## 4.1 Red River Forests Partnership

The Red River Forests Partnership WESTCARB Project is a 98-acre ponderosa pine afforestation project on lands owned by the Red River Forests Partnership and managed by WM Beaty & Associates, Inc. The site is at 3,880' elevation, east of Shingletown, Shasta County, California (T31N, R01E, Section 24) (**Figure 2**). The lands to be afforested were occupied by brush, mostly greenleaf manzanita with some *Prunus* (**Figure 3**). The site can support vigorous ponderosa pine growth provided brush, which competes aggressively for limited summer soil moisture and light, is controlled during establishment and early growth phase. Access is excellent via paved county road to unit (less than one mile from State Hwy 44). Soils at this site consist of Windy and McCarthy Stony Sandy Loam, depth 40-60"; well drained, moderate to high permeability. Site class is estimated III Dunning.


**Figure 2. Aerial photo of the 98-acre Red River Forests Partnership afforestation site, with blue outline**

Site preparation by mechanical clearing of brush was completed in July through September 2007 (**Figure 3**). In March-April 2008, ponderosa pine seedlings grown by Cal-Forest Nursery were planted at 300 trees per acre. In spring-summer 2009, the project was treated with a follow-up directed foliar release (weed control) spray by handcrews.

**Figure 3. Baseline conditions at Red River Forests Partnership site (top) and site preparation in August 2007.**

*Brush removal*

Two different approaches to disposal of the existing brush were explored at the Red River Forests Partnership project. In the original plan, brush was to be piled and burned in fall 2007. However, the Red River project met each of the criteria outlined in Section 3.5 for consideration of removal of brush for biomass energy generation.

The Red River Forests Partnership project represented a relatively large project, very heavy and decadent manzanita brush (1 or more chip van loads per acre), flat terrain, excellent access via paved roads directly to the unit, about 30 miles total distance to the Wheelabrator Shasta biomass energy plant, a land manager willing to experiment with the process as long as the site was left ready for planting and any temporary roads or landings mitigated, a grinding contractor willing to grind and transport brush piles to Wheelabrator for the price Wheelabrator would pay for the fuel, and most significantly, the willingness of afforestation contractor Total Forestry to take on the added cost and risk of piloting this procedure.

**Figure 4. Grinding and removal of brush from Red River Forests Partnership site to Wheelabrator Shasta biopower plant**

Grinding and removal was ultimately only partially successful at this site. Brush was piled in windrows for the grinding contractor to remove with a tub grinder pulled along the pile or the pile brought to the grinder. Fugitive emissions during this process were controlled by a water truck. The grinder was able to produce clean fuel from the top of these windrows, but the lower part of the windrows was found to have too much soil for successful grinding or for fuel acceptable to Wheelabrator. Grinding production rates suffered when water needed to control dust from roads was not available to control dust emissions from grinding of piles, leading to a lower production rate and less cost-effective operation for the grinding contractor. As a result some fuel was produced and delivered to Wheelabrator, but the remaining brush had to be pile-burned in the conventional manner to leave the site ready for planting.

This was a learning process for Total Forestry, Winrock, Wheelabrator and the land manager WM Beaty & Associates. Grinding and removal could still be considered for future afforestation projects where the criteria suggested above are met. The option of brush grinding and removal was considered on a case-by-case basis for the other pilot projects, and was implemented on one other project, but at such high cost that replication potential is questionable.

Even if only partially successful, the exercise at Red River Forests Partnership provided valuable information from a research perspective on technical feasibility, site conditions, costs, and approach. To the extent afforestation of brush fields, demonstrated through research funds under WESTCARB, is taken up by landowners as a carbon offset or climate mitigation

opportunity, it is important to demonstrate techniques and constraints on this activity. If afforestation for carbon becomes a significant opportunity adopted by a large number of landowners, this may promote additional investment in grinding and removal equipment by businesses developing expertise in these techniques, leading ultimately to improved results and lower costs.

*Survival Monitoring*

The project area was surveyed on August 30, 2010 with 50 1/100$^{th}$ acre plots. The survey found 328 ponderosa pine seedlings per acre. A possible reason for more trees per acre in 2010 than were planted in 2008 is likely that net acres are actually less than 98 acres due to small rocky areas, unburned brush piles and roads used for biomass operations that did not get planted but were not counted as plots when they were encountered in the survey.

*Costs*

The total cost of afforestation at this site was $81,532 or $832/acre. This cost includes mechanical site preparation ($503/acre); seedlings ($61/acre); planting costs ($101/ac); and post-treatment spraying ($167/ac).

The grinding and removal approach to brush disposal involved added costs, for a water truck and post-project removal (sub-soiling) of temporary roads and landings. This increased the combined cost of mechanical site preparation and brush disposal (pile burning / grinding and removal).

*Baseline carbon stocks*

Based on data from 8 measurement plots installed prior to clearing manzanita brush at the Red River Forests Partnership site, baseline carbon stocks in brush are estimated at a mean 42.6 t C/ha (63.3 t $CO_2$/ac) with a standard error of 3.8 t C/ha and a 90% confidence interval of 17% of the mean. The variability in this data indicates that 23 plots would be needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 51.5 t C/ha (31 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 300 ponderosa pine trees per acre planted in 2008, a 99% survival rate, and 30 ponderosa pine trees per acre naturally regenerated. Table 2 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 2. 100-year growth projections on Red River Forest Partnership 2008 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2018 | 328 | 0 | 5 | -16 | -59 | -5,739 |
| 2028 | 322 | 0 | 11 | -10 | -37 | -3,626 |
| 2038 | 316 | 2,434 | 26 | 5 | 18 | 1,734 |
| 2048 | 316 | 6,465 | 41 | 21 | 75 | 7,369 |
| 2058 | 278 | 11,344 | 55 | 34 | 126 | 12,366 |
| 2068 | 246 | 15,649 | 68 | 47 | 172 | 16,883 |
| 2078 | 218 | 18,624 | 77 | 56 | 205 | 20,092 |
| 2088 | 179 | 21,350 | 84 | 63 | 232 | 22,739 |
| 2098 | 149 | 23,769 | 90 | 69 | 253 | 24,759 |
| 2108 | 126 | 25,936 | 94 | 73 | 268 | 26,296 |

Grinding and removal of brush, in place of pile burning, would displace some fossil fuel emissions from electricity generation and produce a small added benefit. If this were successfully implemented on the project as a whole, brush of about 10 bone dry tons (BDT) per acre on 98 acres might yield 980 MWh of electricity at a biopower plant. Assuming this quantity of electricity would otherwise come from fossil fuel alternatives and assigning it a GHG intensity of 1,100 pounds $CO_2e$ per MWh, the project would deliver an additional 489 $tCO_2e$ from fossil fuel emissions displacement. This benefit would accrue in the initial year of site preparation and brush removal, whereas the much larger carbon sequestration benefits accrue over 40 years.

## 4.2 Brooks Walker Jr, et al

The Brooks Walker, Jr. et al WESTCARB project is a 7-acre mixed conifer afforestation project on lands owned by Brooks Walker, Jr. et al and related trustees, and managed by WM Beaty & Associates, Inc. The afforestation site, called the Table Mountain brushfield, is at 5,440' elevation in eastern Shasta County, California (T33N, R02E, Section 36 south ½) (**Figure 5**). The lands to be afforested are currently dominated by brush, mostly greenleaf manzanita with some snowbrush and Fremont silktassle. The site can support ponderosa pine, red fir and Douglas fir growth provided brush, which is competing aggressively for limited summer soil moisture and light, is controlled during establishment and early growth phase (**Figure 6**). Access is via seasonal dirt logging roads, ¼ mile from site. Soils at this site consist of Nanny Gravelly Sandy Loam & Windy & McCarthy very stony sandy loam. Site class is estimated III Dunning.


**Figure 5. Aerial photo of the 7-acre Brooks Walker afforestation project, with white outline**

Site preparation by mechanical clearing of brush began in September 2007. Brush disposal at this site was by conventional pile-burning, in fall 2007, as the site is too distant and access too difficult to permit consideration of removing brush to a biomass energy facility. In fall 2007, crews conducted an initial hand application of pre-emergent Velpar DF spray to keep brush, forb and grass seeds from germinating and competing with seedlings. In April-May 2008, ponderosa pine and red fir seedlings were planted at approximately 300 trees per acre. In spring-summer 2009, the project was treated with a follow-up directed foliar release (weed control) spray by handcrews.

*Survival Monitoring*

The Brooks Walker project was surveyed for survival on August 30, 2010 with 21 1/100$^{th}$ acre plots. The survey found 225 ponderosa pine trees per acre and 40 red fir trees per acre, for an 88% survival rate. In addition, there were 5 Jeffrey pine tree per acre, which had seeded in naturally.

*Costs*

The total cost of afforestation at this site was $8,854 or $1,265/acre. This cost includes site preparation, including slash disposal and spraying ($1,115/ac); seedlings ($71/ac); and planting ($79/ac). The project is relatively expensive compared to other WESTCARB afforestation pilots, due to the remote location and small project size. Unlike the larger projects, it provided an opportunity to test afforestation at relatively high (for Shasta County) elevation.

*Baseline carbon stocks*

Based on data from 5 measurement plots installed prior to site preparation at the Brooks Walker project site, baseline carbon stocks in brush are estimated at a mean 5.8 t C/ha (8.6 t $CO_2$/ac), with a standard error of 0.6 t C/ha and a 90% confidence interval of 23% of the mean. The variability in this data indicates that 27 plots would be needed to attain a 90% confidence

interval of 10% of the mean. The upper bounds of the 90% confidence interval is 7.4 t C/ha (3 t C/ac).

**Figure 6. Baseline conditions on the Brooks Walker project. Note heavy brush in foreground, timber in background, indicating growth potential.**

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 180 ponderosa pine (100% survival) and 120 red fir (33% survival) planted per acre in 2008, and 45 ponderosa pine and 5 Jeffrey pine trees per acre naturally regenerated. Table 3 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 3. 100-year growth projections on the Brooks Walker 2008 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2018 | 270 | 0 | 5 | 2 | 7 | 47 |
| 2028 | 264 | 0 | 9 | 6 | 22 | 154 |
| 2038 | 259 | 2,290 | 24 | 21 | 77 | 539 |
| 2048 | 251 | 6,088 | 40 | 37 | 136 | 950 |
| 2058 | 217 | 11,260 | 55 | 52 | 191 | 1,340 |
| 2068 | 197 | 15,888 | 68 | 65 | 238 | 1,663 |
| 2078 | 179 | 20,471 | 79 | 76 | 279 | 1,951 |
| 2088 | 151 | 23,540 | 89 | 86 | 315 | 2,208 |
| 2098 | 130 | 26,410 | 97 | 94 | 345 | 2,413 |
| 2108 | 114 | 29,013 | 103 | 100 | 367 | 2,567 |

## 4.3 Hendrix-Phillips Tree Farm

The Hendrix-Phillips Tree Farm WESTCARB project is a 20-acre ponderosa pine afforestation project on lands owned by the First Descendants of the Phillips Family Trust. The afforestation site is at 2,200′ elevation near Oak Run in Shasta County, California (T33N, R1W, Section 16 southwest ¼) (**Figure 7**). Current vegetation is scattered trees (black oak, grey pine & ponderosa pine), brush (primarily whiteleaf manzanita with some greenleaf manzanita, buckbrush, buckeye and poison oak), and some forbs and grasses. The area can support good ponderosa pine growth provided brush, which is competing aggressively for limited summer soil moisture and light, is controlled during establishment and early growth phase. Access is via seasonal dirt road into unit, a few miles from a paved county road. Soil types include Aiken Stony Loam: loam, deep (60″+) well drained, rocky; Aiken Loam: loam, deep well drained, not rocky; Cohasset Stony Loam: 48″-60″ deep, well drained; Supan very Stony Loam: 24-40″ deep, very stony. Site class is II to IV Dunning.

Site preparation by mechanical clearing of brush began in October 2007. Brush disposal by grinding and removal to a biomass energy facility was considered at this site, but ultimately not considered cost-effective due to quoted prices of $700-800/acre for mechanical site preparation and brush removal. Therefore brush disposal was by pile-burning in fall 2007. Prior to planting, crews broadcast by hand pre-emergent Velpar DF spray to keep brush, forb and grass seeds from germinating and competing with seedlings. In late February 2009, crews planted 6,000 containerized ponderosa pine seedlings, at 300 trees per acre, and installed mesh netting to protect seedlings. In spring 2009, crews sprayed re-sprouting poison oak that otherwise would have overtopped the conifer seedlings.

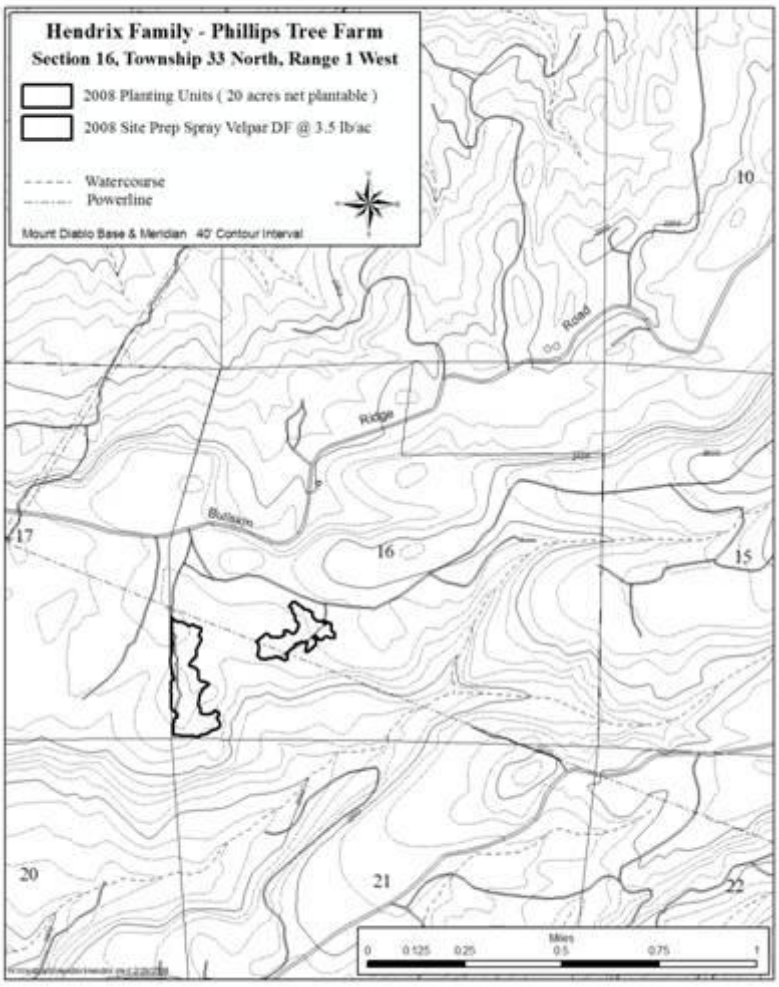


**Figure 7. Map of the 20-acre Hendrix-Phillips Tree Farm WESTCARB afforestation pilot project**

*Perpetual conservation easement*

One of the unique features of this WESTCARB afforestation pilot is that the landowner has for some time managed the entire ownership (approximately 1,000 acres, including the 20-acre afforestation site) under a perpetual conservation easement managed by the Pacific Forest Trust. Unlike many private landowners for whom the Climate Action Reserve's (California Climate Action Registry's) previous forest protocol requirement of a perpetual easement presented a significant barrier to participation, the Phillips Family Trust had the ability to proceed through the entire process of entity- and project-level reporting to the Registry, third-party certification, and even selling carbon "credits" produced by their afforestation activity to a willing buyer. The 20 acre brushfield, which is now a plantation/forest, was included in a CAR Conservation Forestry Project (called Improved Forest Management or IFM by the current protocols). Cost for registering and certifying just the 20 acres for an afforestation project would have cost more than revenue generated, so they likely would not have proceeded with a

reforestation project on that 20 acres alone even though they met the conservation easement requirement.

*Survival Monitoring*

On August 12, 2010, twenty 1/100th acre plots were sampled with the following results: 280 ponderosa pine trees per acre are very well distributed throughout the project area (Survival after two years = 90%). All of 20 plots were stocked with at least one ponderosa pine. Most of the mortality occurred in the first growing season (summer of 2009) and most of the surviving trees are very healthy and vigorous (e.g. good stem caliper, buds and needle color and length for two year old seedlings). The high survival rate occurred despite precipitation levels at 14% of normal during the first year of seedling establishment. Scattered throughout the entire project area are one and two year old ponderosa pines that seeded in as a result of the project activities (clearing and competing vegetation control). In the eastern unit one & two year-old gray pine seedlings also seeded in (~150 trees per acre) as a result of project activities. Most of the project area is also occupied by grasses, forbs and 6 month old whiteleaf manzanita that germinated in 2010. Some poison oak has re-sprouted and is scattered throughout the project area. There a few small areas that have been invaded by yellowstar thistle.

*Suggested potential future activities*

To prevent the growth of brushy fuel loads and to maintain conifer vigor and health, a directed foliar spray application on the seedling whiteleaf manzanita should be conducted in the spring of 2011 or spring of 2012, prior to conifer bud elongation. Manzanita can be controlled with 2% LV4 (ester formulation of 2,4D) or with 5% glyphosate product (e.g. Razor) plus 3% to 5% methylated seed oil surfactant. In conjunction with this treatment yellowstar thistle could be treated with a low rate of Transline in the mix (¼%). In the summer of 2011 or 2012 re-sprouting poison oak should be treated with 3% to 5% glyphosate product plus 1% surfactant. During any of these treatments spray contact on the ponderosa pine seedlings must be avoided. In approximately 6 to 8 years (2016-2018) a pre-commercial thinning treatment will likely be needed to reduce stocking levels to approximately 170 trees per acre, leaving the most vigorous ponderosa pine at 16 foot by 16 foot spacing. Please note that these are suggested possible future treatments, and it is necessary to obtain a specific recommendation for spraying from a licensed Pest Control Advisor prior to any treatment. Also to prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total cost of afforestation at this site was $24,453 or $1,223/acre. This cost includes site preparation including brush disposal ($560/ac); seedlings ($60/ac); planting costs including first follow-up chemical application (385/ac); and additional follow-up spraying ($218/ac). The project is relatively expensive compared to other WESTCARB afforestation pilots, due to the location and relatively small size.

Pursuing brush grinding and removal on this project would have increased the cost of mechanical site preparation and brush disposal by at least $235/acre, and increased the total project cost to $30,158.

*Baseline carbon stocks*

Based on data from 10 measurement plots installed prior to site preparation at the Hendrix-Phillips project site, baseline carbon stocks in brush are estimated at a mean 49.4 t C/ha (73.3 t $CO_2$/ac), with standard error of 4.5 t C/ha and a 90% confidence interval of 17% of the mean. The variability in this data indicates that 28 plots would have been needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 59.4 t C/ha (24 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 300 ponderosa pine planted per acre in 2008, and a 93% survival rate. Table 4 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 4. 100-year growth projections on the Hendrix Phillips Tree Farm 2008 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2018 | 279 | 0 | 5 | -19 | -70 | -1,408 |
| 2028 | 274 | 0 | 10 | -14 | -51 | -1,029 |
| 2038 | 269 | 2,452 | 24 | 0 | 0 | -2 |
| 2048 | 250 | 6,310 | 39 | 15 | 55 | 1,098 |
| 2058 | 220 | 10,883 | 52 | 28 | 103 | 2,051 |
| 2068 | 201 | 14,998 | 64 | 40 | 147 | 2,931 |
| 2078 | 176 | 18,618 | 73 | 49 | 180 | 3,591 |
| 2088 | 146 | 21,607 | 81 | 57 | 209 | 4,178 |
| 2098 | 126 | 23,525 | 87 | 63 | 231 | 4,618 |
| 2108 | 110 | 25,814 | 91 | 67 | 246 | 4,911 |

## 4.4 Goose Valley Ranch

The Goose Valley Ranch WESTCARB project is a 60-acre mixed conifer afforestation project on lands owned by the Denny Land & Cattle Company – Goose Valley Ranch, LLC. The afforestation site is at 3,680' to 3,900' elevation, north and west of Lake Margaret, approximately 5 miles west of Burney, Shasta County, California (T35N R2E Section 8 - NE½ of NE¼; NE¼ of NW¼; SE¼ of NW¼; NE¼ of SW¼) (**Figure 8**).

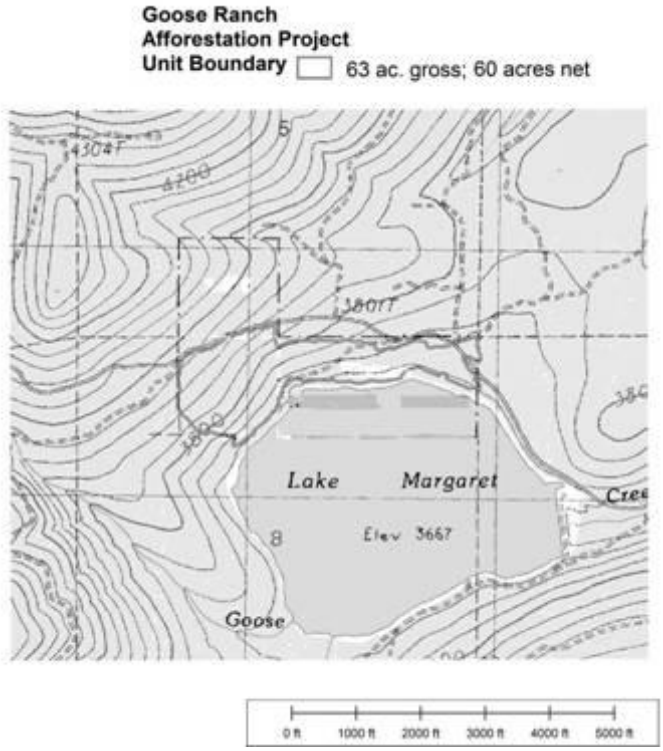


**Figure 8. Map of the 60-acre Goose Valley Ranch afforestation project**

The site was dominated by thick brush, primarily *Ceanothus cordulatus* (whitethorn), approximately 5' high, 15+ years old, with some bracken fern, manzanita, squaw carpet, gooseberry, and some grasses and forbs (**Figure 9**). There was an estimated 2-10% cover of scattered black oak and willow trees. Soils include Depner Gravelly Sandy Loam (on approximately 30 acres) and Wyntoon Sandy Loam (on approximately 30 acres in N½ of NE¼). Site class is Dunning site II / CACTOS site index 74. Afforestation in ponderosa pine, Douglas fir and incense cedar should be successful, considering the soils, site class and performance of these species on adjacent parcels, provided that brush that is competing aggressively for limited summer soil moisture and light is controlled during the establishment and early growth phase.

**Figure 9. Baseline conditions at Goose Valley Ranch site (left) and ponderosa pine and incense cedar 30 months after planting and control of competing vegetation (right)**

Site preparation by mechanical clearing of brush began in October 2007. Brush disposal by grinding and removal to a biomass energy facility was considered at this site, but ultimately not pursued, due to a combination of cost (quoted prices of over $650/acre for mechanical site preparation and brush removal) and potential ground impacts on slopes near Lake Margaret. Therefore brush disposal was by pile-burning. In March 2008, the 60-acre site was planted at 290 trees per acre with 13,000 ponderosa pine, 2,200 Douglas fir, and 2,200 incense cedar seedlings grown at the Cal-Forest Nursery. Planting was followed in spring 2008 by a directed foliar spray application by hand crews to control competing vegetation and allow seedlings to become established. Following the planting, the project area was sprayed with Round-Up, based on the landowner's desire to avoid use of a heavier herbicide. However, there was significant return of understory brush vegetation, which required application of stronger herbicides in the summer of 2009 in order to ensure survival of the tree seedlings.

*Afforestation on past fire sites*

One of the unique features of the Goose Valley Ranch pilot is the opportunity to conduct afforestation on sites that have burned in past wildfires and returned to persistent brush rather than forest. This is known as the "brush-and-burn" cycle in Shasta County; unless salvage logging and reforestation is conducted immediately after a severe fire, as is often done by the forest industry, burned lands tend to be occupied by brush, which excludes the natural regeneration of conifers. Once established, the brush vegetation state endures for many years or decades, and/or because brush also poses a very high fire risk, may burn again before conifers are able to re-colonize the site and eventually grow through and out-compete the brush. The same phenomenon was noted in earlier Winrock analyses, where areas classified as rangeland but surrounded by classified forest land were shown to match precisely with past fire perimeters (Brown et al 2007). These lands are likely misclassified as rangelands, since they are not suitable for any sort of grazing, and may instead represent the sort of arrested succession to forest implied in the "brush-and-burn" cycle. Winrock analyses identified these lands as a special sort of afforestation opportunity, where opportunity costs to landowners might be low

or zero (no foregone forage production), but assumed high conversion costs might more than overwhelm this advantage.

Several WESTCARB afforestation pilots present an opportunity to afforest such lands. In the case of Goose Valley Ranch, the project site is a brushfield burned in the 1992 Fountain Fire. Immediately adjacent lands owned by Sierra Pacific Industries were reforested following the fire, but smaller private landowners generally lack the resources for reforestation. The neighboring SPI lands however illustrate what afforestation on this site (similar conditions and soils) could produce over 15 years (**Figure 10**).

**Figure 10. Sierra Pacific Industries lands neighboring the Goose Valley Ranch site, illustrating potential conifer growth on these lands over 10-15 years.**

A potential added GHG benefit is that WESTCARB/landowner-funded actions to convert brush back to forest will have the effect of reducing fuel loads and thus future fire danger at this location. Thus afforestation poses the possibility of interrupting the brush-and-burn cycle, with the direct GHG benefit of the carbon sequestered in conifers net of baseline carbon stocks in brush, and the added indirect GHG benefit of possibly reducing emissions from future fires. This is an important co-benefit and one that has received little attention; WESTCARB efforts to create a methodology for quantifying reduced GHG emissions from wildfires have primarily focused on fuel reduction/biomass energy activities that involve thinning of understory fuels in forest lands rather than conversion of brush to forest.

*Survival Monitoring*

On August 24, 2010, sixty four 1/100th acre plots were sampled with the following results: 242 trees per acre including 211 ponderosa pine + 17 Douglas fir + 14 incense cedar per acre (survival after two years ~ 100% PP, 39% DF & 37% IC). Almost all of the mortality occurred in the first growing season (summer of 2009) and most of the surviving trees are healthy and vigorous (e.g. good stem caliper, buds and needle color and length). Conifer seedlings are well distributed throughout the project area. Stocking on ~ 8 acres in the most eastern portion of the project area is less than the remainder of the project, but still adequate. Control of competing vegetation is generally good, but there are enough whitethorn re-sprouts and some bearclover to warrant monitoring for possible treatment in a few years. There are many residual large conifers and black oaks scattered throughout the project area.

*Suggested potential future activities*

To minimize future hazardous brushy fuel loads and to maintain conifer vigor and health, brush density and growth should be monitored and treated if needed within the next few years. In 5 or 6 years (~2016) a pre-commercial thinning treatment will likely be needed on all but the eastern most 8 acres to reduce stocking levels to approximately 170 trees per acre, leaving the conifers at 16 foot by 16 foot spacing. Prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total cost of afforestation at this site was $61,958 or $1,033/acre. This cost includes site preparation including brush disposal ($438/ac); seedlings ($61/ac); planting costs ($106/ac); and follow-up spray ($428/ac).

Pursuing brush grinding and removal on this project would have increased the cost of mechanical site preparation and brush disposal by least $260/acre, and increased the total project cost to $78,163.

*Baseline carbon stocks*

Based on data from 10 measurement plots installed prior to site preparation at the Goose Valley Ranch project site, baseline carbon stocks in brush are estimated at a mean 41.7 t C/ha (61.8 t $CO_2$/ac) with a standard error of 3.3 t C/ha and a 90% confidence interval of 15% of the mean. The variability in this data indicates that 21 plots would be needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 49.1 t C/ha (20 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count completed in August 2010, with 208 ponderosa pine (100% survival), 43 Douglas fir (39% survival), and 39 incense cedar (37% survival) planted per acre in 2008, and 2 ponderosa pine trees per acre naturally regenerated. Table 5 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 5. 100-year growth projections on the Goose Valley Ranch 2008 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2018 | 241 | 0 | 5 | -15 | -55 | -3,307 |
| 2028 | 236 | 0 | 11 | -9 | -32 | -1,949 |
| 2038 | 231 | 2,821 | 25 | 5 | 19 | 1,131 |
| 2048 | 220 | 6,652 | 42 | 22 | 81 | 4,871 |
| 2058 | 190 | 12,378 | 57 | 37 | 136 | 8,171 |
| 2068 | 171 | 17,002 | 71 | 51 | 188 | 11,251 |
| 2078 | 143 | 21,122 | 81 | 61 | 224 | 13,451 |
| 2088 | 119 | 24,063 | 89 | 69 | 254 | 15,211 |
| 2098 | 102 | 26,290 | 95 | 75 | 276 | 16,531 |
| 2108 | 90 | 29,285 | 100 | 80 | 294 | 17,631 |

## 4.5 Lammers Properties

The Robert Lammers WESTCARB project is a 50-acre mixed conifer afforestation project on lands owned by Robert Lammers. The afforestation site is at approximately 3,900' elevation, south of Highway 299E and west of Burney, Shasta County, California (T35N R1E, S ½ of NE ¼ of Section 34) (**Figure 11**).

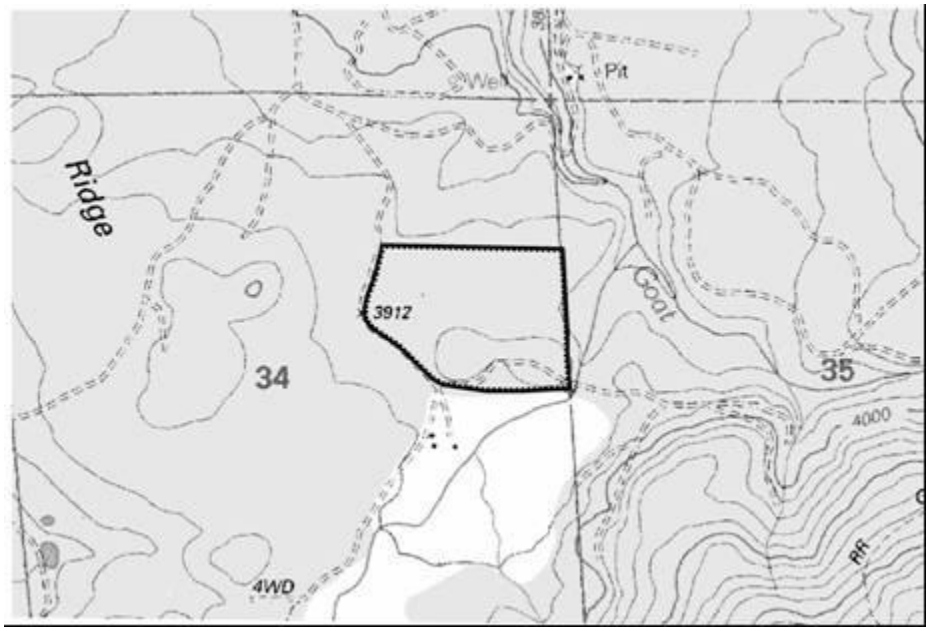


**Figure 11. Map of the 50-acre Lammers afforestation project**

Prior to the 1992 Fountain Fire the vegetation at this site was Sierra Mixed Conifer forest. After the 1992 Fountain Fire, mixed conifer forest was replaced by brush, mostly greenleaf manzanita

(*Arctostaphylos patula*) with very minor amounts of whitethorn (*Ceanothus cordulatus*) and deerbrush (*Ceanothus integerrimus*), and less than 5% cover of re-sprouted black oak trees (*Quercus kelloggii*) interspersed in the brush, primarily in the southern portion of the project area. Soils are Windy & McCarthy stony sandy loams; well drained; moderately deep (48" to 52" depth to bedrock); rapid permeability; slightly to moderately acid. Site Class is estimated Dunning III. Afforestation in a mix of ponderosa pine and Douglas fir would be well suited to these soils and site conditions. This is a suitable site for "High" NSTIA ponderosa pine orchard seed which should provide at least 10% or greater volume growth than seed collected in the wild from unknown pollen sources.

Site preparation by mechanical clearing of brush was conducted in summer 2008. Brush disposal was accomplished by grinding and removal to a biomass energy facility; Burney Mountain Power received the brush for biomass energy feedstock. However, though haul distance, good road access and flat topography are all conducive to brush grinding and removal, the costs of removing brush for biomass from this project turned out to be prohibitive on a commercial scale (see additional cost details below). In late fall 2008, crews sprayed 3 lbs. Velpar DF per acre to control competing vegetation prior to planting. In March 2009, the 50-acre site was planted at 249 trees per acre with 8,180 one-year old containerized ponderosa pine seedlings and 4,275 one-year old containerized Douglas fir seedlings.

*Afforestation on past fire sites*

The comments above for Goose Valley Ranch also apply to the Lammers property, which is located in the middle of the 1992 Fountain Fire. The Lammers property was not reforested, and therefore returned to brush after this fire, but is surrounded by industry (Roseburg Resources) lands that were immediately salvaged and reforested. The Roseburg lands provide a clear illustration both of the suitability of this site to support afforestation in pine or mixed conifers, and potential growth of such trees over the next 15 years (**Figure 12**). As described above, returning this brushfield to mixed conifer forest is likely also to reduce future risk of fire and associated GHG emissions.

**Figure 12. Baseline conditions at Lammers WESTCARB afforestation pilot site. Note the brushfield to be afforested on the right, compared to similar lands on the left owned by Roseburg Resources and forested in the years following the 1992 Fountain Fire.**

*Survival monitoring*

On August 12, 2010, fifty 1/100$^{th}$ acre plots were sampled with the following results: 159 ponderosa pine + 14.3 Douglas fir trees per net acre are very well distributed throughout the project area (Survival after two years ~ 97% for PP & 17% for DF; **Figure 13**). The poor survival of the Douglas fir is likely due to the sandy soil type (Windy-McArthy), which is deep but has very low available water holding capacity, in combination with the relatively dry spring & summer of 2009. Although initial survival and establishment of planted Douglas fir seedlings on this soil type and dry summer climate is difficult, those that did survive are now well established and should grow well on this site. Almost all of the mortality for both species occurred in the first growing season (summer of 2009) and most of the surviving trees are healthy and vigorous (e.g. good stem caliper, buds and needle color and length for two year old seedlings). Portions of the project area are occupied with re-sprouting whitethorn, Prunus spp. and black oaks. Throughout most of the project area, 4 month old greenleaf manzanita seedlings seeded in during 2010 but appear to be suffering the effects of residual Velpar DF uptake. In late August 2010 the landowner contracted with a licensed Pest Control Operator to treat the resprouting whitethorn, Prunus spp. and black oaks that would otherwise have severely impacted the health and vigor of the young conifer seedlings.

**Figure 13. Douglas fir and ponderosa pine seedlings 18 months after planting on the Lammers project**

*Suggested potential future activities*

In order to minimize the growth of brushy hazardous fuels and to maintain conifer vigor and health, the landowner should monitor the greenleaf manzanita seedlings over the next few years and treat if needed. This treatment would likely involve a directed foliar application in the spring of 2012, prior to conifer bud elongation, using 2% LV4 (ester formulation of 2,4D) or 5% glyphosate product (e.g. Razor) plus 3% to 5% methylated seed oil surfactant. The treatment should avoid spray contact on the conifer seedlings. Current stocking of 173 trees per acre is the ideal stocking level for post pre-commercial thinning stocking level at plantation age 7 to 10 after pre-commercial thinning typically occurs. Since most mortality occurs within 2 years after planting no further planting or pre-commercial thinning treatments should be needed, provided that the manzanita brush is controlled for the next few years. Unless an unusual and significant die off of the ponderosa pine occurs in the next few years interplanting is not necessary and unless natural seeding of conifers significantly increases the number of conifer trees per acre in the next few years a pre-commercial thinning treatment is not likely to be needed. Please note that these are suggested possible future treatments, and it is necessary to obtain a specific recommendation for spraying from a licensed Pest Control Advisor prior to any treatment. Also to prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total price of afforestation at this site was $42,885 or $857/acre. This includes site preparation ($687/ac); seedlings ($67/ac); and planting costs ($104/ac). However, the contractor who completed the chipping and removal of brush to a biomass facility significantly underbid the job and found that it was a far more costly process than anticipated. The full cost for chipping and removal, after subtracting income from the sale of chips, was $1,565.50. This increased the actual costs of the project to $87,675 ($1,753.50/ac).

*Baseline carbon stocks*

Based on data from 7 measurement plots installed prior to site preparation at the Lammers project site, baseline carbon stocks in brush are estimated at a mean 29.8 t C/ha (44.3 t $CO_2$/ac) with a standard error of 3.4 t C/ha and a 90% confidence interval of 22% of the mean. The variability in this data indicates that 34 plots would be needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 37.9 t C/ha (15 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 164 ponderosa pine (97% survival) and 86 Douglas fir (16% survival) planted per acre in 2009. Table 6 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 6. 100-year growth projections on the Lammers 2009 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2019 | 173 | 0 | 4 | -11 | -42 | -2,079 |
| 2029 | 169 | 0 | 7 | -8 | -31 | -1,529 |
| 2039 | 166 | 1,634 | 17 | 2 | 6 | 304 |
| 2049 | 163 | 4,402 | 29 | 14 | 50 | 2,504 |
| 2059 | 159 | 9,303 | 42 | 27 | 98 | 4,888 |
| 2069 | 147 | 13,343 | 54 | 39 | 142 | 7,088 |
| 2079 | 134 | 17,804 | 65 | 50 | 182 | 9,104 |
| 2089 | 124 | 22,167 | 75 | 60 | 219 | 10,938 |
| 2099 | 115 | 25,567 | 83 | 68 | 248 | 12,404 |
| 2109 | 102 | 28,321 | 89 | 74 | 270 | 13,504 |

## 4.6 Frase property

This 43-acre ponderosa pine afforestation project is located at T33N R5W Section 29 (S½), northwest of Redding at low elevation (800') and with site conditions distinct from any other WESTCARB afforestation pilot (**Figure 14**). Soils in the area, according to NRCS mapping, are "Goulding very rocky loam, 30 to 50 percent slopes, eroded" which is described as a shallow (16" to 20") soil. Seed zone is 521 (southwest portion of zone). Site class is Dunning IV on slopes and low III on flatter areas. Mechanical site preparation, through mastication of previously existing heavy manzanita brush, had already been conducted by the landowner. Current vegetation is small manzanita seedlings, toyon, coffee berry, poison oak, blackberry, and scattered black and live oak and ponderosa pine, gray pine and knobcone pine from seedling size to 80' tall. Site preparation was done in fall 2008 and involved only chemical treatment to control competing vegetation (since mechanical site preparation by mastication had been done

by the landowner prior to this pilot project). In February 2009, 12,140 ponderosa pine seedlings were planted at 282 trees per acre.

The unique feature of this pilot is a site typical of tens of thousands of acres below 2,000' elevation where fumes from copper smelting circa 1910 killed all the vegetation from Kennett south to Red Bluff, along the west side of the Sacramento River. Prior to the ponderosa pine die-off from smelting, some of the forest in this general area was probably harvested in the very late 1800s and/or very early 1900's for fuel and mine timbers. Most of the ponderosa pine that has regenerated in the vicinity of the project area was planted by the Civilian Conservation Corps in the 1930s. Survival was spotty but where seedlings survived the trees have grown fairly tall, even on steep slopes that were heavily impacted by gully erosion. Most of the area, however, is occupied by decadent brush that periodically burns. Soil erosion subsequent to the smelting-caused vegetation die-off has likely degraded site productivity, more so on the steeper slopes in the general vicinity. As there are still several thousand acres of this former ponderosa pine habitat now occupied mostly by brush, this project made an excellent afforestation pilot project for potential replication throughout the area.

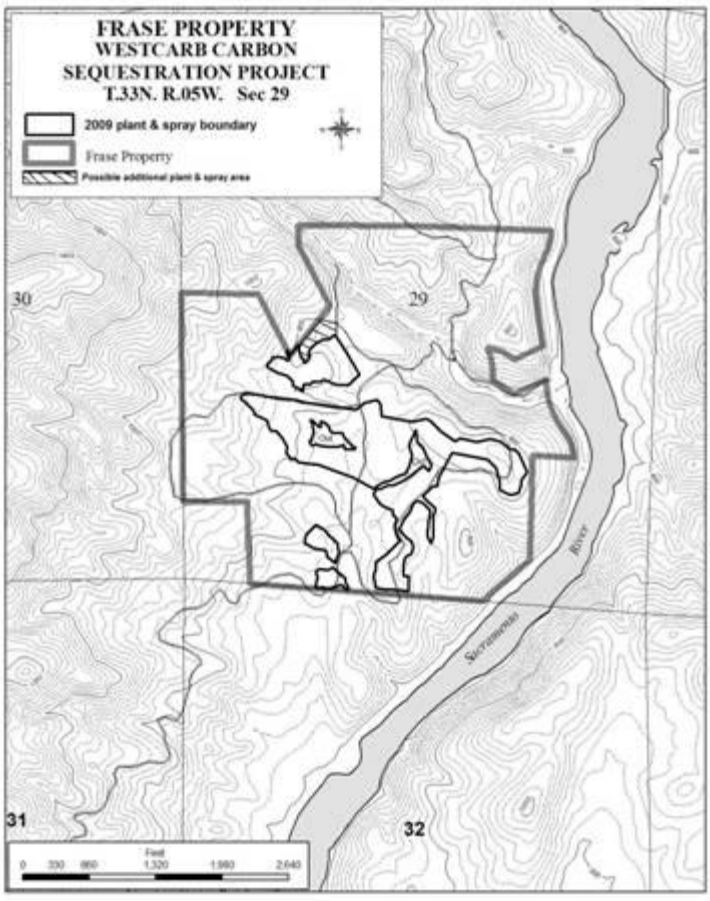


**Figure 14. Map of the 43-acre Frase afforestation project**

*Survival monitoring*

On August 25, 2010, fifty-one 1/100th acre plots were sampled with the following results: 263 ponderosa pine trees per acre are very well distributed throughout the project area (Survival after two years = 263/282 = 93%, Figure 15). Only one of the 51 plots was not stocked with at least one ponderosa pine and this plot was within an un-sprayed watercourse buffer where grasses and forbs outcompeted first year conifer seedlings for soil moisture in the summer of 2009. Most of the mortality occurred in the first growing season (summer of 2009) and it occurred in the spray buffer areas near watercourses where grasses and forbs were not treated. The ponderosa pine seedlings that did survive in those untreated buffers are mostly of poor vigor and would benefit from a release treatment. However most of the project area is comprised of ponderosa pine seedlings that exhibit very good vigor (e.g. good stem caliper, buds and needle color and length for two year old seedlings). The tree size and dark green needle color of many seedlings growing in the portion of the project area that was burned by the 2008 Motion Fire indicate that the release of nitrogen by the burning of the dead masticated brush more than outweighed any possible negative effects of the loss of "mulch" on the shallow eroded soils. There is also a significant number of two year-old knobcone or gray pine trees per acre that seeded in, mostly in the northwest portion of the project area where the 2008 Motion Fire released seed from serotinus pine cones. Most of the project area is also occupied by 6 month old whiteleaf manzanita seedlings, forbs and grasses that seeded in during 2010 and were prevalent on many plots. Some coffeeberry, Yerba Santa, poison oak, live oak and blackberry patches have re-sprouted and are scattered throughout the project area.

**Figure 15. Ponderosa pine seedlings 18 months after planting on Frase project. Manzanita brush left outside of project area in the background.**

*Suggested potential future activities*

In February or March of 2011 grass and forbs within a 5 foot radius of ponderosa pine seedlings should be treated with a directed foliar spray of a generic glyphosate product and surfactant. This should be the final grass and forb treatment needed because once ponderosa pine seedlings are well established (e.g. "free to grow" for 3 years) they should be vigorous and deeply rooted enough to survive and grow well with grass and forb competition. However aggressive brush competition should be controlled for a few more years. In order to prevent the growth of brushy fuel loads and to maintain conifer vigor and health, a directed spray application on the seedling whiteleaf manzanita germinates is likely to be needed in 2011 or 2012. Sometime around 2016 a pre-commercial thinning treatment is likely to be needed to reduce stocking levels to approximately 170 trees per acre, leaving mostly the most vigorous ponderosa pine at 16 foot by 16 foot spacing. Prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total cost of afforestation at this site was $25,812 or $600/acre. This cost includes chemical site preparation ($261/ac); seedlings ($46/ac); planting costs ($175/ac); and follow-up spray ($118/ac).

Total operational costs were relatively low because brush removal had been completed prior to the pilot project, reducing the costs of mechanical site preparation.

*Baseline carbon stocks*

Because the landowner had cleared the project area prior to inception of this pilot project, for the purposes of reducing fire risk, there was no existing vegetation and the baseline carbon stocks are considered to be zero.

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 282 ponderosa pine (93% survival) planted per acre in 2009. Table 7 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 7. 100-year growth projections on the Frase 2009 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|
| 2019 | 262 | 0 | 5 | 18 | 788 |
| 2029 | 257 | 0 | 8 | 29 | 1,261 |
| 2039 | 252 | 1,315 | 20 | 73 | 3,153 |
| 2049 | 248 | 4,900 | 33 | 121 | 5,203 |
| 2059 | 222 | 7,506 | 44 | 161 | 6,937 |
| 2069 | 201 | 11,200 | 55 | 202 | 8,672 |
| 2079 | 186 | 14,338 | 65 | 238 | 10,248 |
| 2089 | 166 | 16,437 | 73 | 268 | 11,510 |
| 2099 | 143 | 18,354 | 79 | 290 | 12,456 |
| 2109 | 124 | 20,514 | 85 | 312 | 13,402 |

## 4.7 Kloeppel property

This 51-acre ponderosa pine afforestation project is located at T35N R1W Section 25 (NE¼), at 2,900' to 3,160' elevation, on Highway 299E west of Burney, Shasta County, California (**Figure 16**). Like Lammers and Goose Valley Ranch, the proposed afforestation site is in the area burned by the 1992 Fountain Fire, where industry planting on nearby lands indicates strong growth potential along with the potential to achieve carbon storage, improved habitat, and fire risk reduction by returning the brushfield to forest. The proposed site is currently dominated (95% cover) by brush, with 90% consisting of 6-10' tall deerbrush (*Ceanothus integerrimus*), and in more open areas deerbrush, chinkapin, manzanita, poison oak, dogwood, bracken fern, squaw carpet, and some forbs and grasses. There is an estimated 5 to 10% cover in trees consisting mostly of scattered black oak and a few big-leaf maple. Prior to the Fountain Fire, the area was a mixed conifer forest of primarily ponderosa pine and Douglas fir and some black oak in the understory. Soil is Cohasset Stony Loam, site class Dunning site II or better. Mechanical site preparation and brush disposal by pile burning took place in summer 2008. The area was planted in March 2009 with 16,010 one year-old containerized seedlings (11,920 ponderosa pine & 4,090 Douglas fir), 314 trees per acre.


**Figure 16. Map of the 51-acre Kloeppel afforestation project**

*Survival monitoring*

On August 24, 2010, fifty 1/100th acre plots were sampled with the following results: 262 trees per acre including 222 ponderosa pine + 40 Douglas fir trees per net acre (survival after two years ~ 95% for PP & 50% for DF) are very well distributed throughout the project area (**Figure 17**). Almost all of the mortality occurred in the first growing season (summer of 2009) and most of the surviving trees are healthy and vigorous (e.g. good stem caliper, buds and needle color and length for two year old seedlings). Six month old deerbrush seedlings which germinated in 2010 are prevalent along with lesser amounts of manzanita germinates. If this young brush is not treated within a few years it will grow rapidly to cover most of the project area and overtop the conifers, competing aggressively for light and soil moisture. Also if not treated it would grow into a hazardous fuel load. Portions of the project area are also occupied with noxious non-native weeds specifically Scotch broom, yellow star thistle and Himalayan blackberries along with native re-sprouting poison oak, bracken fern, Prunus spp. and black oaks. Grasses and forbs are seeding into the project area but should not cause a problem to conifers that are now well established. After WESTCARB II operational funding expired, the landowner has done an excellent job of treating blackberries and other brush on the limited number of acres he can operationally treat by himself.

**Figure 17. Beaty forester conducting 2nd year stocking survey on Kloeppel project**

*Suggested potential future activities*

To minimize future hazardous brushy fuels and to maintain conifer vigor and health, a directed foliar application on brush seedlings should be conducted in 2011. Also treatments should be made on the noxious weeds and re-sprouting native brush. These treatments should avoid spray contact on the conifer seedlings. In 5 or 6 years (~2016) a pre-commercial thinning treatment might be needed to reduce stocking levels to approximately 170 trees per acre, leaving the conifers at 16 foot by 16 foot spacing. Prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total cost of afforestation at this site was $45,870 or $899/acre. This cost includes site preparation including brush disposal ($517/ac); seedlings ($65/ac); planting costs ($187/ac); and follow-up spray ($130/ac). An additional $1,745 was spent after the planting to install erosion control measures.

*Baseline carbon stocks*

Based on data from 9 measurement plots installed prior to site preparation at the Kloeppel project site, baseline carbon stocks in brush are estimated at a mean 19.2 t C/ha (28.6 t $CO_2$/ac) with a standard error of 2.5 t C/ha and a 90% confidence interval of 24% of the mean. The variability in this data indicates that 51 plots would be needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 24.8 t C/ha (10 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 234 ponderosa pine (95% survival) and 80 Douglas fir (50% survival) planted per acre in 2009. Table 8 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 8. 100-year growth projections on the Kloeppel 2009 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2019 | 262 | 0 | 5 | -5 | -18 | -941 |
| 2029 | 257 | 67 | 12 | 2 | 7 | 368 |
| 2039 | 252 | 4,282 | 30 | 20 | 73 | 3,734 |
| 2049 | 222 | 10,823 | 48 | 38 | 139 | 7,100 |
| 2059 | 194 | 18,998 | 65 | 55 | 202 | 10,279 |
| 2069 | 168 | 25,670 | 78 | 68 | 249 | 12,710 |
| 2079 | 138 | 29,969 | 89 | 79 | 290 | 14,767 |
| 2089 | 116 | 34,049 | 97 | 87 | 319 | 16,263 |
| 2099 | 100 | 37,389 | 103 | 93 | 341 | 17,385 |
| 2109 | 87 | 41,566 | 108 | 98 | 359 | 18,320 |

## 4.8 Sivadas property

This 46-acre ponderosa pine afforestation project is located at T33N R2W Section 9, at 1,700′ to 1,780′ elevation (**Figure 18**). All-season access is good via paved and gravel roads. According to USDA NRCS Shasta County Area Survey, soils at the site are Supan very stony loam, 0 to 30%; parent material is residuum weathered from tuff breccia; well drained, depth to lithic bedrock is 33 to 37″, available water capacity is low 0 to 10″ depth ranging from 0.9 to 1.4 inches and at 10 to 33″ depth ranging from 3.0 to 7.8 inches. Baseline vegetation is dense, tall brush (> 80% cover) consisting primarily of greenleaf and whiteleaf manzanita with some poison oak, whitethorn (*Ceanothus cordulatus*) and deerbrush (*Ceanothus integerrimus*).

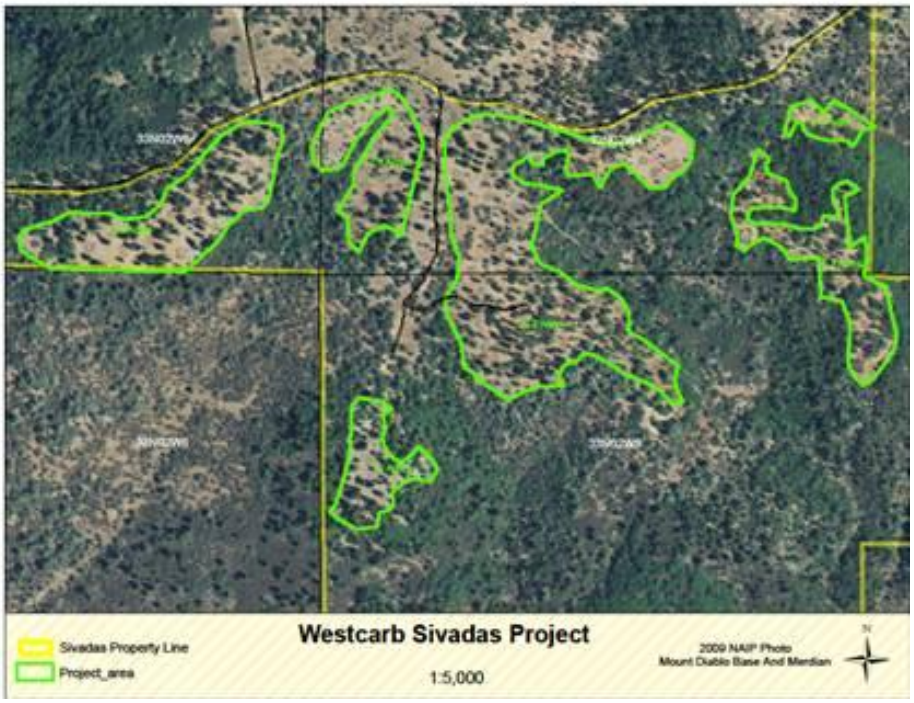


**Figure 18. Map of 46-acre Sivadas afforestation project, with yellow outline showing property boundary, and green outline showing project area**

Planted ponderosa pine seedlings, along with the existing scattered overstory (~10%) of black oak, blue oak, ponderosa pine and gray pine, and gray pine that will likely naturally seed in for several years after the brush is cleared, will provide a diverse mix of tree species from this afforestation project. For good conifer seedling survival and growth in the long, hot and dry summer climate, controlling manzanita, poison oak and grasses that compete aggressively for limited soil moisture during the first few years of establishment will be critical.

The extreme fuel load and configuration of the tall, dense brush on the proposed afforestation site poses a significant risk of catastrophic wildfire to the surrounding forests and watershed (**Figure 19**). Controlling the re-invasion of manzanita brush has the added benefit of lowering and maintaining lower hazardous fuel loads. The proposed project area is classified as a "high" treatment priority area in the Sugar Pine Community Wildfire Protection Plan; afforestation has the co-benefit of meeting the objectives of the Community Wildfire Protection Plan by greatly reducing the hazardous fuel loads.

**Figure 19. Sivadas afforestation site, with dense manzanita brush posing hazardous fuel loads and fire danger to overstory of sparse black oak and ponderosa pines**

In 2008 ponderosa pine seedlings were grown in a nursery from appropriate seed zones. Mechanical site preparation by piling took place in summer 2008, retaining conifers, oaks and large woody debris where operationally feasible. The option of brush grinding and removal to a biomass energy facility was considered for this project, due to heavy brush, reasonable haul distance either to Wheelabrator or one of the biomass plants in Burney, and good road access. However, it was determined that the roads into the property were not useable by chip hauling vans and brush removal was not economical, so it was pile-burned in fall 2008. In early 2009, crews planted 9,070 one-year old containerized ponderosa pine seedlings at 197 trees per acre, followed by installation of seedling protection netting. There were a large number of residual pine and oak trees, so although planting specifications were for 300 trees per acre at 12'x12' spacing, far fewer trees were actually planted. In spring 2009, a directed foliar spray application by hand crews was done to control re-sprouting poison oak and germinating manzanita seedlings and grass.

*Survival Monitoring*

On September 10, 2010, 38 1/100$^{th}$ acre plots were sampled with the following results: 192 ponderosa pine trees per acre are very well distributed throughout the project area (Survival after two years = 97%, **Figure 20**). All of the plots were either stocked with at least one planted ponderosa pine or were not planted because they were fully occupied by residual large oaks and/or ponderosa pine. Most of the mortality occurred in the first growing season (summer of 2009). Surviving trees that are relatively "free to grow" are healthy and vigorous (e.g. good stem caliper, buds and needle color and length for two year old seedlings), but trees that are under competitive stress from heavy grass cover and/or residual overstory oaks and/or pines are smaller and much less vigorous. Most of the project area is also occupied by grasses, forbs, one year old whiteleaf manzanita seedlings and some re-sprouting black oak, live oak, poison oak and buckbrush. The very heavy grass cover in the large middle unit is significantly impacting the growth and vigor of the ponderosa pine seedlings. The western unit is also occupied by wild grape that is competing with some of the ponderosa pine for light and soil moisture. There are several large residual black oak and ponderosa pine in the project area that

are impacting the growth and vigor of the ponderosa pine seedlings within their shade and/or rooting zone.

**Figure 20. Two-year old Ponderosa pine seedling on Sivadas**

*Suggested potential future activities*

If the landowner plans to harvest oak for personal and/or commercial firewood use, oaks that are stunting ponderosa pine seedlings should be a priority for removal (harvest operations should be conducted so as not to damage the ponderosa pine seedlings). Treating the grasses and forbs within a 5 foot radius of ponderosa pine seedlings in the early spring of 2011 would greatly enhance the survivability of many ponderosa pine, especially in the 20.2 acre middle unit. In order to prevent the growth of brushy fuel loads and to maintain conifer vigor and health, a directed foliar spray application in 2011 or 2012 on the seedling whiteleaf manzanita and re-sprouting poison oak is needed. During any of these treatments avoid spray contact on the ponderosa pine seedlings. Treating the brush in the next few years is critical to maintain the long term fuel reduction benefit of the reforestation work as well as the survivability of the ponderosa pine seedlings. In approximately 6 to 8 years (2016-2018) a pre-commercial thinning treatment might be needed in some areas to reduce stocking levels to approximately 170 trees per acre, leaving the most vigorous ponderosa pine at 16 foot by 16 foot spacing. Please note that these are suggested possible future treatments, and it is necessary to obtain a specific recommendation for spraying from a licensed Pest Control Advisor prior to any treatment. Also to prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total cost of afforestation at this site was $35,805 or $778/acre. This cost includes site preparation including brush disposal ($474/ac); seedlings ($41/ac); planting costs ($157/ac); and follow-up spray ($107/ac).

*Baseline carbon stocks*

Based on data from 11 measurement plots installed prior to site preparation at the Sivadas project site, baseline carbon stocks in brush are estimated at a mean 83.3 t C/ha (123.7 t $CO_2$/ac) with a standard error of 11.7 t C/ha and a 90% confidence interval of 26% of the mean. The variability in this data indicates that 72 plots would be needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 109.2 t C/ha (44 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in September 2010, with 197 ponderosa pine (97% survival) planted per acre in 2009. Table 9 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 9. 100-year growth projections on the Sivadas 2009 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2019 | 191 | 0 | 5 | -39 | -144 | -6,612 |
| 2029 | 188 | 0 | 8 | -36 | -133 | -6,106 |
| 2039 | 184 | 1,870 | 19 | -25 | -92 | -4,250 |
| 2049 | 180 | 4,966 | 32 | -12 | -45 | -2,058 |
| 2059 | 174 | 9,488 | 44 | 0 | -1 | -34 |
| 2069 | 157 | 13,231 | 55 | 11 | 40 | 1,822 |
| 2079 | 144 | 17,155 | 64 | 20 | 73 | 3,340 |
| 2089 | 135 | 21,359 | 73 | 29 | 106 | 4,858 |
| 2099 | 118 | 23,784 | 81 | 37 | 135 | 6,207 |
| 2109 | 103 | 26,049 | 87 | 43 | 157 | 7,219 |

## 4.9 Eilers property

This 20-acre combined ponderosa pine and blue oak afforestation project is located at T33N R2W Section 9, at 1,700' to 1,780' elevation. The project consists of three small units. All-season access is good via rocked and dirt roads. Soils on the middle and west units are suitable for growing ponderosa pine, but the soils on the third unit (east unit) are shallow and marginal for commercial conifer production. Site class is estimated Dunning IV on west and middle units, V or less on east unit. Current vegetation is comprised of re-sprouting poison oak, live oak and black oak, grasses, forbs and brush (mostly manzanita) germinate seedlings less than one foot tall. There is an overstory of ponderosa pine, gray pine, black oak and blue oak, averaging approximately 10% canopy cover. Large piles of dead brush are in the proposed afforestation units. Due to the small size and economies of scale, the project was feasible because it was done in conjunction with the nearby Sivadas afforestation project.

The landowner's objective was to reduce fire hazard risk and promote watershed and wildlife resources by establishing long-term tree cover with minor shrub, grass, and forb understory, in

place of the dense brush and sparse tree cover that had previously occupied the site. Two acres in the project area are suitable for planting blue oak and ponderosa pine (very low site) and the remaining acres are suitable for ponderosa pine. Experience in operational-scale oak regeneration projects in California is insufficient to provide a reliable basis for estimates of costs and risk for this project. For good conifer seedling survival and growth in this long, hot and dry summer climate, controlling manzanita, poison oak and grasses that compete aggressively for limited soil moisture during the first few years of establishment are critical. Controlling the re-invasion of manzanita brush has the added benefit of reducing hazardous fuel loads. It is likely that some gray pine seedlings will naturally seed in over time following brush removal.

In 2008, ponderosa pine seedlings were grown in a nursery from appropriate seed zones. WESTCARB partners monitored the blue oak acorn crop on the property in fall 2007 in hopes of collecting ripe acorns to plant. During that year, however, the acorn crop was insufficient, and oak planting was delayed a year. Acorns were collected in the fall of 2008, and culls were sorted out using water immersion method. Oak planting occurred in February 2009. Blue oak acorns were planted only on the 2 acres of the low-site unit, at 50 spots per acre, 2 acorns per spot, followed by installation of 100 4' rigid seedling/sapling protectors anchored with posts. Weeds were sprayed within 4' of oak planting spots. Piling of brush had already been completed by the landowner, so the only site preparation needed prior to planting was to burn piles of residual brush. Ponderosa pine planting was done in early 2009, with planting of 4,160 one year-old containerized ponderosa pine seedlings on all 20 acres at 208 trees per acre. Planting was followed by installation of seedling protection netting around ponderosa pine seedlings, and a directed foliar spray application by hand crews to control any re-sprouting poison oak and newly emerging brush germinates, forbs and grasses.

*Survival Monitoring*

A survival survey was conducted on September 10, 2010. Approximately 150 ponderosa pine trees per acre (tpa) are distributed throughout the project area with approximately 70 blue oak spots (35 tpa) occupied by one or two seedlings on two acres along with the planted ponderosa pine at about 100 tpa. Surviving ponderosa pine that are relatively "free to grow" are healthy and vigorous (e.g. good stem caliper, buds and needle color and length for two year old seedlings), but trees that are under competitive stress from heavy grass and/or Brewer's oak cover and/or residual overstory oaks and/or pines are smaller and much less vigorous. In some of the areas cleared for planting ponderosa pine, gray pine seedlings are seeded in. The blue oak seedlings, which grow slower than most oak species, are still well below the height of the Tubex treeshelters with some showing signs of leaf stress from the shelter and/or from competing vegetation. (**Figure 21**)

**Figure 21. Blue oak seedlings that germinated from two planted acorns are still well below height of Tubex Treeshelter (L). Six month old Gray pine seedling that germinated after clearing and initial vegetation control (R)**

Most of the project area is also occupied by grasses, forbs, one year old whiteleaf manzanita seedlings and some re-sprouting black oak, live oak, poison oak and buckbrush. It appears that the landowner has invested in treating some of this brush after funding from the WESTCARB II grant expired. The very heavy cover of Brewer's oak in the western portion of the 2-acre pine & oak unit is significantly impacting the survivability and/or growth of the ponderosa pine and blue oak seedlings. There are heavy patches of grass scattered throughout the entire project area which have also impacted conifer seedling survival and continue to threaten the survivability and/or growth of existing ponderosa pine seedlings. There are several large residual black oak and ponderosa pine in the project area that are impacting the growth and vigor of the ponderosa pine seedlings within their shade and/or rooting zone.

*Suggested potential future activities*

Provided cattle remain excluded from the 2 acre blue oak unit, the Tubex Shelters may be removed at this time from around the blue oak seedlings that have germinated and survived. No evidence of stock or wildlife browsing appears to have occurred to unsheltered blue oak seedlings and as blue oak grows very slowly there might be a negative effect of the shelters on the oaks should they remain in place next summer.

If the landowner plans to harvest oak for personal or commercial firewood use, large residual oaks that are stunting ponderosa pine seedlings should be a priority for removal (harvest operations should be conducted so as not to damage the ponderosa pine seedlings).

Treating the grasses and forbs within a 5 foot radius of ponderosa pine seedlings in the early spring of 2011 would greatly enhance the survivability of many ponderosa pine especially in areas where grass cover is heavy.

In order to prevent the growth of brushy fuel loads and to maintain conifer vigor and health, a directed foliar spray application in 2011 or 2012 on the seedling whiteleaf manzanita and re-sprouting poison oak is needed (**Figure 22**).

During any of these treatments spray contact on the ponderosa pine seedlings should be avoided. Treating the brush in the next few years is critical to maintain the long term fuel reduction benefit of the reforestation work as well as the survivability of the ponderosa pine seedlings.

Please note that these are suggested possible future treatments, and it is necessary to obtain a specific recommendation for spraying from a licensed Pest Control Advisor prior to any treatment. Also to prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

**Figure 22. The heavy grass and forb cover in some areas (L) should be treated in spring of 2011 because it is significantly reducing ponderosa pine seedling vigor compared to "free to grow" ponderosa pine seedlings (R) growing without much weed competition for limited soil moisture.**

*Costs*

The total cost of afforestation at this site was $7,084 or $354/acre. This cost includes pine seedlings and acorn collection ($77/ac); planting costs ($123/ac); and follow-up spray ($154/ac). Brush removal had been completed prior to the pilot project, so there were no costs for mechanical site preparation, resulting in low overall costs.

*Baseline carbon stocks*

Because the landowner had cleared the project area prior to inception of this pilot project, for the purposes of reducing fire risk, there was no existing vegetation and the baseline carbon stocks are considered to be zero.

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in September 2010. Two separate projections were made for the two different planting regimes. In the first, 208 ponderosa pine trees per acre were planted, with a 72% survival rate. Table 10 shows growth and carbon stocks for the pine planting over a 100 year period, starting in year 10. In the second, 208 ponderosa pine (48% survival) and 35 blue oak (70% survival) were planted per

acre in 2009. Table 11 shows growth and carbon stocks for the pine/oak planting over a 100 year period, starting in year 10.

**Table 10. 100-year growth projections on the Eilers 2009 pine planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|
| 2019 | 150 | 0 | 4 | 15 | 264 |
| 2029 | 147 | 0 | 6 | 22 | 396 |
| 2039 | 144 | 383 | 11 | 40 | 726 |
| 2049 | 141 | 1,870 | 18 | 66 | 1,188 |
| 2059 | 139 | 3,497 | 25 | 92 | 1,650 |
| 2069 | 136 | 4,583 | 33 | 121 | 2,178 |
| 2079 | 133 | 6,515 | 41 | 150 | 2,706 |
| 2089 | 131 | 8,650 | 48 | 176 | 3,168 |
| 2099 | 125 | 10,622 | 55 | 202 | 3,630 |
| 2109 | 119 | 12,118 | 61 | 224 | 4,026 |

**Table 11. 100-year growth projections on the Eilers 2009 oak/pine planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|
| 2019 | 135 | 0 | 5 | 18 | 37 |
| 2029 | 132 | 0 | 6 | 22 | 44 |
| 2039 | 129 | 256 | 10 | 37 | 73 |
| 2049 | 126 | 1,420 | 15 | 55 | 110 |
| 2059 | 124 | 2,580 | 21 | 77 | 154 |
| 2069 | 121 | 3,486 | 27 | 99 | 198 |
| 2079 | 118 | 5,212 | 34 | 125 | 249 |
| 2089 | 116 | 7,246 | 40 | 147 | 293 |
| 2099 | 113 | 9,196 | 47 | 172 | 345 |
| 2109 | 111 | 10,846 | 53 | 194 | 389 |

## 4.10 Wilson property

This 14-acre ponderosa pine afforestation project is located at T34N R1W Section 29 (S½), in two units ½ mile apart, at 1,600′ (east unit) and 1,700′ (west unit) elevation (**Figure 23**). Access is fair, via unpaved roads and a bridge whose weight capacity needs to be confirmed. According to USDA NRCS Shasta County Area Survey, soils on the west unit are Marpa gravelly loam, 30 to 50 percent slopes (slopes on the proposed project area are 0 to 30%); residuum weathered from shale parent material; 26″ to 30″ deep; well drained; moderately suited for hand planting. Although the soil type in general is listed as capable of growing ponderosa pine, black oak, Douglas fir, and white fir, at this elevation and ridge top exposure ponderosa pine would be the most suitable for young seedling survival. On the east unit, soils are Neuns very stony loam, 8

to 50 percent slopes (slopes on the proposed project area are 0 to 30%); residuum weathered from greenstone parent material; 23" to 27" deep; well drained; moderately suited for hand planting. Current vegetation consists mostly of dense, 6 to 15 foot tall non-sprouting manzanita species and a sparse (< 5% cover) black oak, blue oak, ponderosa pine, gray pine and Douglas fir overstory. The brushfields with sparse re-sprouted oaks likely formed after a wildfire many decades ago.

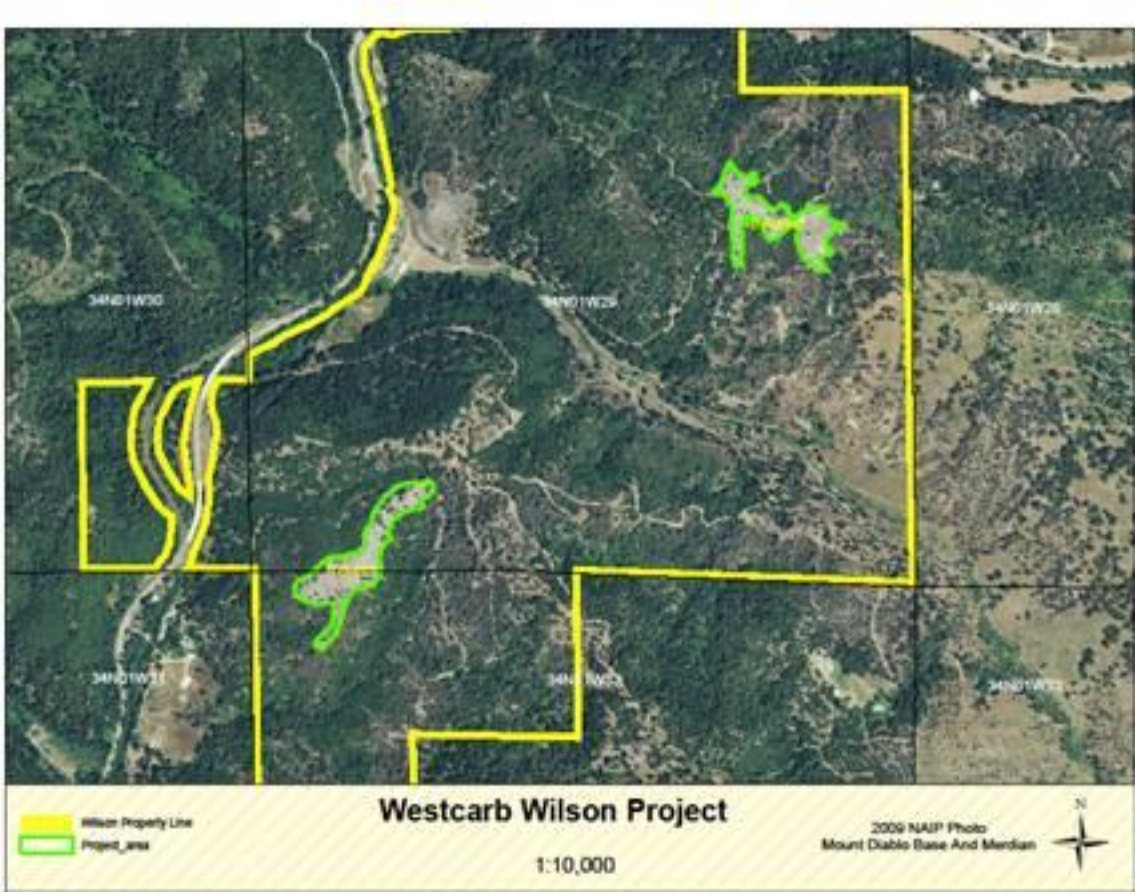


**Figure 23. Map of 14-acre Wilson afforestation project, with yellow outline showing property line and green outline showing project area**

Site preparation entailed mastication of brush. Due to the relatively low elevation, hot dry summer climate and shallow, somewhat eroded soils, there is a greater risk of plantation failure than at higher elevation sites and better conifer growing, non-eroded soils. The benefits of this proposed project go beyond afforestation because preparing the site for planting by masticating the tall, dense brush on these ridges would also reduce fire hazard risk to the property and surrounding forestland. Mastication rather than mechanical clearing was appropriate because of the shallow, erodible soils and non-sprouting brush species; mastication causes less soil disturbance, provides dead woody material cover that will reduce soil moisture loss from evaporation, and provides shade from the summer sun on the lower stem portion of the young seedlings that will be planted into the site. The mulching effect of the mastication also reduces

the amount of weeds competing with the conifer seedlings for limited soil moisture and nutrients.

In 2008, ponderosa pine seedlings were grown in a nursery from appropriate seed zones. Site preparation occurred in summer 2008 using an excavator equipped with a masticating head. In February 2009, crews planted 3,830 one-year old containerized ponderosa pine seedlings at 273 trees per acre, followed by installation of seedling protection netting. Planting was followed by a directed foliar spray application by hand crews to control newly emerging forbs and grasses.

*Survival Monitoring*

On August 12, 2010, 19 1/100$^{th}$ acre plots were sampled with the following results: 247 ponderosa pine trees per acre are very well distributed throughout the project area (Survival after two years = 90%, **Figure 24**). All of the 19 plots were stocked with at least one ponderosa pine. Most of the mortality occurred in the first growing season (summer of 2009) and most of the surviving trees are very healthy and vigorous (e.g. good stem caliper, buds and needle color and length for two year old seedlings). Most of the project area is also occupied by 6 month old whiteleaf manzanita seedlings that seeded in during 2010. Some poison oak, live oak and blackberry plants have re-sprouted and are scattered throughout the project area.

**Figure 24. Control of competing vegetation through chemical treatments & masticated "mulch" has led to very healthy & vigorous seedlings on low conifer timber site soils**

*Suggested potential future activities*

In order to prevent the growth of brushy fuel loads and to maintain conifer vigor and health, a directed foliar spray application on the seedling whiteleaf manzanita should be conducted in the spring of 2011 or spring of 2012, prior to conifer bud elongation. Manzanita can be controlled with 2% LV4 (ester formulation of 2,4D) or with 5% glyphosate product (e.g. Razor) plus 3% to 5% methylated seed oil surfactant. In the summer of 2011 or 2012 re-sprouting poison oak should be treated with 3% to 5% glyphosate product plus 1% surfactant, blackberries should be treated with 2% Garlon 4 or Element 4 (active ingredient triclopyr). During any of these treatments avoid spray contact on the ponderosa pine seedlings. In approximately 6 to 8 years (2016-2018) a pre-commercial thinning treatment is likely to be needed to reduce stocking levels to approximately 170 trees per acre, leaving mostly the most vigorous ponderosa pine at 16 foot by 16 foot spacing. Please note that these are suggested possible future treatments, and it is necessary to obtain a specific recommendation for spraying from a licensed Pest Control Advisor prior to any treatment. Also to prior to pre-commercial thinning a registered professional forester (RPF) should be consulted.

*Costs*

The total cost of afforestation at this site was $18,198 or $1,300/acre. This cost includes site preparation ($695/ac); seedlings ($54/ac); planting costs ($335/ac); and follow-up spray ($216/ac).

*Baseline carbon stocks*

Based on data from 8 measurement plots installed prior to site preparation at the Sivadas project site, baseline carbon stocks in brush are estimated at a mean 65.0 t C/ha (96.6 t $CO_2$/ac) with a standard error of 4.7 t C/ha and a 90% confidence interval of 14% of the mean. The variability in this data indicates that 15 plots would be needed to attain a 90% confidence interval of 10% of the mean. The upper bounds of the 90% confidence interval is 75.8 t C/ha (31 t C/ac).

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 274 ponderosa pine (90% survival) planted per acre in 2009. Table 12 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 12. 100-year growth projections on the Wilson 2009 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | Net C stored/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|---|
| 2019 | 247 | 0 | 5 | -26 | -94 | -1,318 |
| 2029 | 242 | 0 | 9 | -22 | -79 | -1,113 |
| 2039 | 237 | 2,289 | 22 | -9 | -32 | -446 |
| 2049 | 231 | 5,983 | 37 | 6 | 23 | 324 |
| 2059 | 203 | 10,350 | 50 | 19 | 71 | 992 |
| 2069 | 185 | 14,369 | 61 | 30 | 111 | 1,556 |
| 2079 | 171 | 18,493 | 71 | 40 | 148 | 2,070 |
| 2089 | 142 | 21,516 | 79 | 48 | 177 | 2,480 |
| 2099 | 123 | 23,779 | 86 | 55 | 203 | 2,840 |
| 2109 | 107 | 25,908 | 91 | 60 | 221 | 3,096 |

## 4.11 Lakey property

This is a 60-acre project located at T37N R4E, and includes portions of SE ¼ Section 27 & SW ¼ of NE ¼ Section 26 (**Figure 25**). The property is at approximately 3,750'-3,880' in elevation with slopes ranging from 0-40%, and aspects mostly facing north and northwest. Soil types according to the NRCS Intermountain Soil Survey include Chirpchatter-Hunsinger Complex and Jellico-Splawn Complex, about 30 acres each. The site is part of approximately 700 acres that burned in the July 2007 Power Fire, which was a fairly severe burn. Vegetation prior to the project included burned skeletons and stubs of what had been dense, decadent brush consisting of Greenleaf Manzanita, scrub oak, squawbush, deerbrush, and redbud, with some scattered trees consisting of Oregon white oak and California black oak. Prior to the Power Fire, the site and surrounding area consisted of 26 year old brush and oaks that resprouted and/or became well established after the 1982 Chalk wildfire. Although no remnant ponderosa pine stumps were found in the burned area, there are some ponderosa pines growing on these same soil types in the general vicinity.

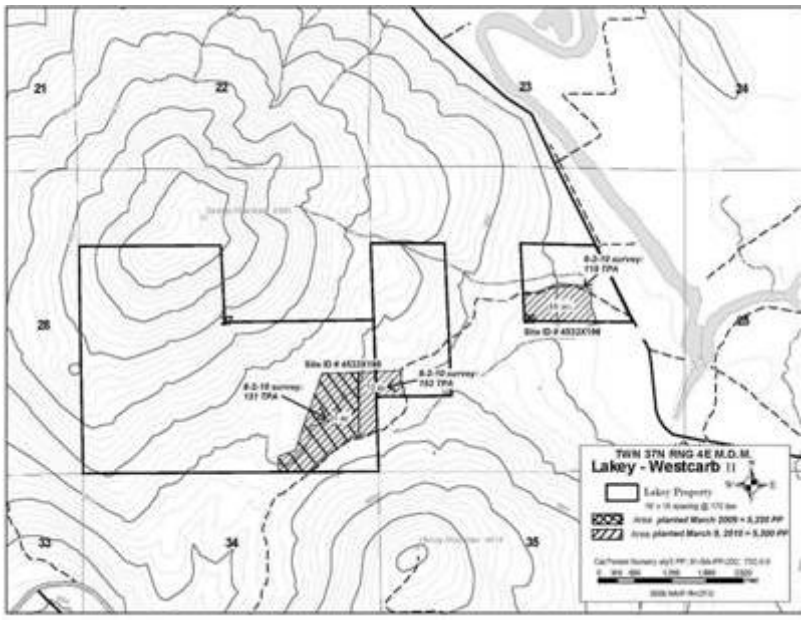


**Figure 25. Map of 60-acre Lakey afforestation project, with solid outline showing property boundaries, cross-hatched area showing 2009 planting, and hatched area showing 2010 planting**

Implementing this project presented a unique opportunity because the fire was relatively recent and underbrush has not reestablished in the area. This means that there is minimal need for pretreatment activities, saving time and money, and avoiding removal of carbon sequestered in brush species. The project is an excellent pilot project on lands that are typical of the hundreds of acres of non-stocked federal and private forestland in this vicinity that require management to become productive native conifer forests (mostly ponderosa pine and possibly Douglas-fir).

In March 2008, a test planting was conducted to determine how ponderosa pine seedlings would fare on the burned-over soil, and especially to determine if netting would be needed to protect the seedlings from browse. The test planting yielded a 90% survival rate after one growing season. The project area was sprayed in both the early summer and fall of 2008 to reduce competition from resprouting brush and scrub oaks. In March 2009, 5,270 one-year-old containerized ponderosa pine seedlings were planted on 31 acres at 170 trees per acre. In March 2010, a second planting of 4,930 seedlings occurred on 29 acres. The area was monitored for the need for follow-up weed control. Both plantings were followed by a directed foliar spray application by hand crews to control newly emerging forbs and grasses.

*Survival Monitoring*

On August 25, 2010, 68 1/100$^{th}$ acre plots were sampled with the following results: 132 ponderosa pine trees per acre are very well distributed throughout the project area (Survival after two years = 75%, **Figure 26**). Most of the seedling mortality occurred in the first growing season, during which precipitation levels were about 20% of normal. The ponderosa pine seedlings that did survive in most of the project area exhibit good vigor. The best survival occurred in the 2010 planting on the upper unit (13 ac with survival of 153 tpa) and the poorest

survival occurred on the lower unit which was also planted in 2010 (16 ac. with survival of 119 tpa). Although 2010 was a better planting year than 2009 due to more spring rainfall, the upper unit that was planted in 2009 (31 ac. with survival of 131 tpa) had better survival than the lower unit planted in 2010 because the upper unit is comprised of slightly better soils (slightly deeper & higher water holding capacity). There is a negligible amount of competing grasses, forbs or brush in the project area.

**Figure 26. Ponderosa pine seedling 6 months after planting (L) and 18 months after planting (R)**

*Suggested potential future activities*

The current stocking of 130 trees per acre is ideal for the landowner's long term objectives to turn the brushfield into an open timber stand with grass and forb forage understory. However if funding and seedlings are available in spring of 2011, interplanting about 800 ponderosa pine seedlings on the lower 16 acre unit could be done to bring that unit up to 170 trees per acre. No grass, forb or brush treatments are necessary for 2011. It is anticipated that no future grass or forb treatments will be needed because once ponderosa pine seedlings are well established (e.g. "free to grow" for 3 years) they should be vigorous and deeply rooted enough to survive and grow well with grasses and forbs. However brush competition should be monitored and controlled if needed for a few more years. The project area should also be monitored for invasive species in future years and treated if necessary. Pre-commercial thinning will not likely be needed in the future due to the wide initial spacing.

*Costs*

The total cost of afforestation at this site was $28,919 or $482/acre. This cost includes site preparation ($106/ac); seedlings ($31/ac); planting costs ($199/ac); and follow-up spray ($146/ac). Total operational costs were relatively low because shrub cover had not reestablished on the site following the Power Fire, and as a result there was no need for mechanical site preparation and brush removal.

*Baseline carbon stocks*

Because the land had burned in the Power Fire and vegetation had not regrown prior to inception of this pilot project, there was no existing vegetation and the baseline carbon stocks are considered to be zero.

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 177 ponderosa pine (75% survival) planted per acre in 2009 and 2010. Table 13 shows growth and carbon stocks for a 100 year period, starting in year 10.

**Table 13. 100-year growth projections on the Lakey 2009 planting**

| Year | Trees per acre | Board feet/ac | Total C stocks/ac | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|
| 2020 | 133 | 0 | 4 | 15 | 880 |
| 2030 | 130 | 0 | 6 | 22 | 1,320 |
| 2040 | 128 | 831 | 12 | 44 | 2,640 |
| 2050 | 125 | 2,861 | 20 | 73 | 4,400 |
| 2060 | 123 | 4,794 | 29 | 106 | 6,380 |
| 2070 | 120 | 7,752 | 37 | 136 | 8,140 |
| 2080 | 118 | 10,563 | 46 | 169 | 10,120 |
| 2090 | 115 | 13,308 | 54 | 198 | 11,880 |
| 2100 | 107 | 16,197 | 62 | 227 | 13,640 |
| 2110 | 101 | 18,782 | 69 | 253 | 15,180 |

## 4.12 Bureau of Land Management

This is a 7 acre project located within the San Buenaventura Land Grant, with no township, range, or section number. The land is at approximately 500' in elevation with mostly flat slopes. According to the NRCS Shasta County Soil Survey, there are two soils in the project area, each about 50% of the total area: Anderson gravelly sandy loam and Reiff gravelly fine sandy loam. Site class is marginal for commercial conifers. The pre-project vegetation was thick, well-rooted grass and forb cover. The soils are low site quality and are best suited for oak trees; the planting entailed primarily valley oak, but also some canyon live oak, based on acorn availability.

**Figure 27. Tubex shelters protecting oak seedlings on BLM afforestation project**

Site preparation entailed direct foliar spraying to reduce weedy vegetation. Prior to planting, the area was disked to assist with planting and weed control. Acorns were harvested from the nearby area in January 2009, and water-tested to ensure viability. Prior to planting, approximately 75% of the acorns had begun to germinate having an approximate ¼ - ½ inch root tip. Vegetation was scalped out prior to planting one acorn at each spot. In February 2009, 143 spots per acre were planted with acorns. Acorns were planted ½ - 1 inch deep in a hole dug several inches deeper than acorn was actually planted. Whole was backfilled to allow ½ to 1 inch for planting. If germinated, root was planted down, and un-germinated acorns were planted on their side. Three-foot-tall Tubex Treeshelters were installed over planting spots and anchored to 4' wooden white oak stakes (**Figure 27**). The landowner agreed to monitor weed growth, mow the surrounding areas, and retreat with foliar spray as necessary.

*Survival Monitoring*

During the months after the initial acorn planting, the project area was not maintained to prevent weed growth from competing with the oak seedlings and there was 95% mortality. In order to compensate for this, a second acorn planting was done in January 2010. The site was monitored in August, 2010, and there were a total of 253 successful spots, a 25% survival rate.

*Costs*

The total cost of afforestation at this site was $13,160 or $1,880/acre. This cost includes acorn collection ($186/ac); planting costs ($1,237/ac); and follow-up spray ($457/ac). The planting costs are far more expensive than for the other projects because they require a great deal of labor to plant each spot and install Tubex shelters. The follow-up spray is relatively expensive in part because initial weed treatment by mowing did not occur as planned, and vegetative regrowth therefore required heavy chemical treatment. Because the landowner covered the site

preparation with mowing and disking, these costs are not included in the total. In addition, the replanting following the initial poor survival was done by volunteers as part of a high school biology curriculum and so these costs are also not incorporated in the total.

*Baseline carbon stocks*

Prior to inception of this pilot project, the area consisted of only herbaceous plants, and no shrubs or trees were removed during site preparation, so the baseline carbon stocks are considered to be zero.

*Projected growth and carbon benefits*

Growth was modeled in FVS over 100 years, based on the survival count done in August 2010, with 143 acorn spots (25% survival) planted per acre in 2009. Diameter growth projected by FVS was unreasonably low, so look-up tables for afforested western oak stands in the Pacific Southwest (Smith *et al*, 2006) were also consulted, and values were included based on the 25% survival rate on this planting. Table 14 shows growth and carbon stocks from both FVS and look-up tables for a 100 year period, starting in year 10.

**Table 14. 100-year growth projections on the BLM 2009 planting**

| Year | Trees per acre | Total C stocks/ac (FVS) | Total C stocks/ac (look-up table) | $CO_2$ stored/ac | Total $CO_2$ |
|---|---|---|---|---|---|
| 2019 | 36 | 4 | 1.6 | 6.0 | 41.7 |
| 2029 | 35 | 5 | 2.5 | 9.2 | 64.5 |
| 2039 | 34 | 5 | 4.4 | 16.0 | 112.0 |
| 2049 | 33 | 5 | 7.8 | 28.7 | 200.8 |
| 2059 | 32 | 5 | 11.8 | 43.2 | 302.2 |
| 2069 | 31 | 5 | 15.2 | 55.7 | 389.8 |
| 2079 | 30 | 5 | 17.9 | 65.7 | 459.8 |
| 2089 | 29 | 5 | 20.2 | 73.9 | 517.5 |
| 2099 | 28 | 5 | 22.0 | 80.7 | 565.0 |
| 2109 | 27 | 6 | 23.6 | 86.4 | 604.5 |

# 5.0 Summary of Pilot Projects

- Approximately 400 landowners were contacted regarding participation in WESTCARB afforestation pilot projects, through targeted mailings, watershed groups and other mechanisms.
- Forty-four landowners were formally surveyed on their interest in afforestation, willingness to share costs, specific site conditions on their lands, acres available, species preferences and other factors.
- Seventeen site-specific afforestation planting and maintenance plans were developed, detailing acres available, soils, seed zones, site class, precipitation, elevation, slope, terrain, current vegetation and other conditions affecting afforestation, estimated costs, and step-by-step plans for mechanical and chemical site preparation, planting, and early maintenance treatments.
- Twelve landowner agreements for WESTCARB afforestation pilot projects have been signed and implemented, totaling 476 acres of afforestation. Projects range in size from 7 to 98 acres, averaging 40 acres.
- Project baselines consisted of a variety of brush species, mostly fairly dense. Baseline carbon stocks ranged from zero, for a project that had recently burned in a wildfire, to 34 metric tons of carbon per acre, on a project with dense old-growth Manzanita.
- Projects were planted to ponderosa pine, mixed conifer stands, or native oaks. After 60 years, net carbon stocks on conifer plantings ranged from 11 t C/ac to 73 t C/ac. The native oak planting had net carbon stocks of 24 t C/ac after 60 years.
- Survival of planted conifer seedlings was high, despite limited rainfall in the year of planting.

**Table 15. Summary of all WESTCARB Shasta County afforestation pilot projects**

| | | | | Baseline | | Afforestation | | | Net Carbon Stocks (t/ac) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project | Acres | Total cost | Cost/ac | Cover species | C stocks (t/ac) | Species | Trees/ac planted | Survival | 10 years | 20 years | 40 years | 60 years | 100 years |
| **Red River Forests Partnership** | 98 | $81,532 | $832 | manzanita | 21 | Ponderosa pine | 300 | 99%, plus ingrowth | -16 | -10 | 21 | 47 | 73 |
| **Brooks Walker** | 7 | $8,854 | $1,265 | manzanita | 3 | Ponderosa pine & red fir | 300 | 73%, plus ingrowth | 2 | 6 | 37 | 65 | 100 |
| **Hendrix-Phillips Tree Farm** | 20 | $24,453 | $1,223 | manzanita | 24 | Ponderosa pine | 300 | 93% | -19 | -14 | 15 | 40 | 67 |
| **Goose Valley Ranch** | 60 | $61,958 | $1,033 | whitethorn | 20 | Ponderosa pine, Douglas fir, incense cedar | 290 | 83%, plus ingrowth | -15 | -9 | 22 | 51 | 80 |
| **Lammers** | 50 | $42,885 | $858 | greenleaf, deerbrush, whitethorn | 15 | Ponderosa pine & Douglas fir | 249 | 69% | -11 | -8 | 14 | 39 | 74 |
| **Frase** | 43 | $25,812 | $600 | none | 0 | Ponderosa pine | 282 | 93% | 5 | 8 | 33 | 55 | 85 |
| **Kloeppel** | 51 | $45,870 | $899 | greenleaf, deerbrush | 10 | Ponderosa pine & Douglas fir | 314 | 84% | -5 | 2 | 38 | 68 | 98 |
| **Sivadas** | 46 | $35,805 | $778 | manzanita | 44 | Ponderosa pine | 197 | 97% | -39 | -36 | -12 | 11 | 43 |
| **Eilers** | 20 | $7,084 | $354 | none | 0 | Ponderosa pine (18 acres) | 208 | 72% | 4 | 6 | 18 | 33 | 64 |
| | | | | | | Ponderosa pine & blue oak (2 acres) | 258 | 52% | 5 | 6 | 15 | 27 | 53 |
| **Wilson** | 14 | $18,198 | $1,300 | manzanita | 31 | Ponderosa pine | 274 | 90% | -26 | -22 | 6 | 30 | 60 |
| **Lakey** | 60 | $28,919 | $482 | none | 0 | Ponderosa pine | 177 | 75% | 4 | 6 | 20 | 37 | 69 |
| **BLM** | 7 | $13,160 | $1,880 | none | 0 | Oak | 143 | 25% | 2 | 3 | 8 | 15 | 24 |

Table 15 shows a summary of all of the pilot projects, including cost, baseline carbon stocks, and projected carbon stocks resulting from afforestation.

The projects varied widely in per acre cost, based largely on the intensity of site preparation prior to planting and vegetation control to decrease competition following planting. Eilers and Lakey had the lowest per acre costs, because in both cases there was no brush to remove in the project area when the pilot project began. The BLM had the highest per acre cost, due to both the intensity of hand planting acorns and installing protection and the fact that weed control was not undertaken early and intensive measures were required later. The most expensive conifer plantings, on a per acre basis were Brooks Walker, Hendrix Phillips and Wilson, all of which had extensive brush cover which had to be removed prior to afforestation, as well as fairly intensive needs for post-planting weed control.

The costs listed in this report only address the actual costs of afforestation, and do not include the cost of monitoring, measurement, and registration of a carbon project on a registry. These costs vary depending on the project area and the requirements of the registry, but likely start at $8 per acre per year.

The baseline carbon stocks also varied, ranging from zero to 34 tons of carbon per acre, with the areas with dense Manzanita having the highest carbon stocks.

The variation in net carbon stocks resulting from tree planting was due to a number of factors. In cases where the baseline carbon stock was high, such as Sivadas and Wilson, the net carbon stored in the planted trees will not exceed the baseline stocks until year 30 or later. Site quality, species planted, number of trees per acre planted, and seedling survival all have an impact on forest growth and therefore carbon stocks. Fir, for instance, sequesters more carbon than does ponderosa pine, but across the projects, fir had a much lower survival rate than pine. Oaks grow at a very slow rate and therefore do not store much carbon at all. However, there are other reasons to grow oaks. The pine and oak planting on Eilers shows that it is possible to achieve decent survival in both on a relatively low site, and yield some carbon benefit.

*Carbon offsets*

By their nature, afforestation projects generally have a lag time before an adequate amount of carbon is accumulated to overcome the baseline deduction, and thus before sufficient offsets are generated for a sale. Of the 12 pilot sites, more than half had negative carbon balance after ten years—that is emissions from the baseline exceeded removals by the planted trees (Table 15). Even after 20 years, five sites were still in a negative balance. But by 40 years after the start of the planting, practically all (one exception) had a positive carbon balance of between 11 to 41 t C/ac.

Given the time lag between initiation of the planting and a positive carbon balance on the pilot sites, we determined what price of carbon offsets would be required for each of these projects to break even. The 40 year time frame was chosen for this analysis as by this time all projects have a net positive gain in carbon. In addition to the establishment costs described above (see Table 15 and individual project descriptions), total project costs used to determine the breakeven price included costs incurred from participation in the carbon market. These costs are monitoring and

maintenance costs ($2.30/ac/yr), a one-time carbon market enrollment fee ($4/ac), and carbon market maintenance costs ($2/ac/yr)[7].

Without addressing other deductions for risk factors, the breakeven point differs widely across the projects. Setting aside the project that has not achieved positive net carbon stocks (Sivadas) and the BLM project with low carbon accumulation and very high establishment costs, the minimum breakeven offset price at 40 years is $6.41/t $CO_2$ (Frase) and the maximum is $67.09/t $CO_2$ (Wilson). The mean is $17.47/t $CO_2$ and the median is $10.62/t $CO_2$. Table 16 shows the breakeven price for carbon offsets for each project at 20, 40, 60, and 100 years.

**Table 16. Breakeven price of carbon offsets ($/ton $CO_2$) for Shasta County afforestation pilot projects; empty cells indicate that the project had not reached net positive carbon stocks**

| | 20 years | 40 years | 60 years | 100 years |
|---|---|---|---|---|
| Red River Forests Partnership | | $13.09 | $6.35 | $4.73 |
| Brooks Walker | $61.59 | $10.62 | $6.41 | $4.63 |
| Hendrix-Phillips Tree Farm | | $25.44 | $10.13 | $6.74 |
| Goose Valley Ranch | | $14.99 | $6.93 | $5.00 |
| Lammers | | $20.14 | $7.83 | $4.76 |
| Frase | $23.52 | $6.41 | $4.27 | $3.32 |
| Kloeppel | $134.86 | $7.72 | $4.66 | $3.71 |
| Sivadas | | | $25.79 | $7.69 |
| Eilers - pine | $20.18 | $8.03 | $5.09 | $3.36 |
| Eilers - oak/pine | $4.09 | $9.64 | $6.22 | $4.05 |
| Wilson | | $67.09 | $14.20 | $7.88 |
| Lakey | $26.00 | $8.97 | $5.48 | $3.62 |
| BLM | $179.09 | $70.09 | $38.95 | $26.30 |

# 6.0 Conclusions and Recommendations

## 6.1 Conclusions

Landowner interest in conducting afforestation for carbon sequestration appears very strong, and landowners are willing to share costs for projects intended to increase carbon sequestration. The level of interest garnered through the landowner outreach process resulted in many more potential projects than could be funded directly through WESTCARB. Landowners appear to have a range of reasons for their interest, including: interest in multiple revenue streams and other values from afforestation; relatively cautious interest in evolving carbon market opportunities; personal desire to contribute to mitigating climate change; and interest in improving forest health or reducing fire risk.

Despite the high level of interest in implementing projects, landowners had very limited understanding of carbon markets, offset project protocols, potential future carbon prices,

[7] These costs are estimated based on current information. They may vary for different properties and different carbon registries, and are subject to change over time.

structure and timing of transactions, and other aspects of carbon projects. Some efforts have been made to provide education on these topics, but this was challenging due to the fundamentally uncertain and rapidly changing nature of carbon markets and the underlying policy context.

Projects with lower opportunity costs, such as converting brush fields (caused by lack of forest recovery after fires) to forest, and project designs allowing flexibility to landowners in future management of afforested areas, were understandably more attractive. The opportunity, identified in Phase I, of afforesting past fire sites that have returned to more or less permanent brush, has proved extremely attractive and appears to have significant replication potential. However, conversion costs, although varying by project, were quite high, depending on the requirements for site preparation needed to remove brush and prepare sites for planting. In addition, the potential carbon benefits vary widely, and those projects with high baseline carbon stocks do not yield a net carbon benefit for 30 to 40 years after project implementation. For these reasons, it is critical to thoroughly assess feasibility of individual projects prior to full investment and implementation.

Afforestation of oaks in rangeland posed special challenges for implementation, landowner interest, and landowner cost-share willingness. This may in part be attributable to several decades of landowner education promoting oak eradication to increase forage. This could be in part a perception problem as it appears feasible to allow oaks and cattle to coexist by simply protecting oak seedlings for several years after planting. There have been few examples of operational-sized oak regeneration projects completed in California to provide a reliable track record for success. Thus only two WESTCARB afforestation pilots involved oak planting, one of which was in combination with ponderosa pines. The combined oak/pine mix will produce a mixed-species forest and also give landowners greater carbon market revenue potential than planting oaks alone. The oak planting yielded very limited carbon benefits, and is not a viable project type for carbon purposes alone.

The operational process, requirements and costs for afforestation are well understood. The only significant operational challenge encountered was the attempt to use brush grinding and removal to a biomass energy facility, in place of conventional pile-burning. This practice is only technically and economically feasible on certain sites, and part of the challenge to broader implementation is the scarcity of operators with appropriate expertise and equipment.

In the context of current debates over the role of offset projects in existing voluntary and future regulated markets, afforestation projects such as those implemented under WESTCARB are likely to meet all the criteria for high-quality offsets. The projects are straightforward to measure, monitor and verify, can produce clear carbon benefits net of the baseline, are relatively transparent and enforceable, and are amenable to securing of project risk through various mechanisms. Perhaps most significant in offset project debates is a question of "additionality," which is defined differently in different markets and protocols. Implementing afforestation in project designs similar to the WESTCARB pilots seems clearly to meet all carbon market protocol requirements for biological, regulatory and financial additionality.

Afforestation appears to have substantial environmental co-benefits in creating a healthier forest with mixed species and wildlife habitat diversity, providing timber and biomass fuel

values, and reducing fire risk by interrupting the "brush-and-burn" cycle. It may have an additional climate *adaptation* benefit if afforestation projects can be placed strategically in upper watershed locations to help mitigate the expected effects of climate change on water availability and timing (California Energy Commission 2006).

## 6.2 Recommendations

- WESTCARB states should continue to support efforts to explore the potential of afforestation to contribute to state GHG reduction goals. Many different afforestation project designs are conceivable, some of which were piloted under WESTCARB and could be replicated broadly elsewhere in California and the WESTCARB region. Afforestation can make a significant contribution to carbon sequestration, climate change mitigation and adaptation, and should be considered as part of the broad portfolio of strategies under consideration by the State of California (Climate Action Team and AB32) and analogous policy processes in other WESTCARB states.

- Ongoing outreach and education is necessary to keep landowners informed about the opportunities to conduct afforestation for carbon sequestration, evolving carbon markets and climate change policies, and requirements for participation.

- As discussions continue about GHG accounting and offset project protocols, both in the voluntary and regulated market contexts, flexible mechanisms should be considered to address barriers to broader landowner participation, while maintaining high standards for real, additional, independently verifiable, permanent, enforceable, predictable, and transparent GHG reductions. Important mechanisms to increase accessibility of carbon projects include aggregation of multiple projects on small ownership so that they can improve economies of scale and stacking of project benefits and income streams.

## 6.3 Benefits to California

The State of California has enacted the Global Warming Solutions Act of 2006 (AB32), which directs the Air Resources Board to develop greenhouse gas emission regulations in order to meet the State's target of statewide emissions at 1990 levels by 2020. Regulations are currently being developed and are scheduled to take effect in 2012. By Executive Order on October 17, 2006, Governor Schwarzenegger directed the ARB to develop a comprehensive market-based compliance program as part of these regulations, which would allow the State to achieve the most cost-effective emission reductions and also permit trading with the European Union and the northeastern states' Regional Greenhouse Gas Initiative. One of ARB's tasks has been to decide what types of activities are eligible for trading under the market-based compliance program, including what types of forestry activities and what specific protocols or requirements will need to be met in order for credits from such projects to be traded. Results from WESTCARB afforestation pilot projects in northern California have helped to inform State policy developments and market eligibility questions, while also addressing issues of landowner uptake, project costs, measurement, monitoring and verification.

Significant debate continues over the appropriateness and role of offsets (emission reductions by sources not included in a cap-and-trade program) in achieving GHG reduction goals, what types of offsets should be allowed, what eligibility criteria offsets must meet, and protocols for

rigorous measurement, monitoring and third-party verification. Executive Order S-20-06 charged the AB32 Market Advisory Committee with advising the Air Resources Board on the design of a market-based compliance or "cap-and-trade" program. The committee recommended in its June 2007 final report that such a program include offsets, without limitation and both inside and outside California, provided such projects meet a series of stringent criteria. Offsets should be "real, additional, independently verifiable, permanent, enforceable, predictable, and transparent," as well as meeting standards for rigorous accounting methods and environmental integrity (Market Advisory Committee 2007).

Afforestation projects like those being demonstrated under WESTCARB are perhaps the most likely to meet the Market Advisory Committee's criteria for high-quality offsets. Projects are straightforward to measure, monitor and verify; clearly meet biological, regulatory and financial additionality tests; are enforceable, predictable, and transparent; and provide various environmental co-benefits. Projects demonstrated to meet these quality criteria are likely to be attractive to landowners/carbon credit suppliers and to entities purchasing offsets, either under the market-based compliance components of regulatory programs or in rapidly growing voluntary markets.

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# Annex A: Invitation and Agenda, WESTCARB Shasta County Landowner Outreach and Stakeholders Meeting (October 26, 2006)



Western Shasta RCD and Winrock International are inviting Shasta County stakeholders – landowners, land managers, ranchers, foresters and others – to a kickoff meeting of the West Coast Regional Carbon Sequestration Partnership (WESTCARB) on Thursday, October 26, 2006.

WESTCARB, led by the California Energy Commission, is one of seven US Department of Energy regional partnerships across the US working to demonstrate ways to sequester carbon dioxide and reduce emissions of greenhouse gases linked to global warming. Terrestrial (forestry and land use) sequestration options being investigated for Shasta County include afforestation of marginal rangelands, improved management of hazardous fuels to reduce emissions from wildfires, biomass energy, and forest management.

In part, this will be a follow-up meeting to the June 2005 "Shasta County Stakeholders Meeting" in Redding. Winrock will report on the results of its research into forestry and land use opportunities that can sequester carbon and provide benefits to landowners.

A second purpose is to provide information to landowners, land managers and other stakeholders about the types of activities planned for Shasta County under WESTCARB, including opportunities to participate in afforestation, fuel management and forest management activities and what the benefits and costs of participation might be. Winrock, Western Shasta RCD and other WESTCARB partners will provide an overview of project opportunities, evolving carbon credit markets, requirements for implementing, measuring and reporting projects, and related issues. The attached flyers provide further information.

| | |
|---|---|
| **Date:** | Thursday, October 26, 2006 |
| **Time:** | 1:00 p.m. to 5:00 p.m. |
| **Location:** | Lassen Conference Room<br>Western Shasta RCD<br>6270 Parallel Road, Anderson, CA 96007 |
| **RSVP/further information:** | Priscilla Benson, (530) 365-7332 ext 216<br>Priscilla@westernshastarcd.org or |

Mike Harris, (530) 365-7332 ext 214

# WESTCARB LANDOWNER OUTREACH
# &
# SECOND SHASTA STAKEHOLDERS MEETING

**DATE** Thursday, October 26, 2006, 1:00 – 5:00 PM

**LOCATION** Lassen Conference Room
Western Shasta RCD
6270 Parallel Road, Anderson, CA 96007

**PURPOSE** The West Coast Regional Carbon Sequestration Partnership (WESTCARB), led by the California Energy Commission, is one of seven US Department of Energy regional partnerships working to demonstrate ways to sequester carbon dioxide and reduce emissions of greenhouse gases linked to global warming. Terrestrial (forestry and land use) sequestration options being investigated for Shasta County include afforestation of marginal rangelands, improved management of hazardous fuels to reduce emissions from wildfires, biomass energy, and forest management.

This meeting will provide an opportunity to report back to those who attended a June 2005 "Shasta County Stakeholders Meeting" in Redding on the results of Winrock's research into forestry and land use opportunities that can sequester carbon and provide benefits to landowners. Secondly, the meeting will provide information to landowners, land managers and other stakeholders on the WESTCARB activities planned for Shasta County. WESTCARB partners will provide an overview of project opportunities, evolving carbon credit markets, benefits and costs of implementing carbon projects, and requirements for measurement, monitoring and reporting.

**AGENDA**

1:00 Welcome
*Mary Schroeder, Western Shasta RCD*

1:05 Meeting Overview
*John Kadyszewski, Winrock International*

- Review of State- and County-level research to date funded by California Energy Commission – Public Interest Energy Research Program

- Overview of WESTCARB terrestrial sequestration activities in Shasta County

1:15 WESTCARB objectives
*Rich Myhre, WESTCARB*

1:30 Afforestation of Marginal Rangelands
- Summary of findings for Shasta County on carbon sequestration from afforestation of rangelands: *Silvia Petrova, WI*
- Overview of WESTCARB afforestation plans: *Tim Pearson, WI*
- Afforestation planting and maintenance techniques: *Bob Rynearson, WM Beaty & Associates*
- PG&E's Climate Protection Tariff - opportunities for landowners conducting afforestation to supply carbon credits: *Dave Goehring, PG&E / Robyn Camp, California Climate Action Registry*

2:10 Open discussion - landowner questions and concerns on afforestation

2:45 Break

3:00 Improved Management of Hazardous Fuels
- Summary of findings for Shasta County on improved fuels management to reduce greenhouse gas emissions from wildfire: *Nick Martin, WI*
- Commercial timberland perspective on fuel reduction: *Bob Rynearson, WM Beaty & Associates*
- Public lands perspective on fuel reduction: *TBD*
- Non-industrial private lands perspective on fuel reduction: *Jack Bramhall, Western Shasta RCD*

3:40 Open discussion - landowner questions and concerns on fuel reduction

4:15 Conservation-Based Forest Management for Carbon Sequestration
*John Nickerson, Pacific Forest Trust*

4:30 Overview of the California Climate Action Registry: opportunities and requirements for landowners, summary of existing forest sector protocols, and new protocol development outlook
*Robyn Camp, California Climate Action Registry*

4:45 Wrap up and next steps
*John Kadyszewski, Winrock International*

5:00 Adjourn

# Annex B: Shasta County Landowner Willingness to Participate Survey

*Purpose*
To identify the types of landowners who may be interested in committing themselves to future participation in climate-change mitigation forest plantation programs and to understand the conditions under which landowners may be interested.

*Objectives*
1. To understand the willingness of Shasta County[8] range landowners to plant trees on their lands for the purposes of carbon sequestration.
2. To determine cost-share levels at which landowners will be willing to plant additional lands to trees.
3. To assess the extent and type of land that individual landowners would be willing to plant if their expectations for cost-share support were met.
4. To evaluate species preferences for plantation on their lands.
5. To validate survey commitments by providing selected landowners with opportunities to plant their lands with pilot project funding.

*Background*
Finding landowners willing to plant additional lands to trees for the purposes of carbon sequestration is an important part of the Shasta County pilot project under the West Coast Regional Carbon Sequestration Partnership (WESTCARB). A survey was proposed and agreed to ensure the landowner selection process will be as objective as possible and at the same time provide valuable data on how landowners perceive the potential opportunities from forest carbon sequestration projects.

*Methods*
This study will be implemented by the Western Shasta County Resource Conservation District, supervised by Leslie Bryan of the RCD with guidance from Winrock International.

Landowner target groups will be those who own range, scrub or disturbed forest lands on which natural forest or plantations do not currently exist. Three categories of landowner have been identified as a useful stratification of the sample population of landowners:

A. Family landholdings that have been held for two or more generations in the same family, and for which the current owners have made some form of commitment that these lands will remain in family ownership well into the future.

[8] Shasta County is the official location of WESTCARB pilot activities. However landowners in neighboring counties, interested in similar activities and with similar land types, may also be surveyed for potential involvement.

B. Landowners who have part-time interests in the land, are most likely absentee-owners and have few financial investment constraints for their properties.
C. Owner-occupants who are first-generation owners of the land

The survey will be administered to at least 20 owners in each of these three strata, or about 60 landowners total, if possible. Landowners will be selected by the RCD using their records, selecting landowners in each of the three classes above. If feasible, a minimum landholding size of 100 acres should be targeted, but landowners with smaller holdings but strong interest should not be excluded. Phone contact with potential interviewees will be made by the RCD as the list of survey participants is constructed.

The survey is designed to take 15 minutes or less after the initial introductory explanations and pleasantries. It is assumed that the RCD will be able to identify the land holdings and have cadastral and vegetation data for each of them before the interviews take place.

Survey methods will be determined by the RCD based on their experience. Options include phone interviews, on-site interviews by an RCD staff member (preferable to phone interviews if time permits), or possibly administering the survey in conjunction with a watershed group meeting. The interviewer should begin by providing a brief explanation about WESTCARB, climate change, afforestation opportunities for landowners, opportunities to market carbon credits from afforestation in California, and the purpose of the survey. If done in a watershed group meeting, this general introduction could be made to the group and then the survey administered individually.

The interviewer should complete the attached interview data sheet during or immediately after the interview.

Data from the interview data sheets will be entered by the RCD into an Excel spreadsheet to be provided by the Winrock survey coordinator. Original data sheets will be retained by the RCD until the completion of the Project. The completed Excel worksheet will be provided by the RCD to the Winrock survey recorder for statistical analysis by Winrock.

The RCD interviewer may bring along with them a map of the land holding (preferably with cadastral boundaries over an aerial photo backdrop) so that specific land areas where a landowner is interested in planting trees can be marked. Alternately, this can be done in a follow-up meeting if the RCD believes landowners would be more comfortable with a two-step process.

**Interview Data Sheet**
**Shasta County Landowner Willingness to Participate Survey**

Interviewer name: _____
Date of interview: _____

**This section to be completed before the interview:**
Landowner name: _____
Site identifier: (RCD to use their own resources to positively identify the parcel(s) the owner(s) will discuss during the interview)
Land holding size: _____acres
Ownership strata: _____ Family-owned (A)
_____ Absentee/part-time occupant (B)
_____ Full-time occupant, first-generation (C)

**Following information to be collected during the interview:**

| Question | Response |
|---|---|
| 1. Confirm parcel information noted above, correct as needed | |
| 2. What would you need in order to be willing to plant additional trees on your land? | Circle all that apply:<br><br>A. Nothing needed, plan to do anyway<br>B. Cost-sharing for planting cost<br>C. Cost-sharing for planting and maintenance cost<br>D. Cost-sharing for irrigation, tree protector systems, or associated costs<br>E. Opportunity to market wood products from project<br>F. Opportunity to market carbon credits from project<br>G. Seedlings<br>H. Additional information<br>I. Other: |
| 3. If cost-sharing is required:<br>What level of cost-sharing would you require? | _____ $ per acre or<br><br>_____% of total cost |

| | |
|---|---|
| 4. If everything specified above was provided (e.g. cost-sharing, information, seedlings, etc) how much land would you potentially be willing to plant with trees? | _____ acres or<br><br>_____% of total holding |
| 5. Willingness to participate in annual photo documentation and 2 page survey for 10 years | Yes or No |
| 6. Landowner Objectives | Record landowner property objectives in rough order of priority:<br>A. Income production<br>B. Aesthetics<br>C. Recreation<br>D. Timber production<br>E. Homestead<br>F. Other (list here): |
| 7. If interested and prepared to do so, can you designate which parts of your land you would be willing to plant? [OPTIONAL] | [This question should only be asked if the landowner is strongly interested and ready to designate on the map of their landholding specific areas/vegetation types they would be willing to plant. Otherwise, this step can be done in a follow-up meeting with interested landowners.] |
| 8. What is the current state of the proposed site? | Record any site description information available such as accessibility, slope, existing vegetation, etc. |
| 9. Which tree species would you most like to plant on your lands? | Circle all that apply:<br><br>A. Commercial hardwoods<br>B. Commercial softwoods<br>C. Mixed hardwoods/softwoods<br>D. Non-commercial hardwoods<br>E. Non-commercial softwoods<br>F. Brush species to improve wildlife |

| | |
|---|---|
| | habitat and privacy<br>G. No preference<br>H. Not sure<br>I. These species (list here): |
| 10. What concerns do you have about tree planting on your property? | Circle all that apply:<br><br>A. No Concerns<br>B. Decreased forage<br>C. Increased fire risk<br>D. New Federal or state regulations<br>E. Increased land management costs<br>F. Other (list here): |
| 11. Please feel free to add any other comments. | Record landowner's comments or concerns. |

# Annex C: Site-specific planting and maintenance plans for WESTCARB afforestation pilots

**WESTCARB II – REFORESTATION PROPOSAL**

**RED RIVER FORESTS - SHINGLETOWN**

BACKGROUND

Legal: T31N R01E Sec 24

Acres: 160 (project estimate is for just 50 acres, but could do more if needed)

Access: Excellent. paved county road to unit & less than one mile from to State Hwy 44..

Annual Avg PPT: approx. 45" to 50" (rain & snow)

Seed Zone: 522

Elev: 3,880'

Slope: 0%

Aspect: n/a

Site Class: III?? Dunning.

Soil Type(s): Windy and McCarthy Stony Sandy Loam; depth 40-60"; well drained & mod. To high permeability

Vegetation: mostly greenleaf manzanita brush w/ some prunus.

Frost-free period = _____ days,

Brushfield well defined on photos but would need to delineate specific project area and flag, GPS and precisely map. The following plan was based upon previous visits (fall 2006) to the property and also from examining aerial photos, soils maps, etc..

PROJECT PLAN

1. Summer 2007: Pile brush w/ cat equipped w/ brush rake.
2. Fall 2007: burn piles
3. November 2007 (or immediately after snow melt in Spring 2008): Broadcast by helicopter pre-emergent Velpar DF spray to keep brush, forb and grass seeds from germinating and competing w/ seedlings.
4. Late March – mid April 2008: plant 15,000 NSTIA lot 1N PP seedlings.
5. Spring/Summer 2009: Follow up directed foliar release spray by handcrews. If no release occurs within Grant time limits, then a spray will likely be needed in 2010 or 2011 after the Grant has expired.

**WESTCARB II – REFORESTATION PROPOSAL**
**BROOKS WALKER ET AL – TABLE MT. BRUSHFIELD**

BACKGROUND

Legal: T33N R2E Sec 36 (S½)

Acres: 14

Access: Fair-poor. Several miles of maintained, seasonal dirt logging roads to access unit which is ¼ mile away from road.

Annual Avg PPT: approx.60" (mostly snow)

Seed Zone: 522

Elev: 5,440'

Slope: 25-30%

Aspect: S to SW

Site Class: III? Dunning.

Soil Type(s): Need to verify: Nanny Gravelly Sandy Loam & Windy & McCarthy very stony sandy loam

Vegetation: mostly greenleaf manzanita brush w/ some snowbrush and Fremont silktassle

Frost-free period = 90? days,

Brushfield well defined on photos . The following plan was based upon previous visits (fall 2006) to the property and also from examining aerial photos, soils maps, etc.. Even though this is only 14 acres on some tough brush, there are nearby operational projects that would keep some of the fix costs low if funding were available from the grant to reforest this brush field on stony soils.

PROJECT PLAN

1. Summer 2007: Pile brush w/ cat equipped w/ brush rake.
2. Fall 2007: burn piles
3. Fall 2007 Broadcast by hand pre-emergent Velpar DF spray to keep brush, forb and grass seeds from germinating and competing w/ seedlings.
4. April - May 2008: plant pond pine, red fir and doug fir seedlings that are in excess of adjacent operational planting job.
5. Spring/Summer 2009: Follow up directed foliar release spray by handcrews. If no release occurs within Grant time limits, then a spray will likely be needed in 2010 or 2011 after the Grant has expired.

**WESTCARB II – REFORESTATION PROPOSAL**
**HENDRIX – PHILLIPS TREE FARM**

BACKGROUND

Legal: T33N R1W Sec 16 (SW¼)

Acres: (very approx.) 20
Access: seasonal dirt road into unit a few miles from paved county road.
Annual Avg PPT: approx. _____" (mostly rain)
Seed Zone: 522
Elev: approx. 2,200'

Slope: 0% - 30%

Aspect: none to all
Site Class: II to IV Dunning

Soil Type(s):

Aiken Stony Loam: loam, deep (60"+) well drained, rocky

Aiken Loam: loam, deep well drained, not rocky.

Cohasset Stony Loam: 48"-60" deep, well drained

1. Supan very Stony Loam: 24-40" deep; very stony

Vegetation: scattered trees (black oak, grey pine & pond pine) and brush: primarily whiteleaf manzanita with some greenleaf manzanita, buckbrush, buckeye and poison oak; and some forbs and grasses.
Frost-free period = _____ days,

Specific project area needs to be laid out if project is approved. The following plan was based upon a site visit w/ landowner. Due to configuration of brush vs. timber edges only a very rough approximation of acres was possible (20 acres), needs field layout of boundaries to calculate actual acres that would be suitable for reforestation. Although grey pine and very low vigor ponderosa pine are growing in the brush, the area can support good ponderosa pine growth provided brush (that is competing aggressively for limited summer soil moisture and light) is controlled during establishment and early growth phase. The 20 acre understocked area consists of 4 soil types with Cohasset and Aiken being deep, well drained loams and very suitable for ponderosa pine establishment and growth and the Supan soils being shallower and poorer, but still adequate for growing ponderosa pine.

PROJECT PLAN

1. Summer 2007: Pile brush w/ cat equipped w/ brush rake. Do not pile live black oaks.
2. Fall 2007: burn piles
3. Feb.-early March 2008: In conjunction w/ planting and seedling protection installation, first: Broadcast by hand pre-emergent Velpar DF spray to keep brush, forb and grass seeds from germinating and competing w/ seedlings.
4. Feb.-early March 2008: Immediately after broadcast spray plant 6,000 seedlings w/ 1foot x 1 foot scalp to remove Velpar and weed seeds away from seedlings.
5. Feb.-early March 2008: immediately after planting install mesh netting around seedlings.

6. Spring/Summer 2009: Spray re-sprouting poison oak (and if needed manzanita seedlings) if there is satisfactory window within confines of Grant term. If no release occurs within Grant time limits, then a spray will likely be needed in 2010 or 2011 after the Grant has expired.

**WESTCARB II – REFORESTATION PROPOSAL**

**Denny Land & Cattle Co. - Goose Ranch (Lake Margaret)**

BACKGROUND the following information pertains to proposed reforestation area(s):

Location of Potential Reforestation Area: T35N R2E Sec 8 (NE ½ of NE ¼; NE ¼ of NW ¼; SE ¼ of NW ¼ and NE ¼ of SW 1/4) North and west of Lake Margaret approximately 5 miles west of Burney, CA. On lands burned in the 1992 Fountain Fire.

**Acres**: approx. 60 to 100+ (*suitable & feasible for reforestation project*)

**Access**: Excellent. Via two locked gates on good rocked road that provides excellent access through the northern portion of proposed reforestation unit about 4 miles from Hwy 299E. Crews have access into the unit and a D7 crawler tractor can be transported by low-bed into the unit. Further access throughout the unit can be opened for hand planting and spray crews after a dirt road within proposed reforestation unit is cleared during piling operations.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
Located and GPS'd NE Corner of Sec. 8 T35N, R2E and found some old blazed trees South and West of corner. Where proposed unit borders adjacent ownerships, lines are easily Identifiable by 10+ year old planted PP on adjacent ownership or blazed line in timber.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project) The landowner's RPF, Dennis P. indicated that there are no easements or utilities etc. within the proposed area.

**Sensitive areas** (e.g. streams, springs, unstable areas, archeological sites etc.): Lake Margaret. Landowner's RPF. requested a 150 foot buffer from high water mark for clearing and spraying. Dennis P. does not know of any arch. sites or unstable areas in clearing area and none observed on quick walk down brush covered road. Landowner does not want to use soil active herbicides such as Velpar or atrazine. But would allow use of glyphosate and possibly imazapyr products.

**Annual Avg PPT**: Approx. 50" to 60" in the form of rain and snow (according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)

**Seed Zone**: __521__

Elev: approx. 3,680' to 3,900'

Slope:__0__% - __20__%

**Aspect(s)**: __South & East facing__

Site Class:_ Dunning Site II; CACTOS site index 74;

**Soil Type(s)**:

1) ***Depner Gravelly Sandy Loam*** *(Approximately 30 acres): Tephra parent material; sandy loam, deep (40" to 60"), well drained, moderately rapid permeability; very high available water capacity;*
2) ***Wyntoon Sandy Loam*** *(Approximately 30 acres in N ½ of NE ¼ Sec. 8):: parent material = alluvium derived from igneous rock; sandy loam; deep (> 60"); high available water capacity, well drained.*

**Vegetation**:

Brush: Primarily Ceanothus cordulatus (whitethorn), approx. 5' high, thick, 15+ years old; with some bracken fern, manzanita, squaw carpet & gooseberry. Trees: 2 to 10% cover of scattered black oak and some willows. Some grasses & forbs.

**Frost-free period** = 80 to 100 days,

**THPs, CFIP, FIP projects etc.**:.

In hopes of getting CFIP funding, or cost share funding from another source, Landowner's RPF contracted to grow at Cal Forest in Etna the following for outplanting spring 2008:
PP: 10,800 Fruit Growers seed, Lot #5
DF 3,600 Fruit Growers seed, Lot #7
IC 3,600 521-4.0, 95-IC-11

General comments: Landowner's RPF said that they would like to use WESTCARB II funds to site prep in 2007 and plant in spring 2008 seedlings that they have currently growing in nurseries which would reforest about 60 acres. He would then apply for CFIP funding to site prep and plant later the remaining 100+ understocked areas of the ownership. So he needs to know fairly soon if Winrock is interested in using WESTCARB II funds for planting the seedlings currently growing in the nursery.

A portion of Landowner's share would be paid for by contribution of 18,000 seedlings at approximate value of: $3,640

*Note: Although the following plan is based upon planting only 60 acres using only Goose Ranch's 18,000 seedlings under contract @ Cal Forest, this site is also suitable for NSTIA 1N seedlings owned by WESTCARB II grant and currently growing at Cal Forest Nursery for outplanting in Spring 2008. So, if no other landowner is agreeable to planting the 10,500 NSTIA 1N seedlings which are still not attached to an agreed upon 2008 planting project, then another 35 acres can be site prepped in 2007 for planting in 2008 in addition to the proposed 60 acres.*

PROJECT PLAN

1. Summer 2007: Pile 60 acres with a D-7 Cat equipped with a brush rake.
2. Fall 2007: Activity: Burn piles on 60 acres (if conditions are not right and/or piles not sufficiently dry, then burn piles in fall 2008).
3. March or April 2008: Plant 60 acres at 300 trees per acre with: 10,800 Ponderosa pine 3,600 Douglas- fir and 3,600 incense cedar (seedlings from landowner)
4. late April to May 2008: Directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray 5% generic glyphosate formulation (e.g. Buccaneer, Razor etc.) mixed w/ 5% methylated seed oil (e.g. Hasten, MSO or MOC etc.)
5. Spring 2009: Monitor for need to apply follow-up spray treatment. If needed and WESTCARB II funds are still available, negotiate spray agreement (cannot determine need or estimate cost until summer of 2008 or spring of 2009).

**WESTCARB II – REFORESTATION PROPOSAL**

**The Lammers Ranch – Lammers Properties, L.L.C. - Robert Lammers**

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T35N R1E, S ½ of NE ¼ of Section 34

**Acres**: 53 (*suitable for proposed reforestation project*)

**Access**: Excellent: Less than 2 miles south of Hwy 299E off of the Moose Camp Rd and accessed by private rocked road across Roseburg Resources Co. to the rocked road that borders the west side of project area. A crawler tractor can be low-bed transported directly to the project area. Spraying and planting crews can access all sides of the unit via rocked main road on west edge and a 4WD dirt road around the remainder of the project area.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
Property lines between Lammers and Roseburg Resources on the North and East side of the proposed project are clearly identified by a fence that separates Lammers' road encircling the project area and Roseburg's 10+ year old plantation. The east ¼ corner of Section 34 and the N 1/16 corner Sections 34/35 were located.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): Robert Lammers stated that there were no easements or utilities within the project boundaries.

**Sensitive areas** (e.g. streams, springs, unstable areas, arch. sites etc.): There are no streams or wet areas within the proposed project area. There is an unnamed tributary to Goat Creek west of the project area. This tributary flows out of the Lammer's meadow property in a NE direction through Roseburg Resources Co. Summer flows in this portion of the tributary are dependent upon irrigation water that is piped into the meadow by gravity flow from Goat Creek and several springs to the east of Lammers' property. Rainbow and brown trout have been observed in the tributary and Goat Creek (as per Lammers' 1998 Forest Management Plan prepared by Lloyd Keefer, RPF). The landowner does not know of any pre-historic or historic sites within the project area.

**Annual Avg Precipitation**: 50 to 60" almost all in rainfall *(according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)*

**Seed Zone**: 522 (NE portion of 522, only about one mile from the SE portion of zone 521).

Elevation: approx. 3,900'

Slope: 0% - 5%

**Aspect(s)**: n/a

Site Class: Dunning site III (estimated).

Soil Type: Windy & McCarthy stony sandy loams: Parent material = residuum weathered from basalt. Stony sandy loam; well drained; moderately deep (48" to 52" depth to bedrock); rapid permeability; slightly to moderately acid.

**Vegetation**: Prior to the 1992 Fountain Fire the vegetation in the proposed project area was Sierra Mixed Conifer forest. After the 1992 Fountain Fire the mixed conifer forest was replaced by brush, mostly greenleaf manzanita (Arctostaphylos patula) with very minor amounts of whitethorn (Ceanothus cordulatus) and deerbrush (Ceanothus integerrimus), and less than 5% cover of re-sprouted black oak trees (Quercus kelloggii) interspersed in the brush, primarily in the southern portion of the project area.

**General comments:**

The landowner is interested in planting ponderosa pine and Douglas fir which are well suited to the site and would not easily naturally seed into the area as would more shade tolerant conifer species (white fir and incense cedar) that produce more frequent crops of lighter weight seed that disperses much further in the wind. This is a suitable site for "High" NSTIA ponderosa pine orchard seed which should provide at least 10% or greater volume (i.e. carbon) growth than seed collected in the wild from unknown pollen sources.

All of the brush species in the project area are vigorous resprouters. Unlike the two manzanita species at lower elevations, Arctostaphylos viscida and A. manzanita, that do not normally resprout, the manzanita species at this elevation (Arctostaphylos patula) is a resprouter. So the most appropriate method of site preparation would be to clear and pile the brush. The most appropriate disposal method for the brush piles likely would be burning. However, Burney Mountain Power is twelve miles to the east in Johnson Park and depending on wood fuel market conditions, might be interested in removing the brush for biomass energy fuel.

Although there are other brushfield reforestation projects proposed in the 1992 Fountain Fire area, this proposed project is on a different soil type and different main brush type (manzanita), and at a higher elevation. The landowner has also demonstrated a commitment to reforesting his forest lands that were burned in the 1992 Fountain Fire by his cost share work with the NRCS to treat brush and plant other portions of his property.

**PROJECT PLAN**

1. Summer/Fall 2007 Winrock (or its consultant, Bob Rynearson) locate and purchase Douglas-fir seed from appropriate zone and elevation and NSTIA H 521/522 ponderosa pine seed from CDF or another NSTIA cooperator (private company).
2. Fall 2007: Winrock (or its consultant, Bob Rynearson) contract with Cal Forest Nursery to grow 10,570 styro 5 containerized ponderosa pine and 4,530 styro 8 Douglas-fir seedlings for outplanting in spring 2009. Ship seed to Cal Forest Nursery by November 2007.
3. Summer 2008: General Contractor (or its subcontractor) clear and pile brush on 53 acres, retaining black oaks where feasible and leaving brush around some of the oaks as micro-site cover for wildlife.
4. Late October or early November 2008 (after start of fall rains but before winter snow): General Contractor obtain necessary permits and broadcast spray 3 lbs. Velpar DF per acre on 53 acres.
5. Late Fall 2008: General Contractor prepare and submit Smoke Management plan and obtain necessary permits and burn piles.
6. January, February or early March 2009 (after seedlings lifted and packed at nursery): General Contractor transport seedlings from Cal Forest Nursery and place in cold storage.
7. Late March or April 2009 (after snowmelt when soil temperature is at 42 degrees or higher): General Contractor plant 10,570 styro 5 containerized Ponderosa pine and 4,530 styro 8 containerized Douglas-fir seedlings on 53 acres at 285 trees per acre (12′ x 12′ spacing & 12′ from existing black oak trees).

**WESTCARB II – REFORESTATION PROPOSAL**

**David Frase – George Belden** (landowner - RPF)

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T33N R5W Section: S ½ 29

**Acres**: 50 gross and approx. 43 net plantable (*suitable for reforestation project*)

**Access**: Very good: 3 miles from pavement, a dirt road accesses the project area. In June 2007, BLM constructed a road which accesses the project area on the east end along the ridge and was then GPS'd by Bob Rynearson w/ Garmin 76CSx . According to BLM, plans are to rock the road within the next few years.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
No surveyed lines or corners were located during the site visit. The landowner's RPF, George Belden said that all of the masticated area is within the ownership. note: The project area including masticated units, roads and property lines was mapped using NAIP photos controlled by a Shasta County assessors map to fit USGS public land survey lines and some portions of masticated areas mapped out as being south of the property line. So the property line on the south needs to be confirmed and/or a surveyed corner needs to be GPS'd to establish better control for more accurate mapping of property lines.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): Need to check with the landowner and/or RPF to see if there are any easements or utilities that would be impacted by the proposed reforestation project.

**Sensitive areas** (e.g. streams, springs, unstable areas, arch. sites etc.): There is a "wet" area in the draw east of the dirt 4WD road which was not masticated and will be excluded from spraying and planting operations.

**Annual Avg. Precipitation**: 50" to 60" almost all in rainfall *(according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)*

**Seed Zone**: 521 (SW portion of seed zone).

Elevation: approx. 800'

Slope: 0% - 20%

**Aspect(s)**: slightly East, South or West facing

Site Class: possibly low Dunning site III to site IV.

Soil Type: The Shasta County Soils Map provided by the NRCS lists the soil as "Goulding very rocky loam, 30 to 50 percent slopes, eroded" which is described as a shallow (16" to 20") soil. However the actual slope within the project area is only 0 to 20 percent. Although the soil description does not indicate it is a forest soil there are many healthy ponderosa pine trees growing within the project area. The landowner's RPF, George Belden, indicated that the site class on the slopes is a Dunning IV and on flatter areas a low III. The parent material of Goulding very rocky loam is residuum weathered from greenstone.

**Vegetation**: Until 2005 the project area consisted of dense, 8 to 15 foot tall manzanita (90% to 100% cover) with a very scattered ponderosa pine, knobcone pine and gray pine overstory (5% to 10% cover). This vegetation type likely formed after a ponderosa pine forest was killed in the very early 1900's as a result of mining and copper smelting operations. In the spring of 2005 the landowner mechanically masticated

approximately 50 acres (net 43 acres with approximately 7 acres of brush left for habitat and/or riparian protection). This low elevation manzanita does not significantly re-sprout, so the current brush includes a dense population of manzanita seedlings (about 1′ tall) over the entire area that germinated from seed after mastication; sparse to moderate cover over the entire area of Toyon (2′ to 6′ tall), coffee berry (2′ to 6′ tall) and poison oak (2 to 4′ tall); and a moderate cover of blackberries on only about 4 acres. Grasses and forbs cover about 60% of the area where the masticated slash layer is not covering the ground or is very shallow. Current trees include: 2′ to 3′ tall black and live oak and scattered ponderosa pine, gray pine and knobcone pine from seedling size to 80′ tall. Small knobcone and gray pines seedlings that seeded in after the ground was exposed in 2005 are sparsely populated throughout the area, but the ponderosa pine has not seeded in much after the mastication so most of the sparsely populated ponderosa pine are large trees ranging from approximately 12″ to 24″ dbh.

**General comments:**

This area is typical of tens of thousands of acres below 2,000 foot elevation where fumes from the copper smelting circa 1910 killed all the vegetation from Kennett south to Red Bluff, along the west side of the Sacramento River. Prior to the ponderosa pine die-off from the smelting, some of the forest in this general area was probably harvested in the very late 1800s and/or very early 1900's for fuel and mine timbers. Most of the ponderosa pine that has regenerated in the general neighboring vicinity of the project area were planted by the CCC in the 1930s. Survival was spotty but where seedlings survived the trees have grown fairly tall, even on steep slopes that were heavily impacted by gully erosion. Most of the general area, however, is occupied by decadent brush which periodically burns. Soil erosion subsequent to the smelting-caused vegetation die-off has likely degraded the site productivity, but more so on the steeper slopes in the general vicinity. The scattered naturally regenerated trees on the project area seem to be growing well possibly due to soil build up over the many decades of litter fall from the brush on the gentle slopes within the project area.

Since there are still several thousand acres of this former ponderosa pine habitat that is now occupied mostly by brush, this project would make an excellent pilot project for reforestation. Due to the very low elevation, hot dry summer climate and somewhat eroded soils, there is a greater risk of plantation failure than there is for projects at higher elevation sites with non-eroded soils. The landowner seems willing to try planting the site back to ponderosa pine even though conifer seedling establishment is a little risky on this site.

Since the soils were eroded several decades ago, after the forest was denuded, and it is a low elevation, hot summer site, masticating the old brush rather than piling it was a wise choice for site preparation. Instead of mechanically clearing the 2 to 4 foot tall brush that has now invaded the project area, a chemical treatment would be much more appropriate to prepare the site for planting conifers. This treatment will not only preclude the need to mechanically disturb the shallow soils, it will also provide dead shade during the hot summer for young seedlings that will be planted into the site.

There is another 30 to 40 acres of heavy brush on gentle slopes on the north portion of the property which can be masticated in preparation for planting ponderosa pine. The landowner indicated interest in possible participation for this work under WESTCARB II grant cost share funding. However at this time, with the uncertain progress of the BLM road construction that would provide better access, this project proposal does not include plans for that reforestation work. But it is a project to consider under WESTCARB II (if time allows) or the California Forest Improvement Program (CFIP) when the road construction is completed.

PROJECT PLAN

1. Summer 2007: Winrock (or its consultant, Bob Rynearson) locate and purchase ponderosa pine seed from lowest elevation 521 source available.
2. Fall 2007: Winrock (or its consultant, Bob Rynearson) contract with Cal Forest Nursery to grow 11,610 styro 5 containerized ponderosa pine seedlings for outplanting in winter 2008/09. Ship seed to Cal Forest Nursery by November 2007.
3. February – early April 2008 (depends on seasonal growth stage of target vegetation): General Contractor purchase chemical & conduct chemical site preparation consisting of three distinct treatments using handcrews equipped with backpack sprayers:
    1. On 43 acres, to control manzanita (6" to 2' tall), poison oak, forbs and grasses: Broadcast foliar spray application of 2,4D Low Volatile ester, 4 lb/gal a.i., @ 3qt/ac (or 2 qt/ac @ 6 lb/gal a.i.) + generic Roundup original formulation (e.g. Buccaneer, Razor etc.) @ 1.5 qt/ac.
    2. On 43 acres, to control Toyon and Coffeeberry (2' to 6' tall): Directed foliar application of 2% Chopper (a.i. imazapyr) + 2% generic Roundup original formulation (e.g. Buccaneer, Razor etc.) mixed w/ 5 % methylated seed oil
    3. On 4 acres to control Himalayan blackberries: Directed foliar application of Garlon 4 @ 1%.
4. Winter 2008/09 (Dec. '08 or Jan. '09): General Contractor transport from Cal Forest Nursery, place in cold storage and then plant 11,610 styro 5 containerized Ponderosa pine seedlings on 43 net acres at 270 trees per acre (12' x 12' spacing & 12' from existing ponderosa pine).
5. Winter 2008/09 (Immediately after planting): General Contractor purchase & install seedling protection netting (8 mil "light" netting should be sufficient) on 11,610 styro 5 containerized Ponderosa pine seedlings.
6. February or March 2009: General Contractor purchase chemical & conduct directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray newly emerging forbs and grasses with 2% generic Roundup original formulation (e.g. Buccaneer, Razor etc.) mixed w/ ¼ % non-ionic adjuvant.

**WESTCARB II – REFORESTATION PROPOSAL**

**Kloeppel** (landowner name)

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T35N R1W Section: NE ¼ 25

**Acres**: approx.50 to 120 (*suitable for reforestation project*)

**Access**:. Excellent: Paved roads (Woodhill Rd, Cove Rd and Hwy 299E) are very close to reforestation units and a seasonal dirt/gravel roads access unit from these paved roads.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
Property lines fairly well identified. NE section corner of 25 located and GPS'd. property line to north is Roseburg Resources young plantation.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): PGE easements for above ground lines (500 KV and smaller line) are located on property and are fairly well delineated.

**Sensitive areas** (e.g. streams, springs, Unstable Areas, Arch. sites etc.): A ditch and/or water line runs on south side of property. There is one draw in or near the project area, but there are no seasonal or permanent watercourses. Landowner has a well for domestic use. He is OK with glyphosate, but would rather not use a soil active chemical that could leach into the water table on this high rainfall site.

**Annual Avg PPT**: approx. 60" mostly rainfall

**Seed Zone**: 521/522 (Just north of boundary between 521 and 522). This area is an excellent fit for the NSTIA 1N seed lot that is currently being grown at Cal Forest Nursery for 2008 outplanting.

Elevation: approx. 2,900' to 3,160'

Slope: 0% - 20%

**Aspect(s)**: slightly west and/or south facing

Site Class: Dunning site II or better. (ponderosa and Douglas-fir trees planted on same soil type on adjacent ownership (Roseburg) about a decade ago are growing very well).

Soil Type: Cohasset Stony Loam: Soil texture: loam ; depth:48-60 inches; rockiness: stony; drainage: well drained, moderate permeability;

**Vegetation**: brush: 95% brush cover w/ 90% consisting of 6 to 10 foot tall deerbrush (Ceanothus integerrimus). In more open areas of lighter brush areas of deerbrush, chinkapin, manzanita, poison oak, dogwood, bracken fern and squaw carpet and some forbs and grasses. 5 to 10% cover of trees consisting mostly of scattered black oak and a few big leaf maple. Prior to 1992 Fountain Fire, the area was a mixed conifer forest primarily ponderosa pine and Douglas fir and some black oak in the understory.

**THPs, CFIP, FIP projects etc.**: THP approved in 1992 a few months before Fountain Fire. .

**General comments:**

The landowner is interested in planting ponderosa pine and was concerned that Douglas fir (DF) would not fit since many residual DF have recently died. I pointed out that those DF were likely weakened from fire damage and have finally died. I noted stumps and logs on the ground of large DF trees that were killed in the fire. The site is very good for growing both ponderosa pine and DF.

This is an excellent site and elevation to plant the NSTIA 1N seedlings growing at Cal Forest Nursery for planting in 2008. Since there are currently about 10,500 seedlings that still need a site for 2008 planting, I recommend that 50 acres be planted at 300 trees per acre w/ 70% NSTIA 1N ponderosa pine (50 acres x 300 TPA x 0.7 = 10,500 NSTIA 1N PP) and 30% Douglas-fir. I would need to contact some other foresters in the area to see if we could purchase 4,500 DF that are now growing in a nursery.

Also, there are many more acres in need of reforestation, so if Winrock decides that the grant could/should fund more, then I could write up a proposal for 30 to 50 more acres to reforest in addition to the 50 acres in the following plan and estimates.

PROJECT PLAN

1. Summer 2007: Pile 50 acres with a D-7 Cat equipped with a brush rake. Contact neighboring industrial landowners for availability of 4,500 Douglas-fir seedlings to purchase for 2008 outplanting.
2. Fall 2007: Activity: Burn piles on 50 acres. (if conditions are not right and/or piles not sufficiently dry, then burn piles in fall 2008)
3. Early Spring 2008: Plant 50 acres at 300 trees per acre with 10,500 Ponderosa pine and 4,500 Douglas-fir (need to purchase 4DF seedlings). If no DF seedlings are available then plant 35 acres with NSTIA 1N PP in 2008 and the remaining 15 acres in 2009.
4. Immediately after planting, install seedling protection netting (8 mil "light" netting should be sufficient).
5. Spring 2008: Directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray 5% generic glyphosate formulation (e.g. Buccaneer, Razor etc.) mixed w/ 5% methylated seed oil (e.g. Hasten, MSO or MOC etc.)
6. Spring 2009: Monitor for need to apply follow-up spray treatment. If needed negotiate spray agreement (cannot determine need or estimate cost until summer of 2008 or spring of 2009).

**WESTCARB II – REFORESTATION PROPOSAL**

**Darryl Deaton property**

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T29N R9W, N½ Section 17

**Acres**: 50 acres (*suitable for proposed reforestation project*)

**Access**: Excellent: Project area is approximately ¼ to one mile NW of Hwy36 and accessed by ¼ mile of rocked road (where a lowbed trailer could unload a crawler tractor) and then ¼ mile of dirt road that transects most of the project area.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
According to the landowner all of the reforestation units proposed for planting are well within his property.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): The PG&E transmission easements (overhead lines) on the property should be excluded from the project area. The landowner did not mention any other easements or utilities within the proposed project area.

**Sensitive areas** (e.g. streams, springs, unstable areas, arch. sites etc.): There are no streams or wet areas within the proposed project boundary units.

**Annual Avg. Precipitation**: 30" to 40" mostly in rainfall *(according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)*

**Seed Zone**: SW edge of 332 (about one mile north of the NW portion of zone 371).

Elevation: Approx. 2,600' to 2,700'

Slope: 0% - 20%

**Aspect(s)**: around ridges with aspects facing all directions

Site Class: Very low. Marginal for commercial conifers.

Soil Type: According to the NRCS Shasta County Soil Survey the two soils in the project area are listed as "Maymen very stony loam, 30 to 80 percent slopes, eroded" with "depth to lithic bedrock at 13 to 17 inches" and Millsholm gravelly loam, 30 to 50 percent slopes" with depth to lithic bedrock at 16 to 20 inches". However the project area is on flat to 20% slopes and the soils are at least 24" deep based upon digging a few test holes and observation of soil profile at road cuts. The parent material for both soil types is described as: "residuum weathered from sedimentary rock". The Available water capacity class for both soil types is listed as "very low", 1.5 inches (Maymen) to 2.1 inches (Millsholm) of water in the top 5 feet.

**Vegetation**: Old, dense brush consisting mostly of chamise (*Adenostoma fasciculatum*) and buckbrush (*Ceanothus cuneatus*) with some greenleaf manzanita (*Arctostaphylos patula*).

**General comments:** The landowners objectives are to reduce the high fire hazard risk and protect and enhance the watershed and wildlife resources over time by replacing dense, decadent brushfields with a forest of native pines (gray and ponderosa) and oaks. Effects from historical grazing and fire management practices (and possibly other practices) in the general area have combined with the climate and soils to create tens of thousands of acres of brush that grows old and decadent and then periodically burns such that few conifers, especially ponderosa pine, are left on the landscape. Oaks which re-sprout

after fire and gray pine which seeds into poorer sites better after catastrophic wildfire provide sparse to moderate cover over some of the general area. But it appears some of the long past grazing practices in combination with fire and climate regime has left many thousands of acres in the general area with much less oak forest cover than is possible.

The proposed project area is a typical example of a brushfield in the general area that likely could support blue oak and gray pine and possibly even ponderosa pine. The landowner is interested in planting ponderosa pine even though the site is marginal for commercial conifers and there is less chance of seedling survival than there is on better conifer sites. Experience in the area indicates that after brush removal a fair amount of gray pine seedlings are likely to naturally seed into the project area, even with the very sparse overstory of gray pine (<1% cover). The landowner is also interested in establishing some blue oaks in the project area. There has not been enough operational sized oak regeneration projects completed in California to provide a reliable track record for success with this proposed large scale oak regeneration project, but the landowner seems willing to try. Regardless of seedling survival success, clearing the brush for site preparation will have the added benefit of reducing hazardous fuel conditions along key ridge tops.

Considering the very low water holding capacity of the soils and the long, hot and dry summer climate, controlling vegetation which would compete aggressively for limited soil moisture during the first few years of conifer and oak seedling establishment is critical. Controlling the re-invasion of brush would have the added benefit of keeping hazardous fuel loads from growing back to the current very hazardous fuel loads.

**PROJECT PLAN** (*Although the soils and climate make the chance of successfully afforesting this proposed pilot project area less than it would be for the other sites proposed to date for WESTCARB II afforestation, the careful implementation of the following plan should provide the best chance of success.*)

1. Summer/Fall 2007 Winrock (or its consultant, Bob Rynearson) locate and purchase ponderosa pine seed from zone 332 or 371 and as close as possible to 2,700′ elevation.
2. Fall 2007: Winrock (or its consultant, Bob Rynearson) contract with Cal Forest Nursery to grow 13,250 styro 5 containerized ponderosa pine for outplanting in spring 2009. Ship seed to Cal Forest Nursery by November 2007.
3. Summer 2008: General Contractor (or subcontractor) using crawler tractor equipped with a brush rake, clear and pile brush on 50 acres, retaining oaks and gray pines and leaving as much small woody debris to cover the ground as operationally feasible.
4. Late Fall 2008: General Contractor prepare and submit Smoke Management plan and obtain necessary permits and burn piles on 50 acres.
5. Fall 2007 or 2008: Landowner and Winrock's consultants monitor blue oak acorn crop on his property and if there is a good healthy crop then when acorns are ripe: Winrock or WSRCD? or General Contractor? collect acorns, sort out culls w/ water immersion & store sound seed.
6. Late December - January 2007 or 2008 (after sufficient rainfall replenishes soil moisture) General Contractor plant blue oak acorns on 50 acres averaging 30 spots per acre (precise, equal distant spacing not required or even desired) @ 2 acorns per spot. Install 1,500 4′ tall Tubex Treeshelters and anchor with 5′ lightweight metal fence posts. Spray any weeds, if present, within 4′ of planting spots.
7. January 2009 (after seedlings lifted and packed at nursery): General Contractor transport ponderosa pine seedlings from Cal Forest Nursery and place in cold storage.

8. Late January or February 2009: General Contractor plant 13,250 styro 5 containerized Ponderosa pine seedlings on 50 acres at 265 trees per acre (12′ x 12′ spacing & 12′ from existing trees and Tubex Treeshelters/planted oaks).
9. Late January or February 2009 (Immediately after planting): General Contractor purchase & install seedling protection netting (8 mil "light" netting should be sufficient) on 13,250 styro 5 containerized ponderosa pine seedlings.
10. March or April 2009 (After emergence of resprouting brush leaves, if any, and germinate brush seedlings and grass): General Contractor purchase chemical & apply directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray resprouting chamise, if present, and newly emerging brush germinates, forbs and grasses with 2% generic glyphosate formulation (e.g. Buccaneer, Razor etc.) mixed w/ ¼ % non-ionic adjuvant.

**WESTCARB II – REFORESTATION PROPOSAL**

**Raja Shiva Das property**

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T33N R2W, of Section 9

**Acres**: 40 (*suitable for proposed reforestation project*)

**Access**: Very good: Approximately four miles of rocked road (Backbone Ridge Rd via Seamans Gulch Rd. of off Hwy 299E near the Diddy Wells CDF station) provides good all season access to the project area. The intersection of the Backbone ridge road and the paved Sugar Pine road is ½ mile east of the property, but access via the sugar pine road is subject to permission and might not be available for heavy equipment use.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
Two surveyed corners at each end of the property line (a portion of which would be the south boundary of one of the reforestation units) were located and GPS'd by Bob Rynearson on the site visit. There was no surveyed line found however.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): The landowner did not mention that there are any easements or utilities within the project boundaries.

**Sensitive areas** (e.g. streams, springs, unstable areas, arch. sites etc.): There are no streams or wet areas within the proposed project area. There are a few draws which should be buffered from operations.

**Annual Avg. Precipitation**: 40" to 50" almost all in rainfall *(according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)*

**Seed Zone**: 521 (S portion of 5212, about 3 miles from the N portion of zone 522).

Elevation: Approx. 1,700' to 1,780'

Slope: Mostly flat with a few areas up to 25%

**Aspect(s)**: Flat to slightly S or SW facing

Site Class: Dunning site.

Soil Type: According to USDA NRCS Shasta County Area Survey: Supan very stony loam, 0 to 30%; parent material = residuum weathered from tuff breccia; well drained, depth to lithic bedrock is 33 to 37 inches; Available Water Capacity is low @ 0" to 10" depth ranging from 0.9 to 1.4 inches & @ 10" to 33" depth ranging from 3.0 to 7.8 inches; moderately suited for hand planting.

**Vegetation**: Mostly dense, tall brush (> 80% cover) consisting primarily of greenleaf and whiteleaf manzanita with some poison oak, whitethorn (Ceanothus cordulatus) and deerbrush (Ceanothus integerrimus). There is a overstory of ponderosa pine, gray pine, black oak and blue oak, averaging approximately 10% canopy cover in the project area. The extreme fuel load and configuration of the tall, dense brush in the proposed reforestation area poses a significant risk of severe damage from catastrophic wildfire to the existing trees and surrounding forests and watershed.

**General comments:** Although Supan soils in general are considered low for timber productivity, the soils within the proposed project area are relatively deep (for this soil type) and support dense and tall manzanita brush and also a sparse overstory of numerous large, vigorous ponderosa pine that apparently seeded in many decades ago prior to the brushfield establishment. Some ponderosa pine seedlings were planted a few years ago by the landowner in the shaded fuelbreak adjacent to the proposed project area on the same soil type. Most of these survived and are growing adequately. The ponderosa pine seedlings that did not survive, or survived but are growing poorly, would have done better had the competing vegetation been controlled around them.

Ponderosa pine would be the most appropriate species to plant. Planted ponderosa pine seedlings along with the existing scattered overstory of black oak, blue oak, ponderosa pine and gray pine (and the gray pine that will likely naturally seed in for several years after the brush is cleared) will provide a diverse mix of tree species over time. For good conifer seedling survival and growth n this long, hot and dry summer climate, controlling vegetation (mostly manzanita, poison oak and grasses) which would compete aggressively for limited soil moisture during the first few years of establishment is critical. Controlling the re-invasion of manzanita brush would have the added benefit of keeping hazardous fuel loads from growing back to the current very hazardous fuel loads.

The proposed project area is classified as a "high" treatment priority area in the Sugar Pine Community Wildfire Protection Plan. The following proposed plan will provide the added benefit of meeting the objectives of the Community Wildfire Protection Plan by greatly reducing the hazardous fuel loads.

**PROJECT PLAN**

1. Summer/Fall 2007 Winrock (or its consultant, Bob Rynearson) locate and purchase ponderosa pine seed from the southern portion of zone 521 or the northern portion of zone 522 and from the lowest available elevation.
2. Fall 2007: Winrock (or its consultant, Bob Rynearson) contract with Cal Forest Nursery to grow 10,800 styro 5 containerized ponderosa pine for outplanting in spring 2009. Ship seed to Cal Forest Nursery by November 2007.
3. Summer 2008: General Contractor (or subcontractor) clear and pile brush on 40 acres, retaining conifers, oaks and large woody debris (LWD) where operationally feasible.
4. Late Fall 2008: General Contractor prepare and submit Smoke Management plan and obtain necessary permits and burn piles.
5. January 2009 (after seedlings lifted and packed at nursery): General Contractor transport seedlings from Cal Forest Nursery and place in cold storage.
6. Late January or early February 2009: General Contractor plant 10,800 styro 5 containerized Ponderosa pine seedlings on 40 acres at 270 trees per acre (12' x 12' spacing & 12' from existing trees).
7. Late January or early February 2009 (Immediately after planting): General Contractor purchase & install seedling protection netting (8 mil "light" netting should be sufficient) on 10,800 styro 5 containerized Ponderosa pine seedlings.
8. March or April 2009 (After emergence of poison oak leaves and germinate manzanita seedlings and grass): General Contractor purchase chemical & conduct directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray resprouting poison oak and newly emerging brush germinates, forbs and grasses with 2% generic glyphosate formulation (e.g. Buccaneer, Razor etc.) mixed w/ ¼ % non-ionic adjuvant.

**WESTCARB II – REFORESTATION PROPOSAL**

**Curt Eilers property**

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T33N R2W, of Section 9

**Acres**: 8 acres in three units (*suitable for proposed reforestation project*)

**Access**: Good: Approximately four miles of rocked road (Backbone Ridge Rd) off of Hwy 299E just east of the Diddy Wells CDF station provides good all season access to within a few hundred feet of 2 of the units and ½ mile from the third unit which is accessible via a dirt road off of the rocked road.

**Survey lines & corner locations:** (if feasible GPS closest known surveyed corner/s)
According to the landowner all of the reforestation units proposed for planting are within his property.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): The landowner did not mention that there are any easements or utilities within the project boundaries.

**Sensitive areas** (e.g. streams, springs, unstable areas, arch. sites etc.): There are no streams or wet areas within the proposed project boundary units.

**Annual Avg. Precipitation**: 40" to 50" almost all in rainfall *(according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)*

**Seed Zone**: 521 (S portion of 521, about 3 miles from the N portion of zone 522).

Elevation: Approx. 1,700' to 1,780'

Slope: 0% - 30%

**Aspect(s)**: N, W and E facing

Site Class: west & middle units: Estimated Dunning Site IV; Site V or less on east unit.

Soil Type: Soils on two of the three units (middle and west units) are suitable for growing ponderosa pine, but the soils on the third unit (east unit) are shallow and marginal for commercial conifer production.

**Vegetation**: Prior to clearing and piling with a crawler tractor the vegetation was mostly dense brush. Current vegetation is comprised of resprouting poison oak, live oak and black oak, grasses, forbs and brush (mostly manzanita) germinate seedlings less than one foot tall. There is a overstory of ponderosa pine, gray pine, black oak and blue oak, averaging approximately 10% canopy cover. Large piles of dead, brush are in the proposed reforestation units.

**General comments:** The proposed project area is very small, consisting of 3 units totaling 8 acres, ¼ to ½ mile apart. So this proposed project would only be feasible if most operations were done in conjunction with operations on the proposed Araja Sivadas afforestation project adjacent to the south. So the Shiva Das project would need to be approved by Winrock and the landowner for this project on Eiler's property to be feasible.

To reduce fire hazard risk and promote watershed and wildlife resources, the landowner is primarily interested in establishing long term tree cover w/ minor shrub, grass, forb understory instead of the dense, decadent brush with sparse tree cover that would occur without further management. Two of the eight acres are suitable for planting blue oak and ponderosa pine (very low site) and about 6 acres are suitable for ponderosa pine reforestation. The landowner is interested in planting blue oak. There has

not been enough large operational scale oak regeneration projects completed in California to provide a reliable basis for estimates of costs and risk for this project. For good conifer seedling survival and growth in this long, hot and dry summer climate, controlling vegetation (mostly manzanita, poison oak and grasses) which would compete aggressively for limited soil moisture during the first few years of establishment is critical. Controlling the re-invasion of manzanita brush would have the added benefit of keeping hazardous fuel loads from growing back to the current very hazardous fuel loads. It is likely that some gray pine seedlings will naturally seed in over time after brush removal.

**PROJECT PLAN**

1. Summer/Fall 2007 Winrock (or its consultant, Bob Rynearson) locate and purchase ponderosa pine seed from the southern portion of zone 521 or the northern portion of zone 522 and from the lowest available elevation.
2. Fall 2007: Winrock (or its consultant, Bob Rynearson) contract with Cal Forest Nursery to grow 1,400 styro 5 containerized ponderosa pine for outplanting in spring 2009. Ship seed to Cal Forest Nursery by November 2007.
3. Late Fall 2007: General Contractor prepare and submit Smoke Management plan and obtain necessary permits and burn piles on 8 acres.
4. Fall 2007 or 2008: Landowner or Winrock (its consultant or WSRCD?) or General Contractor monitor blue oak acorn crop and if there is a crop then collect when ripe. Sort out culls by water immersion and store.
5. December or January 2007 or 2008 (after sufficient rainfall replenishes soil moisture) General Contractor plant blue oak acorns on 2 acres at 50 spots per acre (30 x 30 spacing @ 2 acorns per spot), install 100 4′ rigid seedling/sapling protectors anchored with posts. Spray any weeds if present.
6. January 2009 (after seedlings lifted and packed at nursery): General Contractor transport seedlings from Cal Forest Nursery and place in cold storage.
7. Late January or early February 2009: General Contractor plant 1,400 styro 5 containerized Ponderosa pine seedlings on 6 acres at 200 trees per acre (12′ x 12′ spacing & 16′ from existing trees) and on 2 acres at 100 trees per acre (21′ x 21′ spacing).
8. Late January or early February 2009 (Immediately after planting): General Contractor purchase & install seedling protection netting (8 mil "light" netting should be sufficient) on 1,400 styro 5 containerized ponderosa pine seedlings.
9. March or April 2009 (After emergence of poison oak leaves and germinate manzanita seedlings and grass): General Contractor purchase chemical & conduct directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray resprouting poison oak and newly emerging brush germinates, forbs and grasses on 8 acres with 5% generic glyphosate formulation (e.g. Buccaneer, Razor etc.) mixed w/ 5 % Methylated Seed Oil (e.g. Hasten, MOC, MSO etc.). If the General Contractor conducts this as a site prep treatment during the late spring of 2008 instead of as a release treatment in 2009, it would be preferred, but would not be able to do in conjunction with spray operations on Shiva Das.

**WESTCARB II – REFORESTATION PROPOSAL**

**Fred Wilson property**

BACKGROUND the following information pertains to proposed reforestation area:

Legal: T34N R1W Section: S ½ 29

**Acres**: 15 acres total in two units (*suitable for reforestation project*)

**Access**: fair: Units are accessed via 4WD dirt roads about one mile from HWY 229E near mile marker 49 via a private bridge crossing over Cedar Creek. Prior to project approval need verification from landowner that the bridge weight capacity and width is suitable for moving in an excavator equipped with masticating head.

**Survey lines & corner locations:** According to the landowner and WSRCD property maps and photo, the proposed project boundaries are well within the property lines.

**Easements & Utilities** (location of all easements, including above and underground utilities on or near project): According to the landowner there are no easements or utilities within the proposed reforestation project boundaries.

**Sensitive areas** (e.g. streams, springs, unstable areas, arch. sites etc.): According the landowner there are no know archeological sites within the project boundaries. There are no watercourses or wet areas within the project boundaries. There is a draw south of the east unit which should have a minimum 50' equipment buffer. There is an excavated and and/or dammed spring area in, or very near, the southeast portion of the east unit. Prior to equipment operations Winrock's consultant(s) and landowner would need to set up appropriate protection measures if any that will be needed.

**Annual Avg. Precipitation**: approximately 50" almost all in the form of rainfall *(according to "Mean Annual Precipitation for California" isohydel map compiled by S.E. Rantz)*

**Seed Zone**: 522/521 (in zone 522 less than one mile south of the border with zone 521).

Elevation: approx. 1,600' (east unit); 1,700' (west unit)

Slope: 0% - 30%

**Aspect(s)**: primarily west and/or south facing or flat on ridge.

Site Class: west unit: moderate to low; east unit: very low.

Soil Types: The Shasta County Soils Map provided by the NRCS lists the following:

West unit: Marpa gravelly loam, 30 to 50 percent slopes (slopes on the proposed project area are 0 to 30%); residuum weathered from shale parent material; 26" to 30" deep; well drained; moderately suited for hand planting; although the soil type in general is listed as capable of growing ponderosa pine, black oak, Douglas-fir, and white fir, at this elevation and ridgetop exposure, ponderosa pine would be the most suitable for young seedling survival.

East unit: Neuns very stony loam, 8 to 50 percent slopes (slopes on the proposed project area are 0 to 30%); residuum weathered from greenstone parent material; 23" to 27" deep; well drained; moderately suited for hand planting.

**Vegetation**: The vegetation in the proposed project area consists mostly of dense, 6 to 15 foot tall non-sprouting manzanita species and a sparse (< 5% cover) black oak, blue oak, ponderosa pine, gray pine and Douglas-fir overstory. These brushfields w/ re-sprouted oaks likely formed after a wildfire many decades ago.

**General comments:**

The proposed project area is approximately 15 acres, consisting of two units that are about ½ mile apart. Due to the relatively low elevation, hot dry summer climate and shallow, somewhat eroded soils, there is a greater risk of plantation failure than there is for projects at higher elevation sites and better conifer growing, non-eroded soils. The landowner is willing to consider planting even though tree seedling establishment is a little risky on this site. The benefits of this proposed project go beyond reforestation because preparing the site for planting by masticating the tall, dense brush on these ridges would also provide the benefit of reducing fire hazard risk to the property and general forestland.

The brush is mostly non-sprouting species and the soils are not very deep and appear to have been slightly eroded several decades ago, prior to the presence of the current brush, and it is a low elevation, hot, dry summer site. Therefore, masticating the dense brush rather than piling and burning it would be the most appropriate treatment to prepare the site for planting. This site preparation treatment should cause less disturbance to the shallow soils and it will also provide dead woody material cover that will reduce soil moisture loss from evaporation. The masticated material will also provide some shade from the summer sun on the lower stem portion of the young seedlings that will be planted into the site. The mulching effect of the mastication would also reduce the amount of weeds competing with the conifer seedlings for limited soil moisture and nutrients. Ponderosa pine is the most suitable seedling to plant on this hot, dry summer site. There are numerous oaks throughout the general property and the scattered oaks in the project area will either be retained or, if inadvertently masticated during site preparation, they will resprout vigorously.

PROJECT PLAN

1. Summer 2007: Winrock (or its consultant, Bob Rynearson) locate and purchase ponderosa pine seed from lowest elevation 521 or 522 source available.
2. Fall 2007: Winrock (or its consultant, Bob Rynearson) contract with Cal Forest Nursery to grow 4,300 styro 5 containerized ponderosa pine seedlings for outplanting in winter 2008/09. Ship seed to Cal Forest Nursery by November 2007.
3. Summer 2008: General Contractor (or its sub-contractor) using an excavator equipped with a masticating head, masticate brush on 15 acres.
4. January or early February 2009: General Contractor transport from Cal Forest Nursery, place in cold storage and then plant 4,300 styro 5 containerized Ponderosa pine seedlings on 15 acres at 285 trees per acre (12' x 12' spacing & 12' from existing oak trees).
5. January or early February 2009 (Immediately after planting): General Contractor purchase & install seedling protection netting (8 mil "light" netting should be sufficient) on 4,300 styro 5 containerized Ponderosa pine seedlings.
6. February or March 2009: General Contractor purchase chemical & conduct directed foliar spray application by hand crews equipped with backpack sprayers and seedling protector shields. Spray newly emerging forbs and grasses on 15 acres with 2% generic glyphosate formulation (e.g. Buccaneer, Razor etc.) mixed w/ ¼ % non-ionic adjuvant.

# Annex D: Annual Landowner Survey for WESTCARB Afforestation Projects

**Date** _____

**Name** _____

**Mailing Address** _____
_____

**Telephone** _____ **Fax** _____ **E-mail** _____

**Winrock International Agreement Number** _____

**Please indicate that you have attached four project photos (electronic format preferred)**
Looking North ___ Looking South ___ Looking West ___ Looking East ___

**Estimate of trees from initial planting currently surviving:**
75-100% ___
50-74% ___
25-49% ___
0–24% ___

**Reason for loss during past year:**
Live trees intentionally removed ___ Accidentally removed ___
Trees died/damaged by: Fire ___ Infestation ___ Drought ___ Unknown ___
Other ___ (Please explain below)
_____
_____
_____

**Maintenance Performed during Past Year:**
Did you irrigate? ___
How much? _____
How often? _____

Was hand and/or mechanical weeding performed? ___
When? _____

Was chemical weed control used? ___
Herbicide _____
Concentration _____
Method of application _____
Date of application _____

Was fertilizer used? ___
Analysis of fertilizer _____
Concentration _____
Method of application _____
Date of application _____

Was pruning conducted? ___
When? _____
For what purpose(s)? _____

**Tree health within past year:**
Do the trees seem healthy? Please comment on observed health and growth:
_____
_____
_____

**Is the project currently registered with a carbon registry organization (e.g. California Climate Action Registry)? ___**
If yes, how have you found the experience?
_____
_____
_____

If no, why not? _____
_____

**If participating in a registry, have you sold carbon credits? ___**

**How would you rate your current level of satisfaction in participating in the Winrock/WESTCARB afforestation pilot project:**
Very High ___ High ____ Moderate ___ Low ___ Very Low ___
Comments: _____
_____

**What is your level of interest in participating in additional afforestation projects, and why?**
Very High ___ High ____ Moderate ___ Low ___ Very Low ___
_____
_____
_____

**Is there anything else you would like to add to help us understand the success of your project?**
_____
_____
_____