Treasure Valley Forest Carbon:

An assessment of community forestry potential to mitigate the impacts of a changing climate

December 2017

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Treasure Valley Canopy Network

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The Nature Conservancy Idaho

ACKNOWLEDGMENTS

We thank the following individuals for their contributions to the preparation of this document: Lisa Eller, Megan Grover-Cereda, Rachel Holmes, Brian Jorgenson, Scott Maco, Mark McPherson, Greg McPherson, and David Stephenson.

The **Treasure Valley Canopy Network**[1] is dedicated to enhancing the region's community forest. It is our mission to work collaboratively and support efforts that link urban forests to infrastructure, economy, human health, ecology and the community. We actively seek opportunities to grow the urban forest and make it sustainable by securing funding and promoting further applied research.

The Nature Conservancy[2] is a leading conservation organization working in Idaho and around the world to protect ecologically important lands and waters for people and nature.

Ecosystem Sciences Foundation[3] provides professional services in environmental sciences, planning and design. Ecosystem Sciences' non-profit Foundation actively develops and supports projects that have strong local support, have solid opportunity for the successful application of designs, and are based on real, measurable improvement of the ecosystem.

This project was funded in part by the Idaho Department of Lands in cooperation with the USDA Forest Service. The institutions involved in this project are equal opportunity providers.

CONTENTS

Executive Summary....................2
A. Introduction....................4
B. Background....................6
C. Methods....................12
D. Carbon Storage Now and in the Future....................13
E. Discussion....................20
F. Recommendations....................27
G. Endnotes....................29
H. Literature Cited....................31
I. Appendix – Carbon Analysis....................33

TREASURE VALLEY FOREST CARBON ASSESSMENT: EXECUTIVE SUMMARY

Community forests can help Idaho become more resilient to a changing climate and limit risks to our economy and way of life. Natural systems, such as community forests in the Treasure Valley, offer immediate opportunities to reduce emissions of greenhouse gases like carbon dioxide (CO_2) that have led to rising temperatures, decreasing snowpack, and more frequent and intense wildfires.

Ecosystem Sciences Foundation, The Nature Conservancy, and Treasure Valley Canopy Network developed this report to better understand how the Treasure Valley's forests can mitigate the effects of a changing climate. The Treasure Valley is a semi-arid valley in southwestern Idaho that spans two counties (Ada and Canyon) and nine municipalities (including the state capital, Boise) and is home to roughly 40% of the state's population.

2 metric tons

The equivalent amount of carbon dioxide stored by a large mature tree

This report builds on a 2013 assessment that found:

- Treasure Valley community forests collectively store 1.4 million metric tons of CO_2 valued at $29 million.
- These community forests provide $9.4 million annually in economic benefits from improved air quality, decreased storm water runoff, and carbon storage.
- There are currently 2.4 million trees in the Treasure Valley, with room for twice that many.

To demonstrate the climate mitigation potential of local community forests, we evaluated the carbon impacts of four tree planting projects implemented in the Treasure Valley since 2013. Using protocols developed by City Forest Credits (http://www.cityforestcredits.org/), we estimated the amount of carbon stored by these plantings and its value.

Key Findings:

- Project partners planted 8,275 trees since 2013.
- After 25 years, these trees can store 15,211 metric tons of CO_2. This is an amount equivalent to taking 5,433 Treasure Valley drivers off the roads for one year.
- If these plantings had earned carbon credits, they would be worth between $304,226 and $532,395, which could have been used to defray the costs of planting and maintaining trees (perhaps up to 30%).

There is an opportunity to increase the pace and scope of tree planting and stewardship efforts here, but it will take an increase in investment. Carbon credits provide one potential tool for increasing this investment and the capacity for Treasure Valley forests to reduce greenhouse gas emissions.

Key Recommendations:

- The Treasure Valley Canopy Network will work with existing partners to find additional resources for community tree plantings and maintenance.
- The Network will document the value of carbon and co-benefits (storm water, energy, and air quality) from tree planting projects.
- The Network will facilitate strategic planting projects with partners to secure carbon credits for sale to local buyers. Proceeds can be used to support local community forests.

PLANTING A TREE PROVIDES A TANGIBLE WAY THAT ALMOST ANYONE CAN MAKE A DIFFERENCE.

Community tree plantings help reduce greenhouse gas emissions, but they are not a panacea. Stabilizing our rising temperatures will take action by all of us to increase energy efficiency, decrease waste, and improve natural resource management. But planting a tree provides a tangible way that almost anyone can make a difference. And our community forests benefit us in many other ways, including cleaning the air we breathe and providing cool shade in the summer.

Tree-by-tree and step-by-step, individual Idahoans can make a difference in the face of a changing climate. Working together, we can do even more.

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http://www.tvcanopy.net/forest-carbon/

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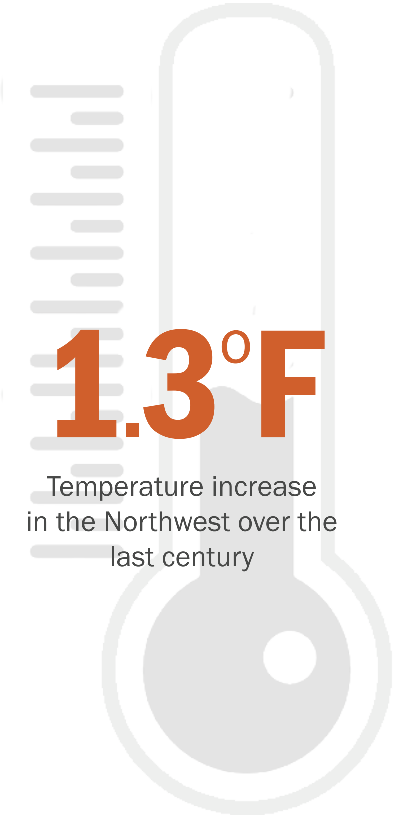
Ecosystem Sciences Foundation

A. INTRODUCTION

Data show that temperatures are on the rise in Idaho. Over the last century, temperatures in the Northwest have increased by 0.7°C (1.3°F). While this amount of warming seems small, it has had significant impacts in Idaho, particularly in terms of wildfire and water availability. For example, the extent of burned land in Idaho increased by 3.58 acres per square mile from 2000-2014 compared to the period 1984-1999, the highest such increase in the United States (U.S. EPA, 2016). Impacts such as increased wildfires, earlier snowmelt run-off, and decreased water availability are affecting the lives of all Idahoans.

The impacts of a changing climate will become more severe unless we all take steps to reduce global emissions of greenhouse gases. Temperatures will continue to rise for the foreseeable future, but to avoid the worst impacts, we must limit global warming to 2°C (3.6°F) (IPCC, 2014). Meeting this target will require reducing greenhouse gas emissions from diverse sectors and places, including Idaho.

Community forests can help Idaho become more resilient in the face of a changing climate and limit risks to our economy and way of life. Addressing climate impacts can present opportunities for innovation and economic growth in many facets of human life. For example, changes in how energy is produced and used are essential to reduce carbon dioxide (CO_2) emissions and can provide economic opportunities. However, energy changes alone will not be sufficient to limit global warming to 2°C (3.6°F).



1.3°F

Temperature increase in the Northwest over the last century

Changes in land use—including community forestry—are also a crucial part of the solution. Natural systems such as forests offer immediate opportunities to reduce emissions. In fact, by protecting and restoring key natural systems and incentivizing more sustainable uses of working lands, we could enable landscapes worldwide to mitigate up to an additional 37 percent of the carbon emissions needed to help nature, wildlife, and people thrive (Griscom et al., 2017).

Community Forests Can Reduce Climate Impacts

This report builds from the *Treasure Valley Urban Tree Canopy Assessment* (Plan-It Geo, 2013) that highlighted the $9 million in annual economic benefits our community forests provide by removing air pollutants, reducing storm water runoff, and removing carbon dioxide from the atmosphere. This report will take a closer look at how our community forests can help reduce the impacts from a changing climate.

At 25 years after planting, a large tree in the Treasure Valley will store the equivalent of almost 2 metric tons of carbon dioxide (tCO_2e)[a], reducing the amount of CO_2 emitted to the atmosphere. Nearly two and a half million trees populate our Treasure Valley cities, with room for many more.

Photo © Lance Davisson

The purpose of this report is to determine the potential for increasing carbon sequestration in our community forests and to identify the best strategies for doing so. Along the way we will highlight the potential co-benefits for clean air, clean water, and energy savings that come with increasing our community forest canopy. We will also examine ways to generate revenue to help finance future tree planting and stewardship.

Our hope is that this report will inspire and empower the citizens and communities of the Treasure Valley to address Idaho's changing climate through community forestry. We also hope it will help us all think about other ways we can work to decrease carbon emissions in the Treasure Valley. Tree-by-tree and step-by-step, individual Idahoans can make a difference in the face of a changing climate. Working together we can do even more.

B. BACKGROUND

Increasing temperatures are impacting our communities, economy, and way of life. More destructive wildfires and decreasing snowpack are examples of climate impacts that affect us all. Nature-based solutions—like planting and caring for trees—can play a major role in reducing greenhouse gases like carbon dioxide that lead to changes in climate. This section reviews the causes and effects of our changing climate, and how forests can address those causes.

The Greenhouse Effect

The exchange of incoming and outgoing radiation that warms the Earth is often referred to as the greenhouse effect because a greenhouse works in much the same way.

Incoming ultraviolet radiation easily passes through the glass walls of a greenhouse and is absorbed by the plants and hard surfaces inside. Weaker infrared (IR) radiation, however, has difficulty passing through the glass walls and is trapped inside, thus warming the greenhouse. This effect lets tropical plants thrive inside a greenhouse, even during a cold winter.

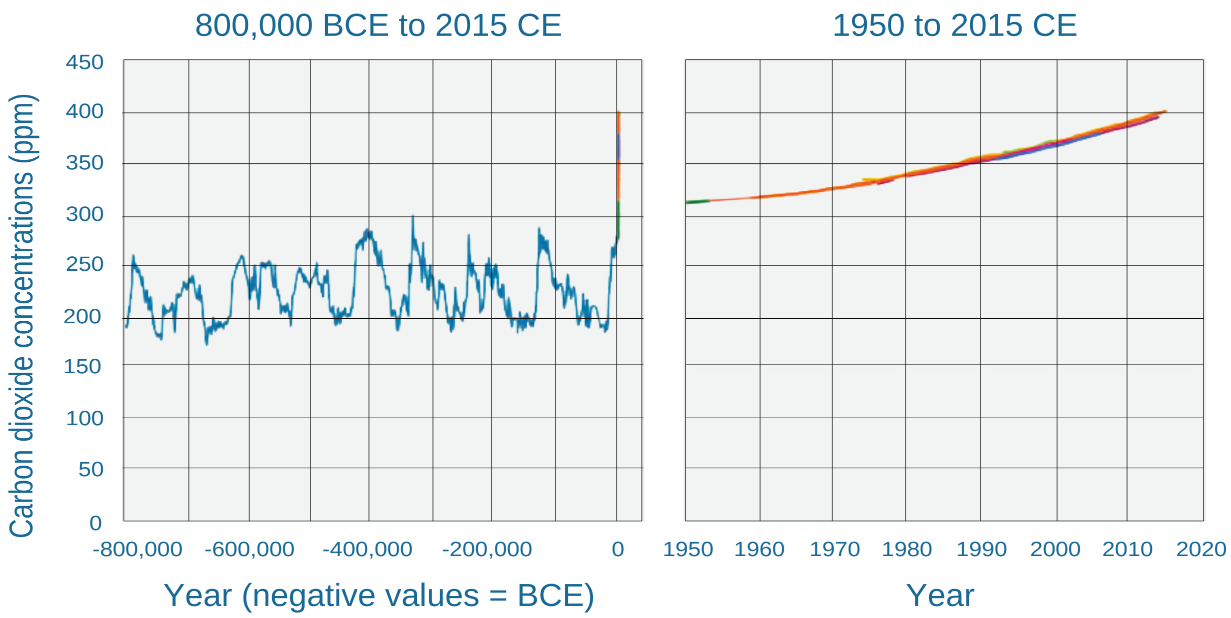
Carbon dioxide (CO_2) and other greenhouse gases absorb IR radiation and prevent it from escaping into outer space. The net effect is the gradual heating of Earth's atmosphere and surface, a process known as global warming (Lallanila, 2016).

Global concentrations of greenhouse gases have risen to unprecedented levels over the last few centuries (U.S. EPA, January 2017). Carbon dioxide concentrations have increased 43% since the late 1700s, rising from an annual average of 280 parts per million (ppm) to 401 ppm in 2015.

43%

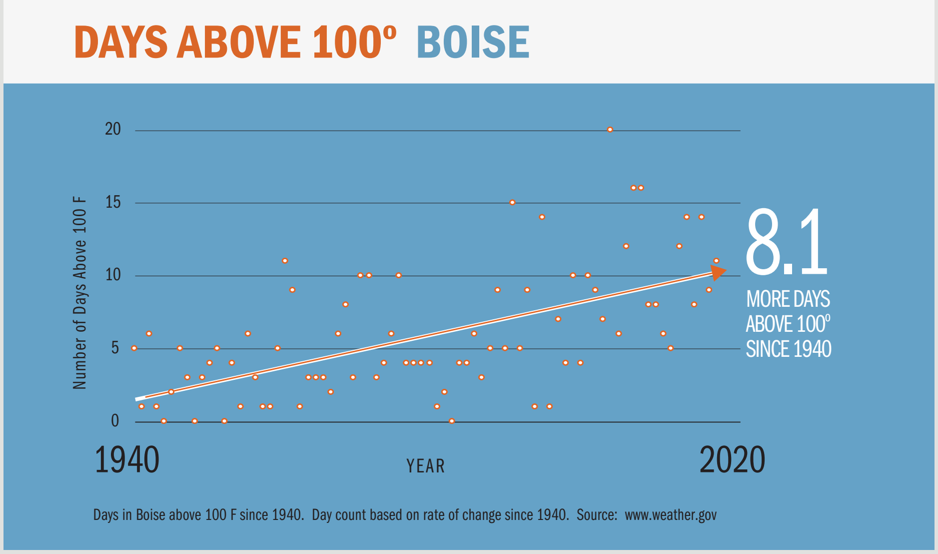
Increase in carbon dioxide concentrations since the late 1700s

Global Atmospheric Concentrations of Carbon Dioxide Over Time



Increases in atmospheric concentrations of greenhouse gases increase global warming. In 2016, Earth's surface temperatures were the warmest since modern record keeping began in 1880. 2016 was the third year in a row to set a new record for global average surface temperatures. Average temperatures have risen globally and across the U.S. since 1901, with an increased rate of warming over the past 30 years.

In Idaho, this has resulted in increased temperatures, increased annual forest acreage burned, and other changes (Klos et al., 2015). For example, from 1971-2005 the average annual observed temperature in the Snake River Plain increased 1.4°C (2.5°F) (Hoekema and Sridhar, 2011).



DAYS ABOVE 100º BOISE

8.1
MORE DAYS
ABOVE 100º
SINCE 1940

Days in Boise above 100 F since 1940. Day count based on rate of change since 1940. Source: www.weather.gov

Although these average temperature changes may seem small, the result is big changes in temperature extremes.

For example, the average annual number of 100 degree (F) days in Boise has more than tripled since the 1940's.

Natural Climate Solutions

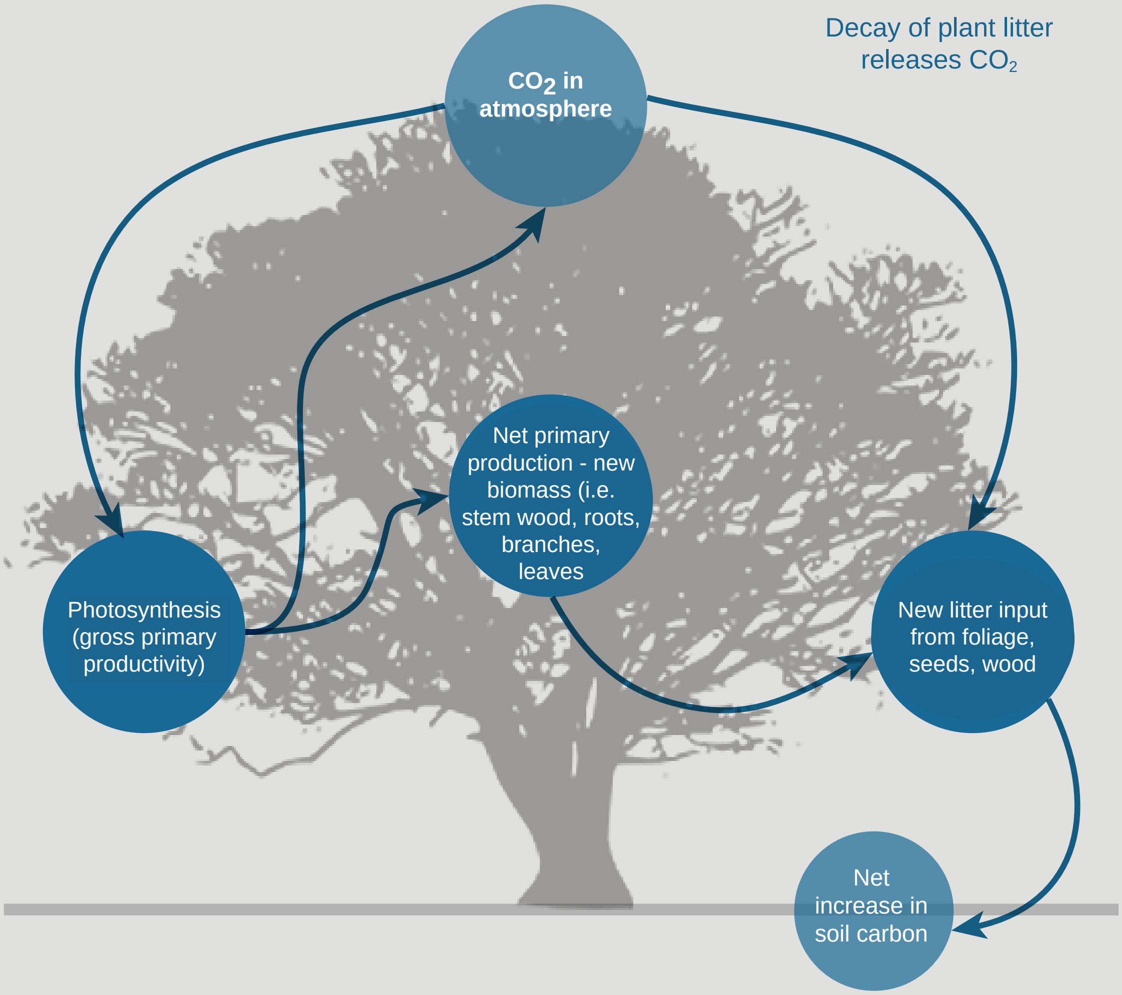
The changing climate is a global problem, and it requires solutions on a global scale. Luckily, we have the technology to reverse greenhouse gas trends. In fact, some of the best climate technology is already deployed on a global scale, having been refined by nature for more than 350 million years in the form of trees and other plants. Through photosynthesis, trees combine carbon dioxide, sunlight and water to produce clean air, clean water and healthy soil in addition to products like chocolate, rayon and timber.

Our lands provide an untapped opportunity: proven ways of storing and reducing carbon emissions in the world's forests, grasslands and wetlands. These natural climate solutions can cost-effectively achieve up to 37% of the 2030 emission reduction goals that world leaders established at the 2015 Paris Climate Convention (Griscom et al., 2017). This means that nature-based solutions—such as stopping deforestation, restoring coastal ecosystems, and planting trees—can get us more than a third of the way to the emission reductions needed by 2030.

The Role of Forests

Forests provide one of our greatest assets in reducing carbon emissions. As they grow, trees store carbon. Through the process of photosynthesis, trees absorb carbon dioxide from the atmosphere, store the carbon as wood, and release oxygen back to the atmosphere. Although forests do release some CO_2 from decay and respiration, healthy forests store carbon faster than they release it.

In fact, a single tree can store hundreds of kilograms of carbon over its lifetime (CFC, n.d.). Around 2.4 million trees make up the Treasure Valley's community forests, resulting in significant carbon storage. Simply put, the more trees we grow, and the healthier they are, the more we all can help reduce carbon dioxide in the atmosphere.



Where does the carbon go?

A summary of the carbon exchange associated with a typical woodland.

This is important because carbon dioxide is the main contributor to global warming. In 2015, CO_2 accounted for about 82.2% of all U.S. greenhouse gas emissions from human activities (U.S. EPA, April 2017). By taking up and storing carbon, trees remove carbon dioxide from the atmosphere and keep it from contributing to a changing climate. Together, U.S. forests offset approximately 13% of U.S. emissions from burning fossil fuels in 2011, and from 10 to 20% of U.S. emissions each year (U.S. Forest Service, 2017).

We've shown how trees remove CO_2 from the atmosphere, but can forests really make a difference in stabilizing climate? Yes, but it will take a large-scale effort that includes avoiding deforestation and improving forest management around the world in addition to planting trees. While the scale of the challenge is large, by understanding and using the resources available close to home, we can play our part in making a difference.

PHOTOSYNTHESIS

Trees and other plants need carbon dioxide (CO_2) from the atmosphere to grow. Trees use energy from sunlight to combine CO_2 from the air with water (H_2O) to form carbohydrates that get stored as wood, leaves, and roots. Forests play a key role in the global carbon cycle by absorbing CO_2 during photosynthesis, storing carbon above and below ground, and producing oxygen (O_2) that people and animals use to breathe.

$CO_2 + H_2O + \text{sunlight} \rightarrow CH_2O + O_2$

Treasure Valley Community Forest and Ecosystem Services

In 2013, Idaho Department of Lands (IDL) and a collaborative of local public, private and non-profit professionals from across the Treasure Valley (collectively the Treasure Valley Canopy Network - http://www.tvcanopy.net/) completed the Treasure Valley Urban Tree Canopy Assessment (the "UTC Assessment"; Plan-It Geo, 2013) and Treasure Valley i-Tree Ecosystem Analysis (IDL and U.S. Forest Service, 2013).

This UTC assessment incorporated data from the i-Tree Ecosystem Analysis together with a geospatial urban tree canopy assessment. Together, these assessments create a complete picture of the ecosystem services produced by the region's urban forest, estimate the percentage of urban forest tree canopy across the landscape, and provide tools to strategically manage the urban forest resource to maximize return on investment for environmental and community benefit.

The i-Tree Ecosystem Analysis measured the ecosystem services produced by the region's community forest—i.e., the collective trees and landscapes in the Treasure Valley, both naturally occurring and planted. The ecosystem services measured included: carbon storage[b], carbon sequestration[c], storm water mitigation[d], and removal of air pollutants.[e] The carbon and ecosystem service metrics from the UTC Assessment, supported by the i-Tree Software Suite (n.d.; https://www.itreetools.org/), provide baseline information for this Treasure Valley Forest Carbon Assessment.

Summary results from the Treasure Valley iTree Ecosystem Analysis (IDL and U.S. Forest Service, 2013).

ECOSYSTEM SERVICES	**QUANTITY**	**VALUE**
Carbon		
Carbon Storage	1,365,057 metric tons CO_2e	$29,200,000
Carbon Sequestration	51,622 metric tons CO_2e/yr	$1,100,000
Avoided Carbon Emissions	-4,780 metric tons CO_2e/yr	$-102,000
Co-Benefits		
Storm Water	124,990,000 gal/yr	$1,117,000
Energy Conservation[f]	-96,830 MBTU/yr (heating/natural gas) & 11,641 MWH/yr (cooling/electricity)	$-315,500
Air Pollution Removal	526.3 metric tons/yr	$7,500,000

While it is important to understand the value of the services provided by the Treasure Valley's forest, is it really possible to monetize that value?

City Forest Credits

City Forest Credits (CFC) (http://www.cityforestcredits.org) is a new organization trying to make it easier for community tree planting and preservation projects across the United States to earn and sell certified carbon credits. A carbon credit (often called a carbon offset) is a credit for a project that reduces or removes greenhouse gas emissions. Governments, industry or private individuals can purchase these credits to compensate for the emissions they are generating. CFC has developed a set of tools for estimating community forest carbon storage and developing carbon credits to sell.

Our hope is that by using City Forest Credits or a similar framework, Treasure Valley communities can monetize some of the values their trees provide. Future community tree planting projects can be guided by the protocols of City Forest Credits

Photo © Christian Nafzger

and rely on partnerships with various public and private organizations that plant trees throughout the Treasure Valley. Partner organizations might include: The Idaho Department of Lands Community Forestry Program; Treasure Valley Canopy Network; the Cities of Boise, Nampa, Meridian, Caldwell, Star, Eagle, Kuna, and Middleton; Idaho Nursery and Landscape Association (INLA); Ada County Highway District (ACHD); and Idaho Power Company.

We have developed several case studies using the methods outlined in City Forest Credits to showcase tree planting projects that mitigate carbon impacts throughout the Treasure Valley. If accepted into City Forest Credits, these projects would qualify for carbon and bundled (storm water, energy, and air pollution) credits that could provide funding to support ongoing management of the community forest resource.

C. METHODS

For our case studies, we used City Forest Credits' Revenue Estimation Tool (n.d.; http://www.cityforestcredits.org/protocols/) to derive the amount of CO_2 (metric tons) stored by trees and the value of the carbon credits at one, three, five, and twenty-five years after planting. The Revenue Estimation Tool derives carbon credits and the value of the credits based on the species, number, and size of the trees planted per project.

Treasure Valley Canopy Network partners provided the data entered into the tool:

- The Treasure Valley Shade Tree Project supplied the number and species of trees distributed from 2013 through Spring 2017.[g] We used a subset (2017 spring distribution) of the Treasure Valley Shade Tree Project for one of the case studies.
- The City of Boise provided the species and number of trees planted under their ReLeaf and NeighborWoods programs.
- The Boise River Enhancement Network (BREN) supplied the number of cottonwoods and willows planted along the Boise River in 2017. BREN also provided the design plans for the Cottonwood Creek daylighting and restoration project which centers on riparian restoration through cottonwood and willow plantings.

The Appendix (Section I) documents the details of the analyses.

D. CARBON STORAGE NOW AND IN THE FUTURE

Section B above provides a snapshot of carbon storage and sequestration in the Treasure Valley Canopy from 2013, but we also want to know how much additional carbon recent and future plantings will deposit in the Treasure Valley's carbon bank. Using tools from City Forest Credits (CFC, n.d.), we developed seven case studies. These included four recent tree planting projects in the Treasure Valley, one planned project, and two hypothetical future projects.

We evaluated the carbon impacts of four tree planting projects implemented in the Treasure Valley since 2013.[h] In all, project partners planted 8,275 trees. Based on CFC tools, after 25 years these trees will have stored 15,211 tCO_2e, taking into account tree mortality.[i] This is an amount equivalent to taking 5,433 Treasure Valley drivers and passengers off the roads for one year.[j] If these plantings had earned carbon credits under CFC, the credits could be worth between $304,226 and $532,395.

Similarly, we looked at three possible future projects—one that's already in the planning phase and two potential future projects. If implemented, these three future projects would plant an additional 1,735 trees, storing about 3,013 tCO_2e. If these future projects earned carbon credits, they could be worth between $58,388 and $102,180. We'll look a bit more closely at each of these case studies in the following sections.

Summary of projects (Existing, Planned, Hypothetical) examined using the City Forest Credits' carbon calculator tools.

NAME	TYPE	TREES PLANTED
Treasure Valley Shade Tree	Existing	7,563
ReLeaf Boise	Existing	289
NeighborWoods	Existing	173
Boise River 2017 Riparian Planting	Existing	250
Cottonwood Creek Daylighting Riparian Planting	Planned	360
Ada County Neighborhood Improvement Project	Hypothetical	1000
Boise Park Planting Initiative	Hypothetical	375

Treasure Valley Shade Tree Project: Existing Project

The Shade Tree Project is the largest sustained tree planting program in the Treasure Valley. Since this project started in the fall of 2013, it has provided over 7,500 shade trees to residents throughout the region. Project partners include Idaho Power Company, Treasure Valley Canopy Network, Idaho Department of Lands, the U.S. Forest Service, Arbor Day Foundation, and local municipalities. Though the aim of the project is to provide shade trees to residential homeowners to be planted for energy conservation, it also has significantly increased carbon sequestration in Treasure Valley communities.

Over the course of the project, the partners have distributed trees at events throughout the Treasure Valley (Nampa, Caldwell, Boise, Kuna and Meridian) and in 2017 in Mountain Home. Since the project began, residents in Ada, Boise, Canyon, Elmore, Payette and Owyhee Counties have received trees. Project partners have distributed over twenty different tree species and cultivars to residents, with oaks, river birch, and tulip trees being the most popular.

Based on CFC protocols, the 7,563 trees planted under the Shade Tree Project will have stored 14,126 tCO_2e, adjusted for projected mortality, after 25 years. If these plantings had earned carbon credits under CFC, the credits could be worth between $282,521 and $494,411.

Projected carbon storage and averaged value of carbon credits from trees planted in the Treasure Valley Shade Tree Project 2013 to 2017.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
7,563	14,126	$388,466

7,500

Number of tress planted by the Shade Tree Project since 2013

The Shade Tree project targets residential plantings on the west side of homes where trees provide the most cooling benefits from summer sun. Idaho Power estimates this project could save 5 million kilowatt hours over 20 years, enough electricity to power 20 homes over that period. Those 5 million kilowatt hours (= 5,000 MWh) would also amount to about 315 tCO_2e in avoided greenhouse gas emissions from power generation.[k] Together with the carbon storage cited above, this would amount to 14,466 tCO_2e in greenhouse gas mitigation.

The Treasure Valley Shade Tree Project has grown since its inception in 2013. In the spring of 2017 alone, the partners distributed 1,307 trees. This amounts to about 2,429 tCO_2e stored through projected carbon sequestration over 25 years.

Boise Community Forestry Program

The City of Boise Community Forestry Program (http://parks.cityofboise.org/community-forestry/) manages all public trees within the City of Boise. The program has several community tree planting programs—including ReLeaf and NeighborWoods highlighted below—that can be used to implement tree planting projects for carbon mitigation.

ReLeaf Boise: Existing Project

ReLeaf Boise, part of the Boise Community Forestry Program, is an annual shade tree planting program in which volunteers help the City plant trees in public rights of way. The trees are free of charge to property owners, but availability is limited. ReLeaf Boise occurs each year on the last Saturday of April.

The City does not track the exact number and species mix of trees planted in the ReLeaf program, so we developed a hypothetical list of species and number of trees based on information from Boise city forester Brian Jorgenson. We projected that the ReLeaf program provided a mixture of 289 of mostly large-sized broadleaf deciduous tree species during the period 2013-2017. After 25, years, these trees will store about 509 tCO_2e worth between $10,183 and $17,819.

Projected carbon storage and averaged value of carbon credits from trees planted in the ReLeaf Boise program, 2013 to 2017.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
289	509	$14,001

NeighborWoods: Existing Project

The City of Boise also runs the NeighborWoods shade tree planting program. The goal is to provide free trees to property owners to plant on private property within 10 feet of the public right-of-way (the street or sidewalk). NeighborWoods provides trees and their benefits to individual property owners and to the public streets, which in turn provide benefits to the City as a whole. Trees are free to citizens, but availability is limited. Property owners must pick up the trees and plant them in an agreed upon space on their properties.

The NeighborWoods program distributed 173 trees since 2013 that will store an estimated 292 tCO_2e after 25 years. If these plantings had earned carbon credits under CFC, the credits could be worth between $5,835 and $10,211.

Photo © The Nature Conservancy (Devan King)

Projected carbon storage and averaged value of carbon credits from trees planted in the Boise NeighborWoods program, 2013 to 2017.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
173	292	$8,023

Boise River Enhancement Network (BREN)

BREN (http://www.boiseriverenhancement.org) is a public-private partnership dedicated to ecological enhancement of the Boise River that flows through the Treasure Valley. Below we evaluated one completed project and one planned project spearheaded by BREN.

Boise River 2017 Riparian Planting: Existing Project

Before river levels rose in 2017, BREN volunteers planted over 200 willow cuttings and 50 cottonwood trees at a riparian site on the Boise River near Eckert Road. Idaho Department of Fish and Game provided plants and materials. Once flows receded in summer 2017, volunteers also visited the site to provide water to the willow cuttings on a weekly basis.

After 25 years, these trees will store 284 tCO_2e, worth between $5,688 and $9,954. It is important to note that this stretch of the Boise River experienced historically high flows in spring 2017 after the planting occurred. It appears that most of the trees survived the high flows, but a final assessment has yet to be made; this could significantly impact the amount of carbon stored.

Projected carbon storage and averaged value of carbon credits from trees planted in BREN's 2017 Riparian Planting.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
250	284	$7,821

Cottonwood Creek Daylighting Riparian Planting: Planned Project

BREN has received funding to implement this project. The project centers on restoring Cottonwood Creek through Julia Davis Park. This project is in the design phase, and will restore riparian habitat along 440 feet on both sides of the creek. Willow cuttings will be planted every 3 feet on both sides of the creek, resulting in roughly 300 trees planted. Cottonwoods will be planted every 15 feet, resulting in 60 trees planted.

After 25 years these trees will have stored about 397 tCO_2e, worth between $7,942 and $13,898 in potential carbon credits.

Projected carbon storage and averaged value of carbon credits from trees planted in BREN's planned Cottonwood Creek project.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
360	397	$10,920

Ada County Neighborhood Improvement Project: Hypothetical Project

Ada County Highway District (ACHD) works with landowners in several county neighborhoods to improve public rights-of way along community streets by installing sidewalks, vegetation, and trees. In this hypothetical scenario, we estimated carbon storage if Ada County planted a mix of 1,000 large and medium broadleaf deciduous trees across 10 neighborhoods. The trees available to landowners are found in the *Tree Selection Guide for Street and Landscapes throughout Idaho* (Boise Parks & Recreation Department, 1995).

This hypothetical planting would store 1,879 tCO_2e after 25 years, potentially generating between $35,699 and $62,475 in carbon credits.

Projected carbon storage and averaged value of carbon credits from trees planted in a hypothetical Ada County right-of-way project.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
1,000	1,879	$49,087

Boise Park Planting Initiative: Hypothetical Project

In this hypothetical scenario, the City of Boise, in conjunction with the Treasure Valley Canopy Network and the Arbor Day Foundation, developed a new initiative to plant five trees in every suitable city park. Boise parks are well known for their trees, which provide respite from the summer heat, along with multiple other benefits to residents. Boise has identified 75 of its over 100 parks as eligible for the park planting initiative. Arbor Day Foundation is donating the 375 trees, while the Network is providing volunteers to assist in the tree planting effort. The 375 large shade trees are a mix of oak (*Quercus spp.*), coffeetree (*Gymnocladus spp.*), catalpa (*Catalpa spp.*), and planetree (*Platanus spp.*).

This hypothetical planting would store 737 tCO_2e after 25 years, potentially generating between $14,747 and $25,807 in carbon credits.

Projected carbon storage and averaged value of carbon credits from trees planted in a hypothetical City of Boise parks project.

TREES PLANTED	tCO_2e STORED AFTER 25 YR	VALUE
375	737	$20,277

E. DISCUSSION

What does the carbon stored by our community forests mean in the big picture of greenhouse gas mitigation? One point of comparison is the amount of CO_2 that cars and trucks emit in the Treasure Valley. In 2016, vehicles in Ada and Canyon Counties emitted about 1,796,085 metric tons of CO_2e.[1] That's about 35 times the amount (51,622 tCO_2e) sequestered by trees each year and about one-third more than the total amount stored in Treasure Valley trees (1,365,057 metric tons of CO_2e), according to the *Treasure Valley i-Tree Ecosystem Analysis* (IDL and U.S. Forest Service, 2013). Given the imbalance between the vehicle emissions (very high) and carbon sequestered in trees (low, relative to vehicle emissions), planting trees alone will not solve the problem.

Ultimately, a strategy involving diverse actions will be required to reduce greenhouse gas emissions and mitigate the effects of a changing climate. This strategy will include replacing fossil fuels with clean energy, increasing energy efficiency, and investing in a suite of natural climate solutions like tree planting, avoided deforestation, and improved forest management. Fortunately, municipalities, businesses, agencies, and citizens in the Treasure Valley are beginning to reduce emissions by increasing energy efficiency, using alternative transportation, and implementing other climate mitigation measures.

While not sufficient alone, tree planting *can* significantly shrink our personal carbon footprints. Every resident in the Treasure Valley accounts for about 2.7 metric tons of CO_2 from driving every year. If each of us planted and cared for a single red oak or other large tree, over its lifetime that tree could store 2.0 metric tons of CO_2, offsetting 70% of our individual impact from driving for a year. Planting and caring for a red oak and a medium-sized tree like a linden would offset all the driving emissions for a year. It may not be feasible for every Treasure Valley citizen to plant two trees per year, but this example illustrates the scale of action required to reduce carbon emissions sufficiently to mitigate climate change.

2.7

Metric tons of CO_2 every resident of Treasure Valley accounted for from driving in 2016

This begs the question of how much carbon can be sequestered collectively by the Treasure Valley through the planting and caring of trees. As we showed in our projections, the case studies we reviewed accounted for about 8,275 trees planted over the last 5 years. By the year 2042, these trees will have stored more than 15,000 tCO_2e.

How much could we feasibly do to accelerate high quality plantings to increase carbon storage? Major planting initiatives in other metropolitan areas like Sacramento, Indianapolis, Philadelphia, and New York have set, and in some cases met, impressive goals for tree planting. These range from planting 100,000 to 1,000,000 trees. In New York City, partners were able to meet their million-tree goal in less than a decade, increasing the city's tree canopy by about 20% (NYRP, n.d.). In order to do so, they raised more than $360 million in public and private funds.

Next, we will take a look at potential limiting factors for increasing tree canopy in the Treasure Valley: space, water, and money.

Photo © Christian Nafzger

Ecological Potential

How many trees can the Treasure Valley sustain from an ecological perspective? This question boils down to the amount of space and water available. The 2013 *Treasure Valley Urban Tree Canopy Assessment* found that tree cover averages about 10% of Treasure Valley communities, ranging from a high of 20% in Garden City to a low of 5% in Middleton (Plan-It Geo, 2013; p. 25.). Using smaller boundaries, one-quarter of all parcels in the study area had a canopy cover exceeding 28%, demonstrating what is already possible. Based on analysis and established best practices, the 2013 *Assessment* recommended an urban canopy goal of 20% for Treasure Valley communities (Plan-It Geo, 2013; p. 44). The 2013 *Assessment* also found that about 40% of the land in the Treasure Valley comprised “possible planting areas” (PPAs). Therefore, from this perspective, space is not likely to be a limiting factor in reaching the 20% canopy goal.

What about water?

We live in a desert. When the settlers arrived in what's now called the Treasure Valley, the tree canopy was likely limited to those areas around the river, streams, wetlands and springs where there was enough water for trees to grow. Since then, we've built up an impressive irrigation infrastructure that today waters our lawns, parks, fields, golf courses, and crops. The *2013 UTC Assessment* found that irrigated turf grass—excluding farmland, golf courses, and sports fields—comprises 21% of the Treasure Valley. An increase in tree canopy over even half of this land would double regional tree canopy.

Water scarcity will be an important issue facing the Treasure Valley in the coming decades. However, most trees will do well in those irrigated turf grass areas identified above without additional water (but with a change in how they are watered). Therefore, we conclude that water is not a limiting factor for the kinds of increases in tree canopy that would be feasible.

We conclude that water is not a limiting factor

From this quick look at the canopy, we might conclude that space and water are not limiting factors in reaching the goal for 20% canopy cover. Given that the current tree population is estimated at 2.4 million trees at 10% canopy cover, meeting the 20% goal would translate to a total future population of 4.8 million trees, or planting and caring for an additional 2.4 million trees. How much would that cost?

Resources

Extrapolating from the New York City example at roughly $360/tree, it would cost $860 million to meet the 20% canopy cover goal. But most things are cheaper in the Treasure Valley than in New York. Based on the *Temperate Interior West Community Tree Guide* (Vargas et al., 2007, p. 104), planting, staking, and mulching a 1.5-inch to 2-inch caliper tree in our region costs between $165 and $207 in 2017 dollars, adjusted for inflation. For simplicity, we will use an average of $186 per tree. Multiplied by 2.4 million trees, that comes to $446 million to get to 20% canopy.

That's just for planting the trees. There are additional costs for pruning and other maintenance. Based on the *Temperate Interior West Community Tree Guide* (Vargas et al., 2007), tree care costs from sapling to stump removal are approximately equal to the initial planting cost, totaling about $900 million to plant and care for an additional 2.4 million trees. Conclusion: money is the limiting factor for reaching the 20% canopy goal for the Treasure Valley.

In addition to the costs and carbon impacts of planting, pruning and managing the urban forest, there is the factor of carbon emitted when a tree is no longer alive. In order to improve efficiencies of using dead trees for beneficial use rather than leaving it to waste, local partners in the Treasure Valley have begun urban wood utilization efforts. These efforts remove urban trees and process them into functional end products, such as furniture or local artwork that can then be sold at a local market. One example of these efforts is highlighted by a local Treasure Valley partner, 208 Urban Timber, LLC (http://www.208urbantimber.com).

Revenue

The 2013 i-Tree Ecosystem Analysis found that our existing community forests provide about $9.4 million per year in ecosystem services like removing air pollution, treating storm water, and sequestering carbon. What if we were able to monetize those benefits to invest in more trees?

That's where City Forest Credits can come into play. Take, for example, the hypothetical Ada County Neighborhood Improvement Project described earlier. In this case, we estimated that planting 1,000 medium and large trees would store 1,879 tons of CO_2 after 25 years with a potential value of $49,087 in carbon credits—or an average of about $49 per tree.

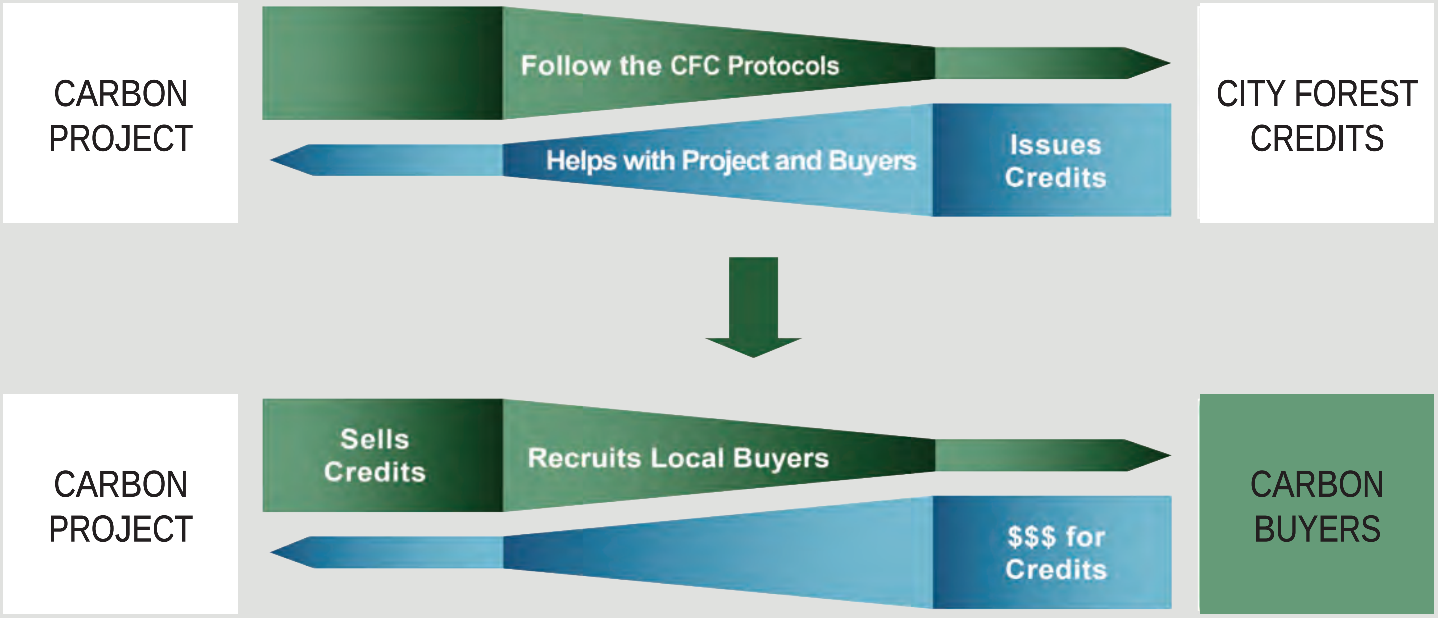
Based on the 2007 report, the cost of planting for a public entity such as Ada County is about $165. Maintenance costs for the tree would be another $130, for a total cost over the life of the tree of about $295. If Ada County were able to sell carbon credits for the tree for $49, this would offset the initial planting cost by 30% and the total life cycle cost by almost 17%. If Ada County reinvested the revenue from carbon credits in planting more trees, the County could augment its initial 1,000-tree project with another 170 trees for the same net investment.

In our case studies, existing projects accounted for 8,275 additional trees planted over the last five years in the Treasure Valley, worth potentially $418,311 in carbon credits. Reinvested in additional plantings, revenue from credits could pay for an additional 2,249 trees[m], bringing the total number to 10,524 trees.

Looking at the two examples above shows the potential for generating significant revenues that could help pay for planting and maintaining trees in the Treasure Valley.

How Do City Forest Credits Work?

The diagram and explanatory text below show how the carbon credit process works.



Start at the top left of the diagram at the green box labeled "Carbon Project:"

- The Carbon Project follows the rules in the City Forest Credits (CFC) carbon protocols.
- CFC provides information and assistance to help Projects, and also helps recruit a buyer for the credits.
- CFC issues carbon credits to the Project (after verifying that the Project has followed the rules).
- The Project sells its credits to a Buyer. Projects may recruit a local company as buyer.
- The Buyer's dollars for the credits flow directly to the Project (minus a small fee to CFC, which is a non-profit entity).
- The Project can use those dollars for any use – to defray planting and maintenance of project trees, to start other projects, or for anything else.

City Forest Credits[n]

City Forest Credits (CFC) is a national non-profit organization issuing tradeable carbon credits to community forest projects in the U.S. CFC has developed an urban forest carbon protocol for community forest planting projects. This protocol is the “rulebook” projects must follow to earn credits, which CFC terms Carbon+ Credits.

If projects follow the protocol, CFC issues Carbon+ Credits to the project. Carbon+ Credits bundle metric tons of CO_2 with quantified storm water runoff reductions, energy savings (cooling), and air quality benefits. The project can sell those Carbon+ Credits to buyers such as local companies or municipalities desiring credits to meet sustainability goals. Cash flows from the buyers to the projects.

The CFC tool for quantifying co-benefits was not available at the time we estimated the carbon benefits in our case studies. However, the values we assign to our carbon credits reflect the expected price of “bundled” Carbon+ Credits incorporating storm water, air quality, and energy benefits. As temperatures in the Treasure Valley continue to rise, our community forests will become increasingly important for reducing air pollutants like ozone and volatile organic compounds as well as mitigating the urban heat island effect.[o]

Community trees are expensive, but they deliver a host of co-benefits to the environment, citizens, and companies that help keep their cities green and healthy. While community forest credits cannot compete with other types of carbon credits on price alone, we believe they deliver values and services commensurate with the cost.

Conclusion

The Treasure Valley’s community forest stores a significant amount of carbon, but planting trees alone will not achieve the greenhouse gas reductions needed to stabilize our climate. That will require a whole suite of climate mitigation strategies. However, planting community forests can serve as one tool for reducing greenhouse gas emissions while providing multiple co-benefits for people and nature. Tree planting and stewardship also provides a tangible action that individuals can take to mitigate their own carbon footprints.

The ecological potential is high for storing additional carbon in the Treasure Valley’s forest canopy, but planting and maintaining trees in community forests is expensive. In order to achieve significant increases in canopy, partners will need to significantly increase funding for plantings and maintenance. City Forest Credits offer a means for generating revenue from carbon credits from community forestry projects. These revenues could provide the financial incentive for increased plantings in the Treasure Valley while providing a visible environmental benefit for companies or other buyers of carbon credits.

Photo © Maddy Baker

F. RECOMMENDATIONS

In order to build and sustain a suite of natural climate solutions in Idaho's Treasure Valley, we must start by working together with existing partners who are currently planting and managing our region's tree resource. By investing in collaboration facilitated by the Treasure Valley Canopy Network (the Network), we recommend partnering with existing and new tree planting partners throughout the region to implement the proposed actions. Given the semi-arid climate of the Treasure Valley and limited resources, all strategies will emphasize these key factors:

(1) Engaged partners;
(2) Strategic focus of planting efforts to maximize environmental benefit;
(3) Long-term funding to support the activity.

All of these actions will rely on partner contributions, but will need additional funding support which could include: grant funding sources; City Forest Credits (CFC) carbon credits; and additional public and private funding sources. Funding through the CFC will rely on collaboration with local and regional "carbon buyers" secured and facilitated by the Network. Carbon buyers may be local Treasure Valley corporations, agencies or non-profit organizations whose missions include sustainability goals furthered by supporting urban forestry and carbon mitigation projects.

The following are a list of existing and potential projects and programs where the Network can begin facilitating and tracking carbon projects and impacts over the next several years.

Existing projects / programs

	Lead Partner	**Strategic Focus**	**Long-term funding support**
Treasure Valley Shade Tree Project	Idaho Power Company	Residential energy conservation	Idaho Power Company
ReLeaf Boise	City of Boise	Residential tree planting	City of Boise
NeighborWoods Boise	City of Boise	Residential and transportation corridor (storm water and air quality)	City of Boise
Boise River Riparian Plantings - multiple projects throughout the riparian corridor	Boise River Enhancement Network (BREN)	Habitat restoration	BREN and City Forest Credits

Potential future projects / programs

	Lead Partner	Strategic Focus	Long-term funding support
Municipal Park Planting Initiatives (can be implemented in any of the 9 TV cities)	Partner municipality (Boise, Nampa, Caldwell, Meridian, Eagle, etc.)	Community development and recreations	Partner municipality and CFC
Ada County Neighborhood Improvement Project	ACHD and partner municipalities	Residential and transportation corridor (storm water and air quality)	ACHD, municipal partners and CFC
Parking Lot/Urban Heat Island Retrofits	Partner municipality/ corporate landowner	Air quality and urban heat island reduction	Municipal partners, corporate landowners, and CFC
Nursery Industry Incentive Program	Nursery industry partner (Jayker Re-Wholesale nurseries, etc.)	Residential tree planting (raising awareness and marketing)	Nursery industry and corporate partners

Proposed Actions

YEAR 1

1. Network begins tracking tree planting projects throughout the Treasure Valley and documenting carbon and co-benefit (storm water, energy, and air quality) impacts from these projects. Tracking will begin with active municipal partners, Idaho Power Company and BREN.
2. Network facilitates one pilot project with an existing partner to secure CFC credits in collaboration with a local carbon buyer. The pilot project will prioritize a location where a single landowner retains ownership of the land and trees. Potential projects include: large municipal park plantings or BREN riparian plantings.

YEAR 2-5

1. Network continues to track planting projects and document carbon and co-benefits impacts, expanding to more partners including transportation agencies, large landowners, nursery partners, etc.
2. Network facilitates multiple CFC projects, prioritizing large single landowner projects where tree ownership and growth can be tracked and documented by the registry over 25 years.

BEYOND YEAR 5

1. Network continues to track carbon impacts on all partner planting projects.
2. Network facilitates multiple CFC projects for interested and eligible partners and carbon buyers.
3. Replicate partner projects and programs where they have the greatest impact, including: Treasure Valley Shade Tree Project (growth beyond the Treasure Valley), municipal tree planting projects throughout the Treasure Valley and beyond.

G. ENDNOTES

[a] *Based on the City Forest Credits (n.d.; http://www.cityforestcredits.org/protocols) Revenue Estimation Tool for a large, broadleaf deciduous tree.*

[b] *According to the Treasure Valley i-Tree Ecosystem Analysis (IDL and USFS, 2013 p.9), approximately 371,950 metric tons of C are stored by trees in the Treasure Valley, which corresponds to removal of 1,365,057 metric tons of CO_2 from the atmosphere (1 metric ton of C = 3.67 metric tons of CO_2). This is valued at $29,200,000. Each year about 51,622 metric tons of CO_2 are removed from the atmosphere by these trees, which sequester 14,066 metric tons of C/yr. Annually, this is valued at $1,100,000. Carbon storage and sequestration dollar values are calculated based on $71/ton of C. On a canopy area basis, these carbon storage and sequestration estimates correspond to 5.6 kg C/m^2 of tree canopy and 0.21 kg C/m^2 of tree canopy per year, respectively.*

[c] *"Storage" refers to the cumulative amount of carbon stored as tree biomass. "Sequestration" refers to the rate at which trees accumulate carbon, usually on an annual basis.*

[d] *The i-Tree Ecosystem Analysis (IDL and U.S. Forest Service, 2013; p.37) estimates that trees in the Treasure Valley intercept approximately 125 million gallons of storm water runoff per year, which is valued at about $1,120,000/yr. This is based on an estimate of 2,431,611 trees in the Treasure Valley in 2011, representing 119 mi^2 of leaf area that intercept 16,780,338 ft^3 of rainfall/yr, and can be valued at $1,117,178, assuming $0.067/$ft^3$ (Plan-It Geo, 2013; p. E-37). This translates to about 6.9 ft^3 of interception/yr per tree or 51.6 gal/yr per tree (1 gal = 0.13368056 ft^3).*

[e] *The i-Tree Ecosystem Analysis (IDL and U.S. Forest Service, 2013; p. 34 & E-34) estimated trees in the Treasure Valley remove 526.3 metric tons of air pollution/yr (580 tons/yr), which is valued at about $7,500,000/yr. This air pollution includes CO (14.7 metric tons/yr), O_3 (250.3 metric tons/yr), NO_2 (27.8 metric tons/yr), SO_2 (0.5 metric tons), and PM<10µ (233.0 metric tons/yr). Note: 1 lb = 0.000453592 metric ton; 2000 lb = 1 short ton = 0.907184 metric ton.*

[f] *Note negative energy conservation impacts of the current urban forest in the Treasure Valley. This is based off the best available science and modeling of the i-Tree program. This negative value is due to winter heating costs associated with areas where trees—especially conifers—shade buildings during winter months, creating an additional cost for heating. This reiterates the importance of future strategies that plant the right tree in the right place to reduce summer cooling costs and not negatively impact winter heating costs. This strategy is being employed through the Treasure Valley Shade Tree Project by planting large deciduous trees to the west of homes.*

[g] *Idaho Department of Lands and the USDA Forest Service provided funding for this project.*

[h] *We use direct carbon storage estimates that do not account for greenhouse gases emitted in the planting and maintenance of trees (e.g., from trucks, chainsaws, and chippers).*

[i] *Metric tons of CO_2e stored at the end of year 25 minus 20% mortality and a 5% deduction from the CFC revenue estimation tool.*

[j] *Based on 2.7 metric tons of CO_2e/yr per capita Vehicle Miles Traveled (VMT) for Treasure Valley residents.*

[k] *We used U.S. EPA's eGRID product (2014; February 2017) to calculate total annual plant CO2 equivalent emissions per total annual plant net generation (0.063 metric tons CO2e/MWh) for Idaho Power's utility service territory. [0.063 metric tons CO2e/MWh x 5,000 MWh = 315 metric tons CO2e].*

[l] *Greenhouse gas emissions from vehicles in the Treasure Valley (1,796,085 metric tons CO_2e/yr) were estimated using methods described by the U.S. Environmental Protection Agency (September 2017; https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references). Annualized Vehicle Miles Traveled (VMT) (4,390,923,472 mi/yr) and Per Capita VMT (6,700 mi/yr) for Ada and Canyon Counties in 2016 were provided by the Community Planning Association of Southwest Idaho (COMPASS; http://compassidaho.org/). These are the calculations:*

$$\frac{4{,}390{,}923{,}472\ \text{mi}}{\text{yr}} \ \mathrm{X}\ \frac{1\ \text{gal gasoline}}{22\ \text{mi}} \ \mathrm{X}\ \frac{0.008887\ \text{metric tons CO}_2}{1\ \text{gal gasoline}} \ \mathrm{X}\ \frac{0.989\ \text{CO}_2}{1\ \text{CO}_2\text{, CH}_4\ \&\ \text{N}_2\text{O}}$$

$$= \frac{1{,}796{,}085\ \text{metric tons CO}_2\text{e}}{\text{yr}}$$

$$\frac{6{,}700\ \text{mi}}{\text{yr}} \ \mathrm{X}\ \frac{1\ \text{gal gasoline}}{22\ \text{mi}} \ \mathrm{X}\ \frac{0.008887\ \text{metric tons CO}_2}{1\ \text{gal gasoline}} \ \mathrm{X}\ \frac{0.989\ \text{CO}_2}{1\ \text{CO}_2\text{, CH}_4\ \&\ \text{N}_2\text{O}}$$

$$= \frac{2.7\ \text{metric tons CO}_2\text{e}}{\text{yr}}$$

[m] *At $186 per tree initial planting cost. Most of the trees in the case studies came from the Treasure Valley Shade Tree project in which homeowners take on the maintenance costs.*

[n] *The text and graphics in this section come from City Forest Credits. n.d. http://www.cityforestcredits.org/. Accessed 2017-09-08.*

[o] *As urban areas develop, buildings, roads, and other infrastructure replace open land and vegetation. These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape. On a hot, sunny summer day, the sun can heat dry, exposed urban surfaces, such as roofs and pavement, to temperatures 50–90 °F (27–50 °C) hotter than the air (U.S. EPA, October 2017).*

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I. APPENDIX: CARBON ANALYSIS

The following tables detail the case studies presented in Section D of the overall report. All the tables below are from the City Forest Credits tool (n.d., accessed 2017-09-20) and are divided up by the project they describe. There are five existing projects, in which trees have already been planted, one planned project in which trees will be planted, and two hypothetical projects that examine potential future scenarios. Tables 1 and 2 below detail the CO_2 and mortality adjustment for all projects described within this report.

Table 1. CO_2 Value

	CO_2 \$ per metric ton
Low	$20.00
High	$35.00

Table 2. Mortality Adjustment

% Survival	80.0%

Treasure Valley Shade Tree Project All Years (Including Spring 2017 Offering): Existing Project

Table 3. Planting list for Treasure Valley Shade Tree Project All Years

Species	# of Trees
Bur Oak	698
Common Hackberry	127
Exclamation London Planetree	59
Frontier Elm	426
Ginkgo	175
Greenspire Linden	393
Hackberry	363
Happidaze Sweetgum	106
Heritage River Birch	199
Kentucky Coffeetree	128
London Planetree	130
Moraine Sweetgum	141
New Harmony' American Elm	295
Northern Red Oak	617
Princeton Elm	195
Red Maple Armstrong	36
Redmond Linden	52
River Birch (clump form)	870
Sourwood	87
Suncole" Sunburst Honeylocust"	47
Swamp White Oak	812
Tulip Tree	882
Unkown	12
Valley Forge Elm	92
Worplesdon Sweetgum	621
Grand Total	7563

Table 4. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values.

Tree Type	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	6844	14,165.3	13,457.1	$269,141.58	$470,997.77
Brdlf Decid Med (30-50 ft)	719	704.2	668.9	$13,378.97	$23,413.19
Total	7563	14,869.5	14,126.0	$282,520.5	$494,411.0

Table 5. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	1,412.6	$28,252.1	$49,441.1	5,650.4	$113,008.2	$197,764.4
plus error	1,624.5	$32,489.9	$56,857.3	6,498.0	$129,959.5	$227,429.0
minus error	1,200.7	$24,014.2	$42,024.9	4,802.8	$96,057.0	$168,099.7
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						
	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	4,237.8	$84,756.2	$148,323.3	2,825.2	$56,504.1	$98,882.2
plus error	4,873.5	$97,469.6	$170,571.8	3,249.0	$64,979.7	$113,714.5
minus error	3,602.1	$72,042.7	$126,074.8	2,401.4	$48,028.5	$84,049.9
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						

Treasure Valley Shade Tree Project, 2017 Spring Offering: Existing Project

Table 6. Planting list for Treasure Valley Shade Tree 2017 Spring Offering

Species	# of Trees
Tulip Tree	143
Northern Red Oak	139
Greenspire Linden	136
Bur Oak	135
River Birch Clump	134
Frontier Elm	130
Swamp White Oak	130
Hackberry	127
Worplesdon Sweetgum	118
New Harmony Elm	115
Total	1307

Table 7. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values.

Tree Type	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	1171	2,423.7	2,302.5	$46,049.79	$80,587.14
Brdlf Decid Med (30-50 ft)	136	133.2	126.5	$ 2,530.65	$4,428.64
Total	1307	2,556.9	2,429.0	$48,580.4	$85,015.8

Table 8. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	242.9	$4,858.0	$8,501.6	971.6	$19,432.2	$34,006.3
plus error	279.3	$5,586.8	$9,776.8	1,117.4	$22,347.0	$39,107.3
minus error	206.5	$4,129.3	$7,226.3	825.9	$16,517.4	$28,905.4
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						

	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	728.7	$14,574.1	$25,504.7	485.8	$9,716.1	$17,003.2
plus error	838.0	$16,760.3	$29,330.4	558.7	$11,173.5	$19,553.6
minus error	619.4	$12,388.0	$21,679.0	412.9	$8,258.7	$14,452.7
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						

ReLeaf Boise: Existing Project

Table 9. Planting list for ReLeaf Boise

Species	# of Trees
Honeylocust	20
Red Oak	10
Sugar Maple	15
Hackberry	22
London Planetree	35
Tuliptree	42
Elm	5
Linden	3
Callery Pear	25
White Ash,	35
River Birch	40
Gingko,	22
Sweetgum	5
Swamp White Oak	5
Crabapple	5
Total	289

Table 10. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values.

Tree Type	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	234	484.3	460.1	$9,202.09	$16,103.66
Brdlf Decid Med (30-50 ft)	50	49.0	46.5	$930.39	$1,628.18
Brdlf Decid Small (15-30 ft)	5	2.6	2.5	$50.08	$87.64
Total	289	535.9	509.1	$10,182.6	$17,819.5

Table 11. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	50.9	$1,018.3	$1,781.9	203.7	$4,073.0	$7,127.8
plus error	58.5	$1,171.0	$2,049.2	234.2	$4,684.0	$8,197.0
minus error	43.3	$865.5	$1,514.7	173.1	$3,462.1	$6,058.6

± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement

	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	152.7	$3,054.8	$5,345.8	101.8	$2,036.5	$3,563.9
plus error	175.6	$3,513.0	$6,147.7	117.1	$2,342.0	$4,098.5
minus error	129.8	$2,596.6	$4,544.0	86.6	$1,731.0	$3,029.3

± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement

NeighborWoods: Existing Project

Table 12. Planting list for NeighborWoods Program

Species	# of Trees
Honeylocust	5
Red Oak	7
Sugar Maple	5
Hackberry	15
London Planetree	22
Tuliptree	15
Elm	7
Linden	6
Callery Pear	13
White Ash,	25
River Birch	3
Gingko,	15
Sweetgum	20
Swamp White Oak	6
Crabapple	9
Total	173

Table 13. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values.

Tree Type	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	130	269.1	255.6	$5,112.27	$8,946.48
Brdlf Decid Med (30-50 ft)	34	33.3	31.6	$632.66	$1,107.16
Brdlf Decid Small (15-30 ft)	9	4.7	4.5	$90.14	$157.74
Total	173	307.1	291.8	$5,835.1	$10,211.4

Table 14. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	29.2	$583.5	$1,021.1	116.7	$2,334.0	$4,084.6
plus error	33.6	$671.0	$1,174.3	134.2	$2,684.1	$4,697.2
minus error	24.8	$496.0	$868.0	99.2	$1,983.9	$3,471.9
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						
	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	87.5	$1,750.5	$3,063.4	58.4	$1,167.0	$2,042.3
plus error	100.7	$2,013.1	$3,522.9	67.1	$1,342.1	$2,348.6
minus error	74.4	$1,487.9	$2,603.9	49.6	$992.0	$1,735.9
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						

Boise River 2017 Riparian Planting: Existing Project

Table 15. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values. (Riparian plantings consist of only Cottonwood [BDL] and Willow [BDM].)

Tree Type	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	50	103.5	98.3	$1,966.26	$3,440.95
Brdlf Decid Med (30-50 ft)	200	195.9	186.1	$3,721.55	$6,512.71
Total	250	299.4	284.4	$5,687.8	$9,953.7

Table 16. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	28.4	$568.8	$995.4	113.8	$2,275.1	$3,981.5
plus error	32.7	$654.1	$1,144.7	130.8	$2,616.4	$4,578.7
minus error	24.2	$483.5	$846.1	96.7	$1,933.9	$3,384.2
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						
	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	85.3	$1,706.3	$2,986.1	56.9	$1,137.6	$1,990.7
plus error	98.1	$1,962.3	$3,434.0	65.4	$1,308.2	$2,289.3
minus error	72.5	$1,450.4	$2,538.2	48.3	$966.9	$1,692.1
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						

Cottonwood Creek Daylighting Project: Planned Project

Table 17. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values. (Riparian plantings consist of only Cottonwood [BDL] and Willow [BDM].)

	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	60	124.2	118.0	$2,359.51	$4,129.14
Brdlf Decid Med (30-50 ft)	300	293.8	279.1	$5,582.32	$9,769.06
Total	360	418.0	397.1	$7,941.8	$13,898.2

Table 18. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	39.7	$794.2	$1,389.8	158.8	$3,176.7	$5,559.3
plus error	45.7	$913.3	$1,598.3	182.7	$3,653.2	$6,393.2
minus error	33.8	$675.1	$1,181.3	135.0	$2,700.2	$4,725.4

± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement

	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	119.1	$2,382.5	$4,169.5	79.4	$1,588.4	$2,779.6
plus error	137.0	$2,739.9	$4,794.9	91.3	$1,826.6	$3,196.6
minus error	101.3	$2,025.2	$3,544.0	67.5	$1,350.1	$2,362.7

± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement

Ada County High District Neighborhood Improvement Project: Hypothetical Project

Table 19. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values. (Hypothetical Projects only used the Tree-Type Abbreviation.)

Tree Type	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	825	1,707.5	1,622.2	$32,443.28	$56,775.74
Brdlf Decid Med (30-50 ft)	175	171.4	162.8	$3,256.35	$5,698.62
Total	1000	1,878.9	1,785.0	$35,699.6	$62,474.4

Table 20. Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	178.5	$3,570.0	$6,247.4	714.0	$14,279.9	$24,989.7
plus error	205.3	$4,105.5	$7,184.6	821.1	$16,421.8	$28,738.2
minus error	151.7	$3,034.5	$5,310.3	606.9	$12,137.9	$21,241.3
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						
	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	535.5	$10,709.9	$18,742.3	357.0	$7,139.9	$12,494.9
plus error	615.8	$12,316.4	$21,553.7	410.5	$8,210.9	$14,369.1
minus error	455.2	$9,103.4	$15,931.0	303.4	$6,068.9	$10,620.6
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						

Boise Park Planting Initiative: Hypothetical Project

Table 21. Summary of planting sites and CO_2 (t) stored at the end of 25 years plus low and high dollar values. (Hypothetical Projects only used the Tree-Type Abbreviation.)

	No. Sites Planted	CO_2 Stored (t) at the End of Year 25 (with Mortality)	CO_2 (t) Stored at the End of Year 25 Minus %5 Deduction	Low $ Value at the End of Year 25	High $ Value at the End of Year 25
Brdlf Decid Large (>50 ft)	375	776.2	737.3	$14,746.95	$25,807.15
Total	375	776.2	737.3	$14,746.9	25,807.2

Table 22. .Summary of CO_2 (t) stored by trees within the year after planting (10%), year 4 (40%), and year 6 (30%), with error and high and low estimates.

	In the Year After Planting (10% CO_2 t)	Low $ Value In the Year After Planting	High $ Value In the Year After Planting	In Year 4 (40% CO_2 t)	Low $ Value in Year 4 (40% CO_2 t)	High $ Value in Year 4 (40% CO_2 t)
Grand Total CO_2 (t):	73.7	$1,474.7	$2,580.7	294.9	$5,898.8	$10,322.9
plus error	84.8	$1,695.9	$2,967.8	339.2	$6,783.6	$11,871.3
minus error	62.7	$1,253.5	$2,193.6	250.7	$5,014.0	$8,774.4
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						
	In Year 6 (30% CO_2 t)	Low $ Value in Year 6 (30% CO_2 t)	High $ Value in Year 6(30% CO_2 t)	In Year 26 (20% CO_2 t)	Low $ Value in Year 26 (20% CO_2 t)	High $ Value in Year 26(20% CO_2 t)
Grand Total CO_2 (t):	221.2	$4,424.1	$7,742.1	147.5	$2,949.4	$5,161.4
plus error	254.4	$5,087.7	$8,903.5	169.6	$3,391.8	$5,935.6
minus error	188.0	$3,760.5	$6,580.8	125.3	$2,507.0	$4,387.2
± 15% error = ± 10% formulaic ± 3% sampling ± 2% measurement						