Christopher Knop

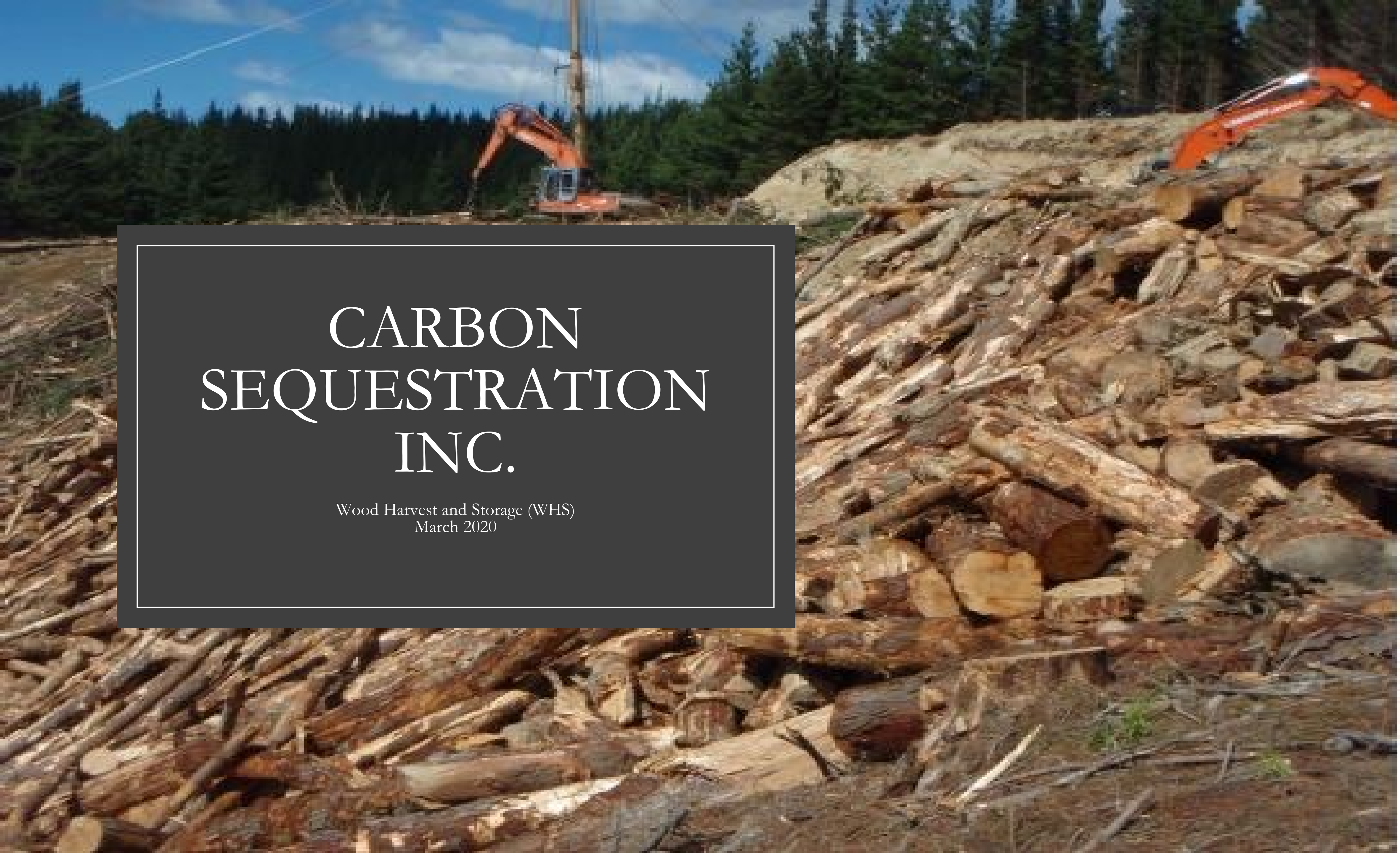
CEO of Carbon Sequestration Inc., an active partner with timber management groups and timber owners in the American South to reduce global CO_2 levels.

Board Certified in Oil, Gas & Mineral Law by the Texas Board of Legal Specialization.

Oil and gas experience includes energy contract litigation, A&D, title, regulatory and corporate counsel.

Owner of the Knop Law Firm, PLLC; President of Bankers Oil Corporation.

J.D. from South Texas College of Law (2005); B.A. from the University of Texas at Austin (2002).



CARBON SEQUESTRATION INC.

Wood Harvest and Storage (WHS)
March 2020

CARBON
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THE ZENG (2008) METHODOLOGY: CARBON SEQUESTRATION VIA WOOD BURIAL WOOD HARVEST & STORAGE ("WHS")

Ning Zeng's methodology focuses on the economical sequestration of carbon dioxide through wood burial.

Zeng's peer-reviewed methodology includes sequestration via wood burial. Zeng argues that by burying wood in pits, it prevents the eventual release of carbon dioxide into the atmosphere.

Zeng explains that in order to properly sequester the carbon, pit construction must be secure in order to prevent the release of carbon dioxide and methane.

Zeng's proposal includes different examples of pits (Figure 1) and proper depth for security (Figure 2).

As seen in Figure 1, the use of slash is optimal for efficient and economical sequestration.

Figure 1

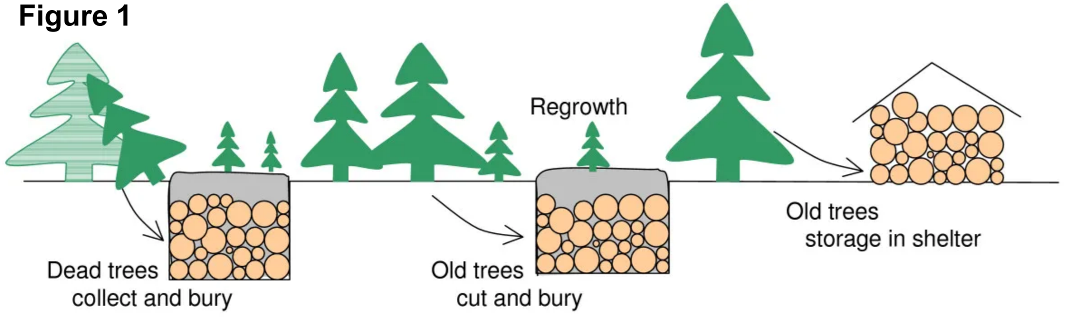
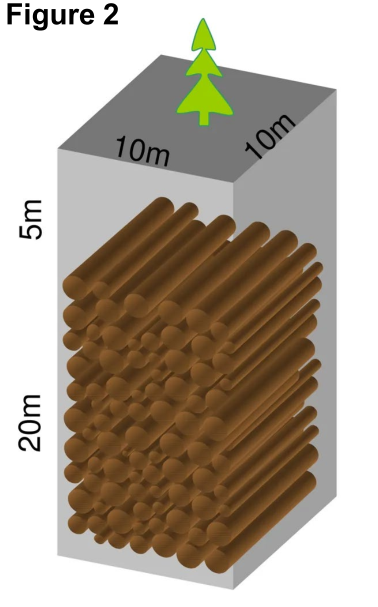
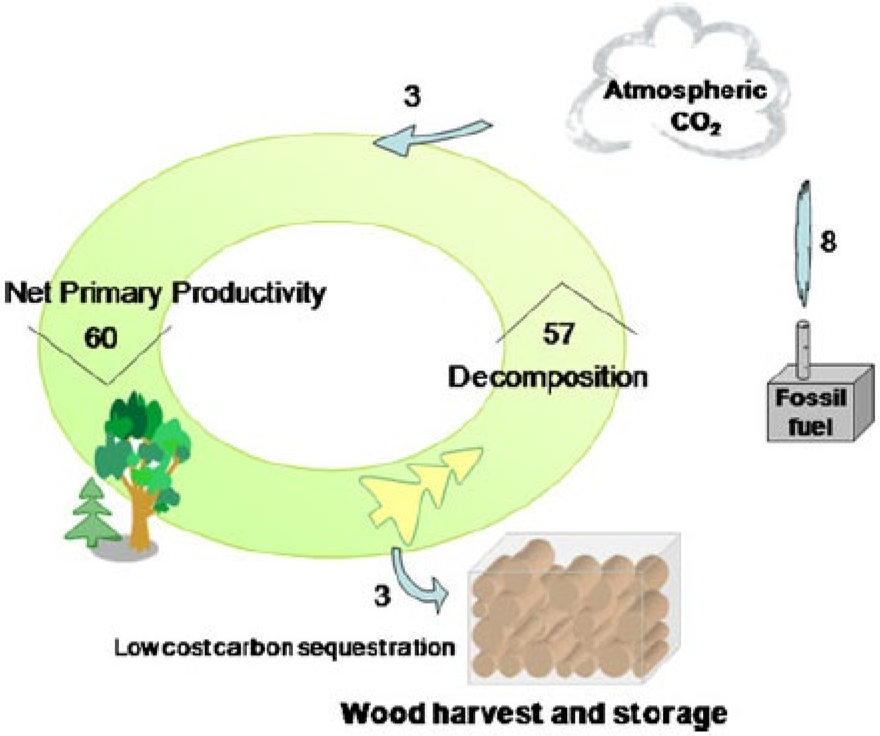


Figure 2





Annual Global Uptake = (220B tCO2)

Natural Emissions = 209 tCO2

Fossil Fuel Emission = 36B tCO2

Net Emissions Annually = 17B tCO2

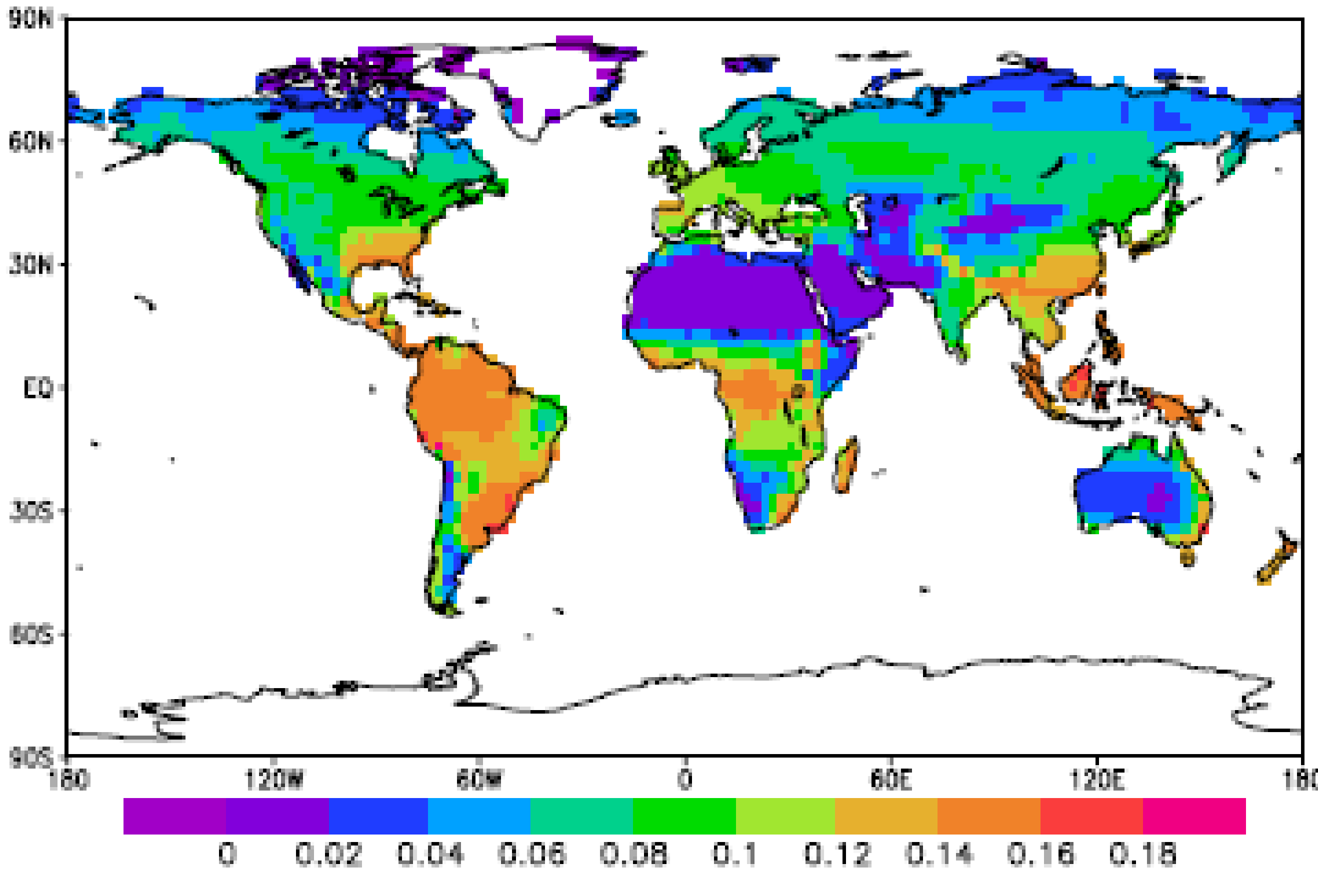


Figure 4
World coarse wood production rate estimated by the model VEGAS in kgC m^{-2} y^{-1}.

Decomposition of Buried Wood

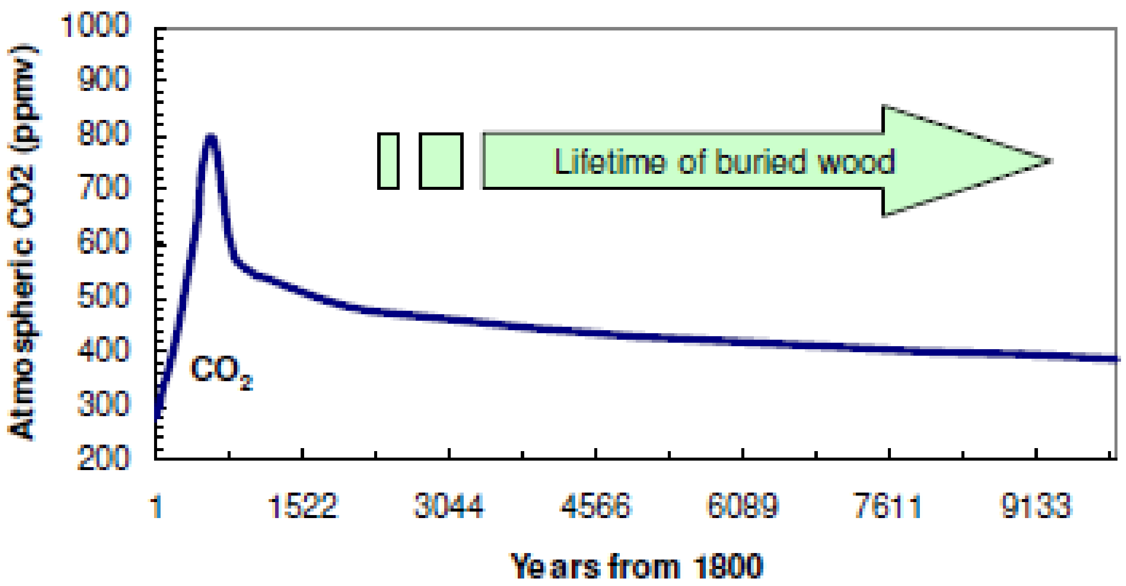


Figure 7
Lifetime of buried wood can be substantially longer than fossil fuel CO_2 residence time in the atmosphere. CO_2 concentration is based on a scenario in which 1000 GtC fossil fuel is burned in the next few hundred years.

Carbon Sequestration Inc.
Published by Christopher Knop [?] · 2 March at 11:52 ·

This Kauri tree was discovered and dug up at the site of a new furniture store in Henderson, New Zealand. Scientists assessed it at 45,000 years old. Again, the tree was sealed off and saturated underground, which kept the timber preserved in exceptional condition.

About This Website

NZHERALD.CO.NZ

Kauri unearthed at building site may hold ancient secrets

Learn More

Decomposition of Buried Wood

Carbon Sequestration Inc.
Published by Christopher Knop [?] · 13 February ·

The longevity of Venice's wooden foundation, centuries old, is due to a lack of oxygen and constant moisture. Under these balanced conditions, wood, which consists of approximately 50.00% carbon, does not decompose.

About This Website

ANCIENT-ORIGINS.NET

The Construction of Venice, the Floating City

Learn More

Venice, Italy, is known by several names, one of which is...

Carbon Sequestration Inc.
Published by Christopher Knop [?] · 26 January ·

https://www.wcvb.com/.../use-for-massachusetts-wood-b.../8177056 This was done near the water (in old shipyard), in very shallow, presumably very wet, conditions. The wood's mere existence reinforces the argument that dead wood carbonizes when sealed from oxygen, which could lead to long-term sequestration (CCS).

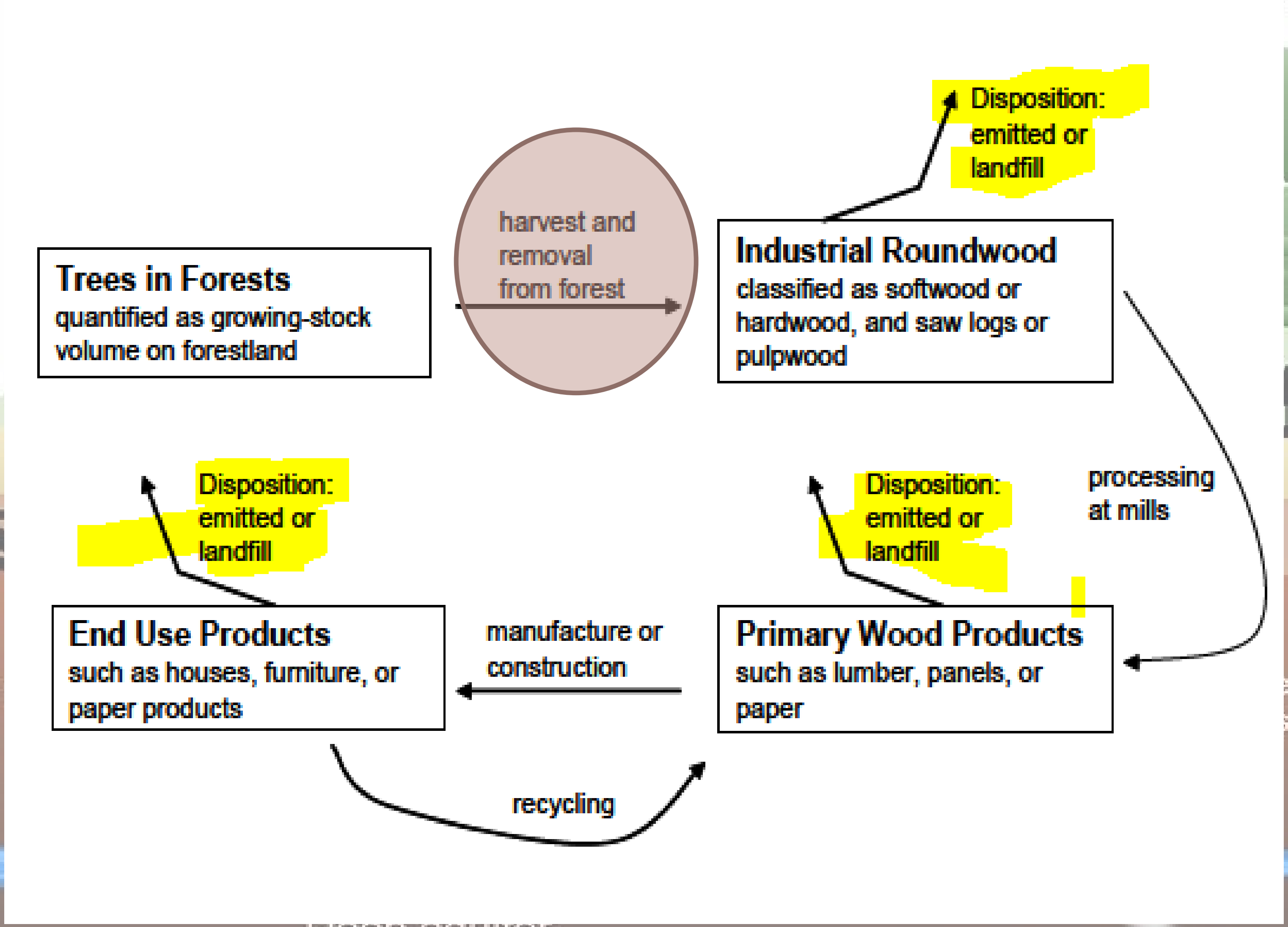
About This Website

WCVB.COM

300-year-old wood found buried in Boston

Learn More

If wood could talk, the old beams in Thomas Mann's lumb...



Industrial Sources of Wood to Sequester

There are several sources for the credits:

1) **From slash remaining after the clear-cutting of traditional timber operations, which will be the focus of this presentation,**

1) Waste at the creation of the eventual wood product.

1) Disposal of end use products that would otherwise be emitted. In the case of a landfill, a separate disposal measurement at the same site could be made for wood products or other carbon-intense products.

1) No-till farming, algae farming, direct capture of CO2 from ambient air, pioneered by Bill Gates Co., Carbon Engineering, and CO2 secondary oil & gas recovery operations, such as those done by Denbury.

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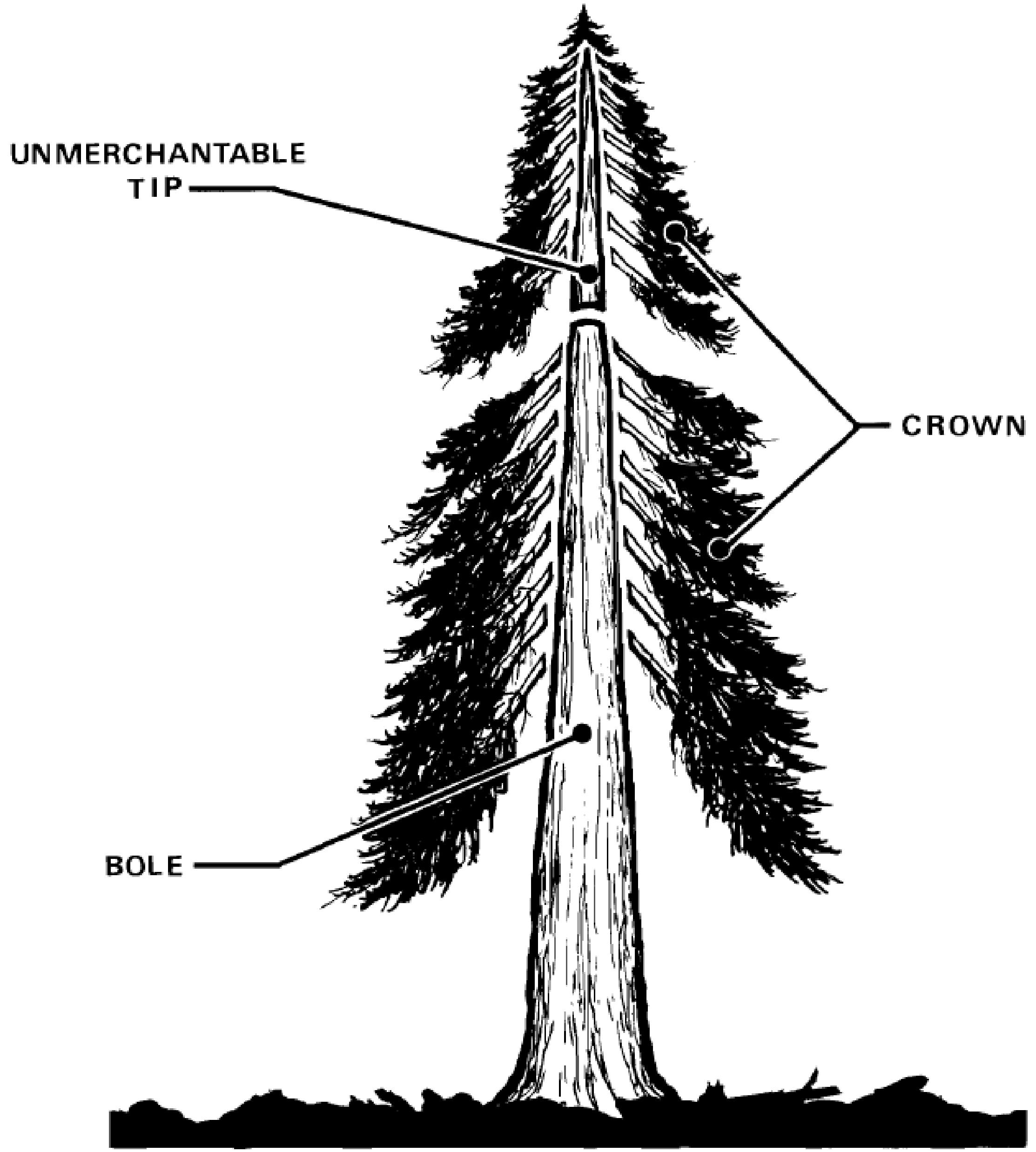

Figure 1.--Different relationships are required to predict weight of slash produced from crowns (foliage and dead and live branchwood), unmerchantable bole tips, and boles (defect and breakage).

“Slash”

After clear cutting, 5 – 12 green tons CO2 / acre remains as non-marketable as “slash” wood which can be piled into sets for delivery.

These numbers increase substantially if Pulpwood is also purchased at the cutting.

Current market conditions make it impractical to burn the slash or pulpwood for electricity.

To be street legal, slash and pulpwood must be transported in <5 ton loads, with prices of approximately $0.90 - $1.50 / mile.

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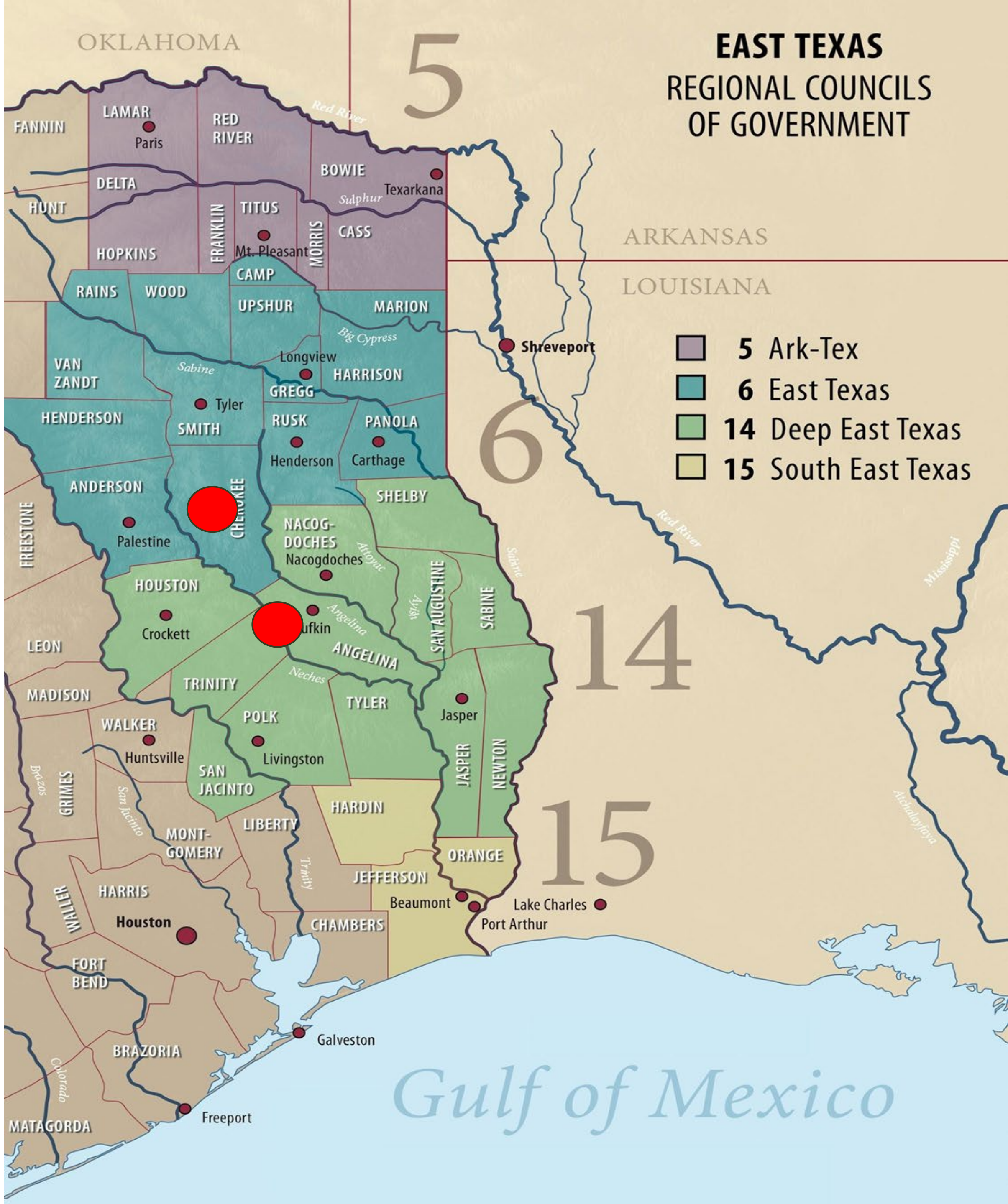
WHAT PROPERTY WILL WE BE USING?

Currently, the American Forestry Management (AFM) Service has supported our sequestration objective by connecting us to local property owners in East Texas. This geographical location strengthens our methodology, according to soil engineers and a professional methodologist we have consulted with. Both AFM and privately-owned properties have been arranged to support pit construction and sequestration. We want to continue to expand our property throughout East Texas by working with Timberland Investment Resources.

Possible Locations



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This handbook contains procedures for predicting weights of slash--the needles, branches, unmerchantable bole tips, and broken and defective bole material--that remains after timber cutting or thinning. In the past, inability to quantitatively describe downed woody debris such as logging slash has made it difficult to evaluate and communicate debris problems. The capability to predict quantities of slash permits planning for debris problems before they are created. However, predicting slash does not guarantee easy solutions to slash problems, but rather provides a sound foundation for making decisions and formulating plans. Professional experience and good judgment will continue to play important roles in debris management.

Slash is produced from three portions of trees: (1) crowns (foliage and branches); (2) unmerchantable bole tips; and (3) defective and broken boles (fig. 1). Different methods are required to predict weight of slash from each source. For crowns, the procedures in this handbook are based on predictive relationships between slash weight and tree d.b.h. that were developed from trees sampled in Montana and Idaho (Brown 1976).[1] The relationships for estimating unmerchantable bole tips were developed by Faurot.[2] The procedure for estimating defective and broken boles relies on estimates of merchantable volume, defect, and breakage supplied by users.

SLASH WEIGHT SUMMARY

Stand 16 Location Cool Man Ck.
Unit 4 Date 8-26-76 Page 1 of 1

	Number of trees /acre from inventory by species						Crown weight/acre (pounds) by species					
DBH	G.Fir	Larch					G.Fir	Larch				
1	300						1590					
2	100						1660					
10	38						9196					
11	30						8070					
12	20	9					6020	1647				
13	16	10					5392	1920				
14	15						5665					
15												
16	10						4710					
17		5						1225				
Total							42293	4792				

SUMMARY OF DEBRIS WEIGHT

(1) Cutting		(2) Trampling		(3) Breakage	
Pounds/acre	Tons/acre	Pounds/acre	Tons/acre	Pounds/acre	Tons/acre
43,835	21.92	3250	1.63	8462	4.23

Predicted weight. (1) + (2) + (3) Tons/acre = 27.8

(4) Existing downed debris. Tons/acre = 18.0

Total debris. (1) + (2) + (3) + (4), Tons/acre = 45.8

Figure 2.--Slash summary form showing a sample estimate of trees expected to be cut and trampled and the resultant slash. Crown weight per acre is the product of number of trees per acre and crown weight per tree from table 3. (A sample form is inserted in the back of this handbook.)

STEP 3. *Estimate slash weight for defect and breakage as:*

$$w = V \times f \times s/2000 \quad (1)$$

where

w = weight of logging residue from defect and breakage, tons/acre
V = merchantable volume of trees' to be cut, ft^3/acre
f = fraction of merchantable volume expected to be left on the ground as defect and breakage
s = density of wood, lb/ft^3

Slash CO2 Content Estimates (from USDA –Forestry Dept.)

Current yields for a 30-year stand are approximately 200 tons CO_2 / acre. Because of current carbon prices, most of that wood is better sold as timberwood.

Upon clear cutting, 5 – 10 tons CO_2 / acre (and sometimes up to four times as much) remains as non-marketable as "slash" wood which can be piled into sets for delivery. Slash from thinning, if pulpwood is not included, is closer to 1 ton CO_2 / acre.

Currrent market conditions make it impractical to burn the slash for electricity. As prices increase, some pulpwood may be available for sequestration.

To be street legal, slash must be transported in <5 ton loads, with prices of approximately \$0.90 - \$1.50 / mile.

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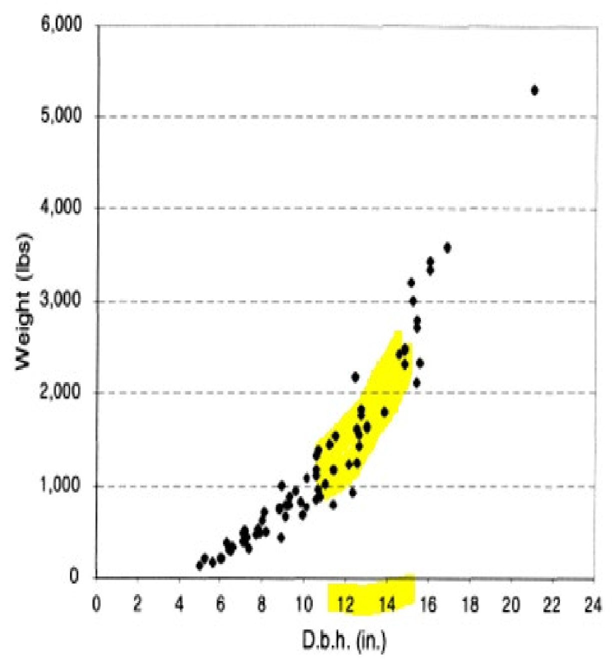
Table 2.—Predicted whole-tree green weight, in pounds, from tree weight regression equations

Tree dbh (inches)	Source of tree weight equation		
	Brenneman	Monteith	Wartluft
1	4	5	5
2	24	21	25
3	65	67	65
4	131	145	130
5	227	255	222
6	356	395	343
7	520	566	496
8	722	769	683
9	965	1,003	906
10	1,251	1,268	1,166
11	1,581	1,564	1,465
12	1,958	1,891	1,804



Hardwoods Are Heavier than Pines, Providing for Superior Slash Economics

Forestry management teams may decide to add carbon credits to their tool kit, thereby expanding the amount and types of land they are able to profitably manage.

TABLE 1. Merchantable weight (tons) of hardwood trees *by diameter or circumference at breast height in inches.*

Diameter Inches	Circumference Inches	Weight Tons
12	38	0.75
13	41	0.92
14	44	1.09
15	47	1.28
16	50	1.48
17	53	1.69
18	57	1.92
19	60	2.16
20	63	2.41
21	66	2.68
22	69	2.95
23	72	3.25
24	75	3.55
25	79	3.87
26	82	4.20

TABLE 3. Adjustment factors for RED OAK group of tree species.

Species	Factor
Southern Red Oak	1.054
Black Oak	1.033
Northern Red Oak	1.018
Cherrybark Oak	1.015
Nuttall Oak	0.999
Water Oak	0.996
Willow Oak	0.963

TABLE 4. Adjustment factors for WHITE OAK group of tree species.

Species	Factor
Post Oak	1.026
Overcup Oak	0.997
White Oak	0.958

TABLE 5. Adjustment factors for MISCELLANEOUS tree species.

Species	Factor
Mockernut Hickory	1.013
Shagbark Hickory	0.987
Bitter Pecan	0.966
Sweetgum	0.974

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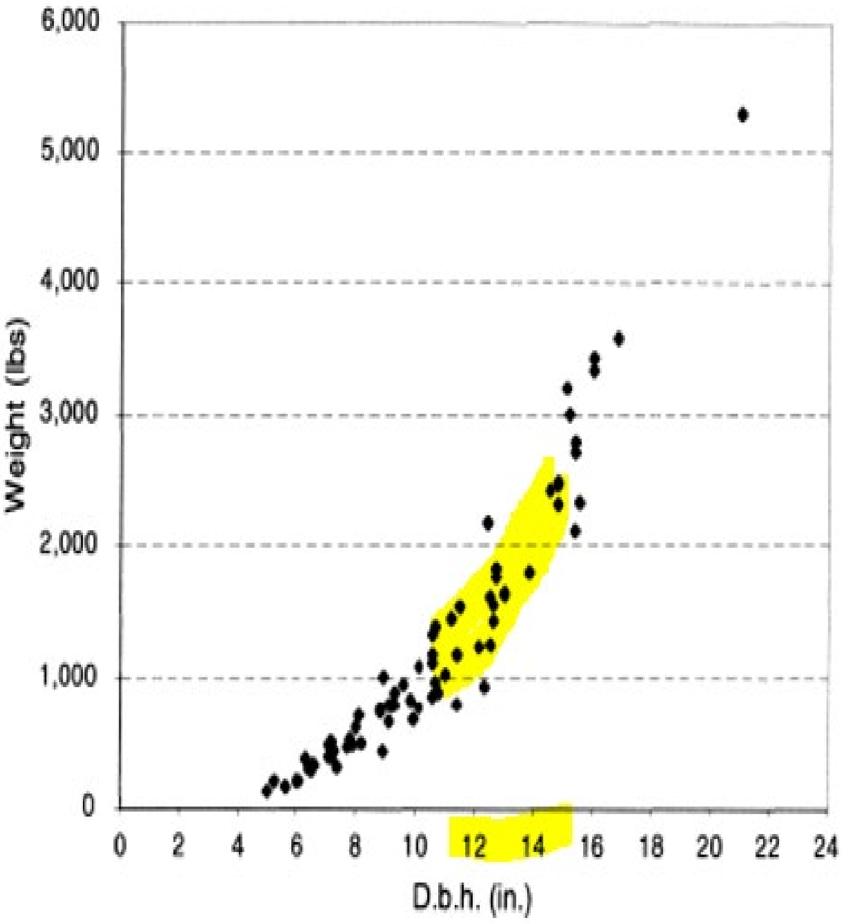
WEIGHT PER TREE--TOTAL CROWN AND TIP

TABLE 1.--Weight per tree by d.b.h. of all material for crowns and unmerchantable bole tips to a 3-inch top

3-INCFI TOP

D.b.h. (inches)	PP	LP	WL-WP	DF	GF	AF	WC-WH	ES
	Pounds							
4	35	29	31	40	45	37	34	40
5	48	36	36	51	60	47	44	53
6	66	46	43	64	77	61	56	69
7	87	59	52	80	97	79	70	87
8	113	74	62	97	120	100	86	108
9	143	92	72	116	146	125	104	131
10	177	112	84	137	175	154	124	156
11	216	133	97	160	207	187	145	183
12	259	155	110	184	242	226	168	213
13	307	179	125	210	281	269	193	246
14	359	205	140	239	324	319	220	280
15	416	233	156	269	370	375	249	317
16	478	262	173	301	422	437	280	357
17	544	293	190	334	477	489	312	399
18	616	325	209	380	538	546	347	444
19	692	360	228	429	587	607	383	492
20	774	396	248	482	637	671	421	542
21	861	433	268	537	688	739	462	596
22	953	473	289	597	741	809	504	652
23	1,050	513	311	659	796	883	549	712
24	1,150	556	334	725	852	960	595	775
25	1,260	600	357	795	909	1,040	644	841
26	1,370	645	382	869	968	1,120	695	911
27	1,490	693	406	946	1,030	1,210	748	985
28	1,620	741	432	1,030	1,090	1,300	804	1,060
29	1,750	792	458	1,110	1,150	1,400	862	1,140
30	1,890	844	485	1,200	1,220	1,490	922	1,230
31	2,030		513	1,290	1,280		985	1,320
32	2,180		541	1,390	1,350		1,050	1,410
33	2,330		570	1,490	1,420		1,120	1,510
34	2,490		600	1,600	1,490		1,190	1,610
35	2,660		630	1,710	1,560		1,260	1,720
36	2,830		661	1,820	1,630		1,340	1,830
37	3,010		693	1,940	1,700		1,410	1,950
38	3,200		725	2,060	1,780		1,500	2,070
39	3,390		758	2,190	1,850		1,580	2,200
40	3,590		792	2,320	1,930		1,670	2,330



Slash Weight for Pine

Crown + Tip weights for pine are approximately one- fifth (1/5th) of total weight.

More aggressive slash cuttings could result in higher slash yields and also higher timber wood prices and quality.

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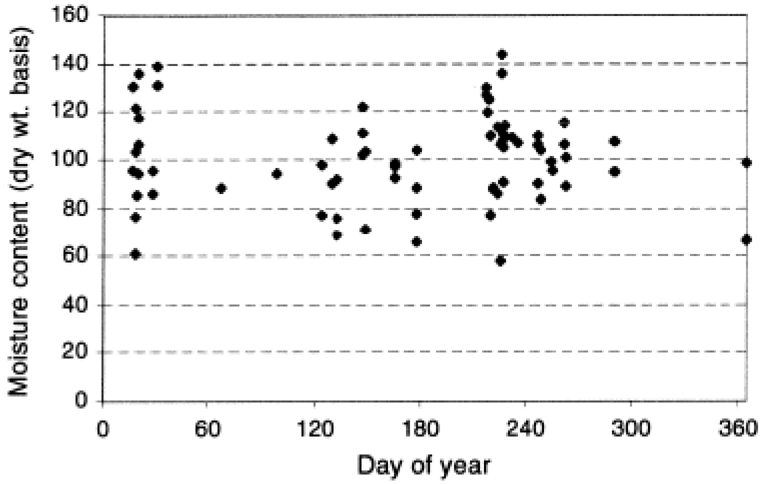

Figure 2—Moisture content of sample trees by sampling date.

Table 1—Effect of age on bole moisture content

Age class	Observations	MC[a]
	Number	*Percent*
11–15	8	124.4 a
16–20	6	120.5 a
21–25	14	99.5 b
26–30	12	98.2 b
31–35	12	93.7 b
36–40	16	93.0 b

MC = moisture content.

Table 4.—Biomass yield table using basal area and trees cut per acre to predict thinning yields from trees $\geq$ 1.0 inch dbh (based on yield model developed from Brenneman's tree weight equation).

Number of trees cut per acre	Basal area removed in thinning, square feet per acre						
	30	40	50	60	70	80	90
	Green tons/acre						
100	32	44	55	67	78	90	101
200	30	41	53	64	76	87	99
300	28	39	51	62	74	85	97
400	25	37	48	60	71	83	94
500	23	34	46	57	69	80	92
600	20	32	43	55	67	78	90
700	18	30	41	53	64	76	87
800	16	27	39	50	62	73	85
	Dry tons/acre						
100	18	25	31	38	45	51	58
200	17	24	30	37	43	50	56
300	16	22	29	35	42	48	55
400	14	21	27	34	41	47	54
500	13	20	26	33	39	46	52
600	12	18	25	31	38	44	51
700	10	17	23	30	36	43	50
800	9	15	22	29	35	42	48

Moisture Content ("MC") must also be taken into account when determining carbon stocks.

MC = (green weight – dry weight) / (dry weight) × 100

A stand older than 20 years generally has a MC below 100, meaning the dry weight is approximately one-half (1/2) of the green weight.

Moisture content in the leaves and head of the tree is higher than the trunk.

Slash dries quickly, but delivery will be preferable ~30 days or more after clear-cutting, when moisture content is lower.

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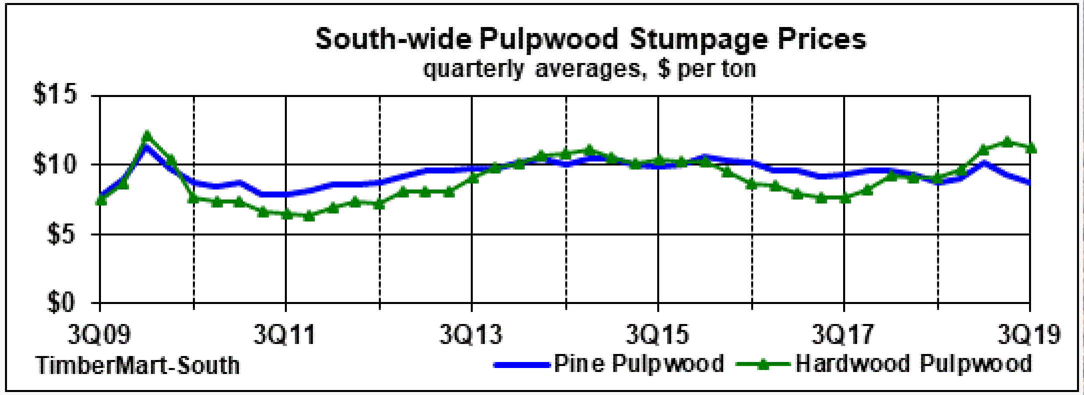

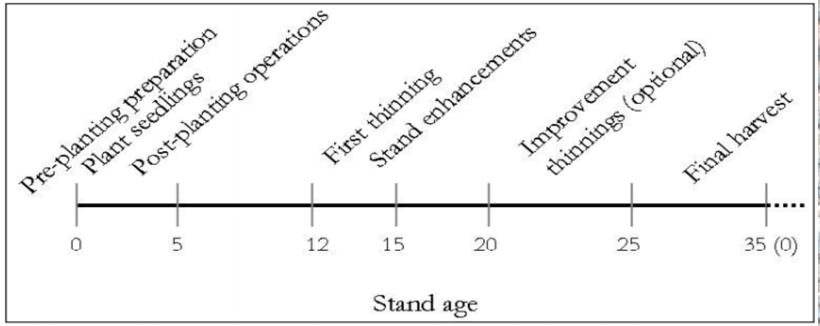

Figure 2. Planted loblolly pine stand management timeline.

Table 2. Estimated Yield Per Acre for Loblolly Pine Plantations.[1]

Site Quality[2]	Trees/A Planted	Age 15 - 1st Thinning[5]				Age 25 - 2nd Thinning[6]				Final Harvest (~ Age 35)			
		PW[3]		ST[4]		PW		ST		PW		ST	
		Cords	Tons	MBF	Tons	Cords	Tons	MBF	Tons	Cords	Tons	MBF	Tons
Low	400	2	6	0	0	2	6	0	0	3	9	2	25
Low	700	3	9	0	0	8	23	0	0	4	10	2	25
Medium	400	4	12	0	0	2	6	0	0	10	26	4	44
Medium	700	6	17	0	0	9	24	0.1	1.5	16	44	3	36
High	400	7	18	0	0	6	16	0	0	11	29	5	55
High	700	9	24	0	0	15	40	0.2	2	18	49	3	36

Pulpwood ("PW") Yields as a Percentage of Sawtimber ("ST") and the Opportunity to Sell Pulpwood for Burial

Thinning –

15 & 25 years; PW+ST yields 25% and 50% of final harvest, respectively.

Clear Cutting –

Pulpwood yields 30% of total yield at clear cutting

Price -

Pulpwood prices are currently around $8.50 / ton. In the future, as carbon prices increase, Carbon Sequestration, Inc., may be able to pay this at the cutting, reducing delivery costs and improving economics for management companies.

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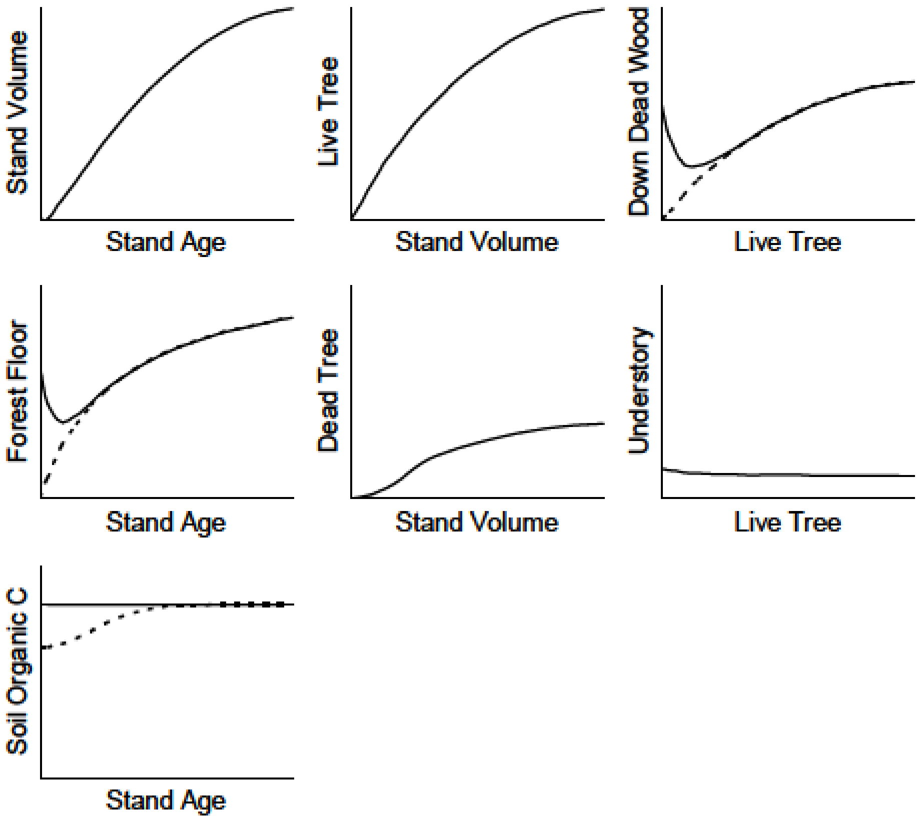

Figure 2.—Graphs indicating the basic relationships between the components of the forest ecosystem carbon tables. Figures are not drawn to scale; numerical representation for each graph is available from the tables. Dashed lines are qualitative representation of where afforestation tables (Appendix B) differ from the reforestation tables (Appendix A). Note that stand volume refers to growing-stock volume of live trees.

A47.—Regional estimates of timber volume and carbon stocks for loblolly and shortleaf pine stands on forest land after clearcut harvest in the South Central

Age	Mean Volume	Mean carbon density						
		Live tree	Standing dead tree	Under-story	Down dead wood	Forest floor	Soil organic	Total nonsoil
years	*m³/ha*	*tonnes carbon/hectare*						
0	0.0	0.0	0.0	4.2	9.2	12.2	41.9	25.6
5	0.0	10.8	0.7	4.7	7.7	6.5	41.9	30.3
10	19.1	23.1	1.3	3.9	6.8	6.4	41.9	41.5
15	36.7	32.4	1.6	3.5	6.2	7.5	41.9	51.2
20	60.4	42.2	1.8	3.3	5.9	8.7	41.9	61.9
25	85.5	52.0	2.0	3.1	5.8	9.8	41.9	72.8
30	108.7	59.6	2.1	3.0	5.8	10.7	41.9	81.2
35	131.2	66.6	2.3	2.9	5.9	11.5	41.9	89.1
40	152.3	73.1	2.3	2.9	6.0	12.2	41.9	96.4

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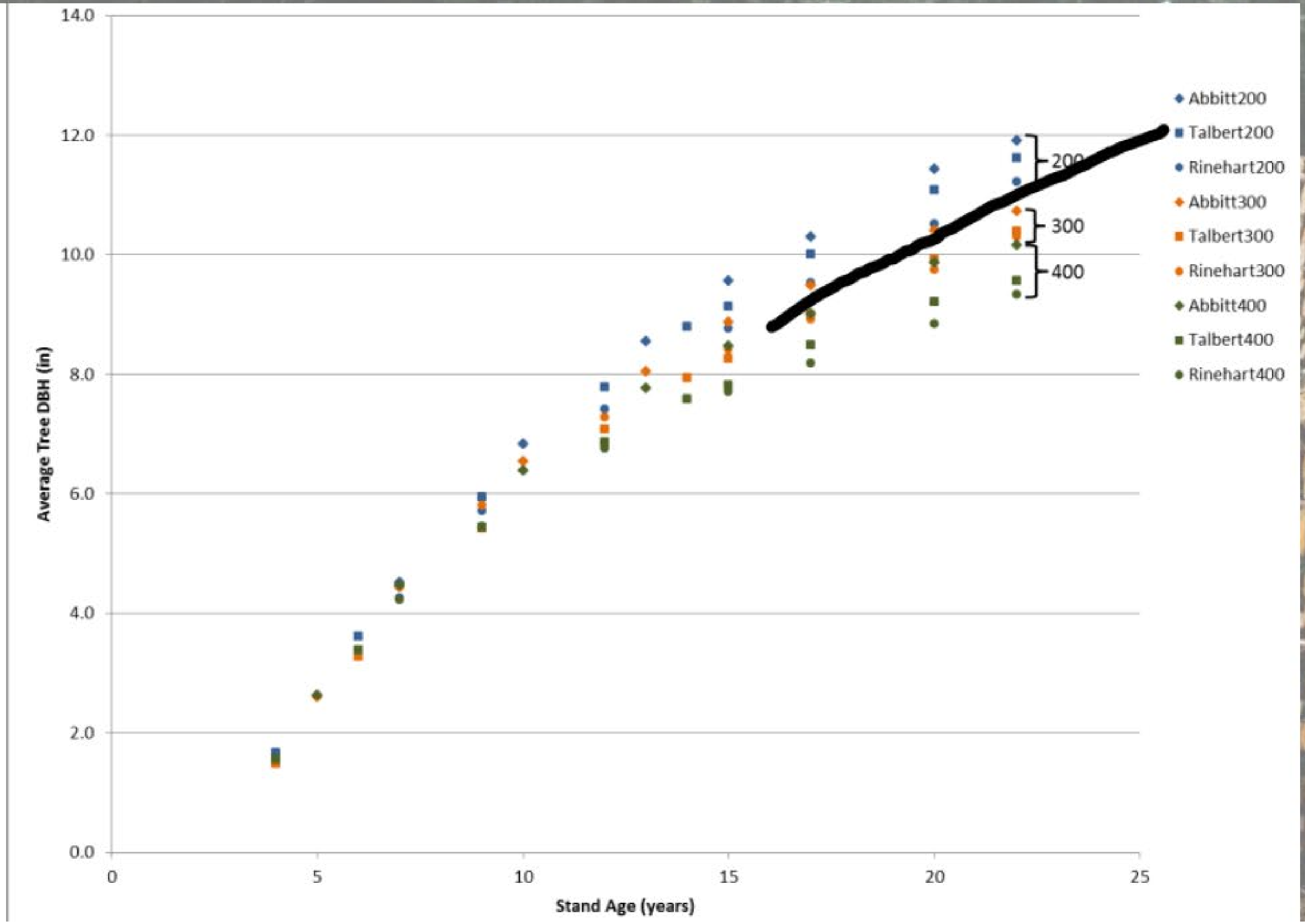


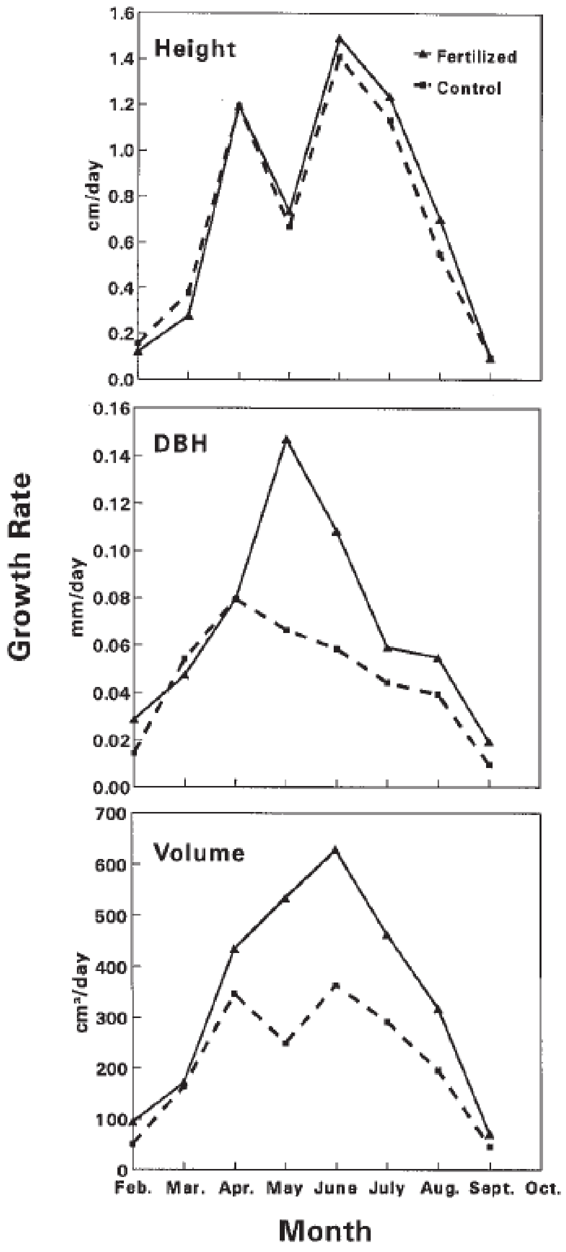
Possible Upsides to Carbon Stocks Yields

Average DBH at year 25 for a typical loblolly stand should be around 12.50", for a green weight of ~1,650 lbs (see slide 6) and dry weight of ~1,450 lbs of CO2 per tree.

A stand with 700 surviving 12.50" DBH trees / would thus have a carbon stock of ~461 metric tons / acre at year 25.

That implies an annual yield per acre of over **18 metric tons / ac / yr, providing ~50.00% upside to the economics on Slide 3, which could generate revenue up to $900.00/ac/yr in CO2 credits.**

Fig. 1. Daily growth rates for tree height, DBH, and stem volume index of fertilized (solid lines) and control (broken lines) loblolly pines.



ASSESSING THE CARBON MARKET

Market prices per ton of sequestered carbon using different, stackable carbon credit opportunities.			
$12.00	$32.50	**$25.00**	$220.00
Voluntary Market: American Carbon Registry	Federal Credit through IRS (45Q)	EU Emission Trading System (EU ETS)	Low Carbon Fuel Standard (LCFS)

Costs per ton of sequestered carbon using different methods on the current market.		
$150.00	$1,000.00	**$40.00**
Direct Air Capture w/ Geological CCS	Chemical Scrubbing w/ Geological CCS	Our Method (WHS)

See Appendix for more information on these carbon markets.

CARBON SEQUESTRATION INC

HOW WILL WE OBTAIN CARBON CREDITS?

Federal Government Credit

Satisfy the written requirements of Section 45Q of the IRS Code (26 USC SEC 45), which dictates the need to establish a qualified facility, qualified carbon oxide, and a geologically secure site.

Our company has met these standards and will qualify for the carbon credits provided by the government.

See appendix for more information on federal credits.

Low Carbon Fuel Standard (LCFS) Credit

By qualifying for the LCFS with an approved methodology, we will be able to offer our carbon credits on the market.

See appendix for more information on LCFS.

American Carbon Registry Credit

The American Carbon Registry is an international database that tracks carbon credits with an approved methodology.

See appendix for more information on ACR.

THE SCIENCE REALLY WORKS.

It's easy to deny the idea that wood burial could actually remove excess carbon from our atmosphere.

It's impossible to deny the facts.

Our methodology, carbon sequestration via wood burial, is a **peer-reviewed** method that has been **proven through experimentation** under the advisory of Dr. Ning Zeng, a scientist at the University of Maryland. We have been communicating closely with Dr. Zeng to ensure that our methodology is consistent with the available research.

Carbon sequestration via wood burial involves the burial of old, dead wood in a geologically secure pit, to prevent to eventual release of carbon dioxide from this material.

The scientific literature on this methodology is exponentially increasing, as scientists around the world are continuously examining the effectiveness of this method of sequestration.

We believe that wood burial is an attainable method of carbon sequestration, but also that it is, by far, the **most economical and efficient method of sequestering carbon**.

OUR METHOD IS ECONOMICAL AND PRACTICAL.

Many methods of carbon sequestration are extremely expensive, and not at all cost-effective.

However, our methodology is both economical and practical.

Carbon sequestration via wood burial is also the **most cost-effective and practical. We let photosynthesis do the heavy-lifting.** Competing methods can cost up to a thousand dollars per ton of qualified carbon. For sequestration methods like chemical scrubbing and direct air capture, the costs of machinery and constant research render the entire methodology as inefficient and unnecessarily expensive.

When we set out to develop methods for sequestering carbon, cost-effectiveness and practicality were our primary goals. We firmly believe that our methodology is the most successful form of sequestration in the world due to the feasibility, accessibility, scalability, and practicality of the projects.

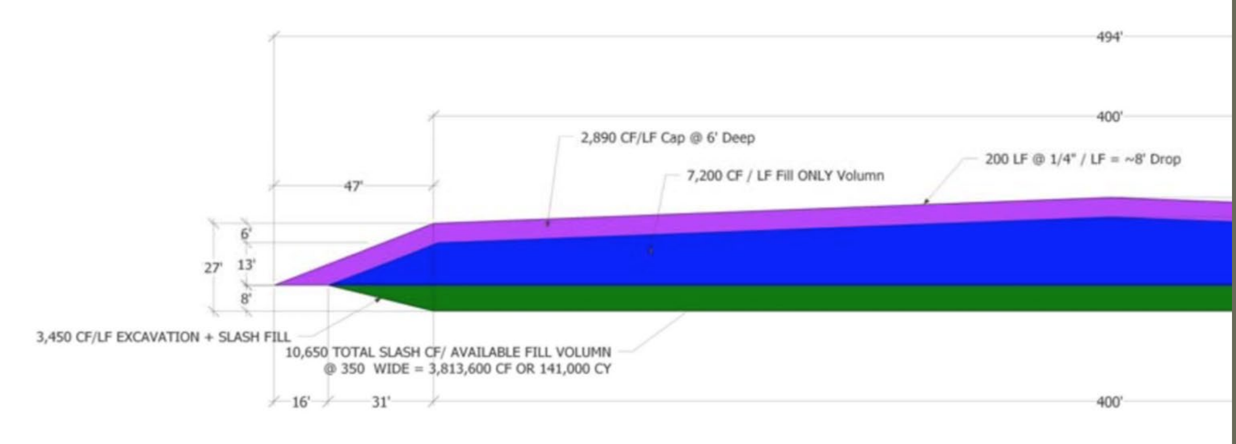
PIT DESIGNS

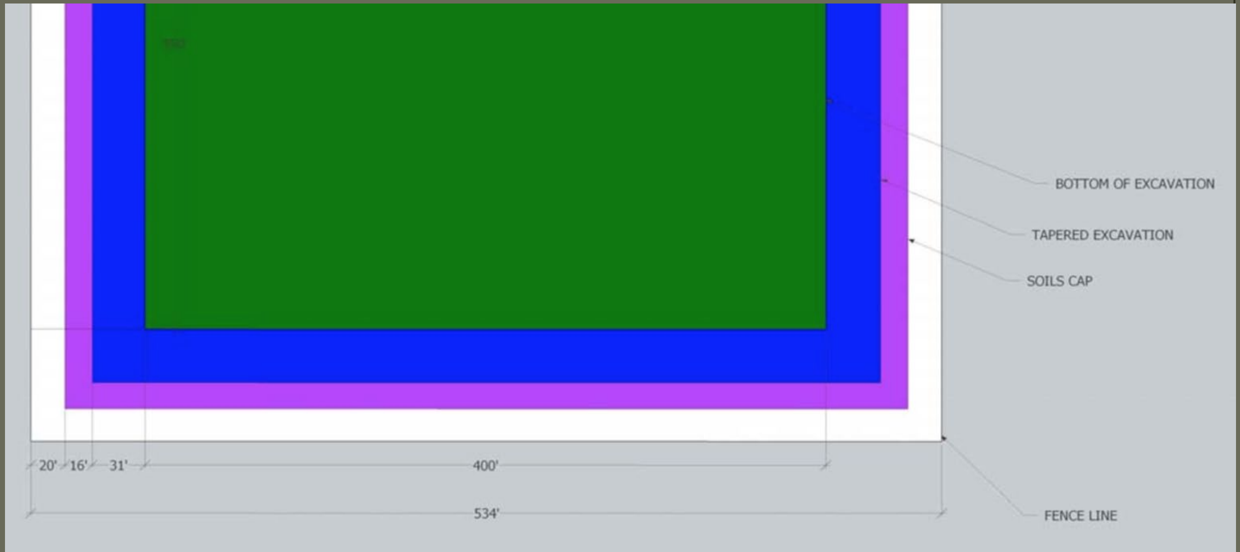
Option 1: The Mega Pit

Best economics on a per ton basis

Measurements:
Tonnage Sequestered: 50,000
450’ x 500’ x 19.00’

Digging Operation
~141,000 cubic yards moved if fully below ground; 48,000 cubic yards moved if half above ground, then existing soil used to create ~19’ mound (6’ soil coverage on top + 13’ slash above-ground + 8’ slash below ground = 27’ gross height).





ADDITIONAL SOURCES

Federal 45Q Credits

https://www.irs.gov/pub/irs-access/f8933_accessible.pdf
https://www.law.cornell.edu/uscode/text/26/45Q

LCFS Credits

https://ww3.arb.ca.gov/fuels/lcfs/credit/lrtcreditreports.htm

ACR Credits

https://americancarbonregistry.org/california-offsets/california-offset-program

Carbon sequestration via wood burial

Zeng, N., A.W. King, B. Zaitchik, S.D. Wullschleger, J. Gregg, S. Wang, D. Kirk-Davidoff, 2013: **Ecological carbon sequestration via wood harvest and storage: An assessment of its practical harvest potential**. *Climatic Change*. 118 (2), 245-257, DOI: 10.1007/s10584-012-0624-0.[pdf]

Zeng, N., 2008: **Carbon sequestration via wood burial**. *Carbon Balance and Management*, 3:1; doi:10.1186/1750-0680-3-1. [Download from CBM]

Seminar on carbon sequestration via wood harvest and storage (WHS) at the Eni Foundation, July 2016 FEEM website [pdf]

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ADDITIONAL SOURCES

CSI Wood Burial

https://docs.google.com/presentation/d/e/2PACX-1vRe-GSr4-cr38oxE_C603pwKKWvSMP2oxElyREf2s2oTe_CpaEynJ0ASsJASN_2on-NyOSal-K566r4/pub?start=false&loop=false&delayms=3000

Bloomberg Carbon Clock

https://www.bloomberg.com/graphics/carbon-clock/

https://www.bloomberg.com/graphics/carbon-clock/BLOOMBERG-CARBON-CLOCK-TECHNICAL-WORKING-PAPER.pdf

https://www.bloomberg.com/graphics/climate-change-data-green/carbon-clock.html

Direct Air Carbon Capture

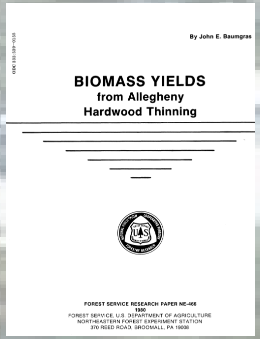
https://www.wri.org/blog/2019/07/co2-direct-air-capture-plant-will-help-extract-oil-texas-could-actually-be-good-climate

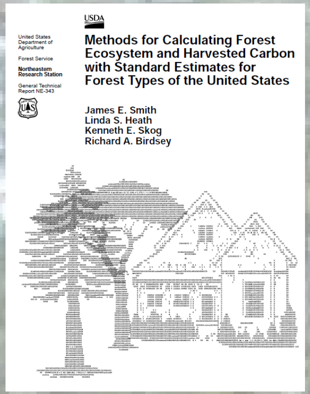
Chemical Carbon Scrubbing

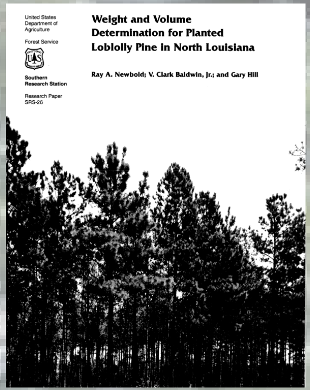
https://news.stanford.edu/news/2011/december/extracting-carbon-air-120911.html

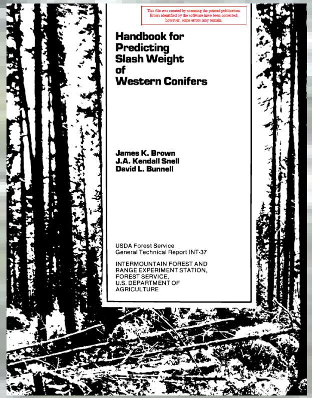
**Pro forma cash flow available upon request.*

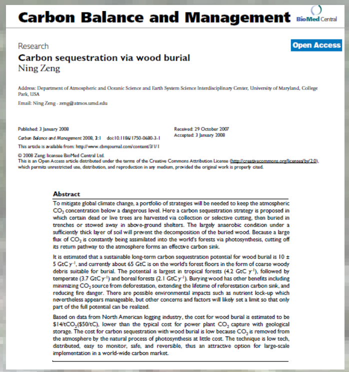
I hereby certify that the above information is true and accurate to the best of my knowledge.

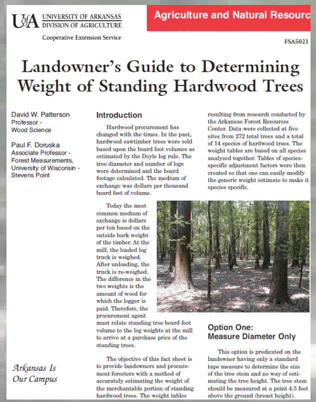


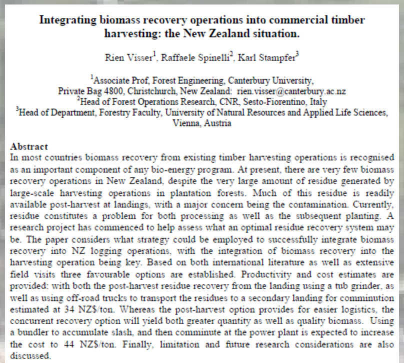












http://www.timbermart-south.com/prices.html

Additional Sources

THANK YOU!!

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