

## Greater Flagstaff Forests Partnership

### *Wrap-Up and Implementation Report Restoration Resources and Investment Potential*

#### *Executive Summary*

July 2002

In 2001, the Grand Canyon Forests Partnership (GCFP) (now known as the Greater Flagstaff Forests Partnership) retained Oregon-based Mater Engineering, Ltd. to:

- ✓ *Consolidate the lessons learned* from prior research undertaken by the GCFP between 1998-2000, regarding utilization of small diameter Ponderosa pine from the Partnership's restoration sites in the region;
- ✓ *Evaluate and test new small-scale manufacturing technologies* likely to positively impact viable utilization of the region's small diameter resource;
- ✓ *Update* the existing and projected *larger wood flow picture* in the region;
- ✓ *Update* information on existing and emerging *markets* for products that could be manufactured from the region's small diameter resource; and
- ✓ Based on the results from the above:
  - ❖ *Identify specific investor interest* in bringing new technology to the region;
  - ❖ Identify a strategy plan for *inviting investor participation in the region*.

The base report for the project was completed in October 2001. Preliminary materials testing of the regions' resource in new manufacturing technology was completed in April 2002. A Final Document was issued to the GCFP in July 2002, encompassing the results of both elements of the project effort.

#### **At-A-Glance Results:**

- **Using forest stewardship and restoration activities as a base in 2001, the region began harvesting sufficient volume of wood resource to warrant serious consideration of establishing an efficient small log processing operation.** With current volumes at less than half of what the region was harvesting back in the early 90's, timber sales planned for 2002 (as of October 2001) from the Apache-Sitgreaves, Coconino, and the southern end of Kaibab National Forests were estimated to be between 90,000 – 100,000 ccf (hundred cubic feet). (More recent data [March 2002] indicates that planned timber sales for 2002, will be more than 130,000 ccf). Approximately 50% of the region's current and projected timber volume will be small diameter timber (5"-9" dbh).

- Since no efficient small log processing mills exist in the region, small diameter Ponderosa pine logs (often referred to as “blackjack” pine) from the Grand Canyon Forest Partnership restoration sites were shipped to Oregon for mill trials where small log processing technology is in operation and processing small diameter inland pine. **The logs were processed and dried, with ease, producing higher lumber grade recovery in 80% of the lumber produced.** Further, lumber not used in value-added materials testing for the project was immediately sold into the Pacific Northwest pine markets. Oregon mill operators stated, *“The Partnership logs are equal or better to the small pine logs we typically process. If we can get their logs to our mill at a reasonable rate, we’ll take all the logs the Partnership can send.”*

#### **Timber vs. Log Measurement**

Timber or trees are measured on the stump. A 9” tree is 9” in diameter at breast height (54”) (dbh). This diameter includes bark.

Logs are measured for diameter and taper. A 9” log is typically measured as 9” at the small end diameter (sed), inside of the bark. If the log has a taper of 1.5” in 16 ft. then the large end diameter (led) would be approximately 10.5” if the log were 16 ft. long.

A 12” dbh tree may have two logs, one >9” sed and one < 9” sed depending on taper.

- Preliminary materials testing of the lumber manufactured from Partnership logs through new **value-added technologies** produced very encouraging results:
  - ❖ Lumber from small diameter Ponderosa pine produced results in glulam beam production, when combined with a thin layer of Kevlar (the material bullet-proof vests are made of), equal to the performance of non-reinforced glulam beams made from **Douglas fir**.
  - ❖ That same lumber from small diameter Ponderosa pine, when impregnated with a new starch-based (non-toxic) treating formula, **became hard enough to be used in American, Asian, and European furniture and flooring markets**, and increased the wood resistance to fire – to the highest rating of any wood tested.
  - ❖ Instead of relying only on traditional visual grading of lumber, a unit of the lumber from the small diameter Ponderosa pine was sent through a new affordable in-line lumber grading technology. **By mechanically grading each piece of lumber in the production process, the value of approximately 30% of the small diameter Ponderosa pine lumber could have been increased based on structural applications.**
  - ❖ Even the bark, sawdust, and chips from the region’s small diameter Ponderosa pine logs **produced market-quality composite cabinet panels and moulding**, when combined with recycled plastic and processed in a new small-scale, energy-saving high-compression molding process recently introduced into the US.
- The positive results of the preliminary materials testing of the region’s resource prompted **interest from new technology manufacturers to consider investing in the region**. Larger-volume testing is required to verify results, but manufacturers have already become partners in the project by thus far financing over 50% of preliminary materials testing costs.

- Potential partner/investors are anxious to accelerate further testing of the wood resource, moving toward establishing new production operations in the region, **but are uncertain of the viability of such an effort due to lack of stability in the regions' wood flow supply over time**. Existing value-added wood product manufacturers in the region who have created new products and new markets from small-diameter Ponderosa pine are also requesting immediate attention to stabilizing longer-term wood flow from the region's National Forests. Initiating **longer-term (3-5 year) forest management planning** on National Forests in the region coupled with implementation of **an intra-regional resource coordination protocol** will greatly increase the opportunity to expand current production opportunities, and bring new investment, new manufacturing, and new jobs to the region ... all based on sustainable forest management practices.

### *Taking a Closer Look At . . .*

#### *. . . the Region's Resource*

The Northern Arizona region has, without question, experienced a dramatic change in wood flow offering from National Forests in a little over a decade. In 1989, timber volume sold off the Coconino, Apache-Sitgreaves, and Kaibab (Williams District) equaled approximately 160 million board feet (mmbf) annually, with over 90% of the timber volume sold as sawlogs (>9" dbh). And – as might be expected – production capacity in the region was targeted to the efficient processing of larger logs.

By 1991, a sharp decline in overall timber volume sold was evident, but sales that did occur were still heavily weighted to large logs. By 1995, timber volume from the surrounding National Forests had plunged to unprecedented low levels; the regions' production infrastructure for large log processing had become notably reduced; smaller log sales were on the rise but compensating infrastructure to efficiently process the small logs remained out of reach - in part, due to a) the low volume of timber sales overall on an annual basis and b) the inconsistency of timber sales between Ranger Districts. The implementation of National Fire Plan in 2000, allowed the region to reexamine the potential for rebuilding a forest products economic base. However, now that economic base would be rooted in forest stewardship and forest restoration as the driver to defining appropriate production technology.

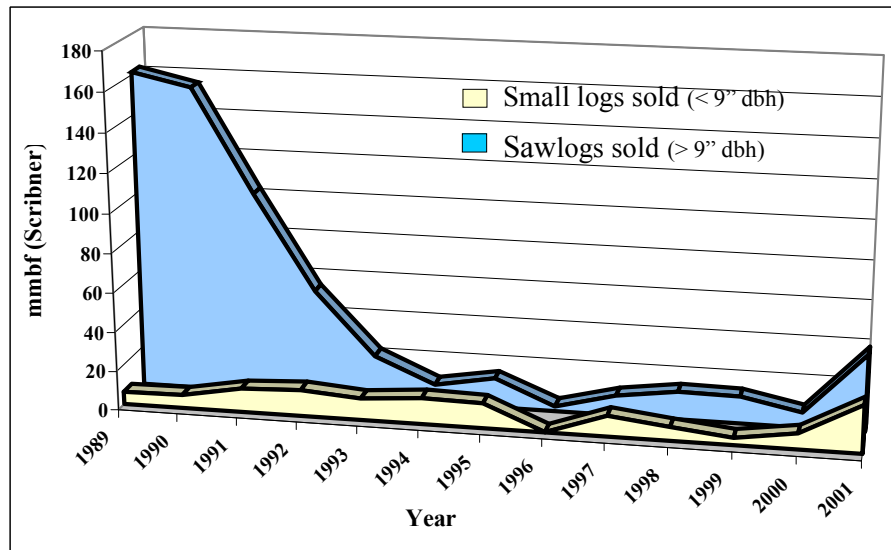
Data for the charts below was obtained from all Forest Service timber sale documents for the studied Forests dating from 1989. Each individual timber offer was examined and the following categories were tabulated per offer: 1) the two diameter classes reported (<9" dbh and 9"+ dbh); 2) mmbf volume; 3) species; 4) Ranger District; and 5) disposition of the offer, whether it received a winning bid or whether it received no bids.

#### **Small Logs vs. Sawlogs**

In preparing and tracking timber inventory and sales the Forest Service typically refers to timber or trees less than 9" dbh as **small logs** or pulp.

Timber or trees equal to or greater than 9" (dbh) are typically referred to as **sawlogs** even though the top of the tree may produce a small log with a sed of less than 5".

**Timber Volume Sold by Diameter and Year  
Apache-Sitgreaves, Coconino, Kaibab (Williams Ranger District)**



*\* mmbf = million board feet*

National Forests Future Resource Availability

In April 2001, Region 3 National Forests in Arizona and New Mexico submitted a 2-year plan for timber sales that incorporated fiscal years 2001 and 2002. The plans were further revised and released in February 2002, and they extended the planning horizon from 2 to 5 years... an ideal time period for prospective timber sale buyers to plan their purchases. The chart below depicts planned timber volume offered by diameter class, by year. Note that the units have changed from mbf (thousand board-feet) to CCF (hundred cubic feet) as per new Forest Service recording requirements.

Existing data suggests there is potentially enough annual volume from Apache-Sitgreaves, Coconino, and Kaibab National Forests to sustainably support a moderately sized industrial development program focused on the efficient processing of both sawlogs and small diameter logs.



Public land managers in northern Arizona uniformly expressed a strong interest in finding local processors to utilize small diameter Ponderosa pine material from their lands. Most land managers and others who were interviewed for this project were unaware of some of the new technologies for processing small logs into value-added products.

Consistent with this was a tendency to look for low-value end-uses for small log material such as pellets, chips, and pallet lumber. Buyers of softwood products who were interviewed also expressed a strong interest in using local Ponderosa pine based on a desire to support the local economy.

Wood products businesses require a relatively stable annual harvest volume as one of the most important element of new or expanded business operations. This is often expressed as a supply “*guarantee*” in quantifiable volumes and time frames.

There currently appears to be little coordination of timber sales activity between National Forests, and between National and state forests (Trust Lands and Arizona Department of Transportation-ADOT). Coordination would be valuable in stabilizing supply and reducing timber transport time and costs. The lack of timber sales coordination is dramatically evident in the following combination, map/graphs delineating Ranger District timber sales in the three National Forests over time.

#### **Board Feet vs. Cubic Feet**

In the past, the Forest Service measured timber volume in board feet (bf), a method of estimating the volume of product that can be produced from the log. Common reference to this measure is million board feet (mmbf) or thousand board feet (mbf).

In recent years, the Forest Service has converted their practices to measuring timber volume in cubic feet (cf). This method is based on mathematical formulas that calculate the actual volume of solid wood in a tree or log. Common reference to this measure is 100 cubic feet (ccf).

The conversion between the two methods of measurement varies with the scales used and the size of the tree. Typical conversion in Northern Arizona would be 4 to 6 bf per cf, depending on log size.

Several unavoidable - even unintended - impacts have occurred partially as a result of uncoordinated, sporadic resource offerings in Ranger Districts within the regions' three National Forests during the past 5 years. **These impacts have had a direct undesired influence on the GCFP restoration project efforts:**

- *contributing to a severe reduction of primary processing options in the region (converting logs into lumber, veneer, etc.).*
- *relegating log resource derived from restoration work to a lowest commodity value in the market (if any value is garnered at all) as a result of lack of processing options in the region, and lack of "secured" supply offering to potential buyers.*
- *greatly diminishing the likelihood of securing investments and investment partners for increasing the potential of the resource toward a) higher value-added processing, and b) new product uses.*

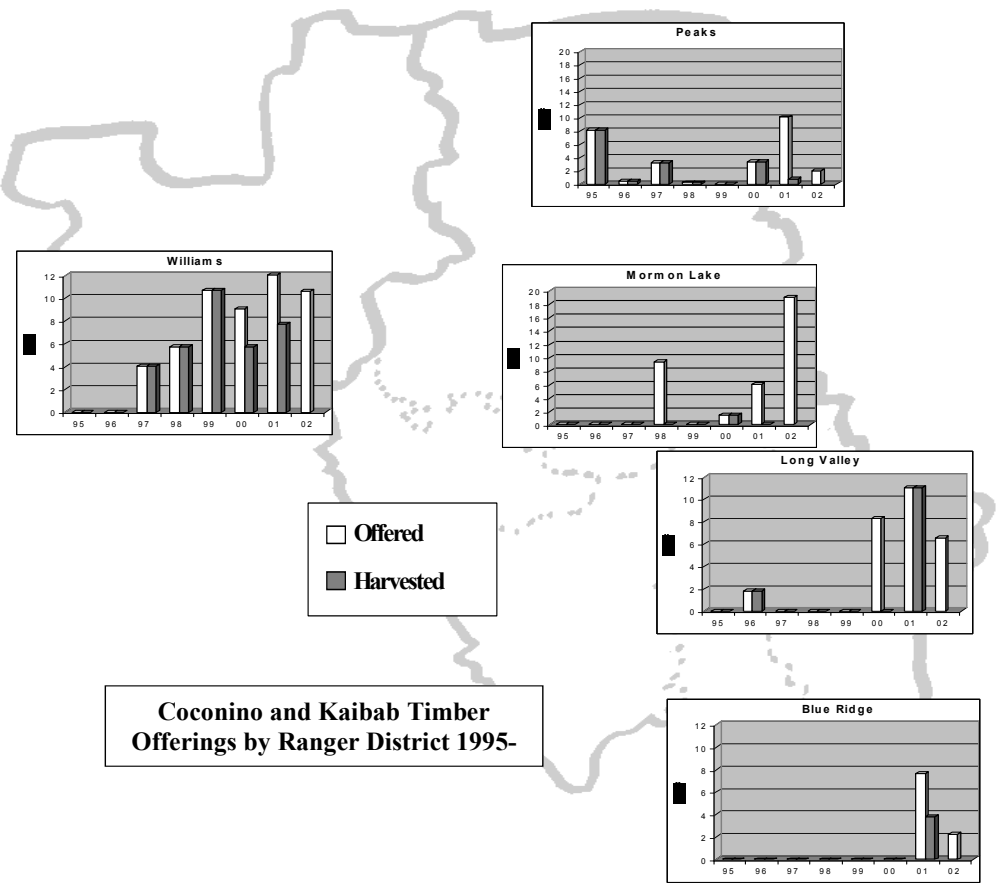
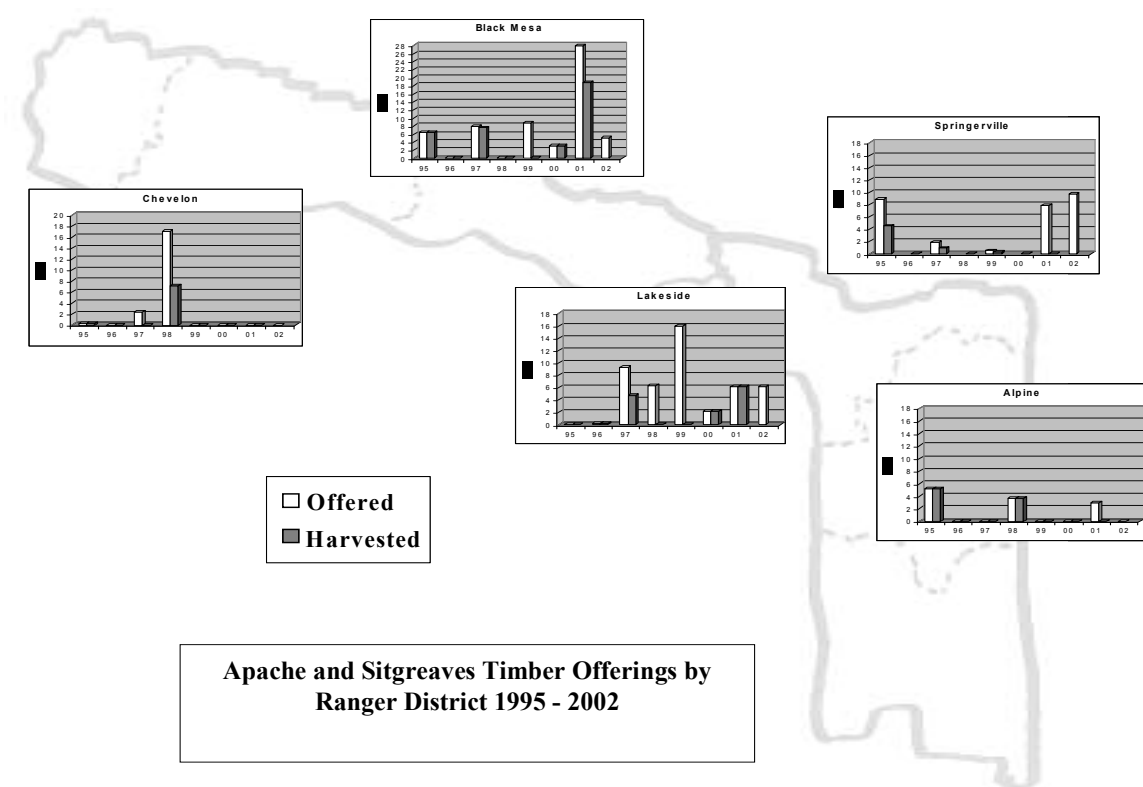
In analyzing the resource flow history in the region, it becomes very clear that without stabilization of supply produced from stewardship, fuel reduction, and restoration efforts both in volume and log mix, GCFP project efforts will simply not be allowed to effectively become implemented.

\*\*\* The key to attracting investments to Northern Arizona in new technology is *consistency/coordination* of volume and log mix over an extended period of time (5-year minimum). \*\*\*

#### Challenges:

- National Forest land managers have not been able to plan timber sales and treatments beyond one to two years, too short a time horizon for business development, due to a lack of funding, staff, and NEPA protocol.
- Business people who were interviewed had a “mistrust” of the Forest Service and were reluctant to trust federal lands as a source of wood:
  - \* Cutbacks in federal timber production have almost eliminated the regions’ wood products industries. Business owners believe that environmental considerations trumped economic considerations (and that the Forest Service was responsible);
  - \* Subsequent promises of timber supply never materialized.
- Lack of updated inventory data – Resource managers interviewed said their greatest need is updated inventory data.

Currently, logs from trees less than 9” dbh are considered too small to economically produce solid wood products. The lack of solid wood pulp mills and other alternatives in Arizona contributes to many trees less than 9” dbh being treated as slash and stacked and burned after harvest to clean up the site.



Recommendations:

**Initiate an inventory assessment** of the National Forest Plan acres to be harvested in Northern Arizona, including geographic location (e.g. Ranger District).

**Develop multi-year plans** (beyond 2 years) that result in approximately the same harvest volume per year to ensure even annual flow with minimal variability.

**Coordinate timber sales activities between National Forests (Ranger Districts), ADOT, and State Trust Lands** for the purpose of reducing haul times and costs, and creating a more leveled wood flow that investors can rely on.

**... Technology Opportunities**

For this project, a series of tests on small diameter Ponderosa pine from Northern Arizona were conducted for the purpose of identifying technologies that can add value to the timber resource. The test results of five different technologies provide the region with baseline information to help determine the feasibility of investment in new or upgraded manufacturing facilities within the region. (See full report for details)

**Small Log Processing:** - The purpose of the mill trial was to determine the potential for processing small diameter Ponderosa pine logs from restoration sites on modern, efficient small log processing systems, and to provide lumber produced from these logs for further technology testing employing E-Grader, FiRP, Sorbilité, and Indurite technologies. To facilitate this test, Grand Canyon Forest Partnership entered into a memorandum of understanding with Kinzua Resources of Pilot Rock, Oregon. Kinzua was selected because they currently process Ponderosa Pine small logs from inland western states and they have a CAE/McGehee, SL 2000, single pass, small log processing system.

In December 2001, 2 truckloads of logs were shipped from Northern Arizona to Kinzua Resources' mill in Pilot Rock, Oregon. These logs were selected as a representative sample of small logs in the 6"-9" small end diameter (sed) range with a taper of 1.5" to 2" in 16 feet. The logs were taken from the GCFP Fort Valley ecosystem restoration project outside of Flagstaff, which harvested logs no greater than 16" dbh. All but 3 logs were bucked to 16 feet in length. According to the logger, the logs were a mix of 30% from small diameter timber (< 9" dbh) and approximately 70%, second segment logs, from larger diameter timber (9"-16" dbh). No significant processing difference was noted in any of the logs.

On January 28, 2002, Kinzua processed the logs through their small log processing line. The logs were processed in the same manner they process Ponderosa Pine from the Inland Pacific Northwest. Other than separating the logs and lumber for inventory and tracking purposes, the logs and lumber were processed along with their normal pine run.

**Results**

*Log Scale and Quality:*

The logs were scaled at Kinzua by the mill’s certified scalers (NW Log Scalers) using Scribner, East Side Rules. A total of 249 logs were received. In general logs were relatively straight with an average diameter (sed) of 7.08”. Mill personnel were impressed with the quality, taper, and straightness of the logs compared to the Inland Northwest logs they normally process.



5” to 9” 16’ logs on log deck at Kinzua

*Green Lumber Production:*

All logs received were processed through the mill. No problems were experienced due to log form, quality, or size. Overrun of approximately 1.52 and a lumber recovery factor (LRF) of 6.42 bf/cf was realized. These factors are similar to results from processing Inland Northwest Ponderosa Pine.



CAE/McGehee SL2000

Mill personnel stated that the logs ran through the machine as easily as any of the pine logs from the Inland Northwest.

*Drying:*

Drying was accomplished in standard softwood dry kilns with dry bulb/wet bulb controls. The test lumber was placed in the kiln along with similar sizes of Ponderosa Pine from the Inland Northwest Region. A standard kiln schedule was used requiring 72 to 96 hours for drying. Lumber was dried to 12% to 16% moisture content. No significant drying defect was noted beyond what would normally be expected. A little warp in top boards and some additional splitting from drying were noted.

*Planing and Finished Lumber:*

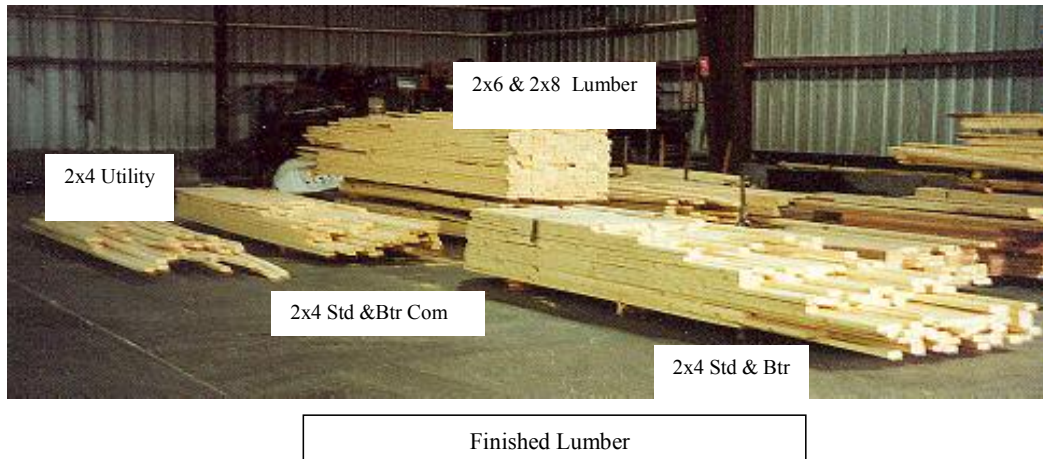
All of the lumber was processed through the planing mill using the same settings and grades that the mill uses on Inland Northwest Pine.



Finished Lumber Grading Station

Lumber was graded by the mill’s certified graders and separated by grade on the sort chain. Kiln and trim loss was approximately 3.5%, within norms for Ponderosa Pine.

Grade recovery for the test logs was good. Almost 80% of the lumber produced was graded as 2 & Btr, with approximately 30% grade as 2 common or better, the highest grade that should be expected from these logs.



### ***Conclusions:***

The small diameter Ponderosa pine logs from Arizona were similar to the logs processed at Kinzua from the Inland Northwest. Lumber recovery and overrun were typical for the industry. The drying and planing of the lumber presented no problem and required no special treatment or scheduling.

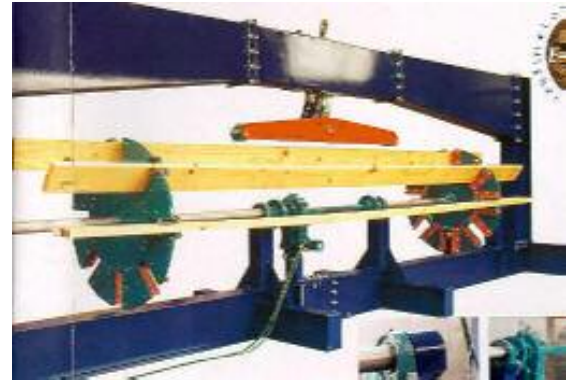
The logs were processed through the Kinzua small log system without any changes from the mill's normal practices. Mill personnel observed that no unusual problems were experienced in processing the Arizona logs. They did note the higher density of the suppressed Ponderosa Pine but that did not cause problems in processing.

The general impression of the mill personnel was that these logs were as good or better than the Ponderosa pine they currently process. They went as far as saying, if they could get these logs to their mill at reasonable price they would take all they could get.

***Lumber strength testing system (E-Grader)*** – A small, affordable automated machine for measuring actual lumber strength during in-line processing, with a significantly lower price than competing equipment. This machine accurately identifies lumber that can be certified for structural applications (and sold at a higher price), and essentially augments human visual grading. Visual grading, of necessity, is very conservative, but the use of this mechanical system has resulted in increases of higher grade lumber compared to visual grading.

- **Results:**

140 pieces of visually graded, 2 x 4 lumber were processed through the E-Grader. Based on the results, 30% or 42 pieces could have been upgraded to a higher strength grade.

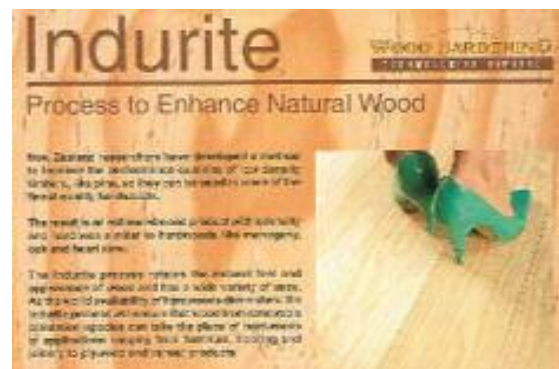


- **Conclusions:**

With proper manufacturing, a 30% increase in grade, using the E-Grader in the process line, may be realistic for the regions' resource.

The E-Grader not only adds grade value to lumber but can provide the mill with feedback on its production parameters—especially if the mill is trying to saw for higher value structural grades. The higher strength wood identified by the E-Grader is ideal for reinforced glulam beams and “makes this Arizona’s Ponderosa pine an attractive option.”

**Wood hardening and fire resistance treatment (Indurite)** – An environmentally safe treatment fluid made from soy and corn starches that can harden wood and increase its fire resistance. This new treatment process, which can use existing pressure treating equipment, is especially beneficial for softwoods that heretofore could not be used for products such as flooring. The potential increased fire resistance, when boric acid is added to the solution, may be highly beneficial in opening up additional structural markets where fire resistance is critical.



- **Wood Hardening Results:**

The Indurite solution increased the hardness of 1 x 4 and 2 x 4 boards by 89% in the sapwood and 29% in the heartwood.

The permeability of Ponderosa pine requires a viscous hardening solution, and therefore the pine must be dried prior to treatment to a maximum of 20% content. The thinner 1x4 boards dried more than the 2x4 boards during the drying period and consequently absorbed more solution.

- **Fire Resistance Results:**

The spread of flame results for treated Ponderosa pine were superior—at the highest possible standard index for any wood species. Treated Ponderosa pine exceeded treated Radiata pine flame spread time by greater than 115 seconds at which point the standard test was terminated.

The Smoke Developed Index for treated Ponderosa pine is the same as that for treated Radiata pine, 3, and both are superior to untreated Radiata pine, 8. “...the material burns quite cleanly.

*Both the Spread of Flame and Smoke Developed measures are used in determining a material's fire resistance and compliance with fire safety standards.*

○ **Conclusions:**

The wood hardening results – especially for the sapwood – would increase the value of the wood for use in furniture and flooring manufacturing. The treated 1x4 boards adequately meet industry standards for wood flooring however, additional marketing analysis will be required to determine market potential.

This initial “proof” testing had limited samples to work with. Further tests with a higher sample count are needed to determine the best possible combination of moisture content and formulation to increase hardness and density. The promising flame test results were also based on a few samples; tests on more samples are recommended to demonstrate consistent results. Code testing will be required prior to introducing this material into the fire rated materials market.

**Plastic/wood composite from wood waste (Sorbilite)** – A small scale system that combines wood waste (sawdust, bark) with recycled plastic to produce a solid material that can be molded into high value parts such as cabinet doors, doors, furniture components, moldings, and other complex items.

○ **Results:**



Three samples of high value products/parts were produced from 35 pounds of a wet Ponderosa pine bark, hog fuel, and sawdust mixture from the Oregon mill trial site. The resulting parts, two types of cabinet panels and a moulding, were smooth, hard and dense and coffee brown in color. One sample was veneered with high grade Black cherry; the other two were partially primed to demonstrate the coverage and adherence of an off-the-shelf primer.

○ **Conclusions:**

A quality product can be produced from the Ponderosa pine residual. The plastic-to-wood ratio can be adjusted by modifying the type and particle size of wood waste used, and production can accommodate varying relative supplies of recycled plastic and wood waste. Full market and economic feasibility analyses will be required to determine the potential for molded products manufacturing in the region.

**Fiber Reinforced Polymer glulam beams (FRP)** – glulam beams that have a thin ribbon of Kevlar fiber laminated to or sandwiched in the lowest beam layers to significantly increase beam strength. This reinforcement layer allows the use of low-grade lumber (e.g. knotty) and lower strength species (e.g.

Ponderosa pine) that are less expensive than conventional laminate lumber. The reinforced beams are glued up with a new adhesive (Greenweld) that is strong, fast setting, does not require expensive heating or radio-frequency equipment for curing.

○ **Results:**

The reinforced Ponderosa pine glulam beams significantly exceeded the unreinforced beams in all strength tests. When compared to standard, non-reinforced Douglas fir glulam beam, the reinforced Ponderosa pine beams demonstrated nearly identical bending strength.



The inherent safety factor that was determined in the beam strength tests was between 2.8 to 3.0; this is higher than the 2.1 safety factor required for structural materials. The higher safety factor provides leeway for cost savings by reducing the Kevlar reinforcement fiber in the beam and/or reducing the beam cross-section. Ponderosa pine beams can also be strengthened for higher load applications by the addition of a higher-grade top and/or bottom laminations.

○ **Conclusion:**

Ponderosa pine from small logs can be utilized to make fiber reinforced glulam beams for structural purposes that meet or exceed structural safety factor requirements. Further testing is necessary to verify these results and to explore how to increase strength without increasing cost. FRP glulam technology is currently accepted as an engineered material in most building codes however, additional code testing will eventually be required to fully commercialize other Ponderosa pine, FRP products.

**... Market Opportunities**

The small diameter Ponderosa pine is currently considered a lower grade (lower value) material because of its smaller diameter and higher rate of defect such as knots. However, its lower cost can make it very attractive to manufacturers compared to the other pine species. Further, as described in the *New Technologies* section, innovations in wood manufacturing technology can help to make Ponderosa pine competitive with species like the Southern yellow pine.

The GCFP restoration and fuel reduction effort is a *good “win-win” story* about the environment, business, and public safety. The message in itself can be considered a “value-added” benefit because of its ‘green’ origins and its capability of eliciting positive public and political perceptions.

Arizona is in a growth region that includes Utah, southern California, Colorado, and parts of New Mexico, Nevada, and Texas. These states also enjoy growth in housing for the largest and richest class of

homebuyers and remodelers: upper middle-aged (“Boomers”) and retired people. In the overall homebuilding and remodeling industry, there is increasing interest in ‘green’ building and green materials, especially among major homebuilders and retailers, e.g. Centex and Home Depot, respectively. Lastly, Arizona is traversed by east-west rail routes in the above-mentioned growth states—important for business because rail is a low cost method of hauling long distances.

On the downside, the limitations of developing value-added business based on small diameter Ponderosa pine include:

- increasing competition from wood from other regions (domestic and overseas);
- the overall loss of Arizona’s wood products industry infrastructure;
- the substitution of other materials for traditional Ponderosa pine uses;
- deep seated industry mistrust of wood supply from federal lands;
- the industry and code officials perception that Ponderosa pine is not suitable for construction;

**Product and Market Recommendations (See full report for details):**

While any business plan in the region would have to address specific market options for products produced from small diameter Ponderosa pine, several general market factors contribute to underscoring the opportunity for both primary products and new value-added product development in the region:

- Despite (or perhaps because of) a downturn in the US economy, demand for wood products used in housing repair and remodel have been rising. Americans are pouring money into home improvements as a way to increase the value of their homes in a difficult investment environment. Seven out of ten households in the US are planning a home-improvement project in the next 6 months – spending at least \$1,000 to do the job. 20% of those planning household improvements will spend \$10,000 or more.
- With the tariff on Canadian softwood lumber implemented, US wood product manufacturers are finding rising market demand (and prices) for softwood commodity lumber to replace the \$5.7 billion softwood lumber sales per year normally provided by Canadian producers. The North American softwood lumber market is forecast to be favorable for 2002-2004, with rebounding housing starts and the repair and remodel industry driving the upward trend (spurred by low interest rates).
- Specific product line growth trends also look quite promising – responding to the new housing starts and, particularly, the repair and remodel industry sector. Kitchen cabinet and bathroom vanity sales in January 2002, rose a healthy 15.5% over January 2001 sales; wood component parts and dimension sales growth was 7% during the last year; the wood flooring industry sector growth matched the rise in the repair and remodel industry with over 70% of wood floor sales used in remodeling projects this last year; moulding and millwork sales increases have also matched the growth trends of the repair and remodel sector; and structural, engineered, wood products (such as glulam beams) are a rapidly expanding market that is forecast to grow by over 500% between 2000 and 2010.

Given the available new equipment and technologies, the following general markets indicated below may be the best targets for products made from small diameter Ponderosa pine (see full report for more market trend details and new technology matches):

<i>New Technology</i>	<i>Products with Market Growth</i>
<p><b>Sorbilite:</b></p> <p>The Sorbilite system molds wood waste and recycled plastic together into: panels, parts for windows, doors, furniture, and decorative millwork and moulding. Wood waste includes sawdust, chips, bark, and hog fuel.</p>	<ul style="list-style-type: none"> <li>○ Kitchen and bath cabinets</li> <li>○ Components: decorative door and cabinet insert panels, window parts, furniture parts</li> <li>○ Moulding and millwork</li> <li>○ Furniture</li> <li>○ Art and architectural decoration</li> </ul>
<p><b>Indurite:</b></p> <p>This treatment solution uses soy and corn starches to significantly increase hardness, strength, and fire resistance of wood. Tests of lumber from small diameter Ponderosa pine treated with Indurite have shown extraordinary improvement in lumber characteristics. Indurite solutions can also include color and preservatives (fungicides, pesticides).</p>	<ul style="list-style-type: none"> <li>○ Door parts</li> <li>○ Ready to install doors</li> <li>○ Flooring</li> <li>○ Paneling</li> <li>○ Fire doors</li> </ul>
<p><b>E-grader</b></p> <p>This grading machine mechanically tests each lumber piece for inherent strength. Tests on lumber from small diameter Ponderosa pine show the potential to “upgrade” up to 30% of lumber that has been visually graded.</p>	<p>Structural Lumber for:</p> <ul style="list-style-type: none"> <li>○ Framing</li> <li>○ Glulam beams</li> <li>○ Trusses</li> <li>○ Other Engineered Wood Products</li> </ul>
<p><b>Fiber Reinforced Polymer, FRP</b> (for glulam beams)</p> <p>A layer of high tensile strength fiber in the lower layer of glue laminated beams, made with lumber from small diameter Ponderosa pine, has been tested with positive results.</p>	<p>Structural and non-structural materials:</p> <ul style="list-style-type: none"> <li>○ Glulam beams</li> <li>○ Trusses</li> <li>○ Engineered Wood Components</li> <li>○ Other engineered wood products</li> </ul>

**“Green” building products:**

Green building products, as the name implies, are considered to be natural or safe for humans and the environment. A product’s ‘greenness’ is defined in many ways, some expected and some not. Examples of ‘green’ products: products made from recycled or reused materials, or sustainably-produced materials that did not result in environmental damage; materials that have a direct benefit for both human and the environmental health; products made through a production process that uses low energy and water inputs; or products made from raw materials are non-toxic and environmentally safe substances.

Wood Products:	Other Products:
<ul style="list-style-type: none"><li>◦ <i>Sustainably-grown forest products</i></li><li>◦ <i>Wood-plastic composites</i></li><li>◦ <i>Non-toxic wood preservatives</i></li><li>◦ <i>Wood flooring</i></li><li>◦ <i>Products from wood waste</i></li><li>◦ <i>Engineered wood products</i></li></ul>	<ul style="list-style-type: none"><li>◦ <i>Natural linoleum flooring (cork, linseed oil)</i></li><li>◦ <i>Recycled plastics, tire rubber, paper, etc.</i></li><li>◦ <i>Natural fibers for floor and wall coverings</i></li><li>◦ <i>Cotton insulation</i></li><li>◦ <i>Non-toxic or natural finishes and sealants</i></li><li>◦ <i>Soy-based glues, milk-based paints</i></li></ul>

**“Green Building” is a relatively new movement among architects and builders to design and build homes and commercial buildings that are environmentally friendly.** The movement’s goal is to reduce dependence on non-renewable resources such as petroleum, steel, and aggregate, and thereby reduce impacts to nature. Green Building tenets cover everything from site planning to protect natural areas, to energy conservation, to the use of sustainably produced materials.

The push in *forest certification* on public and private forestlands across the US may also hold unique market potential for products made from small diameter Ponderosa pine. Certification is a value-added independent audit process that assures timber manufactured into products comes from well-managed “sustainable” forests. The forest certification movement has grown significantly over the last few years, with major US retailers now requiring certified wood products to be sold off their store shelves. Many of these same retailers actively seek other environmentally-appropriate products such as:

- ❖ Products made from recycled or reused material (*Sorbilite*)
- ❖ Products made from low-value resource, reducing demand on high-value resource (*Sorbilite, Indurite, E-Grader, FiRP*)
- ❖ Products made in operations using low energy and low water consumption during the manufacture of the product (*Sorbilite, Indurite, FiRP*)
- ❖ Products made from waste streams (*Sorbilite*)
- ❖ Products made with non-toxic, environmentally-safe substances (*Sorbilite, Indurite*)

### *... Investor Opportunities*

Manufacturers of four out of the five new technologies the Arizona pine was tested on appear quite interested in investing in the Flagstaff region. The technology manufacturers paid over 50% of all testing costs, and company principals indicated the following for future activity:

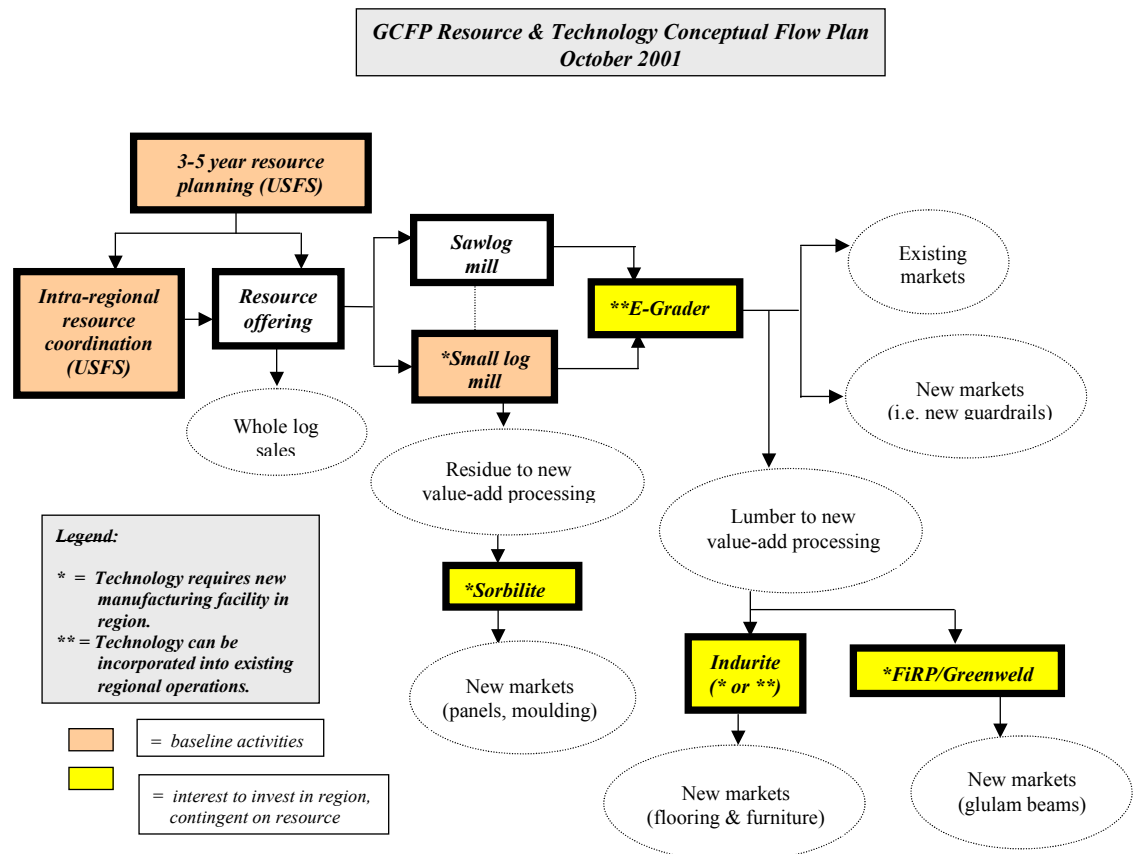
- **E-Grader and Greenweld Technology:** Company representatives are interested in a joint venture or loan financing for a project in Northern Arizona that would use the E-grader and fast cold-set glue resins for finger jointing and laminated beam stock.
- **Fiber Reinforced Polymer (FRP): FiRP, Inc.** representatives are keenly interested in working with the Partnership as a partner or investor in setting up an enterprise in Arizona. The company already has two licensees in the State – Imperial Laminators and Tru Trus, and sees value in using the restoration pine in product development.
- **Sorbilite:** Company representatives expressed a strong interest in exploring a joint venture with the Partnership, and have multiple financing options for consideration. A German-based company, Sorbilite is currently assisting with establishing other operations in the mid-west and is looking to expand elsewhere in the US.
- **Indurite:** Company representatives stated that they are interested in partially funding research and development for new products made using Indurite treated Ponderosa pine. However, they would likely not enter into a joint venture but would seriously consider funding processing equipment, amortizing the cost based on a throughput basis.

### *What's Needed Next ...*

The Northern Arizona region may be uniquely positioned to take advantage of new manufacturing technologies – and correlating investor interest – to create a new type of forest products industry in the region ... one based on forest stewardship and restoration, and adaptive smaller-scale technology. Preliminary resource testing looks positive. However, virtually all the identified potential for the region rests with the critical need to coordinate and stabilize the resource offering from the three National Forests. The *Resource and Technology Critical Path* (below) illustrates the vital relationship the following three elements play in the region's overall potential for success:

- Providing administrative priority, support, and timelines for reinitiating **longer-term (3-5 year) resource management planning** within the USFS. Much work has already been accomplished in the region (most recently with a preliminary forecast of timber offerings through 2006, for Apache-Sitgreaves, Coconino, Kaibab (South), Prescott, and Tonto National Forests. Refining projections and establishing a strategic plan, with assistance from the Greater Flagstaff community, for securing additional funding to implement longer-term planning is crucial.

- Through pilot project development, creating the nation's first **intra-regional resource offering protocol** to help stabilize resource offering on a landscape level must be quickly undertaken. Capacity-building for managing this effort both within the USFS and the Partnership will be required. The model developed for this new resource offering protocol and the lessons learned would be used as a template for application in many other regions across the US.
- Stabilizing the resource supply and planning for the long-term has little chance of affecting positive change in the region without establishing the appropriate primary production technology to efficiently process the resource. **Investment in small log processing mill** (either as a stand-alone facility or incorporated within an existing facility) is the third pivotal action for the region. Business plan development based on the newly projected longer-term resource offerings would need to be accomplished, and preliminary facility siting evaluations should be undertaken. **It is important to note that all the new processing technology and investment interest generated through this project cannot happen without investment in an efficient, cost effective, small log mill.**



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