CHAPTER 1 – EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report explores the feasibility of developing a sustainable, Pinyon-Juniper (P-J) fueled power plant at two prospective sites (Prince and Pony Springs Substations) in Lincoln County, Nevada. Participants in the study included Lincoln County (LC); A-Power Energy Generation Systems, Ltd (A-Power); Lincoln County Power District No. 1 (LCPD); and the Bureau of Land Management (BLM). LCPD and BLM provided data on the supply of biomass, the cost of planning and administering vegetative treatments, and the ability of the existing LCPD transmission lines to transmit power. With this high-quality data and cooperation, the project study team analyzed all aspects of the feasibility of developing biomass energy in Lincoln County, Nevada. This Executive Summary briefly recaps the findings in each area of analysis, as well as the high-level recommendations about the feasibility of biomass fueled power in Lincoln County.

The rationale for siting a biomass fueled power plant in Lincoln County is two-fold: First, it is envisioned that significant quantities of biomass may result from treating and rehabilitating the 2.91 million acres of Pinyon Juniper (P-J) woodlands in the region that the BLM's Ely Resource Management Plan (Ely RMP) has identified as overly mature. As part of the restoration process, long-term stewardship contracts would allow for both treatment activities to occur and for biomass fuel to be supplied to the prospective power plant. Second, one of the project sponsors, A-Power, has recently started a manufacturing facility in Southern Nevada with a relatively large requirement for power (5 MW peak). A-Power is interested in understanding the feasibility of supplying that facility with renewable power or selling renewable power to the power grid.

1.2 KEY REPORT FINDINGS

1.2.1 Review of Previous Studies

A number of prior studies have examined the cost of treating P-J forests. In general, those studies focused on treatment costs rather than utilizing the biomass produced. As a result, the focus was on reporting costs in terms of dollars per acre. While that information is useful to land managers, it is of limited use for the purposes of this study because costs must be known on a dollars per ton of fuel produced basis. Nevertheless, the previous research provided insights that created a beginning point for understanding critical factors such as fuel volumes per acre and the equipment typically used to treat P-J.

1.2.2 Review of Alternate Products

From a technology perspective, there are many products that could be made from P-J, including mulch, animal bedding, wood pellets, panel products, pulp chips, etc. However, from a cost perspective, there are significant limitations on what products can cost effectively be made from P-J. This is because the cost of delivering P-J biomass to a facility is estimated to range between $75 to nearly $175 per bone dry ton, depending on the characteristics of the woodlands from which it was harvested. Even at the low end of that scale, the costs are high relative to wood fiber that can be obtained from other sources in other regions (e.g., roundwood from timber harvests and by-products from sawmilling operations).

Despite the cost limitation, there are several products that can most likely feasibly utilize P-J. These include firewood, posts and poles, and rustic furniture. The upside for firewood is that it is available locally and, therefore, is likely a lower cost alternative than firewood shipped in from other regions.

Limitations of the firewood option are that a large-scale operation is not likely because the character of the wood (many limbs and twisted and bent logs) makes it difficult for mechanized firewood processing equipment to effectively handle the material, and local markets for which it has a cost advantage are very limited. The same is true of using P-J to make posts and poles. On the other hand, there is likely a market among certain agricultural producers seeking to minimize the presence of chemicals from preservative treated wood posts and poles. In any case, it does not appear that these products could be produced on a large enough scale to utilize much of the P-J biomass resulting from landscape treatments within the Ely BLM District.

1.2.3 Biomass Fuel Supply Assessment

An estimated 4.8 million bone dry tons of fuel within 50 miles of the Pony Springs Substation and an estimated 5.4 million bone dry tons of fuel within 50 miles of the Prince Substation may result from the BLM's planned P-J treatments. The 10 MW power plant considered in this study would consume about 67,300 bone dry tons[1] of fuel annually. Thus, fuel supply is not a limiting factor to the feasibility of biomass power in Lincoln County. In the vegetative management scenario considered in this study, that amount of fuel would come from the treatment of approximately 9,800 acres of P-J each year (approximately 6.9 bone dry tons of fuel per acre).

The cost of P-J biomass fuel delivered to a prospective power plant is very high, however. In the first year of plant operation, the all inclusive cost for P-J fuel is estimated to be about $97.50 per bone dry ton. This includes costs of about $79.00 per bone dry ton for felling, skidding, chipping and transporting, $3.65 per bone dry ton for rehabilitating treated areas, and a $15.00 per bone dry ton cost incurred by the BLM for planning, administering and monitoring treatments of P-J woodlands consistent with the BLM's Ely Resource Management Plan (Ely RMP).

[1] Throughout this report, biomass volume is expressed in units of bone dry tons. This convention is used in the biomass industry because it eliminates moisture as a variable when describing fuel volumes. In actual practice, all biomass contains some level of moisture, which can typically range from as low as 20 percent to over 50 percent of the total weight. For this study, it was assumed that biomass would average 40 percent moisture when delivered to the power plant. Thus, the actual weight of biomass fuel as received is the bone dry volume divided by 0.60. For example, 66,000 bone dry tons equals 110,000 green tons.

The estimated delivered costs are significantly higher than fuel costs observed in projects in other regions. The project team has not discovered a reasonable scenario under which a power generation project in Lincoln County could afford to pay the all inclusive cost of P-J restoration treatments and thereby eliminate all BLM costs to implement the P-J treatment component of the Ely RMP.

Accordingly, a feasible P-J biomass energy project in Lincoln County, and likely any industrial use of P-J biomass, will require that BLM continue to bear a significant portion of the cost of planning, administering, implementing and monitoring the treatment of P-J woodlands. The contribution of a proposed 10 MW biomass energy project in assisting BLM with said costs would not be insignificant, perhaps ranging between $28 and $120 per acre in the "base case" scenario to between $214 and $306 per acre in the "best case" scenario.

1.2.4 Review of Potential Plant Sites

Two potential plant sites were selected prior to the start of this study – the Prince and Pony Springs Substations of the LCPD. Both substations connect directly to the main 69 KV transmission line that forms the backbone of the LCPD power distribution system. The Prince Substation currently has a 15 MVa transformer, whereas the Pony Springs Substation has only a 3 MVa transformer.

Both existing transformers receive power at 69 KV and step it down to 24.9 KV to serve the distribution system. Tying a generation project onto this system without additional transformation is somewhat problematic since most generators matched to a 10 MW power plant generate power at either 12.47 KV or 13.8 KV.

Other considerations in plant siting include proximity to fuel, permitting issues, water availability, land availability and the presence (or lack thereof) of heat customers. Based on the balance of those considerations, the Prince Substation site appears more favorable.

1.2.5 Review of Thermal Energy Users

While several potential thermal energy users (e.g., The Lincoln County Courthouse, Grover C. Dils Medical Center, the various Lincoln County School District facilities) exist in Lincoln County, none possess the characteristics that would make them ideal (e.g., use of 10 percent or more of the residual heat from the biomass plant, use of low pressure steam to allow for maximizing power generating efficiency, and only limited variation in demand from day to day and season to season). Of the existing thermal energy users, one of the largest is the Caliente Youth Center. However, it would consume only one half of one percent of the thermal energy available from turbine extraction or exhaust. For this reason, the decision was made not to site the facility at a location with an identified thermal energy user, but to instead site the facility at an effective interconnection point and in the center of the available fuel supply.

1.2.6 Transmission Infrastructure

The LCPD's main transmission line is 69 KV and is radial. The peak load of the system is about 18 MW. Unless loads are particularly heavy, all power comes from an allocation on the federal hydroelectric system on the Colorado River. The radial nature of the system means that it is interconnected with the power grid only in the vicinity of Las Vegas, but not "looped" or interconnected with the power grid at the far northern end of the line. Substantial line loss is a characteristic of radial systems that transmit power over long distances (9-10 percent of all power in this case). Thus, the development of a power plant in Lincoln County would benefit LCPD in terms of lowering line loss. Please note that it is not possible to quantify (in dollars) the benefit of the lowered line losses without LCPD conducting a detailed study. Any power sold from the prospective project would travel south to the Reid Gardner Substation of NV Energy. From there, it could be wheeled through various interconnections to Southern California or other interconnected locations in the West. This is a positive finding for the prospective power plant.

1.2.7 Markets for Renewable Power

A number of laws affect the market price of other power with which biomass power must compete. The Public Utilities Regulatory Policies Act (PURPA) requires utilities to purchase power from qualifying independent facilities at the utility's avoided cost. Avoided cost is the incremental cost an electric utility avoids by purchasing an equivalent amount of power from a Qualifying Facility (QF). A facility only qualifies if the fuel used to generate the power is renewable or is waste derived. A power plant using P-J biomass fuel would be a qualifying facility. In Nevada, the Public Utilities Commission (PUC) does the calculation of the utility's avoided cost, but has no jurisdiction over LCPD who has a very low "avoided cost" for nearly all of the year.

Subsequent laws also required public utilities and power marketing agencies to "wheel" power across their systems to other buyers, if requested. The cost of wheeling is regulated.

Finally, Nevada passed a Renewable Portfolio Standard (RPS) in 2009 that requires NV Energy to obtain 15 percent of its power from renewable sources by 2011 – 2012, 18 percent during 2013 – 2014, 20 percent during 2015 – 2019, 22 percent during 2020 – 2024, and 25 percent after 2025.

NV Energy has responded to the RPS with Requests for Proposals (RFPs) for renewable power. NV Energy then selects projects for development from the proposals. Recent winning bidders among non-solar projects have been awarded contracts in the range of $81 – $98/MWh with a 1 percent annual escalation. For solar projects, which have a separate RPS requirement and a Renewable Energy Credit (REC) multiplier, the prices have been from $132 – $135/MWh with the same 1 percent escalator. For this study a power price of $95 per MWh was assumed given the range in prices observed in other non-solar NV Energy renewable power projects. The price used in this study is comparable with the net amount that might be received from a sale to a California utility who typically buys delivered power on a fixed-price, long-term basis.

1.2.8 Environmental Permitting & Regulatory Requirements

The permitting of a 10MW project at the Prince substation should present no unusual permitting challenges. The Lincoln County Special Use Permit process will cover all local issues with respect to access, noise, traffic, aesthetics, etc. and will require several months to complete. The Nevada Division of Environmental Protection (NDEP) has a streamlined process for the permitting of renewable energy facilities. With the use of dry cooling, the issues of water and wastewater are rendered minor, and it is assumed that the moderate volumes of ash produced will be reused.

The air emission control equipment proposed will require a Class I permit from NDEP, which will likely require in excess of one year to obtain due to the necessity to model emissions using representative long term meteorological data. All of eastern Nevada, north of Las Vegas, is in compliance with all ambient air quality standards, simplifying the permitting process.

1.2.9 Technology Assessment

A boiler with a moving-grate, air-swept stoker system is appropriate for combusting P-J woody biomass. That technology is mature and proven. In addition, the base case scenario considered in this project assumes use of an air-cooled condensing system. The advantage of such a system is that it virtually eliminates the need for water at the prospective plant. However, the penalty paid for such a system is that it raises the capital cost of the project by about 10 percent and lowers the efficiency of the electrical generation process by about 6 percent. Conservatism dictated that an air cooled system be the base case, but a wet cooled system is included in the sensitivity analysis.

1.2.10 Incentive Programs and Project Financing

The capital investment of $47.5 million for the biomass power plant modeled in this study will be a major financing effort and will require substantial financial strength and strong financial packaging expertise by the developer.

Numerous state and federal programs can help lower the cost and facilitate the financing of alternative energy projects. There are state sales tax credits and a property tax reduction for renewable production facilities of 10MW or more in Nevada. At the federal level, an investment tax credit/production tax credit election (which can be converted to a grant) is available, but the election feature is programmed to disappear at the end of 2011, and no extension is foreseen. Also potentially available are accelerated depreciation and other federal grant/loan guarantee programs.

In some instances, other programs may be layered on to support project financing. These including New Markets Tax Credits, Rural Utilities Service Loan Program, Local Revenue Bonds, U.S. Department of Agriculture Loan Guarantee, U.S. Department of Energy Loan Guarantee, Site Lease to a Third Party Developer, Partnership with Purchasing Utility, and Prepayment for Power, as appropriate in each individual case.

1.2.11 Financial Analysis

The capital cost, including the required equipment, project management, site preparation, working capital, interconnection, fuel receiving, etc. is estimated to be $47.5 million. That information, along with operating costs, was entered into a “base case” financial model. The financial model was structured to return a fuel cost at which the power plant would provide the project’s investors with a 15 percent net present value after tax return on their equity.

The result of the analysis was that the “allowable” fuel cost (or the cost which the plant can afford to pay and have the project still be attractive to a private investor) was $27.00 per bone dry ton, which is about $70.00 per bone dry ton less than the estimated all inclusive delivered fuel price of $97.50 (the finding in the fuel supply analysis). This means that the annual fuel cost would have to be about $4.7 million (67,300 bone dry tons per year x $70.00 per bone dry ton) lower than projected for the project to generate a return that would be acceptable to a private investor.

In addition to the “base case” scenario, a “best case” scenario was modeled in which key assumptions about financing, owner’s equity, and the required rate of return were loosened (e.g., lower target rate of return, lower interest rate on debt, lower equity in the project, wet cooling etc.) Despite the modifications, the “best case” scenario still returned an “allowable” fuel cost (again, the cost that the plant can afford to pay and have the project still be feasible) of $52.00 per bone dry ton, which is still roughly $45.50 per bone dry ton less than the all inclusive delivered fuel cost estimate.

1.3 CONCLUSIONS AND RECOMMENDATIONS

This study demonstrated that there is an adequate supply of biomass fuel available from the P-J woodlands in Lincoln County. In addition, the BLM has indicated a willingness to make that fuel available by entering into long-term supply agreements with a biomass project developer via stewardship contracts. Other key feasibility factors such as interconnection, permitting, and technology provide no significant obstacles to the development of a biomass fueled power plant.

However, the high cost of planning, implementing and monitoring P-J woodland treatment projects results in a high cost per bone dry ton of biomass fuel. This is true regardless of site. The high fuel cost severely limits the feasibility of the project. It is clear that a biomass plant in Lincoln County cannot be developed using the traditional model of the power project paying the complete BLM cost of planning, implementing and monitoring P-J treatment projects. Public/private cost sharing models must be pursued if such a project is to go forward. Two possibilities are discussed in the next section.

Another limiting factor is that the current LCPD transmission system may only be able to support a 10 MW plant. A larger plant would provide some economy of scale related to the plant’s fixed operating and capital costs, but a much larger plant could not be developed without first increasing the transmission capacity of the existing lines. More research regarding the cost of such upgrades is required to definitively determine whether the cost of upgrading the lines can be justified by the larger plant.

1.4 CONDITIONS FOR FEASIBILITY

Since the project has been judged not feasible using a traditional model, it is useful to discuss the conditions needed for the project to become feasible. In simple terms, one option is to reduce costs and the other option is to increase revenue. Each of the following paragraphs describes ways in which both might be accomplished to move a biomass project closer to feasibility.

In terms of reducing costs, the fuel required to operate the plant is the largest ongoing annual operating expense. If the prospective power plant were to pay the all inclusive fuel cost, the annual total would be over $6.5 million. The base-case financial analysis showed an “allowable” fuel cost of about $1.8 million. Thus, the fuel cost would have to be reduced by about $4.7 million annually for the project to become attractive to a private investor. One method of reducing the fuel cost is for a federal agency (e.g., the BLM) to contribute funds to treatment projects that would reduce the cost by the appropriate amount. Of course, such a program would be contingent upon funding.

In terms of increasing revenue, it may be possible to raise the value of the Portfolio Energy Credits (PECs) associated with biomass power to be equivalent to that of solar power. For example, if the plant produces 82,000 MWh of power per year and the value of the PECs were increased by 1.4 times (to gain equivalency to their value for solar) and the value per PEC was $20, then the project would realize a gain in revenue of about $2.30 million dollars per year. That additional revenue could be used to offset, in part, the high fuel cost. The process of changing the value of the PECs is legislative and would require modification of Nevada’s current Renewable Portfolio Standard.

CHAPTER 2 – INTRODUCTION

2.1 PROJECT DESCRIPTON

Lincoln County is located in Southeastern Nevada and has a total land area of 10,637 square miles or approximately 6.8 million acres. The area is characterized by two climate types: 1) arid desert – mainly in the southern third of the county and 2) semi-arid steppe – mainly in the northern two-thirds of the county.

Woodlands comprised of Single-leaf Pinyon Pine and Utah Juniper, known collectively as Pinyon-Juniper (P-J), cover a significant portion of the land area in Lincoln County. While both species can be found growing together, Pinyon Pine is generally the dominant species at higher elevations, while Juniper is more likely to be found at lower elevations that are usually more likely to face drought conditions. Trees of both species are normally no more than 25 feet tall.

The Bureau of Land Management (BLM) is a federal agency of the Department of Interior that is responsible for managing and conserving public land, including P-J woodlands. In Lincoln County, BLM lands are managed by the Ely District Office and the Caliente Field Office. According to the Ely Resource Management Plan (Ely RMP)[2], the Ely District, which includes both White Pine and Lincoln Counties, contains a total of about 3.6 million acres of P-J. Of that total, 2.91 million P-J acres are currently classified as overmature. The Ely RMP states that the desired condition is for only 179,000 acres of overmature P-J woodlands to exist within the Ely District.

Those statistics illustrate a widespread trend in the Great Basin region; P-J woodlands are expanding both in extent and density. It is estimated that P-J woodlands in Nevada expand by 100,000 acres annually. The impacts of these changing conditions include: increased susceptibility to wildfire, disease, and insects and reduced viability of native plant species that provide feed, water, cover, and living space for animal species. To mitigate these adverse impacts, the BLM (through the Ely RMP) is proposing vegetative treatment prescriptions aimed at establishing healthy, productive, and diverse populations of native or desirable nonnative plant species.

It is envisioned that these vegetative treatments, as well as other land management activities, could be accomplished in part, through long term stewardship contracts. Stewardship contracting is a relatively new approach to federal land management in which management treatments are accomplished by allowing private organizations or businesses to remove woodland products (e.g., biomass, etc.) from treated sites in exchange for performing services to restore and maintain healthy ecosystems. For example, mechanical thinning may be used to reduce tree densities to desired levels.

---

[2] Ely Proposed Resource Management Plan/Final Environmental Impact Statement, November 2007. Available at: http://www.blm.gov/nv/st/en/fo/ely_field_office/blm_programs/planning/ely_rmp_2007.html

In exchange for the cost of completing such activities, private organizations or businesses would be allowed to sell the resulting biomass for energy generation or other off-site industrial purposes.

Historically, a impediment to implementing mechanical thinning projects in P-J woodlands is the cost. Thus, a secondary objective of this study is to identify the value returned to the land by the vegetative treatment of P-J forests and the subsequent utilization of biomass for energy generation purposes. These findings are more fully described in Chapter 10.

Since biomass can be used to generate renewable power, the economics of mechanical thinning may change as demand for renewable power develops. The need for renewable power is being driven by the adoption of Renewable Portfolio Standards (RPS) throughout the United States. An RPS is a law that requires certain utilities in a state to get a certain percentage of their power from renewable sources by a certain date. Nevada's RPS calls for 25 percent renewable power by the year 2025. Power generated from the combustion of woody biomass qualifies as renewable.

Thus, given the need to develop renewable power and given the biomass available from the restoration of P-J forests, Lincoln County (LC) and A-Power Energy Generation Systems, Ltd. (A-Power) have agreed to jointly fund a study to determine the feasibility of constructing and operating a P-J biomass fueled electric generating facility at two prospective sites – the Prince Substation (located near Caselton, NV) and the Pony Springs Substation (located about 30 miles north of Pioche, NV). A-Power is supporting this study because they are considering constructing and operating a renewable energy related assembly facility in southern Nevada which may require up to 5 megawatts of electrical energy. A-Power is also interested in selling biomass generated electrical energy into the southern Nevada and southern California energy markets.

LC and A-Power have retained the services of The Beck Group (BECK), a Portland, Oregon based forest products and bioenergy planning and consulting firm. BECK is assisted in its work by Mr. Bill Carlson, Principal of Carlson Small Power Consultants (CSPC) of Redding, California.

The following report contains the complete findings of BECK and CSPC. Both BECK and CSPC appreciate the opportunity to assist on this important project.

2.2 BIOMASS POWER

A biomass-fueled power plant produces useable heat and electrical power through the combustion of wood fiber. More specifically, biomass materials are combusted in a furnace. The biomass materials typically combusted include: 1) forest residues (thinning and restoration biomass); 2) mill by-products – bark, sawdust, planer shavings, and pulp chips; and 3) urban wood waste – construction and demolition waste, industrial wood waste, and municipal wood waste. The walls of the furnace are lined with water filled pipes, so as the biomass is combusted, the high pressure water in the pipes boils to steam. The steam is then heated to a higher temperature before exiting the boiler and entering the turbine generator (T-G).

The T-G is a rotating multi-stage unit that drops the steam temperature and pressure at each stage as thermal energy is converted into mechanical energy and eventually into electricity in the generator. In some cases, steam is extracted from the T-G at an appropriate pressure for use in heating applications (e.g., heat for drying lumber, or some other manufacturing process, or space heating). When some steam is used in a heat application, it is called cogeneration, or combined heat and power (CHP). When the heat is not utilized, it is called stand alone power (SAP). In this report, BECK uses the term power plant and does not differentiate between the two facility types.

Through the process just described, biomass fuel is converted into electricity and useful heat. Historically, the cost of producing biomass-fueled power relative to the cost of fossil fuel and hydro-generated power has been a stumbling block. However, this situation is changing with the advent of RPSs and an associated appreciation in the value of renewable electrical energy, as well as with the introduction and continuation of government incentives for the development of renewable power. All of these factors have combined to increase the viability of biomass energy projects.

2.3 PROJECT ORGANIZATION

This report explores the feasibility of developing a sustainable, biomass-fueled electric generating plant in the vicinity of Pioche, Nevada. The project has been organized into a series of tasks, each of which addresses a particular aspect of biomass power feasibility. The tasks and their corresponding chapter in this report are listed below.

- Task 1 Review Previous Studies (Chapter 3)
- Task 2 Review of Alternative Markets and Products (Chapter 4)
- Task 3 Biomass Fuel Supply Assessment (Chapter 5)
- Task 4 Assessment of Potential Plant Sites (Chapter 6)
- Task 5 Identification of Thermal Energy Uses in Lincoln County (Chapter 7)
- Task 6 Review of Power Transmission Infrastructure (Chapter 8)
- Task 7 Market Analysis of Power Sales (Chapter 9)
- Task 8 Evaluation of Optimal Facility Scale (Chapter 10)
- Task 9 Environmental Permitting & Regulatory Requirements (Chapter 11)
- Task 10 Evaluation of Energy Production Technology (Chapter 12)
- Task 11 Incentive Programs (Chapter 13)
- Task 12 Financial Analysis (Chapter 14)

CHAPTER 3 – REVIEW OF PREVIOUS STUDIES

3.1 INTRODUCTION

In recent years, several studies have been completed relating to the management and utilization of P-J biomass in Lincoln County. These include:

- *Pinyon-Juniper Biomass Utilization Study: For Lincoln County, Nevada*. September, 2004, and a 2005 update. Completed by Resource Concepts, Inc. Carson City, Nevada.

- *Pinyon-Juniper Biomass Utilization Study: Cost Documentation Report*. August, 2004. Completed by Resource Concepts, Inc. Carson City, Nevada.

- *Industrial Utilization of Pinyon-Juniper Biomass Resulting From Thinning Treatments in White Pine and Lincoln Counties, Nevada: Business Considerations.* June, 2005. Completed by Intertech Services Corporation. Carson City, Nevada.

- *Analysis of Potential Industrial Demands of Pinyon-Juniper Resources in Lincoln and White Pine Counties* – January, 2006. Elizabeth Fadali et al., University of Nevada Reno.

- *Ely District Approved Resource Management Plan (BLM Ely RMP).* August 2008. Bureau of Land Management.

This section summarizes the key findings of this prior research regarding the P-J resource. While the objectives of these studies differ from this current study, they do provide insights and information that are useful and relevant to the current biomass cogeneration feasibility study. Regarding the heat content of P-J, BECK is not aware of any published studies documenting P-J's higher heating value. However, BECK learned that P-J has a higher heating value of 8,950 BTU per pound[3].

3.2 PINYON-JUNIPER RESOURCE

According to the BLM Ely RMP approximately 31 percent of the Ely BLM District is comprised of P-J woodlands. Those woodlands are dominated by two major species: Utah Juniper (Juniperus osteosperma) and Single-leaf Pinyon (Pinus monophylla). The P-J forests have been expanding into grass and shrub lands throughout the area for decades. Also according to the BLM Ely RMP, over 80 percent of the P-J woodland type contains high tree densities and high canopy closure with little or no understory.

[3] Personal Communication: Dave Allen, Fuel Manager, HL Power Company. Wendel, California.

One example of the high tree densities is illustrated on the sample plots examined in the P-J Biomass Utilization Study completed in 2004, the average tree density was 271 trees per acre, and the average tree canopy cover was estimated to be approximately 40 percent. The tallest trees were in the range of 21 to 25 feet in height. In the sample plots, the above ground tree biomass was estimated to be 23,090 pounds or 11.5 bone dry tons per acre. The woodlands were typically comprised of about 2/3 juniper and 1/3 pine.

3.3 COST OF FELLING, SKIDDING AND CHIPPING P-J

The following sections provide a summary of three studies that evaluated the costs associated with the felling, skidding (moving felled trees to a central processing area), and chipping of trees in P-J woodlands.

3.3.1 Lincoln County Study Plot

During the P-J biomass study completed in 2004, the costs associated with the treatment application methods were compiled and reported in the Cost Documentation Report. A brief description of the treatment activities completed during this project is presented in Table 1. Note that the per acres costs in the study were based on the contract prices of the BLM Mount Wilson Project described in Section 3.3.2.

Approximately 12 acres of P-J woodland near the Pony Springs area were part of the study plot. In the study, all mature trees were cut down and removed to determine how existing understory plants and newly seeded plants would respond to different vegetative management treatments. Most trees were felled by feller-bunchers. Trees larger than 16 inches in diameter at the base were hand-cut with chain saws. Cut trees were placed into small piles so they could be skidded (i.e., pulled along the ground to a central location). Skidding was accomplished by using a rubber-tired skidder equipped with a grapple. Whole trees were chipped with a 27-inch whole-tree chip-harvester, with the chips being stockpiled at the landing and later spread over the test plots. The estimated conversion between cubic yards and bone dry tons is 10 cubic yards per bone dry ton. Thus the cost per bone dry ton for felling and piling, skidding, and chipping is $58.50 per bone dry ton.

TABLE 1: SUMMARY OF OPERATIONAL COSTS FOR LINCOLN COUNTY STUDY PLOT

Operation	Acres	Total Cost ($)	Cost per Hour per Machine ($)	Cost per Acre ($)	Volume Produced (Cubic Yards)	Cost per Cubic Yard of Chips ($)
Felling and Piling	12	3,120	89.66	260		
Skidding	12	1,740	42.65	145		
Chipping	12	3,420	168.63	285	1,415	2.42
Total	**12**	**8,280**		**690**	**1,415**	**5.85**

3.3.2 Mt. Wilson Fuels Reduction Project

As described in the *Pinyon-Juniper Biomass Utilization Study For Lincoln County, Nevada*, another P-J project, known as the *Mount Wilson Fuels Reduction Project*, was completed in 2004 under the direction of the BLM. The contract involved thinning P-J stands on 740 acres to a density of about 25 large trees per acre. Rubber-tired feller-bunchers were used to cut and bunch the trees. Rubber-tired grapple skidders and a front end loader with forks were used to move the material to the chipper. A 27-inch chipper was used to convert the trees into chips. The chips were subsequently hauled 2 – 3 miles to an old airplane landing strip where they were stockpiled. A summary of the contract items associated with this project are presented in Table 2.

TABLE 2: SUMMARY OF CONTRACT ITEMS FOR MT. WILSON FUEL REDUCTION PROJECT

Operation	Cost Per Acre ($)
Cutting	260
Skidding	145
Chipping	285
Subtotal	**690**
Hauling (with chip van 2 – 3 miles)	115
Total	**805**

The BLM reported that the estimated biomass removed was 5 – 7 tons per acre on the lower elevation sites that consisted mostly of juniper and 10 tons per acre on steeper terrain that contained both Juniper and Pinyon.

3.3.3 Ward Mountain Fuels Reduction Project

As described in the *Pinyon-Juniper Biomass Utilization Study For Lincoln County, Nevada*, another relevant project was undertaken in 2004 under the direction of the BLM's Ely office. It was known as the *Ward Mountain Fuels Reduction Project*. The project involved the thinning, removal, and chipping of 345 acres of P-J. The woodland was thinned to a density that left approximately 25 larger trees per acre. 82 acres were treated by BLM crews felling with chainsaws and a mechanized shear. The remaining acres were treated by a private contractor using rubber-tired feller bunchers for thinning and biomass removal, with a front-end loader used to feed the chipper. Chips were loaded into 20 cubic yard capacity belly dump trucks and were transported offsite to a location that created a 26 mile round trip haul distance. Table 3 summarizes the costs associated with the project.

TABLE 3: SUMMARY OF COSTS FOR WARD MOUNTAIN FUEL REDUCTION PROJECT

Operation	Cost per Acre ($)
Cutting and piling	800.87
Slash Collection	12.87
Slash Chipping	12.87
Whole-log chipping	249.29
Subtotal	**1,075.90**
Hauling (with belly dump trucks – 26 miles roundtrip)	179.71
Total per Acre Cost	**1,255.61**

The contractor indicated the cutting and piling operational costs were artificially high and some of the other items somewhat low due to the contractor's need to realize cash flow early in the project. The contractor also indicated that the overall costs per acre are accurate. The slash collection and chipping costs were the result of the hand felling and would not be necessary if all the thinning was performed mechanically. The average yield was estimated to be 8.5 tons per acre.

Finally, in a somewhat similar project, the Nevada Division of Forestry's Pioche Conservation crew created fire breaks and thinned an additional strip of land along private roads in the Mount Wilson community. The total cost per acre was estimated to be $1,455.84, of which $183.60 was for chipping.

Table 4 summarizes the costs observed during the various projects. Again, note that the Lincoln County study plot assumed the per acre costs observed in the BLM Mount Wilson Fuel Reduction Project.

TABLE 4: SUMMARY OF PREVIOUS PINYON-JUNIPER FELLING AND CHIPPING PROJECTS

	Cost per Acre ($)			
Operation	**Lincoln County Study Plot**	**Mt. Wilson Fuel Reduction Project**	**Ward Mountain Fuel Reduction Project**	**Mt. Wilson Fire Break Project**
Cutting, skidding and piling	405	405	801	
Chipping	285	285	249	184
Total	**690**	**690**	**1,050**	
Tons per Acre	20.6	5 – 10	8.5	
Calculated Cost ($/Green Ton)	33.50	69 – 138	127.64	
Acres Treated	12	745	345	

3.4 SUMMARY

Based on the past projects referenced in this section, it is evident that there is substantial variability in the cost per acre for the thinning and chipping of P-J. This is because a number of factors affect the cost, including how many trees per acre are removed, the terrain being treated, the equipment that is used, the extent of hand labor that is required, and how effectively the equipment is operated.

The fuel treatment projects listed in Table 4 were all relatively small. This raises the question of whether the P-J treatment cost would decline due to an economy of scale if restoration projects were larger. If P-J was harvested consistently across a large number of acres, one would expect that techniques and equipment modifications would lead to lower costs per ton of P-J removed. However, the lower cost would not be a product of the number of acres treated since those are essentially unit operations. Rather, the reduced costs would come from process innovation. In BECK's judgment, even with savings by process improvements, the per ton treatment costs will remain far above the ability of a biomass power plant to pay the full cost of treatment as a delivered to the plant fuel cost.

Another important consideration in the previous studies is that the cost is always expressed in terms of dollars per acre. While expressing costs on that basis is useful for land managers, it is not useful for power plant managers who need to know costs on a dollars per bone dry ton basis. In the prior studies, the volume per acre values are estimates based on conversions from other units of measure (e.g. cubic yards) rather than actual measured weights of biomass removed. In addition, it is not always clear whether the volumes described are green tons (including moisture) or bone dry tons.

For these reasons, in BECK's opinion, these figures should be viewed with some caution, particularly the tons removed per acre.

CHAPTER 4 – REVIEW OF ALTERNATE PRODUCTS

4.1 INTRODUCTION

The P-J resource in Lincoln County has long been utilized in various forms by residents of the region. The traditional uses have included firewood (i.e., fuelwood) for heating and cooking, fence posts, mine timbers, posts and rails for livestock enclosures, Christmas trees and production of charcoal for use in local smelters. Pinyon pine trees have been a source of pine nuts used for food.

A number of other products can conceivably be produced from the P-J resource. Those products/end uses are discussed in a later section of this chapter. No large-scale businesses exist that utilize P-J. That situation is a clear indication of the limited feasibility of utilizing P-J as a feedstock. Therefore, the key focus of this chapter is to provide insights into the likely viability of these products/end uses rather than provide a quantitative analysis of the feasibility of various end-use products made from P-J.

4.1.1 Economic and Market Considerations

While there is a market for many of the products that could be manufactured from P-J, the real question is whether they can be made at prices that are competitive in the marketplace. These include:

- Raw material cost and volume
- Distance to market/transportation issues
- Competitiveness of the industry/other producers
- Substitute products
- Marketing, sales and distribution
- Market conditions and outlook

One of the most important factors in determining whether a given product can be produced from P-J and sold at competitive prices is the cost of delivering the fiber to a manufacturing facility. Based on research completed as part of this project and the experience of others, the costs of P-J thinned and skidded to the landing ranges from $25 to $80 per bone dry ton. The wide range is caused by differences in equipment productivity when operating in areas with differing tree density. In areas with more trees per unit of area, costs are lower.

Based on the biomass felling, skidding, and chipping cost analysis completed as part of this study, chipping costs are estimated to be $13 per bone dry ton and hauling costs are estimated to range between $7.50 and $33.00 per bone dry ton depending on haul distance. This means the cost of P-J delivered to a plant site in the area can range from as low as $75 to nearly $175 per bone dry ton. Based on raw material costs at those levels, several of the potential products/end-uses for P-J would become non-competitive (due to high prices) in the marketplace.

The cost of transportation to market is particularly important when the freight cost represent a significant portion of the product value. This means the lower the value of the product, the shorter the distance that product can be shipped to market. Conversely, a high value product can be shipped longer distances to market. The existence of the Union Pacific Railroad mainline in Lincoln County may allow products to be shipped longer distances. However, in BECK's experience railroad customers need to ship very large volumes in order to obtain consistent service and competitive rate quotes. The scale of any business using P-J is likely to be relatively small and therefore not a good match for utilizing cost competitive rail transportation.

For many wood products, if the existing producers/industry has significant excess production capacity, the probability that new producers can successfully enter the market is greatly reduced. Similarly, if the existing producers are having difficulty meeting demand, there is a higher chance of success for new entrants.

In many cases, products that could be made from P-J must compete with substitute products. For example, in the southwest, bark mulch must compete with gravel/small rocks in some landscaping applications.

Manufacturing products is only one aspect of creating and maintaining a successful enterprise. Marketing and sales are equally, if not more, important. Having a strong sales person or staff is critical.

4.1.2 Assessment of Product/End Use Markets

The following section provides insight about alternate uses for P-J.

4.1.2.1 Mulch and Related Products

Mulch is generally produced from bark or other low value material (e.g., urban wood waste, tree trimmings, etc.). With the relatively high cost of P-J fiber, it will likely be too costly. In addition, wood mulch reportedly has a tendency in dry climates to dry out, which in turn allows wind to blow it away. There appears to be a very limited local market for this material. The other two logical markets would be Las Vegas (which is currently very depressed) and the Salt Lake City area. There is a least one mulch producer in Salt Lake City with whom BECK staff members have talked that produces regular and colored mulch from tree trimmings and other urban waste that they receive at no cost. Since the local mulch producers in both Las Vegas and Salt Lake City obtain much of their raw material at little or no cost, the comparative cost of transporting P-J derived mulch from Lincoln County to market in Las Vegas or Salt Lake City is likely to be cost prohibitive.

4.1.2.2 Animal Bedding and Litter

Shavings and sawdust are often used as animal bedding for horses, chickens, turkeys, etc. To a lesser extent chips can also be used. The market value of this material is relatively low, and when sold in bulk, transportation costs can be somewhat high (on a per ton basis) since it has low density on a cubic basis, therefore limiting the distance it can be hauled economically. There may be some possibility of using ground or shredded P-J fiber as a filling inside a pet bed/pillow as is done with western red cedar, but this would likely be a niche market and require only modest amounts of P-J.

4.1.2.3 Densified Fuel

Densified fuel generally comes in three different forms: pellets, briquettes (larger pieces of "pressed" wood made into shapes likely hockey pucks) and fire logs (e.g., presto-logs). Currently, most densified fuel sold in the U.S. is in the form of pellets for residential heating. The pellets require very clean, bark-free fiber that, when burned, produces little ash. The ash content of Pinyon may be an issue for residential pellets. Nearly all the residential pellets and briquettes produced in the U.S. are made from wood fiber that is a by-product of lumber manufacturing (e.g., shavings or sawdust). This fiber is much less costly than fiber derived from chipping logs. Currently, an oversupply situation exists in the U.S. for residential pellets. This has resulted in lower prices paid to producers. It would appear possible to produce industrial pellets or briquettes that would accept a much higher bark content that would be more suitable for P-J. These pellets would be suitable for heating schools or other non-residential buildings with boilers that could burn biomass. Unfortunately, with the high wood cost for P-J wood fiber, the price of industrial pellets would likely be higher than alternative biomass supplies of such materials.

4.1.2.4 Wood Composites

In the last decade or so a number of products (e.g., decking) that contain wood fiber and other materials, particularly plastics, have emerged**.** These are sometimes referred to as "plastic wood". In nearly all instances, the percentage of wood fiber is relatively low. The wood fiber is typically sawdust and would have a cost much lower than would be possible utilizing P-J. Even if possible, the volume of P-J that would be required would be low. The major plastic lumber producers (e.g., Trex) have extensive distribution networks that would be a significant barrier to new entrants. Another type of composite material is a cement board that is a combination of cement and wood. In reality, cement board is comprised mostly of cement with only a relatively small percentage of wood fiber used to reduce weight and provide better board properties (e.g., machinability)

4.1.2.5 Cellulosic/Wood Ethanol

In recent years, there has been significant research and development to produce ethanol from wood (as opposed to corn). To date, commercialization of cellulosic ethanol in the U.S. has been very limited. None of the bench scale producers has used

P-J fiber, so testing would be required to determine the suitability of the fiber as a feedstock. The capital costs for a cellulosic ethanol plant are very high, and a producer would require a long-term, secure, affordable fiber supply. The long-term outlook for ethanol is uncertain since the economics have been dependent on government subsidies/incentives, and currently there is over capacity in the corn ethanol industry.

4.1.2.6 Biodiesel

This product reportedly can be produced from a variety of different types of biomass and agricultural waste. P-J fiber, because of its high cost, would not serve as an affordable feedstock for this product.

4.1.2.7 Wood-based Panels

Oriented-strand board (OSB) is a structural panel produced from softwood and hardwood logs. The producing plants are large and require a large volume of relatively inexpensive logs (e.g., pulpwood). It is unclear if P-J would be suitable. In addition, the OSB industry has a very significant problem with excess capacity. Particleboard is a non-structural board that is made from small particles of dried wood (i.e., sawdust). Particleboard is almost exclusively made from residual wood fiber and not chips. Raw material costs from P-J likely would be too high and field produced chips would not meet the quality specifications. Medium-density fiberboard (MDF) has problems similar to those of particleboard and is viewed as not an appropriate end-use for P-J fiber.

4.1.2.8 Other Chemicals

While a number of chemicals (e.g., furfural, levulinic acid, formic acid) can be produced/extracted from P-J, the high fiber cost would likely make these products not economic in the marketplace.

4.1.2.9 Absorbent Material

While P-J fiber could be used as absorbent material that can be used to clean up spills and provide barriers required to protect the environment at construction sites, it is likely that fiber cheaper than P-J is available.

4.1.2.10 Pulp Chips

While it may be possible to make good quality pulp chips from P-J trees (if the bark can be fully removed), there are no pulp mills within at least 1,000 miles of the region. The cost of transporting chips to Oregon or Washington would likely be prohibitive, particularly when coupled with the high cost of felling and chipping.

4.1.2.11 Other Products

It appears feasible to produce rustic log furniture from juniper, as it is with other species such as lodge pole pine. The development of this type of business would require individuals who have the design aptitude and skill needed to craft the products. In addition, it would require artisans/craftsmen that are willing to do the design and manufacturing work. It will also require the location of firms (i.e., dealers) that are willing to sell the products in a retail setting in a more populous location. Again, the volumes would be very low.

Traditional fence posts are be produced from P-J. However, it does appear that there is little demand in the local area since most of the fences are constructed with steel posts. A related item that may have some market potential is agricultural posts, particularly those that are used in vineyards. These can be used as an alternative to pressure treated wood posts that are used to support rows of grapes. The juniper, as a member of the cedar family, has some natural resistance to rot. This characteristic is particularly appealing for vineyards that focus on being organic since the posts would not contain the preservatives of treated posts.

It may be possible to produce sawn lumber from the Utah juniper similar to that sawn from Western juniper. Western juniper, however, is typically much larger in size than the Utah juniper found in eastern Nevada. If it is feasible to produce lumber from Utah juniper, there would be an opportunity to produce furniture (e.g., tables), paneling, decking and strip flooring. These markets would likely be niche markets that would be small and specialized.

Firewood continues to be a market for P-J. It may be somewhat difficult to produce firewood on a large scale from pinyon since it does not split well using commercial firewood splitters due to the character of the wood.

In BECK's view, veneer does not appear to be a feasible production option for P-J

4.1.2.12 Co-firing in an Existing/Proposed Coal Plant

The concept of co-firing biomass in coal-fired plants as a supplemental or replacement fuel has been attempted for decades by various utilities in the U.S. The results are typically that, while it is technically feasible and has emission benefits, the percentage of coal that can be replaced by biomass without unit derating (lowering the output of the power plant) is low, and the fuel preparation cost is high and uncertain.

The problem lies in the inherent difference between the characteristics of wood and coal. Coal shatters when struck with a hard object. That shattering can be followed by grinding to produced a fine powder, which can be burned in suspension in a standard utility boiler. The shattering and grinding processing steps require relatively little energy and therefore moderate cost. The anatomy of wood, in contrast, requires multiple processing steps in order to reduce particle size and moisture to achieve a state where it can be burned in suspension. All of that processing is both energy intensive and expensive.

Relative to coal, other problems with using wood are that it has higher moisture content and lower heating value. Both factors cause the unit derating mentioned above. On the other hand, wood has less sulfur than coal and burns with a lower flame temperature (less NOx generation), both positives from an environmental standpoint. Wood is also typically more expensive than coal on a delivered cost per million BTU basis due to the necessity of having to gather it from across the landscape and then deliver the low BTU product over a long distance.

Coal co-firing is a potential use of P-J from Lincoln County. The Reid Gardner coal-fired power plant of NV Energy sits south of the Lincoln County line in Moapa. This four unit plant has a total generating capacity of 587 MW. Converting even one of the older 114 MW smaller units to biomass co-firing could consume all the likely P-J produced by a large scale restoration project in Lincoln County. In addition, the fuel could be delivered by rail from Caliente and thus could avoid the large capital investment required for a standalone biomass power facility.

There are two problems with this alternative: technology and cost. Regarding technology, all four Reid Gardner units use pulverized coal technology, meaning that prior to firing, the coal particles are reduced to a fine powder, which allows suspension burning (no boiler grate). Wood simply cannot achieve the level of fineness required for suspension burning without a tremendous investment in energy for processing.

Regarding cost, the cost for wood would be higher than the cost of coal. The Energy Information Agency (EIA) of USDOE published the 2009 price for coal delivered to Nevada power plants as $47.37/ton. In the case of Reid Gardner, this is Utah coal. For a typical Utah bituminous coal of 12,600 BTU/LB., as received with 5 percent moisture, the cost would be $1.88 per million BTU delivered.

In the case of Lincoln County biomass delivered to a Caliente railhead, as developed as part this study, an estimated cost of $25/BDT would cover chipping and transport to Caliente, but would cover none of the cost of cutting or skidding the P-J to roadside. Adding rail loading and delivery to Moapa would likely raise the delivered price to $40/BDT at Moapa. This is $2.23/million BTU for a lower heating value product arriving in chipped form. Accounting for the lower combustion efficiency of biomass (74 percent vs. 85 percent) raises the equivalent price to $2.56/million BTU. This price still does not include the cost to prepare the biomass for firing. It does not appear that P-J biomass delivered to Reid Gardner would represent a near term business opportunity for NV Energy.

There are other coal combustion technologies, such as grate firing and fluidized bed combustion, which do not require the size reduction of pulverized coal combustion. These technologies could use the P-J in the chipped size in which it arrives. Nevada has two other coal-fired plants, the NV Energy North Valmy facility (525 MW) near Battle Mountain and Newmont Mining's TS Ranch plant (240MW) in Eureka County, but both again use pulverized coal technology. The same is true of the Intermountain Power Project (1,614 MW) near Delta, Utah, the closest Utah coal-fired plant.

It is also important to note that there are new technologies in development: biochar and torrefaction. Both involve the heating of wood fiber in the absence of oxygen to essentially create a material similar to charcoal. Each technology can potentially solve the biomass preparation problems and improve firing efficiency to rival that of coal. However, both technologies are just developing, which makes it difficult to predict how each technology may improve co-firing economics. This is because the new technologies, while improving processing characteristics and increasing energy density, do so by consuming many of the BTU's in the biomass. As a consequence, there is less total heating value per unit of weight to deliver to the coal-fired plant. This, in turn, means that the cost per BTU delivered will be higher, which in turn aggravates the cost problem described earlier in this section. Whether this loss is offset by the handling and efficiency advantages is yet to be determined.

As a consequence of all the preceding factors, coal co-firing does not appear to represent an economic alternative use for Lincoln County P-J at this time. Future carbon legislation could change that outcome, but is not part of today's decision making.

4.2 Summary of Market Options

Based on the analysis completed for this project, the market options for products that could be produced from P-J are rustic log furniture, posts, firewood and potentially lumber. There is a firm located in Klamath Falls, Oregon near the California border called JMAR that produces a variety of products from Western Juniper, including square posts, peeled posts, lumber, decking and paneling. JMAR is a non-profit that provides employment opportunities for persons with disabilities and receives support (and was built with funds) from local wood products companies. The firm has been operating on a limited basis in recent months due to lack of market demand. More information about JMAR can be found at their website: http://juniperwoodproducts.com.

Figure 1 shows peeled juniper posts used in an agricultural setting. It may be possible to used posts that are not sawn or peeled.

FIGURE 1: PEELED JUNIPER POSTS USED IN AN AGRICULTURAL SETTING

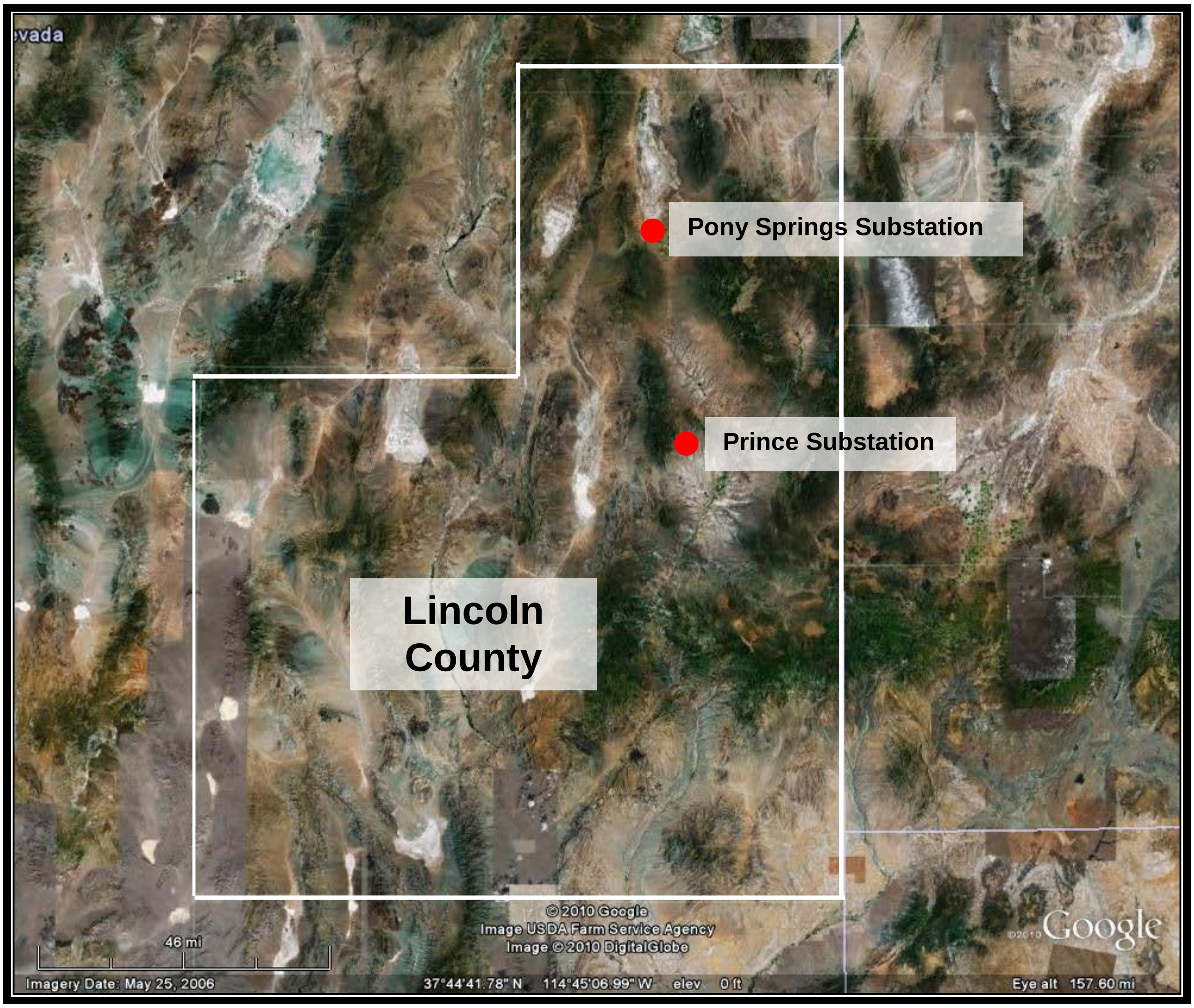
It appears that this mill has had some modest success in producing and marketing products from Western juniper since its inception a few years ago. However, this appears to be due to the financial support of local industry and other benefactors. It is unclear if the Utah juniper (due to its smaller size) could support the manufacture of similar products such as sawn 6" x 6" posts for vineyards or other applications. Another important factor in this operation is that there is a well established forest products industry in the area that provides timber felling resources and ready markets for the wood waste produced by the mill. Due to the characteristic knotting and twisting of Juniper logs, a large percentage of the timber brought to the plant ends up as waste. Finally, JMAR is strategically located with good access to the growing wine industry in northern California and Southern Oregon.

In summary, while there may be some market opportunity for products that can be produced from P-J, these will likely be small, specialized products that can be produced by local entrepreneurs that have an interest in developing these potential business opportunities. None will likely consume the output of the landscape level treatments envisioned by the BLM in Lincoln County.

CHAPTER 5 – BIOMASS FUEL SUPPLY ASSESSMENT

The biomass supply assessment is focused on two prospective power plant sites – the Prince Substation (located near the town of Caselton, NV) and the Pony Springs Substation (located about 30 miles north of Pioche, NV) (see Map 1). These sites were selected prior to the commencement of the study. The two sites were chosen primarily because they were judged to minimize the cost of interconnecting the power plant to the power grid. The substation site selections were recommended by the Lincoln County Power District (LCPD) in consultation with representatives of Lincoln County and A-Power.

MAP 1: PROSPECTIVE POWER PLANT LOCATIONS



5.1 GENERAL INFORMATION ABOUT THE SUPPLY AREA

This section contains general information about the supply area's climate rainfall, wet/dry seasons, etc. Regarding temperature, the average temperature ranges from the 10 to 40 degrees Fahrenheit in winter and from about 50 to 80 degrees Fahrenheit in the summer.

With respect to rainfall, much of the annual precipitation is the result of spring snow storms and summer time convective thunderstorms. Total annual precipitation in the region is about 10 inches per year. Precipitation in the region is heavily influenced by the Sierra Nevada Mountain Range that lies generally on the eastern border of Nevada and runs north and south. The prevailing westerly winds bring moisture from the Pacific Ocean. As the warm, moist air ascends the Sierra Mountains it cools and precipitates from the air in the form of rain or snow. This results in very dry conditions on the lee side of the mountains. Lincoln County is in the "rain shadow" of the Sierra Nevada Mountains.

Flooding is infrequent, but can occur in the spring as melting snow in the mountains runs off in various streams. This can be especially true when warm rain falls on mountain snow packs.

With respect to groundwater, the Carbonate Rock Aquifer underlies much of southern and eastern Nevada. The Pony Springs site lies within the Lake Valley Water Basin. The perennial yield of water in that basin is 12,000 acre-feet per year, which can be compared to committed resources in the basin of 29,981 acre-feet per year. The Prince site is on the northern edge of the Panaca Valley hydrographic area. It has a perennial yield of 900 acre-feet per year and committed resources of 28,134 acre-feet per year. In both cases, the numbers mean that the alluvial groundwater resource is fully allocated by the Nevada Division of Water Resources.

Regarding soil types in the region, they vary depending on location. Basin floors occupy level to gentle slopes and can be very deep. These soils are moderately coarse to fine-grained. Alluvial Fans and Stream Terraces occupy level to moderate slopes and range from fine to coarse texture. Fan Piedmonts are formed where alluvial fans coalesced into a single linear feature that paralleled a mountain front. These soils have moderately steep slopes and can be shallow to very deep.

5.2 BIOMASS SUPPLY AREA AND VOLUME

A critical aspect of any biomass fueled power plant is identifying the supply and delivered cost of biomass fuel. Accordingly, BECK has organized this chapter into four subsections described as follows:

1. **Supply Area Estimate** – an estimate of the area (acres) capable of supplying fuel.
2. **Supply Volume Estimate** – an estimate of the volume (bone dry tons) per unit of area.
3. **Delivered Cost Estimate (direct costs)** – an estimate of the costs directly associated with BLM vegetative management treatments aimed at restoring P-J forests to historic conditions. This includes costs such as thinning trees, moving (skidding) them to a central processing area, chipping the material into a form suitable for use as fuel, and transporting the fuel to the prospective biomass plant. It also includes the cost of rehabilitating treated lands.
4. **Administrative Cost Estimate (indirect costs)** – an estimate of the indirect costs associated with the BLM planning and administering all of the activities associated with stewardship contracting efforts aimed at restoring P-J forests.
5. **Total Cost Estimate (all inclusive)** – the sum of both the direct and indirect costs associated with vegetative management treatments on P-J forests.

5.3 SUPPLY AREA ESTIMATE

In this section of the report, BECK describes the methods used to estimate the biomass supply area and the number of acres judged to be accessible for the vegetative treatment of P-J. BECK also classifies the acres into categories, which are differentiated by the volume of P-J per acre.

The criteria used to estimate the accessible number of acres were:

- From both the Pony Springs and Prince Substations, a supply circle with a 50-mile radius was assumed. Based on BECK's experience with biomass projects throughout North America, a 50-mile radius is a good general rule of thumb because material transported from distances beyond that radius quickly become cost prohibitive.
- BECK used Geographic Information System (GIS) data from the Bureau of Land Management's (BLM) Ely District to identify acres classified as P-J within each 50-mile working circle.

- The total number of P-J acres provided by the BLM data was filtered to estimate the accessible number of P-J acres. Any P-J acres that fell into any of the following categories were excluded from the accessible acreage estimate:
  - Acres that fell within a wilderness area.
  - Acres that were in areas with slopes exceeding 30 percent.
  - Acres that had been burned in a fire since 1981.
  - Acres on private land. Note that this filter had minimal impact since, per the U.S. Forest Service Forest Inventory and Analysis database[4], private forestland in all of Lincoln County is estimated to be only 29,900 acres out of a total of 1.848 million acres.

Note from the **Prince Substation** map (Appendix 1) and **Pony Springs Substation** map (Appendix 2) that each 50-mile radius circle extends into Utah. This means that some of the potential supply area falls within land managed by other BLM administrative units and some also falls within the Dixie National Forest, which is managed by the U.S. Forest Service. BECK contacted staff at the BLM's St. George Field Office regarding the availability of inventory data for the area within the 50 mile working circle in Utah. While data is available, it was not obtainable before the results of this study were due.

As will be shown in the following sections, the supply estimates indicate ample biomass exists without including the area in Utah. Therefore, BECK has elected to complete the study without the inventory data from Utah. Another reason for this course of action is that involving more BLM administrative units makes the administration of any potential stewardship contracts more difficult.

Based on the preceding criteria, Table 5 shows the estimated number of accessible acres at various distance increments from each prospective location.

TABLE 5: ESTIMATED NUMBER OF ACCESSIBLE ACRES AT VARIOUS DISTANCE INCREMENTS FROM PRINCE AND PONY SUBSTATIONS

Distance Increment (Miles from Center Point)	Pony Springs (Accessible Acres within Increment)	Pony Springs (Accessible Acres Cumulative Totals)	Prince (Accessible Acres within Increment)	Prince (Accessible Acres Cumulative Totals)
0 to 10	73,900	73,900	34,100	34,100
11 to 20	169,500	243,400	122,800	156,900
21 to 30	122,000	365,400	328,700	485,600
31 to 40	114,800	480,200	198,500	684,100
41 to 50	159,600	639,800	38,000	722,100

[4] Forest Inventory and Analysis database. Maintained by the USDA Forest Service, accessed at: http://www.fia.fs.fed.us/.

5.3.1 Classifying Accessible Acres by Tree Density

The next step in BECK's analysis involved classifying accessible acres into groups sorted by tree density. The classification system used is described in a rangeland fuels guide[5]. Each classification category is defined as follows:

Phase 1 — Trees are present on the site, but the shrub and herb layers are the dominant influence on ecological processes (hydrologic, nutrient, and energy cycles). The total average volume per acre in this category is 3.5 bone dry tons per acre.

Phase 2 — Trees are co-dominant with shrub and herb layers. All three layers influence ecological processes. The total average volume per acre in this category is 10.2 bone dry tons per acre.

Phase 3 — Trees are the dominant vegetation and the primary layer influencing ecological processes. The total average volume per acre in this category is 23.0 bone dry tons per acre.

BECK assigned the total accessible P-J acres at each location (shown in Table 5) into one of the three preceding Phase Classifications. This was completed on the basis of findings from a study[6] on the age and structure of P-J forests across the Intermountain West in combination with direct input from BLM staff and one of the study's authors, Dr. Robin Tausch, Supervisory Range Scientist and Plant Ecologist at the USDA Forest Service Rocky Mountain Research Lab in Reno, Nevada. According to Dr. Tausch, the P-J forest in Lincoln County is 25 percent Phase I, 50 percent Phase II, and 25 percent Phase III. Given that breakdown of total acres by phase category, Table 6 and Table 7 show the number of acres at each location by Phase classification.

---

[5] *Guide for Quantifying Fuels in the Sagebrush Steppe and Juniper Woodlands of the Great Basin.* A publication of the Sagebrush Steppe Treatment Evaluation Project. Accessed at: http://www.sagestep.org/pubs/fuelsguide.html.

[6] Age Structure and Expansion of Pinyon-Juniper Woodlands: A Regional Perspective in the Intermountain West. USDA Forest Service, Rocky Mountain Research Station, Research Paper Report RMRS-RP-69. Accessed at: http://www.fs.fed.us/rm/pubs/rmrs_rp069.pdf.

TABLE 6: ACCESSIBLE P-J ACRES AT PRINCE CLASSIFIED BY PHASE

Distance Increment (miles from center point)	Phase I Acres	Phase II Acres	Phase III Acres	Total Within Zone Acres	Cumulative Acres
0 to 10	8,500	17,100	8,500	34,100	34,100
11 to 20	30,700	61,400	30,700	122,800	156,900
21 to 30	82,200	164,300	82,200	328,700	485,600
31 to 40	49,600	99,300	49,600	198,500	684,100
41 to 50	9,500	19,000	9,500	38,000	722,100
Total	**180,500**	**361,100**	**180,500**	**722,100**	n/a

TABLE 7: ACCESSIBLE P-J ACRES AT PONY SPRINGS CLASSIFIED BY PHASE

Distance Increment (Miles from Center Point)	Phase I Acres	Phase II Acres	Phase III Acres	Total within Zone Acres	Cumulative Acres
0 to 10	18,500	36,900	18,500	73,900	73,900
11 to 20	42,400	84,700	42,400	169,500	243,400
21 to 30	30,500	61,000	30,500	122,000	365,400
31 to 40	28,700	57,400	28,700	114,800	480,200
41 to 50	39,900	79,800	39,900	159,600	639,800
Total	**160,000**	**319,800**	**160,000**	**639,800**	n/a

5.4 SUPPLY VOLUME ESTIMATE

In addition to understanding the area that is accessible for the vegetative treatment of P-J, it is also important to understand the volume (expressed in bone dry tons) of P-J that can be obtained from those acres. In this section of the report, BECK describes the methods used to estimate the biomass supply and provides volume estimates.

5.4.1 Volume Estimate Methodology

Regarding the methodology used to estimate volume, BECK considered information from a number of sources including:

- An interview with a biomass contractor (Tim Thayer) in Northern California who thins Western Juniper on private lands and markets it to the Honey Lake power plant in Wendel, CA. Mr. Thayer indicated that he averages about 7 to 8 bone dry tons of material harvested per acre treated. He also stated that it is common for dense patches of western juniper to yield over 20 bone dry tons of biomass per acre. In BECK's judgment this is one of the most accurate estimates of volume per acre because it is supported by actual weight measurements. One confounding factor though is that Mr. Thayer typically deals with western juniper rather than the Utah juniper that is prevalent in Lincoln County. The western juniper trees tend to be larger than Utah Juniper.

- Previous fuel treatment projects completed by the BLM including Ward, Gleason, Mount Wilson, and Meloy Stewardship projects. Data provided by the BLM indicates that the amount of biomass harvested per acre on those projects ranges from a low of about 3.3 green tons per acre to a high of about 11.2 green tons per acre. To compare these values expressed in green tons to the other values expressed in bone dry tons, one must multiply the green ton weight by 0.75 (assuming the material is about 25 percent moisture). It is clear that the per acre volumes observed by on the BLM stewardship projects are lower than what is reported from other sources.

- A research study completed by Resource Concepts, Inc. near Pony Springs, Nevada. This study was conducted on 12 acres and found that 11.5 bone dry tons per acre were removed during a thinning treatment. The methods for calculating that volume per acre are not described in the study. However, BECK developed its own method to calculate the volume per acre and estimated that 18.4 bone dry tons per acre were removed from the site.

- A review of the Rangeland Fuels Guide[7] published as a part of the Sagebrush Steppe Treatment Evaluation Project. This study estimated that the volume per acre on P-J lands ranges from about 3.5 to 23.0 bone dry tons. The range depends on a variety of factors including the density of the trees, elevation, and the mix of species.

Clearly the volume per acre estimates vary considerably across these different sources, ranging from a low of about 2 bone dry tons per acre in some of the BLM stewardship projects to over 23 bone dry tons per acre in the Rangeland Fuels Guide. Some of the variation is explained by differences in tree density, elevation, and slope aspect. Other factors influencing the volume per estimates are the methodologies used to calculate (rather than actually weigh) the per acre volumes.

Based on BECK's review of the data, the Rangeland Fuels Guide was judged to be the best available source of information for estimating the biomass volume per acre. This is primarily because of the rigor that was used to collect the data. As described in that document, the volume per acre estimates are based on data collected during transects of woodlands of various types (called phases). Data collected along the transects include tree count (trees per acre) and measurements of tree size (height and

---

[7] *Guide for Quantifying Fuels in the Sagebrush Steppe and Juniper Woodlands of the Great Basin.* A publication of the Sagebrush Steppe Treatment Evaluation Project. Accessed at: http://www.sagestep.org/pubs/fuelsguide.html.

diameter). That information was then used to calculate the average tree volume (expressed in bone dry tons per acre).

Given the use of the Rangeland Fuels Guide data as the definitive volume per acre estimate, Table 8 shows the key assumptions made regarding: 1) the volume per acre in each phase, and 2) the thinning intensity that would occur during treatment of those acres.

Please note that BLM staff reviewed a draft of copy of this report and felt the volume per acre estimates based on the Rangeland Fuels Guide were too high relative to their experience with stewardship projects. The importance of the volume per acre estimates are that if the biomass power plant project were developed and the volume per acre was lower than what is projected by the Rangeland Fuels Guide, it would hamper project feasibility. On the other hand, should the volume per acre estimates be higher than what is estimated by the Rangeland Fuels Guide, project feasibility would be improved.

TABLE 8: P-J VOLUME PER ACRE ESTIMATES (BDT/ACRE)

Phase Classification	Total Volume (BDT/Acre)	Thinning Intensity (% of Volume Removed)	Thinned Volume (BDT/Acre)
Phase I	3.5	75	2.6
Phase II	10.2	50	5.1
Phase III	23.0	75	17.3

Regarding the thinning intensity values shown in Table 8, those are based on a combination of discussions between BECK, Kyle Teel, BLM Ely District fire ecologist, and Dr. Tausch about how heavily the woodlands of each phase type would be thinned in order to achieve the vegetative management objectives described in the Ely RMP.

Other things to note about the information presented in Table 8 are that the net volume per acre estimates account for losses from factors such as tree breakage during felling and processing. Also note that since the volume estimates shown in the tables are expressed in bone dry tons, the actual weight of the biomass felled and removed from the site is likely to be 1.33 to 1.66 times higher (depending on the moisture content of the trees when felled). This is not because a greater number of trees will be felled, but is simply the difference associated with expressing the volume on a bone dry basis versus a green (water included) basis.

Given the acres shown in Table 6 and Table 7 and the volume per acre values shown in Table 8, Table 9 and Table 10, they illustrate that nearly **5.44 million bone dry tons** of biomass are estimated to be available within a 50 mile radius of the Prince Substation and nearly **4.82 million bone dry tons** are estimated to be available within a 50 mile radius of the Pony Springs Substation, respectively.

This means that a 10 MW power plant (which would consume 67,300 bone dry tons annually) could be supplied from the currently accessible fuel at the Prince location for 81 years. Similarly, enough currently accessible fuel is available surrounding the Pony Springs location to supply that plant for 72 years. Biomass power plants are depreciated within 20 years, but typically have useful operating life of 50 years or more.

TABLE 9: PRINCE SUPPLY VOLUME ESTIMATE (BONE DRY TONS)

Distance Increment (Miles from Center Point)	Phase I (BDTs)	Phase II (BDTs)	Phase III (BDTs)	Total within Zone (BDTs)	Cumulative (BDTs)
0 to 10	22,300	87,200	147,100	256,600	256,600
11 to 20	80,600	313,100	531,100	924,800	1,181,400
21 to 30	215,800	837,900	1,422,100	2,475,800	3,657,200
31 to 40	130,200	506,400	858,100	1,494,700	5,151,900
41 to 50	24,900	96,900	164,400	286,200	5,438,100
Total	**473,800**	**1,841,500**	**3,122,800**	**5,438,100**	n/a

TABLE 10: PONY SPRINGS SUPPLY VOLUME ESTIMATE (BONE DRY TONS)

Distance Increment (miles from center point)	Phase I (BDTs)	Phase II (BDTs)	Phase III (BDTs)	Total Within Zone (BDTs)	Cumulative (BDTs)
0 to 10	48,600	188,200	320,100	556,900	556,900
11 to 20	111,300	432,000	733,500	1,276,800	1,833,700
21 to 30	80,100	311,100	527,700	918,900	2,752,600
31 to 40	75,300	292,700	496,500	864,500	3,617,100
41 to 50	104,700	407,000	690,300	1,202,000	4,819,100
Total	**420,000**	**1,631,000**	**2,768,100**	**4,819,100**	n/a

5.5 DELIVERED COST ESTIMATE (DIRECT COSTS)

Another critical aspect of the fuel supply is the cost of thinning, processing, and transporting the fuel to the prospective power plant. In this section, BECK describes the methods used to assess the various costs and provides cost estimates separated into the various processing/rehabilitation functions.

5.5.1 Costing Methodology

This section describes the methodology used to estimate the cost of conducting vegetative treatments using mechanized equipment, including a list of the equipment required to conduct vegetative treatments.

A mechanized approach is required to cost-effectively treat P-J woodlands at the scale envisioned by the Ely RMP. Thus, based on BECK's experience in the areas of biomass thinning and processing technology and based on interviews of contractors currently producing biomass fuel from Juniper woodlands, BECK assumed that a tracked feller-buncher would be used to fell the trees, a grapple skidder would be used to transport the felled trees to a central processing area, a drum chipper would be used to chip the felled trees into fuel, and chip vans would be used to transport the fuel from the treatment area to the power plant. Figure 2 provides pictures of the various pieces of equipment.

FIGURE 2: MECHANIZED EQUIPMENT USED TO FELL, SKID[8], CHIP AND TRANSPORT P-J BIOMASS

Tracked Feller Buncher – This piece of equipment operates on tracks to minimize soil impacts. It fells the trees to be harvested and then accumulates the felled trees into bunches. Typically, each bunch consists of about 8 trees.

Grapple Skidder – This piece of equipment operates on four rubber tires and is equipped with a large grapple for grabbing and holding onto a group of trees that have been felled and bunched. The grapple securely holds the trees as they are transported from the harvest site to a central processing area.

Chipper – This piece of equipment processes whole trees into small chips, which are suitable for burning in most boiler systems. The chipper is often accompanied by a tracked excavator equipped with a grapple-head for feeding the trees into the chipper.

Chip Van – The chipper typically blows the chips directly into a chip van, which is a piece of equipment designed to transport the chips from the treated area to the power plant. Some chip vans have a walking floor for self-unloading, while others rely on a truck dumper at the final destination to empty the trailer.

[8] Note that no felling and skidding pictures of P-J material were available. The pictures shown are mainly taken in other regions are only meant to illustrate the process.

Regarding the methodology used to estimate the costs, BECK utilized a combination of interviews with existing contractors who process Western Juniper into biomass fuel and who provided information about their costs. Western Juniper forests tend to have slightly larger trees than P-J forests. Thus, the operating costs in such forests are likely to differ slightly from P-J forests. Nevertheless, they provide information form actual operations. In addition, BECK "built-up" cost estimates based on key factors such as hourly machine operating costs and hourly productivity. The hourly operating costs used include costs such as fuel, labor, repair and maintenance, loan amortization, and depreciation. Also included is a profit margin for the contractor. With respect to the "built-up" cost estimates, BECK obtained hourly machine operating costs from various sources. [9,10,11]

5.5.2 Costs Expressed on a Per Unit Basis

A key finding from BECK's analysis is that machine productivity, and therefore cost, is affected by the number of trees per acre. In other words, machine productivity decreases (on a bone dry tons per hour basis) in areas with fewer trees per acre (e.g., Phase I acres). This means that biomass from Phase I acres is more expensive than biomass from Phase II or Phase III acres. Similarly, biomass from Phase III acres (which has more trees per acre) is lower cost than biomass from Phase I and II acres. For this reason, BECK has developed different cost estimates for material originating from each Phase. Table 11 shows BECK's estimated costs on a dollars per bone dry ton basis.

TABLE 11: P-J DELIVERED COST ESTIMATE (DOLLARS PER BONE DRY TON)

Cost Category	Phase I Cost Estimate ($/BDT)	Phase II Cost Estimate ($/BDT)	Phase III Cost Estimate ($/BDT)
Felling and Bunching	78.75	49.38	24.52
Skidding	33.24	20.84	12.16
Chipping	13.41	13.41	13.41
Transport*	7.50 to 33.00	7.50 to 33.00	7.50 to 33.00
Total	**132.90 to 158.40**	**91.13 to 116.63**	**57.59 to 83.09**

* The transport cost depends on the travel time between the treatment location and the power plant. The values shown are the high and low ranges.

---

[9] Fuel Cost Reduction Simulator, a spreadsheet-based forest harvesting cost simulation model. Accessed at: http://www.fs.fed.us/pnw/data/frcs/frcs.shtml. Last updated March 26, 2010.

[10] Production, Cost, and Soil Compaction Estimates for Two Western Juniper Extraction Systems. Accessed at: http://www.cas.umt.edu/facultydatabase/FILES_Faculty/1111/WJAFJuniper.pdf. Western Journal of Applied Forestry. Volume 21, Issue 4, 2006.

[11] A Comparison of Harvesting Systems for Western Juniper. Beth Dodson, International Journal of Forest Engineering. January 2010.

As previously described, the following key assumptions about operating costs and productivity are from a combination of interviews with existing contractors and from values in published studies. More specifically the key assumptions are:

- The hourly operating cost of the feller buncher was assumed to be $110 per hour. Machine productivity was calculated for each phase type based on the average amount of time needed for the machine to move (or reach) from tree to tree, sever the tree, and finally accumulate felled trees in bunches of approximately 8. Note that to achieve bunches of 8, the feller buncher needs to not only fell the trees but also "smash" them together on the ground so that the bunch is compact enough for the skidder to pull 8 trees per skid.
- The hourly operating cost of the grapple skidder was assumed to be $80 per hour. For each phase type, the machine productivity was calculated based on an average of 8 trees per skid and approximately 6 to 7 minutes per skidding cycle, depending on phase type.
- Biomass material accumulated at the landing through the actions of the feller buncher and grapple skidder would be chipped with a drum chipper. The chipper was assumed to have an operating cost of $295 per hour and an average productivity of 22.0 bone dry tons per hour.
- Trucking costs were calculated on the basis of a $90.00 per hour operating cost and an average payload of 15.0 bone dry tons per truckload. Given those parameters, transportation costs were calculated for round-trip travel times for each 10 mile increment in a 50 mile radius working circle, assuming 1.5 road miles per mile of radius. The low end of the cost range $7.50 per bone dry ton is for the first 10 mile increment. The cost ranges to $33.00 per bone dry ton for the 50 mile distance increment.

5.5.3 Rehabilitation Costs

Up to this point in the analysis no cost has been included for rehabilitating areas after vegetative treatments (e.g., reseeding treated areas with preferred grasses, shrubs, and forbs). Based on data provided by the BLM, the cost for rehabilitation is $50 per acre. Since costs need to be expressed on a dollars per ton basis for the analysis of power plant feasibility, Table 12 shows the $50 cost per acre converted to cost per ton for each phase.

TABLE 12: REHABILITATION COSTS PER ACRE ESTIMATES

Phase Classification	Rehabilitation Cost ($/Acre)	Biomass Volume (BDT/Acre)	Rehabilitation Cost ($/BDT)
Phase I	50	2.6	19.23
Phase II	65	5.1	11.76
Phase III	100	17.3	5.78

It is important to note that costs per bone dry ton shown in the preceding table cannot just be added to the delivered costs shown in the preceding section because according to BLM staff not all treated acres need rehabilitation. Under the assumption that 10 percent of the total fuel will come from Phase I acres, 40 percent from Phase II acres and 50 percent from Phase III acres and assuming that 10 percent of the Phase I acres require rehabilitation, 33 percent of the Phase II acres require rehabilitation, and 66 percent of the Phase III acres require rehabilitation, **the weighted average rehabilitation cost would be $3.65 per bone dry ton.**

5.6 ADMINISTRATIVE COST ESTIMATE (INDIRECT COSTS)

In addition to the costs directly associated with conducting vegetative treatments, other administrative costs must also be considered. These include costs incurred by the BLM in the planning, administration and monitoring of vegetative treatments. According to data provided to BECK by the BLM Ely District fire ecologist, Kyle Teel, this would include funding for additional staff consisting of a project lead, fuels planner, archeologist, ecologist, wildlife biologist, and field technician. The total cost to the BLM for the additional staff and existing staff required to carry out vegetative treatments would be $850,000 in Year 1 and $670,000 in each subsequent year. These costs are estimates based on treating approximately 9,800 acres per year.

The BLM would also incur costs for contracting with private entities to complete cultural inventories and to meet the requirements of the National Environmental Policy Act (NEPA). The BLM has estimated the cost for cultural inventories to be $35 per acre. For the NEPA work, BLM has estimated the cost to be $29,000 per year. Table 13 summarizes all of the preceding costs and expresses them on a dollars per bone dry ton basis. For the purpose of converting dollars per acre costs to dollars per bone dry ton, it was assumed that 9,600 acres would be treated annually (10 percent Phase I, 40 percent Phase II, and 50 percent Phase III).

TABLE 13: SUMMARY OF INDIRECT COSTS ($/BDT)

Cost Category	Annual Cost ($)	Bone Dry Tons	Year 1 Staffing Cost ($/BDT)	Subsequent Years Staffing Cost ($/BDT)
Cultural Inventory	336,000	67,300	4.99	4.99
Staffing (Year 1)	850,000	67,300	12.63	n/a
Staffing (subsequent years)	670,000	67,300	n/a	9.96
NEPA	29,000	67,300	0.43	.43
Total Year 1	**1,215,000**		**18.05**	
Total (Subsequent Years)	**1,035,000**			**15.38**

5.6.1 Total (All Inclusive) Cost Estimate

In the preceding sections, the various costs associated with managing P-J woodlands have been examined individually. The following section provides information on the delivered cost of P-J fuel when considered all inclusively (i.e., felling, skidding, chipping, hauling, rehabilitation, and administrative).

5.6.2 Supply Cost Curve

Since the delivered cost varies depending on travel time, Table 14 and Table 15 show the amount of fuel available at various cost levels for each location broken out by travel time (distance) from the prospective plant location.

TABLE 14: PRINCE SUPPLY COST CURVE

Travel Time Zone	Source Category	Within Zone Bone Dry Tons	Within Zone Delivered Cost ($/BDT)	Cumulative Bone Dry Tons	Cumulative Delivered Cost ($/BDT)
0 - 10	Phase III	147,100	76.62	147,100	76.62
10 - 20	Phase III	531,100	82.62	678,200	81.32
20 - 30	Phase III	1,422,100	88.62	2,100,300	86.26
30 - 40	Phase III	858,100	94.62	2,958,400	88.69
40 - 50	Phase III	164,400	102.12	3,122,800	89.40
0 - 10	Phase II	87,200	110.16	3,210,000	89.96
10 - 20	Phase II	313,100	116.16	3,523,100	92.29
20 - 30	Phase II	837,900	122.16	4,361,000	98.03
30 - 40	Phase II	506,400	128.16	4,867,400	101.16
40 - 50	Phase II	96,900	135.66	4,964,300	101.84
0 - 10	Phase I	22,300	151.93	4,986,600	102.06
10 - 20	Phase I	80,600	157.93	5,067,200	102.95
20 - 30	Phase I	215,800	163.93	5,283,000	105.44
30 - 40	Phase I	130,200	169.93	5,413,200	106.99
40 - 50	Phase I	24,900	177.43	5,438,100	107.31
Total		**5,438,100**			

TABLE 15: PONY SPRINGS SUPPLY COST CURVE

Travel Time Zone	Source Category	Within Zone Bone Dry Tons	Within Zone Delivered Cost ($/BDT)	Cumulative Bone Dry Tons	Cumulative Delivered Cost ($/BDT)
0 - 10	Phase III	320,100	76.62	320,100	76.62
10 - 20	Phase III	733,500	82.62	1,053,600	80.80
20 - 30	Phase III	527,700	88.62	1,581,300	83.41
30 - 40	Phase III	496,500	94.62	2,077,800	86.09
40 - 50	Phase III	690,300	102.12	2,768,100	90.09
0 - 10	Phase II	188,200	110.16	2,956,300	91.36
10 - 20	Phase II	432,000	116.16	3,388,300	94.52
20 - 30	Phase II	311,100	122.16	3,699,400	96.85
30 - 40	Phase II	292,700	128.16	3,992,100	99.14
40 - 50	Phase II	407,000	135.66	4,399,100	102.52
0 - 10	Phase I	48,600	151.93	4,447,700	103.06
10 - 20	Phase I	111,300	157.93	4,559,000	104.40
20 - 30	Phase I	80,100	163.93	4,639,100	105.43
30 - 40	Phase I	75,300	169.93	4,714,400	106.46
40 - 50	Phase I	104,700	177.43	4,819,100	108.00
Total		**4,399,100**			

Given the information shown in both of the preceding supply cost curves, it is apparent that from the perspective of minimizing cost, the best approach would be to treat only Phase III acres. However, based on discussions with BLM staff, it would also be preferable to treat some Phase I acres each year to prevent those acres converting to woodland from the more preferable sagebrush.

While the Ely RMP identifies objectives for vegetative treatments of P-J woodlands, it does not identify specific acres planned for treatment, nor does it account for the competing factors of minimizing delivered cost and treating acres in multiple phase classifications. Given this ambiguity, BECK has consulted with Kyle Teel, BLM Ely District fire ecologist, and calculated an overall average delivered cost, assuming that 10 percent of the fuel will come from Phase I acres, 40 percent from Phase II acres, and 50 percent from Phase III acres. **Therefore, the all inclusive delivered cost of the fuel is calculated to be $97.56 per bone dry ton, as shown in Table 16.**

TABLE 16: ESTIMATED AVERAGE DELIVERED FUEL COST – YEAR 1 ($/BDT)

Phase Classification	Percent of Fuel from Phase Type	Total Fuel Volume Needed (BDT)	Fuel Volume from Phase Type (BDT)	Delivered Fuel Cost ($/BDT)
Phase I	10	67,300	6,730	151.93
Phase II	40	67,300	26,920	110.16
Phase III	50	67,300	33,650	76.62
Totals	**100**		**67,300**	
Weighted Average				**97.56**

In addition to identifying the weighted average delivered cost, the information shown in Table 16 can also be used to identify the number of acres treated per year in each Phase type and the average volume removed per acre. This is illustrated in Table 17.

TABLE 17: WEIGHTED AVERAGE YIELD PER ACRE AND ACRES TREATED PER YEAR

Phase Classification	Yield (BDT per acre)	Area treated per year (acres)
Phase I	2.6	2,600
Phase II	5.1	5,300
Phase III	17.3	1,900
Weighted Average/Total	6.9	9,800

CHAPTER 6 – REVIEW OF POTENTIAL PLANT SITES

As will be discussed in further detail in Chapter 8, the LCPD transmission system has as it's backbone a radial, 69 KV line that extends north to Pioche from the Tortoise Substation near Moapa. The line terminates at Pony Springs, north of Pioche. There is also a 69 KV line branching off the backbone line that serves the Caliente area through the Antelope Canyon sibstation. LCPD has preliminarily estimated that the existing 69 KV system can support the interconnection of a 10MW or smaller biomass project. LCPD has also indicated the existing lines may support a slightly larger project, but that is unknown without conducting more detailed engineering studies. The total LCPD system peak load is currently 18MW, so the upside for interconnection on the existing system is likely to be only modestly beyond 10MW, and almost certainly not beyond the system peak load.

Discussions with LCPD indicate they have evaluated possible interconnection at both the Prince and Pony Springs Substations, which are both 69/24.9 KV. LCPD believes that interconnection at either location is feasible up to 10MW. Prince is the main distribution substation in LCPD's northern area and contains a 15 MVA 69 KV/24.9 KV main transformer. Pony Springs is a smaller rural substation with a 3 MVA, 69 KV/24.9 KV main transformer.

Generators in the size range anticipated for the Lincoln County project, typically generate power at either 12.47 KV or 13.8 KV. In some cases, such generators generate power at as low as 4.16 KV. However, in all cases, it would be necessary to transform the biomass project's output to 24.9 KV, which is the low voltage needed for connection to LCPD's 69 KV substations at Prince, Pony Springs and Caliente. A generator with an output voltage of 24.9 KV could be purchased to eliminate the need to transform the biomass project's power. However, doing so would leave the project vulnerable to limited ability to find a replacement in the event of a generator failure, as the universe of potential replacement units would be much smaller.

Thus, in BECK's judgment, it appears that the prudent business decision would be to purchase a 13.8 KV/24.9 KV or a 13.8 KV/69 KV transformer for the project site to allow the project to tie into LCPD's system on either the low voltage side of the substations or the 69 KV system directly, which would cost approximately $750,000. The 69 KV/24.9 KV transformer at Pony Springs, at 3 MVA, is too small to accept the output of the 10MW plant and so would need to be replaced regardless.

It would appear, prior to further study by LCPD, that a 10MW or smaller project could tie onto LCPD's 69 KV system at numerous locations, provided an appropriately sized 13.8 KV/69 KV transformer is provided (along with the appropriate breakers, switches, relays and communications equipment). This means the project would have some siting flexibility, provided it does not venture far from LCPD's existing 69 KV system.