Final Report

Biomass Feasibility Study

**Prepared For
Ak-Chin Indian
Community**

December 2005

Final Technical Report

Ak-Chin Indian Community Biomass Feasibility Study

December 2005

Period Covered: **July 1, 2005 to December 31, 2005**

DOE Award Number: **DE-FG36-04GO14022, A000**

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EXECUTIVE SUMMARY

The Ak-Chin Indian Community (Community), through Ak-Chin Energy Services (ACES) (formally known as the Ak-Chin Electrical Utility Authority (AKEUA)) requested a study to determine the feasibility of siting a Bio-power installation on the Ak-Chin Indian Community Reservation (Reservation) lands in Pinal County, Arizona. The Community's objectives for the project include creating technology-based jobs and revenues for Community members, diversifying the Community economy, providing a beneficial and environmentally sound program to utilize chicken litter generated on Community lands, and to increase the Community energy self-sufficiency. To meet these objectives, ACES has requested a study to assess the feasibility of various technologies such as an anaerobic digester, gasifier and/or co-firing designs so as to derive the maximum value from the available resources by converting animal manure and other organic wastes into energy while maintaining the natural fertilizer value for the Community Farm lands.

Methane production and utilization for energy generation is technically feasible. The key to success is consistent management of the current method of organic feedstock collection and transportation to the proposed facility. Direct economic benefits from the project would be electricity and hot water production to offset energy purchases for ACES. Direct management benefits from the project would be a strategy that enhances an efficient organic fertilizer protocol for use on the Community Farm. Some non-monetary benefits from completion of the project are odor control and pathogen and fly reduction.

Through a grant from the Department of Energy (DOE) the Community developed a project team led by ACES under the supervision of technical contact Leonard Gold. As a first step in the feasibility study, ACES sub-contracted with RCM Digesters, Inc. and Daystar Consulting, LLC (Project Team). RCM Digesters, Inc began field survey work during September of 2004 to assess the organic waste resource base on and near the Reservation. The aim of the survey was to identify organic waste sources, locate and map the proximity of the organic waste to potential facility sites, and to collect field observations for later characterization of the biogas production potential of each source. This field survey summary data will be the baseline information for developing the feasibility of a bio-power facility on Community lands.

With support from the Project Team, RCM completed onsite assessments and sampling of the poultry farm and visited a large dairy adjacent to the Community. This report identifies digestible resources on and near the reservation, but focuses analysis on an immediate opportunity at the Hickman's Egg Ranch located in the Community Industrial Park. Other small sources of digestible organic waste on tribal land are a meat packing plant and Casino food waste. However, those sources would not offer significant quantities for digester input.

The Hickman's Egg Ranch is comprised of 5 high-rise belt houses with a current total population of approximately 1.5 million chickens. The chicken litter collection belts under the cages transport enough chicken litter out of the barns to fill 8 trucks per day, or about 100 tons per day of chicken litter at 25% solids. The chicken litter is trucked to available fields on the Community Farm where it is incorporated into the soil as a crop fertilizer.

The most viable biomass utilization option would be to build a digester system designed to process fresh chicken litter from the chicken houses at the Industrial Park site. At the current chicken population of 1.5 million a digester could produce about 1,000 kilowatts (kW). The future population of 1.9 million chickens could produce over 1,100 kW.

The proposed digester design would be a complete mixed reactor for chicken litter. The digester system will include a reception tank, a digester vessel, and an effluent storage tank. Solid chicken litter would require dilution for digestion. Chicken litter would be mixed in the influent tank with egg washing water, recycled digested chicken litter and fresh water for dilution and pumped into the digester. Post digestion, there would be 2 or 3 times the volume of material. Options for delivering the resulting material to the farm fields include trucking, piping or combining with irrigation water. The digested material will have virtually no odor and will not support the growth of flies. The digested material will retain the pre-digestion nutrient levels for nitrogen.

Employing anaerobic digester technology utilizing available wastes to generate biogas is feasible. The ultimate success of the project will depend on developing an acceptable and cost effective program to fertilize the Ak-Chin Farm croplands using liquid digester effluent.

1.0 INTRODUCTION

The Ak-Chin Indian Community (Community) is a federally recognized Indian Tribe, whose lands comprise about 22,000 acres forty five miles southeast of Phoenix, Arizona. About 16,000 acres of the reservation lands are under cultivation by the Ak-Chin Farm (Ak-Chin Farm), a Community-owned enterprise. Additionally, the Community has sited a large privately owned egg-laying operation within their industrial park located in the eastern corner of Community lands. The Community is seeking new opportunities to diversify its economy, create new jobs for the Community members, and to increase their level of energy self-sufficiency, all while managing their lands and resources in an environmentally sound manner.

Though the Hickman's Egg Ranch and the Ak-Chin Farm were originally located in rural areas of the county, there is increasing encroachment of high-density urbanization and development. The Ak-Chin Farm operations wish to reduce the environmental risks associated with their chicken litter management, including odor, pathogens and methane emissions. As a proactive solution to these problems, the Project Team is an active partner in considering the installation of anaerobic digesters or other suitable technology to biologically or otherwise treat animal manure for environmental purposes and to generate financial returns. The regional nature of this project offers a unique opportunity to distribute treated nutrients onto the Ak-Chin Farm lands that are under intense crop farming and routinely require additional nutrient applications.

Additionally, the Ak-Chin Bio-power project offers an exceptional opportunity of mixing desirable organic institutional waste streams with the chicken litter and dairy manure to further enhance the biogas production from the facility. The project concept was well received by institutions as a proactive method to utilize waste streams and generate renewable energy.

1.1 PROJECT OBJECTIVES

The Community's stated objectives for the bio-power facility project include:

- Increase the Community's energy self-sufficiency
- Provide an environmental benefit by improving utilization of the chicken litter fertilizer
- Create technology-based jobs for the Community members
- Diversify the Community economy
- Generate revenues for the Community government operations

The technologies to be used at the proposed installation must readily handle chicken litter generated at the Hickman's Egg Ranch either alone or in combination with other biomass material as identified. The technologies used must retain the fertilizer value of the feedstock(s) after the energy value has been extracted.

1.2 PROJECT IMPLEMENTATION PLAN

This Biomass Feasibility Report is an assessment prepared to identify potential organic waste sources to be used as feedstock for a regional bio-power production facility on the Ak-Chin Indian Community reservation in Pinal County, Arizona. The report is prepared at the request of the Community, through ACES and their project team. The report is organized with sections written in response to each of the eight tasks as defined in the Project Management Plan under the Project Description and Implementation Plan. Each section will build on and utilize data and information collected and developed in each of the preceding sections.

Task 1 – Resource Assessment

- Determine availability and quality of chicken litter located on the Reservation
- Determine availability and quality of other biomass feedstock located both on and off the Reservation
- Determine fuel value and suitability of feedstock for the project
- Review land uses, existing infrastructure and environmentally sensitive areas
- Prepare a pre-design and economic feasibility study to estimate costs and benefits of an anaerobic digester system
- Compare costs of developing alternative facility sites
- Identify a most suitable location using findings of this data

Task 2 – Power Utilization Assessment

- Study Community's current and future electrical needs
- Determine potential market for any excess power produced
- Assess the existing infrastructure for delivering power to the identified market
- Develop an economic model to calculate costs and economic returns

Task 3 – Technology Review

- Prepare a comprehensive analysis to consider a range of feedstock and product mixes
- Research alternative technologies to a digester system such as direct fired stoker furnaces, co-firing biomass & conventional fuels, gasification, and fluidized beds
- Assess impacts and economics of existing and future environmental regulations as they pertain to each of the technologies
- Develop a comparative economic analysis of each technology selected for further consideration including feedstock collection costs, operational costs, maintenance costs, facility siting considerations and projected product sales and revenue

Task 4 – System Design(s)

- Develop energy and mass flows for selected technology(s)
- Design for an installation including: location, unit operations and equipment, maintenance, manpower, feedstock requirements, and outputs
- Develop a preliminary operations and maintenance plan

Task 5 – Manpower Development Assessment

- Identify training needs
- Develop manpower estimates
- Assess associated costs, including operation and maintenance costs

Task 6 – Economic Assessment

- Based on the preceding report findings, the economic viability of each option will be compared based on net revenue and return on investment
- A business plan for the best option will be developed
- An environmental impact checklist will be completed

Task 7 – Ak-Chin Community Compatibility Assessment

- Environmental impacts and benefits will be compared
- Employment opportunities will be projected
- Effects on cultural and social traditions of the Community will be identified

Task 8 – Financing and Final Report

- Identify and resolve any remaining project barriers
- Identify and develop ownership structure
- Negotiate and develop financing arrangements
- Finalize the Biomass Feasibility Study and present to the Community

2.0 RESOURCE ASSESSMENT

Digestible Resource

Currently the Ak-Chin Farm receives about 100 tons of Hickman's Egg Ranch chicken litter per day. The two Hickman's Egg Ranch trucks apply solid chicken litter using side-sling spreaders. Each truckload covers about 3 acres of bare or "open" ground. The chicken litter is disked into the soil within 12 hours after spreading. This procedure started in July 2004 to reduce odor and flies. The Ak-Chin Farm generally uses all of the chicken litter to fertilize its crops, which include cotton, barley, potatoes, alfalfa, and recently corn. The fall season is the most difficult time of the year to have enough "open" fields ready for these chicken litter applications. When there is inadequate open land or wet fields, the farm may temporarily stockpile chicken litter in the fields. The cost of commercially prepared fertilizer has increased 30 to 40% over the last several years so the Hickman's Egg Ranch chicken litter is highly valued by the Ak-Chin Farm.

Other Digestible Resources

Food waste from restaurants, cafeterias and prisons, food-processing waste, animal manures, and certain other organics can be mixed and co-digested to make biogas. Nearby cities and developing neighborhoods produce a great quantity of degradable organics and could also be considered as sources. If these or any other sources can produce segregated waste streams, i.e. without metal, glass or plastic, the putrescent materials can be sent to an anaerobic digester. However, the Community will have to decide if it wishes to import digestible waste materials that would require payment of a tipping fee for these materials to be accepted, but would allow the production of additional energy.

One possibility that could pay the Community a return from both tipping fees and high biogas output would be treatment of food processing wastes such as vegetable oils from restaurant fryers and grease trap wastes. Although they contribute little in the way of crop fertilizer nutrient value, these organics are highly degradable wastes that must be hauled from restaurants and processing plants regularly for a fee. This process has proven to be valuable to California and New York state dairy digesters.

2.1 INTRODUCTION TO BIOGAS TECHNOLOGY

Anaerobic digestion is one of the few manure treatment options that reduces the environmental impacts of manure, while preserving the fertilizer value and producing savings and revenues. Anaerobic digestion will not eliminate all of the negative aspects of manure disposal. However, it will result in a positive return on the manure management investment, converting it from its usual liability status.

Much information has been published about energy production from anaerobic digesters. Equally important, however, is the proper design and operation of a digester, which will biologically stabilize organic wastes, reduce odor, improve fertilizer value, and reduce pathogens. It can be expected that future regulations will increasingly require environmental control of farm wastes. Thus advantages include:

- Anaerobic digestion in a digester will reduce biological oxygen demand (BOD) and total suspended solids (TSS) by 80-90%.
- Odor is virtually eliminated. The digester will have minimal effect on the nutrient content of the digested manure.
- Pathogen reduction is greater than 99% in a 20-day hydraulic retention time (HRT) mesophilic digester (100 degree F).
- Half or more of the organic nitrogen (Org-N) is mineralized to ammonia (NH_3-N) thereby enhancing the ability of growing plants to utilize the nitrogen.
- Only a small amount of the phosphorous (P) and potassium (K) will settle as sludge in most digesters.

Manure consists of partially decomposed feed, waste feed and water. Manure alone or manure diluted with process water and flush water is generally too concentrated to be decomposed aerobically in a manure treatment or storage structure, because oxygen cannot diffuse into solution fast enough to support aerobic bacteria. Therefore, manure is broken down sequentially by groups of anaerobic bacteria. An anaerobic digester is a vessel sized to grow and maintain a population of methane bacteria that feed on organic wastes placed in the unit. The bacteria grow without oxygen, decompose the waste, and produce methane as a useable fuel byproduct. Methane-producing bacteria are slow growing and environmentally benign. They require an environment with a pH greater than 6.5 and adequate time to convert organic acids into biogas.

Anaerobic digestion can be simply grouped into two steps. The first step is easy to recognize because the initial decomposition results in bad manure odors. In the second stage methane bacteria consume the products of the first step and produce biogas - a mixture of methane and carbon dioxide. Biogas from a stable digester contains 60% - 80% methane. Biogas is virtually odorless but contains a small amount of odiferous mercaptans such as hydrogen sulfide.

Numerous examples where effective odor control goals have been met with the installation of a digester can be found in various publications. The early pig manure digesters in the US were installed principally to control manure odors. A pork producer in Pennsylvania has a long history of effective odor control with his manure digester system. The farm is located within one half mile of towns and sub-divisions and had acute odor problems prior to installing a digester. The heated digester has stabilized the manure, collected usable gas and most importantly, satisfies the objections of the neighbors, town council, and state regulators.

There are several additional examples of successful manure digester projects designed and installed by RCM Digesters, Inc. primarily for odor control measures. The AA Dairy in Candor, N.Y. has reported a high measure of odor control that has put the dairy back in good standing with its neighbors. Swine facilities in Colorado, Illinois, Wyoming and South America have all reported a significant benefit from the tremendous odor reduction provided by their digester systems. While difficult to assign an exact measurable quantitative reduction in odors, the fact that nuisance complaints have stopped against these facilities supports the effectiveness of the digester systems in odor reductions.

Complex anaerobic processes for treatment of high-strength organic wastewaters are widely adopted in most countries of the world. Large centralized plants in Europe digest combinations of animal manures and municipal solid wastes for energy and non-energy benefits, such as district heating. European governmental actions to reduce agricultural and industrial pollution, and control municipal solid waste landfill expansion raised costs for organic waste producers. Anaerobic digestion is more extensively used in Taiwan and Europe where animal waste pollution has been regulated for a longer time. The US and Pacific Rim countries have seen a recent increase in the use of digesters due to tighter enforcement of regulations.

In Europe, Germany led the way in small on-farm digesters for odor control. Italy developed a series of farm anaerobic digestion systems. European determination to address issues such as odor control resulted in construction of over 2,500 new anaerobic digestion plants since 1987. Denmark and the Netherlands decided that small individual plants were not economically efficient and moved forward with large systems for groups of farms. The most experience with large centralized digestion facilities has been in Denmark, where more than 20 plants are now operating. More than 50 large, centralized digesters are operating in Europe, with more under construction or being planned. Some of these facilities have been in operation for more than 10 years. The goal of the centralized plants is to provide waste management and to redistribute nutrients in odorless liquids or solids to farms.

2.1.1 Biogas Production Potential

The following Table 1 shows the expected ranges of biogas and electric production from typical US farm raised animals. The output is based on confined animal production, high cost feeds and 100% collection of fresh manure.

Table 1
Biogas Production Potential
Based on Typical Nutrition and 100% Manure Collection

	kWh/ head/day	Biogas Production ft3/head/day
Dairy Cow	2.5-3.7	65-80
Sows	0.2 - 0.3	5-7.5
Nursery Pigs	0.06 - .09	1.4–2.1
Finisher Pigs	0.15 – 0.22	3.5-5.5
Beef/Feeder	1.8 – 2.2	45-55
Laying Hen	.01	0.25

2.1.2 Anaerobic Digester System Components

An anaerobic digester is a vessel sized to grow and maintain a population of methane bacteria that feed on organic wastes introduced into the unit. An anaerobic digester system includes manure collection, pretreatment, an anaerobic digester vessel, biogas recovery system, and biogas handling and use equipment.

Manure must be collected fresh and on a regular schedule for digestion. A very important design consideration is the amount and potential contaminants of any process water included in the manure collection. Process water includes all water from all sources that mixes with manure prior to digestion.

Pretreatment may be used to adjust the manure or slurry contents to meet process requirements of the selected digestion technology. A mixing tank or solids separators are examples of some pretreatment options. An anaerobic digester is an engineered containment vessel designed to promote the growth of methane bacteria. The digester may be heated or unheated, mixed or unmixed, a simple tank or a very complicated media packed column. Manure characteristics and chosen collection technique determine the type of anaerobic digestion technology that can be used.

Biogas formed in a digester bubbles to the surface and may be collected by a fixed rigid top, a flexible inflatable top or a floating cover depending on the type of digester. The collection system then directs biogas to gas handling components.

Biogas may be filtered for mercaptans (products that contain sulfur) and moisture removal. Biogas is usually pumped or compressed to operating pressure and then metered to the gas use equipment. Biogas that is pressurized and metered can be used as fuel for heating, absorption cooling, electrical generation and cogeneration. Biogas can be substituted for low pressure natural gas or propane in the equipment listed in the following Table 2.

Table 2
Biogas Use Options

<u>Biogas Fueled Engine</u>

- Electrical generator - electricity for use or sale, heat recovery optional
- Refrigeration compressors - cooling, heat recovery optional
- Irrigation pumps - pumping, heat recovery optional

<u>Direct Combustion Options</u>

- Hot water boiler - for space heat, process and cleanup hot water
- Hot air furnace - for space heat
- Direct fire room heater - for space heat
- Absorption chiller - for cold water production, heat recovery optional
- Stove – for cooking gas

2.1.3 Available Anaerobic Digestion Technologies

Many configurations of anaerobic digesters have been developed but may or may not be commercially available for farms. Table 3 lists the operating characteristics of digester technologies. Covered lagoons, complete mix and plug flow digesters are commercially available. Complete mix and plug flow digesters reuse some of the energy produced to keep the digester warm to maximize the rate of methane production while covered lagoons are not heated. All can be built at a farm scale successfully. The key to success is a good design, proper equipment selection, and operator training. Digesters are operated by farms every day without excess cost or interruption of normal daily business.

Table 3
Types of Digesters and Their Characteristics

Type of Digester	Level of Technology	Influent Solids Concentration	Solids Allowable	Supplemental Heat	Hydraulic Retention Time (HRT) (days) (1)
Ambient Temperature Covered Lagoon	Low	0.1 – 2.0 %	Fine	No	40+
Complete Mix	Medium	2.0 – 10.0 %	Coarse	Yes	15+
Packed Reactor (2)	Medium	0.5 – 2.0 %	Soluble	Yes	2+
Plug Flow (3)	Low	11.0 – 13.0 %	Coarse	Yes	20+

(1) HRT = Hydraulic Retention Time = digester volume/daily influent volume
(2) Attached growth reactors
(3) Dairies only

2.1.4 Cost Effectiveness of Anaerobic Digestion

The economics depend on the cost of electricity or heat energy. Digester projects can generally be shown to be cost effective for facilities with electricity costs of greater than $0.06/kWh and where the facility can use most of the electricity on site.

If there is value to fertilizer improvement, pathogen reduction or odor control and it can be accounted for in the farm balance sheet, then a digester may become even more profitable. If a farm has to meet government regulations on waste management, a digester may be substituted for other waste management strategies. The costs of a digester system may have a very high return over spending money on a non-revenue generating alternative to achieve environmental compliance.

Most biogas projects rely on a multitude of benefits to recover the necessary initial capital investment. Heat that can be utilized to offset current needs, disease control that keeps animals and people healthy, and odor control that keeps people happy and productive are benefits that are seldom assigned their true economic worth. In some cases a digester has recovered its cost by avoiding financial penalties , neighbor complaints or lawsuits resulting from manure odors and flies. In other cases, the digester improves the handling characteristics of the material and saves the farm money on manure handling and utilization practices.

Digesters are considered expensive because of the time and capital costs involved in most projects. However, farms have been rapidly consolidating into larger units that must deal with larger pollution potential. The large pollution potential results in more agricultural businesses wanting to take advantage of digester technology to benefit from production of energy while reducing pollution. Digesters are cost competitive with other manure treatment technologies. Surprisingly, farms or farm advisors do not regularly consider return on investment. Farmers assume that pollution control is a cost item and choose a lesser-cost alternative rather than considering any revenue generation alternatives. Government encouragement has had a strong effect in implementing digester projects. There are thousands of digesters in Taiwan and hundreds in Europe where the environmental benefits of anaerobic digestion are recognized and promoted.

In the longer-term analysis, an anaerobic digester will improve the profitability of most, but not all farms. In the future, the advantages of the systems will be more fully appreciated. There are hundreds more agricultural and municipal digesters in the US today than there were 10 years ago. Industry has embraced the technology as a lower cost alternative for pollution control and many farms will most likely follow suit. When the technology is compared with alternatives, farmers realize that distinct advantages exist. If farms in all countries must meet similar pollution control regulations, then they will all consider their options and many will select digestion for the small financial advantage it will generate.

Farms and governments are recognizing the need for control of point source and non-point source discharge from animal production and processing facilities. But controls are usually expensive. Digesters make money for the farm through the production of heat and/or electricity, the reduction of odor, reduction of flies, reduction of pathogens, killing of weed seeds, and improvement in fertilizer values. Additionally, green tag incentives and green house gas tax reduction credits may further enhance the economic benefits of digester projects. All of the benefits can be verified. Therefore, anaerobic digestion can be a solution to problems associated with animal waste streams.

2.1.5 Alternative Technologies

Direct combustion or incineration is another technology that can be employed with a bio-power installation. Animal manure that is sufficiently dry can be incinerated to power a steam-turbine generator. Chicken litter is a good candidate for direct combustion because it has relatively low moisture when excreted. In this scenario, the litter would be cleaned from the poultry barns and trucked to the generating plant. After combustion, the ash would be trucked to the fields and used as fertilizer. There are chicken litter-fired power plants in operation in Europe. However, the feasibility of using direct combustion to meet the project objectives must be studied in more detail in order to ensure that the value of chicken litter as a fertilizer is preserved.

Other options for the system operations may become apparent as the project is developed. Additional technologies such as biomass gasification are further examined in the “Technology Assessment and Review” section of this report.

2.2 CONCEPTUAL DIGESTER SYSTEM FOR AK-CHIN

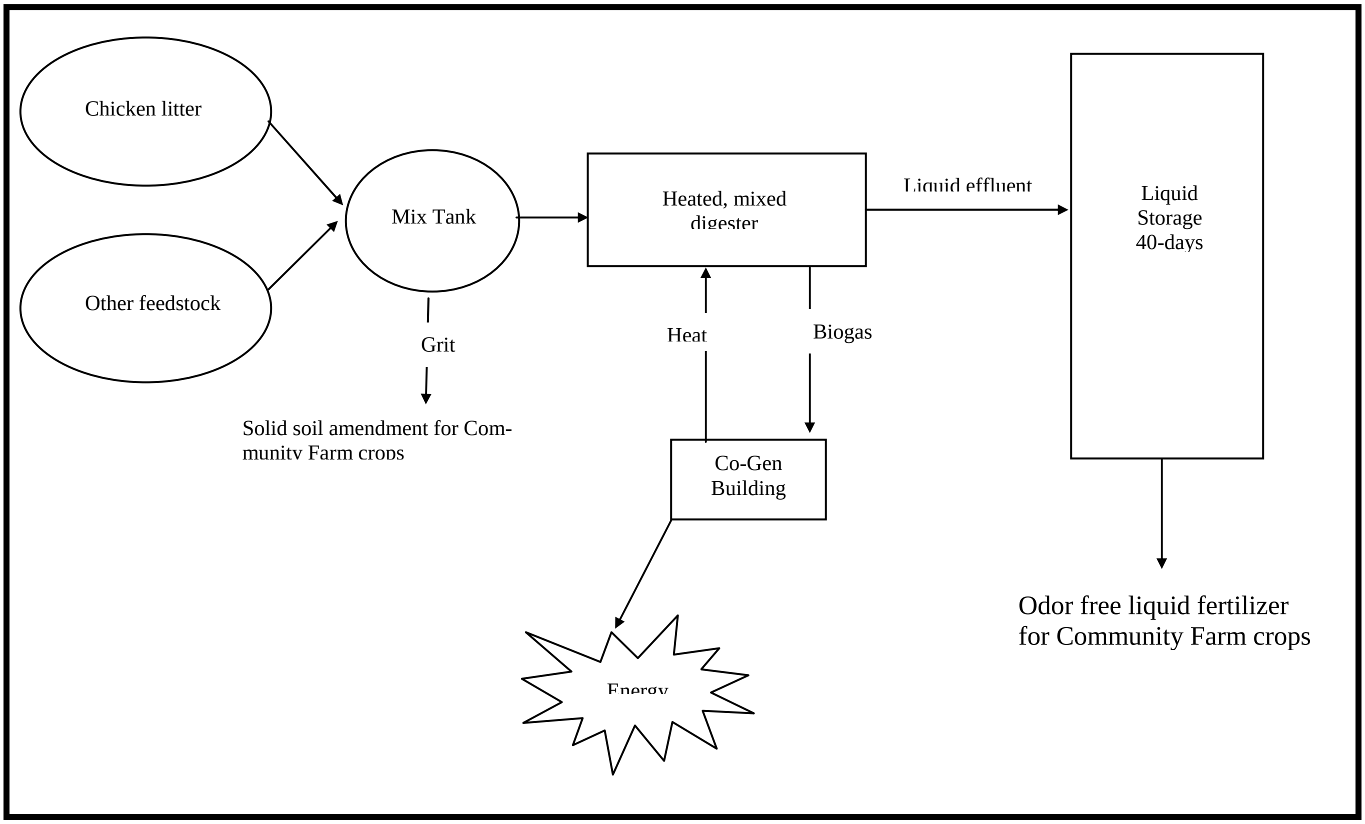
The Ak-Chin project concept could be readily developed utilizing an anaerobic digester system. Chicken litter would be deposited daily into a heated mixed digester with an impermeable membrane gas collecting cover. Water and other organic feedstock would be added as needed to liquefy the chicken litter. With a mixture of various feedstocks and the need to dilute the relatively dry chicken litter, mechanical mixing is necessary. The organic feedstock mixture would be digested and biogas would be produced. The digesters would be heated for optimum gas production. Biogas could be used to produce heat and electricity. Any solids collected during the process could be used on the farm or marketed as a soil amendment. Liquid effluent from the digester will be stored in a waste storage tank to preserve fertility and applied as fertigation water to crop lands.

Concept

The basic concept as shown in Figure 1 below, would be a digester system to digest the chicken litter in a heated mixed digester located near the Hickman’s Egg Ranch in the Ak-Chin Industrial Park. Other organics may be added to the digester to increase biogas yields. Ultimately all the effluent from the digesters would be field-applied to fertilize crops. The land area required will be based on the balance between fertilizer content of the effluent and nutrient needs of the crops.

This portion of the study will derive system parameters for a digester system based on the chicken population numbers, chicken litter generation rates and chicken litter characteristics found at the Hickman’s Egg Ranch; it will also provide a cost estimate for the system and performance projections as well as assess project economics.

Figure 1
CONCEPTUAL DIGESTER PROCESS FLOW



2.2.1 Digester Costs and Benefits Summary

RCM developed an Ak-Chin digester design based on the assumption of utilizing only the chicken litter from the Hickman's Egg Ranch. The dairy manure as well as considerations for other organic feedstock as identified and described later in the report have not been incorporated in this feasibility assessment. The digester design presented in this analysis will accommodate an organic waste stream from 1.5 million chickens.

Capital Costs

It is estimated that the digester system installed cost will be approximately $5.5 million. This cost estimate includes a 40-day effluent storage structure, two chicken litter tanker trucks and two liquid chicken litter spreader wagons. The cost estimate assumes commercial pricing as opposed to agricultural pricing. All system components are commercial grade quality and assumed to be installed by commercial contractors. By the third year of operation the annual operation and maintenance (O&M) costs for this system are estimated at $207,882. The O&M figure assumes a cost of $0.015/kWh for the engine O&M, includes $15,000/year for soil testing and $75,000/year for hauling the digester effluent to the Farm's fields.

Benefits

Based upon the value of energy estimated to be paid by Ak-Chin Energy Services (ACES) to purchase power at a delivery point at the Reservation of $0.065/ kWh, it is estimated that the system will produce $459,113/ year in electricity sales to ACES. The heated digester system could produce electrical power averaging about 1,045 kW. The electricity generated can be used on the Reservation to meet the ACES electrical needs. ACES would make arrangements to market any excess electricity, though based on existing and future load requirements, ACES will be able to use all the output.

The gas produced by a digester could also be used to fuel a gas-fired boiler to produce hot water for heating or other uses. Additionally, renewable energy tax credits and green house gas reduction credits have been researched and considered for this project. It is estimated that the renewable energy tax credit would be worth $63,570 per year and the green house gas tax credit, based upon discussions with Environmental Credit Corporation, is estimated to be worth $69,947 per year for the project. The payback period for this system estimated with an electrical value of 6.5 cents per kilowatt-hour, an assumption of the production tax credits, and a debt equity ratio of 75:25, is 13.1 years if no grants are included. With the inclusion of a renewable energy grant for $500,000, the payback drops to 9.8 years.

There are fertilization benefits from digested effluent that can enhance irrigation application techniques and crop utilization of the nutrients. Environmental benefits include a significant reduction of odors, flies and pathogens from the waste stream. Stockpiled or unincorporated surface applications of chicken litter can attract and produce flies. Many industrial food processors or concentrated animal feeding operations have waste storage pits, ponds, or basins, which often produce offensive odors. These structures were usually designed for waste storage needs and not necessarily for effective waste treatment. Consequently, the waste storage structures produce disagreeably odiferous volatile organic acids due to incomplete anaerobic digestion. On the other hand, complete anaerobic digestion produces a stable and relatively odorless effluent along with the biogas. The treated liquid form the anaerobic digestion process can be stored long term without any odor concern, due to the dominance of non-odor inducing anaerobic bacteria in the storage reservoirs.

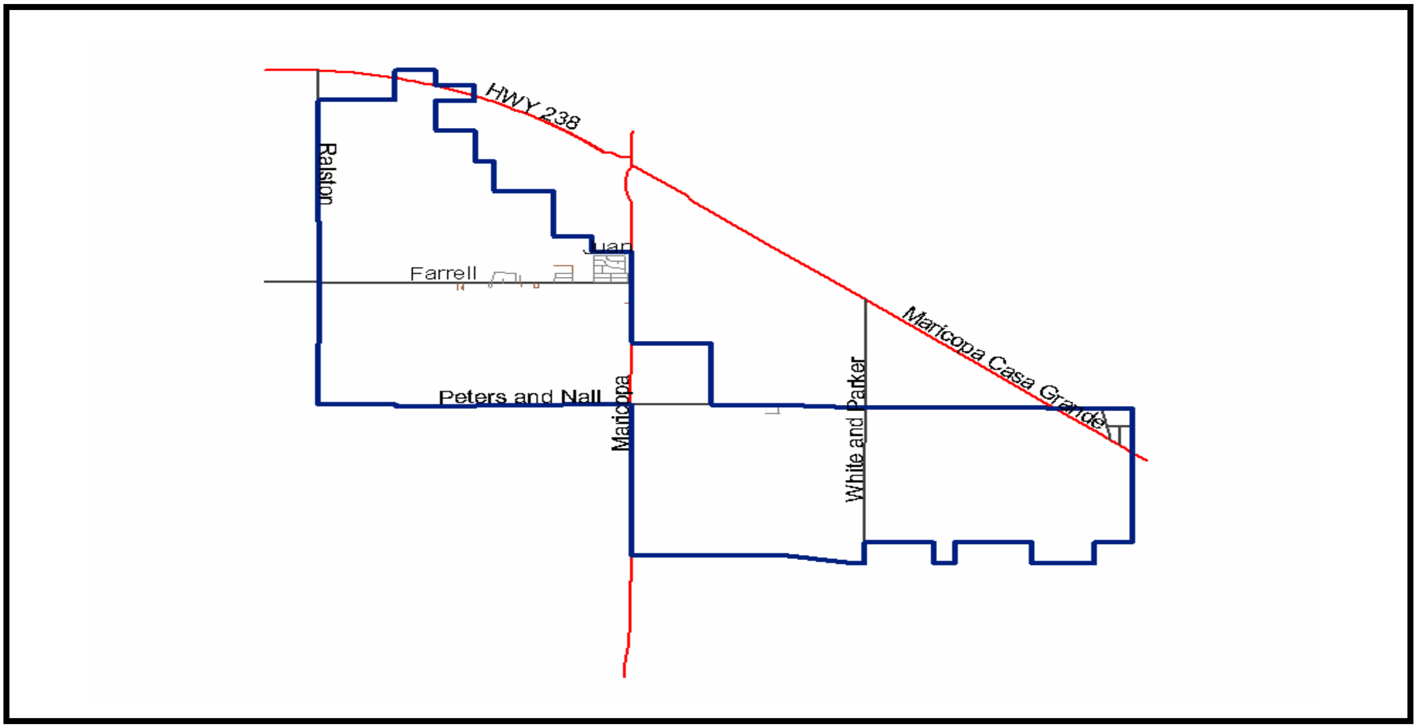
2.3 AK-CHIN LAND USE, PLANNING AND INFRASTRUCTURE ASSESSMENT

Meeting with Planning Department

The Project Team met with Bart Smith, Community Planner from the Ak-Chin Planning and Development Office. The primary purpose of the meeting was to identify any planning or zoning constraints that the bio-power project should consider. The Planning Office has requested that the project feasibility study clearly indicate siting considerations for the bio-power system. RCM acknowledged siting concerns and offered that one of the key objectives during the development of the feasibility analysis is to examine all possible system locations and their proximity to both existing and planned primary Community infrastructure. These considerations would include identifying residential neighborhoods and planned housing areas, available Community Farm lands for land application, and how the planned trucking and hauling routes interface with current traffic patterns. These issues will be studied to help ensure the digester is constructed in a configuration and location that is a workable arrangement with the current nutrient management system and the current traffic patterns.

The area within the Ak-Chin Indian Community Indian Reservation (Reservation) as shown on Figure 2 below, was reviewed by the Project Team, including aerial photographs. Four major areas of the Reservation were identified as potential sites, including the Industrial Park along the eastern edge of the reservation, the Tribal Office Complex on Peters & Nall Road, the AK-Chin Village and planned residential development along Farrell Road near the center of the Reservation, and the remaining Tribal lands known as “The Farm” that are under current cultivation. Other features that were identified and located on the maps included the Harrah’s Casino, the surrounding electrical substations, the irrigation water reservoir, the Community drinking well, and all major roadways. In addition to these features, a “sensitive area” lying in the northwest portion of the reservation in a geological feature known as the Vekol Wash was identified as a “no-go” area for the digester system location.

Figure 2
Ak-Chin Indian Community Reservation
Boundary Map



The Planning Department states that the project must work with the existing structures and features on the Reservation lands and must be financially feasible. In general zoning regulations on the farmlands are very broad and only include usual requirements such as roadway setbacks. A Farm Board makes all decisions for the Ak-Chin Farm. The Planning Department coordinates with the Farm Board when any agricultural lands are being converted to commercial endeavors. It was noted that a 1-year notice is required to take any crops out of production. In general, the Planning Department is working with Ak-Chin Farm to seek new and better crops with "value added" opportunities with the common goal of realizing improved agricultural economics on the Reservation lands, which could be further enhanced with more consistent fertilizer nutrient content that would result from the digestion process.

Meeting with the Ak-Chin Farm Manager

The Project Team also met with Steve Coester, Farm Manager for the Ak-Chin Farm. The primary purpose of the meeting was to identify and consider any Farm issues or constraints that a digester or other technologies for the bio-power project might create. Currently Ak-Chin Farm receives about 100 tons of Hickman's Egg Ranch chicken litter per day. The two new Hickman's Egg Ranch trucks spread on the fields with side-sling spreaders. Each truckload covers about 3 acres. The chicken litter is disked into the soil within 12 hours after spreading. Since this procedure started in July 2004, there have been reports of fewer flies observed. The fall season is the most restrictive time of the year to have enough "open" fields ready for application. However, it was noted that enough other farms in the area want the chicken litter that it allows the Ak-Chin Farm to broker the chicken litter for off-site delivery eliminating the need to stockpile it. Over the past several years the value of chicken litter for fertilizer has gone up 30% to 40%, so the Hickman's Egg Ranch chicken litter is very valuable to Ak-Chin Farm. The Ak-Chin Farm generally uses all of the chicken litter to fertilize a variety of crops, which include cotton, barley, potatoes, alfalfa, and more recently corn.

The Ak-Chin Farm management stated to the Project Team that they had concerns about how to handle chicken litter fertilizer in a liquid form from a digester. The major concerns were centered on the issues of fertilizer application times, application delivery methods, and the dilute nature of the liquid material. The entire Ak-Chin Farm is divided into small strip fields, each within some varying stage of a constantly shifting crop rotation cycle. Each crop requires a different fertilizer rate and time of application. For example, no fertilizer is applied to the cotton fields after July. It was apparent through discussions with the Ak-Chin Farm that utilizing the digester effluent through introduction into the existing irrigation system would not be a manageable approach with this cropping strategy. Further, the rate of dilution with 100,000 gallons of effluent per day from the digester discharging into the irrigation system for delivery would create problems. For example, during the summer months, the digester effluent would get diluted with up to 400 acre-feet of irrigation water from the reservoir and could not provide the current fertilization rates for the various crops. In the fall and winter months when the flows are lower, the digester effluent would provide to high a level of fertilizer for the various crops.

The Ak-Chin Farm uses a cotton-to-barley-to-alfalfa crop rotation in addition to potatoes grown pursuant to a contract with Frito Lay. The current crop acreage distribution is summarized in Table 4.

Table 4
Ak-Chin Farm Crop Acreage

Crop Type	Current Acres
Alfalfa	4,000
Cotton	5,000
Potatoes	1,500
Barley	3,500
Corn/Green chop	1,000

The Ak-Chin Farm has recently begun to grow corn and sorghum for Milky Way Dairy. April through July is the most intense crop time. Most of the hay goes to the feedlots in 1-ton square bales. Barley is harvested as grain and milled for dairy mix feed. In 2004, the Ak-Chin Farm contracted to grow 1,000 acres of green chop feed for the Milky Way Dairy. Next year they may consider more feed crops such as corn and alfalfa. The cotton market is not good due to competition with third world markets and the potato crop for Frito Lay was down 18% attributed primarily to the effects of the Atkins Diet fad on consumer buying habits. If dairy feed cropping becomes the trend, a corn and sorghum silage rotation could be double cropped each year. The corn would be harvested in July and the sorghum crop could come off in September and October.

The lands on the west edge of the Ak-Chin Farm are irrigated from west to east from a large lateral canal that runs south to north along Ralston Road. Buried mainline runs from the reservoir east along Peters & Nall Road. Other irrigation in this part of the Reservation is from open ditches. The Project Team was provided a cropping map showing the field size and proximity; however, neither the crop plan for the current crop rotation nor next year's rotation was depicted on the map. It was noted that the alfalfa fields are on a 2 or 3-year rotational cycle and the pecan trees planted in the odd shaped fields that develop along the diagonal drainage ditches are perennials.

The west side of the farm is a primary growing area for potatoes. The fertilizer applications must be carefully monitored because too much nitrate (NO_3) is bad for the "chippers" and they won't fry correctly. These potatoes are round white potatoes and differ from the Russet potatoes commonly known from the Idaho potato growing regions. The amount of NO_3 the potatoes receive correlates to the sugars they develop. Too much sugar in the potatoes causes brown spots when they are fried. Too many brown spots can cause an entire crop to be rejected. The potato fields get between 450 to 500 pounds of NO_3 from chicken litter per acre before planting. About 30 gallons per acre of a 9-30-0-ammonia phosphate liquid fertilizer is added into the irrigation ditches in early spring. The potato fields are irrigated with pivots drawing from the irrigation ditch. About 6,000 acres are currently under this system. The new sprinkler systems use low pressure, with small (<3/32") orifice nozzles that require relatively clean water to operate properly. Digester effluent could be effectively delivered to the crops through the existing irrigation system if larger orifice nozzles (1/2 inch) were installed.

The Ak-Chin Farm has a high degree of soil variability ranging from heavy gumbo to sand, making the intricate crop rotation and fertilizer schedules even more complicated. Given the current cropping, irrigation and fertilizer strategies in place, the Ak-Chin Farm will require a digester effluent approach that will not compromise their fertilizer application rates or schedules. A project solution must be identified that promotes an effective and financially feasible utilization of the digester effluent as the fertilizer of choice on the Ak-Chin Farm croplands. There are solutions to this issue and options have been identified to support proceeding with a digester system approach. Since the Ak-Chin Farm is already accepting and managing the nitrogen, the issue centers on how nitrogen is distributed, not whether it can be effectively used.

2.4 SYSTEM DESIGN CONSIDERATIONS

2.4.1 Climatic Conditions

Weather data averages compiled by the USDA from the weather station at Maricopa, Arizona were reviewed to develop project design considerations. The region has very hot and dry summers with cool winter temperatures. The period of record extends from 1960 to 2004 and is summarized in Table 5.

Table 5
Weather – Maricopa, Arizona

	Avg Max Temp-Degrees F	Avg Min Temp Degrees F	Avg Rain - in.
January	66.4	34.5	0.73
February	71.1	38.1	0.82
March	77.1	42.7	0.86
April	85.9	48.5	0.25
May	95.3	57.3	0.11
June	105.0	66.6	0.16
July	107.2	76.0	0.82
August	104.9	74.5	1.05
September	99.9	66.5	0.70
October	88.8	52.9	0.58
November	75.2	40.6	0.62
December	65.9	34.0	0.95
Ave/Total	**86.9**	**52.7**	**7.64**

The average yearly total rainfall is reported as less than 8 inches. The average annual rainfall during the hot summer season (May through September) is recorded at about 3 inches.

Cooler winter temperatures may add to the system parasitic requirements to keep the digester at optimum warm temperatures for peak performance. Monthly average temperatures range from a low of 34.0 degrees F in December to a high of 107.2 degrees F in July. Prevailing winds and peak storm winds are primarily out of the west. Wind direction is taken into consideration in the overall system design and layout.

2.4.2 Soils and Subsurface Conditions

Soils and Subsurface

The soils on the Ak-Chin Farm are highly variable ranging from sand to heavy clay.

Topography and Geology
The entire Community lies within a very flat expanse of farmland.

Surface Water

No natural surface water features were observed. There is a reservoir in the southwest corner of the Community lands. There was evidence of storm water runoff channels in the northwest corner as well as near the industrial park in the southeast corner of the Community.

Groundwater

Depth to groundwater is in the range of 300 to 750 feet.

Engineering should take into consideration the load bearing capacity of the soil, depth to bedrock and depth to groundwater.

2.5 EVALUATED FEEDSTOCK SOURCES

2.5.1 Hickman's Egg Ranch

The Hickman's Egg Ranch (Hickman's Egg Ranch) is located in the Ak-Chin Industrial Park off the Maricopa Casa Highway along the eastern edge of the Reservation. Initial estimates suggest that Hickman's Egg Ranch at capacity could make biogas for more than 1,000 kilowatts (or 1 megawatt) of renewable energy. The current existing business relationship involves Hickman's Egg Ranch producing eggs and hauling and spreading chicken litter daily onto Ak Chin Farm croplands. Additional details about chicken litter collection and bird feeding regimens were discussed. A composite sample of chicken litter from each of the five barns was collected for analysis.

The Hickman's Egg Ranch is comprised of 5 belt houses with about 300,000 chickens per barn for a current total population of 1.5 million chickens. There is some indication that the Hickman's Egg Ranch would like to expand to a total population of 1.9 million birds. The Hickman's Egg Ranch is producing 810,000 eggs (3 truckloads) per day. The Hickman's Egg Ranch brings in 6 truckloads of feed per day at 25 tons each or about 150 tons of feed per day. The collection belts under the cages transports enough chicken litter out of the barns to fill 8 trucks per day. The exact size or hauling capacity of the chicken litter spreader trucks was not known but it is estimated that based on the feed conversion capacity of chickens, the quantity of chicken litter would be about 60% of the quantity of the incoming feed, or about 90 tons per day of chicken litter at 25% solids.

It is estimated that the daily freshwater makeup required to dilute the chicken litter for digestion would be on the order of 60,000 – 100,000 gallons. The current egg washing water contains food grade soap and is discharged to a lined evaporation pond north of the barns. This water could be diverted and used to help dilute the chicken litter for the digester. However, it should be sampled to identify the chemical make up and to determine any potential effect on digestion. The Hickman's Egg Ranch can provide a Material Safety Data Sheet (MSDS) to determine any possible effects of the soap on the digester outputs. There are water meters on the incoming well water and that data could be gathered for further examination if needed for future waste calculations. It was estimated that each of the 45 employees accounts for 30 gallons of the daily water consumption that is managed as a wastewater and discharges to the industrial sewage lagoons across the street. The Hickman's Egg Ranch also generates a moderate quantity of broken egg waste per week. This waste stream is collected and hauled away for processing into pet food.

The chickens are fed using an energy basis on-demand feeding schedule. It was noted that they eat less in the summer months, which means there will be less feed stock for the digester. Each barn contains chickens that are about 16 weeks apart in age. This requires 5 different feed formulations to meet the growing and production schedule of each group of birds, which produces different compositions of litter. The feed is based on various formulations containing calcium (limestone), protein, and energy. Vitamins and minerals remain constant for each formula.

Chicken litter samples from each barn were collected. Each sample was a composite of 5 random grab samples from each of the 5 barns. The samples were labeled simply Barn 1 through Barn 5. Samples were submitted to a Phoenix based laboratory for analysis. It was noted that the chickens in Barn 4 are molting and on restricted feed, which means there is less protein in the food. The feeding schedule and bird makeup for each barn is summarized in Table 6.

Table 6
Hickman Barn Schedule

Location Barn #	Bird Age Weeks	Pounds of Feed Per 100 wt	Protein %
1	24	20.4	23.8
2	110	21.1	13.5
3	97	19.8	15.1
4	77	12.3	3.3
5	28	18.2	20.4

This feed formula changes constantly to match the chickens' uptake and their output. About once per week, the egg case weight is measured to evaluate the balance.

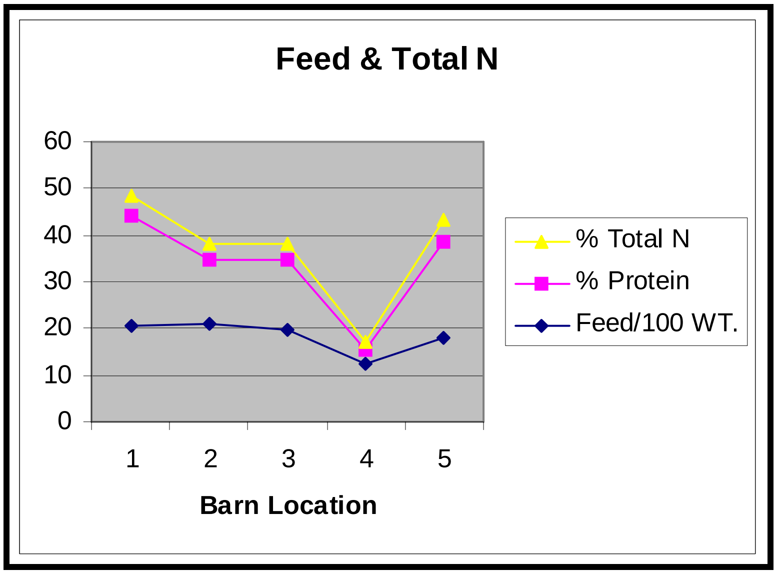
Chicken litter was evaluated from each of the five barns. Five random grab samples were collected from each barn and combined into a composite sample to represent the makeup of the chicken litter from that barn. An independent local laboratory analyzed the samples. The results are summarized in the Table 7 and Figure 3 below.

Table 7
Hickman Barns Chicken Litter Analysis

BARN #	Feed/100 WT.	% Protein	% Total N	Ppm Ammonia	% P2O5	% K2O	% TS	% TVS
1	20.4	23.8	4.1	3700	4.8	3.1	25.1	56.9
2	21.1	13.5	3.4	840	3.8	2.2	30.5	56.9
3	19.8	15.1	3.3	2000	3.4	2.3	25.8	52.7
4	12.3	3.3	1.7	880	1.8	1.3	38.8	84.4
5	18.2	20.4	4.5	12000	5.0	2.2	25.2	62.6

Figure 3

Comparison
Feed Ration to Total Nitrogen in the Chicken Litter



The analysis demonstrates that the fertilizer value in the raw chicken litter is variable depending on from which barn the chicken litter has been collected. This analysis suggests that unless the chicken litter is combined and mixed from all the barns, **the raw** chicken litter fertilizer application per acre will be highly variable. On the other hand, **the digester system** would provide an evenly mixed and homogenous liquid fertilizer, which would decrease the need for chicken litter testing to assure proper agronomic application rates to the crops.

The result of the recent USDA audit was discussed. There is a program that recommends a number of birds per cage. If the USDA recommendations are followed, each barn could reduce its stock to 226,000 birds from current maximum stocking at 310,000 birds per barn. It was understood that the Hickman's Egg Ranch has a target population of 1.9 million birds in their future expansion plans. At the target bird population, the Hickman's Egg Ranch could generate nearly 500,000 pounds of chicken litter or approximately 35,000 pounds of nitrogen per day. Results from the chicken litter sample analysis provided necessary data to fully model and evaluate the chicken litter for gas production potential. Development of the agronomic application balance between the nitrogen requirements for the Ak-Chin Farm crops and the actual available nitrogen from the chicken litter fertilizer as digested will be based on the sample results.

2.5.2 Milky Way Dairy

The area biomass resource assessment continued with a tour of the nearby Milky Way Dairy. The Project Team met with Ari deJong, owner of the Milky Way Dairy and his son-in-law, Jonathan. The dairy is located adjacent to the northwest corner of the Reservation. Preliminary estimates indicate that the dairy could make enough biogas for approximately 1,000kilowatts of renewable energy. Ak-Chin Farm operations and current waste management practices were discussed followed by a brief farm tour.

Milky Way Dairy is a new facility. Production animals have been on site for about 1 year. There are currently about 6,400 cows in freestall barns. The target population is for 7,000 milking cows. The dairy has two continuously operating parlors, each with an 80-stall rotary platform milker. The cows are housed in freestall barns with shade curtain walls and flushed manure collection systems. They are bedded with dried manure solids. There are 4 barns (1,300 feet long) that house 4 groups of 320 cows each, for a total of 5120 cows and two smaller barns that each house 2 groups of 320 cows for a total of 1280 animals. There are 65 barn lanes that get flushed 3 times per day in roughly a 5-hr cycle. Each lane gets an 8 to 10 minute flush cycle. The water comes from the waste storage pond using a 60 hsp pump and 15 inch pipes at an estimated delivery rate of 2,000 gpm.

No fresh water is added to the flush water in the barns. On the mechanical side of the farm, it is estimated that the farm uses about 400,000 gallons per day including the misters and sprinklers to cool and wash the cows. The fresh water comes from a well on the southwest corner of the barnyard complex that is 1,275 feet deep. It is unknown how many gpm the well yields. There is a 25,000-gallon water storage tank near the wellhead. This water is used to clean the parlors, milk house and equipment. Fresh water flows through the refrigerator condensers and is then recycled to the cow watering troughs. Additionally, fresh water that is used to cool the cows with misters operating at 160 to 180 psi. It was noted that the misters are operated to essentially evaporate the water to avoid getting the freestall-bedding wet. Water use in the sprinkler pre-wash pens is not known but could be substantial and requires additional study.

Large open drylot corrals with shade roofs are under construction and will soon house the dry cows, the heifers and young replacement stock. Current population increase is at a rate of 50 calves born each day. Milky Way coordinates with their farm in Visalia, CA and they move stock between the farms frequently. Currently young calves are shipped to Visalia when they reach 200 pounds. The eventual target population for the Milky Way dry cow and replacement stock facilities is between 12,000 to 14,000 animals. These animals will be fed on concrete, curbed feed lanes that will also be flushed by the manure collection system. Control of sand on the existing curbed flushed feed lanes is reported to be good. No estimate for flush volume or manure collection was currently known for this undeveloped area of the farm.

The flush system at the Milky Way Dairy is a gravity flow system. Flush water flows from the barns through a 13-foot deep concrete sand trap, over a weir, and south into a concrete ditch that feeds into a series of manure solids settling pits. There are 10 side-by side-settling pits with a common discharge weir at the east end. Two of the pits are used at a time to receive wastewater from the sand trap ditch. When full of solids, two new pits are activated and the full pits are left to dry out to recover the solids. June is the hottest month and it is estimated that the evaporation rate is about 9”. The prevailing wind is out of the west.

The crusted solids are scooped from the pits with a track hoe excavator and spread on the drylot corrals to further dry and compost. Solids from these drylots are eventually recovered and used as bedding in the freestall barns. Currently the farm is importing solids for bedding until the drylot pens are fully constructed and populated at the target numbers. After discharging over the settling pit weir, the liquid flows north into the waste storage pond to be recycled as flush water back to the barns and irrigation onto croplands. The storage pond is estimated to be about 900 feet long x 500 feet wide with an average depth of 10 feet and is estimated to hold about 33.8 million gallons. The bottom of the pond slopes from 3 feet deep at the north end to about 20 feet deep at the south end. The 60-hp pump in the pond also serves as the irrigation pump in addition to recycling flush water for manure collection.

The current milk production is averaging about 69 pounds per cow. It is anticipated that will rise to 74 pounds per cow as they get acclimated to the new facility. The wet feed ration is 150 pounds per cow. It is estimated that the dry matter feed ration is about 49 pounds per cow in the summer and up to 55 pounds per cow in the winter. The ration is based on corn silage, hay and haylage. From October through April, the ration includes 25 pounds of green chop. Milky Way farms about 300 acres and has arrangements with the Ak-Chin Farm for purchase of additional feed.

The Milky Way management estimated that the average electrical bill at the dairy has been ranging from $37,000 to $47,000 per month. They have a 3500-hp Caterpillar generator that is capable of generating 2 megawatts for backup. The freestall barns have a ½ hp fan located about every 6.5 feet in the barns. There are2,270 fans configured into 3 banks with each bank consuming about 270kW of power (rated).

The site visit concluded with the assumption that Milky Way Dairy is interested in some degree of participation in a digester project with the Community; however, details would certainly need to be clarified and negotiated. The dairy suggested that they would be willing to provide their wastewater to the digester at the going cost of irrigation water. In return, they would want solids back for bedding and enough irrigation water for 300 acres. While the dairy manure offers the potential of being able to generate increased biogas and thus produce additional energy, it was not deemed to be a practical option in the near term.

2.6 ALTERNATIVE DIGESTER SITE COMPARISONS

After reviewing the data collected up to this point, three possible digester system locations have emerged for consideration and a map showing the sites is found in Appendix B. Each site has pros and cons to be weighed. Additional sites and strategies may become apparent as other feedstock opportunities and bio-power system technologies are more fully investigated.

Site #1. Located near the Industrial Park perhaps adjacent to the existing sewage lagoon yard. The advantages are proximity to Hickman's Egg Ranch chicken litter and the facility's egg wash water storage basin. There would be minimal investment or trucking required to collect the chicken litter from the chicken barns and deliver it to the digester. This site also offers the shortest haul from the Frito Lay plant, should their food waste become part of the digester feedstock. This site has good road access with no traffic problems. Distribution electric facilities are in close proximity and an electrical substation is located nearby to the south. In addition, there is already a non-potable water pumping station that delivers CAP water to the Hickman's Egg Ranch and it is well away from residential areas. This site meshes well with the existing industrial land use in the area.

The disadvantages are minimal. While it is highly unlikely that pumping liquid effluent would ever become desirable, this location would make doing so even less desirable because it is located at the lowest end of the irrigation system and there is no existing infrastructure to integrate with the irrigation system. Should a plan evolve to incorporate the Milky Way wastes, this site is a long distance from the dairy.

Site #2. Located in the southwest corner of the Reservation near the irrigation water reservoir. The advantages include a nearby substation for electrical hook up; proximity to the reservoir for dilution water and the site is well away from residential and business enterprises. The digester system located at Site #2 could be constructed on nut grove land and limit the impact on other production crops land. The site integrates easily with the existing irrigation system, a suitable access road exists and the site has proximity to the Milky Way Dairy.

The main disadvantage of this site is that it is greater than 10-miles from the Hickman's Egg Ranch, which is the primary digester feedstock. This site would require the need to cross the main north-south highway with each load of chicken litter to the digester.

Site #3. Located near the center of the Reservation west of the current Farm office complex. The advantages are the central location, the proximity to the buried mainline for the irrigation system, shorter chicken litter haul from the chicken farm than site #2 and there is no major highway to cross. It is well away from the village residential area and the casino. Its proximity to existing offices would foster more consistent system monitoring and coordination with farm practices.

The disadvantages are that access to reservoir water may require over 4 miles of pipeline, distance from the dairy makes using their flushed manure less feasible and the site may be objectionable to the tribal office complex.

2.7 DIGESTER SYSTEM DEVELOPMENT PROCESS

Numerous design factors and system considerations must be factored into an effective and efficient digester system. The system analysis included in this report only considers the Hickman's Egg Ranch chicken litter for digester feed.

2.7.1 Digester Feedstock

Table 8 is a summary of the waste parameters of the proposed Hickman's Egg Ranch digester system.

Table 8
Waste to Digester

Animal Units	6000	1000 lb units
Chicken Litter Production	4009	ft3/d
Dilution Water	8018	ft3/d
Total Chicken litter Inflow	12027	ft3/d
Chicken litter VS	42881	lb/d

2.7.2 Digester System Parameters

The influent volume is comprised of the animal chicken litter plus process and dilution water expressed as cubic feet/day. This quantity is used to size the digester, estimate the average gas flow and determine the engine generator size.

2.7.2.1 Process Water Additions to Chicken litter

The Hickman's Egg Ranch collects the chicken litter as excreted on a series of chicken litter collection belts in each barn. The egg washing and equipment cleaning water is collected separately from the animal chicken litter and diverted to a lined evaporation pond located north of the barns. The egg washing water is included as a portion of the dilution water needed for the digestion process.

2.7.2.2 Rainfall Runoff Additions to the Chicken litter

The annual average precipitation reported at nearby Maricopa is about 7.6 inches per year. A storm water diversion plan should be included in management considerations. Adequate management of storm water additions to the digester feedstock is also a requirement for proper digester function. Site grading to minimize storm water "run-on" into any chicken litter collection or handling areas, plus the addition of gutters if needed to route barn roof water away from the chicken litter collection system are management practices to consider for the Hickman's Egg Ranch.

2.7.2.3 Other Waste Streams Added to Chicken litter

The current plan to import outside organic matter for digester feed stock has not been agreed upon and therefore has not been fully explored and developed at this time. Based on observations of other operating mixed feedstock digesters, the addition of other organic waste to the digester can definitely increase the gas production potential of the system.

3.0 POWER UTILIZATION ASSESSMENT

On September 18, 1996 the Ak-Chin Indian Community (Community) adopted a Plan of Operation establishing the Ak-Chin Electric Utility Authority, whose name was recently changed to Ak-Chin Energy Services (ACES). On November 1, 1997, ACES begin providing electric service to the entire array of customers on the Ak-Chin Indian Community Reservation (Reservation). Since 1997 ACES' load has grown from approximately 1.9 megawatts (MW) to approximately 5.7 MW's. As discussed below, ACES would be able to utilize all the power produced from the biomass project to supplement existing resources to meet both existing and future load requirements. In addition, some expansion of ACES' existing infrastructure will allow the system to deliver the power to the ACES loads. Further, as part of the economic assessment ACES will evaluate the availability of renewable energy incentives and credits from state, federal and private institutions. Finally, the cost including both the purchase and delivery of supplemental power have been identified. This is the cost that ACES could pay to purchase the power produced from the digester project and is incorporated into the cost benefit analysis.

3.1 COMMUNITY'S CURRENT AND FUTURE ELECTRICAL NEEDS

Electric Utility

ACES has approximately 377 customers made up of 257 residential, 66 commercial, 50 industrial & agricultural and 4 accounts for serving all the streetlights on the Reservation. Some of the customers served by ACES include the Community's casino, the water and wastewater facilities, the industrial park (where Hickman's Egg Ranch is located), and the Clinic, Elderly Center, Fire Department, Police Department and dialysis center.

ACES receives a power allocation from the Salt Lake City Integrated Projects (SLCIP or Colorado River Storage Project (CRSP)) federal hydroelectric project administered by the Western Area Power Administration (Western). ACES' CRSP contract allocation is listed below in Table 9, though the actual amount received varies by season and hydrology. In addition, both the current and future CRSP rates are also listed below in Table 9. Effective October 1, 2005 there was a 9% increase in the CRSP cost of power.

Table 9

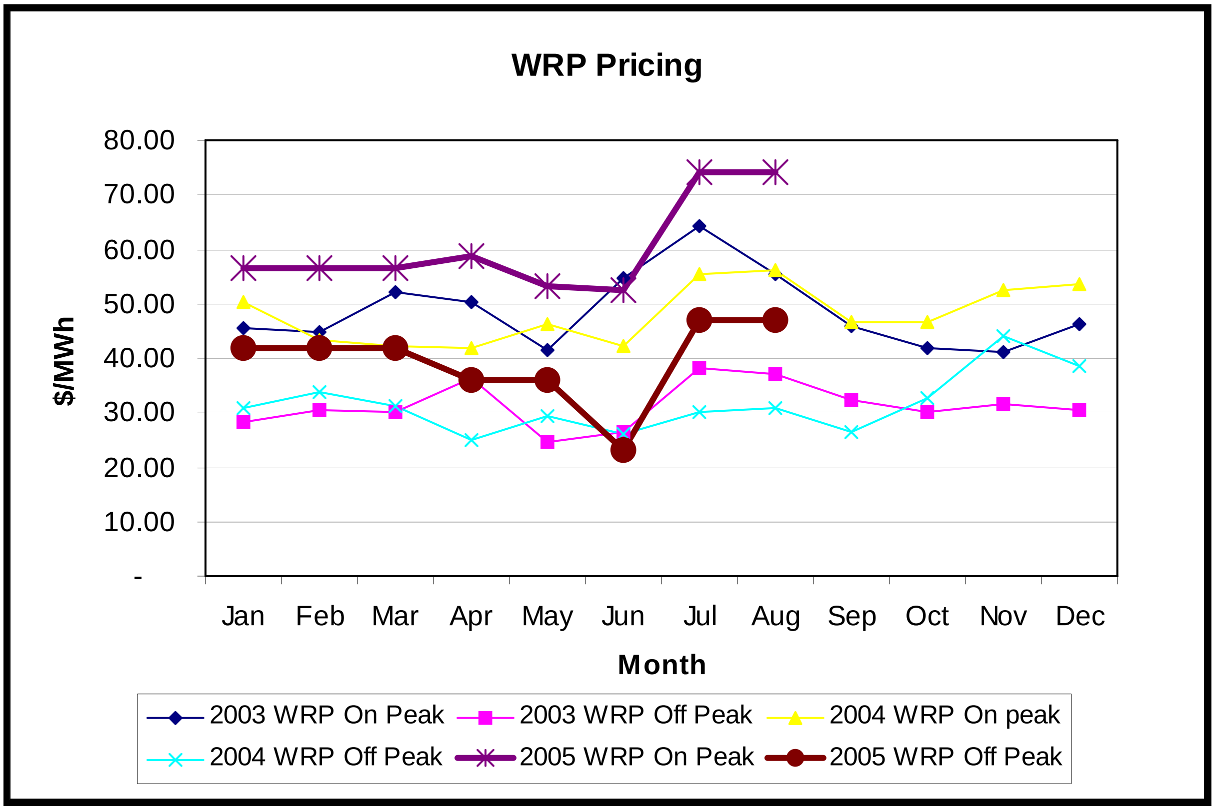
CRSP At Pinnacle Peak			
Winter Seasonal Energy (kWh)	Summer Seasonal Energy (kWh)	Winter Seasonal CROD (kW)	Summer Seasonal CROD (kW)
4,273,433	9,373,563	1,920	4,244

Salt Lake City Area Integrated Projects Firm Power Rate		
	Current	**Effective October 1, 2005**
Capacity	**$4.04 per kW per month**	**$4.43 per kW per month**
Energy	**$9.50 per MWh**	**$10.43 per MWh**

Further, under its CRSP contract ACES can purchase Western Replacement Power (WRP) to provide supplemental power to meet the ACES load requirements. While this has served ACES in the past, with the price of WRP rising significantly and with the ACES loads growing, ACES will need additional supplemental power to stabilize the cost of power as well as to meet future load growth.

Below is a Graph1 showing the WRP monthly on and off peak prices for 2003, 2004 and 2005 year-to-date. As can be seen, the WRP prices have risen in 2005. Much of the rise can be attributed to the rising cost of natural gas. While historically natural gas has been priced at around 4 $/mmbtu, natural gas prices have risen to over 9$/mmbtu.

Graph 1



During the course of the project several utilities were contacted to obtain purchase power prices for the upcoming 2 –3 years. The price of purchasing power on a 24 by 7 basis excluding transmission and losses has ranged from 55 – 70 $/MWh depending upon the time frame when the inquiry was made. Transmission charges can add between 5 – 10 $/MWH and losses can be in the 4 – 8% range. ACES' CRSP allocation is first delivered at Pinnacle Peak and then wheeled from Pinnacle Peak to Maricopa Substation. The losses for this portion of the delivery path are 4%. From Maricopa Substation the power is wheeled to the Reservation boundary. The losses for this portion of the delivery path are 8%. So the total losses for power from Pinnacle Peak to the Reservation boundary are12%. The equivalent value of power purchased from Pinnacle Peak and delivered to the Reservation adjusted for losses would be in the range of 62 – 78 $/MWH. Further if wheeling were added to the cost of power delivery at the Reservation boundary it would be in the 60 – 90 $/MWh. For purposes of the economic evaluation of the biomass project, a conservative value for the avoided cost of power delivered to the Reservation boundary was assumed to be 65 $/MWh.

3.2 EXISTING POWER DELIVERY INFRASTRUCTURE

Facility Electrical Configuration, Use and Cost

It is proposed that the site for the biomass facility should be constructed in close proximity to ACES existing 12 kV distribution facilities. This would enable ACES to directly interconnect the biomass facility into its distribution system and utilize the power output to directly serve load. This would result in a reduction in losses and wheeling costs as well as reducing the cost of interconnection. Once the site location is determined, firm interconnection costs will be identified. For estimating purposes it was assumed the cost to interconnect to ACES 12 kV distribution system would be around $100,000.

With respect to green energy, the Arizona Corporation Commission (ACC) has implemented a requirement that those utilities that are regulated by it must provide a certain percentage of power from renewable resources. The credit for the production of green energy can be sold and is commonly referred to as a green credit, which is the value received when the credit is sold. It should be noted that ACES is not regulated by the ACC. Further, the market for green credits in Arizona is not robust and regulated utilities have been slow in embracing renewable projects not built in their service territories. It should also be noted that green credits can be sold anywhere in the United States and so the project is not limited to just Arizona. For purposes of this project it has been assumed that ACES will be able to market the green credits (renewable energy tax credits and greenhouse gat tax credits) at a value as much as $133,517 per year.

4.0 ALTERNATIVE TECHNOLOGY REVIEW

4.1 FEEDSTOCK AND PRODUCT MIXTURE OPTIONS

The Milky Way Dairy was investigated as a potential source of additional feedstock for the project. Combining the feedstock from the dairy and the chicken Hickman's Egg Ranch offers overall system output benefits. The dairy offers a viable source of biomass for significantly increased gas production as well as providing some of the necessary dilution water for the chicken litter.

Milky Way Dairy is a new facility located adjacent to Community lands. The target population is for 7,000 milking cows plus up to 14,000 dry cows and replacement stock. The dairy uses a gravity flow, flushed manure collection system. There are 65 barn lanes that get flushed 3 times per day in roughly a 5-hr cycle. Each lane gets an 8 to 10 minute flush cycle at an estimated delivery rate of 2,000 gpm. The waste storage pond is estimated to hold about 33.8 million gallons. The waste storage pond water is continuously recycled as flush water back to the barns as well as irrigated onto Milky Way croplands.

The Milky Way Dairy has expressed interest to participate if a digester system were developed by the Community to process flushed dairy manure. The Ak-Chin Farm has recently begun to grow corn and sorghum for Milky Way Dairy. Barley is harvested as grain and milled for dairy mix feed. In 2004, the Farm contracted to grow 1,000 acres of green chop feed for the Milky Way Dairy. The Farm may consider producing additional feed crops such as corn and alfalfa. Based on these observations, a cooperative working relationship already exists between the Community and the Milky Way Dairy.

Another option for consideration by the Ak-Chin Community would be to develop a second digester site designed to digest flushed dairy manure in an ambient temperature covered lagoon using the Milky Way Dairy waste stream as the primary feedstock. This system could be located on Community lands across the road from the existing dairy waste collection and storage structures. It is estimated that the Milky Way site would be capable of producing over 1 megawatt of electricity.

Food waste from restaurants, cafeterias and prisons, food-processing waste, animal manures, and certain other organics can also be mixed and co-digested to make biogas in a digester. Nearby cities and developing neighborhoods produce a great quantity of degradable organics and could be considered as sources. If these or any other sources can produce segregated waste streams, i.e. without metal, glass or plastic, the putrescent materials can be sent to an anaerobic digester.

Another revenue enhancement for the project is tipping fees for treatment of food processing wastes, vegetable oils from restaurant fryers and grease trap wastes. Although these products are highly degradable, they have low content of fertilizer elements such as nitrogen. Biogas production increases with input such as these wastes thereby increasing electrical and heat energy outputs. This is a proven process in operating California and New York complete mix digesters. However, the Ak-Chin Community will have to decide if it wishes to enter the waste disposal market.

4.2 GASIFICATION PROCESS DESCRIPTION

The principal technology being considered by the project is anaerobic digestion. The digester would be a complete mixed reactor for chicken litter. Post digestion, there would be 2 or 3 times the volume of material in liquid form. Ak-Chin Farm has expressed concerns about converting their current raw chicken litter fertilization strategy to accommodate the use of the liquid effluent from the digester. This conversion would entail either developing a system of pipes to move effluent fertilizer to the fields or converting the trucks and spreaders that currently haul raw chicken litter to haul and spread liquid. While Ak-Chin Farm raised liquid delivery concerns, the scope of the project included that the Project Team explore other options for converting the chicken litter to electricity without creating the need for the Ak-Chin Farm to reform its fertilization practices or lose the fertilizer as a resource.

Pyrolytic Steam Reforming Gasification (PSRG) is an emerging technology that can extract the methane gas from carbonaceous materials and produce a benign ash that retains some the material's original fertilizer value. The PSRG gasification of carbon based feedstock without the introduction of air or oxygen is at the technological heart of the Carbon Conversion Technologies, Inc. (CCT) Gasification Conversion System (GCS). The ability to provide gasification of carbon based feedstock without the introduction of air or oxygen represents a major step in providing clean non-diluted, high-energy (450 to 550 BTU/SCF) product gas. The patented process has features necessary to allow the conversion of the carbon components without the oxygen of composition and the oxygen entrained within the feed generating excessive carbon dioxide or runaway temperatures.

The reactor consists of a multi stage system that stages reactions of the carbon materials in the feed allowing the conditioning of the materials at each stage of the process. These steps include:

- Reactor feedstock preheats with waste heat from the process heater.

- Gradual carbonation and devolitization of the feed allows the oxygen of composition and entrained oxygen to react near or below the combustion point of the feed. This is also accomplished using waste heat from the reactor.

- The devolitized feed material is induced to the entrained flow reactor/heater by way of a patented cyclonic inducer. This allows the material entering the reactor to do so within the vortex of a cyclone gas stream. This increases the residence time of the feed material within the reactor and prevents the solid feed material from coming in contact with the reactor walls, thus preventing fouling of the reactor with tars, phenols etc. The process reaches the final temperature within this section of the system. Unreacted material and unreactable components of the feedstock are carried through the reactor and are eliminated from the process loop by a cyclone separator located at the discharge of the reactor. This material may be re-introduced at the inlet of the reactor for additional reaction.

- A second stage cyclone is located further down the process flow path to remove any ash or entrained materials from the hot process gas.

- The quench circuit designed into the system is a critical component of the overall process. The formation of boudouard carbon will occur when the product gas (Syn-Gas) is allowed to cool too slowly. The quench circuit quickly drops the product gas from the reactor process temperature below the carbon formation zone. Any tars and phenols still in the product gas condense at these lower temperatures and are removed or reinjected into the feedstock input. A number of stages of filtration are employed prior to the gas exiting the process.

- The energy required to propel the feed material through the reactor is supplied through an eductor using the cooled and filtered process gas. A compressor is used to boost a small side stream of the product gas to a pressure that will allow the use of this eductor. The eductor enables the process material within the reactor to maintain sufficient velocity to maintain the cyclonic action. This technique allows the reactor to avoid outside materials from entering the reaction or the requirement of introducing a large quantity of excess steam to the process. This technique also allows close control of the components of reaction within the PSRG process and variability of the composition of the syn-gas produced so that it more closely fits the purpose for which it is being produced.

Efficiency In Feedstock Utilization

Although relative efficiency varies somewhat by feedstock, the CCT PSRG GCS is more efficient than competing processes because it completely reacts all the available carbon and has a greater reduction in the volume of residue. It is also more efficient than competing technologies in that it requires less energy per unit of power. Additionally, some of the byproducts, e.g. hydrogen, certain hydrocarbons, and excess heat can be used to generate power and heat (thermal energy) for the process, offsetting some of the power & energy that may otherwise be required from the grid or co-production sources.

"Designer" Gas

The CCT PSRG GCS process enables relatively easy manipulation of the composition and characteristics of the syn-gas to match the specific chemical, BTU or other requirements of its end use.

High Btu Content

The CCT PSRG process also generates a high BTU gas that can be custom tailored to the end use requirements. Energy content of the syn-gas ranging between 450 and 900 BTU / SCF can be achieved. The resultant high BTU gas can be compressed and stored, thus enabling time shifting of syn-gas utilization.

Energy Efficiency

In addition to efficient utilization of the feedstock, the CCT PSRG GCS process is also energy efficient; and energy self sufficient once the process has been started. Only a small amount of energy (Natural Gas, Propane) is necessary to initiate the process, after that the CCT PSRG GCS generates all the energy necessary to power and sustain the process.

Size

The CCT GCS also features a small footprint. An installed plant producing 20,000 gallons of ethanol per day requires a space of 100’ by 150’ (1/3 Acre) plus finished product storage and space requirements for the feedstock. Because of the small footprint the GCS can be skid mounted and is easily scalable. The small footprint also allows great flexibility in site selection depending only on the economics and permitting requirements of the project. PSRG GCS systems can be sited close to either the ultimate end user of the produced products or the source of the feedstock. This can eliminate many of the project’s potential problems associated with transportation. Local codes and ordinances as well as community perceptions can significantly affect the final physical dimensions required for a plant.

Environmental Impact

Perhaps the most powerful aspect of the CCT PSRG Technology is that it is so environmentally friendly. It is a completely closed process except for the negligible emissions of the gasifier heat source. Therefore, it virtually eliminates any of the odorous discharges, noxious gases, or problem emissions. Moreover, the residue from the process is a relatively small volume of solids that are environmentally benign, with trace minerals that in some cases are suitable for use as fertilizer or an animal feed supplement. These ash residues can also sometimes be used in road construction or to manufacture building blocks.

The ability to take a large volume of waste materials, e.g., biosolids, municipal solid waste, agricultural waste, chicken litter and landfill bound grass clippings, yard waste, etc., and recover something valuable, leaving a comparatively very small amount of absolutely benign material has community and society benefits. There is a natural synergy between CCT’s technology and those public agencies and private companies tasked with handling enormous volumes of society’s waste products.

Landfills and other waste storage and handling facilities are always sources of pollution, contention and controversy. The CCT technology has the capability and potential of drastically reducing in volume or eliminating the amount of waste that must be disposed of in a landfill and using that waste as feedstock for gasification that results in job creation, tax production and profit making products. At the same time, the volume of residue that may have to be land filled, depending on the feedstock, is reduced to a very small fraction of the feedstock’s original volume and weight. Moreover, the residues characteristics are changed drastically from the original feedstock to a benign clay-like solid or ash, odorless, nontoxic and non-hazardous.

Implementation Time

The CCT GCS also has a comparatively short fabrication and deployment lead-time. CCT can build and bring on line a modular facility capable of generating approximately 4 megawatts of power in about 12 months. Thereafter, the company could deliver and deploy a waste to ethanol generation facility of the same output capacity each 2 months provided all systems were part of the same contract and ordered at the same time. Pictures of 2 different types of CCT's are shown below in Figure 4.

Figure 4

25 ton per day PSRG Gasifier without enclosure, feed auger, and ash shoot

25 ton per day PSRG Gasifier with enclosure, feed auger, and ash shoot

Laboratory Testing - Comparison of the fertilizer values between the gasifier and the Digester:

Samples of chicken litter from the Hickman's Egg Ranch hen houses were collected and blended before shipment to Hazen Research Inc. for lab testing. Previous chicken litter testing did not provide the data necessary for the performance of the analysis of the PSRG process on the chicken litter resource. Hazen performed proximate and ultimate analysis of the chicken litter sample to determine energy values, moisture content, and the chemical composition of the residual ash.

The samplings reporting comparative basis parameters are summarized in the Table 10.

Table 10
Hickman Chicken Litter – Hazen Lab Analysis

Reporting Basis (%)	As received	Dry Samples
Moisture	67.89	0.00
Carbon	10.65	33.17
Hydrogen	1.20	3.75
Nitrogen	1.71	5.33
Sulfur	0.11	0.35
Ash	12.72	39.62
Oxygen	5.72	17.78
TOTAL	100.0	100.0

The ash samples were calcined at 1110 degrees F prior to the analysis. The elemental analysis of the ash is summarized in Table 11 below.

Table 11
Ash Analysis

Element	% of Ash
SIO_2	9.01
AL_2O_3	3.16
TIO_2	0.02
FE_20_3	0.48
CAO	45.10
MGO	2.98
NA_2O	1.55
K_2O	6.93
P_2O_5	14.74
$S0_3$	1.88
CL	1.63
CO_2	16.76

The residual ash comprised 39.62% of the dry content of the sample (12.2% as received). Gasifying 100 tons per day of chicken litter would produce approximately 12 tons per day of ash. The ultimate elemental analysis indicates that the ash contains 6.93% (.83 tons) Potassium and 14.74% (1.77 tons) Phosphorous. The elemental analysis does not indicate the presence of any Nitrogen remaining in the ash, which would eliminate this option from consideration because of the criteria that the nutrient value of the chicken litter must be returned to the Farm.

For comparative purposes the elemental characteristics of the liquid digester effluent were converted to dry basis percentages and compared to the gasification ash elemental characteristics. Inorganic elements are collectively listed as “ash”. Remaining organic nutrients from both processes are compared for potential crop fertilizer value in Table 12.

Table 12
Comparison: Digester Effluent and Gasification Ash

Digester Effluent (Dry Basis)	Element %	**Gasification** Final Residual	Element %
ASH	55	ASH	78.9
Total K Nitrogen	21	Total K Nitrogen	0
Phosphate	11	Phosphate	14.4
Potassium	13	Potassium	6.7
TOTAL	100	TOTAL	100

PSRG Electrical Energy Production

PSRG requires biomass feedstocks with approximately 40% moisture content to provide the steam necessary for the process. The chicken litter samples contained 67.9 % moisture and a dry BTU value of 8726 Btu per pound. The dry value must be adjusted down by 40% to account for the moisture content of the feedstock as it enters the gasifier. The output of the gasifier must also be reduced by the amount of energy consumed in converting the moisture to steam.

Reducing the moisture content of the raw chicken litter from 70% to 40% would reduce the quantity of the available feedstock to 55 tons per day. Processing 18,102 tons of chicken litter (@40% moisture), (32,800 tons at 70%). 14,000 tons or 3.4 million gallons or 10.3 acre feet of water would be removed from the waste stream and be available for use by the farm.

<u>55 Tons per day (TPD) Chicken litter Only</u> - If the Gasifier only processes the available 55 tons per day of chicken litter and no other supplemental feedstocks, the gasifier will produce enough syn-gas to produce 1,360 kilowatts of electrical power. (The syn-gas would be combusted in an engine generator to produce electricity.). The system would have an estimated availability of 90% or 7884 hours per year. The gasifier operates with an overall thermal efficiency of 29%, producing 10,100,000 kilowatt-hours per year.

Using only the available chicken litter feedstock, the project would not be capable of producing power at the Ak-Chin Energy Services' target avoided cost rate of $.065 per kilowatt hour (based on 80% financing and 20% equity investment of the $6,838,000 cost of the project). Sale of "Green Tags" associated with the project, at $0.010 / kWh can bring the cost of power to approximately $0.085/kWh. In either case, the Net Present Value and the Internal Rate of Return on Equity are both negative and project is not economic.

<u>125 Tons per day (TPD) Mixed Chicken litter and Biomass</u> - The 55TPD input to the gasifier represents only 44% of the capacity of a basic gasifier unit. To make the project economic, would require full utilization of the 125TPD capacity of the gasifier and would require the gasification of 70 tons per day of additional biomass at 40% moisture content and an energy value of 4800Btu per pound.

Summary Of Gasification System Analysis

If the Gasifier only processes the available 55 TPD of chicken litter and 70 TPD of other supplemental biomass feedstock, the gasifier will produce enough syn-gas to produce 3.81 megawatts of electrical power. The system would have an estimated availability of 90% or 7884 hours per year. The gasifier operates with a global efficiency of 29.6 % producing 28,567,000 kilowatt-hours per year.

Using the available chicken litter feedstock plus securing other biomass, the project would be capable of producing power at the ACES' target avoided cost rate of $.065 per kilowatt hour (based on 80% financing and 20% equity investment of the $8,890,000 cost of the project). Sale of "Green Tags" associated with the project, at $0.010 / kWh and capture of production tax credits can bring the cost of power to the desired $0.065/kWh and an 18.5% Internal Rate of Return on Equity.

Conclusion Of Gasification System Analysis

The gasification system is not economically favorable at the current daily volume of biomass available from the chicken litter. The process is certainly capable of producing electricity from the Hickman's Egg Ranch chicken litter, however there is not enough litter available per day to make the system economically viable. The financial analysis demonstrates that the gasification system would require feedstock at a rate of 125 ton per day (dry basis). Acquisition of an additional 70 tons per day of a dry, high quality organic feedstock would be necessary before the gasification process would be feasible.

Additionally, the lab analysis shows that gasification removes all of the nitrogen from the chicken litter during the process. Since it is an important project parameter to select a process that preserves the fertilizer nutrient value of the chicken litter available to the farm crops, it was determined that the gasification process, as well as stoker furnaces or co-firing biomass processes were not viable technologies for this project.

5.0 DIGESTER SYSTEM DESIGN

A complete mix, heated, anaerobic digester system for the Hickman's Egg Ranch chicken litter feedstock is sized and presented for approximately 1,500,000 chickens. The report evaluates the chicken litter as feedstock for a digester system located at Site#1, the Industrial Park as described in section 2.6 above. Detailed comparison costs for evaluating siting the same basic type of digester system at Sites 2 and 3 were not developed due to high costs associated with transporting the chicken litter feed stock to the digester plus a delivery system to move the digester liquid effluent back to the farm fields.

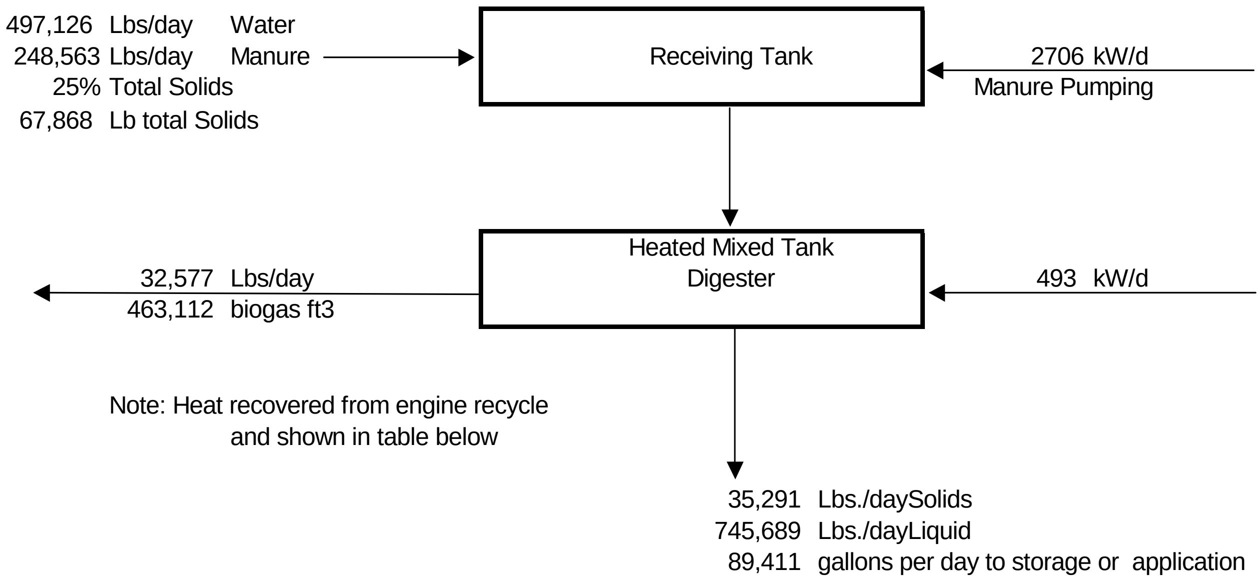
A typical energy and mass balance table has been developed for the digester system. It is summarized as Figure 5,a flow chart of the process in the next section.

5.1 Energy And Mass Flows

Figure 4

Material and Energy Balance for Chicken Manure Power Production

Ak Chin Feasibility Study



Mass Balance	**Lb/d**	**Lb/d**	**%**
Solids from Chickens	**67,868**		
Solids into digester	67,868		
Solids to Gas		32,577	48%
Solids to Storage		35,291	52%
totals		67,868	100%

Energy Balance	**BTU**	**BTU**	**%**
	Production	**Use**	
New Btu Produced	301,022,898		
kWh Produced		85,615,929	28%
Generation Parasitics		6,849,274	2%
Manure Pumping		40,956,000	14%
Separating		1,682,609	1%
Net Kwh Production		36,128,046	12%
Hot water for digester/farm		138,470,533	46%
System losses		76,936,436	26%
TOTAL	301,022,898	301,022,898	100%

5.2 System Installation Designs

5.2.1 Selecting and Sizing the Digester

The Hickman's Egg Ranch collects their chicken litter using a mechanical belt collection system in each of their barns. No dilution water is added to the chicken litter. This chicken litter mixture would be diluted for optimum performance in a heated and mixed digester. A complete mix digester can be a tank or covered lagoon configuration. The system proposed for the Hickman's Egg Ranch would be developed in steel tanks rather than concrete tanks or lagoons. Currently, this is the most cost effective design approach.

The complete mix digester will be heated and not subject to any seasonal performance variations. It will efficiently produce gas year round. Unheated digesters make more gas in the summer than in the winter. Heated digesters can be smaller because the rate of reaction is higher when the bacteria grow in a controlled and warmed environment.

Digester operation is dependent on controlling manure quantity and quality. All of the following factors need to be reviewed prior to constructing a digester. Each could affect the digester size.

1. If there is any outside organic waste (such as dairy manure, food waste or cheese whey), it could be added to a digester to make more gas. If such a scenario is pursued, it is recommended that an agreement concerning quantity, content and constant availability of the material be developed. This plan would need to be accounted for in the final digester system design.
2. Not more than 25% of design volatile solids may come from any non-manure source.
3. Sufficient grit will settle in the digester to require cleaning in 6-12 years, depending on dirt contamination and water management.

The calculated values for the Hickman's Egg Ranch system are presented in Table 13.

Table 13
Digester Parameters

	Hickman Poultry	
Total Animal Population	1,500,000	# of chickens
Influent Volume	89,964	gal/d
Digester Volume	80,182	Ft^3
Number of Digesters	1	ea
Diameter	90	ft
Depth	38	ft
Cover Dimension	6,330	Ft^2

5.2.2 Digester System Outputs

Between 30% and 35% of the chicken litter volatile solids reaching the digester will be converted to biogas (60% methane, 40% CO^2, water saturated). It is assumed that chicken litter from the poultry farm could be gathered fresh to be mixed and fed daily to the digester. Table 14 shows the projected system output based on these assumptions.

Table 14
System Outputs

Gas Production	463,112	ft3/d
CO2 Equivalent	46,631	Metric T/yr
Electricity Energy Output	1,045	kWh avg
Excess Heat Recovery	5,388,817	Max Btu/hr
	4,920,414	Min Btu/hr

The electrical performance of the system run at the expected average kWh has been modeled and presented in following table. It is assumed that all electricity will be sold.

Table 15
Poultry Digester - System Performance
(Selling electricity at $0.065/kwh, with energy production tax credits)

Type of Digester		Heated Digester	
Electricity purchase offset		$ -	
Sale of excess electricity		$ 459,113	
Renewable energy credit		$ 63,570	
Greenhouse Gas Tax Credits		$ 69,947	
Hot Water Offset		$ 0	
TOTAL POTENTIAL BENEFIT			$ 592,630
Operation and maintenance			
Engine/kWh	$ 0.015	$ 105,949	
Soil Testing/yr		$ 15,000.00	
Extra Disking/yr		$ 75,000.00	
TOTAL O&M			$ 195,949
% of Kilowatts replaced		0%	
% of the electric bill offset		0%	
% of heat purchase offset		100%	

5.2.3 System Scenario Summary

Chicken litter from the Hickman's Egg Ranch is deposited into a new chicken litter collection/mix tank. Fresh water, egg wash water and eventually recycled digestate from the digester will be used to dilute the chicken litter. As described later in Section 8.1 subheading "Water Quality", there is sufficient water capacity for this project. The chicken litter slurry will be mixed and pumped into a heated complete mix digester. Grit from the raw chicken litter will be settled and removed from the mix tank. It can be used as a soil amendment to the cropland. Digester effluent will be pumped into a 40-day capacity liquid storage tank where it will be held until land applied to the fields.

The digester will be designed for a 20-day hydraulic retention time (HRT). Hot water pipes from the generator in the digester vessel will keep the digester at a controlled temperature. The heated chicken litter is anaerobically digested by bacteria and produces biogas that is collected under the digester cover. As the digester is fed, effluent is hydraulically displaced out of the far end of the digester over a discharge weir into an effluent tank and pumped to the storage tank. After digestion, the chicken litter is a thinner liquid and is handled easily as irrigation water on to the fields.

It is most cost effective to locate the engine building as near to an existing electric interconnection point as possible. Another building site consideration is near the digester to facilitate effective digester heating with the hot water recovered from the heat exchangers on the engines. Biogas will be piped underground to a 30ft x 40ft gas use shed ("Co-Gen" Bldg) that contains the engine generators and heat recovery equipment. The captured biogas will be combusted in the reciprocating engine for production of electricity and hot water. A Caterpillar 3519 LFG engine will control its output to match the gas supply. Waste heat is reclaimed from the engine cooling system and exhaust system as hot water. Insulated hot water pipes will carry the hot water to the digester heating system as well as to other determined heat use sites. A small pump will circulate the water. New service wiring will connect the generator output to the electrical service. Appropriate safety relays will be part of the new system to meet requirements of the local utility.

5.2.4 Digester Component Detail

Chicken Litter Flow Elevation Profile

A site construction temporary benchmark (TBM) would be used for digestion system construction. The digester effluent would exit the digester and be pumped to a 40-day storage tank.

Chicken Litter and Wastewater Collection

The Hickman's Egg Ranch is comprised of 5 belt houses with about 300,000 chickens per barn for a current total population of 1.5 million chickens. The target population is 1.9 million chickens. The Hickman's Egg Ranch is producing 810,000 eggs (3 truckloads) per day. The collection belts under the cages transport enough chicken litter out of the barns to fill 8 trucks per day, or about 90 to 100 tons per day of chicken litter containing 25% solids.

It was estimated that the daily freshwater makeup required to adequately dilute the chicken litter for effective digestion would be on the order of 60,000 – 90,000 gallons per day. The Hickman's Egg Ranch currently discharges egg washing water to a lined evaporation pond north of the barns. This wastewater could be utilized as additional dilution water for the chicken litter, and offset some of the clean makeup water into the system. More detailed study of the egg plant's process flow is required to determine the exact daily volume of this wastewater.

Chicken Litter Influent Mix Tank

In most digesters, a collection tank sized to accommodate at least two days of collected chicken litter is installed. It allows for some interruption of operations to make repairs, as well as mixing of the waste for more uniform digester feed. Chicken litter will be pumped from the mix tank into the digester.

Field Piping: Chicken Litter Transmission or Transport to the Digester

The chicken litter will be collected on the chicken litter removal belts and either trucked or augured to the digester mix tank. The chicken litter will be mixed and slurried with dilution water comprised of egg wash water, recycled digestate and fresh water as needed. Mixers and pumps have been included in the cost estimates for this system to allow for necessary accommodation of the incoming chicken litter and dilution water.

Digester type

The digester system would be a heated complete mix digester. It will be configured as a round tank with an attached floating top.

Digester size

The digester is sized for 20 days of chicken litter retention. The digester tank will be 28 feet deep by 109 feet diameter with a minimum 2 foot freeboard. The volume will be 240,545 cubic feet.

Digester construction materials

The digester would be constructed with 29-gauge sheet metal. The tank will have rigid walls and a floating top will be attached. The digester will have an effluent overflow weir. The weir keeps gas in, maintains the chicken litter level, and lets digester effluent out.

Influent chicken litter pipe

The influent chicken litter and dilution water mixture will enter the digester through a PVC pipe located in the wall of the digester tank.

Digester heating

The digester will be heated by circulating hot water through heat pipes inside the digester. The pipe will not corrode because there is no acid and no air in the digester.

Digester insulation

Due to the cool winter nights, insulation may be recommended for the top and exposed sidewalls of the digester.

Digester mixing

A complete mix digester requires agitators or mixers, which will be incorporated into the final system design.

Digester gas collection

A floating flat top will be secured to the top the digester wall. A gas withdrawal pipe will be installed inside the digester under the cover.

Digester pipe chase size and location

The digester influent chase is a leak proof box adjacent to the digester wall where hot water pipes enter the digester and gas pipes leave the digester. Sometimes the chicken litter entry pipe may pass through this same box. The pipe chase housing gas and water plumbing will be located near the feed port of the digester. A covered pipe chase sized to accommodate the piping is built onto or near the side of the digester.

Digester effluent structure

The digester effluent flows out of the digester and over a weir that is built into the sidewall of the digester.

Effluent Tank/Chamber

Digested liquid overflows the effluent weir into a covered effluent tank for pumping to storage, cropland or a tanker for hauling. Digestate management is discussed in a later section.

5.2.5 Biogas Utilization

Field Piping

All buried pipes will be a minimum of 3 feet below the finished grade. All plumbing will run underground.

Influent Piping

The existing chicken litter collection belts at each barn will be utilized to collect chicken litter into a truck. Chicken litter will be deposited into the mix tank and mixed with dilution liquids. The mix tank will be fitted with a pump and piping to feed the digester tank.

Gas piping

The collected biogas would be piped to the engines in a PVC buried pipe. Another PVC pipe to a flare will be buried and properly sloped to avoid water becoming trapped and blocking the pipe. The flare is used to burn off excess biogas in a controlled manner.

Hot water piping

Hot water collected from the gas utilization system would be piped to the digester in buried pipe. Additional surplus hot water could be sent to a heat exchanger for other heating needs.

Effluent Piping

Effluent piping is planned to deliver the digested effluent to a storage tank or directly into chicken litter tankers depending on the cropping needs.

Location

Biogas use equipment should be located close to the digester system and the chosen interconnection location. Moreover, distance should be minimized between the heat recovery system and the heat uses. Exact placement will be determined during development of the Basis of Design Document and engineering plan drawings for the project. It is usually the case that proximity to electrical service connections is the economical choice.

Equipment Housing

The engine-generator should be housed in a 30'x 40' building. The typical building design will meet National Building Code standards with painted steel walls.

Gas Management

Once the gas is collected from under the digester cover, it must be moved to the gas use equipment. Typical gas management would include a gas pressurization unit with meter, gas blower and particulate filter and associated process control equipment. The meter will track the system output and is a good indicator of overall digester operation. A particulate filter will remove some water and hydrogen sulfide from the gas.

Excess Gas Flare

Excess gas must be safely burned. Excess biogas would be released through a relief valve and burned in a 4-inch flare that will be located a minimum of 100 feet from any structure.

Gas Use

Biogas could be used to fuel:
1. Cogeneration system - 1.5 million chickens will produce an average of 1,045 kWh
2. Engine driven equipment, such as a refrigerator compressor
3. Hot water boiler system
4. Irrigation pumps

Engine Notes

The engine should include safety devices such as: low oil level shutoff, high oil temperature and high water temperature shutoff.

Electricity Generation Notes

The generator would be wired into the selected interconnect main electric panel. Automatically operated motor contactor at the generator and manual disconnects in the engine room and in the electric panel room will ensure safe high quality power. The engine generator will operate in parallel with the utility system at a constant level of output controlled by the biogas supply equipment. Parallel generation means that electricity generated by the biogas unit will be mixed with the utility supplied power. A utility-approved electrical safety system will be required to insure disconnection of the generator from the utility system during power outages to avoid energizing power lines away from the site. Typical interties of this type include solid-state commercial relays to monitor voltage, amperage and frequency.

Hot Water Recovery, Storage and Utilization

Hot water recovered from the engine cooling system will be collected for digester heating. A hot water circulating pump of about 10 horsepower would be required. Digester temperature maintenance is paramount to assuring adequate digester operation and performance. Recovered hot water in excess of that required by the digester can be used to offset any identified hot water need near the site. Optionally, more heat recovery is available from engine exhaust.

5.2.6 Digestate Management Plan

Digestate is a combination of liquids and some residual solids that were not digestible. The digester produces a biologically stabile digestate that has very little odor, has a 99% pathogen reduction, contains most of the nutrients of the original chicken litter, and is not a good host for fly production. Grit and other solids will be separated and collected at the mix tank. The digested liquid is then field applied to cropland.

Solids Separation System

Grit separation before the chicken litter mixture enters the digester is desirable. When system details are verified the system layout will be designed to integrate grit collection and removal at the mix tank. The solids may be used as a soil amendment for the croplands. Table 16 shows typical liquid nutrient characteristics after digestion.

Table 16
Forecast Characteristics of Liquid

Moisture	97.80%
T. Solids	2.20%
V. Solids, %T.S.	51.70%
Ash	1.10%
TKN	0.42%
NH4+(%of N)	0.30%
P2O5	0.23%
K2O	0.25%
PH	8.42
COD, mg/l	20,763
BOD, mg/l	4,905
Vol. Acids	610
Fecal Coliform	622

Storage of Digestate and Nutrient Management Plan

A 40-day effluent storage facility has been included in the system design and cost analysis. This storage capacity will provide the Ak-Chin Farm with flexibility in their nutrient utilization schedule in the event there are unsuitable days for land application. It is recommended that a detailed plan for the beneficial use of digestate nutrients be developed. A nutrient management plan that results in applying nutrients to cropland at the correct time and in the required quantity to meet crop fertility needs can optimize the value of the effluent nutrients. The digester system provides the added benefits of processing the raw chicken litter fertilizer into a homogenous and odor free liquid with much of the nitrogen mineralized to enhance the nutrient uptake rate of crops.

The Ak-Chin Farm has an existing nutrient management plan developed to utilize raw chicken litter to meet the needs of the cropping strategy. While it is beyond the scope of this study to develop a detailed nutrient management plan and application schedule, digester effluent nutrients could be utilized following similar nutrient management strategies as are used in the current farm practices. In an effort to support this approach, the project has included $15,000 per year in the overall budget to provide the Ak-Chin Farm with soil testing data.

5.3 AK-CHIN DIGESTER SYSTEM COSTS AND BENEFITS

Design Components and Estimated Cost

Table 17. items 1 –7, shows the components of the digester system for the Ak-Chin project. RCM developed a cost estimate for the project assuming commercial pricing for the components listed on the line item sheet as opposed to agricultural pricing. The components are all commercial grade and priced to reflect installation by commercial contractors.

The system proposed for the Hickman's Egg Ranch would be developed in steel tanks rather than concrete or lagoons. The estimated overall cost for the installed digester system is $5,492,574. This includes the cost of collection tanks, the digester vessel, a 40-day storage tank, all equipment, the engine-generator set, design engineering and contingencies. The cost estimate includes the cost to purchase two tanker trucks and two liquid spreader wagons needed to land apply the digester effluent. The systems component elements are summarized in the following table.

Table 17
Digester Components

1. Influent and Effluent Tanks				
Influent tank		89,963.78	gallons	
Digester feed agitator		2	ea	20 hp
Digester feed pump		2	ea	10 hp
Effluent tank	40 day capacity	3,873,512	gallons	
Effluent pump		1	ea	50 hp

Table 17 - Continued
Digester Components

2. Digester					
	HRT	20 day capacity	240,545	ft3	
	Freeboard	2	Ft		
	Depth	28	ft deep		
	Diameter	109	Ft		
	Cover Area	9,252	ft2		
	Effluent Structure and piping		200 ft		
	Mixer		5	ea	17 hp
	Heat Exchanger and hardware				
	Top insulation				
	Gas intake and installation				
	Cover				
	Cover installation materials				
	Gravel				

3. Engine Equipment and Material	
Generator	Caterpillar 3516 LFG
Radiator	
Controls, piping misc hardware	
Metal Building to house	

4. Other Site Elements
Interconnecting water and gas pipe
Foamtrap
Candlestick Flare, fittings & piping
Flame arrester
H2 Scrubber

Table 17 - Continued
Digester Components

5. PREFAB GAS AND HOT WATER CONTAINERS		
Container - 40'	2 ea	including:
Doors – 2		
Ventilation fans – 2		
Inlet air openings – 2		
Dividers – 1		
lights and receptacles		
fire sprinkler		
Electrical MCC 2 (mixer, gas, hot water)		
Gas Skid	including:	
Particulate filter		
Gas blower		
Glycol chiller		
Allen Bradley PLC		
Gas meter		
Hot water skid	including:	
Pipe		
Expansion tank		
Tempering valve		
Circulating pump		
Fresh water plumbing		
Wiring		
Interconnecting piping		
Instrumentation - visual readout, SCADA adaptable		
Assembly		

Table 17 - Continued
Digester Components

6. Installation of Equipment and Material		
Mobilization		
Labor to place cement/rebar/wire mesh		
Labor to install new tank, insulation and siding		
Labor to install chicken litter equipment		
Install mixer		
Install heat rack		
Install Cover		
Form rental		
Equipment rental		
Crane		
Site prep		
Pipe Trenching		
Underground pipe installation		
Setting H2S scrubber		
Setting Containers		
Site Internal Electrical		
Flare install		
Gravel		
Shipping		
Contingency		
Engineering, technology, startup		
Construction Management		
Travel		
Insurance and performance bond		

7. Trucking and Spreading		
Chicken litter Tanker Trucks	8,000 capacity	2 **ea**
Liquid chicken litter spreaders	W/injection tool bar	2 **ea**

Project Economics

Certain assumptions were used for this analysis. Some are based on values known to be accurate for such projects. It was assumed that all electricity would be sold. Electric offset values based on the energy component of Community electric bills were not developed. Though gas production may be entirely converted to electricity, in reality the electrical generation system will be operational about 90% of the hours of the year due to outages and maintenance. Gas produced during those times cannot be economically stored and will be automatically flared. Numbers may not precisely compare with cash flow tables due to rounding errors. An economic analysis was conducted based on factors and assumptions summarized in Table 18 and in Table

19 below.

Table 18
Project Economic Assumptions

Project life	20	years
Loan period	20	years
Down Payment	25	%
Loan Interest Rate	6	%
Discount Rate	8	%
Tax Rate	0	%
Depreciation	straight line	
O&M Costs	$ 0.015	/kWh
Energy Cost Growth	3	%

Table 19
Project Operational Assumptions

System Thermal parasitic	as needed	
System Power parasitic	10%	
System "uptime"	90%	
Boiler efficiencies	80%	
Electric Offset value	$ 0.065	/kWh

Based upon the investment and benefit assumptions made above, the economic analyses for various potential scenarios for the system are described in Table 20 and Table 21.

Table 20
Economic Analysis of Investment

Calculated Values	No Grant
System Cost	$5,492,574
Amount Financed	$4,119,431
3rd Year Revenue	$628,721
3rd Year O & M	$207,882
Performance Values	
Net Present Value	($308,504)
Internal Rate of Return	4.4%
Payback Years	13.1

Table 21
Economic Analysis of Investment with $500,000 Grant

Calculated Values	
System Cost	$4,992,574
Amount Financed	$3,744,431
3rd Year Revenue	$628,721
3rd Year O & M	$207,882
Performance Values	
Net Present Value	777,889
Internal Rate of Return	19%
Payback Years	9.8

2.9.2 Digester System Benefits

Monetary Benefits

There is positive cash flow for the project. The methane recovery and utilization system will produce financial gain for the digestion system owner over the 20-year life of the project. The principle monetary benefit would be the value of biogas as a fuel for a generator and selling electricity into the utility grid. A 20-year cash flow analysis for each of the financial scenarios summarized above is found in Appendix A. The assumptions of no depreciation or customary potential tax benefits have been modeled for consideration in developing the project. This represents a conservative economic analysis, because both deprecation and tax benefits could be used to attract partners to the project such that the overall financial picture would be enhanced. Thus, if at some point if the Community should decide to proceed with the project, the decision as to bring in outside partners would need to be addressed and the resulting economic impact assessed. The green house gas tax credit is calculated based on the conversion of C02 and is valued at $69,947 per year. The assumption of a renewable energy production tax credit is valued at $63,570 per year.

5.4 STEPS TO ACHIEVE SUCCESSFUL PROJECT DEVELOPMENT

The history of farm digesters in North America shows that they are successful if properly designed and managed. Each project location has unique design demands. Attempting to replicate construction of an existing unit (aside from the legal implications) may result in an inappropriate selection of technology that is insensitive to the realities and expectations of the project. Most often designs that ultimately failed were inappropriate because they were proposed, designed and built by individuals or firms who, though well intentioned, lacked experience. Success is expected with a chicken litter digester, if a good design is chosen.

Should the project proceed, the services of a design firm with documented experience and liability insurance should be obtained. The firm should have worked with similar chicken litter, in a similar setting, and at a similar scale. The firm should be able to make output projections based on similar projects. The firm should be prepared to provide a detailed operation and maintenance manual upon startup of the system. The firm should agree to provide operator training and technical assistance to ensure a smooth startup.

The digester system will need daily oversight and consistency in management. Immediate attention to unexpected maintenance, as well as daily observation and record keeping should be reliably collected and recorded. If not, digester outputs and equipment runtime may suffer. All farm waste inputs will need to be routinely monitored to track quantity and makeup. Any materials that might be damaging to the digester operation must not enter the collectable manure for the digester.

Should the project proceed, an experienced operator who will be in position for several years should be located and a waste collection program developed that follows a regular schedule to ensure consistent digester feed. Evaluate the chicken litter collection and plumbing system should be evaluated to eliminate any vulnerable points where contaminants might enter the chicken litter stream to the digester. Systems should be developed to maintain all system operational records. Finally, acceptance of any off farm wastes into the digester should not be allowed without first consulting the system designer.

Should the project proceed, a regular maintenance log for the generation equipment should be established. Follow all manufacturers' recommendations for maintenance intervals on the equipment. Secure services of only qualified mechanics and electricians in the event of major repairs.

6.0 MANPOWER DEVELOPMENT

6.1 TRAINING NEEDS

Digester system operations require minimal onsite training to convey the basic daily system needs. System designers would typically include an operation and maintenance manual as well as providing ongoing technical support. Record keeping protocol would be developed to meet the needs of system observations to ensure optimum performance. Additional record keeping requirements may unfold pertaining to environmental regulations or permit requirements.

6.1.1 Safety

When operated properly, digesters are safe. In addition, there are very few pieces of equipment or practices used with a digestion system that are not already utilized on the farm. Biogas is 60% methane and does not contain the oxygen necessary for combustion. The digester top does not allow oxygen to enter the digester. As with all manure management, confined spaces must be ventilated for safe entry. As with all internal combustion engines, certain operating norms should be maintained. This application is little different from standby engines using natural gas or propane.

Redundant electronic safety relays and logic in the cogeneration control panel will also prohibit engine generator operation during outages. US utilities require utilization of locks to secure equipment when maintenance on the electrical equipment and lines is planned. Local and federal regulations and standards, as applicable, should form the basis for operation.

6.2 MANPOWER ESTIMATES AND ASSOCIATED COSTS

It is estimated that the operation of the digester will require 1.25 full time equivalents (FTE). Although the digester will require daily intermittent observation and data recording, it will not necessarily require all day or full time positions. For budgetary planning purposes, the digester operator FTE salary was estimated at $30,000 per year. This represents a project cost of $37,500 per year. Actual salary ranges should be investigated to more accurately reflect employment pay scales in the project area.

7.0 ECONOMIC ASSESSMENT

7.1 SYSTEM COMPARISONS

Current Practice: Trucking Raw Solid Chicken Litter

The current chicken litter handling method is to truck raw chicken litter to available fields through out the Community. Chicken litter is spread followed by disking the fields to incorporate chicken litter into the soil. The stated benefit of this practice is the ability to control chicken litter applications to the current multiple-crop, rotational strip farming practice. In the final financial analysis, the cost of this practice must be accurately calculated and compared to the liquid effluent application alternative. This analysis should include the cost to purchase equipment, operator costs for trucks plus the associated field tractor time, licenses and insurance, and repairs and maintenance. Custom chicken litter haulers who were interviewed in early 2004 for a project in another state were quoting trucking rates from $60 to $80 per hour. That rate has undoubtedly increased with rising fuel costs.

There are other aspects associated with the solid chicken litter trucking that require additional consideration. During field data collection for the project, chicken litter samples were pulled from each of the poultry houses. The analysis indicated that there is a high degree of variability in the fertilizer value from barn to barn. As a result, each truckload of chicken litter will also be highly variable. It would be very difficult to track and account for the actual fertilizer content per pound of chicken litter in each of the 8 truckloads per day without an extensive and continuous composite chicken litter sampling program.

Additionally, the chicken litter trucks must travel on and cross major roadways in order to reach all of the farm's fields. The possibility of traffic accidents involving the chicken litter trucks is increasing on these roads with higher volumes of traffic from the new high-density housing developments that are growing around the Community. Trucking raw chicken litter increases the possibility of spillage on the roadways, which can trigger nuisance complaints. Raw chicken litter applications also create odor and fly problems, which can impact the Community and other tribal enterprises.

Digester Options for Utilizing Treated Liquid Effluent

If anaerobic digestion is the chosen technology, the current raw chicken litter trucking practices will no longer be needed, but rather different trucking practices will need to be employed. The digestion process will turn the solid chicken litter into a nearly odorless, treated liquid effluent with some separable solids. The digested effluent has monetary value as a high quality organic fertilizer for the Ak-Chin Farm. Chicken litter (effluent) handling practices can be optimized to produce economic gains for the farm operation.

Liquid application equipment has been developed that greatly improves the efficiency of liquid form nutrient utilization. Systems that conserve ammonium nitrogen (NH_3N) and provide nutrients in balance with crop needs increase the economic value of the chicken litter. Studies at Colorado State University have measured the impacts of various application methods on nitrogen volatilization losses. The nitrogen losses, represented as "total N" are summarized in the following table.

Table 22
Comparative Nitrogen Volatilization Losses

APPLICATION METHODS	ESTIMATED NITROGEN LOSS
Sprinkler irrigation	35 to 60%
Broadcast without cultivation	10 to 25%
Broadcast with cultivation	1 to 5 %
Injection/drag hose	0 to 2 %

The nutrient application method utilized with liquid digester effluent will preserve a greater percent of the fertilizer value and is another overall beneficial factor to consider with the digester system. Estimates of the values for nitrogen loss for both solids and liquids is shown in the table below. Nitrogen is the most valuable component in the chicken litter. Assuming a very conservative estimated value of $0.21/lb, the value of nitrogen is $81.66 per 1,000 diluted gallons (or$0.08166 per diluted gallon). The type of application method employed determines the amount of nitrogen loss to the atmosphere, which in turn affects the overall value of the product.

Table 23
Estimated Value of Nitrogen Loss

System Comparison	Solids	Liquids
Nitrogen loss/1,000 gal manure	$0.49	$0.20
Nitrogen loss/day	$49.00	$20.00
Annual nitrogen loss	$17,885.00	$7,300.00
Annual fertilizer savings/liquid injection		$10,585.00

Source: Based on Colorado State Study

Based on the previous assumptions, the comparison of the value of nitrogen by application method is summarized in Table 24.

Table 24
Comparative Nitrogen Fertilizer Value Lost per 1,000 gallons

APPLICATION METHODS	ESTIMATED NITROGEN VALUE LOST
Sprinkler irrigation	$3.45 to $5.92
Broadcast without cultivation	$ 0.99 to $ 2.47
Broadcast with cultivation	$0.10 to $0.49
Injection/drag hose	$ 0.00 to $ 0.20

On average, a broadcast chicken litter application assuming incorporation within 12 hours of spreading, assuming the highest rate of loss shown in Table 24, will lose about $0.49 per 1,000 gallons of chicken litter. If the chicken litter lies on the surface of the field for more than 12 hours, the fertilizer value decreases significantly. Assuming the highest rate of nitrogen loss shown in Table 24 for a liquid injection system, the value lost is about $ 0.20 per 1,000 gallons of chicken litter. Based on these assumptions, a liquid injection system can easily save over $10,000 per year in fertilizer value over a solid chicken litter broadcast application system, because of the reduced losses associated with a liquid injection system. This does not reflect transportation costs.

Since transporting liquid nutrients to the field can be costly and time-consuming, three transportation options to support a liquid injection system were evaluated for the feasibility analysis.

7.1.1 Option 1. Pipeline

The first option developed for consideration was the concept of a nutrient pipeline. The pipeline option was presented to the Ak-Chin Farm Board during the interim status meeting in January 2005. In this scenario, the digester proposal would rely on pumps, pipes, and as much as possible, the existing irrigation systems that are already in place on the Ak-Chin Farm to move the liquid effluent from the storage lagoons to the fields as fertilizer for the crops. Installed pressure lines were estimated at $15.00 per foot. The price of 4” PVC sewer pipe was estimated to cost about $0.90 per foot. It was estimated that 10-miles of new effluent pipeline equipped with 90-access valve sites would cost about $573,000 and would offset the current cost of solid chicken litter trucking in less than 3 years.

7.1.2 Option 2. Tanker Truck and Liquid Chicken Litter Spreader

In this scenario, liquid effluent would be trucked to the fields. In many regions of the country, over-the-road tankers with capacities of 6,000 to 8,000 gallons are utilized to transport liquid or slurry chicken litter to the edge of the field. The Federal Motor Carrier regulations were consulted to determine vehicle gross weight and tandem axle weight limitations in Arizona. Tandem axle weight limit is set at 34,000 pounds per axle and the gross vehicle weight is 123,000 pounds. The overall gross vehicle weight (GVW) of an 8,000-gallon capacity tanker is estimated to be 47 tons, which is well below the GVW limit for Arizona highways. Assuming a 9-axle truck and tanker trailer configuration, the axle spacing can be set to meet the tandem axle weight limit. Any specific load limits for bridges on the local area roads would need to be determined.

There are pumps available for purchase that are capable of filling an 8,000-gallon tanker in 6 minutes. The liquid nutrients would be pumped from the effluent storage facility into the tanker truck and transferred to smaller liquid chicken litter spreaders in the fields. These spreaders can be equipped with injectors and disking bars to immediately incorporate the effluent nutrients into the soil. Liquid chicken litter spreaders have been designed with wide floatation tires to minimize soil compaction.

The liquid chicken litter spreaders are equipped to self-load from the tanker truck and can run at relatively high speeds with low horsepower tractor requirements. It is believed that his option cuts application costs by eliminating one of the passes in the field to spread and incorporate the nutrients. A one pass disking operation is estimated to save the Farm $77,350 annually in tractor time. Some concerns have been voiced regarding whether the liquid injection tool bar would be adequate to effectively work up the fields. It is recommended that a local dealer be contacted to provide information and perhaps a field demonstration to further evaluate the capability of the liquid chicken litter spreaders.

This scenario also reduces the truck time per day by 2 hours per truck because the tractor and spreader will handle the actual field application time. Assuming a truck rate of $85.00 per hour, this represents a cost savings of $340.00 per day. This reduction of truck time and the resulting savings could help to offset the cost of purchasing two new liquid fertilizer wagons.

7.1.3 Option 3. Combination Pipeline and Liquid Chicken Litter Spreader

This scenario combines the concepts from the other two effluent options presented thus far. A mainline carrying the liquid nutrients to various locations on the farm could be developed. Based on the nutrient delivery needs identified by the Farm, risers and valves could be installed and developed as filling stations for the liquid spreaders at key locations. The liquid chicken litter spreaders are equipped with self-loading pumps that could receive effluent from these pipeline locations; the nutrients would then be hauled to the nearby fields and be applied and incorporated in one pass over the fields. This option combines the benefit of eliminating all forms of chicken litter trucking on the roadways while representing an estimated savings from $313,000 to $390,000 per year depending on the actual number of trucking hours that are offset. The additional benefit is the ability to deliver nutrients in a highly controlled and precisely measured manner.

A variation to the pipeline and liquid chicken litter spreader system is a flexible drag hose delivery system instead of the liquid spreader wagons. A high volume, medium pressure pump located at the effluent storage structure would deliver liquid nutrients to the edge of the field at the field mid-point using standard 6 to 8 inch irrigation line. A 4 inch soft irrigation hose is connected to the pipeline riser valve at the mid field station. Chicken litter is delivered through the flexible drag hose to a tractor with toolbar-mounted injectors or splash plates immediately in front of the normal tillage implement, presumably a disk. The flexible towed hose system distributes chicken litter at rates of up to 1,000 gallons per minute. One dragline tractor setup reportedly injects one million gallons of effluent in three to four days. The advantage to this system is the elimination of trucking as well as the purchase and maintenance of the liquid spreader wagons.

System Configuration Summary

Table 25 summarizes the currently known elements in a comparison of the effluent delivery options discussed above. The costs of current solid chicken litter handling practices conducted by the Ak-Chin Farm are budgetary estimates based on other similar farm practices. The Ak-Chin Farm has not verified the actual cost of these operations. The budgetary estimate of the annual operating costs to deliver digester effluent to the fields using a pipeline is based on mass balance calculations and the system parasitic loads (power required to operate the system equipment) to pump chicken litter. This annual operating cost was converted to an operational cost assuming an electrical value of $0.065 per kWh. The annual operation savings reflected in the liquid tanker truck option is based on the assumption that one tractor pass through the fields can be eliminated by combining liquid application and disking practices in the same pass. The annual operation costs of the final scenario assumed $80,000 per year to pump the effluent to the fields and $75,000 to inject and disk into the soil.

Table 25
Budgetary Estimates for Digester Effluent Utilization Comparison

System Configuration	Annual Operation Costs	Additional Equipment Costs	Annual Operation Savings	Annual Fertilizer Savings
CURRENT Solid chicken litter Trucked Broadcast application tractor/disk	$390,283			
OPTION 1. Liquid chicken litter pipeline with existing irrigation system	$80,000	$837,000	$390,283	none
OPTION 2. Liquid chicken litter tankers with liquid spreader & injectors	$312,933	$342,000	$77,350	$10,585
OPTION 3. Pipeline with liquid spreaders/injectors	$155,000	$937,000	$235,283	$10,585

Non-monetary benefits

There are other project benefits that are significant although somewhat difficult to assess with an exact dollar value. The benefits of a liquid tanker with an injection system or a flexible hose system for application include optimizing the application schedule, maximizing the nutrient conservation of the chicken litter, controlling odor and reducing flies, eliminating chicken litter transportation on the roads, and saving time and money by combining the chicken litter spreading and incorporation steps into a one-pass nutrient application process. Table 26 summarizes non-monetary benefits expected from the installation of a digestion system.

Table 26
Non-Monetary Benefits of a Digestion System

1. Odors from chicken litter will be greatly reduced when biogas is produced in a controlled fashion, captured and burned.
2. Pathogenic organisms in the digested chicken litter will be greatly reduced.
3. Recovery and combustion of methane reduces the uncontrolled release of methane, a highly reactive greenhouse gas, from chicken litter management to the atmosphere.

Table 27 developed by the University of Nebraska Cooperative Extension Service, summarizes and compares the key elements of various system benefits that have been discussed for consideration.

Table 27
Environmental Comparison of Various Chicken Litter Application Systems

	Uniformity of Application	Conservation of Ammonium	Odor Control
Solid Chicken litter with Flail Spreader	FAIR	VERY POOR	FAIR
Liquid Chicken litter with Center Pivot Irrigation	FAIR	POOR	VERY POOR
Liquid Tanker with knife injector deep incorporation	GOOD	EXCELLENT	EXCELLENT
Drag Hose shallow incorporation	GOOD	EXCELLENT	EXCELLENT

Summary

Three liquid digester effluent delivery systems have been compared to the current raw chicken litter application practices utilized by the Ak-Chin Farm. Annual operational costs for a pipeline based delivery strategy are estimated to be considerably lower than for either trucking solid chicken litter or liquid effluent to the fields. It was estimated that the annual operational cost savings from OPTION 1, a pipeline delivery configuration utilizing the existing irrigation system to apply the effluent over trucking chicken litter solids, could offset the cost of the pipeline in 2.2 years. However, it was determined that a pipeline delivering effluent to the existing irrigation delivery system did not provide the flexibility and control that is needed to meet the nutrient application schedule and crop rotational strategies currently practiced by the Ak-Chin Farm.

Option 2, Trucking liquid effluent to the fields and off loading into liquid chicken litter wagons with injector tool bars compares favorably to the cost of hauling raw chicken litter and applying with flail broadcast spreaders. Studies have shown that incorporating liquid nutrients into the soil preserves more of the original fertilizer value from the chicken litter than broadcasting the raw chicken litter. The value of this fertilizer savings was conservatively estimated at $8,500 per year. This method could also assume a small cost savings in trucking costs over hauling and spreading solids due to a quicker trip turn-around with the larger liquid tanker trucks. Preliminary information regarding the expected performance of the injection tool bar on the liquid spreaders suggests additional cost savings by eliminating one tractor pass over the fields for disking nutrients into the soil. However for purposes of the feasibility analysis, these assumptions were not included. The project budget actually included an additional cost of $75,000 per year to ensure a total offset for the current Ak-Chin Farm solids handling practices. Additionally, incorporating liquid digester effluent into the soil is the best method to control odor and flies that are commonly associated with raw chicken litter application practices. It was estimated that the combined annual cost savings from operations and fertilizer value would offset the cost of new equipment in about 4 years.

Based on the preliminary cost and environmental benefits analysis, the most favorable system configuration would appear to be Option 3, a pipeline pumping effluent to various crop blocks and off loading into liquid field application wagons equipped with injector tool bars. This approach eliminates all of the high cost and traffic risks associated with trucking any form of nutrients to the fields. The liquid application wagons could deliver nutrients in a highly controlled schedule to match any crop rotation schedule. The liquid effluent would provide nutrients for the crops in an evenly mixed solution that would be predictable and require less testing to determine application rates. All of the nutrient conservation opportunities as well as the environmental benefits discussed above would be provided with this configuration. Although this strategy would cost the most initially, it is estimated that the cost savings from eliminating the trucking plus the nutrient conservation value would offset the additional expense over the other systems in 3.8 years.

Ultimately the strategy that is adopted will be based on ongoing input from the Ak-Chin Farm and the Community Council. Once the best option to meet all the project goals and expectations has been determined, a business plan will be developed.

7.2 ALTERNATIVE ENERGY ECONOMIC INCENTIVES

Arizona Renewable Portfolio Standard

Under Arizona's Environmental Portfolio Standard (EPS), regulated utilities in the state are required to generate a certain percentage of their electricity with renewable energy according to the following schedule:

* 0.2% in 2001
* 0.4% in 2002
* 0.6% in 2003
* 0.8% in 2004
* 1.0% in 2005
* 1.05% in 2006
* 1.1% in 2007-2012

Eligible technologies include solar electric, solar water heating and solar air conditioning, landfill gas, wind and biomass. Solar electric power must make up 50% of total renewables required in 2001, increasing to 60% in 2004-2012. Arizona Public Service, a utility, has requested and received a rule waiver allowing it to meet a portion of its EPS requirements using geothermal resources.

Funding for the EPS comes from existing system benefits charges and a new surcharge for the ratepayers to be collected by the state's regulated utilities. The new surcharge is capped at $0.35 per month for residential customers, $13 per month for non-residential customers and $39 per month for customers with loads over 3 MW. At least $15 million-$20 million will be collected annually to support the EPS.

The Arizona Environmental Portfolio Standard is currently under review and proposed modifications are being developed. At this time, the EPS is expected to be increased to 10% by 2012 and 15% by 2017. The proposed changes would eliminate the solar set aside and open the provision of other forms of renewable energy to independent power producers.

At this time, APS is working on development of a variety of biomass energy projects around the state including a farm and dairy waste assessment in the agricultural area near Ak Chin. However, APS has demonstrated its preference for building and operating its own projects rather than entering into purchase power agreements with independent power producers; one exception to this involves a landfill gas-power purchase from Tucson Electric, which has for the most part satisfied the company's requirement for non-solar purchases under the current EPS. However, should the EPS be increased by the Arizona Corporation Commission, APS would be much more interested in purchasing the credits.

The lack of examples of purchase power agreements and EPS credit purchase agreements executed by APS leaves open the question of how much APS would be willing to pay for renewable energy. To date, APS has been purchasing solar EPS credits, but not from large–scale producers.

Renewable Energy Certificates – Green Tags

Green Tags are a tradable commodity developed by the electricity industry. Green Tags enable wind farms, solar and other renewable electricity generators to receive added value for the emissions reductions and other environmental benefits their plants generate. Biomass facilities are qualified producers of Green Tags.

Electricity generators that burn fossil fuels produce two things: electricity and emissions consisting of airborne pollutants and greenhouse gases. Clean electricity generators reduce the amount of emissions from fossil fuel generators when clean electricity generators replace the fossil fuel generator's electricity. When clean electricity generators operate, the grid must give these generators priority over other (more polluting) generators. This directly reduces emissions of pollutants and greenhouse gases.

Green Tags represent the reductions in emissions and other environmental benefits of clean energy generation. They are a valuable commodity that is separate and distinct from the electricity itself. Like electricity, however, Green Tags are quantified in units of electricity. For each megawatt hour (MWh) of electricity a clean electricity generator produces, it also generates a one-MWh Green Tag.

If the sale of a clean electricity generator's electricity is arranged so that the buyer gets only "generic" or "null" electricity, and no rights to claim ownership of or responsibility for the resulting environmental benefits, the Green Tags remain with the clean electricity generator's owner. When there are no local buyers willing to pay extra for their electricity as "clean" electricity, clean electricity generator's owners can sell the generic electricity locally at market prices, and sell the Green Tags to other purchasers, remote or local, to obtain the extra revenues they need for their projects to be economically viable.

The U.S. market for Green Tags is in the early stages of development. The market is more advanced in Europe, where Green Tags are actively traded for the emissions reductions they represent. Buyers purchase "credits" or "allowances" for these emissions reductions as a means to avoid having to reduce their own emissions of the various pollutants including greenhouse gases.

Environmental attributes of a Green Tag vary with the renewable technology and the electricity grid energy or fuel displaced. For solar and wind systems with no air emissions, the average grid MWh displaced in the U.S. has reduction value of:

- 1,400 lbs. carbon dioxide (no cap/trade)
- 6 lbs. NOx (before cap/trade)
- 3 lbs. SOx (before cap/trade)
- 0.027 lbs. Mercury

Standard green tags are sold from existing projects as they generate kWh, usually through short-term sales. Small projects are often overlooked due to transaction costs. Purchase and sale provides financial support for the projects and builds demand for new projects.

In an emerging "green tag futures" approach, Green Tags are sold from projects under construction. Pre-payments are made for a stream of future green tag rights. Multi-year agreements that include pre-paying for the tags overcome transaction costs and avoids performance and sales risks. Pre-payment has the ability to actually help build new facilities.

Green Tags can be used to meet mandates such as RPS (minimum renewable portfolio standards for utilities) and Regulatory guidelines (e.g. IRP goals). Green Tags can also fulfill voluntary/customer choice program content for green pricing programs for utilities, energy service provider product offers, and green tag resellers and green tag-based emission reductions.

Green Tags can be sold or consumed only once. A utility cannot sell Green Tags into a green pricing program and also count them toward a RPS requirement. A building powered by a solar array that has sold its Green Tags cannot say it is powered by solar, but can say it hosts a solar array.

Wholesale cost of Green Tags, received by generators and power marketers, generally range from $1 to $10 per MWh. Retail price for Green Tags generally range from $10 to $25 per MWh, but recent trends are downward. Retail price is largely driven by the above-market costs of the renewable projects and consumer preference to support solar and wind. Where significant regulatory mandates are in place to require utilities and other suppliers to purchase a minimum level of renewable energy to serve their customers, short-term price increases have occurred.

The current market for Renewable Energy Certificates (RECs) or Green Tags ranges between one cent and one and a half cents per kilowatt hour, generally purchased in 1000 unit blocks or ten to fifteen dollars per MWh.

The market value of the RECs from the AK Chin project is affected negatively by two factors. The project will utilize chicken litter as a fuel source. Buyers of RECs are generally more disposed to purchasing credits from wind and solar projects because they have no emissions. The perception of consumers that Chicken litter is being combusted is generally negative. The fact that the biogas from the project is in fact being combusted in an engine genset that produces emissions is the other negative factor that reduces the potential market for the Ak Chin project RECs.

The negative attributes of the project are offset by two other positive attributes. The project is located on Native American land and there are environmental benefits to the local area from stopping the direct land application of raw chicken litter to the fields. Groundwater pollution prevention and helping Native Americans develop renewable energy resources are elements of projects that many REC purchasers support.

The Project Team will work with REC marketers to determine the specific value and potential markets for the RECs. A determination will be made as to the feasibility of pre-payment, short-term, or long-term purchase agreements for the RECs. The possibility of selling the RECs to an Arizona utility or energy service provider, to satisfy their EPS requirements, will also be negotiated during the Due Diligence phase of the project development.

Renewable Electricity Production Credit

The Renewable Electricity Production Credit (REPC) is a per kilowatt-hour tax credit for electricity generated by qualified energy resources. Enacted as part of the Energy Policy Act of 1992, the credit expired at the end of 2001, and was subsequently extended in March 2002 as part of the Job Creation and Worker Assistance Act of 2002 (H.R. 3090). The tax credit then expired at the end of 2003 and was not renewed until October 4, 2004, as part of H.R. 1308, the Working Families Tax Relief Act of 2004, which extended the credit through December 31, 2005. The Energy Policy Act of 2005 modified the credit and extended it once again through December 31, 2007. The expiration date for solar facilities remains December 31, 2005.

Section 710 of the "American Jobs Creation Act of 2004" expanded REPC to include additional eligible resources -- geothermal energy, open-loop biomass, solar energy, small irrigation power, landfill gas, municipal solid waste combustion, and refined coal -- in addition to the formerly eligible wind energy, closed-loop biomass, and poultry-waste energy resources. The Energy

Policy Act of 2005 further expanded the credit to certain hydropower facilities and Indian coal (coal reserves owned by an Indian tribe or were held in trust by the U.S. for the benefit of an Indian tribe).

REPC now applies to the following resources:

* wind
* closed-loop biomass
* open-loop biomass
* geothermal energy
* solar energy
* small irrigation power (150 kW - 5 MW)
* municipal solid waste
* landfill gas
* refined coal
* hydropower
* Indian coal

The REPC provides a tax credit of 1.5 cents/kWh (in 1993 dollars), adjusted annually for inflation, for wind, solar, closed-loop biomass and geothermal. The adjusted credit amount for projects in 2005 is 1.9 cents/kWh. Electricity from open-loop biomass (closed loop biomass utilizes a dedicated agricultural crop as a fuel source), small irrigation hydroelectric, landfill gas, municipal solid waste resources, and hydropower receive half that rate -- currently 0.9 cents/kWh.

The duration of the credit is 10 years. However, open-loop biomass, solar, geothermal, small irrigation hydro, landfill gas, and municipal solid waste combustion facilities placed into service after October 22, 2004 and before enactment of the Energy Policy Act of 2005 August 8, 2005 are eligible for the credit for a five-year period.

Tax Credit Bonding

The Ak Chin biomass project is an open-loop biomass facility and is eligible for the REPC for a period of ten years, if placed in service before December 31, 2007. The Community, however, is not a taxable entity and therefore has no need for the tax credits. The Energy Policy Act of 2005 includes relevant provisions in Title XIII – Tax Incentives - Targeted Expansion of Tribal Bond Authority for Clean Renewable Energy Bonds. **Clean Renewable Energy Bonds (CREBs) (§ 1303).** The Act creates a new tax credit associated with ownership of bonds. A project may be financed with CREBs if 95% of the proceeds are used to finance capital expenditures incurred for facilities qualifying for the Production Tax Credit under 26 U.S.C. § 45. Instead of tax-free interest characterizing traditional private activity bonds issued by governments, CREBs are zero-interest so bondholders receive a quarterly tax credit. Qualified issuers include governmental bodies, tribal governments, and mutual or cooperative electric companies. The Secretary of Treasury can allow CREBs up to an aggregate of $800 million nationally. CREBs will encourage individual private investment in renewable energy projects, providing a benefit to both the bondholding taxpayer in the form of a tax credit and the renewable energy sector in the form of additional private financing. The authority to issue these bonds expires December 31, 2007.

The Ak Chin biomass project is eligible for the REPC at a rate of 0.9 cents per kilowatt-hour for a period of ten years. The potential value of the tax credits from an approximately one-megawatt facility with 90% availability would therefore be $709,560 over a ten-year period. (1000 kW x 8760 hrs/year x 90% x $.009 x 10 years). The expenses associated with issuing and marketing the bonds would represent a deduction from potential revenue. Conversely, the value of the tax credit will increase with inflation.

The Project Team will coordinate with the Community to establish project-financing strategies including Clean Renewable Energy Bonding. These tax credits can be monetized and sold to private firms needing the tax credits. They are usually discounted (don't get full benefit for them) but can still be worth the effort. There is also a Renewable Energy Credit Incentive available to tribes that "mirror" the PTC. It actually pays the benefits rather than offering them through tax reductions. For tribes building biomass plants, it pays 1.5 cents/kWh in 1993 dollars escalated for 10 years, if the plant is commercial before 12/31/07.

Grants

USDA Farm Bill

Section 9006 of the 2002 Farm Bill requires the U.S. Department of Agriculture (USDA) to create a program to make direct loans, loan guarantees, and grants to agricultural producers and rural small businesses to purchase renewable-energy systems and make energy-efficiency improvements. This program is known as the Renewable Energy Systems and Energy Efficiency Improvements Program.

The USDA has implemented this program through a Notice of Funds Availability (NOFA) for each of the last three years. The latest round of funding, totaling $22.8 million, was made available in March 2005. Half ($11.4 million) of this sum is available immediately for competitive grants. Renewable-energy grants range from $2,500 to $500,000 and may not exceed 25% of an eligible project's cost. Applications are generally submitted to the appropriate Rural Development State Office in June. The remaining half ($11.4 million) will be set aside through August 31, 2005, for guaranteed loans for renewable-energy and energy-efficiency projects. Any funds not obligated under the guarantee loan program by August 31, 2005, will be reallocated to the competitive grant program as of that date.

The USDA is now in the process of developing regulations for this program, after having issued a proposed rule on October 5, 2004, and receiving comments filed by December 15, 2004. The USDA anticipates publishing the proposed regulation later this year.

Under the proposed rule, eligible renewable-energy projects include wind, solar, biomass and geothermal; and hydrogen derived from biomass or water using wind, solar or geothermal energy sources. The maximum *grant* award is 25% of eligible project costs up to $500,000 for renewable energy projects and $250,000 for energy efficiency improvements. Assistance to one individual or entity is not to exceed $750,000.

Under the *guaranteed loan* option, funds of up to 50% of eligible project costs (with a maximum project cost of $10 million) can be available. A combined grant and guaranteed loan under this program cannot exceed 50% of eligible project costs and the applicant or borrower is responsible for having other funding sources for the remaining funds.

In 2004, USDA funded 37 anaerobic digester projects under this program, totaling $9.5 million

The Project Team, through ACES will apply, as soon as possible, for funding from this program to support the project. Award of the grant funds is reflected in the sensitivities to the project pro-form economic analyses.

<u>DOE Renewable Energy Development on Tribal Lands</u>

Under this Program, DOE is solicits applications from Federally-recognized Tribes, Alaska Native villages and Alaskan Native Corporations to either:

1) Conduct feasibility studies for the development of economically sustainable renewable energy installations; or
2) Develop sustainable renewable energy projects.

Feasibility studies must be the result of a previously conducted resource analysis, which resulted in an identified renewable energy resource. Development projects must be the result of a previously conducted feasibility study, and may be either: 1) a renewable energy hardware demonstration as a step toward commercial development; or 2) pre-development activities associated with planned future commercial development.

Applications may include generation for local consumption, direct use such as building uses, water pumping, or other off-grid power uses, or for export off Tribal Lands to generate revenue.

Eligible technologies under this announcement include, photovoltaic (solar electric), concentrating solar power, solar thermal systems (i.e., active or passive solar technologies for space or water heating, or power generation technologies), wind, biomass power, hydroelectric, geothermal electric generation, geothermal resources for direct heating or cooling applications, and other renewable or renewable hybrid systems.

The maximum award available under this program is $250,000. The Ak Chin Biomass project will be eligible to apply for other funding to offset project costs.

8.0 AK-CHIN COMPATIBILITY ASSESSMENT

8.1 ENVIRONMENTAL IMPACTS AND BENEFITS

Odor and Air Quality

Waste storage structures and chicken litter stockpiles will produce effusive and disagreeably odiferous volatile organic acids due to incomplete anaerobic digestion. On the other hand, long term, or complete anaerobic digestion produces a stable and odorless mixture of methane and carbon dioxide. The treated liquid from the anaerobic digestion process can be stored long term or land applied without any odor concern, due to the dominance of non-odor inducing anaerobic bacteria that would populate the storage reservoirs.

An anaerobic digester is a vessel designed to contain decomposing chicken litter for sufficient retention time to effectively treat or digest raw chicken litter. It is designed to operate at a desired temperature in order to encourage and enhance the growth of methanogenic bacteria that break down the odor-causing agents in the waste. The effluent of a digester has been described as an “earthy smell with some ammonia present.”

Biogas formed in a digester bubbles to the surface and may be collected by a fixed rigid top, a flexible inflatable top or a floating cover depending on the type of digester. The collection system directs biogas to gas handling components. All of the methane will be captured and burned either in an engine-generator to produce electricity and heat energy or in an emergency by-pass flare. In this way, the system effectively removes a harmful greenhouse gas from the environment.

Ten micron sized particulate matter (PM10) emissions are typically associated with fugitive dusts and smaller particles of solid chicken litter application practices that carry harmful substances to the atmosphere. A liquid collection system and an enclosed anaerobic digester completely avoid this kind of emission potential.

Methane is the byproduct of any anaerobic decomposition of organic materials. Typical chicken litter handling techniques emit a tremendous amount of methane to the atmosphere. By coupling the automated chicken litter collection system in the poultry barns with immediate introduction to the anaerobic digester, nearly all the potential and customary methane emissions will be avoided.

It has been well proven that anaerobic digestion will virtually eliminate excessive odors on dairy farms, including storage ponds and irrigation fields. Numerous examples where effective odor control goals have been met with the installation of a digester can be found in the literature. In 1995, Dr. A.C. Wilkie et al from University of Florida published a paper titled, “Anaerobic Digestion for Odor Control” detailing system successes. The 1997, *Proceedings of the 3rd Biomass Conference of the Americas* included papers published on the effectiveness of anaerobic digesters for odor control.

The early pig manure digesters in the US were installed principally to control manure odors. Two pork producers in Pennsylvania have a 20-year history of effective odor control with their manure digester system. Both farms were located within one mile of towns and sub-divisions and had acute odor problems prior to installing a digester. In both cases, the heated digesters have stabilized the manure, collected usable gas and most importantly, satisfied the objections of the neighbors, town council, and state regulators.

There are several additional examples of successful manure digester projects designed and installed by RCM Digesters, Inc. primarily for odor control measures. The AA Dairy in Candor, N.Y. has reported a high measure of odor control that has put him back in good standing with his neighbors. Swine facilities in Colorado, Illinois, Wyoming and South America have all reported a significant benefit from the tremendous odor reduction provided by their digester systems. While difficult to assign an exact measurable quantitative reduction in odors, the fact that nuisance complaints have stopped against these facilities supports the effectiveness of the digester systems in odor reductions.

More and more, quantitative odor reduction studies associated with manure digesters are being conducted. The Department of Animal Sciences at N. Carolina State University (NCSU) conducted a laboratory study and reported a decrease in odor offensiveness in digested manure. An odor control "BMP's and Design Considerations" presentation is posted on the Idaho Department of Agriculture web page. In this report, the Technical Services Group reported that anaerobic manure digestion processes could reduce odors by as much as 60 to 80%.

Biogas burning or any direct combustion systems will require air emissions considerations. Any 1-megawatt facility will trigger the air emission standards. An environmental checklist to be used for the final project development is included in the appendix.

Water Quality

The Project Team met with the Director for the Ak-Chin Environmental Protection Department (EPD). The primary purpose of the meeting was to identify any tribal environmental issues or constraints that the digester project should consider. The primary EPD concerns were related to any impact on the cropland application management plan that would produce any adverse affects on the community wells. In addition to water quality concerns, it was reported that the EPD regularly receives numerous complaints about flies around the industrial park, manure spillage on the roadways, and odor complaints throughout the reservation. The EPD believes that if a digester system could meet state and federal permit requirements and greatly reduce flies and odors, that most likely there would be no local objections to the project.

There are over 100 wells on the Ak-Chin Farm that were decommissioned during the water rights appropriations. The Reservation's current Central Arizona Project (CAP) allocation is 75,000 acre-feet. It was noted that the 80,000 – 160,000 gallons per day needed to slurry the chicken litter for digestion would be insignificant if CAP water is used. Since the industrial park well cannot keep up with the demand from the Hickman's Egg Ranch swamp coolers, CAP water use is already encouraged as much as possible at the Hickman's Egg Ranch. The

Community has two drinking water wells. Most of the Community takes its drinking water from the well on Farrell Road. The nitrate level in this well is 8.5 ppm. The well at the industrial park has fewer hookups and mostly serves the businesses at the park. This well was measured at 6 ppm nitrates. The drinking water standard limits nitrates at 10 ppm. As a result, both drinking water wells are considered to be very high in nitrates. Additionally, the well water is at the upper limit for arsenic due to natural occurring deposits in the local soils. Due to these groundwater conditions, there are concerns about “field burnout” from the chicken litter applications and the potential for leachate to further affect groundwater.

Another consideration was the new EPA rule that eliminates the chicken litter semi-solids exemption from permit requirements. The rule defines a facility with 82,000 or more laying hens as a Confined Animal Feeding Operation (CAFO) and requires an application for a National Pollutant Discharge Elimination System (NPDES) permit for chicken litter discharge. However, under this new rule, such a CAFO operation has an opportunity to apply for a “No Potential To Discharge” (NPTD) determination. If the facility can demonstrate that it will not discharge wastewater to any water of the U.S. under any condition, then it will be exempt from NPDES permitting. Hickman’s Egg Ranch is subject to either a NPDES permit application or responsible for submitting adequate data and a plan to qualify them for a NPTD by February 2006. Involvement in a digester system for the bio-power project may provide a waste treatment process that would qualify Hickman’s Egg Ranch for NPTD status. If the Hickman’s Egg Ranch is participating in the digester system project with chicken litter feedstock input records and effluent and soil nutrient testing data, the system might have a very high return over spending money on a permit driven, non-revenue alternative.

8.2 EMPLOYMENT OPPORTUNITIES

It is anticipated that the digester system would create a minimum of 1.25 full-time equivalent (FTE) jobs at 8 hour/day; 7 days/week; 365 days/year. These positions are summarized in Section 6.2 above. The digester will require daily routine observation, detailed record keeping for feedstock input and gas production, effluent sampling for nutrient values, and basic engine service and maintenance.

Current ongoing jobs associated with the project will include two full-time truck drivers to transport effluent to the fields and two tractor operators to incorporate the effluent into the soil. A nutrient utilization planner and tracker to assist the Ak-Chin Farm Manager with soil testing is another possible associated position. In the near future, environmental permit applications and monitoring reports are another possible project related job opportunity.

The renewable energy project may create significant public interest. A part-time system tour guide and public relations position could evolve. Another possibility involves regional resource assessment to identify and secure other sources of biomass that could be incorporated into a larger Tribal “Alternative Energy Park” encompassing a growing system as opportunities are discovered.

In summary, there are at least eight potential employment opportunities would be associated with the initial project. Other spin-off job opportunities may evolve as the project is developed and potentially grows.

8.3 EFFECTS ON CULTURAL AND SOCIAL TRADITIONS

The Project Team met with the Director for the Ak-Chin Cultural Resources Department and three staff members. The primary purpose of the meeting was to identify any tribal cultural or archeological issues or constraints that the digester project should consider. The Community's Archeological Ordinance requires that any ground disturbing activity triggers department monitoring. The first step for preliminary project siting will require a "Pedestrian Survey" by the department. The siting choice could be denied if any sensitive or archeological materials are found. If these issues arise during ground disturbance, a process is initiated with the Community Elders who in tern make their recommendations to the Community Council. It was noted that this could be a slow and time-consuming process.

The Cultural Committee is currently reviewing the zoning laws within the Village area. It was noted that the county zoning maps currently show "heavy industrial zoning" along the railroad tracks and Cowtown Road, which is the road parallel to the railroad tracks near the feedlots. The Committee also stated that they are interested in preserving and protecting natural habitat areas including the alluvial fan from the wash in the northwest corner of the reservation as well as the wash adjacent to the Industrial Park.

9.0 FINANCING AND FINAL REPORT

9.1 REMAINING PROJECT BARRIERS

Issue: Utilizing Liquid Effluent

Research clearly shows that the liquid effluent is a viable and cost-saving fertilizer option. The final method of application must be further developed in cooperation with Ak-Chin Farm to ensure that the selected system best meets the needs of the Ak-Chin Farm.

Significance

Should the Project Team and Ak-Chin Farm not reach a viable strategy to utilize the digester effluent, the project as conceived will not work. In addition, there must be adequate land available near the digester location to agronomically apply the liquid digester effluent.

Recommendation

Preliminary findings indicate that there are liquid fertilizer strategies that work. The next step, should the project proceed, would be to confirm the viability of the preferred liquid handling option through joint review of the detailed cost comparison analysis that accurately compares current costs of the solid chicken litter handling practices to the preferred liquid handling option. This would include utilizing the assistance of the Ak-Chin Farm's nutrient management specialist to consider a cropping strategy and fertilizer application schedule that can compare current raw chicken litter spreading to the liquid digester effluent in full detail.

Issue: Cost Estimating

To arrive at costs for this analysis, RCM used "contractor built" estimating techniques, unless otherwise noted. Rapidly rising material and transportation costs are a constant factor affecting the budget estimates. The prices estimated should be reliable for 6 months after the date of the report.

Significance

Analysis results based upon the current construction estimates indicate the project would be cost effective. Ultimately, the method of construction and degree of contractor involvement will affect the costs. Long delays in the project schedule may create increases in the original budget due to rising material costs incurred during delays.

Recommendation

Should the project proceed, approaches need to be examined to help keep construction cost within the range that allows the project to continue to be cost-effective. This should include evaluating the least cost method for construction utilizing local labor and equipment or contractors who are capable of the construction needed. Develop a maximum system design capacity based on best estimates for waste generation expansion plans for the project to ensure that costly system "retrofits" are not needed during the effective lifespan of the project. Develop and follow a project schedule to avoid costly delays and downtimes. Identify and resolve any project showstoppers, such as lengthy permit requirements, as early in the project process as possible.

9.2 OWNERSHIP STRUCTURE

At this point in time the ownership structure has not been determined. For purposes of the economic analysis, it was assumed that the Community would be the sole owner of the project. However, the final ownership structure is closely linked to the final financing arrangements made if the project proceeds to implementation. Other ownership arrangements will be explored once a decision has been reached as to whether or not to proceed with the project. The final ownership arrangement will need to satisfy the Community's needs and ensure the financial viability of the project.

9.3 FINANCING ARRANGEMENTS

At this point in time the final financial arrangements have not been determined. For purposes of the economic analysis, it was assumed that the Community would provide 25% equity and finance 75% of the remaining project costs. The final financial arrangements will be linked to the final ownership structure as well as to the availability of grants and other incentives associated with renewable energy projects. The final financial arrangement will need to satisfy the Community and ensure the viability of the project.

9.4 FINAL BIOMASS FEASIBILITY SUMMARY

The most sensitive elements of the final biomass analysis are the cost of the project and the value of the energy and liquid fertilizer. The cost of each system has been optimized based on the assumptions. Additional benefits from potential sources of funding such as grants were not include in the analysis. While estimates were made fore the quantity and value of the products, if the project proceeds they should be further investigated. In taking a conservative approach to the feedstock for the digester, potential outside organic feedstocks were not included in the analysis. Additionally, the report included sensitive elements such as environment and aesthetics that relate to quality of life aspects for the Community. While quantifying these elements is difficult, the report did address them from a qualitative viewpoint.

In conclusion, the digester system meets the stated goals of the project. The digester approach is

- technically feasible,
- offers numerous monetary benefits to the Community,
- offers non-monetary benefits to the Community, and
- can provide a delivery system for the liquid fertilizer that can meet the needs of the Ak-Chin Farm for a satisfactory and feasible strategy to utilize liquid effluent produced by the digester system.

APPENDIX A

	A	B	C	D	E	F	G	H	I	J	K
1	**Base Case:**	**No Grant, No Production Tax Credit, 25% Equity**									
2	**Round Digester**										
3	Year	1	2	3	4	5	6	7	8	9	10
4	**Costs**										
5	Down Payment	$ 1,373,144	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Principal payment	$ 111,985	$ 118,704	$ 125,826	$ 133,376	$ 141,378	$ 149,861	$ 158,853	$ 168,384	$ 178,487	$ 189,196
7	Interest expense	$ 247,166	$ 240,447	$ 233,325	$ 225,775	$ 217,772	$ 209,290	$ 200,298	$ 190,767	$ 180,664	$ 169,955
8	Operation and Mainte	$ 195,949	$ 201,828	$ 207,882	$ 214,119	$ 220,542	$ 227,159	$ 233,974	$ 240,993	$ 248,222	$ 255,669
9	**TOTAL CASH EXPENSES**	$ 1,928,244	$ 560,980	$ 567,036	$ 573,274	$ 579,698	$ 586,315	$ 593,131	$ 600,151	$ 607,382	$ 614,830
10											
11	**Revenues**										
12	Electricity purchase offset	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13	Sale of excess electricity	$ 459,113	$ 472,886	$ 487,073	$ 501,685	$ 516,736	$ 532,238	$ 548,205	$ 564,651	$ 581,590	$ 599,038
14	Electric Capacity Savings	$ 63,570	$ 65,477	$ 67,441	$ 69,464	$ 71,548	$ 73,695	$ 75,905	$ 78,183	$ 80,528	$ 82,944
15	Hot Water Offset	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
16	Greenhouse Gas Tax Credits	$ 69,947	$ 72,045	$ 74,207	$ 76,433	$ 78,726	$ 81,088	$ 83,520	$ 86,026	$ 88,607	$ 91,265
17	**TOTAL CASH REVENUE**	$ 592,630	$ 610,408	$ 628,721	$ 647,582	$ 667,010	$ 687,020	$ 707,631	$ 728,860	$ 750,725	$ 773,247
18											
19	Pretax NET	$ (1,335,615)	$ 49,428	$ 61,684	$ 74,309	$ 87,312	$ 100,705	$ 114,499	$ 128,708	$ 143,343	$ 158,417
20	Depreciation	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629
21	Total Tax deductions (1)	$ 717,744	$ 716,903	$ 715,836	$ 714,523	$ 712,944	$ 711,077	$ 708,900	$ 706,388	$ 703,515	$ 700,252
22	TAX	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
23											
24	**AFTER TAX CASH FLOW**	$ (1,335,615)	$ 49,428	$ 61,684	$ 74,309	$ 87,312	$ 100,705	$ 114,499	$ 128,708	$ 143,343	$ 158,417
25	**CUMULATIVE CASH FLOW**	$ (1,335,615)	$ (1,286,187)	$ (1,224,502)	$ (1,150,194)	$ (1,062,882)	$ (962,178)	$ (847,678)	$ (718,970)	$ (575,627)	$ (417,210)
26											
27	(1) The value of depreciation, O&M expenses, and interest expense multiplied times the tax rate.										

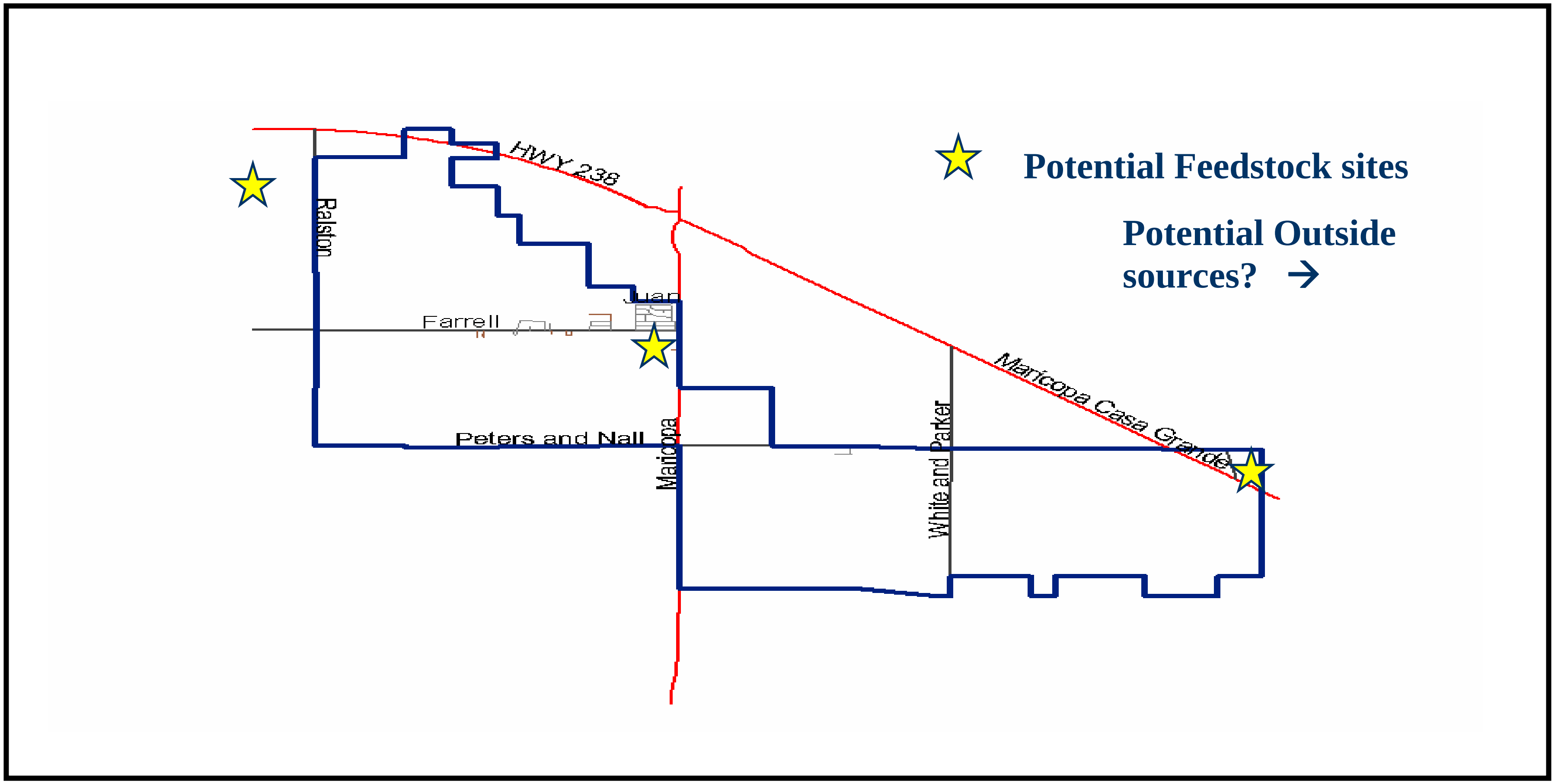
	A	B	C	D	E	F	G	H	I	J	K
29	**Base Case:**	**No Grant, No Production Tax Credit, 25% Equity**									
30	**Round Digester**										
31	Year	11	12	13	14	15	16	17	18	19	20
32	**Costs**										
33	Down Payment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
34	Principal payment	$ 200,548	$ 212,581	$ 225,336	$ 238,856	$ 253,187	$ 268,378	$ 284,481	$ 301,550	$ 319,643	$ 338,821
35	Interest expense	$ 158,603	$ 146,570	$ 133,815	$ 120,295	$ 105,964	$ 90,772	$ 74,670	$ 57,601	$ 39,508	$ 20,329
36	Operation and Mainte	$ 263,339	$ 271,239	$ 279,377	$ 287,758	$ 296,391	$ 305,282	$ 314,441	$ 323,874	$ 333,590	$ 343,598
37	**TOTAL CASH EXPENSES**	$ 622,501	$ 630,402	$ 638,540	$ 646,923	$ 655,556	$ 664,449	$ 673,609	$ 683,043	$ 692,760	$ 702,769
38											
39	**Revenues**										
40	Electricity purchase offset	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
41	Sale of excess electricity	$ 617,009	$ 635,520	$ 654,585	$ 674,223	$ 694,449	$ 715,283	$ 736,741	$ 758,844	$ 781,609	$ 805,057
42	Electric Capacity Savings	$ 85,432	$ 87,995	$ 90,635	$ 93,354	$ 96,155	$ 99,039	$ 102,011	$ 105,071	$ 108,223	$ 111,470
43	Hot Water Offset	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
44	Greenhouse Gas Tax Credits	$ 94,003	$ 96,823	$ 99,728	$ 102,720	$ 105,801	$ 108,975	$ 112,244	$ 115,612	$ 119,080	$ 122,653
45	**TOTAL CASH REVENUE**	$ 796,445	$ 820,338	$ 844,948	$ 870,296	$ 896,405	$ 923,297	$ 950,996	$ 979,526	$ 1,008,912	$ 1,039,179
46											
47	Pretax NET	$ 173,944	$ 189,936	$ 206,408	$ 223,374	$ 240,849	$ 258,848	$ 277,388	$ 296,483	$ 316,152	$ 336,411
48	Depreciation	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629	$ 274,629
49	Total Tax deductions (1)	$ 696,571	$ 692,438	$ 687,820	$ 682,682	$ 676,983	$ 670,683	$ 663,739	$ 656,104	$ 647,727	$ 638,556
50	TAX	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
51											
52	**AFTER TAX CASH FLOW**	$ 173,944	$ 189,936	$ 206,408	$ 223,374	$ 240,849	$ 258,848	$ 277,388	$ 296,483	$ 316,152	$ 336,411
53	**CUMULATIVE CASH FLOW**	$ (243,266)	$ (53,331)	$ 153,077	$ 376,451	$ 617,300	$ 876,148	$ 1,153,536	$ 1,450,019	$ 1,766,171	$ 2,102,582
54											
55	(1) The value of depreciation, O&M expenses, and interest expense multiplied times the tax rate.										

	A	B	C	D	E	F	G	H	I	J	K
1	**Case A:**	**$500,000 Grant, No Production Tax Credit, 25% Equity**									
2	**Round Digester**										
3	Year	1	2	3	4	5	6	7	8	9	10
4	**Costs**										
5	Down Payment	$ 1,029,858	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Principal payment	$ 83,989	$ 89,028	$ 94,370	$ 100,032	$ 106,034	$ 112,396	$ 119,140	$ 126,288	$ 133,865	$ 141,897
7	Interest expense	$ 185,374	$ 180,335	$ 174,993	$ 169,331	$ 163,329	$ 156,967	$ 150,224	$ 143,075	$ 135,498	$ 127,466
8	Operation and Mainte	$ 195,949	$ 201,828	$ 207,882	$ 214,119	$ 220,542	$ 227,159	$ 233,974	$ 240,993	$ 248,222	$ 255,669
9	**TOTAL CASH EXPENSES**	$ 1,495,171	$ 471,193	$ 477,248	$ 483,486	$ 489,911	$ 496,528	$ 503,344	$ 510,364	$ 517,595	$ 525,042
10											
11	**Revenues**										
12	Electricity purchase offset										
13	Sale of excess electricity	$ 459,113	$ 472,886	$ 487,073	$ 501,685	$ 516,736	$ 532,238	$ 548,205	$ 564,651	$ 581,590	$ 599,038
14	Electric Capacity Savings	$ 63,570	$ 65,477	$ 67,441	$ 69,464	$ 71,548	$ 73,695	$ 75,905	$ 78,183	$ 80,528	$ 82,944
15	Hot Water Offset	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
16	Greenhouse Gas Tax Credits	$ 69,947	$ 72,045	$ 74,207	$ 76,433	$ 78,726	$ 81,088	$ 83,520	$ 86,026	$ 88,607	$ 91,265
17	**TOTAL CASH REVENUE**	$ 592,630	$ 610,408	$ 628,721	$ 647,582	$ 667,010	$ 687,020	$ 707,631	$ 728,860	$ 750,725	$ 773,247
18											
19	Pretax NET	$ (902,541)	$ 139,216	$ 151,472	$ 164,096	$ 177,099	$ 190,492	$ 204,287	$ 218,496	$ 233,131	$ 248,205
20	Depreciation	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972
21	Total Tax deductions (1)	$ 587,295	$ 588,134	$ 588,847	$ 589,422	$ 589,843	$ 590,098	$ 590,169	$ 590,039	$ 589,692	$ 589,107
22	TAX										
23											
24	**AFTER TAX CASH FLOW**	$ (902,541)	$ 139,216	$ 151,472	$ 164,096	$ 177,099	$ 190,492	$ 204,287	$ 218,496	$ 233,131	$ 248,205
25	**CUMULATIVE CASH FLOW**	$ (902,541)	$ (763,326)	$ (611,853)	$ (447,757)	$ (270,658)	$ (80,166)	$ 124,121	$ 342,617	$ 575,748	$ 823,953
26											
27	(1) The value of depreciation, O&M expenses, and interest expense multiplied times the tax rate.										

	A	B	C	D	E	F	G	H	I	J	K
29	**Case A:**	**$500,000 Grant, No Production Tax Credit, 25% Equity**									
30	**Round Digester**										
31	Year	11	12	13	14	15	16	17	18	19	20
32	**Costs**										
33	Down Payment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
34	Principal payment	$ 150,411	$ 159,436	$ 169,002	$ 179,142	$ 189,890	$ 201,284	$ 213,361	$ 226,162	$ 239,732	$ 254,116
35	Interest expense	$ 118,952	$ 109,927	$ 100,361	$ 90,221	$ 79,473	$ 68,079	$ 56,002	$ 43,201	$ 29,631	$ 15,247
36	Operation and Mainte	$ 263,339	$ 271,239	$ 279,377	$ 287,758	$ 296,391	$ 305,282	$ 314,441	$ 323,874	$ 333,590	$ 343,598
37	**TOTAL CASH EXPENSES**	$ 532,713	$ 540,614	$ 548,753	$ 557,135	$ 565,769	$ 574,661	$ 583,821	$ 593,255	$ 602,972	$ 612,981
38											
39	**Revenues**										
40	Electricity purchase offset										
41	Sale of excess electricity	$ 617,009	$ 635,520	$ 654,585	$ 674,223	$ 694,449	$ 715,283	$ 736,741	$ 758,844	$ 781,609	$ 805,057
42	Electric Capacity Savings	$ 85,432	$ 87,995	$ 90,635	$ 93,354	$ 96,155	$ 99,039	$ 102,011	$ 105,071	$ 108,223	$ 111,470
43	Hot Water Offset	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
44	Greenhouse Gas Tax Credits	$ 94,003	$ 96,823	$ 99,728	$ 102,720	$ 105,801	$ 108,975	$ 112,244	$ 115,612	$ 119,080	$ 122,653
45	**TOTAL CASH REVENUE**	$ 796,445	$ 820,338	$ 844,948	$ 870,296	$ 896,405	$ 923,297	$ 950,996	$ 979,526	$ 1,008,912	$ 1,039,179
46											
47	Pretax NET	$ 263,731	$ 279,723	$ 296,195	$ 313,161	$ 330,637	$ 348,636	$ 367,176	$ 386,271	$ 405,940	$ 426,198
48	Depreciation	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972	$ 205,972
49	Total Tax deductions (1)	$ 588,263	$ 587,138	$ 585,709	$ 583,951	$ 581,835	$ 579,333	$ 576,415	$ 573,046	$ 569,193	$ 564,816
50	TAX										
51											
52	**AFTER TAX CASH FLOW**	$ 263,731	$ 279,723	$ 296,195	$ 313,161	$ 330,637	$ 348,636	$ 367,176	$ 386,271	$ 405,940	$ 426,198
53	**CUMULATIVE CASH FLOW**	$ 1,087,684	$ 1,367,407	$ 1,663,603	$ 1,976,764	$ 2,307,401	$ 2,656,037	$ 3,023,212	$ 3,409,483	$ 3,815,423	$ 4,241,622
54											
55	(1) The value of depreciation, O&M expenses, and interest expense multiplied times the tax rate.										

APPENDIX B

Area Map
Ak Chin Indian Community Reservation Lands
And
The Relative Location of Potential Digestable Feedstock



USDA
Form RD 1940-20
(Rev. 6-99)

Position 3

FORM APPROVED
OMB No. 0575-0094

REQUEST FOR ENVIRONMENTAL INFORMATION

Name of Project

Location

Item 1a. Has a Federal, State, or Local Environmental Impact Statement or Analysis been prepared for this project?
☐ Yes ☐ No ☐ Copy attached as EXHIBIT I-A.

1b. If "No." provide the information requested in Instructions as EXHIBIT I.

Item 2. The State Historic Preservation Officer (SHOP) has been provided a detailed project description and has been requested to submit comments to the appropriate Rural Development Office. ☐ Yes ☐ No Date description submitted to SHPO ____________

Item 3. Are any of the following land uses or environmental resources either to be affected by the proposal or located within or adjacent to the project site(s)? *(Check appropriate box for every item of the following checklist).*

	Yes	No	Unknown
1. Industrial	☐	☐	☐
2. Commercial	☐	☐	☐
3. Residential	☐	☐	☐
4. Agricultural	☐	☐	☐
5. Grazing	☐	☐	☐
6. Mining, Quarrying	☐	☐	☐
7. Forests	☐	☐	☐
8. Recreational	☐	☐	☐
9. Transportation	☐	☐	☐
10. Parks	☐	☐	☐
11. Hospital	☐	☐	☐
12. Schools	☐	☐	☐
13. Open spaces	☐	☐	☐
14. Aquifer Recharge Area	☐	☐	☐
15. Steep Slopes	☐	☐	☐
16. Wildlife Refuge	☐	☐	☐
17. Shoreline	☐	☐	☐
18. Beaches	☐	☐	☐
19. Dunes	☐	☐	☐
20. Estuary	☐	☐	☐
21. Wetlands	☐	☐	☐
22. Floodplain	☐	☐	☐
23. Wilderness *(designated or proposed under the Wilderness Act)*	☐	☐	☐
24. Wild or Scenic River *(proposed or designated under the Wild and Scenic Rivers Act)*	☐	☐	☐
25. Historical, Archeological Sites *(Listed on the National Register of Historic Places or which may be eligible for listing)*	☐	☐	☐
26. Critical Habitats *(endangered /threatened species)*	☐	☐	☐
27. Wildlife	☐	☐	☐
28. Air Quality	☐	☐	☐
29. Solid Waste Management	☐	☐	☐
30. Energy Supplies	☐	☐	☐
31. Natural Landmark *(Listed on National Registry of Natural Landmarks)*	☐	☐	☐
32. Coastal Barrier Resources System	☐	☐	☐

Item 4. Are any facilities under your ownership, lease, or supervision to be utilized in the accomplishment of this project, either listed or under consideration for listing on the Environmental Protection Agency's List of Violating Facilities? ☐ Yes ☐ No

______________________________ Signed: ______________________________
(Date) *(Applicant)*

____
(Title)

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collections is 0575-0094. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.