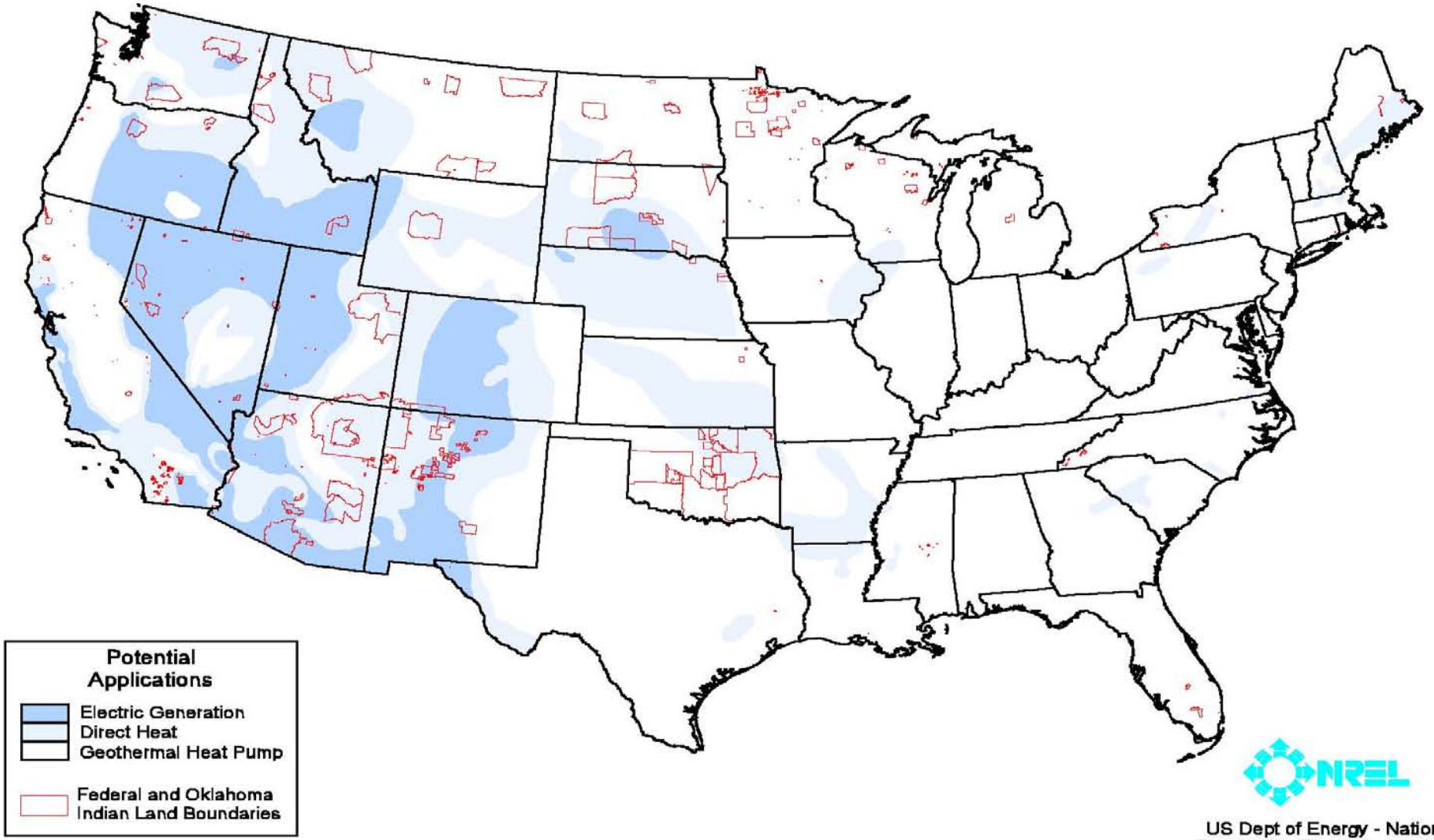
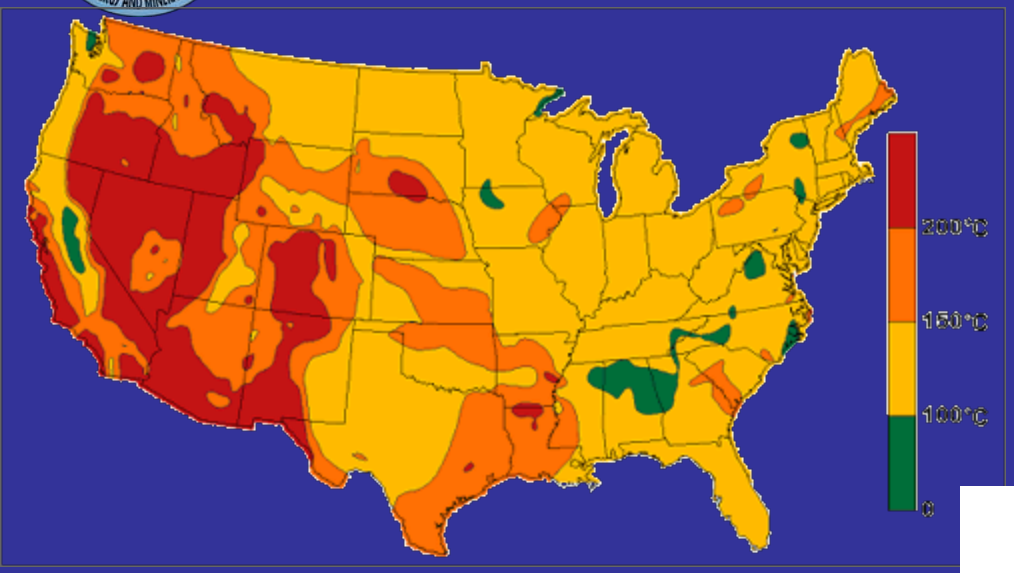
Assistant Secretary – Indian Affairs
Office of Indian Energy and Economic Development

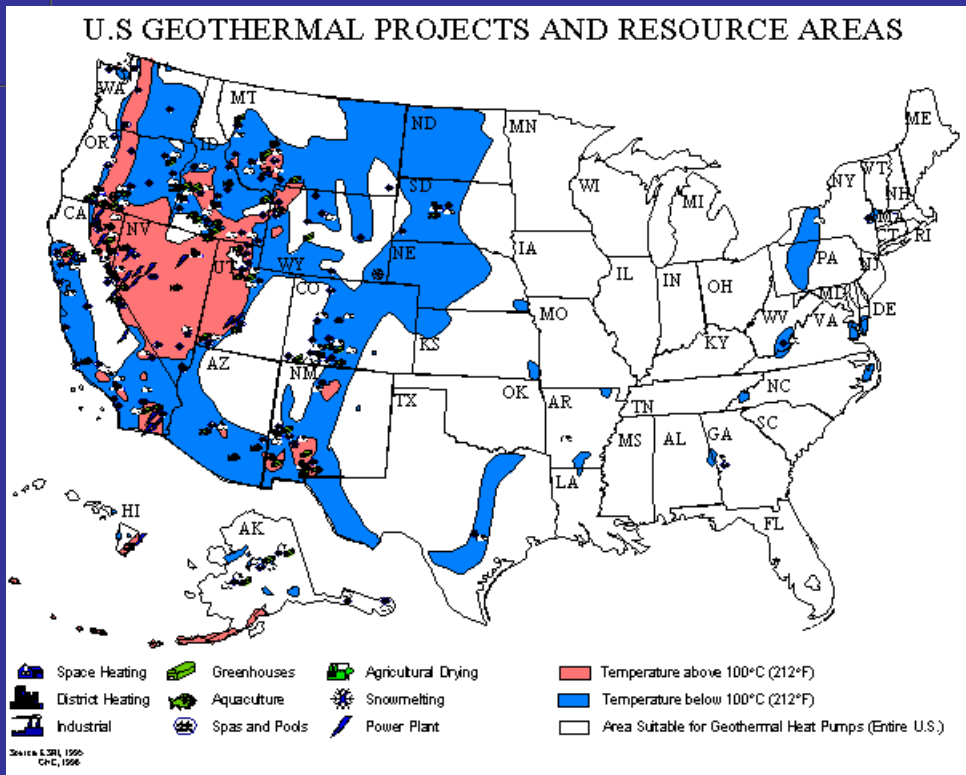
**Division of Energy and Mineral Development**
**Lakewood, Colorado**

# Geothermal Potential



# Geothermal Maps



# Rosebud Health Center

**Purpose: Provide geothermal water to heat health center**

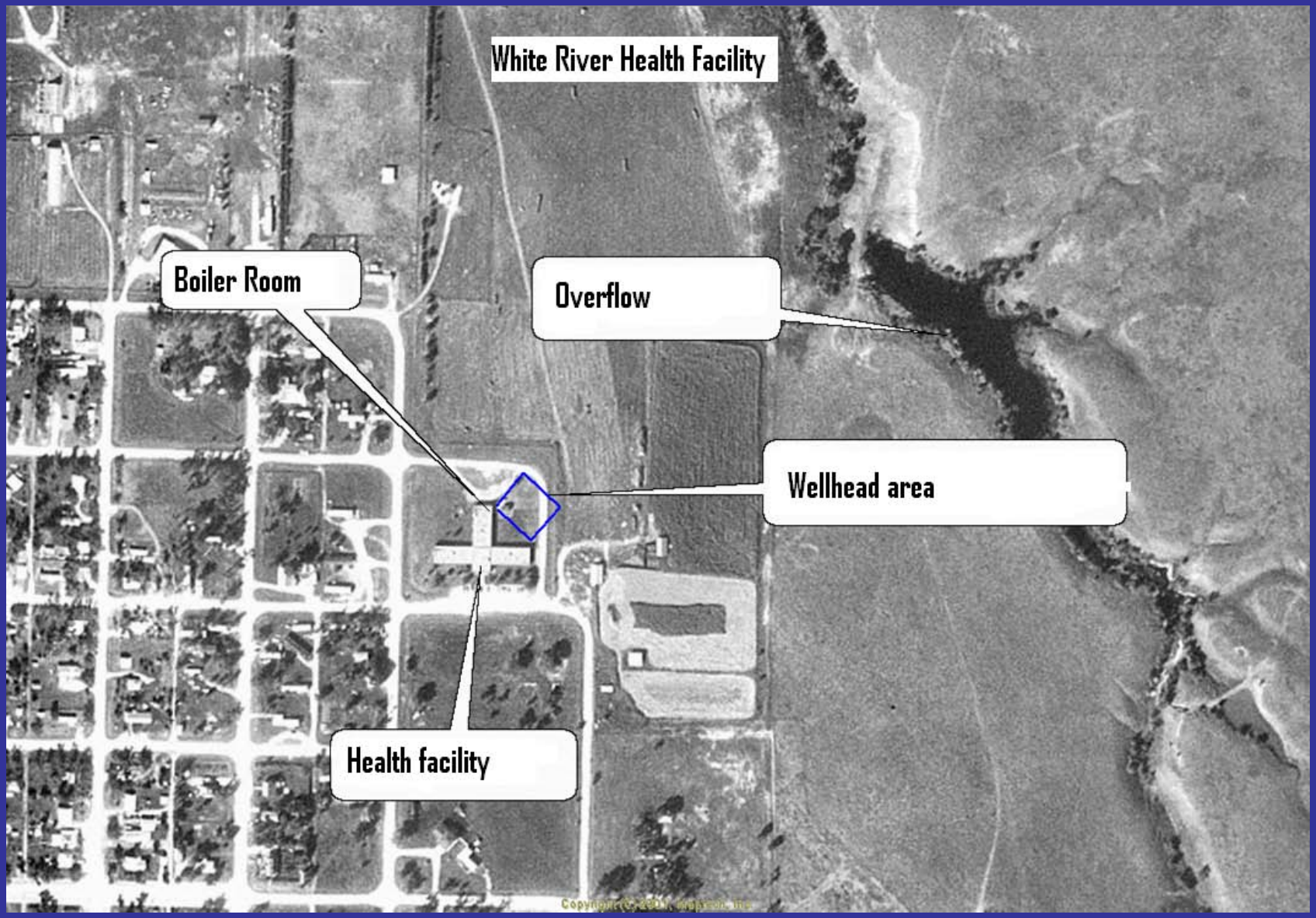
**Savings: ± $50,000 per year – offset propane cost**

**DEMD contracted University of Colorado for engineering support**

**PROJECT:**

**Drill 3300' Madison Formation well for ±160º F water**
**Use hot water to replace boiler requirements in facility**
**Use hot water for laundry facility**
**Build greenhouse on facility property for patient therapy and food – heat with Madison water**

# Rosebud Health Center



# Rosebud Health Center

Total DEMD funding to date: $195,000

| | |
|---|---|
| **Drilling Well Estimate:** | **$ 230,000** |
| **Facility Modification Estimate:** | **$ 38,000** |
| **TOTAL FUNDS REQUIRED:** | **$ 268,000** |
| **ADDITIONAL FUNDS REQUIRED:** | **$ 73,000** |
| **DEMD 2008 FUNDS:** | **$ 45,000** |

**Estimated completion date – Fall 2008**

# Cheyenne River Geothermal

**Use existing hot water well to build a sustainable industry for the Tribe**

**Project: Geothermal well providing water to heat greenhouse and aquaculture**

**Jobs: 40 jobs with fish processing included**

**Income: +$ 200,000 per year**

# Cheyenne River Geothermal

**Total DEMD funding to date: $300,000**

**Work performed: Reworked well & built office**

**DEMD funds remaining(2007): $130,000**

**Drilling funds from private contribution: $60,000**

**DEMD 2008 funds: $45,000**

# Cheyenne River Geothermal

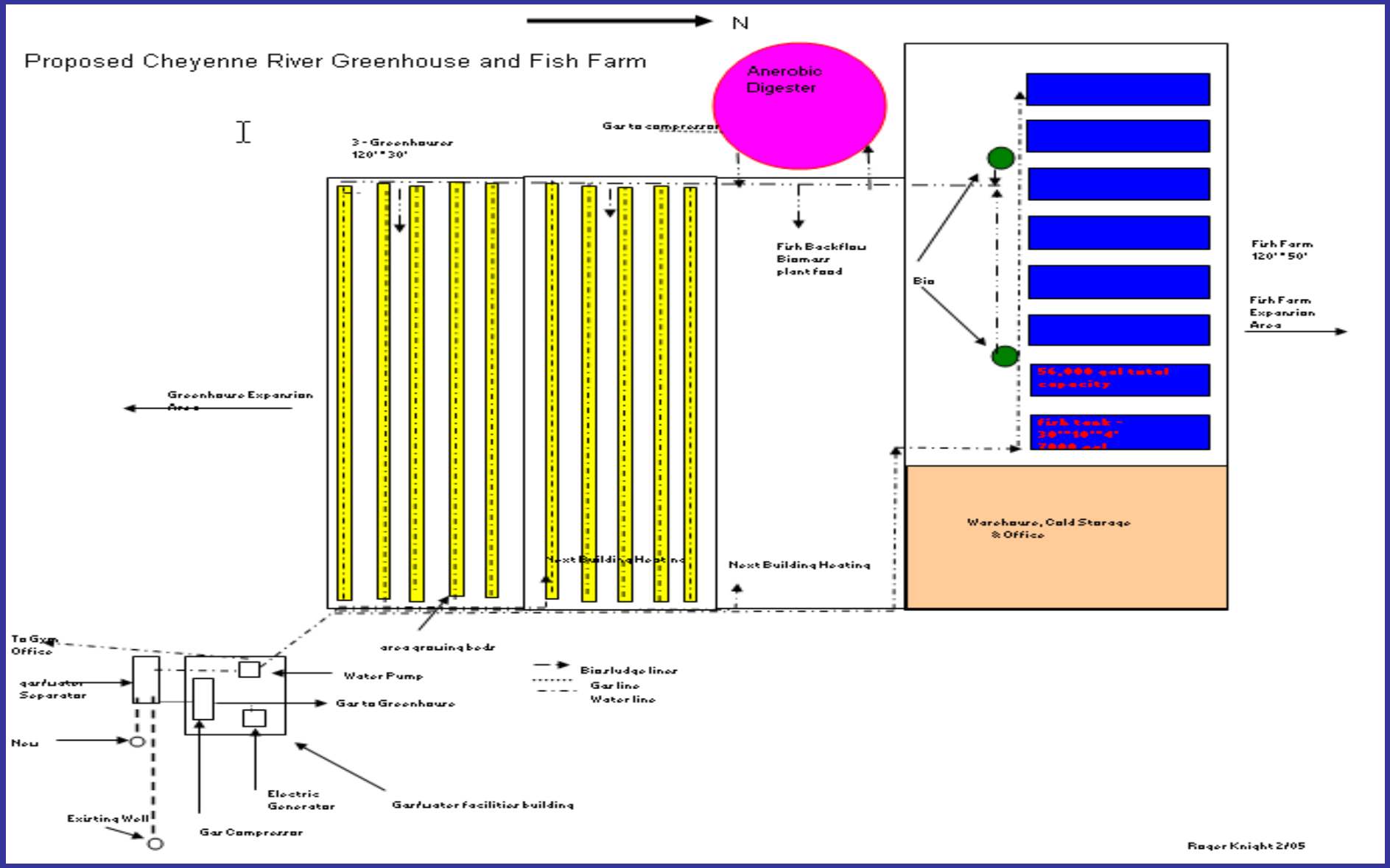
**Additional project funding estimate:**

| | |
|---|---|
| Drill 2nd well: | $ 210,000 |
| Well completion: | $ 30,000 |
| Surface equipment: | $ 60,000 |
| Greenhouse: | $ 100,000 |
| Aquaculture facility: | $ 200,000 |
| **TOTAL FUNDS REQUIRED** | **$ 600,000** |

**ADDITIONAL FUNDS REQUIRED $ 360,000**

# Cheyenne River Geothermal

# Cheyenne River Geothermal



# Cheyenne River Geothermal

**Specialty Jobs required:**

**Agronomist**

**Aguaculturalist**

**JC program in Alamosa Colo.**

**Tribe needs to plan ahead for positions**

# Economic model

| Expenses | unit | $/unit |
|---|---|---|
| Facility Mgr | $/yr | 50000 |
| Fish, purchase | $/fish | 0.1025 |
| Plants | $/plt | 2.00 |
| Electricity | $/ft2/yr | 0.75 |
| Gas | $/ft2/yr | 2.25 |
| Employees | $/yr | 20000 |
| Electricity | $/kwh | 0.054 |
| Emulsion processing | $/fish | 0.20 |
| Fish food | $/lb | 0.21 |
| Fish facility | sq ft | 6000 |
| greenhouse base | sq ft | 13800 |
| GH head house | sq ft | 3000 |
| GH # of employees | | 6 |
| FF # of employees | | 6 |
| Fish emulsion empl | | 3 |
| Processing # employees | | 0 |
| Processing cost | $/lb | 0.20 |
| Processing, yes=1, no=0 | | 0 |
| Total Employees | | 16 |
| CO2 cost | $/ton | 90 |
| Use CO2, yes=1, no = 0 | | 0 |

| Assumptions | |
|---|---|
| Live fish purchased/ yr | 55556 |
| Fish Mortality% | 10% |
| FF Employees, #/lb fish | 0.00006 |
| lb of fish sold/ yr | 100,000 |
| Wholesales price $/lb/fish | 2.00 |
| Proc sales price of fish, $/lb | 3.00 |
| Lbs food req./ lb fish | 1.50 |
| # Tomato Plants/ yr | 2,700 |
| lb. Tomato/ Plant | 38 |
| Sales price of Tomato, $/lb | 1.95 |
| GH Employees, #/plant | 0.0022 |
| Gas purchased, % of time | 0.00% |
| Electricity purchased, % | 0.00% |
| Fish Emulsion sales, $/fish | 2.00 |
| # tomatoes/sq ft | 0.25 |
| GH building cost, $/sq ft | 20.00 |
| FF building cost, $/sq ft | 14.00 |
| GH building, sq ft/unit | 3600 |
| FF building, sq ft/unit | 6000 |
| GH Diff from base 3 bldg | 0 |
| GH base size, # bldg | 3 |
| Lb fish processed/day | 303 |
| lb fish/ # emply process | 150 |
| Process value added $/lb | 1.00 |
| CO2 usage, ton/sq ft/yr | 0.0034 |
| Inc tomato prod.w/ CO2, % | 30.00% |

**Variable Values Yellow highlights**

# Cheyenne River Geothermal

## Economic model for Cheyenne River Project

| Cap Exp | 100% | M$ |
|---|---|---|
| Well | 100 | 100 |
| Rework well | 37 | 37 |
| General Facilities | 108 | 108 |
| Greenhouse | 345 | 345 |
| Fishfarm | 610 | 610 |
| Emul Process, fish | 4 | 4 |
| | | |
| | | |
| | | |
| TOTAL CAPEX | 1203 | 1204 |

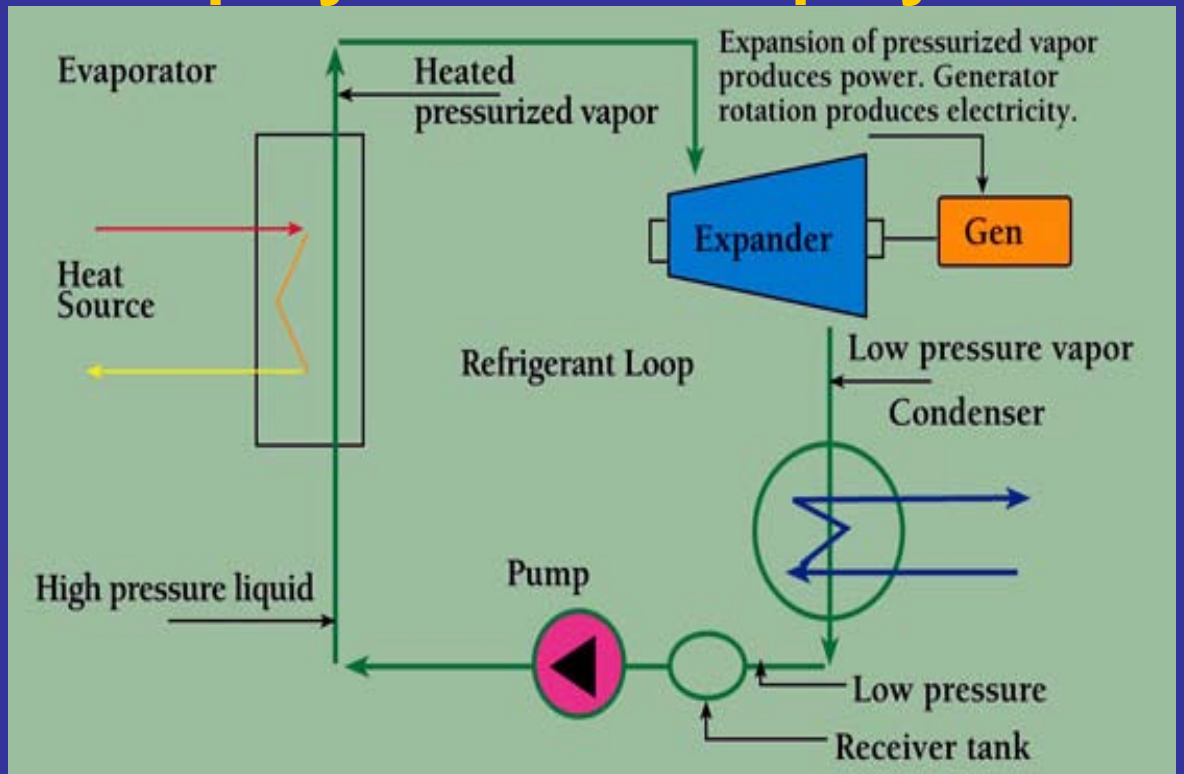
| Income | M$/yr |
|---|---|
| Tomatoes | 200 |
| Tilapai | 300 |
| Fish Emulsion | 111 |
| Processing, value added | 0 |
| CO2 Tomatoes inc | 0 |

### Output values

| Tomato Plants/yr | | 2,700 | NPV | M$ |
|---|---|---|---|---|
| | Lb Fish/yr | 100,000 | 10% | 746 |
| Case 1 | | | 8% | 1005 |

# Rankin Cycle

- Makes electricity by recycling existing low level waste heat or pressure
- Consumes no fuel
- Creates no emissions
- Employs closed loop system




*Surplus heat captured by the evaporator is used to "boil" the working fluid into a vapor.*

*Under pressure, the vapor is forced through the screw expander, turning it to spin an electric generator.*

*The vapor is cooled and condensed back into a liquid in the condenser.*

*The working fluid liquid refrigerant is pumped to higher pressure and returned to the evaporator to repeat the process.*

# Resource Application

- Geothermal sources
- Hydrothermal sources
- Stationary IC engines
- Coal fired power plants
- Oil & Gas Industry
- Industrial process waste heat

# Resource Application

## Hot Liquids to Power*

| Output kW (60Hz) | Heat Input (Btu/hr) | Minimum Waste Heat Temp (°F) | Flow Rate (gpm) |
|---|---|---|---|
| 30 | 1,000,000 | 200°F | 100 |
| 50 | 1,900,000 | 200°F | 200 |
| 100 | 5,000,000 | 200°F | 500 |
| 500 | 22,500,000 | 200°F | 2,000 |

*Sources: Stationary IC Engines - Geothermal - Landfill - Biomass - Hot Water from Industrial Processes

## Hot Gases to Power*
Exhaust Temp °F - Exhaust Flow = CFM

| Output kW (60HZ) | 400°F | 500°F | 600°F | 700°F | 800°F | 900°F | 1000°F |
|---|---|---|---|---|---|---|---|
| 20 | 7,038 | 4,392 | 3,159 | 2,580 | 2,274 | 2,112 | 1,961 |
| 40 | 13,715 | 8,622 | 6,228 | 5,063 | 4,495 | 4,110 | 3,860 |
| 100 | 33,133 | 20,427 | 14,814 | 12,122 | 10,788 | 9,817 | 9,069 |
| 500 | 158,123 | 99,193 | 71,490 | 57,933 | 51,588 | 47,032 | 43,505 |
| 1000 | 302,675 | 190,732 | 138,042 | 112,021 | 99,732 | 90,981 | 85,110 |
| 1500 | 444,304 | 277,999 | 200,101 | 162,252 | 144,839 | 132,134 | 122,180 |

*Sources: Micro-turbines - Stack Gases - Food Processing - Thermal Oxidizers - Factories

## Pressure to Power*

| Output kW (60HZ) | Inlet Pressure | Outlet Pressure | Flow (kg/s) | Flow (scfm) |
|---|---|---|---|---|
| 30 | 290psi/20Bar | 86psi/6Bar | 0.3 | 940 |
| 650 | 600psi/41.5 | 100psi/6.9Bar | 4.5 | 14,000 |
| 1450 | 600psi/41.5 | 100psi/6.9Bar | 27.3 | 85,500 |

*Sources: Pipeline Pressure Letdown Stations - Geo Pressure from Oil Wells

# Resource Evaluation

# Application Economics

| System Size kW | Capex | Annual Operating Hours | Value of Electricity Annual $.10/kWh | Annual OPEX | Payout years |
|---|---|---|---|---|---|
| 30 | $81,500 | 8500 | $25,500 | $1,275 | 3.36 |
| 50 | $128,500 | 8500 | $42,500 | $2,125 | 3.18 |
| 100 | $250,000 | 8500 | $85,000 | $4,250 | 3.10 |
| 200 | $465,700 | 8500 | $170,000 | $12,750 | 3.09 |
| 500 | $1,215,000 | 8500 | $425,000 | $21,000 | 3.01 |

# Contact information

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