INTRODUCTION

The Bureau of Land Management (BLM), under the Department of the Interior, administers what remains of the Nation's once vast land holdings—the public domain. The public domain once stretched from the Appalachian Mountains to the Pacific Ocean. Of the 1.8 billion acres of public land originally acquired by the United States, two-thirds went to individuals, industries, and the States. Of that remaining, much was set aside for national forests, wildlife refuges, national parks and monuments, and other public purposes, leaving BLM to manage more than 272 million acres—about one-eighth of the Nation. The BLM also manages mineral estate underlying 572 million acres, 300 million acres of which are administered or owned by other agencies or private interests. Most of the lands managed by the 9,000 BLM employees are found in 11 western states, including Alaska, although small parcels are scattered throughout the eastern United States. Management is based on the principles of multiple use and sustained yield, a combination that balances the needs of future generations for renewable and nonrenewable resources. These resources include recreation, range, timber, minerals, watershed, fish and wildlife, and natural scenic, scientific and cultural values.

The use of the public lands has changed throughout our Nation's history, and continues to evolve. Today, the public lands are valued for their environmental resources, the recreational opportunities they offer, the cultural resources they contain, and their vast open spaces. Management priorities are changing to accommodate the growing need of suburbanites to "get away from it all."

The BLM is committed to maintaining the health and productivity of our Nation's public lands by relying on sound scientific and technical information regarding soils, water, vegetation, wildlife, and other components of the natural environment. Renewable energy use has long been considered a viable energy source. In response to Executive Order 12759 – Federal Energy Management, and Executive Order 12902 – Energy Efficiency and Water Conservation at Federal Facilities, the BLM is continuing its efforts to conserve energy in the operation of facilities and equipment under its jurisdiction.

For many years, photovoltaics has been used by the BLM at remote facilities as an economical power source when electrical-grid power extensions are too expensive to be considered. Fossil-fuel generators have frequently been used as a source for electrical power; however, expensive maintenance, operation of the generators and fuel storage and clean-up have led many facility operators to look for more reliable energy sources. Photovoltaics has been chosen in many cases as this cost-effective power source.

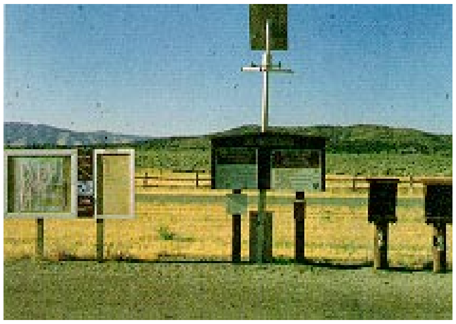
In April of 1995, a partnership titled Renew the Public Lands was developed between the BLM and the U.S. Department of Energy, Photovoltaics Division, in conjunction with the Photovoltaics Systems Assistance Center (PVSAC) at Sandia National Laboratories in Albuquerque, New Mexico, to perform a survey of existing PV uses, identify potential new opportunities within the BLM, and identify barriers or obstacles to the expanded use of PV. Several pilot projects have been identified which represent sound economical and technical PV options. These projects are being developed in collaboration with PVSAC.

METHODOLOGY

In July 1995, the BLM Director transmitted a memorandum to each State Director and District Manager explaining the survey. The survey forms requested information on existing PV systems and potential opportunities for expanding the use of PV within the BLM. The information received from the survey was compiled and has been used to form the foundation for the remainder of the report.

Personal follow-up visits to each State Office were made to allow detailed discussion of the potential opportunities with the State Engineer and individuals submitting projects and to share some excellent design documentation available from the PVSAC. The visits lend credibility to the survey and helped increase the familiarity with PV throughout the BLM.

No previous attempt has been made to quantify the performance of the existing PV systems within the BLM. This report should provide an overview of BLM's photovoltaics efforts. It is hoped that through the efforts of this Renew the Public Lands partnership, managers, designers, and maintenance people will be introduced to the technology and pursue the expanded use of renewable energy within their area.



FILLMORE FIELD OFFICE, UTAH
Little Sahara Recreation Area
50-watt array, 200-amp-hr battery provides lighting for fee station at night.

CURRENT PHOTOVOLTAICS USE WITHIN THE BLM

The use of PV systems by the BLM is occurring over a broad geographical area and in many climatic conditions. Historically, PV energy was first used in communication systems at remote locations, such as radio repeater sites on mountaintops. These systems were typically designed and installed by the electronics technicians familiar with electricity and wiring. PV energy is effective in supplying power for resource monitoring equipment such as the Remote Auto Weather Station (RAWS). In the last several years, PV systems have been used to meet larger power needs, such as water pumping in the range and recreation programs, remote facility power, indoor/outdoor lighting, and ventilation fans in restrooms. The power demand of most PV systems in the BLM is less than 1 kilowatt. Figure 1 illustrates the number of PV installations in each application category.

Survey results indicate most of the systems are used on a year-round basis and 95 percent of the existing systems reported in the survey are still in operation. Existing systems were categorized into four age groups, with the percentages of each listed below:

- 42 percent less than 2 years old
- 26 percent 2 to less than 5 years old
- 17 percent 5 to less than 10 years old
- 15 percent 10 years or older

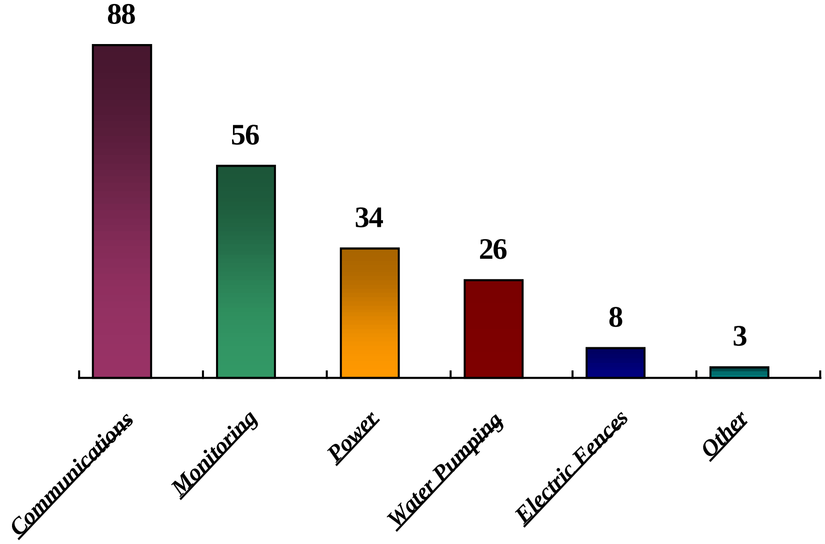


Figure 1. Existing PV use by application

Follow-up investigations revealed that not all PV systems were included in the survey. It is estimated that the survey included only 80 percent of those systems currently in operation. A listing of the reported PV systems currently in use is in Appendix A.

The survey also requested information concerning the operation and maintenance (O&M) costs for the existing PV systems, and the following responses were received:

12 percent of the systems required no O&M costs
34 percent of the systems required less than expected O&M costs
50 percent of the systems required expected O&M costs
4 percent of the systems required higher than expected O&M costs

At this time, the operation and maintenance of PV systems can seem quite complicated especially if operators are not familiar with PV technology. However, with a little training on the components that make up a PV system, the sequence in which they are installed, and an understanding of the function of each component, maintenance and troubleshooting can become routine and easily managed. Resources are available for assistance in maintaining PV systems. The energy supply industry, including several local electrical utilities, can provide long term maintenance and service agreements for a monthly fee.

Photovoltaics can often provide a cost effective power source, but it is not the solution for every power need. Designers need to assess each individual case, evaluate the reasonable alternatives, and perform life-cycle and cost-benefit analyses to determine if a PV system is the best choice to provide long-term economical power.

BARRIERS TO EXPANDED USE

Survey participants identified barriers (see appendix B) which cause apprehension in the implementation of photovoltaics projects in their management areas (see Figure 2). The major barriers are:

1. Lack of familiarity with photovoltaics.
2. High initial cost of a photovoltaic power system.
3. Anticipated vandalism of the system once it is installed.

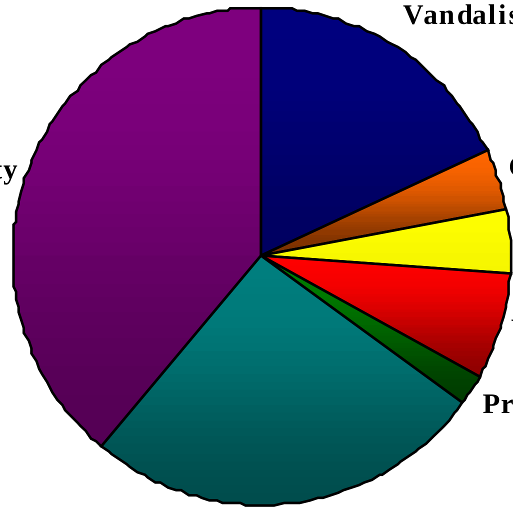


Figure 2. Barriers to the expanded use of PV

LACK OF FAMILIARITY

The lack of familiarity with photovoltaics was indicated in over 40 percent of the responses as the principal reason for not applying the technology. This unfamiliarity and uncertainty was expressed by management designers and operating personnel.

Photovoltaics technology can be introduced in a general format through technical presentations at national and statewide workshops in an effort in increase familiarity with the technology. Sandia's PVSAC and PV industry members can provide excellent technical assistance. Technical training is required to provide a fundamental foundation for design and maintenance personnel that will offer a better understanding of photovoltaics, sources for obtaining goods and services, and assistance with trouble-shooting problems. Photovoltaic site assessments can also be provided for site-specific recommendations concerning system feasibility as well as enhancing communications among the BLM management, designers, and maintenance personnel regarding photovoltaic power.

INITAL COST

Photovoltaics generally has a higher initial installation cost than more traditional remote power generation options like engine generators. Once installed, however, photovoltaic power systems require little maintenance and generally have a lower life-cycle cost than other power options. In tight budget times managers may find it difficult to justify the higher initial costs. However, with the current partnership opportunities, often the initial cost impacts can be shared or defrayed. Nevertheless, the power option with the lowest life cycle cost should be the best choice.

VANDALISM

According to the survey, one of the highest reported barriers to the expansion and use of photovoltaics was a concern with vandalism. Although the reported number of incidents was quite small (less than 6), the remote location of many systems and the exposure of system components to potential damage were, and will continue to be, significant concerns. However, vandalism can be minimized through careful placement of modules, removal during off-season, and the use of portable PV power systems. In some cases, vandalism to the whole site has decreased due to security lighting or the presence of a host. Vendors have many good suggestions to minimize the effect of vandalism, such as lockable enclosures, and vandal-resistant hardware.

OTHER BARRIERS

Other barriers identified in the survey include site suitability factors like terrain, vegetation, or climate concerns as well as visual impacts. Systems can be installed in a visible location and interpreted for the public or some distance away and out of site of the facility.

Computer visual simulations can show how the developed area would look after the proposed PV system has been constructed. Array tilt and structure design can address snow load problems.

There were also concerns over the long term availability of replacement and procurement of system components. Vendors are striving to make procurement as simple as possible for government agencies through GSA Supply Schedules and over the phone credit card purchases. The government purchasing policies are also becoming somewhat streamlined. Systems can be purchased in complete kit from a single vendor ready for BLM installation. Careful specification of contractor and system requirements can ensure robust and predictable system performance. The PVSAC is available to review specifications and contractor submittals, and analyze performance assessments.

The Renew the Public Lands partnership puts the BLM in contact with the best people in the industry who have addressed the same barriers. The partnership will also develop a network of experienced BLM designers and operators. Becoming more familiar with the technology enables more far-sighted decisions and will save BLM significant maintenance and operations dollars in the future.

POTENTIAL OPPORTUNITIES FOR PV SYSTEMS WITHIN THE BLM

Over 200 new potential PV opportunities were identified in the survey based on the existing power requirements and the knowledge of the PV technology currently within the BLM (see appendix C). As the familiarization with photovoltaics grows and users are introduced to the vast array of applications, this number is expected to increase dramatically. Figure 3 represents the potential opportunities submitted, categorized by application. A list of all potential opportunities is included in the appendices.

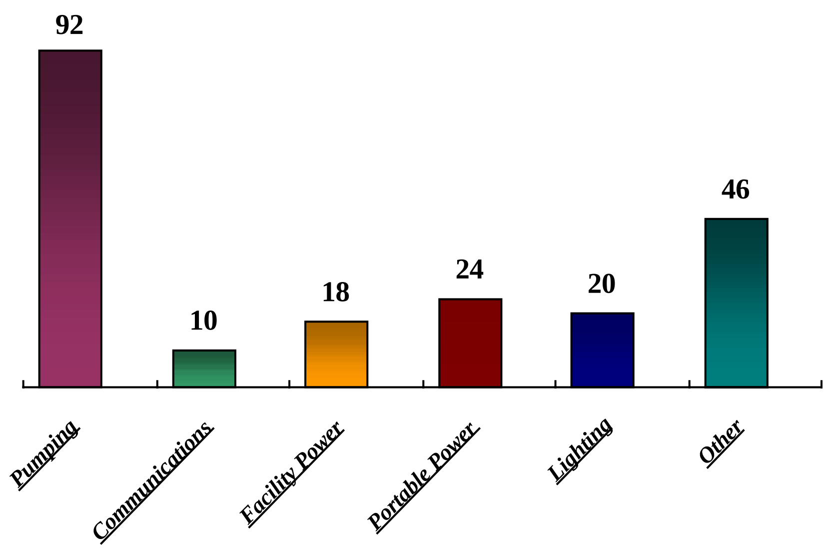


Figure 3. Potential PV use by application

RECREATION OPPORTUNITIES

There are many more future opportunities in these same categories, not identified in the survey, offering a potentially large sustainable market to the PV industry. There are over 1,500 developed campgrounds, picnic areas, recreation areas, and historical sites within the BLM nationally, and very few sites currently have electrical power or potable water. In order to accommodate the increased pressure put on public lands by the recreating public, more recreational facilities will have to be provided. By necessity, these facilities must be sustainable. For example, the New Mexico State Engineer indicated that the presence of a campground host reduced vandalism by $10,000 to $15,000 a year. A portable PV power supply would meet the host power needs and would pay for itself in less than one year. Other improvements to recreation sites might include restroom lights, bulletin board lights, ventilation fans, potable water pumping systems, emergency call boxes, etc. The settings and power needs of these facilities lend themselves to photovoltaics use.

MEDFORD DISTRICT, OREGON
Rogue River Ranch
Each year, thousands of hikers and Rouge River rafters visit this historic ranch museum and view the interpretive displays on the PV/wind/hydro-hybrid system.

In addition to the developed recreation areas, there are several thousand more trail heads, overlooks and interpretive sites throughout 2,000 miles of the Wild and Scenic River System, 1,700 miles of National Trails, 85,000 miles of fishable streams, and 25 million acres being considered for wilderness designation. There are many opportunities for interpretive lighting, restroom facilities, interpretive trails and signs, picnic facilities, additional campground facilities, and remote field stations.

WATER PUMPING OPPORTUNITIES

The recreating public is not the only potential beneficiary of PV power systems. About 20,000 farmers and ranchers graze 10 million head of livestock on 15 million acres of public land each year.

In order to support the grazing program, the BLM pumps water with over 7,500 maintenance-intensive wind mechanical pumps in New Mexico alone. Similar wind-mechanical and engine-generator powered water pumps are almost as common in other western States. Water is delivered from springs and wells and distributed through more than 100,000 water systems, each of which could benefit from PV pumping.

The broad base of PV opportunities in recreation and range settings represents a potential market opportunity of close to $1 billion to the PV and energy supply industry. The key to capturing the BLM market is to familiarize BLM employees with appropriate applications of the technology and to find ways under the current agency funding system to finance the initial cost or develop other funding mechanisms that will achieve the BLM goals and meet the needs of the public land users.

IMPLEMENTATION

There is no lack of technical assistance in planning and implementing photovoltaic projects. Funding partnerships are also available and provide a win-win project for all involved. Partnership opportunities exist with various State and Federal agencies, national laboratories, utility companies, various private and public associations (especially those involved in environmental preservation), and with the PV industry. Cost-share assistance can come in the form of feasibility studies, design and contract preparation, project funding, pilot programs, system monitoring, etc. The Department of Energy was directed by Executive Order 12902 to develop a plan for increasing "the use of solar and other renewable energy sources" and to "develop a model set of recommendations to assist agencies in eliminating identified barriers."

SAN PEDRO PROJECT OFFICE
Sierra Vista, Arizona
San Pedro Riparian National
Conservation Area
200-watt array, 200-amp-hour battery provides power for host and lights for contact station building.

PARTNERSHIPS

Many examples of partnerships already exist. The San Pedro Project Office in Sierra Vista, Arizona, has worked closely with the Friends of the San Pedro to obtain funding for the maintenance of a small PV system within the San Pedro Riparian National Conservation Area. The Vernal and Richfield Field Offices in Utah have a partnership with the State of Utah Department of Natural Resources, Office of Energy and Resource

Planning, and currently use portable water pumping systems for cattle and wildlife. The Utah State Office has worked closely with the PVSAC to design and install two 1.3 kilowatt PV systems at a remote ranger residence on the Green River and at a ranger residence/visitor contact station near Grand Gulch. The PVSAC also helped the Arizona State Office to develop a large PV system for a future visitor center. Enhancement funds from the Intermodal Surface Transportation and Efficiency Act (ISTEA) and assistance from the PVSAC are being used by Nevada's Winnemucca District to use PV pumping in a drinking water system at a campground/rest area along U.S. 50. Local ranchers, grazing associations, educational institutions, and State agencies are also involved in partnerships.

PILOT PROJECTS

As part of the Renew the Public Lands partnership, cost-share funds were made available for pilot projects that would expand BLM's familiarity with PV technology and would help develop the experience within the BLM necessary for a sustainable process. Priority will be given to projects submitted that would replace existing fossil-fuel engine generators. Other selection criteria include maintenance, fuel, and other savings; resources served or protected (riparian, noise, environmental, or vandalism); and interpretation value. Technical assistance will be coordinated with the Utah State Office and the PVSAC as required to assure proper cost analysis, design, equipment selection, procurement, and installation. The PVSAC staff have visited several of the potential BLM sites. During these visits and subsequent discussions, they have presented effective alternatives to management and staff, promoted the use of PV with maintenance personnel, and provided design and specification review for the engineering staff. The service and enthusiasm provided by the PVSAC have been outstanding and have produced very successful projects. Each project will be developed and documented in a standardized manner that would allow for duplication of the PV systems in other BLM applications.

A brief discussion of each project with preliminary size and cost estimates follows. A report discussing the completed projects will be compiled and made available later.

SAND WASH RANGER STATION

PRICE RIVER FIELD OFFICE, UTAH
ESTIMATED COST: $30,000

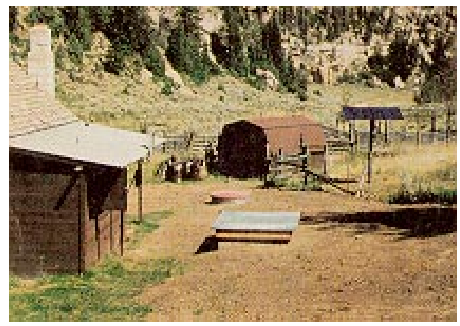
The Sand Wash Ranger Station is located on the Green River at the head of Desolation Canyon. This ranger residence/contact station, which is occupied seasonally from April through November, provides permitting capabilities to rangers for recreational river trips through Desolation Canyon. Sand Wash also has historical significance as a landmark describing Major John Wesley Powell's exploratory voyage through Desolation Canyon and as the site of the Sand Wash Ferry used to transport livestock from the early 1920s until 1952.

A photovoltaics system was installed at this site in the summer of 1995, which consisted of a 1.4 kilowatt array, 3,600 amp-hour battery bank, and a 1,500 watt inverter. This system provides AC power to the residence and 12 volt DC to the radio for communication with the field office. The backup power source is a propane generator that can also be used to charge the batteries as needed.

WARD JARMAN'S SOUTH CAMP CABIN

VERNAL FIELD OFFICE, UTAH
ESTIMATED COST: $8,000

South Camp Cabin is an administrative site used by the BLM and others when working in remote areas of the Book Cliffs. The cabin was built and the site developed by former BLM employee Ward Jarman. After Ward passed away, the site was dedicated in his honor as Ward Jarman's South Camp. The cabin offers hot and cold running water, toilet, shower, sleeping room for six, and a propane-powered refrigerator and stove.



VERNAL FIELD OFFICE, UTAH
Jarman's South Camp Cabin
Provides power for lights, small appliances, and water booster pump at this administrative site.

In the summer of 1995, the BLM installed a photovoltaics power system which facilitates electrical requirements for the cabin and a booster pump. The system includes a 330 watt, fixed pole-mounted array, 530 amp-hour battery bank, and a 1,500 watt inverter. The existing propane generator provides an excellent source of backup power as well as a battery-charging source.

KANE GULCH VISITOR CONTACT STATION

SAN JUAN FIELD OFFICE, UTAH
ESTIMATED COST: $50,000

Cedar Mesa is an archeologically rich area in San Juan County, Utah, possessing numerous ancient cliff dwellings, with great opportunities for camping and hiking. This contact station is the portal to Grand Gulch, which is one of the many canyons accessing Cedar Mesa and is occupied from April through November. The existing contact station provides a place for visitors to learn more about the area, purchase maps, and gather additional information specific to the areas they plan to visit.

The Kane Gulch Visitor Contact Station was powered with a propane generator until the summer of 1995. It is now used as a backup power supply to the newly installed photovoltaics power system. The new system consists of 1.4 kilowatt tracking array mounted on a portable trailer with a 3,600 amp-power battery bank and a 4,000 watt sine-wave inverter which allows for future expansion. The batteries are installed in an underground concrete vault to help reduce the impact of extreme temperature variations on battery performance.

Water for the site will be pumped from the well to a storage tank by a PV powered pumping system. Water will be gravity fed through the distribution system to the Contact Station and Ranger Residence. The separate array will be 1.3 kilowatt. The pump total dynamic head is about 400 feet and will produce a minimum of 1,800 gallons per day.

ROGUE RIVER RANCH

MEDFORD DISTRICT, OREGON
ESTIMATED COST: $30,000

The Rogue River Ranch lies at the confluence of the Wild Rogue River and Mule Creek. The area surrounding the ranch offers an abundance of recreational opportunities, including the Rogue River Ranch national hiking trail. In the summer months, the ranch is host to approximately 150 visitors a day; but historians and recreationists alike come to the ranch year round to enjoy the beauty and reflect on life in the early 1900s.
The ranch is currently powered with hydroelectric and photovoltaics applications, using a diesel generator as backup. This project consists of enlarging the size of the existing array, increasing the battery bank to allow for more power storage, and installing a 4 kilowatt inverter for the availability of AC power and battery-charging capabilities.

HICKISON PETROGLYPHS

BATTLE MOUNTAIN DISTRICT, NEVADA
ESTIMATED COST: $20,000

Hickison Petroglyphs Recreation Area is located about 25 miles east of Austin on U.S. 50 and is abundant with cultural and natural history. The site includes a self-guided walking tour of nearby petroglyphs, a picnic area for those who are just out for the day, and overnight camping for recreationists who wish to spend a little more time in the great outdoors. Though the site offers a great experience for today's recreationists, the lack of drinking water has hindered use of the site.

The Hickison project will include the installation of a PV pump system for an existing well. Completion of this project will allow the BLM the opportunity to provide drinking water at the Hickison Petroglyph Recreation Area.

WINNEMUCCA DISTRICT, NEVADA
Granite Peak
80-watt array provides years around communications in remote district areas.

BURRO CREEK CAMPROUND

KINGMAN FIELD OFFICE, ARIZONA
ESTIMATED COST: $28,000

The Burro Creek Campground provides the only developed camping facilities along a 128-mile stretch of U.S. 93 between Wickenburg and Kingman, Arizona. The facility provides 25 individual campsites, as well as two group sites. Sites contain grills, tables, and shade structures. A well onsite provides water throughout the campground and is used to irrigate selected trees during the hot summer months. Two restroom buildings serve the campground, each containing separate men's and women's facilities. Visitor use of the campground is heaviest from October through April. Approximately 70 percent of the use during this period comes from January through March. The facility also receives day use by picnickers and swimmers.

The project will consist of equipping both restrooms with lighting systems. The engine generator water pumping system will also be replaced with a PV water pumping system, and a portable PV system will provide basic electrical needs for the campground host.

HOBO CAMP

SUSANVILLE FIELD OFFICE, CALIFORNIA
ESTIMATED COST: $8,000

The Bizz Johnson Trail occupies the old right-of-way of the Southern Pacific Fernley and Lassen branch line railroad between Susanville and Mason Station, 4 miles north of Westwood. This was one section of a proposed line intended to connect Portland, Oregon, with San Diego, California, traveling through Klamath Falls, Susanville, and points in Nevada. Now this branch is a pedestrian and equestrian trail which links the nearby communities. Most of the trail traverses the rugged Susan River Canyon, with beautiful views of the surrounding mountains and reminders of the railroad and logging days of the past. The entire grade is usable as a hiking and equestrian trail. Horseback riders, hikers, joggers, and mountain bicyclists use the trail. In the snowy winter months, cross-country skiers and snowmobilers can be seen traveling its length.

This project consists of providing a portable PV power system for the host site of Hobo Camp, a campground located near the Susanville end of the Bizz Johnson Trail. The system will include a 380 watt array, a 480 amp-hour battery, and an 800 watt inverter, all mounted on a trailer that can be pulled from the site for winter storage.

MINE SHAFT SPRING

BUTTE DISTRICT, MONTANTA
ESTIMATED COST: $10,000

A small PV pumping system was installed at the entrance of an abandoned mine shaft in the Butte District. The water is pumped from April through September and is used by over 400 yearlings. The system requirements are 3,000 gallons per day and 15 feet of head. The water is pumped from the mine shaft to a storage tank and troughs.

BLM PORTABLE PV SYSTEMS

The presence of a campground host has proven to be very effective in minimizing vandalism at BLM campgrounds. In order to attract a host to the many remote facilities, 16 small portable PV systems were purchased. These trailer mounted systems will provide about 1 kilowatt-hour/day of 120 VAC power for electrical needs such as lighting, microwave oven, and evaporative coolers. A small AC engine generator can be used to augment the system when the loads exceed the PV capacity.

These systems were placed at a variety of locations throughout the BLM. Sites include:

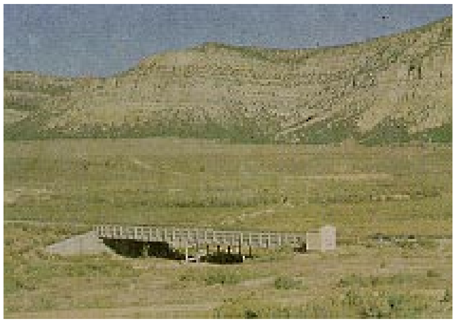
- Big Bend Campground, Moab, Utah
- Sand Island Campground, Moab, Utah
- Pariette Wetlands, Vernal, Utah
- Red Cliffs Campground, Cedar City, Utah
- Baker Dam Campground, Cedar City, Utah
- Brad Field Campground, Montrose, Colorado
- San Pedro Visitor Center, Sierra Vista, Arizona
- Hobo Camp Campground, Susanville, California
- Rocky Point Campground, Susanville, California
- South Steen's Campground, Burns, California
- Orilla Verda (2 each), New Mexico
- Wild Rivers (2 each), New Mexico
- Angel Peak, New Mexico
- Fort Cummings, New Mexico

POWDER RIVER BASIN GROUNDWATER MONITORING

CASPER DISTRICT, WYOMING
ESTIMATED COST: $10,000

In 1994 the BLM initiated a water resource monitoring program in the central Powder River Basin. This program was designed to monitor the effects of the development and production of coal bed methane on water resources and to provide an early warning system for possible unacceptable adverse impacts to those resources. It is anticipated that this project will be ongoing for 10 years or longer. As of May 1996, six groundwater stations and one surface water station have been established. Each station records pertinent parameters 24 hours a day and is stored in an electronic data logger. A small photovoltaic system is used to supply power to the data logger and monitoring devices.

Planned for 1996 is the addition of nine more groundwater stations. Each will require a photovoltaic power system to provide power to the monitoring equipment. Six of the stations will be equipped with radiotelemetry which allows remote access of the recorded data.



CASPER DISTRICT, WYOMING
Red Creek Streem Gauge
This system includes two 56-watt panels for powering a data logger and a water level sensing gauge. Three 20-watt panels are connected in series to power a 36-volt pumping sample.

COTTONWOOD CREEK WATERSHED MONITORING

CASPER DISTRICT, WYOMING
ESTIMATED COST: $12,000

This project is an effort to monitor the impacts of grazing on an allotment in the Cottonwood Creek drainage, a tributary to the South Fork Powder River, located in northwest Natrona Country, WY. The monitoring layout is being designed to support rainfall-runoff modeling within this allotment as well as in other areas with similar hydrologic character. The initial hydrologic monitoring design includes five precipitation stations and three stream gauges. All eight monitoring stations are to have radio telemetry capabilities. Each monitoring station will require a photovoltaic power system to supply power to the data logger and radiotelemetry equipment.

Appendix A – Existing Photovoltaic Systems

	State	District	Site	System Type
1	Alaska	BLM/AFS	Glacier Mountain	Communication
2	Alaska	BLM/AFS	Lone Mountain	Communication
3	Alaska	BLM/AFS	Negrohead	Communication
4	Alaska	BLM/AFS	Pope Creek Dome	Communication
5	Alaska	BLM/AFS	Totson Mountain	Communication
6	Alaska	BLM/AFS	Tozy Mountain	Communication
7	Alaska	BLM/AFS	Various sites (10 each)	Remote Auto. Weather Station
8	Alaska	Galena	Blackburn	Communication
9	Alaska	Galena	Granite Mountain	Communication
10	Arizona	Arizona Strip	Big Ridge	Communication
11	Arizona	Arizona Strip	Black Point	Communication
12	Arizona	Arizona Strip	Hudson Point	Communication
13	Arizona	Arizona Strip	Mobile Home	Residence Power
14	Arizona	Arizona Strip	Mokiac Well	Water Pumping
15	Arizona	Arizona Strip	Mt. Logan	Communication
16	Arizona	Arizona Strip	Mt. Trumbull Fire Station	Communication
17	Arizona	Arizona Strip	Parashont Admin. Site	Communication
18	Arizona	Arizona Strip	Scrub Peak	Communication
19	Arizona	Arizona Strip	Travel Trailer	Residence Power
20	Arizona	Phoenix	Burro Creek Rec. Site	Restroom Power
21	Arizona	Phoenix	Byner Watering Facility	Water Pumping
22	Arizona	Phoenix	District Office	Mister System
23	Arizona	Phoenix	Emerey Hudson Trailhead	Area Lights
24	Arizona	Phoenix	Greenwood Peak	Communication
25	Arizona	Phoenix	Hayden Peak	Communication
26	Arizona	Phoenix	Horesthief	Communication
27	Arizona	Phoenix	Midway Well	Water Pumping
28	Arizona	Phoenix	Mobile System	Facility Power
29	Arizona	Phoenix	Painted Rock Campground	Restroom Power
30	Arizona	Phoenix	Perkins	Communication
31	Arizona	Phoenix	Table Top Campground	Restroom Power
32	Arizona	Phoenix	White Tank	Communication
33	Arizona	Phoenix	William Ranch	Communication
34	Arizona	Safford	Construction Well	Water Pumping
35	Arizona	Safford	San Pedro Riparian Center	Facility Power
36	California	Bakersfield	Bear Mountain	Communication
37	California	Bakersfield	Caliente Mountain	Communication
38	California	Bakersfield	Chimney Peak F.S.	Communication
39	California	Bakersfield	Lover’s Leap	Communication
40	California	Bakersfield	McCabe Flat Campground No.	Restroom Power
41	California	Bakersfield	McCabe Flat Campground No.	Restroom Power
42	California	Bakersfield	Potato Peak	Communication
43	California	Bakersfield	S. Fork American River	Restroom Power
44	California	Bakersfield	S. Fork American River	Restroom Power
45	California	Bakersfield	Washburn Ranch River	Communication
46	California	Susanville	Greens Peak Repeater	Communication
47	California	Susanville	Johnson Well #3	Water Pumping
48	California	Susanville	Yellow Peak Repeater	Communication
49	Colorado	Grand Junction	Gibler Spring & Pipeline	Water Pumping
50	Colorado	Craig	Pump Spring	Water Pumping
51	Colorado	State Wide	Various sites (10 each)	Restroom Power
52	Colorado	State Wide	Various sites (15 each)	Communication

	State	District	Site	System Type
53	Colorado	Craig	Independence	Communication
54	Colorado	Craig	Yarmony	Communication
55	Idaho	Boise	Bennett Mountain LO	Facility Power
56	Idaho	Boise	Danskin Mountain LO	Facility Power
57	Idaho	Boise	Highway 95 Well	Water Pumping
58	Idaho	Boise	Juniper Mountain	Facility Power
59	Idaho	Boise	Lookout Mountain	Communication
60	Idaho	Boise	Lucky Peak	Communication
61	Idaho	Boise	Mud Flat	Communication
62	Idaho	Boise	Notch Butte Well	Water Pumping/Communication
63	Idaho	Boise	South Mountain LO	Facility Power
64	Idaho	Burley	Twin Peaks	Communication
65	Idaho	Coeur d’ Alene	Iron Mountain	Communication
66	Idaho	Coeur d’ Alene	Waspshill Ridge	Communication
67	Idaho	Idaho Falls	Big Southern Butte	Communication
68	Idaho	Idaho Falls	Black Mountain	Communication
69	Idaho	Idaho Falls	Wet Creek	Water Pumping
70	Montana	Butte	Log Gulch Campground	Venting
71	Montana	Lewistown	Bond Water Well	Water Pumping
72	Montana	Lewistown	King Ranch	Water Pumping
73	Montana	Lewistown	Solar Wells (3 each)	Water Pumping
74	NIFC		Various (337 each)	Remote Auto. Weather Station
75	Nevada	Carson	Fort Sage	Communication
76	Nevada	Elko	Bobs Flat	Electric Fence
77	Nevada	Elko	Goose Creek	Facility Power
78	Nevada	Elko	Jacks Peak	Communication
79	Nevada	Elko	Kerns Mountain	Communication
80	Nevada	Elko	Knoll Mountain	Communication
81	Nevada	Elko	Midas EFR Project	Electric Fence
82	Nevada	Elko	Mount Tenabo	Communication
83	Nevada	Elko	Spruce Mountain	Communication
84	Nevada	Las Vegas	Blue Diamond	Communication
85	Nevada	Winnemucca	Blue Lakes	Communication
86	Nevada	Winnemucca	Gerlach	Communication
87	Nevada	Winnemucca	Granite Peak	Communication
88	Nevada	Winnemucca	Mobile Peak	Communication
89	New Mexico	Winnemucca	Star Peak	Communication
90	New Mexico	Las Cruces	Blanco Tank Well	Water Pumping
91	New Mexico	Las Cruces	Canyon Well	Water Pumping
92	New Mexico	Las Cruces	Lancey Well	Water Pumping
93	New Mexico	Las Cruces	Mason Draw	Water Pumping
94	New Mexico	Las Cruces	Pole M Well	Water Pumping
95	Oregon	Burns	Big Indian Trail	Counter
96	Oregon	Burns	Little Blitzen Trail	Counter
97	Oregon	Burns	Page Springs Trail	Counter
98	Oregon	Burns	Riddle Mountain LO	Facility Power
99	Oregon	Burns	Steens Mountain	Communication
100	Oregon	Burns	Wagontire LO	Facility Power
101	Oregon	Burns	Wagontire Mountain	Communication
102	Oregon	Coos Bay	New River	Restroom Power
103	Oregon	Eugene	Huckle Berry Mountain	Communication
104	Oregon	Lakeview	Coglan Butte	Water Pumping
105	Oregon	Lakeview	Devil’s Garden Well	Water Pumping

	State	District	Site	System Type
106	Oregon	Medford	Cedar Spring Repeater	Communication
107	Oregon	Medford	Ninemile Repeater	Communication
108	Oregon	Medford	Onion Repeater	Communication
109	Oregon	Medford	Rogue River Ranch	Facility Power
110	Oregon	Medford	Table Mountain	Communication
111	Oregon	Medford	Tallowbox Repeater	Communication
112	Oregon	Salem	Yellowstone Repeater	Communication
113	Oregon/Wa	Spokane	Rosa Rec. Site	Restroom Power
114	Oregon/Wa	Spokane	Waukesha Spring	Water Pumping
115	Utah	Cedar City	50 Mile Bench	Communication
116	Utah	Cedar City	Bumblebee	Communication
117	Utah	Moab	Kane Gulch Ranger Sta.	Communication
118	Utah	Moab	Mineral Bottom	Communication
119	Utah	Moab	Moss Back	Communication
120	Utah	Moab	Sand Wash	Communication
121	Utah	Moab	Sand Wash Ranger Sta.	Facility Power
122	Utah	Richfield	Big Flat Well	Water Pumping
123	Utah	Richfield	Granite Ridge	Communication
124	Utah	Richfield	Granite Wash	Water Pumping
125	Utah	Richfield	South Creek Ridge	Communication
126	Utah	Salt Lake	Black Creek	Communication
127	Utah	Salt Lake	Red Spur Repeater	Communication
128	Utah	Salt Lake	Windy Peak	Communication
129	Utah	Vernal	Gosslin Mountain	Communication
130	Utah	Vernal	South Camp Cabin	Facility Power
131	Wyoming	Casper	Belle Pourche River	Monitoring
132	Wyoming	Casper	Bolton Creek	Monitorin/Irrigation
133	Wyoming	Casper	Cheyenne River	Monitoring
134	Wyoming	Casper	Dry Cheyenne River	Monitoring
135	Wyoming	Casper	Haystack Butte	Monitoring
136	Wyoming	Casper	Hill 8018	Communication
137	Wyoming	Casper	Lawn Creek	Monitoring
138	Wyoming	Casper	Lodgepole Campground	Water Pumping
139	Wyoming	Casper	Marquiss/Lighthouse (6 ea)	Monitoring
140	Wyoming	Casper	Precip Sta. (16 ea)	Monitoring
141	Wyoming	Casper	Rattlesnake Weather Sta.	Monitoring
142	Wyoming	Casper	Red Creek	Monitoring
143	Wyoming	Casper	South Fork Powder River	Monitoring
144	Wyoming	Casper	Stream Gauges (6 ea)	Monitoring
145	Wyoming	Rawlins	Antelope Raw	Electric Fence
146	Wyoming	Rawlins	Cow Creek	Electric Fence
147	Wyoming	Rawlins	Diamond Springs Res.	Electric Fence
148	Wyoming	Rawlins	District Office	Facility Power
149	Wyoming	Rawlins	Middle Beaver Pasture	Electric Fence
150	Wyoming	Rawlins	Muddy Creek	Water Monitoring (Bridger)
151	Wyoming	Rawlins	Muddy Creek	Water Monitoring (DAD)
152	Wyoming	Rawlins	Muddy Creek	Water Monitoring (Reach 3)
153	Wyoming	Rawlins	Omera Meadow	Electric Fence
154	Wyoming	Rawlins	Upper Muddy Creek	Electric Fence

Appendix B – Potential Photovoltaic Opportunities

	State	District	Site	System Type	Contact
1	Alaska	BLM/AFS	RAWS	Monitoring	Keith Pollock
2	Arizona	Arizona Strip	Mt. Trumbell Admin. Site	Facility Power	W.F. Wells
3	Arizona	Arizona Strip	Pakoon Airstrip	Facility Power	W.F. Wells
4	Arizona	Arizona Strip	Paria Field Station	Facility Power	W.F. Wells
5	Arizona	Arizona Strip	Paria Trailer	Facility Power	W.F. Wells
6	Arizona	Arizona Strip	Virgin River Campground	Communication	W.F. Wells
7	Arizona	Arizona Strip	Whitney Pass Fire Station	Facility Power	W.F. Wells
8	Arizona	Phoenix	Bull Canyon	Water Pumping	Mike Blanton
9	Arizona	Phoenix	Burro Creek Rec. Site	Portable Power	Bill O'Sullivan
10	Arizona	Phoenix	Burro Creek Rec. Site	Remote Lighting	Bill O'Sullivan
11	Arizona	Phoenix	Burro Creek Rec. Site	Water Pumping	Bill O'Sullivan
12	Arizona	Phoenix	Oatman	Communication	Bob Davis
13	Arizona	Phoenix	Painted Rock Campground	Remote Lighting	John Reed
14	Arizona	Phoenix	Trailer System (4 each)	Portable Power	John Reed
15	Arizona	Phoenix	Wild Cow Spring Rec. Site	Remote Lighting	John Reed
16	Arizona	Safford	Bonita Creek	Portable Power	Doug Anderson
17	Arizona	Safford	Bonita Creek	Remote Lighting	Doug Anderson
18	Arizona	Safford	San Pedro/Historic Home	Portable Power	Dorothy Morgan
19	Arizona	Safford	San Pedro/Historic Home	Remote Lighting	Dorothy Morgan
20	Arizona	Safford	San Pedro/Historic Home	Trail Lighting	Dorothy Morgan
21	Arizona	Safford	San Pedro/Murry Springs	Remote Lighting	Dorothy Morgan
22	Arizona	Safford	San Pedro/Visitor Center	Facility Power	Doug Anderson
23	Arizona	Yuma	Betty's Kitchen	Remote Lighting	Doug Anderson
24	Arizona	Yuma	Betty's Kitchen	Restroom Power	Rudy Tafaya
25	California	Susanville	Hays Peak	Communication	Don Wanabo
26	California	Susanville	Hobo Camp	Portable Power	Rudy Tafaya
27	California	Susanville	Mahogany Mountain	Communication	Don Wanabo
28	California	Susanville	Rocky Point	Portable Power	Gordon Gordunio
29	Colorado	Craig	Blue Ridge	Communication	Gordon Gordunio
30	Colorado	Craig	Hebron Water Dev. (6 each)	Water Pumping	Gordon Gordunio
31	Colorado	Grand Junction	East Desert Well	Water Pumping	Gordon Gordunio
32	Colorado	Grand Junction	Edges Lake	O2 Enhancement	Gordon Gordunio
33	Colorado	Grand Junction	Flat Iron Spring	Water Pumping	Gordon Gordunio
34	Colorado	Grand Junction	Gibbler Pipline	Water Pumping	Gordon Gordunio
35	Colorado	Grand Junction	King Mountain	Water Pumping	Gordon Gordunio
36	Colorado	Grand Junction	King Mountain Cabin	Water Pumping	Gordon Gordunio
37	Colorado	Grand Junction	Mud Springs	Portable Power	Gordon Gordunio
38	Colorado	Grand Junction	Navel Oil Shale Springs (6 each)	Water Pumping	Gordon Gordunio
39	Colorado	Montrose	Blue Canyon Springs	Water Pumping	Gordon Gordunio
40	Colorado	Montrose	Brad Field	Portable Power	Gordon Gordunio
41	Colorado	San Luis	La Garita Well	Water Pumping	Gordon Gordunio
42	Colorado	San Luis	Noland Well	Water Pumping	Gordon Gordunio
43	Colorado	Various	State Wide (4 each)	Water Treatment	Gordon Gordunio
44	Idaho	Boise	Bennett Mountain LO	Facility Power	Bob Stucker
45	Idaho	Boise	Mud Flat (multiple wells)	Water Pumping	Shelley Cooper
46	Idaho	Boise	South Mountain LO	Facility Power	Bob Stucker
47	Idaho	Coeur d' Alene	Long Mountain	Communication	Jerry Haalans
48	Idaho	Coeur d' Alene	Mineral Ridge Boat Launch	Lighting	Steve Fraaze
49	Idaho	Idaho Falls	Big Desert	Water Pumping	Randy Watson
50	Idaho	Shoshone	Bell Mountain LO	Lighting/Security	Roger Dairymaple
51	Montana	Butte	?? (3 each)	Restroom Power	Kent Satterlee
52	Montana	Butte	?? (6 each)	Lighting	Kent Satterlee

	State	District	Site	System Type	Contact
53	Montana	Butte	?? (piston pump)	Water Pumping	Kent Satterlee
54	Montana	Butte	Mine Shaft Spring	Water Pumping	Kent Satterlee
55	Montana	Lewistown	Upper Missouri (30 each)	Water Pumping	Mike Montogomery
56	Montana	Lewistown	Upper Missouri Rec. Site	Water Pumping	Mike Montogomery
57	Nevada	Battle Mountain	Hickison Petroglyph Site	Water Pumping	Jon Ekstrand
58	Nevada	Carson	Grimes Point	Lighting	Leonard Brouse
59	Nevada	Carson	Walker Lake	Remote Campground	Jon Ekstrand
60	Nevada	Elko	Hank’s Creek	Monitoring	Nancy Whicker
61	Nevada	Elko	Various Sites	Electric Fence	Gary Back
62	Nevada	Elko	Wilson Recreation Site	Water Pumping	Jon Ekstrand
63	Nevada	Las Vegas	Apex Communication Site	Communication	Jerry Lovelady
64	Nevada	Las Vegas	Bare Mountain	Communication	Jerry Lovelady
65	Nevada	Las Vegas	Red Rocks Vista	Lighting	Sal Estrada
66	Nevada	Winnemucca	Misc. sites	Water Pumping	Ken Mann
67	New Mexico	Albuquerque	Orilla Verde (2 each)	Portable Power	Steve Jordan
68	New Mexico	Albuquerque	Wild Rivers (3 each)	Portable Power	Steve Jordan
69	New Mexico	Farmington	Angel Peak	Portable Power	Steve Jordan
70	New Mexico	Las Cruces	Fort Cummings	Portable Power	Steve Jordan
71	Oregon	Burns	Fish Lake Campground	Portable Power	Fred McDonald
72	Oregon	Burns	Riddle Bro’s Ranch	Facility Power	Fred McDonald
73	Oregon	Burns	South Steens Campground	Portable Power	Fred McDonald
74	Oregon	Burns	Stock Well Pumping	Water Pumping	Stan Woodworth
75	Oregon	Coos Bay	East Shore	Restroom Power	Don Porior
76	Oregon	Coos Bay	Park Creek	Water Pumping	Don Porior
77	Oregon	Medford	Rogue River Ranch	Facility Power	John Bethea
78	Oregon	Spokane	Turn Point Light Station	Facility Power	Gene Wehmeyer
79	Oregon	Spokane	Washburn Lake Pump Sys.	Water Pumping	Gene Wehmeyer
80	Utah	Cedar City	50 Mile Bench	Communication	Paul Chamberlian
81	Utah	Cedar City	Baker Dam Campground	Portable Power	Paul Chamberlian
82	Utah	Cedar City	Baker Dam Campground	Restroom Power	Paul Chamberlian
83	Utah	Cedar City	Bald Hills	Water Pumping	Dave Corry
84	Utah	Cedar City	Bumblebee	Communication	Jack Hayes
85	Utah	Cedar City	Chimney Rock	Water Pumping	Allen Bate
86	Utah	Cedar City	Coyote Buttes	Monitoring	Paul Chamberlian
87	Utah	Cedar City	Devil’s Garden	Water Pumping	Allen Bate
88	Utah	Cedar City	Escalante Canyon	Electric Fence	Allen Bate
89	Utah	Cedar City	Hard Head Well	Water Pumping	Allen Bate
90	Utah	Cedar City	Little Valley/Death Ridge	Water Pumping	Allen Bate
91	Utah	Cedar City	Paria Canyon Wilderness	Campground Power	Paul Chamberlian
92	Utah	Cedar City	Red Cliffs Campground	Restroom Power	Paul Chamberlian
93	Utah	Cedar City	Sheep Hollow	Water Pumping	Mary Casady
94	Utah	Cedar City	Trailer System	Portable Power	Craig Sorenson
95	Utah	Moab	Cleveland Lloyd	Facility Power	Bob Dalla
96	Utah	Moab	Kane Gulch	Facility Power	Bob Dalla
97	Utah	Moab	Kane Gulch	Water Pumping	Bob Dalla
98	Utah	Moab	Sand Island	Portable Power	Bob Dalla
99	Utah	Moab	Sand Wash	Facility Power	Bob Dalla
100	Utah	Richfield	Cow Hollow Spring	Water Pumping	Billy Shepard
101	Utah	Richfield	Delta Unit Well	Water Pumping	Billy Shepard
102	Utah	Richfield	Granite Wash Well	Water Pumping	Billy Shepard
103	Utah	Richfield	Headquarters Well	Water Pumping	Billy Shepard
104	Utah	Richfield	Konosh Well	Water Pumping	Billy Shepard
105	Utah	Richfield	Lakeview Well	Water Pumping	Billy Shepard

	State	District	Site	System Type	Contact
106	Utah	Salt Lake	Clover Campground	Portable Power	Gary Weiser
107	Utah	Salt Lake	Hopsage Well	Water Pumping	Gary Weiser
108	Utah	Salt Lake	Middle Fork Otter Creek	Water Pumping	Gary Weiser
109	Utah	Salt Lake	Randalph Creek	Water Pumping	Gary Weiser
110	Utah	Vernal	Chipeta Cabin	Facility Power	Gary Hunter
111	Utah	Vernal	Gosslin Mountain Well	Water Pumping	John Wood
112	Utah	Vernal	Indian Crossing	Water Pumping	Gary Hunter
113	Utah	Vernal	Jarvie Historic Site	Facility Power	Gary Hunter
114	Utah	Vernal	Pariette Admin. Site	Facility Power	John Wood
115	Utah	Vernal	South Camp	Facility Power	John Wood
116	Utah	Vernal	South Camp	Water Pumping	John Wood
117	Utah	Various	12 each	Monitoring	Larry Maxfield
118	Wyoming	Casper	Cottonwood Creek	Monitoring (6x)	Mike Brogan
119	Wyoming	Casper	Lonetree Well	Water Pumping	Mike Brogan
120	Wyoming	Casper	Powder River Basin	Monitoring (9x)	Mike Brogan
121	Wyoming	Rawlins	Chicken Springs	Water Pumping (3x)	Andy Warren
122	Wyoming	Rawlins	Long Creek	Electric Fence	Roy Packer
123	Wyoming	Rawlins	Split Rock	Lighting/Security	Mike Jensen