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Contents

Trends in Equipment and Facilities Design

Trends

A publication of the Park Practice Program

The Park Practice Program is a cooperative effort of the National Park Service and the National Recreation and Park Association.

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- | | |
|--|---|
| <p>2 Introduction
by Frank C. Goodell</p> <p>3 Innovative Park Design for the
1980's
by John W. Bright</p> <p>10 Energy-Efficient Sportsmen's
Park
by R.O. Forson</p> <p>14 Facility Design: Style or
Stereotype?
by Bill Sontag</p> <p>18 Fremont's (NB) Vandal-Resistant
Restrooms
by Joe Collins</p> <p>22 Equipment for Battling Forest
Fires
by Steve Such
Plus: Example of evaluation
report assessing a Fire Fighting
Skidder</p> | <p>28 Rediscovering Geothermal
Energy
by Ray Lowery, Jr.</p> <p>31 How the Forest Service Tests
Equipment
by Eunice Waldmann</p> <p>37 Alternate, Energy-Saving
Vehicle Technology
by John Hoke</p> <p>47 Electric Vehicles in the Park
by John Hoke</p> <p>48 Who Can You Turn To?</p> |
|--|---|

Keeping equipment up to date and designing facilities that are esthetically pleasing, yet energy-efficient, are continuing challenges to the park and recreation community. Heavy visitor use and hard weathering make us constantly aware of the need to design, develop and/or modify recreation centers, parks, benches, park vehicles, and the myriad equipment and structures that help provide a safe and enjoyable experience for the visitors.

Within this issue of *Trends in Equipment and Facilities Design*, professionals from the National Park Service, Fish and Wildlife Service, Forest Service, state, county and city park and recreation departments share with us their designs and processes for producing better and more energy-efficient equipment and facilities. They cover the conceptual approach, the way of dealing with the challenge, on through the pragmatic design drawings for specific facilities. The issue has a wealth of drawings and photographs to illustrate the points dealt with in the articles.

Regardless of your park and recreation specialty, we think you will enjoy reading this issue to learn of some

interesting currents at play in this "hardware" area. Jay Bright, of the National Park Service's Denver Service Center discusses some exciting and innovative designs that the Center is involved with. Photovoltaic systems that convert sun energy directly to electricity and preservation of a sunken boat through innovative design are only two of the DSC projects mentioned in his article.

Owen Forson provides a case study of the Sportsmen's Park in Clark County, Nevada. This energy-efficient park is located in the shadow of a hydroelectric dam and is designed to service recreation vehicles, tent campers, picnickers, boaters and shore fishermen. Bill Sontag, from the Interior Department's Fish and Wildlife Service, shares some geographically harmonious facility designs that are used throughout their National Wildlife Refuge System. These designs are part of the Service's *Basic Interpretation and Recreation Facilities Manual*.

A case study of vandal-resistant restrooms is presented by Joe Collins of Fremont, Nebraska. And in Steve Such's article on the improvements recorded in Michigan's forest fire management and control program we

learn about the benefits of experimentation with new equipment and design modifications.

Raymond Lowery describes the geothermal system designed and developed for an indoor recreation center in Kingston, Pennsylvania. And the processes by which the Forest Service develops and tests equipment for their national forests are related by Eunice Waldman.

Concluding this issue of *Equipment and Facilities Design*, John Hoke briefs us on several case studies of better energy conservation through the use of alternative fuels and vehicular technologies, flowing from experimentations undertaken in that organization.

We in the Park Practice Program staff have enjoyed the preparation of this issue. Don't overlook previous *TRENDS* topics that bear on similar or related subject matter. A list is published inside the back cover.

Innovative Park Designs for the 1980s

by John W. Bright

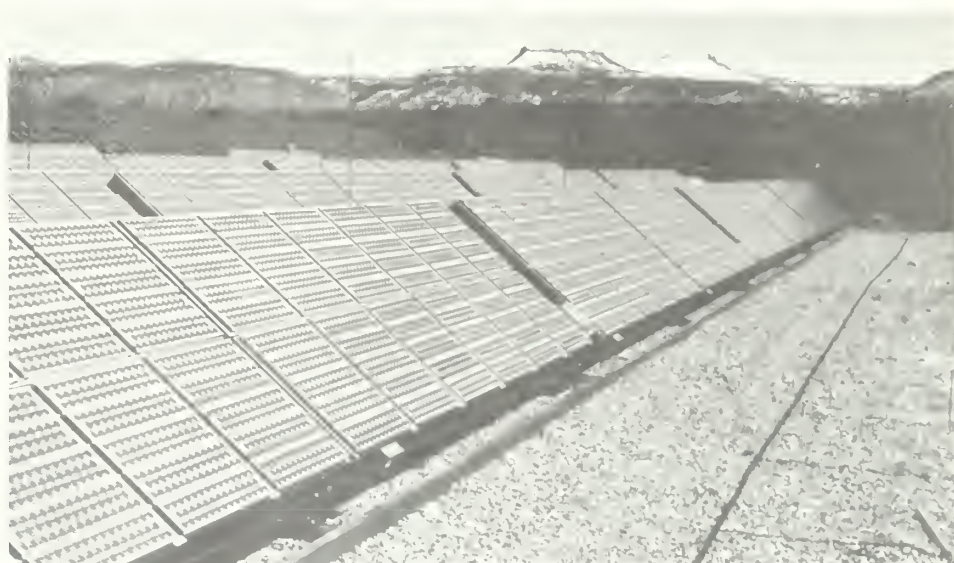
The National Park Service established the Denver Service Center (DSC) in 1971 to centralize its planning, design, historic preservation, and construction services for the more than 300 units of the National Park System. In recent years, particularly, the DSC planners and designers have developed a number of innovative designs for park equipment and facilities. From a need to develop alternative energy sources, these prototypes have evolved to solve unusual problems in historic preservation and to adapt park facilities to special environments. All have been devised to get the most "bang for the buck."

Photovoltaic Systems

Space-age technology is proving to be particularly applicable to the isolated, wide-open spaces that characterize much of the National Park System. The world's largest photovoltaic system for converting sun energy directly to electricity was installed recently at Natural Bridges NM (UT). The project was designed by Massachusetts Institute of Technology's Lincoln Laboratories with Department of Energy funding and site-adapted by DSC engineers and landscape architects. This 100 kw demonstration project provides all the electrical power for that remote park, replacing two noisy diesel-powered electrical generators. The site for the field was carefully chosen to reduce its visibility and surface disturbances.

Many other less monumental photovoltaic systems—some in operation for 17 years—power 32 radio repeaters and numerous interpretive devices and weather stations. At Isle Royale National Park (MI) a photovoltaic unit provides power for a fire lookout and 100-watt radio repeater, replacing a power line that was both unreliable and an unacceptable intrusion through a designated

At Natural Bridges NM, Utah, the world's largest photovoltaic system converts the sun's energy to electricity, providing electricity for the remote park.



At Rocky Mountain NP, the photovoltaic unit to power the oil flush comfort station is designed into the structure.

Photos: National Park Service

wilderness area. At Rocky Mountain National Park (CO) two isolated comfort stations with oil flush toilets, previously powered by gasoline-powered generators, now are powered by photovoltaic cells.

Solar Projects

The National Aeronautics and Space Administration and the National Park Service have joined hands on a number of prototype and experimental solar energy projects. NASA supplies equipment design, manufacture, and instrumentation, while the NPS provides the site and installation. Such systems now heat a park residence at Carlsbad Caverns National Park (NM), power the visitor center at Ocmulgee National Monument (GA), heat and cool the visitor center at Mount Rushmore National Memorial (SD), and heat an auditorium at Yosemite National Park (CA).

Installations of 526 solar domestic water heating systems for park employee quarters are underway throughout the National Park System. Other solar heating and hot water systems are on the drawing boards for visitor centers at Colorado and Navajo National Monuments (CO, AZ), Carlsbad Caverns National Park (NM), Fire Island National Seashore (NY), and Gateway National Recreation Area (NY, NJ).

Cooperative solar energy projects with NASA are heating and cooling the visitor center at Mount Rushmore; and heating an auditorium at Yosemite NP.



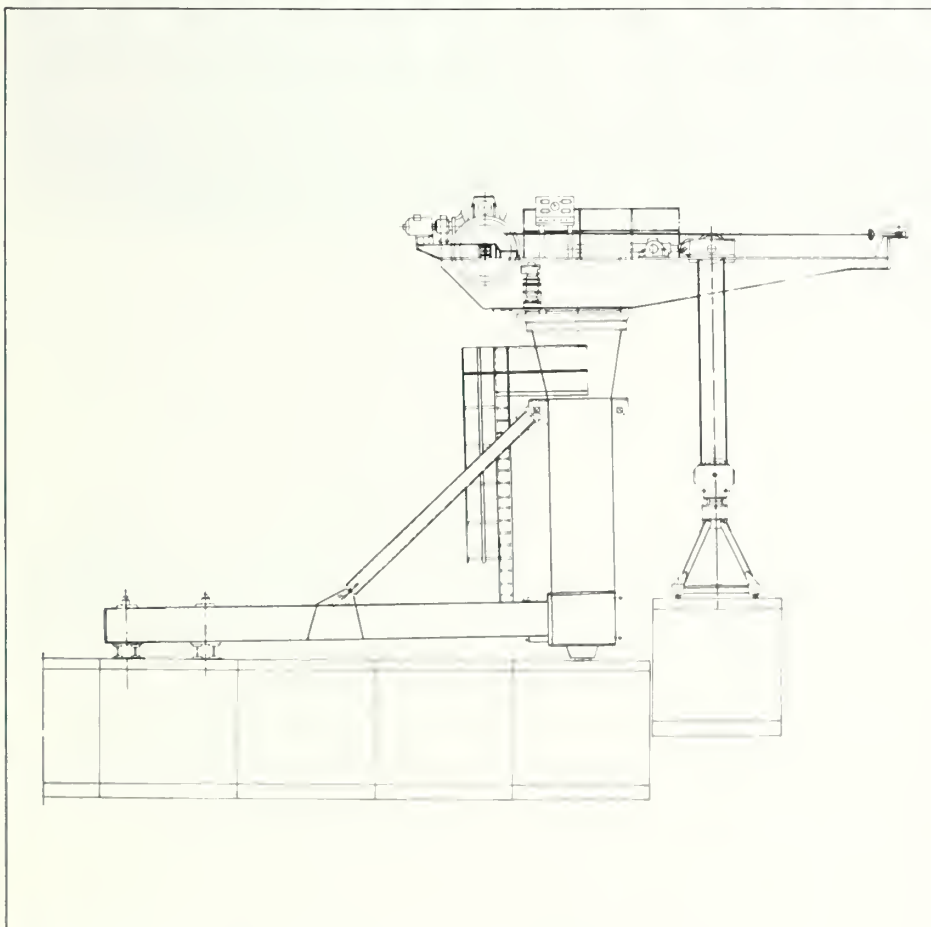
Photos: National Park Service



DSC landscape architects conceived the complex Linn Cove Viaduct to gracefully span a geologically sensitive area at Grandfather Mountain, North Carolina.

Post-Tension Bridge

Another innovative design using high technology is for the Linn Cove viaduct, a key structure for filling the last gap in the 470-mile (752 km) Blue Ridge Parkway (NC, VA). Now under construction, this post-tensioned bridge will span a geologically sensitive and hazardous site. The bridge, one of a handful of such structures in the world, will be built on a double curve with superelevation. It is unique because it will be built from the top down to protect geologic features from unnecessary disturbance. Conceived by DSC landscape architects, the exceedingly complex structural and construction engineering is being handled by the Federal Highway Administration and consultants Muller and Figg. To accomplish the tricky top-down construction, cantilevered precast segments will be glued out from an abutment to a temporary pier. The permanent pier will be built from the cantilevered deck. Construction then will move on across that pier to the next section, and so on, to the opposite abutment of the 1,243-foot structure. The contractor, Jasper Construction, has developed some highly specialized casting, transporting, and installation equipment to build this unusual structure designed to protect park values.



Special casting, transport and erection gear will be used to place the 50-ton segments on the viaduct

A time capsule of Civil War naval construction, armament, and artifacts, The U.S.S. Cairo was raised out of the Yazoo River mud in 1964, intact but in poor condition.



A detailed scale model of the gunboat was built to guide preservation specialists in reconstruction and ghosting of missing parts.

Historic Preservation Challenge

Innovative design in historic preservation is saving the gunboat U.S.S. *Cairo*. Sunk in 1862 by a Confederate torpedo near Vicksburg, Mississippi, she rested for more than 100 years in the mud of the Yazoo River until she was raised in 1964. Though badly damaged in the raising, she was intact. The gunboat is a virtual time-capsule of Civil War naval construction, armament, and artifacts. Unfortunately, exposure to the atmosphere accelerated the deterioration of her wooden components.

Funds have been appropriated and designs conceived to preserve, display, and interpret the vessel. This long-range project, now in its third year, so far has involved returning the massive boat by segments in steel cradles from her Pascagoula storage site to Vicksburg, setting her in a dry-land tub, constructing a museum and viewing plazas, building a conservation workshop, and erecting a protective space-frame shelter.

The most important phase is now underway—putting the gunboat back together, fully armed, for on-board interpretation. The emphasis is on preservation, with liberal ghosting of



important missing forms and shapes, thus avoiding conjecture and the high costs of full restoration. Although the architects have the original plans for the gunboat, they are not exactly the same as the as-constructed boat itself. It seems the Civil War shipwrights did a considerable amount of innovating. Consequently, a detailed, scale model of the gunboat had to be built to provide an on-site guide for the preservation specialists. The model also guides the construction of

the final cradling system, interpretive access, and ghosting.

A final phase, following preservation, includes completion of the plaza and site developments. This exceedingly complex undertaking has involved many experts: historians; naval, historical, and contemporary architects; landscape architects; interpretive specialists; civil, structural, mechanical, and electrical engineers; and a host of craftsmen, shipwrights, metal workers, masons, and so forth.



A comfort station at Newhalem Campground.

Campground Structures

One of the few new campgrounds built by the NPS in the last several decades reflects yet another new design concept for park facilities. All structures at the 120-site Newhalem Campground in North Cascades National Park (WA)—comfort stations, amphitheater projection building, entry station, and campfinder residence—use a pole construction of heavy timber trusses and purlins, steeply sloping metal roofs, and stained wood walls. The project, designed by Jones and Jones of Seattle received the 1981 honor award of the American Wood Council. It is totally accessible to the physically handicapped.

Comfort Station and Visitor Contact Facilities

No discussion of park facilities would be complete without mention of a comfort station. The Benji, a prototype toilet facility designed for the National Capital Mall, is distinctive, readily identifiable, and relatively vandalproof. It is pleasing in appearance and does not detract from presidential monuments nearby.

The design for this innovative and unusual facility passed the scrutiny of the Advisory Council on Historic Preservation, the Commission of Fine Arts, and the National Capital Planning Commission, as well as the NPS's own internal review. Four Benjis now fit comfortably in the monumental setting, where they serve millions of visitors each year.

Similar to comfort stations, visitor-contact facilities are characteristic of the park landscape. A new visitor-contact station at Dinosaur National Monument (CO, UT) represents an

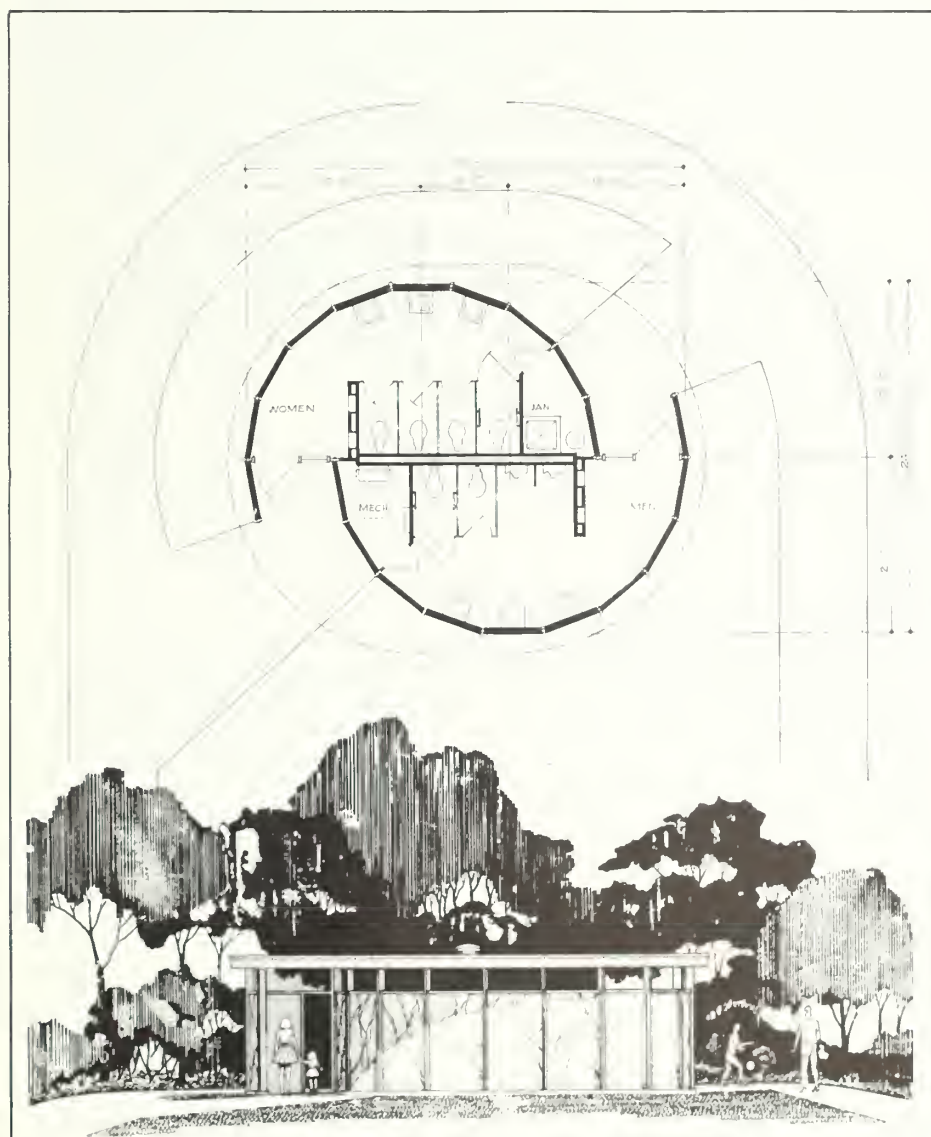


PHOTO: National Park Service

The Benji toilet facility designed for the National Capital Mall is distinctive looking and relatively vandalproof, and yet does not detract from nearby national monuments.

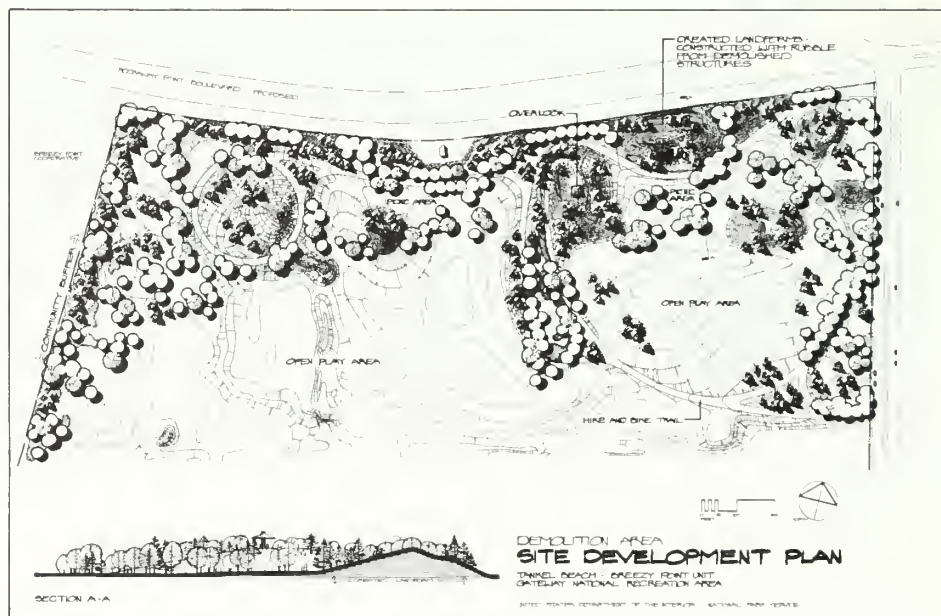


outstanding design accomplishment in energy efficiency and service to the public. Visitors can park their cars, pass through the contact station for an introduction to the monument's resources, then board a shuttle to the world-famous dinosaur quarries.

The building's generously sized space-frame roof, boldly stark in its profile, provides a column-free interpretive plaza that unites various functional spaces. Sunlight penetrates from the sides and through skylights, reducing lighting requirements while enhancing the interior. The station has an active solar heating system. The exterior design makes liberal use of native stone in walls and roof supports.

Recycled Demolition Rubble

What would you do with two unwanted, unfinished 15-story highrise buildings in your park? The DSC planners were faced with destruction of a project, instead of construction of one, at Gateway National Recreation Area. Rubble from demolition by explosion was left on the site to avoid expensive haul-away costs. To get rid of this eyesore and safety problem, the rubble piles will be contoured, covered, and vegetated to create interesting and useful landforms.



Faced with two unwanted, unfinished 15-story highrise buildings in Gateway National Recreation Area, DSC planners called for their demolition. Then, to avoid the high cost of hauling away the rubble, a landscape design incorporated the piles of brick, concrete and steel into contoured, covered and vegetated hills.

Appropriate Site Specific Design

A DSC architect proposed a bold solution reminiscent of the surprise attacks of the Nez Perce warriors in an attempt to unify the scattered, disconnected units of the Nez Perce National Historical Park.

Overlooks are scattered throughout the park, incorporating strong structural shapes, supergraphics, and lances symbolic of the Nez Perce's initial successes, later frustrations, and eventual failure in their resistance. This interpretive theme is established at the White Bird Battle interpretive

shelter and carried throughout the park, successfully tying together the many sites commemorating the valiant Nez Perce.

Most parks are plagued with too many cars, which is certainly true of Yosemite National Park and particularly Yosemite Valley. A public transit system alleviated the traffic situation. Now the NPS is taking the next step, removing the evidence of

automobile domination. Beginning at the park's administrative and visitor activity center, the jumble of parked cars has been removed from in front of the center.

In its place, a pedestrian mall has been physically and visually rejoined to an adjacent meadow. With its traditional scale and character restored, the area once again provides excellent viewing and interpretive



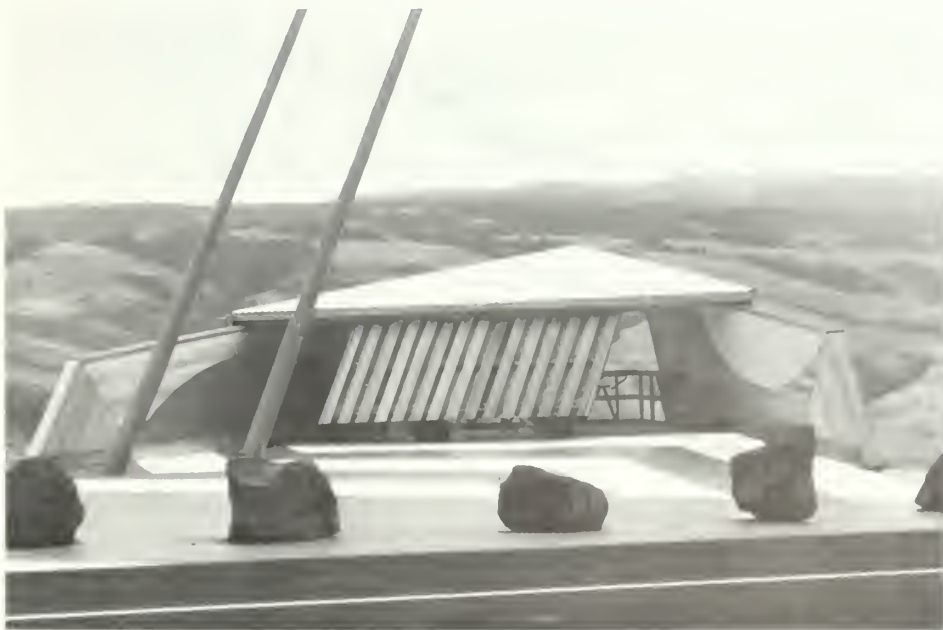
Photos: National Park Service

Yosemite National Park is typical of the evolution of a park plagued by too many cars. As early as 1927, a parking lot full of cars greeted visitors. In the mid-1960s, cars still jammed the parking lot. Today an interpretive cove in the mall occupies what was the parking lot in the 1927 and 1960s photographs. Future work in the mall east of the visitor center includes removal of additional paving.

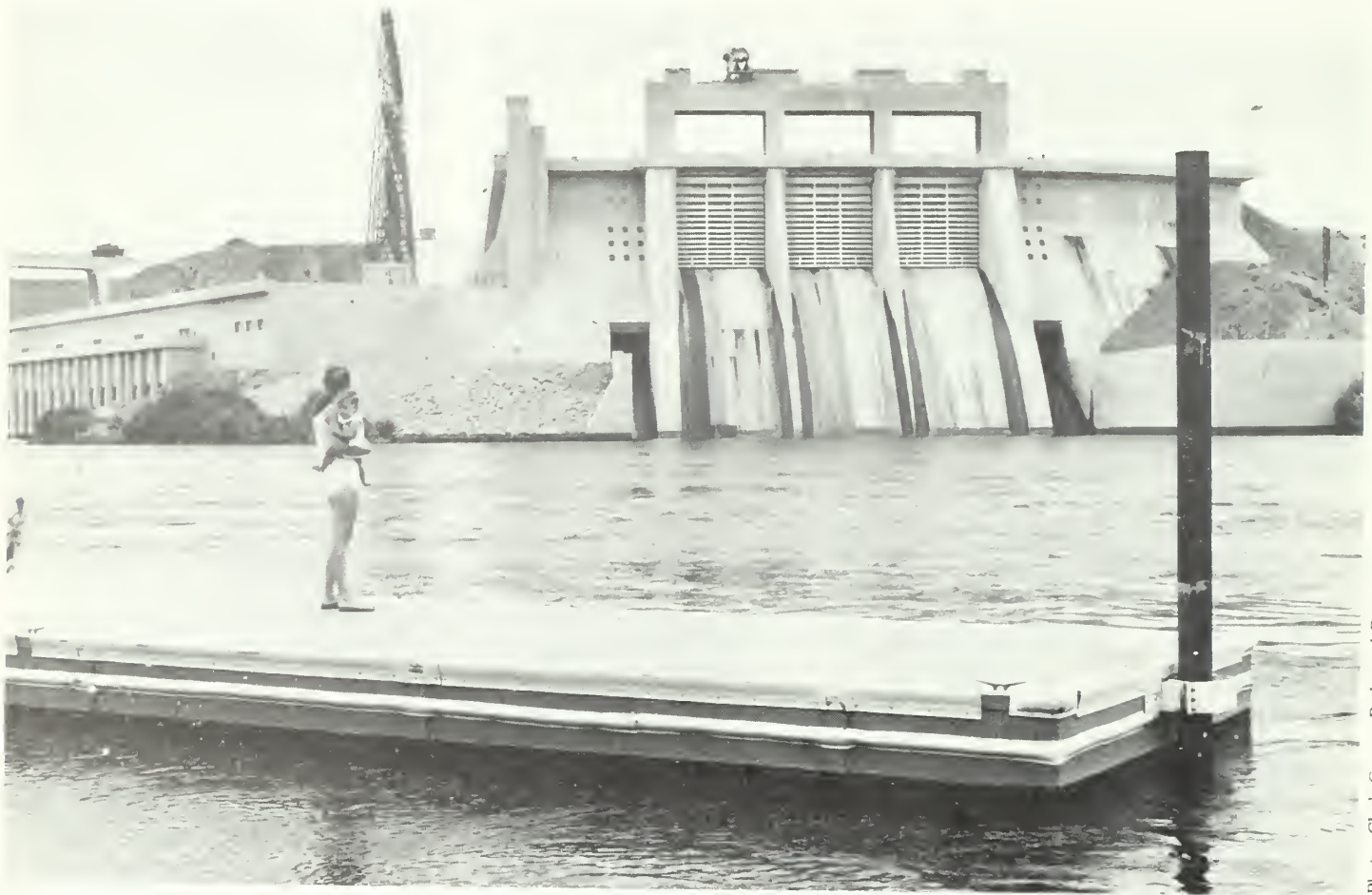
spaces in harmony with the environment.

These are a few of the unusual design projects illustrating geographical and topical park problems handled by professionals at the Denver Service Center.

Jay Bright is assistant manager of the Denver Service Center where he directs a multi-disciplinary team providing planning, design, construction, and historical preservation services to the National Park Service's Southeast and Southwest Regions. Previously he worked in the Park Service's Southeast and National Capital Regional offices, in the director's office, and in the former Eastern Service Center. He has taught at the College of African Wildlife Management in Tanzania and has contributed numerous articles to professional journals. Bright is a Fellow of the American Society of Landscape Architects and holds a Council of Landscape Architectural Registration Boards certificate.



Overlooks at Nez Perce National Historical Park are designed by DSC planners to incorporate strong structural shapes, supergraphics, and lances symbolic of the Nez Perce's initial successes, later frustrations, and eventual failure in their resistance.



View of boat float in Colorado River below Davis Dam.

Photo: Clark County Parks and Recreation

"Necessity is the mother of invention," aptly describes the development of Sportmen's Park by the Department of Parks and Recreation, Clark County, Nevada. In 1977, Clark County Commissioners planned what was then an unusual park to service recreation vehicles, tent campers, picnickers, boaters, and fishermen along the shores of the lower Colorado River as it leaves the border of Nevada. The proposed facility was to be located in a well-known fishing area for large mouth bass, striped bass, and trout.

Situated in the shadow of the hydro-electric Davis Dam, today the

park's major facilities include water pumping and storage, an electrical system, and a sewage disposal operation, all cost effective because they utilize the natural desert environment in their everyday operation. The constant desert winds pump the water, generate the electrical power, and aid in the evapo-transpiration of sewage waste. The year-around warm air and ground temperatures combine with the air movement to complete a sewage disposal cycle. While these innovations are unique since many were established in the early ranching days of Clark County, they are unusual in their use adjacent to a

hydro-electric dam and a river because of their environmental impact on residents downstream.

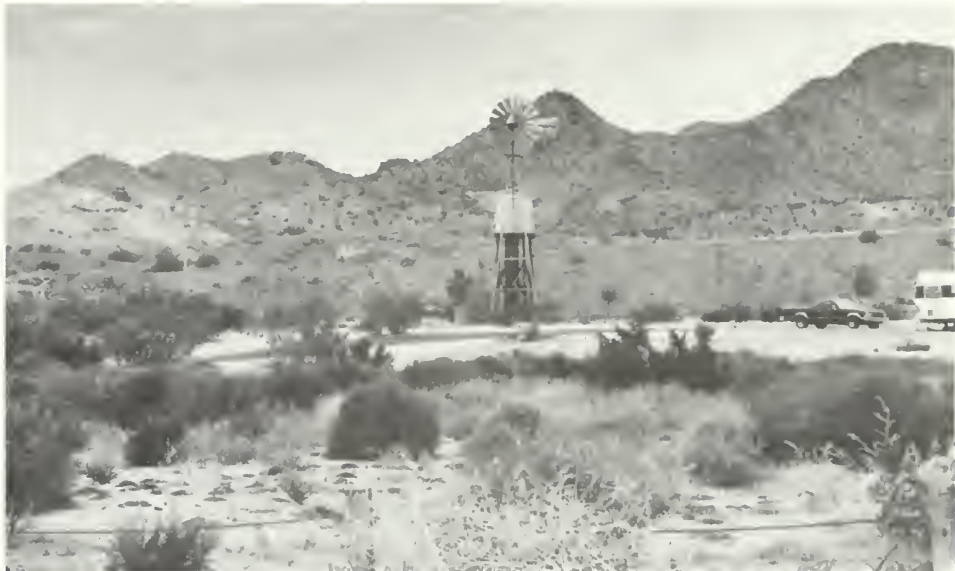
In addition, the park provides boat trailer parking; a permanent, specially designed restroom facility accessible by the handicapped; running water and flush toilets; a special fish cleaning station; a water well with a windmill pump; elevated water storage tank, and domestic water system; a sewage treatment system; a wind generator for the electrical system; driveway cable barriers; trees and landscaping; picnic tables; and other features.

Budgetary Problems

In planning the park, the county parks landscape architect faced varied and interesting challenges including budget constraints, lack of electrical service, and sewage disposal. Providing the necessary public services within the established budget was the paramount problem because of the rapid inflation rate for construction development. Of equal importance with budget considerations was the lack of public electrical transmission service even though the giant hydro-electric generating plant at Davis Dam is located within approximately 800 feet of the north park boundary. To compound the problems, the Nevada State Health Department, in conjunction with the Clark County Board of Health, maintains a moratorium on underground sewage disposal designs that would allow sewage to be returned to the water table or the Colorado River.

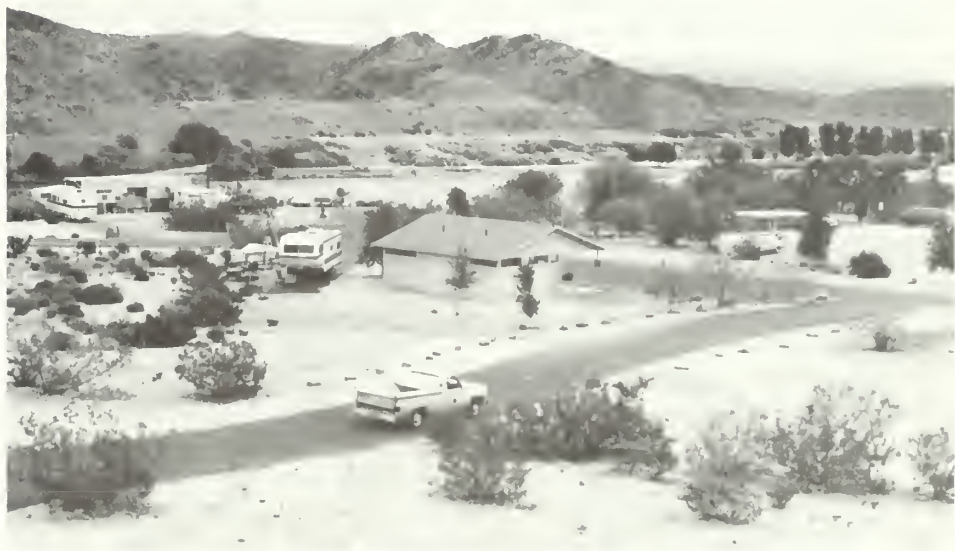
The problems were resolved only after extensive research and analysis. In the end, the park was built within the established budget, providing an environmentally acceptable project and serving the public needs as originally conceived in the master plan. The original project budget estimate for construction development at Sportsmen's Park was set at \$202,500. Since the county constructed parks primarily with 50%-50% matching funds from the federal Land and Water Conservation Fund, the initial \$202,500 budget figure was reduced \$100,000 because only \$50,000 in FY 1976 was available from the federal government for this project.

The planners decided the project could be constructed within the reduced budget, provided the work was completed by county work forces. Plans were set to schedule and develop the project within a two-year



View of the general park area with water windmill pump system and the surrounding desert.

Photo: Clark County Parks and Recreation



View of general park area and restroom.

Photo: Clark County Parks and Recreation

period, using primarily parks maintenance employees with assistance as necessary from the Clark County Public Works Department.

Electrical Service

Electrical service at Sportsmen's Park was of primary importance. Cost analyses of bringing in public utility electric service from the nearest source showed it to be prohibitive. The cost of service alone would exceed 25% of the total development budget.

Other sources of power had to be found. The natural winds in the Colorado River Basin were the logical solution. An electrical wind generating system was designed, using time-proven equipment and innovative accessories, to provide basic power to light the restroom buildings and maintenance shop, and to provide full services to the caretaker's and construction foreman's office.

The basic power system consists of a commercial 12-volt wind generator that feeds a bank of heavy-duty storage batteries through a solid state voltage regulator. The main power service from the storage batteries is transmitted to the appropriate facilities through buried underground wiring. The individual lighting system in the restroom building is controlled by a spring-loaded timer during dark hours.

Because the wind in the river basin is constant and reliable throughout the year, a water system using a windmill and water storage tank was designed to provide the domestic water service for the park. The water system consists of a windmill with a 12-foot (3.66-m) diameter fan mounted on a 40-foot (12.19-m) steel tower driving a 3 $\frac{3}{4}$ -inch (.09-m) pump cylinder. The water is pumped into an elevated storage tank, which in turn services the entire park site.



View of windmill water system and water tower with Davis Dam in background.

Photo: Clark County Parks and Recreation

Sewage Disposal

Because the moratorium restricted waste water disposal into the ground of the Colorado River, an evapo-transpiration system (ET) was designed to accommodate sewage disposal. The ET system was selected for four basic reasons: (1) It complies with the regulations; (2) It requires no constant maintenance; (3) It can handle the variable loading, typical to a park of this type, without failure, and (4) Its design was cost effective for this project.

The evapo-transpiration sewage disposal system consists of a septic tank holding vessel that discharges its liquid into a basin that is sealed from the lower earth strata with a polyvinyl chloride liner. The basin is filled with gravel and sand, and is covered with native soil. The liquid discharges transpires to the surface of the basin where it evaporates into the

atmosphere. This odorless system is designed for a capacity flow of 4,300 gallons of effluent per day.

The project was funded by the Clark County commissioners from the recreation and capital improvement budget, with matching funds of 50% from the former Bureau of Outdoor Recreation's Land and Water Conservation Fund.

Historical Background

The Sonoran desert region of southern Nevada long has been appreciated by outdoor recreation enthusiasts for its low population density, varied experience opportunities, and abundance in wildlife. The areas adjoining the Colorado River south of Davis Dam in Nevada are extremely popular because they are accessible and offer some traveler services.



View of front of the rest room building.

Photo: Clark County Parks and Recreation

The Interior Department's former Bureau of Reclamation between 1903 and 1931 withdrew public lands for about four miles from the Colorado River in Nevada to prepare for dam, power, and reclamation projects. Upon completion of these projects, the National Park Service recognized this land as a recreation and scenic protection area. The river areas were planned for water-oriented activities such as boating, water skiing, swimming, and fishing. The upland areas, on the other hand, provided recreation experiences depending chiefly on natural desert and mountain features. Visitor studies conducted in the area a decade ago when very few services were available showed an annual average of approximately 951,000 people in the vicinity of Davis Dam, strongly justifying additional recreational facilities.

The Clark County Board of Commissioners, recognizing early the need

for additional recreation facilities in southern Nevada, accepted and signed a lease of land for recreational purposes with the Interior Department, Bureau of Reclamation, on Jan. 14, 1969. The lease area included 16.5 acres of land on the Colorado River, south of Davis Dam, officially designated as Sportsmen's Park. As use in the area increased, the public demand for services helped shape the master plan and development.

The Interior Department's former Bureau of Reclamation, a lessor of the park site, was extremely helpful during planning and construction. The former Heritage Conservation and Recreation Service provided funds through the Land and Water Conservation grants system to fund 50% of the design and construction of the park. As early as April 1962, the Nevada Fish and Game Commission, with a local sportsman's organization, evaluated the park's site

and signed a use agreement with the former Bureau of Reclamation for the site's management. (This agreement was cancelled in 1969 by request of Fish and Game in favor of the county's recreational lease.)

The only legal requirements related to the Sportsmen's Park project were the federal lands leases and correct advertising and bid practices for the project construction items. Bids were taken in accordance with Nevada's revised statutes.

Phase Two of the Project

The project already has been expanded since development was completed. Clark County commissioners earmarked funds to match with funds from the Nevada motorboat fuel fund and the former Bureau of Reclamation funds to provide approximately \$184,000 to improve the existing boat ramp, to build a quay, gangway and boat float, to provide additional fisherman's parking, and to build a shoreline fisherman's trail. The second construction phase began in mid-1979 with new waterside facilities constructed to be accessible to the handicapped.

In addition to the funds mentioned above, the Clark County commissioners expanded the former Bureau of Reclamation lease to enlarge the Sportsmen's Park area by another 10 acres for further development similar to the work already completed.

R.O. Forson is Director of Clark County Parks and Recreation Department. A practicing recreation professional for more than 20 years, Forson is responsible for the construction, maintenance, and development of the energy-free Sportsmen's Park facility.

Facility Designs: Style or Stereotype?

by Bill Sontag

A comfortable, attractive, and predictable level of quality in basic visitor facilities: this was the goal of the Great Lakes States Region of the Fish and Wildlife Service when it began to compile a new *Basic Interpretation and Recreation Facilities Manual* in 1977. Lynn Greenwalt, then director of the service, ordered a nationwide approach to the problem. An impartial and fresh examination of the inconsistent and sometimes mediocre quality of refuge public use facilities was sought by design contractors from the firm of Maas & Grassli, Inc. of Ogden, Utah.

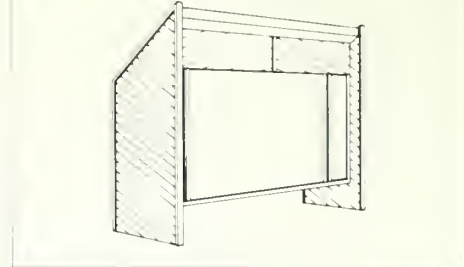
Directed and supported by the Division of Refuge Management in Washington, DC, the contractor undertook a nationwide needs assessment. The assessment included questionnaires directed to outdoor recreation planners and refuge managers across the country, as well as on-site examination of "typical" refuge topographies and habitat types. The inquiry identified the most frequently needed facilities, specified preferred dimensions based on functional requirements, and described the five physiographic regions which typify most refuge environments.

All 68 respondents to the 12-question assessment were also asked their opinion on design of visitor facilities. Responses showed that standardization of facility design was *not* a universally accepted idea. The top priority "design goals," favored by managers and planners were weather proofing, 3-dimensional display capability, and ample size for effectiveness; "design for uniformity and visual continuity" was the least

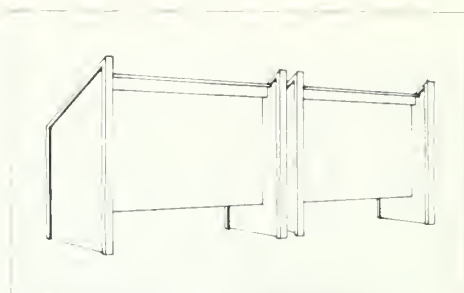
popular idea. "Standardization is basically a cop-out solution for the unimaginative mind", said one respondent. Therefore, project design consultants reassessed their own goals, agreeing that refuges possessing the necessary staff, funding, inclination for, and access to, imaginative solutions to site-specific design problems would be exempt from mandatory use of the Facility Design Manual.

Typifying the traditionally "low key" thrust for public accommodations on refuges, as well as the System's emphasis on interpretation for visitors, respondents gave the highest priority to a roofed interpretive structure. Managers and planners further specified that the structure should provide weather protection for both visitors and displays, and include viewing stations and weatherproof leaflet dispensers within a 10' x 10', three-sided enclosure. (See illustration.) Second and third choice preferences were a free-standing, upright interpretive display structure, with an interpretive observation deck. Least preferred choices included fence designs, bicycle racks, and trash receptacles; these were all subsequently dropped from further design emphasis.

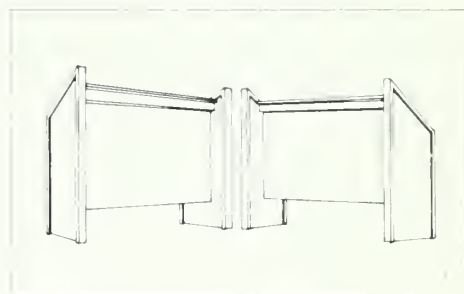
Priority ranking of seven design goals reflecting National Wildlife Refuge needs showed respondents' sensitivity to resource themes. First priority design attribute was stated as "...consistent with the visual character of each landscape region." Second was "facilities should be vandal resistant." Third priority was "facilities which could be"... constructed by youth program workers with limited professional supervision."



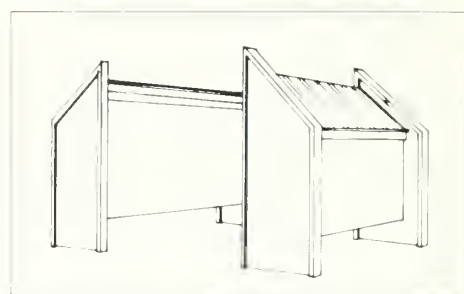
Interpretive facility, basic unit



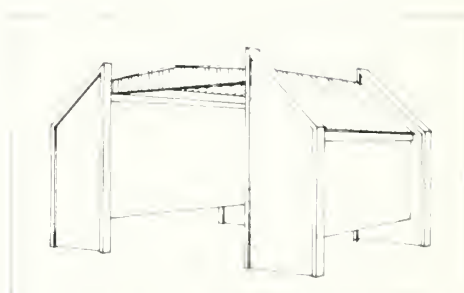
Juxtaposed multiple units



"L" configuration

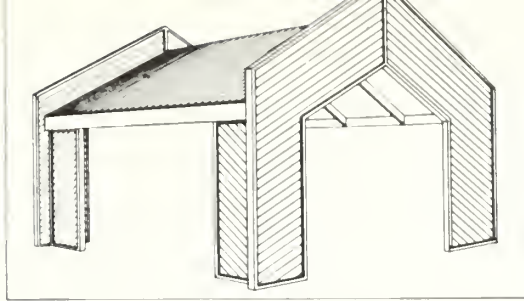


Facing double units

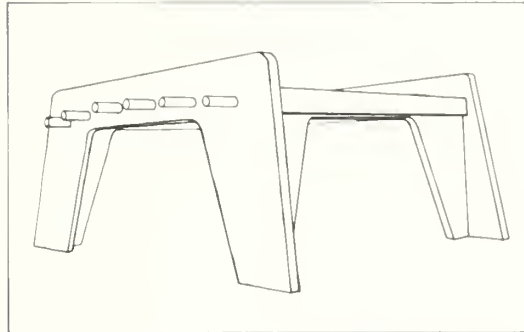


Facing, optional canopy

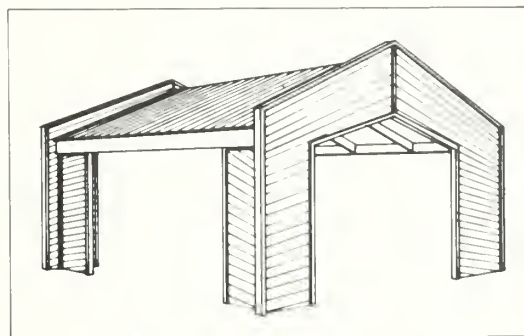
Interpretive or information display facility design illustrates modular versatility responding to varying exhibit needs and site requirements.



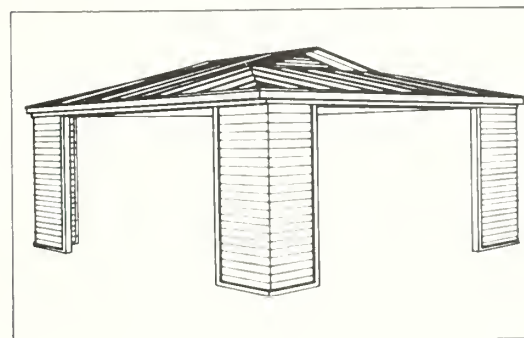
Mountain family



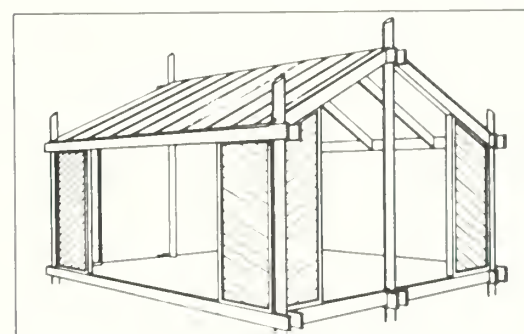
Southwest family



Deciduous forest family



Prairie family



Coastal family

On-site examination of several refuges yielded recommendations that facility designs blend harmoniously with five major landscape themes and habitat types. These also should acknowledge regional construction materials and color selections. The facility design priorities were coupled with the five landscape themes, resulting in architectural or design "families" each consisting of a wayside interpretive *display facility*, a *fee collection booth*, an *environmental education shelter*, and a *multiple restroom facility*. Designs for these were prepared for each of the landscape regions, namely the *arid southwest*, the *coasts*, the *prairies*, the *mountains*, and the *deciduous forests*. (See illustration.) A sixth "family," unrelated to landscape themes, contains additional designs and product ideas which may be used in most of the five physiographic regions. Included here are illustrations and information on a multiple/vault restroom, an observation tower, leaflet dispensers, seating benches, gates, an observation deck, a boardwalk, a photo blind, trash containers, and several structures sign. (See illustration.)

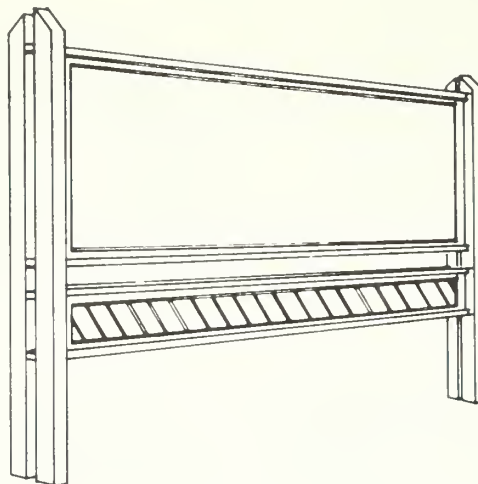
Thus, the *Basic Interpretation and Recreation Facilities Manual* becomes a catalog, or "wish book" of sorts, from which a refuge manager can select needed facility designs, and receive straightforward guidance regarding choice of appropriate appearance, materials, and colors.

Environmental education shelter floorplans (approximately 16' x 16') accommodate 20 persons comfortably, while design variations demonstrate recognition of landform, vegetation, and cultural differences.

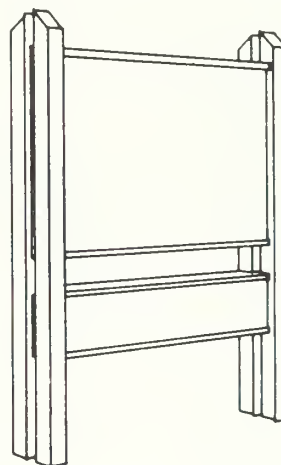
Copies of the manual were provided to each refuge manager, Area Office, and Regional Office. The seven Regional Offices (Portland, Albuquerque, Twin Cities, Atlanta, Boston, Denver, and Anchorage) were also provided with complete "bills-of-material" and detailed, reproducible construction drawings for each facility in the manual. Information on the manual includes a line drawing perspective sketch of each facility in each family, intended function, brief description of materials, overall dimensions, a list of optional components, one-time-use carrying capacity (if appropriate), and construction drawing sheet reference numbers. On the manager's request, the Regional Office will forward the necessary construction drawing sheets and bill-of-materials for delivery to the construction contractor or refuge construction crew. (See illustration.)

Loose-leaf binding and single-color printing of illustrations were employed to facilitate rapid adjustments, if needed, to small *parts* of the document should unforeseen difficulties surface during construction and utilization; deletions and additions are more easily accommodated with this format. Diligent monitoring of the new manual and subsequent improvements should permit constant enhancement of its value to refuge personnel and the public being served.

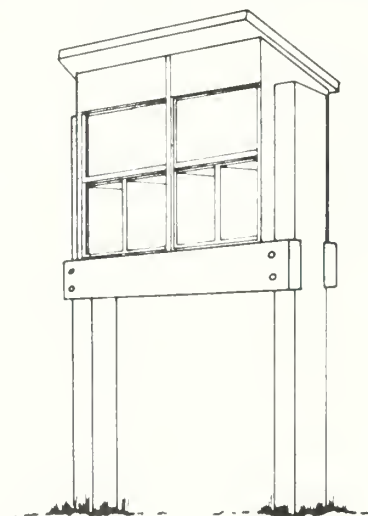
Variant family components may be successfully utilized alongside units from several other design families.



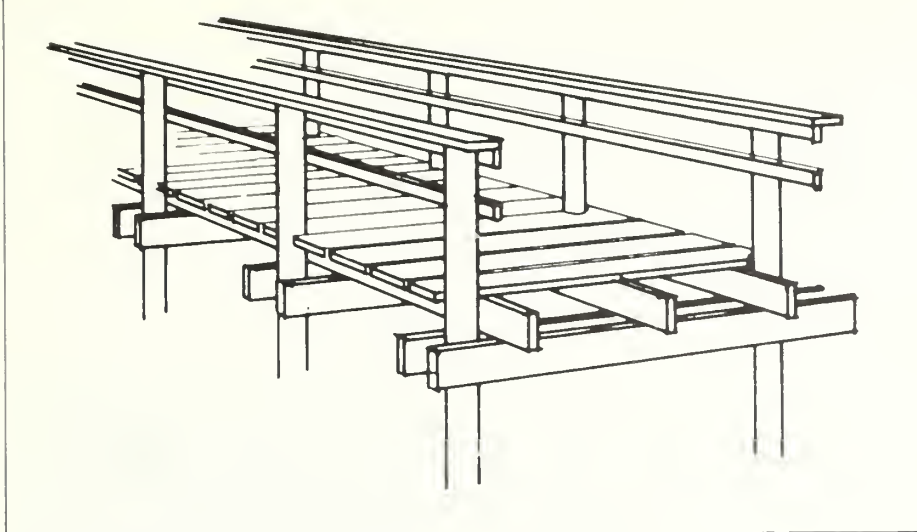
Entrance sign structure



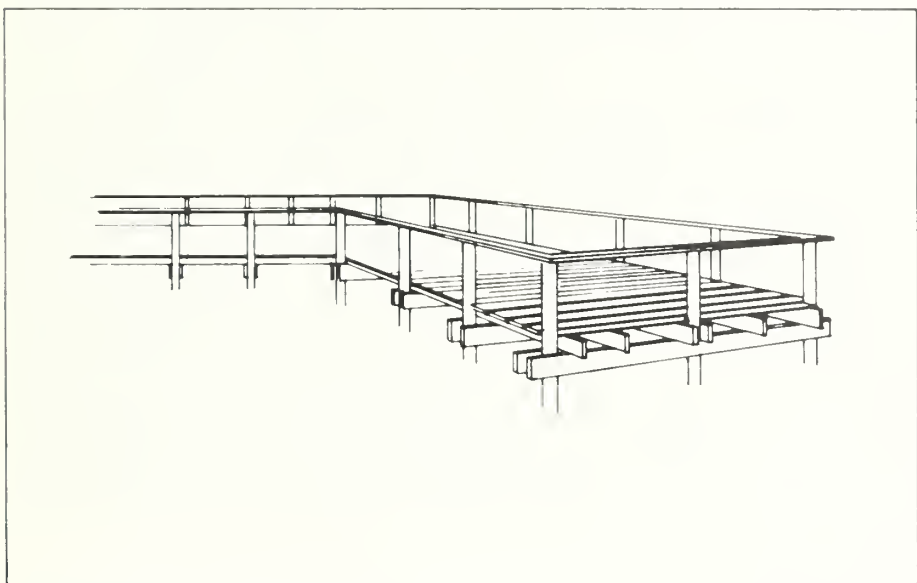
Interpretive sign structure



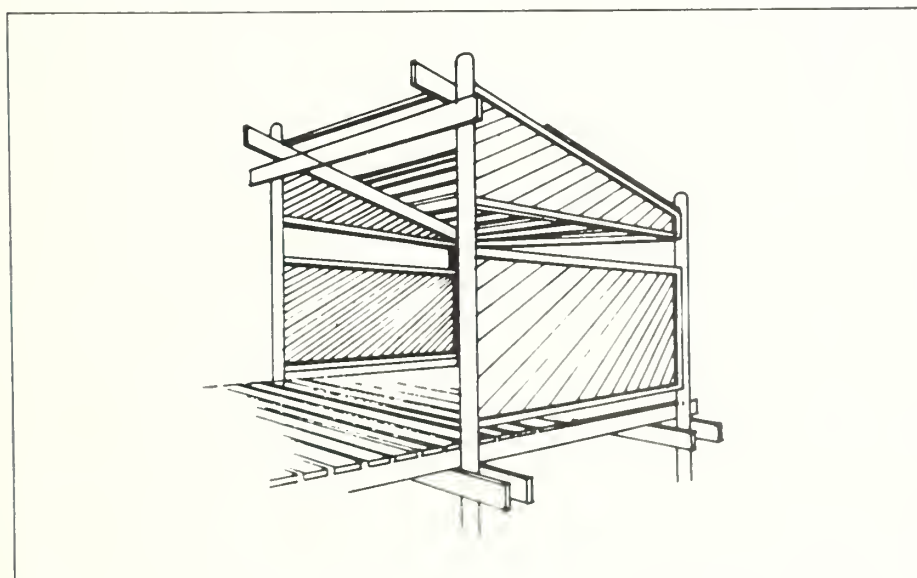
Standard leaflet dispenser multiple unit



Basic boardwalk facility (Variant family)



Interpretive observation deck optional



Photography blind optional

During the first few years of operations utilizing the new manual, refuge managers are required to submit to the design contractors an evaluation of each completed facility and a description of any difficulties encountered during construction relative to site, materials, drawing specifications, and so forth. They also must assess visitor reaction to the facility.

Evaluation and upgrading notwithstanding, the success of the Fish and Wildlife Service's *Basic Interpretation and Recreation Facilities Manual* now depends on the consistency and aggressiveness with which it is put to use by field personnel. The manual may not put an end to "field expedient" provision of public facilities, but it is intended to eliminate the mediocre and improvisational flavor which often characterizes such expediency. Attractive designs, uniform quality, correlated architecture, and physiologic sensitivity are the chief ingredients of the manual which may accomplish this goal.

Bill Sontag is an Interpretive Specialist in the Division of National Wildlife Refuges of the U.S. Fish and Wildlife Service.

Optional components for some facilities are designed for ease of integration with a basic unit.

In Fremont, Nebraska, the parks and recreation department and municipal engineering department have worked together for more than 15 years in designing and building small, low-cost restrooms that are vandal-resistant. The concept was developed and implemented by Ron Donahue, former superintendent of parks and recreation for the city.

The restrooms, designed for a relatively small volume of traffic, usually are located in neighborhood parks. In most cases, their only functions are to provide toilet facilities for park patrons and a small storage area for the recreation department's summer playground program. The restrooms are served by city sewer and water services.

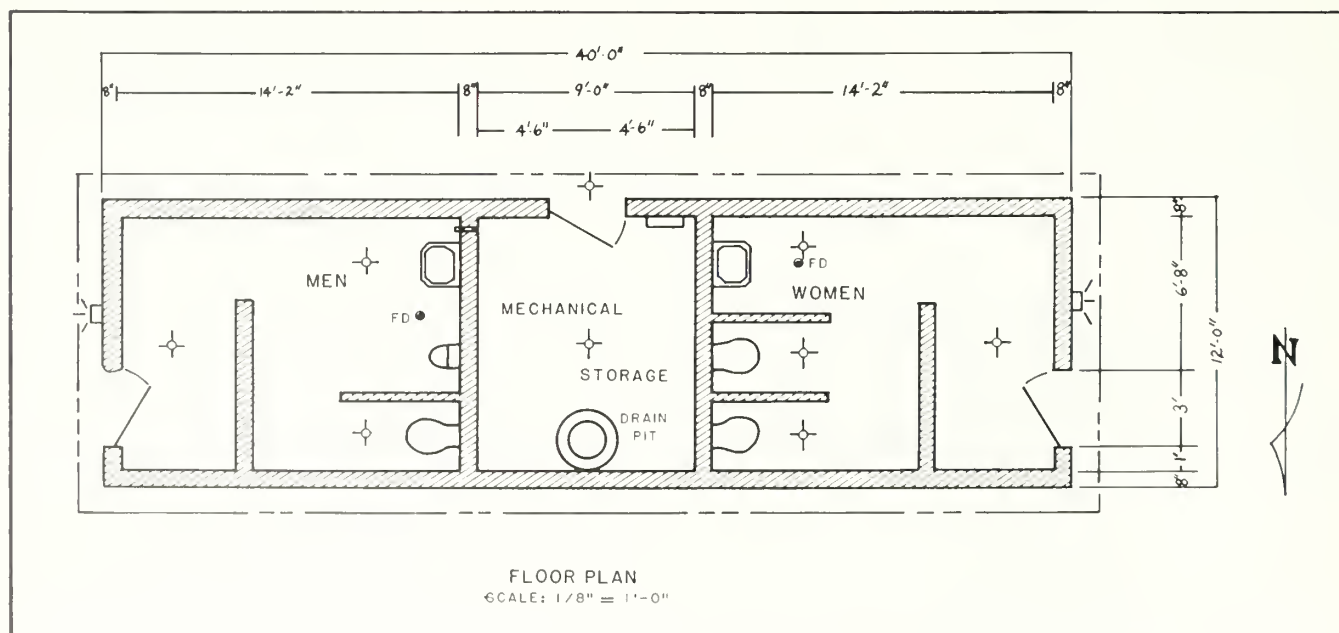
Basic Design Remains Constant

The initial design, developed in the early sixties, provided for a structure with outside dimensions of 22'4" x 10' (6.7 x 3 m), a size not adequate by today's standards requiring accommodations for the handicapped. The basic design has remained constant over the years except for minor variations and improvements.

The walls are constructed of concrete block, laid on a concrete pad. A 4' (120 cm) walkway is poured around the building after the structure is completed. The early design provided for a storage room approximately 4' x 10' (1.2 x 3 m). Later models have a slightly larger storage area. Plumbing fixtures are wall-hung

prison models. Stools have no lids and flush with a button mounted in the wall. Lavatory water faucets are the push type that shut off automatically after a given amount of water is metered. Plumbing pipes, valves, and the electrical service panel all are located in the storage room for easy servicing and protection against vandals. The flat roof consists of 5" (12.5 cm) of lightweight concrete poured in place. Light fixtures are flush-mounted in the concrete and are protected by a clear plastic cover. Lights are controlled by a time clock in the storage room.

Early models were built with several glass blocks installed in the front wall under the roof line to provide adequate natural lighting during





Vandal-resistant restroom in Fremont, Nebraska.

daytime hours. The glass blocks, however, proved vulnerable to vandals and since have been eliminated from the design. Some decorative blocks replace the glass under the roof line. It also is installed in two locations at floor level to allow some natural light inside the restrooms and to ensure proper ventilation. Interior walls are painted with a semi-glass epoxy enamel. Exterior walls are painted in soft earth tones.

Restroom and storage doors are heavy-duty steel. The early model

restroom door locked with a key. A privacy lock for patrons was provided inside the restrooms. Later models provide door knobs without a locking mechanism. Doors are secured by a hasp welded to the door and frame, held with a padlock. Experience showed that welding the hasp is far more durable and vandal-resistant than bolting or screwing the hasp to the door and frame. It would be fairly simple to weld a hasp and a pin on a chain to the interior door frame and door for privacy of restroom patrons if needed. We do not provide for that option, however, and have had no complaints regarding the matter.

All Doors in the Front

Many of the early model restrooms have a door at each corner in the front of the building and a door to the storage room on the back of the building. This has worked very well; however, by locating the storage room door in the front of the building, along with the other two doors, lighting and supervision is simplified. More important, the possibility that vandals would go to the back of the building to pry on or



Photo: Fremont Parks and Recreation Department

A vandal-resistant restroom modified to include a larger storage area and incorporate a tongue and grooved plank ceiling and a gable roof.

vandalize the storage room door is eliminated. Since park personnel or other service people no longer need to go behind the restroom, hawthorne and thorny shrubs can be planted there to control loitering.

Possible Variations

One objection to Fremont's restroom design is that despite minor variations, each additional unit built tends to look like a carbon copy of all the other units. The Fremont Parks Department has experimented with various paint and trim designs seeking visual relief from the apparent monotonous design of the flat-roofed

block restroom buildings. None of the attempts has been particularly effective.

One restroom was constructed with rough, deep-fluted block and waterproofed with clear sealant. A flat concrete roof of precast hollow core panels was installed. Material and labor costs ran higher with the fluted block. The structure has been in service for approximately six years with no problems of marking or painting on the rough exterior finish. If vandals ever do paint on the rough texture of the fluted block, it would no doubt be very difficult to remove. Another option, in place of the fluted block, would be to vary the exterior finish with brick or stone.

None of these variations is particularly effective, however, unless the building's roof line is significantly altered—such as with a hip or gable. Some sacrifice must be made in durability and vandal resistance if these kinds of roofs are installed because they most likely would have to be made of wood.

The last restroom built in Fremont incorporated a gable roof with wood shingles. The ceiling was constructed of tongue and groove plank finished with stain. A small cupolo was added to the roof for aesthetic purposes. The building has been in service about two years with no vandalism to either the roof or ceiling. Before



Photo: Fremont Parks and Recreation Department

Restroom and picnic shelter adapted to an ice skating shelter in winter.

construction of the new restrooms, the old building was vandalized regularly.

Combination Restroom-Ice Skating Shelter

The Fremont Parks Department has adapted the flat-roofed restroom design to a combination restroom and ice skating shelter by extending the poured, lightweight concrete roof and floor pad. The back of the restroom becomes one wall of the shelter, and one side wall of the restroom is extended full length so that two walls of the shelter are fully enclosed. The other two walls are blocked up approximately 3' (90 cm) high and left

open for summer. In winter, the shelter is fully enclosed by installing plywood panels in the two open walls. Heat is ducted into the shelter from a small furnace in the storage room.

The low flat roofs are sometimes tempting for youths to climb, but there isn't much damage that vandals can do to it other than stuff rocks or sticks down the sewer vent pipe. This action can be prevented by installing a return bend or two 90° elbows. One word of caution: because of the low roof line, electrical power should be brought to the structure underground rather than overhead in the event that someone might climb onto the roof.

Fremont's restroom design appears to be proving worthy over the years. There is, however, ample opportunity to challenge designers to incorporate variation and attractiveness to match the structure's serviceability.

Joe Collins is Director of the Fremont, Nebraska Parks and Recreation Department.

Forest Fires

by Steve Such

Michigan's Forest Fire Experiment Station at Roscommon was built in 1930 at a time when the state was losing the war against forest fires. During that year, some 290,000 acres of land were lost to forest fires. In battle after battle, fire came out the winner with the state counting its death toll in terms of billions of trees lost on hundreds of thousands of acres. By comparison, only two forest fires in recent years have exceeded 20,000 acres (8,000 hectares) burned, the Upper Peninsula Seney fire in 1978 and the Mack Lake fire near Mio in the Spring of 1981.

The Need

Conservationists, especially staff of the Michigan Conservation Department (now the Department of Natural Resources) and members of the state legislature recognized by the late 1920s that forest fire destruction had to be reduced. Appreciation was growing for forest lands as sites for residences, vacation homes, and public recreational facilities. The value of forests as wildlife habitats, as products, and as soil conservation sources was gaining recognition. It was apparent that before good land management practices could be applied, the threat of wildfires had to be controlled.

In 1920, the Conservation Commission authorized the establishment of a state Forest Fire Experiment Station to investigate problems related to forest fires and to take whatever steps seemed necessary and feasible to deal with these problems.



A military 2½ ton (2.25 t) 6x6 truck converted to a forest fire tanker with 1,000-gallon (3,600 L) water capacity.

The Forest Fire Experiment Station studied the overall impact of forest fires on the state and its people, identified problems related to forest fire activities, and developed improved fire fighting methods. Studies were undertaken quickly in fuels, fire behavior, weather, and similar fire-related elements. The immediate and overriding concern of field personnel was for equipment to help in fighting fires. Thus, as attention was directed toward this need, the station grew as an equipment development center.

Acclaimed Worldwide for Innovative Equipment

Since its establishment 50 years ago, the station has become one of the best known and most successful producers of innovative fire fighting equipment in the world. Designs for new equipment and modifications of

standard equipment by the station's staff have become prototypes for use throughout the country.

The Michigan center, along with two more recently developed U.S. Forest Service stations in San Dimas, California, and Missoula, Montana, represent all forest fire equipment development activity in the U.S. and much of the world.

The station's designing and fabricating activities are coordinated with these other stations and with the forest fire research centers at Missoula, Riverside, California, and Macon, Georgia. In this way, any new information about suppressing chemicals or new instruments for fire danger rating systems can be applied immediately in a practical way.

Under a federally assisted program, the station, also called the Roscommon Equipment Center, serves 20 northeastern states. Equipment

designed and built at the center is being tested in 18 of these states.

With its equipment and buildings valued at about \$4 million, the Roscommon Experiment Station may be a bargain for taxpayers. After Michigan employees built the station, the state has invested \$50,000 in it. All supplies, from used Army trucks and scrap metal to nuts and bolts of every size, are free government surplus. For example, during the past five years, the station crew has adapted 40 high-performance multi-stage centrifugal pumps designed for forest fire application. They are mounted on military excess property gasoline engines, saving at least \$1,000 on each unit over commercial costs.

All Inventions in Public Domain

Because of costs, time and certain legal restraints, none of the dozens of inventions blueprinted by the station's staff has been patented. They are in the public domain.

The experiment station converts large, used military trucks to forest firefighting tankers fitted with 1,000-gallon water tanks and firebreak plows designed and constructed at the center. Under modification is a super tanker truck to haul a 1,500 gallon (5,700 l) tank, the largest yet designed.

The center's bread and butter items include tankers with custom-fitted brush protectors, safety equipment, and hydraulically operated plows mounted on crawler tractors. Several sizes of hydraulic cylinders to lift and lower the plows are made at the center.

Some of the important designs conceived by the center's staff that have had the most impact in the forest fire fighting field include: a shallow well sinking system designed for drilling wells fast at a fire site; a sand casting machine that throws sand on big fires faster and more efficiently than a thousand men with shovels; a mobile aerial tanker to effectively water ground to extinguish or retard fires; hydraulically operated water pumps; and fire plow attachments for all types of vehicles.

Cooperative Network

Michigan's forest fire fighting program benefits from the center's cooperation with other states and the federal government, as do other divisions of the state's Department of Natural Resources. The center is known to many DNR employees for designs of all kinds of gadgets needed for special projects. The center's crew can, and will, tackle almost any challenging new equipment idea request. Crew members modified a wood planer for the DNR Brighton Forestry Nursery, saving the cost of a new \$10,000 planer. For the Wildlife Division's post mortem work on deer and bear, they built a stainless steel autopsy table and collapsible, portable weighing device for use at roadside locations of deer-car accidents. Work for the DNR Information and Education Division included the salvaging and repair of an \$800 photograph flattening machine and construction of a 24-foot high floatable perch to photograph osprey in the Dead Stream Swamp.

The station today continues to exist for its primary and original purpose, that of making fire control safer and more efficient through mechanization.

Although damage from forest fires has been reduced greatly during the past 50 years, the need for forest fire prevention is greater than ever. Forest lands, as well as all land in Michigan, have increased in value dramatically since 1930. There are more acres of forested lands today, because improved fire management practices have allowed a second growth of forests to mature. Challenges for the Michigan Forest Fire Station continue.

As part of its work, the Roscommon Equipment Center at the Michigan Forest Fire Experiment Station tests and evaluates equipment. Following is a summary of a typical evaluation.

SKIDDERS IN FOREST FIRE CONTROL

Traditionally, forest fires in the Lake States, as in many other parts of the country, have been fought with either dirt or water, or both. Devices to do this work have included a wide array of implements from shovels and pails to bulldozers, tractors with plows, and off-the-road tanker trucks in the jeep, 4x4, and 6x6 classes. The best features in these earlier fire suppression systems have been combined into a single fire fighting unit which hints rather convincingly at doing, with one machine, much of the work previously requiring several pieces of equipment. Tests in Michigan with modified forestry skidders have shown them to be a promising new tool in forest fire control.

The Fire Fighting Skidder

The first fire fighting skidder was developed 11 years ago in Michigan around an original idea of the Canadian Electric Power Company, which experimented with the articulated machine for power line right-of-way maintenance. The company reasoned that the skidder, with its excellent cross-country mobility, could carry large amounts of herbicidal liquids into remote areas for spray treatment of nuisance vegetation.

Tests by the Canadian Electric Power Company proved their thinking to be correct and the off-the-road tanker soon caught the eye of fire control officials who saw in the machine a potential for fire fighting.

Subsequently, the original skidder-tanker was shipped to Michigan where a heavy-duty hydraulically-operated fireline plow was mated to the skidder with an ingenious new hitching arrangement.

Trials and demonstrations in Michigan and throughout much of the eastern and southern U.S. with the skidder-tanker-plow unit provided adequate evidence for further consideration of skidder machines for forest fire suppression.

Modifications of the original design included lowering the tank silhouette and overall center of gravity of the machine. A specially designed V-shaped blade was added to the skidder, as was a two-way radio, a powered winch, and incidental hand tools.

The fire fighting skidder's weight, when fully loaded, is approximately ten tons, or about twice the weight of the machine as delivered new. The major part of this weight is the 500 gallons of water carried in a tank behind the operator. Despite its seemingly great weight, the skidder travels safely at road speeds up to 15 mph and will, with relative ease, negotiate terrain previously accessible only to crawler equipment. The vehicle's cross-country mobility is its outstanding characteristic and the one which has created national interest in the machine for woods use of all kinds, including forest fire control.

Four skidders were used in the Michigan evaluation tests. They were powered by engines in the 90-100 horsepower class and all were similar in size, weight, appearance, power, tire size, etc. Transportation to and from fires was by low-boy semi-trailers that can be hauled at speeds up to 50 mph. Field experience has shown that early worries about delivery time needed to get skidders from their station to the fire site were mostly unfounded. Skidders reach fires in approximately the same time as for movement of heavy crawler equipment. In some cases, even faster times were noted where skidders were unloaded from their conveyance and allowed to move under their own power once they were near the fire scene.



This prompted one agency to totally eliminate the hauling unit, allowing the skidder to move on its own wheels and under its own power from the work station to fires. The radius of the operation for this experiment was somewhat arbitrarily established at 30 miles (48 km), a distance the skidder can reach easily in two hours. Test results in self-delivery of skidders are inconclusive, but the practice is expected to have only limited application at best.

The Skidder Tanker

All skidder water tanks have been constructed of steel, are rectangular, and carry 300 to 500 gallons (1140 to 1900 l) of water. Their interiors are



Photo: Michigan Forest Fire Experiment Station

Author Steve Such, supervising engineer at the Michigan Forest Fire Experiment Station, stands beside a forestry skidder that is being converted for use in forest fire control.

coated with a heavy, mastic petroleum by-product. The coating material, reported to have certain self-healing characteristics, a good low-cost rust preventive for the interior of steel water tanks. Some new coatings may be superior to this earlier product.

Pumps used with the skidder tanker have been both positive displacement and centrifugal types. The optimum output of these pumps has been set empirically at 20 to 35 gallons (76-133 l) per minute at pressures ranging from 100 to 300 pounds (45-135 Kg) per square inch. The controlling factors in establishing flow and pressures are the amount of water and working time available to the fire fighter per load of water. Recently the volume of

water discharged per minute on fires has been rising steadily because larger volumes of water can be carried to the fire by bigger and better equipment. Discharge pressures, on the other hand, have dropped steadily.

A fire fighter using a skidder in fire suppression has several options in discharging the water. A nozzle is available in the operator's compartment and there is a nozzle at the rear of the unit. There is also water left or right from fixed orifices mounted directly on the front of the skidder.

The Skidder Fireline Plow

The heavy-duty Michigan hydraulic plow attached to skidders is the same plow used in Michigan on crawler

tractors, but the mounting is new and it offers an interesting concept in hitch mechanisms. Known as the float hitch, the new design preserves the inherent high undercarriage clearance of forestry skidders, but still allows the plow to perform freely and efficiently in all ground conditions, soft or hard, smooth or rough. A hydraulic locking arrangement permits fixing the plow at any depth or position during plowing or transporting. The skidder hitch has been cited as the machine's most unusual added feature and the basic elements of its design have been incorporated into plow hitches on trucks and tractors.

The skidder hitch is wholly hydraulically-operated through two valves controlling a pair of double-acting hydraulic cylinders. One valve has a float position from which the hitch draws its name. One of the two cylinders raises and lowers the plow and the down pressure that can be placed on the plow. The second cylinder controls the hitch assembly up or down a distance of 18 inches (4.5 cm) at the hitching point. Both cylinders are operated independently, but each is dependent on the other for best operation.

The skidder plow is carried upright, fixed in this position with a positive, (not hydraulic) locking device. When unlocked, the plow is lowered to the ground, then forced into a normal plowing position as the draft vehicle moves forward. A spring assembly mounted on the top of the plow compresses with hydraulic down pressure to allow a flexing action under certain ground conditions.

The hitch is allowed to float except when in difficult plowing conditions (downed trees, strongly rooted shrubs, clay soils). Then the hitch is locked by moving the valve lever into neutral position. Locking can be done at any point along the vertical 18-inch path of the hitch point. Firelines produced with the double bottomed plow average 72" (180 cm) wide and 5" to 6" (12.5 to 15 cm) deep. Exposing this much mineral soil handles most forest fire problems, especially when the natural dirt fire break is reinforced with water pumping equipment.

Other Skidder Accessories

Perhaps no accessory is more important to a fire fighter than a reliable communications system. For general safety, welfare, and convenience, two-way radios have been as much a part of the fire fighter's trade as have plows and pumps. Michigan skidders in fire control are equipped with radios that are portable, easy to move, and readily adaptable from vehicle to vehicle. They can be hand carried when necessary. Radios on fire fighting equipment have been credited several times with life-saving action resulting from their use.

Front mounted mechanical or hydraulic-powered winches are now considered a necessity for safe, effective operation of the skidders. Even with their exceptional mobility, skidders have been known to get stuck or hung up. Then winches become an indispensable aid to the operator.

Front mounted blades for light dozer work, for brush and debris removal, and for machine and operator protection have been incorporated in skidders adapted for fire control duty. A V-type blade that moves ground trash to either side of the machine appears to be the most practical blade design at the present time, but more evaluation of blade types and performance is needed before a final design judgment can be made.

Simple hand tools (shovels, axes, etc.) and other light accessories (fuses, portable fire shelters, etc.) are added to skidders to make them as complete a fire machine as possible.

In sum, the skidder, made up as it is with all of its components, provides each operator with more fire power today than has been available to a single man any time in forest fire history. So great is this force that operators must be specifically trained to reap the full benefits from the machine.

Advantages of Skidders

The main advantage of forest fire fighting skidders is their versatility. They can deliver large payloads of water to remote fire locations and plow firelines in forested areas at relatively high speeds. Research and tests indicate that no other machine used to date for forest fire control has the same capacity of the skidder in the two basic categories of a draft vehicle and a fire pumper.

In its present form, the skidder can, in the least amount of time, take more water into more forested areas than has been possible with any other vehicle ever used in fire control. Only the fire bomber can exceed the skidder's delivery time. Under certain conditions, too, the skidder can plow firelines at rates nearly double that of other conventional plowing equipment such as crawler tractors. The skidder is a comfortable machine to operate; its speed provides an uncommonly high escape safety factor for operators faced with fire blow up situations. At other times, because of its speed and agility, it allows fire fighters to move rapidly between hot spots. Visibility is excellent from the skidders because the operator rides high and can, for the most part, see unobstructed in all directions. There is some limited visibility to the rear

because of the water tank. Skidders require less maintenance than many other machines used for similar purposes, accounting for many conversions from track vehicles to rubber tired ones.

Disadvantages of Skidders

Some drawbacks to fire control skidders include the facts that: (1) They are high in initial cost; (2) They require special operator training; (3) There is limited rear visibility while plowing; and (4) They are subject to specialized maintenance. None of these drawbacks likely will be considered serious deterrents to the use of skidders if they continue to perform as dramatically and impressively as they have in their first few years of testing and use. The growing acceptance of skidders adapted for fire control is evident from favorable feedback from operators who have recorded their experiences with skidders on running wildfires.

Conclusions

Skidders appear to be earning a distinct role in suppressing the nation's forest fires. The combination of high speed, great power, articulation, and excellent cross-country mobility already have made skidders naturals for woods use in logging operations. These properties seem to offer the same efficient application in forest fire suppression. Further evaluation under actual fire conditions will have to be made before these machines can be considered absolutely proven and

totally safe for fire control. Some component redesign may be necessary eventually, especially if new forest fire control uses (personnel carriers, supply vehicles, reconnaissance units, etc.) are to be considered. The maximum potential of these machines in forest fire control is yet to be established and documented. Based on recorded data the machine appears to be making a strong bid for a permanent place in America's forest fire fighting arsenal.

Steve Such, supervising engineer of Michigan's Forest Fire Experiment Station at Roscommon, frequently attends annual meetings in Washington, D.C., with national representatives of the forest fire fighting field. He is a member of the National Wildfire Coordinating Group formed five years ago, a group of teams that advise federal authorities on national forest fire fighting needs.

Rediscovering Geothermal Energy

by Ray Lowery, Jr.

Energy conservation are two words that have increasingly crept into the vocabulary of municipal officials, their residents, and private industry. Many systems, some very exotic, have been analyzed, discussed, and tried. One town, Kingston, Pennsylvania, a residential community of 18,000 people in northeastern Pennsylvania, has rediscovered an energy source it considers more dependable than solar or wind power, and more universally applicable. The source is geothermal energy.

Kingston has constructed a \$1.1 million, 17,500 square foot (1575 m²) indoor recreation center that uses geothermal energy to heat the entire facility and provide hot water for the showers. The new facility, which opened in May 1981 contains a large gym, which can be separated in half by a mechanical partition; three

racquetball courts; an exercise area; an activities area; a TV lounge; a meeting room with kitchenette; an equipment room; and locker and shower facilities. In addition, the recreation director and his secretary have offices.

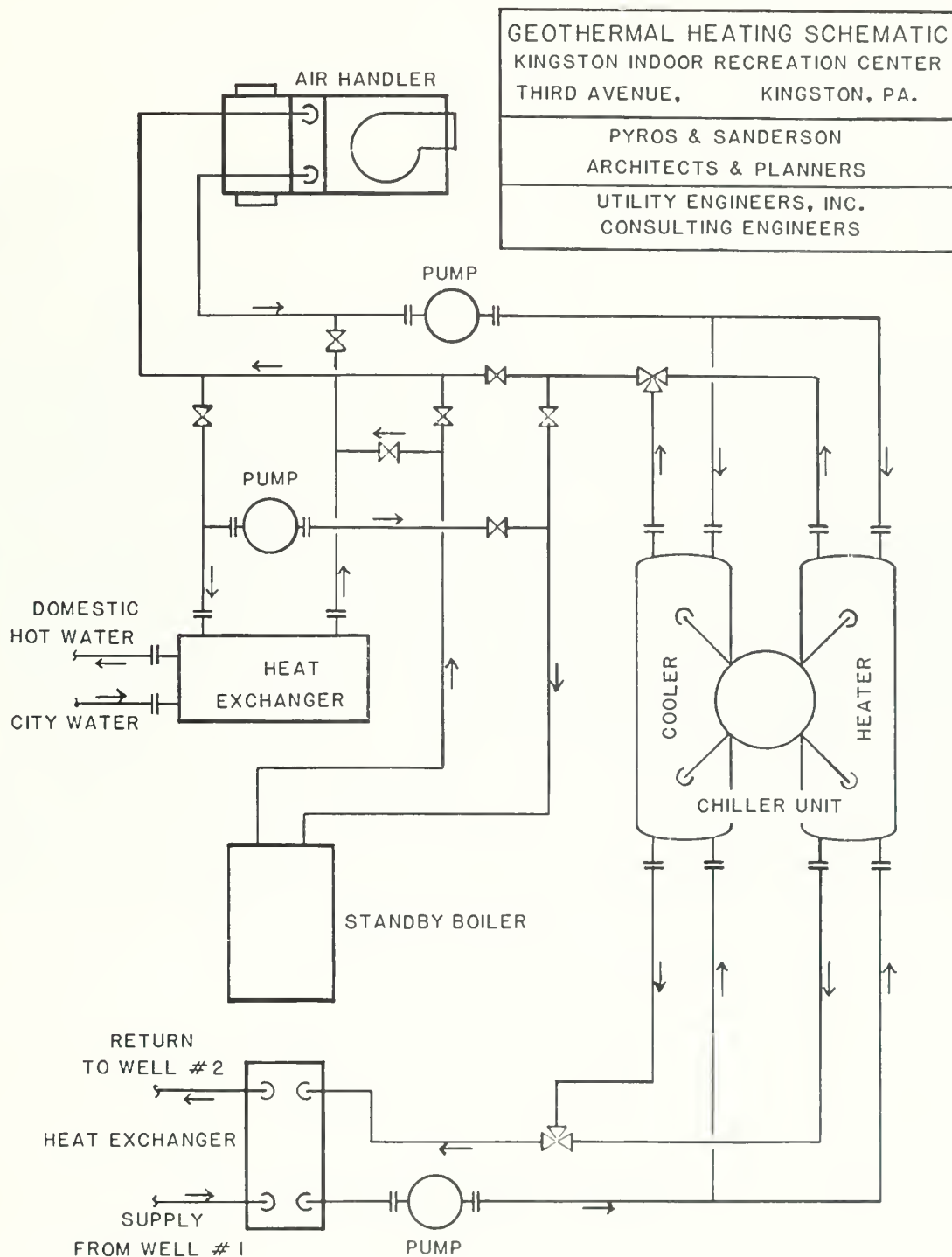
The center's geothermal system is relatively simple and inexpensive (see Table). Two wells, one supply and one return, were drilled to approximately 190 feet (57.92 m) below the surface into an underground water pool. This water, at a constant 52° to 54°F, (12° to 15°C) is pumped into a closed loop heat exchanger, then discharged into the ground. The raw ground water is rather acidic and corrosive, and therefore is not fit for circulation through the entire system.

Clean, non-acid water is heated by the heat exchanger and pumped into a conventional chiller unit. The water

enters at approximately 50° F (10° C) and leaves it at 120° F (49° C). The chiller unit is, in reality, a heat pump, which, through compression with gaseous material, drives the water temperature up to 120° F (49° C). The heat is then transferred throughout the building just as with any other conventional HWAC system.

The geothermal system's initial cost is \$20,000 higher than a conventional system because of the two wells and the heat exchangers. The long term energy cost savings from the geothermal system compared with the traditional costs for providing heat and hot water for this 17,500 square foot (1575m²) building look like this:

		Savings Using Geothermal
Electricity (\$0.05/Kw Hr)	\$16,417 per year	\$10,942
Oil (\$1.00 per gal)	13,360 per year	7,885
Gas (\$0.375/CCF)	7,003 per year	1,528
Geothermal	5,475 per year	



Geothermal heating schematic



Photo: Kingston, PA

Kingston's indoor recreation center is heated by geothermal energy.

At today's prices, these are impressive figures. As the cost of oil, electricity, and natural gas continue to increase, the savings from the geothermal system will be even more dramatic. The price of ground water obviously will not increase.

When gasoline reaches \$1.50 per gallon price, recreation professionals are predicting that local governments will be placed on the horns of another dilemma. The price of gasoline will force more and more people to seek recreation closer to home, thus putting pressure on local governments to increase their recreation programs. In the past, recreation

has been a low priority item in municipal budgets, susceptible to early budget-balancing cuts.

The geothermal system offers a practical way to help stabilize or reduce recreation program costs. The system can be used in other municipal buildings such as fire houses, police stations and warehouses. Geothermal is not new and has been used in the warmer climates of the South and Southwest. But perhaps it offers the greatest potential for the high energy cost areas of the Northeast and Midwest.

Kingston's project was funded by an innovative grant from the U.S. Department of the Interior's former

Heritage Conservation and Recreation Service, the Luzerne County Community Development Program, and Kingston's Community. For additional information, the following people may be contacted: *Project Engineer*, Utility Engineer, Inc., 1460 Wyoming Avenue, Forty Fort, PA 18704; *Project Architect*, Pyros & Sanderson, 1 South Main Street, Wilkes-Barre, PA 18701; *Contractor*, Sordoni Construction Company, 45 Owen Street, Forty Fort, PA 18704.

Ray Lowery, Jr., is Municipal Administrator of Kingston, Pennsylvania.

How the Forest Service Develops and Tests Equipment

by Eunice R. Waldmann

Our Equipment Development and Test Program operates under the direction of the U.S. Department of Agriculture, Forest Service Engineering Division. Started shortly after World War II with a staff of one mechanical engineer and a clerk typist, the program today consists of two equipment development centers and a Washington office staff of four which guides and coordinates the activities of the centers.

The two equipment development centers provide highly specialized technical services to help land managers to do their job more effectively and efficiently. They serve the nine Forest Service regions and cooperating federal and state agencies, making available information, concepts, equipment, and ideas to better manage public land.

Located at San Dimas, California, and Missoula, Montana, each equipment development center has a staff of approximately 50 employees representing various disciplines including mechanical engineers, electronic engineers, foresters, photographers, writer-editors, draftsmen, equipment specialists, technicians, and support personnel.

Some of our present projects involve:

- timber management (nurseries, harvesting, and silviculture)
- recreation management (water quality, sanitation, and recreation facilities)
- wildlife
- range management (seed collection, disturbed land reclamation, drills)
- watershed (soil compaction)
- aviation and fire management (tankers, hoses, nozzles, retardants, retardant aircraft, ignition devices, parachutes, smokejumper gear, and aircraft accessories)
- forest roads and trails (road maintenance equipment, trail construction and maintenance methods, road deterioration, explosives, and traffic counters)
- forest signing (porcupine resistant signs, reflective sign materials, and vandalism prevention)
- forest pest management (aerial application of pesticides)
- safety management (avalanche control, employee health program, protective devices for hearing conservation, poison ivy/oak prevention methods, and employee fitness)
- law enforcement.

Each center is assigned between 50 and 65 projects per year. These projects start as requests from people in the field and from organized groups such as the Fire Equipment Working Team (FEWT), the Vegetative Rehabilitation and Equipment Workshop (VREW), and the Forest Regeneration Committee (FRC). Project proposals, which include plans of action and estimated costs, are prepared at one of the centers and each fiscal year all project proposals received are compiled by the equipment development staff in the Washington office. A book of proposals is then prepared and distributed to interested staffs with the Forest Service, such as Timber Management, Recreation, Safety, and Aviation and Fire Management. Meetings are held and the contributing staff, in coordination with the equipment staff, sets up a program for each center with both short-term goals for the fiscal year and long-term goals for the following three years.

The following project descriptions further explain the equipment development centers' work.



Photo: USDA Forest Service

The San Dimas Slash Machine

Aviation and Fire Management

The Missoula Center manages and maintains some 50 specifications and standards that procurement and supply agencies use in contracting for fire and aviation equipment and supplies. Some of the more recently written or revised specifications range from sleeping bags and fire-resistant shirts to anti-fog goggles and forest fire shelters.

The San Dimas Equipment Development Center continually updates specifications and standards, providing a state-of-the-art reference on cost-effective equipment. Revisions are made to the specifications and standards when considerable changes to an existing document are involved. Amendments are used when changes are minimal.

Another ongoing project at the San Dimas Center involves the maintenance and updating of existing Forest Service fire tanker drawings so that procurers will have current information about the latest models. This project incorporates technological changes that might improve fire suppression equipment or add to the safety of fire crews.

Technical assistance to Forest Service regions, contractors, and other governmental agencies is also provided. For example, more than 100 copies of reduced and full-size prints with specifications (technical data packages) of the Model 41, 51, and 60 fire tankers were forwarded upon request. Fifty sets of technical data packages also were sent to the two regions for contracting.

The San Dimas Equipment Development Center has issued an *Equip Tips* on a liquid-concentrate (LC) blender and also a package of drawings for use in installing the LC blender. A test plan was written to obtain ground-applied retardant effectiveness data. Ten of the blenders have been installed by the Pacific Southwest Region, with technical assistance from the center. Center personnel conducted training on the blenders, their use, and calibration.

Timber

The San Dimas Slash Machine: The equipment development center at San Dimas investigated many types of slash treatment machines in search of a cost-effective device to thin, young,

dense timber stands and simultaneously treat the resulting slash. As part of this effort, the center analyzed and tested typical blades from both vertical- and horizontal-shaft cutting machines in its slash cutting test facility. From the test results, a prototype cutterhead was designed, built, and tested at San Dimas. A refinement of this cutterhead has now been mounted on a Hydro-Ax Model 1,000 prime mover to make up the current San Dimas Slash Machine.

Engineering

Signs Program: Most of the signs projects are conducted at the Missoula

Equipment Development Center. This program includes maintaining traffic control signs, developing and testing reflective sign materials, developing a sign maintenance vehicle, evaluating pavement marking and delineator, researching ways to prevent vandalism of Forest Service signs and materials that resist porcupine damage.

The Hydraulic Rock Rake: The Missoula Equipment Development Center has designed the rock rake specifically for work on forest roads. It incorporates design features recommended by Forest engineering road maintenance personnel, like side shifting (to keep the vehicle away from the road edge), and rotation in two

planes (to eliminate "deadheading" and improve spreading surface materials).

The new rake attaches easily to the bed of a 1-ton service truck and is operated entirely from the cab. Electrohydraulic controls allow the operator to adjust the rake while moving, for rapid maneuvering around stumps, over cattle guards, and through turnarounds.

Two hydraulic cylinders control rake pressure on the road. Adjusting the pressure difference between the cylinders tilts the rake. Neutralizing the pressure in both cylinders allows the rake to "float," conforming to the road's surface.



Hydraulic Rock Rake



Modified Hodder Gouger

Hinged sections at each end of the rake fold up, reducing its 11-foot width to 8 feet. This allows the rake to be transported on public highways at normal speeds while still mounted on the truck.

The new rock rake can mean more efficient road maintenance operations due to:

- more miles of road bladed each year,
- less swamper time spent removing rocks,
- greater motor grader productivity.

Range

Information Workgroup Support:

Under this project the Missoula center personnel support the Vegetative Rehabilitation and Equipment Workgroup (VREW), an organization of federal and state agencies and private groups concerned with rangeland

rehabilitation. Center activities in behalf of the workgroup include preparing, printing, and distributing the annual report; maintaining mailing lists; establishing a library of workgroup reports and films; and contacting various organizations and institutions that could benefit from this information.

The Modified Hodder Gouger: This project is assigned to the Missoula Equipment Development Center. The gouger excavates depressions in the soil surface that collect moisture and protect seeds and seedlings from wind and water erosion. These depressions enhance revegetation and speed rehabilitation of disturbed semi-arid ranges. The gouger is towed behind a tractor and powered by the tractor's hydraulic system. A seed drill box can be mounted on the rear of the gouger frame to allow seeding and gouging in one operation. Since 1977, the gouger has successfully treated disturbed rangeland on western sites.

The machine was developed through a cooperative effort between the USDA Forest Service Missoula Equipment Development Center and Montana State University at Bozeman, funded by the Bureau of Land Management and its Energy Mineral Rehabilitation Inventory and Analysis Program.

Production has averaged 20 acres per day for gouging and seeding native grass seed.

Automatic up and down cycling excavates depressions 3 to 4 feet (.91 to 1.22 m) long, 18 to 22 inches (.46 to .56 m) wide, and 6 to 8 inches (.15 to .20m) deep. About 4,000 depressions are excavated per acre.

Safety

The Occupational Safety and Health Program: The Safety program at Missoula includes projects such as the Physical Fitness Training Program,



Clearwater Yarder

Photo: USDA Forest Service

safety products evaluation, safety equipment specifications, Health and Safety Code revision, Chain Saw Chaps improvement, retest of hard-hats, leg protection for handtool users, evaluation of present measures for preventing poison oak/ivy, and the combination oil/gas safety can.

Under the Physical Fitness Training Program, Missoula has prepared the following materials:

- **Measuring Your Physical Fitness**—A slide-tape program plus illustrated script available from the National Audio-Visual Center.
- **Fitness and Work Capacity**—A publication explaining the relationship between fitness and hard-to-do jobs; available from Superintendent of Documents, US Government Printing Office (GPO).

- **Fitness Trail**—A publication on how to build and use a fitness training circuit.

Recent work has largely centered around providing signs, information, and assistance to field units constructing Fitness Trails. More than 200 of these trails have been constructed to date. Missoula is establishing a commercial supply source for the signs and completing the trail publication for stocking through GPO. Missoula is also evaluating electronic pulse counters for use in the step test.

Forest Residues/Timber

The Clearwater Yarder: Work on this project was done at the Missoula Equipment Development Center. Where terrain and soils limit conventional ground skidding, advanced cable yarding systems—like the Clear-

water Yarder—offer a solution for removing small timber or dead wood. The Yarder is a lightweight, three-drum system that makes harvesting small material practical. The Forest Service developed this yarder concept for the Clearwater National Forest in Idaho to remove dead wood from areas unsuitable for broadcast burning.

Since August 1977, the Clearwater Yarder has been used at sites in five western states, and has operated more than 1,600 hours without major breakdown. A second Clearwater Yarder has been operating in the south since October 1979. Daily production has ranged from:

- 95 to 174 tons (of slash)
- 68 to 100 cords of firewood
- 8,000 to 12,000 board feet

Recreation

Trail Maintenance Equipment Handbook: Maintaining trails with handtools is becoming a lost art. Since most young people know little about the many handtools once common in the Forest Service, the goal is to furnish information concerning the use and care of handtools for trail maintenance. Missoula has prepared such a draft handbook for trail maintenance, which will be sent out for review and then printed in final.

Compost Toilet Evaluation: San Dimas has completed a limited 1-year evaluation of approximately 20 compost toilet installations located throughout the United States. The results are inconclusive as to whether this approach to a viable, cost-saving alternative to transporting human waste from recreation sites is feasible. Nevertheless, the evaluations to date have provided a better understanding

of composter operational maintenance procedures and of the problems and data for comparing the relative merits of the different compost systems that were monitored. Further testing is required to determine whether composting causes the required biological reduction in human waste masses to produce the desired pathogen-free substance with a high-ash content. Among the composters evaluated were both those that are batch loaded periodically with the toilet waste and those that are an integral part of the toilet and, thus, have their wastes continuously composted. In either case, the waste mass is periodically "dusted" by an employee who adds carbon-oriented materials such as leaves, bark, sawdust, etc. Under this project, the use of solar-powered helio-thermal and helio-electric devices to assist in the biological reduction of waste masses is also being studied, and a design for such

equipment was developed. San Dimas plans to purchase and field test the solar equipment on a continuously composting toilet.

The Centers work on a large variety of projects not mentioned here. Printed information may be obtained and questions answered by writing to the centers.

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Equipment Development Center
444 East Bonita Avenue
San Dimas, California 91773

USDA, Forest Service
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Alternate Fuels and Vehicle Technologies

by John Hoke

Keeping our numerous parks healthy requires using a variety of vehicles, tools, and other equipment that burn petroleum-based fuels. Much of our equipment consists of conventional road-oriented vehicles that either are used as is, or are modified to meet special park needs.

With the advent of the first oil crises in 1973, the attitude toward using this kind of equipment began to change. The National Park Service established an Energy Conservation Management Policy to develop cost-effective alternative energy uses. The objective of this policy is to find new ways to reduce the Park Service's reliance on petroleum-based fuels without jeopardizing the needs for mobility and equipment operations.

The National Park Service's National Capital Region (NCR) has looked into ways to reduce or eliminate petroleum fuels consumption while performing the same work. Success of these initial efforts has encouraged NCR to expand its hunt for new ideas. One option is seeking ways to operate conventional electric tools with power from the battery banks of small electric vehicles, instead of using noisy, fuel-wasting gasoline engines.

The range of electric vehicles can be extended by on-board engine-generator packages. Because they have to produce only the *mean* power requirements they are extremely efficient power supplements. Also, they can be converted to run well on ethyl alcohol.

NCR also has developed easy and effective engine modifications for maintenance and grounds-care equipment such as lawnmowers and agricultural and garden gasoline engine tools up to 75 HP that run well on straight alcohol. A gasoline-powered utility golf cart was among the early conversions for alcohol fuel.



An AC power tool is plugged into the fender-mounted AC outlet of this electric battery-operated tractor.

This conversion process became the cornerstone for an alternate fuels program, which since has acquired highly skilled and trained mechanics and supervisors who can modify

gasoline-powered equipment to operate on alternate fuels.

NCR also has experimented with alternate fuels in other vehicles and equipment. Alcohol as a fuel has been

Photo: William Clark, NPS



An early-model electric battery-operated tractor can silently operate on a 36-volt battery pack.

Photo: William Clark, NPS

tried for pickup trucks without problems. A building boiler-heating system in one of NCR's outlying parks was successfully equipped to burn alcohol.

Surprisingly benefits of the alternate fuels program spilled over into numerous unexpected areas: lower equipment costs, lower maintenance costs, simpler operation, as well as a

marked reduction in petroleum energy use. As the gap between alcohol and gasoline prices narrows, alcohol becomes even more attractive as a fuel.

The attributes of alternate fuels are not always comparable to their traditional counterparts. It is therefore important to point out that while electric vehicles can serve many pur-

poses, they are best appreciated on their own merits. They should not be considered primarily as substitutes for conventional highway automobiles. Their qualities most enjoyed are the *differences*, not their similarities, to automotive equipment. It is these differences that should be evaluated and used to improve park operations.

Alcohol fuel offers special advantages, including clean, emissions-free combustion that leaves minimum deposits on internal engine parts. Alcohol fuel is renewable fuel, and can be produced domestically to meet demand.

NCR wants to share some of its successes in these new technologies with other parks.

Site Patrol Vehicles

NCR has several years' experience using both two- and three-wheeled (small bicycle-type) runabouts, as well as in-plant and golf-cart utility vehicles. They are used primarily as one- and two-passenger site patrol vehicles. All were chosen because they are small and light enough to go where conventional vehicles cannot, and for their minimal impact on walkways and turf. Most of the larger carts are less than 46" (115 cm) wide and as little as 27" (67.5 cm) wide for the bicycle-type equipment, and some of these can be equipped with rear-end drive ratios that enable them to operate efficiently at slow speeds necessary to move through crowds or haul heavy loads.

A four-wheeled, electric-drive vehicle, similar to a golf cart, is used year-round. It is equipped with standard size, high-capacity and long-lived batteries that exceed 125 ampere hours capacity. (This means that the battery can deliver constant power at a rate of 75 amperes for 100 minutes.)

Varieties of this basic vehicle are in use at several parks by rangers, work-crew, site managers, and the U.S. Park Police. Equipped with knobby turf tires, it provides excellent traction on turns, in mud, and under winter conditions. The vehicle can carry two passengers and up to 500 pounds of freight. Rear-facing seating for two additional passengers is available instead of the cargo box.



This Site Supervisor electric utility cart is of "footprint" weight on the ground; turf damage is almost nil.

Photo: William Clark, NPS

While it is hard to give a fixed range for this vehicle because each park's topography differs, its range level, mixed terrain (sidewalks, grass, etc.) is of as much as 30 miles (48 km) per charge. Rear end axle ratios also influence range limitations.

When such vehicles are to be used mostly on walkways, experience shows that a foot-on-the-floor (that's how electric vehicles are most efficiently operated) speed of 11-15 miles (12.6-24 km) per hour is best.

On park roads that are generally level, higher-speed rear ends can be used to get speeds up to 20 miles (32 km) per hour. Circuit modifications can allow slight bursts of speed (as much as five more miles per hour) on level ground. Speed, not power, is enhanced by this technique, known as field-weakening. Similar to overdrive in a standard automobile, it

must be used with care so as not to strain the motor.

Among the companies that market this utility version of the golf cart are Club Car of Augusta, Georgia; Taylor-Dunn of Anaheim, California; and Cushman of Lincoln, Nebraska. Various models are available on standard GSA schedules. Many special options are available (e.g., choice of battery charger, methods of battery interconnection, etc.). When approaching manufacturers, ask about similar vehicles that have been purchased by other parks.

Vehicles of this kind are not designed like automobiles, but when used by jurisdictions like NPS, they can be licensed as all-purpose vehicles (as can tractors, large lawnmowers, etc.). As such they must be marked with the conventional slow-moving vehicle triangle, and be equipped with proper

street headlights and turn-signals. In some cases, a revolving under-the-top mounted amber dome light is a useful added precaution. (Under-the-top, rather than on it, is advisable since a top light might be struck when going under low-hanging tree limbs.)

One-Person Patrol Vehicles

The small, three-wheeled bicycle-type vehicle is probably the lowest-cost set of wheels for routine, in-park patrol use. Originally marketed under the trade name of electric chair, as a vehicle for handicapped people, its controls (speed brakes, horn, etc.) are located on the handlebar steering assembly. It can be equipped with a small trailer to haul light loads, power tools (that can operate off the vehicle's battery pack), interpretative leaflets, etc. A child's wagon can be towed just as effectively, making the cost for the trailer minimal.

While this unit can often be licensed for street use in states with Moped laws, for safety's sake it should be confined to park pathways, bike-ways, and other such controlled routes.

Because the unit is only 27" (67.5 cm) wide, it can negotiate narrow accesses in any but the most rugged and steep terrain. Initially designed for the handicapped, it easily negotiates hallways and elevators in buildings. It is an excellent choice for patrolling both indoor and outdoor areas.

Several of NCR's units are being used very successfully by the U.S. Park Police for patrol duty in and around the Kennedy Center (a theatre complex) in Washington, D.C. All areas of the building, as well as the surrounding grounds, are patrolled with these small, clean, silent-running electric vehicles. Pedalpower, a division of General Engines in Thorofare, New Jersey, is the manufacturer.

Electric and Engine-Bicycle

NCR also has experimented with a number of electric-assisted bicycles, including two-, three-, and four-wheeled versions. Each is equipped with small electric-drive systems that can carry a load at about 15-18 mph (24 to 28.8 km per hour). Depending on the battery pack chosen, all have a general range of 15-20 miles (24 to 30 km) per charge. Most are equipped with pedal systems so the driver can help start the vehicle by pedaling, taking on some of the load during this high-drain period. This greatly increases the vehicle's range.

When ordering this kind of equipment, be sure to specify deep-cycle batteries specifically designed for electric-drive systems. Most bicycle-based systems use 12-volt batteries. While conventional automobile floating service batteries will drive these vehicles, they will not give much range or last as long, because they are not built for heavy drain demanded by electric vehicles.

Several small gasoline and diesel engine assist packages can be attached easily to standard bicycles. They are designed to take some of the work out of pedalling over long patrol routes, especially going up hills. Most modern units are very quiet. Some of these engines can be converted to operate on alcohol, but even when used with conventional petroleum fuels, their fuel use per mile of patrolling is almost negligible compared to that of the conventional patrol automobile. Engine-assist packages are available from mail-order houses and bicycle and motor-cycle outlets.

In most cases, bicycle systems tend to be best suited for use on clearly established roads and surfaced pathways. Few of them have springs other than those in standard bicycle seats. If the intended use is for rougher trails, extra attention will be needed in selecting equipment. Some bicycles have larger-gauge spokes, which beefs up the system to take more punishment and carry heavier loads. Most manufacturers for this equipment have heavy-duty options available.

While three-wheeled vehicles often are less expensive than four-wheeled ones, they are generally less stable. They are suitable primarily for use at slow speeds and over flat terrain. Golf course concessions have experienced more accidents where three-wheeled carts are used on rolling terrain.

- **Tires:** Choice of tires is important. Slick balloon tires provide the greatest weight distribution on the ground and thus are the least punishing to the turf. They are also magnets for nails, glass, and other debris common to high-visitation areas.

Knobby turf-tires, another form of balloon tires, are a better choice. They leave a footprint less punishing than a human's. A pistol tire plugging kit and a battery-operated pump (snapped onto two of the cart's batteries) are a must for working in remote areas. With these, a tire usually can be repaired quickly and pumped up without removing it from the vehicle.

- **Batteries:** Selection of batteries isn't simply a question of cost. Some batteries offer multi-year life; however, equipment that is highly seasonal can be damaged by being left standing for long periods of time, wiping out the economic benefits of long-lived batteries. For seasonal and light use, lower-cost, one-year batteries can be used. If equipment is to be used year-round, particularly hard-working units such as trash haulers, the longer-life, higher capacity batteries are better.

Battery chargers that cut off automatically without timers are a good investment, particularly if many people use the equipment. Although they cost more initially, they can pay back the difference many times over in reduced maintenance, including elimination of human errors that can reduce battery life.

Good interconnection between batteries with wire gauges no thinner than #4 are important. Bolt-down wire connectors, particularly those with crimped fittings, should be avoided. These easily can fail to make a complete electrical connection. With a dielectric drop at such poor tie points, the process that causes battery terminal corrosion quickly develops. Conventional automotive wrap-around terminal post connectors are preferred. Also now on the market is a quick-disconnect post connector that incorporates a high-pressure clamping fixture that makes this vital connection point very effective. NCR's experience with them has been very favorable. They are marketed by the Korosion-Clean Klamp Company of Glendale, California.

Alternate Fuels

Because alcohol is not available everywhere (except in hardware stores in small tins at high prices), it helps to know reliable supply sources. A commercial distillery may exist near a park's area. With a little missionary work, even if the distillery-operators have not sold alcohol for this purpose before, their interest and participation may be evoked. Alcohol will not be as cheap per gallon as gasoline, but used correctly, increased engine performance and reduction in engine maintenance will reduce or eliminate cost differences.

Cold weather can cause problems in alcohol-fueled gasoline-engine equipment. When cold, alcohol-fueled engines will be hard to start. Storing the vehicle in a garage can reduce these winter problems. Another possibility is to install start-up kits commonly used by snow-mobilers. These kits consist of a spray can of cold weather starting fuel mounted in the engine compartment. A fixed dose of the starting fuel is squirted into the carburetor as the engine is started. A dash-mounted button controls this function. Once the engine starts, it quickly warms up, and continues to operate normally.

Of conventional equipment, those driven by four-cycle engines run best on alcohol. With a few exceptions, two-cycle engines require that their fuel and oil be mixed. Since alcohol does not mix with petroleum oils, castor oil must be used. It may be hard to find, and it has an unpleasant odor. NCR is experimenting with simple catalytic combustion exhaust cleanup devices to diminish this odor problem. As yet, none is available on the market.

Conventional units already tested using alcohol include lawn-mowing equipment ranging from single blade push-types to large gang-mower assemblies. Converting them from gasoline to straight alcohol is not difficult; it usually can be done by park maintenance staff. NCR has written a paper on this conversion process. Copies are available on request.

Extending Electric Vehicles Range

Aside from obvious maintenance such as keeping batteries clean, watered, well-connected, and always starting out each day with a full charge, there is another way to get more miles per day out of the vehicle.

This simply involves plugging in the vehicle whenever it is at rest during the day, even during periods as short as fifteen-minute stops. This may not seem worth the bother, but batteries that have just been under load, regardless of their state of charge, will draw current from the vehicle charger at a high rate if plugged in immediately after even a short run. Admittedly, this calls for plenty of power outlets, so it may not be practical in every jurisdiction. It also requires having the battery charger with the vehicle. Electric vehicles with chargers mounted on-board are practical and also make overnight recharging easier. When the charger is a wired-in part of the vehicle, all that is required is to plug it in. Another advantage of the on-board mounted charger is to enable more flexible assignment of the vehicle: it can be left at another duty station overnight, rather than having to be returned each day to its base of operation where its charger is kept.

Numerous manufacturers make this kind of equipment. Among those we tried were by Pedalpower; Palmer Industries of Endicott, New York; Hedstrom Company of Bedford, Pennsylvania; and Lyman Electric Products of South Norwalk, Connecticut.

Heavy-duty delivery bicycles for those who want to make up their own electric drive packages are available from the Workman Trading Company of Brooklyn, New York; Pedal Power; Palmer Industries; and Hedstrom.

Gasoline Engine Patrol Vehicle

NCR recently tested a fuel-driven unit made by Yamaha that embodies all the virtues of the electric vehicle or four-wheeled carts: small, attractive, quiet, low procurement and maintenance costs. These units do not possess the usual electric vehicle drawbacks like fixed range per charge and limited hill-climbing ability. Even when gasoline is used as a fuel, the vehicles are very economical to operate. The NCR test vehicles are fueled by alcohol, however.

These vehicles are powered by a two-cycle engine. Because its oiling is by direct injection to key lubrication points in the engine, there is no need to mix oil with the fuel as is usual with two-cycle engines. This permits the easy, direct use of straight alcohol as fuel without having to mix it with oil. Because the vehicle also can operate at higher speeds, about 20 + mph (32 + km), it lends itself to limited street use when properly equipped with street lighting packages, slow-moving vehicle markers, and other safety features. It can climb any grade that conventional vehicles can negotiate, and it can also operate over very long distances on one tank of fuel. An extra gerry-can of fuel can be carried aboard for extended trips. The engine

automatically stops when the vehicle stops, and automatically starts when the accelerator is depressed. This very useful refinement saves fuel and reduces noise and pollution. This unit is distributed by numerous golf course supply outlets.

A wide variety of small, gasoline-powered, balloon-tired utility carts are being marketed, which, when converted to alcohol, also serve excellently as patrol vehicles and for utility work. Several firms that make this equipment are included in the GSA Federal Schedule. Examples of these vehicles in operation can be seen at local golf course maintenance units. As substitutes for pickup trucks, their use can result in real fuel savings.

Grounds Maintenance Equipment

Many alternatives to conventional equipment including both gas and electric-drive equipment, have surfaced recently.

The maintenance staff of NCR developed a hydraulic-lift tilt bin vehicle to interface with a conventional street packer. Trash picked up in the electric vehicle from walk-side "tulip bin" trash receptacles can be dumped directly into the pick-up tray of the street packer. This eliminates time-consuming double-handling. Because it undergoes fairly rigorous service, this unit is equipped with 12 batteries instead of the usual 6, and a heavier charger that can handle such an enlarged battery pack on one overnight charge.



Photo: William Clark, NPS

This unit is also equipped with a small gasoline-engine on-board generator assembly for recharging the vehicle battery pack, while underway, away from electric mains.

Fully charged, the vehicle can prowling the grounds all day without risk of power failure. Made by the Taylor-Dunn Company, this vehicle is on GSA schedule.

A conventional golf-utility electric vehicle can be combined with a large industrial vacuum cleaner to pick up almost any kind of light trash. The unit originally was operated by gasoline engine. Noise problems and a need for better vacuum control, led to its conversion to electric operation, deriving its power from a heavy-duty battery pack. Following conversion and testing by the Brentwood Sheetmetal Shops of NCR, the maker of the gasoline-drive version of the vacuum cleaner, Hollowell Engineering Company, of Garden City, Michigan, has just introduced an all-electric version.

A very small garden tractor designed for a variety of uses can be fitted with a host of accessories, including front-end gang-mowing assemblies and snow-plow blades. It has a multi-speed gearbox, so that in low gear it can tow a load and climb steep terrain.

Marketed as a quiet-running, battery-operated tractor with the home gardener in mind, its battery pack cannot handle the usual park maintenance service day (about five hours of continuous use between charges). Despite this liability, the vehicle performs chores requiring extra traction in high visitation areas where engine noise would be a problem. The tractor is marketed by Wheel Horse of South Bend, Indiana.

NCR has experimented with methods to extend the range of electric vehicles by on-board charging while away from power line recharging sources. This is known as "hybridization."

Selecting Alternative Vehicles

While new technologies often have much to offer, some general practical park management practices need to be considered before selecting specific kinds of alternative equipment.

- **Vehicles:** In-plant vehicles, with front wheels located well back from the front end of the vehicle, usually just beneath the driver's seat, are not suited for off-road, over-the-turf use. This front wheel location can cause front-end plowing when driven down steep berms, over rough terrain, and even over low roadside curbs or through curb ramps. The conventional golf-cart with its front wheels well forward is better suited to off-road use.

Hybridization, extending the range of electric vehicles by using on-board engine-driven charging, is becoming increasingly popular. Without it, battery-powered equipment is limited to whatever energy the vehicle's battery pack can store. Because electric vehicles offer other benefits, this shortcoming has not discouraged their development and use. By installing an on-board, engine-driven battery charger, batteries can be charged during the day while away from electric mains. The obvious question then arises: "Why bother with the electric drive system if you're going to carry around an engine, anyway?"

First of all, the electric advantages are not sacrificed by the presence of the gasoline engine, nor is the engine a simple replacement for electric drive. Since the engine need not run all the time, the vehicle can run silently on its batteries when engine noise would be a problem. At other times the engine can be started to top up the batteries. Another advantage of having both systems on board is the availability of a relatively small engine-generator system. It need be

only big enough to deliver the vehicle's mean power requirement, not a maximum needed to climb a steep grade or pull a full trailer. All the engine-generator does is recharge the batteries. Doing this single task, the generator system is required only to operate at one fixed speed, permitting more efficient fuel use (engines that must vary their speed when used solely to power such equipment are not very fuel-efficient).

Mobile Auxiliary Power

Many vehicles can be used to provide AC electric current in the field.

Because of their large reservoirs of battery energy, a little—tapped off the vehicle's propulsion batteries—can do a great deal of useful work.

A special sensing circuit automatically turns on the motor-generator when any power tool plugged into the vehicle's AC outlets is turned on, making it unnecessary to first turn on the motor-generator before the tool can be used, and then turning it off when the tool's job was done. The sensing circuit makes it impossible to accidentally leave the motor-generator on to deplete the vehicle's battery power reserve.

Work crews can use a number of conventional electric-powered devices like line-cord electric lawnmowers, edgers, hedge-clippers, and other shop tools, in areas away from a power line. Also, since electric versions of these tools are more reliable and require less maintenance than their gasoline counterparts, work schedules are less frequently disturbed by down-time caused by tool failure.

The power these motor-generator systems consume is usually so small as to rule out virtually any risk of running the batteries down to where

they cannot provide power to get home on the remaining charge. With hybrid (electric and gas-engine driven) vehicles, the on-board engine-generator eliminates such risks.

Likewise, a 12-volt DC motor-generator can be teamed up with a small, skid-mounted, deep-cycle, 12-volt battery, complete with carry-handle. It can be thrown in the back of any vehicle, and can thus provide power anywhere.

The 12-volt version of the motor-generator also can be used on the gasoline-engine patrol vehicle or any gasoline-driven equipment where a starting circuit for the system incorporates a 12-volt battery on board.

When using this battery, smaller than those in an electric vehicle, to power the motor generator, care must be taken to not run it down to where it cannot restart the engine. If a pull-rope hand starter is on the vehicle, restarts are less of a problem, but running batteries to very low levels is not good for them. A power drain rating is listed on the motor-generator's identification plate. Simple mathematics determines how many hours tools can operate from it without threatening basic vehicle operation.

Vehicle Maintenance and Parts Supply

"Backstopping" simply means taking appropriate steps to properly maintain alternate fuel vehicles. It can add new dimensions to maintenance and resource management. But an important consideration involves making sure that existing facilities are equipped to handle new ideas and equipment. A golf cart or two, taken on for special service purposes, will not be much of a problem to maintain, but it is important that at least one person on the maintenance staff knows how to care for the cart's

routine needs and where to get help when malfunctions arise.

In some areas, procuring golf carts also includes making some kind of arrangement that the seller be available to fix it if it breaks down. The seller should also be called upon after procuring such vehicles to provide a little training to someone on the maintenance staff: how to rewater its batteries, make sure the wiring is tight, and other routine preventive maintenance considerations.

If success with these vehicles leads you to expand their application to fleet proportions, serious consideration must be given to backstopping them as a specific and different function within the park's regular maintenance facilities. Either of the two following avenues of approach should be entertained:

1. Sub-contracted Service Arrangements:

This involves making a contractual arrangement with a local supplier of golf carts, or in-plant electric vehicles, to provide all repairs for such equipment. In some urban areas, there are firms that deal with the repair of specialized small-engine systems and electric-drive equipment. It can be an elevator-maintenance firm, a firm that is familiar with electric propulsion systems, or a motor-cycle sales and repair shop.

2. Installation of a Repair Facility with the Park Maintenance Unit:

Such a facility consists of at least one staff member within a crew who has a background in the technical aspects of whatever new equipment you want to take on, or who is specifically trained for working with the new vehicle. This training can consist of making arrangements with the equipment supplier for some on-the-job training at the supplier's base facility.

A new maintenance facility must also be equipped with any and all tools that are uniquely associated with keeping such specialized equipment running. This need not be an additional auto shop. Except where it might not be advisable to mix the functions, there is no reason why the existing auto shop lift cannot be used.

There are tools, however, such as special tire-changing rigs, that are needed for the special small tires of these vehicles. Certain specialized small-engine diagnostic and electrical evaluation tools are also needed (such as a good multi-meter), as well as tools for making the special wiring for batteries.

Stock Unusual Items

Spare parts for specialized equipment should be stocked in wise amounts. Electric vehicles, for example, use special solenoids and other devices that, while not expensive, just aren't found at local hardware and auto-supply shops. These must be readily available from a local supplier, or else stocked in limited quantity. Where electric vehicles are involved, a source of deep-cycle golf-cart batteries must also be established, so that there will not be long waits between necessary battery replacement that will deprive you of the vehicle's service.

These are important considerations, the ignoring of which can destroy a good idea, and usually result in blaming the new vehicle unjustly for the problems that occur. Again, the supplier of such vehicles is in the best position to help you determine what parts you ought to have on immediate hand and what tools you should purchase to fortify your operation for handling new systems.

Proving the Value of New Technology

New ideas are among the more important aspects of successfully upgrading the ways to do things in our parks. New ideas are a dime a dozen, and if they are not winnowed for only their good points, a lot of harm can be done.

Mark Twain's observation is worth noting: "The man with a new idea is a crank, until the idea succeeds." It's human nature to react against new ideas, for the simple reason that most people are inclined to feel that if the way they've been doing something works so well, why knock it.

You should take special care, therefore, when you try a new approach, to keep good records that will help determine:

- If the new idea works - and is it worth it.
- If the new idea DOESN'T work.
- If it is successful enough to share with other parks.

Spread the Word

New technology applications in the parks thrive on the COMMUNICATION and exchange of new ideas—including those that DIDN'T work—with other park managers in the park system. The latter point about informing others about things that don't work should be taken seriously. A case in point: while small



Use of electric utility cart and electric battery—operated tractor has eased petroleum consumption at NCR.

electric runabouts are proven winners in some parks, they are not candidates for service in, say, Harpers Ferry National Historical Park. There are almost no flat roads in Harpers Ferry, just hills. For such a terrain as this, a gas-driven (alcohol) equivalent is the better choice. And in very remote parks, the use of any specialized equipment may have to await the time when the costs of completely backstopping a new facility in

such remote locations can realistically be offset by the savings such new equipment can offer. But share your experience. When you try something new, tell others about it. NCR's Energy and Technology Division in Washington welcomes your ideas, both successes and failures, for it is in an excellent position to broadcast new ideas and experiences to everyone's benefit.

Electric Vehicles in the Parks

by John Hoke

National Capital Region has been using small electric vehicles for resource management and maintenance for eight years. Experimentation with conventional golf-carts has led to the development of an electric site patrol vehicle and a hybrid gasoline-electric drive tractor.

Electric Site Patrol Vehicle

This is a commercially available electric utility vehicle modified by the National Capital Region resource management staff. The modifications include an on-board-mounted motor generator that provides 110 volt, 60-cycle AC power from the vehicle's main battery bank. Power from this system is made available at standard all-weather AC outlets mounted on each side of the vehicle. With this system, the vehicle can provide AC electrical power anywhere the vehicle navigates, and can operate conventional AC power tools such as electric hedge-clippers, lawnmowers, edgers, and chainsaws. It even can park next to a remote park bandstand and provide silent power for operating a sound system.

The on-board AC power feature can replace noisy gasoline-powered grounds maintenance tools in areas of high-visitation activities, such as concerts, where noisy equipment is inappropriate. These vehicles do the chores other conventional equipment cannot do as economically, and often are able to maneuver in narrow walks and trails where some other vehicles cannot.

The vehicle is recharged at night with an automatic charger, enabling park personnel to use the vehicle all day and draw on its spare power to run power tools plugged into its AC outlets. With this "soft-on-the-turf"

runabout vehicle, supervisory maintenance staff can be flexible around the grounds.

The vehicle's electric power consumption is nominal compared to the energy requirements of more conventional automobiles and pick-up trucks. Even with battery depreciation (about 2-3 cents a mile), the vehicle's energy cost per mile is at least half that of other equipment. Added benefits of the electric cart include aesthetic suitability to the park environment—they are silent running and emit no odors, and their open design encourages greater contact between the vehicle's driver and the visiting public.

The electric site patrol vehicle described here, equipped with the AC generating system, is a GSA item that costs less than \$3,000. Optional equipment includes top, extra rear-facing seats (in place of a utility box) as well as headlights, turn signals, and special warning lights. These options are necessary if the vehicle will be used on public roads as an all-purpose vehicle between in-park duty stations.

Gasoline-Electric, Hybrid Drive Tractor

The battery-operated Wheel Horse initially was marketed as a home lawn and garden tractor. It is equipped with an on-board engine-generator package that extends the range of the vehicle after a night's charge. The tractor operates totally on the battery output, but the batteries can be recharged periodically by running the engine-generator. Where silence is important, the vehicle can operate with the engine-generator off. Out on the nearby roads, while moving between posts, the engine can be turned on to recharge the batteries.

Originally designed to burn gasoline, the on-board engine-generator was later converted to operate on straight ethyl alcohol so it would not draw on petroleum fuel reserves.

The same AC generation package on the site patrol vehicle was added to this tractor, so that it also becomes a mobile AC power source. The tractor has a wide range of accessory tools and earth-working systems, including ganged, winch-hoisted, rotary electric-driven lawnmower blades and snow-plow blade. The tractor is equipped with a gearbox, and the drive ratios range from dead-slow (with remarkable pulling strength) to reasonable road speeds. Being quite small, it can operate in park environments where other tractors cannot go safely, and does not inflict considerable harm to the environment.

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