



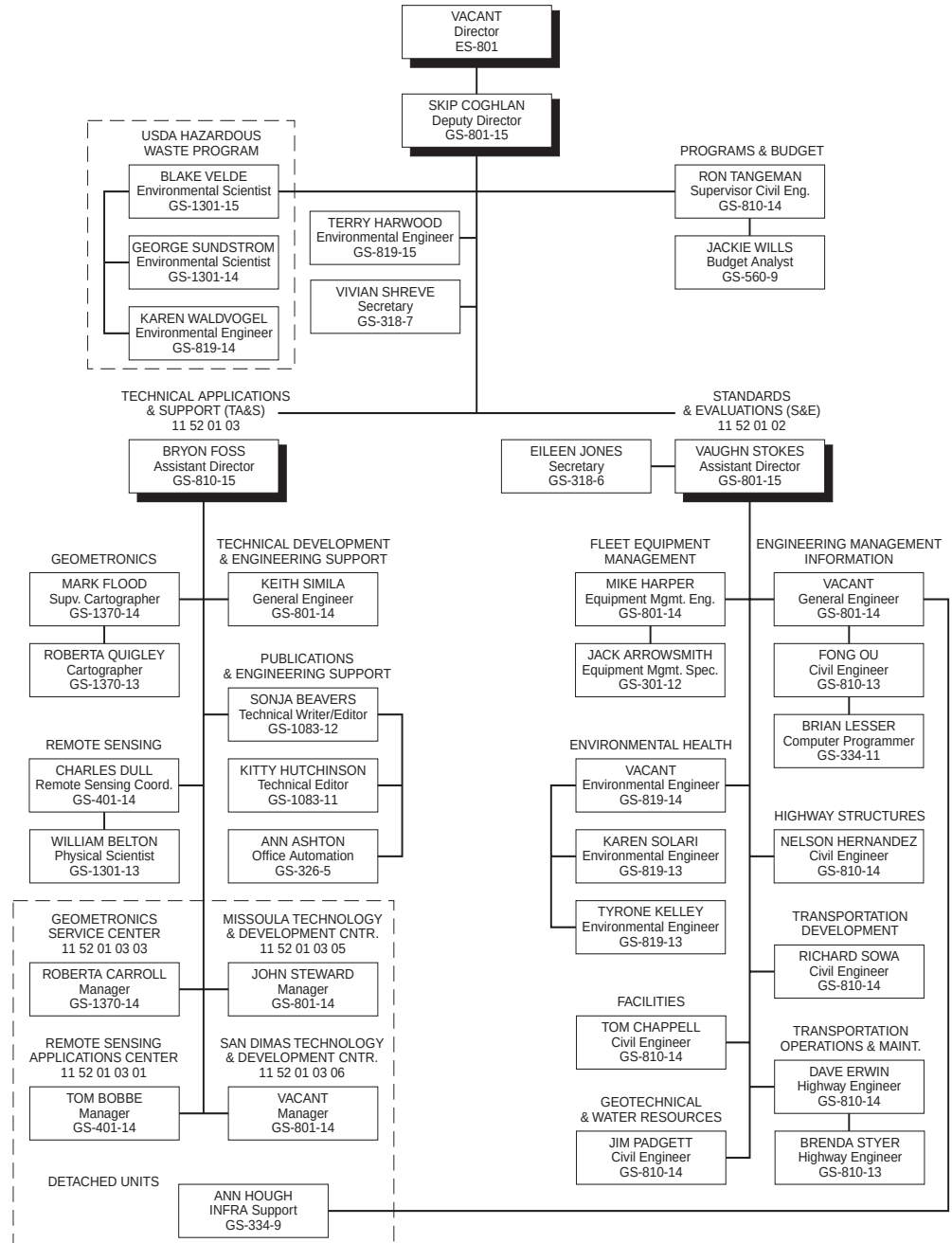
Engineering Field Notes

Engineering Technical Information System

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Washington Office Engineering Staff

We have many new faces at the Washington Office, so we included this article to let our readers know who is responsible for what. The organization chart below shows the organization of the Engineering Staff. The following pages contain summaries of the staff positions and the people who fill them.



Director's Office

Gerald T. (Skip) Coghlan, Acting Director of Engineering

Skip acts as technical advisor and consultant to Chief and Staff on engineering-related matters, including highway, bridge, architectural, mechanical, and civil engineering. He provides overall leadership for planning, organizing, and coordinating engineering activities Servicewide and is responsible for managing the activities of both the Washington Office Staff and the four detached units.



Vivian Shreve, Staff Secretary

Vivian reviews all correspondence, reports, and mail; directs customers to the appropriate staff person; and prepares and distributes the Monday morning staff meeting notes. She also provides backup support to the Budget Analyst and acts as the travel coordinator. In the absence of the National Forest Systems Associate Deputy Chief's secretary, Vivian provides backup.



Blake Velde, Director, USDA Hazardous Waste Management Group (HWMG), Office of the Assistant Secretary for Administration

Blake provides departmental policy, guidance, and oversight for management of the hazardous waste responsibilities of USDA. He represents the Department on various interagency work groups, including the National Spill Responses Team and the Secretary's Hispanic Issues Task Force.



George Sundstrom, Environmental Scientist, USDA Hazardous Waste Management Group

George conducts oversight reviews and assists in managing USDA's hazardous waste central account.



Karen Waldvogel, Environmental Engineer, USDA
Hazardous Waste Management Group

Karen provides oversight and management assistance in the Department's involvement with CERCLA sites.



Ronald J. Tangeman, Program Manager,
Engineering Management

Ron is responsible for preparing the budget to include engineering support of resource activities. He coordinates and prepares Engineering's Service-wide input to the outyear budget package, for presentation to Congress for appropriation (including explanatory notes). He provides input and represents Engineering during preparation of the National Forest System budget for recommendation to the Chief, and compiles Engineering's portion of the annual Program Budget Advice. He also compiles the annual Road Accomplishment Report and provides accomplishment statistics for the Report of the Forest Service. He provides program management of the Washington Office and detached units' budgets, and serves as liaison with Regional Engineering budget coordinators.



Jacqueline A. (Jackie) Wills, Budget Analyst

Jackie is the liaison between Engineering and the National Finance Center, the Program Development and Budget and Financial Management Staffs, and the Regional Offices. She reviews vouchers and travel authorizations, maintains a budget expenditure tracking system to keep a daily record of charges to the appropriate management codes, and prepares most of the requisitions for the Staff.



Consultation and Standards

Vaughn Stokes, Assistant Director

Vaughn is responsible for managing, at the national level, transportation planning, road preconstruction and construction, road operations and maintenance, FA&O facilities, environmental engineering, equipment management, tramways, bridges, dams, geotechnical engineering, and engineering management information. His staff is responsible for national policy and monitoring of field activities for compliance with national direction. Vaughn also provides primary staff support for all of these activities to the Director.

Eileen Jones, Secretary

Eileen is responsible for reviewing documents prepared by Standards and Evaluations before submitting them to the Assistant Director for approval. She is responsible for answering the phones, greeting visitors, and referring to appropriate staff members or the Assistant Director. Eileen is responsible for providing general clerical support to the Standards and Evaluations Staff.

Nelson E. Hernandez, Program Manager, Bridge and Tramway Engineering

Nelson is responsible for setting standards and evaluating the Regional bridge and tramway engineering programs. The bridge program includes the design, construction, inspection, and maintenance of road and trail bridges. The tramway engineering program consists of reviewing tramway designs and monitoring tramway construction, load tests, and other safety operations.



Michael D. Harper, Program Manager, Equipment Management

Mike provides national leadership and direction for the management of all fleet equipment in the Forest Service. He is the technical advisor and consultant to the Director of Engineering, other Washington Office staffs, and the Chief and Staff on equipment-related issues. He is responsible for ensuring the economical, safe, and legal acquisition, operation, maintenance, and disposal of equipment, and for developing and mentoring a skilled cadre of personnel to manage our fleet equipment. Mike participates with USDA and other Federal agencies on legislative and administrative activities to affect the formulation of laws, regulations, Executive orders, and policies that relate to fleet equipment management programs and budgets.



John R. (Jack) Arrowsmith, Equipment Management Specialist

Jack provides assistance to the Equipment Management Program Manager. Based on field needs and requests, Jack is responsible for Service-wide procurement of equipment through the General Services Administration. To resolve problems and coordinate fleet-related activities, he maintains a close working relationship with field units, the General Services Administration, and equipment manufacturers.



Vacant, Program Manager, Environmental Engineering

The incumbent has primary responsibility for drinking-water systems, wastewater treatment and effluent disposal systems, solid wastes, and hazardous materials and wastes. Duties include overall coordination of the Federal Facilities Compliance Program.

Karen M. Solari, Environmental Engineer

Karen is responsible for providing guidance in the areas of waste management, waste minimization, and assessment and cleanup of hazardous waste sites.



Tyrone Kelley, Environmental Engineer

Tyrone is responsible for water and wastewater systems and the pollution prevention program. He also coordinates the Emergency Relief for Federally Owned (ERFO) Roads Program through the Federal Highway Administration.



Thomas W. Chappell, Program Manager, Facilities Engineering

Tom provides technical and program advice and consultation on buildings and related facilities and facilities management practices and procedures to the Director and Forest Service field units. He works with National Forest Systems, Research and Development, and State and Private Forestry facilities, including visitor centers and Job Corps support facilities. He also recommends and implements direction for all facility-related matters.



David Erwin, Program Manager, Transportation Planning Operations and Maintenance

Dave provides national program management for transportation system planning, operations, and maintenance. The primary area of emphasis is roads, with technical assistance provided for trails and other transportation system facilities. Dave is also the national sign coordinator, and he provides engineering assistance to the cost-share program.



Brenda L. Styer, Assistant Transportation Operations and Maintenance Engineer

Brenda provides national program leadership for transportation system planning, operations, and maintenance. She provides technical assistance for roads, trails, and other transportation system facilities. Brenda is also the national coordinator of the Construction Certification Program.

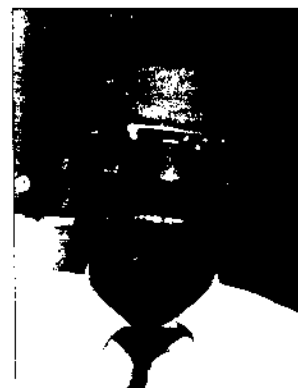


Vacant, Program Manager, Engineering Information Management

The incumbent is responsible for managing the development of new ways to use computers for collection and analysis of engineering data to support the planning, management, and inventory of the Forest Service infrastructure. This person is one of the leaders moving the Forest Service toward an integrated information system. As a member of the Infra Project Steering Team, the incumbent coordinates the development of a working component of the corporate database.

Fong L. Ou, Staff Information Manager

Fong provides assistance and support to the Program Manager for Engineering Information Management and serves as Staff Information Manager. He supports the use of the Data General System, the 615 System, and microcomputers, and coordinates the local and national engineering system applications.



Brian S. Lesser, Computer Program Analyst

Brian provides assistance and support to the Program Manager for Engineering Information Management. He assists the Staff Information Manager in serving as liaison between the Engineering and Information Resources Management Staffs. He is responsible for diagnosing and troubleshooting computer problems, assisting staff in the use of the Data General System and microcomputer systems and software, and writing computer applications to track engineering-related information.



James W. (Jim) Padgett, Program Manager, Geotechnical and Dams Engineering

Jim provides leadership and direction in the geotechnical area, which involves the characteristics, analysis, and use of soil, rock, and other construction materials. Emphasis areas are road surfacing materials, surfacing design methods, slope stability evaluation methods, and the evaluation and implementation of new technologies. In the dams area, Jim deals with the development, operation, and management of dams, locks, and water transmission facilities. Emphasis areas are safety of owned and permitted dams, inventory and tracking status of dams, and consistency with current laws and regulations. Additional responsibilities include work in the Coordinated Technology Implementation Program with the Federal Highway Administration, nuclear gauge safety, and development projects with the Forest Service Technology and Development Centers and the Regions.



Technical Applications and Support

Richard W. Sowa, Program Leader, Transportation Development Engineer

Richard is the technical advisor and consultant to the Director of Engineering and the Washington Office staff on transportation development-related matters, including road location, survey, design, estimating, contract preparation, and contract administration. He is responsible for the Federal Lands Highway Program and is liaison with the Federal Highway Administration. Richard is also coordinator of the Roads Steering Committee for Technology Development.



Bryon Foss, Assistant Director

Bryon is responsible for managing remote sensing, mapping, technology and development, aerial photography, technical information, and engineering support. His staff is responsible for developing national policy and monitoring field activities for compliance with national direction. Bryon provides primary staff support for all of these activities to the Director.



Keith A. Simila, Program Manager, Technology and Development

Together with the Center Managers, Keith oversees the work done at the Technology and Development Centers in Missoula and San Dimas, where development activities use engineering skills to advance technology to solve natural resource management problems. Keith's role is to market the program to agency officials, bring in new work, coordinate existing work with sponsors, establish policy, and remove barriers to efficient operation of the Centers.



Sonja K. (Turner) Beavers, Technical Publications Writer-Editor

Sonja is responsible for all aspects (writing, editing, graphics, formatting, printing, and distribution) of publishing technical engineering documents, including *Engineering Field Notes*, *Engineering Management (EM)* series publications, public information documents, and newsletters. She is the directives coordinator, and she supervises support and technical information personnel. She also coordinates personnel activities (recruitment, training, awards, staffing, and so forth) for Engineering, including the detached units.



Kitty Hutchinson, Technical Editor

Kitty assists in the production of all staff publications, newsletters, brochures, and directives. She manages the Technical Information Center, providing publications, directives, information, and technology transfer support to the staff, field units, libraries, and the general public. Kitty also tracks all subscriptions and memberships, serves as assistant property management officer, and maintains the Chief's map file.



Ann M. Ashton, Office Automation Assistant

Ann provides clerical support to the Technical Applications and Support staff and, when needed, provides backup for the Staff Secretary. She maintains several mailing lists used by the publications group, assists with the annual update of the Engineering Service-wide Personnel Data Report, and responds to requests for posters and publications. Ann also installs software, downloads Data General documents, and uses various software packages to develop charts, graphics, and presentation materials for the staff.



**Charles W. (Chuck) Dull, Program Manager,
National Remote Sensing**

Chuck plays a key role in the management and coordination of Service-wide remote sensing and associated technology activities. His responsibilities include coordinating remote sensing activities within the Forest Service and between the Forest Service and other USDA agencies, other Federal agencies, and private industry; investigating advanced aerospace, industrial, military, and other research developments in remote sensing; facilitating technology implementation of remote sensing applications; and providing remote sensing technology support to international forestry programs.



**William R. (Bill) Belton, Assistant, National
Remote Sensing**

Bill represents the Forest Service on issues relating to coordination of the acquisition, production, distribution, and use of digital geographic data and imagery by Federal agencies. He also works on coordination issues involving the Global Positioning System and civil agency use and management of the system. Bill provides support and recommendations on the production and integration of digital spatial data into geographic information systems.



Mark A. Flood, Program Manager, Geometronics

Mark provides technical direction and leadership in the planning, analysis, and development of Regional base mapping and base geospatial data development projects. In collaboration with the Manager of the Geometronics Service Center, he coordinates these into a broad, overall mapping and data development program.



Roberta M. Quigley, Staff Cartographer, Geometronics

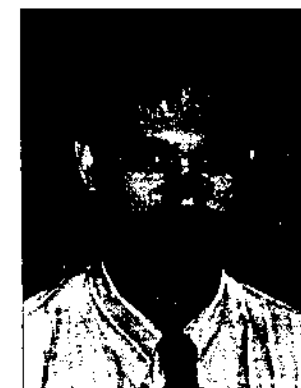
Roberta is the deputy member of the U.S. Board on Geographic Names and a member of their Publicity Committee. She provides support to the Geometronics and Remote Sensing Program Leaders in areas relating to remote sensing and aerial photography. She is responsible for keeping the Forest Service manual and handbook information pertaining to geometronics current, and acts as liaison between the Washington Office and Regional and forest personnel in geometronics-related matters, including mapping, geographic names, and aerial photography.



Detached Units

Tom Bobbe, Manager, Remote Sensing Applications Center (RSAC), Salt Lake City, Utah

Tom provides leadership and management oversight to the program leaders responsible for the RSAC's mission of providing technical support in the evaluation and development of and training and assistance in the use of remote sensing, GIS, image processing, and related technologies for all resource applications.



Roberta (Robin) Carroll, Manager, Geometronics Service Center (GSC), Salt Lake City, Utah

Robin is responsible for managing the activities of the GSC. Founded in 1975 as the national mapping center for the Forest Service, the GSC provides a wide variety of map and base digital geographic data products and services for all areas administered by the Forest Service.



Vacant. Manager, San Dimas Technology and Development Center (SDTDC), San Dimas, California

The incumbent is responsible for overall management of the SDTDC. Projects and activities are assigned by various Washington Office Directors. The Directors generally appoint national steering committees who seek out resource management problems and issues considered nationally significant. These are prioritized and recommended for funding and assignment to the technology and development program. The Centers search out the latest technology appropriate for problem resolution and publish their findings—reports, videos, newsletters, and so forth.

John E. Steward, Manager, Missoula Technology and Development Center (MTDC), Missoula, Montana

John provides overall leadership and guidance in program development and implementation of activities at the MTDC. He serves as a staff assistant providing technical advice and consultation to the Assistant Director for Technical Applications and Support and works with the Technology and Development Program Manager and national steering committees in accomplishing the Center's projects. Development projects at the Centers use engineering skills to advance technology to solve natural resource management problems.



Retaining Wall With an Eye on the Past

Robert L. Freel
Civil Engineer
Region 3, Coronado National Forest

In late December 1993, southern Arizona was hit by weeks of warm rain, much of which fell on snow in the nearby mountains. The result was widespread flooding throughout the area, causing several million dollars worth of damage to facilities and transportation systems in the mountains and desert lowlands. One area of the Coronado National Forest to receive heavy damage was the Sabino Canyon Recreation Area, a narrow canyon with very heavy visitor use located just inside the boundary between the City of Tucson and the Coronado.

Some of the areas in the canyon damaged included bridges and loose-stacked retaining walls used to protect fill slopes along the main roadway into the canyon. The road was originally built in the 1930's by the Civilian Conservation Corps, and many elements of it have significant historical value. As planning for the repairs progressed, we had concerns of how we might make repairs that would withstand a similar event and still retain a look consistent with the 1930's work. We decided to build a reinforced concrete retaining wall and use stacked rocks as the front form.

To begin, you must have a source of rocks. Some questions to consider in your search for a source are:

- How many do we need?
- Do we need to import them or is the quantity such that they can easily be scavenged from the immediate area?
- Are the visual requirements of the site such that the color of the wall must blend with the surroundings?

The rock must have some variety in size, but in general should be larger than 12 inches in one dimension yet small enough to be lifted into place by one man. The best rocks are the fractured variety with a more flat, tabular form rather than the rounded river cobble rocks, when possible.

Stability of the foundation of the wall is critical. Some considerations are:

- Is the location such that high water can undermine the foundation?
- Can water get behind the wall from around the end?
- Is the support material non-erodible (bedrock) or is the material large enough (boulders) that it will be stable in another flood event?

The footer should be placed on a stable foundation and be reinforced to be able to bridge small spans should erosion undermine it. The foundation may be formed on both sides, so long as you are confident that the top is below expected scour exposure depth. The front face (or both) of the footer can also be formed of large rocks moved into place, and then the gaps filled by wedging in smaller stones. We found this to work better than cutting wooden forms in areas where the footer base was very irregular. The appearance of this face is not of much concern because it should remain below ground.

A part of the footer is the vertical wall reinforcing steel and the rock support grid that is anchored in the footer (figure 1).

A minimal amount of structural rebar was used because of the tiebacks spaced along the height of the wall. While the structural rebar is in the rear of the wall, another grid of rebar (nonstructural) was placed about 1 foot from the front face. This "support grid" allowed the face rocks to be stacked up to 4 feet high on a batter (we used 8:1) (figure 2).

Without this grid upon which to lean the rocks, it is nearly impossible to batter the face; it turns out to be nearly vertical and more susceptible to "blowout" when placing the concrete. The grid size can vary with rock size and does not need to remain the same throughout the wall. We used #5 rebar on 24-inch centers each way.

The early design of our wall started out as a commercially available loose stacked retaining wall system. This system required a reinforced earth type tieback system using "Geogrid" type fabric at 4-foot vertical intervals extending at least 7 feet into the backfill. We used this same method;



Figure 1. Footer with curb



Figure 2. *Support grid*

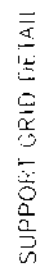
thus the wall became the vertical face element of a reinforced earth unit. This block of reinforced earth also took care of the tipping forces on the wall as well as most of the moment induced into the wall by the backfill pressure (figure 3).

We found that the best way to anchor the reinforcing grid to the wall was to use short pieces (about 2 feet) and cast half of it into the concrete and secure the rest to the forms. When the form was removed, the grid could be pulled away from the face of the concrete and then spliced.

Immediately behind the wall was a curtain of fabric-enclosed drain rock that eliminated any possible hydrostatic head on the wall from near the top of the wall to weep holes on top of the footer.

As you can probably guess, the way the rock is stacked is the most important factor in determining the visual quality of the finished wall (figure 4).

A factor to consider in deciding how much effort to put into picking and positioning the rocks is the distance from which the wall will normally be viewed. The closer the viewing point, the greater the need for care in selecting and placing the rocks. Another important point is that gaps are



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needed between the rocks to allow the concrete to be forced through from the back to the front. The maximum size of all the gaps should be about the same so that while vibrating the mud into the smallest crevices you will not have excessive flows through the larger ones. Be sure that a significant portion of the rock will be embedded in the concrete. Sometimes this requires that the rock be positioned such that the longest dimension is perpendicular to the front face. Try not to stack rocks behind a face rock, as this makes it very difficult to get the face rock embedded in the concrete.

After the rocks have been stacked, but before the back form has been placed, use pressured water (preferably something like a fire hose) to thoroughly wash the stacked rocks from the back side so that the concrete will adhere (figure 5).

With the forms all in place and the rocks cleaned, you are now ready for the concrete. The concrete is a normal 3,000-psi mix. However, the slump should be 5 to 6 inches so that it will intrude into all of the gaps between the rocks when vibrated (figure 6).

Some areas will require what would normally be considered excessive vibration to force the concrete to the front face. Someone needs to be looking at the front face as the vibrating of the mud takes place to ensure that concrete is oozing through all of the gaps. While it is necessary to vibrate the concrete until all rocks are embedded in the concrete, there is a real possibility of collapsing the stacked rocks with the pressure of the mud while vibrating. We used some 6 x 6 welded wire fabric on the front surface of the rocks tied frequently with wire to the forms in the rear or to the rebar to help stabilize this condition (figure 7).



Figure 4. Stacking rocks



Figure 5. *Washing back side of rocks before placing concrete*



Figure 6. *Placing concrete*

We also tried using a medium gray colored concrete so that, as someone looked at the surface, the concrete that they saw exposed in the gaps would appear to be just shadows. The results were not as dramatic as we had hoped; maybe an even darker color would have helped to create the effect we were looking for.

The last step is to wash the excess concrete from the front surface (figure 8).

Wait until the concrete has been in the forms for about an hour, then wash the front face with a pressure hose to remove concrete that has been slopped on the front or that has been vibrated through the larger gaps. Wash away the excess mud until you obtain a somewhat uniform depth from the face of the rocks to the exposed concrete visible in the gaps.

Our project was done by an 8(a) contractor. We were testing an unproven method, working on a narrow road that had to be made passable for a shuttle bus at least twice every hour. In addition, pedestrian traffic was heavy and constant. The overall contract cost of the wall (including excavation and backfill but not base and asphalt for the roadway) was \$43.80 per square foot.

Public response to the completed structure (figure 9) has been very favorable.

For further information write or call Robert Freel, Coronado National Forest, Tucson, AZ. DG: R.FREEL:R03F05A. Telephone: (520) 670-4840.



Figure 7. Wire mesh support on front fence



Figure 8. *Washing front face after placing concrete*

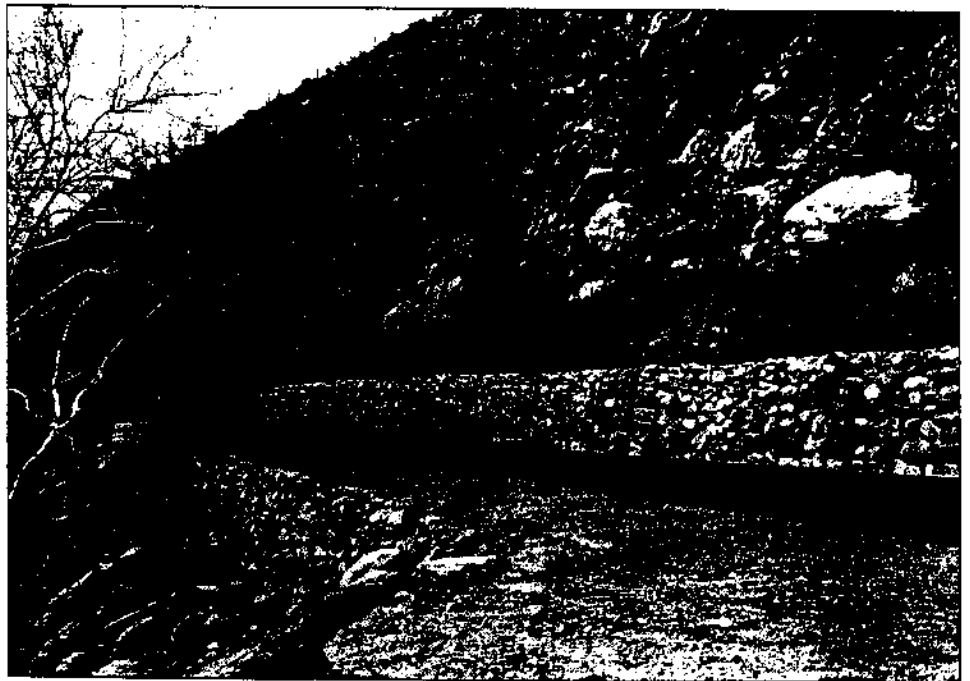


Figure 9. *Completed structure*

Sustainability—Building Green for Both Humans and the Environment

Anna J. Jones-Crabtree, P.E.

Civil Engineer

Region 2, Grand Mesa, Uncompahgre, Gunnison National Forest

The building industry is “going green.” New recycled building materials, more energy efficient HVAC and lighting systems, water conservation measures, construction site recycling, and increases in the healthiness of the work environment are all reflective of this current movement. Yet, this movement is not merely about doing what is right for the natural environment. It is also about making decisions based on what may be right for humans now and in the future. In other words, the building industry is adopting the concepts of sustainability.

What exactly is this thing called sustainability, and how is it going to impact the Forest Service engineering operations of the future? The purpose of this article is to first, explain the concept of sustainability and its relation to the built environment. Secondly, it will identify the current policy direction available for implementation of sustainable concepts into Forest Service facilities. Finally, it proposes an information network for sharing experiences and knowledge about sustainability and buildings.

What Is Sustainability?

The resulting impacts of human population and technology on Earth's resource base are profound. The potential long-term implications of these impacts have spurred a movement of growing concern over the ability of human development to prevent violation of Earth's support systems and thus to preserve the quality of life available for future human generations. In essence, how can humans develop sustainably? Is it possible to balance natural resources and ecosystem viability over time while maintaining desired human living standards and economic growth? These are questions the Forest Service confronts on a daily basis. Resource management, stewardship, and the conservation ethic are integral to sustainability. Yet, sustainable forestry issues have as much to do with use of resources as with resource management. Those of us involved in Forest Service engineering operations are well aware that balancing the resource equation involves not only a myriad of environmental issues, but also an understanding of the impact of those issues in a broader social and economic context.

This same balance is true of the building industry. No longer can the singular issues of time, cost, and quality be used to measure the performance of any building project specifically within the limited context of the project. Now and in the future, performance will need to be embedded in a larger environmental, social, and economic context (Vanegas 1995, Kibert 1994). Sustainability as it relates to the built environment essentially

The Built Environment, Sustainability, and the Forest Service

involves three main issues, which are important at every stage in the life cycle of a built facility (adapted from U.S. Department of Energy 1997):

- Efficient use of all resources (energy, water, material, and land) and minimization of waste.
- Conservation of the natural environment, the source of all of our resources.
- Creation of a healthy built environment for existing and future generations.

The environmental and human impacts committed to creating the overall built environment are extensive. As the population continues to expand, the enormous resources required to construct, operate, and maintain the world's buildings will also expand. Currently, buildings and the construction industry worldwide account for (Roodman 1995):

- One-sixth of the world's freshwater withdrawals.
- One-quarter of the world's wood harvest.
- Two-fifths of the world's material and energy flows.

It is estimated that U.S. buildings and the construction industry account for (Croxtan 1994, Brand 1994, Dibner 1992):

- More than 54 percent of total energy usage.
- \$60 billion per year spent on medical expenses related to sick building syndrome.
- 740 million tons of carbon dioxide produced from U.S. commercial-related buildings.
- More than 50 percent of the Nation's wealth.
- Employment of more than 10 million people.
- 13 percent of the U.S. gross national product.

Specifically, U.S. Federal facilities account for (Dibner 1992, Chappell 1996):

- More than 500,000 buildings owned and/or leased by the Federal Government (16,090 buildings are managed by the Forest Service).
- 3.1 billion square feet of floor space. (22.2 million square feet are Forest Service related).
- Consumption of 60 billion kilowatthours of energy each year at a cost of more than \$3.5 billion.
- Utilization of several hundred cubic miles of water each year.

- Expenses of approximately \$15 billion annually in design and construction (State and local governments may account for an additional \$50 billion spent per year).

Clearly, the decisions of those of us involved with designing, constructing, operating, and maintaining the built environment of the Forest Service have long-term impacts for both the environment and present and future generations of humans. Recognition of these impacts has led major building-related professional groups to incorporate the concepts of sustainability into their operations. The American Society of Civil Engineers has adopted a policy statement concerning the role of the engineer in sustainable development. The American Institute of Architects has published an environmental resource guide detailing the potential life-cycle environmental impacts of building materials and components. Conserving resources and creating more productive and healthy spaces for humans is becoming our responsibility in not only our personal lives but our professional lives as well. For example, it is one thing to recycle your newspapers at home. It is quite another undertaking to incorporate construction job site recycling. It may not be a problem to install high-efficiency lightbulbs in 10 to 20 lights at home. However, to install several hundred high-efficiency lightbulbs and fixtures in all district offices on one forest involves significant financial and time outlays. Obtaining fresh air in your home is simple—you open a window. Obtaining fresh air in a multistory office with a malfunctioning HVAC system and new carpeting isn't so easy.

So what does this mean to us in the Forest Service? Do we have a whole new set of sustainability tasks to incorporate into our already full capacity workload? No! The essence of sustainability isn't something new to us in the Forest Service. After all, we've been attempting to build and sustain low-maintenance, longlasting, durable, environmentally and visually low impact facilities and projects for a long time. However, there are opportunities to incorporate the concepts of sustainability, by expanding our knowledge about the state-of-the-art in sustainable building technologies and related policies and direction. Several Federal groups are working on making this information available to us.

Building Sustainability-Related Policies and Federal Groups

A few specific policies that are available to justify sustainable design, construction, operation, maintenance, and deconstruction are listed in table 1. This is not an inclusive listing. The Federal Energy Management Program (FEMP) homepage at <http://www.eren.doe.gov/femp/> provides a more comprehensive listing. In addition to specific policy statements, there are several Federal groups working specifically toward incorporating sustainability into daily operations. These groups are listed in table 2. Again, this listing is by no means comprehensive, but is meant to serve as a starting point for discussing and implementing the issues surrounding sustainability.

Existing Forest Service Sustainability Showcase Projects

Understanding what policy direction is available to support sustainability-oriented decisions is only part of fully implementing sustainability into our built environment. The other part involves showcasing our accomplishments in implementing sustainable actions so that others can learn from the challenges and successes of those projects. As stated, the Forest Service has been grappling with the concept of sustainability for a long

Table 1. Relevant Sustainable Building Policy and Direction

Relevant Policy or Direction	Description
National Energy Conservation Policy Act of 1978—Title 42, U.S. Code, part 8259	Directs the completion of audits, surveys, and retrofits on existing buildings to maximize energy savings and to construct and lease buildings that will meet established standards for energy reduction.
Energy Policy Act of 1992 (Public Law 102-486)	Establishes energy use reduction goals for Federal facilities and establishes criteria for water conservation.
Executive Order 12902, Energy Efficiency and Water Conservation at Federal Facilities (3/8/94)	Directs Federal agencies to increase energy efficiency and water conservation at Federal facilities through purchase of products in the upper 25 percent of energy and water efficiency, and promote the use of solar and other renewable energy sources.
10 CFR Part 435, Energy Conservation Voluntary Performance Standards for New Buildings	Mandatory for Federal buildings. Establishes energy conservation standards for the design and construction of new buildings.
Executive Order 12873, Federal Acquisition, Recycling and Waste Prevention (10/20/93)	Directs Federal agencies to incorporate waste prevention and recycling in daily operations and the use of environmentally preferable products and services.
USDA Secretary's Memorandum 9500-6 (9/13/96)	Establishes USDA's support for policies, programs, and activities related to sustainable development in forestry or community initiatives. Establishes a mechanism to coordinate these activities.

time. However, this does not mean we have fully incorporated the associated actions into our built environment. Shouldn't an agency whose main focus is "Caring for the Land and Serving People" (which in essence is acting sustainably) work harder at walking the talk? Think about how many employees and customers use our facilities on a daily basis. Each of these contacts is an opportunity to showcase our facilities as incorporating sustainable concepts and encourage the average users to also incorporate sustainability into their lives. There are numerous opportunities to share and exchange information with other government agencies attempting to adopt and understand sustainability. However, we must first be able to share and exchange information, among ourselves and our line officers, about our successes and the challenges we encounter on all of our projects. Several Forest Service facility projects and related work are briefly described in table 3, along with a contact person for further information. This listing is by no means comprehensive. If you are aware of or involved

Table 2. Federal Groups Related to Sustainability

Group	Description/Contact Info
President's Council on Sustainable Development	Established under Executive Order 12852. Its purpose is to advise the President and develop a national sustainable development strategy. See http://www.whitehouse.gov/WH/EOP/pcsd/index.html .
Forest Service Committee on Sustainable Development	Includes a representative from each deputy area. Jim Bedwell, Chief Landscape Architect, is an ad hoc member working on built environment issues. The Committee works with the USDA Committee on Sustainable Development. Contact J.Bedwell:W01C.
Department of Energy Center of Excellence for Sustainable Development	Targets a variety of community development issues (energy, economic growth, buildings). See http://www.sustainable.doe.gov .

with other Forest Service built environment projects that incorporate the concepts of sustainability and that deserve to be showcased as examples, please send a brief description to the DG address listed at the end of this article.

So, What Do You Think?

Does the idea of sustainability have a role in Forest Service engineering or is it really viewed as just another “thing to do”? Can we realistically call ourselves conservation leaders if we do not lead conservation through resource use as well as in management? As highlighted earlier, buildings and the building industry are major contributors to resource use. Conservation is no longer relegated to the ‘ologists and foresters alone. Those of us in Forest Service engineering also have a role. We have significant amounts of policy direction that point to the role we can take. However, unless those of us who are responsible for the actual implementation of those policies agree to be active participants and share what knowledge we gain from implementation, both among our peers and our line officers, our impacts will be severely limited, as will our budgets. It is apparent that the building industry as a whole is adopting the concepts of sustainability and green building. Can or should the Forest Service also become a frontrunner in this movement? After all, do we not already have a head start? How many private-sector building professionals have the opportunity to work this closely to the Nation’s resource base and interact on a daily basis with non-engineering earth science disciplines?

Sustainability as it relates to the built environment isn’t just another program. It is a way of life that balances both human needs and environmental conservation. It will require good scientific knowledge to implement. One of the Forest Service’s guiding principles involves selecting the most appropriate technologies in the management of resources. What better place to apply appropriate technologies than to the use of resources and

Table 3. Forest Service Sustainability Showcase Projects

Project	Sustainability Traits	Contact Info
Morehead Ranger Office and Visitor Center, Daniel Boone NF	Constructed in 1991. Incorporated geothermal heating, shelf lighting in offices because siting of building allowed good daylighting. Used gang-nailed trusses allowing for smaller lumber sizes. Used rock reflecting natural outcroppings on site.	Maurice Hoelting (404) 347-2526 M.Hoelting:R08b
Matterhorn Campground Paving, Uncompahgre NF	Constructed in 1996. Used recycled asphalt paving for campground roadway.	Doug Marah (970) 874-6632 P.Marah:R02F04a
Use of Recycled Timbers, Forest Products Lab	Research and development on guidelines for reuse of lumber and timber taken from existing military and warehousing facilities. Developing a grade stamp for recycled timber. June issue of the <i>Forest Products Journal</i> will publish an article about utilization of wood waste, including reused timber.	Dr. Robert Falk (608) 231-9255 rfalk@facstaff.wisc.edu
Lower Jemez Recreation Area, Santa Fe NF	Restoration of 6 miles of riparian habitat in conjunction with construction of facilities to better manage recreation activities. Building materials and colors reflect vernacular of the area. Recycled wood and plastic fencing installed, recycling bins incorporated into the recreation use facilities.	Ruth Doyle (505) 438-7823 R.Doyle:R03F10a
El Portal Visitor Center, Caribbean NF	Constructed in 1996. Careful siting of facility to limit disturbance necessary for building and parking. Daylighted with natural lighting. Open-air facility to take advantage of trade winds, thus minimizing air conditioning. Incorporation of natural water flow on site.	Maurice Hoelting (404) 347-2526 M.Hoelting:R08b
Las Huertas Picnic Site, Cibola National Forest	Use of a 1,024-watt photovoltaic array provides power for water pumping, a host site, and restrooms. Array is trailer mounted for seasonal use and use at other sites.	Mike Noland (505) 761-4650 M.Noland:R03F03a
Brugess Junction Visitor Center, Bighorn NF	Constructed in 1992. The 5000 sq. ft. visitor center incorporates 255 recycled structural heavy timber members with mortise and tenon joints. Includes an interpretive display highlighting recycled timber use.	Lexie Carroll (307) 674-2634 A.Carroll:R02F02a

human environments embedded into our built facilities? The underlying concepts of sustainability are obviously not new to those of us who are involved with Forest Service engineering (as seen by the projects presented previously). It is clear that we have many more opportunities to operationalize the concepts of sustainability that we do not always capture because of lack of information and knowledge about the state-of-the-art in sustainable building technologies.

Closing the Gap Between Information and Knowledge

The last goal of this article—creation of a sustainable information network—is targeted at bridging this gap between information and knowledge. In addition, it will provide a forum for discussion about how to implement sustainable concepts when initial costs and the competitive markets for more sustainable products and methods are not always conducive to easy implementation. The proposed network will function as a way to:

- Post questions about the idea of sustainable building.
- Request information from other Forest Service professionals.
- Share wins and challenges of your experiences in implementing sustainability, physically in the built environment, mentally within the line officers of the agency, and financially over the long term.

The network will serve as a mechanism to allow nationwide input to the contents of a multi-agency sustainable resource guide, to be published next fiscal year as a technology and development project. If you are interested in actively participating in such a network on the DG, which will share information via member requests concerning sustainable facilities (design, construction, operation, maintenance, and deconstruction) as well as discuss implementation of sustainability-related policies, please send a DG note to A.Crabtree:R02F04a. Please include your name, DG or IBM address, position, and a brief thought you have about Forest Service facilities and sustainability. Information may also be faxed to Anna Jones-Crabtree at (970) 874-6698.

Author's Endnote

I have spent the last year and a half on a leave of absence from the Forest Service to specifically study the concepts of sustainable design, construction, operation, and maintenance of facilities. Most of that time was spent working with the Center for Sustainable Technology and faculty members of the schools of Civil and Environmental Engineering and Public Policy at Georgia Institute of Technology. Sustainability is not another mantra. It is an idea that is actively being discussed and implemented in all industry sectors. I appreciate the opportunity to share and help to implement the knowledge and expertise I have gained as a result of my leave of absence. I am excited about learning more from those in the Forest Service who have been attempting to implement sustainability a lot longer than I!

Bibliography

Brand, S. *How Buildings Learn*. Penguin Books. New York, NY, 1994.

Chappell, T., Chief Facilities Engineer, USDA Forest Service. Personal communication, 1996.

Croxton, R. *Audubon House*. John Wiley & Sons, Inc. New York, NY, 1994.

Dibner, D.R., Lemer, A.C. *The Role of Public Agencies in Fostering New Technology and Innovation in Building*. Building Research Board. Washington, DC, National Academy Press, 1992.

Kibert, C.J., ed. *Establishing Principles and a Model for Sustainable Construction*. Proceedings of the First International Conference on Sustainable Construction, Tampa, Florida, November 6-9, 1994. International Council for Building Research Studies and Documentation (CIB TG 16).

National Science and Technology Council. *Technology for a Sustainable Future: A Framework for Action*. Washington, DC, Office of Science and Technology Policy, 1994.

National Science and Technology Council. *Bridge to a Sustainable Future: National Environmental Technology Strategy*. Washington, DC, Office of Science and Technology Policy, 1995. Also available at <http://www.nttc.edu/environmental.html>.

Patterson, M. "Under the Green Roof." *Buildings* 91(2) 64-65 (1987).

Pendergast, J. "Engineering Sustainable Development." *Civil Engineering* 63(10) 39-42 (1993).

President's Council on Sustainable Development. *Sustainable America: A New Consensus for Prosperity, Opportunity, and A Healthy Environment for the Future*. Washington, DC, 1996. Also available at <http://www.nttc.edu/environmental.html>.

Public Technology, Inc., in conjunction with U.S. Department of Energy. *Sustainable Building Technical Manual: Green Building Design, Construction and Operations*. Washington, DC, 1996. Also available at <http://www.sustainable.doe.gov/ss/ptipub2.html>.

Roodman, D.M., Lenssen, N. "A Building Revolution: How Ecology and Health Concerns Are Transforming Construction." Worldwatch Paper 124. Washington, DC, Worldwatch Institute, 1995. Available from the Worldwatch Institute at <http://www.worldwatch.org/pubs/paper/124.html>.

USDA Forest Service. *Buildings and Related Facilities Handbook*. Washington, DC, U.S. Department of Agriculture, 1995.

U.S. Department of Energy. Federal Energy Management Program. Federal Energy Management Program home page, 1997. Available at <http://www.eren.doe.gov/femp/>

Vanegas, J., DuBose, J., Pearce, A. *Sustainable Technologies for the Building Construction Industry*. Proceedings of the 1995 Symposium on Design for the Global Environment, College of Architecture, Georgia Institute of Technology. Atlanta, GA, 1995.

Stress-Skin Panel Construction of a Small Cabin

Gerald Herbrandson
Civil Engineer
Region 10, Tongass National Forest

Introduction

The Forest Service constructs and maintains a number of small cabins at remote locations in support of its administrative responsibilities. It is an engineering challenge to use new technology in a continuing effort to provide the most cost-effective solutions to the land managers.

Background

Most of the Tongass National Forest of southeast Alaska is located on many isolated islands accessed only by float plane or boat. Few road systems interconnect the many management land use areas. This isolation and lack of conventional access is further compounded by adverse weather that often limits boat and air travel. These conditions dictate the construction and operation of isolated work centers and administrative sites to provide short-term housing for field personnel. These housing units become a health and safety necessity during adverse weather conditions. They also function as emergency housing in the event of changing weather conditions.

Objective

Remote facilities should be designed to minimize field construction costs and to be economical to operate. The ideal facility should also provide a relatively high degree of employee comfort and privacy. Systems used in the past include personal tents, wall tents, small panelized framed cabins known as knock-down cabins, recreation-type kit homes (such as Pan Abode), RV trailers, mobile homes, and modular construction.

New Concept

In 1995, the Wrangell Ranger District in the Stikine Area of the Tongass identified a need for remote administrative housing. They decided to use a 20-foot by 24-foot cabin composed of expanded polystyrene (EPS) foam panels. This type of construction appeared to meet the functional administrative needs while being an economical solution from both the construction and the operation and maintenance perspective. The cabin was designed to serve two occupants. Figure 1 shows the basic floor plan, and figure 2 shows the basic cross-sectional view.

The panels are manufactured with a T-1-11 simulated exterior siding that is fully primed and weather resistant. The exterior is functional and aesthetically acceptable as constructed. As an alternative, vinyl siding, which not only improves the appearance of the cabin but will greatly reduce exterior maintenance requirements, can be installed.

The energy efficiency of this method of construction is well documented. Case studies of conventional insulated framed homes compared with panel framed homes show energy cost savings of 50 to 66 percent. It is fully

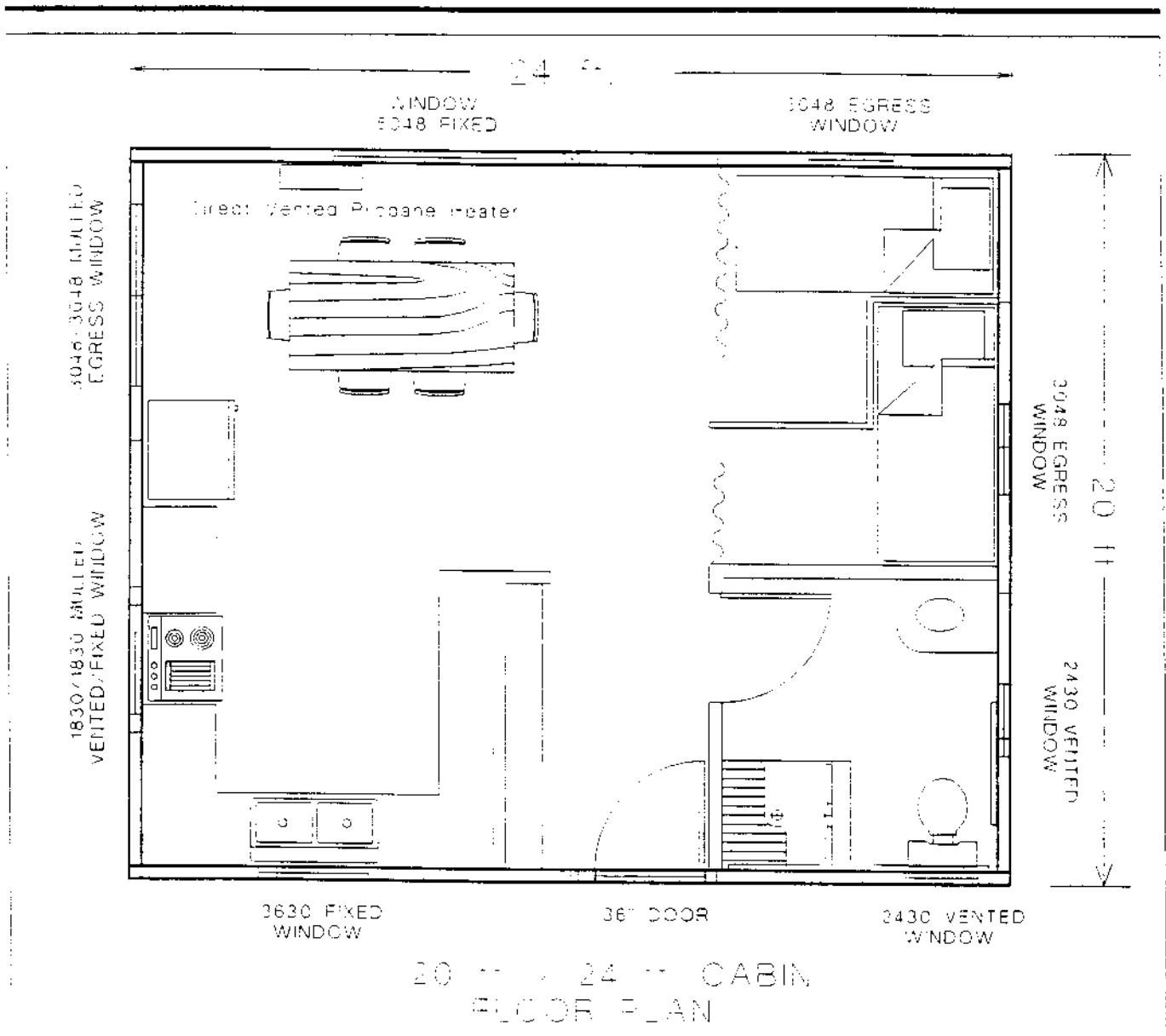


Figure 1. Cabin floor plan

expected that no heating source will be required until the temperature drops below 40 °F. On the other hand, whenever outside temperatures exceed 60 °F, ventilation may be required to prevent excess heat buildup from the stove, water heater, and general lighting.

Expanded Polystyrene Foam Panels

EPS foam panels, also known as stress-skin panels, are composed of an expanded polystyrene core 4 to 12 inches thick with oriented strand board (OSB) facings usually $\frac{1}{2}$ or $\frac{5}{8}$ inches thick. The basic panels are manufactured 4 feet wide by 24 feet long. They are then cut to the required length, usually maintaining their 4-foot width. Window and door openings are cut out and framed in with solid 2× lumber. The panels are lightweight, structurally rigid, and provide excellent insulation characteristics.

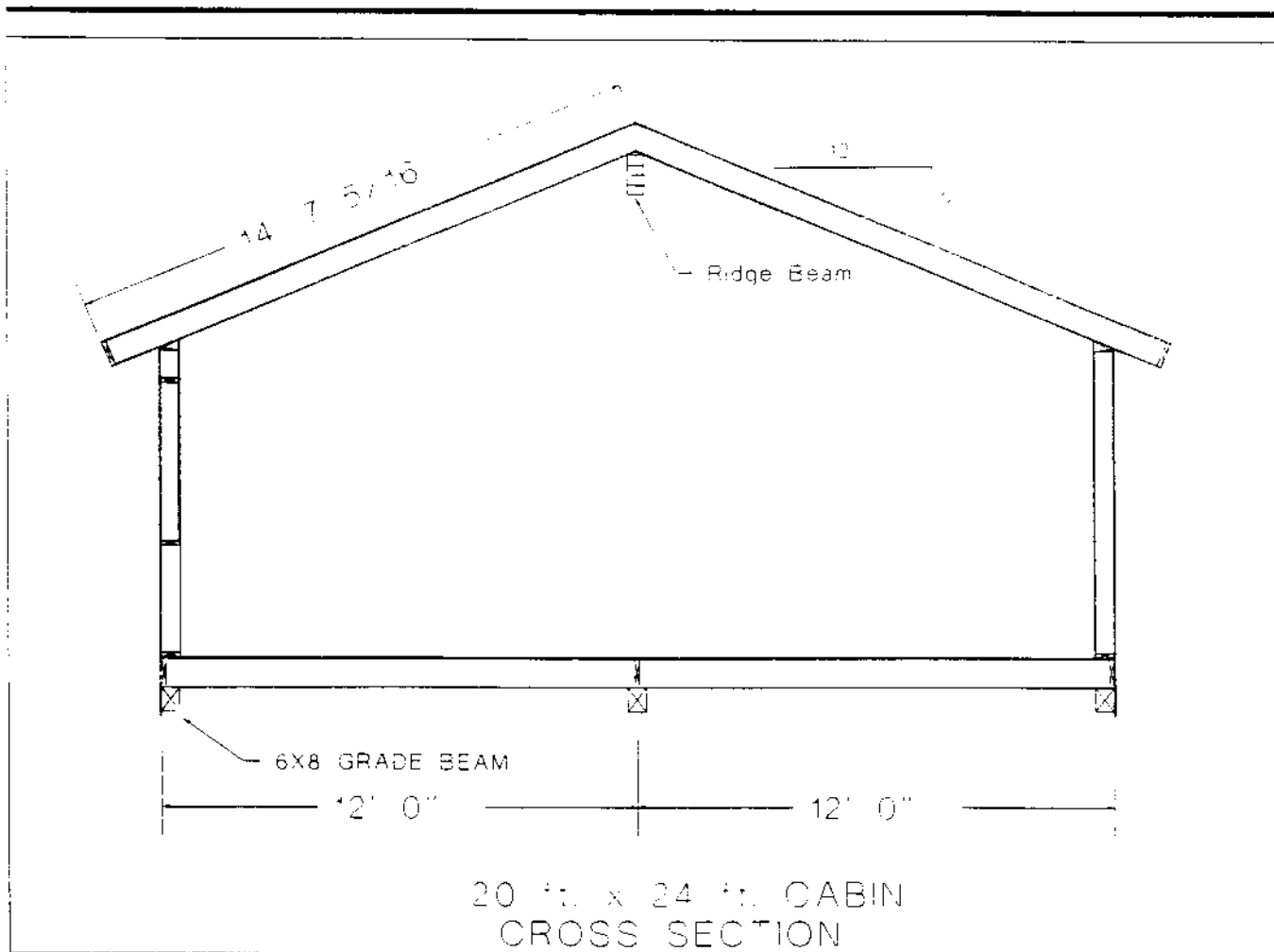


Figure 2. Cabin cross-section

The panels can be used to form the floor, wall, and ceiling systems. Typically, the only structural members used in addition to the panels in a single-story structure are the longitudinal grade beams and a longitudinal ridge beam. Floor spans are typically 12 feet or less. Roof spans are up to 20 feet, depending on snow-load requirements. Adjoining panels are joined by either a spline system or a dimensional lumber tongue-and-groove system. The completed panel systems are joined with continuous rim joists, plates, or fascia boards for the floor, wall, and roof systems, respectively.

Single-story structures can be constructed totally by hand, although it is helpful to have the use of a boom truck when installing the roof panels.

Summary of Materials

Following is a summary of the materials for a 20-foot by 24-foot cabin:

Foundation System

Three 6 × 8 timber-grade beams, 20 feet long, each supported at three locations. The foundation system can be as simple as concrete pier blocks, provided appropriate tiedowns are provided.

Floor System	Quantity	10 panels
	Width	4 ft.
	Length	12 ft.
	Core	7¼" EPS
	Interior facing	½" OSB
	Exterior facings	½" OSB
	Insulating value	R-30
	Design load	40 lb./sq.ft. live load
	Weight per panel	204 lb. (approx. 4.25 lb./sq.ft.) (see note below)
Wall System	Quantity	23 panels
	Width	Varies (typically 4 ft.)
	Height	8 ft. side walls Gable walls vary
	Core	5½" EPS
	Interior facing	½" OSB
	Exterior facings	½" OSB LP-11 Innerseal Siding
	Insulating value	R-24
	Weight per panel	Varies, max. 224 lb. (approx. 4 lb./sq.f.t) (see note below)
Roof System	Quantity	12 panels
	Width	4 ft.
	Length	14 ft. 8 in.
	Core	7¼" EPS
	Interior facing	½" OSB
	Exterior facings	5⁄8" OSB
	Insulating value	R-30
	Weight per panel	250 lb. (approx. 4.25 lb./sq.ft.) (see note below)
	Design load	60 lb./sq.ft. snow load
Windows	Thermo-Pane vinyl casement, series 5000 Milgard Manufacturing, Inc. 1010 54th Ave. East P.O. Box 11368 Tacoma, WA 98411-0368	
Door	Insulated metal clad door	
Roof	Slope 5/12 30 lb. building paper Galvanized metal drip edge 29 gage baked enamel metal roofing with ridge cap and gable trim	
Entry	Entry porch and steps are site specific.	

Note: The weights given assume that the panels are dry. The wood components of the panels do absorb water if exposed to the weather, and this will increase panel weights substantially. This can be minimized by careful handling and protection. It is possible to have the panels sealed at the factory with a sealer, such as Thompson Water Seal, which will provide some protection.

Material and Construction Costs

The overall cost of a 20-foot by 24-foot cabin, excluding field delivery and the foundation system, is about \$33,140 (or \$69 per square foot). Following is a breakdown of these costs.

20 ft. × 24 ft. cabin with windows and door	\$16,400
Roof building paper	\$80
Metal roofing and accessories	\$900
Door, window, and battens trim	\$200
Front entry and steps	\$300
Interior paint	\$120
Total:	\$18,000
Vinyl siding, including labor (optional)	\$3,400
Interior partitions and kitchen cabinets	\$5,500
Total:	\$26,900
Labor costs for field erection (see note)	\$6,240
Total Facility:	\$33,140

Note: Labor costs assume 30 person days at \$190 per day plus \$18 per day field per diem.

The stress-skin panels were purchased through the Small Business Administration 8(a) program. The panels were manufactured by:

Entercept, Inc.
3100 9th Avenue SE
Watertown, SD 57201
(605) 882-2222 FAX (605) 882-2753

Other suppliers exist in the Northwest, including:

U.S. Building Panels, Inc.
10901 Lakeview Avenue
Tacoma, WA 98499
(206) 581-0288 FAX (206) 581-0344

Premier Building Systems
AFM Corporation, R-Control
4609 70th Avenue East
Puyallup, WA 98371-2465
(206) 926-2020 FAX (206) 926-3992

Method of Construction

Most of the panels are small enough and light enough that they can be handled and installed by a crew of four. It is desirable to have at least six individuals available during the installation of the roof panels. The total building, including door, windows, and roofing system, can be constructed in a single week (figure 3).

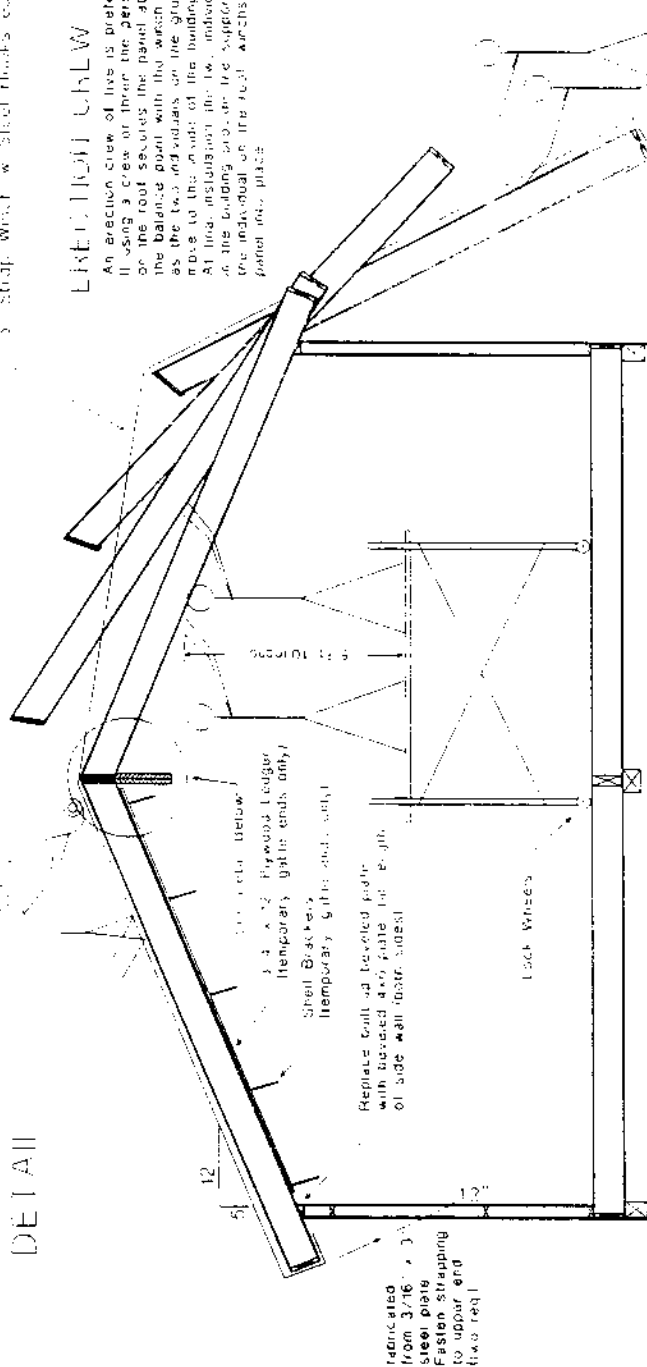
Day One

Once the foundation system and grade beams are in place, the first step is to place the floor panels. The order in which the panels are placed is identified on the plans. After the floor panels are in place and secured, the rim joists and wall plates are installed (figure 4). It should take less than a day for this portion of the work.

[illegible]

Live: 1101 UHLW

An erection crew of five is preferred if using a crew of three the person at the roof second the panel at the balance point with the wrench sees the two, if not the third person. The erection crew of five is preferred if using a crew of three the person at the roof second the panel at the balance point with the wrench sees the two, if not the third person.



WINCH NARRATIVE

Fasten one of the steel rods¹ around the end of one of the lined panels and around the bottom of the panel just below the fastener² strapping between the two rods, using a strap wrench between the two rods, as shown in the drawing. Pull the individual on the tool continuously pulls the slack through the winch. As the panel is lifted into place, when the panel is seated the individual on the tool tightens the winch to secure the panel and strap it into place. Winch is left in place until panel is properly secured w/straps.

OUTER GABLE PANELS

The outer panels overhang the eaves by 1 ft 11 in. These panels require temporary support until they are secured to the interior panels.

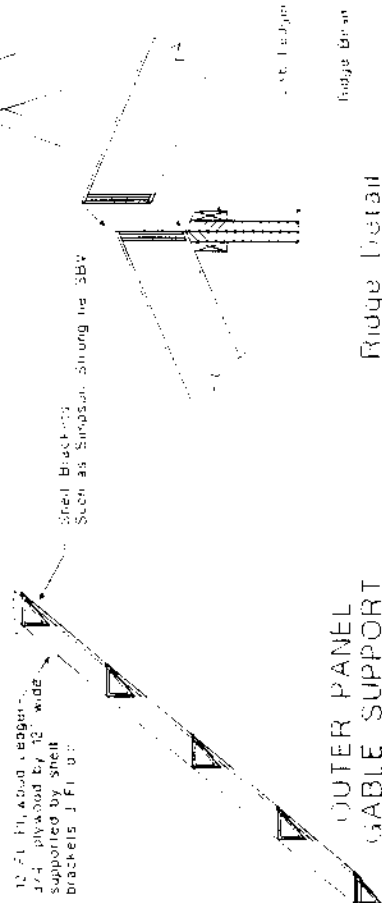


Figure 3. Installation concept

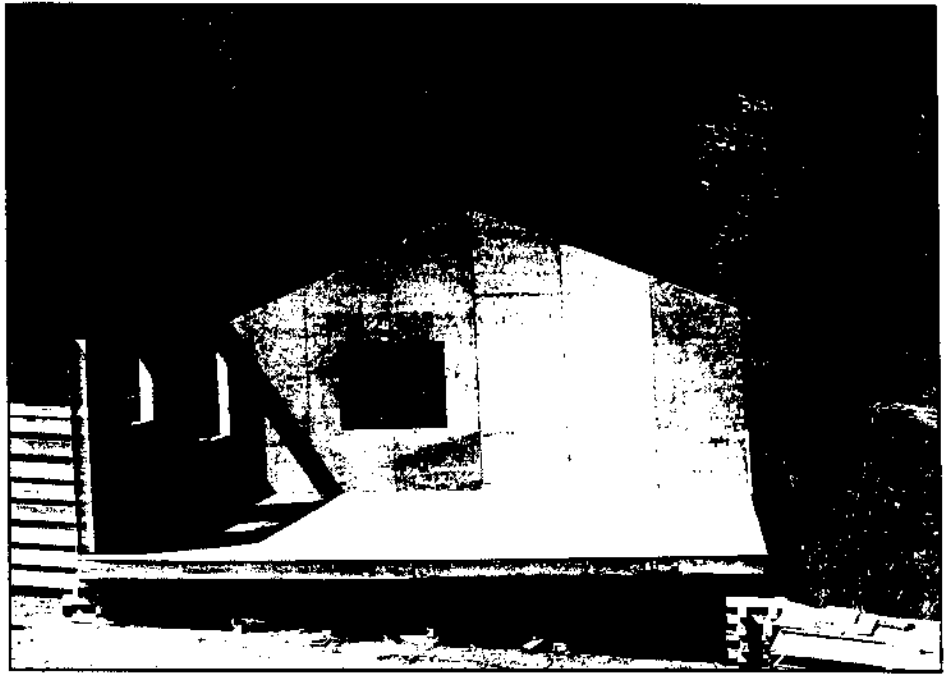


Figure 4. *Floor panels and wall installation*

Day Two

Next the walls are lifted in place and secured. Once again, the order of placement is identified on the plans. After all the wall panels are in place, the top plates are installed. Weather conditions permitting, this will proceed very smoothly and take less than a day.

Day Three

The cabin has a 20-foot ridge beam to be installed. If a boom truck is not available, it can be installed manually. With a little careful planning and rigging, the beam can be installed safely by the use of ratchet straps (figure 5). This may take a couple of hours depending upon the equipment available.

Once the ridge beam is in place and secured, the total system should be carefully inspected for proper alignment prior to beginning the roof system. In preparation for installing the roof panels, it is wise to construct and install at least four 24-inch x 24-inch knees along one exterior gable wall to support the first roof panel until it can be secured in place.

Day Four

Assuming a boom truck is not available, the roof panels can be installed with a six-person crew. There are a number of methods of lifting and installing the panels, depending on the available equipment. Regardless of what system or method is used, a safety line such as a 3-inch ratchet strap should always be used. The order of panel placement and the proper method of attachment are identified on the plans. The first two panels will take the most time to install, possibly up to 1 hour each. The remaining panels should move much more rapidly. As the system is perfected, it may take as little as 20 minutes or less per panel. Once all the panels are in place, the remaining straps and securing screws should be installed.

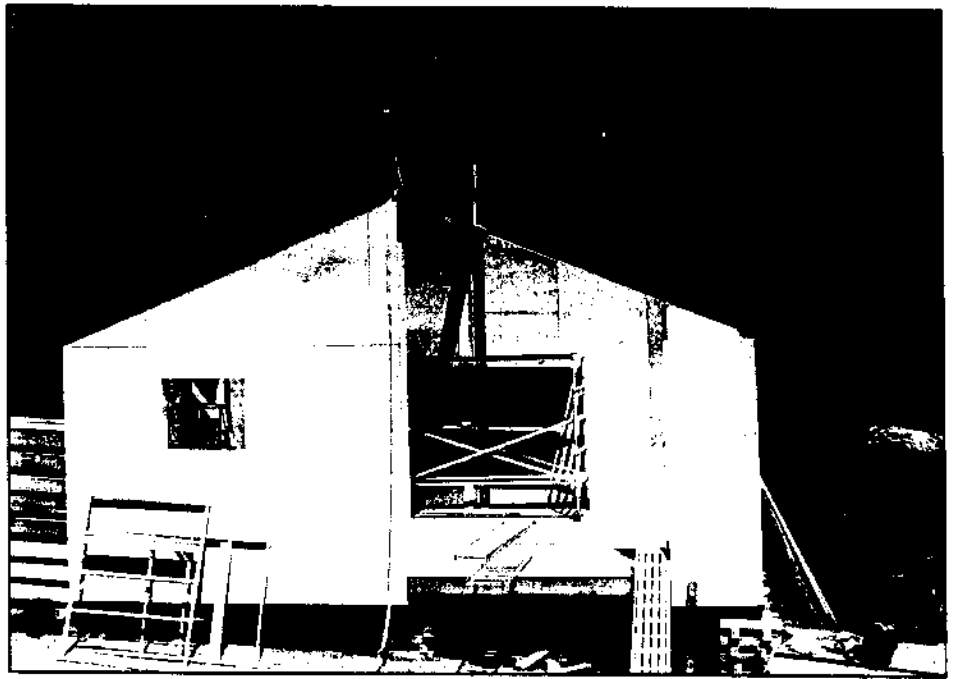


Figure 5. *Installation of ridge beam*

Day Five

The last day should be used for installing the building paper on the roof, installing the windows and the door, and general site clean-up. If all goes well, work can now begin on installing the metal roofing. Figure 6 shows the nearly complete cabin.

Tools and Equipment

Following is a list of tools and equipment that would be helpful to have on hand during the construction process:

Typical carpentry tools:

- Hammer
- Square
- 4-ft. level
- 25-ft. and 100-ft. tape measure
- Sledge hammer
- Chalk line
- Hand saw
- Crowbar
- Portable circular saw
- Two cordless drills, 12 volt, with Phillips bits #2 and #3
- Portable power planer
- Come-along
- 6-ft. step ladder
- 16-ft. extension ladder
- One section of staging or scaffolding

Special tools:

- Two 3-inch ratchet straps (similar to a come-along)
- Two steel hooks formed to panel thickness



Figure 6. *Nearly complete cabin*

Weather Considerations

The panels need to be kept dry prior to installation. Except for the roof panels, they can be installed in light rain. However, due to safety and weight, roof panels should be kept as dry as possible during installation. Once the panels are in place, they can become wet with no damage, but they should be protected as quickly as possible and allowed to air dry.

Safety Considerations

A hazard exists any time a relatively airtight building is constructed. This hazard is increased with the installation of heating devices, especially propane. A passive ventilation system was designed for each structure, composed of two 8-inch vents, one installed 12 inches above the floor and the other near the ridge on the opposite wall. These vents provide continual ventilation to the structure. Ventilation during nonoccupancy prevents moisture buildup, thus reducing building maintenance needs. Figure 7 shows the safety notice attached to the face of each vent.

The cabin also has a battery-operated smoke detector, a propane detector, and a carbon monoxide detector.

Accessibility and Comfort

The 20-foot by 24-foot cabin is large enough to comfortably house two individuals. The interior of the cabin is large enough to provide full accessibility, provided appropriate furnishings and fixtures are used.

Relocation

The cabins can be fully assembled using screws that permit dismantling. Even though this opportunity exists, it was found that the panel edges become damaged after repeated handling. It is therefore probably best to limit the number of construction cycles. On the other hand, the cabins weigh about 12,000 pounds and can be moved as one piece on a

WARNING

This cabin is air-tight when the door and windows are closed. Continuous air vents have been installed, one low adjacent to the entrance door, and one high on the wall adjacent to the ridge beam. These vents have been installed to prevent the build-up of stale air.

Do not block or close off either of these vents.

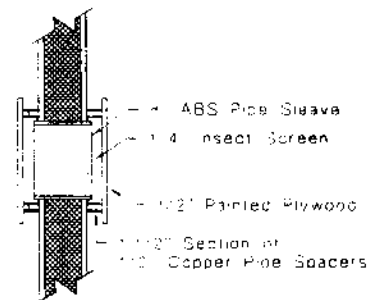
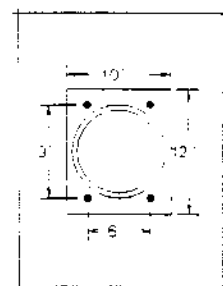
Assure that no appliance or heating system exhausts near either of these vents.

Visually inspect the vents daily to be free of obstruction.

Ventilation Ports

Install one near ridge beam opposite the door and the other 12 inches above the floor adjacent to the front door.

Mount a copy of this poster on the interior face of each vent. Mount a third copy adjacent to the door above the fire extinguisher.



Health and Safety Requirements

Install a 5 lb. ABC fire extinguisher, a smoke detector, a carbon monoxide detector, and a propane detector each cabin.

Sketch of Vent System

Figure 7. Ventilation system and safety notice

conventional tandem-axle tilt utility trailer. The Wrangell Ranger District has moved two buildings in this manner without any difficulty.

Conclusion

Initially the cabins were intended for use as an economical option to improve the quality of housing at temporary camps. The cabin has fully met the District's objective of providing a low-cost, easy to assemble, quality structure. The panels are relatively easy to handle; they can be moved by pickup truck, boat, or helicopter; and they can be assembled by hand in less than a week by a crew of as few as four individuals. Additional cabins have been ordered to meet remote housing needs at other sites on the unit.

The KISS System Outwits Beavers: A Success Story From the Town of South Bristol

David P. Orr, P.E.
Technical Assistance Engineer
Cornell University Local Roads Program

*Reprinted from the Fall 1996 issue of the Nuggets and Nibbles newsletter.
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The Town of South Bristol in Ontario County [New York] had a problem. Beavers were making their pond deeper by plugging an existing road culvert. Despite clearing the pipe and placing a wire-framed grate in front of it, the beavers still prevailed. Constant maintenance was needed just to keep the road from flooding.

The town contacted the New York State Department of Environmental Conservation (DEC). The *solutions* suggested by the DEC were either impractical, too expensive, or unsuccessful, but their *ideas* for outwitting the beavers were good.

While visiting South Bristol this summer, I discussed the problem and possible solutions with Roger Kessler, Highway Superintendent.

Good Idea!

The DEC suggested using a “pipe” made of chicken-wire or mesh. The “pipe” provides a quieter water flow. If beavers do not hear water flow; they do not attempt to plug the pipe.

Problem!

The chicken-wire or mesh “pipe” is crushed when a beaver walks on it.

Solution!

We decided to adapt the “pipe” idea by using a fairly stiff section of concrete wire fabric. Rolled into a tube shape, this fabric supports the weight of a beaver and provides the opening needed to make the flow quiet. The flood control device protects the road and culvert without forcing the beavers to flee.

The town placed the simple beaver flood control device, and it worked! By discussing the problem and getting ideas from different people, a simple solution was found. The KISS system works again!

Follow these tips to make your own simple beaver flood control device:

- The wire mesh pipe must be the same diameter as the pipe it is protecting.
- The wire mesh must be stiff enough to support the weight of a beaver. The “pipe” used in South Bristol was 48 inches in diameter. The wire mesh was 4 inches by 4 inches with 10-gauge wire.
- The length of the wire “pipe” must be at least 4 feet long. If it is too short, the beavers will hear the flow of water and will attempt to stop the flow. Longer is better.
- Contact the NYS DEC [or an applicable local authority] for permission. If the pipe flow is being restricted, the permission will be relatively easy to get. The DEC can also offer advice if another solution is needed.



Engineering Field Notes

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