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Backcountry Sanitation: A Review of Literature and Related Information

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L.1 INTRODUCTION

Sanitation issues associated with recreational activities are often difficult to resolve, particularly in cold climates. Managers and users need information, but literature on sanitation in backcountry settings is scarce, and information on sanitation is often hidden in general outdoor and recreation-related literature.This chapter provides a review of literature, case studies, proceedings and related works dealing with sanitation as it applies to recreation and backcountry use, and presents a chronicle of related research on water quality, recreation and sanitation infrastructure.

L.2 THE EARLIEST RESEARCH

Backcountry sanitation research began in the mid 1970's in response to increased visitation at backcountry sites with low assimilative capacity for human waste. Researchers under the direction of the U.S. Forest Service (USFS) Northeastern Forest Experiment Station in Durham, NH, began to investigate methods of treating and disposing of human waste on-site using a batch (also termed bin or thermophilic) composting system.

Some of the earliest studies, including the work of Fay and Walke (1977), Ely and Spencer (1978), Leonard and Fay (1978), Fay and Leonard (1979) and Plumley and Leonard (1981) detail the batch composting method using a fiberglass-covered plywood bin intersected with perforated PVC (polyvinyl chloride plastic) tubes to increase aeration. The technique used in these early trials was adopted at many sites in New England, and has remained a viable method for managing high volumes of human waste in the backcountry. Contemporary bin composting systems often use high-density plastic containers and liquid treatment devices detailed later in this chapter.

Early studies established that, "(A) bark-sewage mixture can be composted to produce a pathogen-free substance " (Fay and Walke 1977:1) in which "(T)he final product of the compost process is a dark brown, humus-like substance that can be scattered on the forest floor" (Fay and Leonard 1979:37-38).

Leonard and Fay (1978:6) said the composting process was "...as much an art as it is a science," explaining, "(T)he temperature of a compost pile is probably the best indicator of good, aerobic composting."

Ely and Spencer (1978:9) tested the end-product from the batch composting system and found that "...enteric disease-causing organisms (which generally occur in smaller numbers) [sic] could also survive the compost process," and further refined the process by incorporating a drying rack to make the end product safer. "(T)o obtain an end product containing little or no enteric organisms, a six to twelve month holding period is recommended. ...(H)igh pile temperatures are not a guarantee that each and every undesirable organism has been sufficiently exposed to a fatal wet heat. For this reason, composted material should be handled with care at all times."

Leonard and Plumley of the USFS (1979:351, 352) detail the use of both batch composters and a Clivus Multrum continuous composting toilet at several sites in the White Mountain National Forest in New Hampshire. They comment, "(C)omposting systems may be cheaper than the fly-out system or chemical toilets. ...A comparison of total costs over a period of 10 years indicates that composting can be cheaper than other methods despite the additional maintenance time required."

The authors concluded that the batch system offered numerous advantages to other human waste treatment and disposal systems: (1) batch systems are effective in reducing (but not necessarily eliminating) both the volume and pathogenic characteristics of human waste; (2) batch systems can be utilized at diverse backcountry locations; and (3) batch systems offer a cost-effective and economical method of human waste disposal at backcountry sites.

Cook, (1981) also of the USFS, began research of composting toilets in the same period, and described and evaluated the use of 33 bin composters and continuous composting toilet systems in five backcountry locations in the United States. After laboratory tests of fecal coliform content of the end-product from these toilets, Cook (1981:95) found that "(N)either bin nor continuous composting was capable of reducing fecal coliforms to recommended levels," but added, "(I)f the waste after composting can be shallow buried at or near the site [and] results in no detrimental health effects to the public, then perhaps the system of composting can be considered in selected areas."

Passive solar-assisted continuous composting toilet have been used in numerous locations. Franz (1979) and Ely and Spencer (1978) document the use of a Soltran model continuous composting system using large solar panels and an insulated heat storage area to aid the composting process at several sites in the White Mountains of New Hampshire. These units have since been removed because of the expense of installation and maintenance, and their failure to accelerate composting.

Leonard and others (1981) detail sanitation techniques at backcountry sites, including individual disposal, pit toilets, haul-out systems, chemical toilets, advanced composting systems and waterborne waste disposal using filtration and spray disposal systems.

L.3

DEVELOPMENT OF METHODS AND RESEARCH

The National Park Service (NPS) began an active research program in the mid 1980s with the investigation of a dehydrating system and nine Clivus Multrum continuous composting systems in "remote sites that lack power, water, soil depth and vehicle access" in several national parks in the United States (Jensen 1984:1-1). The report states that "(A)ll the compost toilets were found to require a liquid disposal system ...None of the ventilation systems were operating as designed ...Compost systems operating at less than 50% of the recommended loading rate appeared to function with a minimum, or no attention to the process [and] ...None of the units demonstrated the sliding of the solid material on the inclined bottom of the tank." (Jensen 1984:1-1). The dehydrating toilet detailed in the report is a Shasta model and "...required modifications to provide satisfactory performance, [since] drying the large accumulation of solids was not successful" (Jensen 1984:1-2).

The National Park Service also commissioned a study and report on the use of nine batch composting system in North Cascades National Park in Washington (Weisburg 1988) to determine the feasibility of this technique in high-use humid environments.

Further refinement of the batch system was conducted by the Green Mountain Club in Vermont, which coordinated four editions of the "Manual for Bin Composting and Waste Management in Remote Recreation Areas" beginning in 1977, and most recently updated by Pete Ketcham, Field Supervisor of the Green Mountain Club, as part of this Backcountry Sanitation Manual (2001). This edition details the compost process, the operation of the batch system and troubleshooting techniques. It includes schematics of the composting bin, drying rack and outhouse structure, and lists suppliers of plastic bins useful for composting.

Additional refinements to the batch system include the availability of a commercial bin manufactured by Romtec employing a small solar glazing to increase passive solar gain (Drake 1997). Refinements to continuous composting systems include Phoenix composters with tines to mix waste (Land 1995 a) and Bio-Sun Systems continuous composting toilets with large access doors and geotextile fabric to support waste above the floor of the chamber to increase aeration (Lachapelle 1996).

Increasing backcountry use also prompted research relating on the breakdown of fecal coliform and other bacteria using the "cathole" method. Temple and others (1982:357), in their study of shallow catholes in the Bridger Mountains of Montana, "disappointingly" found that even after a year, "(B)acterial numbers remained on a plateau [meaning pathogen levels had not significantly decreased and] ...Depth of burial made no difference."

In the 1980s numerous empirical studies were conducted on water quality in backcountry recreation settings (Silsbee and Larson 1982; Tunnicliff and Brickler 1984; Carothers and Johnson 1984; Bohn and Buckhouse 1985; Suk and others 1986; Flack and others 1988; Aukerman and Monzingo 1989). These studies document bacterial contamination of backcountry surface water, the increase of giardiasis in backcountry waters and methods of examining and quantifying water quality. They reinforced the importance of hygienic behavior in the backcountry.

Solar dehydration has been investigated as a potential backcountry sanitation method by the Forest Service and the Park Service. It has been used with varying success on Mt. Whitney in California (McDonald and others 1987) and in Mt. Rainier National Park in Washington (Drake 1997). In addition, the surface water runoff from the dehydrating toilet at Mt. Rainier was tested by Ells (1997), who was not able to document water contamination. However, the dehydrated end product from these toilets is often high in pathogens, difficult to handle and cannot be disposed of on-site.

L.4

WORKSHOPS AND PROCEEDINGS

Numerous conferences and workshops have focused either peripherally or specifically on waste management options in the backcountry. The Alpine Club of Canada (ACC) held the symposium "Water, Energy and Waste Management in Alpine Shelters" in 1991 at Chateau Lake Louise, Alberta, the first meeting on backcountry waste management. The proceedings describe waste management technologies at various ACC backcountry sites, including septic and gray water systems, fly-out systems and incineration systems (Jones and others 1992).

The "Backcountry Waste Technology Workshop" held March 30-31, 1993, at Mt. Rainier National Park in Washington hosted about 25 participants from Canadian and United States organizations. It considered professional experiences with pit and vault toilets, composting, dehydration, and fly-out and carry-out techniques (Mt. Rainier National Park 1993). Workshop participants identified a need for a document covering design considerations for backcountry waste systems and a need to give higher priority to management of and budgeting for human waste. The agenda was continued the following year in Yosemite National Park in California with a workshop that resulted in a document on continuous composting toilets and issues of compliance, design, construction, operation and maintenance (Yosemite National Park 1994).

The conference "Environmental Ethics and Practices in Backcountry Recreation" in Calgary, Alberta, in 1995, sponsored by the Alpine Club of Canada, contained a session on backcountry waste management, and produced a proceedings of conference papers (Josephson 1997). The proceedings contain an analysis by Drake (1997), who documents the use of a "blue bag" policy for an individual pack-out requirement on several of the popular climbing routes of Mt. Rainier. Drake reports that compliance is much lower than expected.

Most recently, the Australian Alps Best Practice Human Waste Management Workshop was held in Canberra, Australia, March 27-31, 2000, hosted by the Australian Alps National Parks. The proceedings contain more than 30 papers covering such subjects as personal carry-out techniques using "pootubes," and accounts from site managers in Australia and New Zealand of on-site and off-site treatment and disposal techniques including composting, septic and vermiculture systems (which use worms to aid decomposition of waste) (Australian Alps National Parks 2000).

L.5

CURRENT STATE OF KNOWLEDGE

Recent research on perceptions of backcountry waste issues reveals that 25 percent of National Park Service managers find human waste to be a common problem in many or most areas, and 43 percent consider it a serious problem in a few areas (Marion and others 1993). In their study of social and ecological normative standards, Whittaker and Shelby (1988) found that the standard for human waste represented a no-tolerance norm, in which 80 percent of the respondents reported that it was never acceptable to see signs of human waste.

Voorhees and Woodford (1998) document the recent controversy over the expense of several continuous composting toilets in Delaware Water Gap National Recreation Area in New Jersey and Pennsylvania and in Glacier National Park in Alaska. The authors argue that although the project was widely criticized, by using environmentally-sensitive materials the structure actually minimized the life-cycle cost of the facility (Voorhees and Woodford 1998:63).

Further refinements of bin composting have been investigated by the Appalachian Mountain Club White Mountain Trails Program with funding from the Appalachian Trail Conference and the National Park Service. The resulting document describes the "Beyond the Bin Liquid Separation System" used to treat excess liquid from the standard batch-bin composting system (Neubauer and others 1995).

The U.S. Forest Service has continued its commitment to an active research program, particularly through its Technology and Development Center in San Dimas, California, including two documents by Land (1995a,b) describing various bin and continuous composting toilets and other remote waste management techniques.

In addition, the Aldo Leopold Wilderness Research Institute has been active in research on visitation management and low-impact recreational practices, including sanitation in federally designated Wilderness in the US (Cole 1989; Cole and others 1987). Lachapelle (2000) examines human waste treatment and disposal methods in designated Wilderness, and supplies a decision-making matrix and flow chart to help managers consider the pros and cons of various backcountry waste management techniques and their social and biophysical implications.

It is now possible to use DNA testing to reveal the sources of fecal coliform colonies in backcountry water sources. This technique has been used to document human fecal contamination in high-use backcountry areas of Grand Teton National Park in Wyoming (Tippets 1999, 2000).

Studies directed by the USFS examine the use of a passive solar device to further treat and inactivate the end product of composting toilets. These studies indicate that a solar "hot box" can pasteurize compost and save transport and disposal costs, while providing more safety for field personnel (Lachapelle and Clark 1999; Lachapelle and others 1997).

Most recently, Cilimburg and others (2000) have produced a comprehensive examination of various backcountry waste management practices with a focus on past studies of the pathologies of water contamination and their implications for recreational activities.

Many books describe commercial composting toilets and other methods of disposal and treatment of human waste in the backcountry. These include the books by Meyer (1994), who explores anecdotal and often amusing accounts of handling human waste in the backcountry; Hampton and Cole (1995), who describe waste treatment and disposal techniques in a variety of environmental situations; Del Porto and Steinfeld (2000), who detail choosing and planning a composting toilet systems with a focus on commercial systems and related state statutes; and Jenkins (1999), who describes a more homemade approach to batch composting.

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Editor's Note:

This article was originally published in Park Science, a resource management bulletin of the National Park Service, under the citation:

Lachapelle, P. R., and J. C. Clark, 1999. The application of a solar "Hot Box" to pasteurize toilet compost in Yosemite National Park. Park Science 19(1): 1, 20-21, and 24.

The Application of a Solar Hot Box To Pasteurize Toilet Compost In Yosemite National Park

November 11, 1998

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Land managers today are continually searching for sustainable backcountry management techniques while decreasing operational expenditures and the use of human resources. The public is also increasingly concerned about expedient backcountry infrastructure projects including the construction of innovative toilet facilities (Voorhees & Woodford, 1998). Past research has documented composting toilet technologies as a low-cost, efficient and sustainable method of backcountry human waste treatment (Davis & Neubauer, 1995; Land, 1995 a,b; Yosemite NP, 1994; Mount Rainier NP, 1993; Weisberg, 1988; McDonald *et al*. 1987; Jensen, 1984; Cook, 1981; Leonard *et al.*, 1981).

While considerable research has demonstrated the operation and maintenance of composting toilets in the backcountry, few studies have explored proper methods of composting toilet end-product disposal. In 1996, the USDA Forest Service, San Dimas Technology and Development Center and the USDI National Park Service, Yosemite National Park, conducted a cooperative study in the development and operation of a passive solar insulated box (termed the “Hot Box”) to treat the end-product from composting toilets used by hikers in the backcountry. The study demonstrated that the Hot Box could consistently meet U.S. Environmental Protection Agency heat treatment requirements and produce a class A sludge that could be surface-applied as outlined in 40 Code of Federal Regulations (CFR) Part 503 (Lachapelle *et al*. 1997). According to the regulation, this heat treatment is a function of time and temperature.

The study demonstrated that the time-temperature requirement could consistently be met in Yosemite NP, an area that proved ideal because of high ambient air temperatures and consistent sunlight throughout much of the summer.

Field staff at Yosemite NP tested the application of the Hot Box to pasteurize large quantities of end-product during the summers of 1997 and 1998. Field staff report that the Hot Box operated well and required minimal labor under optimal conditions.

All of the end-product removed from backcountry toilets in Yosemite NP was previously sealed in plastic bags, deposited into designated dumpsters and then thrown away in a local landfill. The end-product is now surface-applied out of the park in local flower gardens near the park headquarters in El Portal.

Background

The development of backcountry composting toilet methods resulted from the need to reduce impacts including surface water pollution at overnight sites. Research of backcountry composting systems began in the mid-1970's and focused on sites with up to 2,000 overnight visitors per season (Fay & Walke, 1977; Ely & Spencer, 1978).

Composting technologies became increasingly popular as research documented the ineffective break-down of coliform bacteria using the "cat-hole" disposal technique (Temple *et al*. 1982) and as certain composting toilet technologies were shown to be a low-cost solution for human waste treatment and disposal (Leonard & Fay, 1979; Leonard & Plumley, 1979). Thermophilic composting (also termed batch or bin) and mesophilic composting (also termed moldering or continuous) have been used with varying degrees of success in numerous National Parks (Yosemite, Mt. Rainier, Olympic, Grand Canyon) and National Forests (White Mountain, Green Mountain).

The aim of any composting technology is to optimize conditions for microbial growth. Combining the proper amount of carbon (also termed bulking agent and usually consisting of woodchips or shavings), moisture, ambient heat and oxygen enhances the living conditions within the compost pile for natural oxygen-using microorganisms (aerobes). These aerobes use human waste as a food source and consequently, the waste decomposes over time into a soil-like substance. Disease-causing organisms (pathogens) within the human waste are reduced or eliminated due to competition, natural antibiotics, nutrient loss and heat.

The human waste and the carbon are in most cases manually mixed in an enclosure or sealed bin. The term *end-product* refers to the composted woodchips and human waste. The composting process functions optimally with a carbon to nitrogen ratio of 25-35:1 and a moisture content of 60% (Davis & Neubauer, 1995).

The aim of thermophilic composting, which requires frequent mixing (several mixes per week) and high woodchip input (approximately 1 kg of carbon to 1 liter of human waste), is to kill pathogens quickly and with hot temperatures. These temperatures result from microbial activity and can exceed 45 degrees C. Once a sufficient amount of human waste has been collected, a compost "run" is started and can take up to several weeks to complete.

Mesophilic composting in comparison is a long-term method that can take years to effectively reduce pathogens within the waste. Additionally, the frequency of mixing and the amount of carbon added are considerably lower than thermophilic methods with temperatures within the waste pile ranging between 10 degrees C to 45 degrees C.

However, complete pasteurization of composting toilet end-product by either treatment method can never be guaranteed and depends on the quality of maintenance and site conditions. Heat treatment, such as the Hot Box can provide, is one method to ensure pathogen reduction and meet 40 CFR Part 503. Consequently, the Hot Box can help in a number of ways.

First, if land management policy dictates that the end-product can be surface-applied at the backcountry toilet site, significant savings in transportation costs could result. Additionally, the biophysical and social impacts from using either pack animals or helicopter resources could be reduced.

Second, while land management policy may dictate that the end-product be transported outside of a protected area boundary, heat-treated compost is less of a health and safety issue to field staff. Since, for example, a fundamental tenet of the Wilderness Act states that the wilderness area be “protected and managed so as to preserve its natural conditions” (Wilderness Act of 1964, Sec 2c), surface-applied compost in these areas could be problematic. Unquestionably, increased nutrient levels resulting from on-site disposal could upset natural species assemblages by shifting the competitive advantage to invasive non-native plant species. However, end-product that is heat-treated in the backcountry would be a considerably lower health hazard to field staff regarding accidental spillage during transport or disposal.

Third, if the end-product cannot be surface-applied at the site and the Hot Box cannot be used in the field because of staffing or ordinance issues, landfill disposal savings could result.

Lastly, the treated end-product could be reintroduced into the composting toilets as bulking agent which would reduce the amount of additional bulking agent needed.

Hot Box Description and Application

The Hot Box is a nearly air-tight container that allows the sun’s short-wave radiation or light energy to pass through the glazing. The contents of the Hot Box absorb the light energy and convert it to long-wave radiation or heat energy which becomes trapped inside the box.

The 1996 USFS/NPS study demonstrated that temperatures of over 100 degrees C (212 degrees F) can be reached and temperatures of 88 degrees C (190 degrees F) can be sustained for several hours.

The outside walls, floor and removable tray are fabricated from an approximately .5 cm thick aluminum sheet. A single transparent Lexan® Thermoclear polycarbonate sheet is used as the solar glazing and is bolted at an angle specifically designed to maximize the angle of incidence during the summer solstice for the chosen latitude (at Yosemite NP, 38 degrees north latitude, a 15 degree angle was chosen). This angle could be adjusted for other locations. The inside walls and floor are insulated with 5 cm poly-isocyanurate closed-cell foam. A door is positioned at the back of the Hot Box in order to gain access to the tray. The original Hot Box measured 122 cm x 94 cm x 69 cm at the highest end and 46 cm at the lowest end.

Four new Hot Box’s, measuring 122 cm x 122 cm x 61 cm at the highest end and 20 cm at the lowest end have recently been built and appear to be more efficient because of their larger glazing and decreased internal air volumes.

Yosemite NP field staff operated the Hot Box during the 1997 and 1998 summer seasons at the park headquarters in El Portal. Yosemite contains 6 backcountry composting toilets that collectively produce approximately 20 cubic meters (700 cubic feet) of end-product. Since most of the backcountry composting toilets are located in federally designated wilderness areas, the end-product has been transported outside of the boundaries. End-product is transported in double plastic bags by pack animals to trailheads and then trucked to El Portal. Approximately 9 cubic meters (300 cubic feet) was pasteurized in 1998. Field staff emptied a portion of the bags into the Hot Box tray and allowed the compost to pasteurize for up to one week. It took one operator one-half hour per day two days per week to process approximately one cubic meter (30 cubic feet) of end-product.

The 1996 USFS/NPS study concluded that end-product pile depths in the tray of 12 cm or less and two and one-half hours of direct sunlight with ambient air temperatures exceeding 28 degrees C (83 degrees F) were most effective at meeting the time-temperature requirement. Additionally, a moisture content of 60 percent or less allowed for maximum temperature attainment.

Field staff would mix the end-product in the Hot Box tray several times during the heat-treatment process to ensure thorough pasteurization. After pasteurization, the finished compost was again bagged and brought to local flower gardens and spread thinly on the surface. Operators reported that the pasteurized compost resembled mulch and not human waste in both texture and odor and was therefore more tolerable to work with.

Conclusion

The passive solar Hot Box has been used for two field seasons in Yosemite NP, a location shown to be ideal to effectively pasteurize the compost from backcountry toilets. This application stems from the 1996 USFS/NPS study that demonstrated the use of the Hot Box as an effective method of composting toilet end-product pasteurization. Field staff report that the developed Hot Box technology required a minimum level of attention and maintenance by the operator and produced a compost that is dryer and appears less offensive to handle and transport. It is anticipated that further use of the Hot Box will refine design and performance imperfections.

While stringent regulations may negate the possibility that finished compost be surface-applied in wilderness and national park areas, the Hot Box holds tremendous potential to save either transportation costs and associated impacts in areas where the end-product can be surface-applied on-site, or disposal costs where the end-product must be transported and disposed off-site. Conceivably, this passive technology can serve as a sound and sustainable backcountry management technique, alleviating impacts, costs and extensive use of human and animal resources while providing an added safety margin to field personnel.

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N

Examples of Regulatory Correspondence

State of Vermont

AGENCY OF NATURAL RESOURCES
WATER SUPPLY AND WASTEWATER DISPOSAL

LAWS/REGULATIONS INVOLVED: 10 V.S.A., Chapter 61, Water Supply and Wastewater Disposal and Environmental Protection Rules;
Chapter 1, Small Scale Wastewater Treatment and Disposal Rules
Subchapter 4, Water Supply and Wastewater Disposal
Subchapter 7, Sewage Disposal
Appendix A, Design Guidelines
Chapter 21, Water Supply

CASE No: WW-5-1542 PIN No.# BR83-0001
APPLICANT: University of Vermont
Attn: Rick Paradis
ADDRESS: 153 South Prospect Street
South Burlington, VT 05401

This project, consisting of the construction of a composting-type toilet facility at Butler Lodge, located at Mt. Mansfield State Forest, Stowe, Vermont, is hereby approved under the requirements of the regulations named above, subject to the following conditions:

1. GENERAL CONDITIONS

1.1. The project must be completed as described on the plans and/or documents listed as follows:
Butler Lodge Trail Site Plan, Dated 12/93, VT Department of Forests, Parks, & Recreation,
A Study of System Improvements to Traditional Batch Composting, Dated 1995, Appalachian Mountain Club,
and which have been stamped "APPROVED" by the Wastewater Management Division. No alteration of these plans and/or documents shall be allowed except where written application has been made to the Agency of Natural Resources and approval obtained.

1.2. A copy of the approved plans and the Water Supply and Wastewater Disposal Permit shall remain on the project during all phases of construction and, upon request, shall be made available for inspection by State or Local personnel.

1.3. No alterations to the existing building other than those indicated on the approved plan, which would change or affect the water supply or wastewater disposal shall be allowed without prior review and approval from the Wastewater Management Division.

1.4. This authorization does not relieve you, as applicant, from obtaining all approvals and permits as may be required from the Department of Labor and Industry (phone 479-4434) and local officials PRIOR to construction.

1.5. By acceptance of this permit the permittee agrees to allow representatives of the State of Vermont access to the property covered by the permit, at reasonable times, for the purpose of ascertaining compliance with Vermont environmental and health statutes and regulations and with the permit.

1.6. This permit shall in no way relieve you of the obligations of Title 10, Chapter 48, Subchapter 4, for the protection of groundwater.

2. WATER CONDITIONS

2.1. There shall be no domestic water system connected with this project without prior written approval from the Wastewater Management Division.

3. SEWAGE DISPOSAL CONDITIONS

3.1. This project is approved as an innovative composting system, as described in section 1-203 of the Environmental Protection Rules, to address wastewater disposal at Butler Lodge. The system is designed to reduce the impact of an inadequate wastewater disposal system at the existing lodge. As such, the Wastewater Management Division grants variances under section 1-202 of the Environmental Protection Rules.

Figure N.1—Copy of the wastewater permit issued to the Green Mountain Club in 2000 for the installation of a beyond-the-bin system at Butler Lodge on the Long Trail. This situation was a great example of how a state agency, unaware of composting technology, learned about it when the Green Mountain Club provided a credible plan and specifications for the system. The state subsequently approved the system. Letter from the Green Mountain Club.

WATER SUPPLY AND WASTEWATER DISPOSAL PERMIT
WW-5-1542, University of Vermont
PAGE 2

3.2. The construction of the composting toilet system shall be done in accordance with the approved Appalachian Mountain Club specifications. Representatives of the Green Mountain Club shall submit written documentation verifying proper construction of the system. Any variations required during construction shall be described outlining the need for the variance and the solution.

3.3. The system shall be maintained in accordance with the Appalachian Mountain Club specifications and a maintenance log shall be maintained at the site. During maintenance exposure to all pathagen containing waste shall be minimized and reasonable human and environmental protection required. Prior to the removal and burial of composted waste, representatives of the Green Mountain Club shall contact the Wastewater Management Division so a representative from that office may have the option of viewing and approving the burial site.

3.4. Compost burial sites shall be selected to avoid exposed bedrock, wetland areas, the most environmentally sensitive areas, and areas commonly accessible to hikers.

Canute Dalmasse, Commissioner
Department of Environmental Conservation

By ____________________ 9/25/2000
Donald Wernecke, Regional Engineer

CC Green Mountain Club
Stowe Planning Commission
VT Dept. of Labor & Industry
Central Office of Wastewater Management Division

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

January 29, 2001

David Boone
CT Chapter AMC Trails Committee
370 Gilead Street
Hebron, CT 06248

RE: INSTALLATION OF SHALLOW RED WORM MOLDERING PRIVIES

Dear David:

I have received your letter dated January 11, 2001 requesting clarification as to whether installation of shallow privies which take advantage of red worm moldering to assist in the decomposition process are acceptable for use in Connecticut. As you know, Section 19-13-B103f of the Connecticut Public Health Code does make provisions for construction of non-discharging sewage disposal systems that do not require use of a water supply.

Based upon the description and information, which you submitted concerning this privy, it appears installation would be, suitable in Connecticut provided the bottom of such privy was located at least 18 inches above maximum ground water levels and 4 feet above ledge rock. Installation of privies would still be subject to review and approval by local health agencies. Soil testing could be simplified to crowbar borings to confirm depths to bedrock and shallow post hole excavations to log color, soil characteristics and ground water potential if not excavated during the wet time of the year. The important aspect of any privy is to maintain the structure free from insects, rodents and other animals. The screening should be of adequate strength and opening size to deny access for both insects and animals. We understand the application of red worms is beneficial in speeding up the decomposing process. This will reduce the frequency for privy relocation, as pit privies tend to fill up in time thereby requiring abandonment and relocation to a new pit.

Please feel free to use this letter as a means of notifying local health agencies as to the acceptability of this process and their involvement in the review, testing and approval of such units where applicable.

If you have any questions or would like to further discuss the red worm privy, please contact me.

Very truly yours

Frank A. Schaub
Supervising Sanitary Engineer
Environmental Engineering Section

FAS/jm

n/sewage/letter/red worm1

Phone: 860-509-7296
Telephone Device for the Deaf (860) 509-7191
410 Capitol Avenue - MS # 51 SEW
P.O. Box 340308 Hartford, CT 06134

Figure N.2—A copy of a letter written by the Appalachian Mountain Club's Connecticut Chapter Trails Committee to State of Connecticut's Department of Public Health when seeking permission to install moldering privies on the A.T. in Connecticut. This is an excellent example of one of the key steps in the process of seeking approval for the installation of a sanitation management system on the A.T. Please keep in mind that in other states the process may require writing more than one letter to the state, and may also include town and county health departments." Letter from David Boone, Connecticut Chapter Trails Committee of the Appalachian Mountain Club.

O

GMC Improves Sewage Management Along Long Trail

From *The Register,* vol. 23, number 4 (Winter 1999).

By Pete Ketcham

During the 1999 field season, the Green Mountain Club (GMC) enhanced back-country waste management at several sites on the northern portion of Vermont's Long Trail through several innovations in both technology and technique.

"Beyond the Bin" (BTB) liquid-separating composting toilets were built at both the base of Camels Hump and at Taft Lodge, located just below the summit of Mt. Mansfield, Vermont's highest peak (4,395'). In addition, moldering privies were constructed at Taylor Lodge, Jay Camp, Laura Woodward Shelter, and Shooting Star Shelter. Those projects were made possible by an outpouring of dedicated volunteers and funding from the Vermont Department of Forests, Parks, and Recreation, the National Park Service, and the Appalachian Trail Conference.

Like many overnight sites along the Appalachian Trail (A.T.), local environmental conditions on the Long Trail in northern Vermont present challenges to maintainers trying to manage sewage. Those conditions include thin, poor soils, cold temperatures, high ambient air moisture, and heavy use. Conditions such as those, coupled with a lack of field staff or volunteers, make dealing with sewage effectively nearly impossible. The preferred method of dealing with sewage traditionally has been the pit privy, which still represents the majority of waste-management systems on both the Appalachian Trail and Long Trail. At most sites where the use is low to moderate throughout the season, a pit privy is still the best option. However, when use increases, particularly at those sites with marginal environmental conditions, pit privies fill up and become major headaches.

At many shelter sites, wastes decompose slowly simply because the pit extends well below the biologically active layer of the forest floor (typically the first six inches) or this layer does not exist at all. The waste that accumulates decomposes so slowly that the rate of input from users exceeds the level of decomposition, and the pit eventually will fill up. At many sites, there are no longer places to dig pits. Something must be done to provide adequate sanitation facilities or the future of these overnight sites will be jeopardized. For clubs wishing to develop new overnight sites and facilities, ATC direction requires that the proposed site be able to manage sewage in a way that protects the Trail experience for users, the health of visitors, and the area's resources. With public use on the rise, finding qualified sites is becoming increasingly difficult.

Recently, moldering privies have emerged as a possible alternative for those challenging management situations. GMC, along with several other A.T.-maintaining clubs, has been experimenting with them. Longtime GMC volunteer Dick Andrews constructed the first prototype moldering (slow-composting) privy on the Long Trail/ Appalachian Trail in Vermont at Little Rock Pond Shelter in 1995. A moldering privy utilizes the biologically active, upper six inches of the soil to better advantage by doing away with a pit entirely. Instead, the waste pile sits in a wooden crib constructed on the surface of the soil (see photo). With the waste pile above the ground, a variety of desirable common soil decomposers are attracted to it. Intense scavenging and competition created in the pile by these organisms helps destroy disease-causing pathogens. The pile also receives a lot of aeration from air slats built in the wood cribbing. This higher level of oxygen helps reduce odors. Liquid is allowed to seep into the soil, where it is naturally treated by soil decomposers.

To further aid the decomposition process, field staff and maintainers introduce red-wiggler worms, which have a voracious appetite for wastes of all kind. The worms are particularly useful at colder, high-elevation sites with thin/ poor soils, where the local population of soil decomposers is low. The worms are available from most

Figure O.1—The author stands by a new moldering privy at Talor Lodge on the lomg Trail. (Note two-by-fours for moving privy onto the cribbing.

garden-supply companies. Because the worms will not survive winter freezing, GMC has been "growing" its own worm supply at GMC headquarters. The worms are distributed to volunteers for introduction into toilets each spring.

The above-ground crib (4' x 4' x 30") is constructed using 6" x 6" timbers of either pressure-treated or a rot-resistant wood, such as hemlock, stacked to create air slats to promote thorough ventilation. Air slats are covered on both sides with 1/4" hardware cloth and fine-mesh fly screening that helps to keep the waste in and debris and undesirable creatures out. Systems ranged in price from $90 to $400 per unit, depending on whether the privy building needs replacing.

After two seasons of planning and fund-raising, "Beyond the Bin" (BTB) technology arrived at Taft Lodge on Mt. Mansfield and at the Monroe trailhead at Camels Hump. The BTB was originally developed through a challenge cost-share grant to the Appalachian Mountain Club (AMC) in 1995. AMC, along with former GMC Field Assistant Paul Neubauer, constructed the first BTB along the AMC-maintained portion of the A.T. in New Hampshire. Today, nearly all of AMC's shelter sites along the A.T. have BTB systems.

The BTB is a modification of the GMC's batch-bin method of composting. The system adds a perforated, stainless-steel straining plate in the outhouse waste catcher that allows all liquids to be gravity-separated away from the solids. Once separated, the liquid then flows through a hose to a filter barrel (see photo). The 55-gallon barrel contains layers of anthracite coal and washed septic stone. A biological community will develop in the barrel that will consume pathogens and organic material in the liquid as it percolates through the barrel, before being discharged into the ground.

Figure O.2—The beyond-the-bin liquid filter barrel at Taft Lodge. The barrel contains anthracite coal and washed septic stone and drains out from the bottom into the soil, once filtered. (Photo by Pete Ketcham)

The main advantage of that system is a drastic reduction in the amount of wood chips needed for composting, which also significantly reduces the volume of sewage that needs to be composted. In batchbin systems, excess liquid needs to be sopped up with hardwood bark mulch or wood chips, which soaks up the moisture but expands the volume of the waste. This season, GMC caretakers composted approximately 630 gallons of sewage with the batch-bin system at Taft Lodge, due to the presence of copious amounts of liquid. The BTB should reduce sewage volumes by up to two-thirds annually. In addition, the drier sewage will compost at higher temperatures, producing a stable, pathogen-free end-product that can be safely spread in the woods without threatening the area's water quality.

After two months of operation, caretakers in the field reported a dramatic reduction in the amount of sewage they have had to compost, as well as a decrease in odors from their privies. During the 2000 field season, plans are to retrofit more privies to moldering systems and to modify other existing batch-bin composters over to BTB systems. A batch-bin system with a BTB filtering component will cost between $800 and $1,500. The entire BTB system weighs about 600 pounds and requires many volunteers, to transport to backcountry sites. The BTB is one of the more effective waste-management systems that has been used on the A.T. in New England. The cost is higher than a moldering privy, and it does require frequent maintenance and tending, so it may not be appropriate for some clubs or organizations with smaller budgets or labor forces. Funding for the BTB projects was made possible through generous grants from the Vermont Department of Forests, Parks, and Recreation, the Burlington Section of GMC, and Concept II (a local business) from Morrisville, Vt.

GMC is using the knowledge gained to develop a moldering-privy manual, which will be available in February. Thanks to an NPS challenge cost-share, a backcountry sanitation manual for Trail maintainers will be completed by 2001.

Pete Ketcham is a regional field supervisor for the Green Mountain Club. He also has worked with the Appalachian Mountain Club and Randolph Mountain Club in New Hampshire as a backcountry hut naturalist and facility caretaker.

A version of this article was printed in the Spring 1999 issue of the Long Trail News, GMC's quarterly newsletter.

For more information on backcountry waste management, contact Pete Ketcham at the Green Mountain Club; 4711 Waterbury-Stowe Road, Waterbury Center, Vermont 05677; (802) 244-7037 ext. 17; or <Pete@~greenmountainclub.org>.

P

Owner-Built Continuous Composters

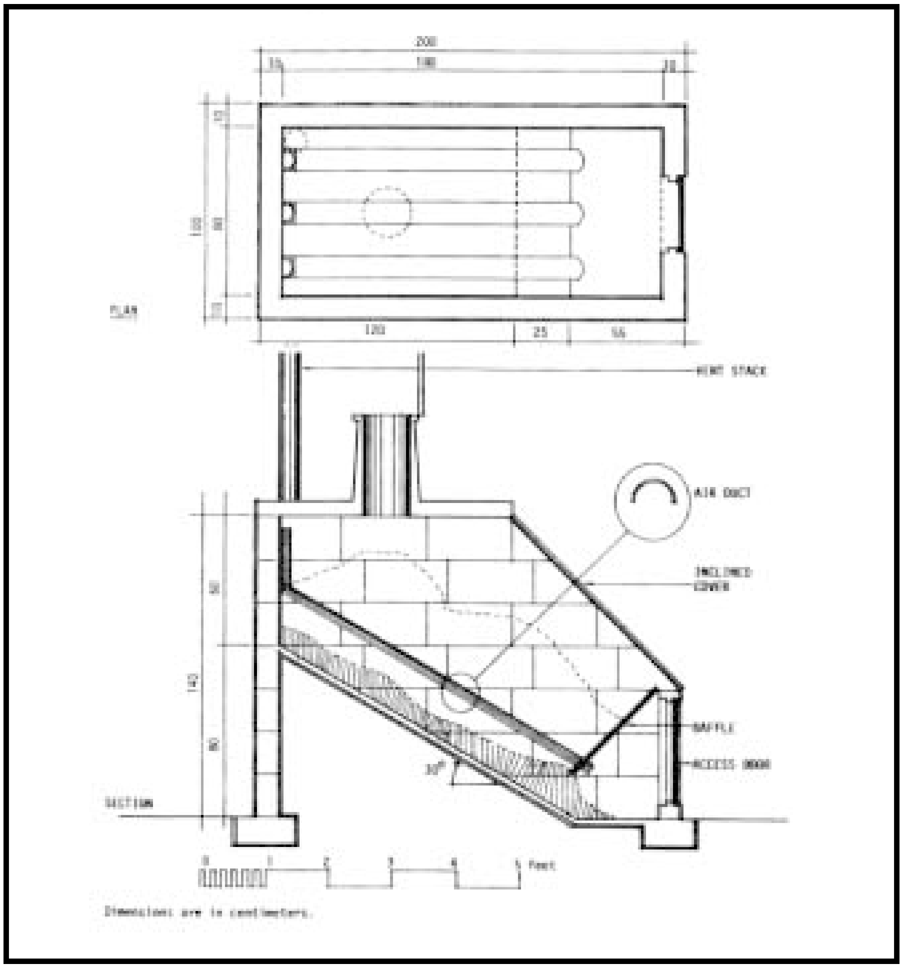

Figure P.1—This is an example of plans for the construction of an owner-built, continuous composting system. The plans pictured are for a Clivus Minimus, which is modeled after the Clivus Multrum. The Pennsylvania Composter, a unit in use on the A.T. in Pennsylvania, Maryland, and New Jersey, is a similar design. Diagram from the Center for Low-Cost Housing of McGill University and The Composting Toilet System Book by David Del Porto and Carol Steinfeld.

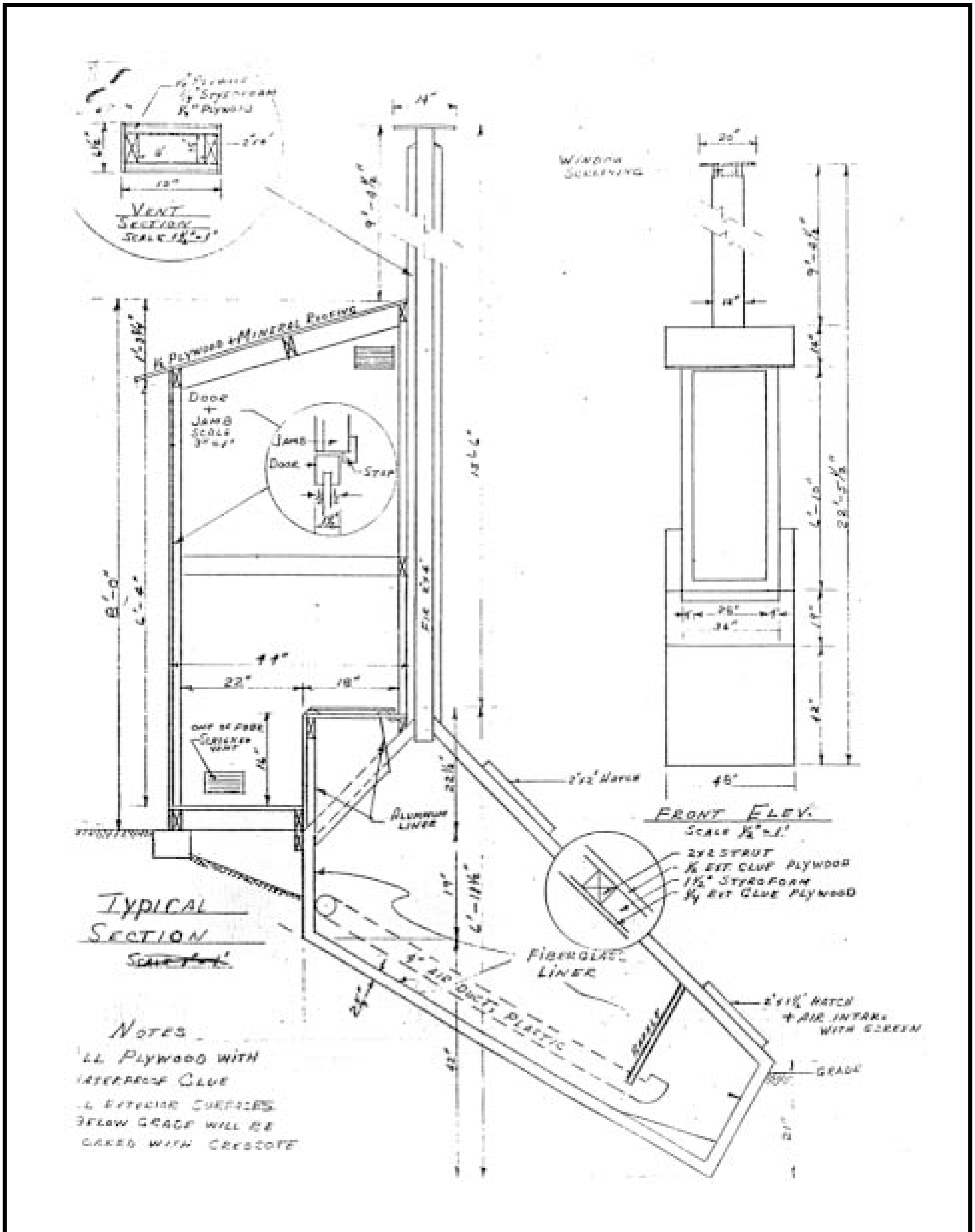

Figure P.2—A diagram of the Mountain Club of Maryland's "Pennsylvania Composter." This system is also referred to as a "Clivus Minimus," because it is an owner-built version of the Clivus system. For plans and additional information, contact the Mountain Club of Maryland's Ted Sanderson (Contact information is in the Contact List in this Appendix)." Diagram from Ted Sanderson and the Mountain Club of Maryland.

Q

Plans for a Wooden Packboard

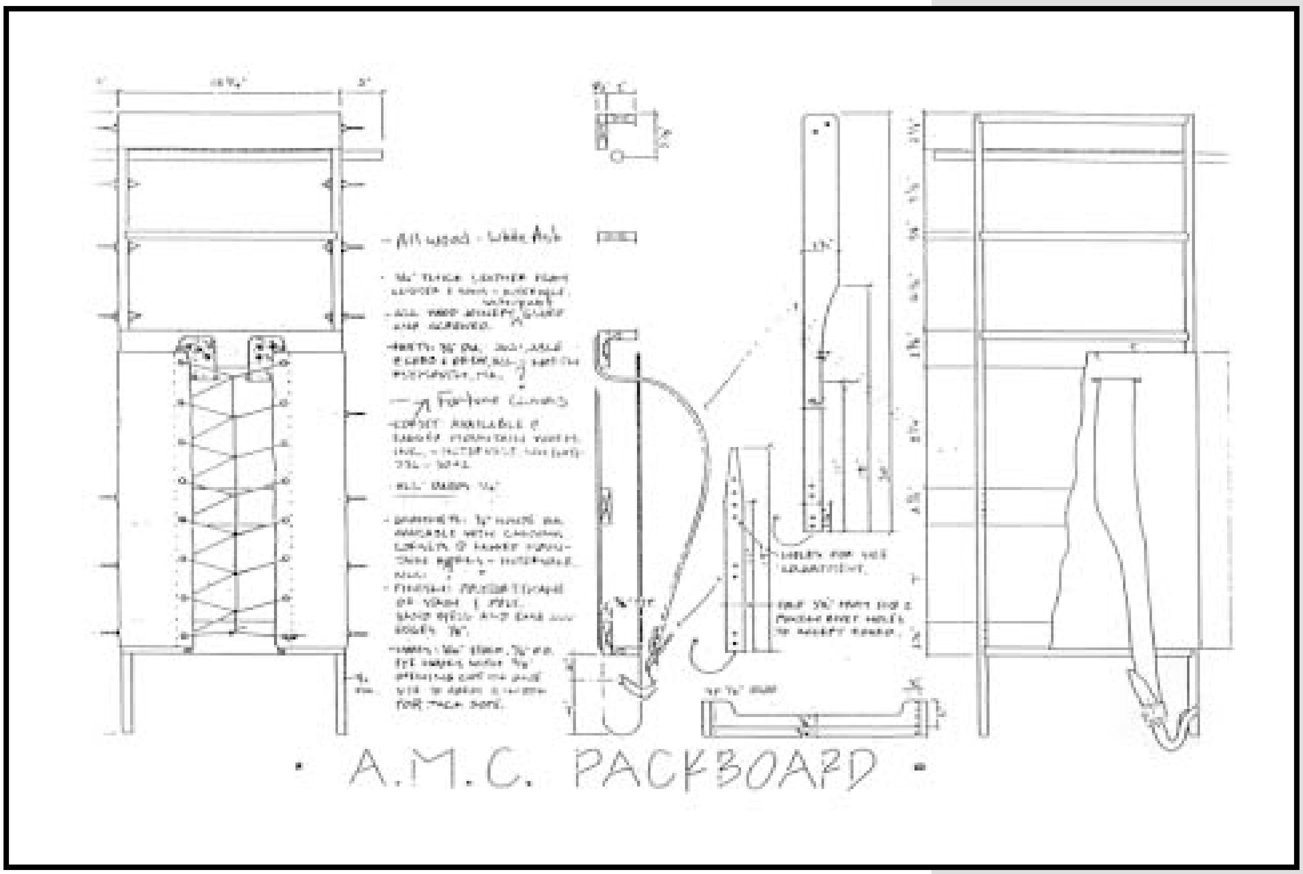

Figure P.3—Plans for construction of the Appalachian Mountain Club's wooden packboard. This packboard has been found to be the best for transporting composting toilet system components into the field as well as bark mulch or other bulking agents by the Green Mountain Club and Appalachian Mountain Club.