TRANSPORTATION RESEARCH RECORD
571

# Utility Facilities in Transportation Corridors

5 reports prepared for the 54th Annual Meeting of the Transportation Research Board

TRB
TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
Washington, D. C., 1976

**Transportation Research Record 571**
Price $2.20
Edited for TRB by Marianne Wilburn

Subject areas
03 rail transport
15 transportation economics
52 road user characteristics
82 urban community values
83 urban land use
84 urban transportation systems

Transportation Research Board publications are available by ordering directly from the board. They may also be obtained on a regular basis through organizational or individual supporting membership in the board; members or library subscribers are eligible for substantial discounts. For further information, write to the Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competence and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The views expressed in this report are those of the authors and do not necessarily reflect the view of the committee, the Transportation Research Board, the National Academy of Sciences, or the sponsors of the project.

LIBRARY OF CONGRESS CATALOGING IN PUBLICATION DATA

National Research Council. Transportation Research Board.
Utility facilities in transportation corridors.

(Transportation research record; 571)

1. Roads—Right of way—Multiple use—Congresses. 2. Urban transportation policy—United States—Congresses. I. Title. II. Series.
TE7.H5 no. 571 [HE355.8] 380.5'08s [388.1'3]
ISBN 0-309-02484-6 76-25115

# CONTENTS

# ENERGY CORRIDOR IN HAWAII

Gordon W. Bradley, Paul T. F. Low, W. E. Estes, Edward J. Burns, and Yolanda Liane, Hawaii Architects and Engineers, Inc.

This paper deals with the concept of an energy corridor. The idea is to establish a precedent for the orderly, controlled transmission of sources of all types of energy from supplier to user. Discussion relates to funding, cost sharing, and amortization by the users; alignment and description of the corridor; administration and leasing; and the role a state can play with private enterprise in the interest of solving the complex problem of transporting energy in a safe, efficient, and environmentally acceptable manner in today's society.

•THE CONCEPT of an energy transmission system is not new; many communities across the country have such systems. But Hawaii has produced what might be a national "first"—an engineering and planning breakthrough called the energy corridor. What makes this system unique is that it was planned from the beginning under the sponsorship and direction of the state of Hawaii.

Like other U.S. cities and states, Hawaii was faced with the need to transport energy from supply sources directly to users or market-distribution points. Because of its island geography and the crucial importance of the tourist industry, the state faced significant problems concerning land conservation, environmental protection, and safety. The state legislature, recognizing both the need to establish convenient and economical means of transporting fuels and other energy sources and the need to protect the natural assets of Hawaii, believed that the state could best manage and control an energy corridor. Therefore, Act 33 was passed and signed into law in 1970. In the act, Hawaii Department of Transportation was designated to establish, maintain, operate, manage, and control the energy corridor to better conserve and use Hawaii's limited land resources in transporting energy on a nonexclusive basis directly from supply source to distribution points.

## GENERAL ALIGNMENT AND DESCRIPTION OF THE ENERGY CORRIDOR

The energy corridor is based on implementation of objectives contained in Act 33, the General Plan of Oahu, and the Foreign Trade Zones Act. Environmental and ecological considerations require that certain industrial installations and activities be located in areas distant from the residential and recreational areas of Honolulu. The General Plan of Oahu provides such an area in a large tract of industrial land at Barbers Point known as Campbell Industrial Park. An existing petroleum refinery is producing 35,000 barrels/day (64.4 $dm^3/s$), and another refinery is producing 29,500 barrels/day (54.3 $dm^3/s$). Ultimately, one or more additional plants may be constructed. Almost all of the petroleum products will require transportation in corridor pipelines. Pipeline transport is required for gas except for possible truck delivery of liquid natural gas. The alternatives for transporting the petroleum products included barge, truck, and pipeline delivery. The convenience, dependability, economics, and minimal environmental impact of pipeline delivery resulted in its selection and provided justification for the energy-corridor concept. Pipeline transport is amenable to intermediate delivery points for consumers in Pearl Harbor, Honolulu International Airport, and Honolulu Harbor areas. A state-owned energy corridor provides a means for locating pipelines of several users in a common right-of-way that might otherwise be constrained

or might be out of harmony with the development and ultimate use of traversed lands. Because all aspects of the energy corridor are state controlled, optimization of land use is ensured.

The energy corridor is 23 miles (36.8 km) long and has a nominal 30-ft (9.1-m) right-of-way over land and a 100-ft (30.5-m) right-of-way under water. The alignment is shown in Figure 1. Although numerous alternate alignments were investigated, many were rejected for economic, environmental, or technical reasons. For example, alternates that would not connect major delivery points between Barbers Point and Honolulu, such as Waiau Power Plant, the U.S. Navy and U.S. Air Force fuel-storage facilities at Pearl Harbor, and the Honolulu International Airport, were discarded because they did not meet the objectives of the corridor.

Colocating the pipeline facilities with highways was explored by the state. Highly improved and populated areas were avoided because of effects on improvements and displacements of families and businesses. The American Association of State Highway and Transportation Officials policy on the accommodation of utilities on freeway right-of-way also was considered in colocating with highways. Except for that portion of the energy corridor within the Interstate Highway near Pearl Harbor and the Honolulu International Airport, conditions under which utilities may be accommodated in the freeway rights-of-way could not be met.

Pipeline routes that greatly extended the length of the pipelines or that involved excessive numbers or lengths of water crossings also were discarded. Such routes would have increased opportunities for damage to the environment. An offshore pipeline was discarded early in the planning process because such a pipeline would be excessively long, and a crossing at the mouth of Pearl Harbor would be subject to damage from vessels, which could result in an oil spill that would impair the environment. In general, the potential for serious damage to ecological systems can be shown to increase when a pipeline is placed in open, unprotected water.

As shown in Figure 1, the preferred corridor alignment extends from the northeast property line of Campbell Industrial Park to terminal facilities at pier 40 in Honolulu Harbor. This terminus was chosen to facilitate connections to the harbor pipeline system. The intermediate delivery points shown in Figure 1 could be provided by users of the corridor to the military facilities in Pearl Harbor. The policy adopted was that any intermediate facilities required by users or consumers for pumping, reheating, monitoring, and measuring flow would be designed and installed under state supervision. These facilities would not be considered a part of the energy corridor.

The corridor is divided into five slots that are being leased separately. Slots were designated by the following labels: mauka 1, mauka 2, center, makai 2, and makai 1. Mauka 1 is the most northerly slot and makai 1 is the most southerly slot. A generalized section with these slots indicated is shown in Figure 2.

Although the nominal width of the corridor on land is 30 ft (9.1 m), easement requirements, obstructions, and the like have necessitated that the real corridor width vary from a minimum of 15 ft (4.6 m) to more than 40 ft (12.2 m). In addition, the standard width of the corridor easement where the alignment passes offshore beneath East Loch at Pearl Harbor and Keehi Lagoon is 100 ft (30.5 m). In many cases along the right-of-way, the corridor shares one of its right-of-way boundaries with the boundary of existing roadways. These easement lines normally are characterized by numerous jogs and irregularities caused by the requirements of bridges, property lines, and the like. In such cases, the nominal energy corridor width of 30 ft (9.1 m) was established only at salient points along the right-of-way so that the easement lines thus constructed would be relatively free of irregularities.

The user of the outside slot was anticipated to prefer to construct its pipeline parallel to the outside right-of-way line rather than parallel to the corridor centerline to avoid costly irregularities in the pipeline. In such cases, subsequent users may establish their slots parallel to this user rather than parallel to the corridor centerline. The slot boundary of the outside slot in such a case is determined by the minimum slot boundary offsets. Future users are advised to refer to "as-built" drawings of previously laid lines that are on file with the Harbors Division of the state department of transportation. Users are expected to keep their pipelines along the centerline of their

**Figure 1. Alignment of energy corridor on Oahu.**

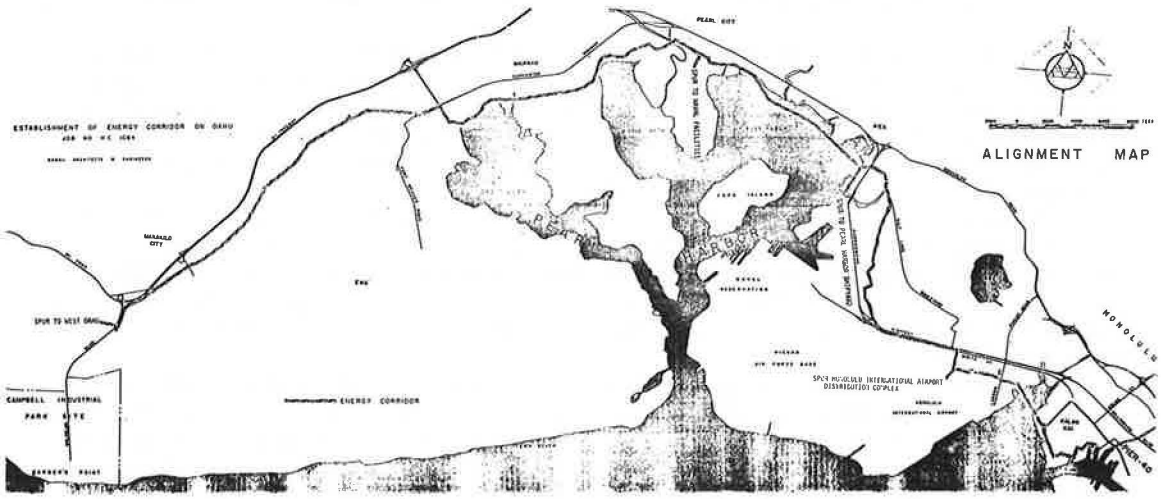
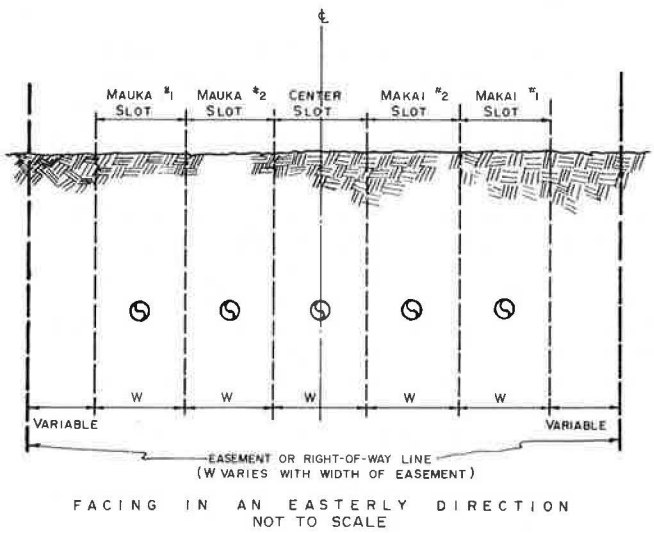



**Figure 2. Generalized section and slot designations.**




FACING IN AN EASTERLY DIRECTION
NOT TO SCALE

assigned slots. However, in cases where lines are required to be moved off the slot centerline, minimum distances must be maintained between outside pipe walls and slot boundaries.

The current energy-corridor easements are pipeline easements only. No special provisions have been made for auxiliary facilities such as heating stations, pumping stations, cathodic-protection facilities, valves, or scraper stations. In cases where these features must extend above the ground surface or outside the user's designated slot, the user is required to make the necessary arrangements with the appropriate property owners and other affected parties.

The assignment of slots to users is on a first-come, first-served basis. The potential user may request any unoccupied slot according to preference and subject to the approval of the state of Hawaii. However, the user must occupy the same slot for the full length of the corridor and may not switch from one slot to another except in extenuating circumstances and as approved by the director of the Hawaii Department of Transportation.

The user is required to design and construct its pipeline and apurtenant structures to be compatible with the requirements of future users. However, any structures thus designed are not required to support more than the builder's facilities. In addition, the design and construction of the facilities must be compatible with the aesthetics of the surrounding area. This condition is particularly significant in the area of the Waiau Power Plant where the corridor exists as an overhead easement.

## FUNDING, COST SHARING, AND AMORTIZATION

The total funds appropriated were $1,400,000 of which $1,000,000 was designated for the land-acquisition program and $400,000 was designated for engineering services. The source of funds would be from the sale of state of Hawaii, reimbursable, general-obligation bonds. Except as later described herein, the state's intent is that no costs, claims, or fees shall be assessed, charged against, or borne by the state for the establishment or the operation of the energy corridor.

By an agreement executed on December 31, 1970, by the state of Hawaii, acting by and through the Hawaii Department of Transportation, the Hawaiian Independent Refinery, Inc. (HIRI), was established as the initial user. In the agreement, HIRI declared a need for such a corridor and agreed to underwrite all necessary reasonable costs for it. Until there was a subsequent user, all costs would be borne by the initial user, and the sharing of costs (to be defined) was not applicable. GASCO, Inc., became a second user in 1974 with the installation of a 16-in.-diameter (40.6-cm-diameter), high-pressure gas line.

A method was adopted to provide for a system of fair sharing of all costs of the corridor. When new, bona fide suppliers are accommodated, all prior users will receive adequate and fair reimbursement for a share of their outlays made up to the time of admission. Future interested parties are permitted to install facilities in and use the corridor and enjoy the same services and privileges as the other participants by paying their share of the costs of the corridor. All authority given under chapter 277, H.R.S., is to be administered by the director of the Hawaii Department of Transportation through its Harbors Division. Included in this authority is the administration of this cost sharing.

An energy-corridor advisory board was established to review costs, cost estimates, and equity of cost sharing, and make recommendations to the director of transportation on all matters pertaining to the responsibilities given to the department in chapter 277, H.R.S. This advisory board is made up of 1 member who is appointed by each authorized corridor user plus members appointed by the governor of Hawaii. The state-appointed members include the chairperson of this Board and others the number of whom always must equal the total of the user members plus 1. Members serve for 4-year periods in staggered terms.

A separate account was established for handling all money and transactions for this energy corridor. This account is separate from all other accounts of the state of Hawaii.

Any subsequent corridors that are established in the state will have their own separate accounts for record keeping. The state added a standard administrative overhead burden calculated by the Department of Accounting and General Services that currently is 5 percent on all revenue paid out of the energy-corridor account. Repayments to prior users are exempt from this additional burden. Direct and indirect costs incurred by the state for both personnel time and out-of-pocket costs are also included. Several exceptions are to be noted. If any parcels of land are acquired in fee simple for the corridor and the director of the transportation department determines that such parcels have value to the state for other purposes, then a credit will be given to the energy-corridor account. In such a case, users are required to pay only for the easement of land that is required for installation of energy transmission systems. The difference between the easement value and the cost of the parcel in fee simple is credited to the account. The advisory board selected an appraiser to establish the easement value. Another exception is when a user is required to make substantial improvements in the corridor that are of direct benefit to all users (current and future). An example of such an action is the relocation of a building off the corridor right-of-way to accommodate construction of a pipeline. In such a case, the user must make application to the director of the transportation department in advance and receive approval for a qualified exception. If the director rules that such an expenditure on the user's part is of value to the corridor as a whole, then the total amount or appropriate portion may be credited to the energy-corridor account for fair sharing of these costs by other users in the same manner that other costs are shared.

Each user is required to maintain its own facilities to the point that maintenance of the corridor by the state is minimal. If any maintenance costs are incurred by the state, they are charged to the account. A reserve fund is established to cover such extraordinary expenditures and initial operating and administration costs. The amount allocated to the reserve fund is $20,000/year for the first 5 years and thereafter as required to maintain a reserve fund of approximately $100,000. The amounts of the reserve fund may be changed as recommended by the advisory board and approved by the director of the Hawaii Department of Transportation.

The users of the energy corridor make payments into the account by estimating the revenues and expenditures of the forthcoming year. On advice by the advisory board, the state prepares an estimate at the beginning of each calendar year of the expected expenditures that will be incurred in the energy-corridor account for the coming fiscal year. This estimate includes an amount to maintain the reserve fund at the required level. Payments into the account by the users are made quarterly, in advance, at the place and in the manner delineated in the lease agreement between the state and the user. If there is only 1 user of the energy corridor, then that user makes all payments into the account that are required by the state. Each subsequent user must make an initial payment into the account for bearing its proportional share of the costs of the establishment of the energy corridor. When there is more than 1 user, then the costs of the corridor for each year will be shared among them in accordance with detailed rules established by the advisory board. Each user enters into a lease agreement with the state of Hawaii to occupy a portion of the corridor for each transmission element. The period of the lease to accommodate the initial user will be as stated in the lease agreement, and the lease for each subsequent user is coterminous with the first lease.

## ROLE OF THE STATE AND HAWAII ARCHITECTS AND ENGINEERS, INC.

In January 1971, the state of Hawaii selected Hawaii Architects and Engineers, Inc. (HA&E), a consortium of professional firms, to assist in implementing Act 33. HA&E was to review the alternative corridor routings and refine the most promising routing into specific, finite locations along a 23-mile (36.8-km) pathway.

Accomplishing the establishment of the corridor within a short time required close coordination of 2 project teams. The first was that of the state of Hawaii. The second, the HA&E project team, consisted of 3 groups: The first covered field surveys and

cadastral work; the second was in charge of refining corridor location, setting design standards, master planning, hydrographic surveying, and forming guidelines for shared use of the corridor; and the third handled the acquisition and appraisals of rights-of-way.

Aerial photographs covered the total area of the proposed route; these were scanned and analyzed, and changes were made in the routing. Teams then went into the field to tie down specific locations. The teams produced 2 types of maps: (a) alignment maps that detailed the route and principal topographic features affecting the route, and (b) parcel maps that showed property lines and areas affected by the corridor.

Five months after retaining HA&E, the governor of Hawaii (responding to mounting public environmental concern) issued an executive order requiring state-funded projects to have detailed environmental impact statements showing how the projects would affect land, air, streams, and ocean. The energy-corridor project technically did not have to comply with the executive order because it had started before the order became effective. However, the state specified that it would be necessary for HA&E to draft a statement. On the basis of evaluation by the engineering, scientific, and social disciplines, the statement concluded that the proposed energy-corridor alignment could be constructed along the preferred route with minimal damage to the environment. The statement also concluded that the construction of pipelines within the energy corridor according to carefully planned construction practices also would have a minimal impact on the environment. Furthermore, a continuing safe operation could be expected because of the satisfactory operating performance of recently constructed pipelines elsewhere. The routing selected for the energy corridor generally (a) followed existing pipelines, roads and railroad rights-of-way; (b) avoided hazardous geological areas; (c) minimized potentially damaging hydrologic effects; (d) avoided ecologically sensitive areas; (e) reduced but did not eliminate overall expected sociological reaction and impact; and (f) was the most environmentally acceptable alternative available for both alignment and mode of transport. It was recognized that some of the information in the impact statement essentially would be unaltered over time. However, other data, such as those related to sociological aspects and, to some extent, to ecology, are fairly unstable and could change, depending on events that cannot be foreseen. Therefore, all conclusions were based on judgment and assessments of information available at the time.

An appraisal report for the fair market value of more than 100 easement parcels for the corridor based on the right-of-way maps was prepared and submitted, and any required reappraisals were made.

## ACCOMPLISHMENT AND SITUATION TODAY

With the exception of a few parcels that are still being negotiated in which major highway construction is under way, acquisition of the energy corridor and all of its preceding work, including layout, location, surveys, and mapping, are essentially complete. One petroleum-products line has been in operation in a portion of the corridor for approximately 2 years. Construction of a 16-in. (40.6-cm) gas line by GASCO, Inc., is complete, and the line is ready for use. Room still exists for 3 more pipeline users in the energy corridor. Negotiations have taken place from time to time with Conoco-Dillingham Oil Company for 2 slots in conjunction with their planned $100 million refinery at Barbers Point. At this time, the future of this refinery remains unsettled. The initial planning of the energy corridor was to satisfy transshipment needs for Oahu through the year 2020. It appears that this initial plan will be fulfilled.

## ACKNOWLEDGMENTS

All parties that have been involved with the energy corridor agree that it is a success and has met the intent and purposes of Act 33. That any pipelines could have been installed in Honolulu without the enabling legislation that produced the energy corridor

is unlikely. The corridor, furthermore, demonstrates rather dramatically what can be accomplished when government and private enterprise work together to solve a problem. The state of Hawaii; the Hawaiian Independent Refinery, Inc.; GASCO, Inc.; and Hawaii Architects and Engineers, Inc., have worked together smoothly and closely throughout the entire project. The Hawaii project, in fact, might well prove to be a working prototype for future energy corridors throughout the United States and other parts of the world particularly in fast-growing industrial communities whose leaders can be convinced of the value of planning for future needs rather than merely allowing events to happen.

# COMMON TRENCHING—STATE OF THE ART

W. J. Boegly, Jr., W. L. Griffith, and A. L. Compere,
Urban Technology Group, Oak Ridge National Laboratory, Oak Ridge, Tennessee

In urban areas, expansion of existing utility systems and the possibility of adding utilities increase competition for available installation space. Installation and maintenance of these utilities cause pavement cuts resulting in more frequent repaving and attendant traffic congestion. Common trenching, the installation of multiple utility lines in a single trench, offers the potential for reducing the number of places in which pavement cuts are made. Although many companies indicate that they use common trenching, it is not a universal practice. The English made a detailed study of common trenching for use in public housing developments and developed standard trench designs and suggested coordinating and operating procedures. Many of these procedures are applicable to the United States. One suggestion, for example, was the use of a single crew for installation, which has proved successful when tried in the United States. Major areas of concern to the utilities are coordination, compatibility, and cost sharing. Coordination can be handled in many ways. Coordinating committees, joint utility procedures, design by a single engineering firm, or use of an outside engineering firm to supervise design and installation and provide scheduling have proved to be successful. Compatibility problems may be eliminated by proper design and choice of construction materials. Cost-sharing formulas have been developed to prorate costs among the utilities. Past research indicates that cost savings from 10 to 20 percent can be anticipated by using common trenching. In addition, if the use of common trenching allows quicker installation, developers, utilities, and highway departments should experience savings.

•EXPANSION of underground utilities in urban areas produces increased competition for available installation space. Such competition is already common for utilities in densely populated areas of larger cities. In suburban areas, the problem is not so acute, but, with increased emphasis on underground utilities, improved installation practices obviously would be highly desirable for both aesthetic and economic reasons. Common trenching, or the installation of multiple utilities in the same trench, could lower costs and reduce the number of trenches required. Although the common trench could be located beneath the roadway, it also could be located outside the roadway. If utilities must be located within the roadway, common trenching would reduce the number of times the pavement would be cut during installation.

In many cases, existing utility facilities are located in the path of proposed highway construction projects. As a result, relocation, replacement, or adjustment must be performed. Thus coordination and scheduling of utility installation are required between the highway contractor and the utility-construction crews. If this coordination is overlooked, project delays that can increase cost to both highway contractor and utilities may result. Use of common trenching can reduce required installation time, amount of space required for utility installation, number of trenches needed, and, if the utilities are located within the roadway, width of pavement that would be subjected to cuts for maintaining the utilities. For highways, minimizing the area of pavement over the utilities could reduce interference to traffic during repairs and the need for repaving the roadway.

Common trenching raises a number of potential problems. Perhaps the major

problem is in coordination and scheduling of installation between the developer and the involved utility companies, although compatibility between utilities and allocation of cost quite often are cited as problems. The purpose of this paper is to summarize current practices and point out advantages or disadvantages to the implementation of common trenching. Greater details on the use of common trenching and the institutional and technical problems involved in this method of utility installation can be obtained from another report (1).

As population increases, demands placed on utility-distribution systems also increase. In addition, population migration from center city areas to suburbs produces a need for wider utility distribution. Current trends indicate that utility companies that have located most of their distribution systems overhead will increase the fraction of distribution systems that are located underground.

Data on which to project future utility needs are sketchy; in the case of certain utilities (such as water and sewers), determining merely the total number of miles (kilometers) of pipes in existing systems is impossible because no central organization appears to keep track of such records.

In an earlier phase of this study for the U.S. Department of Housing and Urban Development (HUD), an attempt was made to estimate growth of various utility systems by using statistical data from utility company annual reports and other sources (2). The results of this study are given in the following tabulation and indicate that large yearly growth rates can be anticipated (1 mile = 1.6 km):

| System | Estimated Annual Growth (miles) |
|---|---|
| Water | 10,000 to 15,000 |
| Sanitary sewers | 10,000 to 25,000 |
| Natural gas | 20,000 |
| Electric power, underground installation only | 6,700 |
| Telephone, underground installation only | 50,000 to 60,000 |
| Community antenna television, underground installation only | 5,000 to 6,000 |

Estimated annual growth for electric power and telephone is in cable miles (kilometers).

## CURRENT PRACTICES

A review of the literature on common trenching in the United States indicates that little documentation exists on the application of this method of installation. However, a survey of 33 utility companies made as a part of the 1969 Institute of Electrical and Electronics Engineers Conference on Underground Distribution found that all but 3 of the companies responding used some form of common trench with telephone companies or other utilities (3). Six of the companies reported 100 percent common trenching with telephone. A third of the companies indicated 80 percent common trenching with telephone. Eight of the companies said that they had performed common trenching with gas utilities, and 1 company reported a recent common installation with a water utility. Unfortunately, detailed data on these installations can be obtained only from the utility companies involved. A few contacts have been made with utility companies, but determining the amount of common trenching that has been installed or is anticipated to be installed in future installations has not been possible.

A number of factors appear to have encouraged the use of common trenching. First, public pressures regarding aesthetics and the environment have led to increased pres-

sure on utilities that use wires to locate their lines underground. Underground distribution is more expensive than overhead distribution, and any installation system such as common trenching that might reduce this cost difference is of interest to all parties concerned. Second, development of new power cables, such as the concentric neutral cable, has increased the safety aspects of common trenching by reducing the possibility of shock if the cable is accidentally severed. Finally, changes made in the National Electrical Safety Code to allow random separation (no fixed spacing required between power and telephone cables below certain voltages) has allowed narrower trenches to be used (4). Furthermore, current highway safety efforts under the federal-aid highway program include the advancement of projects for removing or relocating aboveground obstructions, such as trees, sign supports, lighting poles, and utility poles, that might pose a hazard to motorists because of their proximity to the highway. In some cases, this has resulted in an increased need for locating utility facilities underground.

As a separate part of our studies, we have examined the legal aspects of the underground installation of utilities (5). We found that there appears to be no legal deterrent to common trenching. In fact, some state utility regulatory agencies appear to favor common trenching in their rules and regulations on installing underground utilities in new subdivisions by stating that, whenever possible, electric and telephone cables and gas lines should be installed in the same trench (6).

The first reported instance of the use of common trenching was in 1960 by the Commonwealth Edison Company and Illinois Bell Telephone (7). In the initial trials, a trench 6 in. (150 mm) wide by 36 in. (900 mm) deep was used with the power cable located at the bottom of the trench, and the telephone cable was placed 12 in. (300 mm) above the power cable. Initial trials indicated that (excluding the cost of the service connection) savings of 12 to 15 percent were achieved. Currently, Commonwealth Edison Company and Illinois Bell Telephone are using random separation in their installations. A unique feature of their operation is that 1 crew installs both the power and communication cables (8). New work is split up so that each company does 50 percent of the excavation and installation. As a result, each company performs half of the work, and the cost is shared equally.

Detroit Edison and Michigan Bell use much the same approach as that used in Illinois (9). In 1969, in one new subdivision, the entire job of excavation, installation, and backfilling was reported to have been contracted to an outside firm. Although use of this method has been limited, the trial installations were very successful.

An interesting common trench was designed for an urban renewal project in Pittsfield, Massachusetts (10, 11). Four utilities—gas, power, telephone, and community antenna television—were included in the trench. Because of the large number of power and telephone cables, ducts were located in the bottom of the trench. The resulting trench (Figure 1) was 5 ft (1.5 m) wide and 6 ft (1.8 m) deep. A formula for cost allocation was developed based on the total area of excavation required for each utility to be installed in a separate trench subtracted from the total area of the common trench. Any excess area in the common trench then was split equally among the 4 utilities. Costs then were calculated on the basis of a percentage of trench area.

In 1968, in England, the Ministry of Public Building and Works organized a committee for coordinating underground services on building sites to look at the potential use of common trenching in public and private housing developments (12, 13). An analysis has been made of the proposed English system to study its applicability to the United States and determine areas where the system would have to be modified to be used in this country (14). The committee found that technology did not appear to be the main problem with the possible exception of service connections, which they proposed to install at the same time that the common trenching of the distribution was performed. To be successful, this required that the location of the housing units be fixed early and not be changed. A typical cross section of their proposed trench is shown in Figure 2 (12).

It appeared to the committee that coordination was the main area in which changes would be required for successful application of common trenching (13). They recommended that greater participation take place among all parties involved, that coordination be initiated in the earliest planning stages, that consideration be given to installation by

**Figure 1. Typical cross sections of common trenches.**

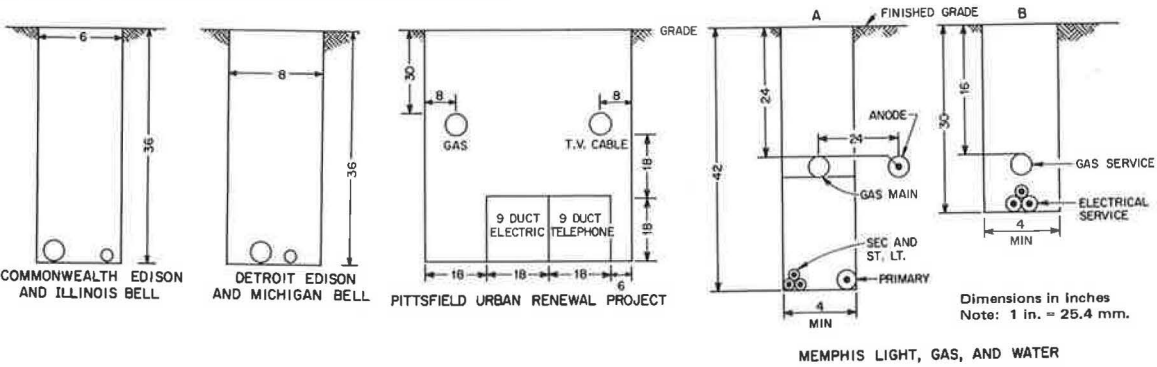
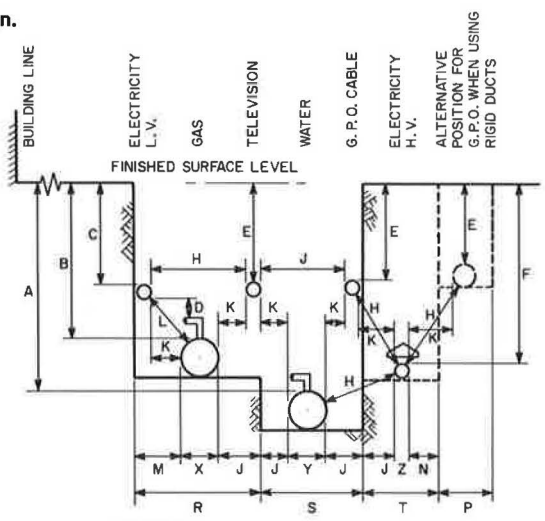



**Figure 2. Proposed English trench design.**




| LETTER | DIMENSION BRITISH (ft) | (in.) | METRIC (mm) | REMARKS |
|---|---|---|---|---|
| A | 3 | 0 min | 900 min | |
| B | 2 | 0 min | 600 min | |
| C | 1 | 6 | 450 | |
| D | | 6 min | 150 min | WITHOUT ADDITIONAL INSULATION |
| E | 1 | 2 min | 350 min | |
| F | 2 | 6 | 750 | |
| H | 1 | 0 min | 300 min | DISTANCE OF H.V. CABLE FROM G.P.O. |
| J | | 6 min | 150 min | REFERS TO MULTICORE CABLE ONLY. |
| K | | 4 min | 100 min | G.P.O. REQUIRE CLEARANCE OF 1ft 6in. (450 mm). |
| L | | 8 min | 200 min | FROM SINGLE CORE H.V. CABLE. |
| M | | 9 min | 250 min | WHEN L.V. INCLUDED, OTHERWISE 6 in. min (150 mm) |
| N | | 5 min | 150 min | |
| P | | 9 min | 250 min | |
| X | VARIABLE | | VARIABLE | GAS PIPE OUTSIDE DIAMETER |
| Y | VARIABLE | | VARIABLE | WATER PIPE OUTSIDE DIAMETER |
| Z | VARIABLE | | VARIABLE | H.V. CABLE OUTSIDE DIAMETER |

R = M + X + J
S = 2J + Y
T = J + N + Z

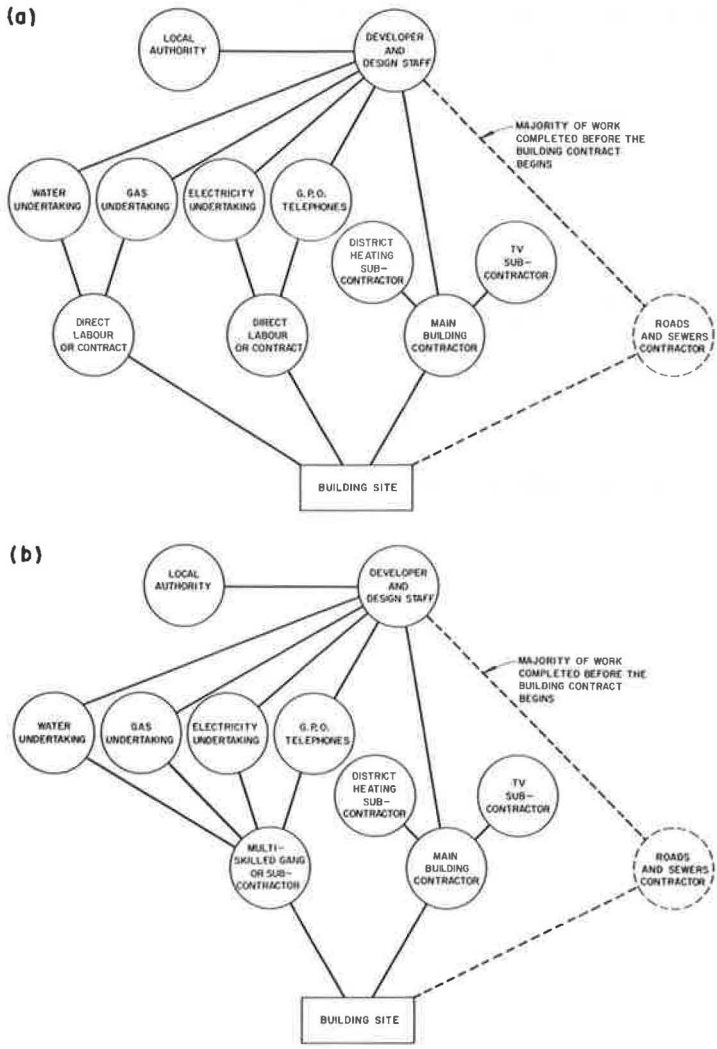



**Figure 3. Organizational arrangements for (a) use of pairing and (b) use of multiskilled crew or contractor.**

a multidisciplinary crew, and that either the developer or the utilities be encouraged to assume financial obligation for the project and be repaid later. Some of their proposed organizational systems are shown in Figure 3.

Many of the cited utility problems also occur in the United States. The major problem appears to be that the developer does not notify the utilities early enough to allow the necessary coordination. Furthermore, the exact location and plan of the housing are subject to greater fluctuation than that envisioned in the English system. Instances have been reported where utilities have joined together on their own initiative to use a common trench. Pressure from developers, building contractors, or highway organizations does not appear to be a factor in their decision. Rather, they appear to have approached the concept on the basis of reduced excavation, and, it is hoped, cost.

## COMPATIBILITY

One of the frequently cited concerns in common trenching is compatibility among the various utilities in the trench. There are concerns over interference between electric cables and communication and signal circuits, corrosion of pipe utilities from stray

electrical currents, and possible contamination of water supplies if sewers are in the common trench.

In 1968, the Edison Electric Institute and the Bell Telephone System completed a study evaluating random separation of power and telephone cables (15). This study utlimately led to a revision of the National Electrical Safety Code to permit random separation. Woodland (16) recommended that random separation with telephone not be used when "feeder" cables are involved and that it should be used only on the subscriber end. Also, on runs longer than 0.5 mile (0.8 km), an analysis should be made to determine whether interference will occur.

Pipe may be subject to corrosion in certain soil conditions, and the presence of stray electrical currents from adjoining power cables might increase the rate of corrosion (17, 18). This could be alleviated by using cathodic protection or plastic gas and water pipes.

Sewers do not appear to be compatible with common trenching because of excess depth of burial and the need to be installed to grade. Also, many state health departments insist on spacing from 6 to 10 ft (1.8 to 3 m) between water lines and sewer lines (19). If a gas leak were to occur, gas possibly might leak into the sewer system.

## COORDINATION

Coordination can be achieved in a number of ways from informal group meetings between the developer and the utilities to formalized procedures and committees. The developers of Foster City, California, attempted to install a coordinated utility system (20). To do this, they hired an electrical engineering design firm as the coordinating agency. Detailed drawings were prepared that showed the exact location of each service for each residential lot. Unfortunately, use of common trenching was not specified and, as a result, was not used extensively.

In 1965, a firm named Coordinated Utilities, Inc., was formed in Berkeley, California, to market a patented system of utility installation that used a special design of common trench (21). It was first used in Walnut Creek, California. U.S. Patent Number 3,263,577 was issued to cover the concept, which included common trenches containing certain utilities under the sidewalk on each side of the roadway. The major feature of the design was the use of a smaller common trench perpendicular to the roadway at each lot line so that utilities from each side trench passed back and forth across the street only once for each 4 lots served. Unfortunately, the owner of the firm died and the company went out of business.

Another example of design and construction of multiple utilities by a single coordinator existed in New York City where a new police headquarters building was being constructed (22). Under a single contract, an engineering firm was employed to determine locations of existing utilities, determine placement of new utilities, schedule work, prepare plans and specifications, and oversee the installation. The utilities agreed to deposit sufficient funds to cover their share of the work. Each deposit was later adjusted on the basis of bid prices and the actual cost of the work.

In California, the Inter-Utility Underground Committee has been formed and is in the process of preparing a written manual of procedures for joint construction (23). This manual will contain forms that will be used to notify the utilities of intent to construct joint facilities, formulas for allocating trench costs for residential and commercial areas, and procedural agreements in effect among various utilities in the state. In addition, in the San Francisco area, Pacific Gas and Electric and the Pacific Telephone Company have developed details for handling common trenching for gas, electric, and telephone lines. These procedures outline planning steps, billing procedures, and cost allocation.

The American Public Works Association in conjunction with the U.S. Department of Transportation has been conducting a research project on the location of utilities in relation to highways. One result of this research has been the organization of a nationwide committee to implement the organization of utility-coordinating committees. Their research findings and recommendations for future actions are covered in a recent report (24).

One of the major concerns of utility companies is excavations, or dig ins, caused by the installation or maintenance of other utilities. Location of all utilities in a common trench possibly could reduce the frequency of dig ins because contractors would know that other utilities exist in the area and therefore would be more careful during excavation. Studies also have shown that dig ins happen less frequently to deeply buried facilities; the use of a common trench can provide this advantage to utilities that normally make shallower installations (25).

## ECONOMICS

Economies in the construction of utility-distribution systems that use common trenching result from: (a) savings in the amout of excavating, backfilling, or repaving; (b) more efficient use of labor through use of a single-crew concept; and (c) improved rate of return on invested capital from a shortened construction schedule.

Although general agreement on the validity of potential cost savings was expressed by the organizations engaged in common trenching, quantifying these factors generally has been difficult because of mixed feelings about the extra planning and coordination required to implement a successful common trenching program. This is in part because any project must be installed one way or another, and few projects are exactly alike. Therefore, comparison of alternatives necessarily requires estimates for alternatives not actually performed. Furthermore, our contacts with utility companies indicate that they are unable to supply information that they feel would be meaningful on the cost of planning, coordination, supervision, and inspection. If common trenching reduces the traffic interference associated with utility installation maintenance and the need for repaving, then reduced costs to highway departments should accrue.

The economics of common trenching are not well documented. Most references merely indicate that money is saved by reduced excavation, but they make no mention of possible increases in installation costs or costs from coordination. In a case study in England to evaluate the recommendations of the Committee for the Coordination of Underground Services on Building Sites, utilities occupying the deepest portion of the trench reported savings of about 5 to 10 percent (26). Utilities occupying the shallow portion of the trench experienced no savings; however, it was felt that in future installations larger savings would occur. In the United States, cost savings have been estimated to be 5 to 10 percent in early trials with an upper limit of about 20 percent after operations have been standardized. These are savings to the utilities only, and do not represent the overall savings that also will accrue to the builder, developer, or highway contractor because of faster installation of utilities and less construction interference caused by trenching. Until more documentation is available, these potential savings cannot be estimated. A detailed case study from planning to final construction will be required to quantify adequately the economics of common trenching.

## CONCLUSIONS

Common trenching has been practiced in the United States to a limited extent since 1960, and a survey of recent literature indicates that increased use of this method of installation is occurring. Various trench designs, methods of installation, and cost allocation procedures have been reported; however, no standardized procedures are commonly used in most of the reported installations. In England, a study was made of common trenching that is probably the most comprehensive evaluation of common trenching problems and procedures in existence. This study pointed out that advantages will occur through greater cooperation between building developers and utility companies if common trenching is used. However, some of the procedures suggested might not be possible in the United States at this time. One of the most obvious of these would be the use of a common crew to install all of the utilities in the trench. This might require changes in union regulations concerning jurisdiction over the installation of various utility lines and the increased training of installation crews.

Benefits accrue to utilities, developers, and highway departments from use of common trenching (reduced excavation costs, faster installation, reduced right-of-way requirements, and possible reduction in dig ins) because all utilities would know the location of the others in the common trench and pavement cuts would be restricted to only a portion of the pavement during maintenance. Whether these factors could reduce the frequency of repaving is not known. There is a need for a detailed, documented case study of common trenching to determine whether the use of common trenching provides the benefit suggested in the literature and to develop standard procedures applicable in the United States.

## ACKNOWLEDGMENT

Research performed at the Oak Ridge National Laboratory was supported by the U.S. Department of Housing and Urban Development and the U.S. Atomic Energy Commission under an interagency agreement and under contract with Union Carbide Corporation.

## REFERENCES

1. W. J. Boegly, Jr., W. L. Griffith, A. L. Compere, W. H. Brown, and J. H. Lord. Technical and Institutional Aspect of Common Trenching. Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-HUD-28, Aug. 1974.
2. W. J. Boegly, Jr., and W. L. Griffith. The Feasibility of Retrieving Utility System Capital and Maintenance Costs From Annual Reports. Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-HUD-16, Sept. 1970.
3. J. L. Mulloy. URD Utility Reports—Coordination. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR (Sup.), Dec. 1969, pp. 72-75.
4. Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines. In National Electrical Safety Code, National Bureau of Standards, U.S. Department of Commerce, Supplement 2 to NBS Handbook 81, March 1968.
5. W. H. Brown. Legal Aspects of Underground Utilities. Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-HUD-27, April 1973.
6. Rules for Residential Electric Underground Extensions. Florida Public Service Commission, Order 5077, Docket 69246-PU, May 22, 1971.
7. J. C. Smith and L. A. Kemnitz. Power and Telephone in Common Trench Cut Underground Cost. Electrical World, Vol. 157, Jan. 15, 1962, pp. 48-51.
8. M. F. Tuntland. Single Crew Installation of Joint URB Cuts Costs. Transmission and Distribution, Vol. 19, No. 6, June 1967, pp. 32-35.
9. R. R. Lieberman. URD Trenching Installations. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR (Sup.), Dec. 1969, pp. 241-246.
10. E. S. Gardner, Jr. Pittsfield Urban Renewal Project. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR, April 1969, pp. 44-50.
11. E. S. Gardner, Jr. Joint Utility Planning and Use of a Common Trench Can Work. Transmission and Distribution, Vol. 22, No. 12, Dec. 1970, pp. 60-62.
12. Coordination of Underground Services on Building Sites: 1. The Common Trench. Ministry of Public Building and Works, Her Majesty's Stationery Office, London, research and development bulletin, 1968.
13. Coordination of Underground Services on Building Sites: 2. Coordination Management. Ministry of Public Building and Works, Her Majesty's Stationery Office, London, research and development bulletin, 1968.
14. W. J. Boegly, Jr., and W. L. Griffith. Urban Utility Technology. In Civil Defense Research Project Annual Progress Report, March 1971-March 1972, Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-4784, 1972, pp. 1-9.

15. Buried Power and Telephone Distribution Systems—Analysis of Primary Fault Tests and Evaluation of Experience With Random Separation. Edison Electric Institute and Bell Telephone System, 1969.
16. F. Woodland, Jr. Electrical Interference Aspects of Buried Electric Power and Telephone Lines. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR, April 1969, pp. 245-251.
17. P. J. Kassak. Joint Trenching—Good or Bad? American Gas Journal, July 1968, pp. 33-36.
18. P. J. Kassak. Design Considerations in Joint Trenching. Proc., 1968 Distribution Conference, Operating Section, American Gas Association, 1968, pp. 193-198.
19. Recommended Standards for Water Works. Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, 1968.
20. K. S. Oliphant. Coordination Cut Costs of Undergrounding. Electrical Construction and Maintenance, Vol. 65, No. 3, March 1966, pp. 116-120.
21. A Look at Leisure Living: Above Ground and Below. Electrical West, Vol. 132, No. 1, Jan. 1965, pp. 34-35.
22. J. J. Kassner. Relocating Substreet Utility Lines. Civil Engineering, Vol. 38, No. 4, April 1968, pp. 86-88.
23. Procedure Manual. Inter-Utility Underground Committee of Southern California, 1970.
24. Accommodating Utility Plant Within the Rights of Way of Urban Streets and Highways. American Public Works Association, Research Project 71-1, 1974.
25. M. R. Plummer. A Characterization of Bell System Problems With Buried Cable Dig-Ups. 1971 Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 71C42-PWR, 1971, pp. 210-212.
26. The Coordination of Underground Services: A Case Study. National Building Agency, London, Rept. SBN 901502 170, July 1970.

# NEED FOR AND APPLICATION OF UTILITY-TRANSPORTATION COORDINATION

C. Richard Kuykendall, American Public Works Association, Chicago

This paper examines the increasing complexities involved in providing essential utility and transportation services. It concludes that a well-organized, representative coordination group is the best mechanism for improving interrelated utility-transportation activities. It identifies and describes key elements that should be considered during the process of forming local utility-transportation coordination groups. It describes how the Utility Location and Coordination Council of the American Public Works Association was organized and is preparing to help local groups improve their practices through a comprehensive national program, a program that is supported by a large number and variety of leading professional, trade, and labor organizations.

•THE CONCEPT of utility-transportation coordination, formal or informal, is not new. It has been around for half a century, as evidenced by formation of the Los Angeles Substructure Damage Control Committee in 1926. Recently, however, more and more agencies, utilities, and contractors are beginning to recognize the need for similar coordinating groups as an essential aspect of conducting business. Also existing committees are changing. A broader scope of activity and greater degree of organization and involvement by a wider variety of groups are emerging. This new look results from the increasing complexities involved in providing essential services and from the ramifications of poor practices in the past. The problem must be identified and recognized by all parties involved before a workable mechanism can be developed and implemented for dealing with the problem more effectively. The problem is multifaceted but can best be described from operational and planning perspectives.

Most of the investment in underground utility line length is in public rights-of-way. Electric, telephone, and telegraph lines, once considered exclusively aerial plants, are now commonly placed underground as a result of changing social values and improved materials. A relative newcomer to the scene is cable television. It, too, is often placed underground. These and other newcomers must share limited space with those utilities already in the underground utility field; these include water mains, sanitary sewers, and storm drains.

Difficulties in placing utility lines underground and locating them for repair and replacement too often result in damages during excavation. Current excavation, or dig-in, problems are creating great economic and social waste. The National Transportation Safety Board (NTSB) of the U.S. Department of Transportation reports that more than 40 percent of all gas pipeline and 20 percent of liquid pipeline accidents are directly related to excavation damage. The Bell System, according to NTSB, reports that its cables were damaged by external contact 87,000 times in 1 year. Eighty-six percent of the damage to underground electrical facilities stems from dig-in activities. Dig ins account for the bulk of damage to large water mains. Other utilities in the public rights-of-way are similarly affected by excavation activities.

Most excavation is accomplished with equipment operated by people considered to be expert at their trades. If these equipment operators are experts, what causes them to make such errors? After damaging an underground facility, many equipment operators report that they were unaware of its existence. One solution to the damage problem is being able to pinpoint the locations of underground utilities. This can be solved in large part (but not completely) by improved locating equipment and procedures. The

importance of improved methods of detecting and mapping underground utility plants and obstacles was addressed in a Stanford Research Institute report (1). This report noted that "up to 10 percent of project dollars is spent on mapping routes and about 80 percent of mapping dollars is spent at street intersections." This research studied 5 advanced detection technologies: acoustic, electromagnetic and radar, infrared, magnetic, and nuclear technologies. The results of this study led to the recommendation for the construction of a prototype multisensing, advanced obstacle-detection system consisting of a pulsed ultrahigh frequency radar complemented by magnetometric and inductive magnetic detection techniques. Although such an advanced detection system that will considerably enhance present capabilities apparently can be developed, it will be some time before such a device is available on the market, let alone commonly used. Therefore, the methods that currently hold the most promise are improved record-keeping procedures complemented by an agressively promoted system for constructors to notify utilities and regulatory agencies of pending excavation work.

With the advent of advanced computer technology, increasing numbers of complexities involved in placing utilities underground, escalating costs of highly skilled technical labor, and need for near real-time retrieval of information, even smaller urban areas may find that a cooperative multiagency computer graphics system has merit over conventional record-keeping map-producing methods. Computer graphics systems typically consist of automatic plotters, digitizers (sensors), a means of display, and related computer units.

The city of Phoenix, Arizona, Public Power Company, Mountain Bell, and Salt River Project joined in conducting a feasibility study of a combined program to produce a single series of maps to be used by all participants. This study concluded that the concepts of cooperative mapping and facility location are feasible and should be pursued further. These conclusions are further substantiated in a recent American Public Works Association (APWA) Research Foundation report (2). The APWA study found that, although many urban areas of the United States could benefit from the use of computerized recording systems with automated graphics techniques, they have lagged behind other Western countries. There are well-established systems in Copenhagen, Paris, and Ottawa. However, interest in computer graphics systems is on the increase. APWA reports that several large urban-area government agencies and public utilities have indicated an interest in exploring the feasibility of transferring technologies from successfully operating systems such as the one developed by the National Capital Commission in Ottawa. The newly established Utility Location and Coordination Council of APWA currently is reviewing this concept.

Another important element of a total coordination program includes an effective system for notifying utilities and regulatory agencies of pending excavation work. One of the more popular call-before-you-dig techniques is the single-telephone-number concept. By dialing a single telephone number, an excavator can contact all participating utilities and government agencies. Unresponsive to pleas by utilities to make several individual calls before digging, excavators have been much more responsive to calling a single number for all underground information. One-call-notification supporters throughout the nation boast of their successes in reducing damages. They report that reducing the dig-in damage rate by 30 to 50 percent is not uncommon. Although there are a variety of notification systems, all report notable successes. A common element in all types of notification programs is a high level of cooperation among participating organizations.

The problem is not limited to the underground or even to utility plants. Every time a street is opened for work on utilities, motorists, pedestrians, and workers are confronted with safety hazards and inconveniences. Reducing the frequency and number of street openings by individual organizations contributes greatly to reducing economic and social impacts of all types. The most obvious way to reduce potential damages and other negative impacts is by coordinated planning of field work. It is the least costly method available and can be implemented in short order. Few actions by both government agencies and utilities attract as much criticism as excavations in a newly resurfaced street or highway do. Better coordinated planning would allow the underground work to be completed before resurfacing. Coordinated planning among government

agencies and utilities, however, must not be limited to projects scheduled only 1 or 2 years in advance of construction. Long-range plans must be shared among all affected parties to provide the lead time needed to make adjustments in capital programs and schedules of each organization.

Great strides have been made in recent times in coordinating transportation and land use planning efforts. In too many cases, however, these planning functions are carried on with little coordination with utility-planning activities. Little regard is given to the problems involved in providing utility services to meet the needs created by changes in land use and transportation patterns. Rezonings for high-density developments have major impacts on utilities; they require lines to be resized before originally anticipated retirement and replacement times. Resulting economic wastes might have been avoided if planners had given proper consideration to needs of utilities before permitting the haphazard changes in zoning requested by land developers. This is not to imply that zone changes should be made only on the ability of utilities to provide needed services, but utility impacts must be a consideration during such processes if economic waste is to be minimized.

Some land developers and planners are actively promoting reduced right-of-way widths in residential subdivisions as a method of lowering development costs. This is an area where little consideration is given by these promoters to the needs of utilities. Utility operating and maintenance needs are of little concern to developers, whose primary interest is reducing the initial costs of the development. Far too often, utility needs are subordinated to other interests, including surface transportation.

These complex problems can be resolved only through the improved coordination of all parties involved in the planning, regulation, and operation of the many uses of the public rights-of-way. The best mechanism for coordinating these activities is a well-structured and recognized representative organization, for 2 reasons. First, the increasing complexity of providing and regulating essential utility services in harmony with other activities that take place in the rights-of-way requires more information, expertise, and authority than can be obtained on an individual basis. In more and more cases, individual actions are becoming increasingly interdependent on others if such actions are to be taken in an economic and socially accepted manner. Second, interaction of utilities and regulating agencies working collectively through an organized mechanism produces superior results to those achieved by an individual organization. The functions of a well-organized and workable coordinating group show that, contrary to basic mathematics, the whole is greater than the sum of the parts. Most managers recognize the need for improved coordination but simply lack the information needed to establish a coordinating group.

Variations in institutional, geographical, and political conditions and types of services provided from community to community make it infeasible to develop a model coordinating group that could be universally adopted. However, a number of factors common to all communities must be taken into consideration in forming a coordinating group and making it an ongoing workable organization. The following suggestions are presented to provide guidance to those interested in forming coordinating groups. Existing organizations may find the suggestions helpful in expanding their current scope of activity. These suggestions are based on observations of successfully operating coordinating groups, interviews with leading national figures in this field, experiences gained in forming and administering nationally recognized voluntary organizations such as the Utility Location and Coordination Council of APWA, and research work (2).

Success of any activity involving people is dependent on good leadership. Seek out the best leaders in all potential membership organizations. They may be administrators, specialized engineers, public relations directors, or line supervisors. What title each holds is immaterial. What is important is that they be able to effect changes and have the ability to perceive the total problem. Good leaders are not always those persons who are the most vocal or those holding positions of recognized responsibility. Some individuals only need to be given an opportunity to lead and they do well.

As soon as the leaders are identified, care should be taken in selecting who should be the group contact person. Try to match personalities and job responsibilities. It is preferable that the group contact person hold an equal or better position than the

person to be contacted. This is especially true in large communities where little if any personal contact is made on a regular basis by these individuals. Be cautious of working titles. Most chief engineers spend more time administering than engineering these days. If your first choice is unable to participate, then ask that someone else from the organization be appointed to represent the organization in the coordinating group. Express the importance of having all affected organizations involved in the group's activities. Be prepared with statistics gathered by similar groups that will help support your position. Some of the representatives of organizations contacted may show little or no interest in supporting the group during the initial stages. When the group has produced positive results, these nonjoiners will have second thoughts. Keep slots open for them and continue to let them know that spaces have been reserved for them. If they were important enough to contact in the first place, they will be needed later. Keep everyone advised of your activities. Send news releases to the press. Give talks to civic clubs. Discuss the subject at staff meetings and send copies of minutes to selected power groups such as city councils, state highway departments, boards of directors, and labor union officials.

When a leadership core is committed to supporting formation of the group, the task of developing a framework for the coordinating group can begin. This framework should consist of a set of bylaws (describing group purpose, membership requirements, election procedures, and related governing requirements), name of the group, documented goals and objectives, a priority arrangement of projects and programs keyed to established objectives, and a statement of subcommittee responsibilities and constraints. The leadership core should include at least 2 major utility companies and the primary regulatory agency from the major geographical area of proposed operation. Generally, the more organizations there are involved in this initial stage, the better the framework developed by the group will be. However, getting a draft formulated quickly is more important than waiting for every organization to join. What is important at this point is that all potential participants understand that they will have an opportunity to comment on the draft and that it will be subject to considerable revision.

Do not be concerned with a need to obtain legal authority to enact certain provisions perceived as being needed, such as authority to regulate utility locations and issue permits. Such authority may not be needed or even desirable. If it is determined to be necessary, then it will be much easier to acquire when the group has achieved credibility in the eyes of those who must yield or grant such authority.

The most important aspect of formulating the coordinating group is to ensure that the framework provides for expansion of group activities. The coordinating group will not be able to accomplish all it desires in a short time. Priorities will need to be developed. One of the top priorities identified may be to develop an improved excavation notification system. Group scope should not be restricted from being involved in other needed activities such as coordinated capital planning. Avoid pitfalls that tend to limit scope. Be careful not to imply to outsiders that their interests are not being considered. Take steps to avoid having labels pinned on the group (such as utility types, highway types, public works types, operating types).

After the general scope of group activities has been formulated, a name that expresses the scope should be selected. Determine your audience. Do you want to reach only persons with a direct interest in the activities of the group (for example, employees and excavation contractors)? What about transportation engineers and administrators, architects, housing contractors and developers, land use planners, and legislators? Selecting a name that everyone will identify with will be difficult, but be careful not to exclude key groups. Some coordinating groups are called utility coordinating committees. This type of name may imply to some people that the group's scope of interest is limited to utility companies and agencies. Words such as utility-transportation location and coordination are more descriptive of the true function. What do the words panel, committee, commission, and council mean to the people with whom you plan to communicate? Great benefits can be gained by using an acronym that also conveys a desired message and is convenient to use. Some of the best known coordination efforts in this nation use acronyms. The use of clearly understood logos and symbols is another aspect to consider at this time.

When the name has been selected for the coordinating group, the process of defining the group's purpose, goals, and objectives is well on its way; that is, if consideration was given in attempting to find answers to 2 questions.

1. In addition to the organizations represented by the leadership core previously noted, what other organizations should be represented?
2. What degree of representation should these organizations have in the coordinating group?

In answering question 1, one should give consideration to 5 areas.

1. All private companies and public agencies providing electric, gas, telephone, traffic-signal, street-lighting, water, sewer, drainage, steam, cable television, oil pipeline, and similar services should be considered.
2. All regulatory and planning agencies at the local, regional, state or provincial, and federal levels should be considered. At the local level, this normally will involve persons holding positions with working titles such as city engineer, county engineer (in small communities, some may be consultants working on annual retainers), traffic engineer, street-utility coordinator, utility engineer, city-county planner, and building inspector. At the state and federal levels, working titles often reflect specific department activities depending on function. First contact may be with divisional or regional personnel.
3. Agents of public agencies and utilities, including general contractors, building contractors, subcontractors, consulting engineers and architects, labor unions, public relations persons, insurance agents, and others, should be considered.
4. Mass media (newspapers, television, radio) should be considered.
5. Public and special interest groups such as civic clubs and merchant organizations should be considered.

With regard to question 2, organizations that regulate the use of the rights-of-way or have facilities officially located therein should be voting members. This generally includes all utilities and most government agencies. The government agencies legally responsible for regulating right-of-way uses must be given a vote. Normally, this includes all municipalities, most county governments (especially those operating under home-rule charters), and state highway departments. Federal agencies have an indirect interest. Generally, an equal vote for each of these organizations will be adequate, even though some public agencies may be restricted by law from providing direct financial support. Some utility services will not be located throughout the coordinating group's geographical area of concern. Although cable television may be legally prohibited from providing such services in a given municipality, it may service the surrounding unincorporated area. Some subdivisions have been developed without the installation of gas services and often are described by electric utilities as being "all electric." Consideration should be given, then, to generally restricting qualified voting members to voting on only those operational activities that will have a direct effect on their facilities. Alternative techniques for providing equitable voting rights include prorating the number of votes or assigning weighted values to votes based on the benefits gained from the group's activities. Until a history of categorized savings is available, an estimate of anticipated savings could be used as a basis for negotiation. The resolution of equitable participation can become a complex issue and will depend on local conditions. Normally, a few leading utilities are willing to provide a negotiated amount of direct "seed" money to get the program under way, and other organizations will provide their share indirectly through contributing personnel services. It may be helpful to have one member organization provide needed office facilities to serve as the center for initial operation. Because most legal and needed working records are often available for reference in a municipal engineering department, the municipality could consider offering the use of such space as its way of sharing in the costs of operating the coordinating group. When the coordinating group is operational and has developed a history of operating costs and yielded short-term economic gains for the participants,

a base will have been developed for use in determining individual organization cost-sharing schemes. If the group is granted authority to issue permits, revenues from permit fees also could be considered as a source for offsetting operating costs.

After the proposed scope and name of the coordinating group have been determined and the potential member organizations have been identified, a set of goals and objectives should be drafted. Any group that is well organized knows what it wants to achieve and how it wants to go about achieving its mission. This is where management-level personnel must be involved. Few lower echelon personnel have had training and experience in developing goals and objectives. They should be consulted, but the actual process of putting their ideas into words should be done by experienced persons. Goals should describe the desired result. Objectives should indicate how to achieve a particular goal. Well-written objectives must be measurable, realistic, and workable. Goals and objectives will not be helpful in determining where mistakes were made, but they will be useful in assessing the group's progress. When writing objectives, keep in mind available work-force and financial resources. To make the objectives measurable, relate them to a time period such as a year. Relating the objective to some quantity per given time [for example, the number of dig-in accidents to be reduced per mile (kilometer) per year] is better still.

Keep in mind that nonjoiners also will be assessing your progress in achieving the goals and objectives. Therefore, including a few objectives that can be achieved in a short time and have high, visible impact is important. Select 1 or 2 projects that have been successfully developed by similar groups throughout the country (uniform map legends and color codes for field marking) and adapt them to meet your local needs.

Thinking of the objectives as specific tasks that must be fulfilled before you reach the goal is helpful. If one of the goals relates to implementing a statewide 1-call notification system, then relate the objectives to stages involving certain geographical areas at specified intervals until all are included. The importance of putting thoughts in writing cannot be overemphasized. The process in itself eliminates much time wasted discussing concepts and forces decisions to be made.

Look to the established purpose for clues in starting the goal-writing process. For example, a purpose might be to reduce the number and severity of accidents involving utility plant, workers, traffic, and the general public and to effect economies related to these activities through the coordinated effort of the group. How can the components of this purpose be described in a manner that will provide clearly understood criteria for determining the group's effectiveness? Certainly, most people would agree that reducing these accidents in an economical manner would be desirable. But simply reducing accidents in an economical manner would not completely satisfy that portion of the purpose to effect economies related to the activity. The need for proper structural pavement repair, which is not necessarily limited to accidental aspects of work activity, must be a consideration of the group. What about coordinated construction and maintenance scheduling, costs of delay to motorists traveling around work sites, and negative economic impacts on businesses? These are a few of the total system costs that should be taken into consideration when writing meaningful goals and objectives. But, because reducing accidents is placed ahead of effecting economies in the example purpose, a priority is implied. Assuming that this is true for the purposes of this example, then it provides the goal writer with 4 basic categories by which the goal-writing process may be started. For example, a goal related primarily to reducing the number and severity of accidents involving utility plant might be drafted as follows: "Develop a comprehensive program that is designed in a manner that will reduce the historical trend of excavation-related damages to utility plants." Who could disagree with this goal? But does it convey the same meaning to everyone who will be involved in working to achieve the goal? Does the word develop also mean that the program must be implemented or does it simply mean that a report will be prepared? If the author intended that the program be implemented, then the goal should have included it. The point here is that one should avoid abstract words in writing goals. Goals should not describe how they are to be accomplished—that is the job of objectives—but they should convey clear understanding of the direction needed to be taken to achieve the desired end.

After the first goal has been drafted, objectives that need to be satisfied for that goal

to be achieved need to be written. Because some goals may never be fully achieved because they require an ongoing effort, it is best if only 2 or 3 objectives are established for each of the goals in the beginning. Although the problem will be more clearly visible by detailed definition, the pure number of objectives required may be too much for the group to achieve within a reasonable period of time. Thus the point is that the objectives must be achievable. If you identify more objectives than you have resources with which to achieve them in a realistic manner, your program will be suspect by those who would prefer that you spend your time in other ways. It is logical then that only the top-priority objectives be documented in the initial stages. After they have been achieved, others can be established.

Starting the process of drafting objectives for a particular goal by categorizing them according to logical steps also is helpful. For example, even though one of the objectives for the example goal might be to establish a simplified method by which excavators may request information on utility locations, writing the objective in a manner that will provide a means of measuring progress in achieving the objective is best. Because this particular objective may be relatively costly and otherwise difficult to implement in a short time, considering it in 2 parts may be best. Therefore, the following 2 draft objectives might be defined:

1. Establish a 1-call system involving a minimum of 3 major utilities and the primary regulatory agency in the southeast portion of the state by July 31, 1976.
2. Expand the 1-call system established as described in objective 1 into a statewide network by July 31, 1978.

Local conditions will dictate the number of utilities and regulatory agencies to be involved initially as will the decision to identify them by name. If the time frame is realistic, then the objective certainly provides a means by which success can be measured—time. Other criteria might relate to the desired reduction of damages to utility plant. This could be described in terms of rates of accidents. The methods selected will be determined, in part, by the degree of sophistication of historical data. But the method that will allow a price tag to be placed on the value of the 1-call system is desirable. Obviously, if the success of objective 1 is readily apparent as being cost effective, then convincing others statewide that they should become participants in the system will be much easier.

Other objectives that are more easily achievable in terms of cost and time requirements should be drafted. These might relate to standards for uniform color and shape of stakes, color and legends for pavement markings, map legends, and the like. These objectives should be able to be achieved in a relatively short time.

An equally important objective for attaining the goal to reduce accidents to utility plants is establishing an improved system of recording locations of utility facilities and other pertinent aspects of the physical environment. Because of the obvious importance of good records, for both operational and planning needs, this may warrant the status of a goal.

After the leadership core has drafted a framework (potential membership, name, bylaws, goals, and objectives) for the coordinating group, it is time to take the package to potential members and start improving working conditions. A well-developed program that takes into consideration these suggestions will have a good chance of success.

Many organizations interested in improving conditions through coordinating groups stand ready to assist in this cause. A national organization committed to improvement in this area is the APWA Utility Location and Coordination Council. Many leading associations and recognized national organizations are supporting its activities to help local and statewide coordinating groups get organized and to assist existing groups in fulfilling their missions.

An NTSB report (3) stimulated widespread interest in and concern for problems caused by excavation activities. One of its conclusions recognized that cooperation among all involved parties is essential to reduce the number of pipeline accidents. It also indicated that the first step in achieving cooperation is generally the formation of utility coordinating committees at the local level. In fact, the NTSB report recom-

mended that APWA take a leadership role in promoting the establishment of local committees and in developing guidelines and standards. As a result of that NTSB recommendation, APWA called a special meeting of leaders from all segments of the industry to explore the desirability and feasibility of APWA's undertaking such a leadership role. The meeting was held in Denver at the 1973 International Public Works Congress and Equipment Show. It resulted in the participants' unanimous support of such an undertaking by APWA. Immediately after that meeting, the APWA Board of Directors authorized the president to appoint a steering committee consisting of both members and nonmembers and charged it with drafting bylaws for a utility location and coordination council. In April, the APWA Board of Directors unanimously approved the bylaws drafted by the steering committee and authorized the president to appoint members to the council's governing body, the executive committee.

Thus, by April 1974, the Utility Location and Coordination Council had become officially organized. Within a month, members of the executive committee had been appointed and the process of organizing the council into a working unit had begun. The first meeting of the executive committee and the inaugural meeting of the council were held in conjunction with the September 1974 International Public Works Congress and Equipment Show in Toronto.

The basic guidelines for carrying out the activities of the council are defined in its bylaws. The bylaws provide that the purpose of the council shall be to

> promote the establishment of state and local utility location and coordination councils or committees and provide guidance and assistance to such bodies in an effort to improve and foster safe working conditions, reduce the number and severity of accidents, minimize inconvenience to the public, and effect economies related to utility construction and maintenance activities through cooperation among all parties involved in utility activities, including contractors, regulatory and utility officials and the general public.

The scope of the council's activity, according to the bylaws, shall include but not be limited to

> developing guidelines for organizing utility location and coordination councils and committees at the state and local level; development of appropriate programs in collaboration with the APWA Education and Research Foundations to meet the needs of the public agencies and utilities represented in the Council; development and dissemination of information; and conducting other activities to advance the purposes of the Council and enhance the quality of services provided to the membership.

Members of the executive committee, functioning under the leadership of a chairperson and vice chairperson, are elected by members of the council. The exceptions, of course, are those members who were appointed before the council established its membership. The executive committee has responsibility for conducting the council's programs and activities and promoting its purposes. It has authority to establish committees necessary to effectively discharge its responsibilities and annually submit reports on its activities to members of the council and to the APWA Board of Directors. The executive committee receives support from regular full-time staff members of APWA.

The 4 types of council membership classifications are regular, associate, affiliate, and cooperative. With the exception of the cooperative member category, all members of the council must be members of APWA because the activities of the council are subsidized solely by APWA. A person applying for membership as a regular member must be designated by a bona fide local coordinating committee as its official representative. A person applying as an associate member must be designated as an official representative by a public agency or public utility member in APWA. Any APWA member may

join as an affiliate member. The cooperative-member classification was established to involve a select number of other leading associations and key organizations in the council. It is restricted to only those organizations that are formally invited by the executive committee. This is the only membership classification that does not require that the organization's representative hold membership in APWA. Collectively, these cooperative members make up the council's advisory panel. Already, 20 have accepted invitations to become cooperative members. This is the council's formal liaison mechanism. It is through the advisory panel that the executive committee receives input from allied organizations and disseminates information related to the council's activities. The leading organizations that have been formally invited to participate on the panel represent the great majority of persons throughout North America who are directly concerned with this subject. They include organizations representing organized labor, professional engineers, contractors, insurance companies, regulatory bodies, government agencies, administrators, utilities, and the like. Collectively, they represent hundreds of thousands of people employed in this industry. And they all have one thing in common—a sincere interest in improving cooperation among allied groups so that they can better serve the interests of their members. That type of enthusiastic support and leadership will serve as a good example for local committees to follow.

The annual meeting of the council is held in conjunction with the APWA International Public Works Congress and Equipment Show. The inaugural meeting of the council that took place in September 1974 in Toronto was the first time that council members had met. The executive committee and the cooperative members advisory panel also met for the first time in Toronto. It was at this point that a consensus was developed on what specific directions should be taken by the council to carry out its mission. Goals and objectives were discussed, and ways of achieving them were reviewed. During this process, it became apparent that priorities would need to be set and committees formed to work on specific projects designed to achieve the council's goals and objectives.

Although a list of well-written goals and objectives had not yet been finished, the council recognized the need to establish special committees. These committees serve as the foundation for implementing council goals. Therefore, 5 special committees were formed for education and training, intergovernmental relations, program, public information, and research.

Before projects were assigned, committees were provided with information needed to carry out their mission. This involved writing objectives describing actions to be taken by each committee in a way that would provide a means for measuring progress in achieving their assignments. It also included documentation of established policies and other characteristics for committee operations. On November 18, 1974, a memorandum was sent to all committee chairpersons describing the work for the 5 committees and 2 task forces as follows:

1. Education and Training Committee
   a. Review workshop outlines and offer suggested timely topics and speakers in vicinity of workshop locations semiannually.
   b. Develop a priority array of needed programs categorized by formal and in-house on-the-job techniques by February 15, 1975.
   c. Prepare concise written proposals for 3 top-priority programs similar to the proposal submitted by the Los Angeles Substructure Damage Control Committee on a work-site-protection training film by June 15, 1975. Proposals should identify possible funding sources to develop and implement recommended programs.
2. Intergovernmental Relations Committee
   a. Collect state (provincial) and federal legislation for dissemination to interested persons on request.
   b. Prepare report of findings for presentation to executive committee at its midwinter meeting and for use in workshops by January 13, 1975.
   c. Prepare, on a regular basis, drafts of short articles on legislation for inclusion in the council's quarterly newsletter.
3. Program Committee
   a. Prepare a list of speakers and topics for the council's portion of the technical sessions held at

the annual International Public Works Congress and Equipment Shows by December 15 of the preceding year.
   b. Develop a similar list of topics for use by APWA chapters by June 15, 1975.
   c. Consider the feasibility of developing a speakers bureau, including publishing a list of volunteer speakers' names and résumés categorized by geographic and subject areas, and present report at the executive committee meeting in September 1975.
4. Public Information Committee
   a. Collect information on public information and relations programs, including samples of techniques and items used in promotional efforts (films, calendars, photographs of billboards, pens, and pamphlets). This information should not be limited to 1-call systems.
   b. Prepare a 20-min 35-mm slide presentation with script coded to slides. Although the data-collection task is an ongoing effort, the slide presentation should be available for presentation to the executive committee at its January 13, 1975, meeting and for use in the January and May 1975 workshop series.
   c. Consider the feasibility of developing and publishing a directory of excavation notification telephone numbers used throughout the continent and submit written report by June 15, 1975.
5. Research Committee
   a. Identify areas of needed applied research, assign priorities, and develop drafts of proposals based on format used by the APWA Research Foundation. Present work plan to executive committee on January 13, 1975.
   b. Identify current programs desirable for technology transfer (for example, the computer graphics technique for recording and locating utility plants of the National Capital Commission in Ottawa).
   c. Review information, such as drafts of reports and proposed questionnaires, submitted to the committee by the APWA Research Foundation.
   d. Serve on technical advisory committees of projects sponsored by the APWA Research Foundation when requested.
6. Goals and Objectives Task Force
   a. Develop a list of 2 or 3 top-priority goals, each with its own list of objectives in a manner similar to the procedure described in Management by Objectives (4).
   b. Include current council programs in the lists of goals and objectives. Submit report to executive committee, January 13, 1975.
7. 1975 Special-Exhibit Task Force
   a. Coordinate and staff a council-sponsored exhibit of local and statewide utility coordination groups depicting their activities (for example, call-before-you-dig and public information programs) at the 1975 International Public Works Congress and Equipment Show in New Orleans, September 20-25, 1975.
   b. Identify similar opportunities for promoting coordination for consideration by the public information committee.

Thus committees have been formed and assigned precise tasks to achieve specific objectives. Developing, achieving, and assessing the council's goals and objectives, however, are recognized by the council as being continuing processes. The executive committee recognizes the need for flexibility to meet changing needs and the constraints of available financial support. But it also realizes the basic need for the council to know what it should be doing and why.

Because APWA has many programs currently under way that can be expanded readily to assist the council in carrying out its mission, the executive committee also identified objectives that would complement such ongoing programs as research and education.

Publishing a newsletter on a quarterly basis is another council objective. Although responsibility for final editing, publishing, and disseminating the newsletter rests with the APWA publications staff, council members are encouraged to submit short articles of interest to the membership. The first issue was to be published in March 1975.

The extent to which the council will fulfill its established objectives and plans for the future depends on the support and cooperation it receives from its members, allied organizations, public agencies and utilities, contractors and others who make up this new, coordinated, industrywide program. Such support takes many forms. It includes attendance at workshops sponsored by the council. It may require public agencies,

companies, and other firms to allow their key employees to spend on-the-job time in support of the council's programs. A sizable amount of the annual service fees paid by public utility members of APWA have been designated for this program. However, additional support from utility companies and contracting and consulting firms and others must be provided if the goals and objectives established by the council are to be achieved in the near future.

APWA formed the Utility Location and Coordination Council to respond to the need for a voluntary coordinated program area. The Utility Location and Coordination Council is now an organized and working force that is receiving enthusiastic support from all sectors. It has a program that, by its very nature, demands support from the entire industry. The Utility Location and Coordination Council serves as a new channel of communication, communication that is essential for improving cooperation and coordination at the community level.

This paper has identified some of the more pressing problems in this field. It promotes the use of a formalized coordinating group as the best means to resolve problems and provide unified plans for developing future programs. It has offered suggestions for consideration in formulating new local coordinating groups and expanding horizons of existing ones. It has described the basic framework of the APWA Utility Location and Coordination Council as an example of how the basic components of organizing a local group have been applied at the national level. But the work of getting a local group organized and operational can be done only at the local level.

## REFERENCES

1. The Use of Advanced Technologies for Locating Underground Obstacles. Stanford Research Institute, June 1974.
2. Accommodation of Utility Plant Within the Rights-of-Way of Urban Streets and Highways. American Public Works Association Research Foundation, SR 44.
3. Prevention of Damage to Pipelines. National Transportation Safety Board, U.S. Department of Transportation, July 7, 1973.
4. Management by Objectives. American Public Works Association Reporter, May 1974.

# WASTEWATER RECYCLING ALONG TRANSPORTATION CORRIDORS

Lloyd A. Dove, Black, Crow and Eidsness, Inc., Engineers, Clearwater, Florida; and E. Grover Rivers, Florida Department of Transportation

This paper discusses the desirability and feasibility of irrigating green spaces within and along transportation corridors with highly treated wastewater. The wastewater recycling technology is based on the 0-discharge, total-recycling wastewater system of the city of Saint Petersburg, Florida, which was recently approved by the U.S. Environmental Protection Agency. This system produces a virus-free wastewater effluent that retains the valuable nutrients essential to plant growth. Properly treated wastewater is proposed to be distributed, where feasible, along and within transportation corridors to preserve water and fertilizer and protect the integrity of the affected green spaces. Streets, highways, and airports are viewed in relation to their use as rights-of-way for the wastewater distributors and as recipients of the treated wastewater. It is demonstrated that policies of the American Association of State Highway and Transportation Officials and federal and state governments have established at least a permissive attitude on this matter. It also is demonstrated that the substitution of treated wastewater for the public water supply in irrigation systems is both desirable and necessary to conserve and preserve the dwindling potable water supply of the United States. Research is recommended on utility-accommodation policies and practices and the feasibility, applications, and limitations of wastewater recycling along and within transportation corridors.

TRANSPORTATION corridors are truly the windows through which we view the nation. Whatever the mode of transportation, some of the most memorable features along the way are the green areas and surface waters within and along these corridors. Massive amounts of water and fertilizer are required to maintain these natural features. As water and fertilizer shortages become more prominent in the United States, we enjoy fewer green areas and permit surface water levels to recede. This paper discusses treated wastewater recycling along transportation corridors. Streets, highways, and airports are viewed in relation to their use as rights-of-way for the treated wastewater distributors as well as recipients of the treated wastewater for certain beneficial uses.

## TREATED-WASTEWATER DISTRIBUTION SYSTEMS

The coordination of transportation and other rural and urban utilities is a prime concern of the Committee on Utilities of the Transportation Research Board. Treated-wastewater distribution systems are of common concern to transportation and other utility officials in the following areas:

1. Conservation of water, energy, and natural resources;
2. Maintenance and beautification of streets, highways, and airports;
3. Accommodation of utilities on street, highway, and airport rights-of-way;
4. Multiple use of street and highway rights-of-way; and
5. Coordinated land use, transportation, and utilities planning.

This paper will take a cursory look at wastewater recycling within and along transportation corridors and will lay the groundwork for the future research needed to integrate and coordinate this new utility.

## NEED FOR WATER CONSERVATION AND RECYCLING

The following is taken from a statement adopted by the Board of Directors of the American Water Works Association on June 18, 1971:

> The Association believes that the full potential of reclaimed water as a resource should be exploited as rapidly as scientific knowledge and technology will allow, to the maximum degree consistent with the overriding imperative of full protection to the health of the public and the assurance of wholesome and potable water supplied for domestic use. Such research and development is considered to be of greater national need than that now being directed to desalinization.

The federal water-pollution-control law provides for 75 percent federal aid to local governments to achieve best practicable waste-treatment technology, which includes treatment and reuse, and land-application techniques.

Technology is now available to treat wastewater to a degree that permits its safe reuse for all but direct introduction into potable water supply systems. Such reuse can conserve much drinking water and massive amounts of energy and other natural resources. Exactly how critical is the need for conserving the domestic water supply? A 1974 report of the Florida Division of State Planning concludes that 90 percent of the water used in the state is derived from the Floridan aquifer, and with a weekly increase of 6,000 new residents, Florida will use up all readily available water by 1985. Severe water quality and quantity problems can be cited in every state. Urban areas are most critical and they must reach out farther each year to satisfy their needs. Treated wastewater can serve as a satisfactory substitute for potable water for many urban uses such as lawn sprinkling, make-up water for low-energy air-conditioning and heating systems, maintaining pond and lake levels, and industrial and power-plant applications.

## WASTEWATER TREATMENT AND REUSE TECHNOLOGY

The reuse of treated wastewater by land application has been practiced in the United States since late in the nineteenth century. The recent concern for 0 discharge of pollutants has created new interest in land applications and greater emphasis on improved technology. A survey in 1964 disclosed 2,192 land-disposal systems in the United States including 1,278 industrial systems and 914 municipal systems. Land-application approaches can be classified as irrigation, overland flow or spray runoff, and infiltration percolation. Primary, secondary, and tertiary-quality municipal effluents have been applied to the land. Most existing systems have not employed acceptable technology, monitoring, and management and have been potentially harmful to people and their environment. Primarily because of pressure and financial support from state and federal regulatory agencies, the most recent wastewater-recycling systems are establishing high standards that will ensure public acceptance of this needed concept. This is essential especially for those urban areas where exposure of the treated wastewater to the public is a prime factor.

The Saint Petersburg, Florida, wastewater-recycling system is an excellent example of modern urban land-application systems. Saint Petersburg is constructing one of the first regional wastewater systems to achieve total recycling and 0 discharge to surface waters. Research started in 1971, and the construction of the first system began in January 1975 and should be completed by 1977. In-plant bacteria and virus inactivation

and controlled natural usage of nutrients are key factors in the design of the system. Flora Mae Wellings of the State Epidemiology Research Center conducted the critical virus studies for the city. She concluded: "One would anticipate a virus free effluent as a finished product if turbidity can be held to 0.5 JTU [Jackson turbidity unit] followed by a breakpoint chlorination of 0.5 ppm for at least 60 minutes."

Rodney Cherry of the U.S. Geological Survey conducted the effluent-irrigation research program. He demonstrated the feasibility of local spray irrigation rates of 2 to 4 in. (5.08 to 10.16 cm)/week with high use of wastewater nutrients by native grasses.

Black, Crow and Eidsness, Inc., designed the wastewater facilities based on findings of the research program. It was demonstrated that a clean wastewater effluent can be produced from a domestic influent treated with a complete mix, activated-sludge secondary-treatment process, followed by chlorination before and after multimedia filtration. Only the valuable nutrients remain. Final quality control is achieved in a retention lake before entry of the treated effluent into a wastewater distribution system. Wastewater production that exceeds demand or does not meet water quality standards is pumped to deep injection wells for storage and possible later reuse; this ensures a fail-safe system from the standpoint of public health. The treated wastewater will be sold to golf courses and other vital green areas along the route of the 14-mile (22.53-km) distribution system. A new section of I-275 is being considered for irrigation. The wastewater also will serve as condensing water for low-energy air-conditioning systems along the route of the distribution pipelines. Digested sludge will be used for a city sod farm and nursery, truck spraying of selected green areas, and in commercial fertilizer. Obviously, each urban environment will be different, and the technology must take this into account. The key consideration is that technology is available and a full-scale demonstration project is being constructed.

## WASTEWATER RECYCLING APPLICATIONS WITHIN AND ALONG TRANSPORTATION CORRIDORS

The urban area holds the greatest potential for wastewater recycling. This is where most wastewater is produced and treated and can be distributed most economically. Agricultural use may be equally valuable in rural areas that are short of water.

The wastewater treatment process can be adapted to meet any indirect recycling application. If the intended end use is to grow grass or other flora, the nutrients should be retained in the treated-wastewater effluent. For maintaining surface water levels in lakes or ponds, the nutrients should be reduced to a point that avoids eutrophication. In various commercial or industrial applications, complete nutrient removal may be required. In some applications, such as power-plant cooling water, demineralization of the treated effluent may be necessary. In all cases, the reduction or inactivation of bacteria and viruses for public health considerations is of paramount importance.

The irrigation and fertilization of green spaces should hold greatest interest for transportation officials. Grass and other plants are functional as well as beautiful in transportation facilities. Healthy plants protect the integrity of the ground surfaces they cover and the structural features they abut. Green spaces are critical to proper drainage, noise control, air quality, and aesthetics.

### Maintenance and Beautification of Transportation Corridors

The most cost effective routing of the treated-wastewater distribution lines is often along existing transportation corridors to major users within the urban area. The placement of these lines within the corridor provides a readily available supply of treated wastewater with nutrients for the maintenance and beautification of grass and plant life. Green spaces along urban transportation corridors are designed to protect the integrity of both the paved and unpaved surfaces. Lack of watering and fertiliza-

tion renders them ineffective for much of the year. Many cities have made showplaces of major thoroughfares through decorative plantings and lush lawns nourished by irrigation systems and fertilizer applications. This practice can be greatly expanded within and along the route of the treated-wastewater distribution lines.

## Maintenance of Surface Water Levels

The state of Ohio has 211 Interstate Highway borrow-pit ponds (exclusive of I-90) that represent 1 percent of the state's standing water. These are located near urban centers. This is typical of the thousands of borrow-pit ponds constructed across the nation as part of the highway improvement programs of the last few decades. These ponds often are neglected and appear as scars on the landscape. These and other surface waters in urban areas can be maintained at attractive levels by using treated wastewater for replenishment.

## Airport Beautification

Major airports require large amounts of water and fertilizer to maintain their green spaces. Treated wastewater can be used as an economical replacement for both. How great is the impact of airports on existing water supplies? Assuming a spray irrigation rate of 2 in. (5.08 cm)/week on 1,000 acres (404.7 $hm^2$) of airport green space, this will require about 8 million gallons water/day (30.28 million $dm^3$/day). This is a major drain on available water, whether it is withdrawn from city water mains or directly from the ground.

## Golf Courses

The nation's population is turning to the sport of golf in unbelievable numbers. For example, the Grand Strand Region surrounding Myrtle Beach, South Carolina, experienced an 800 percent increase in paid rounds of golf from 1962 to 1971. Sixty thousand rounds were recorded in 1962, and the figure increased to 477,000 rounds in 1971. It is estimated that 12 billion gallons (45.42 billion liters) of water and $250,000 worth of fertilizer are required per year to keep the 23 Grand Strand championship golf courses green. Multiply this by the ever-increasing number of golf courses across the nation and the impact is monumental. Most of the nation's golf courses are within easy reach of wastewater-treatment plants by means of distribution lines constructed along transportation corridors.

## Public Parks

The environmental concern of the last decade has resulted in the acquisition of massive land areas for urban and suburban parks. The multiple-use concept for highway improvements also has created numerous park areas along highway corridors. These additions plus the existing parklands constitute a major demand for water and fertilizer. Treated wastewater can efficiently and effectively satisfy this need.

## Agriculture

We stated earlier that urban uses have primary value for treated-wastewater recycling because this is normally where the wastewater is treated and, therefore, distribution costs would be minimized. It should be recognized, however, that worsening agricultural water and fertilizer shortages are making it feasible to transport treated wastewater and its by-product, digested sludge, to the rural areas. The Chicago Metro-

politan Sanitary District uses 8 barges to transport digested sludge to a 7,000-acre (2832.9-$hm^2$) farm in Fulton County, Illinois. In 1971, the city of Phoenix contracted with the Buckeye Water Company to provide treated effluent for irrigation of agricultural land 30 miles (48.27 km) west of the city. Florida's citrus industry imports about 80,000 tons (72 624 Mg) of dried sludge annually, mostly from Chicago and Houston.

### Groundwater Recharge

Los Angeles County, California, is treating about 15 million gallons/day (56.78 million $dm^3$/day) of municipal wastewater and recharging the groundwater for reuse by the city of Whittier Narrows. This concept is being widely explored in many areas of the country. In most cases the aquifers, or groundwater supplies, are separated by several miles (kilometers) from the densely populated urban areas. This constitutes another demand for rights-of-way for treated-wastewater distributors between the metropolitan high-use areas and the recharge areas.

The foregoing discussions describe wastewater recycling needs, technology, and progress. The nation is recognizing the need and benefits of wastewater recycling, and treated-wastewater distribution lines along transportation corridors are now a matter of vital concern to transportation and other utility officials.

## TRANSPORTATION CONSIDERATIONS

The concept of wastewater recycling applies to all types of transportation rights-of-way. Highway rights-of-way are of primary concern, however, because they afford the greatest opportunity for application and have the most compatible routing with the wastewater distribution pipelines.

The need of coordination between highway and transportation officials and other utility officials relative to joint use of rights-of-way is a concern that has not been properly addressed at any level of authority. The necessity for a conservation program for water, a most vital resource, is evident. The recycling of treated wastewater has been given the highest priority by water authorities.

As previously indicated, there is a dependency on use of publicly owned transportation rights-of-way as a contributor to the implementation of such a program by providing the space for distribution lines as well as a receiving ground of the recycled water for the irrigation of the grassy and landscaped areas. To entertain such a proposal forces the transportation engineer to deal with the issue of accommodating parallel utilities within and along the transportation rights-of-way.

The transportation engineer must preserve the integrity of such facilities to the maximum extent possible without jeopardizing any safety or operational features for which the facility was originally designed. The transportation engineer also must achieve consensus goals in view of diminishing land and other natural resources and in view of social concerns.

The limited-access freeway, by nature, is more conducive to a compatible relationship of joint occupancy than any other type of highway system. The broad expanse of open right-of-way, limited interference with local street systems, and more direct routes interconnecting high-density metropolitan areas all contribute to this compatible relationship. However, such compatible features are not sufficient in themselves to override existing policies and interpretations of pertinent laws and statutes, which are among the first and main issues to be resolved before such a concept can be applied.

## POLICIES ON JOINT OCCUPANCY

In general, the various states have adopted, justifiably, a rather firm policy toward

limiting joint occupancy of utilities within limited-access rights-of-way, for limited-access facilities represent the highest type of all highway systems. Experience has shown operational complications, delays in construction activities, and added costs where utilities have jointly occupied rights-of-way on lower classes of highway systems. Therefore, the typical state utility-accommodation guide limits joint occupation of the limited-access highway facilities.

At the federal level, the regulatory as well as the enforcement agency for transportation rights-of-way is the U.S. Department of Transportation. The Federal Highway Administration is the agency responsible for implementing congressional acts related to the development of federal-aid highway systems as well as for developing the policies and procedures necessary to fulfill such implementation. To this end, several memorandums pertinent to this subject have been written. The following quotations are taken from Policy and Procedure Memorandum 30-4.1 (1).

> It is in the public interest for utility facilities to be accommodated on the rights-of-way of a Federal or Federal-aid highway project when such use and occupancy of the highway rights-of-way does not interfere with the free and safe flow of traffic or otherwise impair the highway or its vital quality . . . .

Utility facilities or utilities are defined as

> all privately, publicly or cooperatively owned lines, facilities and systems for producing, transmitting or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, storm water not connected with highway drainage, and other similar commodities.

Federal-aid highway projects are defined as

> those projects administered by a State which involves the use of Federal-aid highway funds for the construction or improvement of a Federal-aid highway or related highway facilities or for the acquisition of rights-of-way for such projects, including highway beautification projects . . . .

The section on general provisions states that

> due to the increasing competition between public transportation and other service facilities for available space, such as for highway, rapid transit, railroad and utility purposes, it is important that rights-of-way be used in the most efficient manner consistent with the overall public interest.

The section on requirements states that

> utilities that are to cross or otherwise occupy the rights-of-way of Federal-aid freeways, including Interstate highways, shall meet the requirements of the AASHTO "Policy on the Accommodation of Utilities on Freeway Rights-of-Way" adopted February 15, 1969, and accepted under PPM 40-2. Application of joint development and multiple-use concepts dictates that maximum use of the highways be made for other purposes where such use does not adversely affect the design, construction, integrity, and operation characteristics of the freeway. In the advancement of these concepts and when the State has legal authority to do so, and so requests, approval may be given for installing trunkline or transmission type utility facilities within a utility strip on and along the outer border of existing freeway rights-of-way.

Appendix A in this memorandum is an amplification of the Federal Highway Administration's view of the provision of the American Association of State Highway and Transportation Officials Policy on the Accommodation of Utilities on Freeway Rights-of-Way that sets forth more specifically the requirements for consideration, review, and subsequent approval of a parallel utility accommodation request. It also extracts excerpts from the FHWA Circular Memorandum of October 1, 1969:

> This memorandum provides a practical method for applying both the AASHTO Policy (on utilities) and the *Joint development* and *Multiple-use concepts* to freeways and utilities, especially at locations within and approaching metropolitan areas where land is scarce and right-of-way is expensive.

It would appear, then, that the provisions of AASHTO, federal, and state policies have established at least a permissive attitude on proposals for parallel utility accommodations provided that specified criteria are met.

If the criteria are met, there is sufficient justification that the best interests of the public are being served, and the state highway agency has the statutory authority, then the issue resolves itself into matters of philosophy or interpretation of applicable policy and procedure memorandums at the various state and federal decision-making levels.

It is our intent neither to ignore previously mentioned inherent drawbacks associated with the parallel utility concept nor to say that the benefits to be derived from the irrigation of publicly owned rights-of-way or adjacent green spaces would justify, in all cases, the application of this concept. There are many ramifications that any transportation administrator must consider before accepting or promoting wastewater distribution lines within or along transportation corridors or allowing these rights-of-way to be used as wastewater recycling areas. Before accepting or promoting wastewater distribution lines, administrators must consider many items related to the preservation of the integrity for which the transportation facility was originally designed and built. Before allowing rights-of-way to be used, administrators should give serious consideration to 3 items:

1. Health and safety;
2. Sociological and psychological impact; and
3. Additional maintenance requirements.

For health and safety, the effect of spray drift to such features as the highway or airport runway needs to be considered. The recycled water must have no deleterious effect on human, animal, or plant life when inadvertent exposure occurs. Impact of high moisture levels on embankments within the recovery area of a vehicle out of control must be studied. Under sociological and psychological impact, acceptance or nonacceptance of such a concept by both the transportation user and adjacent property owners must be ascertained. The maintenance and operational expense for the irrigation system and additional mowing requirements resulting from higher moisture and nutrient levels must be determined. Any special chemical treatments that might be required to overcome an imbalance of nutrients or adverse pH factors, and the effect of the recycled water on roadside and airport objects, such as fences, sign posts, and guardrails, also must be considered.

Water reuse is increasing. This increase is not, however, keeping pace with the demands for domestic or industrial water requirements. It is estimated that the 16 billion gallons/day (60.57 billion $dm^3$/day) required for domestic use in 1970 will double by the year 2000.

Philosophies, attitudes, and the value system of our society are constantly changing with increasing demands on all segments of public works. Society expects public and private institutions to be equally responsible in evaluating the cost effectiveness of alternatives. If those in the transportation profession fail to respond to these public

expectations, a credibility gap will result. If, on the other hand, objective evaluations are made and trade-offs are justified as being in the best interest of the public, then those in the transportation profession will make a positive contribution to the development of society.

In conclusion, we recommend that the Transportation Research Board seriously consider the following research programs:

1. An analysis of state and federal utility accommodation policies and practices, with special emphasis on wastewater recycling and
2. An analysis of the feasibility, applications, and limitations of wastewater recycling along and within transportation corridors.

## REFERENCES

1. Accommodation of Utilities. Federal Highway Administration, Policy and Procedure Memorandum 30-4.1, Nov. 29, 1972.
2. The River of Life. U.S. Department of the Interior, Conservation Yearbook Series, Vol. 6.
3. R. Cherry et al. Hydro-Biochemical Effects of Spraying Waste-Treatment Effluent in St. Petersburg, Florida. U.S. Geological Survey, Tallahassee, Fla., 1973.
4. Wastewater Quality Management Plan for St. Petersburg Wastewater Districts. Black, Crow and Eidsness, Inc., Clearwater, Fla., June 1973.
5. Sludge Treatment and Disposal. In EPA Technology Transfer Manual, Black, Crow and Eidsness, Inc., Gainesville, Fla., Oct. 1974.
6. L. A. Dove. Recycling Allows Zero Wastewater Discharge. Civil Engineering, Feb. 1975.

# SINGLE-VEHICLE ACCIDENTS INVOLVING UTILITY POLES

Nicholas L. Graf, James V. Boos, and James A. Wentworth,
Federal Highway Administration, U.S. Department of Transportation

From the limited data available, utility poles appear to constitute one of the major roadside hazards on U.S. highways. The data indicate that utility poles are one of the most frequently struck fixed objects along the roadside. Utility-pole accidents are estimated to account for more than 5 percent of the national traffic fatalities and more than 15 percent of the fixed-object traffic fatalities. Assessing and resolving the utility-pole accident problem is a formidable task. Contributing factors that make the problem difficult include sketchy accident statistics, lack of uniform standards and enforcement for locating utility poles, insufficient legal authority for states to undertake corrective action, inadequate right-of-way in many areas, and the high cost of current solutions to the problem. The purpose of this paper is to highlight the severity and complexity of the utility-pole accident problem and recommend further specific actions.

•THE MAGNITUDE of the utility-pole accident problem is difficult to determine because relatively few accident statistics are currently available that have the necessary degree of detail to make such a determination accurately. In addition, attempts to resolve the problem must consider the fact, that, unlike other fixed objects occupying highway rights-of-way, utility facilities are not owned by and do not come under the absolute control of either the state or local highway agency. Thus technical, legal, and political issues must be addressed in any program to reduce the magnitude and severity of the utility-pole accident problem.

## PROBLEM

Utility poles generally are metal or timber structures used primarily by electric power companies and the telephone industry for supporting overhead wires and cables. These poles frequently are used jointly by the electric power and telephone industries, and, in urban and suburban areas, also may provide space for police and fire signal systems, street lighting, cable television, and other community utility services. Because of their varied use, accident reports may be inconsistent when they refer to utility poles; sometimes reports identify them as light poles, telephone poles, or simply poles. The majority of utility poles in use are timber and come in a variety of strengths, wood species, preservative treatments, and lengths.

An attempt was made to estimate the total number of utility poles that currently are located on the right-of-way of public roads and streets. The best information available on the total number of timber poles in service nationwide is from a 1958 report in which it was estimated that there would be 140 million utility poles in service in 1975 (1, p. 450). This figure may be somewhat high because of the increase in the number of underground power and telephone installations in the past few years. A conservative estimate of the number of poles now located on public roads and streets would be 60 percent or more of those in service. That would mean that approximately 80 million utility poles occupy highway rights-of-way. This is a rough estimate, but it serves to demonstrate that, even if there were no new installations, the magnitude of exposure to existing utility poles by the highway user is great.

To develop an effective program to relocate, rearrange, or convert existing overhead utilities that currently occupy hazardous locations along roadsides, one must

overcome certain legal obstacles. The primary obstacle concerns who is to pay the cost of such work. When a utility occupies highway right-of-way by permit, the cost of relocation is usually the responsibility of the utility owner. Thus the states may be reluctant to force utilities to modify, remove, or relocate their facilities when the state cannot participate in the cost.

Federal law sets forth the provisions for federal reimbursement for the relocation of utility facilities under the federal-aid highway program (23 U.S.C. §123). This legislation is extremely important to consider in any federally funded program to correct roadside utility-pole hazards. It provides that, when a state pays for the cost of relocation of utility facilities necessitated by the construction of a federal-aid project, federal funds may be used to reimburse the state for such costs in the same proportion as federal funds are expended on the project. However, federal funds cannot be used to reimburse the state when the payment to the utility violates the law of the state or violates a legal contract between the utility and the state.

Currently, 38 states have laws permitting the state to pay for the cost of utility relocation, but such laws contain various types of limitations. For example, several of these states limit the payment of such cost to Interstate projects. Other states authorize payment only for relocating municipally owned facilities. Consequently, there are many instances under current legislation where federal funds may not be used in utility relocations or adjustments.

The accident problem involving a single vehicle and a utility pole is not well defined at the national level. Accident statistics identifying the object struck in fatal and nonfatal injury accidents involving fixed objects have been reported by only a few states in their state summaries of traffic accidents for 1972. Only Kansas, Oklahoma, Pennsylvania, Massachusetts, and Michigan identified the object struck in fatal and nonfatal injury accidents involving fixed objects in their published state summaries of traffic accidents for 1972. Also the data reported do not include some of the more important factors such as whether the pole was set back from the edge of the roadway; type of roadside environment (business, residential, or rural); or average traffic volume and operating speeds. Adequate data are also lacking on the causes of accidents in which a single vehicle strikes a utility pole. An accident of this nature may result from (a) an inability of the motorist to respond properly to specific road and environmental conditions, (b) avoidance of other vehicles or inadequate control or perceptual responses to other traffic, (c) particular motor-vehicle or motorist anomalies, or (d) a combination of highway, environmental, traffic, or driver conditions.

Available information, however, does indicate that utility poles constitute one of the major roadside hazards on U.S. highways (Tables 1 and 2). In some areas, they are the most frequently struck objects in run-off-the-road accidents. Data on utility-pole accidents have been obtained both from state summaries of traffic accidents and from an unpublished survey conducted in North Carolina. These sources show that the frequency of utility-pole fatalities varies from approximately 1 percent of the annual traffic fatalities in Oklahoma to more than 8 percent in Massachusetts. Based on the limited data reported, utility-pole accidents are estimated to account for more than 5 percent of the national traffic fatalities reported annually and more than 15 percent of the fixed-object traffic fatalities (Table 2). That is, utility-pole accidents account for an estimated 2,750 fatalities and 110,000 injuries annually. In addition, an estimated 250,000 utility-pole accidents each year involve property damage only. We believe, based on preliminary contacts with a limited number of states, that many states have collected data that are much more detailed than reported in the state summaries of traffic accidents. Further, each of the states contacted has indicated a willingness to share these data to help define and solve the utility-pole problem.

For example, North Carolina did not identify the object struck in fixed-object accidents in its 1972 and 1973 state summaries of traffic accidents. However, on investigation, they were found to have had this information readily available for the past 6 years. All reported traffic accidents are categorized and entered in a data processing system. By the use of this system, one can quickly and efficiently recall data on any accident category in the system.

Using the North Carolina data processing system in conjunction with police reports,

**Table 1. Accident data from state summaries.**

| Year | State | All Accidents | | | Fixed-Object Accidents | | | Utility-Pole Accidents | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Fatal | Injury | Total | Fatal | Injury | Total | Fatal | Injury |
| 1971 | Kansas | 54,114 | 549 | 16,246 | 7,772 | 148 | 3,082 | 1,846 | 20 | 754 |
| | Massachusetts | 154,714 | 827 | 60,187 | 20,126 | 277 | 8,397 | 5,298 | 67 | 2,535 |
| | Oklahoma | 64,948 | 699 | 14,000 | 8,117 | 240 | 3,164 | 791 | 9 | 297 |
| | Pennsylvania | 301,374 | 2,019 | 82,033 | 44,915 | 669 | 17,323 | 10,054 | 126 | 4,483 |
| | Total | 575,150 | 4,094 | 172,466 | 80,930 | 1,334 | 31,966 | 17,989 | 222 | 8,069 |
| 1972 | Kansas | 61,830 | 552 | 19,877 | 12,164 | 212 | 4,815 | 2,590 | 27 | 1,155 |
| | Massachusetts | 162,911 | 905 | 56,478 | 25,805 | 306 | 10,129 | 7,285 | 80 | 3,342 |
| | Michigan | 359,745 | 1,997 | 113,673 | 63,164 | 647 | 23,867 | 10,159 | 86 | 4,731 |
| | Oklahoma | 68,617 | 722 | 14,253 | 8,705 | 248 | 3,271 | 848 | 7 | 303 |
| | Pennsylvania | 277,556 | 2,085 | 89,080 | 77,948 | 682 | 23,516 | 10,493 | 156 | 4,945 |
| | Total | 930,659 | 6,261 | 293,361 | 187,786 | 2,095 | 65,598 | 31,375 | 356 | 14,476 |

**Table 2. Fatalities from 1972 state summaries.**

| State | Total Fatalities | Fixed-Object Fatalities | Utility-Pole Fatalities | | |
|---|---|---|---|---|---|
| | | | Number | Percentage of Total Fatalities | Percentage of Fixed-Object Fatalities |
| Kansas | 552 | 212 | 27 | 4.89 | 12.7 |
| Massachusetts | 905 | 306 | 80 | 8.84 | 26.1 |
| Michigan | 1,997 | 647 | 86 | 4.31 | 13.3 |
| Oklahoma | 722 | 248 | 7 | 0.97 | 2.82 |
| Pennsylvania | 2,085 | 682 | 156 | 7.48 | 22.9 |
| Total | 6,261 | 2,095 | 356 | 5.69 | 17.0 |

**Table 3. 1971 utility-pole accident composition for Alamance, Buncombe, and Cumberland Counties, North Carolina.**

| Location | Accidents | Property Damage | Injuries | | | | Fatalities | Percentage of Fatality and Injury Accidents | Percentage of Fatality and Injury Accidents at 90 Percent Confidence Limits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Total | A | B | C | | | |
| Central business district | 46 | 21 | 25 | 13 | 8 | 4 | 0 | 54 | 42 to 68 |
| Residential district | 39 | 21 | 17 | 11 | 5 | 1 | 1 | 46 | 32 to 62 |
| Rural area | 37 | 22 | 13 | 9 | 3 | 1 | 2 | 41 | 26 to 56 |
| Total | 122 | 64 | 55 | 33 | 16 | 6 | 3 | 48 | 35 to 56 |

Note: A = visible sign of injury, such as bleeding wound, distorted member, or being carried from scene. B = other visible injury or bruises, abrasions, swelling, limping, and the like. C = no visible sign of injury but complaint of pain or momentary unconsciousness.

we examined in detail the 1971 accident data from 3 North Carolina counties (Alamance, Buncombe, and Cumberland) (Table 3).

Based on data made available from the aforementioned state summaries and additional information from North Carolina, 4 assumptions regarding utility-pole accidents can be drawn.

1. Utility poles are one of the most frequently struck roadside fixed objects.
2. Sufficient data exist to identify the utility-pole accident problem and to establish relationships among accident severity, accident frequency, and roadside environment.
3. A detailed analysis of utility-pole location and spacing, traffic density, and average speed versus frequency and severity of collisions is beyond the scope of the

data currently available.

4. The magnitude of the utility-pole problem dictates that serious attention must be given to this area in a balanced attack on the rigid obstacle problem.

## EXISTING PRACTICES AND PROGRAMS

Historically, it has been in the public interest for public utility facilities to use and occupy the right-of-way of public roads and streets. This is particularly true for roads and streets that primarily provide a land service function to abutting residents as well as for those conventional highways that serve a combination of local, state, and regional traffic needs. This practice generally has been followed nationwide since the early formation of utility and highway transportation networks.

State and local highway agencies regulate the use of highway rights-of-way by utility facilities in accordance with state and local law. In some cases, this regulation is minimal; in others, standards for locating utility facilities are well established. These standards vary depending on the functional class of highway involved and the degree of control exercised by the responsible highway authority. Utilities have various degrees of authority to install their lines and facilities on the rights-of-way of public roads and streets. Their authority also depends on state laws and regulations that differ from state to state. Over the years, state and local highway agencies, in cooperation with the utility industry, developed their own policies for regulating utility use of public roads and streets.

In 1956, at the onset of the Interstate Highway program, federal and state highway officials recognized that the access-control feature of these important highways could be materially affected by the extent and manner in which public utilities cross or otherwise occupy Interstate highways. For this reason, in 1959 the American Association of State Highway Officials (AASHO), which is now the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration (FHWA) and the utility industry, issued the document, A Policy on the Accommodation of Utilities on the National System of Interstate and Defense Highways. This policy later was extended for application to all freeways. Essentially, the policy does not permit utility facilities to be installed longitudinally along and within freeway rights-of-way except where frontage roads are provided or in extreme cases under strictly controlled conditions. In addition, the policy contains specific criteria for horizontal clearances of aboveground utility supporting structures. Developing this policy was a landmark, for it was the first time a national policy had been developed for accommodating utilities on any highway right-of-way.

During the 1960s, utility and highway transportation networks continued to grow in complexity as modern society expanded and intensified its organization of facilities for service and communications. As these networks grew, the frequency of occasions for them to occupy a common right-of-way or to intersect one another as well as the problems stemming from common use continued to increase. It was evident that there should be some national policy to provide reasonable uniformity in the engineering requirements employed by highway agencies for regulating utility use of highway rights-of-way. On February 15, 1969, FHWA issued Policy and Procedure Memorandum (PPM) 30-4.1, Accommodation of Utilities, and on October 25, 1969, AASHO issued A Guide for Accommodating Utilities on Highway Right-of-Way. The only national standards available for installation and maintenance of electric supply and communication lines are those contained in the National Electric Safety Code. The code is voluntary but has been adopted by various governmental agencies and utility organizations. All of these documents have provided guidance for state and local highway agencies in developing new or in modernizing existing accommodation policies. They do not, however, adequately deal with the problem of existing utility-pole hazards for 4 reasons:

1. PPM 30-4.1 primarily concerns new utility installations that are to cross or otherwise occupy highway right-of-way and the relocation and accommodation of existing utility facilities that fall in the path of proposed highway projects. It does not,

except for paragraph 6(c), apply to existing utilities along existing highways. Also, its application is limited to active or completed federal-aid projects.

2. PPM 30-4.1 requires that each state develop its own utility accommodation policy, which is subject to approval by FHWA. It does not prescribe specific criteria to be used by the states in their policy, such as minimum offsets from the roadway for utility poles, but rather leaves this up to the individual states. These policies must necessarily be written in conformity with each state law regarding utility placement on the public right-of-way.

3. The AASHO guide provides only broad criteria relative to the placing of utility poles within highway rights-of-way, and does not establish the relative hazards for such installations.

4. The National Electric Safety Code has only limited reference to utility-pole clearances. The current edition specifies that supporting structures should not be less than 6 in. (150 mm) from the street side of the curb. No provision is made for pole clearances where there is no curb.

Paragraph 6(c) of PPM 30-4.1 provides that, where existing utility facilities are likely to be associated with injury or accident to the highway user, the responsible highway authority is to initiate appropriate corrective measures to provide a safe traffic environment. Federal fund participation in the cost of adjusting or relocating utility facilities in accordance with this paragraph is subject to the provisions of federal law. Federal funds can be used to correct these hazards, but only to a very limited degree, because many states are hampered by lack of appropriate legal authority to pay for such corrective action.

The Highway Safety Act of 1973 contains several new programs for highway safety improvements. Section 210 of the act (23 U.S.C. §153) is a program for the elimination or reduction of hazards caused by roadside obstacles on the federal-aid system other than the Interstate Highway System. Section 230 of the act (23 U.S.C. §405) is a program for the elimination or correction of safety hazards in several categories (including those under Section 210 of the act) on highways not on any federal-aid system. Relocation of utility poles identified as traffic hazards is an example of the type of project that is eligible under these programs.

A continuing engineering survey of all highways to develop a procedure to detect high accident locations through accident analysis has been a requirement of Highway Safety Standard 9 since 1967. The Federal-Aid Highway Program Manual (2) sets forth the details for carrying out this survey for federal-aid highways. A survey is required by Section 210 of the Highway Safety Act of 1973 to identify hazardous roadside obstacles. This survey is considered to be a 1-time survey that will result in specific projects.

Among the types of hazardous obstacles to be identified in this survey are utility poles within 30 ft (9.14 m) of the edge of traveled way except those installed in protected locations. A protected location is considered to be a location behind bridge rail or guardrail, or on a nontraversable slope. Where the posted speed is 40 mph (64.4 km/h) or less, utility poles would be counted only if located within 10 ft (3.05 m) of the edge of traveled way. Also, if the posted speed is 40 mph (64.4 km/h) or less, the area behind a curb designed to inhibit or discourage vehicles from leaving the pavement is considered to be a protected area. These criteria for protected location are applicable only for this survey. Their use is not intended to imply that a roadside obstacle occupying a protected location, as described, does not present some degree of hazard to traffic, but rather that those obstacles not in a protected location present a greater hazard and should receive higher priority for correction.

These safety programs can be effective in eliminating hazards on highways both on and off the federal-aid system. However, because only a few states and political subdivisions have broad authority to pay for utility-pole adjustments or relocations under these programs, the effective implementation of any such projects is seriously hindered.

There are several methods now being used for reducing utility-pole hazards. Joint-use single-pole construction offers an effective way of increasing safety by reducing the number of utility poles along the roadside. Joint use of poles should be encouraged where more than 1 utility or type of facility is involved. This is of particular signifi-

cance at locations where right-of-way widths approach the minimum needed. Although joint use of poles is now a common practice by the electric-power and telephone industries, more extensive use of this practice can result in significant safety benefits.

The use of more attractive, self-supporting utility poles with vertical alignment of cables and wires also should be encouraged, perhaps as a compromise between underground installation and use of conventional wood poles with cross-arm clutter and guy wires. Self-supporting poles with vertical alignment of utility lines have advantages from both safety and aesthetic standpoints because exposure to hazards and unsightly clutter are reduced.

Another effective method of elimination of utility-pole hazards is the conversion of overhead lines to underground lines. Conversion up to this time primarily has stemmed from beautification programs rather than from safety reasons. Installing new facilities underground also has been done by individual utility companies where it is found to be an economical alternate to overhead construction. For example, the Bell System has done a significant amount of underground installations in recent years. It is reported that their inventory of owned poles is decreasing at a rate of 0.5 million poles/year and may be expected to decrease even faster in the future. Their current policy is to use below-ground construction as a first choice in new construction and to replace existing aerial lines with underground lines wherever it is practical to do so.

Underground installation of electric power lines is confined mainly to low-voltage distribution circuits in new residential subdivisions. Where direct burial of electric cable can be used, the cost of underground installation may be as low as 1.5 times the cost of conventional overhead lines. However, the cost of converting all existing overhead distribution lines has been estimated to be a staggering $150 billion.

Underground installation of high-voltage transmission lines can be accomplished only after a number of economic and technological problems have been overcome. Underground transmission lines are many times more costly than overhead lines and are feasible today only in special areas such as metropolitan centers having high demands for power. Underground transmission lines have the advantage of being free from aboveground weather problems; therefore, they would have fewer service interruptions than would overhead lines. However, there are a variety of failures that do affect cables, and interruptions underground may last from a few days to several weeks while the fault is found, the cable is exposed, and the necessary repairs are made. Continued research on underground materials and installation methods could result in a substantial reduction in the overall cost of underground installation of electric transmission lines.

Many utility-pole hazards exist today because rights-of-way acquired for public roads and streets were inadequate to meet future demands for additional use by public utility facilities. When a new highway facility is to be constructed, the responsible highway agency must contact any utility company that has facilities that might be affected by the roadway construction. It is important that consideration also be given to future planned utility facilities that eventually may occupy the highway right-of-way. If utility use of the right-of-way is authorized by law, the right-of-way so acquired must be adequate to safely accommodate those utility facilities.

In the design of local roads and streets, AASHO (3) suggests that right-of-way width should be sufficient to accommodate the ultimate planned roadway, including space for public utility facilities. In addition, it suggests that the use of the right-of-way by utilities should be planned to cause the least interference with traffic using the street. If utility facilities are crowded onto highway right-of-way, both the utility consumer and the highway user suffer the consequences from the standpoints of safety, inconvenience, and added costs.

The breakaway concept has been used for roadside sign structures (4) and lighting supports (5) since the mid 1960s with well-documented success. Research conducted by Wolfe, Bronstad, Michie, and Wong (6) suggests that breakaway concepts also can be applied to utility poles. Although their work must be considered preliminary, it encourages the idea that breakaway designs for utility poles are technically feasible. More comprehensive research is proposed in the near future.

## RECOMMENDATIONS

Based on information currently available, recommendations for further action regarding the utility-pole problem can be made. In the interest of carrying out an effective safety program for the elimination of roadside obstacles under 23 U.S.C. §§153 and 405, each state should seek whatever legislation it may need to permit relocation or adjustment of existing utility poles from hazardous locations along roadsides.

Where appropriate, state utility accommodation policies and practices should be modified and strengthened as necessary to ensure that

1. New pole-line installations along roadsides will be permitted only at locations that are conducive to a safe traffic environment;
2. More extensive use of joint-use single-pole construction will be made at locations along roadsides where more than 1 utility or type of overhead facility is involved, particularly where the right-of-way widths approach the minimum needed for a safe traffic environment;
3. Self-supporting utility poles will be used where appropriate to eliminate the need for guy poles and guy wires to encroach on roadside areas; and
4. On highways with narrow rights-of-way or on urban streets with closely abutting improvements, self-supporting, armless, single-pole construction with vertical configuration of overhead wires and cables (as opposed to conventional crossarm construction) will be employed where needed to permit pole installations as close as possible to the right-of-way line.

Available accident data from the states should be collected, validated, and analyzed. From this, recommended utility-pole setbacks from the traveled way that take into account available right-of-way widths should be established for each type and class of highway (urban or rural, major or minor arterial, collectors, and so forth) and incorporated in utility accommodation policies.

The underground installation of wire and cable facilities should be encouraged and location standards established.

Studies should be undertaken to determine the feasibility of developing breakaway utility-pole designs giving due consideration to

1. Structural feasibility,
2. Devices to minimize electrical hazards, and
3. Legal constraints.

If the studies are encouraging, an in-depth program of concept development should be undertaken.

Measures should be taken to ensure that needed field performance information be reported in a timely manner through either future state summaries of traffic accidents or by other means.

## ACKNOWLEDGMENT

We wish to thank James E. Kirk of the Office of Engineering, Federal Highway Administration, and John G. Viner of the Office of Research, Federal Highway Administration, for their help and guidance during the preparation of this paper. We also wish to thank Glenn Grigg of the North Carolina Department of Transportation and Highway Safety for his assistance in obtaining accident data.

## REFERENCES

1. Timber Resources for America's Future. Forest Service, U.S. Department of Agriculture, Rept. 14, Jan. 1958.

2. Federal-Aid Highway Program Manual. Federal Highway Administration, U.S. Department of Transportation, Vol. 6, Chapter 8, Section 2, Subsection 1, July 3, 1974.
3. Geometric Design Guide for Local Roads and Streets, Part II, Urban. American Association of State Highway Officials, 1970.
4. R. M. Olson, N. J. Rowan, and T. C. Edwards. Break-Away Components Produce Safer Roadside Signs. Highway Research Record 174, 1967, pp. 1-29.
5. T. C. Edwards, J. E. Martinez, W. F. McFarland, and H. E. Ross, Jr. Development of Design Criteria for Safer Luminaire Supports. NCHRP Rept. 77, 1969.
6. G. K. Wolfe, M. E. Bronstad, J. D. Michie, and J. Wong. A Breakaway Concept for Timber Utility Poles. Highway Research Record 488, 1974, pp. 64-77.

# SPONSORSHIP OF THIS RECORD

GROUP 1—TRANSPORTATION SYSTEMS PLANNING AND ADMINISTRATION
Charles V. Wootan, Texas A&M University, chairman

ORGANIZATION AND ADMINISTRATION SECTION
Roger R. Shipley, Illinois Department of Transportation, chairman

Committee on Utilities
James E. Kirk, Federal Highway Administration, chairman
James E. Attebery, Karl E. Baetzner, William J. Boegly, Jr., Lloyd A. Dove, James P. Griner, Albert R. Heidecke, Robert J. Hoffman, Don H. Jones, Albert F. Laube, Roger C. McPherson, John M. Peacock, Anthony R. Phillipich, Barry M. Sweedler, Kenneth W. Walker, Ronald L. Williams

Kenneth E. Cook and Stephen E. Blake, Transportation Research Board staff

The organizational units and the chairmen and members are as of December 31, 1974.