# STEPS TO SUCCESSFUL UTILITY CONSTRUCTION

Brett Ward, Utility Operations Consultant

MTAS
Municipal Technical Advisory Service
*In cooperation with the Tennessee Municipal League*

THE UNIVERSITY of TENNESSEE

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# STEPS TO SUCCESSFUL UTILITY CONSTRUCTION

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***A true story of a sewer plant upgrade in Tennessee:***

Your city is upgrading the sewer plant. The Tennessee Department of Environment and Conservation (TDEC) inspector just left the site. He had taken numerous pictures, written pages of notes and increased your testing schedule on several parameters from three to seven days per week. He also issued the city orders relating to effluent improvement and the contractor orders for erosion control.

The project is already six months behind schedule and is only about half finished. There have been fistfights and revolving inspectors. Your operators are about to quit; the engineer wants more money, and the contractor boldly states, "I don't pay liquidated damages." Before long, the engineer quits. After the contractor leaves, subcontractors and suppliers are calling city hall wanting payment for work and equipment. Each day someone tells you about new problems, and why it's the other guy's fault, and what you should have done to prevent that problem. The TDEC inspector says fix it NOW!

This project, though one of the worst we have seen, is not unique. Many municipal construction projects go bad as the project nears completion. Did they start going bad from day one?

With a desire to improve publicly owned construction projects, the group known as Small Community OutReach and Education (SCORE) investigated the causes and remedies of why construction projects go bad.

## ABOUT SCORE

The mission of the Tennessee SCORE program is to provide water and wastewater information and technical assistance to small communities.

Originally an EPA-funded program administered by the Division of Community Assistance, the SCORE group is currently comprised of personnel from the Division of Community Assistance, Development Districts, Department of Economic and Community Development, Rural Development, Municipal Technical Advisory Service, and Tennessee Association of Utility Districts, with all costs being absorbed by these organizations.

Beginning in 1998 the group has examined the question: **Why do construction projects go bad in the end?** Referring primarily to water and wastewater utility construction that local governments undertake, these same problems also occur in other types of construction as well. Various persons have presented opinions from their areas of work. The following summaries were compiled based on the materials the presenter provided or on notes taken during the presentations.

## WHY CONSTRUCTION PROJECTS GO BAD IN THE END: A SUMMARY OF SIX PERSPECTIVES

**Engineers**—*by Alton Heathcoat, representing the Association of Professional Engineers*

- Poor understanding between parties involved
- Failure to receive timely approvals and permits
- Design errors
- Designing to "wants" not "needs"
- Design changed to fit budget
- Poor onsite inspection
- Poor contractor quality
- Untimely delivery of equipment, reports, payments

**Contractors**—*by Ron Crutcher, representing Association of General Contractors*

- Poor plans and specifications
- Unclear areas of responsibility and authority
- Delays: weather, deliveries, design details
- Payment delays
- Disputes: Who can stop work?

**Owners**—*by Larry McElroy, representing Consolidated Utility District, Rutherford Co.*

- Delays: TDOT, other utilities
- Misunderstandings between parties involved
- Too many bosses
- Professional incompetence among the parties involved
- Gray contract language

**Financial**—*by SCORE members*

- Incomplete forms and application
- Inadequate financial resources
- Incompetence among the parties involved
- No central clearing house

**Construction Managers**—*by Earl Sizemore P.E., representing Sizemore Consulting*

- Poor communication
- Poor plans and specifications
- Inexperienced contractors
- Financial confusion, pay requests, change orders, retainage, payment delays

**Legal Perspective**—*by R. Loy Waldrop Jr., representing Lewis, King, Kreig, Waldrop, & Cantron, P.C.*

- Poor direction and project definition
- Project and funding mismatched
- Personnel quality
- Poor conflict resolution

## ROOT CAUSES OF FAILED CONSTRUCTION PROJECTS

Shortage of

- Skill
- Effective Communications
- Knowledge
- Time
- Money

## HOW TO PREVENT A FAILED CONSTRUCTION PROJECT

SCORE members believe that projects can be improved by enhancing the administrative skills of project owners, that is, the city or utility. The administrative board, whether the mayor and board of aldermen or a utility board, must take full responsibility for the success or failure of the construction project.

If you were building a house, you would not hire an architect or contractor, tell him to "build me a house" and then leave on an extended vacation. You would carefully plan and discuss what you wanted and what it would look like. Plans would be chosen carefully or drawn to satisfy your needs and desires. Fixtures and equipment would be discussed and chosen based upon the needs and desires of the persons using them. Colors and finish details would be specified. Finally the cost of the project must match your available resources. These decisions would be finalized after much discussion between you—the owner—and your builder and/or architect. As the owner, you know what you would like the house to be, and the professionals know how to

make that happen. By working together using everyone's expertise, you can get the best project at the most economical price.

Likewise, in a utility construction project, the owners must carefully work with others to have a successful project. Above all, owner participation is required (Sweeney), and a "partnering relationship" is essential for success and savings (A. Smith, D. Smith).

## OWNER'S RESPONSIBILITIES

First on the list of responsibilities for the owner is to define what is needed, wanted, and affordable. In order to better define the project, professional help may be needed; so securing professional assistance will be an early task. Matching needs and wants to the available resources is always of major importance in construction. As part of the discussions with the various partners in the project, there must be an understanding about the meaning of quality. Without general agreement initially about what is acceptable in materials, safety, inspection, construction practices, time schedules, clean-up, disruption of services, and differing site conditions, there is potential for major disagreements. Just as you would monitor a home construction project, you should monitor a utility construction project to see that your interests are being met and your money being spent wisely. All of this owner involvement may take a significant amount of time, effort and expense, but it will be well worth the investment.

## STEPS TO A SUCCESSFUL CONSTRUCTION PROJECT

The material presented here is intended to be a guide in the process of administering a public construction project. There are six critical areas where the owner (administrative board) must take responsibility:

1. Define the Project
2. Procure Professional Assistance
3. Procure Financial Resources
4. Set Performance Standards
5. Administer the Project
6. Monitor the Project

### 1. DEFINE THE PROJECT

The first and perhaps most important step to making your project a success is to define the project (Waldrup, Heathcoat, Sweeney).

*What is the purpose of the project?*
*What do you want to accomplish when the project is complete?*

These are big-picture questions. At this step, the details are not of major importance. Begin by discussing the following questions within the administrative board. You may not have complete answers, but answer as best as you can. Be cautious about jumping to the details too quickly. The specific technologies and specific solutions will come later, as the technical personnel add their input. Consider the following questions:

*What is the project?*
*Why this project at this time?*
*What problems will be solved?*
*What is the expected useful life?*
*What are the long-term consequences?*
*What opportunities are gained?*
*When does the work need to be completed?*
*Who will manage the project?*
*Can the community afford the project?*
*How will you describe a successful project?*

Review and discuss your deliberations with your city staff. In most cases, staff persons probably initiated the project, so they have already answered some of the important questions for themselves. Their involvement during the project development and decision-making stage is critically important. The persons who work in the area will be able to add some clarity to the questions. They should be able

to fill in some details about current capacities, rates of usage, and regulatory concerns. Their input could redefine the whole project. It may be appropriate to request a technical-assistance provider and/or a regulatory person to be part of your discussion. This person frequently can add direction because he or she will be able to point out options that are not available due to regulations or public health and environmental concerns. They may also direct you toward similar projects that have been successful or unsuccessful.

There may be other technical persons who could be involved in the discussion at this time. Take time to visit similar projects to discover problems encountered or processes that have worked well.

Again a word of caution about jumping to the details: These initial discussions are about general ideas and general concepts. This will be time consuming, but the time is well spent to have a clearly defined project. Consider the following questions for the next round of discussions with staff, regulators or assistance providers:

*What is the project?*
*Will the project solve the problem?*
*What are the long-term consequences?*
*What is the expected useful life?*
*What opportunities are gained?*
*When does the work need to be completed?*
*Who will manage the project?*
*What assistance is needed to complete the project?*
*What are the regulatory considerations?*
*What will the project cost?*
*Can we operate it once it is built?*
*What will operations and maintenance cost?*
*Can the community afford the project?*
*How will you describe a successful project?*

Next, think about operations (Dr. Joe Middlebrook):

*Will a plant be able to produce the needed effluent quality or drinking water quality?*
*Will a collection or distribution system deliver the appropriate service?*
*What are the capital costs?*
*What are the expected operation and maintenance costs?*
*What level of operator skill will be needed? What number of operators will be needed?*
*What is the ability of the community to support the facility?*

The process of defining the project may take significant time. It is a circular process of asking questions of why, what, and how several times to several different groups in order to come to a consensus of what is best to meet the public needs. If this process has involved all the various parties that will be involved in the design and operation, your partnership is well on its way.

## 2. PROCURE PROFESSIONAL ASSISTANCE

Most all SCORE members and presenters expressed concern that the expertise and experience of the individuals involved in the project contribute greatly to its success or struggles. Once you have exhausted your own resources, involve a consulting engineer. *Tennessee Code Annotated* (T.C.A.) 12-4-106 establishes that professional services for local governments be procured based upon recognized competence. Engineers, architects, accountants, lawyers and other professionals should be chosen based on Qualification Based Selection (QBS). In this process, a city or utility requests that persons or groups wishing to provide the specified service submit statements of qualification to the city. From those statements and through interviews, the city would select a qualified persons or firms. Then from this group of qualified applicants the city would request proposals on a particular project or job.

The QBS process is beyond the scope of this paper, but additional information can be obtained from the University of Tennessee Municipal Technical Advisory Service (MTAS). A publication entitled *Qualification Based Selection: An MTAS Guide for Procuring Professional Engineering Services in Tennessee* is available from the MTAS Web site at www.mtas.tennessee.edu.

After selecting an engineer, outline the project definition derived in Step 1. Consider repeating the same set of questions with the engineer that you did with your staff and regulators. Ask for their ideas, recommendations, and timetable of activities. At this time, cost questions are difficult to answer. Initially the answers may be only estimates or relative costs, but as the project progresses more accurate estimates will emerge.

Always remember that the engineer works for the city! The city owns the project; the city will pay for the project; and the city will have to live with the project for many years. The engineer is the person who will take your general ideas or needs and convert them to a detailed project based upon either your guidance or their preferences and according to Tennessee Design Criteria for Sewerage Works or Design Criteria for Water Works and engineering standards. Make sure the treatment options, materials, and equipment chosen by the engineer are affordable, that they match local conditions, and that they will actually do the intended job. Do not let operators, engineers, or others push you into work that is inconsistent with the mission of the utility. Be leery of unproven technology and misapplied technology. Make certain the solution fits your needs and resources. The newest equipment or latest design that worked in another community may not fit your situation.

A very important item for consideration is having "errors and omissions" insurance as a requirement either for statement of qualification submission consideration or for the successful candidate. Quite often, the firm or individual will be working on a project whose cost will exceed the annual revenue or even the net value of the firm or individual. In the event of errors or omissions, the firm will most likely only be able to offer to correct the design work, if the design corrections are not too extensive and expensive. The project costs of actually constructing the corrections would likely be beyond the ability of the firm or individual to bear. The inevitable lawsuit springs to mind, but you "can't get blood from a turnip." If they don't have the financial resources, then they just don't have them. The city would be left "holding the bag." THAT is where "errors and omissions" insurance would come into play. This insurance would provide the financial means to protect the city from a non-functional or otherwise unsatisfactory project (Chlarson).

After the project has been designed by the engineer and approved by the owner and regulatory and funding agencies, seek bids from contractors. The consulting engineer usually provides guidance and evaluation through this process. This person will prepare contract documents, drawings, and specifications and assist in evaluating bids. Accept the lowest responsible bid. Lowest responsible bidder is defined with respect to state purchases as a person who has the capacity in all respects to perform fully the contract requirements and the integrity and reliability that will assure good faith performance (T.C.A. 1200-3-201-6). It was also said in *R. G. Willmott Coal Co. v. State Purchasing Commission*, 54 S.W.2d 634, 635, 246, KY, that in determining who is lowest and best bidder (the) purchasing commission must consider not only the amount of bid but also business judgment, capacity, skill, responsibility of bidder and quality of goods proposed to be furnished. The definitions of lowest responsible bidder and lowest and best bidder in other jurisdictions are similar (Hemsley). If you are going to reject a bid as irresponsible, have adequate documentation to make that decision. When a bid is

significantly lower than the others, use caution, as there is a high risk of problems in these cases (Waldrop).

### 3. PROCURE FINANCIAL RESOURCES

Water and wastewater utilities are very capital-intensive business enterprises. Developing a plan for covering construction costs as well as operation and maintenance is a major part of a manager's job (Young). The decisions made in the plan are basically a way of balancing the answer to the Step 1 questions Dr. Middlebrook posed on page 5:

*Will a project be able to meet the regulatory or water quality requirements?*
*What are the capital costs?*
*What are the expected operation and maintenance costs?*
*What level of operator skill will be needed?*
*What is the ability of the community to support the facility?*

#### *SOURCES OF FUNDS*

There are generally three sources of funds for new construction: equity financing, borrowing, and grant monies. Where there is a long-term capital plan, utility rates can be set that will allow the utility to save funds for future projects. Although this is the most economical way of paying for new construction, it is often impossible to save the amount of money needed for a major capital project. In this case outside funding will be necessary.

There are several sources of outside funds for utility construction in Tennessee. Grant monies are available from the Department of Economic and Community Development in the form of Appalachian Regional Commission and Community Development Block Grants. Sources of grant assistance are your local Development District Office, as well as private grant administrators. Grant/loan combinations are available from the Rural Development Administration (formerly known as Farm Home Administration). Low interest loans are also made for both water and wastewater projects through TDEC, Division of Community Assistance, State Revolving Loan Fund.

Other sources of funds include the Tennessee Municipal League's Bond Fund, your local bank and General Obligation Municipal Bonds. An MTAS publication entitled *Finding Money* gives both a general overview and detailed look at the various sources of grants and loans within the state. To read this publication, go to www.mtas.tenneessee.edu. Often large projects will utilize a combination of funding sources. Occasionally a county will allow a municipality to use the county's grant entitlement that could not be utilized by the county.

In small cities and towns, the consulting engineer will handle much of the paper work associated with the financing. His or her experience with various lenders can be a great help. Larger utilities will have more experienced financial personnel and will wish to handle their own financial work. If you choose to let your engineer coordinate the finances, oversee that work. A review of the financial package by someone who understands the options and their short- and long-term effects on rates and operations may be helpful. In addition to the five previously stated questions, an additional one is, how does the financial package affect total or the life-cycle cost of the project, which includes the construction costs and the operation and maintenance costs?

### 4. SETTING PERFORMANCE STANDARDS

Having clearly stated performance expectations at the beginning of a project follows closely with defining the project. The owners of the project should clearly describe to the engineers, contractors, managers and staff what is expected and what success looks like. The formal conferences that occur throughout a project are the time to have these discussions. Generally there are pre-

design, design review, pre-bid, and pre-construction conferences as well as regular meetings throughout the construction phase. Discussions with these groups at the various conferences should focus on how the work will meet the short- and long-term goals of the project. Listen carefully to what is said. If there is industry-specific language or jargon you don't understand, ask for clarification. Use good communication skills. Repeat vague sentences in your own words and seek support or redirection. Take good notes at the meetings. If problems go to litigation, usually whoever has the best documentation wins.

For example, a successful design should meet regulatory or water quality requirements as a minimum, be affordable to the customers, and be within the operational capabilities of staff who are charged with the responsibility of operating and maintaining the new infrastructure. TDEC will review all plans for compliance with state design criteria. Note that this does not mean that the state guarantees the design will work as you expect (Lemasters). A careful review of the design by your operators for ease of maintenance and operability as well as function may locate potential problems. Ask these questions:

*Will regulatory requirements be met?*
*Will community needs be met?*
*What are the projected operation and maintenance costs?*
*Do the equipment and technology choices match local conditions and capabilities?*
*What are the staffing needs and costs?*

Engineers do make mistakes (Heathcoat). Review the engineer's work. Catching mistakes in the design stage saves money and stress. If developers are making expansions to your distribution or collection system, their plans must also be state approved. The state, however, does not oversee or inspect the actual construction. Inspection is a local responsibility. It is up to the local utility to inspect the construction and oversee the installation to assure that what was designed and approved is actually built. Owners should also hold designers responsible for a design that actually solves the intended problem or yields the appropriate solution.

The quality of a contractor's work is generally documented through inspection. The scope of inspection and who will perform that inspection should be decided early in the project, and the contractor should be notified prior to bidding that exact compliance with the contract will be expected. Generally the consulting engineer provides an inspector, though many utilities are performing their own inspections, especially in water and sewer pipeline construction (McElroy). The cost of inspection can be substantial, so clear agreement about the amount and extent of inspections must be decided to avoid misunderstandings and different expectations. Inspections could be general or detailed. The inspector may be working more than one job, dedicated to one job or a part of one job. Along with the decisions regarding scope of inspections, also have a clear understanding of who can stop work for noncompliance. Roles need to be clearly defined (Crutcher).

Plans and specifications will detail material quality. Shop drawings and material manufacturing specifications need to be provided to the engineer for review and approval for compliance with plans and specifications. Approved shop drawings and materials then are part of the plans and specifications, and no unapproved substitutions are acceptable. Of course after setting high standards for inspection and materials, owners must support the inspector's decisions; otherwise, the inspector has no authority, and inspections will become a waste of money.

Another area of performance to be discussed involves water quality when a sewer or water

treatment plant is being renovated or upgraded. EPA and the state expect all water quality standards to be met throughout construction interruptions. This will require planning and coordination between operators and the construction workers. Here again clear understanding of roles, responsibilities, and authority is critical. If the contractor needs to interrupt plant operations, the operators must be notified in advance. Also operators need to understand that construction will disrupt their routine, and a major amount of adjustment may be necessary for the duration of construction.

A widely known fact in public works is that no matter what type of work you have performed, no matter what its public benefits, if you leave a mess in someone's yard or damage their landscaping or flowers you are in for trouble. This is especially true of the construction of utility pipelines. The cleanup of the construction mess is vitally important. Cleanup in pipeline construction should be a daily process as the construction moves down the right-of-way or easement (McElroy). If quick cleanup is expected, it should be specified in the bid specifications. It is recommended that construction easements be videotaped prior to the beginning of construction. This helps in the resolution of disputes about damages.

The warranty period for new equipment and facilities is often misunderstood. Beginning and ending dates should be clearly stated as well as who is responsible for warranty work, the scope of warranty coverage, and importantly what is not covered. If an inspection is to be performed prior to the end of the warranty period, these details should be specified at the beginning of the project. There should also be clear understanding about start-up and training on the use of all equipment especially the control electronics and computers. All equipment should include operation and maintenance manuals and recommended spare parts.

In construction, always expect problems. Construction projects are major logistical efforts where even the best of planning can be undermined by unforeseen events. Because of this, project budgets should have 10-20 percent of the value of the construction set aside for contingencies. Use this money carefully. A common reason for increasing costs is "differing site conditions." This could be unknown ground water, rock, or difficulties with utility relocation. Easement costs may change, and there is always concern about inclement weather.

Many of these items will be in the various contracts, so read them. If you don't understand them or the technical language, ask questions for clarification or change the language.

### 5. ADMINISTER THE PROJECT

Management of a construction project is the critical role that will determine success or struggle. Managers must be able to understand the full project, simultaneously watch the big picture and fit the details into the picture in a way that leads to success. They must bring together a variety of personnel, materials, and pieces of equipment, and piece them together to meet design. This should be done in a timely manner, on budget, sometimes in harsh and unpredictable conditions and oftentimes without disrupting current operations.

There are various forms of project administration. The most common is for the owners to hire a design engineer, who designs the project, and a contractor, who builds the project according to the design. Another option is the design/build concept, where a single firm is hired to design and build the project. This arrangement has streamlined the process and resulted in significant savings. There are questions, however, about the lack of competitive bidding when using design/build.

A third option is some variation of the construction management process. This option is common in Tennessee with school construction. The construction-manager structure results in an extra party being involved and an extra cost, but this person's involvement often results in a far better project. The cost of construction management must be weighed against the added cost. In small projects, there may be ways to receive the benefits without major extra cost.

With construction management, one person should be designated as project manager. They may work for the engineer, or be a city employee who is dedicated to the project, or a third party who works for the city as a contract project manager. This person is charged with the responsibility of making the project successful and should have direction, authority and resources. His or her loyalty must be to the success of the project and to the owner of the project and not to individual interests. The manager must have outstanding personnel skills along with the technical know-how to manage the construction. And he or she must be able to communicate and organize well and possess mediation skills.

One option for project management is for the engineer to provide this as part of the design service. Advantages of this method are familiarity with plans and specifications that allow quick response to questions related to the documents. Disadvantages include the inability to be completely independent when there are possible deficiencies in the documents. If this option is desired, the scope of work must be decided in early contract negotiations, so the additional cost can be included in the engineering fee (Sizemore).

Another method is to hire a separate engineering firm for the construction phase of the project. This gives complete independence, but it also results in a loss of knowledge and history about the design, which may result in time being lost rehashing decisions (Sizemore).

A third method for project management is generally only available to large utilities, and that is to provide the service themselves (Sizemore).

A fourth method is to hire a third-party project manager. This will add cost to the project, but many owners indicate that the presence of a manager actually saved the utility money. Advantages to this option include review of plans and specifications and bid packages; independent cost review; experience in selection of qualified contractors; improved on-site communication; maintenance of project schedule; and coordinating contractor and subcontractor efforts (Sizemore).

### 6. MONITOR THE PROJECT

A critical role for the project owner is to monitor the project. This is generally done in conjunction with the utility staff. The owners of the project, the city or utility board along with their staff persons, managers, engineers, and inspectors must evaluate the project and their own performances relative to the project (EOA).

The design itself should meet design criteria set by the state. That design and the equipment choices should meet the approval of the operational and managerial personnel. These persons along with the engineer should be able to give an assurance that the design will produce a water quality that meets, at a minimum, the regulatory standards. There should be a level of comfort among the financial persons that the project and subsequent operational expenses are affordable. As construction begins, remind all personnel—from the professionals to the least experienced laborer—that a quality project is expected. Specified materials must be installed according to design, using construction methods that give a long-lasting project and are on budget and on time. The contractor and inspector should

both be documenting the daily activities and progress on the construction site. Payment requests will be made based on the construction progress. Make payments to the contractor quickly. If there are disputes regarding payment requests, reconcile them quickly, preferably using a previously agreed upon method.

In a four-part article in recent issues of *Operators Forum*, entitled "The Operator's Key to Successful Plant Upgrades," the authors recommended that a treatment plant staff person called a "coordinator" is key to improving relations with contractors, subcontractors, engineers, and operators of the facility. Where a third-party project manager is not affordable, this may be an alternative option. Though not in control of the project, a coordinator could serve many functions of a project manager by keeping the parties working as partners and serving as the eyes and ears of the owners.

## SUMMARY

SCORE members firmly believe construction projects that "go bad in the end" actually started out bad or at the least began without thought and planning. The most important element of a public utility construction project is the involvement of informed and dedicated owners. Frequently engineers are hired, money borrowed, and contracts awarded with little knowledge of these parties or of the process by the owners. We simply depend upon the kindness of strangers for the completion of a successful public project. The purpose of this paper is to encourage involvement and to provide direction and information, so involvement actually improves the project.

Owners are encouraged to hire highly qualified personnel for all aspects of the project and to direct them well, listen to them and learn from them. If you do not understand or trust them, get a second opinion. Spend the time necessary to develop a quality project that will actually solve the problems at hand in a way that matches the community resources.

We encourage the use of some type of dedicated construction or project management, a single person committed to a successful project who will see it through from beginning to end. This person needs knowledge of the process, the skills to direct, organize, and manage the process, and the support of the owners. The manager may be a contracted third-party manager or some hybrid, such as a project coordinator, or simply the engineer's inspector who has additional responsibilities and authority. We encourage a partnership approach as opposed to an adversarial approach, which characterizes most failed projects.

Do not get in a hurry or try to perform too much construction with too little money.

Utility construction, like home construction, can be a very high stress process. There are many obstacles and problems that must be overcome, but the thrill of accomplishment is even greater. To complete a treatment plant expansion or pipeline extension on time and on budget is a great accomplishment, and there is nothing as much fun as success. It's our desire that this SCORE material will be instrumental in helping your utility complete a more successful construction project.

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Inquiries and charges of violation concerning Title VI, Title IX, Section 504, ADA or the Age Discrimination in Employment Act (ADEA) or any of the other above referenced policies should be directed to the Office of Equity and Diversity (OED), 1840 Melrose Avenue, Knoxville, TN 37996-3560, telephone (865) 974-2498 (V/TTY available) or 974-2440. Requests for accommodation of a disability should be directed to the ADA Coordinator at the UTK Office of Human Resources, 600 Henley Street, Knoxville, TN 37996-4125.

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