The liaison officer spent three or four days each week at the construction sites. As many as a dozen projects were under construction at one time. This allowed little time to seek out the help of a specialist for each problem that arose. Most of the problems that came up required an immediate response. Likewise, little time was available for consultation with land managers, and the liaison officer had to respond to the state by using the broad objectives set forth by the land managers.

When more than two or three projects were going at the same time, the liaison officer was often hard pressed to accomplish his assignment. In these situations, assistants were used to help monitor the construction as it progressed. Most of these people, however, had to be trained before they were capable of performing adequately. The liaison officer position could be strengthened considerably by assigning qualified people, rather than trainees, as assistants.

Since road construction is primarily an engineering function, it is essential that the liaison officer have an engineering background to properly interpret the plans and specifications and, perhaps more important, to respond intelligently to other agency representatives. As an engineer, he or she is able to differentiate which ameliorative measures are feasible. Although the liaison officer may not be a specialist in hydrology, he or she needs a background in the principles of hydrology. On this project, it was easier for an engineer to recognize proper construction of erosion-control structures. It is also beneficial for the liaison officer to have a background in geology or geological engineering. On the Vail Pass project, this knowledge was needed on several occasions. For example, when the state project engineer wanted to cut the toe of a series of slumps—a procedure that could have triggered a chain reaction of earth slides—the liaison officer explained the possible consequences and the project engineer decided not to make the cut.

The use of a liaison officer is an integral part of any project like the one at Vail Pass. It is recommended, however, that he or she be an engineer, preferably a civil or geological engineer, and that trained assistants be provided, preferably people trained in engineering, hydrology, or landscaping. Ideally, the liaison officer should have one assistant in each of these disciplines.

EVALUATION AND SUMMARY

A key element to a successful project is early planning and preparation before the project is designed. This point cannot be overemphasized. The groundwork must be laid so that there are fewer misunderstandings during construction. Another key element is cooperation and coordination among interested parties. All effort should be directed toward accomplishing the final objective. Everyone has something to contribute and everyone should contribute. This cannot be done if one agency feels it has final control and is jealous of ideas supported by another agency. Such a project is so large and complex that no one agency or person can have all the answers. The success of the Vail Pass project was predicated on the idea that all interested parties were to participate and contribute toward the final goal.

The goal of the Vail Pass project was to construct across a major mountain range an Interstate highway that would be compatible with the mountain environment. The completed highway speaks for itself. The success of the project lies in cooperation and coordination among many individuals and government entities. The entire operation was not smooth; it was often fraught with argument and frustration. But from this apparent chaos emerged innovative ideas and understandings that can be used in future projects of this magnitude. Certainly not everything tried at Vail Pass was successful but, overall, I would recommend few changes.

The Forest Service has officially commended the Colorado Department of Highways for its effort to cooperate in mitigating environmental damage in a very sensitive corridor of public lands.

Abridgment

Meeting the Challenges of Environmental Restrictions in the Vail Pass Project

Robert H. Lowdermilk, H-E Lowdermilk Company, Englewood, Colorado

Although many procedures for complying with Colorado water-quality-control regulations were developed in advance of actual construction of I-70 at Vail Pass, daily observation of the project revealed one thing clearly: Compliance is easier said than done. The actual work situation often dictated procedures other than those specified. Many problems were encountered that had not been anticipated. Meeting environmental requirements on the actual jobsite became a process of finding, analyzing, and solving problems on a continual basis. This resulted in a remarkable effort of cooperation among agencies and contractors.

The purpose of this paper is to provide a contractor's view of the problems encountered and the solutions developed during the Vail Pass experience so that future projects of this nature can be accomplished with greater efficiency and at lower cost to taxpayers.

COPING WITH THE MYSTIQUE OF ENVIRONMENTAL LAW

For the contractor, environmental restrictions meant a whole new way of thinking, even as early as the bidding process. The first thing the contractor had to overcome was a reluctance to bid because of a lack of understanding of the laws themselves.

A cursory reading of the Colorado Water Quality Control Act revealed that the regulations spoke in terms of absolutes: "... to provide that no pollutant be released into any state waters without first receiving the treatment or other corrective action necessary to protect the legitimate and beneficial uses of such waters." And the penalties were stiff: "Any person who fails to notify the division [of pollutant discharge] as soon as practicable shall, upon conviction thereof, be punished by a fine of not more than ten thousand dollars, or by imprisonment in the county jail for not more than one year, or by both such fine and imprisonment."

The science of earthwork has not yet developed to the stage where inadvertent deposits of earth into nearby streams can be totally prevented, let alone noticed and reported. Were contractors to risk heavy fines and imprisonment for the sake of working within laws that were apparently unrealistic?

The Colorado Department of Highways, however, had the foresight to educate contractors on these laws and their consequences before the letting of the project contracts. Thus, even at this early stage was begun the spirit of cooperation that was the basis for the solutions to problems encountered throughout the project.

COPING WITH THE COSTS OF ENVIRONMENTAL LAW

Environmental restrictions and compliance procedures are, of course, not without cost consequences. The direct costs of pollution-control systems and the indirect costs of scheduling, planning, and coordination problems that arise because of the restrictions (which are described below) combine to raise the normal cost of highway construction by more than 15 percent, according to estimates of the Colorado Department of Highways. We now believe the cost may exceed 20 percent.

Many of these costs are unpredictable from the outset. This raised questions at the bid table: How were contractors to be reimbursed for work on undesigned and unpredictable structures and systems for pollution control?

The problem was solved by specifications under which the Colorado Department of Highways separated the unpredictable costs from the normal contract items and paid for them on either a time and materials basis or by bid hourly equipment rates. Using hourly rates for equipment to be used in constructing pollution-control systems on the project greatly reduced the contractor's risk and served all parties equitably. It is recommended that the same procedure be followed on future projects of this type.

Work Scheduling

Many regulations and procedures imposed severe scheduling restrictions on contractors. The Colorado Department of Highways was able to minimize some of these problems by scheduling requests from landscape architects for the use of a contractor's equipment so that the removal of that equipment from a production group would have the least possible economic effect on the contractor. Other scheduling problems, however, simply resulted in increased costs.

One notable cost increase occurred when contractors were required to implant topsoil, seed, and jute mesh on cut or fill slopes each time these slopes extended vertically to a maximum of 9.14 m (30 ft). This specification, combined with the fact that extensive landscaping had to be done before topsoiling could proceed, caused severe scheduling and movement problems in the restricted areas in which the contractors worked. Efficiency was greatly reduced because the same equipment often could not be used on nearby cuts or fills. In some cases, the character of excavation materials varied to such an extent that available equipment was not economically appropriate. In other instances, the number of units of available equipment was not appropriate for the haul distance required (e.g., too many or too few haul units for a particular grade and haul length was a problem because of frequent moves). Other operations, such as pipe installations, occasionally reduced the options available to contractors.

Solutions to this problem were further hindered by the fact that erosion-control measures often could not be implemented far enough ahead to make new cuts and fills available when needed. Operations of landscape architects frequently took longer than expected, further delaying topsoiling, seeding, and other operations in a cut or fill area.

Cost increases occurred when, in response to these and other scheduling problems, contractors selected the solution that was economically the most appropriate. These actions ranged from (a) simply maintaining an excavation operation too long in a cut that really needed to be drilled and shot rather than ripped to (b) forcing extremely crowded and inefficient conditions in a cut or fill area by using excavation and topsoiling equipment simultaneously or (c) completely shutting down a potentially productive group and risking the loss of equipment operators in the process. All of these alternatives were costly.

Preconceived Procedures

It is recognized that specifications can be used to guide or encourage a contractor to accomplish a procedure, such as burning, in a pollution-free manner. The intention may be good, but rigid specifications that mandate a procedure or a type of equipment can be counterproductive. The actual work situation may dictate a different, more valid solution than the one specified. Appropriateness and economy require that a contractor not be tied down to inefficient procedures and equipment. The Vail Pass experience provided the following example.

Because of requirements in the specifications and state burning permits, contractors were required to purchase a generically named piece of incineration equipment for "smoke-free" burning of tree limbs and small trees cleared on the project. When mud-covered trees and limbs were fed into this equipment, the resulting cooking action caused smoke over a long period of time. Eventually, the use of small, portable fans was approved as a substitute procedure and the work was efficiently accomplished.

The Vail Pass experience showed that such interference with efforts to cope with the elements in an optimal way can raise costs and even defeat the original purpose. Freedom and flexibility can be important factors in controlling construction costs, even (or especially) under tight environmental restraints.

Techniques for accomplishing this type of earthwork construction are far more advanced now than they were before the Vail Pass experience. Contractors learned to keep water originating above the work areas from running through work areas and carrying loose earth into streams below by placing plastic-lined ditches or temporary pipes across the project area. We learned that water that originated in the work area could either be channeled into settling ponds and processed before going into streams or sprinkled onto nearby hillsides. We also learned how to more efficiently include landscaping, topsoiling, seeding, mulching, and the construction of pollution-control structures in the cycle of normal earthwork operations. And we learned that, through careful channel changes, we could even improve waters for trout fishing.

In the words of a spokesman from the Rocky Mountain Center on Environment, which recently bestowed an award for the work done at Vail Pass, "The project demonstrated that a highway of significant magnitude can be constructed in an area of delicate environment without inflicting permanent environmental damage." Yet much remains to be learned, not only from the standpoint of developing techniques for working within the laws but also from the standpoint of making the laws themselves more workable. Perhaps this can be a starting point.

Abridgment

The Vail Pass Project: View of the Colorado Department of Highways

Jack Kinstlinger, Colorado Department of Highways, Denver

I-70 was constructed over Vail Pass as part of the Colorado segment of the Interstate highway system. Many safeguards had to be designed and constructed so that the project would be consistent with the goals of the Colorado Department of Highways to improve travel efficiency and safety while preserving the environment of the state. An Interstate highway can cause great damage to the mountain environment, and the cost of minimizing these impacts is necessarily great.

Prior to 1973, Vail Pass was crossed by way of a two-lane highway that wound along the valley bottoms. Motorists had to take care to avoid on-coming automobiles, trucks, and campers while viewing the scenery. In those days roadside maintenance was extensive. Traffic was often delayed by stalled vehicles. Winter accidents multiplied as the skiing industry grew.

Today, Vail Pass is safely traversed on a four-lane Interstate facility. Stalled vehicles do not hold up traffic, and roadside maintenance is minimal. The roadway was designed and constructed to fit the land, and the end result allows the motorist many splendid views of the mountain landscape.

For a while it was thought that Vail Pass would go down in history for other reasons. Lawsuits were pending from local communities, the Bureau of Land Management and the U.S. Forest Service conducted critical on-site inspections daily, major geologic problems threatened the integrity of the facility, and local controversy over the project prompted daily newspaper editorials. Traffic delays caused by construction further fueled the controversy.

From this shaky beginning grew a form of interagency cooperation that has spread to other projects. To solve the mounting construction-related concerns, the department pulled together an interdisciplinary team composed of representatives from the U.S. Forest Service, local environmental organizations and citizens, staff geologists, engineers, hydrologists, and landscape architects as well as consultants and contractors to review project plans for potential impacts. Once the impacts were identified, techniques for mitigating them were developed and designed into the project. A project team was set up at the site to ensure that unforeseen problems were quickly solved.

The Vail Pass experience has produced a number of benefits not evident on the pass itself:

1. Credibility of the Colorado Department of Highways with the citizens and agencies of Colorado has been improved. All parties involved in the Vail Pass project now have an improved understanding of the department's capabilities, intentions, and limitations. In subsequent projects, both large and small, a smoother working relationship between the department and other agencies and a better understanding of each other's concerns have been demonstrated. This results in faster project turnover and savings in project costs.
2. The department's environmental impact statements are now more than just paperwork. Environmental design techniques tested at Vail Pass can now be outlined and specified to minimize potential impact areas. This makes the environmental impact statement a design document that directs rather than limits the future design and construction of a project.
3. The interdisciplinary approach has been strengthened and improved by the willingness of agencies and individuals to participate with the department on future projects. This is essential to the environmental impact statement process.
4. A valuable data base has been established on which the Colorado Department of Highways can draw for future projects. Construction techniques tested and used at Vail Pass can now be used with confidence and cost savings on other Colorado highway projects. Engineering and geotechnical applications and new materials and environmental design techniques are part of this data base. The department is now looking at projects constructed prior to Vail Pass to see if they are possible candidates for reclamation actions.

SUMMARY

Vail Pass has provided the Colorado Department of Highways a training ground for a wide range of design and construction techniques. The lessons gained on the Vail Pass project have produced a more cost-