

HAROLD H. HUBER, Pennsylvania Department of Transportation

PENNDOT'S RESPONSE TO EROSION CONTROL

PennDOT has been engaged in post-construction erosion control activities for many years through the use of seeding, mulching and plantings, proper landscape management, and ditch paving. Mention was made of erosion control during actual earth-moving activities in the PennDOT construction specifications; however, this was not enforced, except possibly when the project was in close proximity to a public water supply. In early 1970 the Federal Highway Administration issued a memorandum requiring that all federal and federal-aid contracts be strengthened to include specific temporary pollution control provisions in contract documents and to provide for direct payment for this work. From this memorandum, Pennsylvania adopted a provision for temporary project water pollution control (soil erosion) for projects let since October 1, 1970. The Pennsylvania Department of Environmental Resources prepared a draft of proposed erosion control regulations printed on February 26, 1972, and public hearings were scheduled in May 1972. The Pennsylvania Environmental Quality Board adopted the regulations in September 1972. This regulation requires that a permit be secured from PennDER for any earth-moving activity in excess of 25 acres with the exclusion of farming activities. In Cumberland County, a research project on erosion control is being conducted jointly by PennDOT, the Pennsylvania Department of Agriculture, and the U. S. Geological Survey before, during, and after the construction of Interstate 81. The erosion control methods used on highway construction projects in Pennsylvania are outlined. Other research projects and studies currently under way are also discussed. Aside from water pollution, the PennDOT pollution control program involves other forms of pollution, e.g., air, land, aesthetic, and social.

PennDOT has been engaged in post-construction erosion control activities for many years through the use of seeding, mulching and planting, proper landscape management, and ditch paving. Prior to 1969, temporary erosion control during actual earth-moving activities was very limited; however, it was considered and provided for in the construction specifications for many years. In the fall of 1928 the Pennsylvania Department of Highways officially established the Forestry and Landscape Unit to monitor roadside development and erosion control aspects of highway development. Between 1947 and 1952, the Pennsylvania State University Agricultural Experiment Station conducted research on grass and legume slope plantings. The techniques established by this research served to guide state programs in erosion control throughout most of the Interstate Highway construction program.

Many other agencies, such as the Soil Conservation Service, U. S. Department of Agriculture; the state soil and water conservation commissions; state fish commissions; and state and local water quality agencies, have worked diligently in the past to develop effective erosion control methods and to try to educate a reluctant public in the proper use of these methods.

The present environmental trend has made all of us aware of the need for an intense effort to curb soil erosion problems that are so prevalent every-

where. Soil erosion can effect serious pollution of rivers, streams, and lakes; it can destroy agricultural lands; it can increase maintenance costs for transportation facilities; and it can create hazardous conditions to homes and other structures. If soil erosion can be kept to an acceptable minimum, we can preserve our national resources, reduce maintenance, reduce damage claims, and create better public relations.

CONSTRUCTION SPECIFICATIONS AND GUIDELINES

When the Federal Highway Administration issued a memorandum entitled, Prevention, Control, and Abatement of Water Pollution Resulting From Soil Erosion in April 1970, it became mandatory that all federal and federal-aid highway contracts include specific temporary pollution control provisions in the contract documents and provide for direct payment for this work. PennDOT adopted Section 212, Temporary Project Water Pollution Control (Soil Erosion), which is now a part of construction specifications. This specification has been in effect for projects (including 100 percent state-funded projects) let in Pennsylvania since October 1970.

Section 212 concerns itself with temporary erosion control measures required during the life of the contract to control water pollution. Temporary measures must be coordinated with any permanent erosion control features specified elsewhere in the contract. Our highway designers are encouraged to incorporate more erosion control features into the actual project plans, where they will become biddable items. The highway contractors find this approach to be much more acceptable during the course of bidding on a construction project.

Erosion control measures include utilization of dikes along the top edge of new fill slopes, dams placed downstream from a project to catch construction debris, sedimentation basins in water courses to allow sediment to settle (must be cleaned periodically), slope drains, diversion ditches along the top of cut slopes, interceptor ditches located perpendicular to slopes, jute matting or soil retention blankets in swales, early seeding and mulching, stage or sequential seeding and mulching on cut-and-fill slopes, and causeways constructed across streams to eliminate stream fording (Fig. 1).

One of the major requirements of Section 212 is that, prior to the start of construction, the contractor submit to PennDOT for acceptance a plan showing anticipated erosion control schedules and methods of operation. This requirement is very important and must be emphasized because it is also a requirement of PennDER in the newly adopted erosion control regulations, which include all earth-moving activities. Earth-moving activities involving developments in excess of 25 acres must apply to PennDER for a permit and must be accompanied by a satisfactory erosion and sedimentation control plan. PennDOT has requested exemption from the permit requirement for earth-moving activities on the basis of the 750,000-sq ft (18 acres) limit on exposed area at any one time and also, because highway construction is performed under bond, on the basis of contract and specifications that substantially provide for and require erosion control during construction activities.

EXAMPLES OF EROSION CONTROL

Throughout the 1970, 1971, and 1972 construction seasons, the use of erosion control measures during highway construction continually increased. Increased use of these measures has resulted in improvements in the design of these features and has created a greater understanding of their function. There are many excellent examples on past highway projects where concern was given to protecting watersheds of public water supplies and where special consideration was made during the early design phase of highway development. In some cases, water treatment plants were built prior to construction of the highway where water quality might be jeopardized. In other cases, sedimentation basins and sod-lined roadside ditches were specified on the plans and constructed prior to the start of earth-moving activities to protect the water quality in a stream. Early and many times multiple seeding and mulching were also specified to provide continuous protection to newly graded sections.

It has become common practice during the dewatering of footer excavations for stream overpasses to pump the water into siltation basins for filtering purposes, prior to returning the water to the stream. This procedure (Fig. 2) is now the accepted standard of PennDOT and has the blessing of the Pennsylvania Fish Commission and the Pennsylvania Soil and Water Conservation Commission.

At the present time the PennDOT Bureau of Design is developing a series of standard drawings covering the design of erosion control devices. This series will become a part of the manual containing standard construction drawings that will be made available to all highway designers and consultants for use during design and construction activities.

PRESENT RESEARCH IN EROSION CONTROL

A research project on erosion control measures currently under way (1) is being sponsored by PennDER, the U.S. Geological Survey, and PennDOT. The purpose of this study is to determine the effectiveness of different types of erosion control measures in reducing stream sedimentation during and after construction.

The study area is located in Cumberland County (Fig. 3), west of Harrisburg, and comprises five adjacent drainage basins of compatible size and drainage characteristics. Four of the basins are to be crossed by Interstate 81 and the fifth basin (basin 1) will serve as a control.

The basins vary in size from 0.38 to 0.76 sq mile and are drained by streams with headwaters near the base of Blue Mountain. Each stream is monitored near the point where it crosses Valley Street, located downstream from the project. The portion of highway to be constructed in each of the four monitored basins is to be subjected to different methods of erosion and sediment control.

The portion of I-81 that crosses basin 2 will be constructed using methods of erosion and sediment control practiced prior to the issuance of erosion control guidelines. A rockfill desilting basin will be provided on the stream below the gauging station to trap excessive sediment. This basin will have to be cleaned periodically during construction and may be removed following completion of the highway. In basin 3, the roadway will be constructed using the current Section 212 of the construction specifications to control erosion and sediment.

The roadway in the remaining two basins, 2A and 2B, will be constructed using modified construction practices in addition to those prescribed by Section 212. For basin 2A, these additional sediment control measures will include providing culverts for the existing streams and separate culverts or drainage ditches or both for the runoff from the construction area and roadway surface. The separate drainage will be directed through off-stream desilting basins or spread over nonconstruction areas before entering the stream. We are also considering using only a sheepfoot roller on this section of roadway to provide some on-site storm-water storage, thereby reducing the quantity of runoff water during each storm.

For basin 2B, the additional sediment control measure planned is the installation of two more elaborate on-stream desilting basins than those used with Section 212. The desilting basins in 2A and 2B will be installed prior to the start of the clearing and grubbing operations and will have to be cleaned during construction. Table 1 gives the basins and the type of erosion control measures to be implemented in each.

The collection of rainfall, streamflow, sediment, and turbidity data is in progress at all five sites. The data collection activities consist of continuous monitoring of rainfall, stream stage, and turbidity. Suspended-sediment samples are collected by automatic sampling equipment at selected intervals. Data will be collected to document the phase of roadway construction and the relative cost of implementing the erosion control features incorporated in each basin. The data will be analyzed to evaluate the effectiveness of the various erosion control measures in minimizing sediment concentrations, sediment discharges, and turbidities.

Figure 1. Causeway constructed across stream eliminates need for fording of stream.



Figure 2. Water being pumped from footer excavation and discharged into sedimentation basin.

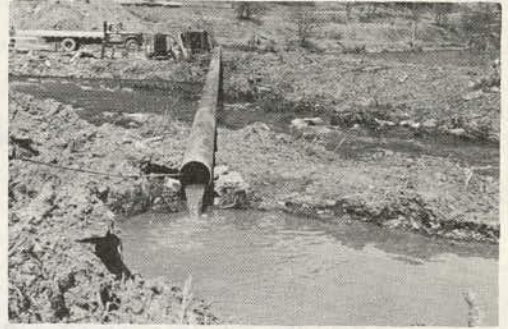


Figure 3. Study area in Cumberland County.

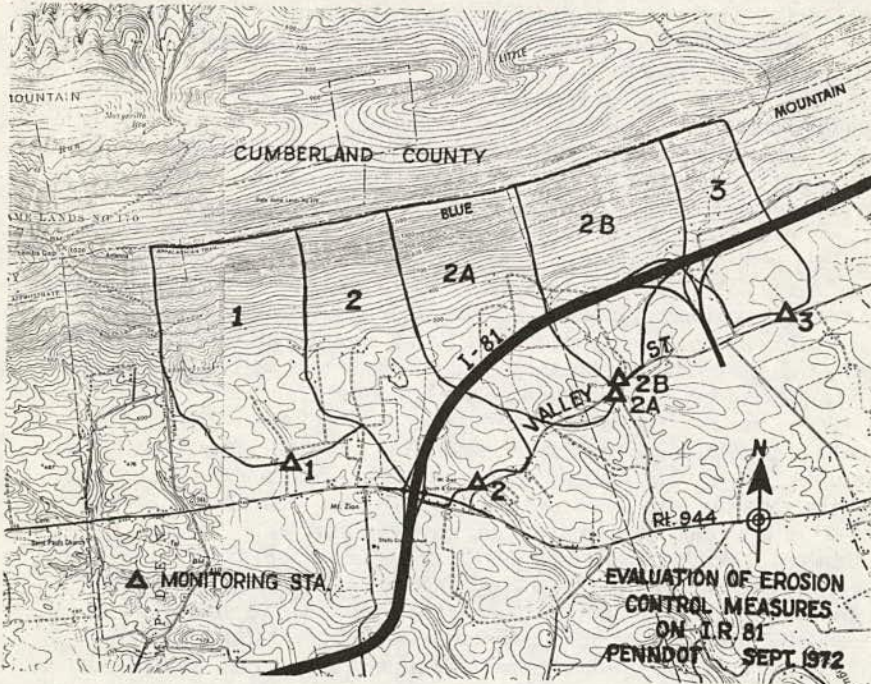


Table 1. Types of erosion control measures to be used on Cumberland County project.

Basin	Main-Line Stationing	Erosion Control Measures
1	Control area	None
2	475 to 516 SB 480 to 522 NB	Practices used prior to Section 212 guidelines
2A	516 to 542 SB 522 to 549 NB	Section 212 plus separate drainage, off-stream desilting, and sheepsfoot roller
2B	542 to 576 SB 549 to 568 NB	Section 212 and on-stream desilting basins
3	586 to 616 SB 589 to 613 NB	Section 212 guidelines

OTHER RESEARCH PROJECTS

Another erosion control study is being conducted by the Department of Civil Engineering of Bucknell University, sponsored by the U.S. Department of Transportation and PennDOT. The study area involves Interstate 80 in the White Deer Creek drainage basin approximately 12 miles south of Williamsport.

The Division of Roadside Development in PennDOT's Bureau of Maintenance conducted an experiment in 1971 to evaluate chemical mulch as an interim means of controlling erosion when multiple or sequential seeding is required during construction or maintenance activities. Four experimental plots were established to compare and evaluate several chemical mulches available at the time.

The bureau is also attempting to consolidate the approximately 1,200 chemical stockpile areas and to eliminate those located close to streams. At many of these areas, asphalt pads and sediment basins have been built to eliminate the leaching problems associated with chemical stockpiling. A study of damage from a model salt storage facility is being conducted near the intersection of I-80 and I-81 in Luzerne County. Continuing studies are being made on the proper use and application of salt for de-icing purposes.

A research project involving stream relocation during highway construction is being jointly sponsored by the Pennsylvania Fish Commission, the U.S. Geological Survey, and PennDOT. During the construction of Penn-15 north of Williamsport, a 2,700-ft relocation of Blockhouse Creek, a fishing stream, is required. Water quality samples and fish and insect data have been collected from the stream prior to highway construction and stream relocation activities. Sampling will continue throughout the construction phase to determine the effects of the relocation on the stream life. Sampling will also take place after construction to determine the length of time required for the stream to return to normal. Past studies of this type have indicated that, with the use of proper planning procedures, effects on the stream life can be minimal.

A research project to investigate the build-up of sodium and chlorine ions in roadside soils has been submitted to the Federal Highway Administration for approval. An excess accumulation of sodium ions in a clay soil has deleterious effects on the soil structure through deflocculation of the clay particles and subsequent disruption of drainage. It is not known how fast these ions may accumulate under various conditions of climate, soil type, and rates of application. In all probability, modifications of design will be required with emphasis on the prevention of salt-laden water coming in contact with clay-containing subgrade soils. This might be done by the use of an impervious surface or by the use of porous granular materials to intercept this water before it penetrates the subgrade. There is also the possibility of the use of additives that will counteract the deflocculation action of the sodium.

ADDITIONAL ENVIRONMENTAL STUDIES

Since the National Environmental Policy Act of 1969 came into being, PennDOT has experienced a tremendous change in its environmental philosophy. PennDOT highway district personnel are actively engaged in the preparation of environmental impact statements, necessitating in-depth analysis of environmental effects along all proposed highway corridors. Other state agencies are required to review and comment on the environmental impacts for all highway proposals within the commonwealth. The Soil and Water Conservation Commission of PennDER is responsible for providing the expertise and performing the necessary study of erosion control for all proposed highways.

Water quality sampling before, during, and after construction of highway projects to evaluate sediment loads in adjacent streams has become a normal procedure in PennDOT. Many of the 11 highway district offices are now equipped with portable water testing equipment and perform their own analyses. Testing equipment is also available in the central laboratory of the Bureau of Materials, Testing, and Research for those district offices that are not fully equipped or where more in-depth analysis is required.

A more comprehensive research project is being proposed to evaluate several existing or recently developed chemical soil stabilizing agents and to determine the relative effectiveness of these materials as compared with the hay and straw mulch currently in use (2). In addition, the length of effectiveness, cost, ease of application, and other factors will be investigated. These chemicals have shown promise of temporarily reducing soil erosion when sprayed on slopes. They form a surface layer of aggregated particles that readily permit penetration of water and air, allow the emergence of germinating seeds, and are relatively stable under rainfall.

The control of erosion and the resulting sediment is a concern that deserves the full attention of everyone involved with disturbance to large quantities of earth. The response to this need by highway design and construction engineers, and especially by contractors, has been gratifying, as evidenced by the growing use of erosion control measures on construction projects today. It is necessary, however, that proper evaluation be made of those erosion control methods and procedures currently in use to determine their effectiveness under varying conditions. It is also important that a continuing search be made for new and improved methods for controlling erosion. Finally, for use to benefit fully from any new developments on the state of the art, it is necessary to find means of effectively disseminating this information.

REFERENCES

1. Reed, L. A. Evaluation of Erosion-Control Measures Used in Highway Construction. U.S. Geological Survey, Sept. 23, 1971.
2. Chittendon, D. G. An Evaluation of Several Chemical Soil Stabilizing Agents. PennDOT, July 25, 1972.