

AN EVALUATION OF THE EROSION-SILTATION CONTROL  
PROGRAM OF THE VIRGINIA DEPARTMENT OF HIGHWAYS  
SUMMER 1973

by

W. Cullen Sherwood  
Faculty Consultant

and

David C. Wyant  
Highway Research Engineer

Virginia Highway Research Council  
(A Cooperative Organization Sponsored Jointly by the Virginia  
Department of Highways and the University of Virginia)

Charlottesville, Virginia

February 1974  
VHRC 73-R33



## SUMMARY

During the summer of 1973 the authors conducted a statewide survey of the present state of the art of the Virginia Department of Highways' erosion and siltation control program. The survey included field observations of erosion and siltation control measures on many highway projects and interviews and discussions with over 50 field personnel actively associated with erosion and siltation control. The notes and observations from this survey formed the basis for 29 recommendations made to the Department through the Research Council's Environmental Research Advisory Committee. The recommendations are presently being implemented.



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INTRODUCTION

During the period roughly encompassing 1969 through 1971 the Virginia Department of Highways instigated an extensive and far-reaching program of erosion and siltation control. Prior to that time Virginia had been recognized as a leader in this area (Dillard, Sherwood and Reynolds — 1970),<sup>(1)\*</sup> but the level of national recognition of the sediment problem and expectations for control were generally low. Since 1969 the nationwide level of concern in the area of sediment pollution has heightened dramatically. Consequently, activities such as subdivision development and highway construction and maintenance, which have a high level of public visibility, have had to show leadership in erosion and siltation control.

To this end, in May 1973 the Environmental Quality Division of the Virginia Department of Highways requested that the Research Council conduct a statewide survey of the present state of the art of the Department's erosion and siltation control program.

GENERAL OVERVIEW

Historical Perspective

A close look at Virginia's past efforts to control erosion and siltation from highway activities indicates that the activities fall into three well-defined eras: 1) the pre-1969 era, 2) the 1969-71 era, and 3) the post-1971 era.

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\* Numbers in parentheses refer to entries in the list of references.

For many years prior to 1969 the Landscape Division worked diligently to develop a program which would stabilize as well as beautify the highway rights-of-way in Virginia. Often with limited funds, this Division made great contributions, mainly in the area of turf development and maintenance. The work of R. E. Blaser <sup>(2)</sup> also contributed greatly to this program. Perhaps even more important, the Division developed a corps of field personnel who had the background and dedication for solving many of the problems involving erosion and siltation. So when increased administrative support and resources were made available about 1969, the era for very rapid improvement in erosion and sediment control began. This 1969-71 period saw tremendous improvements statewide in the control program. Early mulching and seeding and a variety of measures to contain silt-laden waters at the construction site were brought into widespread use.

Since 1971 it appears that the Highway Department has undergone a leveling off period of consolidation and evaluation in the area of erosion and siltation control. Some apparently promising measures have proven to be disappointing in field practice whereas others have proven to be better than expected. Additional measures have been borrowed from industries experiencing similar problems. In every case valuable insights have been gained and lessons learned by both field forces and interested administrative and research personnel.

#### Present Problems and Opportunities

Hopefully, this report will aid in bringing about era number four, wherein the knowledge and experience gained to date will allow a reassessment of the whole erosion-siltation program. Some measures should be eliminated, some altered, and some new ones instigated. These actions should allow a period of rapid improvement and statewide standardization in the control program.

Basically, the philosophy which seems to be evolving is one that says "Keep the soil on the right-of-way." Once soil enters a live stream and the silt and clay fractions become suspended, it is virtually impossible to trap and remove this material. Field forces report that even if a check dam is successful in trapping some silt during low water, the silt is usually mobilized and swept downstream during high water periods. It becomes obvious that the skillful use of such measures as straw bales, berms, brush barriers and scooped-out silt traps must provide the major defense against the escape of silt - and clay-laden waters into live waterways.

An area of constant concern in all disbursements of public monies is the matter of costs. While no specific studies of costs have been made for this report, in at least two cases contractors have indicated to field personnel that instead of increasing costs early seeding and erosion control have actually resulted in savings due to the decreased needs for re-dressing slopes and replacement of soil formerly removed by erosion.

Finally, in making this statewide review of erosion and siltation control it became obvious that the level of expertise and concern in this matter varies widely from district to district and even within projects in some districts. Some projects had a very high level of erosion and silt control, others significantly less control. In general, the interstate and primary jobs exhibited a higher level of control than the secondaries. However, it must be pointed out that a number of high level projects, some in critical situations, showed a minimum level of control.

### An Evolving Process

Erosion and siltation control must be an evolving process. What is effective during one phase of a project might require major alteration and/or additions during the next phase. Often the features shown on plans are not appropriate during certain periods of construction.

This constantly changing situation means that the person responsible in the field must have the experience and orientation to think erosion-siltation control. It also means that control cannot be a one-shot affair but requires constant attention throughout the life of a project. Also, proper maintenance of control measures is necessary. In approximately 50% of the cases observed in the field, control measures had not been optimally maintained. Straw bales were undercut or moved, berms were breached and drop inlets were partially or totally filled with sediment. These occurrences all add up to the age-old problem of personnel. Virginia has moved so rapidly into this era of erosion-siltation control that experienced people are not available for each job. In specific instances inspectors and even project engineers were anxiously willing to exercise erosion and siltation control but were not experienced enough to know how to go about it in the most efficient manner.

In virtually all cases the attitude of the field people contacted was good, ranging from enthusiastic to at least a show of patience. The lack of any widespread negative attitude toward erosion and siltation control would seem to indicate that further improvement in this program can proceed rapidly.

Recommendations that will hopefully result in improvements in the Virginia Department of Highways program of erosion and siltation control are contained in the following section.

## RECOMMENDATIONS

The recommendations presented here have resulted from a number of related efforts aimed at evaluation and upgrading of the Department's efforts in erosion-siltation control. The most important of these have been statewide field observations and interviews with field personnel. Other input has resulted from field monitoring of suspended silt concentrations, contact with other concerned agencies, and a review of the literature. The resultant recommendations have been divided into four categories: (1) Erosion Control, (2) Silt Control, (3) Critical Area Protection, and (4) Organization and Administration.

Erosion Control

Recommendation No. 1: Maintain a Strong Emphasis on Early Seeding and Stage Seeding.

Early seeding appears to be the single most effective effort in the erosion-siltation control program. Any attempt to slacken or alter this effort should be vigorously opposed. Some field people feel that seed is being wasted by seeding rocky or shaley banks or seeding "out of season." Other criticisms have been leveled at the unusual appearance of stage seeded cuts. These criticisms appear to be invalid in view of the great benefits resulting from this program and the fact that the vegetation on slopes so seeded tends to homogenize in a short period of time.

Recommendation No. 2: Use of Rough Grading and Furrowing of Cut and Fill Slopes Should Be Increased.

Rough or furrowed slopes allow the accumulation of seed and moisture necessary for establishment of vegetative cover. It appears that smooth grading and topsoiling may be unnecessary or even deleterious in many cases.

Recommendation No. 3: Establish a Minimum Slope of 1 1/2 to 1 for All Cuts and Fills.

Steep slopes are extremely difficult to vegetate and maintain. Even good stands of turf will sluff during the winter months and suffer from drought during summer if soil slopes are too steep. Good vegetative cover is possible on slopes of 1 1/2 to 1 or less.

Recommendation No. 4: Increase the Use of Half Round Fiber Pipe for Both Temporary and Permanent Drainage.

Half round fiber pipe is light, easy to install and inexpensive. It should be used to a greater extent in temporary down drains. Some projects used sheet plastic as temporary down drains. However, sheet plastic has several drawbacks in that it tears and punctures easily and is hard to retain in place. Increased use of half round pipe as permanent drains should also be considered. Easier and quicker installation, low cost, and greater flexibility of use over concrete paved ditches may make this substitution attractive.



For instance, regrading an area requires all new paved ditches whereas half round pipe could be removed and replaced. Also heavy rains can wash out or damage paved ditches prior to final set.

Recommendation No. 5: Increase the Use of Riprap in Drainage Ways, Along Toe of Fills and as Stone Baffles.

Another substitute for concrete paved ditches is stone. Stone acts as an excellent energy dissipator, allows some vegetation, is difficult to undercut, and may be inexpensive. In many cases the stone is available on the project. The placement of stone baffles in the ditch lines may also slow the flow of water, filter out sediment, and lessen the impact on discharge areas downstream. It should be pointed out here that cement supplies for concrete are becoming increasingly tight and expensive.

Recommendation No. 6: Place Paved Ditches as Early as Possible in the Life of the Project.

On some projects paving of ditches is deferred until late in the construction process. This practice creates two problems. First, the ditches continue to erode during the interim period, and second, significant areas of previously established turf on the cut slopes are usually destroyed when the ditch lines are recut prior to placement of the concrete. This recutting process also tends to steepen or round the lower portion of the cut slope, which may lead to sluffing or other instability.

Recommendation No. 7: Reassess the Department's Policy on the Use of Kudzu.

In a limited number of situations statewide, steep rocky slopes and other adverse conditions make it extremely difficult to establish conventional turf-type vegetation. In many of these cases there are no man-made or natural features which could be disrupted by the aggressive growth of kudzu. It is suggested that a limited research effort be expanded to plant and evaluate kudzu in a number of these situations.

Recommendation No. 8: Consider the Use of Pitch Pines in Place of Virginia Pines as Plantings Along State Rights-of-Way.

Thomas Dierauff, head of the research section, Virginia Division of Forestry, has suggested the use of pitch pines in place of Virginia pines. His reasons for suggesting this substitution are as follows: (1) pitch pines are well suited to the dry, low fertility conditions found on cut and fill slopes. (2) Virginia pines grow strictly from the ends of the limbs, while pitch pines continue to sprout from the lower portions of the stump and could be topped to make them bush out at the low levels. (3) Pitch pines are longer lived than Virginia pines so that removal and replacement costs would be less through time.

Finally, a check of cost indicates that the Virginia Division of Forestry can supply the young pitch pine seedlings for exactly the same price as the Virginia pines.

Recommendation No. 9: Increase Efforts in Establishing Vegetation on Old Bare Secondary Road Cuts.

Large numbers of bare secondary road slopes statewide still remain as chronic sources of sediment pollution. At least one district has a policy whereby anytime they find themselves with left-over seed and mulch in a hydroseeder they apply this material to a nearby bare secondary road slope or one on the way back to the shop rather than wasting the material.

Special seed preparations such as love grass and crown vetch are also being re-searched in test sections in Fairfax County by Dr. Blaser and the Research Council. Valuable information for stabilization of very steep slopes is expected to result from this study shortly.

Silt Control

Recommendation No. 1: Severely Limit All Activities in Live Streams.

As mentioned previously, the basic philosophy should be to keep silt out of live streams to the greatest extent possible. The reason for this is based on the fact that once a particle of sediment gets into a live stream it is very difficult to remove or control. In most instances observed the effectiveness of check dams or barriers in live streams appeared to be questionable. They are expensive and difficult to maintain properly. The same effort and expense directed toward measures designed to keep silt from entering the stream initially would appear to be highly preferable.

The desirability of keeping construction equipment out of streams whenever possible should also be emphasized.

Recommendation No. 2: Limit the Use of Semipermanent Siltation Basins.

The linear nature of highways and the constantly changing construction process make the installation of expensive semipermanent silt control measures such as siltation basins seem impractical in most cases. These measures appear to be most effective where intensive and long-term construction similar to subdivisions or large buildings is involved. In most cases involving highways the use of numerous small, temporary berms and hastily pushed out depressions acting as silt traps will be more effective than a single structure. These small, inexpensive temporary measures can be altered rapidly in response to changing conditions and can be a part of the construction process.

In the use of berms and traps it becomes necessary for the contractor as well as the inspector and other highway personnel to "think erosion-siltation control;" always keeping in mind the question of "What would happen now or tonight if a hard rain fell?"

Recommendation No. 3: The Design Phase Should Minimize Channel Changes and Location of Roads Near Live Streams.

The altering of streams in any way often causes both temporary and long-term conditions which produce silt. Also, construction immediately along streams results in the spilling of construction materials into the streams and the necessity of moving equipment into the streams. Also riprap and retaining walls are built to keep the streams from undercutting the roadways.

In most instances slight alignment changes during the design phase will allow placement of the road at a distance from the stream sufficient to allow a green belt and provide working room for the equipment. During the statewide survey cases were observed in which the placement of the new lanes of an arterial highway on the other side of the existing lanes would have eliminated the necessity for extensive channel changes which were taking place.

Recommendation No. 4: Set Bridge Abutments Well Back from the Edge of Large Streams and Rivers.

At most large streams the bridge abutments are set well back but in a few cases the approach to a bridge is being placed near the edge of the stream, which causes spill over of soil into the stream during construction and also makes the abutment more susceptible to erosion during flooding subsequent to construction.

The limited passage area may also cause greater future flood damage to structures than would a more open one.

Recommendation No. 5: Maximize the Use of Brush for Erosion Prevention During Construction.

In three cases open burning of brush piles on the right-of-way was observed. In other cases brush had been hauled to dumps some distance from the project. In virtually every case this brush would have been valuable as silt control barriers along the right-of-way. It is recommended that whenever possible the brush, root mat, and any other vegetable debris and some soil be pushed into windrows along the downhill edge of the right-of-way. This barrier, particularly along the toe of fills, gives excellent silt control. In most instances the material need not be removed when construction is complete since vegetation will grow over it and the brush will decay and produce humus that will further promote plant growth.

To reiterate, allowing brush to be burned (which is a questionable practice in view of air pollution concerns) or be hauled to waste areas is expensive and also eliminates one of the best materials for silt barriers.

Recommendation No. 6: Use Shallow Lateral Ditches to Divert Silt-Laden Waters into Vegetated Areas.

In many cases construction traverses areas of heavy brush, grass, or forest. It may be preferable to divert water off the project into these noncritical vegetated areas rather than let it build up to large volumes at the toe of hill slopes and run directly into streams. Constructing and maintaining a few of these ditches would cost little while the decrease in water volume flowing directly into the stream and the filtering action of the vegetation on the diverted water could be significant. Straw barriers could be placed at the ends of these ditches if significant volumes of water are expected.

Recommendation No. 7: Pipe and Culvert Placement Should be Designed so that Construction Could be Accomplished Outside of Existing Stream Channels.

At present many designs require the placement of pipes or culverts in existing stream channels. This practice necessitates the excavation of a bypass for the stream during construction and then a change back into the original channel following completion of the structure. This changing back and forth, together with the silt produced by the stream trying to equilibrate in the temporary channel, mobilizes considerable quantities of silt.

The alternative to this problem would be to excavate and place pipes and culverts in openings parallel to the existing stream channel and then make a single diversion of the stream through the structure at the appropriate time.

Recommendation No. 8: Exercise Greater Care in Keeping Sediment Out of Drop Inlets.

Most of the drop inlets observed during the survey were either insufficiently protected or not protected at all. The typical case involved an unseeded and unpaved median or side ditch which had a long slope. In such a case, water in considerable volume will pick up silt and flow down the drop inlet and out into a drainageway or stream.

Straw bales together with a dug out or depressed area around the drop inlet will slow and filter the water before it flows into the structure. Additional barriers at the outlet ends of the drain pipes would further protect downstream waters.

Recommendation No. 9: Exercise Greater Care in Placing Straw Bales.

In virtually every case observed straw bales were properly staked. The weakness noted in several cases involved the flow of water under the bales. Once this started, undercutting became rapid and the effectiveness of the straw barrier was severely reduced. In order to eliminate this problem one district has adopted the practice of placing the bales

in a shallow trench and putting soil back against them. This arrangement forces the water to go through or over the bales rather than under them.

Recommendation No. 10: Place Depressions Behind Long Berms at the Toe of Fills and at the Foot of Denuded Hill Sides.

When brush barriers are not used, a ditch or depression with a berm on the lower side can be an effective silt trap. It can be made large enough so that all of the down flowing water will be trapped and none of the silt will escape. However, in case of very heavy rainfall a straw or rock spillway should be installed to eliminate a breach of the soil berm.

Recommendation No. 11: Bench and Riprap all Fills Which have a Live Stream at or Near the Toe.

Riprap is used extensively at present near the toe of fills so this recommendation is not a new idea. The bench is used in some cases and the results appear to be excellent. First, it forms a place where spilled construction soils will catch rather than fall down into the stream. Second, the flow of water downslope will be broken at the bench. Also, the bench produces an excellent environment for rapid and strong vegetation growth.

#### Critical Area Protection

Statewide field observations substantiate the obvious conclusion that some areas require a far greater effort for erosion-siltation control than others. Areas requiring a high level of protection should be labeled as critical areas prior to construction and be so designated on the plans. These areas would include such features as ponds, lakes, reservoirs, lawns, parks, and streams containing game fish such as trout. Not only a high level of control but constant surveillance and maintenance should be expended in these areas. This suggestion is certainly not to downgrade the control efforts in other areas but it is obvious that many heavily vegetated areas such as forests, second growth lands, and old fields can accept some silt without showing deleterious effects, whereas any additional sediment in a pond or trout stream is obnoxious. With this division in mind the following recommendations are offered.

Recommendation No. 1: Prior to Construction, Evaluate the Level of Erosion-Siltation Control Needed Based on the Potential Off Site Damages Which May Result.

This recommendation is based on the reasons presented above and might be accomplished during the writing of the environmental impact statement, during the design phase, or at the time of the field inspection.

Recommendation No. 2: Leave and Maintain As Long as Possible a Belt of Vegetation Along Streams on or Near Construction.

A belt of vegetation even 50 feet in width can catch and hold a surprising amount of silt. The vegetated area will also produce a minimum amount of silt even if water overflow is heavy. This policy could be tried even during and after the clearing and grubbing operation. If the stream lies out of the roadway or if the stream is large and is to be bridged, the belt might be left undisturbed throughout the job. If a culvert and fill are to be constructed the green belt could be maintained as long as possible before the actual fill is placed.

Recommendation No. 3: Investigate the Use of Gabions in Steep, Erodable Areas Along Critical Streams.

Gabions filled with rocks have seen only limited use in Virginia. However, those field personnel who have experience with what gabions can do are impressed and recommend that they be tried. Their effectiveness might be a subject suitable for a small research project.

Recommendation No. 4: More Work Should be Done to Rehabilitate Streams Which Have Undergone Channel Changes.

This subject also might be worthy of a research project. Where streams have naturally flowed as alternating pools and riffles, channel alteration leaves only a straight chute. Where bushes and trees have shaded the stream, construction often leaves the edges bare of vegetation. Rehabilitation efforts directed toward more natural flow patterns and re-introduction of shading vegetation should be considered. The I-77 alteration involving Wolf Creek in Bland County is an example.

Recommendation No. 5: Explore the Possibility of the Use of Asthetic Arched Structures as Alternatives to Great Cuts and Fills.

In Europe and California beautiful arched structures have been used to dramatic effect to bridge valley areas. When compared to the massive cuts and fills commonly used in most other areas the environmental disruption appears to be much less. If costs can be determined to be even nearly comparable the use of these structures should be considered.

Organization and Administration

Recommendations for organizing and administering erosion and siltation control in the field was not a primary aim of the survey. However, during the interviews and field trips some observations were made and these are offered here for whatever merit, if any, they may contain.

Recommendation No. 1: Where Downstream Use of Water Could be Affected by Silt Generated by Construction a Notification or Preconstruction Conference with Downstream Users May be Helpful.

Examples of downstream users would include municipal and industrial water supplies, swimming facilities, and fishing. The preconstruction conference could point out to the user that any highway induced silt would be temporary and would be controlled to the greatest extent possible with present technology. It will also put the user in a better position to anticipate suspended sediment during and after rains so he can plan his withdrawals and use accordingly.

The public relations aspects of such a program could be considerable.

Recommendation No. 2: Establish the Responsibility for Field Control in a Single Individual in Each Construction District.

This recommendation was offered in the Dillard, Sherwood and Reynolds (1970) report and has been carried out fairly well in most districts. However, the position of the designated person varies from district to district with a corresponding variety of background experience. The assistant district engineer in charge of construction, the landscape superintendent, the landscape associate, and the compliance officer are all charged with this responsibility in one or more districts.

Ideally, a landscape engineer with strong ties to the Environmental Quality Division in Richmond might best handle this job in each district. It is the authors' conclusion that some 50% of this person's time should be spent on erosion-siltation control over the next five years.

Recommendation No. 3: Increase the Technical Aid and Inspector Effort from the Environmental Quality Division to the Individual Charged with Erosion and Siltation Control at the District Level.

A person with extensive experience and knowledge in erosion and siltation control should be made available by the Environmental Quality Division to the districts. This person would work closely at helping the district man in consulting on special problems and dissemination of the latest knowledge on control procedures. This arrangement would ultimately serve to help all districts reach a high level of control and would serve to cross fertilize ideas and innovations from one district to another.

Recommendation No. 4: Increase the Educational Effort on Erosion-Siltation Control at all Levels Down to Inspector.

The authors are convinced that the most important aspect of a successful erosion-siltation program is awareness. The field forces must be induced to "think" erosion-

siltation control. They must consider it important and constantly be on the lookout for problem areas and spots where improvements could be made. If this awareness could be instilled in the man in the field, then the actual monetary costs of control of erosion and siltation will be relatively small. Most of the control measures such as berms and barriers will become part of good construction practice. In fact, as mentioned earlier in this report, in at least two cases erosion and siltation control practices now in effect have actually saved money rather than raising costs significantly.

Obviously, few will quarrel with a program which enhances the environment and saves taxpayers money at the same time.



## ACKNOWLEDGMENTS

The authors wish to express appreciation for the cooperation of the field forces at all levels who provided information and insights for this study. Special thanks are also due Robert L. Hundley and Willie R. Smith of the Environmental Quality Division.

The project was conducted under the general direction of Jack H. Dillard, state highway research engineer, and under the specific direction of Mehmet C. Anday, head of the Soils, Geology, and Physical Environment Section.



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