Environmental Protection Agency
Great Lakes National Program Office
January 1979

EPA

Impact of Nonpoint Pollution Control on Western Lake Superior

Final Report on the Red Clay Project —Summary Report

Preface

The U.S. Environmental Protection Agency was created because of increasing public and governmental concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment.

The Great Lakes National Program Office (GLNPO) of the U.S. EPA was established in Region V, Chicago, to provide specific focus on the water quality concerns of the Great Lakes. The Section 108(a) Demonstration Grant Program of the Clean Water Act (PL 92-500) is specific to the Great Lakes drainage basin and thus is administered by the Great Lakes National Program Office.

Several sediment erosion-control projects within the Great Lakes drainage basin have been funded as a result of Section 108(a). This report describes one such project supported by this office to carry out our responsibility to improve water quality in the Great Lakes.

We hope the information and data contained herein will help planners and managers of pollution control agencies to make better decisions in carrying forward their pollution control responsibilities.

Dr. Edith J. Tebo
Director
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GREAT LAKES NATIONAL PROGRAM OFFICE

January 1979

IMPACT OF NONPOINT POLLUTION CONTROL ON WESTERN LAKE SUPERIOR

"Western Lake Superior Basin Erosion-Sediment Control Project"

RED CLAY PROJECT FINAL REPORT: SUMMARY

A Cooperative Interstate Effort Between the
Ashland, Bayfield, Carlton, Douglas and Iron County Soil and Water Conservation Districts.

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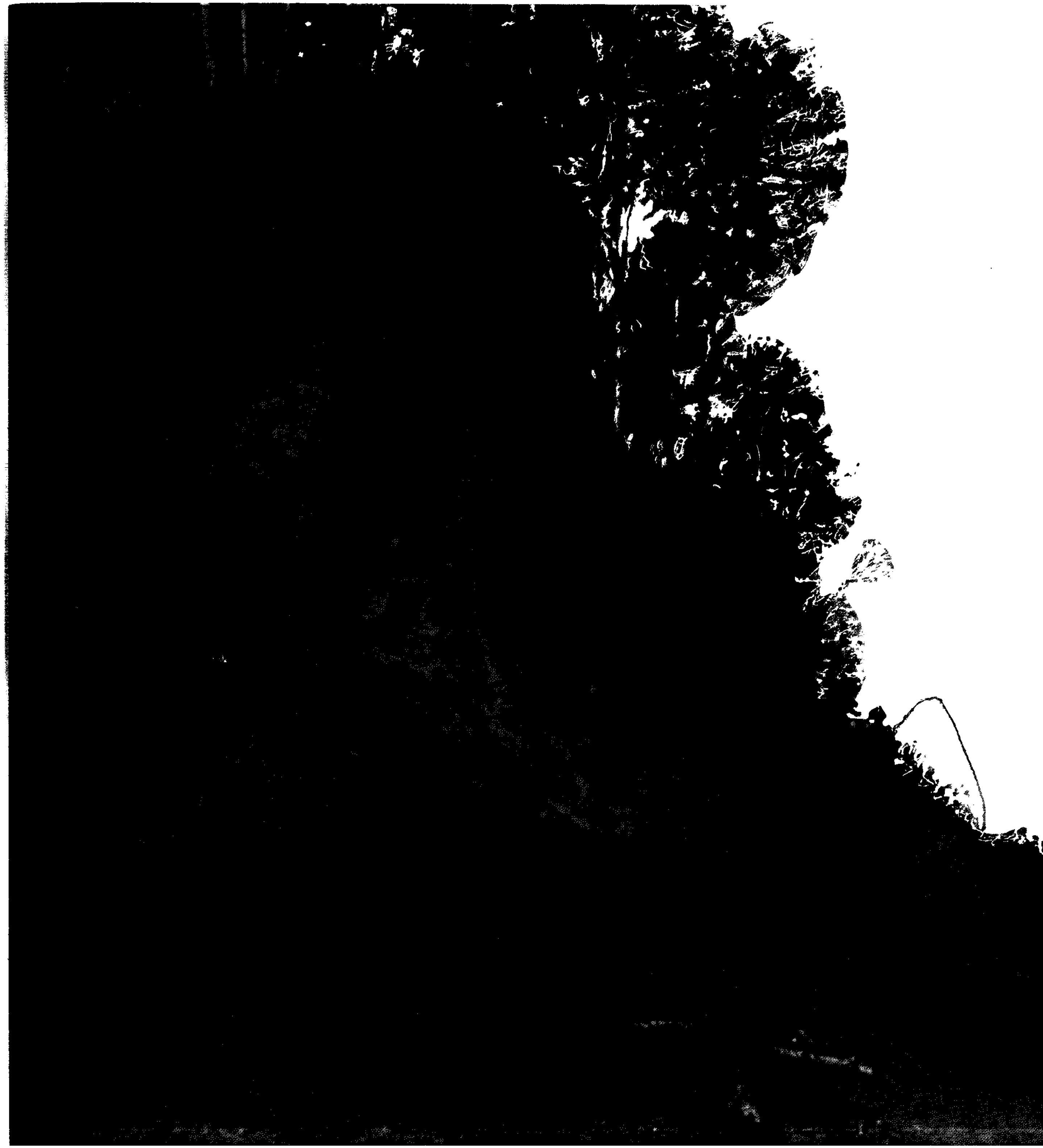

Foreword

Since the first settlers arrived in the western Lake Superior basin, the red clay soils dominating the region have presented problems. For those involved with lumbering, construction, agriculture and transportation, the primary concern was the pervasiveness of the erosion problem and associated damages and costs.

With the formation of soil and water conservation districts in the 1930's and 1940's, the red clay erosion problem, particularly as it affected agriculture, began receiving attention. In the early 1950's the first systematic study of erosion and land use problems was initiated in Wisconsin by the governor-appointed Red Clay Interagency Committee. This early work was primarily aimed at demonstrating techniques for reducing upland and roadside erosion and stabilizing streambanks. The focus of this committee's efforts was more on treating the erosion problem than on abating water pollution.

The first Lake Superior Water Quality Conference in the early 1970's focused some attention on the south shore erosion and sediment problems. In response, Wisconsin's

Red Clay Interagency Committee was given the charge of identifying the extent of the problem and outlining an erosion and sediment abatement plan.

At about this same time, the soil and water conservation districts from Douglas County, Wisconsin and Carlton County, Minnesota met jointly to consider ways of reducing erosion in the Nemadji River Basin. With assistance from the Northwest Wisconsin Regional Planning Commission, the Onanegozie Resource Conservation and Development Project and the Pri-Ru-Ta Resource Conservation and Development Project, the two districts prepared plans for studying the problems and originated proposals for funds to implement the plans.

In 1973 the Wisconsin Board of Soil and Water Conservation Districts was instrumental in arranging a tour of the red clay area for representatives from Region V of the United States Environmental Protection Agency. The Environmental Protection Agency was authorized by Congress to demonstrate new methods for improving water quality in the Great Lakes with funding provided by Section 108 of the 1972 Amendments to the Federal Water Pollution Control Act. In May of 1974 with a grant from the U. S. Environmental Protection Agency and the continuing assistance of many agencies, the soil and water conservation districts from Ashland, Bayfield, Douglas and Iron Counties in Wisconsin and Carlton County in Minnesota began the Red Clay Project.

This document is the final report of the Red Clay Project. It is the summary report which presents the project's findings, conclusions and recommendations and is accompanied by a technical report which contains detailed accounts on the various research and demonstration activities.

EPA Review Notice

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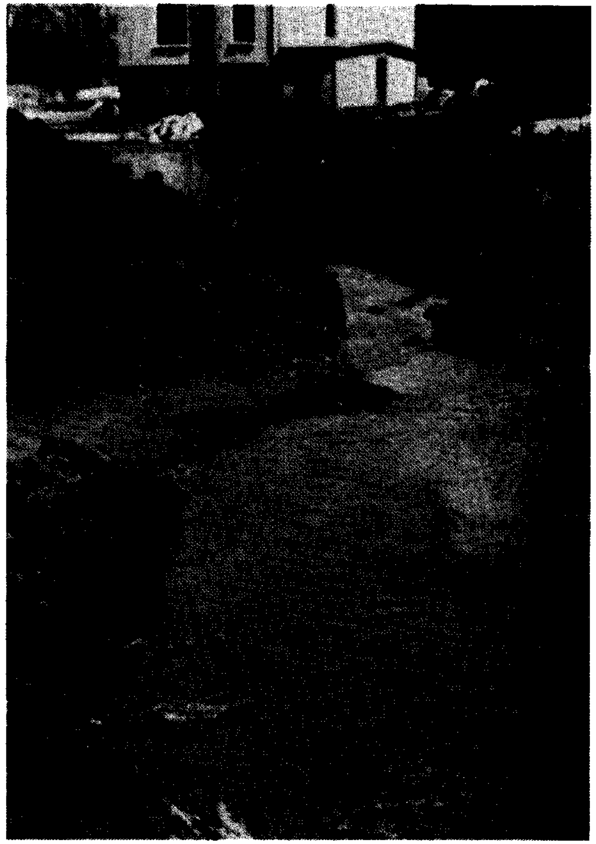
Some nonpoint sources of pollution are streambanks . . .

. . . roadsides . . .



. . . urban construction areas . . .

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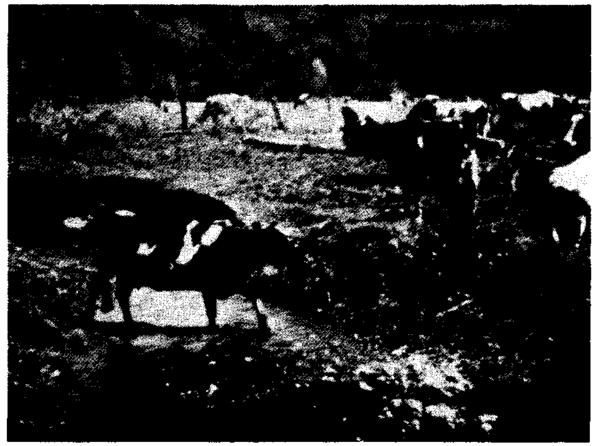


Nonpoint Source Pollution Problems

With the passage of the 1972 Amendments to the Federal Water Pollution Control Act (Public Law 92-500), a renewed national emphasis was placed on solving the problems of water pollution. This act granted powers and authorities for studying the problems and for planning workable ways to solve them.

The act classified the serious water quality problems which inspired it into two major types based on their source. "Point" sources of pollution include readily identifiable sources such as municipal sewage treatment plants and industrial waste discharge systems. "Nonpoint" sources of pollution are less easily identified because they are varied and diffuse. They include runoff and seepage from agricultural land, urban areas, forestry activities, construction and maintenance operations, and mining sites.

Common pollutants from nonpoint sources are sediment, nutrients, pesticides, heavy metals and salts. Of these, sediment is the most abundant and, in some ways, is the most severe because it is not only a pollutant itself, but transports other pollutants.

Red Clay Problems

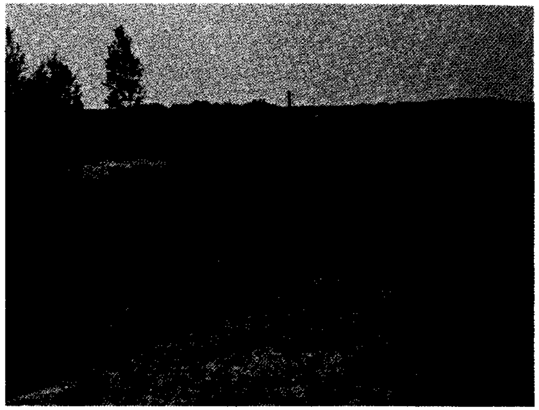
The red clay area of the western Lake Superior basin extends in a narrow band from northeastern Minnesota to the western portion of Michigan's upper peninsula. The predominant soils in this area are red clays interspersed with sands and silts. They were originally deposited as lake sediment during glacial periods but now, due to lake recession

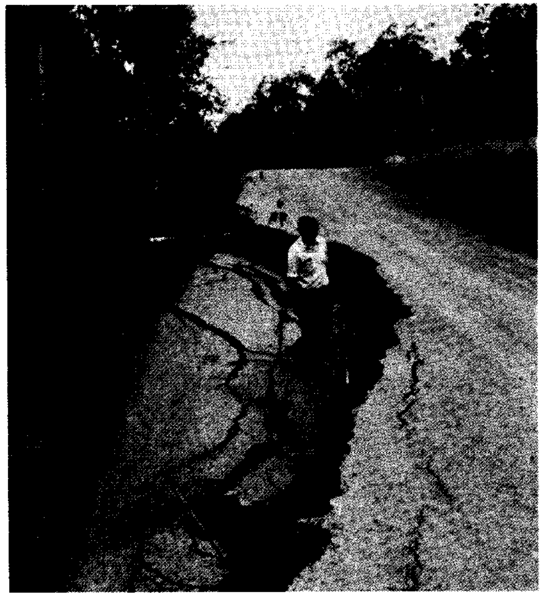
Runoff from barnyards enters streams carrying with it animal wastes and other pollutants.

and geologic uplift, they form much of the land mass of present-day Lake Superior's south shore.

The soils are young and are undergoing a high rate of natural erosion as a geologic equilibrium evolves. When man settled in the area his lumbering, construction and agricultural activities removed the established vegetation and altered drainage patterns in ways that accelerated this already high rate of erosion. Present-day activities, although not intensive, do still aggravate the erosion processes. In turn, erosion is detrimental to man's land and water-based activities alike.

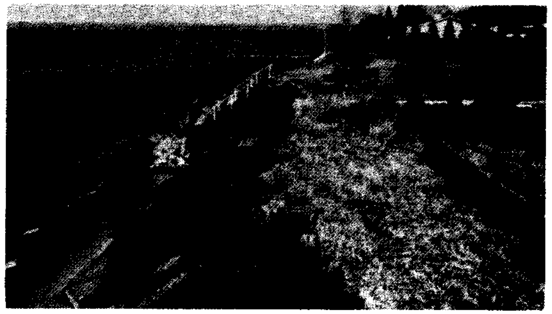
The major nonpoint sources of pollution in this area are the lakeshores, streambanks and other slopes. The damaging pollutants are sediment, turbidity and color. The heterogeneous mixture of clay and sand produces soils with very little stability which, when exposed to varying moisture conditions on steep slopes, often erodes severely. Once in the water, the heavy particles settle out as sediment and the fine particles remain





Above photos: The construction and maintenance of roads in the red clay area removes native vegetation and interrupts natural drainage courses. This accelerates the erosion process which, in turn, can result in damages to roadways.

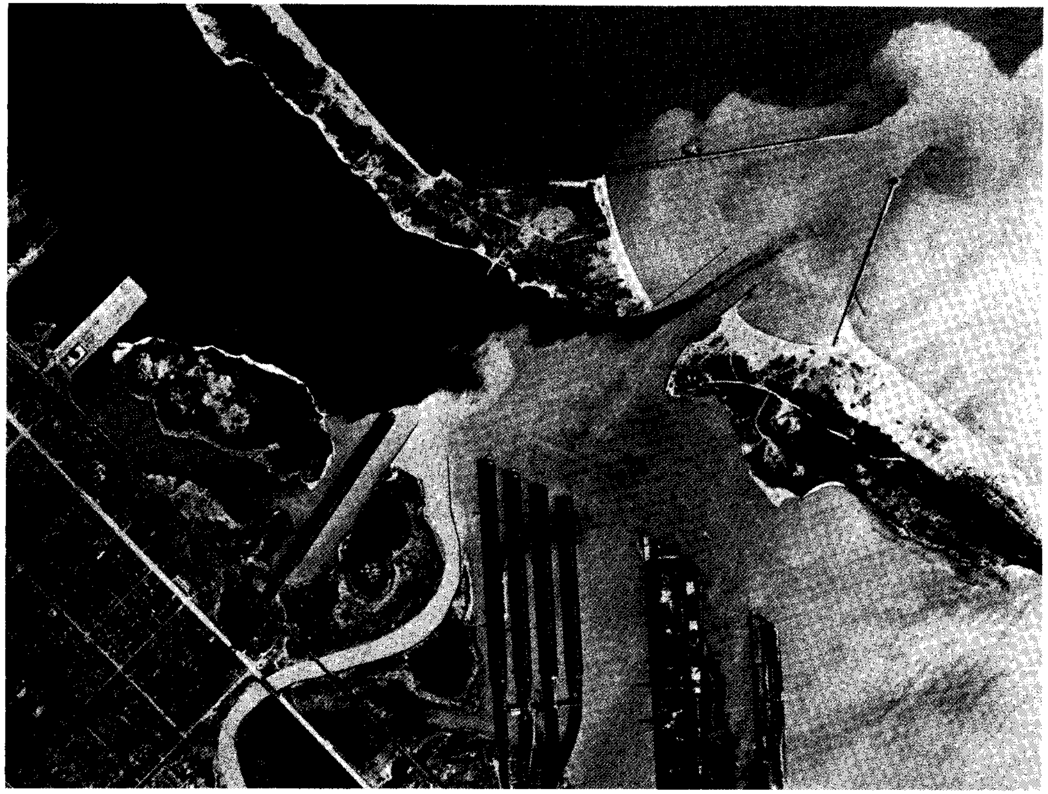
suspended for long periods increasing the water's turbidity. Further, the red clays contain approximately 2 percent extractable iron oxide which produces a very visible and objectionable color. It is this iron oxide which is responsible for the red color of the streams and the red plumes where streams discharge into Lake Superior. This phenomenon occurs even when the turbidity and sediment rates are low.



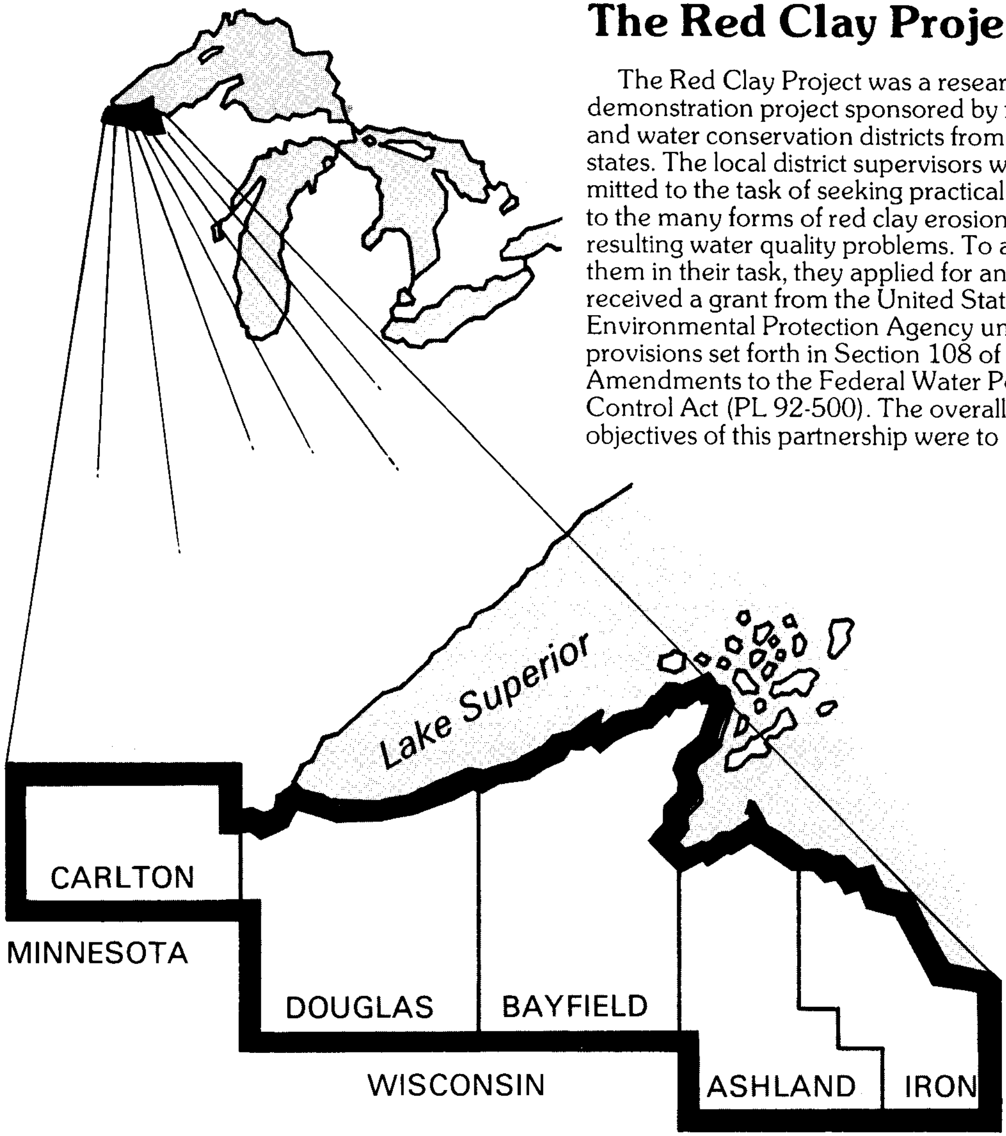
Lakeshores are another source of sediment directly entering the area's waters. In addition, man's structures are threatened by the loss of land.

Top: Like roadside erosion problems, streambank problems are often severe. Unlike roadsides, however, sediment from many streambank erosion sites directly enters waterways.

Above: When erosion proceeds unchecked, large gullies are often formed which can continue to enlarge until corrective measures are applied.



Sediment from the Nemadji River enters into the Superior harbor on the western tip of Lake Superior.



Red Clay Project - general location map

The Red Clay Project

The Red Clay Project was a research and demonstration project sponsored by five soil and water conservation districts from two states. The local district supervisors were committed to the task of seeking practical solutions to the many forms of red clay erosion and the resulting water quality problems. To assist them in their task, they applied for and received a grant from the United States Environmental Protection Agency under the provisions set forth in Section 108 of the 1972 Amendments to the Federal Water Pollution Control Act (PL 92-500). The overall objectives of this partnership were to demonstrate economically feasible methods of improving water quality, to assess the capabilities of existing institutions to cooperatively implement a pollution control program and to provide data and recommendations that could be used in future programs.

The agreement between the federal Environmental Protection Agency and the local soil and water conservation districts involved considerably more interagency cooperation than a strictly two-way, federal-local alliance. Soil and water conservation districts have been legally empowered by their respective states to enter into cooperative agreements with other units of government and their agencies to accomplish common objectives. Since their inception, districts have built up working relationships with numerous federal, state and local agencies. Using their legal authorities and these established relationships, the soil and water conservation districts from Ashland, Bayfield, Douglas and Iron Counties in Wisconsin and Carlton County in Minnesota joined together and called upon their cooperating agencies to help them develop, implement and evaluate the Red Clay Project.

To govern this complex association of institutions, the sponsoring districts formed an executive committee with equal representation from each district. The Douglas County Soil and Water Conservation District was designated the fiscal agent and it assumed responsibility for the grant with the Environmental Protection Agency. The chairman of this five-member committee was also from the Douglas County District. The function of the executive committee was to set administrative policy, approve programs and administer financial affairs.

Although the Douglas County Soil and Water Conservation District was appointed the fiscal agent, under the terms of the grant agreement the individual districts maintained

RED CLAY PROJECT BUDGET BY FUNCTIONAL AREA

Land Management	$ 124,250	3.3%
Land Treatment	$1,144,412	30.4%
Technical Assistance	$ 837,676	22.2%
Monitoring and Evaluation	$ 748,008	19.9%
Research	$ 562,049	14.9%
Information and Education	$ 76,906	2.0%
Administration	$ 265,847	7.2%

RED CLAY PROJECT BUDGET BY COUNTY

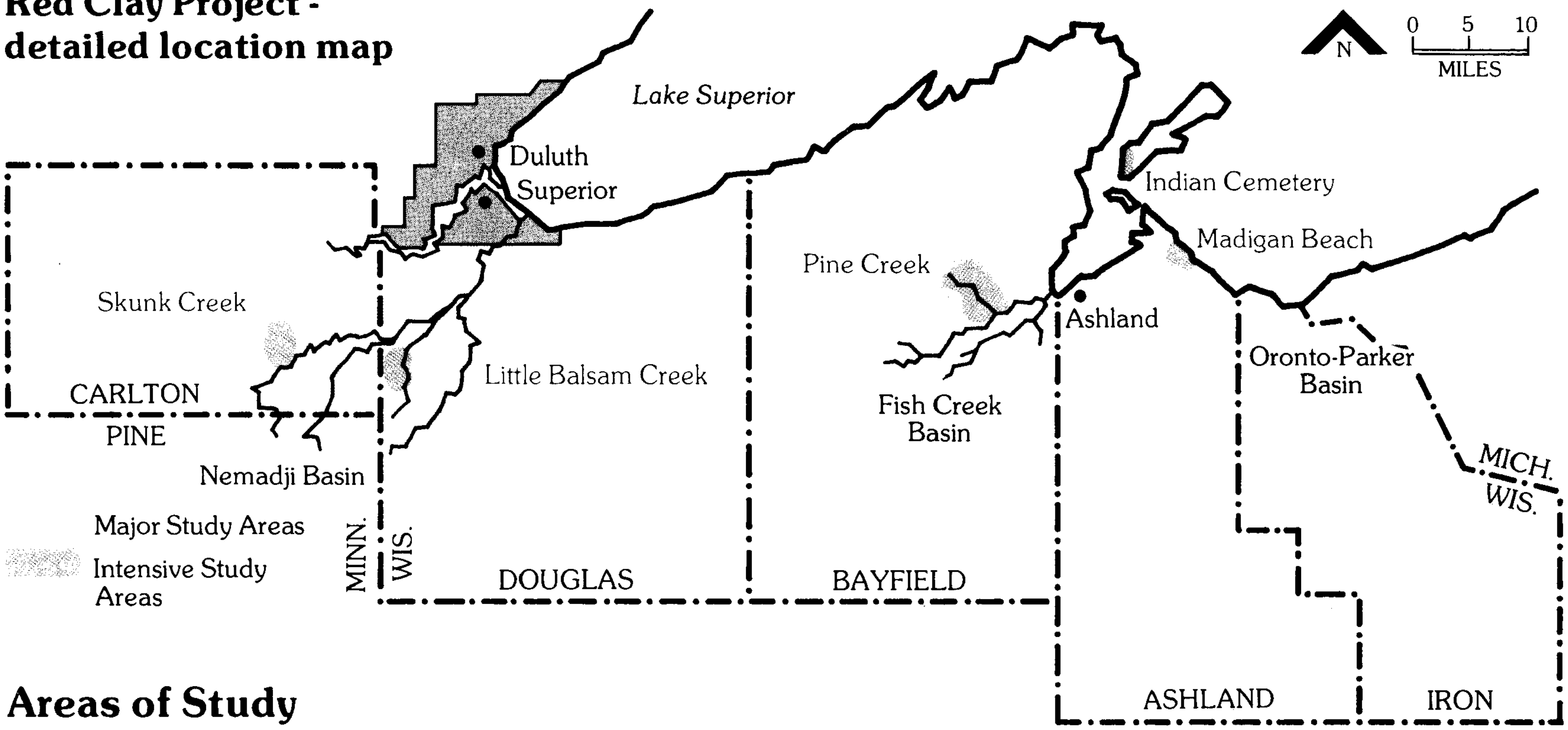
Ashland	$ 249,629	6.6%
Bayfield	$ 507,921	13.5%
Carlton	$1,403,544	37.0%
Douglas	$ 662,580	17.6%
Iron	$ 31,482	.8%
Research	$ 562,049	14.9%
Information and Education	$ 76,906	2.0%
Administration	$ 265,847	7.2%

the authority to manage programs within their district. This authority held by the individual districts included the power to write contracts, make local financial decisions and operate and maintain their own programs and installations. This procedure allowed districts to manage the project in their area consistent with their ongoing programs and policies.

In a similar manner, each soil and water conservation district retained the power to conduct other Red Clay Project operations in a manner consistent with the established order in that district. A voluntary compliance approach was used to solicit participation by local units of government and private landowners. Participation, therefore, depended upon individual priorities, budgets and the ability to provide local services and to meet local costs. The solicitation of landowners for participation in the Red Clay Project was done by each conservation district following procedures established by that district. The cost-share rates for practice installation were also set individually by district. Generally, the cost-share rates were consistent with local conservation aid programs and were not specifically designed to encourage program participation with artificially high rates.

Although many of the project operations were controlled by the individual soil and water conservation districts, overall procedural uniformity was maintained through the use of an operations manual. This manual, prepared especially for the project, outlined procedures for reviewing and approving program items and for obtaining reimbursements in a timely fashion.

Red Clay Project - detailed location map



Areas of Study

Early in the development of the project, several directions for field study were identified by the executive committee and the project director with the assistance of a multiple-agency technical and research advisory committee. Research and field demonstration projects were chosen which would increase the understanding of the mechanisms affecting the pollutant load to area streams and to Lake Superior. Areas of study were also selected which would, in turn, identify the effects of this pollutant load on the streams and the lake. An attempt was made to incorporate a wide range of problem areas but at the same time to have them complement one another and provide an integrated picture of the erosion and water quality problems of the red clay area. A premium was placed on the generation of data essential to the formulation of useful recommendations for the development of long-term water quality programs.

Geographical study areas which were selected were representative of conditions in the entire watershed. Research was conducted only in the Nemadji River basin. The monitoring of water quality and climatic conditions was carried out in all geographic areas where research and field demonstration activities were performed. The following criteria were used to select geographical areas for project studies:

1. The proportion of loamy glacial till and sandy beach deposits in the uplands with respect to the clayey lacustrine basin.
2. The relationship of present land use patterns within the study area to land use patterns in the basin. The ratio of open cropland and pasture to woodland was used to indicate the relative intensity of land use within the area.
3. The presence of actively eroding areas

along the river channels and drainageways. Erosion conditions in the geographical areas were representative of those in the entire basin.

4. The roadside erosion taking place within the study areas. Roadside erosion in the study areas was also representative of the entire basin.
5. The land ownership patterns. Land rights were generally easier to obtain and it was assumed that ongoing practice maintenance would be easier on publicly owned land.
6. Access to the work sites. Most of the eroding areas in the basin had very limited access. Although it was necessary to construct some roads, this was minimized by attempts to select easily accessable sites.
7. The distribution of geographical study areas to coincide with political boundaries. An attempt was made to have at least one study area in each soil and water conservation district. The work done in each study area was determined by the needs of the sponsoring district, the budget limitations of that district and the project and the uniqueness of the site and the proposed work.

Using these considerations, six geographical study areas were selected. In the following discussion, references made to the sediment-producing capabilities of these watersheds were based on the use of the Universal Soil Loss Equation during the planning stages of the project. The study areas delineated for the Red Clay Project were:

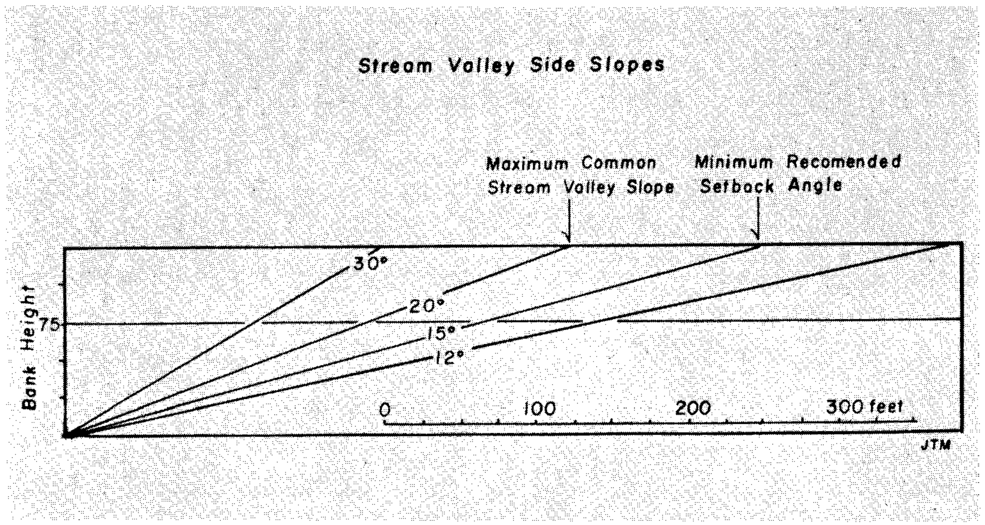
1. Skunk Creek Watershed in Carlton County, Minnesota—A relatively high sediment-producing basin covering approximately 10.7 square miles. Land use intensity within the basin was relatively low. There were, however, numerous streambank and roadside erosion sites in this subwatershed.
2. Little Balsam Creek Watershed in Douglas County, Wisconsin—A moderate sediment-producing watershed covering about 5.4 square miles. Land use intensity within the basin was judged to be relatively low.
3. Pine Creek Watershed in Bayfield County, Wisconsin—A moderate sediment-producing basin covering approximately 15.7 square miles. Land use intensity here was estimated to be moderate.
4. Spoon Creek Watershed in Iron County, Wisconsin—A moderate sediment-producing watershed covering about three square miles. Land use intensity was low.
5. Madigan Beach in Ashland County, Wisconsin—As a site for shoreline protection work, Madigan Beach was selected for its high, actively eroding bluffs and exposure to severe, Lake Superior storms.
6. Indian Cemetery Beach on Madeline Island in Ashland County, Wisconsin—As another area for shoreline protection demonstrations, this site was selected for its low bluff, narrow beach and cultural and historical significance.

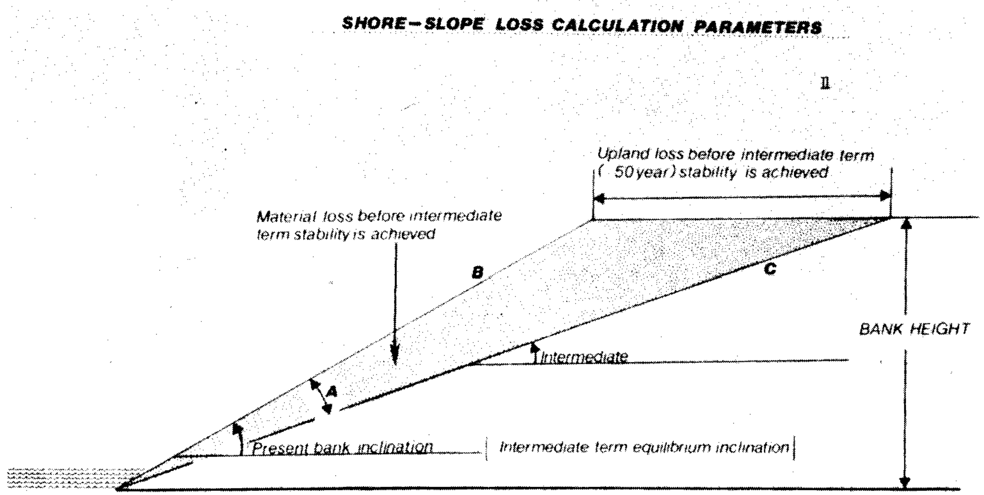
Red Clay Slope Stability Studies

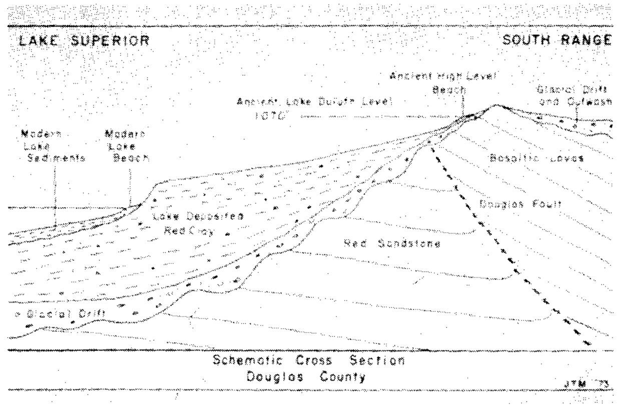
Red Clay Project researchers undertook studies of the condition and behavior of the soils within the Lake Superior red clay area. The purpose of the studies was to utilize available sampling and testing techniques and opportunities to determine the depth of the zones in which massive slope failure normally occurs. Also studied were the mechanical properties and behavioral traits of the soils and their relationships to slope stability and rates of erosion.

These studies resulted in findings which have broadened the field of information on which our understanding of the soils of this region is based. Several conclusions were arrived at from which corrective measures can be derived. The findings and conclusions are:

1. The clay soils of this region generally contain approximately two percent extractable iron oxide.
2. Man's early removal of the forest cover, modification of natural drainage patterns and other activities have promoted drying in a five to seven foot thick surface zone of the clay soils.
3. Drying in this surface zone has changed the mechanical behavior of the clay from a plastic solid to a brittle solid susceptible to fissuring and massive slope failure.
4. Moisture accumulation in fissures provides the necessary lubrication for flowing and sliding to occur within the surface zone.
5. The topography of the red clay area will continue to evolve under the influence of natural processes.
6. There are workable practices which man can incorporate into land use plans which will slow natural erosion processes.







A schematic cross section of Douglas County, Wisconsin depicts red clay deposits in relationship to other geologic features.

At left: A setback formula developed by Dr. Joseph Mengel of the University of Wisconsin-Superior would enable landowners to determine the distance from the edge of the slope at which structures could be built safely for a given period of time.

The Significance of Vegetation in Moderating Red Clay Erosion

The Red Clay Project conducted research on the relationship between erosion and vegetation. Two studies were done to determine how vegetation helps control the amount of water in the soil. Soil stability was suspected to be related to a rather narrow range of moisture content. Dry conditions encouraged soil fractures and crumbling, while wet conditions created liquid-like conditions and soil slippages. Another study was undertaken to determine the way plant roots exert holding power to counteract soil movement.

The findings and conclusions of these studies are:

1. Vegetation plays a major role in retarding erosion in the geologically young red clay soils. However, no type of vegetation alone can completely offset the natural erosion forces.
2. Grasses and herbaceous plants yield beneficial anti-erosion effects. However, their relatively shallow and weak roots do not serve to prevent massive slope failure in surface zones where brittle clay conditions already exist.
3. Woody plant species have stronger root systems which do help prevent slides.
4. Of all vegetation types, climax woody species (such as firs, pines and maples) provide the best erosion control because of their stronger root systems and the manner in which their canopies intercept rainfall.
5. Woody climax vegetation species are not efficient at lowering soil moisture content.
6. Herbaceous species and some woody species (aspens) are relatively more efficient at removing water from soil.
7. The use of vegetative methods specifically for reducing soil moisture content in the surface zones of red clay soils has not been shown to be beneficial for controlling massive slides. Species which are best suited for water removal (grasses and aspens) are most effective in drier years when they tend to lower moisture content too far which, in turn, induces fracturing, fissure formation and a greater potential for massive slide erosion.

Top: Dr. Koch of the University of Wisconsin-Superior and his assistants systematically checked different tree species for their ability to intercept rainfall.

Above: Dr. Donald Davidson, also of the University of Wisconsin-Superior, conducted research on the role of plant roots in stabilizing clay banks and absorbing soil moisture.

Work in the laboratory and in the greenhouse provided much useful information on the role of plant species in erosion control. Here Dr. Lawrence Kapustka of the University of Wisconsin-Superior inspects different plant species grown under controlled conditions.

The Effects of Red Clay Turbidity and Sedimentation on Aquatic Life in Western Lake Superior Basin Rivers

Research was undertaken to assess the effect of relatively low levels of sedimentation and turbidity on aquatic life in red clay area streams. Through systematic water quality monitoring, sampling aquatic life populations and assessing the aquatic environment, researchers studied behavioral patterns of numerous species of aquatic life in both natural and laboratory settings. Researchers were looking for relationships between these aquatic animal species and varying levels of nutrients, turbidity and sedimentation.

Previous aquatic life studies in other areas had focused on situations where man's activities such as logging, mining and agriculture had had the effect of creating extremely high levels of stream sedimentation. The glacial lake deposits of the Nemadji River system are highly erodible even under strictly natural conditions. However, due to the nature of the interrelationship between red clay erosion and red clay sediment, the small particle size of the clay and the amount of extractable iron oxide in the clay, the general condition of the streams is one of low sediment loads, low turbidity and a high amount of color.

Aquatic problems attributed in the past to red clay turbidity have included the substitution of undesirable fish species for more desirable ones, negative effects on spawning runs, decreased oxygen levels and increased nutrients as well as general observations on "adverse effects on biological life processes." None of these statements can be supported by the findings from this research in the Nemadji River basin.

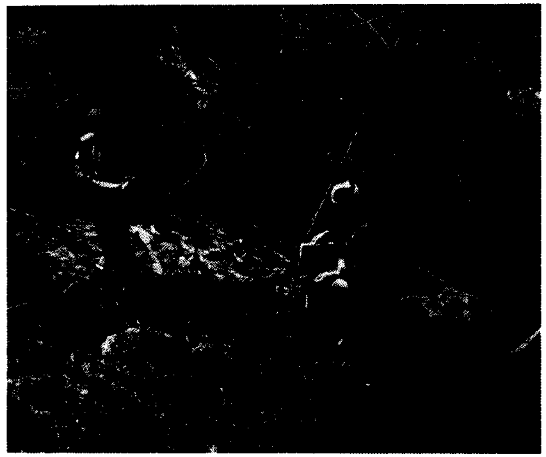
Analysis of areas of Lake Superior and the Nemadji River system which are turbid throughout the year due to erosion of unconsolidated glacial lake deposits indicated that any direct, physical effects of this turbidity and resultant low level sedimentation are minimal. Furthermore, although turbidity does induce important changes in aquatic life behavioral patterns, changes found through this research were, for the most part, considered beneficial rather than detrimental to the survival of native species.

Although a positive balance seems to have been struck between present levels of turbidity and sedimentation, and existing aquatic life in the red clay portions of the Nemadji River, the potentially severe effects of erosion on aquatic life elsewhere, or even here under artificially accelerated conditions, should not be underestimated. It is well known that soil mismanagement can upset the natural balance to the extent that severe short and long-term consequences are inevitable for aquatic flora and fauna.

The findings of this research are that:

1. Red clay does not contribute significant quantities of nutrients to Lake Superior but may serve to transport nutrients contributed from other sources.
2. Oxygen levels are not significantly affected by red clay or associated organics.
3. Primary production does not appear to be

Project researchers, Dr. William Swenson, left, and Philip DeVore, right, of the University of Wisconsin-Superior, undertook research on the effects of red clay sediment and turbidity on fish populations and other aquatic life.



For the aquatic life studies, samples were taken constantly of the various species in red clay area streams.

significantly affected by turbidity within the range of depths at which most production occurs in these relatively shallow streams.

4. Bacteria exhibit no definite trends with turbidity within sites, but do seem to have higher counts in turbid than in non-turbid sites. Fungal counts exhibit opposite trends. Bacterial and fungal populations are generally beneficial to the aquatic system as they are the primary food source for many of the macroinvertebrates.
5. Number of macroinvertebrates per unit area, total number of taxa, diversity, and biomass are not significantly affected by clay turbidity and siltation within the Nemadji River system.
6. The size of particles on the stream bed had much greater effects on macroinvertebrates than turbidity and sedimentation. Only where sand was the primary product were significant detrimental effects of erosion identified.
7. All genera of insects which occurred in clear streams also occurred in turbid streams. Certain insects generally associated with silts, especially certain mayflies and beetle larvae, were found only in the turbid streams.
8. Laboratory monitoring of activity and respiration of the stonefly demonstrated no significant effects at turbidity levels normally encountered in the Nemadji River basin.
9. Fish populations were not demonstrated to change as a result of turbid conditions but rather, because of water temperature and discharge differences between turbid and clear water sites. All species benefitted from increased cover which is harder to maintain in turbid streams due to increased tendencies for slippage at toes of the clay banks.
10. Walleye in the lower Nemadji River, the Duluth-Superior harbor, and Lake Superior benefit from red clay turbidity as it enables them to inhabit the shallow, more productive waters.
11. Rainbow smelt and four species of suckers successfully reproduce in the turbid areas of the Nemadji River.
12. Egg survival bioassays with walleye and rainbow smelt indicated decreased survival at turbidities over 10 ftu. Survival was at least half of control at turbidities prevalent in the Nemadji River. Levels of sedimentation in the bioassay were much higher than in the natural system, probably resulting in higher egg mortality than would naturally occur.
13. Channel form and available cover are the primarly factors affecting fish population size for all species in the Nemadji River system.

Land Management Practices

Although the Red Clay Project offered innovative opportunities and unique challenges, most of the "on-land" erosion control measures were not entirely new to local officials, farmers and other managers of the land. All the counties had long been designated soil and water conservation districts and had applied conventional soil conservation programs frequently in cooperation with the Soil Conservation Service and other institutions.

What was new was the opportunity to accelerate these programs in areas of each district where red clays pose widespread and persistently critical erosion problems. What was unique was the challenge of adapting conventional soil management techniques to the perplexing red clay conditions. What was innovative was a mandate to apply these traditional measures in combinations and in locations which would yield some demonstrable impact on water quality.

A typical five-step, problem-solving approach was followed by investigators in assisting with land management practices. Generally, the first step was to identify critical problems and inventory their locations. The second step was to develop alternative solutions. The third step was to assist in the selection of the most feasible and acceptable solutions. And the fourth and fifth steps were to implement and evaluate the selected land management practices. The presence of an overriding objective of enhancing water quality, and not simply of preventing soil loss, served to influence the work, and decisions about it, throughout each of the five problem-solving steps. Thus, to cite a hypothetical example, given a choice between treating a

TREATMENT PRACTICES

Practice	Unit	Estimated Needs (74)	Planned	Installed	Average* Est. Unit Cost (74)	Average* Unit Cost (78)	Cost-Share Rates Bayfield	Cost-Share Rates Carlton	Cost-Share Rates Douglas
Conservation Plans	NO	46	46	42					
Livestock Exclusion	AC	520	767	574					
Access Roads	FT	34,000	13,180	13,180	3.40	1.62	——	56	75
Animal Waste Systems	NO	4	1	0	15,000.00	0.00	——	75	——
Brush Management	AC	390	64	49	4.00	54.00	60	50	50
Conservation Crop Systems	AC	1,540	252	252	2.00	.92	0	0	0
Critical Area Treatment	AC	9	211	211	666.00	41.00	75	75	75
Crop Residue Management	AC	80	0	0	1.50	0.00	0	0	——
Diversions & Field Ditches	FT	51,800	23,800	11,500	.75	.48	60	75	50
Farm Windbreak	AC	4	0	0	100.00	0.00	——	75	——
Fencing	FT	100,000	113,315	87,565	.70	.71	100	100	80
Field Windbreak	AC	6,200	0	0	.20	0.00	——	75	——
Flood & Sediment Retention	NO	4	6	5	150,000.00	83,895.91	——	100	100
Grade Stabilization (Channel)	NO	4	0	0	15,000.00	0.00	100	100	100
Grade Stabilization (Gully)	NO	4	3	0	7,000.00	0.00	65	——	75
Grass Waterway	AC	106	5	5	500.00	1,272.61	70	75	75
Land Smoothing	AC	810	73	53	25.00	16.50	50	——	50
Pasture & Hayland Manage.	AC	820	1,667	1,580	20.00	15.80	70	0	70
Pasture & Hayland Planting	AC	250	716	634	80.00	109.18	70	75	70
Stocktrail	FT	1,800	4,600	4,600	23.00	9.42	75	75	75
Stream Channel Protection	FT	2,700	2,700	1,054	213.00	332.00	100	100	100
Tree Planting	AC	165	50	18	100.00	162.50	80	75	75
Water Facilities (Ponds & Wells)	NO	0	32	30	2,250.00	2,562.00	100	100	100
Heavy Use Area Protection	AC	0	1	1	750.00	750.00	100		
Road Erosion Control (with structure)	AC	27	27	1	3.872.00	3,872.00	——	75	75
Livestock Crossing	NO	0	6	6	2,000.00	3,217.00	100	100	100
Average cost per long term agreement							12,447	9,000	6,280
Average cost per acre treatment							70	55	98.50

*Cost does not include technical assistance/administration severely critical fertile area which had little likelihood of loading its eroding soil into a water course or treating a moderately critical fallow-soil area which was certain to degrade a nearby body of water, the latter would receive attention through the Red Clay Project.

The Universal Soil Loss Equation was used as an indication of soil loss and the effectiveness of land treatment. The equation could not address the problem of transport nor could it be applied to raw streambanks or slide areas adjacent to streams. In Pine Creek, 90% of the land area averaged .15 tons per acre per year soil loss. Little Balsam Creek study area averaged .55 tons per acre per year and Skunk Creek was within the allowable soil loss (3-5 tons per acre per year). The average annual estimated soil loss for the study areas was slightly less than 1.0 ton per acre. These soil loss estimates indicate that a relatively small percentage of the total land area contributes a disproportionately large share of the sediment in streams and lakes. The task of matching conservation practices to such critical areas is a process which must include an awareness to conditions specific to each site as well as a sensitivity to landowner attitudes, project costs and potential benefits.

Although any erosion control practice may be appropriate under certain conditions, those practices which have been found to be the most applicable to conditions encountered during the course of the Red Clay Project are listed below. The selection of these practices as the most applicable is based on evaluations using the Universal Soil Loss Equation and on-site inspections.

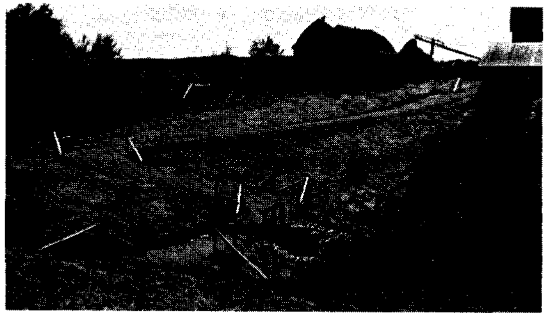
1. *Maintenance of Vegetative Cover.* This practice includes managing for trees, grasses, crop residue and other materials which maintain surface cover and protect the soil from erosion.
2. *Livestock Exclusion.* This practice removes or restricts livestock entry into critical areas. Complementary practices are necessary to maintain this practice.
3. *Alternate Watering Facilities.* This is a complementing practice for livestock exclusion. Watering facilities allow for proper distribution of livestock and provide an alternative to instream watering.
4. *Stock Trails and Walkways.* This is a complementing practice for livestock exclusion. Livestock trails and walkways provide access to areas without creating additional erosion.
5. *Livestock Stream Crossing.* This is a complementing practice for livestock exclusion. Livestock are kept out of streams and provided access to pasture and watering areas. Streambanks and other critical areas are also protected.
6. *Critical Area Seeding.* This includes the establishment of permanent vegetative cover on critical areas.

Above photos: One of the primary recommendations of the Red Clay Project is the use of exclusion fencing to prohibit use in erosion-prone areas. The photo at top shows cattle being allowed to graze on a wooded hillside. Above, the same area is shown after cattle have been excluded.

Above photos: Along with exclusion fencing, livestock trails and stream crossings are recommended by the project. These before and after pictures on the John Lunda farm in Bayfield County, Wisconsin depict the improvements that can be made.

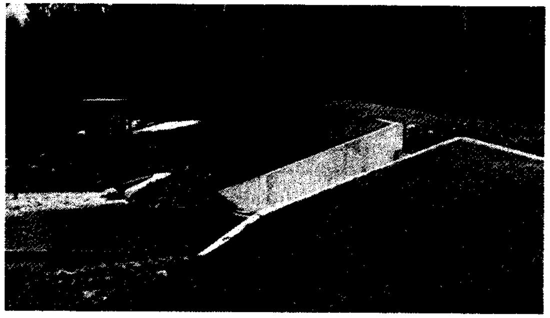
Livestock watering systems, such as this innovative facility on the Clarence Day farm in Douglas County, Wisconsin, provide water for livestock excluded from streams.

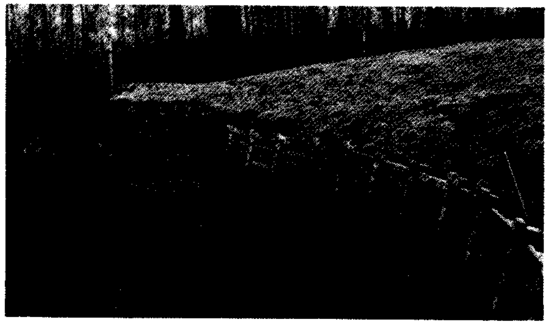
7. *Grassed Waterways and Diversions.* This practice involves the safe disposal of runoff in properly installed and maintained grass channels. It reduces soil erosion and provides stable outlets for runoff.
8. *Animal Waste Management Systems.* This practice includes the control of running water through areas of heavy use by livestock and the development of a system of storage, disposal and utilization for animal wastes to reduce water pollution. Components of an animal waste system are waste storage facilities, water disposal and erosion protection devices (diversions and waterways), animal waste disposal plants, and cropping systems.
9. *Sediment Traps.* These practices are basins created by water retention structures to trap and store sediment.



Above photos: Barnyard improvements such as diversions, grass waterways, fencing, trails and stream crossings are shown here in these before and after pictures on the Walter Johanik farm in Bayfield County.

10. *Streambank Protection and Slide Stabilization.* This includes any protection and stabilization practices which withhold significant amounts of sediment from adjacent waters.
11. *Foodwater Retarding Structures.* These structures serve the primary purpose of temporarily storing floodwater and controlling its release.





Top: An impoundment on the Gerald Hammitt farm in Carlton County, Minnesota serves to trap sediment from Elim Creek.

Center: Depicted above is a grade stabilization structure installed by the project on Skunk Creek in Carlton County.

Above: Concrete cribs filled with riprap protect a stretch of streambank along the Little Balsam Creek in Douglas County, Wisconsin.

The Evaluation of Works Previously Installed by the Wisconsin Red Clay Interagency Committee

From 1958 through 1967, erosion control practices were installed in Ashland, Bayfield and Douglas Counties by the Wisconsin Red Clay Interagency Committee. These practices were monitored and evaluated by that committee and their findings were previously reported. Members of the committee were asked by the Red Clay Project to reevaluate their work to determine the effectiveness of the erosion control methods and practices after adequate time had elapsed for them to have responded to a wide range of weather conditions. The reevaluation also provided current data on erosion control practices and procedures which could be compared with practices and procedures used by the Red Clay Project.

The work done by the Red Clay Interagency Committee primarily consisted of roadside and streambank erosion control measures. Some upland treatments such as grassed waterways were also installed. The reevaluation concluded that, after a lapse of ten to twenty years:

1. Generally, most of these accepted erosion control practices withstood the weathering effects of the past one to two decades and helped stabilize the areas where they were installed.
2. When treating bank erosion, stabilizing the toe of the bank is of primary importance.
3. Proper slope modification, seedbed, preparation and seeding mixtures are necessary to establish protective and stabilizing vegetation.

Members of Wisconsin's Red Clay Interagency Committee inspected a grassed waterway installed in Ashland County.

Streambank and Roadside Erosion Survey

The Red Clay Project undertook a program to collect all existing data on the extent of roadside and streambank erosion problems and to inventory as many of the unsurveyed areas as possible within time and monetary limits.

During the first phase of this program, the literature-search, the most recent survey data on streambank and roadside erosion in the red clay area was collected from all available sources. This information was recorded on maps and in tabular form. The second phase was to survey erosion sites along those roadsides for which data was not obtained in the literature-search and, thereby, making complete the erosion survey of all roadsides in the red clay area of the five counties. Portions of three rivers whose watersheds contrast agricultural land use, recreational use, and undeveloped or wild area were also inventoried. The purpose of the streambank survey was to compare erosion patterns in an attempt to determine the impact of land use.

Roadside erosion surveys were conducted in all five counties of the Red Clay Project area.

The information collected from this study was used as support data for other project activities and will be available for future use by researchers, soil and water conservation districts and others applying conservation practices. The findings of the comparative streambank survey are:

1. Despite differences in land use, the major cause of erosion along all three streams was basically natural. Direct erosion by differential stream discharge undercutting and the resulting bank failure constituted nearly all of the observed erosion sites.
2. At only a few sites was erosion observed that could be directly related to agricultural use and here the direct cause was that of migrating livestock.
3. Man-caused erosion on the banks of the recreational-use stream was evidenced at canoe entry and exit sites. The damage caused by recreational and agricultural use was categorized as minor.

Shoreline Demonstration, Monitoring and Evaluation

Protective, preventive and remedial erosion control measures employable under conditions typical of those encountered along the western Lake Superior shoreline were demonstrated by Red Clay Project researchers at two sites in Ashland County. Interest evidenced in this aspect of Red Clay Project work was, to some extent, attributable to the severity of the problems and the uniqueness of the areas involved. Interest also centered around a contrast in techniques, one conventional and the other innovative.

One of the sites, Madigan Beach, was selected for its high, actively eroding bluffs and its exposure to severe storms. Here a technology entirely innovative for Lake Superior, the installation of Longard tubes, was employed. Longard tubes are large, flexible vinyl tubes filled with sand and coated with a protective epoxy paint. They were placed in a variety of patterns designed to protect the base of shoreline bluffs and to build up a protective sand beach. Design layouts used by Red Clay Project researchers included differentially-spaced groins, seawalls and groin-seawall combinations.

Project Director Stephen Andrews (left) and Project Engineer, Dr. Tuncer Edil of the University of Wisconsin-Madison (right), discussed plans for installing Longard tubes at Madigan Beach in Ashland County.

The tubes were placed in seawall positions to reinforce the toe of the clay cliffs and in groin configurations to help build up protective sand beaches.

Longard tubes help build up a sand beach. When used to protect the toe of cliffs, Longard tubes will probably be more effective when the banks behind them are modified as shown here in the foreground.

The second site, the Indian Cemetery on Madeline Island, was chosen because of its low bluff, narrow beach and historical and cultural significance. Here a conventional rubble-mound revetment was installed.

Both shoreline protection projects underwent construction during the summer of 1977. Subsequently they were monitored and evaluated by Project investigators. At the end of the Red Clay Project, arrangements were made for the U. S. Army Corps of Engineers to initiate a continuous monitoring process for the work at these two locations.

Findings and conclusions which can be offered on the basis of monitoring and evaluation activities completed to date are:

1. Longard tubes appear to be competitive in both cost and performance with more conventional shore protection and beach stabilization structures.
2. Bluff modifications may be an important factor in the successful performance of Longard tubes.
3. Rubble-mound revetments provide positive shore protection at sites with conditions similar to those found at the Indian Cemetery site.

A rubble-mound revetment was installed on Madeline Island in Ashland County to help protect an Indian Cemetery of historical significance. The revetment was used here at this low-bluff and narrow-beach site.

REPRESENTATIVE WATER QUALITY DATA

	NEMADJI 1976	NEMADJI 1977	NEMADJI 1978	PINE 1976	PINE 1977	PINE 1978
Mean Daily Flow CFS	307	230	456	26.50	22.90	26.00
Total P mg/L	.07	.07	.10	.06	.04	.04
P Transport mt/yr	19.2	14.4	40.7	1.4	.80	.90
Total N mg/L	.50	.30	1.10	.24	.30	.37
N Transport mt/yr	137.10	61.6	448.00	5.7	6.10	8.60
Organic N mg/L	.38	.22	.84	.16	.22	.30
Organic N Transport mt/yr	104.20	45.20	342.10	3.80	4.50	7.00
Suspended-Sediment mg/L	53	75	104	28	23	35
Suspended-Sediment Transport mt/yr	77,677	67,240	132,398	1,685	2,389	7,499*
Mean Turbidity JTU	35	30	62	20	13	28

*3,119 mt transported in 1 day following 5" rain over 24 hr. period August 23, 1978
2,224 mt transported in 3 days following storm event May 27-29, 1978

Mr. Eno Giacomini (second from left) of the U. S. Geological Survey in St. Paul discussed the Red Clay Project's water quality monitoring program with NACD's District Operations Committee during a tour of the project's work sites.

Water Quality Monitoring

Monitoring of water quality and sediment was conducted at thirteen project stations. The samples were analyzed for over fifty physical, chemical and biological parameters. In addition, a ground water study was undertaken in Carlton County, Minnesota and a bedload transport study was conducted in the Nemadji River in Douglas County, Wisconsin.

The findings of these activities are:

1. The streams of the red clay area are predominantly event-response in character.
2. Pesticides and herbicides were not found at any concentration in either the water or bottom material samples.
3. Heavy metals were not found except for trace concentrations at detection levels.
4. Fecal coliform—fecal streptococci ratios indicate livestock and wild animals as the primary contributors of fecal waste. Game management and farm animal estimates indicate that 50% or more of the fecal

waste is generated by non-farm animals (population density of 18 persons/mi^2, 15 deer/mi^2, 10 farm animals/mi^2). Shifts in contribution did not occur with fluctuation in flow.

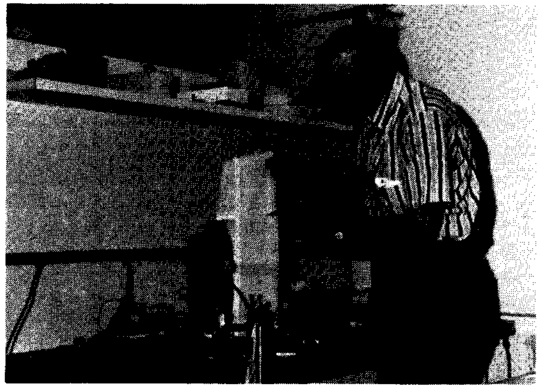
5. Nemadji River suspended sediment concentrations range from 2 mg/L to 1190 mg/L with a 3 year daily mean of 77 mg/L.
6. Nemadji River total phosphorus concentrations range from .01 mg/L to .36 mg/L with a 3 year mean of .08 mg/L.
7. Nemadji River total nitrogen concentrations range from .10 mg/L to 2.4 mg/L with a 3 year mean of .63 mg/L.
8. Nemadji River organic nitrogen concentrations range from .1 mg/L to 2.2 mg/L with a 3 year mean of .48 mg/L. Organic nitrogen is approximately 76% of the total nitrogen and is consistent with expectations of forested watersheds.
9. Except at stations immediately downstream from construction activities it was impossible to identify construction related changes in suspended-sediment concentrations.
10. In a very small watershed such as Pine Creek it was possible to identify upward suspended-sediment concentration shifts that were not related to changes in flow and were probably the result of bank collapse or in-stream activities.
11. The Minnesota ground water study found that in the deep valleys of the upper Nemadji River there is a tendency for upward movement of ground water. This upward movement may cause wetting of fissure zones from beneath thus triggering slides.
12. The Nemadji River bed load transport study found that only 3% of the total sediment load is transported on the bed of the river.

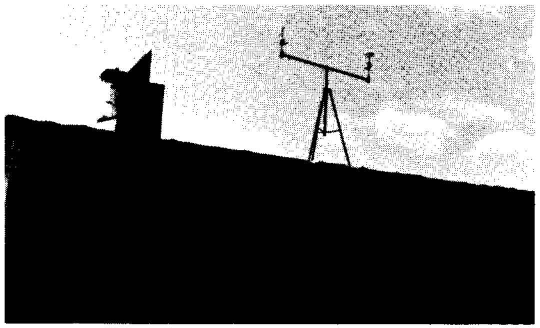
Western Lake Superior Basin Rainfall and Temperature Monitoring

The Red Clay Project conducted a monitoring program designed to record on a continuous basis the intensity of rainfall and wind and to profile the temperature of the air and soil. The program used existing monitoring technology wherever possible, but also involved the development of new low-cost instrumentation techniques. It took place at locations throughout the Skunk, Little Balsam and Pine Creek watersheds.

This micrometeorological data base was generated for its usefulness in illuminating otherwise latent cause and effect relationships between soil loss due to erosion and natural phenomena such as the presence and intensity of rainfall and significant fluctuations of soil temperature along steep banks. The information gathered represented a support service to other research activities and, as such, provided no independent conclusions. However, the results are reflected in related research work.

One of the major developments of this program was the production and refinement of a low-cost system for continuously monitoring precipitation, wind, air and soil parameters at remote sites.





Right top and center: Dr. Donald Olson of the University of Minnesota-Duluth, in top photo, has developed a low-cost system for the continuous, remote monitoring of precipitation, wind and air and soil temperatures.

Right: The relatively inconspicuous monitoring equipment continuously collected weather data at strategic sites throughout the red clay area.

During the planning stages, many agencies worked together to get the Red Clay Project started. Shown here are members of the Minnesota Soil and Water Conservation Board, the Wisconsin Board of Soil and Water Conservation Districts, the Douglas County Soil and Water Conservation District, the Northwest Wisconsin Regional Planning Commission, and the U. S. Environmental Protection Agency.

Institutional Cooperation

The first organized efforts to systematically study red clay erosion and sedimentation problems were distinguished by a unique and extraordinary amount of interagency cooperation. In Wisconsin, the Red Clay Interagency Committee was composed of several state and federal agencies based in the state capital. When working in the red clay area, they received cooperative assistance from locally-based representatives of many more local, state and federal agencies. The Carlton County Soil and Water Conservation District in Minnesota joined with the Douglas County District in Wisconsin to form an interstate alliance of conservation disıricts to seek approaches and funding sources for solving their shared problems.

This multiple agency approach was continued by the Red Clay Project. Rather than attempting an elaborate analysis of what instutional systems might work best, it was determined to use existing relationships developed over the years by county soil and water conservation districts. Throughout the United States, enabling legislation had been passed in each state that permitted the creation of conservation districts as special purpose units of state government. Although they developed differently over the past forty years, districts generally evolved into political entities having effective working relationships with nearly every local, state and federal unit of government and agency concerned with natural resource conservation.

Soil and water conservation districts in Minnesota and Wisconsin are functionally alike in terms of objectives, authorities and district operations. In both states, districts have similar legal responsibilities to conserve the natural resources within their boundaries. They also have similar legal authorities to enter into agreements with other units of government to accomplish common goals. The major difference between them is that in Wisconsin, district supervisors are elected members of the county board who serve on the agriculture committee while in Minnesota, supervisors are elected at large.

Dr. Tuncer Edil (far right, back to camera), described the project's shoreline monitoring work at a quarterly progress meeting in Superior.

Because of the wide geographical area covered by this basin-wide research and demonstration project and because of its five-district, two-state sponsorship, a multiple agency approach to project operations was selected. The sponsoring soil and water conservation districts formed a project-governing executive committee consisting of equal representation from each of the districts. The Douglas County Soil and Water Conservation District was designed the fiscal agent for the entire project and its representative to the committee served as chairman. The committee met monthly to conduct project business. Through agreements, the scope of work and procedures for each district were identified.

Representatives from participating agencies were called together to form a technical advisory committee, an information-education advisory committee and a program advisory committee. These committees met in special sessions and, upon request at the monthly meetings to advise the executive committee regarding project operations. Because none of the districts had staff trained in managerial capabilities, project staff were hired through

Much of the project's research was carried out by members of the Center for Lake Superior Environmental Studies of the University of Wisconsin-Superior. Shown here from left to right are: Larry Brooke, Lorraine Koch, Philip DeVore, Rudy Koch, Lawrence Kapustka, William Swenson, Albert Dickas and Donald Davidson.

Mr. John Streich (left, facing camera), of the U. S. Soil Conservation Service explains the land treatments put in on the Clarence Day (center) farm in Douglas County. The occasion was a project tour by Wisconsin Board of Soil and Water Conservation District members and advisors.

Mr. John Ourada (second from left), engineer with the Duluth Area Soil Conservation Service office, discussed land treatment practices in Carlton County, Minnesota with Mr. Albert Zimmerman (left), Chairman of the Ashland SWCD, Mr. Elmon Ott, Wisconsin BSWCD, and Mr. Jerome Hytry, Wisconsin State Conservationist with SCS.

contracts with capable agencies. All project work elements were accomplished by cooperating agencies and institutions working under contract for the project.

As was stated earlier, the intent of the Red Clay Project was for the existing institutions, soil and water conservation districts, to run the project. No systematic attempts were made to analyze or evaluate these relationships. The following findings and observations are based on subjective assessments by the project director, project specialist and other investigators closely involved with the management and operations of the project.

1. Five soil and water conservation districts from two states effectively sponsored and managed a basin-wide research and demonstration project.
2. The multiple agency approach followed by the project proved to be highly successful even though differences in standards, funding mechanisms and implementing procedures between states posed many communication and operation difficulties.
3. The application of conservation practices was influenced by landowner attitudes, long-range costs and site-specific conditions as well as potential benefits, immediate costs and the general applicability of considered "best" management practices.
4. The application of conservation practices relied upon the voluntary compliance of landowners and units of government. Attempts to prepare and implement a sediment control ordinance met with considerable resistance from local elected officials.
5. In certain critical areas, zoning ordinances or regulations may be the most effective tool to achieve erosion control.
6. Due primarily to a lack of adequate funds, there was a noticeable inability on the part of some town-level and city departments of government to cooperate with soil and water conservation districts.
7. None of the sponsoring soil and water conservation districts had staff capable of managing district affairs and projects.
8. Soil and water conservation districts had to rely principally upon federal and state funds to carry out a program of the magnitude and intensity of the Red Clay Project.
9. Higher cost share rates did help induce landowner cooperation, however many other factors (*e.g.* landowner attitudes, practice maintenance, landowner age, specific farm conditions, encouragement from neighbors and professionals) were influential in determining which practices were applied.

Recommendations

Soil and Water Conservation Districts should be designated as the local management agency.

The local management agency should be given early and continuous involvement in establishing and managing any future non-point source pollution control programs, plans and strategies affecting its area.

The local management agency should be adequately staffed, and constituted so as to provide balanced representation of the area and its water quality interests.

In rural areas where regional problems have been identified, multijurisdictional cooperation should be used as an effective approach for management programs.

Because of significant differences in standards, funding mechanisms and implementing procedures, non-point source pollution control programs in rural area should not involve more than one state.

Multi-agency programs should have a common focus through a single set of goals, objectives and policies to insure effective management and uniform results.

Sufficient evaluation should be conducted prior to implementation to clearly identify critical areas and influential parameters, thus ensuring cost-effective abatement.

Sufficient, but not excessive, levels of cost-sharing should be provided as an incentive for cooperation and to help defray landowner costs.

The local management agency should provide educational programs for citizens, cooperating units of government and agencies to establish and maintain an awareness of water pollution problems and abatement strategies.

The local management agency and its staff should establish close working relationships with units of government, utilities, private landowners and industries to ensure the implementation of erosion and sediment control practices in conjunction with their construction and maintenance activities.

Conservation plans should be prepared for identified critical areas so that specific remedial measures can be applied to those natural or man-induced problem areas where water quality benefits warrant land treatment.

The selection for use of any one, or combination of, management practices should take into consideration site-specific conditions, costs, landowner attitudes and potential benefits.

The local management agency should place a high priority on management practices that provide the greatest benefit at the lowest cost.

Where possible, maximum use should be made of management and vegetative measures. Structural engineering solutions should only be considered where benefits outweigh costs and environmental concerns. Innovative management techniques, sensitive to conditions specific to particular sites and locations, should be encouraged.

In order for long-range water quality benefits to be realized, management practices should be maintained and monitored for extended periods of time.

Water quality programs for the abatement of non-point source pollution should be closely coordinated with other natural resource conservation programs to avoid duplication of effort and expense and to ensure maximum efficiency of all resource conservation and environmental protection programs.

A voluntary compliance approach should be established in future nonpoint source pollution control programs as a first, and preferable, management procedure.

State regulations or local ordinances should be adopted only where effective management techniques necessitate.

If regulatory programs are used, the state water quality management agency should be responsible for setting minimum standards and for overall enforcement.

If regulatory programs are used, the local management agency should be responsible for monitoring compliance and recommending enforcement action.

The toes of slopes at erosion-prone sites should be protected by vegetation or other means.

On streambanks, disturbed areas and other erosion-prone sites, vegetation should be established as early as possible and maintained continuously. For long-term protection, advanced successional woody species should be established, due to their greater root strength. In non-critical areas, woody species should also be phased into a herbaceous cover, whenever possible.

Policies restricting human and livestock activities to those which are compatible with erosion control should be incorporated with active management for protective vegetation on streambanks, disturbed areas and other erosion-prone sites.

Stream channel deepening should be minimized through methods of retarding upland runoff.

In managing for fish habitat, vegetation and woody root systems that aid in the maintenance of undercut banks, steep-sided channels and deep pools should be preserved.

Along streambanks and associated drainage areas, slope stability equations should be employed to demarcate a safe zone within which all human activity that arrests or reverts the successional process would be prohibited.

On or near slopes where surface moisture is low, surface drains and diversions should be used to control water accumulation in fissures.

Longard tubes should be considered a cost-effective alternative where shore protection is warranted. When possible, and practical, installation should be accompanied by regrading of the bluff and reestablishment of vegetative cover.

Framework for Local Management Agency Implementation of Red Clay Project Recommendations

Three primary recommendations emanating from the Red Clay Project are basic to the implementation of a water quality program at the local level and serve as the foundation upon which this framework was developed. These recommendations and basic assumptions are: that soil and water conservation districts should be the local management agencies for implementing the nonpoint source pollution control portion of any future water quality programs, that soil and water conservation districts must have adequate administrative and technical staff, and that districts, as local management agencies, must have early and continuous involvement in establishing, managing and evaluating water quality programs.

The framework assumes that adequate funding is available. It is important to note that when funding is provided from outside sources (non-local management agency), conditions are usually attached which determine, in part, how the funds are expended. Elements of the 208 programs currently being developed in states across the nation would undoubtedly have an impact on the refinement and use by local management agencies of this process.

The following is a step-by-step process designed for soil and water conservation districts acting in the role of local management agencies to carry out the administrative and procedural recommendations of the Red Clay Project in an expedient manner. By following this generalized problem-solving procedure and filling in where needed with the details regarding their geographical area of concern, districts can, in essence, implement a long range program for nonpoint source water pollution abatement. The following implementation process incorporates the procedural recommendations of the Red Clay Project which can apply to all soil and water conservation districts in Minnesota and Wisconsin as well as to similar districts throughout the nation. Project recommendations relating specifically to the Lake Superior red clay area have been presented in the "recommendations" section of this report but are not included in the following framework.

STEP 1, Identification of Problems and Areas of Concern

Purpose:

The first step in this, or any, problem solving process is the identification of the types of problems that exist. Once this is done, an initial estimation of the severity of the problems should be made along with a determination of their geographical extent. The determination of the extent of the problems should include data from monitoring, research and public opinion.

When shared problems are evident, such as might exist between local management agencies within the same watershed, every attempt should be made to pool problem-solving resources. Agreements to cooperate should be established between the involved units of government and all concerned agencies. Unless justification and incentives are unique, such consortia that cross state lines should be avoided.

Actors:

—local management agencies
—other local units of government (municipalities, town boards, county boards or their committees)
—resource conservation agencies
—industries

The Douglas County Soil and Water Conservation District met with the Bayfield County Soil and Water Conservation District to review shared roadside erosion problems and methods for treating them.

—private landowners and land managers
—special interest groups
—interested citizens

Activities:
—gather citizen and local government input
—inventory records to determine current knowledge of problems
—survey the extent of the problems
—identify other local management agencies with similar problems
—identify a coordinating group for local management agencies with similar problems

Step 2, Definition of Purpose

Purpose:

Once the problems have been identified and the geographical and managerial areas of concern have been delineated, those agencies involved must develop a system of goals, objectives and policies. It is important that a single set of goals, objectives and policies be established for everyone working on the program. This is essential where geographical areas transcend political boundaries and agency jurisdictions.

Actors:
—local management agencies
—local, state and federal units of government
—natural resource conservation agencies
—industries
—private landowners and land managers
—special interest groups
—interested citizens

Activities:
—secure cooperative agreements with involved agencies
—hire local management agency administrative and technical staff
—conduct cooperative work sessions and planning meetings
—identify work responsibilities for involved agencies and groups
—prepare goals, objectives and policies
—conduct public advisory meetings to review and, if necessary, revise goals, objectives and policies

Step 3, Inventory and Assessment

Purpose:

The third phase of the program is to prepare a detailed inventory of the resources and the problems in the affected area. This inventory process is necessary for assessing the extent and severity of the problems and will help identify critical areas and determine treatment needs. Not only should the land resource be assessed, but there should be sufficient water quality monitoring prior to implementation to determine the exact nature of the problems and to serve as a base for measuring accomplishments.

Mr. Raymond Polzin, Douglas County Agricultural Agent and Red Clay Project Secretary, is shown here leading a discussion at one of the many public meetings in the project area.

The culmination of the inventory and assessment process is the assignment of priorities to the problem areas. Critical areas which contribute the most to the pollution load of the waters must be identified and ranked according to need and treatment potential. Non-critical areas can also be assigned priority for treatment under complementary or subsidiary programs.

This entire process will require considerable manpower and time.

Actors:
—local management agencies
—resource conservation agencies
—local units of government
—private landowners and land managers
—special interest groups
—interested citizens

Activities:
—arrange for water quality monitoring by qualified personnel
—identify and map critical areas with the assistance of landowners and cooperating agencies
—set priorities for critical areas
—establish cost share rates
—conduct public advisory meetings to review and, if necessary, revise critical area priorities and cost share rates

Step 4, Securing Landowner Cooperation

Purpose:

An important aspect of this entire procedure is the acquisition of landowner cooperation. The most direct method would undoubtedly be the use of regulatory methods. This

At one of many meetings with town boards, Project Director Steve Andrews and former SCS Team Leader Steve Payne work with town board members to plan ways to solve roadside erosion on town roads.

approach, however, does little to improve landowner attitudes, encourage cooperation or solicit effective planning and participation. One indirect method, high rates of cost sharing, may encourage cooperation, planning and participation but, again, does not necessarily improve landowner attitudes.

The development of a good conservation ethic among landowners is necessary to ensure the continued involvement of the landowner in the application and maintenance of conservation practices. Ideally, this should be done throughout the planning and implementation processes and not merely as one step in the process. From the beginning, continuous and concerted educational programs must be undertaken by local management agencies. Only through education can recusant landowner attitudes be altered and can a conservation ethic be developed which would facilitate cooperation, planning and participation and lessen the need for any regulatory programs.

Actors:
—local management agencies
—resource conservation agencies
—local units of government
—private landowners and land managers
—public landowners and land managers
—special interest groups
—interested citizens

Activities:
—initiate and maintain continuing informational programs for the general public
—sponsor educational programs to encourage cooperation from private landowners and units of government
—establish close working relationships with private and public landowners

Step 5, Preparation of Conservation Plans

Purpose:

When critical areas needing treatment have been identified and assigned priority, conservation plans for treating these areas must be drawn up by landowners and qualified professionals. Conservation plans must be directed at specific problems in critical areas and at the potentially most effective treatments for these problems. Conservation planners can not rely solely on pre-established, generalized, "best" management practices.

Site-specific considerations that must go into critical area conservation plans include: assumed efficacy of the proposed practices for each specific site, the costs of installing the remedial measures, the costs for maintaining the practices, the potential benefits to be derived from treatment, and landowner attitudes.

Actors:
—local management agencies
—private landowners and land managers
—public landowners and land managers
—resource conservation agencies
—other qualified conservation planners

Activities:
—develop alternative treatment practices
—select the most workable and acceptable measures in cooperation with landowners
—secure implementation, operation and maintenance contracts with landowners

Step 6, Installation of Conservation Practices

Purpose:

The types of practices included in conservation plans must be determined by the specific characteristics of each individual site. Efforts should be made to use innovative techniques to meet unique site needs. Managerial or non-structural control practices generally can be used more pervasively—and, consequently, more effectively—and at lower costs than structural treatments. In some instances, structures may be recommended where land and water use demands intensive protection. In other instances, regulatory systems, such as ordinances, may be recommended. This may be the case where livestock and human use must be restricted on eroding or erosion-prone zones.

The amount spent on the installation of a conservation practice is a function of the tradeoffs made between the greatest potential benefits and the lowest actual costs. Coupled with a strong educational program, cost-sharing should be used as an incentive for program participation. It must be cautioned, again, that excessive cost-share rates, because they do nothing to improve landowner attitudes, should be discouraged except in extreme problem areas where immediate treatment is needed.

Actors:
—local management agencies
—resource conservation agencies
—private landowners and land managers
—public landowners and land managers

Activities:
—provide assistance and supervision for the implementation of conservation practices by landowner

Mr. Don Benrud (left), District Conservationist with SCS in Barnum, is shown here inspecting a recently installed watering pond on the Edwin Carlson (right) farm in Carlton County.

—cooperate with landowners to ensure timely and successful completion of the contract

Step 7, Maintenance of Practices

Purpose:

Local management agencies should be responsible for inspecting installations and for working with landowners to ensure their continued operation and maintenance. Policies and guidelines will have to be set to provide for inspections, to guarantee continued maintenance and to correct maintenance violations.

In addition to monitoring treatment activities on the land, water quality monitoring will have to be continued to make certain that benefits are ensuing from the applied practices. When water quality benefits are no longer derived from practices, consideration will have to be given to altering practices to meet the needs. When water quality improves to the point where remedial measures are no longer needed, alternate, less costly management practices should be used to maintain the elevated levels of water quality.

Actors:

—local management agencies
—resource conservation agencies
—private landowners and land managers
—public landowners and land managers

Activities:

—inspect practices to determine compliance and efficiency
—meet individually with landowners to encourage practice maintenance
—set policies for correcting instances of noncompliance

Step 8, Evaluation and Adjustment

Purpose:

Conservation practices have to be continually monitored, evaluated and, if needed, modified. The entire water quality management program should also be evaluated continually and changed if necessary. There is nothing unalterable about goals, objectives and policies. When they are no longer applicable to the problems at hand, they should be modified to reflect the current situation. The changing problems, needs, goals and objectives can only be analyzed through a continuous evaluation process.

To aid in the evaluation and adjustment of water quality programs, supplementary natural resource conservation programs can be easily and effectively tied in throughout the process. As an example, the federal Resource Conservation Act program can be used to help evaluate water quality programs or, conversely, evaluations of local water quality programs could be used as a part of the Resource Conservation Program. Similarly, local management agencies can work with ongoing Agricultural Stabilization and Conservation Service programs to set cost-share rates and administer cost-share programs. And as a final example, the application of conservation practices for ongoing soil and water conservation district programs can be readily tied in with the application of conservation practices for water quality programs.

Mr. John Lunda (left), Bayfield County farmer, talks about the work he did with the Red Clay Project to a science class from a nearby school. Under the leadership of Mrs. Sizer (left center), the class developed a physical model of the Pine Creek Watershed and the works installed by the Red Clay Project.

Actors:

—local management agencies
—resource conservation agencies
—special interest groups
—industries
—conservation professionals
—private landowners and land managers
—public landowners and land managers
—interested citizens

Activities:

—continue collection of water quality and land management data to determine practice efficiency
—evaluate data and program operations with cooperating agencies
—establish standards and guidelines for altering ineffective practices
—seek citizen input on program effectiveness and revise, if necessary, goals, objectives and policies

Step 9, Implementing Regulatory Systems (Optional)

Purpose:

Given sound educational programs and

reasonable cost-share rates, general program compliance and practice implementation could be achieved through the voluntary compliance of landowners. At the very least, a voluntary compliance system should be used initially and then, if this fails or if certain practices, such as restricting use, necessitate, a regulatory approach could be tried.

Because of the sensitive nature of regulatory programs, local and state responsibilities must be carefully delineated. For this process, all past experiences as well as innovative techniques should be utilized. Many landowners have expressed the desire that, if needed, regulations and ordinances should be developed and administered at the local (county) level. Locally-elected officials, however, are generally hesitant to take on this responsibility, probably because of their close contact with the affected landowners.

If regulations are used, the state should set minimum standards and should be responsible for overall enforcement. Local management agencies should have the authority for working with landowners to settle disputes, supervise compliance and recommend enforcement action.

Actors:

—local management agencies
—resource conservation agencies
—private landowners and land managers
—public landowners and land managers
—county boards or their committees
—town boards

Activities:

—obtain citizen input on the need for local ordinances and in developing ordinances if deemed necessary
—develop ordinances in cooperation with county and town units of government
—establish standards, supervise compliance and make recommendations for enforcement actions

Concluding Observations

More than four years of erosion, sediment control and water quality demonstration activities are represented in the findings, conclusions and recommendations summarized above. Some of these results belie conventional, or popularly held beliefs, views and attitudes; particularly those refining public perceptions of the nature of the red clay problem or proposing new approaches and methods. But far from all that has been accomplished was unexpected or innovative. Indeed, much project emphasis was intentionally focused on ways in which traditional land use-related institutions, procedures and techniques could be reoriented to meet the challenges posed by society's renewed dedication to clean water.

What was learned from this experiment has significance for the *process* of non-point source water pollution control as well as for the *participants.* In addition, several tools have been developed or refined during the course of the Project. A few concluding observations in these three areas are offered below as a way of further distilling the gist of the experience and relating it to the future.

Process. Red Clay Project activities suggest that key ingredients to successful water quality management fall into three fundamental steps of the management process. As such, these ingredients become conditions or prerequisites which, on the basis of this project's experience, are felt to be needed to sustain effective programs. These conditions are grouped below as they relate to a generalized management process.

1. **Those conditions that aid in the definition of the problems and the goals:**
   —a problem-encompassing management institution, even if multijurisdictional
   —a common set of goals, objectives and policies, even where multiple agencies and levels of government are involved
   —a persistent emphasis on critical area identification and assigning priorities
   —the careful involvement of a full range of inter-and intra-governmental as well as private-sector representatives
   —an ongoing, continuous and broad-based educational program
2. **Those conditions that aid in the identification of alternatives and the mechanisms for selecting from among them:**
   —the preparation of critical area management plans
   —the matching of alternative management practices with site-specific conditions and landowner attitudes
   —the generation of cost-benefit and cost-effectiveness information
3. **Those conditions that aid in the implementation, guidance and evaluation of the management program:**
   —the designation of a soil and water conservation body as the local management agency
   —the reliance on voluntary compliance prior to regulation
   —the use of reasonable cost-sharing to encourage voluntary compliance
   —an emphasis on local innovation and on non-structural, low-cost practices
   —the use of continuous, long-term monitoring programs

Participants. The Red Clay Project results have the potential of affecting three major groups of participants in non-point source water pollution programs in a variety of important ways. A few of the impacts which can be expected are:

Landowners and Private Interests

—increased confidence that abatement actions undertaken will have recognizable water quality payoffs

—continued assurance that society will assist with the problem through technical assistance and cost-sharing

—improved participation opportunities

—expanded knowledge base through research, information and education

Local Units of Government and Their Agencies, including the Local Management Agency

—increased assurance that water quality programs are both beneficial and acceptable through planning and public participation

—greater focus for cooperative action and joint programs through critical problem identification and setting priorities

—more effective reliance on the full spectrum of management tools—preventive and remedial, voluntary and regulatory, structural and non-structural—through formulation of alternatives

Non-Local Units of Government and Their Agencies

—enhanced opportunity for society-wide goals to be achieved in responsive and innovative ways

—improved focus for meaningful roles in cooperation with local program partners

—increased assurance that substantial allocations of time, staff and financial resources will meet the test of cost-effectiveness

Tools. The Red Clay Project has served to spotlight several tools of the trade that promise important dividends for water quality management. Some of these are conventional, such as comprehensive critical area erosion surveys, an open and continuous planning function, and a posture of intensive inter-agency cooperation. Others are refinements of existing technologies, such as the development of a solid state monitoring system for constant recording of precipitation, wind, air and soil factors at remote, unmanned sites. While still others pose unique opportunities for progressive or enterprising management institutions. The last category would include the use of zoning setback formulas for structures adjacent to critical slopes in such a way as to establish a balance between the location's erosion rate and the design life of the proposed structure. It would also include the identification and designation of safe-zone areas, or erosion conservancy zones, where all land-disturbing activities would be excluded in the interest of erosion control.

Perhaps above all else, the Red Clay experience stands as evidence that much of the foundation upon which highly complex water quality problems can be addressed may now be in place. It is possible to overcome traditionally difficult social, economic, political and institutional obstacles through a management perspective balanced by research, technical and financial assistance, and by interagency cooperation and public education. Existing federal, state and local resources, public and private, can be combined in a partnership for enhanced water quality.

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