FLOOD PLAIN MANAGEMENT STUDY NORTH ORE CREEK

LIVINGSTON COUNTY, MICHIGAN

PREPARED BY

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
EAST LANSING, MICHIGAN

IN COOPERATION WITH

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
HARTLAND TOWNSHIP
FENTON SOIL CONSERVATION DISTRICT

SEPTEMBER 1984

FOREWORD

This report defines the flood characteristics of North Ore Creek in Hartland Township, Livingston County, Michigan. Development within the flood plain exists and can be expected to increase in the future.

This cooperative report was prepared for the guidance of local officials in planning the use and regulation of the flood plain. Four potential floods are used to represent the degrees of major flooding that may occur in the future. These floods: the 10-year, 50-year, 100-year, and 500-year, are defined in the report and should be given appropriate consideration in future planning for safety of development in the flood plain. Nearly 9.5 miles of high water profiles show the expected flood elevations and water depths relative to the streambed and flood plain. The 100-year and 500-year potential floods are further defined by flood hazard area photomaps that show the approximate areas that would be flooded. About 100 acres of land would be under water from the 100-year flood.

Flood hazard area photomaps and high water profiles are based on existing conditions of the basin, stream and valley when the report was prepared.

Information in this report does not imply any federal authority to zone or regulate the use of the flood plains; this is a state and local responsibility. This report provides a suitable basis for adoption of land use controls to guide flood plain development, thereby preventing intensification of flood losses.

Assistance and cooperation of the U.S. Geological Survey, Hartland Township, and the Michigan Department of Natural Resources in the preparation of this report is greatly appreciated.

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FLOOD PLAIN MANAGEMENT STUDY

NORTH ORE CREEK

LIVINGSTON COUNTY, MICHIGAN

INTRODUCTION

The flood plains of rivers and streams have been formed by nature to provide for the conveyance of flood flows resulting from large amounts of snowmelt and rainfall. Floods are acts of nature which cannot be wholly prevented by man. Therefore, the long-term solution to reducing flood damage and loss of life is to keep the flood plain free of development which could be damaged or which could obstruct the conveyance of flood waters. There are three basic public actions which can be used to assure that flood plain areas are kept open:

1. Provide public information to make lending institutions and prospective property buyers aware of the flood hazards.

2. Initiate flood plain regulations to prevent the development of the flood plain in a manner which would be hazardous during floods.

3. Acquisition of flood prone areas for use as parks, open space, wildlife habitat and other public uses.

Potential users of the flood plain should base their decisions upon the advantages and disadvantages of such a location. Knowledge of flood hazards is not widespread, and consequently the managers, potential users and occupants cannot always accurately assess the risks. In order for flood plain management to effectively play its role in the planning, development and use of flood plains, it is necessary to:

1. Provide state and local units of government with appropriate technical information and interpretations for use in flood plain management.

2. Provide technical services to managers of flood plain property for community, industrial and agricultural uses.

3. Improve basic technical knowledge about flood hazards in cooperation with other agencies and groups.

Two Michigan state laws provide the Michigan Department of Natural Resources the responsibility and the authority to regulate all development in the flood plain areas.

> Act 288, Public Acts of 1967, establishes minimum standards for subdividing land and for new development for residential purposes within flood plain areas. This act requires that preliminary plats be submitted to the Water Management Division of the Department of Natural Resources for review and determination of flood plain limits. Upon completion of review and establishment of the 100-year frequency flood plain limits, the preliminary plat may be approved and minimum building requirements specified.

Act 245, Public Acts of 1929 as amended by Act 167, Public Acts of 1968, requires that a permit be obtained from the Water Management Division of the Department of Natural Resources before filling or otherwise occupying the flood plain or altering any channel or watercourse in the state. The purpose of this control is to assure that the channels and the portion of the flood plain that are the floodways are not inhabited and are kept free and clear of interference or obstruction which will cause undue restriction of flood carrying capacities.

Requirements established by the Michigan Department of Natural Resources for occupation and development of flood plain areas under Acts 288 and 245 are intended to be minimum requirements only. The Department urges local units of government to adopt reasonable regulations which can be used to guide and control land use and development in flood hazard areas.

The Soil Conservation Service, United States Department of Agriculture, carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulations of Land Use", of House Document No. 465, 89th Congress, 2nd Session and in compliance with Executive Order 11988, dated May 24, 1977. Flood plain management studies are carried out in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management". Priorities regarding location and extent of such studies in Michigan have been set by the Michigan Department of Natural Resources.

The Fenton Soil Conservation District and the Hartland Township Board believed that a flood plain management study was needed for North Ore Creek due to its rapid urbanization and the flooding problems that have already occurred. Hartland Township has determined that there is an increasing need to properly plan for the preservation and use of the flood plain in their urban and rural areas. They have indicated a need to develop technical information along North Ore Creek to develop effective management programs.

Hartland Township has adopted a resolution indicating they intend to use the technical information from the flood plain management study as a basis for adopting zoning regulations, health and building codes, subdivision control regulations, and such other regulations that may be needed to preserve the environmental quality of their natural resources, and to protect the health, safety, welfare and well-being of the citizens of their community.

A request for a flood plain management study was made by the Hartland Township Board. A plan of work, dated April 1982, was agreed to by Hartland Township and the Fenton Soil Conservation District, along with the Michigan Department of Natural Resources and the Soil Conservation Service (as sponsors). Financial contributions for this study were made by Hartland Township. The Fenton Soil Conservation District will assist Hartland Township with public information dissemination.

Hartland Township provided money for aerial photography for flood plain delineation uses and for watershed modelling purposes. They also furnished money to assist the Soil Conservation Service in making field surveys.

Hartland Township and the Fenton Soil Conservation District shared responsibilities for public information dissemination. They also provided input to identify and select appropriate flood plain management alternatives.

The Water Management Division, Michigan Department of Natural Resources provided coordination services with respect to study area discharges and hydraulics. They reviewed the technical aspects of the study and concurred with study results, as applicable, to implement various state statutes through the Federal Flood Insurance Program.

Natural flood plain values were obtained by Soil Conservation Service field people. Aerial photos and field checks were used to identify and delineate wetland areas. Topographic maps, planning commission data and communications with government officials were used to determine land use and development trends. Soils information was obtained from the published soil survey report for Livingston County.

Historic and archaeological data were obtained from township and county historians. Fishery management information was obtained from Michigan Department of Natural Resources field people.

Two floods are delineated, the 100-year and the 500-year frequency events. These floods have an average occurrence of once in the number of years as indicated; e.g. the 100-year flood occurs once in 100 years on the average. The 100-year flood has a 1 percent chance of being equalled or exceeded in any given year. In addition to the two floods delineated on the aerial photomaps, the 10-year and 50-year floods are also shown on the high water profiles. The flood plain management program enacted by local action is to be based on the technical results and recommendations of this report.

The Water Management Division of the Michigan Department of Natural Resources and the Soil Conservation Service, USDA, will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study. For assistance, contact:

Fenton Soil Conservation District
3477 East Grand River
Howell, Michigan 48843
Telephone: (517) 548-1553

DESCRIPTION OF STUDY AREA

Watershed Area

North Ore Creek is located in southeastern lower Michigan in Livingston County. It is located in the U.S. Geological Survey's State Hydrologic Unit 04080203.

Its headwaters are located in the very western edge of Oakland County, surrounding Dunham Lake. From here, it flows in a westerly direction through Bullard Lake into Hartland. From Hartland, it flows in a northerly direction into Parshallville Mill Pond and on into Shannon Lake. From here, North Ore Creek flows into Bennett and Lobdell Lakes and then into the Shiawassee River.

The drainage area is approximately 36.8 square miles with land uses of commercial, residential, agriculture and open space. Current development is mainly subdivision-type near lakes. There are numerous culverts and private crossings along North Ore Creek. Some of these are very restrictive. None cause the flooding of any buildings. Any replacement of culverts should be evaluated to see what the effect would be on downstream flooding. No other studies have been made by other agencies and organizations that relate to flooding in the study area.

Soils in the watershed are dominantly well drained to somewhat poorly drained, with organic areas being very poorly drained. Approximately 50 percent of the soils are loamy, 25 percent are mucks, 18 percent are loamy overlaying sands and gravel, and 7 percent are sandy.

Because of the inland location of Livingston County in southeastern Michigan, the effect of the Great Lakes is not as readily noticed in this county as in many other areas of the state. The main lake effect in Livingston County is the higher percentage of cloudiness late in fall and early in winter, when prevailing westerly winds move cold air across warmer lake water. The average annual temperature is 47 degrees, with extremes of 100 degrees and -16 degrees Fahrenheit. The average annual precipitation is 33.3 inches and is well-distributed. The average annual snowfall is 44 inches. The growing season averages 150 days annually.

Historically, nearly 30 percent of the watershed has been used for agriculture. Major areas of cropland are found in the west portion of the watershed. There are 16 lakes and many swamps in the study area that have a tendency to reduce flood peaks. However, they also encourage development that will cause increased runoff. One additional lake was abandoned in 1975 when its dam washed out.

Study Area Flood Plain

The study area starts at the Parshallville Dam and extends upstream approximately 9 1/2 miles. The study area is identified on Figure 1. The flood plain study was made using a somewhat detailed intensity.

There is very little present development in the study area flood plain. Approximately 5 percent of the area adjacent to the flood plain is developed. This includes commercial and residential land. There are few buildings that have encroached on the flood plain.

Land use in the flood plain is mostly idle land that is in woodland or grown up with vegetation compatible with the wet soil conditions. There are only minor acres of cropland.

Sandy loam and loamy sand soils occupy approximately 50 percent of the flood plain area. They are nearly level, poorly or very poorly drained, and subject to frequent flooding. Major limitations are wetness and the tendency to become flooded.

Muck soils cover approximately 50 percent of the flood plain. They are poorly and very poorly drained and subject to ponding or flooding.

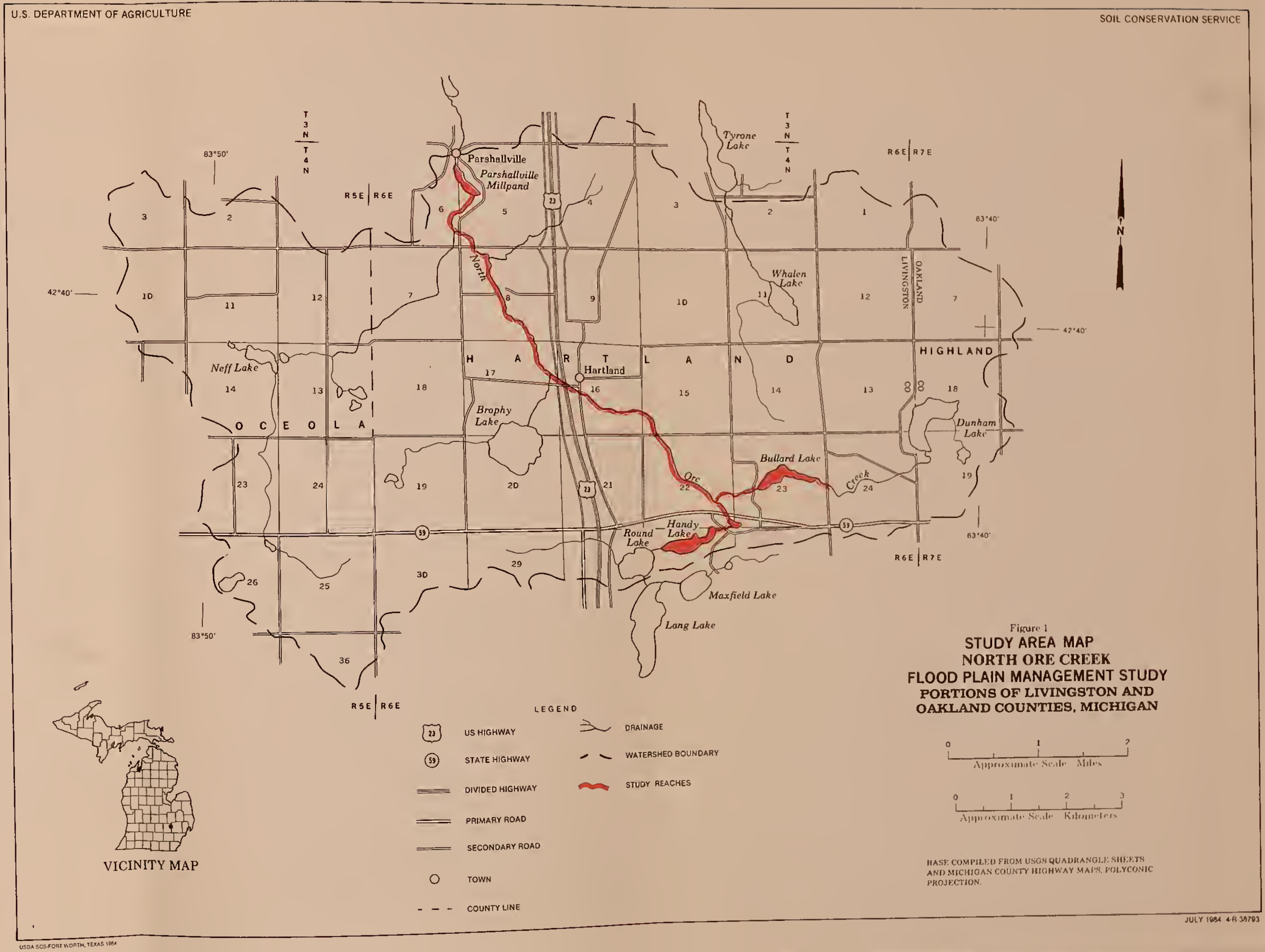

Figure 1
STUDY AREA MAP
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
PORTIONS OF LIVINGSTON AND OAKLAND COUNTIES, MICHIGAN

NATURAL VALUES

Much of the study area flood plain is wetlands, as can be seen by the muck and wet sandy soils. These wetlands are mainly Types 6 and 7 (shrub swamps and wooded swamps, respectively) as described in U.S. Department of Interior, Fish and Wildlife Circular No. 39. There are small isolated areas of marshes. The wooded swamps consist primarily of hardwoods. The meadows and marshes have a variety of spring wildflowers. Bird life is also varied and numerous. There is very little cropland in the flood plain, none of which is considered prime farmland.

The flood plain has a number of natural and beneficial values. It has a minor storage effect on floods but does serve as an overflow area with a high natural retardance value. It serves as a buffer area for the runoff from developed areas adjacent to the flood plain and minimizes the amount of pollutants reaching the creek. It supports a wide variety of plants and wildlife and helps to maintain the water quality.

Many species of wild animals have been observed in the flood plain of North Ore Creek. These include the white-tailed deer, cottontail rabbit, tree squirrels, muskrat, beaver, mink, raccoon, skunk, oppossum, woodchuck and red fox. Because a large portion of the flood plain is found within an extensive wetland, the quality of the habitat for many of the above-named species can be considered good. The flood plain is especially valuable to the deer in the local area because of its use as winter range.

Various species of upland game birds, non-game birds, and raptors are found in the flood plain. These include owls, hawks, ring-necked pheasants, crows, morning doves, sparrows, warblers, robins, blackbirds, thrushes and wrens. Common waterfowl in the flood plain includes the Canada goose, black duck, mallard duck and wood duck. Habitat quality for upland birds can be considered good, and fair to good for waterfowl.

Vegetation in the flood plain includes Alders, Willows, Nine-bark, Red-osier, dogwood, Gray dogwood, Tamarack, Beech, Red maple and White ash. Ground cover includes cattails, sedges, rushes and other herbaceous vegetation.

North Ore Creek and its tributaries are identified by the Michigan Department of Natural Resources Fisheries Division as second quality warm water tributaries. Fish cover includes undercut banks, logs, brush and pools.

Although specific data regarding stream chemistry is not available from local sources, over a period of time the water quality of the stream has generally remained very good.

Although there are no identified archaeological resources in the drainage area, there are some structures and features with historical significance. The first grist mill was constructed by Calvin Bursley on September 8, 1835. Iassiac Parshall constructed a grist mill in what is now the village of Parshallville in 1837. He also opened a general store and a blacksmith shop. Tom Walker's mill, which is still in Parshallville, was constructed in 1871. A sawmill was constructed by Mapes and Bursley on what is now the outlet of Bullard Lake in 1836. The first business in the village of Hartland was a general store opened in 1839 by George Griffin. Hartland's first grist mill was constructed in 1842.

FLOOD PROBLEMS

Most of the annual flooding occurs in the early spring due to snowmelt and early rains. Serious flood damages seldom occur, due to limited encroachment in the flood plain by development. Annual damages are usually confined to agricultural damages and county roads. The last serious flood occurred in April 1975. Approximately 5 inches of rain fell in 3 hours. The Hartland Mill Pond Dam, the Parshallville Mill Pond Dam and the Lake Shannon Dam were washed out.

This study reports high water profiles and areas subject to flooding based on analyses of existing stream hydraulics and current watershed and flood plain land use and cover. Water surface profiles are plotted for the 10-, 50-, 100- and 500-year flood events. The expected extent of flooding from two floods, the 100-year and 500-year, is shown on the 1982 aerial photomaps. The photomaps indicate the approximate areas subject to flooding by the two floods, under present conditions.

To determine expected flood levels at a specific location, use Sheet Index (Appendix A) and refer to the appropriate Flood Hazard Photomaps (Appendix A) to determine the location of the nearest surveyed section and the general area affected. Then, refer to the adjacent plotted high water profiles (Appendix A) to determine the mean sea level flood elevations for that location. Profile elevations may also be used to determine the extent or depth of flooding in any given area by use of detailed field surveys.

Typical valley sections shown on two sheets of Appendix B indicate the effects of the four floods. Flood discharges used for computing high water profiles in the study area are shown in Table 1 of Appendix C. Table 2 in Appendix C shows flood elevations at each of the surveyed valley sections.

Flood water depths in the flood plain generally vary from 0 to 5 feet. Velocities range from 1/10 (0.1) to 4 9/10 (4.9) feet per second.

Primary hazard areas which could experience flooding from large runoff events are around Parshallville Pond and around Handy Lake. There are approximately 21 homes within the delineated flood plain. In some cases, even the more frequent floods (10-year and 50-year) will inundate low areas of the roads. In several cases, driveways will flood even though homes do not.

Total flood plain areas within the study reaches of North Ore Creek, from Parshallville Road to Fenton Road, have been determined. There are approximately 152 acres of permanent lake surface. There are an additional 359 acres of 100-year flood plain and 73 more acres of 500-year flood plain. No identified croplands are flooded within the designated study reaches.

Future development effects were studied based on Map 1, Future Land Use, from the Hartland Township Land Use Plan dated June 12, 1980. Present condition flows were compared to flows for 100 percent development based on Map 1, and the peak flows increased between 1 and 2 percent. This increase would have a negligible effect on flood elevations of North Ore Creek. Additional consideration should be given to flooding along local tributaries due to any development.

Control of the gates at the Parshallville Dam were studied to determine their effect on flood elevations. The greatest effect would be if the gates were fully opened at the beginning of each storm. This would completely drain the lake and would lower the flood peak for the Parshallville Pond only 3/10 (0.3) of a foot. The adverse impacts of this alternative vastly out-weigh the benefits.

While no computations were made to reflect the problems of ice and debris blockage at bridges, because of the wide possible variations in conditions, a few generalized comments can be made. Ice and debris can often totally block an opening. To determine possible effects, look at the high water profile sheets. At each bridge or culvert, a "low point or road overflow" symbol is shown. Based on field surveys, this is the elevation at which the road would flood. If there is no culvert capacity available, all flows would need to go over the road through this low section. The depth of flow and flooding would depend on the quantity of flow, as well as cross-sectional area available for flow.

Technical documentation for this study is on file with the Soil Conservation Service, USDA, 1405 South Harrison Road, East Lansing, Michigan 48823 (telephone 517-337-6612) and the Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909.

EXISTING FLOOD PLAIN MANAGEMENT

The Hartland Township Planning Commission is very much aware of the need for flood plain management. They have adopted a Land Use Plan which addresses several aspects of flood plain management. By adopting the Land Use Plan, the Planning Commission can take into account the sensitive nature of the North Ore Creek Watershed. Planning decisions now made on a site-by-site basis will, under the Land Use Plan, be made in a more consistent manner in regard to land use decisions.

Public participation has been or will be solicited in three phases in the development of this flood plain management study. The public was invited to an initial meeting at Hartland Township Hall. Here, watershed problems and study procedures were discussed.

The second phase is to discuss alternatives for flood plain management. During this phase, the public was invited to express their views on applicable solutions. Their views will guide the Hartland Township Board in their selection and implementation.

The third phase of public participation will be during the final report distribution. The public will be invited to learn how to use the report.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

The objective of flood plain management is to encourage land use and development in such a manner as to minimize potential flood damage. Basic goals are to guide flood plain development consistent with the requirements of nature and the needs of the local area. Flood plain management can:

1. Prohibit uses which are dangerous to public health or safety in times of flood.

2. Restrict building or other development which may cause increased flood heights or velocities.

3. Require that public or private facilities that are vulnerable to floods be protected against flood damage at the time of construction.

4. Protect individuals from investments in flood hazard areas which are unsuited for their intended purposes.

There are numerous flood plain management alternative categories and tools that can be employed to accomplish the above objectives and goals. The ones that apply to this area are suggested below. Other flood plain management techniques should be considered and may well prove to be effective in reducing or preventing flood damages.

1. Present Condition - This is the "no change" alternative which reflects ongoing flood plain development pressures and management trends. Local governmental units can continue to plan, zone and accept or reject requests for alternative flood plain and adjacent land uses. Flood problems may continue to increase if development continues.

2. Land Treatment - This alternative discusses opportunities to minimize or decrease changes in upland runoff and erosion because of land use changes. The traditional approach of accelerating conservation land treatment, by working with landowners to install conservation practices, will minimize soil erosion and reduce flooding. Installation of such measures as tree planting, windbreaks, forest management, permanent vegetative cover and on-site water storage will all reduce runoff, erosion and sedimentation.

As rural areas urbanize, the increase in peak discharges due to more efficient conveyance paths and increased impervious areas can have a significant adverse impact on downstream areas. There is a growing interest on the part of planners, developers and the public in protecting downstream areas from induced flood damages that may accompany increased peaks and stages. Planning authorities are proposing local ordinances that restrict the type of development permitted and the impact development can have on the watershed. One of the primary controls that could be imposed is that future-condition discharges cannot exceed present-condition discharges at some predetermined frequency of occurrence at specified points on the channel.

Methods to control runoff in urbanizing areas reduce either the volume or the rate of runoff. The effectiveness of any control method depends on the available storage, the outflow rate, and the inflow rate. Because a great variety of methods can be used to control peak flows, each method proposed should be evaluated for its effectiveness in the given area.

MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF

Area	Reducing Runoff	Delaying Runoff
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measure for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Groundwater recharge a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir or detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters, diversions, etc.

3. Preservation and Restoration of Natural Values - Flood plains, in their natural or relatively undisturbed state, provide three broad sets of natural and beneficial resources and resource values.

Water resources values include natural moderation of floods, water quality maintenance and groundwater recharge. The physical characteristics of the flood plain shape flood flows. Flood plains generally provide a broad area to spread out and temporarily store flood waters. This reduces flood peaks and velocities, and the potential for erosion.

Flood plains serve important functions in protecting the physical, biological and chemical integrity of water. A vegetated flood plain slows the surface runoff, causing it to drop most of its sediment load on the flood plain. Pathogens and toxic substances entering the main water body through surface runoff and accompanying sediments are decreased.

The natural flood plain has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. The slowing of runoff provides additional time for it to infiltrate and recharge available ground water aquifiers, and also provides for natural purification of the waters.

Flood plains support large and diverse populations of plants and animals. In addition, they provide habitat and critical sources of energy and nutrients for organisms in adjacent and downstream terrestrial and aquatic ecosystems. The wide variety of plants and animals supported directly and indirectly by flood plains constitutes an extremely valuable, renewable resource important to economic welfare, enjoyment and physical well-being.

The flood plain is biologically important because it is the place where land and water meet, and the elements of both terrestrial and aquatic ecosystems mix. Shading of the stream by flood plain vegetation moderates water temperatures; roots and fallen trees provide instream habitat; and near stream vegetation filters runoff, removing harmful sediments and buffering pollutants, to further enhance instream environments.

Flood plains contain cultural resources important to the nation and to individual localities. Native American settlements and early cities were located along the coasts and rivers in order to have access to water supply, waste disposal and water transportation. Consequently, flood plains include most of the nation's earliest archeological and historical sites. In addition to their historical richness, flood plains may contain invaluable resources for scientific research. For example, where flood plains contain unique ecological habitats, they make excellent areas for scientific study. Flood plains may provide open space community resources. In urban communities, they may provide green belt areas to break urban development monotony, absorb noise, clean the air and lower temperatures. Flood plain parks can also serve as nature study centers and laboratories for outdoor learning experiences.

Preserve several selected open space areas, especially in the undeveloped areas. Their preservation, in accordance with soil limitations and good land use management, will reduce development hazards, prevent additional future flood damges and enhance the urban environment.

a. Soils with high water tables should be retained in natural vegetation. No commercial or residential construction should take place on these soils since the limitations are very severe. The Soil Conservation Service has completed a detailed soil survey of Livingston County. Copies of the material, including maps and interpretations, are available for reference in the Fenton Soil Conservation District Office located at 3477 East Grand River Avenue, Howell, Michigan 48843. This information can be used to determine the kind of soils in a given area and their limitations for various uses.

b. Upland open space should be retained in the natural state as much as possible.

c. Private wooded areas on steep slopes should be preserved from all development. Destruction of natural cover on these steep slopes usually causes excessive erosion during construction. Preservation of these wooded sites would also enhance housing developments in the area.

d. Developing areas should provide on-site flood water storage to temporarily store additional runoff volumes and peaks created by their urbanization.

e. Undeveloped flood plain areas should be managed for wildlife and recreation. These areas have potential for an excellent outdoor classroom. North Ore Creek is easily accessible to many school and college students.

4. Non-Structural Measures -

a. Develop and implement, or update, a flood plain protection and zoning ordinance based on the 100-year frequency high water profile and the flood plain delineations (Appendix A). Retaining the storage in the existing flood plain area will be necessary if this flood profile is to remain valid. Reducing the storage capacity in the system will tend to increase elevations and discharges above that indicated in this report.

b. Floodproof buildings and residences already in the flood plain to reduce flood damages. Some basement windows and doors, floor drains and foundations can be modified to reduce effects of flood waters. Materials and supplies stored in vulnerable positions can be relocated and protected. These modifications can be planned and installed where it is desirable and/or feasible to continue using facilities currently in the flood plain.

c. Plans should be developed for alternate routes for auto, truck and emergency vehicle traffic around those roads that will be inundated during the flood. This will require cooperation between city, township, county and state officials.

d. Owners and occupiers of all types of buildings and mobile homes should obtain flood insurance coverage for the structure and contents, especially if located within or adjacent to the delineated flood hazard areas. Hartland Township should make necessary applications, and pass needed resolutions and zoning ordinances to qualify for subsidized federal flood insurance. Contact the Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028 Lansing, Michigan 48909 for additional information.

5. Structural Measures - Flood stages can be reduced by improving flow conditions within the channel and by increasing the stream's carrying capacity. Outlet structures for lakes that do not have a flooding problem could be modified to increase storage during a storm to reduce peak outflow. Care must be taken to control additional flooding around the lake.

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APPENDIX A

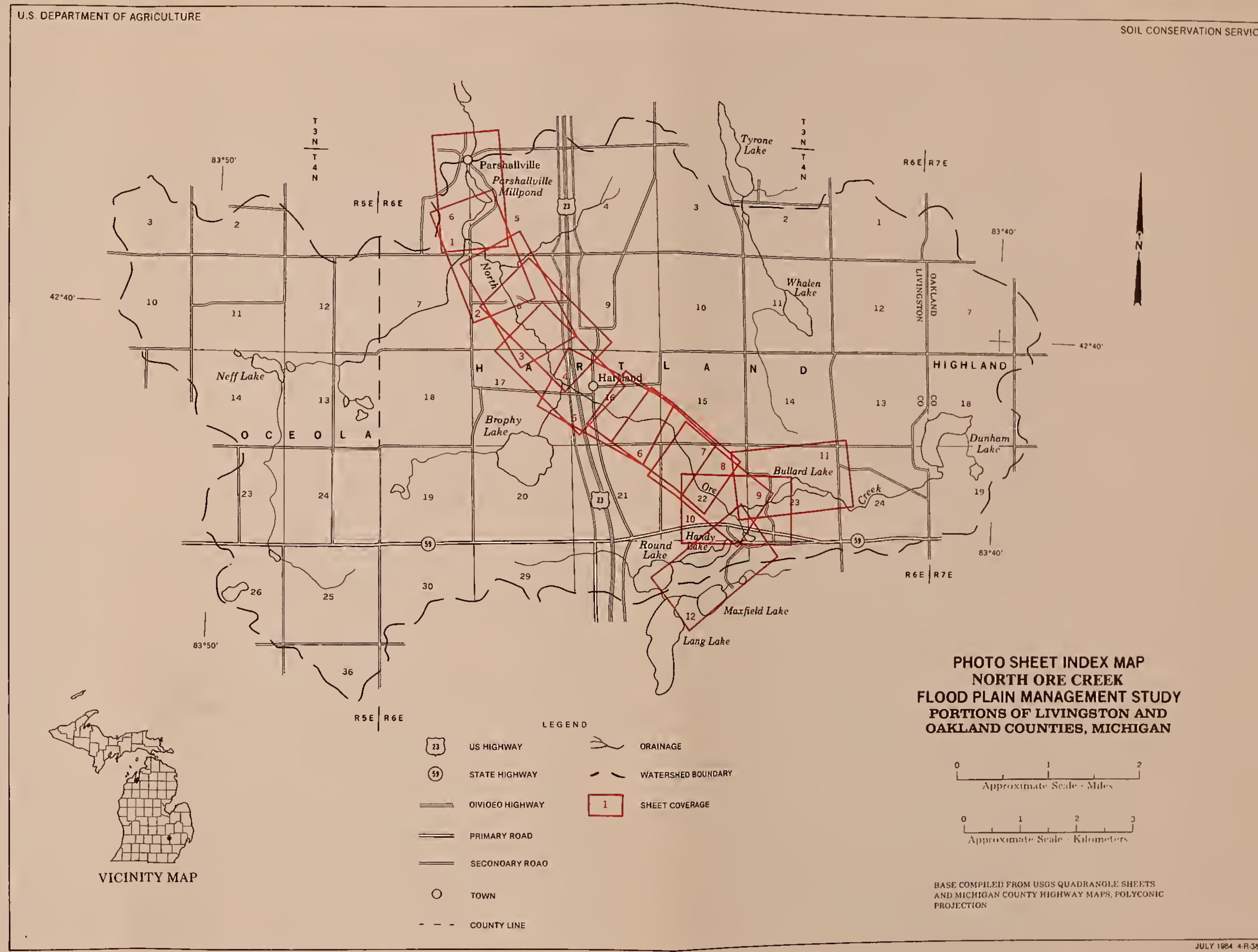
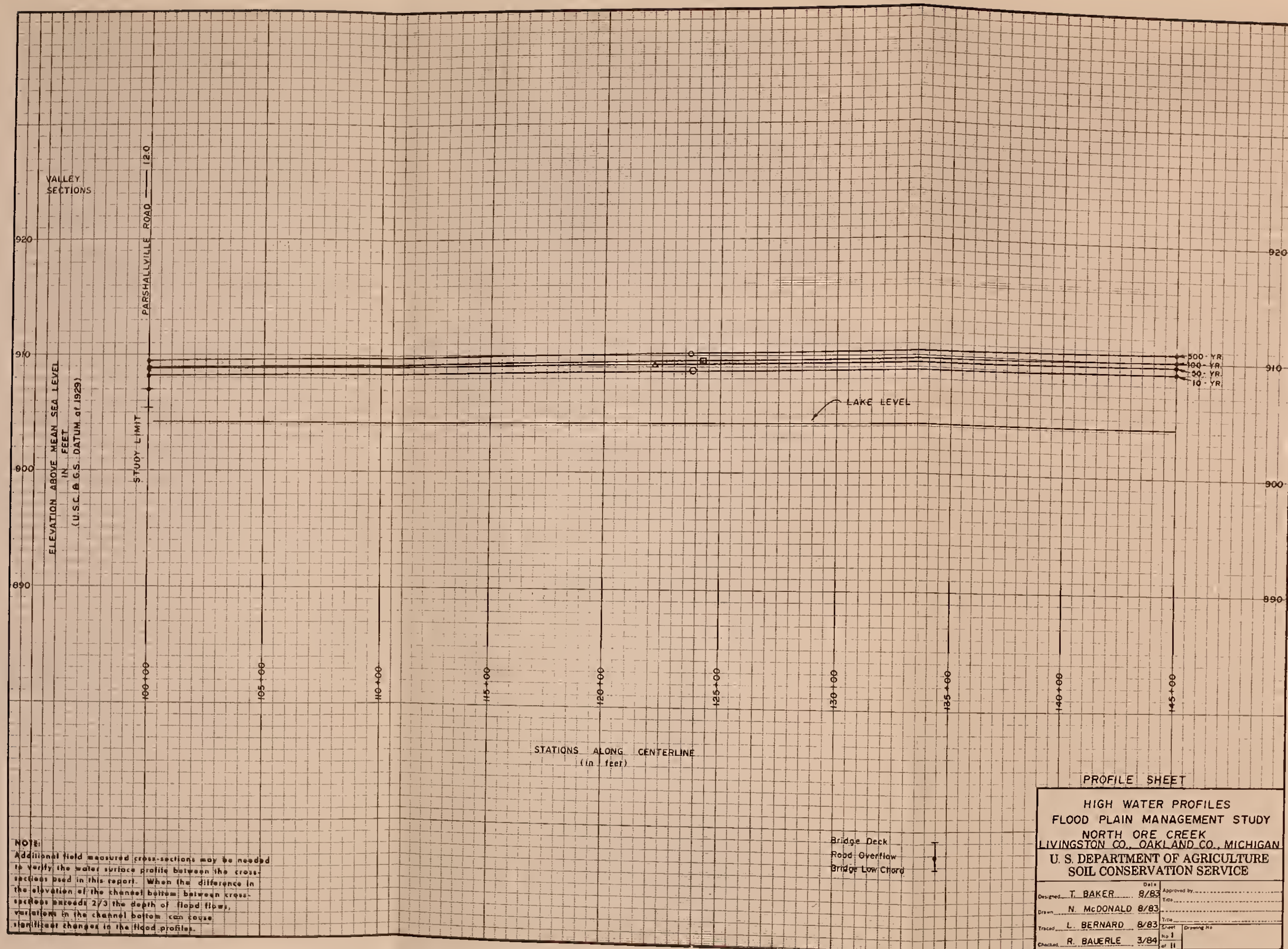


PHOTO SHEET INDEX MAP
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
PORTIONS OF LIVINGSTON AND OAKLAND COUNTIES, MICHIGAN



SCS-ENG-316 (Rev. 2-69)

LEGEND

100 Year Flood Hazard Area	Stream Channel
500 Year Flood Hazard Area	100 Year Flood Elevation
17.25 Valley Section Location	100+00 Channel Station

SCALE 0 — 400 — 800 FEET
0 — 100 — 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

SHEET 1 OF 12

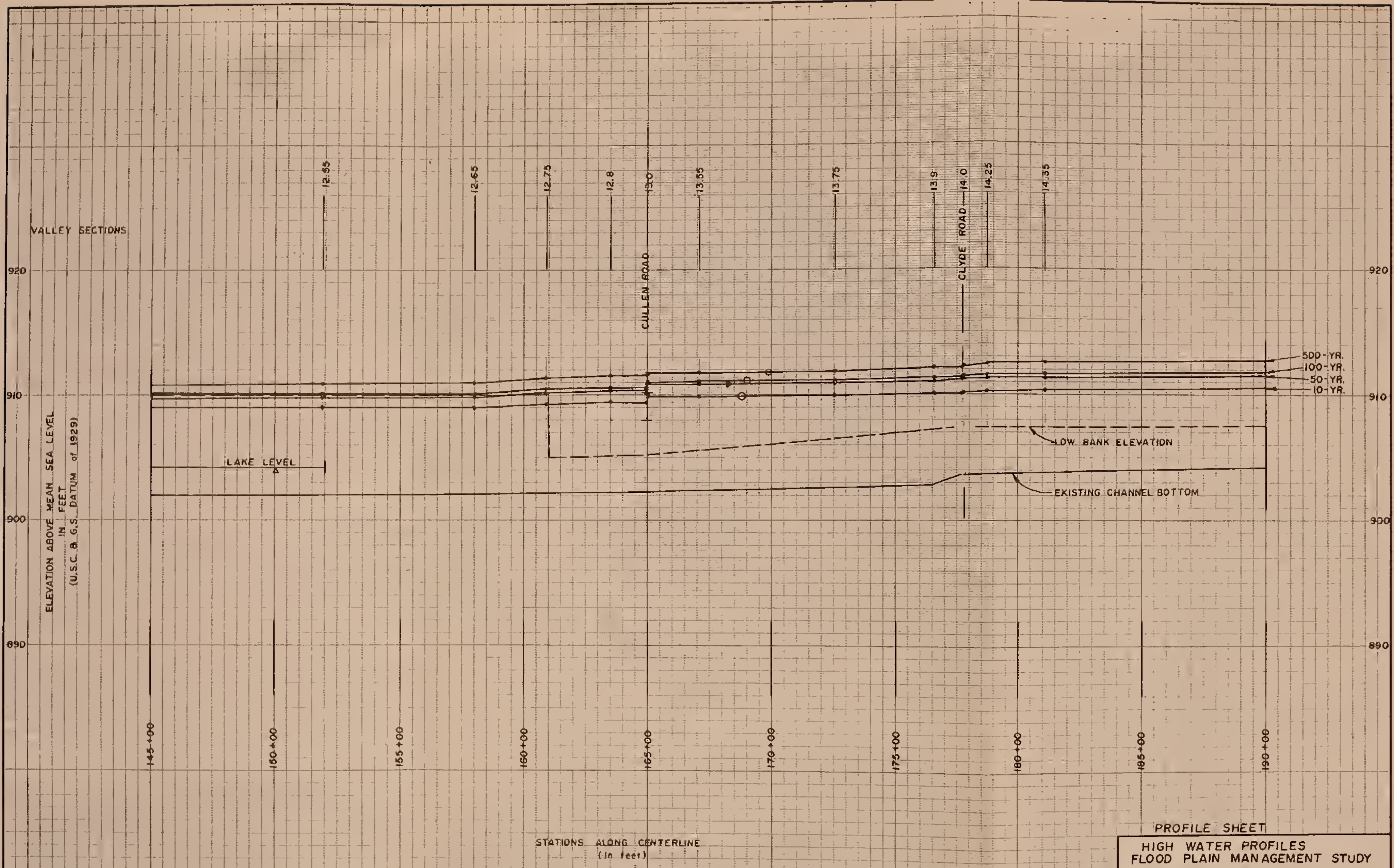
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK

JULY 1984 4-R-38793



NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

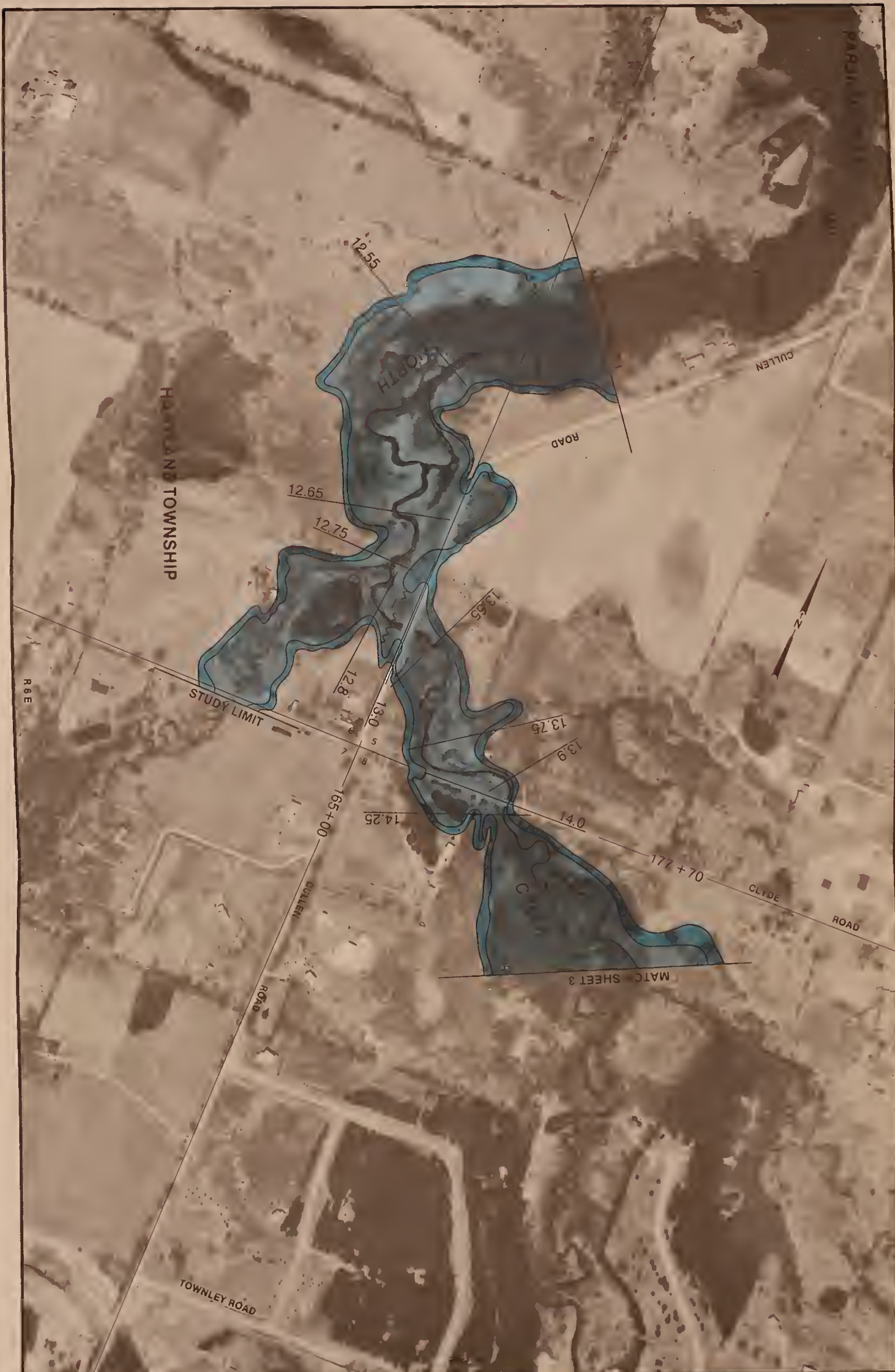
PROFILE SHEET

HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	T. BAKER	8/83	Approved by
Drawn	N. McDONALD	8/83	Title
Traced	L. BERNARD	8/83	Sheet No. 2 of 11
Checked	R. BAUERLE	3/84	Drawing No.

SCS-ENG-316 Rev. 6-73



LEGEND

	100 Year Flood Hazard Area		Stream Channel
	500 Year Flood Hazard Area	911	100 Year Flood Elevation
17.25	Valley Section Location	100+00	Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

JULY 1984 4-R-38793

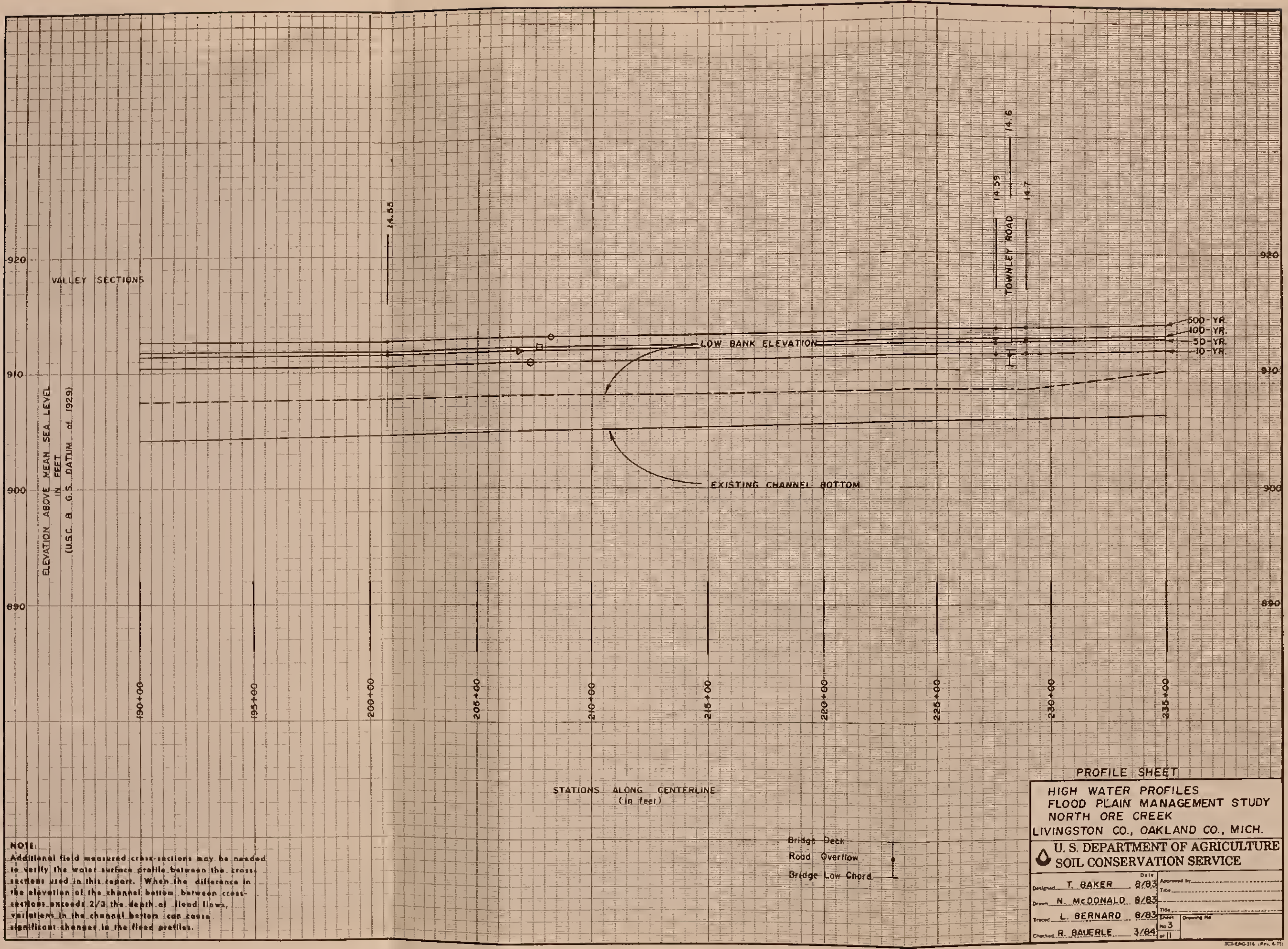
SHEET 2 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK


VALLEY SECTIONS
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
920
910
900
890
14.55
14.59
14.6
14.7
TOWNLEY ROAD
500-YR.
100-YR.
50-YR.
10-YR.
LOW BANK ELEVATION
EXISTING CHANNEL BOTTOM
190+00
195+00
200+00
205+00
210+00
215+00
220+00
225+00
230+00
235+00
STATIONS ALONG CENTERLINE (in feet)
NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.
Bridge Deck
Road Overflow
Bridge Low Chord
PROFILE SHEET
HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T. BAKER 8/83
Drawn N. McDONALD 8/83
Traced L. BERNARD 8/83
Checked R. BAUERLE 3/84
Sheet No. 3 of 11

LEGEND

100 Year Flood Hazard Area	Stream Channel
500 Year Flood Hazard Area	911 100 Year Flood Elevation
17.25 Valley Section Location	100+00 Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

SHEET 3 OF 12

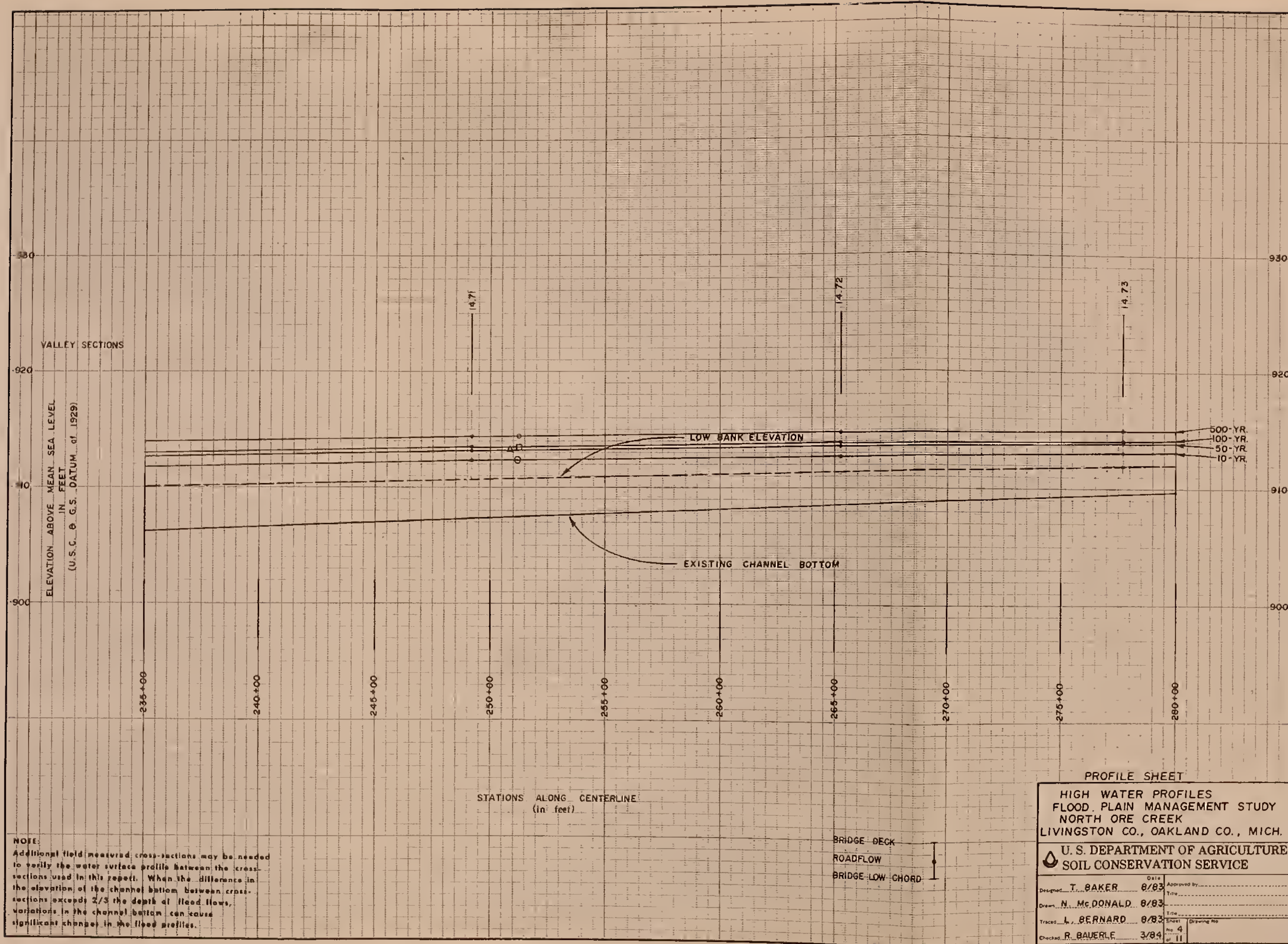
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK

JULY 1984 4-R-38793


VALLEY SECTIONS
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
930
920
910
900
14.71
14.72
14.73
LOW BANK ELEVATION
EXISTING CHANNEL BOTTOM
500-YR.
100-YR.
50-YR.
10-YR.
235+00
240+00
245+00
250+00
255+00
260+00
265+00
270+00
275+00
280+00
STATIONS ALONG CENTERLINE (in feet)
BRIDGE DECK
ROADFLOW
BRIDGE LOW CHORD
NOTE:
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PROFILE SHEET
HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T. BAKER 8/83
Drawn N. McDONALD 8/83
Traced L. BERNARD 8/83
Checked R. BAUERLE 3/84
Approved by
Title
Title
Sheet No. 4 of 11
Drawing No.

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 17.25 Valley Section Location
- Stream Channel
- 911 100 Year Flood Elevation
- 100+00 Channel Station

SCALE 0 — 400 — 800 FEET
0 — 100 — 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

JULY 1984 4-R-38793

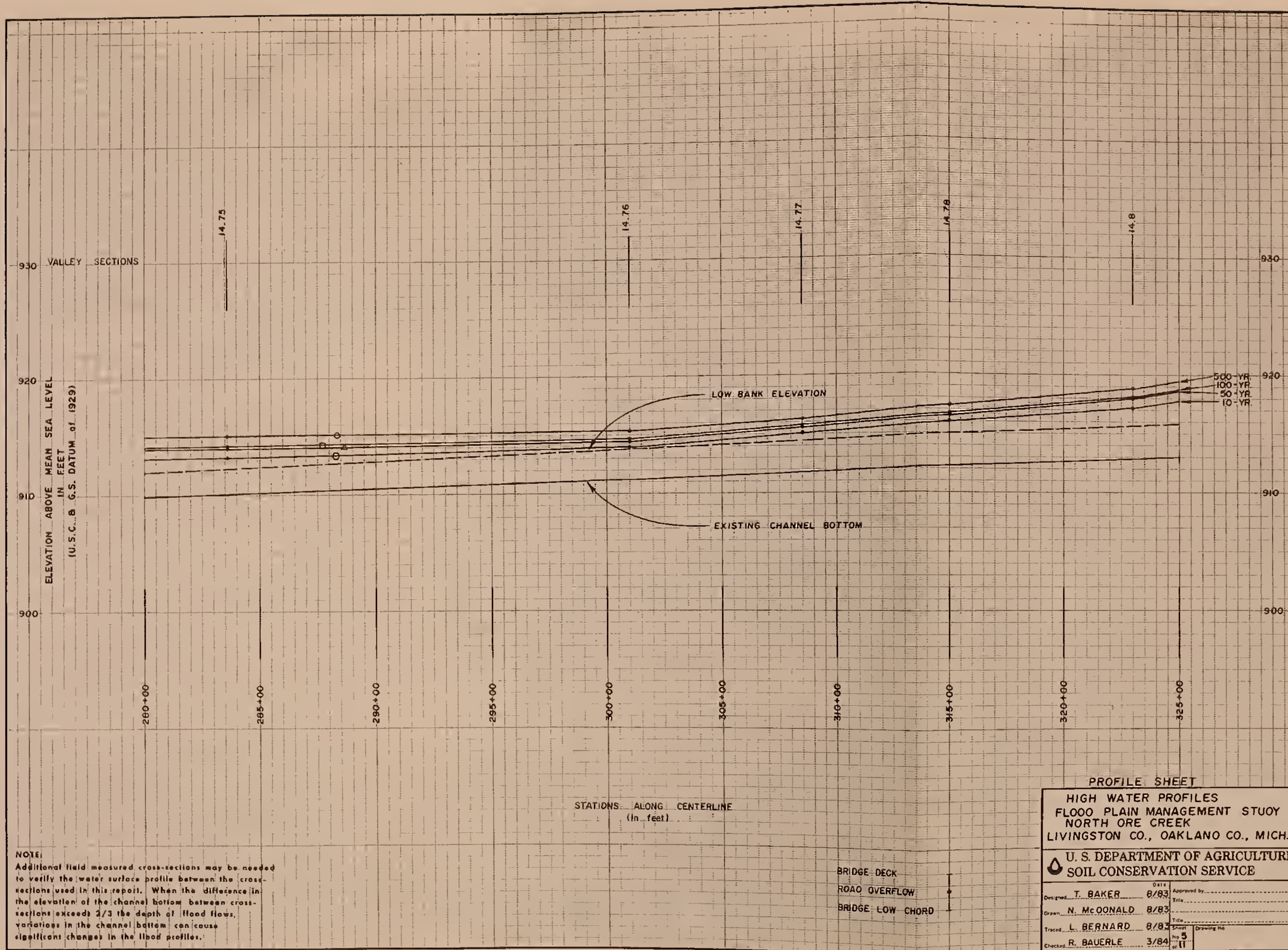
SHEET 4 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK


VALLEY SECTIONS
14.75
14.76
14.77
14.78
14.8
930
920
910
900
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
LOW BANK ELEVATION
EXISTING CHANNEL BOTTOM
500-YR.
100-YR.
50-YR.
10-YR.
280+00
285+00
290+00
295+00
300+00
305+00
310+00
315+00
320+00
325+00
STATIONS ALONG CENTERLINE (in feet)
NOTE:
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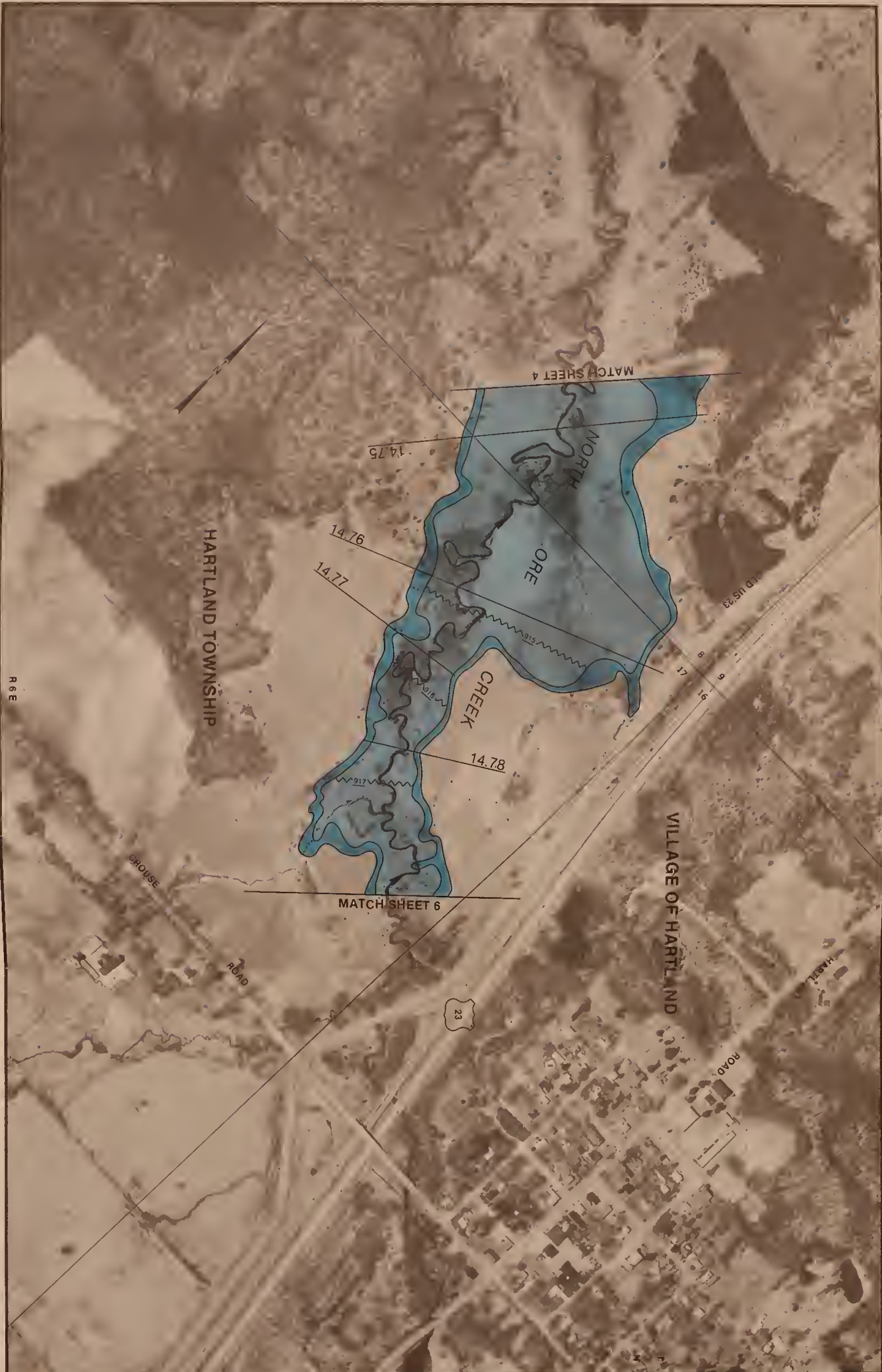
BRIDGE DECK
ROAO OVERFLOW
BRIDGE LOW CHORD
PROFILE SHEET
HIGH WATER PROFILES
FLOOO PLAIN MANAGEMENT STUOY
NORTH ORE CREEK
LIVINGSTON CO., OAKLANO CO., MICH.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T. BAKER 8/83
Drawn N. McOONALD 8/83
Traced L. BERNARD 8/83
Checked R. BAUERLE 3/84
Sheet No 5 of 11



LEGEND

	100 Year Flood Hazard Area		Stream Channel
	500 Year Flood Hazard Area	911	100 Year Flood Elevation
17.25	Valley Section Location	100+00	Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

JULY 1984 4-R-38793

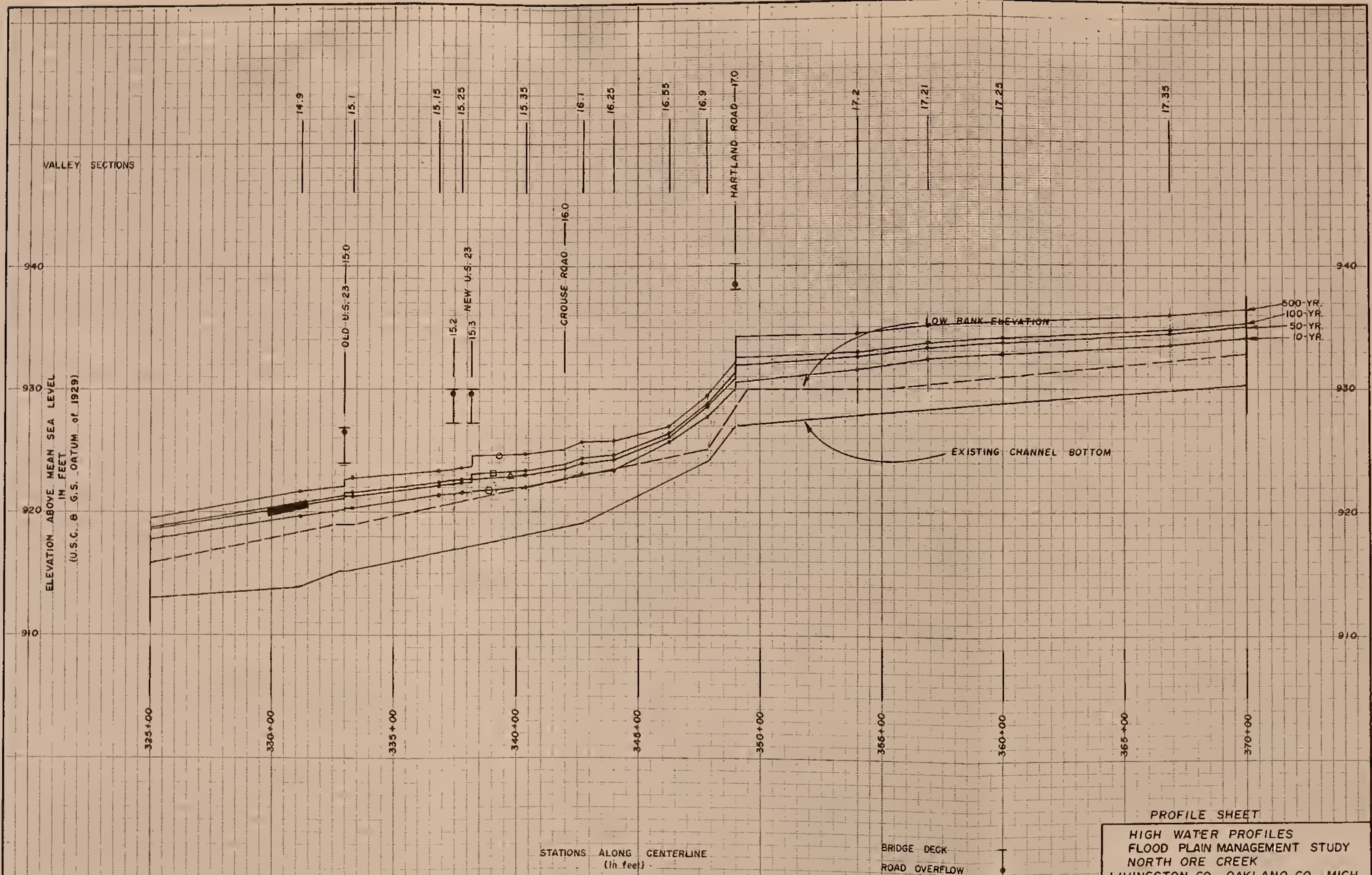
SHEET 5 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK



NOTE:
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PROFILE SHEET

HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	T. BAKER	8/83
Drawn	N. McDONALD	8/83
Traced	L. BERNARD	8/83
Checked	R. BAUERLE	3/84

Approved by
Title
Sheet No. 6 of 11
Drawing No.

SCS-ENG-316 (Rev. 6-71)

LEGEND

100 Year Flood Hazard Area — Stream Channel

500 Year Flood Hazard Area — 911 100 Year Flood Elevation

17.25 Valley Section Location — 100+00 Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

JULY 1984 4-R-38793

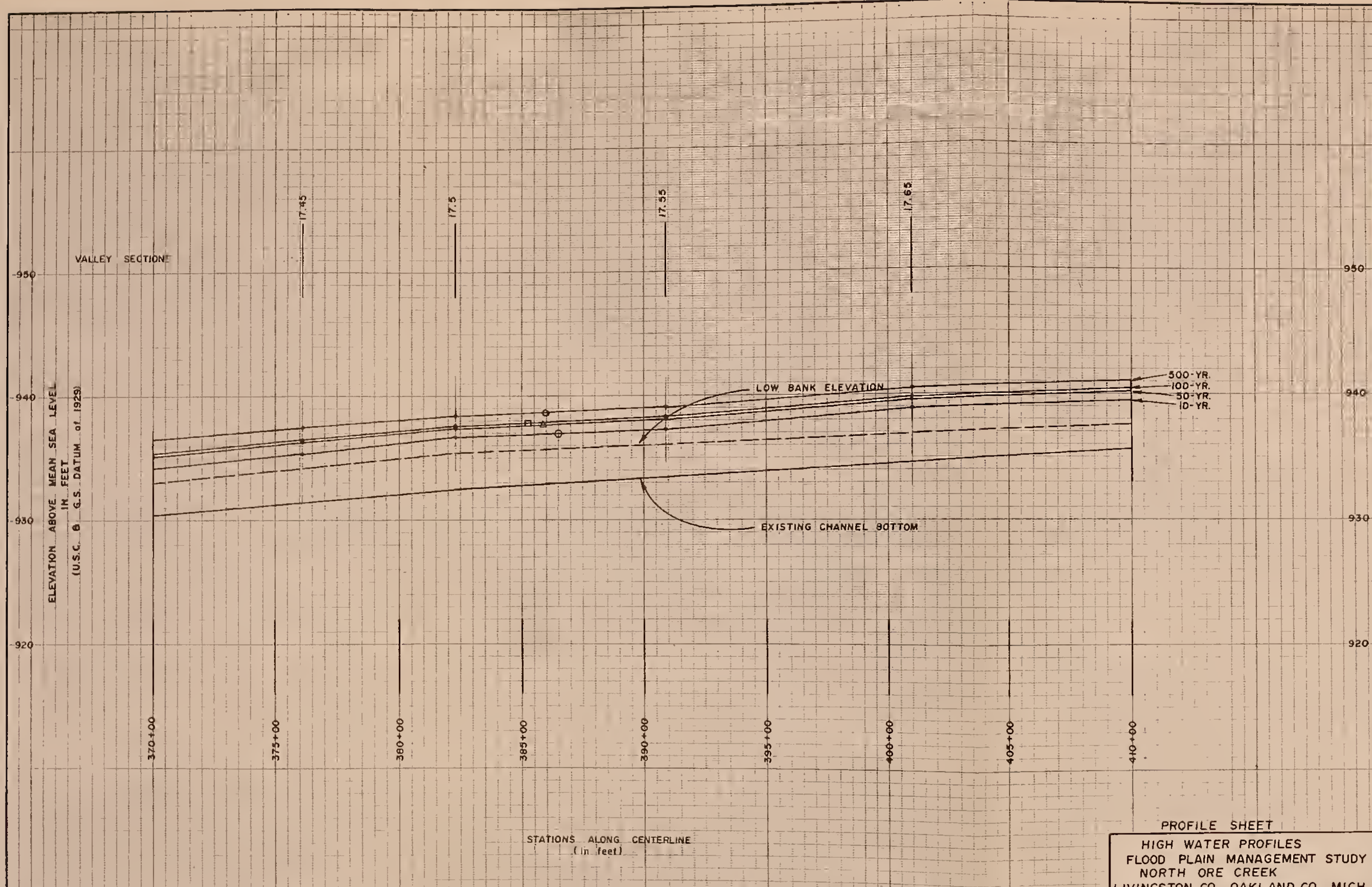
SHEET 6 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK



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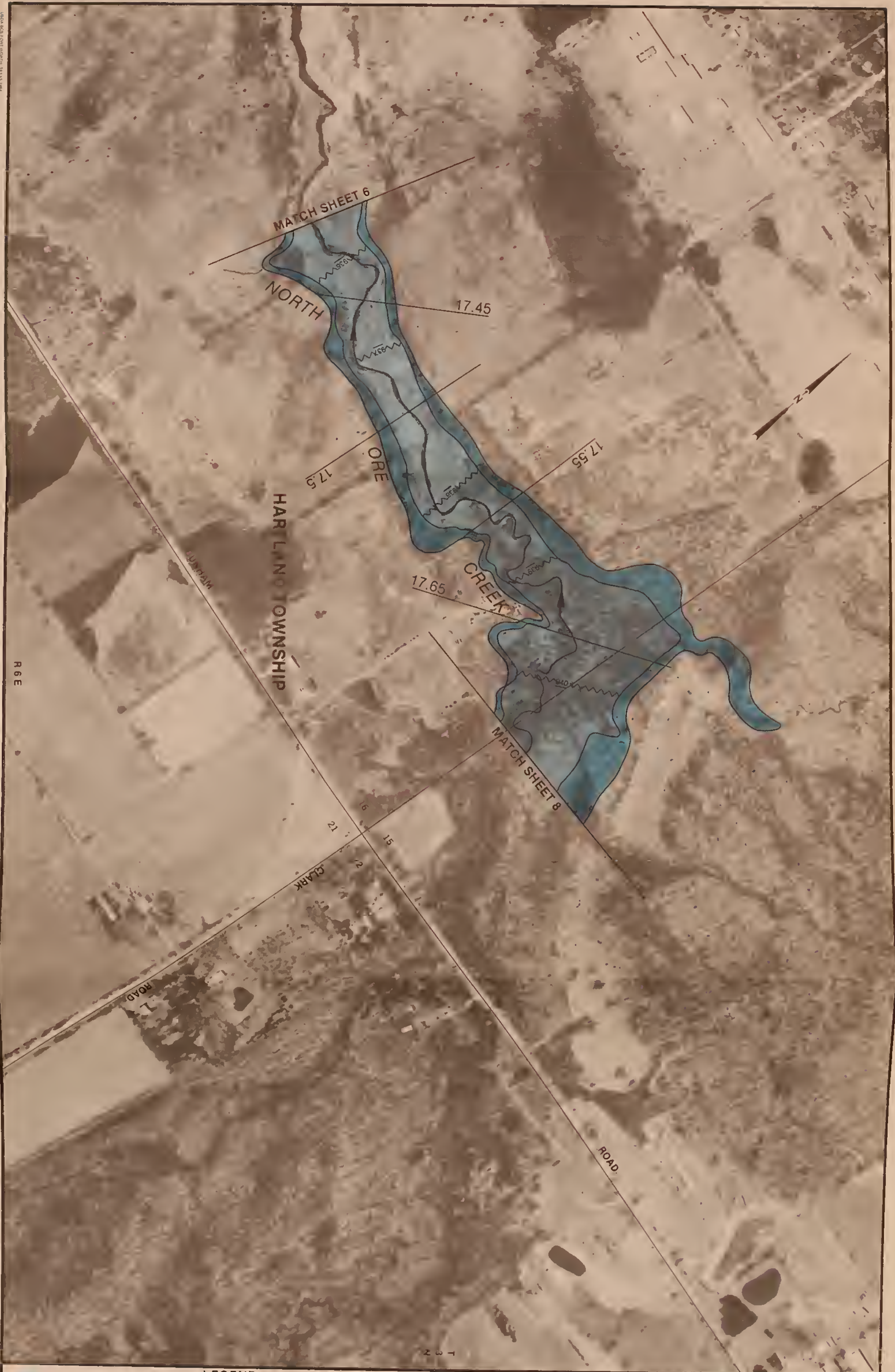
PROFILE SHEET

HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	T. BAKER	8/83
Drawn	N. McDONALD	8/83
Traced	L. BERNARD	8/83
Checked	R. BAUERLE	3/84

Approved by
Title
Title
Sheet No. 7 of 11
Drawing No



LEGEND

100 Year Flood Hazard Area
500 Year Flood Hazard Area
17.25 Valley Section Location
Stream Channel
911 100 Year Flood Elevation
100+00 Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

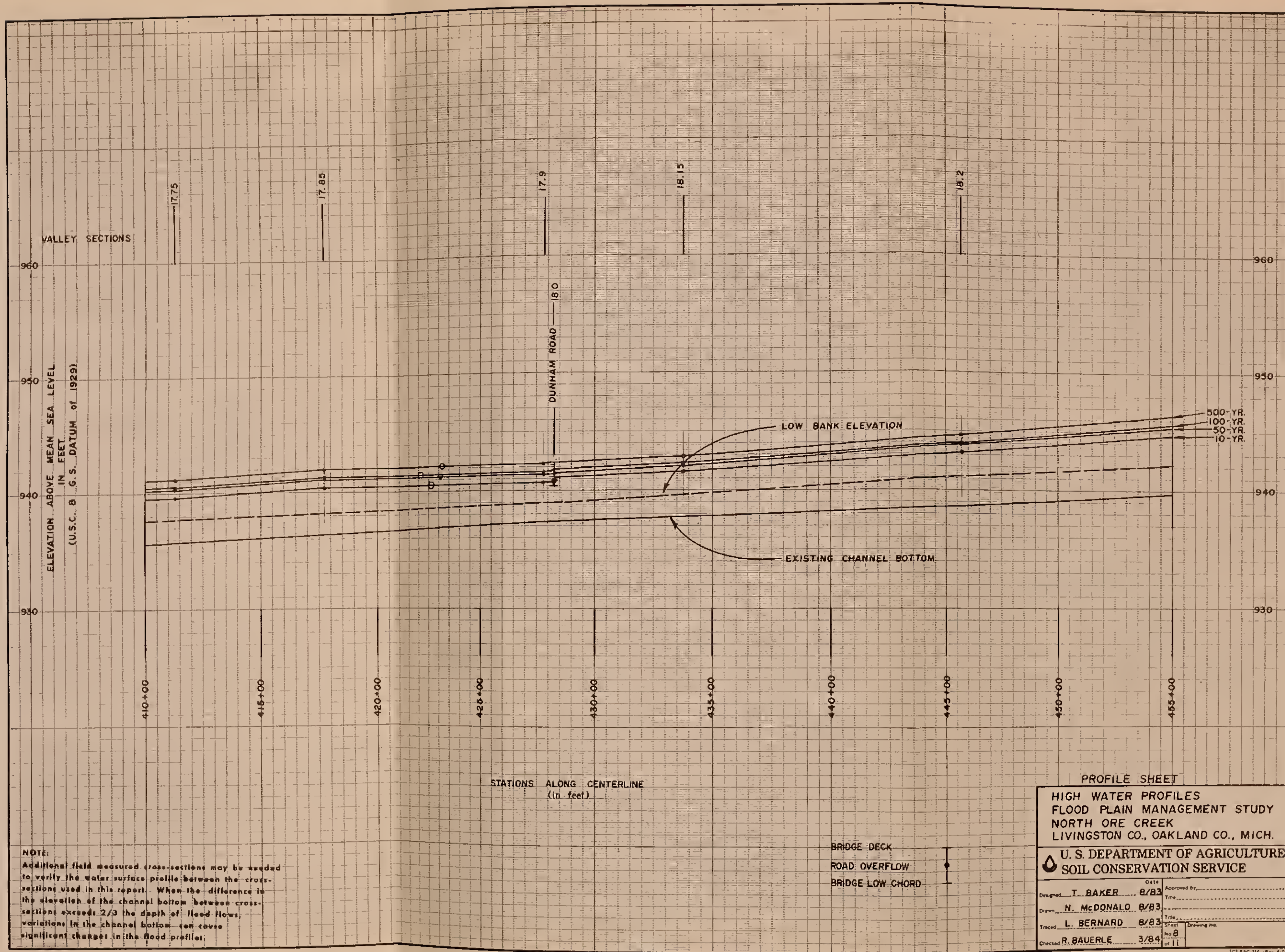
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK

SHEET 7 OF 12

JULY 1984 4-R-38793


VALLEY SECTIONS
17.75
17.85
17.9
18.0
18.15
18.2
DUNHAM ROAD
960
950
940
930
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
LOW BANK ELEVATION
EXISTING CHANNEL BOTTOM
500-YR.
100-YR.
50-YR.
10-YR.
410+00
415+00
420+00
425+00
430+00
435+00
440+00
445+00
450+00
455+00
STATIONS ALONG CENTERLINE (in feet)
BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD
NOTE:
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PROFILE SHEET
HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Date
Designed T. BAKER 8/83
Drawn N. McDONALD 8/83
Traced L. BERNARD 8/83
Checked R. BAUERLE 3/84
Approved by
Title
Title
Sheet No 8 of 11
Drawing No.

LEGEND

100 Year Flood Hazard Area	Stream Channel
500 Year Flood Hazard Area	100 Year Flood Elevation
17.25 Valley Section Location	100+00 Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

JULY 1984 4-R-38793

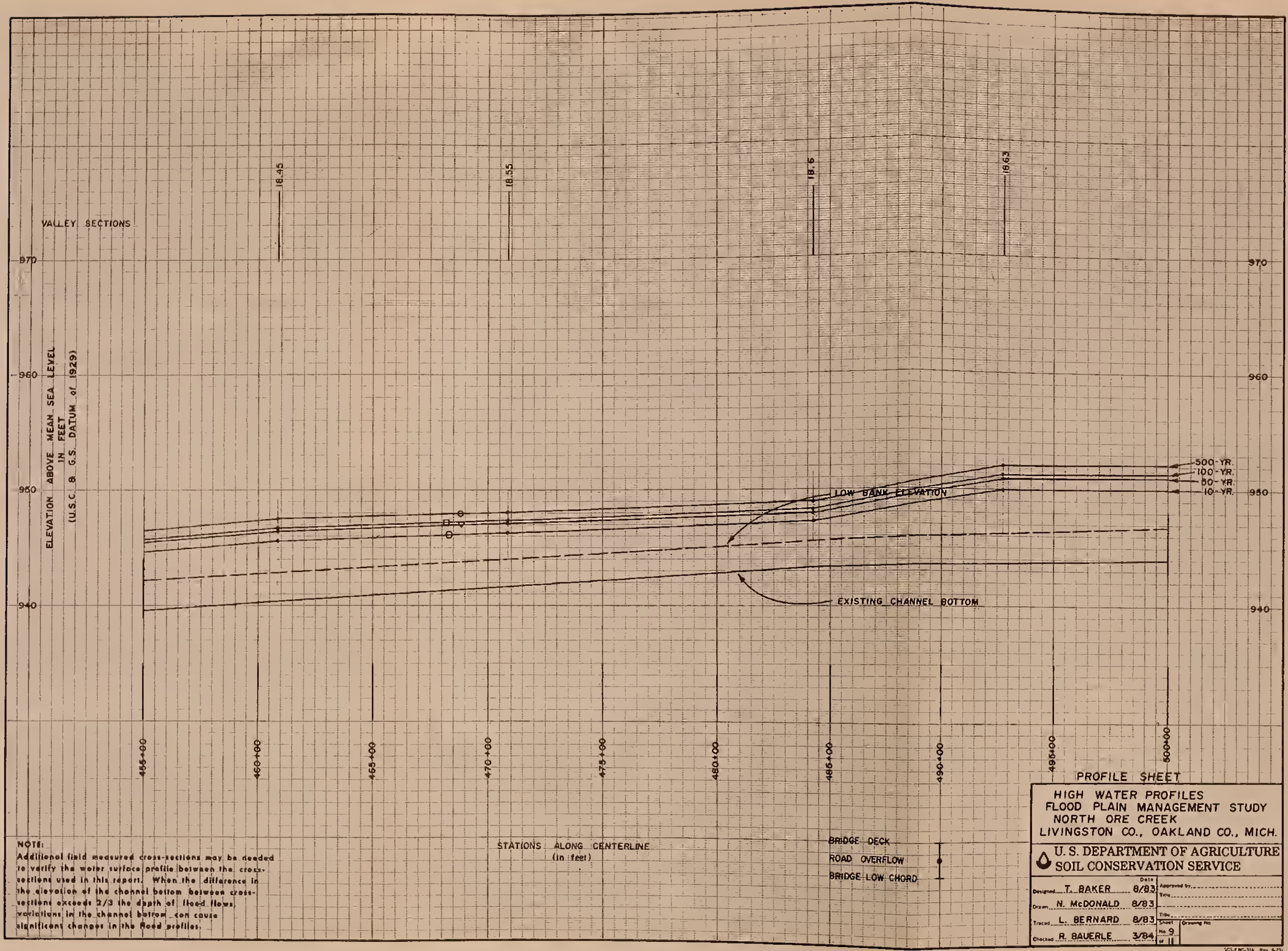
SHEET 8 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK


VALLEY SECTIONS
18.45
18.55
18.6
18.63
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)
970
960
950
940
LOW BANK ELEVATION
EXISTING CHANNEL BOTTOM
500-YR.
100-YR.
50-YR.
10-YR.
455+00
460+00
465+00
470+00
475+00
480+00
485+00
490+00
495+00
500+00
STATIONS ALONG CENTERLINE (in feet)
BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD
NOTE:
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PROFILE SHEET
HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Date
Designed T. BAKER 8/83
Drawn N. McDONALD 8/83
Traced L. BERNARD 8/83
Checked R. BAUERLE 3/84
Approved by
Title
Title
Sheet No 9 of 11
Drawing No

LEGEND

100 Year Flood Hazard Area	Stream Channel
500 Year Flood Hazard Area	911 100 Year Flood Elevation
17.25 Valley Section Location	100+00 Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

JULY 1984 4-R-38793

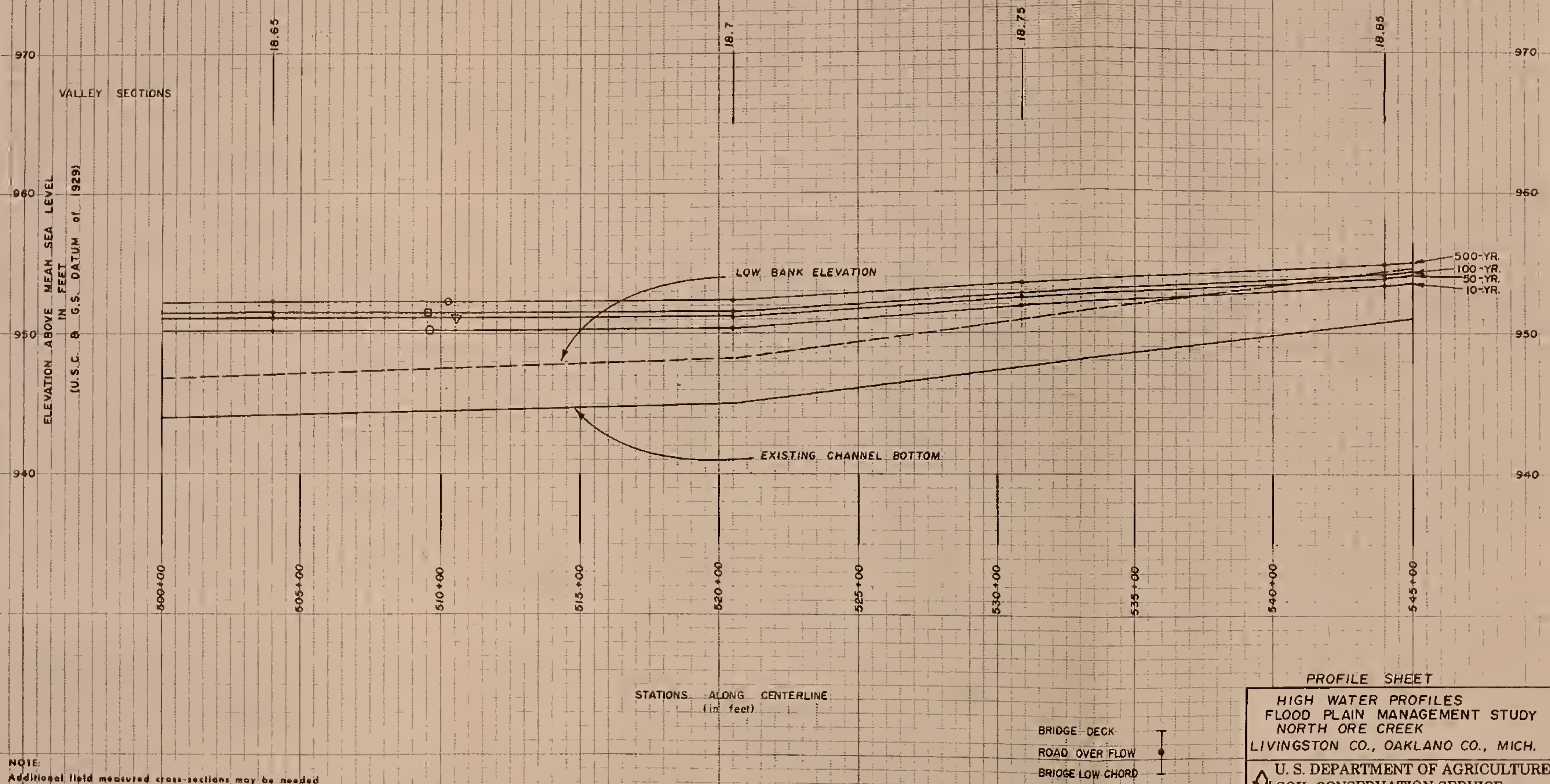
SHEET 9 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK



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PROFILE SHEET

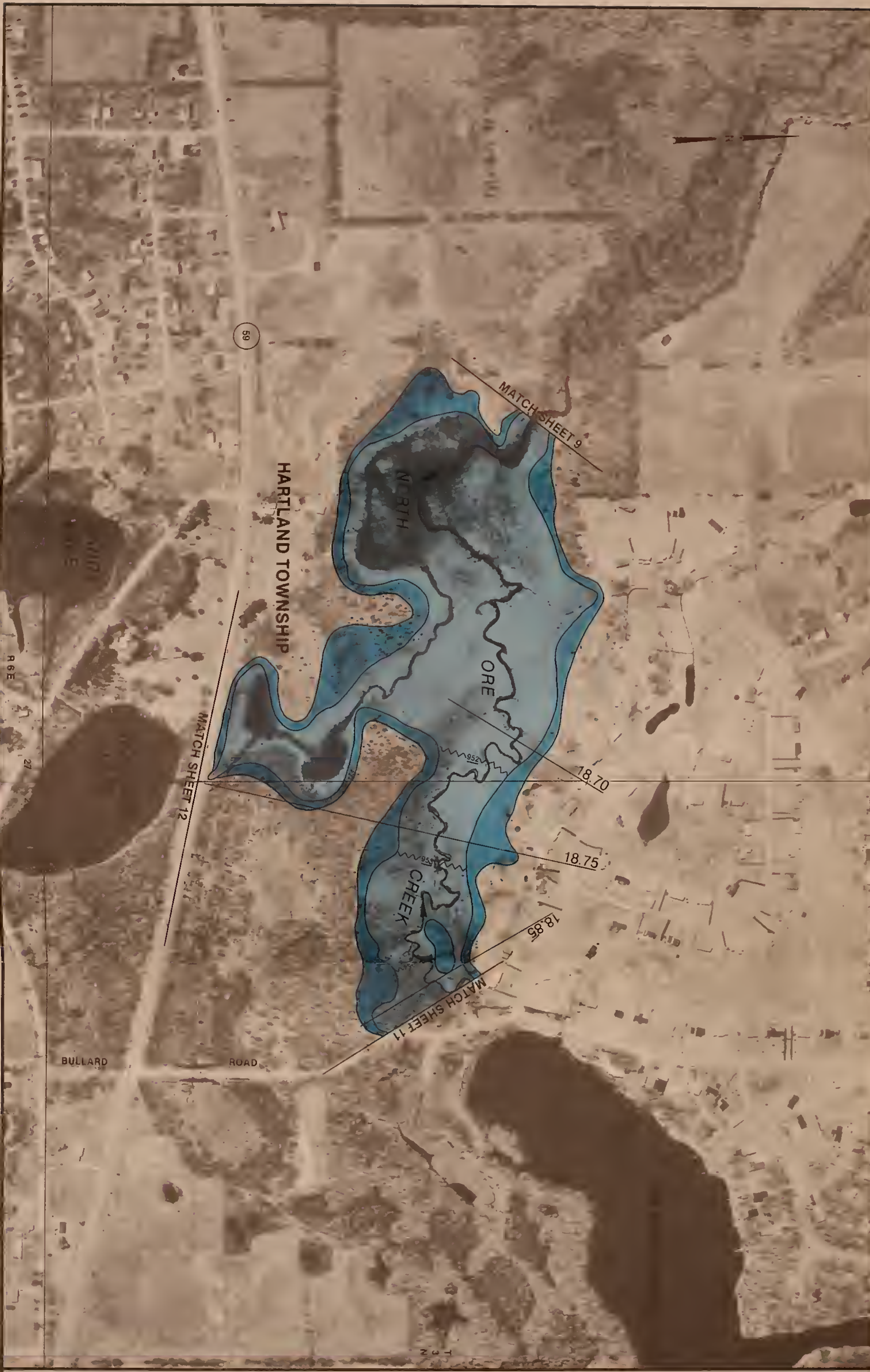
HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLANO CO., MICH.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	T. BAKER	8/83
Drawn	N. McDONALD	8/83
Traced	L. BERNARO	8/83
Checked	R. BAUERLE	3/84

Approved by
Title
Title
Sheet No 10 of 11
Drawing No

SCS ENG 316 Rev. 6-75



LEGEND

100 Year Flood Hazard Area — Stream Channel

500 Year Flood Hazard Area — 911 100 Year Flood Elevation

17.25 Valley Section Location — 100+00 Channel Station

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

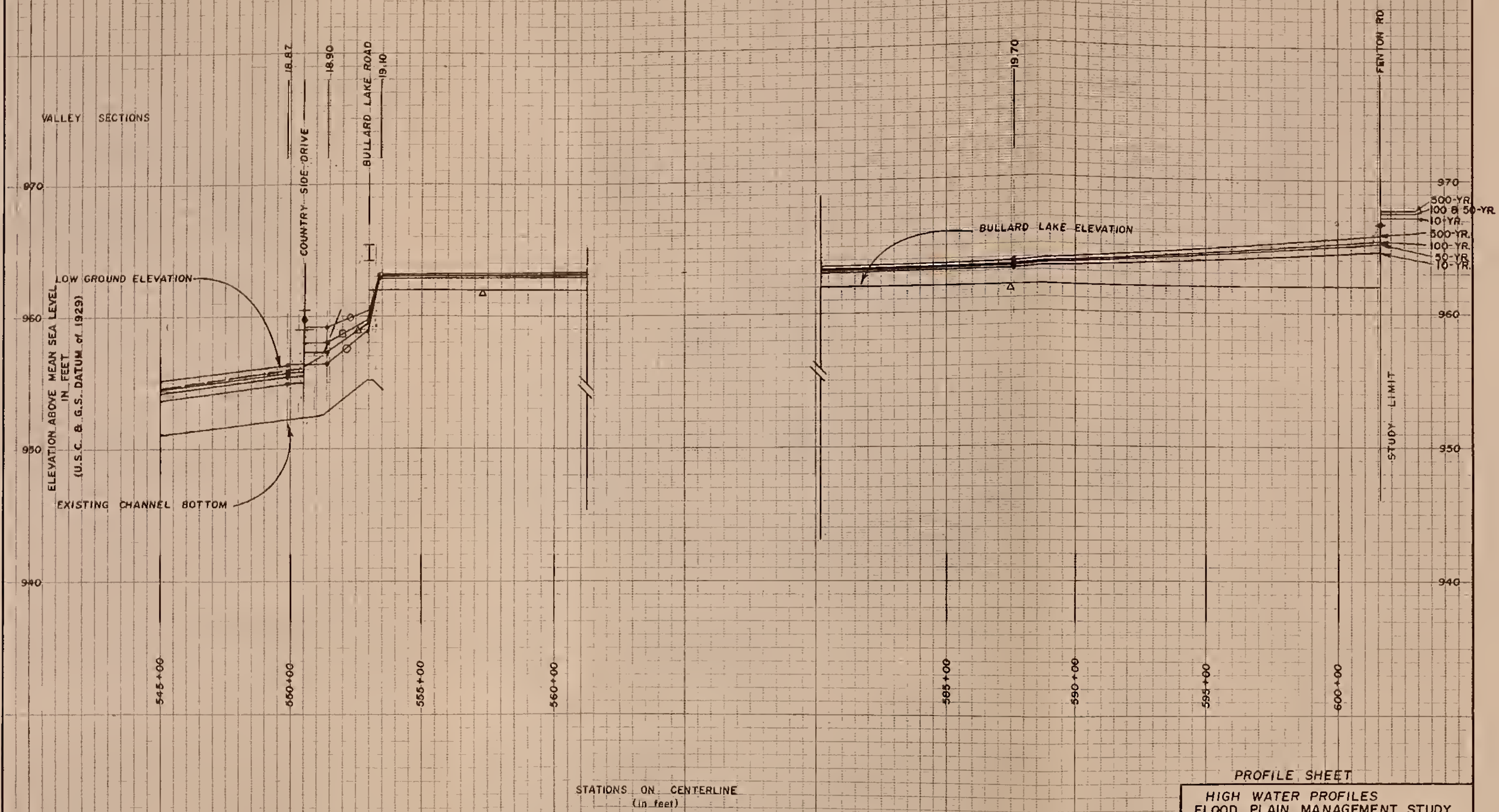
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK

SHEET 10 OF 12

JULY 1984 4-R-38793



BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD

NOTE:
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PROFILE SHEET

HIGH WATER PROFILES
FLOOD PLAIN MANAGEMENT STUDY
NORTH ORE CREEK
LIVINGSTON CO., OAKLAND CO., MICH.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	T. BAKER	8/83
Drawn	N. McDONALD	8/83
Traced	L. BERNARD	8/83
Checked	R. BAUERLE	3/84

Approved by
Title
Title
Sheet No. 11 of 11
Drawing No.

SCS-ENG-316 (Rev. 4-75)

LEGEND

100 Year Flood Hazard Area	Stream Channel	
500 Year Flood Hazard Area	911 100 Year Flood Elevation	
17.25 Valley Section Location	100+00 Channel Station	

SCALE 0 400 800 FEET; 0 100 200 METERS; APPROXIMATE

Limits of Flooding May Vary From Actual Ground Location

April 1982 Photography From Abrams Aerial Survey Corp.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

FLOOD HAZARD AREA

NORTH ORE CREEK

SHEET 11 OF 12

JULY 1984 4-R-38793

LEGEND

100 Year Flood Hazard Area	Stream Channel		
500 Year Flood Hazard Area	911 100 Year Flood Elevation		
17.25 Valley Section Location	100+00 Channel Station	Limits of Flooding May Vary From Actual Ground Location	April 1982 Photography From Abrams Aerial Survey Corp.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

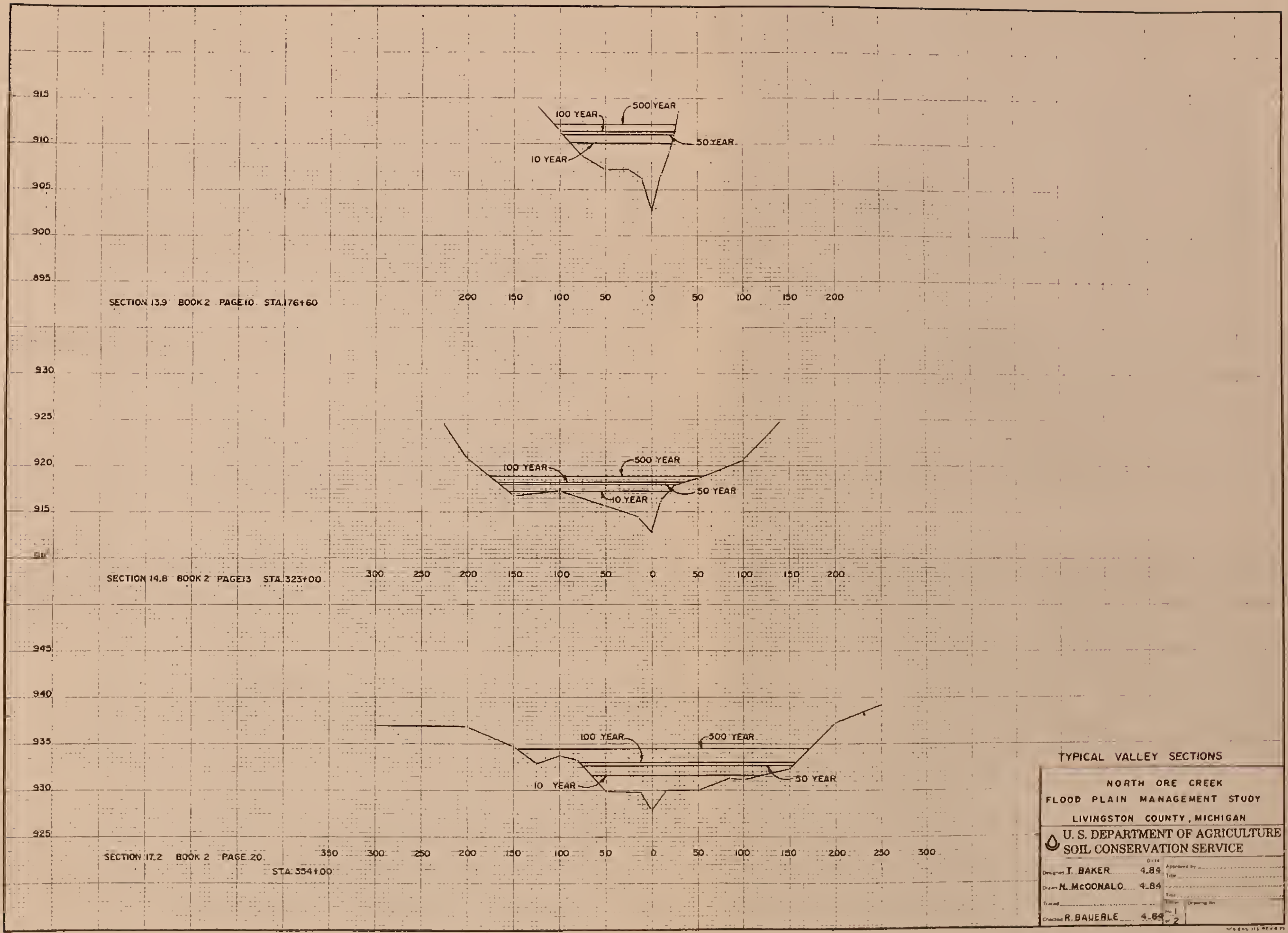
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

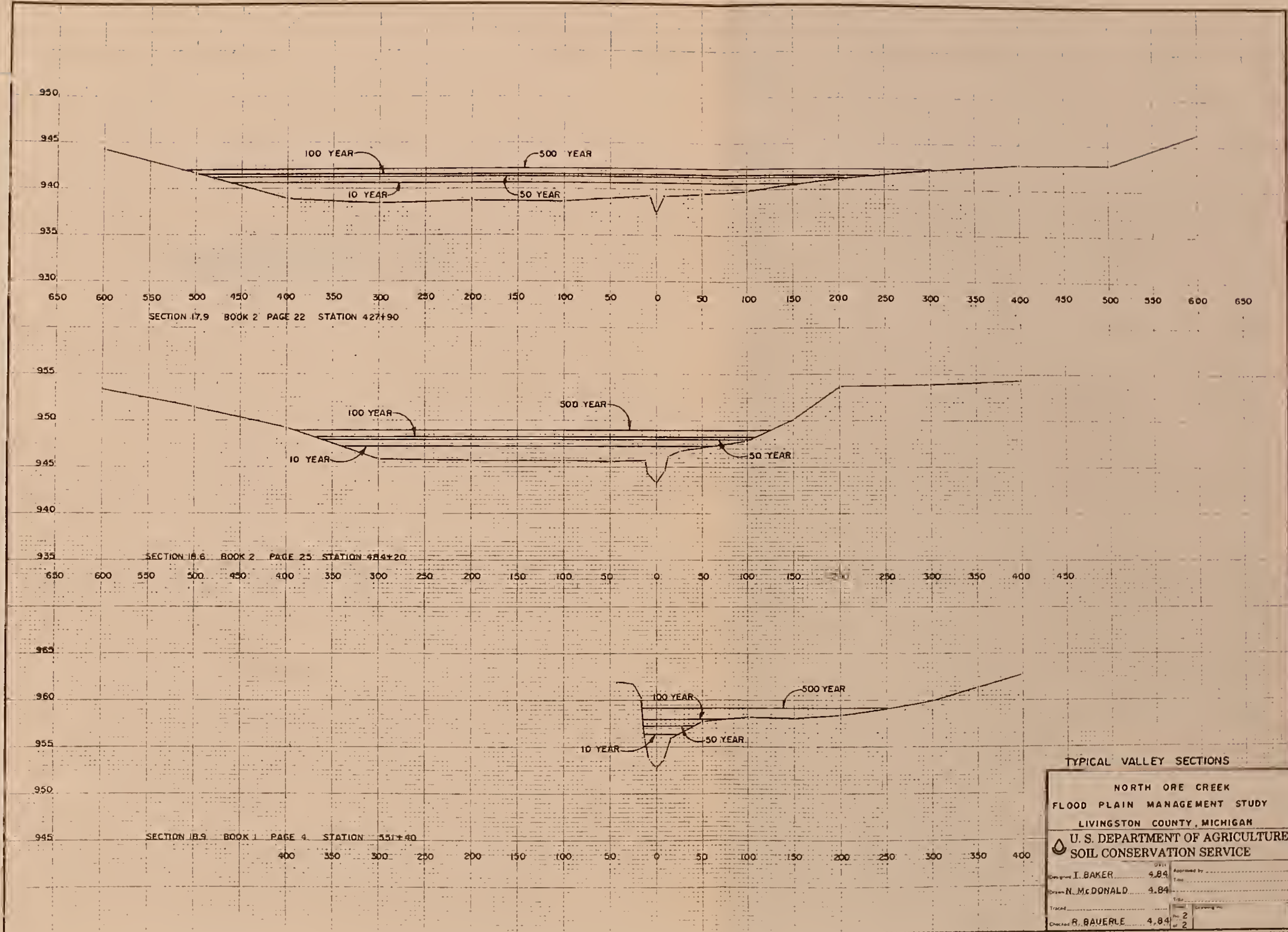
FLOOD HAZARD AREA

NORTH ORE CREEK

SHEET 12 OF 12

JULY 1984 4-R-38793


915
910
905
900
895
100 YEAR
500 YEAR
50 YEAR
10 YEAR
SECTION 13.9 BOOK 2 PAGE 10 STA.176+60
200 150 100 50 0 50 100 150 200
930
925
920
915
100 YEAR
500 YEAR
50 YEAR
10 YEAR
SECTION 14.8 BOOK 2 PAGE 13 STA.323+00
300 250 200 150 100 50 0 50 100 150 200
945
940
935
930
925
100 YEAR
500 YEAR
50 YEAR
10 YEAR
SECTION 17.2 BOOK 2 PAGE 20
STA. 354+00
350 300 250 200 150 100 50 0 50 100 150 200 250 300
TYPICAL VALLEY SECTIONS
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
T. BAKER 4-84
N. McDONALD 4-84
R. BAUERLE 4-84
1
2



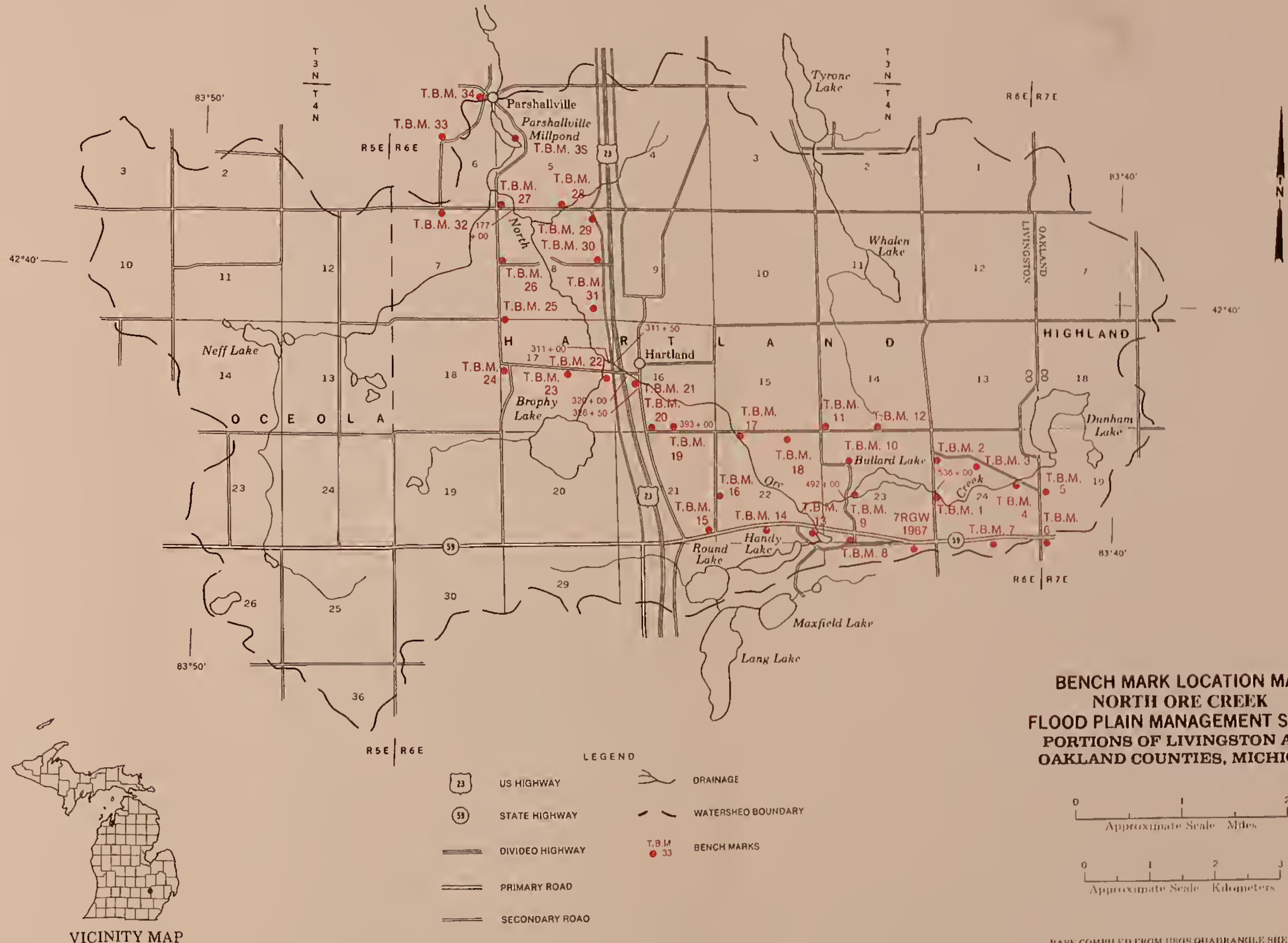
TYPICAL VALLEY SECTIONS

NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
LIVINGSTON COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed I. BAKER	4.84	Approved by
Drawn N. McDONALD	4.84	
Traced		
Checked R. BAUERLE	4.84	Sheet 2 of 2

APPENDIX B



BENCH MARK LOCATION MAP
NORTH ORE CREEK
FLOOD PLAIN MANAGEMENT STUDY
PORTIONS OF LIVINGSTON AND OAKLAND COUNTIES, MICHIGAN

LEGEND

- US HIGHWAY
- STATE HIGHWAY
- DIVIDED HIGHWAY
- PRIMARY ROAD
- SECONDARY ROAD
- TOWN
- COUNTY LINE
- DRAINAGE
- WATERSHED BOUNDARY
- BENCH MARKS

Approximate Scale Miles: 0 1 2

Approximate Scale Kilometers: 0 1 2 3

BASE COMPILED FROM USGS QUADRANGLE SHEETS AND MICHIGAN COUNTY HIGHWAY MAPS. POLYCONIC PROJECTION.

APPENDIX C

TABLE 1 - FLOOD DISCHARGES
NORTH ORE CREEK

Location	TR-20 Sec.	From Sec.	To Sec.	Drainage Area	Estimated Peak Discharges			
					10 Yr.	50 Yr.	100 Yr.	500 Yr.
				Sq. Miles	-cubic feet per second-			
From Parshallville Dam to downstream of Cullen Road	098	12.00	12.75	36.82	975	1,520	1,720	2,470
To upstream of Clyde Road	060	12.80	14.35	22.60	370	605	700	1,070
To downstream of Old US-23	048	14.55	14.90	18.92	335	555	645	965
To upstream of Hartland Road	044	15.00	17.55	18.28	335	545	630	950
To downstream of Bullard Road	039	17.65	18.65	17.52	330	540	625	935
Through Bullard Lake structure-divided flow	103	18.85	19.10	9.71	210	285	340	440
Flow over Bullard Lake dike-divided flow	102	18.85	19.10	4.72	65	150	155	270
To Fenton Road	020	19.10	20.00	11.61	275	435	495	710

TABLE 2 - FLOOD ELEVATIONS AT SURVEYED SECTIONS
NORTH ORE CREEK

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
Parshallville Dam	12.00	100+00	908.2	908.8	908.9	909.5
	12.55	151+90	909.0	909.8	910.1	910.9
	12.65	158+00	909.0	909.9	910.1	911.0
	12.75	160+90	909.3	910.2	910.5	911.4
	12.80	163+50	909.4	910.4	910.6	911.6
Cullen Road	13.00 D 1/	164+80	909.4	910.4	910.6	911.6
	13.00 U	165+40	909.9	910.9	911.0	911.7
	13.55	167+10	909.9	910.9	911.1	911.8
	13.75	172+60	910.0	911.0	911.2	911.9
	13.90	176+60	910.1	911.1	911.4	912.2
Clyde Road	14.00 D	177+56	910.1	911.2	911.4	912.2
	14.00 U	177+74	910.2	911.3	911.5	912.3
	14.25	178+70	910.3	911.3	911.6	912.5
	14.35	181+10	910.4	911.4	911.7	912.6
	14.55	200+80	910.5	911.5	911.8	912.7
	14.59	227+60	911.4	912.4	912.7	913.6
Townley Road	14.60	228+20	911.4	912.4	912.6	913.5
	14.70	228+90	911.5	912.5	912.7	913.7
	14.71	249+20	912.4	913.2	913.5	914.4
	14.72	265+30	912.7	913.6	913.9	914.8
	14.73	277+70	913.1	913.9	914.1	915.0
	14.75	283+60	913.2	914.0	914.2	915.1
	14.76	301+00	914.0	914.5	914.7	915.4
	14.77	308+50	915.1	915.6	915.8	916.3
	14.78	315+00	916.0	916.5	916.7	917.4
	14.80	323+00	917.2	918.0	918.1	918.9
	14.90	331+20	919.7	920.6	920.8	921.7
Old US-23	15.00 D	332+72	920.2	921.1	921.3	922.1
	15.00 U	333+18	920.3	921.3	921.6	922.7
	15.10	333+30	920.3	921.3	921.6	922.8
	15.15	336+80	921.4	922.2	922.4	923.4
New US-23 South Bound	15.20 D	337+15	921.5	922.3	922.6	923.5
	15.20 U	337+75	921.5	922.3	922.6	923.5
	15.25	337+80	921.6	922.4	922.6	923.6
New US-23 North Bound	15.30 D	337+85	921.6	922.4	922.7	923.7
	15.30 U	338+45	921.7	922.7	923.1	924.6
	15.35	340+30	922.0	923.0	923.4	924.7

1/ D and U represent downstream and upstream faces of bridge and indicates bridge head losses for the tabulated floods.

TABLE 2 - FLOOD ELEVATIONS AT SURVEYED SECTIONS - CON'T
NORTH ORE CREEK

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
Crouse Road	16.00	341+80	922.6	923.5	923.9	925.1
	16.10	342+70	923.1	924.0	924.4	925.7
	16.25	344+00	923.4	924.3	924.6	925.8
	16.55	346+20	925.7	926.1	926.4	927.0
	16.90	347+90	927.8	928.6	928.8	929.5
Hartland Road	17.00 D	348+71	930.0	930.8	931.2	932.1
	17.00 U	349+09	930.6	932.0	932.6	934.3
	17.20	354+00	931.6	932.6	933.0	934.5
	17.21	356+80	932.4	933.3	933.7	935.1
	17.25	360+00	932.8	933.7	934.1	935.4
	17.35	366+90	933.6	934.5	934.8	936.0
	17.45	376+10	935.4	936.3	936.5	937.5
	17.50	382+20	936.7	937.4	937.6	938.4
	17.55	390+80	937.3	938.1	938.3	939.1
	17.65	401+00	938.9	939.6	939.8	940.5
	17.75	411+30	939.6	940.3	940.5	941.2
	17.85	417+70	940.4	941.1	941.3	942.0
	17.90	427+90	940.7	941.4	941.6	942.3
Dunham Road	18.00 D	428+10	940.7	941.4	941.7	942.4
	18.00 U	428+40	941.1	941.5	941.8	942.4
	18.15	433+80	941.6	942.1	942.3	942.9
	18.20	445+70	943.2	943.9	944.0	944.7
	18.45	460+90	945.6	946.4	946.7	947.5
	18.55	470+80	946.3	947.1	947.4	948.1
	18.60	484+20	947.3	948.0	948.3	949.0
	18.63	492+70	950.0	950.9	951.3	952.1
	18.65	504+00	950.2	951.1	951.5	952.3
	18.70	520+50	950.4	951.2	951.6	952.4
	18.75	530+90	951.9	952.5	952.8	953.5
	18.85	544+00	953.4	953.9	954.2	954.9
	18.87	549+90	954.9	955.4	955.7	956.3
Countryside Drive	18.89 D	550+30	955.0	955.5	955.8	956.4
	18.89 U	550+90	956.3	957.3	958.0	959.2
	18.90	551+40	956.4	957.3	958.0	959.2
Bullard Road	19.00 D	552+93	958.9	959.4	959.7	960.4
	19.00 U	553+27	958.9	959.4	959.7	960.4
	19.10	553+40	962.9	963.0	963.0	963.1
	19.70	587+60	963.2	963.4	963.5	963.7
Fenton Road	20.00 D	601+37	964.6	965.2	965.4	965.8
	20.00 U	601+83	967.2	967.5	967.5	967.7

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APPENDIX D

INVESTIGATIONS AND ANALYSES

SURVEY PROCEDURES

Field surveys were made of bridges, roads, structures and the channel and flood plain within the study area by the Soil Conservation Service in 1982. Temporary bench marks based on USC&GS mean sea level elevations datum of 1929 were also set at this time and used for this study. They are located and described in Appendix E of this report. Surveys were made using third order accuracy.

For North Ore Creek, 33 valley and channel cross-sections plus 24 roads, bridges and structures were surveyed. Aerial photography flown April 18, 1982 was used as a base for the photo mosaic sheets used to delineate the flood plain and to develop 2-foot contour maps. The 2-foot contour maps were then used to develop 32 additional valley cross-sections.

HYDROLOGY AND HYDRAULICS

Physical data was obtained from USGS topographic maps, soil survey maps, local topographic maps and aerial photographs, as well as on-site field inspections. The watershed boundary was determined from map studies and field checks. The watershed was divided into 41 sub-areas. Drainage areas for the sub-areas were measured. Times of concentration were calculated for each of the sub-watersheds using the Upland Flow method.

Channel flood routings to establish peak discharge-frequency relationships were made using the SCS TR-20 Hydrology Program dated September 1, 1983, and U.S. Department of Agriculture computer facilities. The Modified Attenuation-Kinematic (Att-Kin) method of routing through stream channels is used by this program. This method is derived from inflow-outflow hydrograph relationships. Several types of data were used in developing this watershed model. Time of concentration for each local drainage area was computed from sub-watershed relief, hydraulics and travel length. Drainage area, hydrologic soil groups and land use and cover were used to develop runoff hydrographs.

Temporary flood water storage at several road culverts and bridges was recognized as a potential to modify downstream peak discharges. Data was gathered and evaluated. Opening sizes and type, head available from the top of opening to top of road fill and storage shapes were determined.

The watershed was divided into 41 sub-watersheds for use in evaluating the hydrologic volumes and times. Each sub-watershed was evaluated for land use, soil group, runoff curve number and time concentration.

Six structures and ten valley sections were selected and evaluated to effectively model study area conditions. Elevation-storage-discharge relationships were determined for the six structure sections and elevation-discharge-area relationships were determined for the ten valley sections. The TR-20 computer program uses this data and the Storage-Indication method of evaluating the affect of the structures in reducing peak flood discharges. The six lakes associated with the structures play an important role in reducing the peak discharges. Table 1 (Appendix C-1) lists discharges obtained from the flood routings.

The computer model was verified using a procedure titled "The 1983 DNR/USGS Peak Flow Regression". This regression uses general physical and geological characteristics to estimate peak flow. Comparison of this regression analysis with Butternut Creek and West Branch Swartz Creek flow records showed a very good correlation. The regression analysis showed only ten percent higher than the TR-20 flows.

Water surface profiles were developed using the Soil Conservation Service computer program WSP-2. This program uses the Step method of computation to solve the Bernoulli equation, the Bureau of Public Roads bridge loss procedures, and the culvert loss analysis. Flood discharges determined from flood routings were used in the water surface profile program to develop high water profiles. Manning's "n" values were determined from field investigations of the channel and flood plains.

Normal bridge and channel flow conditions were assumed in the hydraulic computations. No consideration was made for openings blocked by ice or other debris. Channel and flood plain flow characteristics may change due to vegetative growth, sedimentation, scour, debris accumulation, filling and encroachment. Computations for this study considered only those features in the flood plain at the time of field surveys. Future flood plain developments and modifications, as well as changes in the upstream drainage area land use and cover, will require recomputation of the water surface profiles.

Flow from Bullard Lake overtops the dike for the larger storms, and part of the flow crosses Bullard Road south of the outlet bridge. To handle this situation, an estimate was made of how much would flow each way. Separate WSP-2 runs were made and adjusted until flood elevations in Bullard Lake matched for both flow paths.

Starting lake level elevations at the Parshallville Dam were calculated for various configurations of the gates. A check of flows from the Parshallville Dam to the Shannon Lake Dam showed that tailwater below Parshallville Dam would not affect these starting elevations.

Flood plain delineations were made on the contour maps and photomap sheets. Computed water surface elevations at surveyed sections and bridges were used to identify flood plain limits. Between sections, topographic map interpretations and field inspections were used to delineate the flood boundary lines. Limits of flooding shown on the photomaps may vary from actual location on the ground, and the photographic image may vary from true ground location due to inherent aerial photographic displacement. High water profile elevations and detailed field surveys should be used to determine the extent or depth of flooding at any specific site.

Where the limits of the 500-year and the 100-year floods were too close to delineate, the limits of the two flood plains are shown as the same line on the photomap sheets.

Precipitation amounts totaling between four and five inches fell on the North Ore Creek Watershed on April 17-20, 1975. Three dams washed out as a result of that precipitation, and flow over Parshallville Road was observed to be approximately one foot. This storm has been estimated to be approximately a 100-year storm by the Michigan Department of Agriculture Weather Service.

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APPENDIX E

BENCH MARK DESCRIPTIONS *

NORTH ORE CREEK

LIVINGSTON COUNTY, MICHIGAN

7RGW 1967

Section 26, T3N, R6E - On headwall, approximately 800 feet west of intersection of Pleasant Valley Road and M-59.

Standard tablet in center of the headwall, 34 feet south of centerline of M-59.

Elev. 983.75

TBM #1

Section 24, T3N, R6E - At North Ore Creek crossing along Fenton Road.

Chiseled "x" painted on top of east end of 48" CMP, 24 feet east of centerline of Fenton Road.

Elev. 963.99

TBM #2

Section 24, T3N, R6E - 36 feet east and 56 feet south of intersection of Fenton and Hyde Roads.

SCS disk and nail in north side of 18" oak tree.

Elev. 993.46

TBM #3

Section 24, T3N, R6E - Along Hyde Road, 0.5 mile east of Fenton Road, 35 feet south of centerline of Hyde Road and 30 feet northeast of corner of small house.

Lag bolt in north side of power pole.

Elev. 1,022.62

* Elevations based on USC&GS mean sea level datum of 1929.

TBM #14

Section 22, T3N, R6E - 59 feet south and 36 feet west of intersection of M-59 and Melody Place.

Lag bolt in north side of power pole.

Elev. 980.59

TBM #15

Section 21, T3N, R6E - 50 feet north and 25 feet west of intersection of Clark Road and M-59.

Chiseled and painted square on top of west end of 12" concrete culvert.

Elev. 968.64

TBM #16

Section 22, T3N, R6E - 20 feet east of Clark Road, approximately 0.5 mile north of M-59, 45 feet south of drive to the west to an underground house.

Chiseled and painted "x" on east end of 12" CMP.

Elev. 959.05

TBM #17

Section 22, T3N, R6E - At a bridge over North Ore Creek along Dunham Road between Clark Road and Fenton Road.

Chiseled and painted square on southeast concrete wingwall 16 feet south and 10 feet east of center of bridge.

Elev. 941.96

TBM #18

Section 22, T3N, R6E - 155 feet south and 29 feet west of intersection of Dunham Road and a blacktop street to south, approximately 0.3 mile west of Bullard Road.

Lag bolt in north side of power pole.

Elev. 972.25

TBM #19

Section 16, T3N, R6E - 25 feet north of Dunham Road, approximately 0.4 mile west of Clark Road, 15 feet west of a field entrance.

SCS disk and nail in south side of 20" oak tree.

Elev. 964.53

TBM #20

Section 16, T3N, R6E - 29 feet north and 42 feet east of intersection of Dunham Road and Hartland Road.

Rail spike in south side of 24" oak.

Elev. 963.34

TBM #21

Section 16, T3N, R6E - 20 feet south and 14 feet west of centerline of bridge over North Ore Creek on Hartland Road near south edge of Hartland.

Chiseled and painted square on southwest concrete wingwall.

Elev. 940.07

TBM #22

Section 17, T3N, R6E - 28 feet north and 164 feet west of intersection of Crouse Road and Old US-23.

Painted "+" mark on top center of concrete headwall.

Elev. 926.59

TBM #23

Section 17, T3N, R6E - Approximately 0.5 mile west of US-23 on Crouse Road, 24 feet south and 17 feet west of intersection of Crouse Road and driveway to south.

SCS disk and nail in north side of tree stump.

Elev. 953.57

TBM #24

Section 17, T3N, R6E - 28 feet south and 25 feet east of intersection of Crouse Road and extension of Cullen Road at 90° bend.

Lag bolt in north side of 48" oak tree.

Elev. 985.07

TBM #25

Sections 8 and 17, T3N, R6E - 13 feet east of centerline of Cullen Road opposite end of Dwyer Road.

Lag bolt in west side of 25" cottonwood tree.

Elev. 942.62

TBM #26

Section 7, T3N, R6E - 28 feet east and 33 feet north of intersection of Cullen Road and Townley Road.

Chiseled and painted "x" on north end of 12" CMP.

Elev. 932.40

TBM #27

Section 5, T3N, R6E - 35 feet north and 57 feet east of intersection of Clyde Road and Cullen Road.

Lag bolt in west side of telephone pole.

Elev. 917.93

TBM #28

Section 5, T3N, R6E - Approximately 0.5 mile west of US-23 on Clyde Road, 28 feet north and 40 feet east of intersection of Clyde Road and Pleasant Hill Drive.

Chiseled and painted square on east end of 18" concrete culvert.

Elev. 920.41

TBM #29

Section 8, T3N, R6E - 64 feet east and 16 feet south of intersection of Clyde Road and Old US-23.

Chiseled and painted "x" on curb at a post with a reflector.

Elev. 995.13

TBM #30

Section 8, T3N, R6E - 20 feet east of centerline of Old US-23 in line with centerline of Townley Road.

Painted mark on top of steel center post of guard rail.

Elev. 974.54

TBM #31

Section 8, T3N, R6E - 38 feet west of centerline of west US-23 service road at the bottom of a hill between Clyde Road and Crouse Road.

Painted "+" of 535+00 on west concrete headwall.

Elev. 921.71

TBM #32

Section 7, T3N, R6E - 23 feet south and 85 feet east of intersection of Clyde Road and Parshallville Road.

Nail in north side of power pole.

Elev. 939.37

TBM #33

Section 6, T3N, R6E - 60 feet north and 23 feet east of centerline of road at 90° turn to the east on Parshallville Road.

Chiseled and painted "+" on top of large rock.

Elev. 941.63

TBM #34

Section 6, T3N, R6E - 24 feet south of centerline of Parshallville Road at Parshallville Dam.

Chiseled and painted square on southwest corner of dam.

Elev. 907.50

TBM #35

Section 5, T3N, R6E - Approximately 0.4 mile south of Parshallville along Cullen Road, 24 feet west of centerline of Cullen Road.

Chiseled and painted "x" on west end of south 26" CMP.

Elev. 906.47

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APPENDIX F

GLOSSARY

BACKWATER--The resulting highwater surface upstream from a dam, bridge or other obstruction in a river channel or high stages in a receiving stream.

BRIDGE DECK--Elevation of road surface at the bridge.

BRIDGE LOW CLEARANCE--The lowest point of a bridge or other structure over or across a river, stream or water course that limits the opening through which water flows. This is referred to as "low steel" or "low chord". It often is higher than the low point of the roadway.

CHANNEL OR WATER COURSE--An elongated depression either natural or man-made having a bed and well-defined banks varying in depth, width and length which gives direction to a current of water and is normally described as a creek, stream or riverbed.

CHANNEL BOTTOM--The lowest part of the stream channel (either in a constructed cross-section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

CONFLUENCE--A flowing together or place of junction of two or more streams.

CROSS-SECTION OR VALLEY SECTION--A graph showing the shape of the streambed, banks and adjacent land on either side made by plotting elevations at measured distances along a line perpendicular to the flow of the stream.

DATUM--An assumed reference plane from which elevations and depths are measured such as from sea level.

HIGH WATER OR FLOOD PROFILE--A graph showing the relationship of water surface elevation location along the stream. While it is drawn to show surface elevations for the crest of a specific flood, it may be prepared for conditions at any other given time or stage.

ELEVATION-DISCHARGE RELATIONSHIP--The relationship between water surface elevation and rate of flow at a specified location for a range of flow rates.

FLOOD--A temporary overflow by a river, stream, ocean lake or other body of lands not normally covered by water. It does not include the ponding of surface water due to inadequate drainage such as within a development. It is characterized by damaging inundation, backwater effects of surcharging sewers and local drainage channels, and by unsanitary conditions within adjoining flooded habitated area attributable to pollutants, debris and water table.

FLOOD CREST--The maximum stage or elevation reached by flood waters at a given location.

FLOOD FREQUENCY--A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equalled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequence", but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years.

10-YEAR FLOOD--A flood having an average frequency of occurrence in the order of once in 10 years. It has a 10 percent chance of being equalled or exceeded in any given year.

100-YEAR FLOOD--A flood having an average frequency of occurrence in the order of once in 100 years. It has a one percent chance of being equalled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers.

FLOOD PEAK--The maximum instantaneous discharge or volume of flow in cubic feet per second passing a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN--The relatively flat area or low lands covered by flood waters originating with either the adjoining channel of a water course such as a river or stream, or a body of standing water such as an ocean or lake.

FLOOD ROUTING--The process of determining progressively the timing and shape of a flood wave at successive points along a stream. This procedure is used to derive a downstream hydrograph from an upstream hydrograph. Local inflow and tributary hydrographs are considered.

FLOOD STAGE--The elevation at which overflow of the natural stream banks or body of water occurs.

FLOODWAY--The portion of the flood plain including the channel of the stream that is required for the conveyance of flood flow.

FLOODWAY FRINGE--The area of the flood plain lying outside the floodway which may be covered by flood waters originating from an adjoining river or stream.

HEAD LOSS--The effect of obstructions, such as narrow bridge openings, dams or buildings, that limit the area through which water must flow, raising the surface water upstream from the obstruction.

HEADWATER--The tributaries and upper reaches which are the sources of the stream.

HYDRAULICS--The science of the laws governing the motion of water and their practical applications.

HYDROGRAPH--A graph denoting the discharge or stage of flow over a period of time.

HYDROLOGY--The science dealing with the occurrence and movement of water upon and beneath the land areas of the earth.

INUNDATION--The flooding or overflow of an area with water.

LEFT BANK--The bank of the left side of a river, stream or water course, looking downstream.

LOW GROUND--The highest elevation at a specific stream channel cross-section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

MANNING'S "n"--A coefficient of channel and overbank roughness used in Manning's open channel flow formula, commonly called a retardance factor.

REACH LENGTH--A longitudinal length of stream channel selected for use in hydraulic or other computations.

RIGHT BANK--The bank on the right side of the river, stream or water course, looking downstream.

ROAD OVERFLOW--The lowest elevation on a road profile in the vicinity of where the road and stream cross. It is the first point on the roadway inundated if overtopping of the road occurs during a storm.

RUNOFF--That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

TIME OF CONCENTRATION--Time required for water to flow from the most remote point of a watershed to the outlet or other point of reference.

WATERSHED--A drainage basin or area which collects runoff and transmits it, usually by means of streams and tributaries, to the outlet of the basin.

WATERSHED BOUNDARY--The divide separating one drainage basin from another.

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APPENDIX G

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AGRICULTURE IS THE FOUNDATION OF MANUFACTURE AND COMMERCE