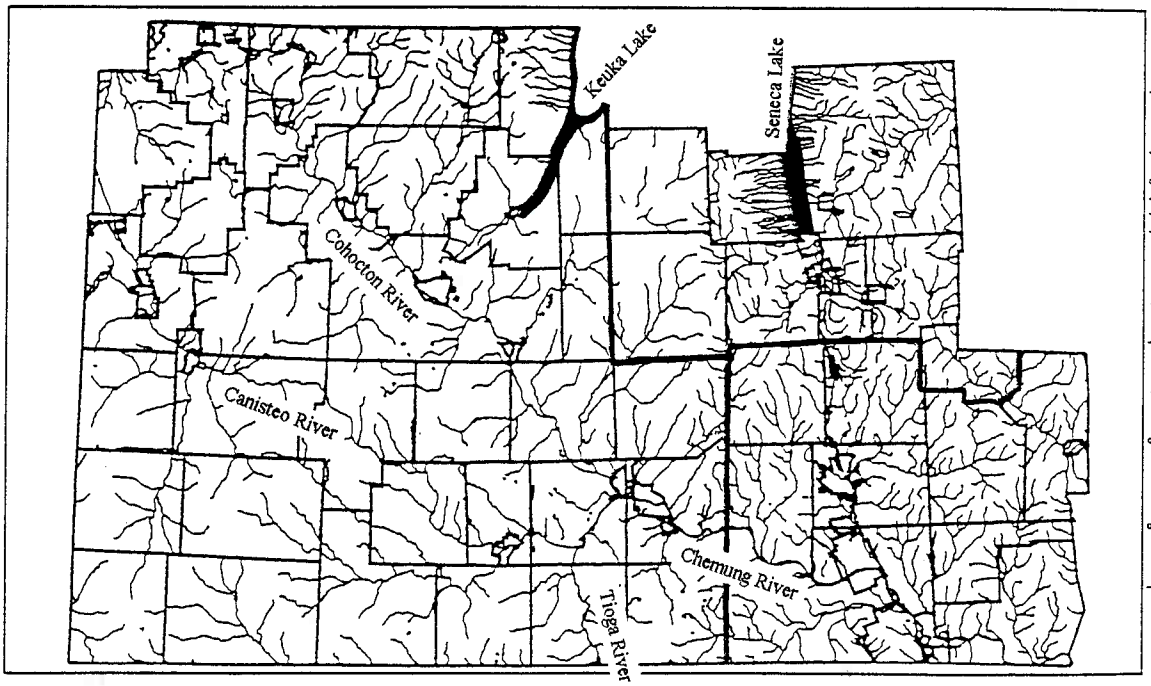
Reducing Flood Damage in the Southern Tier Central Region



Flood Recovery/Mitigation Economic Adjustment Strategy

May 1998

Southern Tier Central Regional Planning & Development Board

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SUMMARY

The Southern Tier Central (STC) Region of New York faces the ongoing risk of serious flood damage. Intense storms of local and regional extent have repeatedly resulted in flooding of lowlying areas throughout the region. The extent of these damages is reduced, but certainly not eliminated, by numerous structural flood control projects. In addition, all municipalities have passed local floodplain management regulations. Yet the flood hazards have not been eliminated. Flooding continues to inflict serious damages that cost the region millions of dollars each year.

Loss of life, property damage, and mental anguish resulting from floods can be reduced by applying corrective and preventive measures. Although floods are natural phenomena that cannot be prevented, their effects are amplified by human activities, such as encroachment on the floodplains and inadequate conservation practices. This report presents recommendations for reducing the vulnerability of the Southern Tier Central Region to flood damages. A comprehensive solution requires the coordinated implementation of many different strategies. Local action is critical for successful implementation of this flood mitigation effort.

The **recommended actions** include:

- offer training for local building officials on implementation of floodplain development regulations;
- update, enhance, and enforce local floodplain development regulations;
- offer flood hazard training for planning boards and other local officials;
- establish vegetated buffers along streams, rivers, and lakes;
- improve local programs for stormwater management and erosion control;
- establish drainage system maintenance programs;
- distribute floodproofing information;
- encourage increased flood insurance coverage by educating insurance, mortgage, and real estate professionals;
- expand programs for stabilizing streams and protecting natural resources;
- enhance flood warning capabilities with improved precipitation and water level gauging;
- maintain and improve emergency response capabilities;
- evaluate structural alternatives for providing additional flood protection; and
- expand public education efforts.

BACKGROUND

Flood damage is an ongoing problem in the Southern Tier Central Region, as it has been throughout recorded history. The streams, rivers and lakes are naturally subject to rising and falling water levels, relocation of stream channels, flooding of valley bottoms, and wave damage on lake shores. Unfortunately, most non-farm development has occurred in the broad river valleys and along lake shores, where the hazard of flooding is an environmental fact of life.

After every flood, the tendency has been for residents to rebuild their lives and pray that "this is the last destructive one." Structural projects have been built in hopes of controlling future flood waters. As time passes, people tend to forget about flooding and become complacent. Additional development occurs in flood-prone areas. Deforestation and upland development increase the amount of runoff. Stream channels are allowed to become clogged with debris. Wetlands are filled. People forget that these actions all increase the risk of future flood damage. In short, residents of the Southern Tier Central Region continue to grossly underestimate the destructive powers of their rivers, streams, and lakes. If future flood damages are to be reduced, flood mitigation measures will need to be incorporated into programs that will outlive the all-too-short memories of area residents.

This Strategy summarizes the history of flood damages in the STC Region and investigates various alternative techniques for reducing future flood threats. It includes an action plan for implementing the flood damage reduction measures that are most appropriate to this region. It is intended to serve as a guide for local community leaders and elected officials to minimize the adverse impacts of future flood events.

Location

The Southern Tier Central Region encompasses Chemung, Schuyler, and Steuben Counties in New York State. The political subdivisions include 3 counties, 3 cities, 23 villages, and 51 towns. The region covers 2,151 square miles and has a population of 213,042 people (1990 Census). The region's drainage system is shown in Figure 1.

The STC Region is situated at the headwaters of three major river basin systems: the Susquehanna, Oswego and Genesee Basins. Most of Steuben and Chemung Counties and part of Schuyler County are in the Susquehanna River Basin, which includes the Cohocton, Canisteo, Tioga, Chemung and Susquehanna Rivers and their tributaries. Steuben and Schuyler Counties include the southern portions of two Finger Lakes in the Oswego River Basin: Keuka Lake and Seneca Lake. Western Steuben County contains areas in the Canandaigua Lake Watershed of the Genesee River Basin.

All watersheds in the Southern Tier Central Region have experienced extensive and repeated damage from flooding, often with little advanced warning. Flooding problems occur along all four rivers (Cohocton, Canisteo, Tioga, and Chemung Rivers), the two Finger Lakes

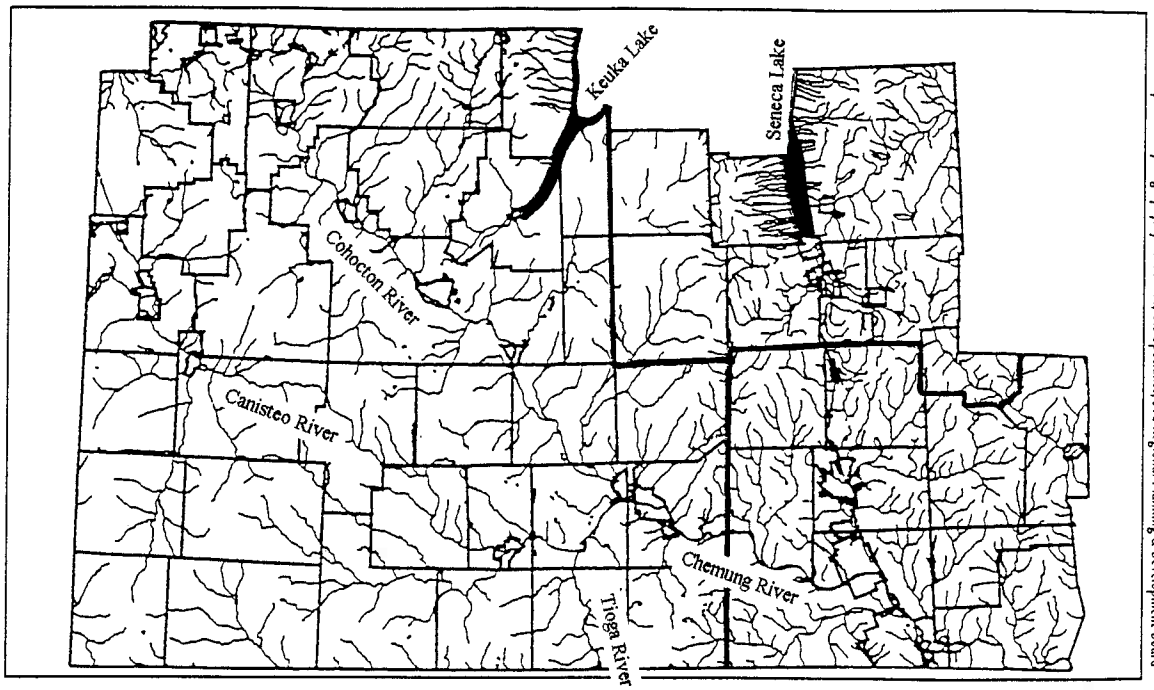

Figure 1. Drainage System of the Southern Tier Central Region.

(Keuka and Seneca Lakes), and most of the streams. Almost every stream in the region has at least a few sites at which flooding or bank erosion threatens homes, property, or infrastructure.

Types of Flooding

Flooding occurs naturally as part of the earth's hydrologic system. Flood-related damages in the STC Region occur in a variety of settings: (1) flooding along rivers and streams (riverine flooding), (2) lake shore flooding, (3) overland runoff and ponding, (4) groundwater flooding, and (5) bank erosion. Although riverine and lake shore flooding can produce widespread damages that receive media attention, repetitive flooding problems from overland flow, ponding, and groundwater are also serious problems in many areas. In addition, progressive erosion of streambanks is an ongoing threat to adjacent development and a major source of sediment accumulation in streams, rivers, lakes, and reservoirs.

Riverine flooding occurs when streams and rivers overflow their banks and inundate adjacent valleys. This occurs when heavy rainfall or rapid snow melt produces water runoff that exceeds the carrying capacity of the channel. Riverine flood damages are frequently triggered or exacerbated by constriction or obstruction of stream and river channels. This blockage can result from undersized drainage structures, debris dams, ice jams, or accumulation of sediment within the channel. Backwater flooding occurs when a stream is unable to flow into a larger stream, river, or lake due to high water in the downstream water body. Because the STC Region is located in a headwaters area with many steep slopes, its rivers and streams are particularly

susceptible to **flash flooding**, in which water levels rise very quickly.

Lake shore flooding occurs when high lake levels inundate the shoreline. Lake shore damage can be compounded by waves that carry the water to even higher elevations. Water levels in Seneca and Keuka Lake are managed by the New York State Canal Corporation which must balance the competing demands of various water uses throughout the Oswego River Basin.

Overland flooding and ponding occur when excess runoff is not carried in a defined channel. It leads to flood damages when structures are improperly sited and stormwater runoff is not properly managed at development sites. Localized flooding problems can be caused or exacerbated by upstream development and logging activities that alter the natural drainage patterns. Shallow overland flow also affects structures that have been inadvertently sited in slight depressions or swales. Development in flat areas with poorly drained soils can experience repeated flooding problems due to the natural ponding of runoff at these sites.

Groundwater flooding results from water below the surface of the ground that seeps through basement walls or backs up through basement drains. Shallow water tables contribute to basement flooding and septic system failures in numerous developed areas throughout the region.

Erosion of streambanks and lake shores and scouring of floodplains are major concerns throughout the STC Region. The severity of these problems is due, in part, to the widespread occurrence of poorly-consolidated glacial deposits, which are particularly susceptible to erosive forces. Natural erosional processes are accelerated during flood events, with some area streams moving as much as 30 feet during a single storm. Bank erosion leads to the loss of lawns and agricultural land and can undermine buildings, roads, and bridges. Severe erosion also degrades riparian and aquatic habitat. Accelerated erosion of banks loosens large volumes of material that are subsequently deposited within stream and river channels, limiting the capacity for carrying water. Eroded material that is carried downstream contributes to increased deposition rates in lakes and reservoirs. Although bank erosion and channel migration are natural processes, they can be accelerated by human activities.

HISTORY OF FLOODING

The Southern Tier Central Region has experienced repeated flooding throughout recorded history. Some of these historic floods are described in Tables A-1 and A-2 (in Appendix A). Marvin W. Copp (in Floods of the Chemung Watershed, 1794-1972, "A Day to Remember," June 23, 1972) documented 35 damaging floods that affected the area in the first two centuries since white settlement. These floods occurred on the average of once every five or six years. And between the years of the large floods, there have been numerous smaller ones. Mr. Copp's book paints a word picture of the recurring devastation that only those living through the floods could understand. Many individuals and countless numbers of domestic livestock did not live through the floods. The history of this region is that every 10, 20 or 25 years, we should expect a very destructive flood.

The most destructive flood on record in much of the STC Region occurred in June of 1972, when Hurricane Agnes turned inland and collided with a high-pressure zone over upstate New York. Torrents of dense rain fell throughout the region, with recorded rainfall values exceeding 14 inches in the westernmost headwaters of the Chemung River. This flood exceeded the design capacity of many of the region's protective works. Levees and floodwalls were substantially overtopped in Painted Post, Corning, and Elmira. Approximately 2% of the entire land area in the STC Region was under water. Thousands of homes were destroyed. Twenty-three lives were lost. The personal suffering and hardship were extensive. The estimated return frequency for this event ranges from 50 to 500 years in various parts of the region.

Floods inflict damage on agriculture, the environment, recreational sites, residences, commercial facilities, industry, publicly owned facilities, and infrastructure. The total cost of these damages can never be fully known. Damage estimates for major events are given in Table A-3 (in Appendix A). The Hurricane Agnes flood of 1972 cost the region about three quarters of a billion dollars in property damage. The estimated damages from subsequent flooding events cost the STC Region an average of $5 million per year. Two floods in 1996 resulted in federal assistance to the three-county region totaling $15.5 million (federal share of Public Assistance, Individual Assistance, and Emergency Watershed Protection Projects for 1095-DR-NY and 1148-DR-NY). The last three major floods in August 1994, January 1996, and November 1996 caused an estimated $29 million of damage in Chemung County alone (assembled by the Rural Association of Mayors and Supervisors of Chemung County).

In addition to the damages from major flood events are the cumulative costs of the numerous smaller events. Recurrent drainage, ponding, and groundwater problems result in localized flood damages at many sites throughout the region. One example of repetitive flooding problems is the Holecek Avenue/Stacia Drive/Mt. Zoar Road area in the Town of Southport (Chemung County) where runoff ponds in and around homes several times each year. This repetitive flooding costs the Town an estimated $12,000 per year, with significant additional expenses incurred by residents.

Between 1978 and 1997, the National Flood Insurance Program paid 561 flood insurance claims in the STC Region for a total cost of $2.5 million (Table A-4 in Appendix A). This represents an average of about $280,000 in flood insurance claims per year, but is only a small fraction of the total flood damages. Surveys of flood damaged areas indicate that the vast majority of flood damages are not covered by existing insurance policies. This is due, in part, to the failure of property owners to purchase adequate insurance. The problem is compounded by limitations of the insurance coverage offered by the National Flood Insurance Program. The potential flood losses for which flood insurance is not available include: many types of basement contents, basement improvements (finished walls, floors, and ceilings), non-building development (roads, culverts, bridges, crops, landscaping, etc.), land, additional living expenses during repair of a flood damaged home, loss of use of property, and the cost of interrupted business.

Stream maintenance and restoration activities comprise a major flood-related expense in the STC Region. Ongoing erosion, sedimentation, and debris problems have been aggravated by recent flooding events. Unstable streambanks threaten property, structures, and roads located adjacent to many of the region's streams. In addition, streambank erosion contributes large volumes of sediment to stream and river channels and to downstream lakes and reservoirs. This has resulted in many unstable channels with restricted capacity to carry water. In order to alleviate these problems and protect threatened development, local governments throughout the region have significantly increased their spending levels for stream projects. An example of this increased commitment to drainage issues is the Town of Elmira (Chemung County), which budgeted $120,000 for a newly established Stormwater/Drainage Department in 1996 and another $120,000 in 1997. Table A-5 (in Appendix A) provides a partial list of recent streambank stabilization and channel clearing projects. Although this list is incomplete, it indicates that recent spending on stream projects has totaled more than $1 million per year in the STC Region. These costs have been incurred primarily by county and local governments, with landowner participation in many of the smaller projects. Funding is currently being sought for additional streambank and channel restoration projects, including a request for $950,000 to re-establish and stabilize Seeley Creek at a site where it threatens 32 properties (Webb Mills in the Town of Southport, Chemung County).

An example of the high cost of streambank erosion is the Bentley Creek Watershed (with an area of 52.4 square miles, located partly within the STC Region). Field surveys in this watershed have documented 33,465 feet of unstable streambank, which result in an estimated 4,700 tons of sediment being transported to the Susquehanna River system on an average annual basis. A low end estimate for the cost of removing this sediment from behind dams on the Susquehanna River is $12 per ton or $56,700 per year (from Preliminary Investigation Report (PL 83-566) for Bentley Creek Watershed, PA and NY, USDA Natural Resources Conservation Service, December 18, 1997).

HISTORY OF FLOOD MITIGATION

Dikes were started in Corning in 1896. Since then the dike systems have been expanded and re-built each time a major storm demonstrated their inadequacies. Following the devastating flood of 1935, the dikes in Corning were raised two feet and concrete was poured along the slopes. Upon completion of this project an Army Corps of Engineers officer remarked that "nothing as bad as that can ever in any way happen to the City of Corning again." But it did. The area was devastated in 1946 by the biggest flood ever and again in 1972 by an even bigger flood.

Over the years, substantial efforts have been made to control flooding by "taming" the rivers. Three flood control dams were built in the Tioga River Watershed, two dams in the Canisteo River Watershed, and four dams in Newtown-Hoffman Watersheds (Table B-1 in Appendix B). The region contains 50 miles of levees and floodwalls, 15 miles of channel modifications (paving, conduits, diversions, realignment, etc.) and other flood control structures (pump stations, check dams, etc.) (Table B-2 in Appendix B). The State Department of Environmental Conservation expends $80,000 to $110,000 each year for scheduled maintenance of local flood protection projects, with additional expenses incurred by local governments and the U.S. Army Corps of Engineers. The operations and maintenance costs for reservoirs that protect the region are also significant.

The major investment for construction and maintenance of flood control structures effectively protects many developed areas in the STC Region. The damages from recent flood events would have been much more severe without the protection of levees, floodwalls, and reservoirs. During both of the 1996 floods, area rivers and streams reached levels that could have devastated adjacent communities, if it were not for the protective structures. All of the region's flood control projects functioned properly and damages were confined to areas not protected by structural projects.

In addition to the major flood control structures, numerous smaller projects have been undertaken to re-establish channels, improve flow capacity, and stabilize streambanks. Protective measures are implemented when rivers and streams threatened roads, bridges, buildings, property, and farmland. In past years, county programs have invested $122,000 in streambank stabilization projects each year ($50,000/year in Chemung County and $43,000/year in Steuben County plus 25% landowner match for both programs). These expenses have increased sharply in recent years. In 1997, the three counties spent approximately $600,000 for streambank stabilization ($200,000 in Chemung County, $50,000 in Schuyler County, and $360,000 in Steuben County), with significant additional contributions by landowners and towns. These expenses are incurred to protect private property adjacent to eroding streambanks. Additional costs are incurred to protect roads and bridges that are threatened by streambank erosion. Since 1992, the U.S.D.A. Natural Resources Conservation Service has funded Emergency Watershed Protection Projects in the STC Region costing $4 million. The costs of additional streambank projects funded by local, county, and state highway departments have not been compiled.

Many non-structural flood mitigation measures have been implemented as well. During the Revolutionary War, Colonial troops encountered Native American villages in the upper Susquehanna River Valley where roughhewn houses were constructed above the ground level to protect them from flooding. In more recent times, zoning and other regulatory measures have been used to prevent inappropriate development in flood-prone areas. All municipalities in the STC Region have passed local floodplain development regulations and are in good standing with the National Flood Insurance Program. These regulations require that new development in designated Special Flood Hazard Areas be protected from inundation by the 100-year storm. Flood forecast and warning systems have been established to provide reliable and timely flood warnings that enable residents, businesses, and governmental units to carry out emergency measures that reduce risks of loss of life, protect valuable property and provide emergency services.

ALTERNATIVE FLOOD DAMAGE REDUCTION TECHNIQUES

A comprehensive program for reducing flood damages requires coordinated implementation of both structural and non-structural strategies. Structural measures reduce flood hazards by controlling the flow of water in rivers and streams. Structural flood control projects include dams, levees, floodwalls, and channel modifications. Non-structural approaches to reducing flood damage are based on an acceptance of flooding as a natural process that cannot be completely controlled. Flooding is only a problem when floodwaters interfere with human activities. *Flooding problems* are thus human creations that can be mitigated by managing human activities in flood-prone areas and managing human activities that affect runoff and drainage.

This Strategy explores a broad range of techniques that can be employed to reduce future flood-related damages and evaluates the potential applications of each technique in the Southern Tier Central area. These flood damage reduction measures are not new or unique to this region. However, ongoing efforts are required to initiate, implement, and maintain the structures, policies, and programs needed to implement these measures. Local action is necessary for successful application of these techniques to the particular circumstances of each community.

Preventive Activities

Preventive activities use planning and management techniques to better integrate the natural and built environments. This approach to the problems of flooding is based on the knowledge that, while floods cannot be totally eliminated, the built environment can be successfully developed if it respects the natural systems. Development in flood-prone areas is permitted only if it is compatible with the threat of floods and if the potential damage from floods can be minimized. Stormwater management and drainage system maintenance programs prevent further degradation of existing drainage patterns.

The preventive activities presented here are intended to restrict inappropriate new development, but do not protect the development that is already at risk of flooding. Floodplain management (through floodplain regulations, zoning, subdivision regulations, or open space preservation) should be emphasized whenever floodplains and other flood-prone areas contain potential development sites. These measures can be applied at small costs in relation to the damages that are prevented.

1. Floodplain Regulations: Floodplain regulations can prevent and control development in flood prone areas where flood losses are most likely to occur. All municipalities in the STC Region currently have floodplain development regulations that enable participation in the National Flood Insurance Program. These regulations control development within the floodplain boundaries defined by the Federal Emergency Management Agency (based on the predicted extent of the 100-year flood). The local regulations specify that new development within the regulated floodplain must comply with elevation requirements

and construction standards that are intended to protect structures from the 100-year flood event.

Unfortunately, floodplain development regulations are not uniformly enforced throughout the STC Region. There exists an ongoing need for training and technical assistance to enable building officials to implement local floodplain development requirements. This training should be available locally every year, with more intensive efforts following severe flooding (when the interest is greatest and to insure that any buildings that have been "substantially damaged" by flooding are brought into compliance with regulations).

Municipalities can enact floodplain development regulations that are more restrictive than the National Flood Insurance Program requirements. The Village of Addison (Steuben County) recently adopted a Flood Damage Prevention Law that requires new and substantially improved buildings in flood hazard areas to be elevated or protected to a level 2 feet above the predicted base flood elevation (2 feet higher than the minimum requirement). Other municipalities should be encouraged to update their floodplain development regulations and incorporate this extra margin of protection. Floodplain development regulations that incorporate additional flood-prone areas (in addition to those identified on Flood Insurance Rate Maps) may be appropriate in some communities. Efforts to strengthen floodplain development standards should concentrate on those municipalities where the mapped floodplains (designated on Flood Insurance Rate Maps) or other clearly-defined flood-prone areas contain potential development sites.

2. Conventional Zoning: Zoning involves the division of a governmental jurisdiction into districts and the regulation within these districts of (1) the use of structures and land, (2) the height and bulk of structures, (3) the size of lots, and (4) the density of use. Because zoning regulations differ from district to district, they can be used to set special standards for land uses in flood hazard areas. Zoning can regulate what uses are located in flood-prone areas and how those uses are to be constructed or carried out. Low density zoning can reduce the potential for flood damage by limiting the amount of development in the floodplain. Any zoning restrictions in regulated floodplains operate in conjunction with the development standards in the local floodplain development regulations.

   Although, not all municipalities in the STC Region have zoning regulations, numerous opportunities do exist to incorporate flood damage reduction objectives into new or revised zoning laws. In particular, low density zoning in floodplain areas should be encouraged. In addition, the depth of basements can be restricted in areas where documented shallow water tables indicate a risk of groundwater flooding.

3. Subdivision Regulations: Subdivision regulations guide the division of large parcels of land into smaller lots for the purpose of sale or building development. These regulations assure that property is suitable for its intended use and that required improvements such as roads, sewers, recreation areas, and water supply systems are provided. Subdivision regulations with special reference to flood hazards can:
   - require installation of adequate drainage facilities;

- require that the location of flood hazard areas be shown on the plat (detailed map of the proposed development);
- prohibit encroachment of floodway areas;
- require that each lot includes a safe building site at an elevation above selected flood heights (either by a lot layout that enables out-of-the-floodplain construction or by filling a portion of each lot); and
- require the placement of streets and public utilities above selected flood protection elevations.

Many municipalities in the STC Region do not have subdivision regulations. The opportunities for including flood damage reduction provisions in subdivision regulations should be pursued whenever a community develops or revises subdivision regulations.

4. Cluster Development: Cluster development can be used to enable and encourage flexibility of design and development of land in such a manner as to preserve the natural and scenic qualities of open land. It requires that a development meet overall zoning density requirements but allows the buildings to "cluster" on smaller lots in areas out of floodplains, wetlands, and other environmentally sensitive areas. Cluster development provisions can be included in zoning or subdivision ordinances or enacted as a separate ordinance.

5. Open Space Preservation: One of the best ways to prevent flood damage is to keep flood-prone areas free from development. Undeveloped buffers along rivers, streams, and lakes allow for fluctuations in these dynamic hydrologic systems with minimal damage to human activities. When floodplains are used for recreation, parking lots or pasture land, relatively inexpensive cleanup is all that is required after a flood. In addition to reducing the potential for flood damages, preserving floodplain lands as open space greatly enhances the natural and beneficial functions that floodplains serve. Recognized benefits of a naturally functioning floodplain include: storage and conveyance of flood waters, reduced flood velocities, groundwater recharge, maintenance of surface water quality, sustenance of diverse ecosystems, and the provision of habitats for fish and wildlife. These areas also provide diverse recreational opportunities, scenic value, and a source of community identity and pride. Clearly, the potential gains for transforming stream and river floodplains from problem areas into value-added community assets are substantial.

Methods for preserving open space in floodplains or other areas of a community include:
- acquiring floodplain land for **parks, preserves, or recreation areas;**
- enacting **setback provisions** that prohibit new buildings close to streambanks and lake shores;
- enacting restrictive development **regulations;**
- establishing **agricultural districts**;
- providing **tax adjustments** (preferential assessment) for land dedicated to agriculture, recreation, conservation or other open space uses;
- implementing a system of **transferable development rights** in which landowners

facing preservation restrictions are given development rights that can be sold to landowners in areas where development is desired;

- securing land use **easements** that prevent development from taking place;
- adopting **floodway development standards** that apply to a wider area than is specified on the Flood Insurance Rate Map; and
- protecting or planting **vegetated buffer strips** along river banks or lake shores to restore natural ecosystem functions.

The Town of Elmira (Chemung County) and the Town of Big Flats (Chemung County) have enacted zoning ordinances that establish Conservation Districts in the regulatory floodway areas. The permitted land uses within these districts are limited to those that allow the passage of floodwaters with minimal damage.

Many municipalities in the STC Region have incorporated stream setback requirements into zoning and subdivision regulations. By requiring that buildings be located at least 30 or 50 feet from a stream or streambank, these setback provisions maintain open space adjacent to rivers and streams. This reduces the likelihood that buildings will be undermined by streambank erosion. It also limits the development in narrow floodplains along streams for which flood hazard areas have not been identified. Because streambank erosion and flooding from streams without mapped floodplains are serious problems throughout the region, stream and lake shore setback requirements are encouraged in all municipalities. Flood damages could be significantly reduced by restricting development adjacent to all rivers, streams, and lake shores and establishing vegetated buffer strips in these areas.

Other methods of preserving flood-prone areas as open space may be appropriate in some areas. The acquisition of undeveloped floodplain land is substantially more expensive than controlling development through regulation and zoning. However, open space preservation through acquisition may be justified when other recreational benefits are also considered.

6. Stormwater Management: Flood hazards are influenced by all development, even that which occurs in areas that do not experience direct flooding. Development reduces the amount of water that can infiltrate into the soil and increases the rate and amount of runoff. This increased runoff will cause more frequent and severe flooding, sometimes affecting areas that have never experienced flooding before. Although the impact of development at a single site may be small, the cumulative impact of many individual development sites can be massive. The adverse impacts of future development can be minimized by implementing stormwater management practices at all new development and timber harvesting sites. Existing problems can be addressed by upgrading existing stormwater systems or installing other remedial measures.

Stormwater management involves the control of water that runs off the surface of the land from rain or melting snow. Past approaches to handling stormwater have concentrated on making culverts bigger and channels straighter in order to move water out of the area as

quickly as possible. As a result, the sheer volume of water rushing off cleared or built up areas often contributes to flooding. Current standards for handling stormwater involve management of water on the development site so that the water flowing onto adjacent land and roads is not substantially altered from pre-development conditions. In other words, development may not make an existing drainage system worse.

Local governments can improve stormwater management practices through the following activities:

- **planning** of anticipated future development and the stormwater management needs;
- enacting **regulations** that require stormwater management at new development and timber harvesting sites;
- **encouraging** implementation of good stormwater practices through education and technical assistance;
- **design and construction** of regional stormwater management facilities (for existing, new and anticipated development); and
- insuring that all stormwater management facilities are routinely **inspected** and adequately **maintained**.

Municipalities throughout the STC Region have existing and potential stormwater management problems that contribute to flood damages. Because it is more cost effective to treat stormwater management during initial land development activities than to correct problems at developed sites, it is recommended that all municipalities require implementation of stormwater management practices at all new development sites. State law requires preparation of a Stormwater Pollution Prevention Plan for any construction activity that will result in the disturbance of five or more acres of land. By enacting stormwater management regulations, a municipality can insure that stormwater management plans are prepared, reviewed, and implemented. Consistent enforcement of strict stormwater management standards will reduce shallow flooding problems in the immediate vicinity of new development and limit the adverse impacts on riverine and lake shore flooding downstream.

Stormwater management measures that are not properly maintained will eventually become less effective and may eventually fail. In order to insure appropriate maintenance, local governments are encouraged to assume responsibility for routine inspection of stormwater facilities and require appropriate maintenance.

7. Drainage System Maintenance: The accumulation of loose debris and sediment in streams and other drainage ways exacerbates flooding problems throughout the STC Region. These problems can be reduced by routine inspection and removal of debris from streams, ditches, culverts, bridges, and other drainage structures. The routine removal of obstructions from channels and drainage structures helps to maintain channel stability and reduce the frequency and severity of flooding problems. When material is removed from stream and river channels, care should be exercised to minimize disturbance of the channel and banks. Where feasible, excavated materials should be

removed from the floodplain to prevent future obstructions. Drainage system inspection and maintenance is encouraged near and upstream of all developed areas. All municipalities in the STC Region would benefit greatly from ongoing, funded programs for drainage system maintenance.

In some areas, the effectiveness of stream maintenance activities can be enhanced by the construction of debris basins. These structures are designed to trap sediment and debris at accessible sites where excess material can be removed with minimal environmental damage.

Property Protection

In many flood-prone areas, existing development suffers repeated damage. Property protection activities are those that reduce flood losses to property that is presently located in harm's way. The objective is to eliminate land uses in flood-prone areas that are incompatible with the threat of floods. Effective procedures include the removal of property from the hazard area, modification of structures to reduce flood damages, and insurance against flood losses. These measures are usually undertaken by property owners on a building-by-building or parcel basis. Permanent retrofitting measures are preferable to temporary measures, such as sandbagging, because there is less dependence on human involvement during a flood. Design Manual for Retrofitting Flood-prone Residential Structures (Federal Emergency Management Agency Publication Number 114, September 1986) describes various flood proofing methods and provides suggestions for selecting and implementing the most appropriate, cost effective measures.

1. Relocation: Future flood damage can be completely prevented by moving a structure out of a flood-prone area to a new location where there is no threat of flooding. The technique for moving almost any house in good structural condition is well developed. It is generally more expensive and time consuming than most elevation techniques, but can be feasible in some cases. In addition to preventing flood damage to structures and their contents, relocation may eliminate the need for infrastructure and emergency services to a flood hazard area. Flooding of surrounding areas may be reduced by removal of structures that obstruct flood flows. Although these objectives can also be met by demolishing a building and buying a new one, relocation of an existing structure is often more acceptable to the owner.

   Relocation appraisals have indicated that the costs of large scale relocation of all structures from floodplain areas would significantly exceed potential flood damages (Comprehensive Water Resources Plan for the Chemung River Basin, Chemung River Basin Regional Water Resources Planning Board, May 1975). However, selective relocation may be feasible for buildings that are susceptible to costly flood damages, are of sufficient value to justify the cost of relocation, and are structurally able to be relocated.

Building relocation or removal should be encouraged at all sites that are subject to high velocity floodwaters. Buildings in these areas can place occupants and emergency personnel at great risk during flood events. In addition, buildings that are dislodged from their foundations by high velocity water and debris can exacerbate flooding problems downstream. During the January 1996 flood, a mobile home that was swept into the Canisteo River was barely able to pass beneath a bridge in the Village of Addison (Steuben County). Had the building become lodged on the bridge, it could have caused a significant amount of additional flood damage.

2. Acquisition: Flood damages can be reduced or minimized by purchasing floodplain land or securing land use easements or the development rights for these areas. The direct acquisition of floodplain land enables complete elimination of all undesired land uses. This technique can be used to permanently preserve an undeveloped floodplain or to demolish and remove structures that are susceptible to flood damages. Less costly options of purchasing development rights or easements are most appropriate for preserving undeveloped floodplain areas.

   In most locations, the costs of land acquisition exceed the costs of potential flood damages. However, these costs may be justified in areas subject to high velocity floodwaters that pose significant risks to residents and emergency personnel. If property is needed for public recreation, parking, or other open space uses, then the acquisition of flood-prone property may be justified.

3. Building Elevation: An effective retrofitting technique is to raise an entire existing structure above the flood hazard. Buildings are elevated on compacted earth fill or reconstructed foundation walls or reset on concrete, steel or wooden piles. The area under a building elevated on piles or columns can be used for parking or other purposes. Although an elevated building may be inaccessible when the surrounding area floods, elevation can protect the building itself from flood damage.

   If the first floor is elevated to the predicted height of the 100-year flood, it will be in compliance with elevation requirements for new and substantially improved structures in most municipalities in the region. However, an additional 2 feet of elevation is recommended to provide an additional measure of safety and, in most cases, a significant reduction in flood insurance premiums.

   Because structures can be elevated on different types of foundations, elevation is practical for many types of structures and flooding conditions. However, it should be avoided in areas where high velocity flood waters are likely to scour the foundation and where flood waters carrying debris or ice might damage the foundation. The structural condition of the building is another consideration.

4. Floodproofing of Buildings: Floodproofing is any method of making buildings resistant to flood damage. Floodproofing strategies are particularly appropriate at sites that experience moderate flooding (i.e., shallow water, low velocity, and short duration).

Although floodproofing measures can generally be provided more effectively and economically in the design of new construction, there are many things that can be done to existing facilities to reduce the potential for flood damage. Some buildings can be protected against low level flooding by completely sealing the structure against the entry of water, called "dry" floodproofing. An alternative strategy is "wet" floodproofing, which focuses on minimizing damage to the interior of a building when water does enter. Methods for floodproofing buildings include:

- water-tight seal around the base of a structure;
- elimination or protection of building openings;
- sump pumps to remove water that seeps into a structure;
- drainage system around the outside of a building;
- use of water-resistant building materials;
- structural reinforcement to accommodate hydrostatic, hydrodynamic, and debris impact loads;
- openings that allow water to enter and exit the structure, thus equalizing hydrostatic pressure;
- protection of footings and foundations from erosion and scour;
- relocation of electrical switch boxes and main gas/water connections above flood levels;
- automatic shut-off valves on fuel lines exposed to flooding;
- shielding of utilities and appliances by surrounding them with a mini-floodwall structure;
- elevation of a utility system on a platform or by ceiling suspension;
- utility relocation to existing space above the danger of flood waters (first floor, upper floor, or attic);
- utility relocation to new space in a utility room addition;
- protective anchoring of fuel tanks; and
- watertight casing around wells used for potable water.

A 1975 study of the Chemung River Basin concluded that the costs of floodproofing all buildings and other facilities in flood-prone areas would exceed the damages that would be prevented. However, "floodproofing of existing residential and commercial buildings was found to be feasible in certain flood damage areas. These areas include the flood plain of the Cohocton River between Painted Post and Bath and unprotected areas of the Canisteo River near Addison and downstream to the confluence with the Tioga River." (Comprehensive Water Resources Plan for the Chemung River Basin, Chemung River Basin Regional Water Resources Planning Board, May 1975.) The cost-effectiveness of floodproofing measures depends on the type of building or facility, the degree of flood hazard to which it is exposed, and the degree of flood protection obtained. Many buildings can be partially floodproofed at a reasonable cost. One of the simplest approaches is to elevate appliances and other items to upper levels within the structure.

Residents and businesses in flood-prone areas throughout the STC Region should be encouraged to undertake appropriate floodproofing measures. In areas that experience

low damage flooding, floodproofing may be more cost effective than the cumulative expenses of flood insurance premiums and deductibles. Property owners who carry flood insurance can supplement this protection with floodproofing measures that protect property not covered by flood insurance. In areas where flood damages are typically confined to the basement, it may be prudent to simply discontinue all use of basement areas.

Particular emphasis should be placed on low-cost floodproofing options, such as removal of items from basement areas and protection of utilities. Damage to utility systems (furnace, air conditioner, water heaters, fuel tanks, plumbing systems, electrical systems, etc.) is one of the most common losses suffered by homeowners during flooding. Fortunately, techniques for protecting utility systems are among easiest and least expensive retrofitting methods to accomplish.

5. Sewer Backup Protection: Because sewer lines are highly susceptible to infiltration, they often become saturated during flooding events. In such cases floodwater may enter a facility through the sewer system and create internal flooding that is near or equal to exterior flood levels. To prevent this, backflow prevention valves should be placed on all plumbing drain lines that are located below predicted flood elevations. Several alternative valve systems can be utilized.

6. Infrastructure Protection: The design of roads, bridges and earthen works can be adjusted to reduce potential damages from high water levels, high water velocities, transport of debris, and extended saturation. Care should always be taken to minimize any alteration of channel and floodplain characteristics. Appropriate design features include:
   - adequate waterway openings;
   - minimal obstructions for lodging debris;
   - high flow channels to accommodate out-of-bank flows;
   - trash racks or debris basins to prevent debris from entering culverts;
   - adequate elevation of bridge and roadway surfaces; and
   - erosion protection for streambanks and embankments.

   The flow capacity of bridges or culverts may have been under-designed or may have become inadequate to pass an increased amount of storm runoff. Enlarging an opening to accommodate the increased flood flow may be necessary. However, care must be taken to avoid adverse downstream impacts. Enlarging a bridge or culvert to relieve a flood problem upstream may transfer the flood problem downstream.

   All drainage structures throughout the STC Region should be inspected and maintained on a routine basis. In order to maintain adequate flow capacity, it is often necessary to remove sediment or debris that partially or completely blocks openings. Some structures require inspection and debris removal during all high water events in order to avoid surcharging.

7. Insurance: Although flood losses are not covered under most insurance policies, property owners can reduce the financial impact of a flood by purchasing flood insurance through the National Flood Insurance Program. Flood insurance is currently available throughout the STC Region for property located within and outside of the floodplains. Flood insurance can be purchased for almost any enclosed building and its contents, regardless of location. If flood insurance is in effect, the policy holder is compensated for some degree of loss suffered during a flood.

In April 1997, there were 2,286 active flood insurance policies in the Southern Tier Central Region (Table A-3 in Appendix A), providing $152.6 million in coverage. Almost a decade earlier, in January 1988, the region had 4,340 flood insurance policies providing $150.6 million in coverage. This represents a 47% reduction in the number of policies. This substantial reduction in flood insurance coverage has occurred throughout the region and is far greater than can be justified by the implementation of flood protection measures during this period.

Significant numbers of buildings that experienced damage from recent floods are known to have been uninsured. Flood damage surveys in the Whirt's Creek and Beecher Creek areas in the Town of Elmira identified 22 homes that experienced flood damage to structures at least once in 1996. Only one of the 22 property owners reported receiving an insurance payment to cover flood losses. This insurance claim represented only 2% ($1,500) of the $65,500 in reported damage to structures and contents. Federal reimbursement through three Individual Assistance grants paid for 14% ($9,360) of the reported damage. The remainder of the damage was paid for by property owners or left unrepaired. The areas surveyed have experienced repeated flood damage from two small streams for which Special Flood Hazard Areas (100-year floodplains) have not been identified. However, few residents in these flood-prone areas have chosen to purchase flood insurance.

This example illustrates the significant need for property owners to assume greater responsibility for protecting their property against flooding. Owners of property in flood-prone areas are often unaware of flood risks and lack accurate information about how to insure against flood losses. The Flood Disaster Protection Act of 1973 specifies that banks and other lenders must require the purchase of flood insurance whenever a federally-backed loan is secured by a building located in a Special Flood Hazard Area. Unfortunately, many property owners fail to evaluate whether the amount of flood insurance required by their lender provides them with a appropriate level of protection. In addition, many flood-prone areas in the STC Region are not mapped as Special Flood Hazard Areas. Owners of property in these areas often erroneously assume that their flood risks are negligible.

Misconceptions about Federal flood insurance are widespread in the Southern Tier Central Region. In the absence of accurate information, property owners are unable to make informed decisions about their insurance needs. Anecdotal information suggests that many insurance agents, mortgage lenders, and real estate agents are poorly informed

about the flood risks and flood insurance. Annual workshops or presentations for members of each of these professions would enable them to disseminate accurate information to the public. Educated professionals would be better able to work with their clients to find cost-effective means of protecting their property from flooding.

Natural Resource Protection

Development and other activities in upland areas frequently cause an increase in the probability and severity of downstream flooding. Flood management must, therefore, encompass the entire watershed, rather than focusing strictly on the floodplain. A watershed is the land base from which all water flows into a common river, lake, or stream. Any activity that affects drainage characteristics or erosion anywhere in a watershed can impact flooding problems at downhill locations. The amount of water flowing in a stream during a flood can be reduced by reducing or retarding the amount of surface runoff from the watershed. Natural resource protection activities can reduce flood damages by preserving or restoring natural areas or the natural functions of watershed areas.

1. Wetlands Protection: Wetlands are areas that are always or periodically filled with water. They serve as natural sponges, holding excess runoff and delaying its flow into streams. When wetlands are drained or filled for development or agriculture, it destroys the natural water-holding ability of the watershed and the flood potential in downstream areas increases. Development in wetlands is regulated by the U.S. Army Corps of Engineers (if development will result in the loss of 1/3 acre or more of wetlands) and by the State of New York (for wetlands delineated on the NY State Freshwater Wetlands Map). Additional protection can be provided by applying the techniques described above for open space preservation of floodplains.

   The preservation of existing wetlands should be encouraged throughout the STC Region. In some areas, it may also be desirable to construct new wetlands or enlarge existing wetlands to improve the water storage capacity of a watershed. A recent wetland assessment in the Seeley Creek and Bentley Creek watersheds (conducted by the U.S. Army Corps of Engineers) has identified potential sites for preservation or creation of wetlands.

2. Erosion and Sediment Control: The ability of a river or stream to contain flood waters without overflowing its banks can be severely restricted by sedimentation within the channel. The erosion that supplies this sediment occurs on the banks of streams and rivers and throughout the watershed. This problem can be addressed by (1) stabilizing streambanks and (2) controlling the erosion and sedimentation that result from development, agriculture, and timber harvesting activities.

   Severe sedimentation problems throughout the STC Region are caused by erosion of stream and river banks. Streambank erosion is a natural process, particularly for streams that cut through highly erodible glacial deposits. However, development pressures and

recent flood events have seriously exacerbated streambank instabilities at numerous locations. This results in excessive sedimentation within the channels and threatens development located close to stream and river banks. All three counties have streambank stabilization programs that encourage and assist with the maintenance of appropriate vegetative cover or rock rip-rap along water ways and drainage areas. The U.S. Fish and Wildlife Service is currently developing a stream restoration plan for Bentley Creek (which flows through the Village of Wellsburg, Chemung County) based on the techniques of applied fluvial geomorphology. Ongoing support is needed for these and other efforts to establish and maintain channel stability, particularly through developed areas.

Channel instabilities and bank erosion can be aggravated by human activities within stream corridors. Roads, buildings, lawns, livestock, and cultivated fields can all have detrimental effects on adjacent streams. These impacts can be reduced by establishing undeveloped vegetated buffers along rivers and streams. Methods for achieving this include: education, supplying appropriate plants, land use restrictions (such as stream setback provisions for buildings), and financial assistance (such as agricultural incentive programs).

Stream and river stability can be enhanced by application of erosion and sediment control practices that minimize the adverse impacts of human activities throughout the region's watersheds. Improved erosion and sediment control practices can be achieved through education (of local officials, developers, farmers, and loggers) and legislation. State law requires that erosion and sedimentation be addressed as part of the Stormwater Pollution Prevention Plan prepared for any construction activity that will result in the disturbance of five or more acres of land. However, local oversight is needed to insure that appropriate plans are developed, reviewed, and properly implemented. Municipalities are encouraged to enact erosion and sediment control regulations.

3. Best Management Practices: Any activity that increases runoff or disrupts natural drainage patterns can increase flooding at down slope and downstream locations. The negative impacts of agriculture, timber harvesting, and other activities can be reduced by implementing "best management practices" to control surface runoff and soil erosion. The land treatment practices that can be implemented to reduce downstream flooding include riparian buffers along streams, tree planting in upland areas, gravel rather than paved surfaces, proper site grading, terraces, strip cropping, contour plowing, water bars, diversion ditches, soil stabilization, and numerous other techniques.

Technical assistance with implementing best management practices is available through county, state, and federal agencies. The Soil and Water Conservation Districts in the three STC counties have strong records of accomplishments in watershed management, including measures to reduce erosion and improve the water retention capacity of soils. The U.S. Department of Agriculture has several programs that provide financial incentives to landowners for implementing conservation measures. New York State Department of Environmental Conservation provides training for loggers in good timber

harvesting practices. In most cases, good land management practices are implemented voluntarily by property owners with or without financial assistance. Ongoing support of these programs will benefit down slope areas as well as the properties on which best management practices are implemented.

When voluntary implementation of best management practices is insufficient, they can be required by local regulations. Several Southern Tier Central municipalities (Towns of Ashland, Big Flats, Elmira, and Horseheads in Chemung County and Village of Painted Post in Steuben County) have enacted timber harvesting ordinances in order to insure that timber harvesting operations have minimal impact on sedimentation and drainage patterns.

Emergency Services

Flood warning and emergency evacuation are essential components of any flood damage reduction program. These measures are the responsibility of municipal and county emergency management staff and the owners or operators of major or critical facilities. Volunteers also play an active role in emergency service activities, working with fire departments, the American Red Cross, and the Flood Warning Service.

1. Flood Warning: Reliable and timely flood warnings enable residents, businesses and governmental units to carry out emergency measures to reduce risks of loss of life, to protect valuable property (either by its removal from the flood area or securing it from water damage), and to provide emergency services. Sufficient warning is the greatest defense against loss of life during a flood.

   The need for timely forecasts of impending flooding is met by the Flood Warning Service in Steuben and Chemung Counties. The Flood Warning Service, operated by Environmental Emergency Services, Inc., is a not-for-profit corporation that derives its funding from contributions made by Chemung and Steuben Counties, and the Cities, Towns, and Villages within those counties. A forecast center (located in the Corning Fire Station) provides a centralized point for data/information collection, analysis, and distribution. This mission is carried out through cooperative activities with the Chemung and Steuben County Emergency Management Offices, the National Weather Service, the New York State Department of Environmental Conservation, the U.S. Army Corps of Engineers, and the U.S. Geological Survey for the mutual benefit of all parties. The Flood Warning Service is operated by trained volunteer staff.

   Flood forecasting and warning capabilities rely on ongoing efforts to maintain and improve data collection, data processing, and communication systems. Recruitment and training are required to maintain the network of volunteers that provide gauge reading, data processing, and communication services.

   A vital component of any flood warning program is the availability of accurate weather

and water level data. Because the STC Region is located in a headwaters area, rain gauge data are essential for maximizing flood warning times. Stream gauges enable prediction of the time and level of downstream flood crests. The existing network of precipitation, river, and lake-level gauges is critically important during flood events and warrants expansion. In recent years, funding cuts have threatened the continued operation of gauges used for flood forecasting. Critical stream and river gauges have been removed from service. High priority should be given to maintaining all existing gauges, resuming operation of discontinued gauges, and adding new gauges to the system. Recommendations for improved operation of the canal system in the Oswego River Basin (of which Seneca Lake and Keuka Lake are a part) include an improved monitoring system and improved data analysis capabilities: "1. Establish a real time automated monitoring system comprised of a network of precipitation gages to measure rainfall and snowfall, coupled with a network of water level sensors at key stream and reservoir locations to verify basin response in terms of water level or stream flow... 2. Automate the data analyses of flows and anomalies (such as wind-driven changes) to assist in determining appropriate actions for Canal System operators." (Operational Audit for the New York State Canal System: Oswego River Basin, Executive Summary, New York State Thruway Authority, New York State Canal Corporation, September 1997.)

2. Flood Response: Flood response efforts prior to and during a flood emergency include: inspection and operation of flood control structures, monitoring of flood and weather conditions, closing roads, evacuation, and temporary property protection measures. These actions require the coordinated efforts of numerous government officials and citizens. During an emergency, structural flood control projects protecting the STC Region, are monitored and operated by the New York State Department of Environmental Conservation and U.S. Army Corps of Engineers. Other emergency response activities are coordinated by the County Emergency Management Offices. State, county, and local highway departments monitor conditions, close roads, and eliminate obstructions when possible. The American Red Cross assists with evacuation centers. Businesses and private citizens can protect their property by sandbagging, removing property from low-lying areas, and moving valuables upstairs.

   Emergency flood proofing measures that can be implemented to protect property when there is sufficient advance warning include:
   - sand bag dikes;
   - sand bagging the entrances to structures or around utilities;
   - earthfill crib retaining walls;
   - stop log barriers; and
   - removing flood damageable items to higher ground.

   The three STC counties and many flood-prone municipalities have Flood Emergency Plans, which enable a rapid and coordinated response to flood emergencies. Flood evacuation planning is designed to temporarily evacuate people and readily movable goods in a timely and orderly manner, thus preventing loss of life and reducing property damage. Ongoing plan review, training, and drills are needed to insure that all aspects of

the emergency response system function effectively during a flood emergency.

Flood emergency planning and emergency response utilizes flood stage forecast maps, which are available for many of the flood-prone communities in the STC Region (see Table B-3 in Appendix B). These maps indicate the floodplain areas that are expected to be inundated as flood waters reach certain flood stages. They are used to identify areas requiring evacuation and to designate evacuation routes. Additional flood stage forecast maps have been requested for two flood-prone areas (Canisteo River in the Town of Addison and Town of Erwin, Steuben County; Meads Creek in the Town of Campbell and Town of Erwin, Steuben County). These areas contain extensive floodplain development that is not protected by levees and would thus benefit from the information on flood stage forecast maps. In addition, local officials who utilize computer Geographic Information Systems have expressed an interest in having flood stage maps digitized in order to identify the property owners affected by particular flood stage levels.

3. Critical Facilities Protection: Facilities that require special attention in a community's emergency response plan include:
   - structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water-reactive materials;
   - hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a flood;
   - police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for flood response activities before, during, and after a flood; and
   - public and private utility facilities that are vital to maintaining or restoring normal services to flooded areas before, during, and after a flood.

   When critical facilities are located at flood-prone sites, safety concerns warrant early notification and facility-specific flood response planning.

Structural Projects

Structural flood control projects are engineered structures designed to keep flood waters away from an area. They include levees, floodwalls, reservoirs, and other measures. They are usually designed by engineers and must be managed and maintained to insure effective operation. The STC Region benefits from numerous structural flood control projects (see Tables B-1 and B-2 in Appendix B), which have prevented significant amounts of flood damage. However, these projects and excessive reliance on the protection they provide may also contribute to increased flood losses at some locations. The limitations associated with reliance solely on structural flood control measures include the following:

- **No area is completely protected.** Flood control structures are designed to protect known flood hazard areas up to a certain limit. When a large flood (such as the 1972

Hurricane Agnes disaster) exceeds the design capacity of protection measures, large-scale devastation can occur in areas that were thought to be protected.

- Structural projects **alter the dynamics of hydrologic systems** and can have adverse impacts beyond the areas they were designed to protect. River channels downstream of dams can experience increased sedimentation due to moderation of peak flows that would naturally flush sediment through the area. Levees, floodwalls, and channelization can increase the height and velocity of water downstream of the protected areas, thus increasing the flood hazards at downstream locations.
- Once development has occurred within protected areas, **additional development may be attracted to adjoining unprotected lands**, with a net result of increased flood risks.

- The sense of security provided by structural flood control projects **can lead to complacency about non-structural methods** of flood damage reduction. Because structural projects only protect limited areas, failure to implement non-structural protection measures can have serious impacts beyond the limits of structural protection.

- Dikes, dams, storm sewers, and channel modifications **require ongoing maintenance**. Failure to provide such maintenance may result in catastrophic flood losses. Reservoirs, even if maintained, gradually fill with sediment which reduces the flood-storage capacity.

- **Some flooding problems are not conducive to structural solutions.** There may be no available site for construction of protective measures. In other cases, physical unsuitability of the site (such as soil or bedrock limitations) may make a project infeasible.

- Land acquisition and construction **costs for structural projects can be prohibitively high**. Many structural flood control projects proposed for the STC Region have not had favorable cost-benefit ratios. Federal agencies can only invest in a project if it can be shown that the potential benefits are greater than the cost of the project. The high costs of structural flood protection projects often cannot be justified as a good investment.

These limitations indicate the folly of relying <u>solely</u> on new structural flood control projects to mitigate flood damages. We simply cannot afford the numerous structures that would be required to "tame" each stream and protect each flood-prone site. However, there are sites in the STC Region where structural projects (particularly small projects) may be warranted and should be considered as part of an overall flood mitigation strategy.

1. <u>Reservoirs</u>: Flood control reservoirs are designed to reduce the amount of water flowing in a stream during a flood by storing some of the floodwater until it can be released safely. The stored water is released slowly during and after the storm to prevent downstream flooding while gradually reestablishing the storage capacity for the next storm. Retention basins are similar to reservoirs, but on a much smaller scale. They are usually associated with local stormwater management programs or streams having small drainage areas. The construction of farm ponds can also contribute to a reduction of

flood damages, as well as providing for recreation, water supply, and other uses.

Several existing and planned reservoirs provide flood protection to the STC Region (see Table B-1 in Appendix B). The construction, maintenance, and operation costs for large flood control reservoirs are high. Several studies have evaluated potential reservoir sites in the STC Region, but the costs could not be justified based solely on the amount of development that would be protected from flooding. In some cases, multipurpose reservoirs might provide favorable benefit-cost ratios if they provide water supply and recreation benefits in addition to flood protection.

In 1975, the Chemung River Basin Board appraised about 60 potential reservoir sites in the Chemung Basin. They concluded that "the Mud Creek (Sonora) site would be justified if potential, long range water conservation benefits and regional expansion benefits are included in the analysis." However, an Army Corps of Engineers study of this reservoir found the project to be infeasible. The Chemung River Basin Board also recommended that project planning studies be conducted to evaluate the multipurpose feasibility of four additional sites (Twelvemile Creek and Campbell Creek in the Cohocton River Subbasin; Purdy Creek with Big Creek as an alternative in the Canisteo River Subbasin). (Comprehensive Water Resources Plan for the Chemung River Basin, Chemung River Basin Regional Water Resources Planning Board, May 1975.) The recommended studies were not pursued.

A 1978 study evaluated 51 potential impoundment sites located in small watershed areas in southeast Steuben County. That analysis was oriented toward development of impoundments ranging in size from 2 to 40 acres (referred to as "farm pond" size impoundments). It was estimated that construction of 50 impoundments would cost $1,112,000 and control 16,862 acres of watershed (10% of the watershed area in southeast Steuben County). The report recommended 14 high priority sites for construction within a proposed 6-year capital program. (Areawide Watershed Protection Network, Southeast Steuben County, prepared for Intergovernmental Council of Southeast Steuben County, prepared by Three Rivers Development Foundation, Inc., November 1978.) It is not known how many of the proposed retention structures were constructed.

The potential for reducing flood damages in the STC Region by developing water retention structures warrants additional evaluation. The emphasis should be on identifying suitable sites for small impoundments in upland areas. In addition, efforts should be made to document the sites of all existing ponds and retention structures to ensure that they receive adequate maintenance.

2. Levees and Floodwalls: Levees and floodwalls currently provide flood protection to areas where concentrated floodplain development has resulted in positive benefit-cost determinations (see Table B-2 in Appendix B). These structures raise one or both stream banks sufficiently to prevent floodwaters from spreading over the floodplain. Levees and floodwalls are designed to protect against flood flows up to a certain point. However, if

water rises over the levee (as it did in several STC communities in 1972), the resulting flood damage may be more catastrophic than that caused by the gradual rise in floodwater without a levee in place. Another disadvantage is the potential for increased flooding upstream or downstream of the protected area. In addition, levees and floodwalls are expensive to build and maintain. Although the existing levee system provides valuable protection, analysis of potential sites for new levees in the STC Region has repeatedly indicated that the areas not currently protected do not meet cost-benefit criteria for levee construction. A possible exception is the Village of Wellsburg (Chemung County), where construction of a dike is among the options recommended for further study (Preliminary Investigation Report (PL 83-566) for Bentley Creek Watershed, PA and NY, USDA Natural Resources Conservation Service, December 18, 1997).

It is sometimes desirable to increase the level of flood protection provided by an existing levee or floodwall. This is accomplished by increasing the height of the structure to protect from floods with higher water surface elevations than the existing wall or levee was built to handle. This option is currently being considered for the Addison flood protection project, which provides only a 40-year level of protection from the Canisteo River and a 10-year level of protection from Tuscarora Creek.

A small levee or retaining wall can provide flood protection to an isolated building or group of buildings. A ring levee can be built to encompass the area to be protected or can tie in with existing high ground. A ring levee may be a desirable protection method for facilities, such as sewage treatment plants, that cannot be adequately floodproofed.

Levees and floodwalls, like all flood control structures, require ongoing maintenance to insure proper operation during flood events. Most of the region's dike systems are conscientiously maintained by the New York State Department of Environmental Conservation. Local governments and the U.S. Army Corps of Engineers have maintenance responsibilities for some structures. Continued support for these maintenance programs is essential to insure the flood protection that owners of protected property have reasonably come to expect.

3. Diversions: Flooding can sometimes be alleviated by creating a diversion channel to convey stormwater runoff or high flows that exceed the capacity of the main channel. A stormwater diversion directs runoff away from developed areas. A high-flow diversion channel is located in the floodplain where it increases the capacity for conveying floodwaters through a developed area without altering flow characteristics or habitat within the main channel.

A high flow diversion can be a cost-effective solution to flooding caused by limited bridge capacity. One such project that has been proposed (Wood Bridge, Town of Campbell, Steuben County) involves construction of a high flow channel on the natural floodplain with culverts to carry water under the road. Other opportunities may exist for successfully implementing diversion techniques in the STC Region.

4. Channel Modifications: Stream and river channels can sometimes be modified to improve their ability to pass flood flows at a lower elevation. Such modifications include:
   - straightening, widening, or deepening a channel;
   - clearing brush, trees, and other obstructions from stream banks;
   - paving the channel; and
   - removal of sand bars or islands.

   If properly designed, channel modification projects can effectively reduce flood levels. However, nature often attempts to revert a channel back to its original state, so continuous maintenance is required. Care must also be taken to minimize the impact to downstream areas. Because high sediment loading currently has a destabilizing effect on many channels in the STC Region, the removal of sand bars or islands may be warranted in many areas.

5. Storm Sewers: Installation of a storm sewer system is often part of site development for large projects. Existing problems with overland flooding and ponding can often be addressed by installation of storm sewers or increasing the capacity of existing systems. The capacity of a storm sewer system can be impaired by sediment deposits within the system or debris accumulation on entrance gratings. Storm sewers, like all other flood control structures, require ongoing inspection and maintenance to insure proper functioning.

Public Information

Public support is crucial to the implementation of any flood mitigation program. Public information activities are thus an important component of any comprehensive solution to flooding problems. These activities inform and educate people about flood hazards, flood protection measures, and the natural functions of hydrologic systems. The educational outreach can be directed toward floodplain residents, property owners, potential property owners, insurance agents, real estate agents, visitors, or other segments of the local populace. An informed public is better able to make responsible decisions about acceptable risks and actions that can reduce those risks.

1. Information About Flood Insurance Rate Maps: There are many benefits to providing Flood Insurance Rate Map information to inquirers. Residents and businesses who are aware of the potential flood hazard can take steps to avoid problems and/or reduce their existing exposure to flooding.

   Local governments can increase flood hazard awareness by posting floodplain maps in municipal buildings. In addition, municipal or county officials can provide information about whether a property is in a Special Flood Hazard Area, what flood zone the property is in (e.g., A, B, X, etc.), what the flood zone designation means, the base flood elevation, and information about the map (community number, panel number and suffix, effective

date, and elevation datum). They can also provide additional information about development restrictions in Special Flood Hazard Areas, other hazards (shallow water table, streambank erosion, etc.), flooding outside of mapped areas, flood insurance, and property protection measures.

2. Flood Information Outreach Projects: Studies reveal that people who live in flood-prone areas tend to believe that they are not going to be affected by floods. In order to combat the complacency that results from these unrealistic attitudes, flood education programs should reach out to people, rather than merely responding to inquiries. There is an ongoing need to inform citizens of the hazards to which they are exposed and thus provide an incentive for implementing protective measures. The general public also needs access to practical information about what they can do to reduce flood losses. Flood hazard and flood protection information can be distributed through a newsletter, utility bill, direct mailing, or as an outreach project. Relevant topics for public outreach include:
   - description and/or map of the local flood hazard;
   - the flood warning system;
   - flood safety;
   - flood insurance;
   - property protection measures;
   - permit requirements for floodplain development and substantial improvements;
   - drainage system maintenance; and
   - natural and beneficial functions of floodplains and other watershed areas.

3. Real Estate Disclosure: Most prospective buyers do not take the time (or know how) to investigate whether a property is subject to a hazard. As a result, many people are caught by surprise when their properties are flooded. One of the best times to advise someone of a flood hazard is at the time they are considering the purchase of property. Real estate agents can be encouraged or required to advise prospective floodplain occupants about the flood hazard. Real estate agents throughout the STC Region could benefit from education about flood hazards, flood insurance, and flood protection measures. If these professionals have access to accurate information about these issues, they will be better able to serve their clients. Informed property buyers would be more likely to purchase flood insurance and implement flood protection measures.

4. Library: The community library is an obvious place for residents to seek information about flooding and flood protection. It is thus important that public libraries have references on flood-related topics, including:
   - a copy of the current Flood Insurance Rate Maps for local communities;
   - up-to-date information about flood insurance;
   - documents on protecting a building from flooding;
   - documents on community floodplain management or flood hazard mitigation;
   - documents on the natural and beneficial functions of floodplains;
   - local accounts of past flood events; and

- directory of sources for additional information on these topics.

5. Technical Assistance: Floodplain residents are more likely to undertake activities to reduce the flood hazard to their property if reliable information is available locally. Municipal and county officials are often able to provide the advice, assistance, and site-specific information that residents desire. It may be beneficial to maintain a list of experts who can provide interested property owners with additional information. Topics about which assistance may be desired include:
   - site-specific information about historic flood events;
   - names of contractors and consultants knowledgeable or experienced in retrofitting techniques and construction;
   - material on how to select a qualified contractor and what recourse people have if they are dissatisfied with a contractor's performance;
   - site visits to review flooding, drainage, and sewer problems or provide advice on contemplated development; and
   - advice and assistance on retrofitting techniques.

6. Environmental Education: Comprehensive management of flooding problems requires an understanding of hydrologic systems and how activities throughout a watershed can affect flooding. Communities throughout the region would be better able to manage flooding problems if citizens had a better understanding of the issues involved. Environmental educational programs for children and adults can further this understanding.

RECOMMENDATIONS

In 1892, when citizens of Corning sought financial assistance for the construction of dikes, state officials advised them to "drill some holes in the bottom of the river so the water could run out." Then, as now, people hoped for a simple solution that would preclude the costly necessity of implementing truly effective flood damage prevention measures. Although the last century has seen many steps to mitigate flood impacts in the STC Region, the problem is not yet solved. And now, as then, the solutions are neither simple nor free.

The severity of recent flood damages highlights the inadequacies of existing flood mitigation efforts. This study supports earlier conclusions that additional flood management activities within the Southern Tier Central Area should be based primarily on non-structural measures (Flood Management Manual: Regional Flood Damage Reduction Program, Southern Tier Central Regional Planning and Development Board, June 1978). Small-scale structural projects may be appropriate in some areas, but they must be complemented by a long-term commitment to preventive, non-structural flood damage reduction activities.

Optimal flood protection requires simultaneous implementation of a number of mitigation measures, each supporting and supplementing the others. The various approaches described in this Strategy can be combined to fit the unique circumstances of any given situation. The principle recommendations for reducing flood damages in the Southern Tier Central Region are summarized below. Because there is no single best solution, this list has not been prioritized.

a. Offer training for local building officials on implementation of floodplain development regulations: A workshop for municipal officials on National Flood Insurance Program floodplain development standards should be offered in the STC Region at least once every year. This will enable local officials to obtain the information and technical assistance needed to consistently enforce local Floodplain Development Regulations.

b. Update, enhance, and enforce floodplain development regulations: All municipalities need to consistently enforce their existing floodplain development regulations. Those that have not already done so should be encouraged to adopt the most recent Model Law for Flood Damage Prevention with the recommended provision that buildings be elevated or floodproofed to two feet above the base flood elevation. If the Department of Environmental Conservation pursues its current plans to re-generate all Flood Insurance Rate Maps in the state, then updating of the local laws would be most appropriately done when the new maps become available. Efforts to strengthen floodplain development standards should concentrate on municipalities with potential development sites within the mapped Special Flood Hazard Areas.

c. Offer flood hazard training for planning boards and other local officials: Annual training in flood hazards and flood damage prevention should be available for planning board members and other local officials. If these officials understand flood hazards in their communities and the steps that can be taken to reduce these hazards, they will be better

able to implement preventive activities and limit inappropriate new development. Flood damage reduction objectives can be incorporated into zoning and subdivision regulations. If the value of natural floodplains is understood, local officials can make wiser decisions concerning any proposed or anticipated floodplain development. With or without regulations, planning board members who understand flooding issues will be better able to advise constituents on development, land use, and drainage issues.

d. Establish vegetated buffers along streams, rivers, and lakes: All municipalities are encouraged to enact a requirement that all new buildings be located a set distance from any streambank or lake shore. This will reduce the likelihood that buildings will be undermined by bank erosion and reduce the susceptibility of buildings to flooding (particularly along small streams where floodplain development regulations do not apply). In addition, setback provisions will protect waterbodies and banks from damage caused by development activities. Wherever possible, vegetated buffer areas should be established along banks and shores.

e. Improve local programs for stormwater management and erosion control: All municipalities are encouraged to require the implementation of good practices for stormwater management, erosion control, and sediment control at all development sites and all timber harvesting operations. This can be done by enacting new ordinances (Stormwater Management and Erosion Control; Timber Harvesting) or by incorporating appropriate provisions into zoning and/or subdivision regulations. With or without regulations, municipalities should encourage implementation of good development practices by insuring that State permit requirements are fulfilled (for any construction activity that will result in the disturbance of five or more acres of land), educating property owners, and providing technical assistance.

f. Establish drainage system maintenance programs: All municipalities are encouraged to establish permanent, funded programs for routine inspection and maintenance of drainage systems. These programs should insure appropriate maintenance of all ditches, culverts, stormwater facilities, flood control structures, and natural stream channels through developed areas. Ongoing maintenance of all structural flood control projects is necessary to insure effective operation during a flood. Routine removal of debris from drainage ways will enhance the capacity to carry water and reduce flooding problems.

g. Distribute floodproofing information: Information and advice about floodproofing and other property protection measures (relocation, building elevation, sewer backup protection, etc.) should be provided to all occupants of flood-prone sites throughout the region. Residents and businesses should be strongly encouraged to undertake appropriate floodproofing measures. In particular, the protection of basement utilities, sewer backup protection, and elevation of basement contents should be encouraged. In some localities it may be appropriate for municipalities to seek financial assistance for implementation of property protection projects.

h. Encourage increased flood insurance coverage by educating insurance, mortgage, and real

estate professionals: Workshops or presentations about flood hazards and the National Flood Insurance Program should be offered annually for insurance agents, mortgage lenders, and real estate agents. These professionals could then provide clients with accurate information and appropriate advice concerning the need for flood insurance protection. All owners of flood-prone buildings should be encouraged to realistically evaluate their flood insurance needs.

i. Expand programs for stabilizing streams and protecting natural resources: Ongoing programs that reduce surface runoff and reduce sedimentation should receive continued support and be expanded wherever possible. Of particular importance are the streambank protection programs administered by the county Soil and Water Conservation Districts. Potential applications of other stream stabilization technologies should be considered.

j. Enhance flood warning capabilities with improved precipitation and water level gauging: The data collection and data processing capabilities of existing flood warning operations should be expanded. All current precipitation and river gauges need to be protected from the repeated threats of budget cuts. Additional gauges should be added to the system. In addition, ongoing volunteer recruitment and training should continue.

k. Maintain and improve emergency response capabilities: Funding is needed for additional flood stage forecast maps and digitizing of existing maps. Flood Emergency Plans should continue to be reviewed and revised on a regular basis. Routine training and drills are needed to insure optimal emergency response capabilities.

l. Evaluate structural alternatives for providing additional flood protection: Hydrologic modeling and site surveys are needed evaluate the potential effectiveness of structural flood protection measures. The measures that are most likely to provide cost-effective solutions to flooding problems include: small impoundments, high-flow diversions channel, stormwater diversions, channel clearing (removal of trees, shoals, and islands), and storm sewers.

m. Expand public education efforts: All of the above efforts need to be supported by ongoing public education programs at the municipal, county, and regional level. As the time since the last flood disaster increases, the emphasis should shift from providing information on request to active outreach programs that utilize civic organizations, schools, newsletters, and community events. A lending library of references, handouts, and educational materials should be established to support these efforts.

APPENDIX A

History of Flooding and Flood Damages

Table A-1 (page 1 of 3)
Major Floods in the Southern Tier Central Region

1784--"Ice Flood" did much damage
1786--"The Pumpkin Flood" caused heavy property loss
1794--waters of the Chemung River were 15-19 feet above normal
1816--the Chemung flooded the lowlands at all points
1817--"Pumpkin Flood" in which hundreds of thousands of pumpkins were washed down the rivers
May 1833--"The Great Inundation" caused heavy destruction in the Cohocton and Tioga Valleys
1840--Knoxville bridge over the Chemung River was carried away
1846--Knoxville bridge was washed away again
June 17, 1857--landslides and washed out train tracks between Corning and Addison
July 2, 1857--more landslides and washed out train tracks
November 10, 1857--during the "Big Flood" boats took people right from the lobby of the hotel at Painted Post to the mountains on the west side of the Tioga River; much livestock and property were lost; many people were hard put to survive until spring
March 24-25, 1859--Monkey Run Creek in Corning overflowed resulting in vast damage to the village
October 1860--Monkey Run Creek flooded flat lands in every direction; there was another Pumpkin Flood with hundreds of thousands of pumpkins going down the Chemung River
September 27-28, 1861--"The Tremendous Flood" washed away large stocks of lumber and over 1200 tons of coal; homes had from one to six feet of water
May 14, 1864--many families moved to their second floors to escape the flood waters; vast amounts of lumber were carried away
March 17, 1865--extensive rains and melting snow resulted in a new high water mark for the Chemung River; heavy damage was experienced along the entire Chemung watershed; there was very great loss in livestock, homes, property, and lumber; three saw mills suffered heavy damage; "The Rebel Prison" was evacuated and barracks were washed away; Elmira lost two bridges; for nearly a week there was no news on the progress of the war
February 15, 1867--a very sudden rise in the Chemung River formed an ice jam that took out a bridge
April 18, 1870--Monkey Run Creek rampaged, despite the prior building of Prichard's Canal; over $40,000 worth of lumber was lost in Gang Mills; no train reached Corning for over three days; the Blossburg Railroad was out for over a week
January 3-4, 1886--the Tioga, Cohocton and Chemung Rivers flooded all of Painted Post, Centerville and most of Corning, with flood waters extending from hill to hill
June 1, 1889--the "Big Flood of 1889" was very destructive to the valley areas of the Tioga, Canisteo and Cohocton Rivers as well as the Chemung River; the crest of this flood was 21 feet 2 inches above normal; damage reached over a million dollars; houses were swept off of their foundations; lives were lost

Table A-1 (page 2 of 3)
Major Floods in the Southern Tier Central Region

November 1889--another flood destroyed crops
May 20-21, 1894--another flood damaged many crops; Chemung River was 4 feet short of the high water mark of the Big Flood of 1889
November 24, 1900--large sections of Corning were flooded by Monkey Run Creek; the Chemung River rose within 36 inches of the high water mark of 1889; the highway from Painted Post to Gang Mills was under 5 feet of water
April 21, 1901--lowlands were flooded, but newly constructed dikes saved the city of Corning
February 1902--more flooding
July 3-4, 1902--heavy property damage and nearly all the crops were destroyed
August 29, 1903--all river flatlands were again flooded by the Chemung River
June 1916--flooding in Addison from the Canisteo River
September 1916--Monkey Run Creek was blamed for another destructive flood in the city of Corning
March 13-14, 1918--Chemung River and feeder streams flooded lowlands in every direction
August 17, 1920--extensive damage in the Corning area; Centerville Bridge was washed away; Chemung River was a foot below the bottom of the Bridge Street bridge
July 7-8, 1935--"Finger Lakes Flood" caused extensive damage throughout south central New York and northern Pennsylvania; more than forty deaths were recorded; damages ran in the hundreds of millions of dollars; refugee centers were everywhere; this was a severe storm and it developed very rapidly
May 28, 1946--the Chemung River crested at an all time high; very heavy livestock and farm losses throughout the watershed; many people lost all of their possessions; Corning Glass Works Factories were damaged; water was 8 inches from the top of the dike system in Corning; damages were in the hundreds of millions of dollars
June 23, 1972--Hurricane Agnes Flood: the Tioga, Canisteo, Cohocton and Chemung Rivers all carried more water than they had ever carried before, resulting in complete chaos; water rolled over dikes and flood walls; retaining walls were hurled out of the way; many areas were demolished; bridges were lost; trailers floated down the rivers; buildings disappeared; 30 feet of water covered the village of Painted Post; the force of the water was so great that the walls of buildings were literally hurled inward; 23 fatalities in Steuben County
September 22-28, 1975--Hurricane Eloise caused another big river flood with over 700 buildings damaged and some destroyed
January 27, 1976--ice jams in Gang Mills, Addison, and Chemung
February 17, 1976--flooding in Big Flats; River Road closed in South Corning
June 19-20, 1976--"Fathers' Day Flood" caused $6 million of damage in Chemung and Steuben Counties
February 26, 1977--ice jams caused localized flooding in Bath, Cameron, and Rathbone, with water in streets and basements
September 25, 1977--7.34 inches of rain in September caused isolated flooding in Kanona, Bath and Prattsburg; flooded cellars throughout the region

Table A-1 (page 3 of 3)
Major Floods in the Southern Tier Central Region

March 21, 1978--roads flooded in South Corning, Erwin, Cameron Mills, Big Flats, and Ashland
August 11, 1978--flash flooding in northern Steuben County and Yates County washed out a road and a bridge
January 24-25, 1979--ice jams in streams caused scattered road closings and washouts; evacuations near Meads Creek in the Town of Erwin
March 4-6, 1979--roads closed due to flooding
February 10, 1981--ice jam in the Town of Campbell
February 19-24, 1981--ice jam in the Town of Campbell
March 13-14, 1982--ice jams caused evacuations in Tuscarora, threatened Campbell, flooded yards and basements in Big Flats, and closed roads
December 13-14, 1983--flooded basements, road closed at Lowman Crossing
February 14-16, 1984--flooding in Big Flats, scattered road closings
June 1984--flooding in western Steuben County
August 13-14, 1984--thunderstorms caused widespread and severe flooding in western Steuben County (also Allegany and Yates Counties); 483 damaged structures; 62 people displaced; 1 death
May 14, 1992--flash flooding in Hammondsport
March 1993--spring melt caused road closings and widespread basement flooding; evacuations in Atlanta, Cohocton, Avoca, and Kanona
April 1993--spring flooding in Schuyler County damaged 675 homes and affected 40 businesses
August 1994--heavy rain associated with Hurricane Beryl caused flash flooding in southern Chemung and southeastern Steuben Counties
January 19, 1996--heavy rain, melting snow, and ice jams caused flooding in river valley communities not protected by dikes and along many streams; hundreds of residents were evacuated from Wellsburg, Big Flats, Campbell, Erwin, Addison, and Kanona
November 8, 1996--flash flooding paralyzed many communities in Schuyler, Chemung, and eastern Steuben Counties; evacuations in Erwin and Campbell; dozens of roads were washed out; traffic was backed up for miles due to flooding of Highway 17 and alternate routes

Sources: Descriptions of events prior to and including the 1972 Hurricane Agnes flood are from Floods of the Chemung Watershed 1794-1972, "A Day to Remember," June 23, 1972, by Marvin W. Copp, 1975. Subsequent events are from newspaper accounts.

Table A-2
Floods of Record in the Southern Tier Central Region

Location	Drainage Area (square miles)	Flood Discharge (cubic feet/sec.)	Lake Level (feet MSL)	Date
Cohocton River near Campbell	470	41,100	--	July 1935
Five Mile Creek near Kanona	66.8	5,110	--	June 1972
Canisteo River at Arkport	30.6	4,820	--	July 1935
Canacadea Creek near Hornell	57.9	21,000	--	July 1935
Tioga River near Erwins	1,377	190,000	--	June 1972
Chemung River at Chemung	2,506	189,000	--	June 1972
Newtown Creek at Elmira	77.5	4,000	--	June 1972
Keuka Lake at Penn Yan	182	--	720.7	1872
Seneca Lake at Watkins Glen	704	--	448.8	June 1972

Sources: Comprehensive Water Resources Plan for the Chemung River Basin, Chemung River Basin Regional Water Resources Planning Board, May 1975; and Report of Flood, Tropical Storm Agnes, June 1972, Oswego River Basin, US Army Engineer District, Buffalo, August 1973.

Table A-3 (page 1 of 3)
Damage Estimates for Floods in the Southern Tier Central Region

June 1972: (recurrence intervals range from 50-year to 500-year)
Susquehanna River Basin -- $624 million[a]
Oswego River Basin -- $4 million[a]
Dwellings completely destroyed -- 5,000[b]
Dwellings suffering major damage -- 45,000[b]
Total -- $750 million[b]

September 1975:
Steuben County -- $11 million[c]
NRCS Emergency Watershed Protection Projects in Chemung County -- $232,960[d]
Chemung County -- $40 million[e]
Total--$51 million

June 1976: Steuben and Chemung Counties
Steuben County -- $8.2 million[c]
NRCS Emergency Watershed Protection Projects in Chemung County -- $202,160[d]
Total -- $10 million[f]

August 1984: Western Steuben County
Public facilities -- $5,330,410[e]
Private facilities -- $1,613,400[e]
Total -- $6,943,810

April 1993: Schuyler County
Homes -- $6.37 million[e]
Businesses -- $1.57 million[e]
Total -- $7.94 million

August 1994: (8-year return frequency based on 24-hour rainfall in Elmira;
3-year recurrence interval for Chemung River discharge near Chemung)
Chemung County:
NRCS Emergency Watershed Protection Projects -- $857,949[d]
Damage to Local Flood Control Project (Seeley Creek) -- $16,000[g]
Hazardous Material Spill (cleanup expenses), Town of Ashland -- more than $500,000[h]
Total -- $3 to 5 million[e]
Steuben County:
Town of Erwin (Town expenses) -- $120,000[h]
Town of Campbell (estimated infrastructure damage; actual repairs are less) -- $100,000[h]
Total -- $500,000[e]
Total -- $3.5-5.5 million

Table A-3 (page 2 of 3)
Damage Estimates for Floods in the Southern Tier Central Region

January 1996: (recurrence intervals for river discharges range from 20-year to 75-year)

Damage to Local Flood Control Projects in Chemung and Steuben Counties -- $107,000[g]

Chemung County:

- Federal Share Public Assistance -- $2,769,437[i]
- Federal Share Individual Assistance -- $946,631[i]
- Private Property Damage (Residential) from Whirt's Creek & Beecher Creek, Town of Elmira -- $96,229[j]
- Private Property Damage (Residential) in Holecek Avenue/Stacia Drive/Mt. Zoar Road neighborhood, Town of Southport -- $69,400[j]
- Private Property Damage (Residential and Business) in Village of Wellsburg -- $1,473,962[j]
- Total -- $20 million[e]

Steuben County:

- Federal Share Public Assistance -- $3,977,744[i]
- Federal Share Individual Assistance -- $919,497[i]
- NRCS Emergency Watershed Protection Projects -- $1,068,128[d]
- Town of Erwin (Town expenses in excess of Public Assistance reimbursement) -- $215,000[h]
- Private Property Damage (Residential and Business) and Emergency Expenses from Meads Creek, Town of Erwin -- $1,948,592[j]
- Total -- $12 million[e]

Schuyler County:

- Federal Share Public Assistance -- $393,188[i]
- NRCS Emergency Watershed Protection Projects -- $62,000[d]
- Damage to Local Flood Control Project (Montour Falls) -- $50,000[g]
- Total -- $1 million[e]

Total -- $33 million

November 1996: (9-year return frequency based on 24-hour rainfall in Elmira; recurrence intervals for river discharges range from 3-year to 15-year)

Chemung County:

- Federal Share Public Assistance -- $1,583,990[i]
- Federal Share Individual Assistance -- $284,835[i]
- NRCS Emergency Watershed Protection Projects (cumulative damages from 3 storms in 1996) -- $717,017[d]
- Damage to Local Flood Control Project (Seeley Creek) -- $125,000[g]
- Private Property Damage (Residential) from Beecher Creek, Town of Elmira -- $64,585[j]
- Total -- more than $3 million

Table A-3 (page 3 of 3)
Damage Estimates for Floods in the Southern Tier Central Region

November 1996 (continued):

Steuben County:

Federal Share Public Assistance -- $1,576,720[i]

Federal Share Individual Assistance -- $374,644[i]

NRCS Emergency Watershed Protection Projects -- $745,769[d]

Town of Erwin (Town expenses) -- $293,000[h]

Town of Campbell (Town expenses) -- $165,000[h]

Private Property Damage (Residential and Business) and Emergency Expenses from Meads Creek, Town of Erwin -- $4,718,970[j]

Total -- more than $8 million

Schuyler County:

Federal Share Public Assistance -- $557,146[i]

Federal Share Individual Assistance -- $172,681[i]

Total -- more than $1 million

Total -- more than $12 million

Sources:

[a] Based on damage estimates in Post Flood Reports, compiled by U.S. Army Corps of Engineers.

[b] Regional Analysis for Development Planning in Disaster Areas, by Barclay G Jones & Hames H. Mars, September 1974.

[c] Areawide Watershed Protection Network Southeast Steuben County, Three Rivers Development Foundation, Inc., November 1978.

[d] Supplied by Natural Resources Conservation Service.

[e] Based on newspaper accounts.

[f] From Flood Management Manual: Regional Flood Damage Reduction Program, prepared by Southern Tier Central Regional Planning & Development Board, June 1978.

[g] Supplied by New York State Department of Environmental Conservation.

[h] Supplied by Municipal Officials.

[I] Supplied by Federal Emergency Management Agency; generally 75% of estimated expense.

[j] Based on flood damage surveys of businesses and homeowners conducted by municipalities.

Table A-4 (page 1 of 3)
National Flood Insurance Program (NFIP) Data
(Municipalities Prioritized by Number of Claims)

Municipality	No. NFIP Claims (1978-97)	$ of NFIP Claims (1978-97)	No. NFIP Policies (1997)	No. A-Zone NFIP Policies (1997)	No. Repetitive Loss Properties
CHEMUNG COUNTY:					
C. Elmira	54	145,445	631	292	0
T. Big Flats	31	120,216	87	24	1
T. Ashland	23	281,697	25	13	2
V. Wellsburg	17	289,620	47	26	0
T. Southport	15	47,948	68	7	1
T. Baldwin	15	19,731	21	13	0
T. Elmira	14	29,369	88	22	0
V. Elmira Heights	14	20,138	43	35	0
T. Horseheads	9	27,508	53	36	0
T. Chemung	8	25,402	26	16	0
V. Horseheads	5	28,620	25	13	0
T. Van Etten	3	8,267	3	1	0
V. Millport	1	11,077	4	3	0
T. Veteran	1	1,085	4	2	0
T. Catlin	1	0	6	1	0
T. Erin	0	0	6	1	0
V. Van Etten	0	0	3	2	0
Chemung Co. Total	**211**	**1,056,123**	**1,140**	**507**	**4**
STEUBEN COUNTY:					
T. Lindley	41	268,761	33	15	5
T. Erwin	35	135,006	124	51	1
T. Campbell	29	130,078	84	55	0
T. Bath	23	84,565	26	22	0
C. Corning	17	39,549	231	3	0
C. Hornell	15	45,621	69	6	1
T. Pulteney	15	17,470	46	22	0
T. Corning	13	27,068	41	19	0
V. Hammondsport	13	13,660	13	4	0
V. Addison	11	136,942	44	38	1
T. Urbana	11	46,948	34	14	0
T. Avoca	9	70,477	14	13	1
V. Painted Post	9	34,314	68	5	0
T. Wayne	9	32,280	19	8	0
T. Hornellsville	7	49,844	28	7	0

Table A-4 (page 2 of 3)
National Flood Insurance Program (NFIP) Data
(Municipalities Prioritized by Number of Claims)

Municipality	No. NFIP Claims (1978-97)	$ of NFIP Claims (1978-97)	No. NFIP Policies (1997)	No. A-Zone NFIP Policies (1997)	No. Repetitive Loss Properties
T. Canisteo	7	23,380	22	7	0
T. Tuscarora	7	11,956	7	6	0
V. Avoca	6	10,259	13	13	0
V. South Corning	5	14,724	37	23	0
V. Canisteo	4	706	7	0	0
V. North Hornell	3	3,199	12	4	0
T. Wayland	3	2,792	10	10	0
T. Addison	2	27,864	3	2	0
V. Riverside	2	3,135	15	1	0
T. Caton	1	24,352	3	1	0
T. Hornby	1	6,951	5	3	0
T. Greenwood	1	2,831	6	2	0
T. Wheeler	1	1,483	4	4	0
T. Cameron	1	658	3	1	0
V. Bath	1	567	6	2	0
T. Woodhull	1	488	2	2	0
T. Jasper	1	449	1	0	0
V. Arkport	1	0	16	14	0
T. Prattsburgh	1	0	6	4	0
T. Howard	0	0	6	4	0
T. Dansville	0	0	6	3	0
T. Hartsville	0	0	4	0	0
V. Cohocton	0	0	3	2	0
T. Bradford	0	0	2	2	0
T. Fremont	0	0	2	0	0
T. Rathbone	0	0	2	0	0
T. Thurston	0	0	2	2	0
T. Cohocton	0	0	1	0	0
V. Wayland	0	0	1	1	0
T. West Union	0	0	1	1	0
V. Savona	0	0	0	0	0
T. Troupsburg	0	0	0	0	0
Steuben Co. Total	**306**	**1,268,377**	**1,082**	**396**	**9**

Table A-4 (page 3 of 3)
National Flood Insurance Program (NFIP) Data
(Municipalities Prioritized by Number of Claims)

Municipality	No. NFIP Claims (1978-97)	$ of NFIP Claims (1978-97)	No. NFIP Policies (1997)	No. A-Zone NFIP Policies (1997)	No. Repetitive Loss Properties
SCHUYLER COUNTY:					
T. Orange	16	28,543	5	1	2
V. Watkins Glen	12	52,768	12	6	0
V. Montour Falls	7	63,957	7	2	1
T. Hector	6	34,091	9	6	0
T. Reading	2	6,206	3	0	0
T. Tyrone	1	233	19	16	0
T. Cayuta	0	0	3	2	0
T. Dix	0	0	3	1	0
T. Montour	0	0	2	1	0
T. Catharine	0	0	1	0	0
V. Burdett	0	0	0	0	0
V. Odessa	0	0	0	0	0
Schuyler Co. Total	**44**	**185,798**	**64**	**35**	**3**
STC TOTAL	**561**	**2,510,298**	**2,286**	**938**	**16**

Source: Flood insurance data supplied by the Federal Emergency Management Agency on 4/17/97 for claims since 1978 and current policies.

Table A-5 (page 1 of 2)
Channel and Streambank Restoration Projects
in the Southern Tier Central Region

CHEMUNG COUNTY:

Chemung County Streambank Stabilization Program (County wide; costs shared by County and landowner), 1977 to 1994 -- $65,000/year

Chemung County 1/3-1/3-1/3 Stream Protection Program (about 50 projects throughout the County; costs shared by County, Municipality, and landowner), 1995 to 1997 -- $500,000

Old Chemung Canal Project (along Diven Creek and Old Chemung Canal in Town of Horseheads, Village of Horseheads, Village of Elmira Heights, Town of Elmira, and City of Elmira), 1997 -- $718,190

Post Creek Channel Maintenance, 1997 -- $2,500

Mudlick Creek Channel Restoration (Town of Southport), 1997 -- $26,880

Seeley Creek Tree Removal (Town of Southport), 1997 -- $86,720

NY State Department of Transportation Seeley Creek Project (in Town of Southport), 1997 -- $270,000

Cuthrie Run Channel Cleaning (Town of Big Flats), 1996 to 1997 -- $23,491

Owen Hollow Creek Channel Cleaning (Town of Big Flats), 1997 -- $6,225

Gardner Creek Channel Cleaning (Town of Big Flats), 1997 -- $265

Yawger Creek Channel Cleaning (Town of Big Flats), 1997 -- $4,798

Whirt's Creek Stabilization, Drop Structures, and Debris Basin (Town of Elmira), 1996 to 1997-- $72,000

Forest Hills Project (Clark's Glen Creek, Town of Elmira), 1996 to 1997 -- $170,000

Bentley Creek Channel Maintenance (Village of Wellsburg), 1974-1996 -- $380,000

Seeley Creek Project, Town of Ashland, 1997 -- $156,000

Jackson Creek Channel Maintenance (Town of Horseheads) -- $2,300

STEUBEN COUNTY:

Steuben County Streambank Stabilization Program (County wide, costs shared by County and landowner), ongoing program -- $57,000/year

Steuben County Emergency Streambank Program (County wide, costs shared by County and landowner), 1997 -- $139,000

Meads Creek Gravel Bar Removal (Town of Erwin), 1988 to 1996 -- $122,000

Meads Creek Channel Maintenance (Town of Erwin and Town of Campbell), 1996 -- $268,000

Town of Campbell Stream Work, 1996 to 1997 -- $50,000

Town of Corning Stream Work, 1997 -- $127,012

Town of Canisteo Stream Work, 1996 to 1997 -- $47,704

Table A-5 (page 2 of 2)
Channel and Streambank Restoration Projects
in the Southern Tier Central Region

SCHUYLER COUNTY:

Schuyler County Stream Maintenance Program, 1997 -- $150,000 (costs shared by County, Municipality, and landowner)

Catherine Creek Channel Restoration, 1997 -- $200,000

Sources: County and Municipal officials.

APPENDIX B

Structural Flood Control Projects and Flood Stage Forecast Mapping

Table B-1
Dam and Reservoir Projects
Protecting the Southern Tier Central Region

Name	Stream	Purposes	Drainage Area (Sq. Mi.)	Height (Feet)	Maximum Flood Control Storage (Acre Feet)
Existing Structures:					
Almond Reservoir	Canacadea Creek	Flood Control, Recreation,	56 90	14,640	
Arkport Reservoir	Canisteo River	Flood Control	30.5	113	7,950
Tioga-Hammond Project	Tioga River & Crooked Creek	Flood Control, Recreation, Water Supply	402	140 (T) 122 (H)	125,000
Cowanesque Reservoir	Cowanesque River	Flood Control, Recreation, Water Supply	298	151	89,000
Marsh Dam	Marsh Creek	Flood Control	3.5	46	364
Park Station Dam	Newtown Creek	Flood Control, Recreation	2.7	53	455
Hoffman Dam	Hoffman Creek	Flood Control	3.6	63	376
Sullivanville Dam	North Branch Newtown Creek	Flood Control, Recreation	18.1	71	2,465
Planned:					
Jackson Creek Dam	Jackson Creek	Flood Control	3.1	52	476

Sources: U.S. Army Corps of Engineers, Natural Resources Conservation Service.

Table B-2 (page 1 of 2)
Local Flood Protection Projects
in the Southern Tier Central Region

Location	Stream	Type of Project	Length (feet)
Addison	Canisteo River	Levee, Wall	3,800
	Tuscarora Creek	Levee	6,800
Avoca	Cohocton River	Levee	8,500
	Cohocton River	Channel Realignment	8,300
	Salmon Creek	Levee	4,500
Bath	Cohocton River	Levee, Wall	11,750
Canisteo	Canisteo River	Levee	8,000
`	Purdy & Bennetts Creeks	Levee	8,400
	Purdy Creek	Concrete Debris Dam	
	Bennetts Creek	2 Check Dams	
Corning Area	Chemung River, Cohocton River, Cutler Creek, Post Creek, Gorton Creek	Levee, Wall, Pumping Station	46,300
	Cutler Creek	Channel Realignment, Drop Structure, Weir	3,000
	Monkey Run	Flume	2,010
	Monkey Run	Pressure Conduit	2,320
Elmira Area	Chemung River	Levee, Wall, 2 Pumping Stations	40,200
	Chemung River	Interceptor Sewer	6,000
	Newtown Creek	Levee	10,000
	Diven Creek	Levee, Pump Station	4,300
	Hoffman Brook	Concrete Conduit	2,000
	Seeley Creek	Levee	14,300
Gang Mills	Tioga River	Levee	16,300
	Beartown Creek	Channel Diversion	8,200
	Beartown Creek	Levee	7,200

Table B-2 (page 2 of 2)
Local Flood Protection Projects
in the Southern Tier Central Region

Location	Stream	Type of Project	Length (feet)
Hammondsport			
	Glen Brook	Concrete Flume	800
Hornell & North Hornell	Canisteo River, Canacadea Creek, Crosby Creek, Chauncey Run	Levee, Wall, 4 Drop Structures, 4 Weirs	59,000
	Canisteo River	Channel Realignment	19,600
	Canacadea Creek, Crosby Creek, Chauncey Run	Channel Paving	10,550
	Canacadea Creek	Check Dam	
	Crosby Creek	Check Dam	
	Chauncey Run	3 Check Dams	
Montour Falls	Catherine Creek	Diversion Channel	9,970
	Catherine Creek	Levee	7,000
	Shequaga Creek	Conduit	560
	Shequaga Creek	Levee	1,600
Painted Post	Chemung River, Cohocton River, Hodgmans Creek	Levee, Wall	8,700
	Chemung River, Cohocton River, Hodgmans Creek	Channel Realignment	6,000
Watkins Glen	Seneca Lake	Offshore Sea Walls	
	Glen Creek	Retaining Wall	

Sources: US Army Corps of Engineers; Addendum to Comprehensive Water Resources Plan for the Chemung River Basin, Chemung River Basin Regional Water Resources Planning Board, December 1977; Flood Insurance Studies for the Villages of Watkins Glen, Montour Falls, and Hammondsport, prepared by Federal Emergency Management Agency.

Table B-3
Flood Stage Forecast Maps
for the Southern Tier Central Region

Steuben County:

Addison Reach, Canisteo River (includes Village of Addison and Town of Addison)
Addison Reach, Tuscarora Creek (includes Village of Addison and Town of Addison)
Town of Bath, Cohocton River
Town of Campbell, Cohocton River
Coopers Plains Area, Town of Erwin, Cohocton River
Town of Corning, Chemung River (includes Village of South Corning)

Chemung County:

Town of Big Flats, Chemung River
Chemung River Near Elmira (includes Town of Elmira, Town of Southport, City of Elmira, Town of Ashland, and Village of Wellsburg)
Newtown Creek (includes City of Elmira, Town of Elmira, Village of Elmira Heights, Town of Horseheads, and Village of Horseheads)

Schuyler County:

none