Surface Water

WEXFORD County is divided between two major drainage areas –watersheds: the Big Manistee River and the Muskegon River (Clam River/Lakes Cadillac/Mitchell). Both flow into Lake Michigan. The Manistee River watershead can be further divided into 60 smaller drainage areas. Among them, some of the major ones include: Pine River, (including Poplar Creek and North Branch Pine River/Fairchild[107]/Spalding Creeks), Slagle Creek, Fletcher Creek, Wheeler Creek (Lake Gitchegumee), Anderson Creek, Silver Creek, Manton Creek, and Fife Lake Outlet. Also there is a large number of named and unnamed feeder creeks to the Big Manistee River in the north central part of Wexford County representing artesian flows from groundwater moving north from the glacial hills toward the river. A map prepared using GIS, on page 136, shows the estimated divides between watersheds in the county.

Watersheds are the areas around a creek, river or lake which drain into that creek, river or lake. Thus any water which does not evaporate or soak into the ground flows downhill to a particular body of water.

The major river systems in the county are shown on a map on page 137. As can be seen by the surface water map and generalized watersheds map, the bulk of the county is within the watershed of the Big Manistee River/Pine River. These two areas provide drainage for most of the southern, central, west and north parts of the county. The Cadillac urban area is within the Clam River/Muskegon River which includes the east central and east-south part of the county.

The Big Manistee River is a federal Wild and Scenic River, administered by the U.S. Forest Service downstream from Wexford County, in Manistee County. Also the Pine River in Wexford County is a federal Wild and Scenic River. The Big Manistee River is also under study by the DNR for designation as a state Natural River. The area under consideration includes all of the river in Wexford County and an unknown number of tributaries.

The bulk of the land along the Pine River is owned and managed by the United States Forest Service. The bulk of the land along the Big Manistee is owned by the State of Michigan (and managed by the Forestry Division of the Michigan Department of Natural Resources) and Consumers Energy Company (formerly Consumers Power). With such designation, plus all the additional attributes associated with the Big Manistee River and Pine River valleys, the resource deserves particular attention.

[107]Fairchild Creek is formerly known as Negro Creek.

Major wetlands in Wexford County include:

- Hinton-Arquilla Creeks headwaters;:
- headwaters to westerly unnamed feeder creeks to Fletcher Creek;
- a network of wetlands which are headwaters to Silver Creek and feeders, Buttermilk Creek feeders, and to the west of Manton Creek;:
- the bayous and valley associated with the Big Manistee and Pine Rivers;:
- headwaters of Fairchild Creek and feeders/Poplar Creek;:
- Brandy Brook (a.k.a. Thousand Acre Swamp); and:
- Heritage-Cadillac Nature Study Area.

A map on page 138 illustrates those areas of the county considered wetlands. Compared to other counties, Wexford does not have a large acreage of lands classified as wetlands. Wexford County land area is 2.017% of the entire county.

There are wetlands in the county which should receive special attention. They include:

1. Brandy Brook;
2. Heritage-Cadillac Nature Study Area;
3. the bayous and valley associated with the Big Manistee and Pine Rivers; and
4. the network of wetlands which are headwaters to Silver Creek and feeders, Buttermilk Creek feeders, and to the west of Manton Creek.

Major Lakes in Wexford include:

- Lake Mitchell,
- Lake Cadillac,
- Hodenpyl Dam Pond,
- Long Lake,
- Lake Gitchegume,
- Billings [dam] Pond,
- Pleasant Lake,
- Stone Ledge Lake,
- Meauwataka Lake,
- Berry Lake,
- Woodward Lake, and
- Round Lake.

These are mostly shallow lakes, where the lake bottom represents locations where the surface of the ground is lower than the groundwater table. Thus all these lakes are spring feed with groundwater.

Along with the discussion of surface water, several areas of Wexford County – mainly along the Clam River –are classified as flood prone or flood hazard areas. The classification exists for townships which have passed resolutions to participate in the National Flood Insurance Program created by the U.S. Congress. A map of these areas is on page 143.

All the streams in Wexford County are quality trout streams because of abundant groundwater discharge into the surface water resulting in cold water streams. With this situation it is very important – from a fisheries perspective – to protect groundwater and stream edges. Especially vulnerable is the Clam River due to warm water from Lakes Cadillac and Mitchell, warm water discharges from industries, city wastewater treatment plant, and storm drains. A multi-disciplinary team with the Michigan Department of Natural Resources have developed a *Riparian Zone Management Guidelines* for land use along stream edges. These guidelines are recommendations for land management along streams which are applicable for the rivers in Wexford.

A listing of major rivers (name of the river with location of mouth, or exit from Wexford County located by township and section number) follows. A complete inventory (including the missing numbering below) of surface water in the county is in Appendix C4, page 373. Also available from the Northwest Michigan Council of Governments, Traverse City, are water quality data and "201" water planning information.

Great Lakes watershed

Lakes Michigan and **Huron** watershed

I. **Manistee River** (sec 30, Springville Twp) at Hodenpyl Dam
   - A. **Pine River**[108] (formerly the South Branch of the Manistee River) (sec. 19, South Branch Twp)
     - 3. **Poplar Creek** (sec. 35, South Branch Twp)
     - 4. **North Branch Pine River** (sec. 36, Cherry Grove Twp)
   - B. **Peterson Creek** (sec. 31, Slagle Twp)
   - H. **Slagle Creek** (sec. 6, Slagle Twp)
   - R. **Fletcher Creek** (sec. 10, Springville Twp)
   - Z. **Wheeler Creek** (sec. 36, Wexford Twp)
     - 1. **East Branch** (sec. 19, Hanover Twp)
       - a. **Lake Gitchegumee** (backwater on East Branch) (sec. 8, Hanover Twp)
   - AA. **Cole Creek** (sec. 32, Hanover Twp)
   - AG. **Adams Creek** (sec. 27, Hanover Twp)
   - AJ. **Soper Creek** (sec. 24, Hanover Twp)
   - AS. **Silver Creek** (sec. 9, Greenwood Twp)
   - AT. **Buttermilk Creek** (sec. 11, Greenwood Twp)
   - BA. **Manton Creek** (sec. 8, Liberty Twp) (part, in sec 3 & 10, Cedar Creek Twp, is **Manton Creek County Drain**)
   - BF. **Fife Lake Outlet** (sec. 10, Liberty Twp)
   - BG. **Chase Creek** (sec. 14, Liberty Twp)
   - BH. **Golden Creek** (sec. 13, Liberty Twp)
     - 2. **Morrisy Creek** (sec. 24, Liberty Twp.)
       - a. **Golden Creek** (sec. 24, Liberty Twp)

II *Muskegon River (not in Wexford County)*
   - A. **Clam River** (parts channelized) (sec. 24, Haring Twp)
     - 7. **Lake Cadillac**
       - d. **Channel/Lake Mitchell** (sec. 6, Cadillac City/Clam Lake Twp)

III. Eleven with their own basin (drys up, re-enters groundwater, ends in pond without an outlet)

Surface water is susceptible to pollution from a variety of sources. Pollution in surface water can result in increased weed and algae growth, premature aging of inland lakes, and lower water quality. People choose to vacation and live on inland lakes due to the water quality. Studies have shown there is a direct link between water quality and economic health (property value, attractiveness to tourists and new business owners) to an area.[109]

Causes of surface water pollution often come from single family home land uses – not just commercial and industrial land uses. Increased chances of surface water pollution are:

- Steeper slopes toward the surface water,
- Clay soils, preventing infiltration of water before entering the surface water,
- Impervious surfaces near the water (sidewalks, decks, driveway, clay soils, roof, etc.),
- Fertility of soils,
- Existence of point sources of pollution (malfunctioning septic drain fields, pesticide/fertilizer storage losses, leaking fuel tanks.
- Existence of point sources of pollution from functioning on-site septic systems (Traditional septic tank/drain field design may remove bacteria, but only a fair job removing nutrients and an even poorer job removing other contaminants. This is usually not an issue with a septic tank/drain field per 80 acres, but can be a major source of pollution in high density situations or when located near a lake or river).

[108]The Pine River from the confluence of the east and north branch to the Tippy Dam Pond is a designated Blue Ribbon Trout Stream. It is also a national recreation river in the Federal Wild and Scenic Rivers program..

[109]*Value of Inland Lakes to the Local Economy, The*; Northwest Michigan Regional Planning and Development Commission; January 1981.

Classic recommendations, for areas of predominantly sandy soils, to prevent pollution to surface water are:[110] [111]

- Make a 5-10 foot buffer strip adjacent to surface water in which minimal or no fertilizer is applied.
- Use zero phosphorus fertilizer, unless a soil test indicates a need for phosphorus.
- Use less than 1 to 4 pounds of nitrogen fertilizer per 1,000 square feet in a year (no more than 1 pound of nitrogen fertilizer per 1,000 square feet at a time). It is even better to use a slow release form of nitrogen fertilizer.
- Do not apply fertilizer in spring until three weeks after the lawn has greened up.
- Mow grass to 3 inches high, or higher. Return clippings to the lawn.
- A minimum parcel size should be 15,000 square feet for three bedroom single family homes (where no public water and sewer available), and a minimum parcel size of 12,000 square feet when both public water and sewer are available. (This would be considerably larger in areas of special concern, such as pristine rivers, fish habitat, or special and unique areas/environments.)
- On water front parcels the parcel width should be a minimum of 100 feet wide throughout. (This would be considerably larger in areas of special concern, such as pristine rivers, fish habitat, or special and unique areas/environments.)
- Minimum set-backs from surface water should be 50 feet for buildings and 100 feet for nutrient sources such as drain fields,[112] highly fertilized area, manure storage. This prevents erosion, nutrient removal (from lawns, roofs, driveways, drain field, etc.) before the material reaches the water. (This would be considerably larger in areas of special concern, such as pristine rivers, fish habitat, or special and unique areas/environments.)
- A minimum vegetation belt of 20 feet in width with natural woody vegetation or woody vegetation planted which is similar to that specified by *Greenbelts: A Circle of Protection for Inland Lakes*.[113] This does not mean no trees can be cut. Trimming for a filtered view is appropriate. But larger trees provide root systems important for nutrient removal and soil stabilization, and shade for retaining low stream water temperatures needed for fish habitat. (This would be considerably larger in areas of special concern, such as pristine rivers, fish habitat, or special and unique areas/environments.)
- Do not allow use of dry wells.
- Soil absorption system (drain field) size should be based on the following formula for a simplistic illustrative purposes. (It does not include the necessary variation for all soil types. This formula is for sandy soils):

  (150 gallons per day × number of bedrooms) ÷ (0.50 gpd/sq.ft.) = sq. ft. drain field size

  or

  (150 gallons per day × number of bedrooms) ÷ (0.75 gpd/sq.ft.) = sq. ft. drain field size

  Thus a three bedroom home would be:

  (150 gallons per day × 3 bedrooms) ÷ (0.50 gpd/sq.ft.) = 900 sq. ft. drain field size.
- Septic tanks should be pumped every one to five years and the scum and sludge depth should be measured once a year.

There is a predominance of research which documents the importance and need for setbacks from surface water and maintenance of vegetation along water edges. While most studies focus on impacts of forest removal for logging, many of the findings also apply to forest removal for purposes of home construction and creation of a yard around the home. They are summarized here:

- Vegetation corridors of at least 100 meters (325 feet) should be considered to provide habitat for neotropical migrant birds. A mean corridor width at which probability of occurrence of neotropical migrant birds is 0.5 its maximum is 76 meters (247 feet). Nest predation and brood parasitism are more frequent along forest edges. Riparian forest greater than 100 meters (325 feet) wide dominated by short-distance migrants; increase quickly to 200 meters, less quickly after that.[114]
- An "impoverished" bird community can exist with a greater than 10 meter (32.5 feet) wide zone. Species sensitive to disturbance need at least a 25 meter (81.25 feet)-wide undisturbed corridor. Thinning to 10 trees per acres resulted in a 46% reduction in breeding birds. Naturally vegetated 125 meter (406 feet)-wide corridor are needed to support a full complement of

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[110] Lyman, G. T. and Rieke, P. E.; *Maintaining Water-Front Turf*; Turf Maintenance Tips To Preserve Water Quality; Michigan State University Extension; April 1999.

[111] Lush, Dr. David P. (Michigan State University Institute for Water Research); letter on comments on sanitary code in sandy soil counties as part of Manistee's ground and surface water protection program.; May 23, 1995.

[112] Setback distances for the traditional design septic tank/drain field really only impacts the amount of time before non-bacteria and non-nutrient contaminant reach the surface water. The additional setback may help with nutrient removal (e.g. woody vegetation uses the nutrients) but will have little impact on other contaminants. David Gregg, District Health Department #10 Registered Sanitarian advocates use of performance standards (not design standards) to protect water quality.

[113] Secrest, Marian and Nagel, Jan; *Greenbelts: A Circle of Protection for Inland Lakes*; Lakeland Report Number 12, University of Michigan Biological Station.

[114] Keller, C.M.E., C.S. Robbins, and J.S. Hatfield (USFS); "Avian Communities in Riparian Forests of Different Widths in Maryland and Delaware;" *Wetlands*; 1993; Vol. 13, No. 2; pages 137-144.

bird communities.[115]

- Canopy density is the most important factor in assuring proper control of stream temperatures (cold temperatures being important for fish). A 100 to 200 foot buffer will ensure protection, but may include more timber than necessary. An 80 foot buffer resulted in maximum canopy density, with 90% density at 55 feet. Protection is not necessarily related to commercial timber volume. Many non-commercial species provide excellent shade. A few large trees with great commercial volume may not provide much shade.[116]
- Streams with bufferstrips greater than 30 meters (97.5 feet) wide did not display logging impacts. Streams with buffers less than 30 meters (97.5 feet) wide showed effects comparable to streams without buffers. Streams logged without bufferstrips and those logged with inadequate buffers showed greater invertebrate density but lower diversity (some species were eliminated, a few increase numbers and dominate) in all cases. Clearcuts result in energy changes (amount and type from regrowth of different type of vegetation), temperature changes and habitat changes (more sediment, etc.). Wide buffers prevent stream disturbance from bank slippage, equipment and off road vehicle (ORV) crossings, etc. There is less stream channel stability in streams without buffers. Failed road crossings significantly affect invertebrate populations.[117]
- There is significant increase in stream discharge following timber harvesting, particularly clear cutting. Accelerated decomposition and leaching of nutrients, increased erosion rates and diluted important ions such as potassium (K), calcium (Ca), magnesium (Mg) and nitrogen oxide (NO_3-N).[118]
- Lack of vegetation strips has a major impact on some fish species resulting from invertebrate diversity being reduced which changes in diet of the fish, and may influence parasite selection. Also results in increased sediment loads, although most of this comes from skid sites, road crossings, etc. Also results in decreased dissolved oxygen levels in some cases due to increased temperatures and other factors. And results in increased aquatic vegetation growth.[119]

In addition the Michigan Department of Natural Resources have developed "best management practices" for timber harvest activity along streams.

Lakes Cadillac and Mitchell

Lakes Cadillac and Mitchell water levels are controlled as a result of a September 1967 Circuit Court order. The lake is set at a minimum summer water level of 1,289.7 feet above sea level and a maximum summer level of 1,290. In winter the water level must be brought down to 1,288.9 feet above sea level by December 15, of each year. The winter low is to prepare for the spring snow-melt runoff. Judge William R. Peterson's lake level order left room for fluctuation to take into account that precipitation and snow melt may exceed the ability to control the water level.

The lake levels are controlled by the Wexford County Drain Commissioner at the Clam Lake River inlet (Lake Cadillac outlet) dam just north of Chestnut Street in Cadillac. The dam, when in the full open position, is able to lower the lake level about one-hundredth (0.01) of a foot a day which does not have any rain fall.

Groundwater

SURFACE and ground water are directly linked in Wexford County. Protection of both has become an issue of concern in Michigan. In 1992 Michigan State University Department of Geography produced a map of the state assessing the vulnerability of groundwater to be contaminated by activities (spills, leaks) occurring on the surface (see page 139, 140). From this Michigan could be divided into three general situations: rural areas with sandy (high vulnerable soils) (Wexford County is in this category), rural areas which are less vulnerable (loam and clay soils predominate), and urban areas.

The Michigan Society of Planning Officials (MSPO) received funding from the Kellogg Foundation as part of its Groundwater Education in Michigan (GEM) to select pilot counties in each of the three situations. The task of the pilot counties was to work with MSPO to develop model programs for protection of groundwater.

Manistee County was selected as the pilot county for sandy – high vulnerable – rural areas of Michigan. The project in Manistee included a major study of the county's groundwater system, using a computerized system of well logs. This made possible an in depth analysis of Manistee

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[115]Croonquiest, Mary Jo, and R.P. Brooks; "Effects of Habitat Disturbance on Bird Communities in Riparian Corridors [central Pennsylvania];" *Journal of Soil and Water Conservation*; 1993 48(1); page 65-70.

[116]Brazier, Jon R. and G.W. Brown; "Buffer Strips for Stream Temperature Control;" *Research Paper 15* and *Paper 865*; Forest Research Laboratory, School of Forestry, Oregon State University; 1973; Corvallis, Oregon.

[117]Erman, Don C., J.D. Newbold, and K.B. Roby; "Evaluation of Streamside Bufferstrips for Protecting Aquatic Organisms;" *Water Resources Center Contribution #165*; Department of Forestry and Conservation, University of California, Berkeley; 1977.

[118]Lynch, James A., and E.S. Corbett (Penn State University); "Effectiveness of Best Management Practices in Controlling Nonpoint Source Pollution from Commercial Clearcuts;" *Nonpoint Pollution - Tools and Techniques for the Future*; Interstate Commission on the Potomac River Basin; 1981; pages 213-224.

[119]Graynoth, E.; "Effects of Logging on Stream Environments and Faunas in Nelson;" *New Zealand Journal of Marine and Freshwater Research*; 1979; 13(1); page 79-109.

County groundwater; direction of flow, depth, various amounts of natural protection and different aquifers. Basically the findings are very little to no natural protection exists, the entire county is one aquifer, and ground and surface water is all interconnected.

A written report on Manistee's effort is *Manistee County Site Plan Review and Groundwater Protection* report[120] which details the recommendations summarized here. The material is presented here with the assumption conditions found in Manistee County would be essentially the same in Wexford County. Some may argue that data from existing well logs may not be reliable enough to make anything but general conclusions. Also, while findings suggest there is not a confining layer to separate groundwater into different aquifers, that can be considered an issue of scale. For example how large does a confining layer have to be before it is considered to be separating groundwater into different aquifers?

"The whole area is a sieve" is an accurate summary of much of Doctor David P. Lusch's findings for Manistee County and most of northern Michigan.. Dr. Lusch of Michigan State University Institute of Water Research and Center for Remote Sensing, provided the geological research on Manistee County for this project. Much of what is applicable to Manistee, is also expected to be the case next door in Wexford County.

Dr. Lusch spent several months reviewing geological data on Manistee County. From soil information Dr. Lusch was able to analyze the top 1½ meters of the ground. A digital soil map was reclassified according to soil permeability. Soil permeability is a measure of how fast a spill will soak in from the surface and seep into groundwater. Soil permeability was broken into five classifications (1) very rapid (most danger for contamination of groundwater), (2) rapid, (3) moderate, (4) slow, (5) very slow (least permeable, least danger for contamination). Most of northern Michigan is expected to be in the very rapid and rapid categories. That means most of the county has a high potential for contamination from activities involving hazardous materials which take place on the surface of the ground.

The area around Manton falls into the "moderate" category. These areas tended to be where heavier soils (clay or loam) exists.

Other areas of the county, in the category of "slow" and "very slow" permeability tend to occur where wetlands exist. That is to say, where the soil is not permeable there is standing water on or near the soil surface.

The point is, most of northern Michigan has a much higher permeability than one wants to see for groundwater protection. The exceptions are either wetlands, or are small areas scattered around the country.

Next Dr. Lusch analyzed the geology from 1½ meters to 11 meters (35 feet) deep. To do this analysis water well logs filed with the Manistee-Mason District Health Department and Geological Survey Division of the Department of Environmental Quality (DEQ) were used. When a well driller puts in water well, he records what was drilled through (well lithology). The well driller is providing estimates in many cases, but it still represents the best information available.

It is possible to look deeper than 35 feet. However there are a number of reasons for only analyzing to a depth of 35 feet:

1. A spill, chemical application, or leaking tank which could result in groundwater contamination will occur near the surface. If humans lose control (in terms of preventing the spill, or attempting to clean it up) that will happen in the top 35 feet. Once a problem is below 35 feet deep, far fewer management options exist to deal with the problem.
2. A properly installed water well should be at least about 30 feet deep or deeper (the minimum depth of a well permitted by law). A properly constructed well has at least a minimum 25 foot casing, and a 3-5 foot screen. Thus, most people should be drawing their water from 30 or more feet down. (In Manistee County only 1% to 2% of the wells in the GIS database were less than 35 feet deep.)

Dr. Lusch analyzed the top 35 feet to find where a clay layer exists, and how thick the clay layer is. This information for each well was then combined with the soil information, explained above.

Data for each well location is plotted on the map, using five classes (1 to 5). The extremely vulnerable wells (1) encountered no clay in the lithology paired with rapidly permeable soils at the surface. The least vulnerable wells (5) penetrated more than 5 feet of clay and occurred in slowly permeable soil areas. Classes 2, 3 and 4 represent progressively better protection based on various combinations of surface permeability and thickness of clay reported in well lithology.

Throughout Manistee County – and thus expected for most of northern Michigan – most wells were categorized as 1 or 2, extremely vulnerable, or vulnerable. There were not many categorized as 4 or 5 (least vulnerable).

Dr. Lusch explained where less vulnerable wells were found, they were nearly always very close to other wells where no clay was detected. This means that even where a clay layer does exist in the upper 35 feet, it does not extend very far.

"There are lots of windows in our protective layers and they are wide open," Dr. Lusch said. "So we have lots of holes in our protection," he said, and not much protection to begin with.

The third step was to in more detail at selected areas. Detailed maps of these areas were prepared to look for locations where clay layers which are 10 feet, or thicker, exists at any depth.

Ten feet of clay was used because it is the minimum

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[120]Schindler, Kurt H.; *Manistee County Site Plan Review and Groundwater Protection; A Training Manual for Zoning Administrators*; Manistee County Planning Commission; May 2, 1995; $22.

thickness required by the Public Health Department for purposes of assuming there is groundwater protection. Also the 10-foot thickness is what was required by the DNR for 'natural sites' for landfills. (The "natural" landfill site is no longer allowed by the DEQ. All landfills must have a liner system.). The idea here, is to attempt to find how deep (down to 125 feet deep) a well must go to reach a less-vulnerable groundwater source.

"Each step of this process does not improve the picture" Dr. Lusch said. A majority of the wells had no clay at any depth (not all wells were drilled to 125 feet deep). A few wells had lithology which encountered 10+ feet of clay. But again there are wells right next to them where no clay exists. This indicates holes exist in what little protection there is even at greater depths.

Dr. Lusch explained even if one finds clay, that does not protect groundwater. It only makes it less vulnerable to contamination, e.g. slows down the speed of the contaminants travel. Clay is not continuous, and clay underground is not solid. The clay is cracked, forming pathways for liquid to travel through it.

A ground surface contour map can also be used to generalize the direction of groundwater flow.

Groundwater will flow from the high elevations on the groundwater contour map toward the low elevations on the groundwater contour map. One can assume the direction of groundwater flow will be at right angles to the groundwater contour lines. Work in Manistee County included a comparison of the ground surface contours with computer-generated groundwater table surface contours made from static water levels from well logs. Study in Manistee County supported the general rule that flow of groundwater moves "downhill" relative to the ground's surface. However there were enough exceptions to this "rule of thumb" that it can not be relyed on. For example in the Lake Cadillac area groundwater flow is northwesterly -- opposite the slope of the surface..

All of the above deals with groundwater movement horizontally or from side to side. It is also important to recognize groundwater moves up and down. Dr. Lusch explained that he examined those water wells in the totally unconfined aquifer. The purpose was to eliminate any wells with confining layers which may distort the water level found in that particular wells. The computer is then used to analyze these wells to look at the static water elevation in each well relative, or compared to, other wells. This analysis was used to identify where groundwater is moving upward or downward.

Groundwater moves through soil much like a weather front moves through the atmosphere. The major influence on upward or downward movement of groundwater are high and low pressure areas. When groundwater is moving upward, it is moving away from a high pressure source lower in the glacial drift, toward a lower pressure higher in the glacial drift. Areas where groundwater moves upward far enough can often be observed at the surface in the form of springs or artesian wells.

Upward moving or downward moving groundwater should not be confused with groundwater discharge or groundwater recharge areas. "All of Manistee County (and northern Michigan) is a recharge area," Dr. Lusch said. Because of the predominance of porous soils, nearly the entire area can be considered to be a groundwater recharge area. A groundwater recharge area is where precipitation and other liquids deposited on the ground are expected to move into the groundwater and replenish the groundwater.

The analysis of groundwater pressure gradients indicates what happens to the infiltrating water after it has moved to the groundwater. In an area of the county where there is an upward movement of groundwater, infiltration inputs would not flow downward (deeper into the aquifer), but rather would stay at the surface of the groundwater table. In areas of the county where there is downward moving groundwater, a liquid that reaches the groundwater surface would be expected to move down to a greater depth before moving laterally.

Dr. Lusch emphasized all of the groundwater in glacial sandy soils areas of Michigan is interconnected. There are not separate aquifers. In some areas, the groundwater is moving sideways, and in other areas of the county the groundwater is moving downward or upward so that all of the water eventually intermingles. All of this part of Michigan is a groundwater recharge area. That means what lands on the surface of the ground and soaks in, gets in the groundwater.

"The upshot of all of this is there is no place to do stupid things to the environment," Dr. Lusch said.

If one is willing to accept the assumption that Manistee and Wexford's geology is essentially the same, then results from work done in Manistee would be equally applicable in Wexford County. Thus the same concerns and same steps should be pursued in Wexford.

That means groundwater protection should be done on a county-wide basis when sandy soil predominates. This means groundwater protection regulations should be adopted everywhere, as well as a county-wide education program. In addition municipal water supplies should have an even greater level of protection; a community wellhead protection program.

Areas around water wells which provide public drinking water (Type I wells) should receive an additional amount of protection.

The Manistee pilot project resulted in two major recommendations:

1. County-wide site plan review for groundwater protection,
2. Development of a wellhead protection program for public water supplies.

The first recommendation is the county-wide ('wall-to-wall') groundwater protection/prevention measures in local zoning site plan review techniques. In Wexford County that would require significant amendments to every single zoning

ordinance. The work done in Manistee includes a sample, or model, zoning amendment for this purpose. The Manistee program was not intended to prevent all sources of groundwater contamination. It is intended to use low-cost preventative design in new construction to significantly reduce the chance of groundwater contamination from accidental spills in the first place (prevention). The sample zoning and site plan review was developed by Mark A. Wyckoff, Planning and Zoning Center, and Lillian Dean, groundwater protection consultant, and Kurt H. Schindler, Manistee County Planner (now a land use and community development specialist with Michigan State University Extension).

A key to the Manistee effort is that no additional permits are required. The process is rolled into the existing zoning administration system to avoid any additional 'red tape.' Extra work, if any, is to be done by local government in its site plan review process before issuing a zoning permit.

Major components of the sample zoning/site plan review are:

(1) require the zoning permit application and site plan to be submitted **after** all other environmental permits have been issued or an agreement to concurrently issue those permits is obtained. This also means the zoning permit application and site plan submitted will already show whatever requirements are necessary to comply with those environmental permits. This will help ensure what zoning requires and does not contradict what other agencies require.

(2) For a proposed land use which uses or generates over a given volume of hazardous materials the site plan will also show the areas where storing, using, loading hazardous substances will occur; location of underground and above ground storage tanks, drains, dry wells, storm water management areas; location of water wells; submission of "hazardous substances reporting form;" and submission of "state/county environmental permits checklist."

(3) The design shown on a site for a proposed land use which uses or generates over a given volume of hazardous materials will be subject to additional approval standards, such as storm water management; drainage; storm drain design; primary and secondary containment for storage of hazardous materials.

Also a county technical committee was formed for the purpose of assisting municipalities, zoning administrators, and new businesses to prevent spills and extremely expensive cleanup costs.

Finally a major education program was initiated (county-wide newsletters and mailings) as well as speaking at various civic groups and municipalities.

The second major recommendation is for municipalities which operate publicly owned Type I water well(s) (e.g. wells for public water systems) to start the process of developing a wellhead protection program. In Wexford County that would include the Cities of Cadillac and Manton, Haring Charter Township, Villages of Buckley and Mesick. Of the five, only Cadillac has started this process. The area to be protected around Type I wells must be determined by doing a detailed hydrogeological study. This study is to determine the area where contamination would come into the public water well within ten years. The study is important; so stricter protection does not exist outside of where that well might receive contaminants. A cost effective way to accomplish this is for several municipalities to work together and jointly hire the same consulting firm to define the area around public water wells from which surface contamination flows into the well water within a 10 year period --wellhead delineation.

The wellhead protection program is to prevent contamination of public water supplies. Once the wellhead delineation is done, increased monitoring, specific water testing, zoning and other measures can be targeted to those areas to protect well water. The program in Michigan is a voluntary part of a national wellhead protection effort.

If the delineation around a publicly owned Type I well is done, then, the municipality will be asked to amend its zoning ordinance to include an overlay zone around those Type I wells. The purpose of the overlay zone is to create a series of concentric areas around the well with varying degrees of stricter groundwater protection. Within this overlay zone, land uses which pose a significant risk to groundwater would either be prohibited or subject to an ongoing groundwater protection program with follow-up inspections. Sample, or model, zoning for wellhead protection was also developed with Manistee's work by Wyckoff, Dean, and Schindler.

The stricter protection around publicly owned Type I water wells may save a municipality money in the long run. The Federal Environmental Protection Agency may require an increasingly long, expensive and continual water testing program for Type I wells. If a wellhead protection program is in place around a public water well system, the EPA's required water testing program may be reduced. This can be a long term cost savings for a municipality operating a public water system.

This type of wellhead protection zoning should not be used unless a hydrogeological study has been conducted to determine the size and shape of the area around a Type I well to be protected. Use of arbitrary circles around a well for this purpose is not recommended, and will not be acceptable for purposes of approval by the Michigan Wellhead Protection Program. There are costs and possible benefits for providing wellhead protection. The costs and benefits will be different for each municipality. Thus it is recommended each municipality obtain actual costs and decide based on what is best for that municipality. The pros (+) and cons (-) are:

+ The program's biggest value is that it takes steps to protect our groundwater, which nearly everyone in rural northern Michigan depends on for drinking, washing, irrigation and so on. This is a prevention program, to

avoid pollution before it happens.

- A hydrogeological study will be needed. Estimates to do such a study range from $10,000 to $40,000 per well (or well field), depending on how much background work is already done. A municipality should determine how much this will actually cost. One public sector source for this is through Dr. Barcelona of Western Michigan University.
+ If the wellhead protection program can be effective the municipality can save money in quarterly water quality testing. Soon-to-maybe-be-required federal Environmental Protection Agency phase II and V water testing is estimated to cost between $10,000 to $12,000 per well per year. Protecting an area around a well, to show certain contaminants are not likely to exist, can reduce these costs.
- There is a risk in conducting the hydrogeological study. It may find a groundwater contamination problem which was not known, thereby increasing costs to monitor or correct. It may show that there are already land uses in the area which should be protected which are high risk, in terms of causing contamination. Thus costs of testing will not be reduced.
+ The municipality may find out before it is a real problem, and is able to take steps to correct it (new well, design changes, etc.) before it is a health/safety problem. There is a social responsibility to provide clean drinking water.
- The wellhead protection zone is more regulation and a more complex zoning ordinance to administer.

Cadillac Area [121] [122] [123]

The City of Cadillac used Lake Cadillac as a source of water from 1800's-1960. In 1958 Michigan Department of Public Health ordered Cadillac to find an alternative water supply. A new wellfield was developed in 1960, on a 23 acre site owned by the City. The Cadillac City wellfield is located in the city's first industrial park. At the time the location was considered an excellent location for purposes of servicing the city's largest water users near the water wells. Wellfield exploration produced 3 aquifers, identified as shallow, intermediate, and deep. At that time the city's consultant recommended deep wells for city supply due to abundant water availability and quality. Thus seven wells were drilled and finished between 300 and 350 feet deep. Two wells produce 700 gallons per minute (gpm) and four wells produce at 1,400 gpm..

However, because the wellfield is in the industrial park, it is also in the vicinity of several groundwater contamination plumes. First is the Northernaire Site with zinc, chrome and cadmium plater contaminants. Northernaire also had a history of sewer use violations. Now, the sewer is plugged and the facility is closed. Another problem was then found with contamination from Kysor, Inc. The Kysor and Northernaire contamination are considered one plume. In this plume, the groundwater contaminates include Chromium and Hexavalent Chromium; 1,1,1 - Trichloroethane; 1,2 - Dichloroethane; Trichloroethene; Tetrachloroethane; and Toluene.

The second plume came to be known later. It was associated with Rexair with high concentraions of organic contaminants. These contaminates flowed toward the city wellfield. After a Michigan Department of Natural Resources (now Department of Environmental Quality) consent order, Rexair began their own cleanup.

City water well number 7 had TCE contamination detected in 1994. The city has stopped using well number 7.

The United States Environmental Protection Agency (EPA) designated two Superfund Sites in the Cadillac Industrial Park: (1) Northernaire Platers, and (2) Greater Cadillac Area Groundwater Contamination. The Department of Natural Resources and EPA used an enforcement and clean up method which starts by identifying "Potential Responsible Parties" (PRP). The EPA and DNR identifies the parties and proceeds to sue each in attempt to accomplish cleanup. The EPA identified: Northernaire; Kysor; Ingraham Property; Four Star Corporation; Four Winns; Mitchell Corporation; Paulstra CRC; and orphan sites (sites where no apparent responsible party exists because the company no longer exists or can not be found). The Potential Responsible Parties in turn would cross claim others.

This approach resulted in a long list of various legal battles, which were likely to take years to resolve. For some there was no end in sight for the legal battles. With this legal entanglement, and that fact that contamination developed into multiple plumes making pinpointing actual responsible parties virtually impossible.

An alternative approach was when Cadillac City and other private parties joined forces to develop an area wide soil-groundwater remediation facility. This was done by creation of a Local Development District for capture of tax dollars for the clean-up – Local Development Finance Authority (LDFA). The approach reduced liability and encouraged existing companies to maintain and expand at their current locations, as well as providing for new businesses to locate in the Cadillac Industrial Park without liability from unresolved contamination issues. The comprehensive approach also provides for economies of scale, with a presumably lower per unit cost than if individual treatment plants were constructed by each affected property owner.

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[121] Campbell, Larry; *Cadillac's Groundwater Cleanup Project* PowerPoint™ Presentation; City of Cadillac Utilities Department; April 27, 2000.

[122] Schindler, Kurt H.; interviews with Pete Stalker, Cadillac City Manager; Steve Cunningham, Department of Environmental Quality; spring/summer 1999.

[123] Campbell, Larry; *LDFA Award Narrative*; City of Cadillac Utilities Department; April 27, 2000.

The Finance Authority was created by the City of Cadillac through Michigan Public Act 281 of 1986, as amended. This district works similar to a downtown development authority, where increased taxes collected from new construction and additions (not inflation) are captured for use by the Finance Authority. The captured taxes would be used for construction of the area wide groundwater cleanup plant. Thus, for the LDFA to work, a large new industry was needed in the industrial park.

That new industry was Cadillac Renewable Energy, a 36 megawatt, wood-fired power plant. Cadillac Renewable Energy resulted in the ability to capture taxes[124] which were then used used to pay the $7.4 million municipal bond (loan) payments for the cost of the cleanup plant construction. The power plant was built by a partnership (including the City of Cadillac and Kysor Industrial Corporation among others).

The Cadillac Renewable Energy plant, itself, does not clean up any groundwater.

The groundwater treatment plant was designed by Fisbeck, Thomson, Carr and Huber of Grand Rapids. It consists of eighteen groundwater purge wells and a cleaning process which includes air stripping of organics and carbon absorption of chromium. The clean up plant started operation in September, 1996. The plant has an annual operation and maintenance cost of $210,000 (which is paid for through a special assessment on the affected properties, 75% ($155,000) to the six Potential Responsible Parties, and 25% ($55,000) to other remaining companies in the Cadillac Industrial Park.

The groundwater clean up plant has been reducing levels of contamination from 1996-1999. Specifically GWTO organics, purge well organics intermediate aquifer, and GWTP chromium.

The overall goal and objective of the LDFA finance system has been:

- Protect City Wellfield.
- Remediate Groundwater (addressed a large area of groundwater contamination).
- Provide a funding source for future industrial area improvements.
- Avoided protracted legal battles.
- Restored value to property in the industrial park.

However there is also the belief by some that polluters are not paying their fair share of the cleanup costs (because taxpayers have bailed them out). As a result there has been public opposition to Cadillac's involvement, some opposition to O&M special assessment, and public opposition to wood fired power plant. Other challenges (or problems) include easements for pipe, air discharge of pollutants, and the EPA Consent Order.

Because of the complexity of the numerous contamination plumes, unique groundwater flow (Lake Cadillac as a surface water discharge into the groundwater), and a suspected large area clay layer separating the lower part of the aquifer from upper aquifers, a straight forward well head delineation in preparation for wellhead protection is not advised. Cadillac is seeking to do a detailed comprehensive hydrological survey of the area through the United States Geological Survey.

Opinion Survey on Ground and Surface Water

SUPPORT for protection of groundwater received the strongest support, above everything else, in the survey of Wexford residents. A sizeable portion of the interview was devoted to exploring residents' beliefs about how county land should be used and protected. These questions were introduced by interviewers as follows: "Many planning and zoning measures can be proposed to guide the use of private land or to protect the environment in the county." Respondents were then asked if they "strongly favor, favor, oppose, or strongly oppose a number of these measures." Responses are summarized in the following table, with measures receiving the strongest support listed first and those receiving the least support listed last.

[124]Tax Increment Financing (TIF). Money raised in this way must be used as directed by Michigan Statute.

Level of Support for Measures to Guide Land Use and Environmental Protection: Percentage Distributions and Means

	*Mean**	Strongly Favor	Favor	Oppose	Strongly Oppose	Don't Know
Regulations to protect ground water quality	*1.41*	60.6	36.4	2.2	0.0	0.7
Regulations to protect quality of lakes and rivers	*1.53*	49.3	46.3	3.2	0.0	1.2
Regulations to preserve vegetation along lakes and streams	*1.75*	33.4	55.9	6.7	1.2	2.7
Preserving vegetation strips along lakes and streams	*1.76*	30.7	57.9	5.9	1.0	4.5
State natural river concept	*1.95*	27.2	49.3	14.6	4.0	5.0
Limiting number of houses sharing lake access	*2.07*	23.3	40.8	23.0	3.2	9.7

*The "strongly favor" response is given the numeric code of 1; "favor," is coded 2; "oppose" is given the code of 3; and "strongly oppose" is coded 4. "Don't know" responses are excluded when the mean is calculated.

Strong support is expressed for the protection of water resources in the county. "Regulations to protect the quality of ground water" are "strongly" favored by about 60 percent of residents and are simply favored by more than 35 percent of them. Similarly, about one half of respondents say that they "strongly favor" "regulations to protect the quality of lakes and rivers," with another 46 percent saying that they "favor" this regulation.

Support for preserving vegetation strips along lakes and streams is also reasonably high, although the percentage of residents who "strongly favor" each of these measures is less than the percentage strongly favoring the protection of water quality in the county. Roughly one third of respondents "strongly favor" "regulations to preserve natural vegetation along lakes and streams," and "preserving vegetation strips along the shores of lakes and streams."[125] Relatively few residents oppose these measures.

About one quarter of respondents "strongly favor" "designating certain rivers in Wexford County as State Natural Rivers" (thereby limiting building close to the rivers and maintaining vegetation in its natural state), and "strongly favor" "putting limits on the number of houses that can share access to a lake through one lakefront parcel of land." On the other hand, almost 20 percent of respondents oppose the State Natural River, and opposition to limiting numbers sharing lake access through a single parcel of land is more than 25 percent.

On Site Sewage Disposal

Restricted Areas for Septic and Drain Fields

PORTIONS of the map on page 145 was developed from the Wexford County Soil Survey to show where a septic tank permit is likely to be denied due to soil type, in or near wetlands, and areas where many northern Michigan health codes requires a 50 foot setback from water for the drain field and a 100 foot setback from water for the drain field. The Wexford County Health code requires a 50 foot setback for both.[126]

If other factors are acceptable –slope, load capacity of the soil– areas shown on the map are where septic tanks may be denied. However this does not necessarily preclude development if a small area waste treatment facility or a sewer system is available.

New Technology

The common septic tank and drain field or dry well which is often the minimum requirement of county health codes has been termed as "state of the art 1910 technology." Today technology exists which are far more effective at treating sewage on site, often better than public sewage systems, for homes commercial establishments including restaurants.

On-site sewage disposal systems have been around for many years in various forms. Early versions of the systems, such as cesspools, drywells, and straight pipes over the bank or to a river or lake provided little treatment of the sewage. With low population densities, these systems were a minimal threat to the environment or public health. With the housing boom after World War II, these systems were still used extensively, but problems started to develop as densities increased. On-site sewage systems were viewed as an unreliable means of sewage disposal to be used until sewers

[125]Two very similar statements about preserving lakeside and riverside vegetation were read to respondents. The term "vegetation strip" was used in one statement. This term was defined as "strips where plants are left to grow undisturbed."

[126]Section 405.421 and 405.342 of *Environmental Health Regulations* for District Health Department No. 1 (Counties of Crawford, Kalkaska, Missaukee, and Wexford) effective May 1, 1989, as amended.

could be extended to serve the site. During the late 1960's and 1970's, some thought all but the most remote regions of the country would eventually be served by sewers. That all changed in the 1981 with changes to the Federal Clean Water Act. It was found that mega sewer systems did not work as well as it was believed they would, and federal grants for such systems were drastically reduced. A considerable amount of research was done on on-site sewage systems in the 1980's. It was found these systems could be relied upon to treat domestic sewage if the systems were properly designed and maintained.

The conventional on-site sewage treatment system consist of a septic tank or primary treatment device and soil dispersal system or secondary treatment device. The purpose of the septic tank is to provide primary treatment of the waste water by settling the heavier solids out of the waste water stream. Fats, greases and oils accumulate on top of the waste water in the tank. The solids settle to the bottom of the tank, where part of the material is digested through anaerobic decomposition. The waste water exits the tank through a baffle which withdraws water from the middle third of the tank which is the clearest water. About one third to one half of the organic matter is removed from the waste water by the septic tank. Considerable amounts of organic material leave the tank suspended in the waste water to under go further treatment in the soil dispersal system. Bacteria levels in the waste water are not significantly reduced in the septic tank. It is necessary to have the undigested material pumped from the septic tank on a regular basis to prevent organic over-loading of the soil dispersal system.

The soil dispersal system or secondary level treatment device typically consist of either a cesspool, drywell, or drainfield. Cesspools and drywells are no longer allowed as they provide very little or no treatment of the waste water leaving the septic tank. The untreated waste water can than contaminate groundwaters and nearby water wells. Drainfields consist of a layer of stone with a network of pipe in the stone to distribute the waste water. Further treatment of the waste water is by aerobic decomposition of the organic material. To provide for this level of treatment, drainfields must be located on well drained soils which can provide lots of air to break down the contaminants in the waste water. This is typically done by restricting drainfields to sites with sandy or loamy soils which do not have a high water table. Heavy clays or soils saturated with water do not contain enough air to treat the sewage. Systems located in these soils will "fail" and discharge improperly treated sewage to the ground water or surface waters, creating a public health and/or environmental hazard. While the sandy or loamy soil are necessary for the above reasons, sandy soil presents another problem. Sandy soils peculate relatively quickly allowing the waste water to move downward below the aerobic area and topsoil area of soil. This peculation, if occurring too quickly, results in a source of groundwater contamination. Thus drainfields are designed larger to further disperse the wastewater.

Unfortunately, as shown by the map on page 145, this leaves many sites that cannot be developed using a conventional treatment system relying totally on the natural soils to treat the sewage. Some sites have moderate limitations and can be modified to provide an aerated zone to provide secondary level of the sewage. These modifications generally are in the form of a "mound," seen around many lakes and streams. Other sites are simply unbuildable using a conventional system.

These conventional sewage treatment systems do a good job of removing bacteria and much of the organic material from the sewage. However, nitrates and other substances are discharge to the ground waters. For twenty or thirty years, municipal sewage treatment plants have been required to treat sewage to a tertiary level. This removes more of the contaminants from the water. There are devices on the market today which make it possible to provide this level of treatment on individual home site. This is done by removing the treatment of the sewage from the natural soils to so sort of mechanical treatment train. As treatment of the sewage is no longer dependant on the natural soils, proper treatment of the waste water can take place on virtually any site, provide adequate land area is available for the treatment train to be installed. Many would argue these types of systems should be installed on all water front properties to protect surface water quality.

Work done by Ted L. Loudon, Ph.D., P.E., Professor and Michigan State University Extension Engineer, results in a presentation of several newer technologies for on site sewage treatment systems. These systems can be suitable for residential, commercial, and cluster sewage treatment systems. Each of these systems can be designed for specific sites and uses. Each can be used singly or they can be used in combination.

First, is a "Wisconsin Mound" system, discussed above, for when there is a need to have greater distance between the bottom of a drain field and the groundwater table. The mound system is a covered, above-ground wastewater treatment system which also recycles the treated water back into the environment. It receives septic tank effluent which is distributed by a pressurized pipe network in the mound over a layer of coarse sand for treatment before moving into the soil under the mound. Treatment occurs by physical filtration and biological decomposition. This system is useful at sites which have shallow groundwater or slowly permeable soils. The mound follows a septic tank and an additional pump chamber. Mound systems can cost $6,000 to $20,000 (including septic tank, pump chamber and engineering design) depending on size and depth required for proper treatment. There is about a $1 a month cost to operate the pump and a maintenance contract is highly recommended (costing about $150 per year).

A Pressure Distribution System, also called a Low Pressure Pipe (LPP), is used whenever it is necessary to pump effluent to a higher elevation and/or to control the soil

loading rate (for very coarse soils) and to reduce soil clogging (slowly permeable soils). This system is a small-diameter pipe network used to supply effluent to soil absorption trenches or other treatment system. A pump or dosing siphon is required to feed and pressurize the system, which provides uniform distribution of effluent throughout the soil absorption area. The pipes in the network will typically have $^1/_8$ inch to ¼ inch drilled holes spaced two to five feet apart. A pressure distribution system usually consists of a septic tank containing a screened pump (or followed by a separate pump chamber) which is connected by a main supply pipe to the distribution pipe network. The pump and its associated controls will add $1,500 to $2,500 to the cost of a standard septic system. The pump will add about $1 to $3 to a monthly electric bill and a maintenance contract is highly recommended (costing about $150 per year).

A Drop Box distribution system is not normally necessary in soils found in Wexford County.[127]

A Single Pass Sand Filter (SPSF), also called an Intermittent Sand Filter (ISF), is a secondary treatment system used to improve the quality of septic tank effluent. It can be used where soil has low permeability, shallow groundwater, or other site limitations. The SPSF greatly reduces the amount of solids which can clog pores in the soil. It also reduces nitrogen and pathogenic organisms. It can provide a level of treatment similar to that of a large centralized municipal treatment plant but with less nutrient removal. The SPSF is used at sites which are not suitable for conventional septic system, and can help protect groundwater quality. The sand filter is typically located below ground between the septic tank and the soil absorption area. A SPSF system can cost from $8,000 to $15,000. Sand filters are now available as kits. The pump will add about $1 to $3 to a monthly electric bill and a maintenance contract is highly recommended (costing about $150 per year).

A Recirculating Sand Filter (RSF) is a secondary treatment system used to improve the quality of septic tank effluent. Such a system is often required for low permeability soils, shallow groundwater and other site limitations. The RSF greatly reduces the amount of solids that clog pores in the soil, reduces nitrogen and pathogenic organisms. It can be used for clustered homes and small community applications. The RSF can provide a level of treatment similar to that of a large centralized municipal treatment plant but with less nutrient removal. Designs may include modifications to enhance nutrient removal. The RSF and a recirculation tank are located between the septic tank and soil absorption area. Screened septic tank effluent flows to the recirculation tank where it is mixed with water already treated by the sand filter. This diluted effluent is pumped to a network of pressure distribution pipes buried in stone near the top of the sand filter. Small, frequent doses are delivered to the treatment media through small holes in the distribution pipe. Physical filtration and biological decomposition are the major treatment processes, removing 95% of the organic matter in effluent. Effluent draining from the filter is split: 75-80% returns to the recirculation tank to dilute incoming septic tank effluent, and 20-25% goes to the soil absorption system.. A RSF for a home (100-200 cubic feet of water flow for a three bedroom home) can range from $8,000 to $15,000. System design by an engineer may add to the cost. A maintenance contract is highly recommended (costing about $150 per year).

An Aerobic Treatment Unit (ATU) treats domestic wastewater by providing an environment where bacteria which require oxygen will decompose waste materials. An ATU relies on natural microscopic organisms – mostly bacteria – to treat wastewater. This is done with an electric motor to drive an aeration device which provides oxygen to the wastewater. That motor runs continuously. When liquid flows out of the aeration chamber the water goes into a clarifying chamber allowing solids to settle from the liquid for further decomposition. Conversion and reduction of nitrogen is achieved as well as a reduction in solids and pathogens. The ATU can be buried like a septic tank, with an access riser and cover at the surface of the ground and a vent to provide oxygen supply. This pre-manufactured unit can replace the conventional septic tank – which treats waste less completely in an anaerobic environment – but may work better if it follows a septic tank. The ATU discharges a much cleaner effluent but, like septic tank effluent, generally requires further treatment in the soil while being recycled back into the environment. The ATU may be used to reduce wastewater strength that enters a drain field. The cost of an ATU can range from $5,000 to $10,000 in addition to the cost of the traditional septic tank and drain field system. Power requirements vary but can range from $10 to $30 per month. A maintenance contract is highly recommended (costing about $150 per year).

The principles behind the aerobic units are essentially the same as those used in municipal sewage treatment plants. They all diffuse oxygen into the waste water to allow aerobic bacteria to digest the organic material and provide for pathogen die off. The units are either suspended growth or packed bed units. Suspended growth units usually have a blower which diffuses air into a tank of waste water. Packed bed unit contain a media over which the waste water is distributed. There are many modifications of both types on the market today. A sand filter is a type of packed bed filter. Others used peat and geo-textiles, and foam as a treatment media.

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[127]A Drop Box distribution system is for sites with slowly permeable soils to fully utilize each soil absorption trench; such as sites with steep slopes. It is used to load septic tank effluent into soil absorption trenches. It can be used in all types of soil. The drop box system relies on gravity, and can be used at sites with any degree of slope. The drop box is a small plastic or concrete box installed below ground with an access riser and cover at the surface of the ground. It contains an inlet, outlets to the trench distribution pipes, and an overflow outlet to allow flow onto other drop boxes in the network. The cost for this system is about the same as for a conventional septic system.

Soils With Limitations for Wastes & Industrial Development

TWO maps on pages 146, 147 is drawn by showing areas of the county that the soil survey indicates have limitations for small commercial buildings and for land applied waste disposal. It is important to make it clear that showing these areas on maps is not to show areas that can not be developed for commercial or industrial. The shading is simply to underline the concern the areas are limited in ability to handle wastes deposited on or in the ground, and have restrictions for small commercial building development. This is because industry can have a lot or very little traditional septic sewage, a lot or very little individual contaminants which may or may not be easily treated.

It would be wise to advocate types of industry that exports any volume of volatile waste products, to a landfill or other remote location for disposal rather than to allow land applied industrial waste disposal. If disposal is required within areas shown on the maps with the limitations, it should be in an engineered facility that contains the material – as the existing soil types will not provide any natural form of containment.

Soils

SOILS information used in this *Fact Book* (see map on page 141) is based on the *Soil Survey of Lake and Wexford Counties Michigan* of August 1985. The soils information is a major source of data on the county's land resources. Soil data is a major factor in determining prime forest lands and timber productivity rates, in identifying nationally prime farmlands and locally essential farmlands, and soil characteristics play a role in determining septic tank feasibility, residential and commercial development, industrial disposal limitations, and so on.

A short listing of the soil types found in Wexford County are:

Sandy Soils. Nearly level to steep, somewhat excessively drained and well drained sandy soils. Not fertile, thus not productive for crops or trees. Fast leaching, which tends to make groundwater vulnerable to contamination from the surface.

Rubicon-Montcalm-Graycalm
Grayling-Graycalm
Kalkaska
Croswell sand
Pits

Sandy Loam Soils. Nearly level, undulating, to steep, well drained loamy and sandy soils.

Emmet-Montcalm
Hodenpyl-Karlin

Loam and Clay-Loam Soils. Nearly level to steep well drained and somewhat poorly drained loamy and sandy soils. Tends to be the more fertile, productive soils. Also tends to be soils that are problems for use of on site sewage disposal systems.

Nester-Kawkawlin-Manistee

Wetland and Flood Plain Soils. Nearly level and undulating, very poorly drained and moderately well drained mucky and sandy soils in bogs, depressions, drainage ways.

Tawas-Croswell-Lupton
Au Gres-Finch sands
Allendale loamy sand
(Fluvaquents and Histosols)
Winterfield sands

Wexford County Soil Usage Chart[128]

(For full details, see *Soil Survey of Lake and Wexford Counties Michigan*[129])

Map Symbol and Soil Series Name	Hydrologic Soil Group	Agri-culture Typical-ly Farmed or Prime Farmland	Forest Site Index 70+ for at Least One Species	On Site Drain Fields (septic system)	Leaching Potential	Limited Devel-opment Due to Slope of Land	Slope is a Problem	Okay for Devel-opment of Home With basement	Okay for Devel-opment of Com-mercial	This is a Hydric Soil
10A AuGres Finch	B	Limited	Yes	No - Wet	medium					
11A Croswell	A			No - Wet	high					
12B Emmet Montcalm	B-A	Prime - Yes		Okay	medium			Yes	Yes	
12C Emmet Montcalm	B-A	Yes		Okay	medium			Yes		

[128]This is a generalization of uses for each soil map unit. Please refer to the soil survey for further details. The soil survey should not be used for site specific information. On-site investigations should be completed for specific projects.

[129]Soil Conservation Service; *Soil Survey of Lake and Wexford Counties Michigan*; United States Department of Agriculture (and U.S. Forest Service, Michigan Agricultural Experiment Station); August 1985.

Map Symbol and Soil Series Name	Hydrologic Soil Group	Agri-culture Typical-ly Farmed or Prime Farmland	Forest Site Index 70+ for at Least One Species	On Site Drain Fields (septic system)	Leaching Potential	Limited Devel-opment Due to Slope of Land	Slope is a Problem	Okay for Devel-opment of Home With basement	Okay for Devel-opment of Com-mercial	This is a Hydric Soil
12D Emmet Montcalm	B-A	Yes		Okay	medium					
12E Emmet Montcalm	B-A			No - Slope	medium	Yes	Yes			
13B Grayling	A			Okay but Poor Filter	high			Yes	Yes	
14A Allendale	B			No - Wet	low					
15B Kalkaska	A	Yes		Okay but Poor Filter	high			Yes	Yes	
15C Kalkaska	A	Yes		Okay but Poor Filter	high			Yes		
15E Kalkaska	A			No - Slope	high	Yes	Yes			
16B Hodenpyl-Karlin	B-A	Prime-Yes		Okay	medium			Yes	Yes	
17A Kawkawlin	C	Prime-Yes		No - Wet	low					
18 Loxley peat	A/D			No - Wet						Yes
19 Lupton Muck	A/D			No - Wet						Yes
20B Montcalm Graycalm	A	Yes	Yes	Okay	high			Yes	Yes	
20C Montcalm Graycalm	A	Yes	Yes	Okay	high			Yes		
20E Montcalm Graycalm	A		Yes	No - Slope	high	Yes	Yes			
21B Nester	C	Prime-Yes		Okay but some wetness	low					
21C Nester	C	Yes		Okay but some wetness	low					
21E Nester	C			No - Slope	low	Yes	Yes			
22 Tawas Roscommon	A/D			No - Wet	low medium (D)					Yes
23B Rubicon	A	Yes		No - Poor Filter	high			Yes		
23E Rubicon	A			No - Poor Filter, Slope	high	Yes	Yes			

Map Symbol and Soil Series Name	Hydrologic Soil Group	Agri-culture Typical-ly Farmed or Prime Farmland	Forest Site Index 70+ for at Least One Species	On Site Drain Fields (septic system)	Leaching Potential	Limited Devel-opment Due to Slope of Land	Slope is a Problem	Okay for Devel-opment of Home With basement	Okay for Devel-opment of Com-mercial	This is a Hydric Soil
24D Rubicon	A			No - Poor Filter, Slope	high	Yes	Yes			
25 Pits	N/A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
26B Manistee Montcalm	A	Yes		Okay	high			Yes	Yes	
26C Manistee Montcalm	A	Yes		Okay	high					
28C Dighton	B	Yes		No - Perk, Poor Filter	medium					
29B Graycalm Grayling	A		Yes	Okay but Poor Filter	high			Yes	Yes	
29D Graycalm Grayling	A		Yes	No	high	Yes	Yes			
30B Kalkaska East Lake	A			Yes - Poor Filter	high			Yes	Yes	
30C Kalkaska East Lake	A	No		Yes- Poor Filter	high	No				
30E Kalkaska East Lake	A	No		No	high	Yes	Yes			
34 Winterfield	A/D	No		No - Wet	Low	No				Yes
35B Mancelona East Lake	A	No	Yes	Yes - Poor Filter	high	No		Yes	Yes	
36B Kalkaska Banded	A	No		Yes - Poor Filter	high	No		Yes	Yes	
36C Kalkaska Banded	A	No	Yes	No	high	No				
36E Kalkaska Banded	A	No	Yes	No	high	Yes	Yes			
37 Fluvaquants		No		No - Wet	n/a	No				Yes

The soil survey is useful for broad planning purposes and for making zoning ordinance policy decisions. However, site inspection is necessary for planning specifics, such as for buildings, roads, farm operation, taxation and so on.

The soil map presented on page 141 is generalized from the soils report. More detail is available from the Wexford County Conservation District. The Wexford portions of the *Soil Survey of Lake and Wexford Counties Michigan* and soil GIS digital files, are adopted and made a part of this *Plan* by this reference. A detailed summary of the soil types found in Wexford County is presented in appendix C5, page 379.

Forestry

USING information from the soils report and data put together by the Prime Forest lands Identification Project

in northwest Michigan,[130] the map on page 142 illustrates the areas in Wexford County which are classified as nationally prime timberlands, timberlands of regional importance and timberlands of local importance.

Forestry for Wexford County is an important industry. The county supports several sawmills, other mills, various loggers, truck drivers, U.S. Forest Service, DNR Forestry). For Wexford and Missaukee Counties, this results in an estimated 325 persons employed. Not included in the above figures are the supplemental incomes for private land owners, farm operations, maple syrup production and seasonal jobs connected with planting, pruning, thinning, etc.

Despite the large number in Wexford already receiving income from an aspect of the timber industry, literature indicates expansion of the timber industry has high potential. The Northwest Michigan Prime Forest Lands Identification Project's reports[131] reiterates this conclusion. In Wexford County, pine and other softwood is an under-utilized resource. The county has many pine stands which remain uncut due to lack of demand for the product, or are thinned as a management practice at a loss. Northern lower peninsula of Michigan had a net growing stock volume of 10,147,659,000 cubic feet (1,406 cubic feet per acre) in 1993, representing a 45.4% increase in growing stock since 1980.[132] In the same time period 515,800 acres of additional forest land (7.7% increase) occurred in the northern lower peninsula. In Wexford County 418 square miles (267,367 acres) of timberland exists; 266 square miles (170,300 acres) as deciduous forest and 132 square miles (84,840 acres) of pine forest, and the remainder in managed Christmas Tree plantations. This forest is found in the Huron-Manistee National Forests, 114.7 square miles (92,600 acres); Pere Marquette State Forest, 95.1 square miles (60,900 acres); corporate forested lands, 17.6 square miles (11,300 acres); and on private lands 147.6 square miles (94,500 acres) in 1993.[133] Within the area of timberland Forest Survey Unit 405.1 square miles (259,300 acres) in Wexford County in 1993; 135.4 square miles (86,700 acres) are sawtimber, 217.9 square miles (139,500 acres) are poletimber and 51.7 square miles (33,100 acres) are sapling and seedling.[134]

Prime forest lands are those lands which are capable of producing sustained high yields of wood products. Capability is determined by the physical and chemical characteristics of the soil. Four classes, or levels, of prime forest lands are recognized as defined by the U.S. Department of Agriculture:

1. "Prime timberlands" - Lands which are capable of producing 85 cubic feet (about one standard cord per acre per year in fully stocked natural stands. These lands are nationally significant.
2. "Unique timberlands" - Lands which are not capable of producing 85 cubic feet per acre per year but are growing substantial quantities of specific high value species or species capable of producing specialized wood projects. Some examples of unique timberlands in other states are those which support black walnut plantations, pecan, and Atlantic white cedar. There are no unique timberlands designated in Wexford County.
3. "Timberlands of statewide importance". - Lands in addition to prime and unique timberlands, that are of statewide importance for the growing of wood. Criteria for delineating these lands are to be determined by a state forestry committee. The Prime Forest Lands Identification Project Technical Committee has developed a regional guideline to use as a substitute until these criteria are determined. These lands consist of soils designated as important forest land by the local resource groups and which produce medium-high to high volumes of wood products.
4. "Timberlands of local importance" - Lands which are not identified as having national or regional significance but are important to our local communities --in the case of Wexford County, important due the to Hydrolake Leasing and Service in McBain, Packaging Corporation of America, in Filer City and two wood-burning generation plants in McBain and Cadillac.

Considerable discussion preceded designating areas of Wexford County as timberlands of local importance, particularly those areas of the county which are sandy soils. Productivity and timber quality in those areas are not good. However, because of the paper/pulp mill in a neighboring county, there is a high demand for aspen and similar lower quality wood. Also, saw mills in the area often manufacture pallets, not calling for high-grade wood. But the demand for large quantity does exist. The major reason for the designation is because of the large volume of land which is forested and available for use by the timber industry – and that industry is local and thus locally important. Quantity, rather than quality, is the basis for the designation.

Old Growth

First, because of historical land use practices, there is little of what many people consider "Old Growth" on the Huron-Manistee National Forests, state forests, and private lands. What does exist is "aspiring" old growth. Areas designated for old growth management on the Huron-Manistee National Forests include early, mid, and late successional ecosystems of the forests. Therefore, old growth

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[130] Nezich, Dennis; *Forest Soils Report, Wexford County* and "Wexford County Prime Forestlands Map;" Northwest Michigan Prime Forestlands Identification Project; Northwest Michigan Resource Conservation and Development Council (RC&D), U.S. Forest Service, Michigan Department of Natural Resources; October 1982.

[131] Nezich, Dennis; *Methods of Maintainng Prime Forestlands for Forest Production Purposes*; Northwest Michigan Prime Forestlands Identification Project; Northwest Michigan Resource Conservation and Development Council (RC&D), U.S. Forest Service, Michigan Department of Natural Resources; September 1982.

[132] Table 25 "Comparison of Adjusted 1980 and 1993 area and Growing-Stock volume by Forest Type, Northern Lower Peninsula, Michigan"; U.S. Government Printing Office; 1994; page 48.

[133] Tables 1, 2, 3, 4 and 5 from: Leatherberry, Earl C. and Spencer Jr., John S.; *Michigan Forest Statistics, 1993*; North Central Forest Experiment Station Forest Service, United States Department of Agriculture 1993 Resource Bulletin NC-170; pages 25-29.

[134] Tables 1, 2, 3, 4 and 5 from: Leatherberry, Earl C. and Spencer Jr., John S.; *Michigan Forest Statistics, 1993*; North Central Forest Experiment Station Forest Service, United States Department of Agriculture 1993 Resource Bulletin NC-170; pages 25-29.

designation on the forests includes wetlands, prairies, barrens, and a range of forest types. To ensure that the current and potential biodiversity was integrated into the design, areas where selected to represent all land type association (ecosystems) found on the Forests. (For a detailed discussion of land types see page 163.) A map of US Forest Service designated old growth is found on page 143

Management for old growth is primarily by natural processes; meaning natural disturbances are allowed to take their course. For example, if trees fell over from a windstorm they would not be salvaged. There are exceptions. First, if there is a threat to public health and safety then management would be able to act to negate that threat. Meaning, if the trees blew over close to someone's home and posed a fire threat then they would be salvaged to reduce the risk of fire. Second, ecosystem restoration activities will be allowed. Red Pine plantations can be restored to native forest composition. Prescribed fire can be use to emulate natural fires to restore prairies, barrens, and savannahs. River restoration will still take place.

Agriculture

THE unique and locally essential agriculture map on page 144 draws its conclusions from the *Soil Survey of Lake and Wexford Counties Michigan*[135] identification of "agriculture typically farmed or prime farm land" soil types. Use of this data allows development of a map that shows prime farmlands and locally essential farmland. These tend to be areas of the county in which clay, loamy-clay, and loamy soils are found.

The map on page 144 is not intended to indicate where farming takes place; it is attempting to present a general idea what areas of the county are best suited for a particular type of agricultural activity.

Farms in Wexford and Missaukee Counties provide an estimated 1988 employment of 650 full-time equivalent jobs (most in Missaukee). The 650 includes migrant and other seasonal jobs. However, each job is equated to a full-time, year-round job. For example, a 20 hour a week job is counted as ½. Additional jobs are related to agriculture from employment with crop, veterinary, animal, horticultural, labor and farm services, and farm related industries. While these industries are agriculture related, they service areas larger than just Wexford County.

While current literature and political thinking is that agricultural related business is a potential for Michigan economic expansion and diversification, this move is not likely to increase the need for additional farmland. Farmland exists, is in use or laying fallow. The issue in Wexford tends to be retention of prime and locally exceptional farmlands for agricultural purposes.

Prime farmland and unique farmland are officially defined in the United States Soil Conservation Service Technical Guide as follows:

1. "Prime farmland" - land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pasture land, rangeland, forest land, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding. Examples of soils that qualify as prime farmland are Palouse silt loam, 0 to 7 percent slopes; Brookston silty clay loam, drained; and Tama silty clay loam, 0 to 5 percent slopes. Prime farmland in Wexford County is shown in the soil survey as 12B, 12C, 12D, and 16B.

2. "Unique farmland" - land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods. Examples of such crops are citrus, tree nuts, olives, cranberries, fruit and vegetables. There are not any Unique farmlands in Wexford County.

For purposes of this plan, the following definition is used for locally exceptional farmlands:

3. "Locally exceptional farmlands" - Areas which are not nationally prime farmland or unique farmland which have Nester, Kent, clayey soils; Emmet, McBride, Menominee, Newaygo or Ubly loamy soils; above clayey or loamy soils in complex with Blue Lake, East Lake, Kalkaska, Karlin, Leelanau, Mancelona or Montcalm sandy soils, or in complex with Emmet, Menominee and Newaygo loamy soils as shown Wexford County Soil Survey as 10A, 12C, 16B, 20B, 21B and 21C. Further, such areas are relatively flat, few rocks, free from urban development, not excessively eroded, not saturated with water, available irrigation water, all in such a manner to accommodate common farming practices in Wexford County.

Agriculture and Forestry

Public Opinion Survey on Agriculture and Forestry

WEXFORD County residents responding to the survey indicated they believe the more productive farmland in Wexford County should be preserved for agricultural job retention.

[135]Soil Conservation Service; *Soil Survey of Lake and Wexford Counties Michigan*; United States Department of Agriculture (and U.S. Forest Service, Michigan Agricultural Experiment Station); August 1985.

Level of Support for Types of Economic Development: Percentage Distributions and Means

	*Mean**	Definitely Favor	Probably Favor	Probably Oppose	Definitely Oppose	Don't Know
Protecting Existing Farms	*1.42*	58.9	36.9	1.5	0.5	2.2

* "Definitely favor" responses are given the numeric code of 1; "probably favor" are coded 2; "probably oppose" are coded 3; and "definitely oppose" are coded 4. When means are computed, "don't know" responses are excluded.

Respondents express considerable support for "protecting existing farms in Wexford County." Almost 60 percent of respondents say that they "definitely favor" protecting county farms, and only two percent of respondents oppose such efforts at all. However, only 1.5 percent of those in the survey have a major part of their income from farming.

Opinions about other types of economic change are more mixed: "Growth in industrial development" (defined as factories and manufacturing), "growth in commercial development (defined as offices and stores)," "increasing winter tourism," and "expansion in tourism related to the lakes in the county" is somewhat less. Less than 30 percent of residents "definitely support" each of these changes, and about one quarter express some level of opposition.

It is easy to say "protect farm land." When one starts exploring how that is done, support usually starts to drop off. The following table shows some public opinion support for some of the common measures which might be used to protect farmland, and for increased use of public land for commercial (e.g. timber harvest) activities. These two measures do **not** receive support from majorities of the sample—"establishing a minimum size for a parcel of land that can be owned" and "increasing access to publicly-owned land for commercial activities such as logging." The percentage of respondents who "strongly favor" such measures is about 10 percent or less, and the number of respondents who oppose these measures outnumbers the number who support them. (Note that the percentage of respondents who have no opinion about establishing a minimum size for a parcel of land exceeds 10 percent.)

Level of Support for Measures to Guide Land Use and Environmental Protection: Percentage Distributions and Means

	*Mean**	Strongly Favor	Favor	Oppose	Strongly Oppose	Don't Know
Increasing parcel size requirements for homes in agricultural areas	*2.30*	11.6	44.6	28.5	5.2	10.1
Establishing minimum parcel size	*2.51*	10.6	30.7	38.1	8.9	11.6
Increasing access to public land for commercial activities	*2.74*	5.2	26.7	46.0	13.1	8.9

*The "strongly favor" response is given the numeric code of 1; "favor," is coded 2; "oppose" is given the code of 3; and "strongly oppose" is coded 4. "Don't know" responses are excluded when the mean is calculated.

Mineral Resources

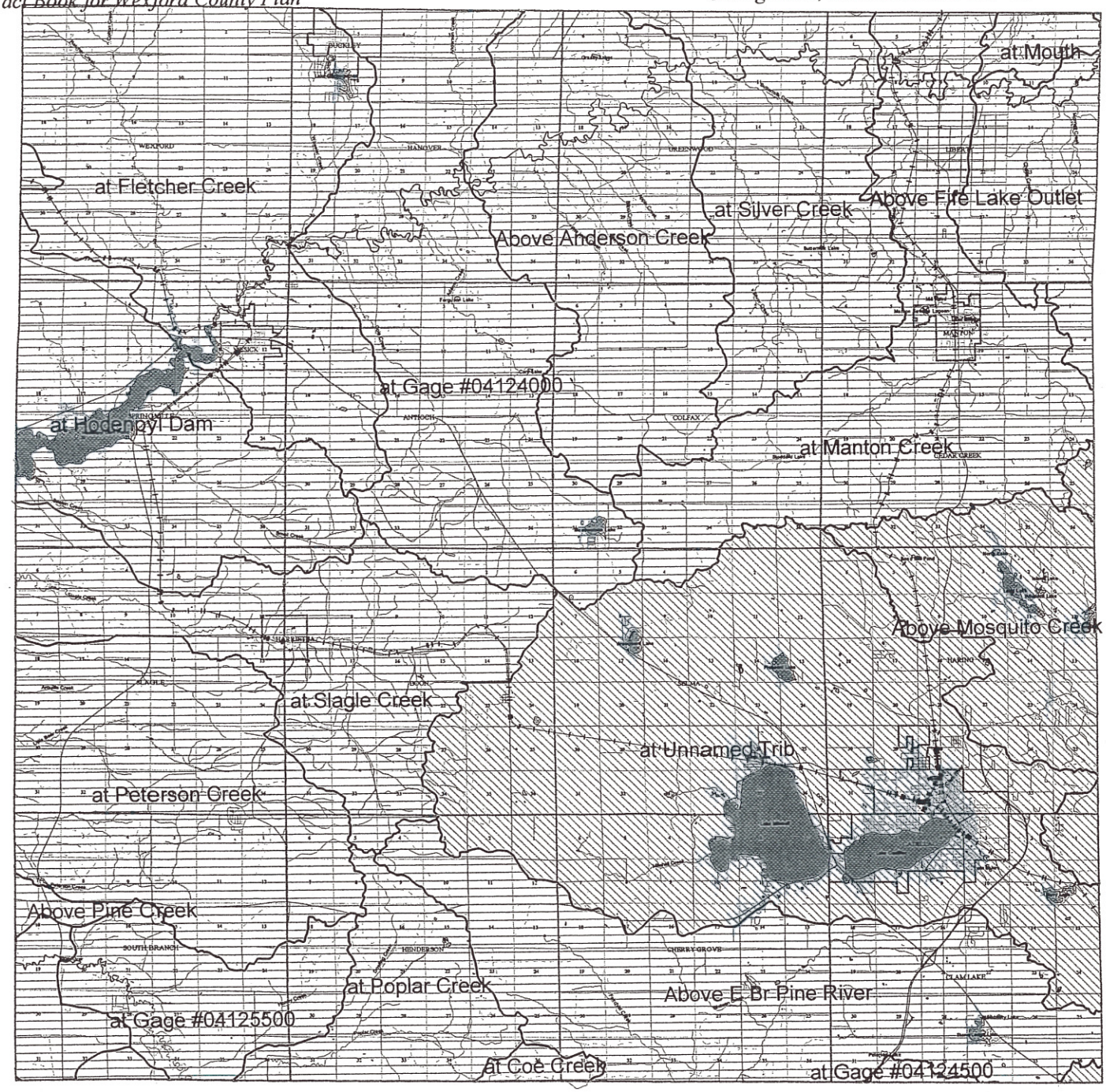
TRADITIONALLY, Wexford County has not had widespread extraction of minerals. Minerals removed from Wexford County have been confined to industrial sand (at Yuma), sand, gravel, and oil and gas (in Wexford Township). An estimated 76 jobs depends on the mineral industry in Wexford County.

The sand and gravel extraction is located where the type and grade of sand and gravel exist. Because gravel is relatively abundant, the location of gravel pits also occurs near the project which will need the supply of gravel in order to reduce transportation costs.

Oil and gas exploration has occurred in and around the Cadillac, Clam Lake and Cherry Grove area; in the Manton, Haring, Cedar Creek and Liberty townships area; and in Wexford Township. Exploration in the Cadillac, Clam Lake and Cherry Grove area occurred in the 1930s, 1940s, and 1950s and again in the 1970s. This effort resulted in dry holes, with no oil or gas found. Exploration in the Manton, Haring, Cedar Creek and Liberty townships area took place in the 1950s, 1960s, and 1970s. This effort resulted in dry holes, with no oil or gas found. Exploration in Wexford Township was part of a largely successful exploration of the larger northern Michigan Niagran Reef. The Niagran Reef, the deposits from a coral reef left from the prehistoric era when this part of Michigan was part of a large ocean bay, extends through Michigan from Manistee on a diagonal through Kalkaska and toward Gaylord. Oil and gas wells are still producing in Wexford Township.

Dry holes (exploration wells which have been drilled and no oil or gas was found) and spent oil and gas wells are

supposed to be pluged according to state regulations. However, older well holes are not always adequately plugged. Other communities have experienced problems with old oil, gas, and brine wells which provide a direct conduit from the surface to groundwater, or groundwater to oil/gas/brine layers in bedrock, or surface to oil/gas/brine layers. This manifests itself when deep well injection technology is used for disposal of material. As material is pumped down, this creates pressure resulting in oil/gas/brine residue to seep to the surface or groundwater through these old wells. There is no record of this happening in the Cadillac area.



WEXFORD COUNTY ESTABLISHED ~ 1869

Major Watersheds

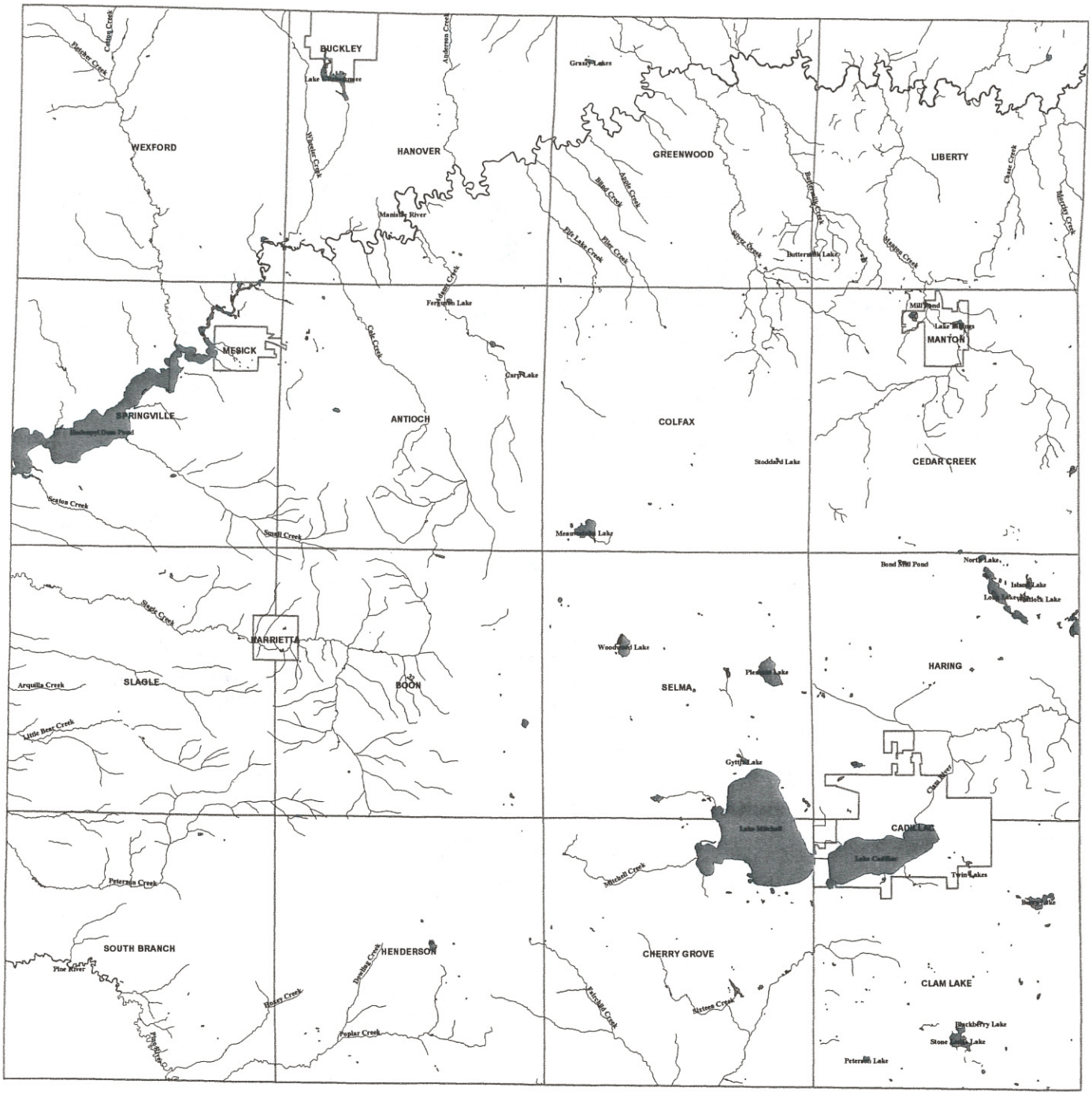
Transportation
- State Trunkline
- County Primary
- County Local
- City or Village Major
- City or Village Minor
- Not Act 51 Certified

Major Watersheds
- MANISTEE
- MUSKEGON

N

3 0 3 6 Miles

SOURCE: Michigan Resource Information System (Michigan Department of Natural Resources) interpretation of watershed divides based on contour information from United States Geological Survey (Topographic maps) 7½ minute series and digitized for use with Geographic Information System (GIS).



WEXFORD COUNTY ESTABLISHED ~ 1869

N
W E
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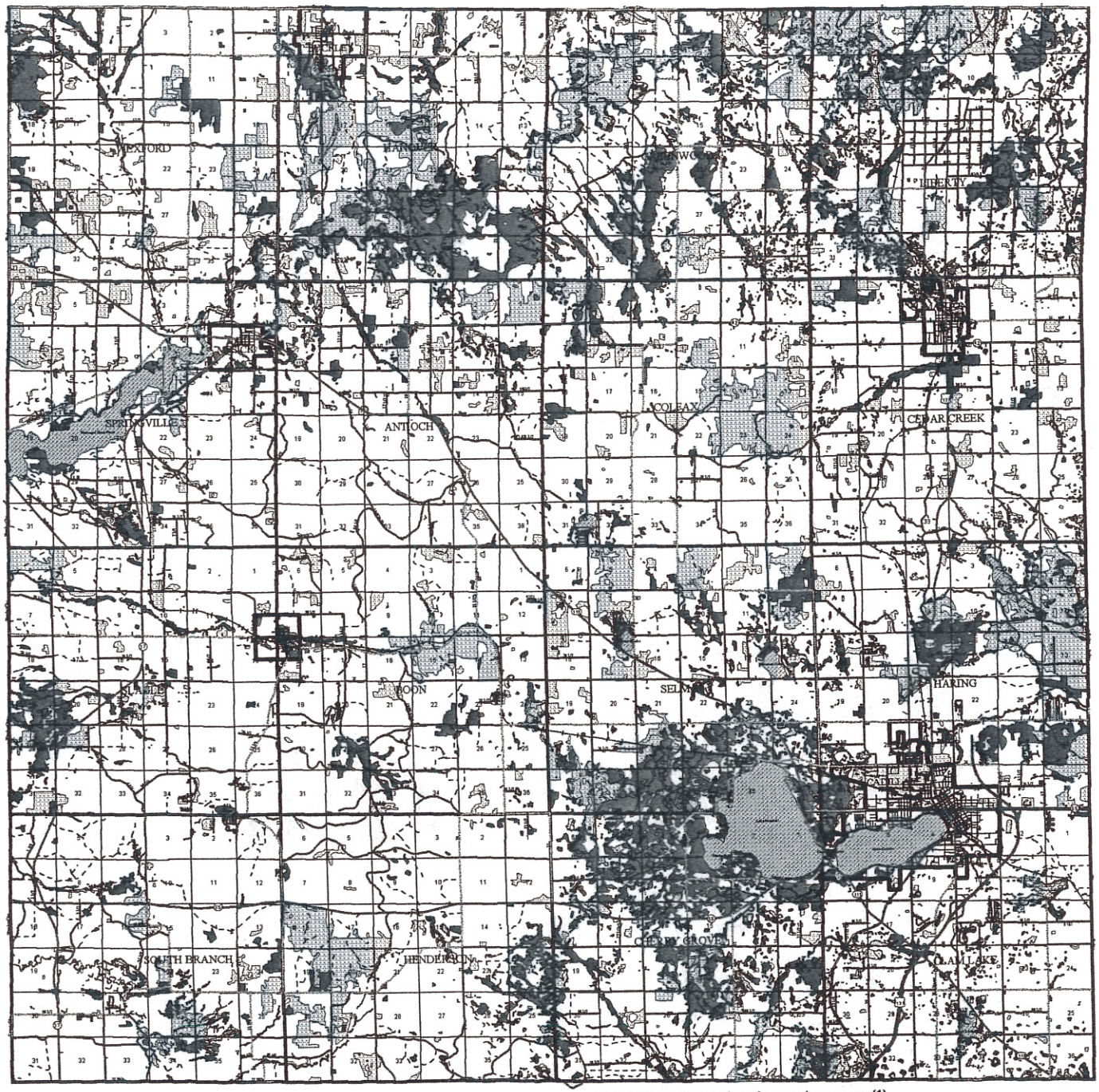
Surface Water Features

SOURCE: Michigan Resource Information System (Michigan Department of Natural Resources) base mapping of water features (rivers, drains, intermittent streams, lakes) based on United States Geological Survey (Topographic maps) 7½ minute series and digitized for use with Geographic Information System (GIS).

2 0 2 4 Miles



WEXFORD COUNTY ESTABLISHED ~ 1869

Wetlands

Highways
- State Highway
- County Primary
- County Local
- City Major
- City Minor
- Not Act 51 Certified
- Railroads
- White Pine Trail

Composite Wetlands
- Lowland Forestation Wetlands

SOURCE: A composite of several sources: (1) Wetland categories from the Michigan Resource Information System (Michigan Department of Natural Resources) Land Use and Land Cover Inventory based on 1978 inferred areal photography interpretation and digitized for use with Geographic Information System (GIS), (2) National Wetland Inventory (U.S. Department of Fish and Wildlife) maps digitized for use with Geographic Information System (GIS) by the Northwest Michigan Council of Governments, and (3) hydric soil categories of the *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA.

This map is for **planning purposes only**. Field checking is necessary to conform the existence of a wetland at any given location.

N W E S

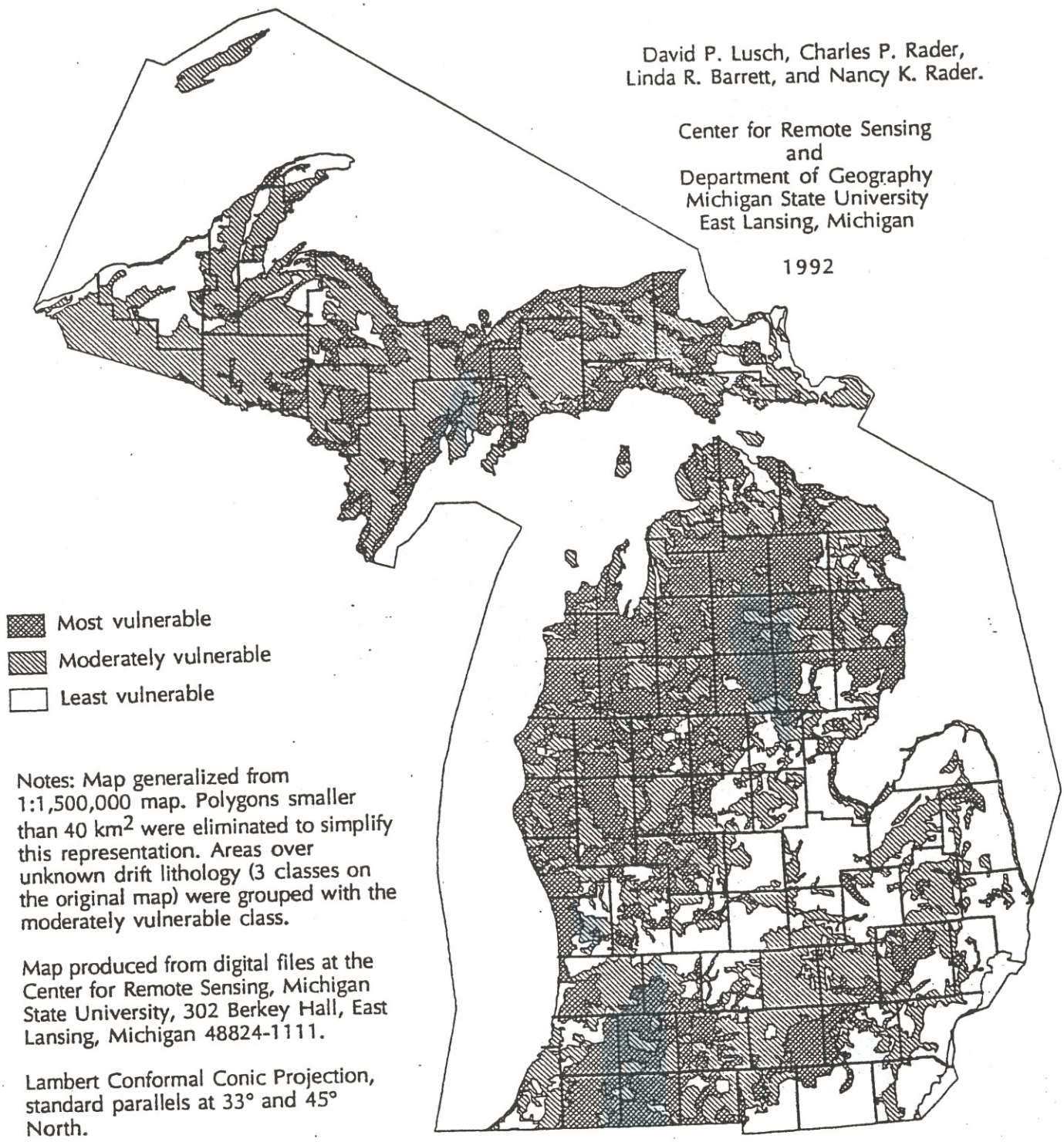
2 0 2 4 Miles

Aquifer Vulnerability to Surface Contamination in Michigan

David P. Lusch, Charles P. Rader,
Linda R. Barrett, and Nancy K. Rader.

Center for Remote Sensing
and
Department of Geography
Michigan State University
East Lansing, Michigan

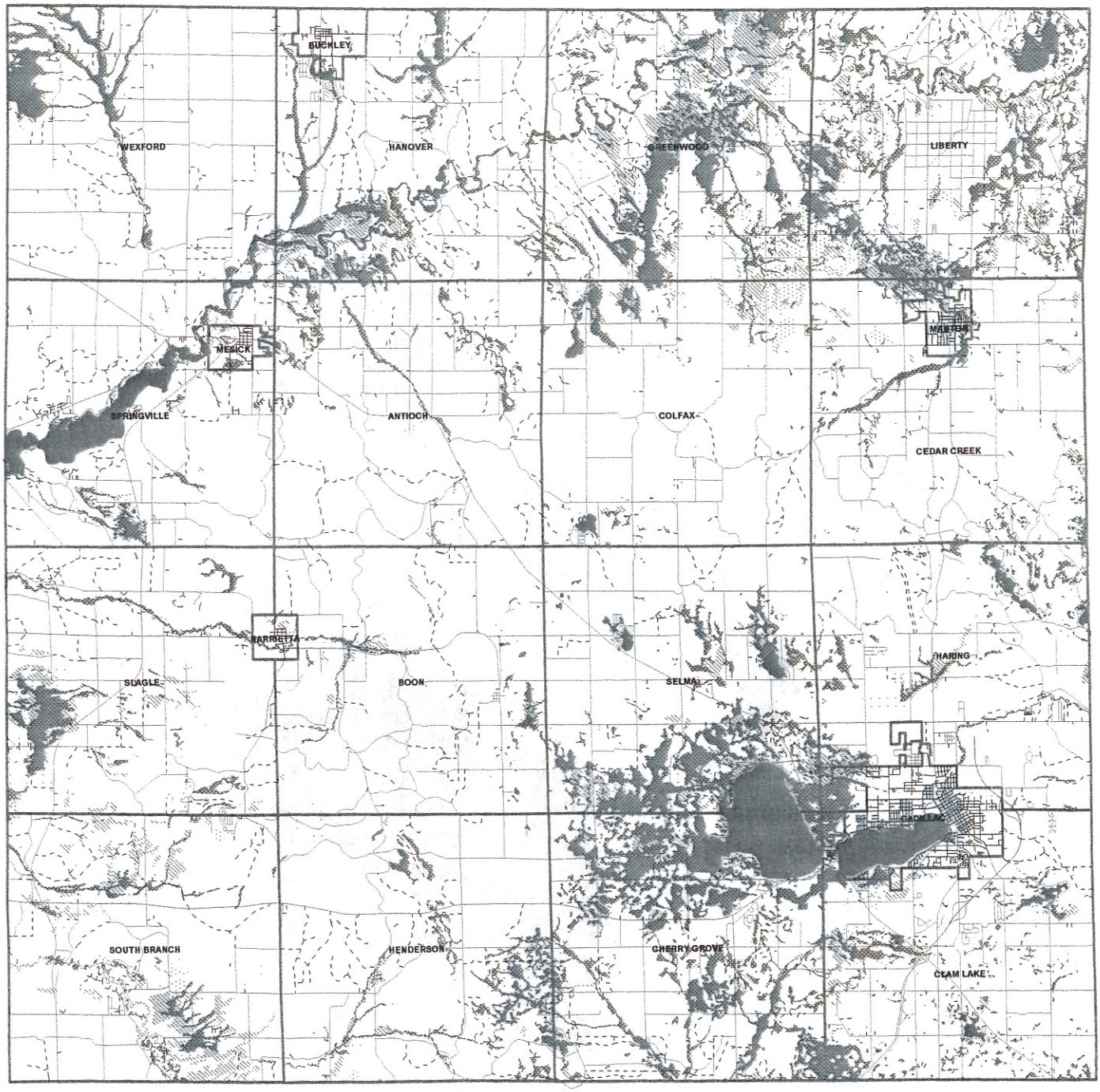
1992



Notes: Map generalized from 1:1,500,000 map. Polygons smaller than 40 km^2 were eliminated to simplify this representation. Areas over unknown drift lithology (3 classes on the original map) were grouped with the moderately vulnerable class.

Map produced from digital files at the Center for Remote Sensing, Michigan State University, 302 Berkey Hall, East Lansing, Michigan 48824-1111.

Lambert Conformal Conic Projection, standard parallels at 33° and 45° North.



Wexford County Soil Survey

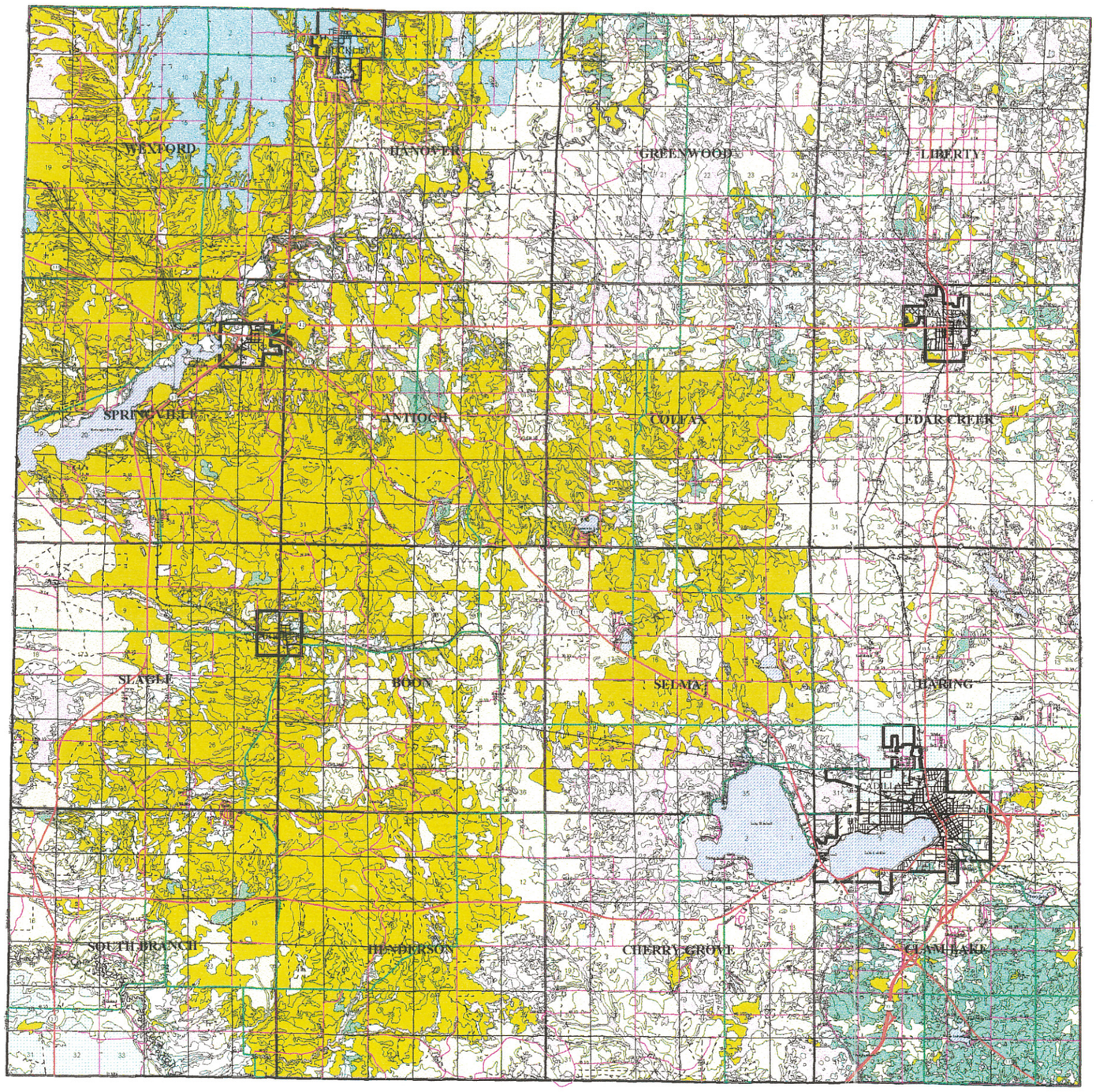
- Surface Water
- +1-1.0
- 0.5-1.5
- 1.0-2.0
- 2.0-3.0

N
W E
S

SOURCE: *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA and tabular information on water tables contained in the published version of the *Wexford County Soil Survey*.

2 0 2 4 Miles

Soils with High Water Table (Units in feet)



General Soil Types

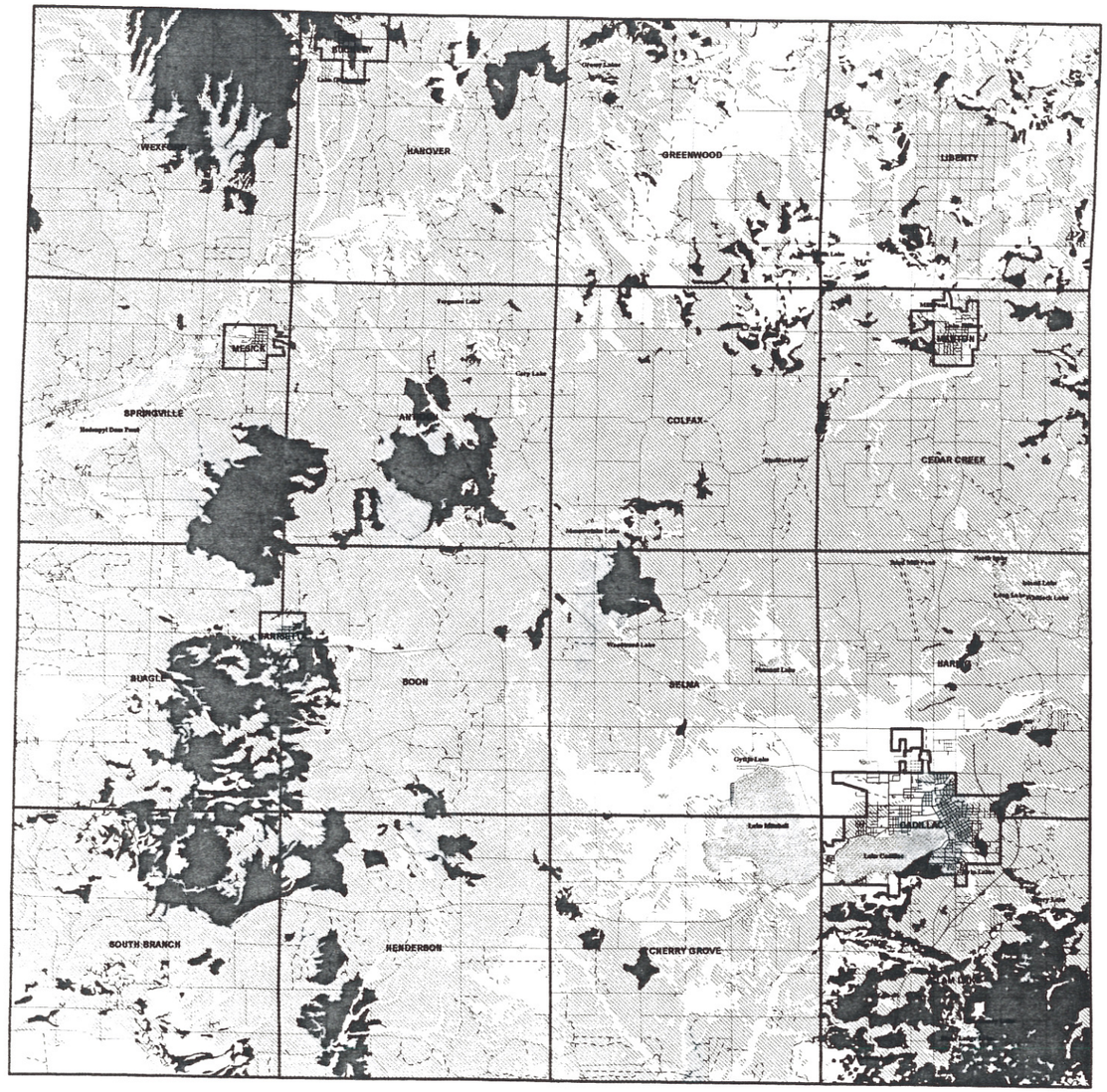
Highways
- State Highway
- County Primary
- County Local
- City Major
- City Minor
- Not Act 51 Certified
- Railroads

Wexford County Soil Survey
- Emmet-Montcalm
- Grayling-Graycalm
- Hodenpyl-Karlin
- Kalkaska
- Nester-Kawkawlin-Manistee
- Rubicon-Montcalm-Graycalm
- Tawas-Croswell-Lupton
- Other

SOURCE: *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA.

N W E S

2 0 2 4 6 Miles



WEXFORD COUNTY ESTABLISHED ~ 1869

Forest Production Potential of Soil Types

Wexford County Soil Survey
Prime Timberlands
Timberlands of Regional Importance

N
W E
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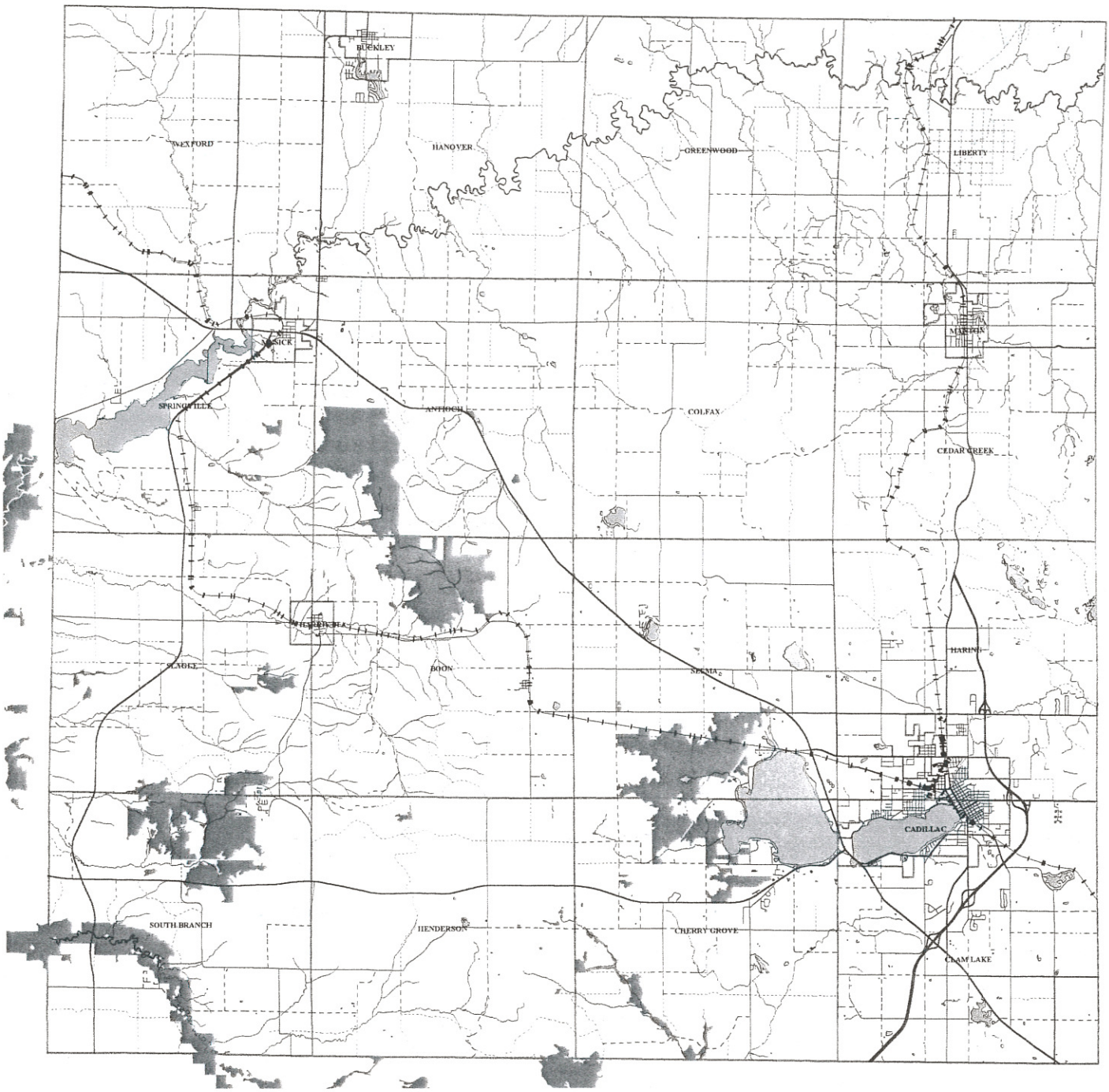
SOURCE: *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA and tabular information on tree growth index contained in the published version of the *Wexford County Soil Survey*; and the *Northwest Michigan Prime Forestlands Project*, 1982.

2 0 2 4 Miles



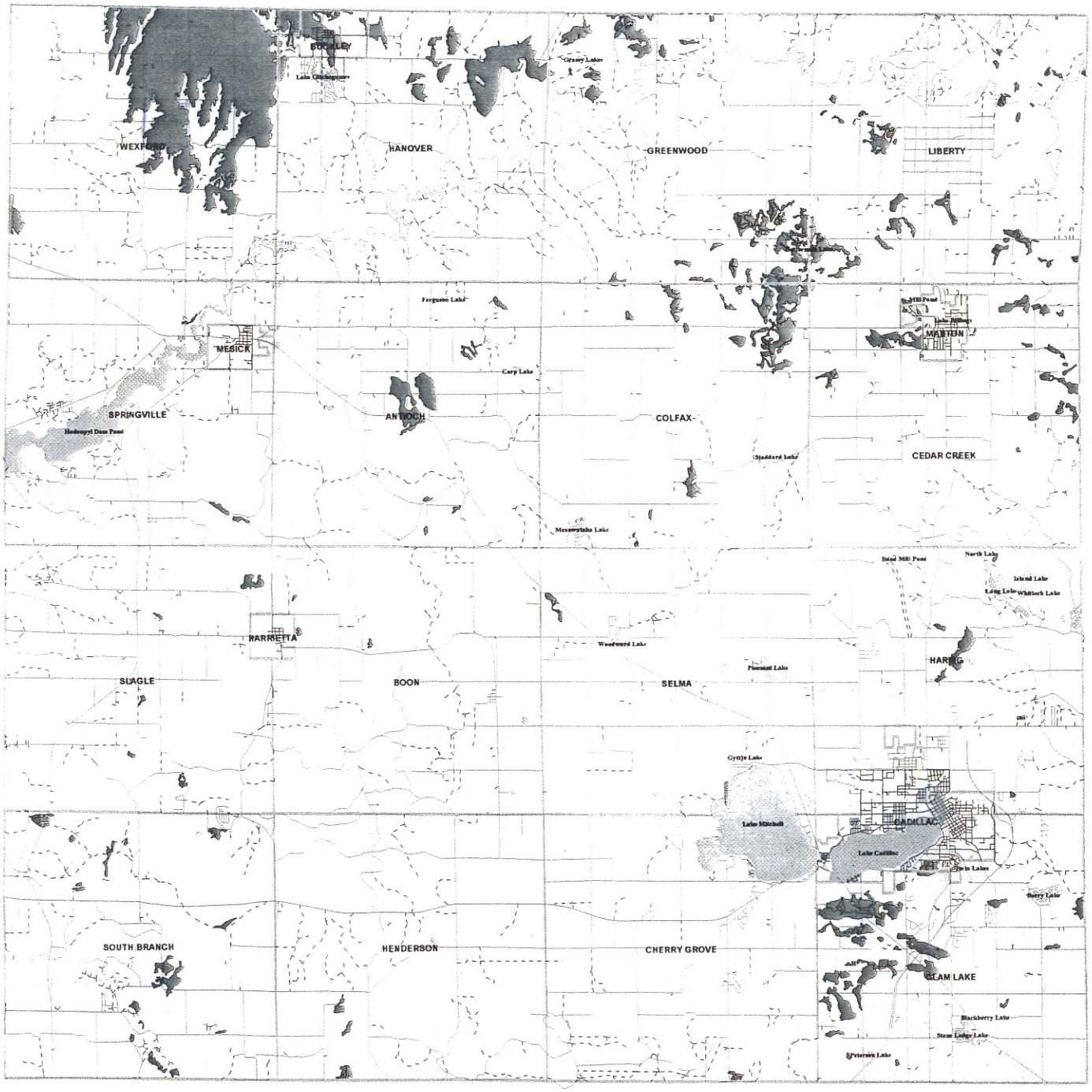
Transportation
- All Season Route
- Paved-Seasonal Restrictions
- Gravel Roads
- Seasonal Roads
- Old Growth Forests

N

Old Growth Forests

3 0 3 6 Miles

SOURCE: Huron-Manistee National Forests supervisor's office, United States Forest Service. Note, there may be more old growth forest designations (not available when this map was prepared) by the Michigan Department of Natural Resources and thus not shown on this map.



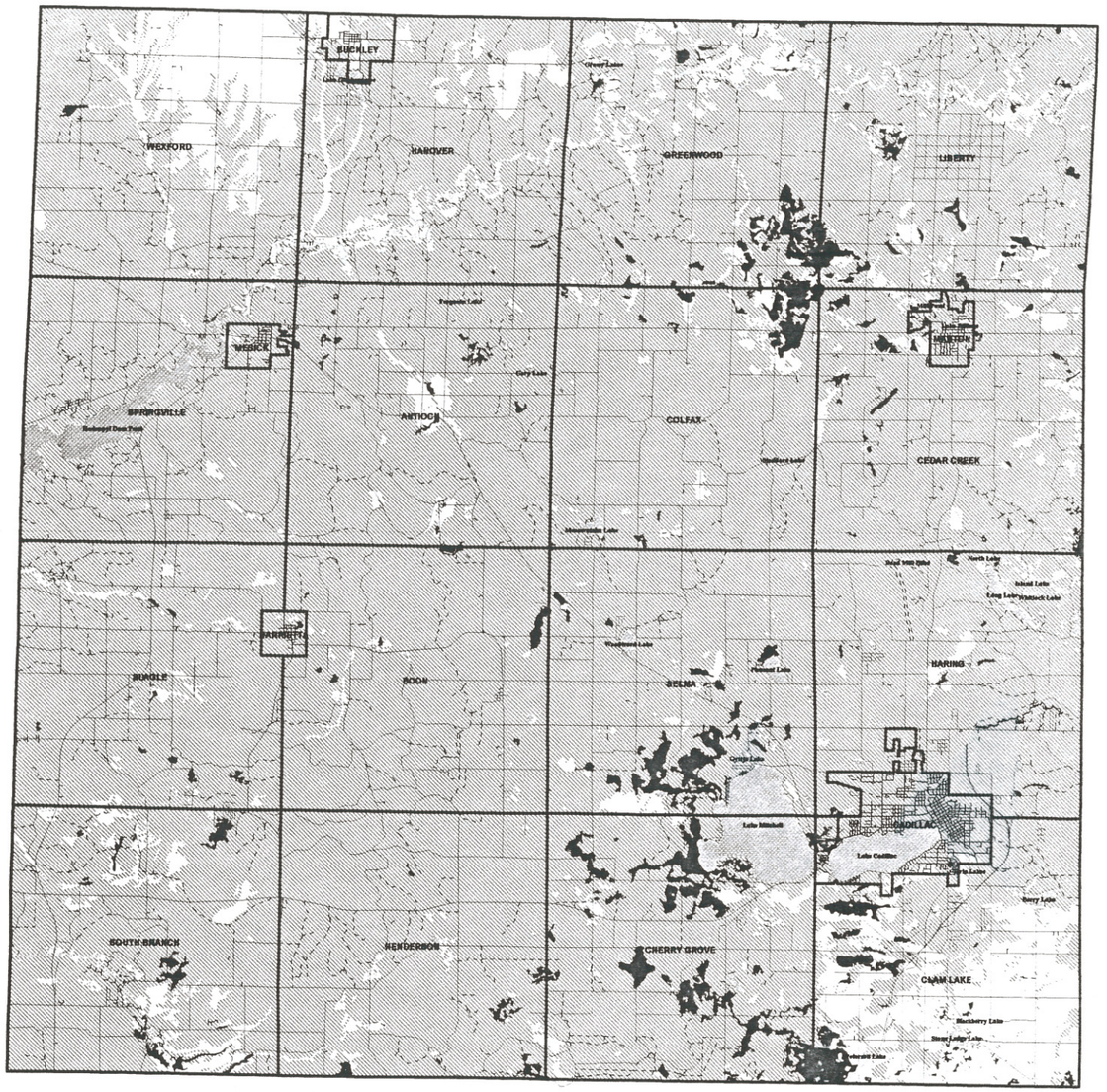
Wexford County Soil Survey
Prime Farmlands

N
W E
S

Agricultural Production Potential of Soil Types

SOURCE: *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA and tabular information on agricultural productivity contained in the published version of the *Wexford County Soil Survey*.

2 0 2 4 Miles



WEXFORD COUNTY ESTABLISHED ~ 1869

Limitations of Soils for Septic Systems

Wexford County Soil Survey

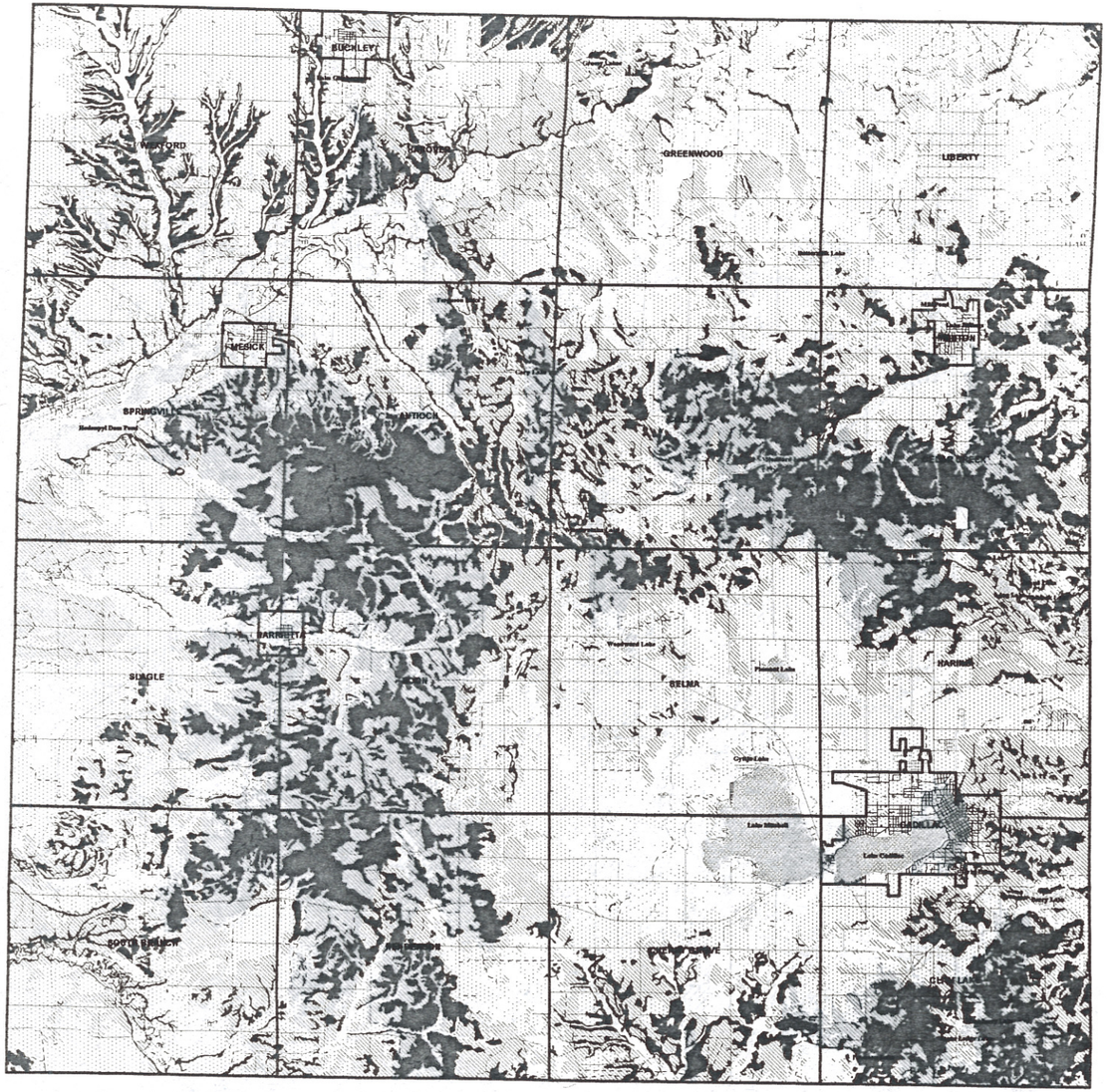
Perc Slowly (More Severe)

Percs Rapidly (Less Severe)

SOURCE: *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA and tabular information on suitability for on-site septic systems contained in the published version of the *Wexford County Soil Survey*.

N W E S

2 0 2 4 **Miles**



WEXFORD COUNTY ESTABLISHED ~ 1869

Slope Characteristics of Soil Types

Wexford County Soil Survey

Flat (0-6%)

Flat to Rolling (0-12%)

Moderate to Severe (12-40%)

SOURCE: *Wexford County Soil Survey* (United States Department of Agriculture, 1985) digitized for use with Geographic Information System (GIS) on a digital orthophoto base by USDA and tabular information on slope contained in the published version of the *Wexford County Soil Survey*.

N W E S

2 0 2 4 Miles

Air and Water Pollution

THE role of the county and municipalities, concerning air and water pollution and land and water margins is not one of direct jurisdiction. Only cities, (Cadillac and Manton), charter Townships (Haring), and charter counties have some ability to adopt stricter ordinances than state air or water regulations. But even that authority is limited. Several counties have attempted to provide the following roles: (1) to provide assistance to citizens wishing to comply with the various regulations, (2) cooperate with state agencies responsible for the various regulations, (3) and take care not to contravene those various regulations with local zoning and plans.

County and municipal governments have an important and direct role in brownfield redevelopment (clean-up of contaminated sites). For discussion on brownfield redevelopment, see page 242.

In addition to the above optional functions the county planning commission has a statutory function to be the county agency which is responsible for coordination and review of capital expenditures – including state and federal agencies. The Planning Commission should take a pro-active role in reviewing state and federal letters seeking public comment on projects, initiatives, and purchase or trade of lands. Comments submitted (if any) should address the proposal's compliance with adopted county plans.

Providing assistance to citizens can take many forms. The most useful is for local officials to be familiar with the individuals in other agencies and to understand what their responsibilities are. This means, when asked, one can make the correct referral. Also the county can keep those agency's permit application forms available for citizens to use. Finally, development of checklists helps a citizen understand when those permits are required.

Cooperation means working with individuals who are employed with the state agencies and reporting possible and actual violations to them. No government agency has enough funding or staff to perform all of its basic functions. It is an important role for local officials to provide an extra pair of eyes and ears for others. This type of help can occur between all levels of government: municipalities, counties, regional or district agencies, and state.

Taking care not to contravene state statutes takes place in many forms. For example an area which includes protected wetlands should not be zoned for intensive development. Zoning or land division ordinances should insure that a new parcel has enough upland to have buildable sites without need to fill protected wetlands. Local ordinances and state statutes should complement and enhance each other, and not create "catch-22" situations for property owners.

When making comment on state or federal proposals, permits, and land acquisitions/exchanges care should be made to recognize a number of points:

1. Virtually every action by a government agency is based on a set of written standards. This is particularly true when reviewing a request for a permit. For comment to be effective, the comments should address those standards. That means obtaining a copy of the standards, or having county staff which is familiar with those standards. When addressing the standards the county's comment is the most meaningful to the state or federal agency. If one wants to support or oppose a particular decision, rationalize the position based on the standards. Opposition or support based on emotion, trumped up statements, or political philosophy, do not – and should not – carry much weight.

2. Recognize that county, municipal, state, and federal agencies must make their decision based on the standards and policy which is written in the respective statute, ordinance, administrative rule, plan, etc. It is not realistic or legitimate to expect an agency to take action based on the number of people opposing or supporting an issue if the standards/rules do not support the same position.

3. If the standards used by the agency seem to create a pre-determined outcome, then the county should turn its attention to changing the standards. This almost always means the county will not have influence over the issue at hand. County, municipal, state, and federal agencies can not change the rules (standards) for a proposal/applicant after the proposal/application has been submitted. Efforts to change the standards means re-writing them. That may mean an amendment to a statute, ordinance, administrative rule, or plan. Changing a statute means an action by the Michigan Legislature or United States Congress, so contacting state or federal elected officials would be the tactic. Changing an administrative rule is an action done by the administrative (Lansing) office of a state agency or others in a federal agency with oversight by the Michigan Legislature or United States Congress. So contacting the administration and state or federal elected officials would be the tactic. Similarly, ordinances are adopted by local elected bodies (township board, village or city council, county board) and not their zoning administrator or planning commission.

The following areas require a permit and regulatory oversight by the respective state agency:

- If the project involves the discharge of any type of wastewater to a storm sewer, drain, lake, stream, wetland or other surface water, one should contact the Michigan Department of Environmental Quality,

Surface Water Quality Division, Permits Section.

- If the project involves the direct or indirect discharge of waste, waste effluent, wastewater, pollutants, cooling water, into the groundwater, or oil on to the ground contact the Michigan Department of Environmental Quality, Waste Management Division., Groundwater Program Section.
- If the project involves construction or alteration of any sewage collection or treatment facility; for facilities discharging to surface waters one should contact the Michigan Department of Environmental Quality, Surface Water Quality Division, District Office; for facilities discharging to groundwater one should contact Michigan Department of Environmental Quality, Waste Management Division, District Office.
- If the project or facility stores or uses chemicals, petroleum products, or salt, depending upon the type substance, secondary containment and a Pollution Incident Prevention Plan (PIP) may be required. One should contact the Michigan Department of Environmental Quality, Waste Management Division, District Office.
- If the project involves the installation, operation, or removal of an underground or above ground storage tank containing a petroleum product or a hazardous substance one should contact the Michigan Department of Environmental Quality, Storage Tank Division.
- If the project involves liquified petroleum gas storage tanks or container filling locations, one should contact the Michigan Department of Environmental Quality, Storage Tank Division.
- If the project involves the installation of a compressed natural gas dispensing station with storage, one should contact the Michigan Department of Environmental Quality, Storage Tank Division.
- If the project involves the generation of hazardous waste, one should contact the Michigan Department of Environmental Quality, Waste Management Division, District Office.
- If the project involves the on-site treatment, storage, or disposal of hazardous waste one should contact the Michigan Department of Environmental Quality, Waste Management Division, Hazardous Waste Program Section.
- If the project involves the transport of hazardous waste or non-hazardous liquid industrial waste, one should contact the Michigan Department of Environmental Quality, Waste Management Division, Hazardous Waste Program Section.
- If the project involves the installation, construction, reconstruction, relocation, or alteration of any process or process equipment (including air pollution control equipment) which has the potential to emit air contaminants, one should contact the Michigan Department of Environmental Quality, Air Quality Division, Permit Section.
- If the project or facility involves the storage, mixing, or distribution of pesticides or fertilizers in bulk quantities, one should contact the Michigan Department of Agriculture, Pesticide and Plant Pest Management Division.
- If the property has ever been subject to remedial action, limited closure, or other environmental cleanup response under part 201, Natural Resources and Environmental Protection Act (NREPA), or if the property is currently subject to a response action, or if the property has a Baseline Environmental Assessment (BEA) completed, one should contact the Michigan Department of Environmental Quality, Environmental Response Division and/or Michigan Department of Environmental Quality, Storage Tank Division.
- If the project involves the on-site storage of sanitary sewage prior to transport and disposal off-site (pump and haul), one should contact the Michigan Department of Environmental Quality, Waste Management Division, Groundwater Program Section.

Soil Erosion and Septic Discharge

Soil erosion issues are governed by state statute[136] but enforced and administered by Wexford County. See discussion on page 258.

The following areas require a permit and regulatory oversight by the respective state agency:

- If the project involves any man-made change in the natural cover or topography of land, including cut and fill activities which may contribute to soil erosion and sedimentation. Will the earth change disturb an area of one acre or more, or occur within 500 feet of a lake or stream? If the answer to both of these is yes, a soil erosion and sedimentation control permit is required; contact the Wexford County Drain Commissioner.

In addition soil erosion issues are a part of various programs of the Wexford County Soil and Water Conservation District with various programs for stream bank erosion control, farm erosion control programs, and so on. The District also conducted a major study of the Clam River watershed identifying major erosion problem sites along the river.[137] For example, Plett Road was found to be the number one contributor of siltation into the Clam River – largely due to being a gravel road on a hill sloping toward the river at the corner of Thirteenth Street.

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[136]Parts 91 and 93 of P.A. 451 of 1994, as amended, (being the soil erosion and sedimentation control part and soil conservation district part of the Michigan Natural Resources and Environmental Protection Act, M.C.L. 324.9101 *et. seq.* and M.C.L. 324.9301 *et. seq.*)

[137]Wexford Soil and Water Conservation District and U.S.D.A Soil Conservation Service and City of Cadillac (Efrain Rosalez); *Upper Clam River Watershed Non-Point Source Pollution Control Watershed Plan*; Cadillac; September 30, 1994.

Household and commercial sewer discharge of less than 10,000 gallons per day are under the jurisdiction of the District #10 Health Department. That agency is enforcing a county ordinance (Health Code). See discussion on page 258.

The following areas require a permit and regulatory oversight by the respective state agency:

- If an on-site wastewater treatment system or septic system be installed then:
  1. For sanitary sewage in quantities of 10,000 gallons per day or less, contact the District #10 Health Department, Environmental Health Division.
  2. For any subsurface discharge of sanitary sewage in quantities equal to or greater than 10,000 gallons per day, or a single treatment system that services more than one property (regardless of gallons),[138] contact the Michigan Department of Environmental Quality, Waste Management Division.
  3. For sanitary sewage in quantities of 6,000 to 10,000 gallons per day: In addition to obtaining a construction permit from District #10 Health Department, Environmental Division, one shall submit a state wastewater discharge notification form and subsequent flow monitoring and reporting are required. Contact: Michigan Department of Environmental Quality, Waste Management Division, Groundwater Permits Unit.
- If the project involves the construction of a well:
  1. water supply well (type I or any public system) or the extension of a water supply service from an existing water system, contact the Michigan Department of Environmental Quality.
  2. residential water well and private type II and III wells, contact the District #10 Health Department, Environmental Health Division.
- If there are out-of-service wells, abandoned wells, or cisterns on the site (drinking water, irrigation, & monitoring wells), contact the District #10 Health Department, Environmental Health Division.
- If the project involves a subdivision or site condominium project utilizing individual on-site subsurface disposal systems or individual wells, contact the District #10 Health Department, Environmental Health Division.

Oil and Gas Exploration

Oil and gas activities are subject to the exclusive jurisdiction of the Supervisor of Wells (who is the director of the Michigan Department of Environmental Quality with day-to-day work and decisions made by the head of the Department of Environmental Quality, Geology Division). This exclusive jurisdiction is repeated in the Township Zoning Act[139] and County Zoning Act,[140] but not in the City and Village Zoning Act.[141] This means local and county government's ability to influence or regulate oil and gas extraction activities is very limited, or non-existent. This is because the State of Michigan has determined that extraction of oil and gas is a necessity to meet the energy and economic needs of the state, so much so, that it outweighs local concerns. The state also has a vested interest in the oil and gas industry as one of the major recipients of oil and gas royalties and income from leasing state-owned oil and gas mineral rights. Further the oil and gas industry in Michigan is politically, and financially very powerful in Michigan. They have a strong presence in Lansing politics.

If there is known oil or gas in a particular location, – only in the Wexford Township area in Wexford County at this time – and it is economical to retrieve and investor money is available; then the oil and gas industry will extract it from the ground. Money talks, and this is a money-driven industry.

If local government tries to stop oil/gas extraction, or hampers it, the industry will complain to the state, and the state DEQ will support the industry indicating local jurisdiction does not exist. If that is not effective the industry will go to court. Even small oil/gas companies are often owned --at least in part-- by large multi-national oil/gas corporations. The industry can usually out-spend, out-lobby, buy better lawyers than a municipality can. Nothing is impossible, but if oil or gas wells are drilled, chances of stopping the production of those wells, or of a well, is very remote, and if successful, will be very expensive.

Local and county government can get much farther ahead working quietly with an oil company to reach a win-win settlement. When doing so, it is important to remember oil/gas industry may have been verbally or publicly chastised and poorly treated in a community they operated in previously, and they may not be willing to give your municipality the benefit of the doubt to start with.

Usually local concerns over oil and gas activity center on noise; smell; dangers of hydrogen sulfide (H_2S) gas leaking; fractionalization of forest lands; multiple corridors for pipelines, flowlines, access roads, electricity, phone; damage to the surface and bed of paved roads and rutting of sand and gravel roads; not receiving any revenue from the

[138] At least one official with the DEQ also maintains that separate treatment systems, if maintained in common by one entity would be considered a "public" system and would be under DEQ jurisdiction. This interpretation might be disputed.

[139] Section 1(1) of P.A. 184 of 1943, as amended, (being the Township Zoning Act, M.C.L. 125.271(1).)

[140] Section 1(1) of P.A. 183 of 1943, as amended, (being the County Zoning Act, M.C.L. 125.201(1))

[141] P.A. 207 of 1921, as amended, (being the City and Village Zoning Act, M.C.L. 125.581 *et. seq.*)

oil/gas activity; source of brines for road maintenance; and wanting the oil/gas industry to be subject to the same restrictions a municipality puts on other types of industries.

Most of the land use, location, and surface activity can be most effectively dealt with when negotiating a minerals lease. Any provision of a mineral lease is negotiable. One should **never** sign the first version of a mineral lease offered. One should never sign a mineral lease without one's own lawyer involved.

The issue of jurisdiction becomes more confusing when trying to draw the line between oil and gas extraction (DEQ jurisdiction) and the refinery process (local zoning jurisdiction). That has been the source of dispute in other counties. Much work to try to resolve this dispute was done by Benzie and Manistee Counties.[142] [143] A summary of those findings are presented here.

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[142]Wyckoff, Mark A. and John Warbach PhD; "Jurisdictional Issues"; *Background Issues White Paper, Antrim Shale Formation: Local Land Use Issues Related to Gas Wells and Processing Facilities*; Benzie-Manistee Oil and Gas Task Force; December 1995.

[143]Wyckoff, Mark A. and John Warbach PhD; *Common Questions on Oil & Gas Development in Michigan*; Benzie-Manistee Oil and Gas Task Force; February 9, 1996.

Oil & Gas local regulation rests more with Local Government	Oil & Gas local regulation rests more with Supervisor of Wells
Local zoning and other ordinance jurisdiction exists in some areas: 1. Concerning location, drilling completion or operation of oil or gas wells does not come under jurisdiction of township or county zoning--but does exist for city zoning according to the three zoning enabling acts.	Local zoning and other ordinance jurisdiction exists only for secondary production facilities: 1. Concerning location, drilling completion or operation of oil or gas wells does not come under jurisdiction of township or county zoning according to the "exclusive jurisdiction" (§61505) clause of the Oil and Gas part 615 of the Michigan Natural Resources and Environmental Protection Act 451 of 1994, as amended (formerly PA 61 of 1939). In the case of city/village zoning some of the oil and gas industry contends the "exclusive jurisdiction" clause also applies. The DEQ and others in the oil and gas industry recognize village and city jurisdiction.
2A. For primary processing (iron sponge, tank battery, flow lines, central processing {compression} facility) located off the wellhead site: The ruling in the Michigan Supreme Court case Addison Township v. Gout (435 MICH 809) indicates jurisdiction exists. 2B. Flowlines can be controlled by local government; at least, at a minimum, through application of soil erosion program. 2C. Local jurisdiction exists for soil erosion permits over flowlines, access roads, and location of the same through other ordinances.	2A. For primary processing (iron sponge, tank battery, flow lines, central processing {compression} facility) located anywhere: The ruling in the Michigan Supreme Court case Addison Township v. Gout (435 MICH 809) was a case about secondary processing facilities, and does not say anything about jurisdiction over primary processing. The "exclusive jurisdiction" clause still exists. 2B. Flowlines can not be controlled by local government, it is part of "exclusive jurisdiction" provision of PA 61 2C. Local jurisdiction does not exist for soil erosion permits (over flowlines, access roads, etc.), just recently withdrawn from local purview by the director of the DEQ.
3. Secondary Processing (hydrogen sulfide {H_2S} and carbon dioxide {$C0_2$} removal plants, refinery operations): The ruling in the Michigan Supreme Court case Addison Township v. Gout (435 MICH 809) indicates jurisdiction exists regardless if before or after the first point of sale.	3. Secondary Processing (hydrogen sulfide {H_2S} and carbon dioxide {$C0_2$} removal plants <u>only if after the first point of sale</u>, refinery operations): The ruling in the Michigan Supreme Court case Addison Township v. Gout (435 MICH 809) indicates jurisdiction exists.
Even if local zoning control does exist, that control is very limited. All three zoning enabling acts contain language which prohibit a zoning decision from having the effect of totally prohibiting a land use (oil/gas well, facility, pipeline, flowline etc.) from within the municipality. Further case law requires that resource extraction (mining, oil, gas, gravel, sand) <u>must</u> be permitted to locate where necessary for the extraction of that mineral (e.g. where the mineral is found).	Local jurisdiction can create a mixed quilt of regulations across the state, providing inconsistency and confusion. Often oil and gas fields sprawl across political boundaries. It does not make sense to require the same oil/gas field to be designed to two, or more, different standards because it happens to be in different municipalities.

Oil & Gas local regulation rests more with Local Government	Oil & Gas local regulation rests more with Supervisor of Wells
The DEQ Supervisor of Wells has exclusive jurisdiction over all oil and gas activities up to the first point of sale. However "all", as used by the DEQ does not preclude local ordinances from adopting regulations which are outside the jurisdiction of the DEQ. Examples include anything not covered by Act 61 or its administrative rules such as local regulation(s) on fencing well and associated surface facilities, screening and painting for visual aesthetics, designation of truck routes (including bonding exclusively for the above) location of hydrogen sulfide (H_2S) and carbon dioxide ($C0_2$) removal plants after the first point of sale.	The DEQ Supervisor of Wells has exclusive jurisdiction over all oil and gas activities up to the first point of sale. Local jurisdiction does not exist for noise or smell if the proposed DEQ 1996 revision of the oil/gas administrative rules are adopted. "All" up to the first point of sale includes drilling, completion, operation, abandonment of oil or gas wells; installation and operation of flowlines; separation and storage of the oil, gas, and water; disposal of waste water; compression of gas; and associated activities. Production equipment and flowlines are necessary and integral parts of the production of the wells, and constrained by the locations and production characteristics of the wells.

The following areas require a permit and regulatory oversight by the respective state agency:

- If the project involves anything to do with the extraction of oil and gas one should contact the Michigan Department of Environmental Quality, Geological Survey Division.
- If the project involves pipeline transportation (beyond the point of first metering) of oil and gas one should contact the Michigan Public Service Commission.

Land/Water Margins

THERE is a set of statutes (and permits) which are required by the DEQ or the Department of Natural Resources which deal with activity in and at the edge of water (inland lakes, rivers, wetlands). Generally a person owns land to the water's edge. A riparian or litoral landowner also has a qualified ownership of the bottomlands. The state owns the water and its surface. Thus activity which is on the bottomland, enlarges or shrinks the water body, may interfere with the natural flow or navigation is subject to oversight and permits from the state.

For an illustration of statutes relating to land and water, see the chart on page 158. The following areas require a permit and regulatory oversight by the respective state agency:

- If the project involves any dredging proposed within 500 feet of a lake, river, stream, creek, or ditch, contact the Michigan Department of Environmental Quality, Permit Consolidation Unit, Land and Water Management Division.
- If the project involves an earth change activity within 500 feet of a lake or stream, creek or ditch, contact the Michigan Department of Environmental Quality, Land & Water Management Division, Soil Erosion & Sedimentation.
- If the project involves dredging, filling, or construction in, across, or under (1) a river, stream, creek, ditch, drain, lake, pond, or swamp (2) wetlands (3) floodplain (area that may have or ever had either standing or flowing water), contact the Michigan Department of Environmental Quality, Permit Consolidation Unit, Land and Water Management Division.
- If the project involves construction of a building or land alteration within 400 feet of a designated natural river or tributary, contact the Michigan Department of Natural Resources, Forest Management Division, Natural Rivers Program Unit.
- If the project involves construction of a building or section system in a designated Great Lakes high risk erosion area, contact the Michigan Department of Environmental Quality, Land and Water Management Division, Great Lakes Section.
- If the project involves dredging, filling, grading, or other alteration of the soil, vegetation or natural drainage, or placement of permanent structures in a designated environmental area contact the Michigan Department of Environmental Quality, Land and Water Management Division, Great Lakes Section.
- If the project involves development, silvicultural activities or contour alterations within a designated critical dune area, contact the Michigan Department of Environmental Quality, Land and Water Management Division, Great Lakes Section.

Solid Waste

THE State of Michigan and counties share aspects of solid waste management.[144] The DEQ is responsible for the design, oversight of operation, cleanup, and licensing of landfills and solid waste incinerators.

The following areas require a permit and regulatory

[144]Part 115 of P.A. 451 of 1994, as amended (being the Solid Waste part of the Michigan Natural Resources and Environmental Protection Act, M.C.L. 324.11501 *et. seq.*); formerly P.A. 641 of 1978, as amended, (being the Solid Waste Management Act, M.C.L. 229.401 *et. seq.*)

oversight by the respective state agency:

- If the project involves land filling, transferring, or processing solid non-hazardous wastes on-site, contact the Michigan Department of Environmental Quality, Waste Management Division, District office.

A county is responsible for adopting a solid waste plan which sets up a system to insure the county has a system to collect solid waste, transport it, and have a place (landfill, incinerator) for disposal of solid waste. The plan also must have a contingency (another place for solid waste to go should the current facility unexpectedly shut down), expansion of existing facilities and other plans to avoid an unexpected shut down, and possibly a system to site new solid waste facilities. The plan also must provide for transportation of solid waste across county lines. Solid waste can not be taken from one county to another unless both the sending county's and receiving county's solid waste plan specifically state that can happen. Finally, a county solid waste plan should provide for reduction, reuse, and recycling of solid waste before it is incinerated or land filled, if practical. A county solid waste plan is developed by a "solid waste planning agency," in Wexford's case the County Department of Public Works, and a 14-member "solid waste planning committee." The 14 members are established by statute and must represent solid waste industry (4), a major solid waste generator (1), environmental interest groups (2), county government (1), township government (1), city government (1), regional planning (1), and the general public (3).

Wexford County is part of the state's regional planning district for northwest Michigan. Other counties in the Northwest Michigan Council of Governments cooperated to do solid waste planning by jointly hiring a single consultant; resulting in realizing cost savings, better coordination, identification of collaboration possibilities. Wexford County did not participate in this regional effort.

A summary of the most recent Wexford County Solid Waste Plan follows:[145]

> Major conclusions resulting from the [solid waste] planning process include:
>
> The selected alternative is one of five explored by the Solid Waste Planning Committee and was selected because it continues the current system yet provides for taking advantage of additional resource recovery opportunities as they arise. This system will be easy to implement for that reason.
>
> Recycling has potential for the future, and its success will be dependant upon the willingness of local residents and business to engage in recycling and upon the viability of recycling markets.

Waste generated in the County is land filled in the licensed Wexford County [owned] Landfill in Cedar Creek Township. Consequently, Wexford County is relatively independent in terms of setting its own solid waste management policies and decision-making processes.

Within the county landfill there is [built cell] space to handle solid waste, at today's volumes, for 10 years. The county landfill has adequate land area to provide [future] capacity over the life of this plan [20 years] plus many years into the future. The plan includes siting criteria, should a new landfill be needed in Wexford County (pages III-26 to III-27). Criteria includes more than 1,000 feet from a dwelling, within ¼ mile of a class A road, and zoned Forest/Open space in the current Wexford Zoning or "similar district" in township zoning. Transfer stations must be in industrial or commercial zoned land; 300+ feet from a dwelling; on a Class A, collector street, or major road. A recycling facility must be consistent with the solid waste plan, no exterior storage of materials, have a means to control dumping of solid waste, accepts clean source-separated recyclable materials.

Missaukee County can bring solid waste into Wexford County, subject to a negotiated agreement. As an emergency backup Manistee (subject to agreement), Leelanau, and Clare counties might bring solid waste into Wexford County.

Should Missaukee ever have a landfill or incinerator in its borders, Wexford County would be able to bring solid waste into Missaukee County. As an emergency backup Wexford County might export solid waste to Manistee (subject to agreement), Leelanau, and Clare counties.

Transportation and collection of solid waste is undertaken effectively throughout the private sector.

There is limited recycling taking place within the County.

At the present time, landfilling is the most economically viable option for final disposal.

There is a need to provide hazardous waste collection and disposal opportunities to the County's residents.

The selected alternative (Alternative I) calls for continued use of the County Landfill for ultimate disposal, with expanded recycling, possibly including both a drop-off recycling collection and curbside system. A central processing facility for recycling may be established as an interim collection point before shipment to recycling markets. As an option, additional transfer station facilities with bins for drop-off recycling could be located within the County, with additional bins for recyclable materials.

The potential for cogeneration, using refuse

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[145]Wexford County Department of Public Works (Gove Associates, Inc.); *Wexford County Solid Waste Management Plan 2000 Update*; Wexford County; January 20, 2000; pages I-1 and III-4 to III-5(a) [brackets added for clarity].

derived fuel, should also be explored.

A household hazardous waste collection program may be instituted.

A Type III Landfill may be constructed to facilitate the disposal of foundry sand.

Since the plan was written the City of Cadillac has received a grant to start a hazardous waste collection system. The DPW and City of Cadillac is in the second year of a seven year grant to provide for hazardous waste collection and disposal.

Also the county was exploring creating a three-county recycling authority (with Manistee and Benzie Counties) for purposes of economy of scale and obtaining critical mass. Wexford chose not to do so, instead creating a smaller operation for an estimated $240,000 annual operating cost (compared to a $205,000 annual operating cost with the three counties) because of concern over public acceptance of the county sharing in investment in infrastructure that would not all be located within Wexford County and loss of total local control. Benzie and Manistee are proceeding with the joint project. The costs are estimates based on building purchase, renovation, new equipment. In both scenarios actual costs are expected to be lower, but will remain the same proportionate to each other.

The county has two drop-off recycling sites at this time. The county is looking at the possibility of six recycling drop off sites (two in the Cadillac area, one each at Buckley, Mesick, Manton, and Harrietta) in addition to a main site or material recycling facility. The Wexford DPW has purchased a building and land from Northwood Recyclers Inc. to establish the county's main recycling collection point at M-115 near E. 34 Road (Boon Road). Recycling includes newspaper, cardboard, number 2 plastic, glass, and tin.

Experience in other communities, throughout the state, show the most cost effective and successful program starts with a pro-active education and promotion strategies would encourage responsible solid waste management and strong reduce/reuse/recycle behavior. Pay As You Throw (PAYT) programs would be widespread throughout the County and heavily promoted. PAYT is a system where the individual discarding solid waste is required to pay for the disposal based on the volume discarded.[146] Thus an incentive to save money is achieved by reducing one's solid waste. Reuse, composting and recycling are methods to accomplish the reduction. Multiple convenient recycling drop-offs would encourage participation by more citizens and businesses. An outreach and education program would promote all aspects of the expanded system and improvements.

Ideally, Diversion Incentive Programs like volume-based (pay as you throw), recycle more, material bans, education, promotion should be a part of solid waste management in a county. To establish a successful recycling program, the following three principles should be followed:

1. Cooperate between the county DPW, municipalities, any of the county's agents or contractors to locate seven (7), or more, recycling drop-off facilities in Wexford County which, as a first priority, should be located in or near the following communities. This might be done through an agreement, or a interlocal agreement:
   - Buckley Village,
   - Mesick Village,
   - Manton City,
   - Harrietta Village,
   - Cadillac City near downtown,
   - Cadillac City near "Cadillac West",
   - Haring Township commercial area.
2. Cooperate between the county DPW, municipalities, any of the county's agents or contractors to locate each drop-off site within or near each community, listed above and any others which may be added in the future, in as much as possible to be at the following types of locations, in order of preference:
   - At a grocery store (North American Industry Classification System of 1997 (NAICS) number 4451)
   - At another food & beverage store (NAICS 445)
   - At a shopping center or mall
   - At general Merchandise Stores (NAICS 452)
   - At other retail trade stores (NAICS 44-45)
   - At a recycling processing facility
   - At a landfill, solid waste transfer station, department of public works.
   - At another location.
3. The design of the drop-off containers is very important to avoid contamination of recycled materials with garbage, and mixing of the various types of recycled materials. The design of the drop-off containers to accomplish this has been developed by Emmet County Department of Public Works – and is the model best suited for northern Michigan counties. The design incorporates clear signage attached directly to the drop-off container, and includes drop ports (the holes through which one puts the recyclables) of a particular shape and size that physically prevents garbage from being easily inserted, and physically prevents most mixing of recyclables. As a result Emmet County has virtually no mixed contaminated recyclable material.

Wexford County DPW (as of this writing, September 5, 2001) has placed recycle drop off containers at the Wexford County Landfill (for Manton), at Mesick at a vacant parcel of land owned by the Road Commission, and at the Northwood site at M-115 near E. 34 Road (Boon Road). The drop-off container portals and signage do not follow the Emmet model.

[146]Pay As You Throw (PAYT) is a volume based charge for disposal of solid waste. It includes pre-paid garbage bags, or bag limits for municipal collection, or graduated fees for level of service. It may include other techniques of limiting volume of solid waste disposed, or charging more for more solid waste being disposed. There are a number of flexible ways do this.

Public Opinion Survey on Environment

IN the opinion survey of Wexford residents, environmental issues received the highest number of responses (21%) to an open ended question on what the most important issue is that affects the quality of life in Wexford County.

A portion of the survey was devoted to exploring residents' beliefs about how county environment should be protected. These questions were introduced by interviewers as follows: "Many planning and zoning measures can be proposed to guide the use of private land or to protect the environment in the county." Respondents were then asked if they "strongly favor, favor, oppose, or strongly oppose a number of these measures." Responses are summarized in the next table, with measures receiving the strongest support listed first and those receiving the least support listed last.

Level of Support for Measures to Guide Land Use and Environmental Protection: Percentage Distributions and Means

	*Mean**	Strongly Favor	Favor	Oppose	Strongly Oppose	Don't Know
Regulations to protect ground water quality	*1.41*	60.6	36.4	2.2	0.0	0.7
Regulations to protect quality of lakes and rivers	*1.53*	49.3	46.3	3.2	0.0	1.2
Regulations to preserve vegetation along lakes and streams	*1.75*	33.4	55.9	6.7	1.2	2.7
Preserving vegetation strips along lakes and streams	*1.76*	30.7	57.9	5.9	1.0	4.5
State natural river concept	*1.95*	27.2	49.3	14.6	4.0	5.0
Limiting number of houses sharing lake access	*2.07*	23.3	40.8	23.0	3.2	9.7

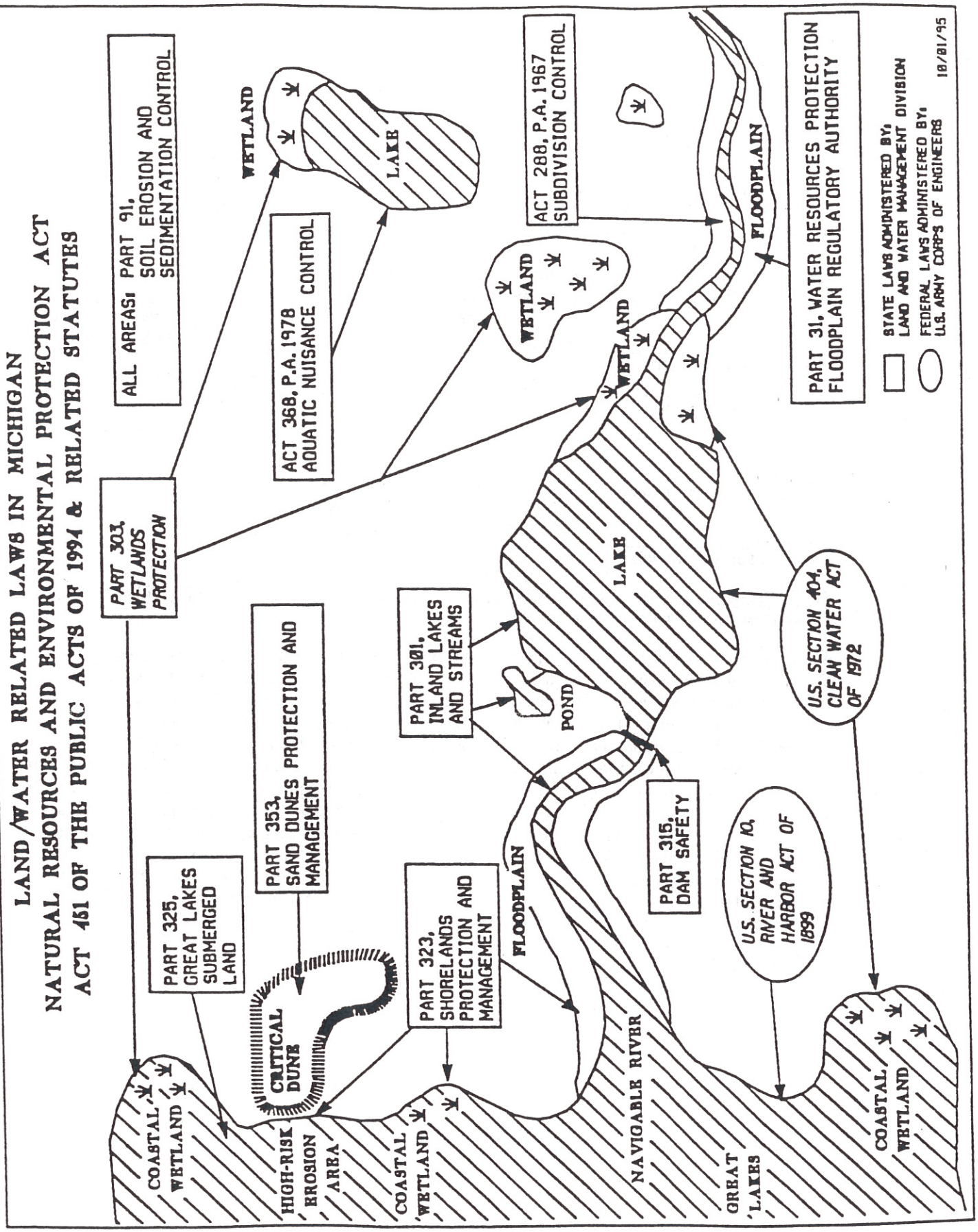
*The "strongly favor" response is given the numeric code of 1; "favor," is coded 2; "oppose" is given the code of 3; and "strongly oppose" is coded 4. "Don't know" responses are excluded when the mean is calculated.

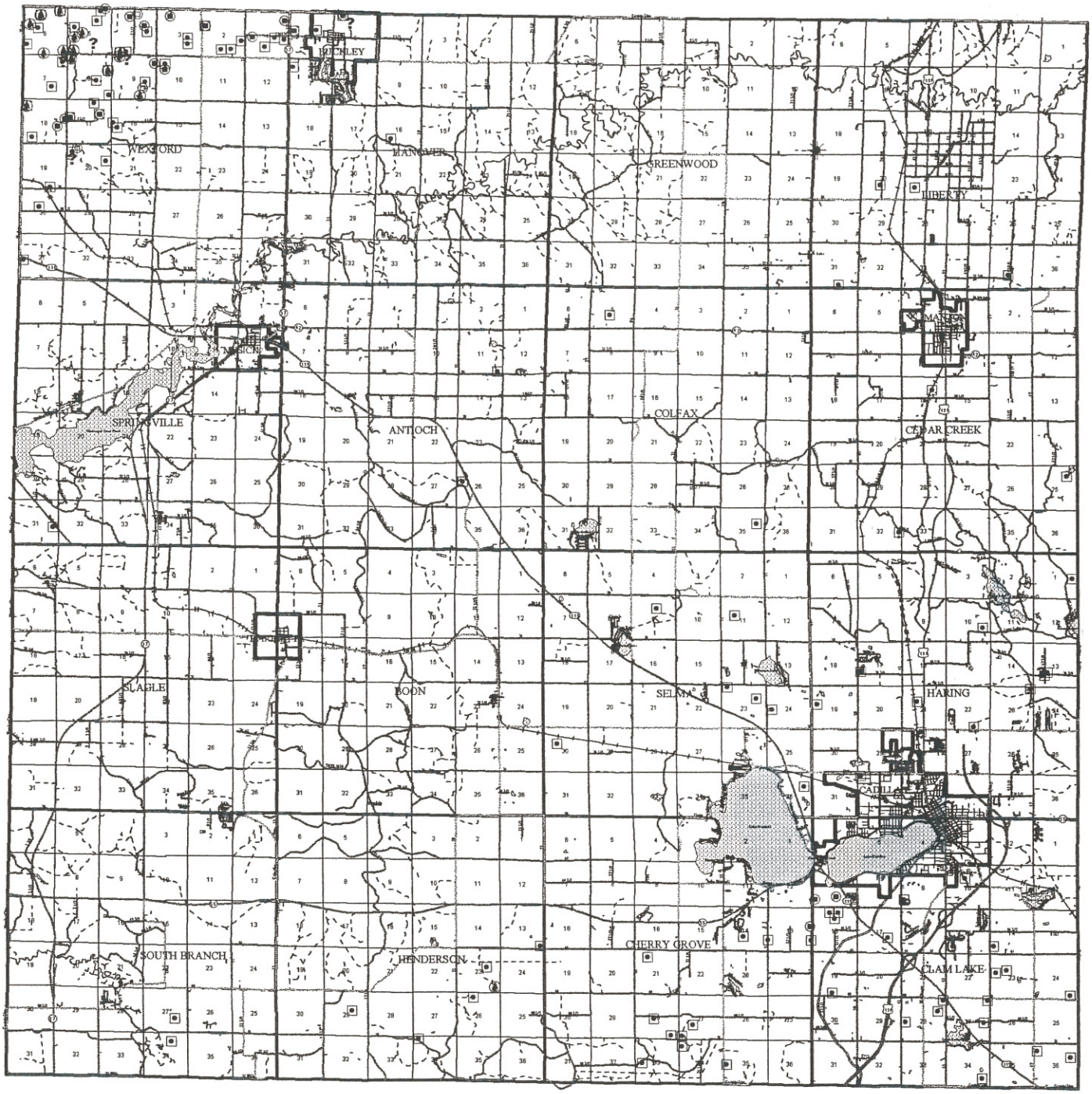
Strong support is expressed for the protection of water resources in the county. "Regulations to protect the quality of ground water" are "strongly" favored by about 60 percent of residents and are simply favored by more than 35 percent of them. Similarly, about one half of respondents say that they "strongly favor" "regulations to protect the quality of lakes and rivers," with another 46 percent saying that they "favor" this regulation.

Support for preserving vegetation strips along lakes and streams is also reasonably high, although the percentage of residents who "strongly favor" each of these measures is less than the percentage strongly favoring the protection of water quality in the county. Roughly one third of respondents "strongly favor" "regulations to preserve natural vegetation along lakes and streams," and "preserving vegetation strips along the shores of lakes and streams."[147] Relatively few residents oppose these measures.

About one quarter of respondents "strongly favor" "designating certain rivers in Wexford County as State Natural Rivers" (thereby limiting building close to the rivers and maintaining vegetation in its natural state), "strongly favor" "putting limits on the number of houses that can share access to a lake through one lakefront parcel of land." On the other hand, almost 20 percent of respondents oppose the State Natural River concept and the protection of environments labeled "special and unique," and opposition to limiting numbers sharing lake access through a single parcel of land is more than 25 percent.

[147]Two very similar statements about preserving lakeside and riverside vegetation were read to respondents. The term "vegetation strip" was used in one statement. This term was defined as "strips where plants are left to grow undisturbed."


LAND/WATER RELATED LAWS IN MICHIGAN
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT
ACT 451 OF THE PUBLIC ACTS OF 1994 & RELATED STATUTES
ALL AREAS: PART 91, SOIL EROSION AND SEDIMENTATION CONTROL
PART 303, WETLANDS PROTECTION
ACT 368, P.A. 1978 AQUATIC NUISANCE CONTROL
ACT 288, P.A. 1967 SUBDIVISION CONTROL
PART 31, WATER RESOURCES PROTECTION FLOODPLAIN REGULATORY AUTHORITY
PART 325, GREAT LAKES SUBMERGED LAND
PART 353, SAND DUNES PROTECTION AND MANAGEMENT
PART 301, INLAND LAKES AND STREAMS
PART 323, SHORELANDS PROTECTION AND MANAGEMENT
PART 315, DAM SAFETY
U.S. SECTION 404, CLEAN WATER ACT OF 1972
U.S. SECTION 10, RIVER AND HARBOR ACT OF 1899
WETLAND
LAKE
POND
FLOODPLAIN
NAVIGABLE RIVER
GREAT LAKES
COASTAL WETLAND
HIGH-RISK EROSION AREA
CRITICAL DUNE
STATE LAWS ADMINISTERED BY: LAND AND WATER MANAGEMENT DIVISION
FEDERAL LAWS ADMINISTERED BY: U.S. ARMY CORPS OF ENGINEERS
10/01/95



WEXFORD COUNTY ESTABLISHED ~ 1869

Oil and Gas Wells

Oil and Gas Wells

- Brine Disposal Well
- Dry Hole
- Gas Well
- Gas Condensate Well
- Oil Well
- ? Other

Highways

- State Highway
- County Primary
- County Local
- City Major
- City Minor
- Not Act 51 Certified
- Railroads
- White Pine Trail

N W E S

2 0 2 4 Miles

SOURCE: R-Map; Michigan Department of Environmental Quality, Supervisor of Wells, database on permitted extraction and deep-well disposal wells in Michigan.

Special Animals and Plants

THIS list includes those animals which are included on the Michigan March 5, 1999 Endangered Species List.[148] The listing of species found/seen in Wexford County is based on the Natural Heritage Biological and Conservation Datasystem lists,[149] Huron-Manistee National Forest Regional Forester's Sensitive Species for Wexford County, and other observations. The Natural Heritage Biological and Conservation Datasystem is an ongoing and continuously updated information base. The database is the only comprehensive single source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. But the database does not provide a definitive statement on the presence, absence, or condition of the natural features in Wexford County since the county has not been specifically or thoroughly surveyed for their occurrence. Furthermore plant and animal populations and natural communities change with time. Therefore, the information provided here should not be regarded as a complete statement on the occurrence of special natural features in the county. The list is based on what is currently or historically found in Wexford County.

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[148]Michigan Administrative Code (R299.1021 through R299.1028), adopted pursuant to part 365 of P.A. 451 of 1994, as amended, being the Endangered Species Protection part of the Michigan Natural Resources and Environmental Protection Act, M.C.L. 324.36501 *et. seq.* (formerly the Michigan Endangered Species Act, P.A. 203 of 1974, as amended, M.C.L. 299.221 *et. seq.*).

[149]Michigan Natural Features Inventory; *Natural Heritage Biological and Conservation Datasystem (Michigan County Element Lists)*; Internet URL www.msue.msu.edu/mnfi; February 2001.

Special Animals and Plants List for Wexford County

Common Name	Scientific: Species and (family)	Michigan List	United States List	Community in Which it Is Found in Wexford County
MUSSELS				
(none)				
INVERTEBRATE				
Grizzled skipper	Pyrgus wyandot	Special Concern		
SNAILS				
(none)				
INSECTS				
Karner blue butterfly	*Lycaeides melissa samuelis* (Lycaenidae)	Special Concern		Not Seen; Possible Habitat
FISHES				
(none)				
AMPHIBIANS				
(none)				
REPTILES				
Wood Turtle	*Clemmys insculpta* (Emydidae)	Endangered	Listed Endangered	Rivers & Adjacent Uplands
Blandings Turtle	*Emydoidea blandingii*	Special Concern		
Eastern Box Turtle	*Terrapene carolina carolina*	Special Concern		
BIRDS				
Coopers hawk	*Accipiter cooperi* (Accipitridae)	Special Concern		Breeding
Northern goshawk	*Accipiter gentilis*	Special Concern		Mature Pine and Hardwood
Red-shouldered hawk	*Buteo lineatus* (Accipitridae)	Threatened		Breeding; Mature Woods with Water
Northern harrier	*Circus cyaneus* (Accipitridae)	Special Concern		Breeding
Kirtland's warbler	Dendroica kirtlandii	Endangered	Listed Endangered	Accidental
Common loon	Gavia immer	Threatened		
Bald eagle	*Haliaeetus leucocephalus* (Accipitridae)	Threatened	Partial Status (federally listed in only part of its range)	Breeding
Osprey	*Pandion haliaetus* (Pandionidae)	Threatened		Breeding
Trumpeter Swan	*Cygnuis buccinator*		(Not listed: USFS sensitive species)	Lakes, Beaver Floodings

Common Name	Scientific: Species and (family)	Michigan List	United States List	Community in Which it Is Found in Wexford County
MAMMALS				
American Marten	*Martes americana*			
VASCULAR PLANTS				
Hill's thistle	*Circium hillii*	Special Concern		
Virginia bluebells	*Mertensia virginia*	Threatened		
Ginseng	*Panax quinquefolius*	Threatened		Hardwoods
Butternut	*Juglans cinerea*		(Not listed: USFS sensitive species)	Floodplains, Homesteads
COMMUNITY (Valued Habitat for Species Diversity, or Pre-european Settlement Pristine Condition)				
Bog				
Emergent marsh				
Hardwood-conifer swamp				
Geographical feature	*Kame*			
Landscape complex				
Mesic northern forest				
Scrub bog, upper midwest type	*Muskeg*			
Wet meadow, upper midwest type	*Northern wet meadow*			
Barrens, upper midwest type	*Pine barrens*			
Poor conifer swamp				
Rich conifer swamp				
Submergent marsh				
OTHER				
Great blue heron rookery				

Landtype Associations

MANAGEMENT of natural resources in Michigan is increasingly a multi-resource management of ecosystems. The material presented here is a summary of *Landtype Associations of The High Plains: Subsection VII.2*[150] and *Landtype Associations of The Newaygo Outwash*

[150]Corner, Richard A., and Dennis A. Albert; *Landtype Associations of The High Plains: Subsection VII.2* (Northern Lower Michigan Ecosystem Management Project, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, National Oceanic and Atmospheric Administration, United States Forest Service); Michigan Natural Features Inventory; Lansing, Michigan; May 1999.

Plain: Subsection VII.3.[151]

The United States is divided into large areas which are distinct landscape ecosystems. This system was developed by the United States Forest Service. Landscape ecosystems must be mapped at several scales because ecosystems occur in a nested hierarchy. Ecological classification allows natural resource managers to understand where and why ecosystems occur and provides a framework for:

- Integrated resource management and planning;
- biological conservation; and
- comparisons of species composition and productivity among ecosystems.

The classification system is divided into areas, listed here, from largest to smallest:

Domain
Division
Province
Section
Subsection
Sub-subsection
Landtype Association (LTA)
Ecological Land Type
Ecological Land Type Phase

This chapter reviews the section, subsection, sub-subsection, and Landtype Association (LTA) for Wexford County. See the map on page 183. Those classifications are:

Section VII: Northern Lacustrine-Influenced Lower Michigan
Subsection VII.2: Highplains
Sub-subsection VII.2.1: Cadillac
Landtype Association VII.2.1. 1111: Steep, broken moraine-ridges; few kettle lakes; excessively drained sand.
Landtype Association VII.2.1. 1222: Steep moraines; many kettle lakes; well drained sandy loam.
Landtype Association VII.2.1. 2111: Flat till plain; excessively drained sand or loamy soil.
Landtype Association VII.2.1. 2221: Broad moraine ridges; few or no lakes; well drained soils.
Landtype Association VII.2.1. 5111: Broad flat outwash plain; excessively drained sand.
Landtype Association VII.2.1. 5149: Broad, flat outwash plain; very poorly drained peat and muck.
Landtype Association VII.2.1. 5211: Pitted outwash plain; excessively drained sand.
Sub-subsection VII.2.2: Grayling Outwash Plain
Landtype Association VII.2.2. 1122: Steep, broken, moraine ridges; few kettle lakes; well drained sandy loam.
Landtype Association VII.2.2. 2211: Broad moraine ridges; few or no lakes; excessively drained sand or loamy soil.
Landtype Association VII.2.2. 2221: Broad moraine ridges; few or no lakes; well drained sand.
Landtype Association VII.2.2. 5111: Broad, flat outwash plain; few kettle lakes; excessively drained sand.
Landtype Association VII.2.2. 5122: Broad, flat outwash plain; well drained sandy loam.
Landtype Association VII.2.2. 5141: Broad, flat outwash plains; very poorly drained sand.
Subsection VII.3: Newaygo Outwash Plain
Landtype Association VII.3. 5111: Broad, flat outwash plain; few kettle lakes or wetlands; excessively drained sand.
Landtype Association VII.3. 5149: Broad, flat outwash plain; few kettle lakes; very poorly drained peat and muck.

Sub-subsection VII.2.1: Cadillac

This sub-subsection includes most of Wexford County, south of the Big Manistee River, east of the flat outwash plain found in the west part of the county. This subsection extends west into most of Missaukee County and south into Osceola, Mecosta Counties and adjacent counties.

The 2,731 sq, mile (7,079 km^2) Cadillac subsection is characterized by moderate to steep moraine topography and well to excessively well-drained sandy soils. Wetlands and lakes are not common because the sub-subsection is dominated by extremely thick deposits of well-drained, sandy till.

The sub-subsection is the second largest in northern Michigan and most (87%) of the land area of the sub-subsection is in private ownership. Based on overall percentages, it ranks 9th (6%) of 12 in state ownership and 6th in Federal ownership (7%). Further, the density of both highways and county roads is relatively high compared to other sub-subsections, ranking 4th and 3rd out of 12, respectively.

Changes in land use/land cover by major landforms:

About one half of the total surface area of the sub-subsection is characterized by steep or irregular moraine topography. About 65% of the steep moraines was covered by American beech/sugar maple forests during resettlement times. Natural disturbances, virtually all some type of windthrow, uncommon or white

[151]Corner, Richard A., and Dennis A. Albert; *Landtype Associations of The Newaygo Outwash Plain: Subsection VII.3* (Northern Lower Michigan Ecosystem Management Project, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, National Oceanic and Atmospheric Administration, United States Forest Service); Michigan Natural Features Inventory; Lansing, Michigan; May 1999.

pine/American beech/red maple forests, were also relatively extensive on moraines (25%). These forest types generally occurred where soils were relatively droughty, nutrient-poor sands. Further, these conifer forests often occurred where moraines were directly adjacent to droughty outwash plains and were thus exposed to wildfires originating on the plains.

Currently, only about 30% of the moraines in the sub-subsection remain covered by mesic northern hardwood forest. About 35% of the moraines has been converted to cropland or pasture, some of which is now old field, with another 16% converted to aspen/birch forests.

The remaining surface area of the sub-subsection is about evenly divided between till plain and outwash plain. In resettlement times, about 50% of the till plain was covered by forests dominated by American beech and sugar maple. Another 40% supported dry-mesic conifer forest. Wetland vegetation types, relatively common on the till plains, covered about 12% of the surface area in resettlement times and were primarily conifer swamps.

Relatively favorable soil conditions and level topography made the till plain valuable for agriculture. Consequently, about 50% of the natural vegetation has been converted to aspen/white birch forests. Hardwood swamps have become the most common wetland type of the till plain as conifer-dominated wetlands were converted following logging. Finally, only about 10% of the till plain supports the once-dominant deciduous forest.

Dry outwash plains within the sub-subsection supported resettlement vegetation very similar to the till plains, with northern hardwood forests covering about 50% and dry-mesic conifer forest covering about 40% of the sub-subsection. The remaining 10% supports a variety of wetland types, most notably conifer swamps.

In contrast to the till plain, only about 20% of the outwash plain has been converted to agriculture because of less favorable soil conditions. Aspen/white birch, a minor cover type in resettlement times, currently occupies about 16% of the dry outwash plain. About 20% of the overall cover is mesic northern hardwood or oak-dominated forest, and about 12% is upland conifer forest.

Poorly drained outwash plains were dominated by conifer swamps in resettlement times. However, upland forests, *e.g.* northern hardwoods and dry-mesic conifer forests (often with a significant component of white pine), occupied better-drained inclusions within these wetlands. These upland inclusions, though individually quite small, combined to cover a significant area of the poorly drained outwash plain (40%). Virtually all of the remaining surface area was dominated by conifer swamp, with only about 5% cover from hardwood swamp types.

Conifer swamps, originally the predominant wetland forest type, are now almost nonexistent, whereas hardwood swamps have increased in coverage from 5% to about 22% of the poorly drained outwash. Aspen/white birch forests now cover about 17% of the area. Currently, about 20% of the poorly drained plain is in agriculture and another 10% is old field. The upland inclusions of deciduous and conifer forests have largely been farmed and these forest types now cover only about 10% of the overall area.

Hydrology:

The hydrologic regimes of Michigan streams occur in a continuum between groundwater and surface-water dominated streams. Groundwater-dominated streams tend to occur in landscapes characterized by high elevation features, *e.g.* end moraines or ice-contact ridges, with coarse-textured soil (sands and gravels). In contrast, surface-water dominated streams tend to occur in flat or low-gradient landscapes with finer-textured soils, *e.g.* lake plains, till plains, and low elevation, fine-textured moraines. At one extreme, groundwater-fed streams tend to have relatively constant, cool to cold temperatures, stable base flows, and low peak flows. Characteristic fishes supported by these streams are species of sculpin, trout, and dace. In contrast, surface water streams have fluctuating, warmer temperatures, very low base flows, and high peak flows. Such streams are commonly referred to as flashy. Examples of fishes common to surface water-streams include sunfishes, mud minnows, and bullheads.

The low, hilly relief and coarse-textured soils of this sub-subsection result in rivers with hydrologic regimes intermediate between those expected from either surface-water-dominated systems or groundwater-dominated systems. Thus, in general, major rivers of Sub-subsection VII.2.1 are characterized by moderately stable base flows and moderate peak flows. The Muskegon River occupies a several mile-wide outwash channel, the largest in the sub-subsection. Other important rivers are the Pine, Little Manistee, and Little Muskegon. As these streams flow west into the deep sands of the Newaygo Outwash Plain, their hydrologic regime becomes much more groundwater dominated and, consequently, their base flows become quite stable with low peak flows.

Three large kettle lakes occur in outwash deposits within this sub-subsection: Cadillac, Mitchell, and Missaukee. Otherwise, lakes are not a common feature of the region.

Special plants, animals, and natural communities:

Prairie-smoke (*Geum triflorum*), a rare plant associated with dry, sandy prairies is known to occur in this sub-subsection as are three state threatened birds: bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and common loon (*Gavia immer*).

LTA 1111: Steep, broken moraine-ridges; few kettle lakes; excessively drained sand.

General description: LTA 1111 is the largest LTA in Sub-subsection VII.2.1 and covers about 23% of its area. In Wexford County, it is the high elevations to the north and west of the Cadillac City area (e.g. Cabefae ski, national forest and state forest lands.)

Glacial geology: LTA 1111 occurs on coarse-textured end moraines.

Topography and soil: Topography is steep and broken with slopes generally ranging between 6% and 40%. Kettle/kame topography occurs locally in Clare County and most units have some rolling to level areas mapped within. Soils, while variable, are usually sandy, excessively drained, and low to moderate in fertility, *e.g.* Rubicon, Montcalm, and Graycalm sands.

Presettlement Vegetation: Northern hardwood forests covered 43% of the LTA, whereas white pine/beech/red maple and American beech/hemlock forests covered 20% and 14% of the landtype, respectively. In addition, fire-dependent white pine/white oak and red pine/white pine forests collectively covered another 11% of the LTA. The remaining cover types, which including oak/pine barrens, were of limited areal extent.

Present Vegetation (MIRIS cover-types): Various types of hardwood forests persist on about 42% of the LTA, however, these are mostly second growth forests with a relatively high component of oak. Another 15% of the landform now supports aspen/white birch forests, which did not occur on the LTA in resettlement Michigan. Pine forests, much of them red pine plantations, occur on 10% of the landtype. Finally, agriculture is locally extensive, with 13% of the LTA in cropland, while another 10% is in abandoned fields, wastelands, or other open lands with herbaceous vegetation or shrubs.

Natural disturbances: Apart from one 40-acre windthrow in Osceola County, United States Government Land Office (GLO) surveyors did not mention natural disturbances in this LTA.

Lakes and streams: Streams are not a significant component of the landscape, although a few small and narrow ephemeral drainages occur. Lakes are not a significant component of the landtype.

Threatened and endangered species and exemplary natural communities: Several rare plants and animals are reported from this LTA, including four of six records for red-shouldered hawk in Sub-subsection VII.2.1., and the only records for eastern flat whorl snail, pine drops, and bastard pennyroyal. Many of these plants and animals are associated with mature forests (*e.g.* Red-shouldered hawks, northern goshawk, and ginseng) but some, such as the eastern flat whorl, occur in wetlands.

LTA 1222: Steep moraines; many kettle lakes; well drained sandy loam.

General description: LTA 1222 is the 3rd largest LTA in Sub-subsection VII.2.1. and covers about 9% of its area. The LTA is widely distributed throughout the sub-subsection, occurring in Wexford, Osceola, Missaukee, and Mecosta counties. In Wexford it occurs in the south part of Clam Lake Township

Glacial and bedrock geology: LTA 1222 occurs on coarse-textured end moraine.

Topography and soils: Topography is steep and broken, with localized hills and kettle/kame topography. Soils are well drained with moderately low fertility and moisture holding capacity, *e.g.* Emmet sandy loams and Montcalm loamy sands.

Presettlement vegetation: Seventy-five percent of the LTA supported northern hardwood forests of American beech and sugar maple, while American beech and sugar maple occurred on another 12%. The remainder of the LTA supported a variety of cover types, including limited acreage of several types of lowland conifers.

Present vegetation (MIRIS current land cover): Agriculture is now widespread on the LTA, with cropland covering about 34% of the area while pastures or abandoned lands of herbaceous vegetation cover another 21% collectively. Aspen/white birch forests, which did not occur here in mappable sized areas in resettlement Michigan, now cover about 10% of the LTA. Finally, second growth forests of northern hardwoods occur on about 11% of the landtype.

Natural disturbance: Although disturbance seems to have been rare in this LTA, GLO notes indicate that small windthrows occurred occasionally.

Lakes and streams: There are many lakes in this LTA and most are not connected to the surface drainage system. Although most lakes are small swales or kettle ponds, Rose, Silver, and Hog Back Lakes in Osceola County are 80 to 300 acres in surface area. Streams are generally small and narrow with low gradient valleys bounded by forested wetlands.

Threatened and endangered species and

exemplary natural communities: None reported to date.

LTA 2111: Flat till plain; excessively drained sand or loamy soil:

General description: LTA 2111, the 4th largest LTA covers about 2% Sub-subsection VII.2 and occurs in Mecosta, Wexford, Missaukee, and Clare counties. In Wexford it occurs in one spot, around Meauwataka.

Glacial and bedrock geology: LTA 2111 occurs on coarse-textured till plain.

Topography and soils: Topography is level to locally undulating or hilly. Soils are generally excessively drained or somewhat excessively drained sands with low to moderately low fertility, *e.g.* Graycalm and Kalkaska sands and Montcalm and Mancelona loamy sands.

Presettlement vegetation: Presettlement forests on this LTA often contained a large component of upland conifers, particularly hemlock and white pine. Forests dominated by mixtures of hemlock and American beech covered about 31% of the LTA, with forests of hemlock and white pine in the overstory covering another 18% Additionally, forests of white pine co-dominant with American beech and red maple covered 10% of the LTA. Northern hardwood forests of American beech and sugar maple were also quite extensive, covering about 19% of the LTA. Finally, cedar, tamarack, or mixed conifer swamps were extensive, covering 19% of the LTA.

Present vegetation (MIRIS current land cover): Conifer dominated forests, both upland and lowland, have been virtually eliminated from this LTA. In contrast, cropland now occurs on 25% of the landtype with unmanned fields of herbaceous vegetation occurring on another 8%. Aspen/white birch forests, an unimportant cover type in presettlement times, now cover about 20% of the LTA and second growth northern hardwood forests cover an additional 8%. Lowland hardwood forests, which now cover 7% of the LTA, have replaced conifers in wetlands.

Natural disturbance: GLO surveyors reported a few small, widely scattered windthrows within this LTA.

Lakes and streams: A few small kettle lakes occur in this LTA, along with several larger lakes in Mecosta County (*e.g.* the 180 acre Young Lake). Streams tend to be small, low gradient and ephemeral.

Threatened and endangered species and exemplary natural communities: Occurrences of both loons and osprey are reported from this LTA but neither species seem to show a strong relationship to this or other LTAs.

LTA 2221: Broad moraine ridges; few or no lakes; well drained soils.

General description: LTA 2221, which occurs in Lake and Osceola Counties and a small part of Wexford along the south county line in south Henderson Township, covers about 6% of Sub-subsection VII.2.1.

Glacial bedrock and geology: LTA 2221 occurs on coarse-textured end moraine.

Topography and soil: Topography ranges from level to broad rolling ridges and hills. Slope are usually less than 12%. Soils are dominated by the Rubicon-Montcalm-Graycalm association. Rubicon sand is excessively drained with low fertility and available moisture, Montcalm soils are well drained, loamy sands, and Graycalm soil is somewhat excessively drained sand with subsurface layers of loamy sand.

Presettlement vegetation: Fifty-four percent of this LTA supported northern hardwood forest of American beech and sugar maple. Most of the remaining area supported upland conifer-dominated forests types. Forests of hemlock mixed with American beech or white pine occupied 18% and 10% of the LTA's area, respectively. Mixed forests of white pine, American beech, and red maple were also locally extensive and occurred on another 10% of the LTA. Finally, red pine/white pine forests occurred on 6% of the land area presumably where soils were most droughty and fires most frequent.

Present vegetation (MIRIS current land cover): Aspen/white birch, a forest type that did not occur in mappable sized areas here in resettlement Michigan, now covers about 22% of the LTA. Agriculture is quite limited, with cropland occurring on only 7% of the LTA and pastures on only 5%. Abandoned fields now cover an additional 13% of the land area. Pine forest persists on about 17% of the LTA and hardwood forest on about 25%. However, these forests are largely composed of conifer plantations and second growth hardwoods in which the conifer component has been all but eliminated.

Natural disturbance: No natural disturbances were reported by GLO surveyors.

Lakes and streams: In Osceola County, streams are bordered by forested wetlands and have steep walled valleys. Otherwise, streams are generally limited to small headwater channels. Although very few lakes occur within this LTA, groups of small ponds occur locally.

Threatened and endangered species and exemplary natural communities: Apart from a single record for wood turtle, no special plants, animals, or natural communities are known from this LTA.

LTA 5111: Broad flat outwash plain; excessively drained sand:

General description: LTA 5111 ranks fifth

out of 26 LTAs in Sub-subsection VII.2.1 and covers about 4% of the sub-subsection. The LTA occurs in Lake, Missaukee, Mecosta counties. A very small part (about one square mile) occurs in Wexford County along the south county line in south-east Henderson Township (near Olga Lake).

Glacial bedrock and geology: LTA 5111 occurs on excessively drained outwash plain.

Topography and soil: Topography is level to gently rolling. Areas of pitted outwash, too small to map separately, occur locally. Soils are deep, excessively drained, acidic, and infertile, *e.g.* Grayling, Graycalm, Plainfield, and Mecosta sand.

Presettlement vegetation: Forests with white pine as a major component occurred on much of this LTA. Thirty percent of the LTA supported forest of white pine mixed with American beech and red maple and another seven percent supported red pine/white pine forests. Forests of American beech and hemlock were also extensive and occurred on 33% of the LTA. Much of the remaining area supported northern hardwood forests of American beech and sugar maple.

Present vegetation (MIRIS current land cover): The LTA has been fragmented into a wide variety of cover types, with the extent of conifer-dominated forests greatly reduced. Cropland is now the most common type and covers 22% of the LTA. Abandoned fields cover another 16%. Although pine and hardwood forests occur on 10% and 5% of the LTA, respectively, much of this is plantation or scattered, second-growth woodlots. Finally, wetlands support lowland hardwood forests. (GLO coverage suggests that much of what has been mapped by MIRIS as wetland may, in fact, be upland hardwood forest.

Natural disturbance: GLO surveyors frequently reported the occurrence of wildfire within this LTA.

Lakes and streams: Streams tend to be low gradient, gently meandering, and groundwater fed. In addition, many large, highly meandering rivers occur within this LTA, including the Muskegon, Little Muskegon, Clam, and Little Manistee. A few small, widely scattered kettle lakes also occur within the LTA.

Threatened and endangered species and exemplary natural communities: A single record for loons and two for great blue heron rookeries are reported from this LTA. However, these species do not seem to show a strong relationship to LTAs.

5149: Broad, flat outwash plain; very poorly drained peat and muck.

General description: In size, LTA 5149 ranks seventh out of 26 LTAs in Sub-subsection VII.2.1. and covers about 4% of the sub-subsection (Table VII.2.1.B). This occurs around Lake Mitchell in Wexford County.

Glacial and bedrock geology: LTA 5149 occurs on poorly drained glacial outwash plains.

Topography and soils: Topography is level or gently undulating. Soils are generally very poorly drained organic with inclusions of poorly to moderately well drained sands occurring locally.

Presettlement vegetation: Over one half of this LTA supported various types of conifer swamps, including mixed lowland conifers (30%), cedar (18%), or tamarack (6%) swamps. Forests of hemlock mixed with American beech (9%) or white pine (8%) were common on sandy areas of intermediate drainage, whereas forests of American beech and sugar maple occurred on sites with moderately well drained soil.

Present vegetation (MIRIS current land cover): While lowland conifer forests persist on only 14% of the LTA, lowland hardwoods, which covered less than 1% of this LTA in presettlement times, now cover 17%. Similarly, aspen/white birch forests, uncommon in presettlement times, also cover 17% of the area. In addition, cropland covers 14% of the LTA and old fields cover another 16%.

Natural disturbance: No natural disturbances were reported by GLO surveyors.

Lakes and streams: A few, widely scattered kettle lakes and marshy ponds occur within the LTA. Along with many small, linear streams, several large, highly meandering rivers occur within this LTA *e.g.* the Muskegon, Clam, and West Branch of the Clam Rivers.

Threatened and endangered species and exemplary natural communities: Exemplary occurrences of a number of natural communities, mostly wetlands types, are reported from this LTA. In addition, single records of osprey and bald eagles, along with two for wood turtle, are reported from the LTA.

5211: Pitted outwash plain; excessively drained sand.

General description: LTA 5211 ranks fourth of 26 LTAs in surface area and covers about 7% of Sub-subsection VII.2.1. (Table VII.2.1.B). The LTA is widely distributed and occurs in Mecosta, Montcalm, Clare, and Wexford counties. In Wexford it is the low areas between Lake Mitchell and the higher elevations (LTA 1111) farther out around Cadillac City area. This LTA also follows both sides of Manton (Cedar) Creek south of the City of Manton.

Glacial and bedrock geology: LTA 5211 occurs on excessively drained, pitted outwash plain.

Topography and soil: Topography is level to strongly undulating. Melting of glacial ice blocks has resulted in the creation of numerous

shallow depressions and kettle lakes. Soils are deep, excessively drained sands with low natural fertility, *e.g.* Rubicon, Montcalm, Graycalm, and Kalkaska sands. In addition, many kettle depressions contain very poorly drained organic soils.

Presettlement vegetation: Vegetation types were variable within and among units of 5211 and this resulted from variable combinations of landscape position, soil chemical and physical properties, and fire frequency. Forests of American beech and sugar maple were concentrated on units in the northwestern portion of the sub-subsection and covered 34% of the LTA. These units were less fire prone than others and had comparatively favorable soil conditions. Other LTAs within the sub-subsection supported a variety of conifer dominated forests, *e.g.* red pine/white pine, white pine/beech, red maple, or beech/hemlock. Lowland conifer was the most common wetland type and occurred on about 6% of the LTA.

Present vegetation (MIRIS current land cover): About 13% of this LTA has been converted to cropland with another 6% in wastelands or other unmanned shrublands. Further, aspen/white birch forests have increased in overall acreage from less than 1% presettlement cover to about 13% today. Northern and central hardwood forests (the latter containing a higher percentage of basswood and oak) collectively cover another one fourth of the LTA, whereas pine forests persist on about 13%. However, much of this remaining forest is pine plantation or scattered, second growth woodlots. The remaining area within the LTA has been converted to wide variety of covertypes of limited extent.

Natural disturbance: GLO surveyors occasionally reported windfalls within this LTA.

Lakes and streams: Numerous kettle lakes of all sizes occur throughout this LTA.. The largest of these, Lake Missaukee, covers about three square miles. Streams are generally low gradient and bordered by forested wetlands, *e.g.* Clam River and Gunnerson Creek.

Threatened and endangered species and exemplary natural communities: Records for several exemplary wetlands occur within the LTA, including both emergent and submergent marshes, bogs and rich conifer swamp. Additionally, several important species of birds are reported from the LTA, including loons, bald eagles, osprey, and red shouldered hawk. Further, four of six known records for goshawk in the sub-subsection occur in this LTA, along with the only record of Blanding's turtle.

Sub-subsection VII.2.2: Grayling Outwash Plain

This sub-subsection includes that part of Wexford County along and north of the Big Manistee River. It also extends into the southern part of Grand Traverse County, northern and eastern parts of Missaukee County. It includes all or nearly all of Kalkaska, Roscommon, Crawford, Oscoda, and Ogemaw Counties.

The 10,525 km^2 (4,061 mi^2) Grayling Outwash Plain Sub-subsection is characterized by a mosaic of steep ice-contact ridges within an extensive glacial outwash plain. The elevation of the sub-subsection is relatively high and due to its interior location, climatic extremes are among the greatest in the state.

The sub-subsection is the largest in Northern Lower Michigan and also contains the most public land. Forty-two percent of the sub-subsection is state-owned and 27% is in federal ownership (1st and 3rd compared to other sub-subsections, respectively). The remainder (48%) of the sub-subsection is privately owned. Further, the density of highways is intermediate compared to other sub-subsections whereas the density of county roads is relatively low, ranking 9th of 12 for the northern lower Michigan.

Changes in land use/land cover by major landforms:

Over 60% of the sub-subsection is glacial outwash plain, including both level and pitted plain, with soils ranging from excessively drained sands to very poorly drained organic soils. The remainder of the sub-subsection consists primarily of sandy ice-contact ridges (20%), rolling till plains (80%), and relatively steep end moraines (6%).

Most of the glacial outwash plain (70%) is well or excessively drained. The presettlement vegetation of the well drained outwash plains was variable, but predominantly xeric conifer forests and pine barrens (43%) on the most fire prone sites, while deciduous forests of American beech and sugar maple (26%) occupied the least fire prone sites. Wildfires were common and often spread for many miles, especially where plains were expansive and without natural fire breaks such as steep ridges or less flammable hardwood-dominated till plains.

Conifer forest remains the dominant cover type of well-drained outwash plains (36%), but due to fire suppression and conversion to extensive conifer plantations, the extent of pine barrens has been greatly diminished. The overall acreage of mesic hardwood forest (21%) on the plains has changed little, but the extent of aspen/white birch forest has increased from 1% to 16%.

Poorly drained outwash plain, though not as extensive as well drained outwash, covers about 17% of this sub-subsection. The poorly drained outwash was dominated by conifer swamps (50%). However, types such as dry-mesic conifers and

northern hardwoods were both common on upland inclusions within the poorly drained plain, covering about 35% of the landform.

Aspen/white birch forest is currently the most common forest type on poorly drained outwash and covers about 30%. Conifer swamps, originally the predominant wetland forest type, have decreased substantially from 53% to 18%. In contrast, hardwood swamps have increased from 3% in presettlement times to 18%. The remainder of the poorly drained outwash consists of numerous types, each with relatively low overall coverage.

Ice-contact ridges, a characteristic landform, cover about 18% of the sub-subsection. The ice-contact features occur as very large, sandy ridges and are often surrounded by outwash plain. Presettlement vegetation was characterized by American beech/sugar maple forests (39%), dry-mesic forests (33%) such as white pine/red pine or white pine/American beech/red maple, and dry conifer forests of jack pine (25%). Ridges with excessively drained sandy soils or those surrounded by large, fire-prone, outwash plains, from which wildfires readily spread, often supported coniferous forests. In contrast, ridges with more favorable soil conditions or those more isolated form fire-prone outwash plains by lakes, large streams, or wetlands, tended to support deciduous forest types.

The extent of hardwood forest on the ice-contact ridges is currently very similar to presettlement times (42%). However, the coniferous forests have been greatly reduced in overall extent from 58% to 12% cover. Further, aspen/white birch forests have increased dramatically from less than 1% to about 30% cover. Finally, about 8% of the surface area of ice-contact ridges is now in old field.

For the most part, the remainder of the sub-subsection consists of till plains and end moraines. Presettlement vegetation of the till plains was largely American beech/sugar maple forests (85%). Although this forest type is still common (27%), the till plain has become highly fragmented into numerous cover types, the most common being cropland (30%), old field (14%), conifer forest (11%), and aspen/white birch (7%).

End moraines were also dominated by mesic American beech/sugar maple forests (55%), but significant coverage of dry-mesic (20%) and dry (19%) conifer forests also occurred. About one half the surface area of the end moraines remains covered by mesic deciduous forests (47%). However, like the till plains, the end moraines have been fragmented into numerous cover types, the most common being cropland (15%), old field (8%), aspen/white birch (12%), and conifer forest (11%).

Hydrology:

The hydrologic regimes of Michigan streams occur in a continuum between groundwater and surface-water dominated. Groundwater-dominated streams tend to occur in landscapes characterized by high elevation features, *e.g.* end moraines or ice-contact ridges, with coarse-textured soils (sands and gravels). In contrast, surface-water dominated streams tend to occur in flat or low-gradient landscapes with finer-textured soils, *e.g.* lake plains, till plains, and low elevation, fine-textured moraines. At one extreme, groundwater-fed streams tend to have relatively constant, cool to cold temperatures, stable base flows, and low peak flows. Example fishes supported by these streams are species of sculpin, trout, and dace. In contrast, surface water streams are commonly referred to as flashy. Examples of fishes common to surface-water streams include sunfishes, mud minnows, and bullheads.

Three major streams, the Manistee, Au Sable, and Muskegon Rivers, plus their many tributaries, originate on extensive outwash plains within Sub-subsection VII.2.2. The catchments of the Au Sable and Manistee Rivers are characterized by high, coarse-textured ice-contact and end-moraine features and vast expenses of coarse-textured outwash plain. This combination of steep topography and coarse-textured soils and coarse-textured soils results in hydrologic regime dominated by groundwater, which in turn, results in high, stable base flows and low peak flows. Most tributaries of these streams are characterized by a similar hydrologic regime. Th headwaters of the Muskegon River occur to the west of Houghton Lake in the large wetland complex called the Dead Stream Swamp. The hydrologic regime of the Muskegon River is more surface water influenced than either the Manistee or Au Sable rivers, but is also fed by moderate amounts of groundwater. Thus, the Muskegon has a fair base flow with moderate peak flows.

Many of the largest inland lakes in northern Michigan occur within this sub-subsection, including Houghton and Higgins lakes and lakes Margrethe and St. Helen. These kettle lakes occur on broad expanses of outwash plain and were formed from large blocks of ice left behind by retreating glaciers, as were several other smaller lakes.

Special plants, animals, and natural communities:

This sub-subsection provides critical nesting habitat for virtually the entire breeding population of federally endangered Kirtland's Warbler (*Dendroica kirtlandii*). The vast outwash plains within the sub-subsection also support most of the remaining jackpine barrens in northern Lower Michigan. Further, virtually all known occurrences

of prairie agoseris (*Agoseris glauca*) and rough fescue (*Festuca scabrella*), both state-threatened plants with northern prairie affinity, occur within this sub-subsection.

LTA 1122: Steep, broken, moraine ridges; few kettle lakes; well drained sandy loam.

General description: LTA 1122, which is concentrated in Oscoda County, covers less than 1% of Sub-subsection VII.2.2. In Wexford it occurs as a small area (about 2 square miles) just north of Manton City in south Liberty Township.

Glacial and bedrock geology: LTA 1122, while mapped by geomorphologists as ice-contact, has loamier soils than most ice-contact in this area, and thus treated as similar moraine features.

Topography and soil: Topography is steep and broken and soils are dominated by well-drained sandy loams and moderate fertility, primarily, Emmet and Ogemaw sandy loams.

Presettlement vegetation: Sixty percent of the LTA supported northern hardwood forests of American beech and sugar maple. Additionally, aspen/white birch forests, an uncommon cover type in presettlement times, covered about 23% of the LTA, compared to about 60% presettlement cover, whereas aspen/white birch forests cover an area similar to its former extent (18% vs. 23% presettlement). The remaining area now consists of pine forest, probably plantation, which did not occur here in presettlement Michigan, and various other forest types with less than 5% cover.

Natural disturbance: No natural disturbances were reported by GLO surveyors.

Lakes and streams: There are a few widely scattered kettle lakes and impoundments within the LTA. Many narrow streams occupy steep valleys, creating highly dissected moraine ridges.

Threatened and endangered species and exemplary natural communities: Apart from the single record for secretive locust, an uncommon insect usually associated with jack pine savannas, no special plants, animals, or natural communities are reported from the LTA (Table VII.2.2.E).

LTA 2211: Broad moraine ridges; few or no lakes; excessively drained sand or loamy soil.

General description: LTA 2211, which is concentrated in Manistee and Wexford Counties, covers about 2% of sub-subsection VII.2.2. It is found along the western edge of Springville and Wexford Counties, (Harlan area) north of the Big Manistee River.

Glacial geology: LTA 2211 occurs as course-textured end moraine.

Topography and soils: Topography is relatively level with steep, incised valleys occurring locally. The dominant soil type is Roselawn loamy sand, a somewhat excessively drained soil with relatively low fertility and moisture availability. There are also significant acres of Rubicon loamy sand and sandy loam. Rubicon loamy sand is characterized by excessive drainage and very low organic matter. Due to the higher percentage of fine particles throughout its profile, Rubicon sandy loam is not as droughty as either Roselawn or Rubicon loamy sand.

Presettlement vegetation: Northern hardwood forests of American beech and sugar maple covered 94% of the LTA in presettlement times. Forests of white pine mixed with American beech and red maple also occurred locally.

Present vegetation (MIRIS current land cover): The LTA has become fragmented into a variety of cover types and 15% of the LTA supports forest types with less than 5% cover. Aspen/white birch forests, which did not occur in mappable sized areas in presettlement times, now cover about 43% of the LTA. Second-growth northern and central hardwood forests (both dominated by American beech and sugar maple but the later type containing relatively more oak and basswood) now collectively occur on another 27% of the area. Finally, cropland occupies about 7% of the landtype, with old fields on another 9%.

Natural disturbance: GLO surveyors reported the occurrence of several windthrows, some as large as 6 to 10 sq. miles.

Lakes and streams: Streams are generally small and narrow with deeply incised valleys. In addition, there are many ephemeral drainages with similar valley characteristics. There are very few lakes within the LTA and these are usually small kettle ponds completely choked with aquatic vegetation.

Threatened and endangered species and exemplary natural communities: Apart from a single observation of bald eagle, no special plants, animals, or natural communities are reported from the LTA.

LTA 2221: Broad moraine ridges; few or no lakes; well drained sand.

General description: In size, LTA 2221 ranks tenth of 35 LTAs and covers about 2% of Sub-subsection VII.2.2. In Wexford it is a small area along the north county line north of Baxter Bridge and a half square mile at the northeast corner of the county.

Glacial and bedrock geology: LTA 2221 is associated with coarse-textured end moraine.

Topography and soils: Topography is characterized by broad rolling hills and ridges. Slope classes range from 0% to 12%. Soils are predominantly by Montcalm and Kalkaska loamy sands, and Emmet and Rubicon sands. These soils are deep, well drained, and moderately low in fertility and available moisture.

Presettlement vegetation: Ninety-one percent of the LTA supported northern hardwood

forests of American beech and sugar maple. Wetlands were forested with various types of lowland conifers.

Present vegetation (MIRIS current land cover): The LTA has become quite fragmented with 19% consisting of various types with less than 5% cover. Cropland, now the most wide spread cover type, occurs on about 29% of the LTA with old fields occurring on another 13%. Pine forests, which occurred on only about 2% of the LTA in presettlement times, now cover 20%; these are largely plantations. Northern hardwood forests also occur on 20% of the LTA, however, this represents a significant reduction compared to presettlement acreage.

Natural disturbance: GLO surveyors reported the occurrence of a small wild fire entering this LTA from an adjacent outwash plain.

Lakes and streams: There are no lakes within this LTA. The headwaters of the Boardman and Manistee Rivers occur within this LTA; these are small, with steep banks.

Threatened and endangered species and exemplary natural communities: One exemplary bog and a single record for bald eagle are reported from the LTA.

LTA 5111: Broad, flat outwash plain; few kettle lakes; excessively drained sand.

General description: LTA 5111 is the largest of 36 LTAs in Sub-subsection VII.2.2 and covers nearly 30% of its area. Large units of the LTA occur in every county within the sub-subsection. In Wexford it occurs in the Mesick and Bagnall areas in north Springville and south Wexford Townships, and at the north county line where U.S.-131 enters the county from the north.

Glacial and bedrock geology: LTA 5111 occurs on deep, sandy deposits of glacial outwash.

Topography and soils: Topography is level to gently rolling or undulating, with steeper slopes occurring along entrenched streams and in the few, widely scattered, ice-block depressions. Grayling sand, a deep, excessively drained, acidic soil with low natural fertility, is the predominant soil. Inclusions of Rubicon and Kalkaska sands, which have somewhat more favorable moisture holding capabilities than do Grayling sand, are also mapped within the LTA. Scattered areas of poorly drained organic soil, too small to map as separate units, are also included in LTA 5111.

Presettlement vegetation: Presettlement vegetation was variable but dominated by fire-dependent, conifer forests, *e.g.* Jack pine, Red pine/white pine, and pine or oak/pine barrens. Northern hardwood forests of American beech and sugar maple were also locally extensive on the LTA, particularly in Wexford and Kalkaska counties, where the narrow outwash plain was less fire prone. Northern hardwoods seemed to show a good correlation with areas underlain by Kalkaska sand.

Present vegetation (MIRIS current land cover): The LTA has become quite fragmented and 27% of its surface area supports cover types with less than 5% individual cover. Although 42% of the LTA still supports pine forests, much of this is red or jack pine plantation. Aspen/white birch forest, a type that did not occur here in presettlement times, now occurs on 14% of the area. Finally, second-growth northern hardwoods occur on another 8% of the LTA.

Natural disturbance: GLO surveyors frequently reported the occurrence of large wildfires within LTA 5111. These fires were among the largest in the state, covering several square miles. Windthrows, sometimes in combination with wildfire, were also often reported.

Lakes and streams: Many important rivers and major tributaries occur within LTA 5111, *e.g.* the Boardman, South Boardman, Au Sable, Pine, and Manistee river systems. These major rivers tend to be large, highly meandering, and bordered by forested wetlands. Often, the valleys of these larger rivers are distinct from the surrounding landscape such that they are separated into different LTAs. Smaller streams and tributaries often are relatively linear with steep, deeply entrenched valleys.

Although the number of lakes per unit area in LTA 5111 is low, there are a large number of kettle lakes overall. The majority of these are relatively small seepage lakes, 5 to 40 acres in area. Mack Lake in Otsego county is surface drained.

Threatened and endangered species and exemplary natural communities: A very large number of special plants, animals, and natural communities occur within LTA 5111 and their individual habitat requirements are quite variable. Although the large number is partly an artifact of the large size of the LTA, many of the plants, animals, and communities seem to show a strong correlation to the LTA, including pale agoseris, Hill's thistle, rough fescue, Allegheny plum, secretive locust, dusted skipper, and Kirtland's warbler. These are all occupants of the dry sand prairies and jack pine barrens which characterize the fire prone outwash plain of this LTA.

LTA 5122: Broad, flat outwash plain; well drained sandy loam.

General description: LTA 5122, which occurs in Grand Traverse and Wexford counties, covers about 1% of Sub-subsection VII.2.2. In Wexford it is found in the better farm soil areas of Wexford Township west of Buckley.

Glacial geology: LTA 5122 occurs as glacial outwash plain.

Topography and soils: Topography of

LTA 5122 is level with slopes usually less than 6%. Soils are predominantly well to excessively well drained sandy loams and loamy sands.'

Presettlement vegetation: As a result of both loamy soils and fire barriers to the west, presettlement vegetation was almost exclusively (94%) northern hardwood forests dominated by American beech and sugar maple. Much of the remaining area was wetland which supported cedar or mixed conifer swamps.

Present vegetation (MIRIS current land cover): Because of the loamy soils, much of the LTA is well suited to agriculture and 60% of its area has been converted to cropland. As a result, northern hardwoods, which once covered 90% of the LTA, now occur on only about 15% of the area. Conversely, pine forests, which did not occur on about 6% of the area; these are largely plantations. The remainder of the LTA supports a variety of cover types of limited individual extent.

Natural disturbance: No natural disturbances were reported by GLO surveyors.

Lakes and streams: A few small kettle lakes and narrow, tightly meandering streams occur within this LTA.

Threatened and endangered species and exemplary natural communities: Single records for two natural communities, bog and mesic northern forest, are reported from this LTA.

LTA 5141: Broad, flat outwash plains; very poorly drained sand

General description: LTA 5141, which occurs only in Oscoda County [*sic*], covers only about 1% of Sub-subsection VII.2.2. In Wexford County it is found at Sherman following both sides of Cole Creek, Wheeler Creek and the Big Manistee River for about three miles.

Glacial and bedrock geology: LTA 5141 occurs as poorly drained glacial outwash.

Topography and soil: Topography is generally level and soils are predominately poorly or very poorly drained Saugatuck and Newton sands.

Presettlement vegetation: Forests of American beech and sugar maple, found on better drained areas, covered about one fourth of the LTA, while forests of aspen and white birch covered 19%. Aspen also occurred in relatively pure stands within wetlands. However, most wetlands supported various types of lowland conifers, which collectively covered 43% of the landtype. About 11% of the lowland-conifer forests also contained a significant component of lowland hardwoods.

Present vegetation (MIRIS current land cover): The LTA as become quite fragmented and 22% of its area supports cover types with less than 5% individual cover. Aspen/white birch forests have increased slightly over presettlement levels and cover only 28% of the LTA. Lowland conifers have been significantly reduced in acreage and now cover only 10% of the LTA vs. 43% presettlement cover. Some former lowland-conifer forests have been converted to agriculture, lowland hardwoods, or shrub/scrub wetlands, which now cover 7%, 10%, and 6% of the LTA respectively. Finally, 8% of the LTA is upland old fields.

Natural disturbance: No natural.

Lakes and streams: Several miles of the Au Sable River and its natural tributaries flow through the extensive forested wetlands of this LTA. There are no lakes.

Threatened and endangered species and exemplary natural communities: Single occurrences of both wood turtle and bald eagle are reported from the LTA.

Subsection VII.3.: Newaygo Outwash Plain

The subsection includes a small area of Wexford County – the flat area along the west edge of the county south of the Big Manistee River along M-37. The subsection also includes the east and central part of Manistee County, east part of Benzie County, west part of Grand Traverse County, west and central part of Lake County, east part of Mason County, and most of Newaygo County.

The subsection has been divided into 21 LTA types.

LTA 5111: Broad, flat outwash plain; few kettle lakes or wetlands; excessively drained sand.

General description: LTA 5111 is the most extensive LTA in the Subsection. In most counties within Subsection VII.3, it occurs as expansive units. In Wexford County nearly all of subsection VII.3 is LTA 5111: the flat area along the west edge of the county south of the Big Manistee River along M-37, except for the headwaters of Arquilla Creek and Hinton (a.k.a. Little Bear) Creek.

Glacial and bedrock geology: LTA 5111 occurs on broad expanses of glacial outwash plain. These broad plains are typically characterized by deep deposits of sand. The LTA is part of a mosaic of other outwash LTAs including 5121, 5131, 5149, 5211, 5221, 5522, 5541, 5542, and 5549.

Topography and soils: Topography of LTA 5111 is level and flat with only localized kettle lakes or wetlands. In Wexford County, parallel, incised channels are deeply eroded into the plain. The 0-2% and 2-6% slope classes characterize most of the LTA. Soils are generally mapped as associations of Rubicon-Grayling,

Grayling-Graycalm, or Plainfield sands, all of which are excessively drained deep sand. In Wexford County, soils are also classified as Kalkaska sand, which is also excessively drained. Slope classes as steep as 40% are encountered on the sides of the floodplain in Wexford County. There are local inclusions of steeper end moraines within this LTA.

Presettlement vegetation: Presettlement vegetation was variable among LTA 5111 units, with upland conifers dominating most of the land surface. Most of these conifer forests were dependent upon wild fires for establishment and persistence, with fire frequency and severity largely determining vegetation dominance. Other environmental factors determining forest composition included outwash size, shape, location, and orientation, local microclimate, and local soil moisture holding capacity. The broadest, most fire-prone expanses of flat outwash plain supported oak/pine barrens, pine barrens, and upland prairie along with large expanses of jack pine forest, red pine/jack pine forest, and red pine/oak forest. On sites with less severe and less frequent fire, often near the western edge of the plain, forests were white pine white pine/red pine, and hemlock/white pine. Forests of northern hardwood or mixed northern hardwood/conifer occurred locally within the district, primarily where there was good fire protection, either on small moraine ridges or on the lee side of natural fire breaks. The largest expanses of northern hardwoods occurred in Grand Traverse, Benzie, and Leelanau counties.

Present vegetation (MIRIS current landcover): The MIRIS current land cover maps show LTA 5111 essentially covered with hardwood and conifer woodland. Some small aspen/birch woodlands and open barren lands are scattered through the hardwood/conifer mosaic. Agriculture is very limited.

Natural disturbance: Several large areas of fire noted in the GLO surveys were within the jack pine dominated forests, often covering several square miles in a single burnt area. These burnt areas were denoted as "burnt pine land", "spruce pine opening," or "burnt pine plains". Windthrows were also common, but these disturbances were generally smaller in area. General Land Office (GLO) survey notes revealed no indications of natural disturbance at the norther end of the district, in Leelanau, Grand Traverse, and Benzie counties.

Lakes and streams: LTA 5111 contains several major streams, including the Muskegon, White, Betsie, Platte, Pere Marquette, and Little Manistee Rivers. These streams generally deeply dissect the sand plain and have relatively narrow floodplains. They are ground-water fed and are noted for stable water levels and temperatures, making many of them among the best of Michigan's trout streams. Each of these large streams is connected to a network of small headwater streams, small drainage lakes, and wetlands. Large lakes are not common, but there are areas with small kettle lakes, most of which are less than 50 acres in size; many of these are seepage lakes with no apparent surface drainage.

Threatened or Endangered Species and Exemplary Natural Communities: LTA 5111 is the most important LTA in the Subsection with respect to occurrences of rare species and exemplary communities. Many of these are rare plants and insects that have habitat requirements associated with dry sand prairie and open barren conditions that were very common in presettlement times. Others are associated with the deep river channels and associated wetlands, *e.g.* red-shouldered hawk, massasauga, wood turtle, and bald eagle.

LTA 5149: Broad, flat outwash plain; few kettle lakes; very poorly drained peat and muck.

General description: LTA 5149 is a widely distributed and somewhat extensive landtype of subsection VII.3. Typically, the LTA occurs within or along the edge of larger areas of excessively drained outwash plain. In a few specific instances, it is found adjacent to ice contact topography or morainal deposits. In Wexford County this LTA is found at the headwaters of Arquilla Creek and Hinton (a.k.a. Little Bear) Creek in Slagle Township.

It should be noted that most LTA units mapped as 5149 contain many intricately mixed inclusions of LTA 5131 and vice versa. Areas where organic and poorly drained mineral soils are intricately mixed to the extent that distinguishing individual map units is impractical have been mapped as 5149.

Glacial and bedrock geology: LTA 5149 is associated with poorly drained peat or muck soils occurring over broad areas of glacial outwash.

Topography and soils: Topography of LTA 5149 is low and flat. Specific soil types and associations vary across the district but are all similar in that they are predominantly organic peat or muck. Typical modern soil associations of LTA 5149 include: 1) the Kingsville-Adrian Association; which is described as very poorly drained sandy mucky soils; and 2) the Tawas-Roscommon association; which is also defined as very poorly drained; muck or muck/sand soils. However, in this association, the organic surface soil is usually underlain by a loose sand substratum. Intricately mixed within the peat and muck soils are significant inclusions of less poorly drained sands and loamy sand soils. All of the soils have a

seasonally high water table. Although most individual inclusions of the well-drained soils are small, their overall acreage is significant.

Presettlement vegetation: Presettlement vegetation within LTA 5149 was characterized by swamp communities dominated by cedar, hemlock, tamarack, jack pine, or a mixed conifer or hardwood overstory. Sandy inclusions and transitional areas were characterized by upland hemlock, beech/hemlock, or beech/sugar maple/yellow birch communities (Table VII.3.C and Appendix 7.3.A).

Present vegetation (MIRIS current land cover): MIRIS current land cover maps show LTA 5149 units dominated by a mosaic of conifer, hardwood, and shrub or emergent wetlands. Inclusions of sandy soils are dominated by upland hardwoods or cropland.

Natural disturbance: For the most part, the GLO survey notes revealed no indications of natural disturbance in LTA 5149. However, in Manistee County, GLO surveyors reported the occurrence of intense wildfire and also extensive windthrows that apparently followed the fires.

Lakes and streams: Streams of LTA 5149 are variable and range from large, highly meandering creeks with broad, well-defined valleys to smaller courses with few members and poorly defined valleys. In Mason County, the majority of streams are man-made drains and straightened stream channels. Apart from a very few large lakes, such as Grass Lake in Benzie County, the lakes of LTA 5149 are generally shallow, small (<50 acres), and marshy.

Threatened and Endangered Species and Exemplary Communities: LTA 5149 provides habitat for a wide variety and relatively large number of special plants, animals, and exemplary communities that associate with wet lands. Of particular interest are the only observations for poor conifer swamp, Engelmann's spike rush, Vasey's rush, and short fruited rush in the Subsection.

Conservancy, Soil Conservation District, Conservation Resource Alliance, WildLink

THE Cadillac Area Conservancy, a land trust, is a non-profit organization established to preserve natural areas and other lands through donation of land, development rights, and deed restrictions in Wexford County. The Conservancy has recently joined a consortium of Conservancies in northwest Michigan (Grand Traverse Conservancy, Leelanau Conservancy, Points Betsie to Sauble Conservancy) to share resources for professional staff and management.

The Wexford County Soil Conservation District is an agency of state government with a local board elected by landowners in Wexford County. Traditionally Conservation Districts have a strong partnership with the United States Department of Agriculture Natural Resources Conservation Service (formerly the Soil Conservation Service). The Soil Conservation District in Wexford has placed priority on assisting landowners with forestry plans, wildlife habitat restoration, groundwater stewardship, and better conservation practices on area farms.

The Conservation Resource Alliance (formerly the Northwest Michigan Resource Conservation and Development (RC&D) Council with strong ties to local Soil Conservation Districts) is a private, not-for-profit corporation committed to "sensible stewardship of the land." This organization services a 13 county area in northwest Michigan, including Wexford County. The Alliance has established collaborative solutions to land use issues to foster locally driven solutions that will preserve or develop land in a positive manner. The Alliance has been particularly successful with projects to address stream bank erosion. Currently it is starting a major fund raising effort to establish a coordinated program along the Big Manistee River and have an active program on the Pine River.

The Alliance is also starting a WildLink program to preserve the rural character of northwestern Michigan. This program is designed to help communities and landowners help wildlife. It is a voluntary landowner program that results in assistance to a landowner in establishing a 5 to 10 year plan for one's own private property.

Habitat fragmentation has resulted from land clearing and development. This fragmentation has become a major threat to maintaining native plant and animal diversity; by reducing or eliminating suitable habitat. This is especially true for animals that require large unbroken tracts of habitat for survival – such as the black bear found in Wexford County. Fragmentation is expected to continue as humans continue to develop the land. However some scientists have used theoretical and field data to suggest potential solutions. One idea is the creation or maintenance of vegetated connections among fragmented habitat blocks that not only provide habitat but also avenues for animals to migrate, disperse, or move among habitat patches in search of food or mates. This is done by preserving high-quality habitats (see Special and Unique Areas, below) and preserving high-quality connections that already exist, enhancing existing low-quality connections by improving the structure and composition of vegetation, or by planting strips of vegetation where little or none currently exists. These connections are commonly referred to as ecological corridors.

An ecological corridor accomplishes linkages to enhance population viability by facilitating movement between occupied patches; facilitating movement of animals through sub-optimal habitat; providing habitat for both plants and animals; providing dispersal routes during environmental change or disturbances; providing refuge

from disturbances such as timber harvests; when along rivers, function as buffer strips to maintain or improve water quality by filtering overland flow of pesticides, herbicides, sediments, other pollutants, providing shade and cooler water temperatures; and maintaining areas that are aesthetically pleasing to humans.

The WildLink idea is simple: use of air photos, soil maps, recommendation for timer management and other approaches and tools to help landowners provide proper habitat for wildlife. When working with a landowner through WildLink, wildlife planning is done for one's property to (1) identify the roles a particular corridor is expected to play, (2) recognize that careful planning is needed if they are going to perform their expected functions, (3) create a plan that is specific for the particular property. The ten main principles for corridors are:

1. Corridors not only provide habitat but also enhance the movements of wildlife.
2. A corridor should be designed to lead animals to suitable habitats without directing them into areas with high risk of mortality (road crossings, areas with a lot of predators).
3. The ecology and biology of species potentially using the corridor should always be considered in the design and establishment of corridors.
4. Newly established corridors should be designed to minimize edges, minimize disturbances from surrounding land use practices, strive to establish and maintain complex vegetation structure in the corridor, and aim to mimic the original vegetation species composition and structure.
5. Wider corridors are better than narrow corridors.
6. Corridors must be viewed as subcomponents of much larger ecosystems, and that other conservation issues need to be addressed concurrently to be successful (e.g. protecting existing habitat areas first).
7. A logical, sensible, and sequential process should be constructed for identifying, developing and conserving corridor networks.
8. Consideration should be given to conducting an ongoing program to manage and protect corridors as well as attempt to monitor the use of the corridor by wildlife once they are established.
9. Consider ways to mitigate the potential disadvantages of corridors.
10. Recognize that science will never have all the answers, and scientific information; establishment of corridors is part of a work in progress and the practice and theory of creating and maintaining corridors may change as knowledge increases.

Special and Unique Areas

A survey of known special and unique features in the county was conducted. Much of that survey material is not reiterated here, nor a matter of public record. Sites, such as those for endangered species, or archaeological sites are intentionally omitted from specific listing in order to protect the areas from the curious, vandals, and so on.

The survey included features listed below:

Areas of Cultural and Historical Significance

a. Archaeological Sites. Those areas containing substantial finds of arrowheads, pottery, fire pits, burial mounds, etc.
b. Historical Sites. Settlements, developments, early cemeteries.
c. Historical Structures. Those on national or state registers or other locally significant homes, buildings or unique rural structures, like round barns.

Areas of an Aesthetic or Scenic Significance

d. Scenic Overlooks. A relatively high Place; a place which provides substantial observation opportunity of surrounding land form, vegetation, water, or of surrounding urban farms.
e. Scenic Roads. A substantial stretch of road that provides a striking sequence of views, mostly free from inharmonious intrusions (may be through natural areas, cultural areas, urban parkways, etc.).
f. Scenic Areas. An area that exhibits a relatively uncommon combination of land form, vegetation, or water with few or no discordant or undesirable sites and with strong expression of the visual elements -- line, form, color, texture.

Areas of Natural Significance

g. Rare Geological Features. Outcrops of unusual minerals or fossils, sinkholes, caves, spits, natural arches, etc.
h. Glacial or Geological Formations. An overlook illustrating topographic features and their development -- a road cut or quarry; a place to view large scale, difficult to visualize features, such as an esker, moraine, ancient shoreline or glacial lake plain.
i. Areas of Endangered, Threatened or Rare Species.

Locally Unique Areas

j. Unique Forest lands, older trees, natural forest.
k. Unique nonforested lands.
l. Unique Water Features. Springs, waterfalls, kettle, oxbow and marl lakes, etc.
m. Unique Wetlands.
n. Other Unique Areas.

Many of the above, includes data from the Michigan Natural Features Inventory. That inventory is a listing of features which are considered rare, endangered or threatened. The listing includes animals, birds, plants, habitats for the same, and so on.

The inventory is not complete, and additional species may be added by filling out a prepared nomination form. The inventory is conducted by the Michigan Natural Features

asked to nominate areas in Wexford County which might be considered special and unique. Those nominations came both in the form of areas to be included and particular points which, when plotted on a map, were found to congregate in certain areas. Agencies which were asked and then submitted nominations for special and unique areas are listed here. Some were not formerly asked (Wexford County Historical Society, Cedar Creek Township Zoning Board, National and Michigan Historic registers), but it was known they were working on an issue involving an area which is then listed here.

Cadillac Area Conservancy (CAC)
Cedar Creek Township Zoning Board (CCTZB)
Department of Natural Resources (DNR).
Michigan State University Extension, Wexford Office (MSUE)
Michigan State [historic] Register List (MSRL)
National Historic Register List (NHRL)
Natural Features Inv. (NFI)
Natural Resources Conservation Service, Wexford Office (NRCS).
United States Forest Service (USFS).
Wexford County Historical Society (WCHS)
Wexford County Planning Dept. (WCPD).
Wexford County Soil Conservation District Board.

After compiling the information listed as 'a' through 'n', above, the location(s) of each were plotted on a map. The locations of the plots provided evidence that most locations tended to congregate along some land feature -- such as archaeological sites along the Big Manistee River valley, threatened and protected species along the Big Manistee River valley and Caberfae Hills area. Thus, areas of the county, each with attributes listed above, can be defined with a boundary. Obviously, all items inventoried are not included within areas of special and unique areas.

It is not the intent to list each feature. Rather, the intent is to designate special and unique areas. This is taken to imply "areas" where several attributes are found, rather than "points" representing a feature. The result is a list of Special and Unique Areas, below, which are also shown on a map on page 184.

List of Special and Unique Areas

H Cultural (Historic, arts) based
C Cultural (built environment, education) based
E Environmental/nature based
S Scenic/tour based
R Recreational activity based
T Resource harvesting (Timber) based

Map Symbol	Name	Reasons	Nominator.
1HER	Big Manistee River (including Pine River)	Historical structures and sites. Archaeological sites. Federal National Scenic River (Pine River). Canoe management (Pine River). Nominated State Natural River (Big Manistee River). Bayous and wetlands associated with the rivers. Dominant public land ownership. Designated areas for Old Growth forest management. North Country National Scenic Trail. Scenic area. "U" valley glacial geological formation. Occupied habitat for rare, endangered and threatened species of plant and animal life. Unique water features (springs, bayous, old meanders, oxbows. Highbank Rollaway overlook Baxter Bridge. Indian Crossing. U.S.-131 State Forest Campground. U.S.-131 Snowmobile Bridge. Numerous creeks feeding into the system. Great fisheries in the total river system.	Department of Natural Resources (DNR). United States Forest Service (USFS). Natural Resources Conservation Service, Wexford Office (NRCS). Michigan State University Extension, Wexford Office (MSUE)

Map Symbol	Name	Reasons	Nominator.
2ESR	Briar Hills	High relief, unique morainal hills. Scenic overlooks. Mushroom and hunting. Wildflower area Semi-primitive non-motorized management area by USFS. Designated areas for Old Growth forest management.	USFS
3ERT	Caberfae Hills	Mackenzie Cross-Country Ski Trail. Caberfae Viewing Platform. Caberfae Ski Resort and area inholding. Large block of public ownership. Few roads or utilities. Scenic area. Irregular relief. Better than normal soils (timber production) than within other USFS lands. Wildflower area Occupied habitat for rare, endangered and threatened species of plant and animal life. Designated areas for Old Growth forest management.	USFS NRCS
4ERT	Long Lake	Long Lake State Forest Campground. Network of lakes around Long Lake. Public ownership block Timber management. Occupied habitat for rare, endangered and threatened species of plant and animal life.	DNR
5ET	Pine River Experimental Forest	Research on timber management. techniques. Prairie-like conditions. Occupied habitat for rare, endangered and threatened species of plant and animal life.	USFS NRCS
6ET	Olga Lake (centered in Lake County)	Public ownership block. Designated areas for Old Growth forest management. Wetland flooding Management area. Occupied habitat for rare, endangered and threatened species of plant and animal life. Timber management.	USFS
7E	Thousand Acre Swamp (a.k.a. Brandy Brook Waterfowl Area, Mitchell Creek Waterfowl Area)	Cedar stands. Prime black bear habitat. Prime wetland areas (bog, muskeg, various swamps). Semi primitive motorized wetlands management area by USFS. Designated areas for Old Growth forest management. Wildlife management area. Occupied habitat for rare, endangered and threatened species of plant and animal life. Need for corridor linkages to the west and south through private lands (not mapped). Selma Center swamp and bog. Benson Bog.	USFS Natural Features Inv. (NFI) Cadillac Area Conservancy (CAC).
8E	Heritage-Cadillac Nature Study	Former Pike rearing wetland Interpretative trails Part of the Mitchell State Park	DNR

Map Symbol	Name	Reasons	Nominator.
9E	Wheatland-Mystic Area	Unique geological features. Predominance of artisan discharge of groundwater. Many small streams, wetlands, man-made ponds. Headwaters for Soper, Filer, Blind, Apple, Silver, Buttermilk Creeks. Wetland complex west of Manton Creek.	NRCS CAC
10E	North Branch Pine River Swamp	High quality swamp within a poorer grade swamp.	NFI
11T	Wheeler-Anderson Area	Large block of public ownership Timber harvest.	MSUE
12T	Greenwood Area	Large block of public ownership. Timber harvest.	MSUE
13T	Chase Creek Area	Large block of public ownership. Timber harvest.	MSUE
14T	Stoddard Lake Area	Large block of public ownership. Timber harvest.	MSUE
15T	Briar Hills Area	Large block of public ownership. Timber harvest. Wildflower area	MSUE
16S	White Pine Trail (former railroad grade)	Scenic bike/hiking trail	Wexford County Planning Dept. (WCPD). MSUE
17S	Caberfae Highway (M-55) (No. 25 Rd to M-37)	Scenic road Managed as a National Scenic Highway by USFS	USFS WCPD
18S	W 40 Road (S 13 (Caberfae) Road to S 23 Road)	Scenic road	MSUE
19S	S & N 17 Road (W 30 Road (Coates Highway) to W 24 Road)	Scenic road	MSUE
20S	W 38 Road (S 15½ Road to S 11¼ (Caberfae) Road)	Scenic road	MSUE
21S	S 49 Road (Seeley Road) (E 48 (McBain) Road to E 52 (County Line) Road)	Scenic road	MSUE
22S	E 22 & E 20½ Roads (N 33 to N 39 Roads)	Scenic road	MSUE
23S	S 13 Road & 11¼ Road (Caberfae Road, Old State Highway) (W 48 (Hoxeyville) Road to W 32 Road)	Scenic road	WCPD

Map Symbol	Name	Reasons	Nominator.
24S	N 17 Road & W 10 Road & N 19 Road (W 6 to 3/4 mile north of W 14 Road)	Scenic road	MSUE
25E	Adams Creek	none given	CAC
26E	Slagle Creek	subdivision risk	CAC
27E	Arquilla Creek	Bear core area and corridor	CAC
28E	Pine River tributaries (Dowling, Poplar, and Hoxey Creeks)	Corridor. Occupied habitat for rare, endangered and threatened species of plant and animal life.	CAC WCPD
29E	Manton (Cedar) Creek	Corridor wetlands	Cedar Creek Zoning Board
30H	Cadillac City Hall (201 North Mitchell Street, Cadillac.)	Historic building Architecture	National Historic Register List (NHRL)
31H	Cobbs, Frank J. House (407 East Chapin Street, Cadillac)	Historic building Architecture	NHRL
32H	Elks Temple Building (122 South Mitchell Street, Cadillac.)	Historic building Architecture	NHRL
33H	Masonic Temple Building (122-126 North Mitchell Street, Cadillac)	Historic building Architecture	NHRL
34H	Mitchell, Charles T., House. (118 North Shelby Street, Cadillac.)	Historic building Architecture	NHRL
35H	Shay Locomotive. (Cass Street, in the city park, Cadillac.)	Historic building Architecture	NHRL
36H	Cadillac Public Library (127 Beech Street, half block east of Mitchell Street, Cadillac.)	Historic building Architecture	Michigan State Register List (MSRL)
37H	Clam Lake Canal (Northeast of 6093 M-115, Cadillac.)	Historic engineering	MSRL
38H	Cobbs and Mitchell, Inc. Building (100 East Chapin, west of Mitchell Street, Cadillac.)	Historic building Architecture	MSRL
39H	Greenwood Disciples of Christ Church (7303 North 35 Road, Greenwood Township.)	Historic building Architecture	MSRL

Map Symbol	Name	Reasons	Nominator.
40H	Manton Fire Barn and City Hall (Southeast corner of West Main and State Street, Manton.)	Historic building Architecture	MSRL
41H	Cadillac Historic District	Historic homes, neighborhood	Wexford County Historical Society
42H	Harrietta Fish Hatchery	Continuously operating fish hatchery	Wexford County Soil Conservation District Board
43H	Coates Highway (W 30 Road, S 23 Road, W and E 34 Road (Boon Road)).	Proposed in the 1930s by Dr. Coates, Kaleva, Michigan, as the route for M-55, marked with monuments in Manistee and Wexford Counties. Goes from Manistee to Lake City.	Wexford County Soil Conservation District Board
42 [Not Mapped]	Buckley farm area, Southeast Cadillac farm area	Prime farm land soils over a broad area.	NRCS

Public Opinion Survey on Special and Unique Areas

A portion of the interview was devoted to exploring residents' beliefs about how county land should be used and protected. These questions were introduced by interviewers as follows: "Many planning and zoning measures can be proposed to guide the use of private land or to protect the environment in the county." Respondents were then asked if they "strongly favor, favor, oppose, or strongly oppose a number of these measures." Responses are summarized in the next table, with measures receiving the strongest support listed first and those receiving the least support listed last.

Level of Support for Measures to Guide Land Use and Environmental Protection: Percentage Distributions and Means

	*Mean**	Strongly Favor	Favor	Oppose	Strongly Oppose	Don't Know
Designating and protecting sites of historical or cultural interest	*1.65*	37.6	56.4	3.0	0.5	2.5
Limits on advertising signs and buildings to protect view	*1.77*	36.9	46.5	11.6	1.5	3.5
Regulations to protect special and unique areas/environments	*1.94*	25.1	49.6	15.1	2.2	7.9
Increasing access to public land for recreation	*2.13*	14.9	54.2	22.0	2.5	6.4

*The "strongly favor" response is given the numeric code of 1; "favor," is coded 2; "oppose" is given the code of 3; and "strongly oppose" is coded 4. "Don't know" responses are excluded when the mean is calculated.

Reasonably high support is expressed for the protection of water resources in the county, support for protecting sites of historical/cultural interest, and assuring scenic views. Although the percentage of residents who "strongly favor" each of these measures is less than the percentage strongly favoring the protection of water quality in the county. Roughly one third of respondents "strongly favor" "designating and protecting sites of historical or cultural interest," "limits on advertising signs and buildings to protect views along scenic roads."[152] Relatively few residents oppose these measures, although about 13 percent of respondents express some level of opposition to limiting signs and buildings to protect scenic views along roadways.

About one quarter of respondents "strongly favor"

[152]Two very similar statements about preserving lakeside and riverside vegetation were read to respondents. The term "vegetation strip" was used in one statement. This term was defined as "strips where plants are left to grow undisturbed."

"extra environmental and zoning regulations" to protect "special and unique environments" in the county. On the other hand, almost 20 percent of respondents oppose the protection of environments labeled "special and unique."

While majorities of the sample favor "increasing access to publicly-owned land for recreational activities such as hunting and water access," the percentage of residents who "strongly favor" these measures is relatively small—less than 15 percent. Similarly, the percentage of respondents expressing opposition to these measures is about 25 percent or more.

The measure "establishing a minimum size for a parcel of land that can be owned" does not receive support from majorities of the sample. The percentage of respondents who "strongly favor" such measures about 10 percent of less, and the number of respondents who oppose these measures outnumbers the number who support them. (Note that the percentage of respondents who have no opinion about establishing a minimum size for a parcel of land exceeds 10 percent.)

Landtype Associations of Wexford County, Michigan

Prepared by Richard A. Corner and Dennis A. Albert
Michigan Natural Features Inventory
Lansing, Michigan
1998

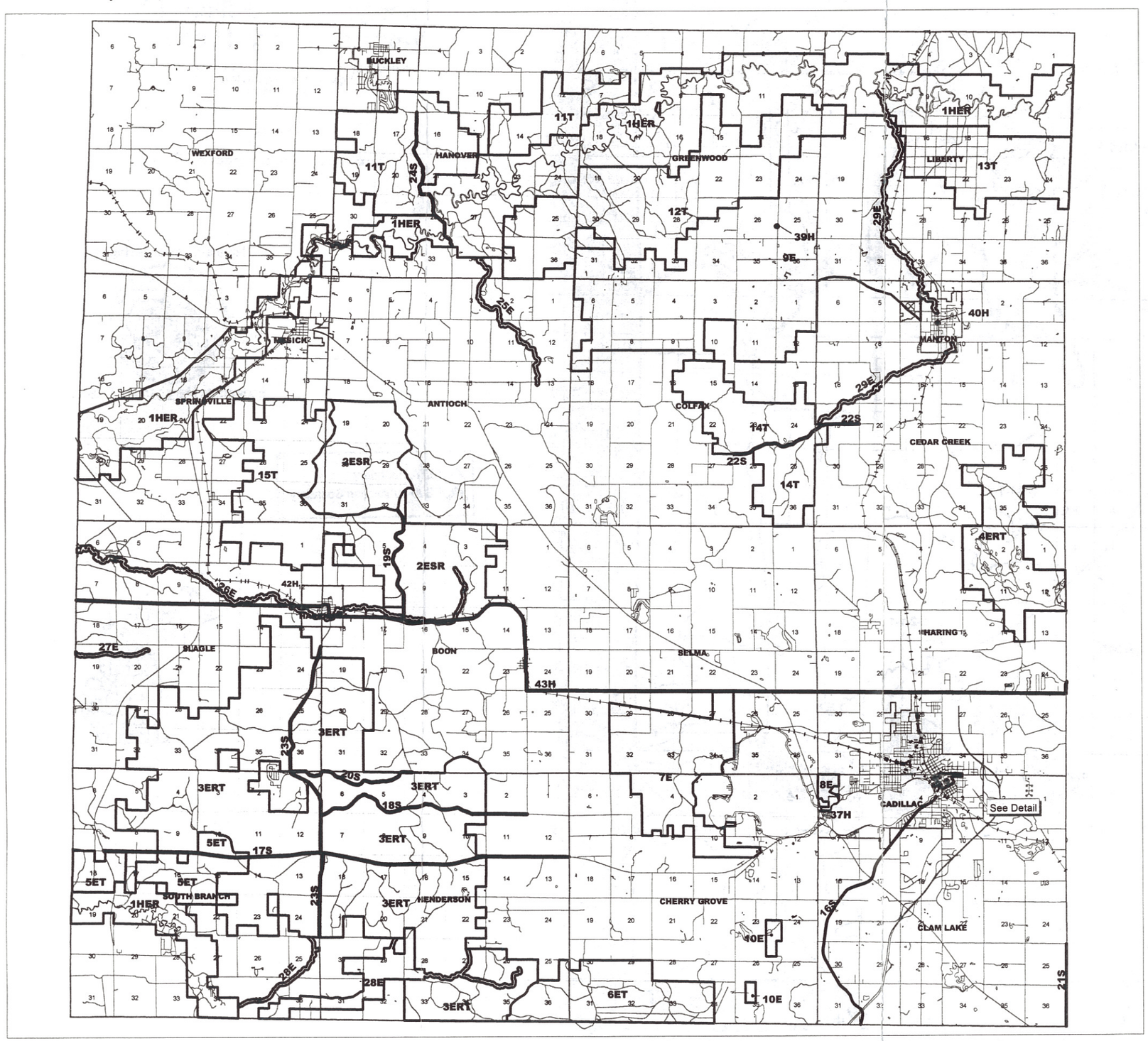
Scale 1:180,000

0 1 2 3 4 5 Miles

Northern Lower Michigan

Ecosystem Management Project

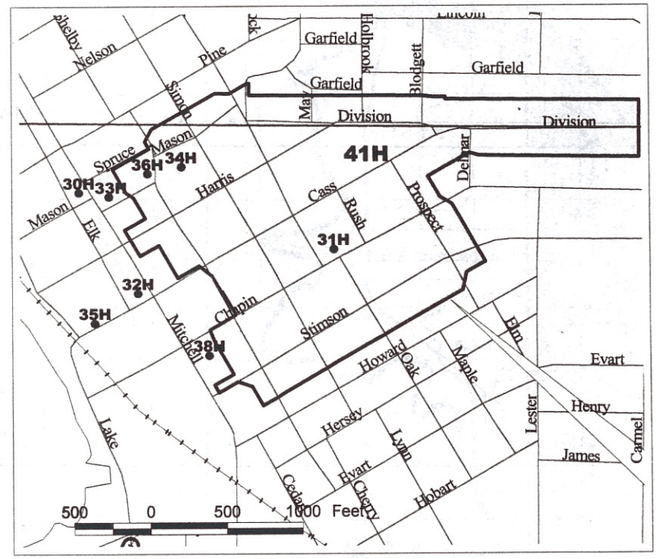
LTA Boundary
Sub-subsection Boundary



Special and Unique Areas

- Historic Locations
- Special and Unique Areas

Downtown Cadillac



SOURCE: Digitized in Wexford County Geographic Information System (GIS) by Mike Green based on primary source material in this *Fact Book*.

N W E S

2 0 2 4 6 Miles

Special and Unique Areas

1HER Big Manistee River (including Pine River)
2ESR Briar Hills
3ERT Caberfae Hills
4ERT Long Lake
5ET Pine River Experimental Forest
6ET Olga Lake (centered in Lake County)
7E Thousand Acre Swamp (a.k.a. Brandy Brook Waterfowl Area, Mitchell Creek Waterfowl Area)
8E Heritage-Cadillac Nature Study
9E Wheatland-Mystic Area
10E North Branch Pine River Swamp
11T Wheeler-Anderson Area
12T Greenwood Area
13T Chase Creek Area
14T Stoddard Lake Area
15T Briar Hills Area
16S White Pine Trail (former railroad grade)
17S Caberfae Highway (M-55) (No. 25 Rd to M-37)
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25E Adams Creek
26E Slagle Creek
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28E Pine River tributaries (Dowling, Poplar, and Hoxey Creeks)
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