2. Description of the Huron Creek Watershed

2.1. Location, Size and Water Bodies

The Huron Creek watershed is a 3.4 square mile watershed located in north central Houghton County, in the Upper Peninsula of Michigan (See Figure 1.1). Communities located within this watershed include the City of Houghton, Portage Township, and the villages of Dodgeville and Hurontown. Huron Creek, the main waterway associated with the watershed, is approximately 3.3 miles in length. The creek's source derives from a wetland area in the southwest corner of the watershed. From this area the creek flows to the east and north, and empties into the Portage Canal (part of Lake Superior) at the watershed's outlet. On the way to its receiving waters, the creek passes through wooded areas, wetlands, urban areas and parks, and also passes under several road crossings.

Huron Creek has two un-named tributaries. One of these tributaries originates in an area south of M-26 and west of Green Acres Road. It then runs south and joins with Huron Creek near where Huron Creek crosses Green Acres Road. The other tributary, referred to as "Shopping Cart Creek" throughout this report, is located in the north-central portion of the watershed, and stretches between the Copper Country Mall and the Houghton Super Wal-Mart. The source of water for this tributary derives from commercial property storm drains and ditches. Prior to its discharge to Huron Creek, it passes through detention ponds that are also located on commercial property. It is unclear whether Shopping Cart Creek was a natural drainage in the past.

Other water bodies within the watershed are the wetlands occupying the bed of the former Huron Lake and small ponds and wetland areas that at times flood to an open-water type wetland habitat. The former Huron Lake is located in the north-central part of the watershed just south and east of the Houghton Super Wal-Mart. Huron Lake is referred to as "former" is because it was an impoundment created by the Huron Mining Company in 1863 by damming Huron Creek with stamp sands (Greer, 2007). Historical mining activities are discussed further in Section 2.7. However, in 2003 the dam was removed due to safety concerns, and the size of the lake dropped by an estimated 50% (Kersten, 2008). The remains of the drained lake are part of a wetland mitigation site owned by the City of Houghton. Wetland mitigation sites are discussed further in Section 2.6.2.

2.2. Political, Demographic and Economic Information

Two municipalities occupy the majority of the Huron Creek watershed: the City of Houghton and Portage Township. Adams Township also occupies a small portion of land in the southwestern part of the watershed. The villages of Dodgeville and Hurontown, also located in the watershed, are part of Portage Township. Figure 2.1 indicates the locations of Portage Township, the City of Houghton, Dodgeville, Hurontown and Dakota Heights relative to the boundaries of the Huron Creek watershed. The 2006 population of the City of Houghton was 7,014. The median income for households was $41,994 and the per capita income was $21,587. About 9.2% of families and 12.4% of the population were below the poverty line. In 2006, 3,141 people reside in Portage Township. The median income for households in the township was $33,080 and the per capital income was $17,655. About 8.1% of families and 14.2% of the population were below the poverty line (Bureau, 2008).

Major economic activities in the county include education, health care, light manufacturing, retail, forest products, tourism and accommodations and food services. Many of the large retailers in Houghton County, such as Wal-Mart, Econo Foods, Shopko, and J.C. Penny, are located in the Huron Creek watershed. Also located in the watershed area are an indoor mall, several small strip malls, and a number of commercial buildings that house government and private offices, motels, restaurants and fast food providers, small healthcare facilities, automobile service facilities, and a number of other service businesses. Michigan Technological University (Houghton) and Finlandia University (Hancock) also employ a significant workforce in Houghton County; however, neither have facilities in the watershed (Greer, 2007).

2.2.1. Water and Sewer Infrastructure

The City of Houghton's municipal drinking water treatment and distribution system draws from a groundwater aquifer whose area of recharge is outside of the Huron Creek watershed. Most of Portage Township is not connected to a water distribution system, and many homes rely on private wells. The exceptions to this are the villages of Dodgeville and Hurontown, which receive water from a treatment and distribution system maintained by Portage Township. The source for this system is a groundwater aquifer outside of the watershed (Kommes, 2008).

Wastewater from the City of Houghton and portions of Portage Township is collected and delivered to a wastewater treatment plant operated by the Portage Lake Water and Sewage Authority (PLWSA). The PLWSA wastewater treatment plant is located outside of the Huron Creek watershed, east of the City of Houghton on the Portage Canal. The villages of Dodgeville and Hurontown have wastewater collection systems that are routed to the PLWSA wastewater treatment plant (Kommes, 2008). Portage Township pays the City of Houghton for its use of the PLWSA wastewater treatment plant.

The remainder of Portage Township contained within the Huron Creek watershed does not have a wastewater collection system, and most homes rely on private septic systems. The wastewater emanating from the Dakota Heights neighborhood (see Figure 2.1) is an issue of particular concern because many of the septic systems in the neighborhood are old; are cesspools (tanks or holes filled with rock), undersized, and have more than one house on a system; are either leaking, in need of repair, or of unknown condition; and are as close as 50 feet from the stream. (Bingham, MacInnes, & Tarbutton, Personal Interviews, 2008). The Dakota Heights neighborhood is located approximately 300 feet upstream of the Kestner Waterfront Park.

Although a few leaks and failures of Portage Township septic systems have been observed, there is currently no evidence that there is direct contamination of the stream from these systems. However, the age and construction of the septic systems poses a potential threat to the water quality of Huron Creek as they are considerably more likely to fail than modern systems (Bingham, MacInnes, & Tarbutton, Personal Interviews, 2008).

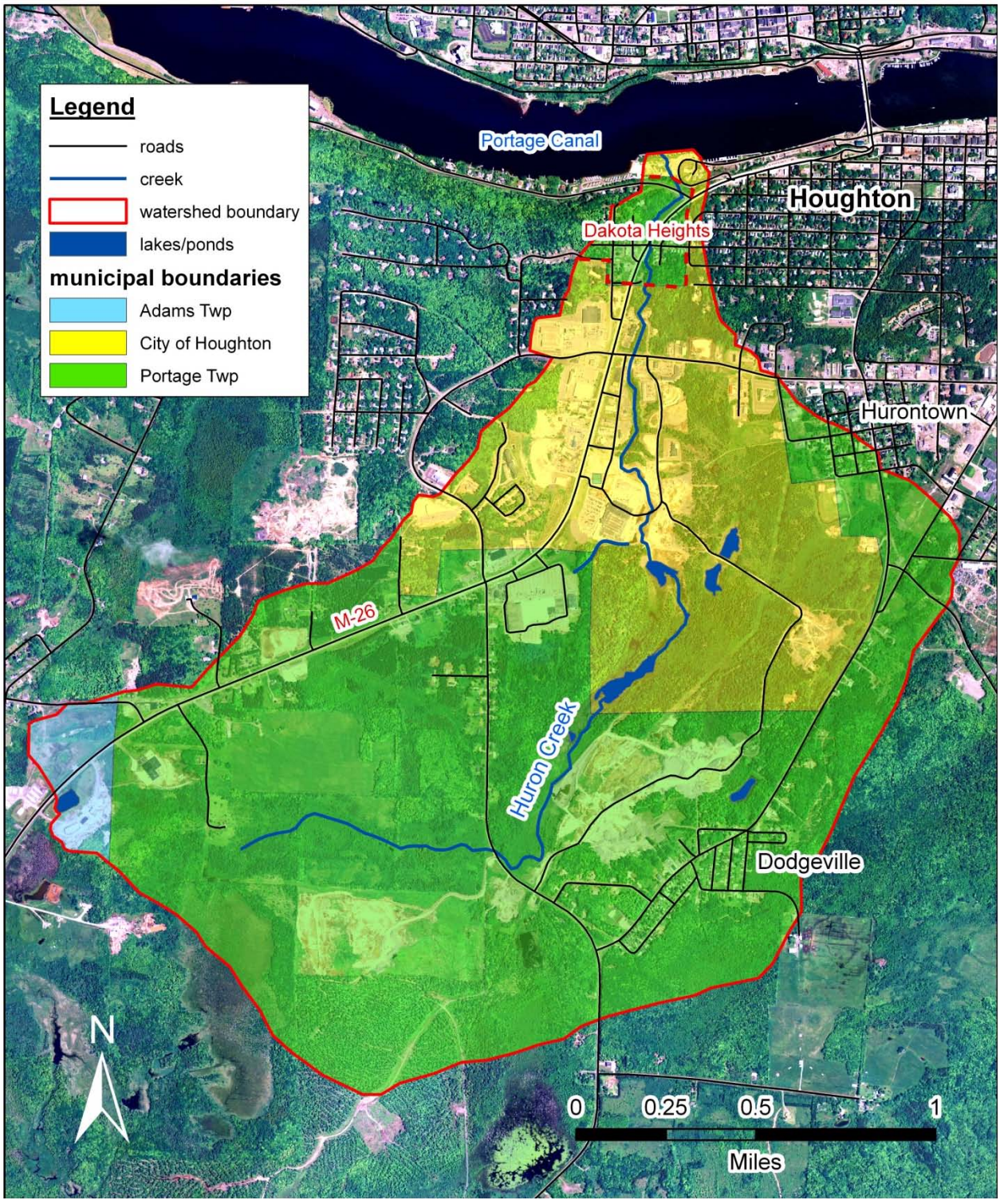

Figure 2.1. Muncipal boundaries in Huron Creek watershed. Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data source: MI Geographic Data Library; 2005 NAIP 1-meter digital orthophoto.

2.2.2. Applicable Regulations

Following are descriptions of federal, State of Michigan, Houghton County Health Department, City of Houghton and Portage Township regulations that are relevant to water quality and other environmental issues in the Huron Creek watershed.

Federal Regulations[2]

- Title 33 United States Code §1251 et seq. (1972) Clean Water Act - The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained (National Pollutant Discharge Elimination System, NPDES). Chapter 26 of Title 33 specifically addresses water pollution prevention and control. Related subchapters include:
    - Subchapter II – Describes federal grant programs for construction of wastewater treatment and collection systems.
    - Subchapter III – Lists water quality standards, effluent limitations, nonpoint source management rules and enforcement procedures.
    - Subchapter IV – Describes the NP DES program, regulations for dredging and waterway and wetland fill regulations.
    - Subchapter VI – Describes federal funding of state water pollution control programs. This includes state-implemented grant programs for watershed management plans.

- Title 7 United States Code §136; 16 U.S.C. §460 et seq. (1973) Endangered Species Act – The Endangered Species Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service (FWS) of the Department of the Interior maintains a worldwide list which, as of Feb. 20, 2008, included 1574 endangered species (599 are plants) and 351 threatened species (148 are plants).

State of Michigan Regulations[3]

- Part 17 Environmental Protection Act – This Act allows citizens, governments, groups and businesses to sue and be sued for actions that are detrimental to the air, water and other natural resources.
- Part 31 Water Resources Protection – This part establishes the water quality standards for surface waters. It requires permits and provides limits for potential pollution discharges.
- Part 87 Groundwater and Freshwater Protection – This act reduces the risks to the environment and public health by preventing groundwater contamination from various pollution sources such as pesticides and fertilizers.
- Part 91 Soil Erosion and Sedimentation Control – Landowners are required to reduce erosion and sedimentation in their usage of the land (such as during construction). Permits are required for any earth disturbance greater than 1.0 acre, or if it is within 500 feet of a stream, lake or non-isolated wetland.
- Part 301 Inland Navigable Lakes and Streams – A permit is required for dredging or filling of bottomlands, changing natural water flow, creating or altering artificial waterways, or similar activities within 500 feet of inland lakes and streams.

[2] From http://www.epa.gov/lawsregs/laws/index.html#cercla.
[3] State regulations from (Cotey, 2003).

- Part 303 Wetlands Protection – This part conserves and regulates the use of Michigan's wetlands. Permits are required for any filling, dredging or draining of wetlands.
- Part 365 Endangered Species Protection – Threatened or endangered wildlife, fish and plants are protected by this law. Penalties for violations are outlined.

More information on the regulations listed above can be found at the Michigan DEQ website: www.michigan.gov/deq.

Houghton County Health Department Regulations

Health code regulations fall under the Superior Environmental Health Code as defined by Section 2441 of Michigan Public Health Code, Act 368, Public Act of 1978. The code was effective March 14, 1998. It is enforced by the Western Upper Peninsula District Health Department. There are several regulations that pertain to water quality; the most relevant regulations involve the location of septic systems. The required distances between septic tanks, wells and water bodies are summarized in Table 2.1.

Table 2.1. Isolation Distances for Sewers, Septics and Privies (Superior Environmental Health Code Committee, 1998)

From / To	Sewer Lines	Septic Tanks	Absorption System	Earth Pit Privies	Vaulted Privies
Residential Well	10	50	50	100	50
Non-Community Well (Type IIB, Type III)	10	75	75	100	75
Community Well (Type IIA)	10	200	200	200	200
Property Lines	--	10	10	10	10
Foundation Wall	--	5	10	20	5
Building/Storm/ Subsoil Drains	--	5	25	25	5
Water Lines	--	10	10	10	10
Embankments	--	10	20	25	10
Lakes or Streams	--	75	75	75	75

City of Houghton Zoning Code (Houghton, 2006)

Section 98-202.D.4 (Site Plan Review Standards) – "Special attention shall be given to proper site drainage so that removal of storm waters will not adversely affect neighboring properties."

Section 98-552.A (Multiple Use Districts, Principle Uses Permitted) – "…Prior to any review, a subdivision plan shall be submitted by the developer to the city planning commission illustrating the intended use of the premises, building and housing arrangements, access routes, docking, parking and related features; and further shall indicate methods, devices and manners by which any waterway will be protected from shoreline erosion, siltation and chemical and biological pollution."

- Section 98-652 (Subdivision Open Space Plan) – This section provides guidelines for modifications to residential lot standards for incorporating open spaces into a subdivision plan. It is stated that open spaces cannot include bodies of water or swamps.

- Section 98-192 (Parking Requirements) – This section states the number of parking spaces required per unit of measure specified for each type of building or land use[4].

A zoning map for the City of Houghton is provided in Figure 2.2.

Portage Township Zoning Code (Portage Township, 2008)

Section 2.13(1)e (General Provisions, Site Development Plan) – "The Planning Commission shall determine that the proposed development is arranged: (e) To insure adequate drainage without jeopardizing adjacent or downstream properties."

Section 3.0 (Zoning Districts) – For RER, LAR, R-1, R-2, R-3 and R-4[5] zones, no dwelling can be located closer than 50 feet to the edge of a lake or stream. In cases of high banks 10 feet or higher, dwellings may be allowed to be closer. (The portion of the watershed that is in Portage Township falls into one of these zoning classifications.)

Section 4.4 (Schedule of Off-Street Parking, Loading and Unloading Requirements) – Table 2.2 describes the number of parking spaces to be provided based on the use or type of building.

A zoning map for Portage Township is provided in Figure 2.3.

Houghton County Zoning Code

At this point in time, Houghton County does not have a zoning code in place.

Table 2.2 Off-Street Parking Requirements for Portage Township, Michigan

Use	Number of Parking Spaces
Single Family	Two per dwelling unit
Two Family	Two per dwelling unit
Multi-Family*	One and one half per dwelling unit
Motels, Hotels, Lodging Houses	One per lodging unit, plus one stall for each 100 sq. ft. of retail sales or dining area
Commercial (except as specified below)	One per 200 sq. ft. of gross floor area
Furniture, appliance stores, machinery sales, wholesale storage	One per 400 sq. ft. of gross floor area
Offices, banks or public administration	One per 400 sq. ft. of gross floor area
Manufacturing, Warehousing	One for each employee on the maximum working shift, plus one for each vehicle used in the conduct of the enterprise

[4] City of Houghton Zoning Code is available online at: http://www.cityofhoughton.com/documents/CH098_9-29-06.pdf

[5] RUR = Rural Residential, RER = Resort Residential, LAR = Lakeshore Residential, R-1 = Low Density Single-Family Residential, R-2 = Medium Density Single-Family Residential, R-3 = High Density Single-Family Residential, R-4 = Medium Density Multi-Family Residential District

Use	Number of Parking Spaces
Churches, Theaters, Auditoriums, and other places of assembly	One per five seating spaces
Hospitals, Rest Homes, Nursing Homes, etc.	One per three employees, plus one per three beds

*In those cases where multi-family dwelling units are intended for occupancy by more than two (2) adults, the required parking spaces shall be increased at a rate of 1-1/2 spaces for each two (2) additional adults.

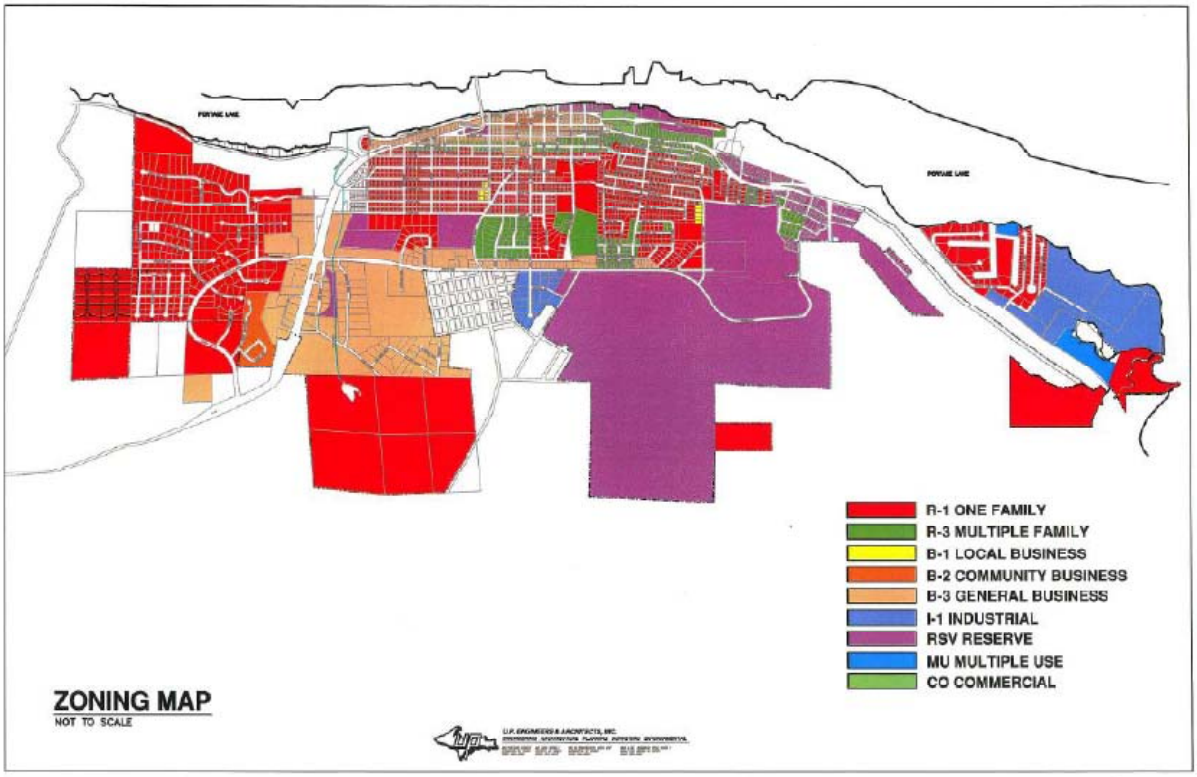

Figure 2.2. City of Houghton zoning map. Source: http://www.cityofhoughton.com/documents/Zoning_Map.pdf (accessed 3/5/09).

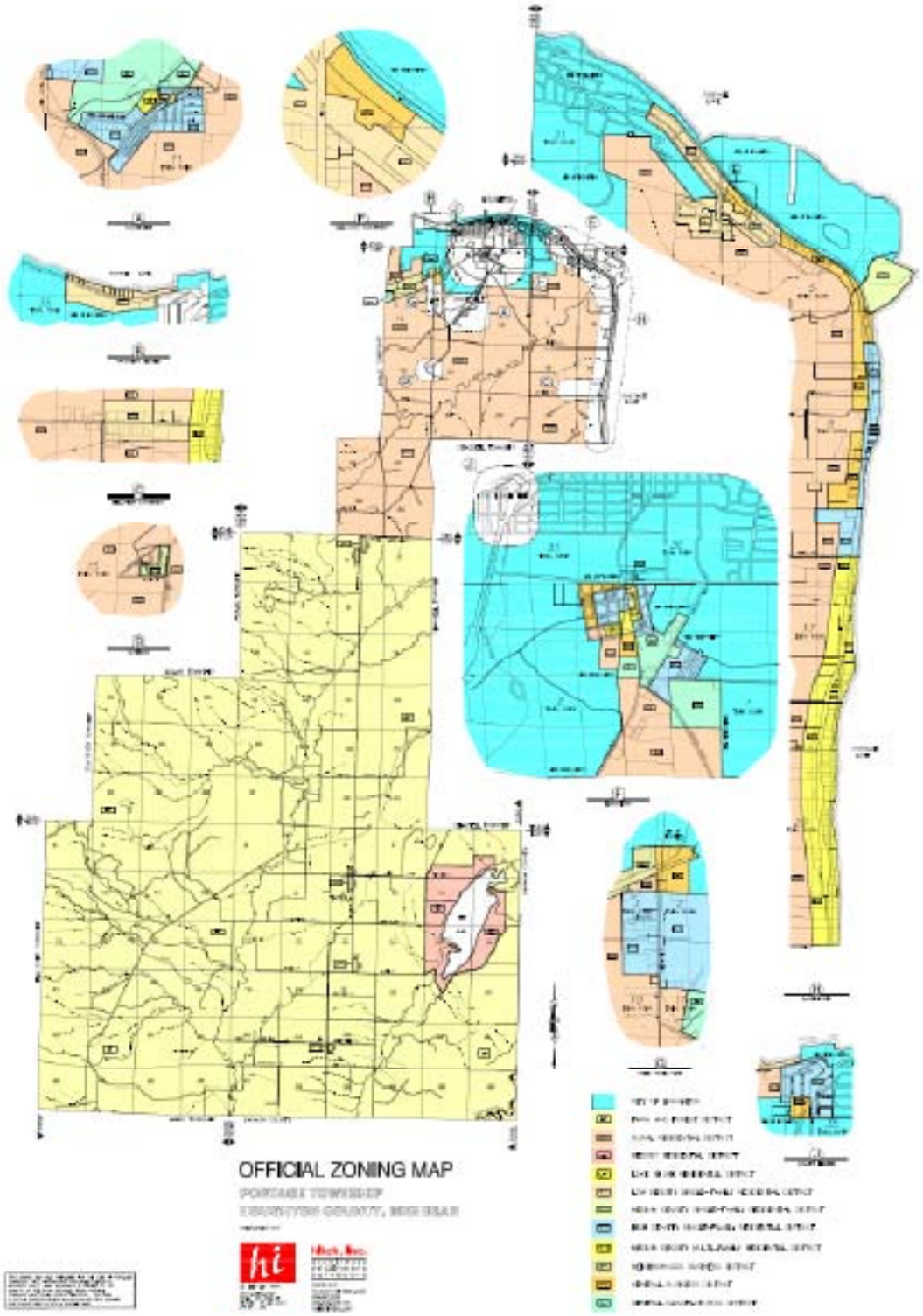

Figure 2.3 Portage Township zoning map.

2.3. Land Use and Development

2.3.1. Land Use Study

Land use information is necessary for creating the "big picture" of what is going on in a watershed. Analysis of land use data can indicate trends in what types of land use are increasing or decreasing over time, and where these changes have occurred or might occur. It can also help assess how valuable land resources such as wetlands, lakes and forests have been utilized and what affects the surrounding land use might have on them.

For this reason, a land use study was completed for the watershed in December 2006. Part of the study was to produce a land use map based on the most recently available aerial photo of the watershed, which was the National Agriculture Imagery Program (NAIP) photo from 2005. Figure 2.4 and Figure 2.5 indicate the percentages of land use in the watershed for this year. Land use maps for 1978 and 1998 also were generated using a geographical information system (GIS). The changes in land use from 1978 to 2005 are shown in Figure 2.6.

Figure 2.4, Figure 2.5, and Figure 2.6 indicate that, as of 2005, the largest land use category in the Huron Creek watershed is forested lands. These areas, combined with wetlands, comprise over 50% of the watershed (52%). The next largest land use is "urban and built up" areas. Since 1978, the only land use category showing significant growth is "urban and built up" areas which has occurred at the expense of the watershed's forests and rangelands (Kersten, Huron Creek Watershed 2005 Land Use Map, 2006). The land use study report is included in Appendix D, which describes methods and data sources, as well as additional study results.

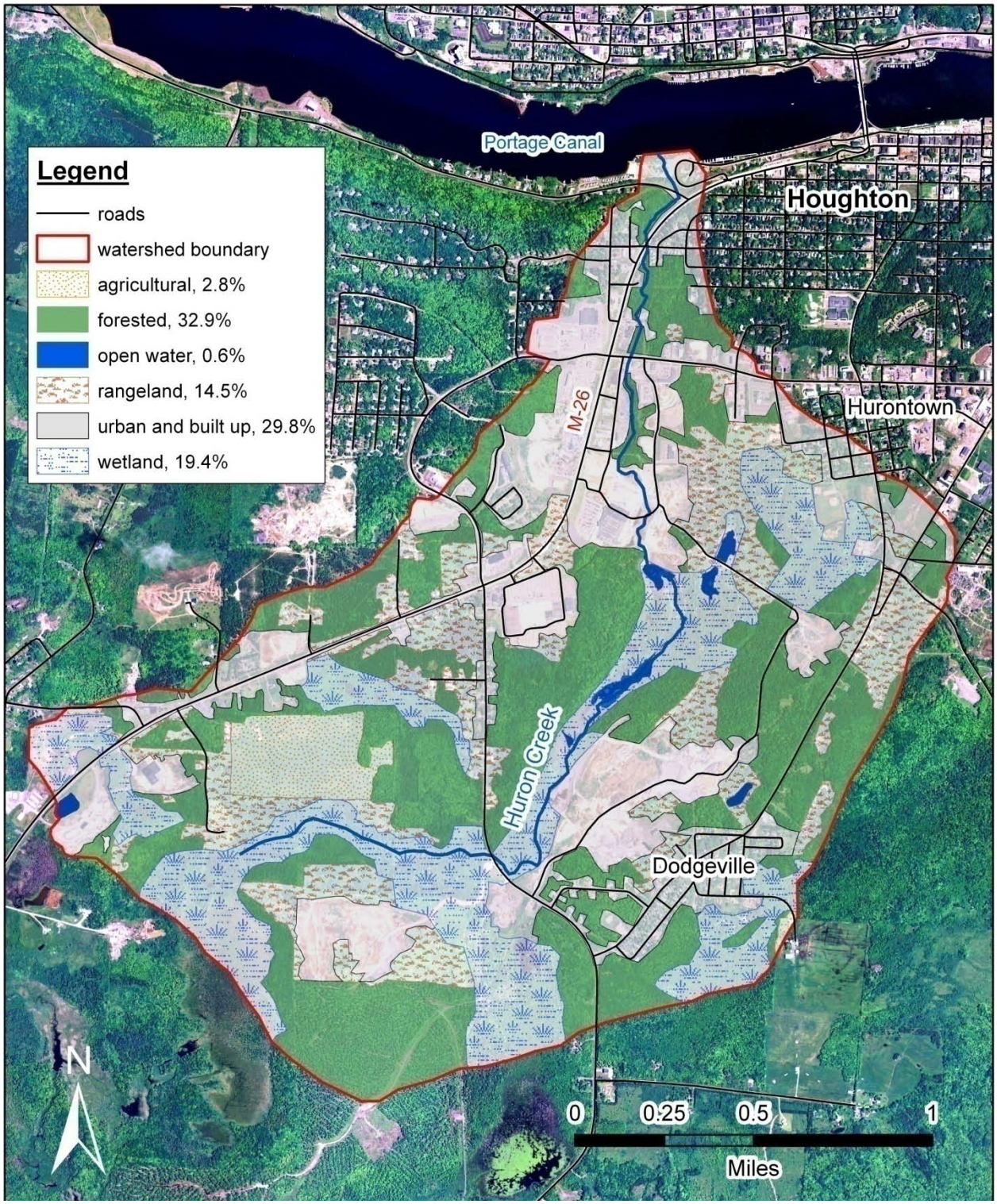

Figure 2.4 Land use in Huron Creek watershed as of 2005. Created by: Linda Kersten, 2/20/08. Map projection: NAD 1927 UTM Zone 16N. Data source: MI Geographic Data Library; 2005 NAIP 1-meter digital orthophoto.

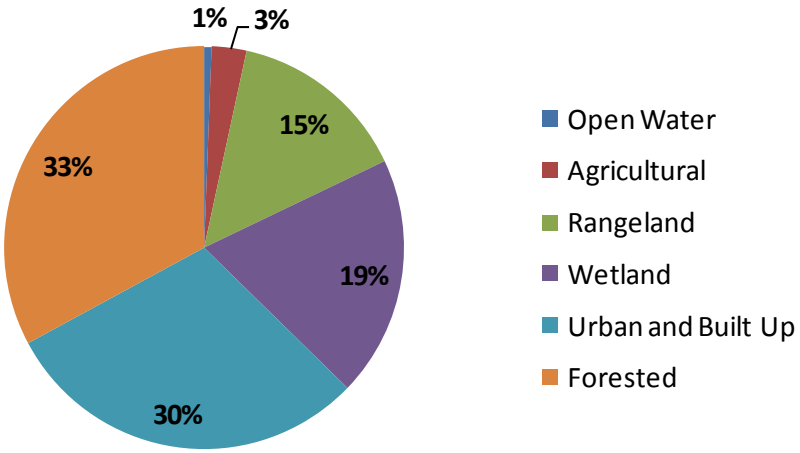

Figure 2.5 Land use distribution in Huron Creek watersheed, 2005.

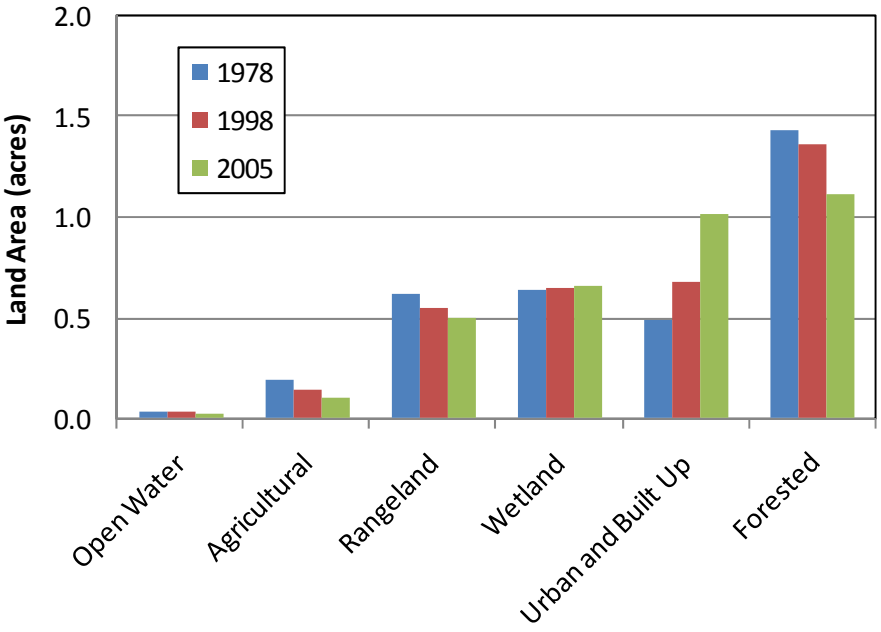

Figure 2.6 Land Use distribution in Huron Creek watershed, 1978, 1998, and 2005.

2.3.2. Development Trends

As indicated by the land use study, urban and built up areas have increased significantly in the Huron Creek watershed. As shown in Figure 2.4, the most concentrated area of development is in the north-central portion of the watershed which stretches down along Michigan Highway M-26. This stretch is commonly referred to as the "M-26 corridor." Significant commercial development began along the corridor in the mid-1970's when a furniture store, full-service grocery, and gas station were built. In 1981, the Copper Country Mall was constructed, bringing in various anchor stores and small retailers. Continued development brought in restaurants and fast-food chains, more grocery and retail stores, and multiple strip-malls (Greer, 2007). Huron Creek flows parallel to M-26 through this portion of the watershed, running directly through the middle of the development area. The progression of development in the M-26 corridor is depicted in the aerial photos in Figure 2.7.

The US Environmental Protection Agency recognizes that significant fractions of impervious surface in a watershed can impact the rate and quantity of water flowing through the watershed as well as the water quality. Studies show that on average, a typical city block generates nine times more runoff than a natural woodland area of the same size (US Environmental Protection Agency, 1996). Experts generally consider a watershed that has 11%-25% impervious surface to be "impacted," while areas that contain more than 25% impervious surfaces are considered "degraded" (Premo, B.J., D.T. Long, R.J. Huggett, D. Premo, W.W. Taylor, G.T. Wolff and K.G. Harrison, 2001) (Unknown, Michigan Department of Environmental Quality (MDEQ), 2003). If one counts parking lots and rooftop areas associated with the commercial development as 100% impervious, an analysis of the land use map in Figure 2.4 indicates that approximately 15% of the Huron Creek watershed has impervious land cover. This analysis does not include residential areas, which exhibit fractions of impervious surfaces of 20%-90%.

In the future, increased development may contribute to this level of impact. Several currently undeveloped locations in the watershed are slated for either commercial or residential development in the near future. The development areas described above are depicted in Figure 2.8. Near-future developments within the limits of the City of Houghton include (MacInnes, 2008):

- the new Saint Peter & Paul Church, to be located near the south end of Evergreen Drive,
- a commercial parcel slated for a large store or business on the south side of Sharon Avenue between Evergreen Drive and the businesses on Razorback Drive,
- a new bank and a new fitness/rehabilitation center to be located on Razorback Drive to the east of Wal-Mart,
- extension and improvement of Razorback Drive to the southwest of Wal-Mart, extending to Superior Road,
- addition of a new road off of the north side of the Razorback extension (#4) to provide access to an area of new residential and commercial development, and
- a large commercial parcel for sale to the south of Wal-Mart and to the east of the Copper Country Mall, and
- a 10-acre residential development located to the north of highway M-26 and west of Green Acres Road.

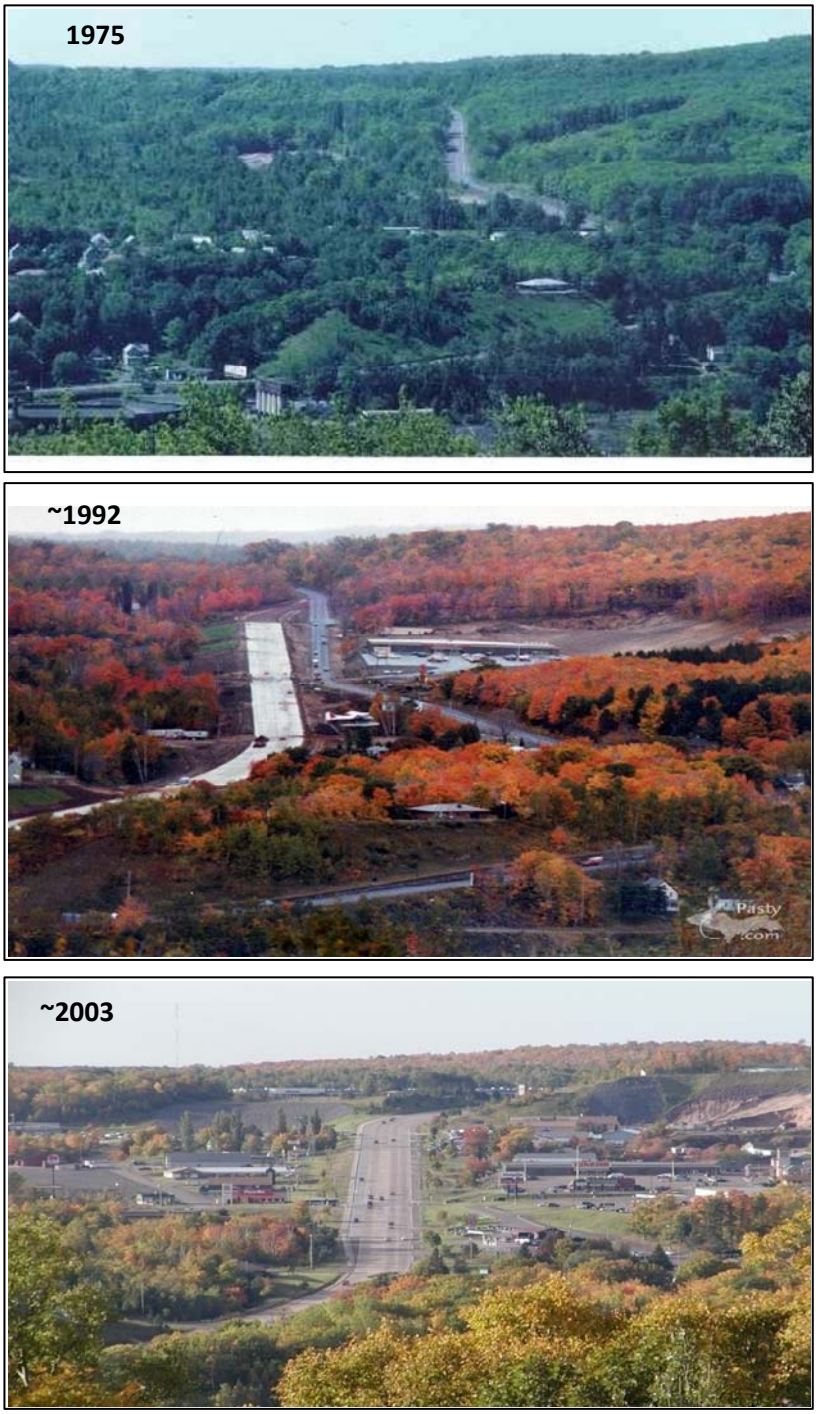

Figure 2.7 Photographs of M-26 corridor in Huron Creek watershed, 1975 (Photo courtesy of Dave Wisti via Greer, 2006), ~1992 (Photo from MTU GEM Center via Greer, 2006), and ~2003 (Photo from MTU GEM Center via Greer, 2006). Photographs taken facing south from Ripley overlook.

Near-future development areas in Portage Township include (Bingham, 2008):

- a commercial parcel slated for a large store or business directly to the south of the Copper Country Mall and
- two commercial parcels located on the north side of M-26 on the east and west sides of Janovsky Road (to the east of Snowmobile Club Road).

2.4. Topography, Geology and Soils

2.4.1. Ground Surface Topography

The ground surface topography of the Huron Creek watershed is displayed in Figure 2.9. From the southern watershed boundaries to near the former Huron Lake, the surface topography is nearly level to gently sloping. Elevations range from 1049 ft above mean sea level (AMSL) at the southern and southeastern boundaries of the watershed to 893 ft AMSL near the former Huron Lake. Ground surface slopes between these locations vary from 2 to 4 percent. The average slope of the creek bed in this location is approximately 1 percent. From the former Huron Lake north to the mouth of Huron Creek, surface slopes greatly increase as the width of the watershed decreases. Average ground surface slopes increase to a range of 6 to 10 percent on both sides of the creek and highway M-26. The surface elevation drops from around 890 ft AMSL to near 602 ft AMSL, which is the historical average water surface elevation of the Portage Canal. The average slope of the creek bed is approximately 4 to 5 percent between the canal and the former Huron Lake. The creek flows over several waterfalls in this portion of the watershed.

The steepest ground surface slopes in the watershed are located along the western boundary near from Festival Foods north to Econo Foods and Shopko. These slopes reach 14 to 17 percent, and were generally unprotected during the years immediately following commercial development. Today however, most of the slopes have been stabilized with terracing and vegetation due to slope stability and liability concerns. Another common way slopes have been stabilized in the watershed is with the placement of “mine rock” from mining operations or construction blasting.

2.4.2. Geology

Bedrock in the Huron Creek area consists of the Portage Lake Volcanics series, and is present across the entire watershed. The Portage Lake Volcanic Series is an extremely thick, Precambrian-aged, flood basalt deposit that filled up an ancient continental rift valley. The dominant rock type is vesicular basalt (basalt with vesicles or “pockets” from gas bubbles). Many of these vesicles are filled with minerals, which classifies it as amygdaloidal basalt. Houghton area amygdaloidal basalts have long had significant economic importance because native copper is one of the more common vesicle-filling and fracture-filling minerals. Numerous Houghton area copper mines have exploited these cupriferous amygdaloidal basalts through from the mid-1800’s to the mid-1900’s (St. John, unknown). Historical copper mining activities are discussed further in Section 2.7.

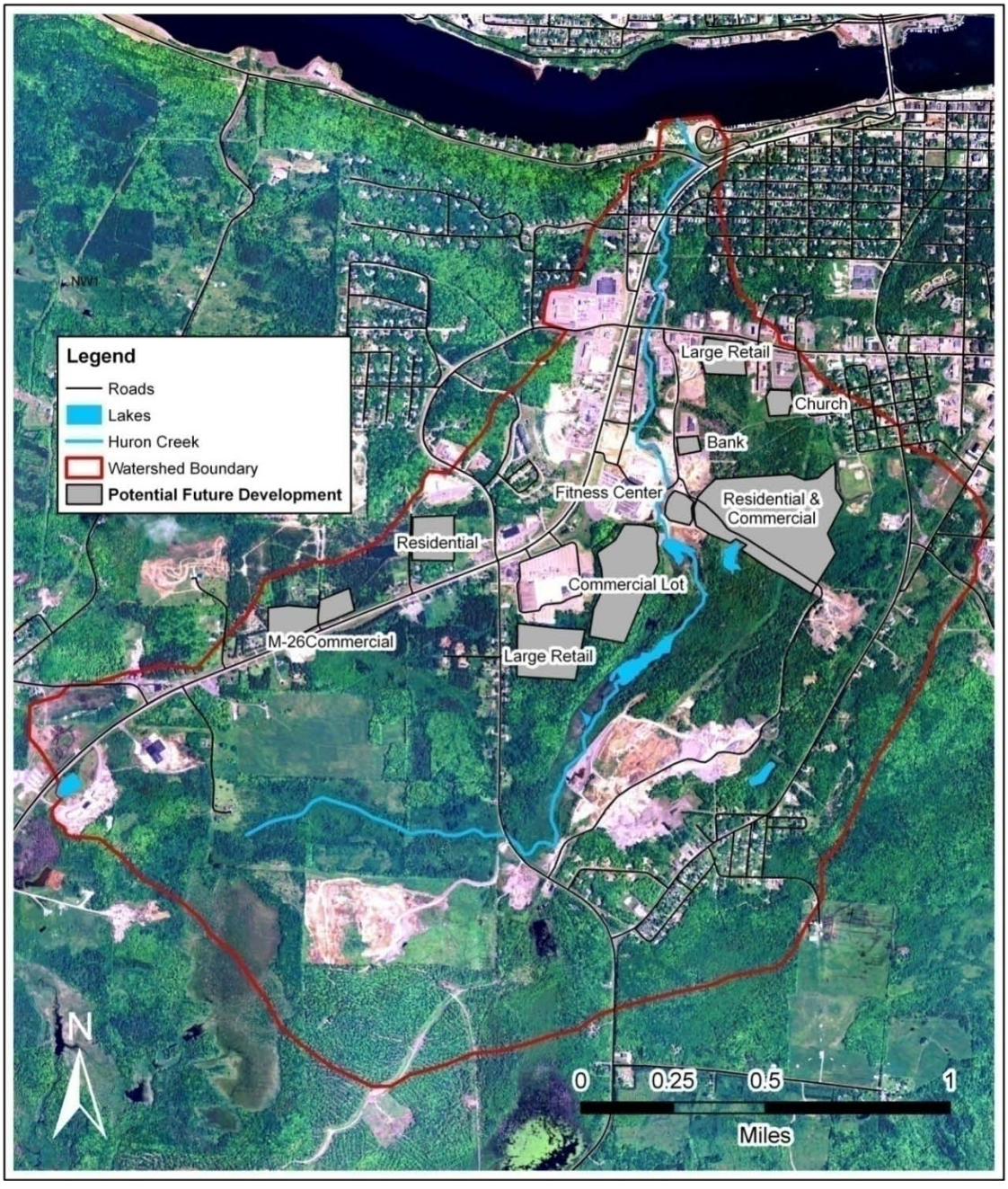

Figure 2.8 Potential near-future developments in Huron Creek watershed. Created by Linda Kersten, 4/10/08. Map projection: NAD 1927 UTM Zone 16N. Data sources: MI Geographic Database; 2005 NAIP 1-meter digital orthophoto.

Although the basalt formation is not generally considered "sulfur bearing" (and does not pose a significant sulfide/acid drainage threat), the waste rock and stamp sands produced from mining have introduced various metals into the environment over the years such as copper, silver and mercury

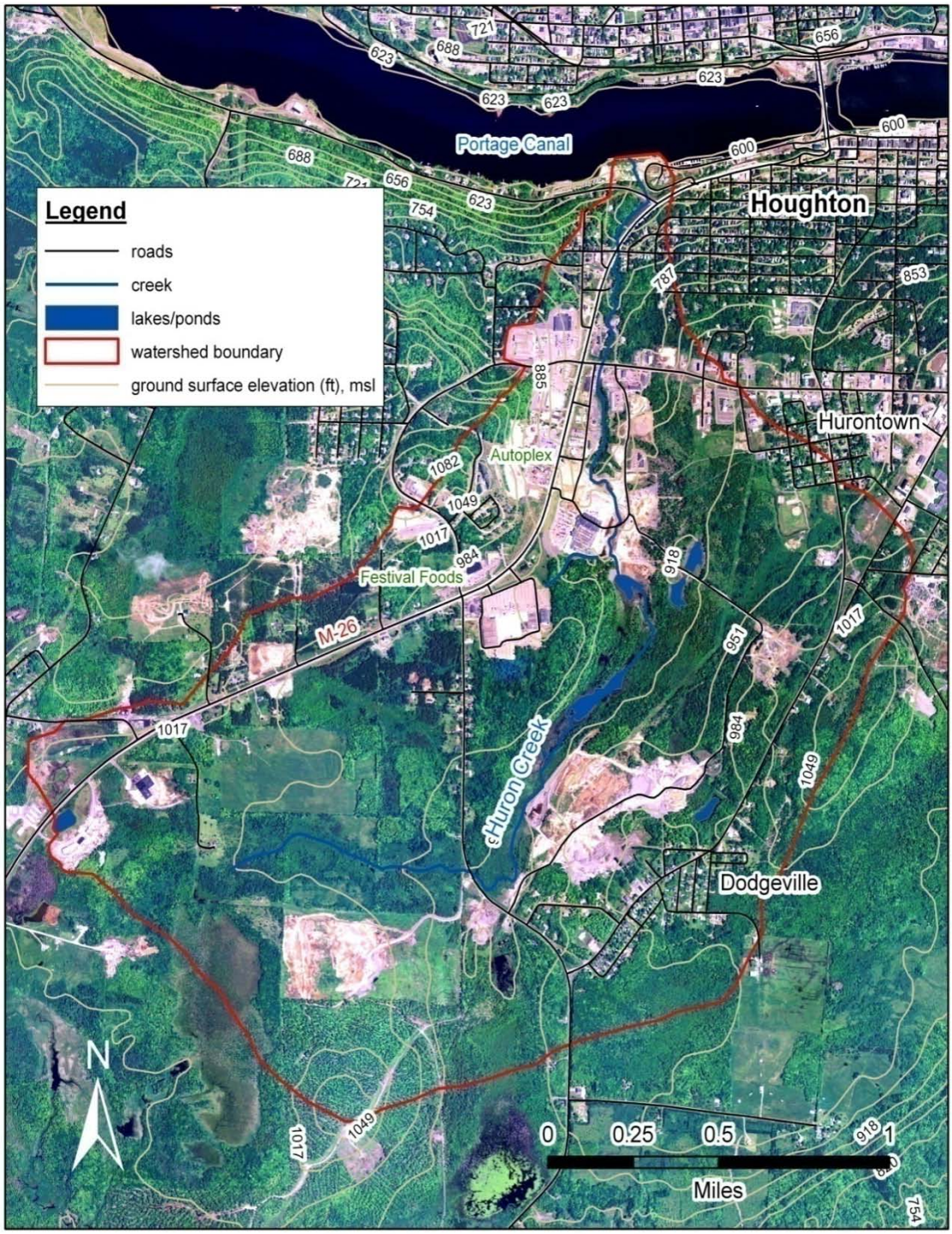

Figure 2.9 Ground surface topography in Huron Creek watershed. Created by Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data sources: MI Geographic Data Library; 2005 NAIP 1-meter digital orthophoto.

(W. Charles Kerfoot, S.L. Harting, Ronald Rossman, John A. Robbins, Unknown). Elevated levels of copper and iron have been documented in Huron Creek that may be attributable to mining activities.

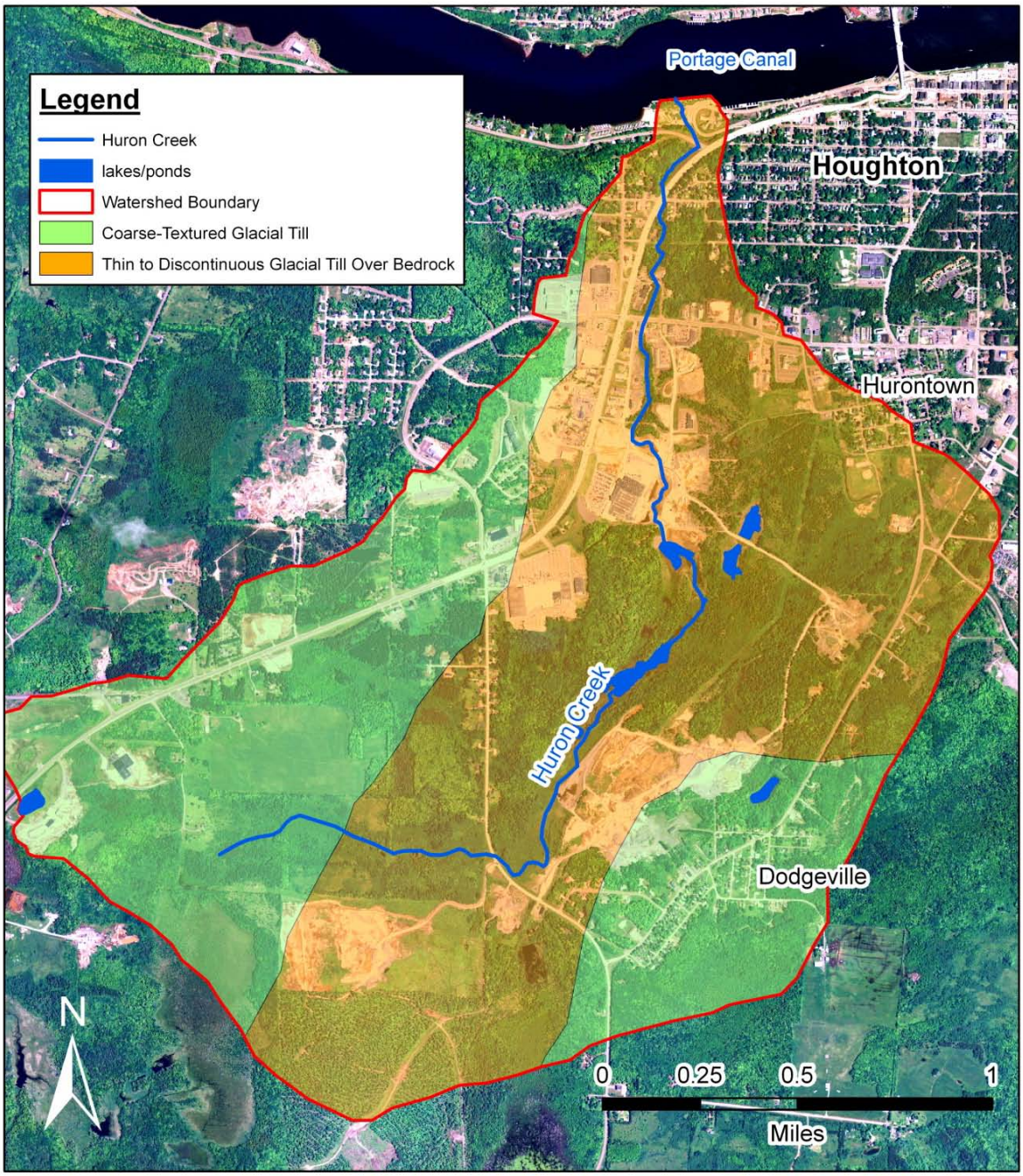

Figure 2.10 Quaternary geology in Huron Creek watershed. Created by Linda Kersten, 1/15/08. Map projection: NAD 1927 UTM Zone 16N. Data sources: 1998 MNFI & MDNR digital quaternary geology maps; 2005 NAIP 1-meter digital orthophoto.

The quaternary (or recent) geology of the Huron Creek watershed consists of glacial till over bedrock. A map showing the watershed's quaternary geology is provided in Figure 2.10. Much of the northern and

central portions of the watershed have thin to discontinuous glacial till. Where the till is discontinuous, there are bedrock outcrops. In the southwestern and southeastern portions of the watershed, the glacial till is coarse-textured (meaning larger sands, gravels and cobbles) and is generally continuous.

Depth to groundwater varies from 0 feet below the surface in wetland and pond areas to 550 feet below the surface on the tops of hills and slopes (MDEQ Water Bureau, USGS- MI Water Science Center, 2005).

2.4.3. Soils

A soils map derived from the Natural Resources Conservation Service (NRCS) soil survey map is shown in Figure 2.11. Each colored polygon in Figure 2.11 represents a different soil map unit that is labeled with numbers and/or letters. These labels correspond to a specific map unit name that indicates soil texture, depth, slope and various other characteristics. Table 2.3 lists map unit labels, names, corresponding soil textures and hydrologic groups. The hydrologic group of a soil indicates its surface water runoff potential when thoroughly wet (NRCS). Full soil type descriptions can be found on the NRCS website at: http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi.

The predominant soil textures in the watershed are sand, sandy loam or gravelly sand. In a few areas, the soils have slightly more silt or cobbles, or are mucky such as in wetlands. Some areas, especially along the perimeter of the watershed, have thin soils among areas of rock outcrop (92B, 92D, 92E). Also indicated are locations of borrow pits (45) and mine dumps (55) which consist of stamp sand and/or mine rock. These locations are primarily in the southeastern portion of the watershed. Stamp sands were produced by stamping mills that were run by the copper mines. The stamping mills were locations where large mined rock was crushed and pulverized for easier extraction of the copper. Stamp sands are the residual materials that were usually deposited adjacent to the stamp mills

Two major sand and gravel quarries are found in the watershed. One is located just west of the town of Dodgeville, and occupies approximately 71 acres. The other quarry is located to the southwest, on the west side of Green Acres Road. It occupies approximately 40 acres. Both quarries are owned by Moyle, Inc., which is in the process of developing another quarry near the south-central border of the watershed. Moyle, Inc. is responsible for implementation and inspection of erosion control and stormwater management measures for these quarries. The company hires employees who are certified under the MDEQ's Stormwater Operator program to carry out the inspections (Moyle, 2006).

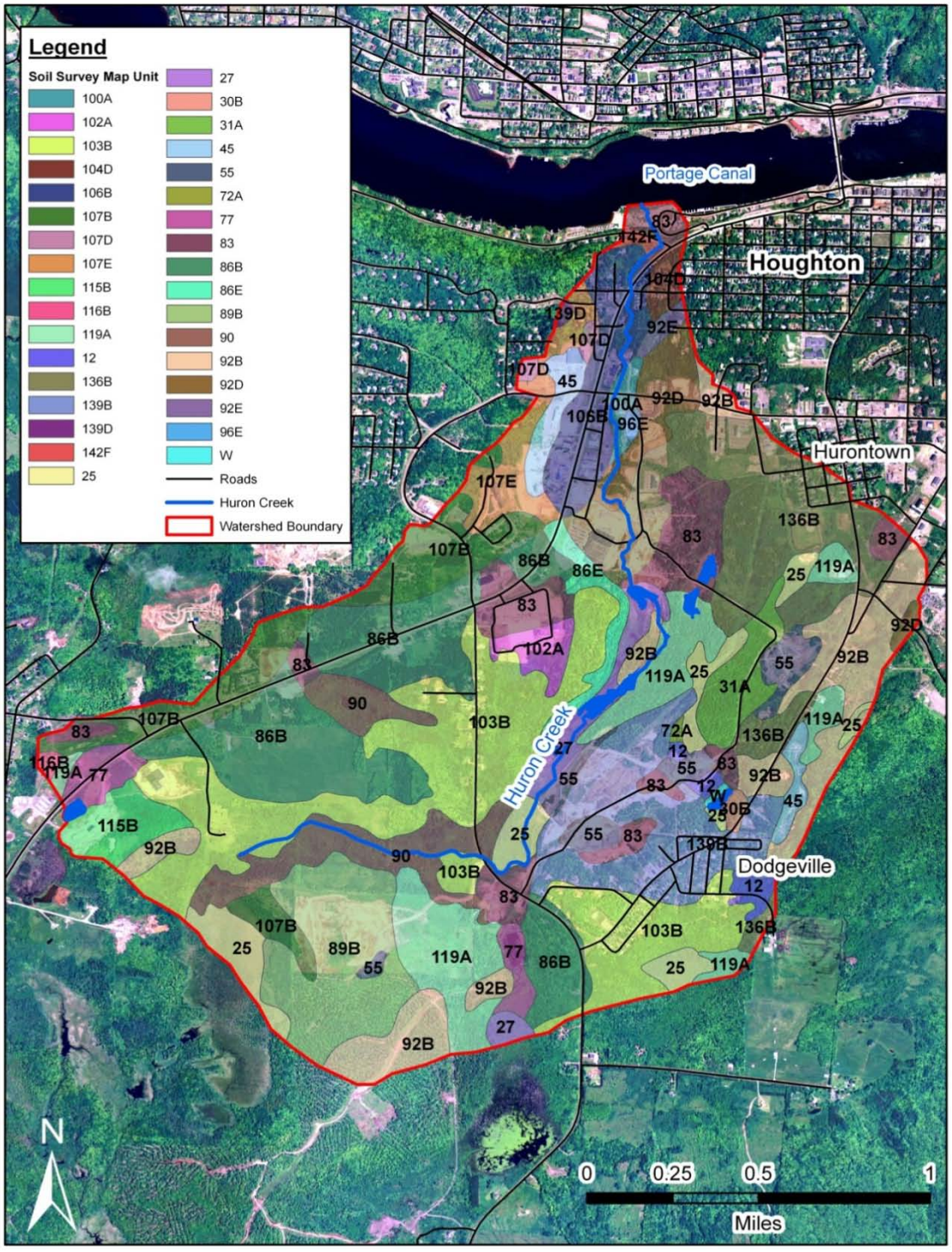

Figure 2.11 Natural Resources Conservation Service (NRCS) soil survey map for Huron Creek watershed. Created by Linda Kersten, 1/16/08. Map projection: NAD 1927 UTM Zone 16N. Data sources: 2000 NRCS Soil Survey of Houghton County; 2005 NAIP 1-meter digital orthophoto.

Table 2.3 NRCS Soil Survey Map Unit Descriptions

Map Unit Label	Map Unit Name	Soil Texture(s)	Hydrologic Group*
12	Gay muck	muck	B/D
25	Lupton and Cathro mucks	muck	A/D
27	Histosols and Aquents, ponded	muck, organics	D
30B	Munising-Skanee complex, 0 to 8 percent slopes	sandy loam, loamy sand	B, C
31A	Skanee-Gay complex, 0 to 3 percent slopes	sandy loam, muck	C, B/D, B
45	Pits, borrow	--	--
55	Dumps, mine	stamp sands and/or mine rock	--
72A	Halfaday sand, 0 to 3 percent slopes	sand	A
77	Tawas-Roscommon mucks	peat, muck, mucky sand	A/D
83	Udipsamments and Udorthents, nearly level	fill	A
86B	Trimountain cobbly fine sandy loam, 1 to 8 percent slopes	cobbly fine sandy loam	B
86E	Trimountain cobbly fine sandy loam, 15 to 35 percent slopes	cobbly fine sandy loam	B
89B	Trimountain-Paavola complex, 1 to 8 percent slopes	fine sandy loam, loamy sand, loamy coarse sand	B
90	Witbeck very stony muck	stony muck	B/D
92B	Arcadian-Michigamme-Rock outcrop complex, 1 to 8 percent slopes	gravelly fine sandy loam, silt loam, rock outcrop	D, C
92D	Arcadian-Michigamme-Rock outcrop complex, 8 to 15 percent slopes	gravelly fine sandy loam, silt loam, rock outcrop	D, C
92E	Arcadian-Michigamme-Rock outcrop complex, 15 to 35 percent slopes	gravelly fine sandy loam, silt loam, rock outcrop	D, C
96E	Liminga fine sand, 15 to 35 percent slopes	fine sand	A
100A	Au Gres-Roscommon complex, 0 to 3 percent slopes	sand, mucky sand	B, A/D
102A	Net-Witbeck complex, 0 to 3 percent slopes	silt loam, loam, sandy loam,	C, B/D
103B	Trimountain-Net complex, 0 to 8 percent slopes	fine sandy loam, silt loam, loam	B, C
104D	Urban land-Udorthents complex, strongly sloping	paved areas, fill soils	--
106B	Urban land-Udorthents-Udipsamments complex	paved areas, fill soils	--
107B	Kalkaska-Waiska sands, 0 to 8 percent slopes	sand, gravelly sand	A
107D	Kalkaska-Waiska sands, 8 to 15 percent slopes	sand, gravelly sand	A
107E	Kalkaska-Waiska sands, 15 to 35 percent slopes	sand, gravelly sand	A
115B	Trimountain-Paavola complex, 1 to 12 percent	fine sandy loam, loamy sand, loamy coarse sand	B
116B	Trimountain-Paavola-Michigamme complex,1 to 12 percent slopes	fine sandy loam, loamy sand, loamy coarse sand, silt loam	B, C
119A	Net-Witbeck complex, 0 to 3 percent slopes, rocky	silt loam, loam, sandy loam	C, B/D
136B	Michigamme-Net complex, 0 to 8 percent slopes, rocky	silt loam	C
139B	Trimountain-Paavola-Waiska complex, 1 to 8 percent slopes	fine sandy loam, loamy sand	B, A
139D	Trimountain-Paavola-Waiska complex, 8 to 15 percent slope	gravelly sand, loamy coarse sand, fine sandy loam	B, A/D
W	Water	water	--

* Group A = High infiltration rate (low runoff potential), Group B = Moderate infiltration rate, Group C = Slow Infiltration Rate, Group D = Very slow infiltration rate. Hydrologic groups are listed perspective to the order the soil names are listed in the complex name. If a soil has a dual hydrologic group (A/D), the first letter is for drained areas and the second letter is for undrained areas (NRCS).

2.5. Climate and Hydrology

2.5.1. Climate Data

Westerly prevailing winds and winters with prolonged periods of snow cover are characteristic of the Huron Creek watershed's regional climate. The Huron Creek watershed is a north-facing watershed located in a northern latitude and therefore does not receive as much sunlight as one that is south-facing or in a southern latitude. The annual average incidence of solar radiation on horizontal surfaces is 1130 BTU/ft^2/day. The greatest solar radiation occurs during the months of June and July (Contes, 2007).

Average temperature during the winter months (November through April) is 23° F. During the summer months, the average temperature is 56° F (Contes, 2007). On average, the area receives 33 inches of annual precipitation[6]. The highest amount of precipitation generally occurs in January in the form of snow with an average of 3.3 inches when measured in melted form (Contes, 2007). When measured in frozen form, the annual average snowfall is 215 inches (Contes, 2007) . Much of the snow is lake effect snow, which is prevalent in the area due to Houghton's location relative to Lake Superior. Since 1952, average on-the-ground snowpack has varied from 14 to 28 inches between December and March. Accordingly, runoff from snowmelt is a significant contributor to Huron Creek's flow in the spring months. In the summer months (June to September), average monthly rainfall varies between 2.8 and 3.3 inches (Contes, 2007). In recent years (2006, 2007) Houghton has received relatively intense rainstorms such as the storm on September 4, 2007 that produced 3.7 inches of rain in less than 10 hours (Weather Underground). Figure 2.12 and Figure 2.13 provide historical total annual precipitation data and monthly average precipitation data for the Houghton area, respectively. Climate trends are discussed further in Chapter 5.

[6] All climate data is taken from the National Climatic Data Center (NCDC) Hancock-Houghton County Airport weather station. This station is located approximately 8 miles from the center of the Huron Creek watershed. The station is located at an elevation of 1074 feet, which is approximately 300 ft higher than the average elevation in the Huron Creek watershed. Higher elevations typically receive more snow, such that the precipitations reported for the Huron Creek watershed here are likely biased high.

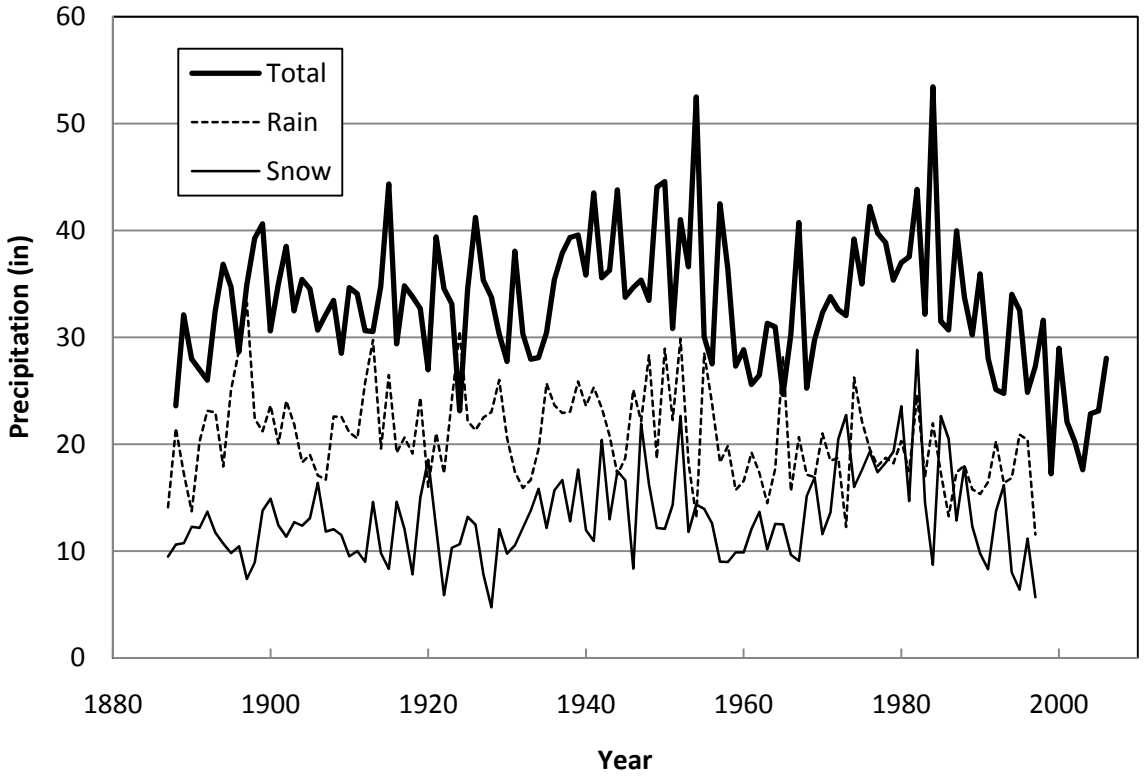

Figure 2.12 Annual precipitation for 1888-2007 (Contes, 2007). Separated rain and snow total data was not available from the NOAA/NCDC website from 1999 onward as of July 2007. Annual data is based on a precipitation year beginning 9/1 and ending 8/31, so that a precipitation year captures an entire winter.

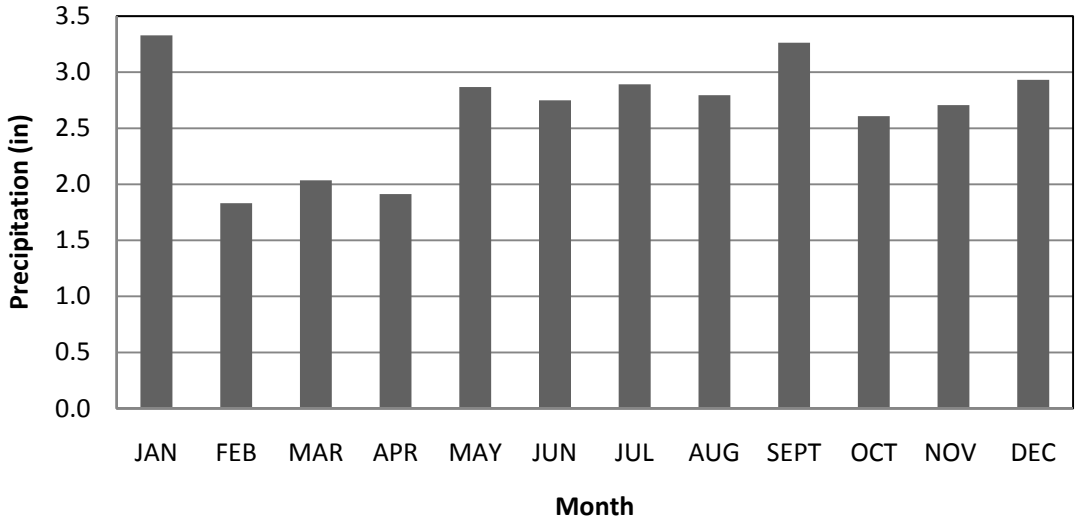

Figure 2.13 Average monthly precipitation over the period 1888-2007 (Contes, 2007).

2.5.2. Hydrology

Short term changes in the rate of flow in response to rainfall and snowmelt events are influenced by land cover and local slopes, among other factors. The upper (southern-most) two-thirds of the watershed (see Figure 2.14) is dominated by forested land and wetlands with relatively gentle slopes. In response to rainfall and snowmelt events, forested lands generally produce relatively small amounts of runoff volumes and relatively slow movement of water across the land surface towards the stream. Wetlands tend to attenuate runoff by collecting water from rainfall and snowmelt events and release the water at relatively slow rates. The prevalence of forested land and wetlands, combined with low slopes give rise to relatively small increases in flow rates in response to rainfall and snowmelt events in the upper portion of the watershed.

In contrast, the lower one-third (northern-most) is dominated by developed land cover and relatively steep slopes, both in the stream channel and the land draining to the stream. The developed land cover consists of relatively impervious materials, such as rooftops and parking lots, which tend to produce high volumes and rapid rates of runoff. The developed land cover includes drains that collect the runoff from rooftops and parking lots and direct the flow through ditches and culverts which eventually lead to the creek. These systems tend to increase rates of runoff to the creek even further. The combination of the relatively impervious materials; direction of flow through drains, ditches, culverts; and the relatively high slopes can generate relatively high increases in flow rates in response to rainfall and snowmelt events in the lower portion of the watershed. The increase in developed land over the past few decades has caused the rate of flow of the creek to increase significantly in response to rainfall and snowmelt events, also referred to “flashy” flow, over the years, which in turn has caused contributed to erosion problems such as those in the Shopping Cart Creek tributary and the Kestner Waterfront Park. The geomorphology survey results provided in Section 5.7 describe some of these erosion areas.

In between rain and snowmelt events, flow into the creek from groundwater seepage, also referred to as baseflow, controls the rate of flow of the creek. Baseflow is essentially rainfall or snowmelt that recharges the near-surface groundwater system and tends to flow from the point of recharge towards the creek. The volume and rate of baseflow is controlled by land cover and slopes. As the amount of less pervious surface increases, baseflow generally decreases, since less water infiltrates the subsurface. The volume and rate of baseflow is also controlled by the elevation of the local groundwater table relative to the stream channel. In most areas of the watershed, it is suspected that the water table is higher than the stream channel, leading to a positive gradient towards the stream. This situation is often referred to as a gaining stream. However, in other areas, most notably downstream of the wetlands in the area where Huron Lake use to be located and upstream of the “Frog Pool” area, it is suspected that the water table is lower than the stream channel. This portion of the stream is described as the “creek re-route area” in Section 2.6.2. This situation leads to what is referred to a losing stream, or, in other words, no baseflow is provided to the stream. It has been observed over the last few summers that the stream is dry in portions of this area in between rain and snowmelt events.

Limited data has been collected on flows in Huron Creek to date. As a substitute for observed flow rate data, flow rates of Huron Creek have been simulated using a rainfall-runoff model. Average and peak flow rates determined from these efforts are described in Section 5.4.

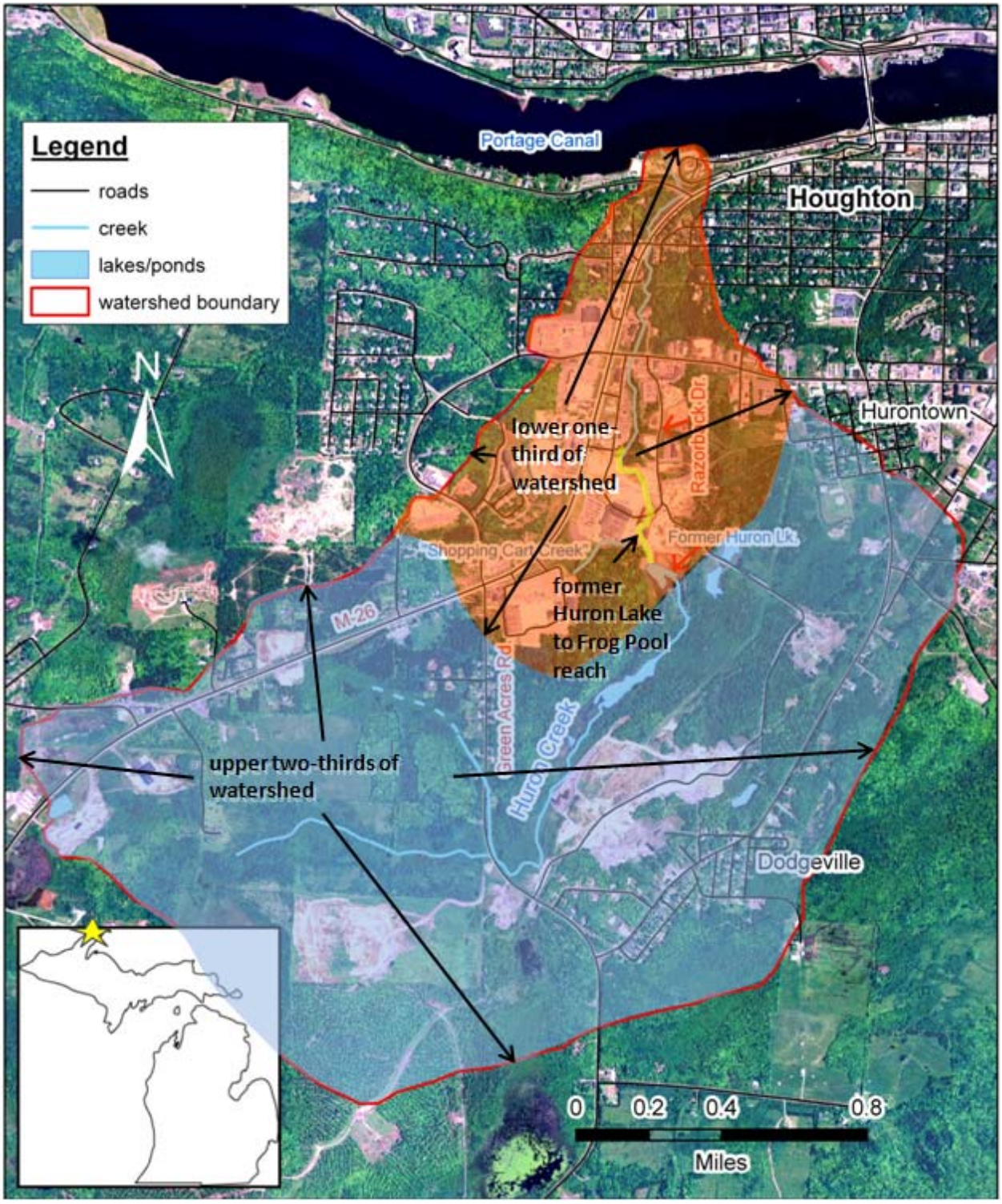

Figure 2.14 General features of Huron Creek watershed relevant to watershed hydrology. Created by Linda Kersten, 1/16/08; Alex Mayer 3/5/09. Map projection: NAD 1927 UTM Zone 16N. Data source: 2005 NAIP 1-meter digital orthophoto.

2.6. Habitats and Vegetation

2.6.1. Native Habitats

Pre-settlement era habitats of the Huron Creek watershed included sugar maple-hemlock forest, sugar maple-basswood forest, mixed conifer swamp and cedar swamp. These habitat types have changed or become fragmented due to clear-cutting that occurred at the turn of the century. Today, upland forests commonly consist of sugar and red maple (*Acer saccharum, Acer rubrum*), paper birch (*Betula papyrifera*), hemlock (*Tsuga canadensis)*, basswood (*Tilia americana*) and elm (*Ulmus americana).* Balsam fir (*Abies balsamea*) is especially common in the understory of these forests, along with several herbaceous plants such as bracken fern (*Pteridium aquilinum*), meadow horsetail (*Equisetum pretense*) and goldenrod (*Solidago spp.*). Red and white pine (*Pinus resinosa, Pinus strobus*) stands are prevalent in the high, sandy portions of the watershed. In mesic habitats (habitats that lie between uplands and wetlands), tree species such as cottonwood (*Populus deltoides*) and quaking aspen (*Populus tremuloides*) are dominant. The percent cover the canopies of these forests provide is generally high in areas without recent disturbance. Details on vegetation and percent cover can be found in the vegetation and riparian buffer survey found in Section 5.8.

Wetland areas occupy approximately 19% of the watershed's land cover (see Figure 2.4). These wetland types include forested wetlands, open-water wetlands and shrub-scrub areas. Shrub-scrub wetlands are especially predominant in riparian zones (areas adjacent to the stream) in the southern portion of the watershed where ground surface topography is relatively flat. Willow species (*Salix spp.)*, red-osier dogwood (*Cornus sericea*) and tag alder (*Alnus incana ssp. rugosa*) are common shrub species in these areas. Plant species commonly found in the watershed's open water wetlands include yellow waterlily (*Nuphar lutea*), floating pondweed (*Potamogetan natans*) and cattail species (*Typha spp*.). The edge of these open water areas often supports various sedge (*Carex spp.*) and rush (*Juncus spp.*) species among others.

The forested wetlands in the Huron Creek watershed are commonly dominated by white cedar (*Thuja occidentalis*), but support a variety of other tree, shrub and herbaceous plant species.

2.6.2. Wetland Mitigation and Creek Rerouting in 2004

In 2004, the Houghton Wal-Mart made plans to expand to a "Super-Center" and applied to the MDEQ for a permit to fill 5.5 acres of wetland and relocate a portion of Huron Creek[7]. Because the wetlands that were to be filled were considered contiguous (connected to other bodies of water), and due to the length of stream to be relocated, the U.S. Army Corps of Engineers and U.S. Environmental Protection Agency also had jurisdictional review of the permit application.

The designated wetland mitigation ratio for this site was 2:1, meaning that the mitigation site would have to be 11 acres in size. The selected mitigation site included the former Huron Lake area (to the southeast of the existing Wal-Mart), and areas of stream located to the east and northeast of the

[7] As a result of negotiations with the City of Houghton, the responsible party and permit holder for the wetland fill and mitigation is the City of Houghton.

existing store. Because part of the proposed mitigation plan was to rehabilitate the Huron Lake area (removal of stamp sands and establishment of vegetation), the City of Houghton negotiated to have the required mitigation area reduced by 10%. This resulted in the final mitigation area being approximately 10 acres. Figure 2.15 shows the creek re-route and mitigation site locations relative to the Wal-Mart expansion.

In addition to the permit application and mitigation site design plans, the City of Houghton was required to provide a wetland mitigation monitoring plan. This plan is required by MDEQ and lays out guidelines for monitoring of the wetland to provide for an established, vegetatively-diverse wetland. The minimum required monitoring period is five years. The proposed permit application and mitigation plan was approved by all regulatory agencies (date unknown) and mitigation monitoring is in progress by the city of Houghton.

Figure 2.15 Wal-Mart expansion wetland mitigation and creek re-routing.

2.6.3. Invasive Species

Various invasive plant species have been observed within the Huron Creek watershed. the more prevalent species include spotted knapweed (*Centaurea stoebe*) and white and yellow sweetclover (*Melilotus alba, Melilotus officinalis*). Species that are least commonly observed include reed canary grass (*Phalaris arundinacea*), glossy and European buckthorn (*Rhamnus frangula, Rhamnus cathartica*),

and purple loosestrife (*Lythrum salicaria*). Of these invasive species, the sweetclovers, knapweed and reed canary grass are currently present in the Wal-Mart mitigation site and creek re-route area. The buckthorn species have been observed in various wooded areas, while purple loosestrife has been observed near the mouth of Huron Creek. The locations of these species are documented in the vegetation survey that is provided in Appendix L, and discussed in Section 5.8. The species described here have been identified as invasive in the state of Michigan according to the Michigan Department of Agriculture's Horticulture Fund 2005 Final Report (Michigan Department of Agriculture, 2005).

2.7. History of Human Activities

As mentioned earlier, mining activities have played a significant part in shaping the history of the area. The Huron Creek watershed (and much of Houghton and Keweenaw County) is positioned over what once was one of the richest deposits of native copper in the world. Copper mining began in the watershed in 1852 with the opening of the Isle Royale mine and one year later, the opening of the Huron mine. The Isle Royale mine was located approximately one-half mile north of present-day Dodgeville, and the Huron Mine was located slightly farther to the north in Section 2, T 54N, R 34W (Greer, 2007) (see Figure 2.16).

In most cases, the copper was separated from the host rock through a crushing or "stamping" process. In 1865, Huron Creek was dammed to utilize water power to run the Huron Stamp Mill, creating Huron Lake. The lake provided the mill with the power and filtration mechanism needed to process the copper and separate it from the waste rock (Greer, 2007). Both the Isle Royale and Huron mines operated independently until production slowed to the point where the operation was no longer profitable. The Isle Royale mine and the Huron mine temporarily ceased production in 1870 and 1893, respectively. However, in 1897 the Isle Royale Consolidated Mining Company (IRCMC) merged the Huron, Isle Royale and Portage mine (another local mine outside of the watershed) into one mining operation. Soon after, in 1899, IRCMC merged again with the Miners Mining Company, forming the Isle Royale Copper Company (IRCC). From 1897 until 1900, the IRCMC and the IRCC continued to use the Huron Stamp Mill for finishing operations. In 1900, the IRCC built a new stamping mill on the Portage canal at the mouth of the Pilgrim River, ceasing the production of stamp sands in the Huron Creek watershed (Greer, 2007).

Throughout this 100 -year-plus mining era, the Huron Creek watershed was impacted in many ways. In addition to the damming of the creek (creation of Huron Lake), the creek itself was often rerouted and moved to optimum locations for use in industrial or agricultural activities. Figure 2.17 shows the location of Huron Creek in 2007 compared to its originally surveyed location in the 1867 State of Michigan Land Office Plat. Also during this period, metals such as copper and mercury may have begun to be introduced into the watershed and creek from infiltration and surface water runoff from the stamp sands (W. Charles Kerfoot, S.L. Harting, Ronald Rossman, John A. Robbins, Unknown). Pulverization of the metal-bearing rock into the stamp sands greatly increased the surface area of the solid materials, potentially increasing the rate of release of contaminants from the solids into water flowing through the solids. Many areas of stamp sand deposits remain in the watershed (refer to the soils map, Figure 2.11), and still have the potential to carry these contaminants to the groundwater and creek.

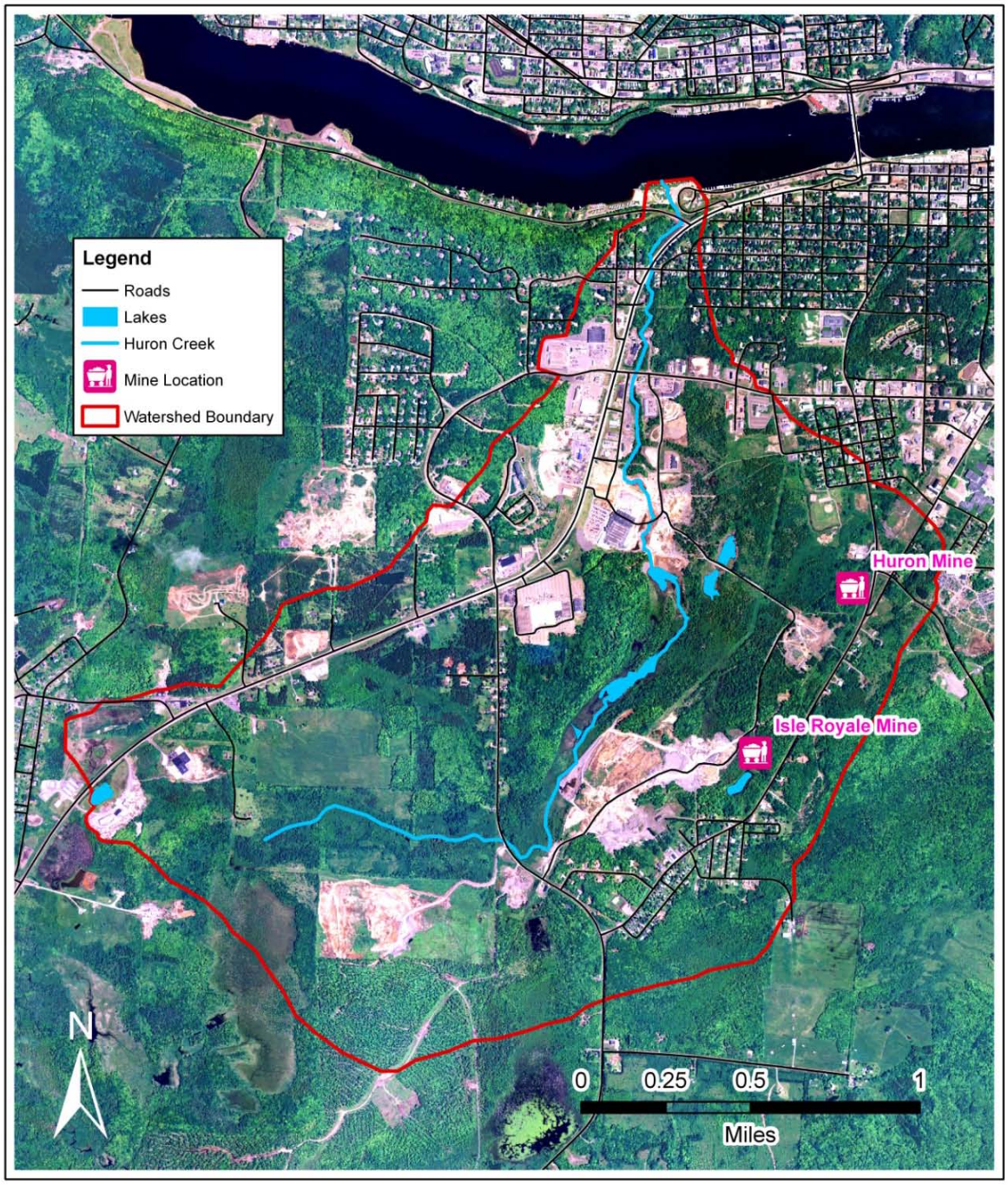

Figure 2.16 Isle Royale and Huron Mine locations (approximate). Created by Linda Kersten, 4/10/08. Map projection: NAD 1983 UTM Zone 16N. Data sources: Michigan Geographic Database; 2005 NAIP 1-meter digital orthophoto.

Deforestation also occurred at a rapid rate during the height of the mining era. The mining companies clear-cut areas near mine sites and stamping mills in order to make room for building construction and transport of mine rock. Clear cutting occurred not only to open up space, but also to provide timber for mine stability, fuel to produce steam power, material for miners to build homes, and tracks for trams and railroads (Greer, 2007). The rapid removal of vegetation and ground cover would have caused a

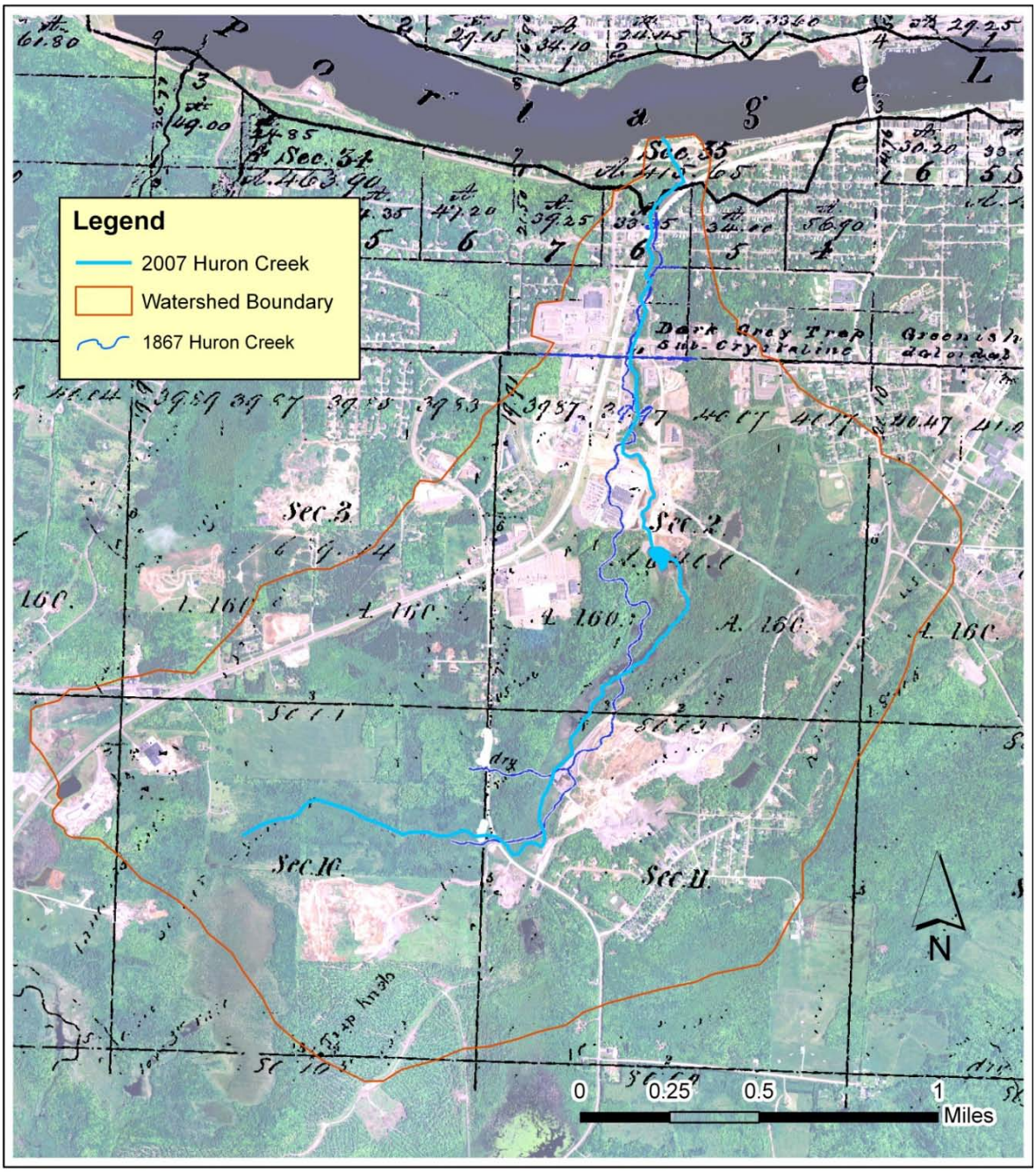

Figure 2.17 Locations of Huron Creek in 1867 and 2007. Geo-referencing of 1867 base map is approximate. Created by Linda Kersten, 10/23/07. Map projection: NAD 1927 UTM Zone 16N. Data sources: State of Michigan General Land Office Plats; 2005 NAIP 1-meter digital orthophoto.

steep increase in soil erosion, which in turn likely caused changes in the appearance and/or location of the creek as a result of bed or bank deposition. Deforested portions of the Huron Creek watershed are apparent in the 1938 aerial photo in Figure 2.18. These areas show recovery however, in the 1963 aerial photo (Figure 2.19), and the 2005 aerial photo (Figure 1.1).

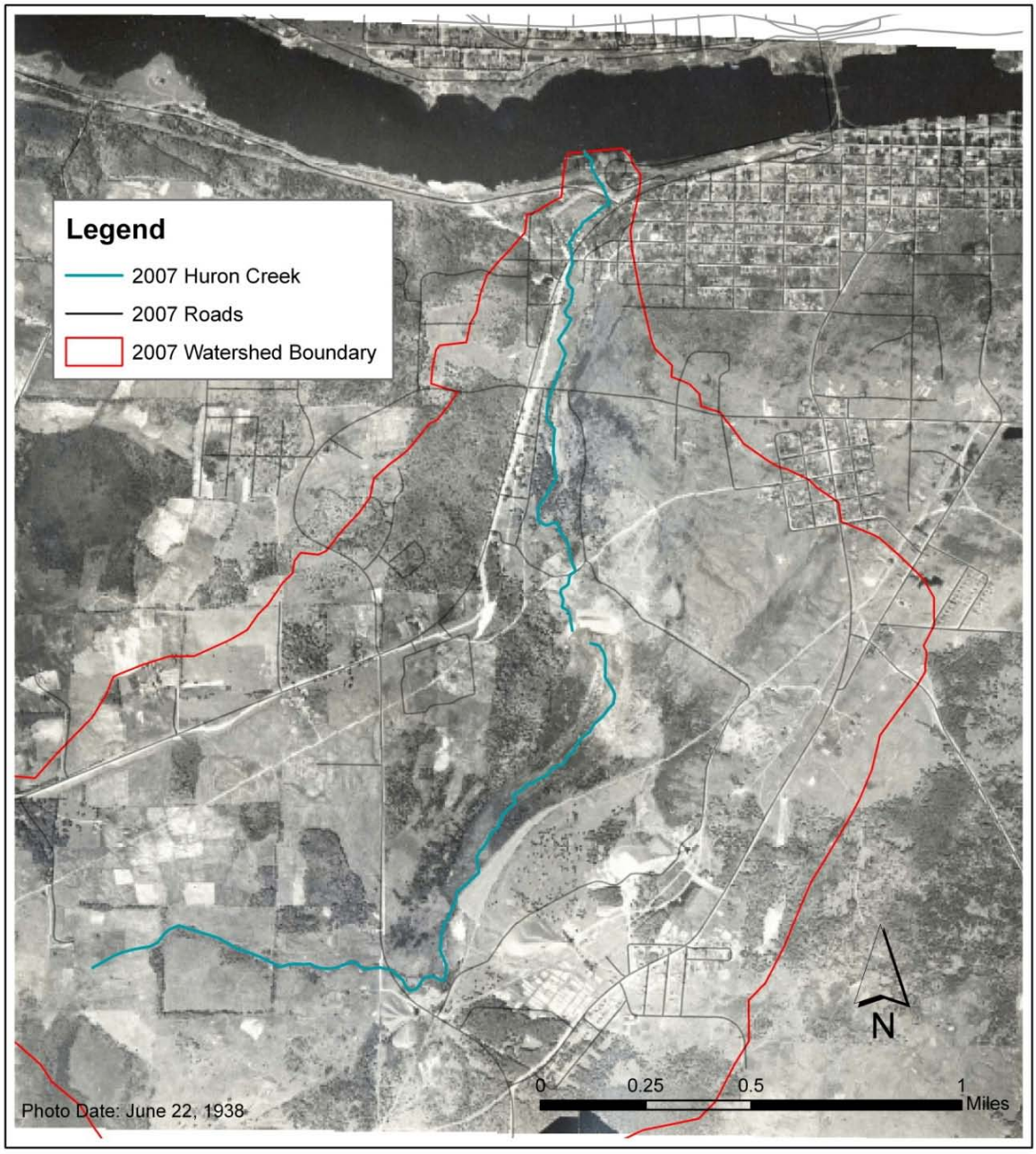

Figure 2.18 Aerial photo of Huron Creek watershed, 1938. Created by Linda Kersten, 10/23/07. Map projection: NAD 1927 UTM Zone 16N. Data sources: Houghton-Keweenaw Conservation District, courtesy of Bruce Peterson.

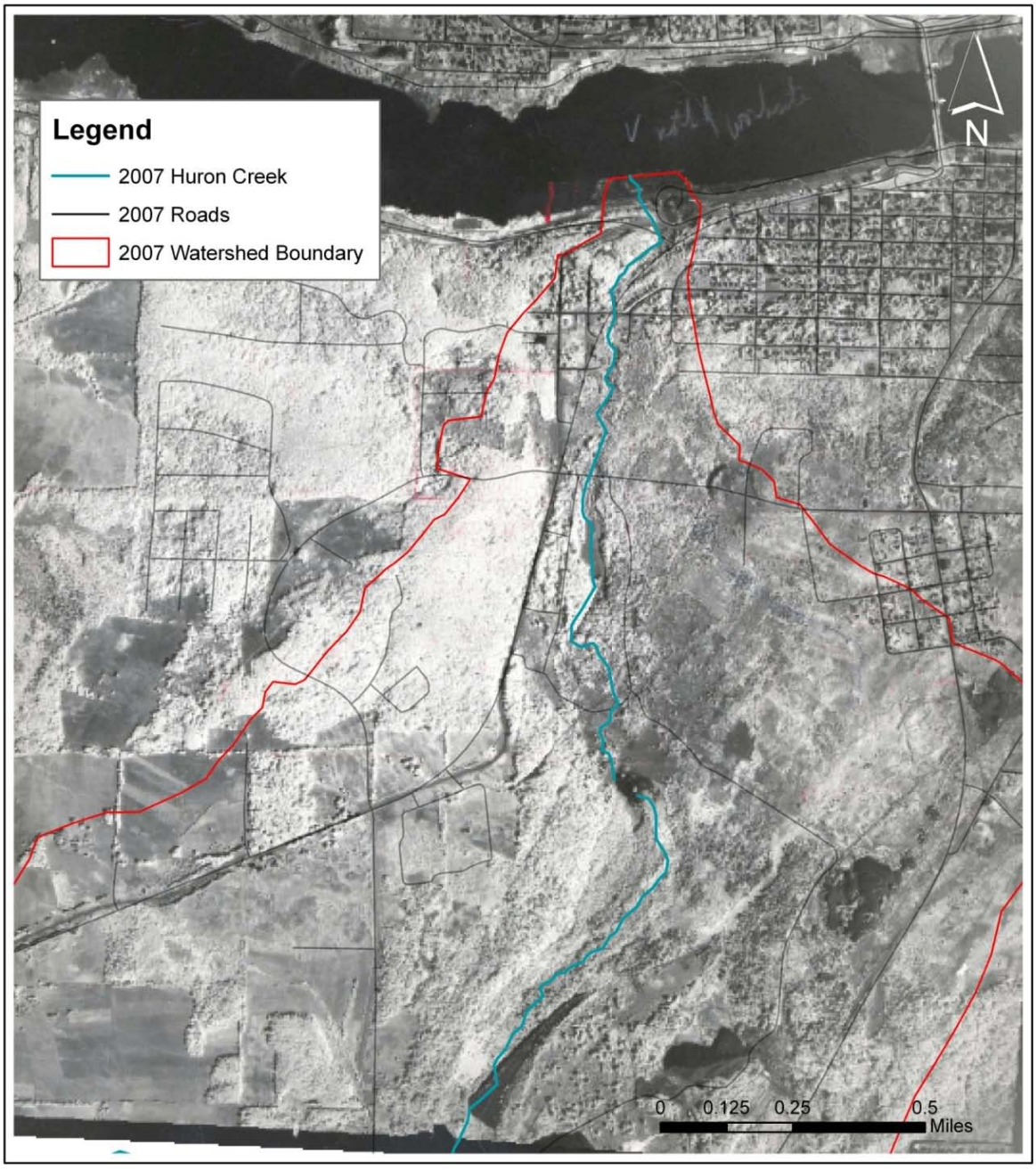

Figure 2.19 Aerial photo of Huron Creek watershed, 1963. Created by Linda Kersten, 10/24/07. Map projection: NAD 1927 UTM Zone 16N. Data sources: Houghton-Keweenaw Conservation District, courtesy of Bruce Peterson. Photo date: 9/13/63.

Despite copper mining's apparent negative impacts on the local environment, mining is an integral part of the region's cultural heritage. Mining brought immigrants from many countries to the area, underlying the cultural landscape that exists today. Many residents do the area have that at one time worked for a local mine, and would like to see the history and culture of the "Copper County" carried on for generations to come. The historical significance of the area has also been recognized by the United States federal government through the creation of the Keweenaw National Historic Park, owned and operated by the U.S. Department of Interior National Park Service (U.S. National Park Service, 2008).