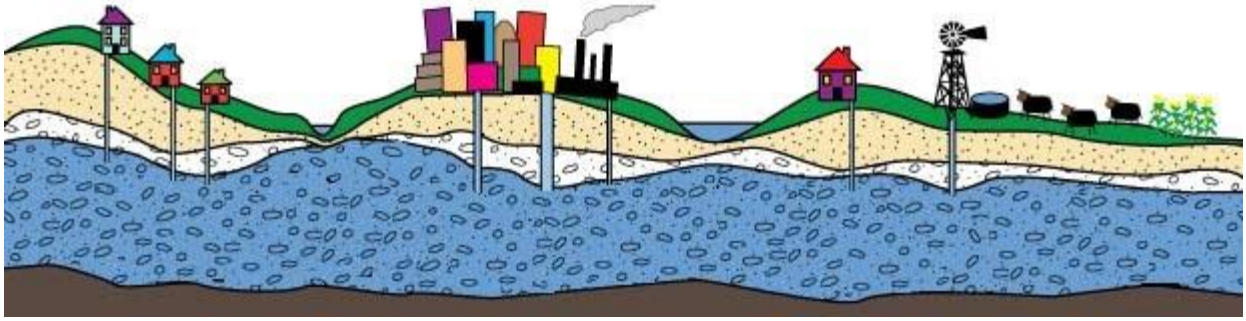
Portage County

Groundwater Management Plan
2017



Prepared By:

Portage County Groundwater Citizen Advisory Committee

Portage County Planning and Zoning Department Staff

Recommended by Portage County Planning and Zoning, Agriculture and Extension Education, and Land and Water Conservation Committees: June 26, 2017

Adopted by Portage County Board: July 18, 2017

Portage County

Groundwater Management Plan 2017

Adopted by the

Portage County Groundwater Citizen Advisory Committee
January 19, 2017

Portage County Planning and Zoning, Agricultural and Extension Education, and Land and Water Conservation Committees
June 26, 2017

Portage County Board of Supervisors
July 18, 2017

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And special thanks to the rest of the Planning and Zoning Department Staff

RESOLUTION NO. 149-2016-2018

TO: THE HONORABLE CHAIRMAN AND MEMBERS OF THE PORTAGE COUNTY BOARD OFSUPERVISORS:

RE: In Support of the Portage County Groundwater Management Plan

WHEREAS, the Portage County Board has long understood the importance of groundwater resources in supporting the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism, the health of groundwater dependent surface water and their ecosystems, and the monetary value of property taxes generated by waterfront property owners; and

WHEREAS, Portage County has undertaken water resource research and planning efforts for over 30 years, with the first Portage County Groundwater Management Plan being adopted after a County-wide planning effort in 1988, and updated in a similar fashion in 2004; and

WHEREAS, significant research and groundwater sampling have been conducted in Portage County since adoption of the 2004 Groundwater Management Plan Update, including the recently completed Little Plover River Study by Wisconsin Geological and Natural History Survey, and the County has continued to work on implementing Groundwater Management Plan recommendations; and

WHEREAS, despite these efforts, issues with groundwater quality and quantity continue to exist, in particular the significant number of County wells containing nitrate-nitrogen and pesticides at levels exceeding adopted health standards, and groundwater withdrawals have periodically exceeded groundwater recharge in certain areas of the County, resulting in diminished stream flows and environmental degradation; and

WHEREAS, in order to manage groundwater resources sustainably, efforts must continue to be made to work cooperatively with surrounding counties, municipalities, and other agencies to better understand what is truly a regional resource issue; and

WHEREAS, Portage County Committees and professional staff are committed to utilizing the research, findings, policy direction, and relationships generated throughout this multi-year planning process to work continuously to maintain adequate groundwater quantity and quality for everyone who relies on it.

FISCAL NOTE: There are no fiscal obligations for the County associated with this resolution

NOW, THEREFORE, BE IT RESOLVED, that the Portage County Board of Supervisors adopts the Portage County Groundwater Management Plan 2017, to guide future County groundwater programs toward the goals of groundwater quality that meets drinking water standards, and adequate quantities of groundwater for County residents, economy, and environmental needs.

DATED THIS 18TH DAY OF JULY 2017.

RESPECTFULLY SUBMITTED,

PLANNING AND ZONING COMMITTEE

Barry Jacowski, Chair

Larry Raikowski, Member

Marion "Bud" Flood, Member

Excused
Jerry Walters, Member

Julie Morrow, Member

LAND AND WATER CONSERVATION COMMITTEE

Dale O'Brien, Chair

Barry Jacowski, Member

Julie Morrow, Member

Gerry Zastrow, Member

Bob Gifford, Member

Roger Bacon, Member

AGRICULTURAL AND EXTENSION EDUCATION COMMITTEE

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Charles Gussel, Member

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SECTION 5.2 – PORTAGE COUNTY GROUNDWATER MANAGEMENT PLAN

A. INTRODUCTION

This Section of the Portage County Comprehensive Plan contains, and functions as, the Groundwater Management Plan (GWMP) for the County. In its first two versions (1988 and 2004), the GWMP was a stand-alone document. From this point forward, it will become a component of this Agricultural, Natural, and Cultural Resources Element. As with its previous versions, this GWMP represents the combined efforts of many individuals concerned with the wise management of Portage County groundwater resources. The discussions, analyses, and inventories are based on the best available information at this time, and provide a strong foundation for continuing a responsive and effective groundwater management program, including the development of specific goals and strategies for planning, management, and education.

Successful completion of this plan revision required assistance from staff of County, State and Federal agencies, including Portage County Planning and Zoning and Health and Human Services Departments; Wisconsin Departments of Natural Resources (WIDNR), Agriculture, Trade, and Consumer Protection (DATCP), and Safety and Professional Services (DSPS); University of Wisconsin, University of Wisconsin Extension; Wisconsin Geological and Natural History Survey (WGNHS), Central Wisconsin Groundwater Center, United States Natural Resources Conservation Service (NRCS) and United States Geological Survey (USGS); and Golden Sands Resource Conservation and Development (RC&D).

As with all programs of this type, conclusions, recommendations, and plans of action will need to be updated in future years as circumstances within the County evolve. A maximum five year revision cycle for the GWMP is recommended. An annual review by the Groundwater Citizens Advisory Committee is also recommended.

Purpose of the Groundwater Management Plan

The purpose of this planning effort is to provide information to the citizens and elected officials of Portage County - to guide their decisions regarding the use of groundwater, and detail how those uses will impact groundwater and surface water resources.

Specifically, this Groundwater Management Plan will: assess the current quality and quantity of the resource (including trends); identify the uses and users that depend on this resource; discuss vulnerabilities to contamination and depletion; categorize the impacts and conflicts related to these uses, and consider potential impacts of changes in uses; and provide options and recommendations for mediating conflicts based on groundwater sustainability.

Authority

The State of Wisconsin's emphasis on preservation and stewardship of groundwater resources was substantially established by 1983 Wisconsin Act 410, which specifically added groundwater protection to the statutory authorization for planning and zoning to protect the public health, safety, and welfare. This legislation, which became effective on May 11, 1984, clearly established groundwater protection as a high priority in Wisconsin. In addition to encouraging local planning and zoning for groundwater protection, this law also established State level programs to set groundwater quality standards, provide compensation for chemically contaminated private wells, regulate groundwater monitoring, develop laboratory certification, provide an environmental repair fund for problem waste disposal sites, and several other new regulatory programs.

In 2011 the Wisconsin Supreme Court (Lake Beulah v. WIDNR) ruled 7-0 that "the Department of Natural Resources has the authority and general duty to consider whether a proposed high capacity well may harm waters of the state". The ruling confirmed and reinforced WIDNR's obligation to uphold the "public trust doctrine", which is grounded in Article IX, Section 1 of the Wisconsin Constitution, and delineated in 281.11 of the Statutes. In May of 2016 the Wisconsin Attorney General issued an opinion stating that the WIDNR did not have the authority to impose requirements and conditions on high capacity wells or consider cumulative impacts of high capacity well pumping. The WIDNR has currently chosen to follow the Attorney General's opinion over the Lake Beulah decision. To find the current high capacity well permit process you can visit http://dnr.wi.gov/topic/wells/HighCapacity.html.

County planning and zoning authority is set forth in s.59.69 of the Wisconsin Statutes. Through this section, the County Board of any county may plan for the physical development and zoning of territory within the county for a number of purposes listed in s.59.69(1), including: "...to encourage uses of land and other natural resources which are in accordance with their character and adaptability;...to encourage the protection of groundwater resources;... to preserve wetlands...to conserve soil, water and forest resources;...to provide healthy surroundings for family life..."

Reference to preparation of a county development plan are contained in s.59.69(3). More specifically, s.59.69(3) provides: "The county zoning agency may direct the preparation of a county development plan or parts of the plan thereof for the physical development of the unincorporated territory within the county..."

Furthermore, zoning and other land use decisions should be based on the development plan as per s.59.69(3)(d): "...The development plan shall serve as a guide for public and private actions and decisions to assure the development of public and private property in appropriate relationships."

In addition to the protections introduced in Act 410 and the State statutes specifically regarding County planning and zoning, Wisconsin's "Comprehensive Planning" Statute, 66.1001, directly addresses conservation and effective management of groundwater resources in its planning requirements. To comply with that directive and assist in focusing its policies regarding land use, conservation, and development, Portage County now takes the step of incorporating the Groundwater Management Plan into its Comprehensive Plan.

History of Groundwater Planning in Portage County

In response to growing concerns regarding groundwater quality, and the change in State regulations regarding groundwater protection, the Portage County Board of Supervisors created a Groundwater Council in September 1984. The Council was composed of local public officials representing various units of government from throughout the County, and was charged with the primary task of developing a strategy and policy for addressing public concerns on groundwater protection and management, for recommendation to the County Board.

To assist in the identification of public concerns and the resolution of problems, the Council created a Technical and a Citizens Advisory Committee.

In 1985 the Groundwater Council, based on input from the County Board and the Technical and Citizens Advisory Committees, established the following priority list for groundwater activities: Protection of public well recharge areas; Development of a comprehensive groundwater protection plan; Aldicarb use; Greater emphasis on information and education; Fertilizer use in agriculture; Nitrate sources and contamination; Coordination and computerization of available groundwater quality data; Hazardous waste generation and disposal; Pesticide use; and Private well permitting and construction. These priorities ultimately led to the development of a Countywide Groundwater Management Plan as the number one priority. The County Board subsequently passed a resolution in December 1985 directing the Portage County Planning Department to prepare a Countywide Groundwater Management Plan in cooperation with other County departments.

After a considerable amount of public input and Committee meetings, the first Portage County Groundwater Management Plan was adopted by the Portage County Board on October 18, 1988. This process was repeated for the subsequent update of the document, which was adopted by the Portage County Board on March 16, 2004. A summary of recommendations from the 1988 and 2004 GWMP, and the implementation status of each, is included in Appendix B.

Following adoption of the first Plan in 1988, several changes were made in the structure of County agencies and committees to facilitate implementation of the recommendations of the Plan. Oversight responsibility for all County groundwater related programs was assigned to the County Planning and Zoning Committee. The Planning Department, Zoning Department, Land Conservation Department, and the groundwater related functions of the Community Human Services Department were consolidated into the newly formed Planning and Zoning Department. The County also hired a permanent Water Quality Specialist at that time. The Technical Advisory Committee was disbanded.

The Citizens Advisory Committee was reformulated to allow each of the incorporated and unincorporated municipalities in the County to appoint a representative. These representatives could not be elected officials nor municipal staff. The name also became the Groundwater Citizens Advisory Committee (GCAC). The task of GCAC was to advise the County Planning and Zoning Committee on ways to implement the recommendations of the Groundwater Management Plan. A reorganization of the GCAC in 1995 established three Subcommittees – Groundwater Management Planning and Implementation, Public Involvement and Education, and Continual Assessment – to play specific roles within the overall groundwater management structure. A change was made in 2009 to allow up to 20% of Committee representatives to be elected officials or municipal staff, if a suitable "citizen representative" could not be found. The Committee currently operates within this configuration.

Following adoption of the 2004 Groundwater Management Plan, a concerted effort went into involving other agencies, especially Golden Sands Resource Conservation and Development and the University of

Wisconsin – Stevens Point (UWSP), in groundwater education. Educational programs were provided in all of the schools in Portage County. Educational programs were also provided to many citizens at the local government board meetings. Using the County Geographic Information System (GIS), a groundwater flow map and well location map were developed for use by professionals and the public. An effort was also made to get accurate and current data for private well nitrate nitrogen and pesticide samples from all reliable sources.

Current Planning Process

A Technical Advisory Committee was re-convened in 2013 to undertake an initial review of the introductory sections of the 2004 Groundwater Management Plan, which led to a reorganization and re-assessment of the Plan content. An independent series of Groundwater Listening Sessions and a Groundwater Stakeholder Summit were held by the Portage County Executive through the fall and winter of 2014/2015. The results of these discussions were incorporated into this planning process.

The Groundwater Citizens Advisory Committee was responsible for assembling the initial preliminary draft of the Plan Update. A public open house was then held on August 25, 2016 to present preliminary findings of the Plan. The resulting feedback and comments from that meeting, along with feedback gathered from the public throughout September and October, were discussed and incorporated into the Plan draft in November 2016. The draft of the GWMP was subsequently forwarded to Portage County Planning and Zoning, Land and Water Conservation, and Agricultural and Extension Education Committees, meeting jointly, for their consideration. The joint Committees met in February, March, April, and May 2017 to discuss and revise the Plan. A Public Hearing on the final Plan was held by these three Committees, and the document recommended to the full County Board on June 26, 2017 for approval and adoption. The Groundwater Management Plan was adopted by the Portage County Board of Supervisors on July 18, 2017.

B. GROUNDWATER BASICS

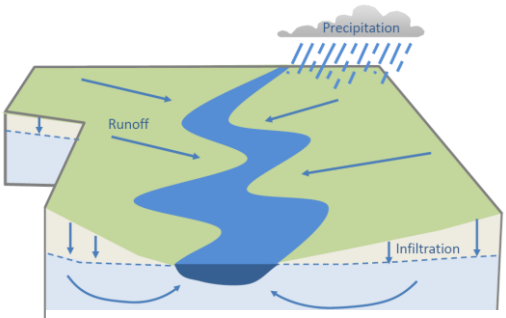


Figure 1. Cycle of groundwater in Portage County

Groundwater is the water that saturates the spaces and pores of unconsolidated materials such as sand, gravel, or silt and the fractures in bedrock such as granite or sandstone. Groundwater originates as precipitation. As rain or snow falls in the Central Wisconsin Region, some runs off the land's surface, some evaporates off the lands surface, some soaks in to the soil (infiltration) and is later taken up by plants and evaporated/"transpired" to the atmosphere, and some infiltrates past plant roots where it becomes groundwater (recharge). The amount of groundwater that infiltrates is determined by how much water the uppermost layer of soil can adsorb. Runoff occurs when rain falls or snow melts faster than water can infiltrate or soak into the ground.

Aquifers are the saturated geology that holds groundwater, and the upper boundary of the aquifer is called the "water table". The volume of the spaces where water is stored is known as porosity. The size and interconnection of these spaces that allows water to flow is called permeability. The porosity and permeability within the aquifer will determine how quickly groundwater moves or how easy it will be to pump.

Groundwater Flow

Groundwater does not remain stagnant but rather moves downward through the spaces, pores and fractures under the influence of gravity; that is, it moves from higher to lower elevations. Groundwater movement can be determined by measuring the difference in elevation between two areas. Groundwater moves from high elevations to low elevations, where it discharges to streams, lakes and wetlands. Once groundwater is discharged to these areas, it is referred to as surface water. Surface water in Portage County is where the water table intersects the lands surface, thus making groundwater and surface water directly connected to one another. The cycle of precipitation, groundwater recharge and discharge to surface waters is a balanced natural system. During drier years, less recharge occurs and water levels and stream levels decline. During wet years, recharge is greater and levels and stream flows can increase.

Groundwater Recharge

The specific rates for runoff, evapotranspiration, and groundwater recharge vary throughout Portage County. Roughly, of the 30-32 inches of overall precipitation that Portage County averages annually, approximately 1-2 inches runoff directly to streams, 20 inches are transpired by plants, and 10 inches infiltrate and recharge groundwater (Holt, 1965; Clancy et al., 2009 and Kraft et al, 2010). Recharge rates in any particular area are largely determined by soil permeability, land uses, and impervious surfaces.
Areas with high percentages of impervious surface can increase runoff and decrease recharge. Land covers such as upland (i.e. nonriparian) wetlands, can help capture runoff and slowly allow the water to infiltrate back into the ground.

Precipitation amounts vary from year to year, ranging from 28-43 inches annually over the last decade. Figure 3 shows annual precipitation amounts at three locations in the Wisconsin Central Sands region (which includes Portage County) from 1930 until 2010, with the average for the area highlighted on the red line. Years such as 2006 received below average amounts of precipitation and years such as 2010 received

above average amounts. Research has suggested that areas, including the Central Sands, have seen increases in precipitation over time (Kraft et al, 2010). Figure 4 shows the annual standard departure of precipitation from the average. The standard departure from average shows the standardized amount by which the precipitation is above or below the long term average. The figure also shows the five year averages of the standard departure from the average. The five year average of the standard departures allows for trends in precipitation over time to be more easily seen.

Groundwater levels are not only affected by annual precipitation variation, but seasonal variation as well. The water table is usually at its highest in the spring following spring recharge, when precipitation and snowmelt exceed evapotranspiration. Through much of the summer, the water table declines as evapotranspiration exceeds precipitation and recharge decreases. Water table levels often continue to decline throughout the fall and winter, with the minimum water table levels being reached in February or March (Holt, 1965). Often the biggest demands are placed on our groundwater during the growing season (May through October) when water table levels and stream flows are already naturally in decline.

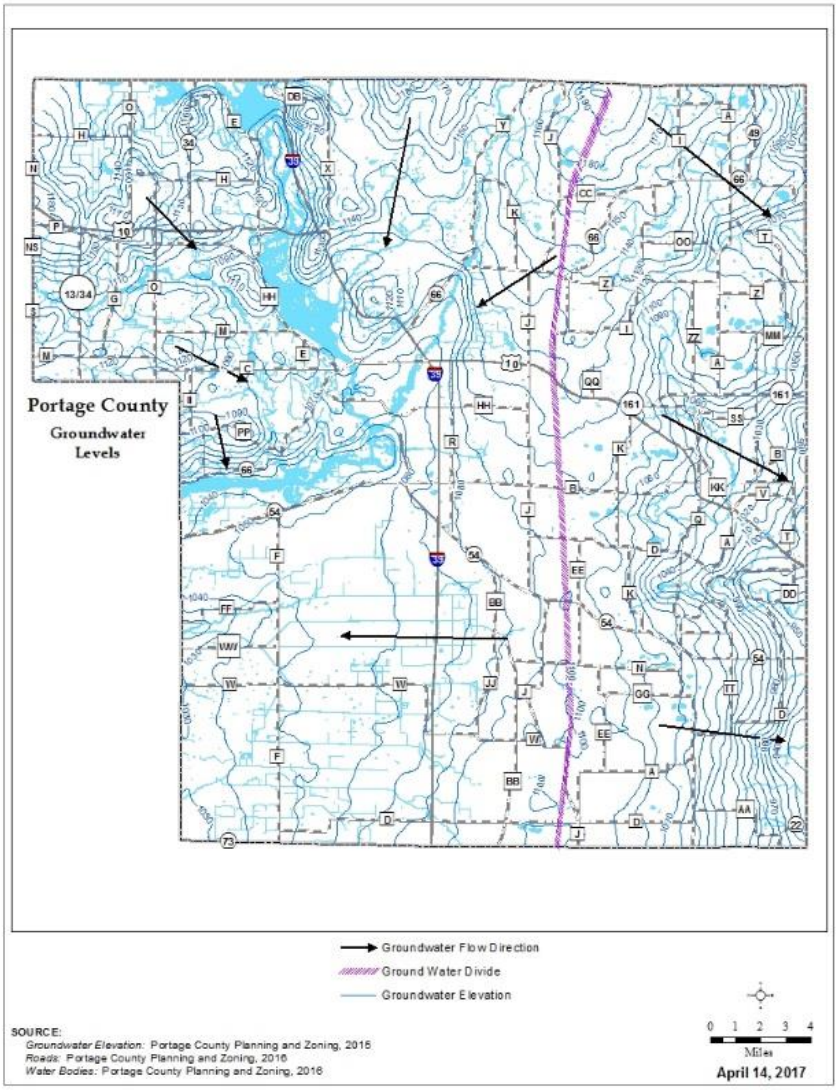


Figure 2. Direction of groundwater flow in Portage County

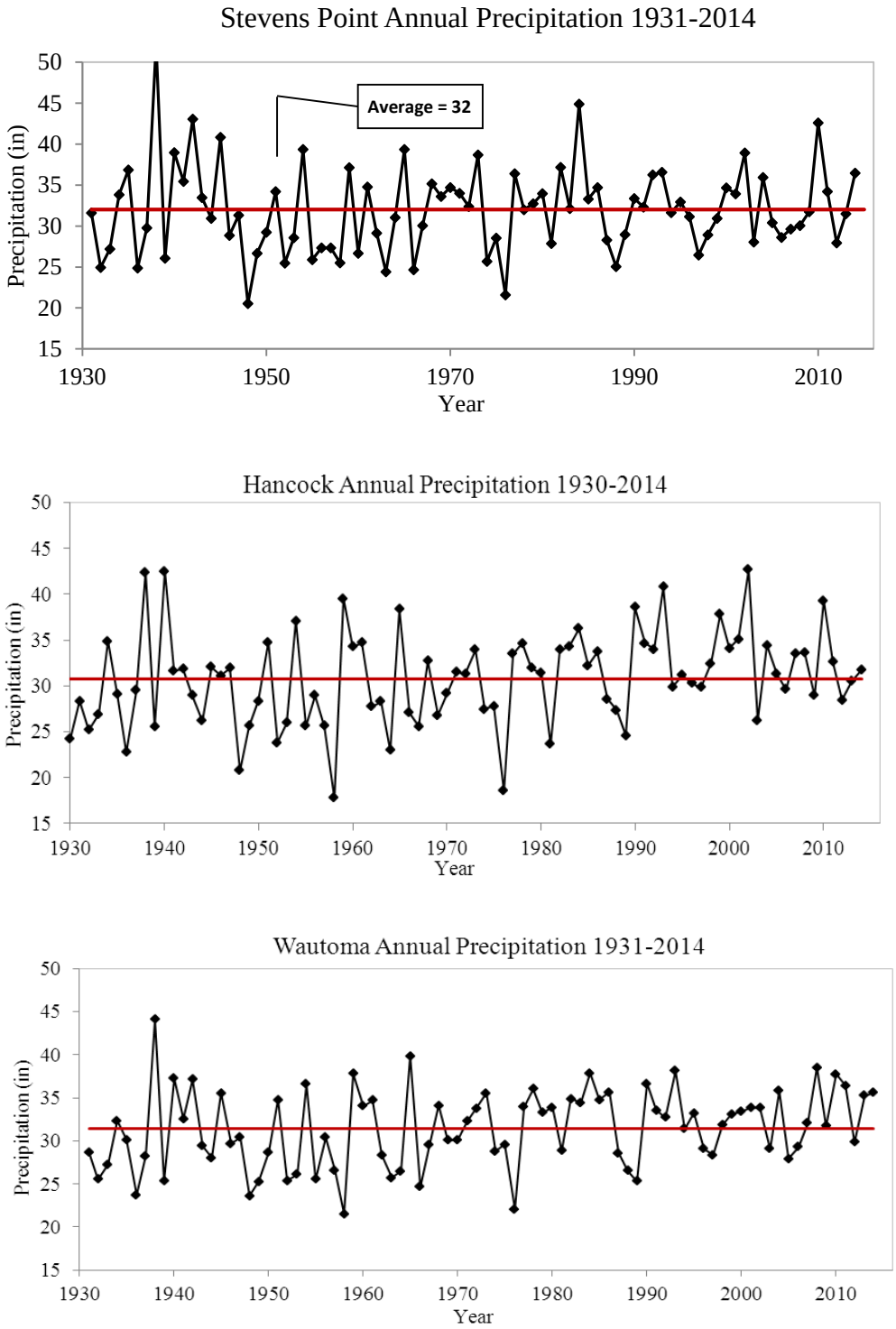


Figure 3. Precipitation at Stevens Point, Hancock, and Wautoma, WI. Stevens Point and Hancock data are from historical records with a few inferred values. Wautoma's data from 1931-2007 are inferred using methods of Serbin and Kucharik (2009) and data from 2008-2014 are from historical records.

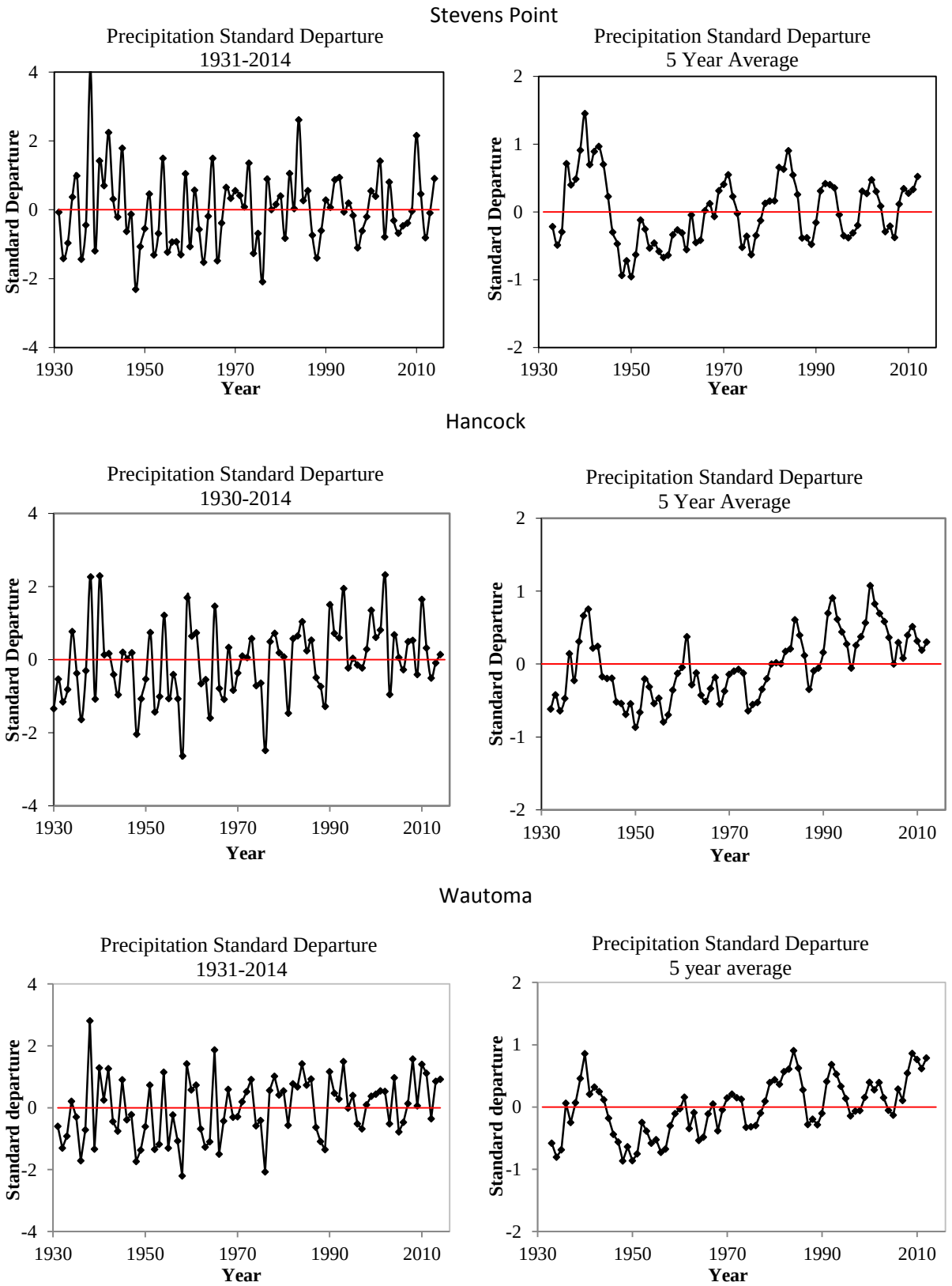
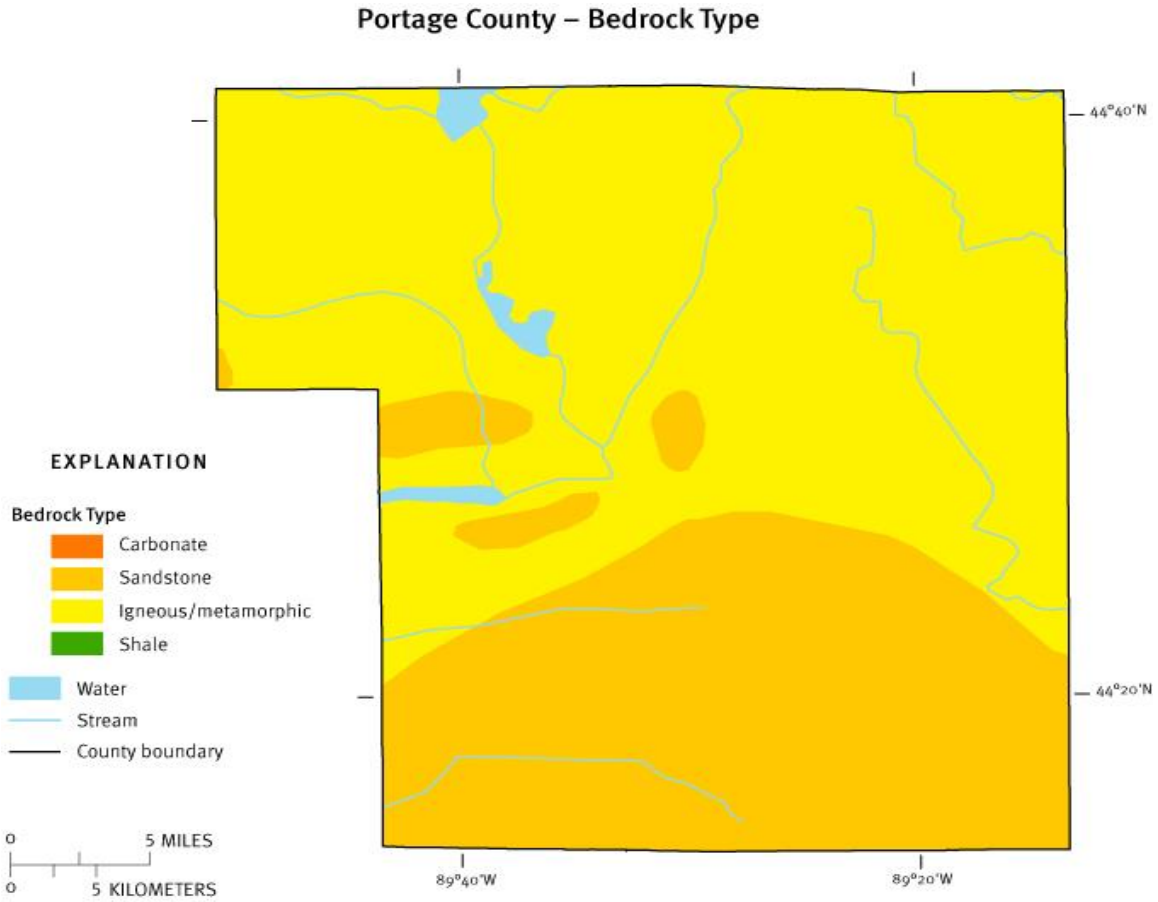


Figure 4. Standard departure of annual precipitation and five year average of the standard departure for Stevens Point, Hancock, and Wautoma.

Aquifers

Aquifers are groundwater-bearing geologic formations. The aquifers that supply Portage County have different physical and chemical properties which can affect the storage, transmission, and quality of groundwater.

Bedrock aquifers underlie all of Portage County but are not always a reliable water source. Portage County has two types of bedrock, pre-Cambrian crystalline rock, often colloquially called "granite", and sandstone (Figure 5). The crystalline rock is ancient and includes true granite, gneiss, and schist. The crystalline rock has a small amount of pore space and hence a low permeability and water holding ability. Water is only able to move or be stored in fractures in these rocks, and because the fractures are often sparse, little water movement or yield occurs. Finding well water in these rocks is often a difficult proposition. The sandstone by contrast is better for finding well water because it is porous and permeable.



This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

Figure 5. Bedrock types in Portage County.

The entire County is underlain by crystalline rock. This rock is exposed or very near the surface (0-20 feet) in the northwest part of theCounty, west of the Wisconsin River and in the Towns of Dewey and Hull (Holt, 1965). South of the Village of Plover the crystalline rock is covered with sandstone. The crystalline bedrock dips from its maximum elevation in the northwest part of the County (1160 ft. at mean sea level) to the east and south. As it does so, it becomes overlain with thicker amounts of unconsolidated ("loose") deposits which may be several hundred feet thick in the southern part of the County.

In much of the shallow bedrock area of the northwest part of the County, the surficial unconsolidated deposits are thin and mapped as "hillside deposits", sandy, silty, and clayey materials which were mostly derived from local weathered rock debris (Clayton, 1986). These hillside deposits are often too thick or lack the permeability needed to be an effective aquifer. The thin deposits and shallow bedrock can make the installation of wells difficult and limit the quantity of water that can be pumped.

The remainder of the County has thick surficial deposits, up to several hundred feet thick that often comprise an effective aquifer. These materials were directly transported and deposited by glacial ice, or by stream water transport from melting glaciers.

Glaciers extended into Portage County as far as the terminal moraine, manifested as a prominent ridge that runs north and south from Custer. West of this terminal moraine the surficial materials resulted from meltwaters that carried sand and gravel as they drained toward an ancestral Wisconsin River. In the far southwest of the County a broad glacial lake was present and extended southward to Baraboo. The sediments west of the moraine are generally thick, well-sorted sand and gravel (Figure 6), and are highly permeable with a large capacity to store groundwater. Eastward from the Custer area terminal moraine lies ground moraine, smaller areas of outwash, and smaller terminal moraines. The glacial deposits in this area also often make for good aquifers. These surficial glacial aquifers are often referred to as the sand and gravel aquifer. Water in this aquifer typically moves about 1-2 feet per day, which is relatively fast for groundwater.

The sand and gravel aquifer is where the majority of well pumping occurs in Portage County. Wells within the sand and gravel aquifer often have a potential yield between five hundred and one thousand gallons per minute (gpm). All municipal water supplies (except the Village of Junction City which obtains its water from granite bedrock) are from wells terminating in sand and gravel aquifers. Private wells in the northwestern portion of the county are often located in cracks or fractures in granite bedrock. Wells within granite bedrock typically produce flows ranging from below one gallon per minute to 60-70 gpm.

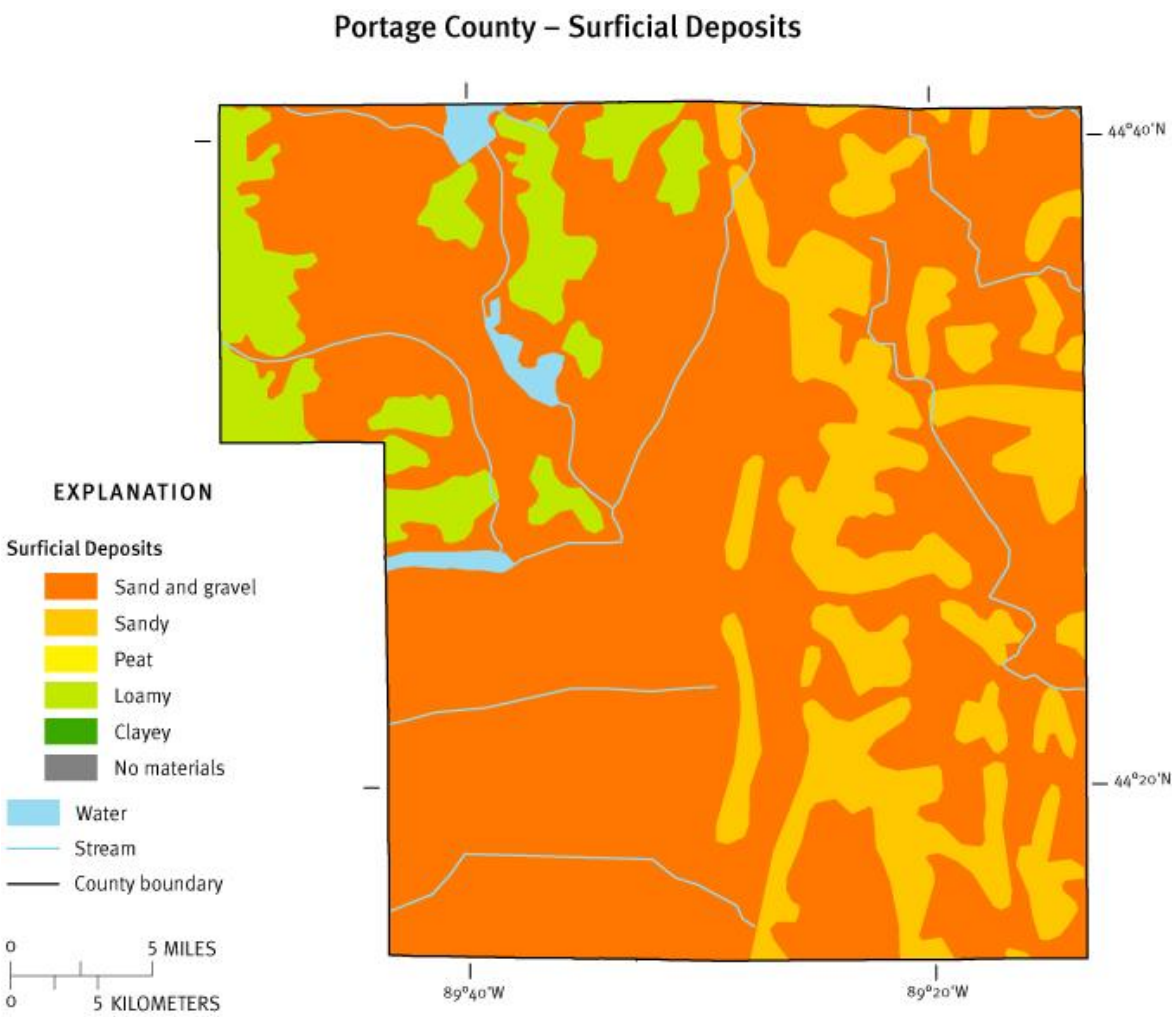


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Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

Figure 6. Surficial deposits of Portage County

C. LAND USES IN PORTAGE COUNTY

The way in which land is used is an important factor in understanding impacts to groundwater resources. Land use is a function of people and their activities.

The population of Portage County in 2015 was estimated by the State of Wisconsin Department of Administration (WiDOA) to be 70,940, up from a 2010 Census of 70,019, and distributed across 1 city, 9 villages, and 17 towns (see Chapter 1 of Plan). A majority of the County population (59%) is concentrated in the City of Stevens Point and the Villages of Whiting, Park Ridge, and Plover. If the adjacent Town of Hull were included, 66% of Portage County residents would live in its central urban core.

Approximately 4% live in the 6 "rural Villages" outside of the Stevens Point urban area (Almond, Amherst, Amherst Junction, Junction City, Nelsonville, Rosholt), leaving roughly one-third of the County population located in the unincorporated area of the 17 towns.

The County's population is projected to increase by nearly 6,000 people by 2040, with nearly 90% of that increase (5,300) anticipated within Stevens Point and the Village of Plover (WiDOA). It is also anticipated that much of this new growth will continue to take place in urban fringes as Stevens Point and Village of Plover continue to grow outward into the Towns of Plover, Hull, and Stockton.

Overall, land in urban areas, (Stevens Point plus the nine incorporated villages) represents about 5% of the total land area in Portage County. The unincorporated Towns account for the remaining 95% of land area, with rural residential and commercial developments accounting for about 4% of this total.

If, as referenced above, over 60% of Portage County residents live in incorporated places on approximately 5% of its land area, centralized public municipal water supplies are often required. Half of the County's incorporated municipalities (Stevens Point and the Villages of Plover, Whiting, Junction City, and Amherst), have municipal water systems. Municipal water systems are regulated by the State of Wisconsin, and require a substantial amount of infrastructure planning, maintenance and oversight. In the Villages of Almond, Amherst Junction, Nelsonville, Rosholt, and Park Ridge, residents use private, on-site wells.

Chapter 8 of this Comprehensive Plan contains "existing land use" information describing the unincorporated areas of the County. This data, assembled from adopted Town Comprehensive Plans, identifies the general categories of "agricultural" and "vacant/undeveloped" as the two largest individual land uses in the County, with each accounting for nearly 40%, or a combined 80% of overall Town land area (Table 1).

Parks/Recreation/Natural Areas account for the next largest land use category at 8.4% of the County unincorporated acreage. These lands could be publicly or privately owned. Public lands may include State, County, or Town parks, nature preserves, boat landings, or athletic fields, etc. Private lands may include golf courses, campgrounds, etc. The Natural Areas subset of this category includes shore lands, wetlands, flood plains, steep slopes, etc., as well as all water features within Portage County. Surface water bodies constitute over 2% of this category, with the DuBay, Stevens Point, and Biron flowages of the Wisconsin River accounting for the majority of this acreage. The information in Table 1 represents the most current approximation of "existing land use" available from the Town Comprehensive Plans.

Another method for describing how land is used is assessment data. The Wisconsin Department of Revenue (WiDOR) annually publishes a variety of reports summarizing use and value of land, and while their definition of "use" is not the same as those used by Portage County Towns for planning purposes (thus the difference in land use totals in Table 1), the relative distribution of uses is still helpful as a reference. Based on the WiDOR Line Summary for 2014 Final Statement of Assessment, the Agricultural real estate class was by far the most extensive real estate class in Portage County. This finding closely parallels the Towns land use designation.

Table 1. Portage County Existing Rural Land Use Acreage, 2005

Existing Land Use	Acres	% of Total Acreage
Residential	19,642	3.7%
Agricultural	206,783	39.2%
Commercial	5,535	0.3%
Industrial	1,330	0.1%
Governmental/Institutional	1,057	0.2%
Parks/Recreation/Natural Areas*	44,539	8.4%
Non-Metallic Mineral Extraction	1,169	0.2%
Right-of-Way (road and rail)	15,531	2.9%
Vacant/Undeveloped	213,144	40.4%
Rural Town Acreage	**503,725**	**96%**
Rural Village Acreage	**4,591**	**<1%**
Urban Area Acreage	**18,948**	**3.6%**
Total County Acreage (Approximate)	**527,264**	**100%**

Source: Portage County Planning and Zoning Department
*Include Water (streams, rivers, impoundments, etc)
Rural Villages = Almond, Amherst, Amherst Jct, Junction City, Nelsonville, Rosholt
Urban Area = Villages of Park Ridge, Plover, Whiting, City of Stevens Point

Table 2. Portage County Acreage by Real Estate Class, 2014

Real Estate Class	Acres	%
Residential	34,640	8.5%
Agricultural	206,305	50.3%
Commercial	5,535	1.4%
Manufacturing	2,335	0.6%
Undeveloped	53,979	13.2%
Ag Forest	45,037	10.9%
Forest Land	58,589	14.3%
Other	3,448	0.8%
Total County Acreage	**409,868**	**100.0%**
Rural Town Acreage	**396,636**	**96.8%**
Rural Village Acreage	**3,271**	**0.8%**
Urban Area Acreage	**9,961**	**2.4%**

Source: Wisconsin Department of Revenue
Rural Villages = Almond, Amherst, Amherst Junction, Junction City, Nelsonville, Rosholt
Urban Area = Villages of Park Ridge, Plover, Whiting, and City of Stevens Point

Further insight into the nature of agricultural land use can be discovered in the U.S. Department of Agriculture, Census of Agriculture (Ag Census), which is performed in five-year intervals, with the most recent being completed for 2012. According to Table 3 below, land classified as being "in farms" declined between 2002 and 2012, but still accounted for over half of the total land area in Portage County. Of the 2012 "farm lands", 157,592 acres were classified as "irrigated farms", with 92,544 of those acres actually under irrigation.

There were approximately 2,800 acres under irrigation in 1954, and 50,000 in 1988 when the first Groundwater Management Plan was written. Over the next 20 years, by 2007, the irrigated acreage had nearly doubled.

Table 3. Agricultural and Irrigated Agricultural Acres in Portage County, 2002, 2007, and 2012

	2002	**2007**	**2012**	**% of Total Land Area in Portage County (2012)**
Land in Farms (Acres)	292,109	281,575	278,673	53%
Irrigated Farms (Acres)	N/A	147,171	157,592	30%
Actual Irrigated Acres	92,330	91,718	92,544	18%

- *Land in farms is the total acreage in all farms in Portage County, irrigated farms is the total acreage of all farms who utilize irrigation in Portage County, and actual irrigated acres is only the acreage that is irrigated in the County.*

Source: U.S Census of Agriculture, 2002, 2007, 2012

The mix of crops under irrigation is not known exactly, but it includes vegetable crops, corn, grain, soybeans, hay, and cranberries. Agricultural high capacity wells that are used for crop irrigation pump groundwater at specific times of the year in order to more profitably grow crops. Dairy farms often use high capacity wells to water animals year round and are increasingly moving to supplemental irrigation to grow their feed crops.

How we use and manage the land within the County can affect the quantity and quality of groundwater. Different land use activities can contribute to both point and non-point sources pollution that in turn can enter groundwater.

Additionally, changes in land uses can impact the amount of recharge groundwater receives. An unintended result of development is that impervious surface increases the amount of precipitation that runs off the surface of the land rather than infiltrates. Development on different sized lots results in different percentages covered by impervious surfaces (Figure 7). Smaller, often urban, lots have higher percentages of impervious surface than larger rural lots. Other development such as commercial and industrial have even higher percentages due to larger structures and additional parking areas. Land uses such as natural areas or

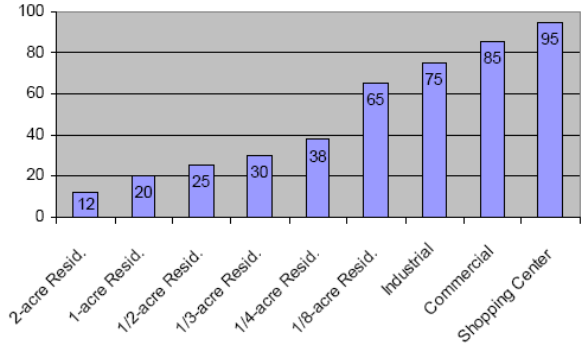

Chart adapted from Ferguson, B. K. 1998. *Introduction to Stormwater: Concept, Purpose, Design*. New York: John Wiley & Sons.

Figure 7. Average Percentage of Impervious Cover by Land Use

vegetated areas allow for infiltration and recharge of groundwater instead of running off, as well as filtering any water that passes through the soils.

Activities associated with each land use require water: water supplies for residential and commercial development, irrigation for agriculture, water for different applications in industrial developments. As these activities grow or shrink over time, the demands for groundwater will as well.

D. GROUNDWATER QUANTITY

Historically groundwater resources in Portage County have been listed as being abundant or adequate to meet needs. However, according to USGS[1], the quantity of groundwater in Portage County and Wisconsin has been affected by increasing industrial and agricultural development.

Our understanding of impacts to groundwater quantity are informed by ongoing monitoring of water levels (ground and surface), review of State-reported pumping information submitted by agricultural, industrial, and municipal users, and assumptions made about rural residential water use.

Monitoring

Monitoring groundwater, lake, and stream levels is pursued as a collaborative effort with State and local agencies, citizens, and UWSP.

Groundwater Monitoring

Located within and adjacent to Portage County are nine long-term groundwater level monitoring wells, referred to as "hydrograph wells", (see Figure 8 below). Water level measurements have been taken at four of these wells consistently since the 1950's. Originally installed by the U.S. Geological Service, periodic water level checks are now performed by Portage County Planning and Zoning staff, as well as USGS[2].

Tracking this groundwater elevation information over many years provides a way to understand the relative status of the water table across the County, and provides one place to begin to understand impacts of different types of development over time on the groundwater resource.

Figures 9 to 12 below illustrate the fluctuations in groundwater elevation at several of these specific well sites. Water levels in monitoring wells over time is shown as the distance to water from the ground surface. The empty circles show the average depth for each year, the straight solid line shows the overall average, and the straight dashed line shows the linear trend of the yearly averages[3]

The hydrograph well information indicates fluctuations in water table levels of approximately ten feet on a recurring basis, and of annual fluctuations of about five feet.

[1] Buchwald, C.A., 2009, Water use in Wisconsin, 2005: U.S. Geological Survey Open-File Report 2009-1076, 74 p.

[2] http://groundwaterwatch.usgs.gov/countymap.asp?sa=WI&cc=097

[3] Kraft, G.J., Mechenich, D.J., Clancy K., Haucke, J., 2010. Groundwater Pumping Effects on Groundwater Levels, Lake levels, and Stream flows in the Wisconsin Central Sands. Stevens Point.

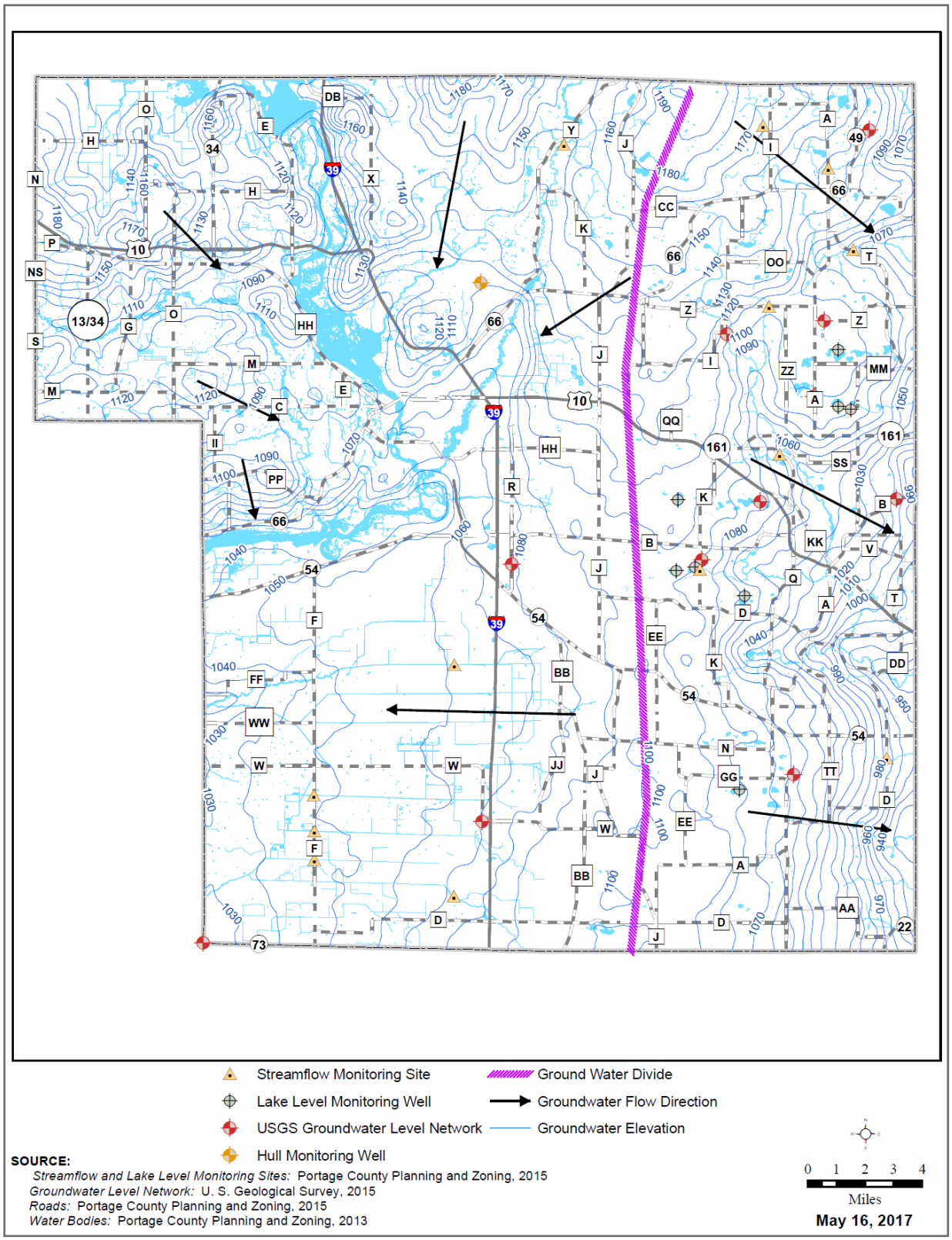

Figure 8. USGS Hydrograph Wells and Portage County Monitoring Wells

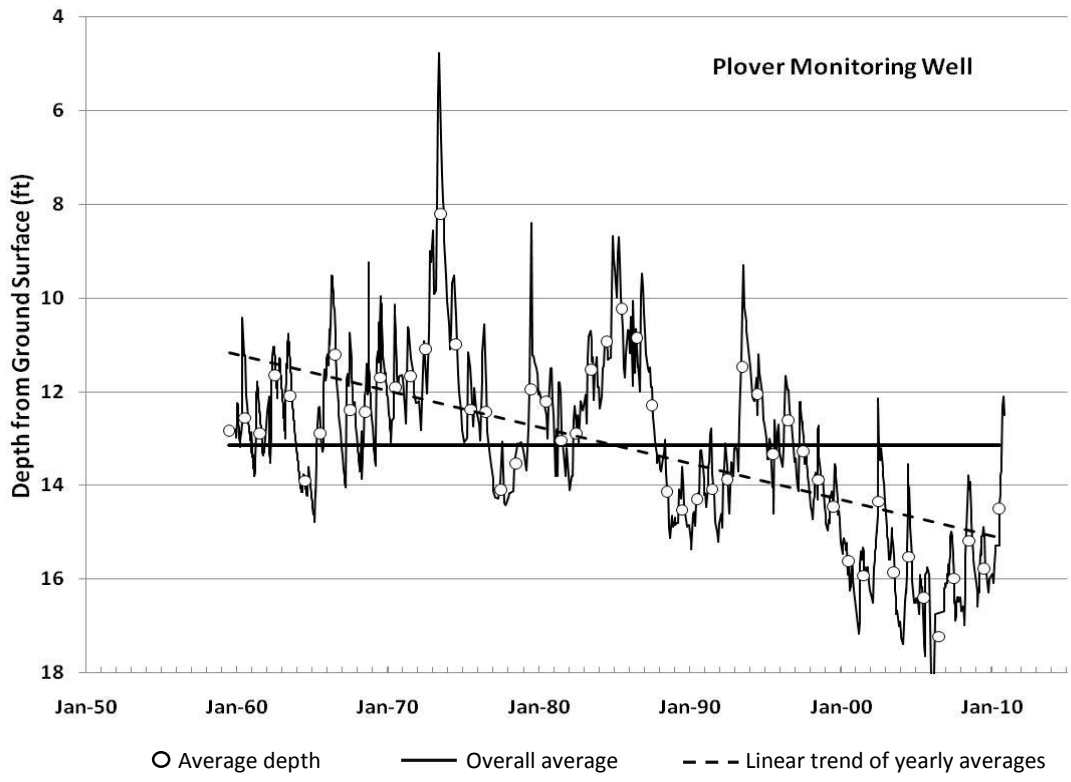

Figure 9. Hydrograph of USGS Plover Well. Source USGS and University of Wisconsin-Stevens Point

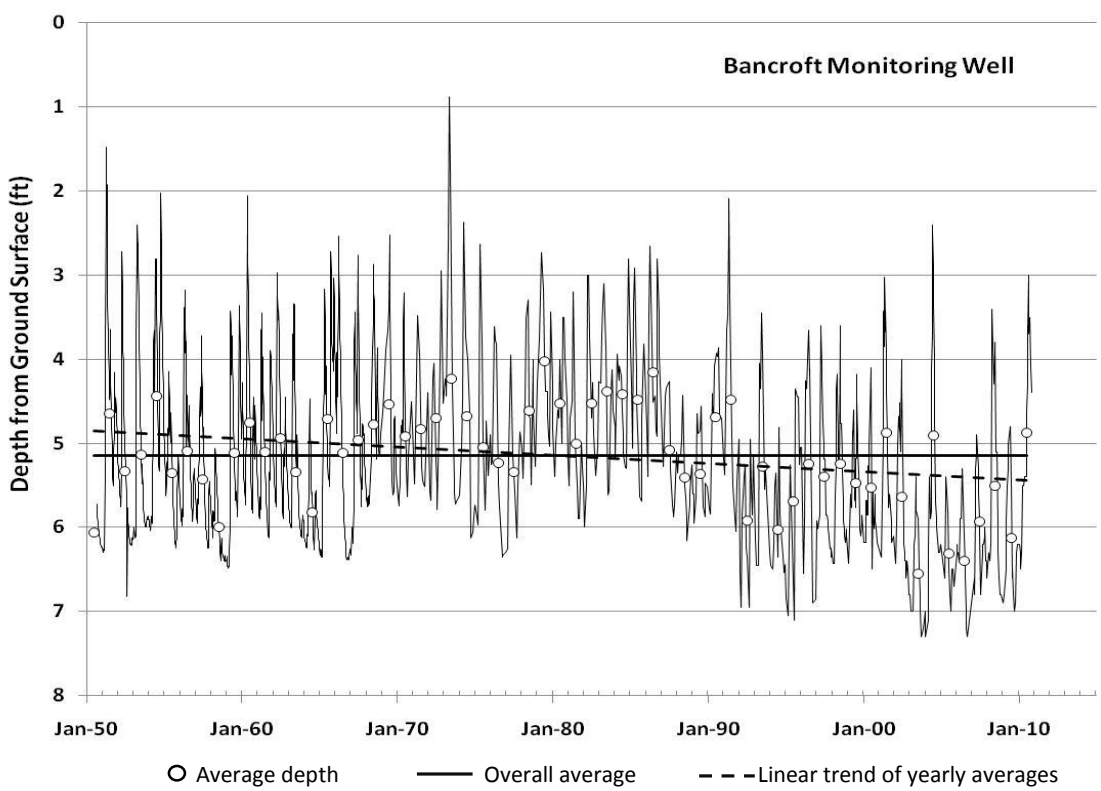

Figure 10. Hydrograph of USGS Bancroft Well. Source USGS and University of Wisconsin-Stevens Point

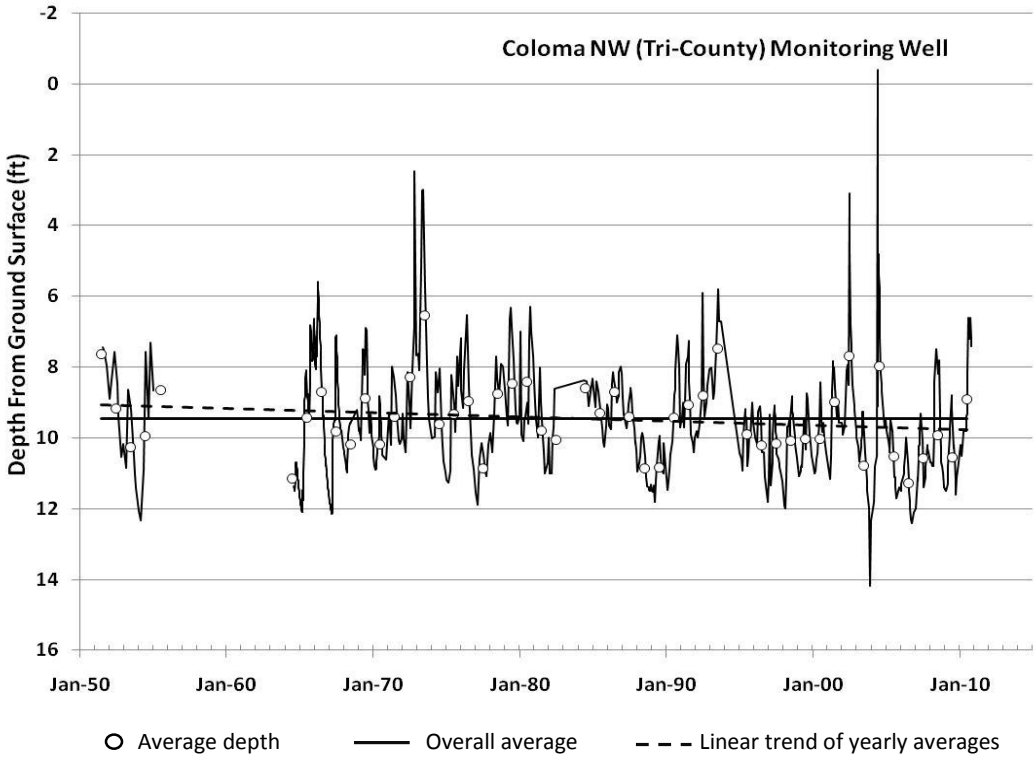

Figure 11. Hydrograph of USGS Coloma Well. Source USGS and University of Wisconsin-Stevens Point

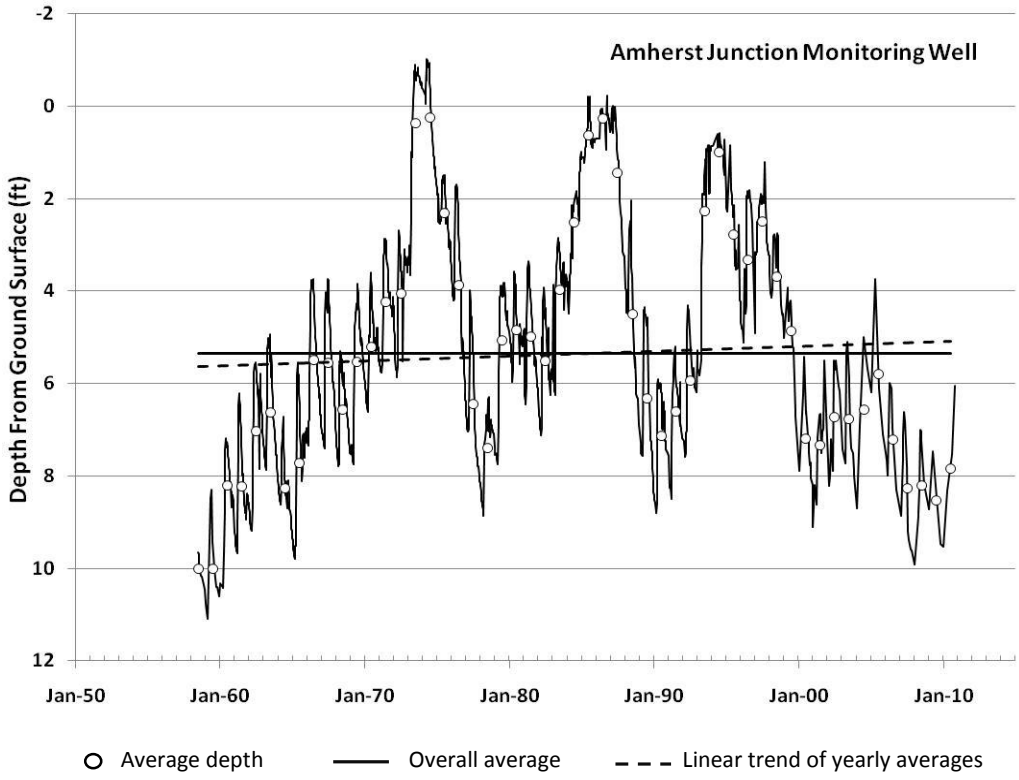

Figure 12. Hydrograph of USGS Amherst Junction Well. Source USGS and University of Wisconsin-Stevens Point

Stream and Lake Level Monitoring

In 2015, the Portage County Planning and Zoning Department, in collaboration with Wisconsin Department of Natural Resources (WIDNR), worked to establish a citizen water level monitoring program that monthly monitors stream base flow of 10 stream sites and lake level monitoring at 12 lake sites chosen by the WIDNR, University of Wisconsin-Stevens Point, and Portage County. The purpose is to increase the number of monitored water bodies and monitoring frequency through a low-cost effort by engaging the resources of trained volunteers. This data will help to show the current status of groundwater and surface water levels throughout the County in areas not previously monitored. This program has not only been implemented in Portage County but in five other counties in the Central Sands Region including Waushara, Wood, Waupaca, Marquette, and Adams. All other counties have been collecting stream and lake levels since 2013 in the same exact manner as Portage County. This program is implemented in two ways:

Lake Level Monitoring

Lakes will be instrumented with a shallow drive point monitoring well that will be installed by County staff close to the lake shoreline, above the ordinary high water mark, and on public property wherever possible, out of the way of lake users. Volunteers conduct the monitoring and are guided by County staff to determine when measurements need to be taken (usually on a monthly basis). Lake level monitors are to be trained by County staff. Lake measurements are reported from the volunteers to the Portage County Water Resource Specialist, which will then be uploaded to the WIDNR Surface Water Integrated Monitoring System (SWIMS) database, posted to the Portage County website and shared with the Town Boards and Portage County Groundwater Citizen Advisory Committee. To improve accuracy of the volunteer efforts, lake levels will be audited by County staff. Lakes currently monitored by citizens for lake levels in Portage County include Adams Lake, Bear Lake, Lake Emily, Lime Lake, Onland Lake, Rhinehart Lake, Thomas Lake, Sunset Lake, and Wolf Lake.

Stream Base Flow Monitoring

Stream monitors are trained in small groups to gauge streams using velocity cross section methods. Velocities are measured using Marsh-McBirney flow meters that were purchased for each county by WIDNR. Training on using the flow meter was provided by UWSP staff. Volunteers conduct the monitoring and are guided by County staff to determine when measurements need to be taken (usually on a monthly basis). Stream measurements are reported from volunteers to the Portage County Water Resource Specialist, which will then be uploaded to the SWIMS database, posted to the Portage County website and shared with the Town boards and Portage County Citizen Groundwater Advisory Committee. To improve the accuracy of the volunteer efforts, stream flows will be audited by UWSP, contingent upon funding. Streams/rivers currently monitored by citizens for stream base flow in Portage County include Allen Creek, Bear Creek, Bradley Creek, Buena Vista Creek, Ditch #4, Flume Creek, Plover River, Poncho Creek, South Branch 10 Mile creek, Stoltenburg Creek, and Tomorrow River.

Reported Pumping Information

Everyone in Portage County relies on and utilizes groundwater. 100% of the drinking water, approximately 87% of irrigation water, and approximately 68% of industrial water is pumped from groundwater. Pumping will always impact groundwater resources in the County. Based on information provided by WIDNR, Portage County pumps more groundwater than any other county in Wisconsin, using more than 20-30 billion gallons of water annually. Groundwater pumping can be divided into five general areas: agricultural, commercial, industrial, municipal, and rural residential. Agricultural, industrial, and municipal water supplies are pumped from approximately 1,224 high capacity wells in the County in 2015 (see Table 5 below). Rural residential and commercial uses pump from some 18,700 low capacity wells (Portage County Well Database). The number of high capacity and low capacity wells in the County continues to grow.

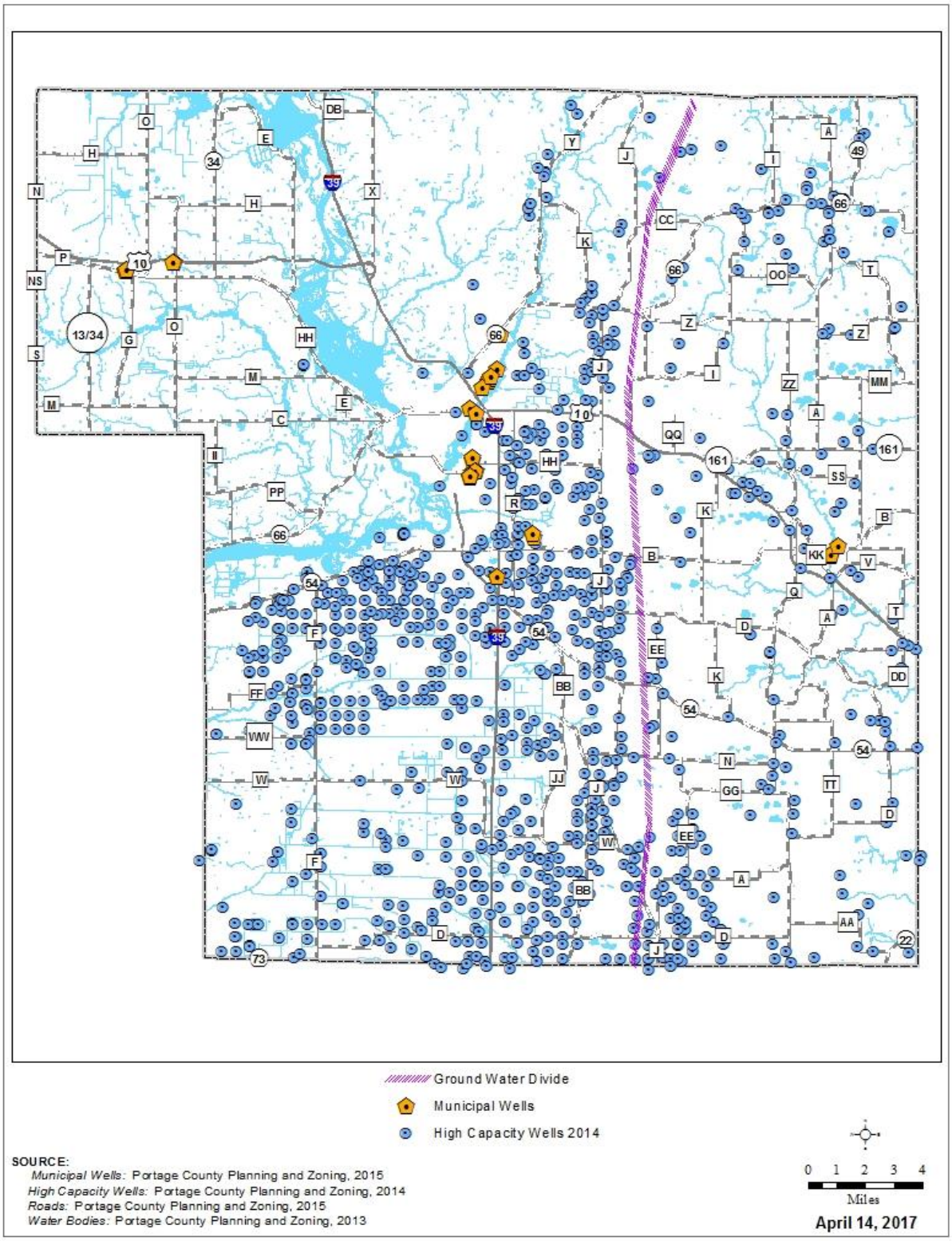

Figure 13. High Capacity Wells in Portage County

High Capacity Well Use

High capacity wells or well systems are defined as one or more wells, drillholes, or mine shafts on a property (contiguous or adjacent land having the same owner) that have a combined approved pump capacity of 70 or more gallons per minute (Section NR 812.07(53) Wisconsin Administrative Code). Any high capacity well in the state must be reviewed and permitted by the WIDNR. The process for reviewing and permitting a high capacity well can be found at http://dnr.wi.gov/topic/wells/HighCapacity.html. WIDNR requires the amount of water pumped from these wells to be reported annually[4]. Portage County has the highest density of high capacity wells per acre in the state of Wisconsin, with the great majority of these attributed to agriculture. Based on WIDNR pumping information, agricultural irrigation accounted for 73% of total Portage County reported groundwater withdrawals in 2011 (76% including cranberry production pumping), 83% in 2012 (84%), 78% in 2013 (81%), 74% in 2014 (76%), and 74% in 2015 (75%) see Table 4 below. The number of active high capacity wells used for agricultural irrigation grew from 628 in 2011 to 777 in 2015 (788 with cranberry production, Table 5) (*WIDNR Jan. 2015 Well Data*).

Table 4. Groundwater withdrawals (gallons) in Portage County 2011-2015 by sector and totals.

Groundwater Withdrawals	2011	2012	2013	2014	2015
Agricultural Irrigation	15,405,724,018	29,038,997,224	20,992,957,773	15,811,475,653	15,574,599,984
Municipal Public Water	2,739,401,886	2,850,091,428	2,648,339,390	2,564,824,140	2,539,176,300
Industrial	1,064,604,042	1,265,366,219	1,264,955,333	1,067,457,967	1,190,122,881
Paper Manufacturing	641,488,355	646,615,008	615,058,920	622,015,184	626,332,896
Cranberry Production	511,583,700	408,610,634	613,335,498	533,228,826	265,904,221
Mining (Non-Metallic)	384,977,306	263,111,800	277,543,665	293,494,406	296,645,253
All Other Uses	347,950,673	429,928,349	607,348,293	502,394,409	490,612,795
Total Portage Co	21,095,729,980	34,902,720,662	26,824,932,614	21,394,890,585	20,983,394,330

*All other can include uses such as aquaculture, commercial, forestry (Christmas trees), plant nurseries, golf course irrigation, dairies, etc.
Source: Wisconsin Department of Natural Resources.

Table 5. Number of high capacity wells in Portage County 2011-2015 by sector and total.

Portage County Groundwater Sources	2011 Active	2012 Active	2013 Active	2014 Active	2015 Active	2015 % of Active
Agricultural Irrigation	628	692	724	760	777	76%
Municipal Public Water	17	18	18	18	19	2%
Industrial	21	26	29	25	27	3%
Paper Manufacturing	5	2	2	2	2	>1%
Cranberry Production	5	9	10	12	11	1%
Mining (Non-Metallic)	6	6	6	7	6	>1%
All Other Uses	170	187	152	168	176	17%
Reported Active	852	940	941	993	1018	
Reported Inactive	69	75	83	144	104	
Unreported	167	108	124	92	102	
Total	1,088	1,123	1,148	1,229	1224	

[4] Wisconsin Department of Natural Resources 2015 Wisconsin Water Use Summary
http://dnr.wi.gov/topic/WaterUse/documents/WithdrawalReportDetail.pdf

Source: Wisconsin Department of Natural Resources.

Municipal wells accounted for 13% of reported groundwater withdrawals in 2011, 8% in 2012, 10% in 2013, 12% in 2014, and 12% in 2015 for a variety of purposes (domestic, commercial, industrial, and others).

Self-supplied industrial use by high capacity wells (including paper making) accounted for 5% of withdrawals in 2011, 4% in 2012, 5% in 2013,8% in 2014, and 9% in 2015. Additional industrial use is supplied by municipalities and therefore is included under municipal use.

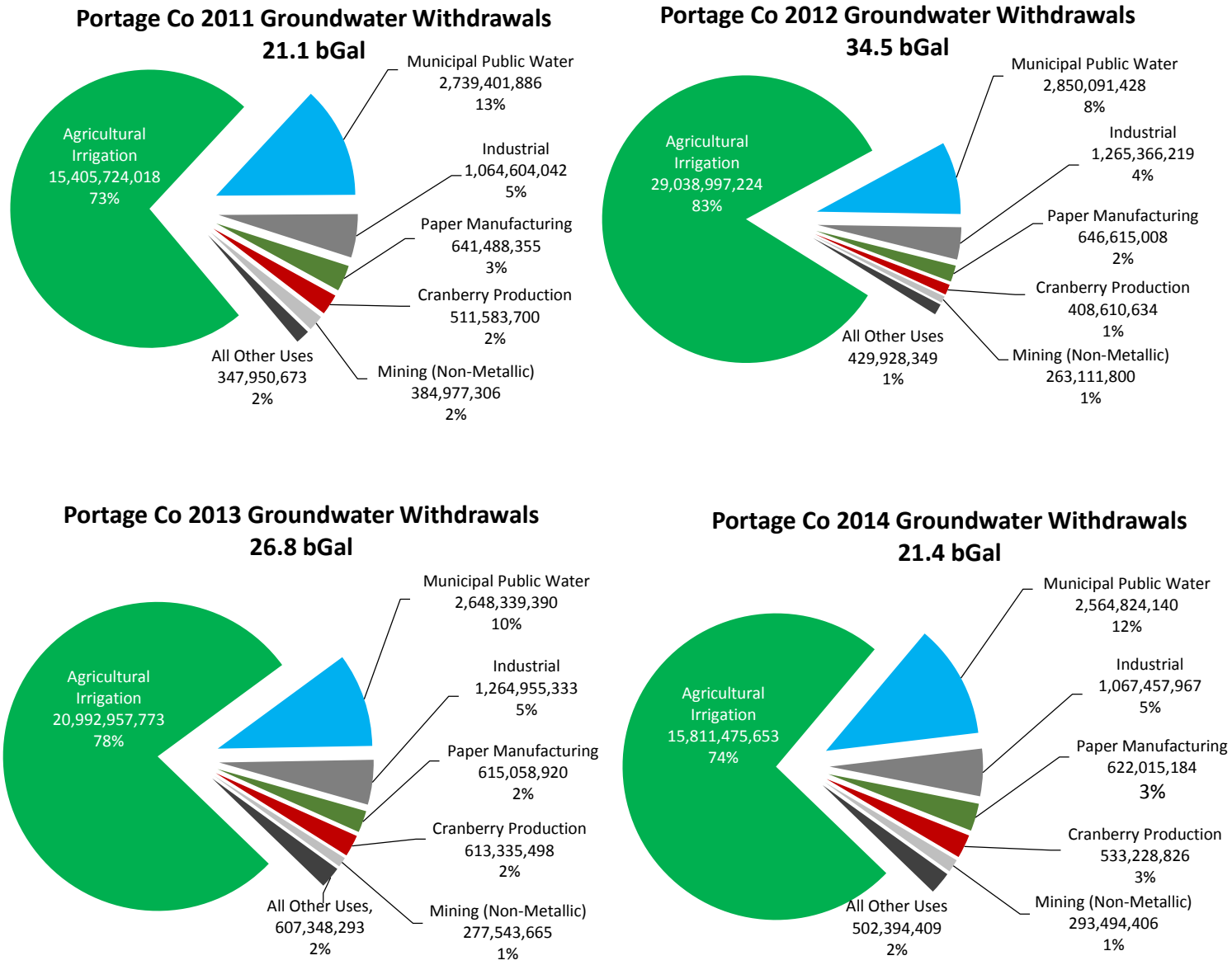

Figure 14. Percentage of total groundwater withdrawals by sector, in Portage County 2011-2015. Figure courtesy of the Wisconsin Department of Natural Resources.

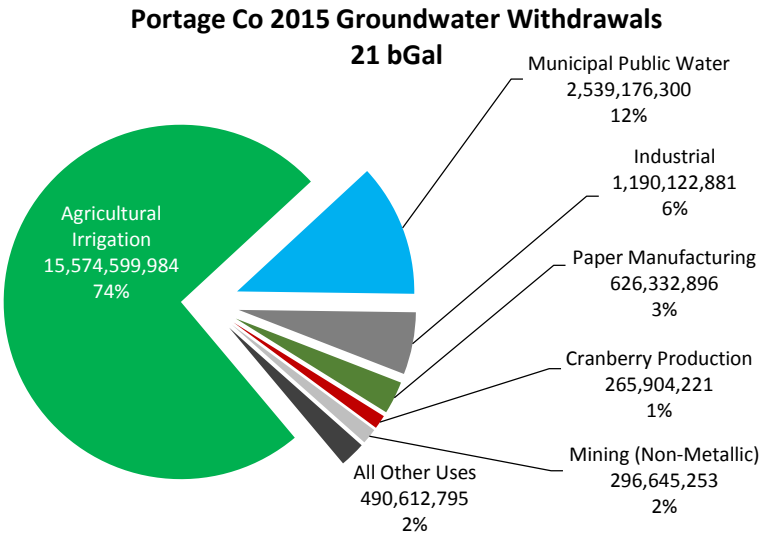

Figure 15 Continued. Percentage of total groundwater withdrawals by sector, in Portage County 2011-2015. Figure courtesy of the Wisconsin Department of Natural Resources.

Rural Water Use

Within the seventeen unincorporated Towns that make up Portage County, residential, commercial, and industrial development consumes groundwater resources to different degrees. There are approximately 18,700 rural private wells that supply water to these areas. A typical rural household will use approximately 150 gallons water per day pumped from their well, which equates to approximately 1.02 billion gallons of water per year. Commercial and industrial development in rural areas, also utilize private onsite wells for water. However, pumping rates vary greatly for their individual operations.

Water Pumped vs. Water Consumed

A distinction needs to be drawn between the amount of groundwater withdrawn and the amount of groundwater "consumed" in the County. In water use accounting, consumptive use means that groundwater is permanently lost from a watershed. This can be from evaporation into the atmosphere, transpiration, incorporation into crops or products, or lost through municipal sewer treatment plants discharging to a river or stream. The amount of water consumed per use varies.

According to the USGS (Factsheet 2008-3032) 90% of irrigation water use is consumptive and not returned to the watershed. Irrigation water is lost through evaporation, transpiration and incorporation into crops. Lawn and garden watering have similar consumption rates. Industrial uses in Portage County have approximately a 10% rate of consumption while residential users with a private onsite wastewater treatment system (POWTS) have a 12% rate. Municipal water use has a variety of consumption rates based on how the wastewater is treated and discharged.

When discussing residential and industrial uses of groundwater, where wastewater is discharged can influence groundwater quantity. About 38% of the County's population utilize POWTS to treat their wastewater, which is then discharged to an onsite drainfield. This allows the water to flow through the soil and eventually reach the groundwater below in almost the same location as where it was pumped. In areas with municipal water, after wastewater is treated it is often discharged to a nearby surface water body.

In some municipalities such as Amherst and Junction City, treated wastewater is discharged close to where the water is pumped or would have naturally discharged. Other municipalities such as Stevens Point and Plover pump water for municipal purposes from the Plover River and Little Plover River basins. The water is used, treated, and then discharged into the Wisconsin River basin. The Stevens Point Wastewater Treatment Facility discharges an average of 4.55 million gallons per day, Village of Plover Wastewater Treatment Facility discharges an average of 1.8 million gallons per day, and the Village of Whiting Wastewater Treatment Facility discharges an average of 0.67 million gallons per day. Taking water from one basin and discharging to a different basin represents a transfer of water. Consumptive use and transfer of groundwater diminish discharge to surface water bodies.

Groundwater Utilization Trends

Groundwater demand can be anticipated to continue to increase in Portage County. While yearly pumping rates can vary depending on influencing factors such as yearly precipitation and temperature (cool wet years usually require less water use), according to USGS, 5-year overall water use estimates have been on the rise across almost all sectors since 1985 (Table 7). In Portage County, population is estimated to increase by approximately 6,000 people between 2010 and 2040, which will require additional water supplies. Total metered sales of municipal water from Stevens Point, Plover, and Whiting have shown relatively steady water use since 2010, with the exception of 2012 which was a year with little precipitation. There is no expectation for this to change in the future without deliberate conservation measures, as have been employed in some locales.

Table 6. Total Metered Water Sales (x1000) of Municipalities in Portage County 2010-2014. Data from individual municipalities.

	2010	2011	2012	2013	2014	2015
Amherst	25,569	26,294	26,865	26,023	24,391	25,292
Junction City	8,604	8,771	8,995	8,563	6,921	6,881
Stevens Point	1,811,870	1,888,381	2,016,413	1,826,996	1,753,414	1,733,586
Plover	359,347	351,483	400,228	371,309	373,521	371,986
Whiting	529,919	543,059	691,593	643,244	656,094	662,368
All Utilities	2,735,309	2,817,988	3,144,094	2,876,135	2,814,341	2,800,113

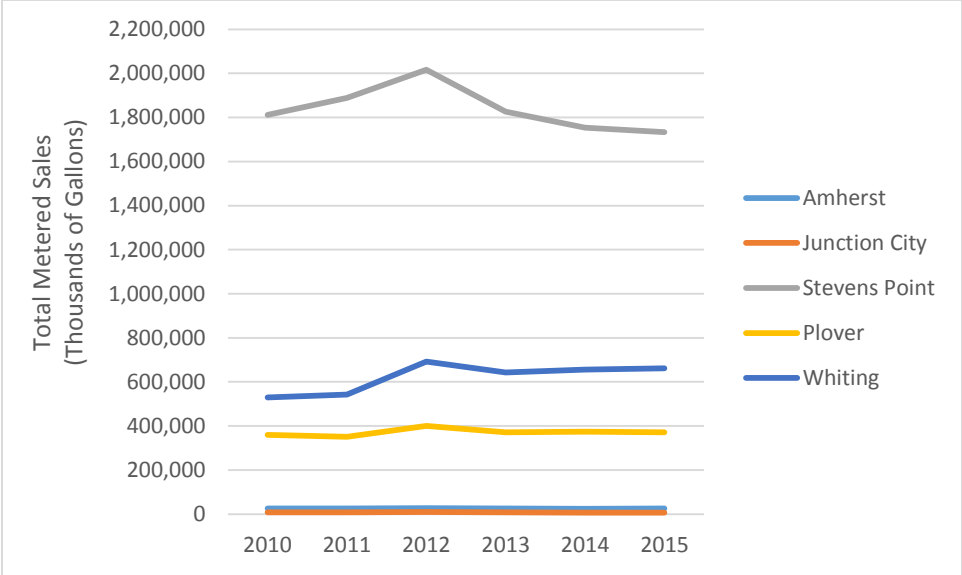

Figure 16. Total Metered Sales (Thousands of gallons) for all Portage County Municipalities 2010-2015. Data from Wisconsin Public Service Commission.

Throughout the County we continue to see a yearly increase in the installation of high capacity wells for a variety of reasons. Historically, Portage County had only 41 high capacity wells in the 1950's, with this number growing to 1,229 in 2014. On average over the last four years of WIDNR data, approximately 4 out of 5 high capacity wells are active in a given year. The agricultural sector had the greatest number of active high capacity wells in 2014, and accounted for the great majority (94%) of the increase in active high capacity wells identified between 2011 and 2014 (Table 5). While high capacity wells have increased in the agricultural sector it is important to note that a number of new irrigation and conservation methods are being employed to try and decrease the amount of water that is being pumped from these wells. Advancements include:

- Systems with soil moisture and temperature probes and atmospheric condition analysis that allow them to be programmed for variable application rates related to actual field conditions.
- Advancements in variable speed pumps that allow adjusting the volume of water and save electricity.
- Low pressure systems and drop nozzles, which allow for more direct application to plants with less immediate evaporation.
- Systems can now be started and stopped remotely versus having to push a button in the field; multiple systems can be viewed and regulated at once.

Local practices have evolved over time through independent action taken by landowners and in response to work done by local committees.

- Land in the Little Plover River watershed has been purchased by the Village of Plover and taken out of irrigated agriculture production.
- Farmers are selecting and rotating crops to reduce needed irrigation.
- An increasing number of farmers are college educated, studying soil and water sciences and better understanding crop production leading to more efficient use of resources.

- Irrigation is used to water and deliver nutrients in highly diluted forms at the correct time; measurements are precise, using quantitative analysis.
- Production per acre and irrigation efficiencies developed over the years have resulted in higher yields per acre. There is better management, better crop and animal genetics, and a better understanding of production practices. Food processor McCain Foods currently contracts approximately 20% less acreage in potatoes than 20 years ago based on increased yields through better technology and fertilization practices.

Table 7. USGS estimated 5 year water use per sector in Portage County. Source: USGS National Water Use Information Program Database

	Public Supply (Million Gallons/Day)	Domestic Supply (Million Gallons/Day)	Industrial (Million Gallons/Day)	Total Agricultural Irrigation (Million Gallons/Day)
1985	4.10	1.76	7.05	22.41
1990	5.10	1.51	4.99	34.41
1995	8.20	1.58	8.07	57.54
2000	8.73	1.57	5.87	60.97
2005	9.85	1.73	11.51	92.17
2010	8.57	1.37	8.10	49.27

Note: Public supply is water withdrawn by public and private water suppliers that furnish water to at least 25 people or have a minimum of 15 connections. Domestic supply is water provided to households by a public water supplier and self-supplied water (USGS National Water Use Information Program Database).

Effects of Pumping on Groundwater Quantity

Groundwater across the State of Wisconsin is generally plentiful enough to supply municipal, industrial, agricultural and domestic use. However, pumping of groundwater does have its impacts. Pumping will lower water levels in aquifers and divert flows from surface waters where it would have discharged. It is a matter of degree as to how big the impact is. It is becoming apparent that in Portage County our activities and uses are having an impact on the quantity of groundwater.

In Portage County one of the most well-known examples of groundwater pumping and its surface water impacts is the Little Plover River, which has been the subject of numerous studies going back to the early 1960's. Weeks et al. (1965) showed small, seasonal pumping impacts existed at that time, and Clancy et al. demonstrated large amounts of pumping impacts began accruing in 1973. Beginning in 2003, very small stream discharges were recorded in the River. Every year between 2005 and 2009 stretches of the River dried completely. Weather and high capacity well pumping were postulated as contributing factors to the dry-ups.

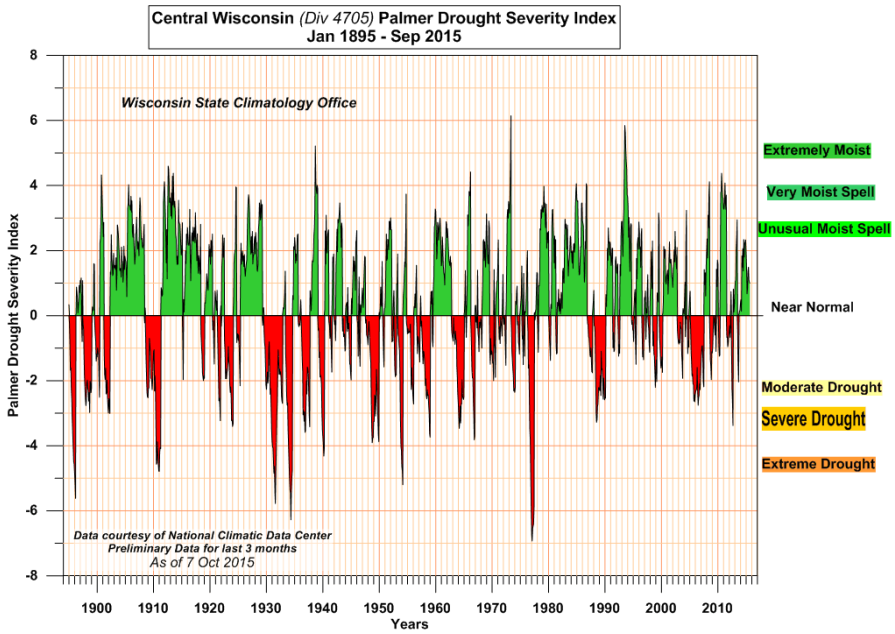

Figure 17. Palmer Drought Index for Central Wisconsin (Wisconsin State Climatology Office, 2015). Note that the 2005 to 2008 period is not substantially droughty compared to the historical record.

However, when compared with the drought index, precipitation measurements and flows in similar streams all showed near average conditions in 2002-2004 and moderately dry conditions in 2005-2007 (Figure 16). Historically the Little Plover River had retained much higher flows during much more extreme drought conditions (Clancy et al, 2009), an indication that climate was not the only factor during 2005-2009[5].

If climate was not the only factor in the drying of the Little Plover River, human activities and land uses must have played a role. As early as 1965, Weeks et al[6] began showing the potential impacts of human use on groundwater in the Little Plover River Basin. Weeks et al[6] estimated that in the Basin the net effects of irrigation development on irrigated land would be a 20% increase in evapotranspiration and a 40-50% decrease in groundwater recharge, which would result in a loss of 0.0004-0.0005 cubic feet per second (cfs) streamflow per irrigated acre. Given that during the time of the Weeks study there was approximately 500 acres of irrigated land in the watershed, average base flow depletion in the Little Plover River was estimated about 2.5%.

In 1997 groundwater flow modeling by Mechenich and Kraft[7] indicated that municipal pumping from Village of Plover wells could cause a greater than 40% average flow reduction in the Little Plover River when they reached their 2005 design average pumping rate of 2.7 cfs.

Statistical and flow modeling conducted by Clancy et al in 2009 sought to understand how much of the streamflow diversion in the Little Plover River might be attributed to groundwater pumping. Statistical

[5] Clancy, K., Kraft, G. J., Mechenich, D.J. 2009. Knowledge Development for Groundwater Withdrawal Management around the Little Plover River, Portage County Wisconsin.

[6] Weeks, E.P., Ericson, D.W., Holt, C.L.R.J. 1965. Hydrology of the Little Plover River Basin Portage County, Wisconsin and the Effects of Water Resource Development. Geol. Surv. Water Supply pap. 1811.

[7] Mechenich, D.J., Kraft, G. 1997. Contaminant Source Assessment and Management Using Groundwater Flow and Contaminant Models in the Stevens Point-Whiting-Plover Wellhead Protection Area. Stevens Point, WI.

approaches indicated missing discharges of approximately 3.9-5.0 cfs in May-August of 2005 and 3.4 cfs in 2006 at Hoover Rd. Flow modeling methods indicated a discharge loss of 3.2-5.4 cfs at Hoover Rd. which agreed well with the statistical approaches used. The flow modeling was able to attribute pumping diversions to individual sectors and individual wells, and concluded that flows in the Little Plover River would have been robust during 2005 and 2006 without the presence of groundwater pumping.

The WIDNR, the Wisconsin Geological and Natural History Survey, and the U.S. Geological Survey started a project in 2014 to create a more fine-tuned model of Little Plover River Basin that would address the cause and effect relationships between stream flows and pumping, and explore different management scenarios. As of the writing of this plan, the full potential of this model for identifying management strategies has not been publicly released.

The Little Plover River is not the only surface waterbody in Portage County to be impacted by groundwater variability. In recent years both Wolf Lake (Town of Almond) and Pickerel Lake (Town of Belmont) have been prominently impacted, including boat landings that are unusable because they are so far out of the water and fish kills due to lack of oxygen during low water levels. Other substantially impacted water bodies include Stoltenberg Creek, Bass Lake, Pine Lake, Boelter Lake, Pleasant Lake, Bear Lake, and Ell Lake among others[8].

While all surface waters experience natural fluctuations in water levels, any naturally occurring low water levels are exacerbated by surrounding groundwater pumping. Long term hydrograph monitoring wells in Central Wisconsin can help differentiate between natural fluctuations and those caused by groundwater pumping. Four of the five hydrograph wells in Portage County have been used to monitor long term trends in groundwater levels. These four wells have been monitored for decades, showing the annual highs and lows of groundwater levels. However, in three of the hydrograph wells (Figures 9, 10, 11) the entire cycle is taking place deeper in the ground, indicating a downward trend in groundwater levels. The situation has not significantly improved, even in years with above normal precipitation. The Amherst Junction Monitoring well is surrounded by fewer high capacity wells and the same cycles of highs and lows can be seen but not at the deeper levels, with an indication towards increasing groundwater levels.

In 2010, Kraft et al[8] set out to quantify the effects of groundwater pumping on surface waters in the Central Sands Region of Wisconsin. They concluded that from 1990s to 2007, while some low water levels in lakes and streams were certainly due to somewhat below average moisture conditions, it could not explain the severely depressed water levels in other areas. Kraft et al found that groundwater pumping removed several feet of water in some lakes higher in the groundwater flow system (closer to the terminal moraine) and where high capacity wells are prevalent. Up to 50% of the average baseflow may be removed on headwater streams. Impacts are less noticeable in areas lower in the groundwater flow system and farther from high capacity wells.

E. GROUNDWATER QUALITY

When discussing groundwater quality, it is important to understand the differences between: 1) natural groundwater quality (which we can do little about except educate ourselves and act accordingly), 2) individual well problems (which we may be able to do something about as water users), and 3) groundwater pollution from human activities and land uses (which we have an obligation to address). County groundwater policies and programs should address concerns related to all three.

[8] Kraft, G.J., Mechenich, D.J., Clancy, K., Haucke, J. 2010. Groundwater Pumping Effects on Groundwater levels, Lake Levels, and Streamflows in the Wisconsin Central Sands. Stevens Point, WI.

Natural Groundwater Quality Issues

The natural groundwater quality in most areas of Portage County is generally good. Where natural water quality problems exist, they include aesthetic concerns such as iron and manganese, and health concerns such as radionuclides, and corrosive water. For more information about all water quality issues in drinking water wells in Portage County you can visit the Wisconsin Well Water Quality Viewer at https://gissrv2.uwsp.edu/cnr/gwc/pw_web/

Iron and manganese are two metals that occur naturally in the sediments and bedrock that make up the County's aquifers. Both are essential to life, but become a nuisance when they are present in water at too high a concentration. The main concern with iron and manganese is not health, but rather taste, odor, and staining of plumbing fixtures and laundry. The US Environmental Protection Agency (USEPA) set a drinking water standard based on aesthetic (not health) concerns of 0.3 parts per million for iron and 0.05 ppm for manganese. Iron and manganese tend to be more of a problem in areas of the County where aquifer materials have little buffering ability, and groundwater is shallow, and in sand and gravel wells screened near bedrock. Individual treatment units, and careful well installation into a different part of the aquifer, are routinely used to deal with these contaminants. Iron and manganese are found throughout the County, but levels are most severe in southwestern and western Portage County. Iron and manganese are two of the biggest issues that municipalities treat for.

Radionuclides are elements that undergo nuclear decay. Nuclear decay is the process by which atoms split to form other atoms, and in the process emit potentially harmful radiation. A number of radioactive elements - radium, radon, uranium, thorium, and others - naturally occur in the bedrock aquifer, particularly at greater depths. The USEPA has established standards for radioactivity in drinking water for public water supplies. The current standards are: "combined radium 226/228 of 5 pCi/L (picocuries per liter); a combined standard of 4 millirems for beta emitters; and a gross alpha standard for all alphas of 150, not including radon and uranium" (http://www.epa.gov/ogwdw000/standard/radionuc.html). We do not know the number of wells in Portage County with exceedances of radioactivity standards, but radon from well water can be a significant contributor of residential radon levels. Between 2012 and 2014 residential radon levels ranged from less than 0.6 to 57.8 pCi/L in Portage County (Radon Information Center, 2014). Radon, when inhaled, is known to contribute to lung cancer, particularly in combination with tobacco smoke. WIDNR encourages homeowners that have household radon levels above 4pCi/L to have their water tested.

Since bedrock wells are more common in the northwest part of the County, this is likely where the greatest radioactivity concerns exist. Over 2,000 Portage County wells terminate in the bedrock aquifer. Only a few have been tested for radionuclides. Significant levels of groundwater radioactivity in deep wells east of Stevens Point have resulted in abandonment of several wells.

Studies by WIDNR in areas of granite wells in other Wisconsin counties have shown dangerous levels of radionuclides in a significant percentage of these wells. No widespread sampling of bedrock wells, similar to that conducted for atrazine in the mid-1990's, has been conducted in Portage County.

Arsenic is a naturally occurring element found in soil and bedrock throughout Wisconsin. Under certain conditions, arsenic can be released into groundwater and enter water wells. There is evidence that arsenic was used as an insecticide in Portage County. While arsenic is a minor concern here in Portage County, the Village of Amherst recently detected levels of arsenic in their municipal supply.

Corrosive water is a term used for naturally soft and acidic water (pH less than 7). The water itself is not harmful; however, its chemistry is right for dissolving metal in plumbing. This results in damage to plumbing (e.g., leaks in copper pipe), but more importantly, dissolved copper and lead in drinking water

can cause severe health problems, ranging from indigestion and headaches, to brain and liver damage, especially in children. Dissolved lead is more of a problem in older homes (pre-1984) when lead solder was commonly used, but dissolved copper is a problem in homes that have copper pipes. Corrosive water is most common in the southwestern part of the County. The City of Stevens Point adds corrosion inhibitors to municipal water to prevent the corrosion of metal in plumbing.

Microorganisms (bacteria, viruses, and others) occur naturally in the environment, including in aquifers and groundwater. Most are harmless or even beneficial, but some can cause disease, and others create nuisance conditions. Coliform bacteria and fecal coliform bacteria are frequently analyzed in well water samples. Coliform bacteria live in soil, water, vegetation, and in the intestinal tracts of animals. Fecal coliform bacteria are members of the group who specifically live in the intestines or in feces. Though natural contaminants, their presence in groundwater is generally from a malfunctioning private onsite wastewater treatment system (POWTS) or livestock waste storage system. Most coliform bacteria do not cause disease; however, they are good indicators that a breach exists in the sanitary condition of a water system. In Portage County, coliform bacteria are usually not present as a groundwater contaminant, but rather, enter wells via a defect (missing well cap, cracked casing, and poor well construction) or move through groundwater from a substandard septic system into a shallow well. Following well reconstruction or repair, disinfection can usually permanently eliminate bacterial contamination.

Unused wells that have not been properly abandoned provide ideal routes for bacteria to enter nearby wells, since contaminants can move directly from the surface to groundwater. Even following abandonment of an unused well, nearby wells may test unsafe for an extended period of time (months), and will probably not respond well to disinfection.

The resource assessment presented here and in Section 5.1 is adequate for developing County groundwater management options. However, analysis of specific development proposals or possible problem areas will require additional site specific data acquisition.

Human Influenced Groundwater Quality Issues

Nitrate-N

Nitrate-N easily dissolves in water and does not adhere to soil which allows it to be easily carried into groundwater, making it one of the most common groundwater pollutants in Portage County. Often when high levels of nitrate-N are present, it can be indicative of the presence of other pollutants such as bacteria or pesticides.

Natural nitrate-N levels in central Wisconsin, absent of all pollution sources, are less than 2 parts per million. The health based enforcement standard and maximum contaminant level (mcl) for nitrate-N is 10 parts per million (as nitrate-nitrogen). Wisconsin also has a preventable action limit (PAL) of 2 mg/l. A preventable action limit, as defined in NR 140, serves to inform the WIDNR of "potential groundwater contamination problems, establish the level of groundwater contamination at which the department is required to commence efforts to control the contamination and provide a basis for design and management practice criteria in administrative rules". In a 1977 report by the National Academy of Sciences[9] concluded that "available evidence on the occurrence of methemoglobinemia in infants tends to confirm a value near 10 mg/L nitrate-N as a maximum no-observed adverse-health-effect level, but there is little margin of safety in this value". This may suggest that the Wisconsin preventable action nitrate-N limit of 2 mg/L is a target which is more likely to prevent substantial health risk to the citizens of Portage County.

There are a number of health risks that have been associated with elevated nitrate-N levels (see sidebar). As nitrate-N (nitrate nitrogen, or NO3-N) are ingested they convert to nitrite (NO2-N) and then can form N-nitroso compounds (nitrosamines) in the digestive tract, or when in contact with other proteins found in food waste and other human produced wastes. Nitrosamines are being studied for long term links to cancer [10](McCasland et al. 2013). There are additional health concerns relating to an increased risk of Non-Hodgkins lymphoma, gastric cancer, and bladder and ovarian cancer[11] (WGCC 2016). The International Agency for Research on Cancer[12] (IARC 2013) has listed nitrates and nitrites as "probably carcinogenic to humans" under certain conditions. Several epidemiological studies have shown a statistical

High nitrate nitrogen levels in drinking water pose serious risks to infants under six months and to the unborn. Households with infants under six months and pregnant women should have their water tested and should not use water that exceeds the state and federal nitrate nitrogen standard of 10 parts per million (ppm).

The Wisconsin Division of Public Health recommends that people of all ages avoid long-term consumption of water that has a nitrate nitrogen level above 10 ppm.

Wells that have had a nitrate concentration between 5 and 10 ppm should be tested annually. Testing may also be useful if there are any known sources of nitrate nearby or high nitrate concentrations have been found in neighboring wells.

[9] National Academy of Sciences, Safe Drinking Water Committee. 1977. Drinking Water and Health. Washington D.C.

[10] McCasland M., Trautmann N., Porter K., and Wagenet R. 2013. Nitrate: Health Effects in Drinking Water Factsheet. Cornell University Cooperative Extension. http://psep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.aspx

[11] Wisconsin Groundwater Coordinating Council. Report to the Legislature. 2016. http://dnr.wi.gov/topic/Groundwater/GCC/

[12] International Agency for Research on Cancer (IARC). 2013. Ingested Nitrate and Nitrite, and Cyanobacterial peptide Toxins. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 94. Page 325. http://monographs.iarc.fr/ENG/Monographs/vol94/mono94-6F.pdf

correlation between nitrate-N exposure and neural tube defects[13] (Brender et al. 2004, 2011, 2013). Further studies would need to be conducted to establish causation but there is an established link between these diseases and elevated nitrate exposure or ingestion. There is also some evidence to suggest a relationship between nitrate-N and anemia, spontaneous abortion/premature labor, or preeclampsia in pregnant women[14] (CDC 2013). These studies show the need for caution among pregnant women consuming nitrate-N and the continued need for private well testing. In its report to the legislature in 2016, the WGCC stated "The health-based enforcement standard (ES) for nitrate-N in groundwater and the maximum contaminant level (MCL) for nitrate-N in public drinking water are both 10 ppm (WI NR 140.10, WI NR 809.11)". A "ppm" (part per million) is equivalent to mg/L for nitrate-N. It is recommended that everyone should avoid long-term consumption of water containing nitrate above this level[11] (WGCC 2016).

The WGCC (Wisconsin Groundwater Coordinating Council) report cites work by Dr. Byron Shaw that states approximately 90% of all nitrate-N inputs to groundwater originate from agricultural sources, 9% from septic systems, and 1% from lawns or other sources[11]. The WGCC report also recommends that "Agencies should develop and evaluate a strategy to promote practices that lead to efficient use of nitrogen and careful or reduced use of pesticides in order to protect drinking water sources." Such strategies can be part of a nutrient management plan (NMP) for individual farms, but without concerted efforts to coordinate these plans, there is little which can currently be done on individual farms to monitor and control such releases. The WGCC report points out that nearly 20% of nitrogen fertilizer is leached to groundwater even with the best NMPs[15] (Norman 2003; Masarik 2003). Threats to aquatic vertebrates and invertebrates are also documented and can be particularly critical at low-flow conditions in base-flow dominated streams, many of which occur in agricultural watersheds, leading to potential die-off of organisms critical to the ecological health of streams and associated fisheries[16] (Stelzer and Joachim 2010; McGurk et al. 2006).

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[13] Brender, J.D. et al. 2013. Prenatal nitrate intake from drinking water and selected birth defects in offspring of participants in the National Birth Defects Prevention Study. Environmental Health Perspectives, 121(9):1083-1089. Available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3764078/

Brender JD, Olive JM, Felkner M, Suarez L, Marckwardt W, Hendricks KA. 2004. Dietary nitrites and nitrates, nitrosatable drugs, and neural tube defects. Epidemiology 15(3):330–336.

Brender JD, Werler MM, Kelley KE, Vuong AM, Shinde MU, Zheng Q, et al. 2011. Nitrosatable drug exposure during early pregnancy and neural tube defects in offspring: National Birth Defects Prevention Study. Am J Epidemiol 174(11):1286–1295

[14] Center for Disease Control (CDC) Agency for Toxic Substances & Disease Registry. 2013. Nitrate/Nitrite Toxicity: What Are the Health Effects from Exposure to Nitrates and Nitrites? https://www.atsdr.cdc.gov/csem/csem.asp?csem=28&po=10

[15] Norman, J.M. 2003. Agrochemical leaching from sub-optimal, optimal and excessive manure-N fertilization of corn agroecosystems. Wisconsin groundwater management practice monitoring project, WR99R001A.

Masarik, K.C. 2003. Monitoring water drainage and nitrate leaching below different tillage practices and fertilization rates. University of Wisconsin-Madison Thesis. 110 pp. Stelzer and Joachim 2010

[16] Stelzer, R.S. and B.L. Joachim. 2010. Effects of elevated nitrate concentration on mortality, growth, and egestion rates of Gammarus pseudolimnaeus amphipods. Archives of Environmental Contamination and Toxicology, 58(3): 694-699.

McGurk M.D., F. Landry, A. Tang, C.C. Hanks. 2006. Acute and chronic toxicity of nitrate to early life stages of lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*). Environmental Toxicology and Chemistry, 25(8):2187-2196.

Although a statistical and ground-truthed study on this contention has not been performed in Portage County, there are numerous studies nationally which directly link poor agricultural management practices with elevated groundwater nitrate-N, poor stream ecological health and declining fish populations.

An understanding of the fate of nitrate-N in groundwater is vital for managing risks associated with nitrate pollution, and to safeguard groundwater supplies and groundwater-dependent surface waters. Denitrification, the process by which nitrate (NO3) is transformed into inert gaseous nitrous oxide products (N2O etc.) is mediated by bacteria in poorly-oxygenated (i.e., poorly aerated) soils, such as those continually saturated in wetland and pond sediments. Such conditions rarely occur near the application sites of N fertilizers since farming in such zones is inefficient or impossible. Riparian zones (near-stream soils and channel banks), wetlands and hyporheic zones (in-stream sediments) appear to be zones of effective, if variable, nitrate cycling, primarily because of high fluxes of organic carbon and saturated conditions near to, or within the soil zone[17] (Buss et al. 2005). Well-drained soils (e.g., sands and coarse sediments) have both high infiltration and leaching capacity (rapidity of recharge to groundwater), and low nitrate attenuation potential, leading to a high probability of excess nitrate in agricultural runoff (in excess of that needed by crops) getting into deeper groundwater. Thus, the ability of various soils and deeper deposits, below the rooting zone, to bacterially consume nitrate in fertile and efficient agricultural land, is low since these soils are well-oxygenated and well-drained. Agricultural areas are often chosen specifically for the presence of well-drained soils, with ponded areas and wetlands avoided.

In contrast to biological transformations, loss of nitrate by leaching is a physical event, with the loss of soluble NO3 as it moves with excess water past the rooting zone[18] (Lamb et al. 2014). Nitrate-N that moves below the root zone has the potential to enter either groundwater or surface water through tile drainage systems or direct infiltration into underlying soils. In coarse soils (sands and glacial drift materials) irrigation water enters and moves more easily into and through larger pores. Infiltration rate, and subsequently the ease at which nitrate-rich water moves past the rooting zone, is higher for coarse textured soils (sands) than for fine textured soils (silts, clays, loams). Therefore, agricultural application of fertilizers rich in nitrogen, and underlain by more permeable soils (low nitrogen attenuation capacity) should be more closely scrutinized in NMPs since they pose a more direct and rapid risk of excess nitrate-N entering deep groundwater, where it can reside and be transported for years, posing a public health risk to municipal and private drinking water supplies.

The Wisconsin Well Water Viewer has compiled voluntary homeowner well test results from the Center for Watershed Science and Education, the Department of Agriculture, Trade, and Consumer Protection, and the Wisconsin Department of Natural Resources Groundwater Retrieval Network over the last 25 years. According to data found in the viewer approximately 19% of voluntary private well tests in Portage County

[17] Buss, S.R., M.O. Rivett, P. Morgan, C.D. Bemment. 2005. Attenuation of Nitrate in the Sub-Surface Environment. Science Report SC030155/SR2. Environment Agency, Waterside Drive, Aztec West Almondsbury, Bristol, BS32 4UD. ISBN: 1844324265

[18] Lamb, J A, F G Fernandez and D E Kaiser. 2014. Understanding nitrogen in soils. University of Minnesota. AG-FO-3770-B (Revised 2014).

exceed the nitrate-N drinking water standard, which is twice the state average of 9%[19]. Nitrate-N ranges found in Portage County ranged between none detectable to a high of 76 ppm (see Table 8). Towns with the largest percentage of private wells exceeding the nitrate-N drinking water standard over time include, Buena Vista, 42% of well tests, Pine Grove 40%, Almond 38%, and Plover 30% (Figure 17). Figures 18-21 shows the location of nitrate exceedances in Portage County, conducted through voluntary homeowner testing. Private well owners have no requirements for testing or action, but monitoring is still suggested.

Table 8. Nitrate Concentrations in Wells in Portage County over the last 25 years from the Wisconsin Well Water Viewer.

Nitrate Concentration in Sample (ppm)	Number of wells	Percentage of Wells Tested
Under 2.0	3925	31.5%
2.1-10.0	6124	49.1%
10.1 and over	2426	19.4%

Currently there are 4 municipalities in Portage County, The Villages of Plover, Junction City, Amherst, and Whiting that are either treating or have replaced a well due to nitrate-N concentrations exceeding the drinking water standard. The City of Stevens Point has taken one well offline. Combined these municipalities have spent well over 5 million dollars trying to bring nitrate levels to within the drinking water standard. Removal of nitrate-N from public or private drinking water supplies is costly, estimated at $32.5M statewide in 2012[11] (WGCC 2016).

Table 9. Municipal Drinking Water System Treatments used in Portage County, WI

Municipal Water System	Type of Treatment	Total Cost	Annual Maintenance
Amherst	New Well	$477,834	
Plover	Anion Exchange	$4,000,000	$24,000
Whiting	Anion Exchange, blending	$669,999	$2,501
Stevens Point	Well taken offline		
Junction City	In the process of installing new well	At least $250,000	
		At least $5,397,833	

Source: Chern, Laura, 2005, Nitrate Removal and Avoidance Costs for Wisconsin Municipalities: Madison, Wis., Wisconsin Department of Natural Resources.

Nitrate-N levels have risen in many areas of the County over time. Though some small areas have shown declining nitrate-N levels, as in the Village of Plover east well field, this is not the norm Countywide. There is evidence that as older cleaner water is discharged from the aquifer it is replaced with newer water with higher concentrations of nitrate-N (Nutrient Management Subcommittee of the Nonpoint Source Pollution Abatement Program Redesign, 1999). Efforts made during the 1990's by farmers and homeowners in

[19] Wisconsin Well Water Quality Viewer, 2015 http://gissrv2.uwsp.edu/cnr/gwc/pw_web/

cooperation with the Stevens Point – Whiting – Plover Wellhead Protection project have had some limited success in reducing nitrate-N loading to the groundwater in the municipal well recharge area. Unfortunately, the efforts did not succeed in lowering levels of this contaminant area-wide.

It is the desire of Portage County to further examine available water quality data to establish trends in nitrate-N concentrations, and other water quality parameters. Establishing trends spatially and over time will allow Portage County to better understand the current status of water quality in the County and what measures might be taken to improve it.

In order to further assist this increase in information and understanding Portage County should consider participation in the "Wisconsin Safer Drinking Water Nitrate Initiative" targeted at reducing nitrate-N concentrations using current best practices. Combined with the presence of a variety of soils with poor nitrate-N attenuation capacity, it is very likely that poor land management, excess fertilizer application, and unrestricted waste management practices, can and do introduce large amounts of nitrate-N into vulnerable soils with high infiltration rates, causing elevated concentrations of nitrate-N in private and municipal drinking water wells. This is particularly the case in many areas of the "Central Sands" region of Central Wisconsin (including Portage County).

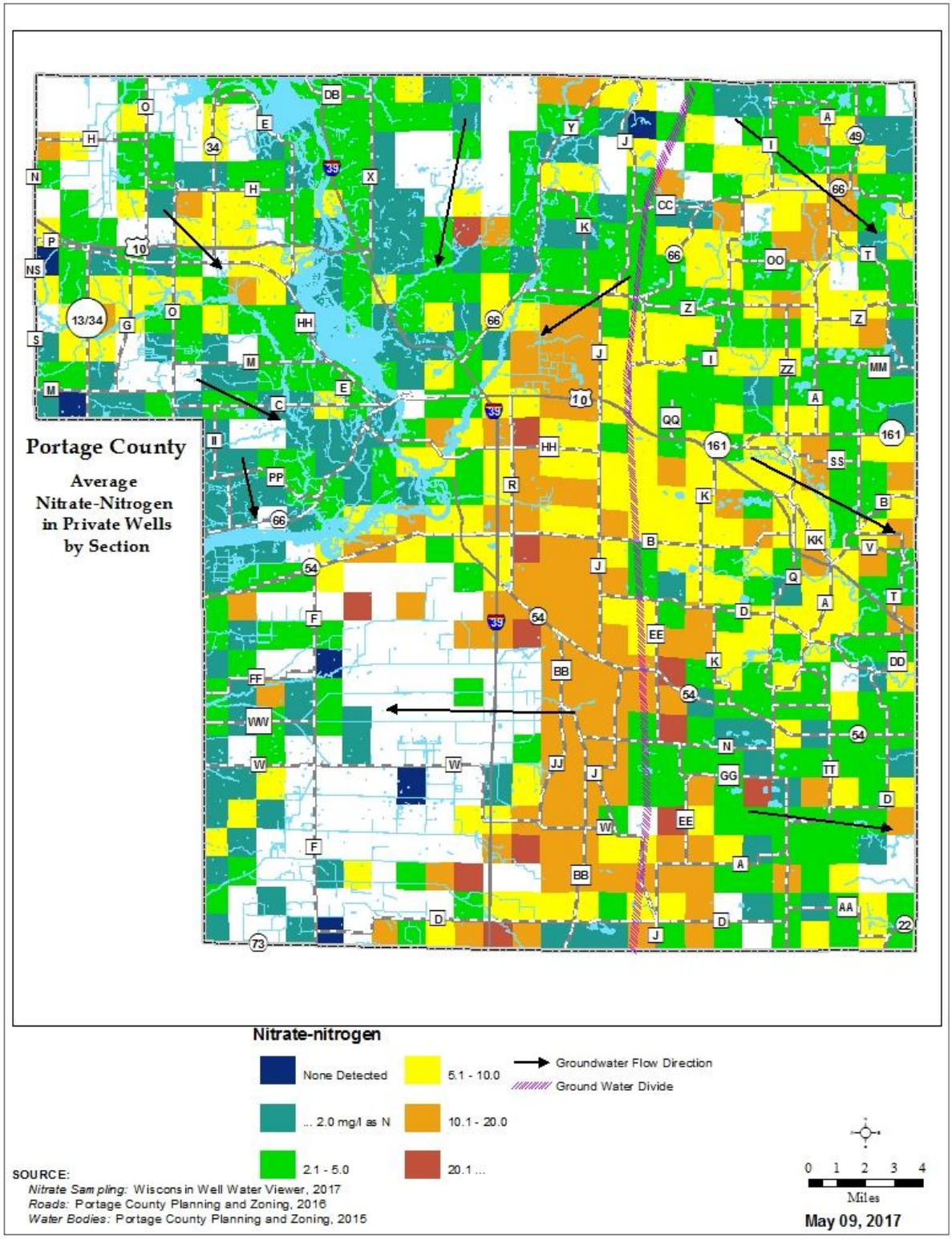

Figure 17. Average Nitrate-nitrogen concentrations in private wells by section in Portage County.

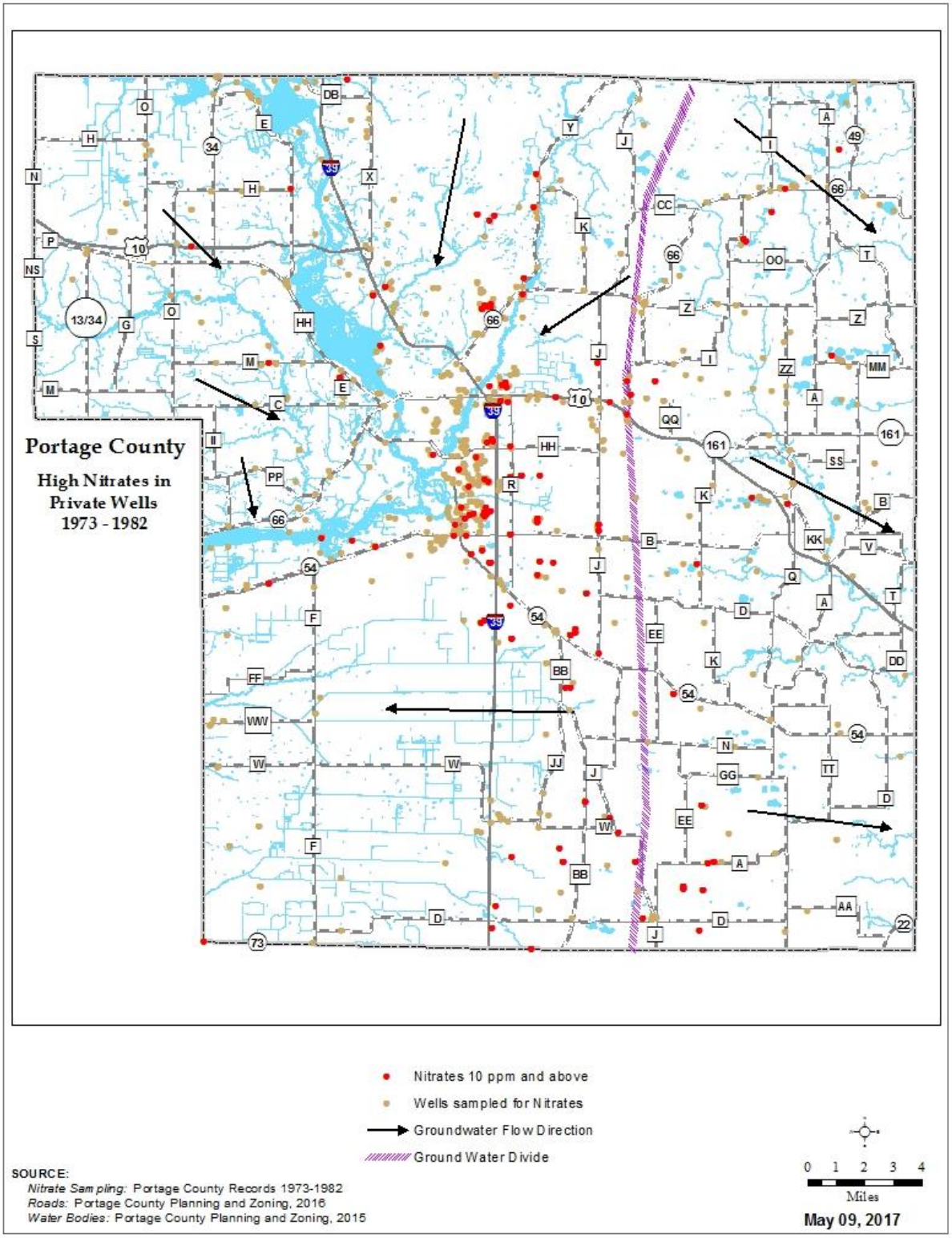

Figure 18. Nitrate Exceedences in Portage County, WI between 1973-1982.

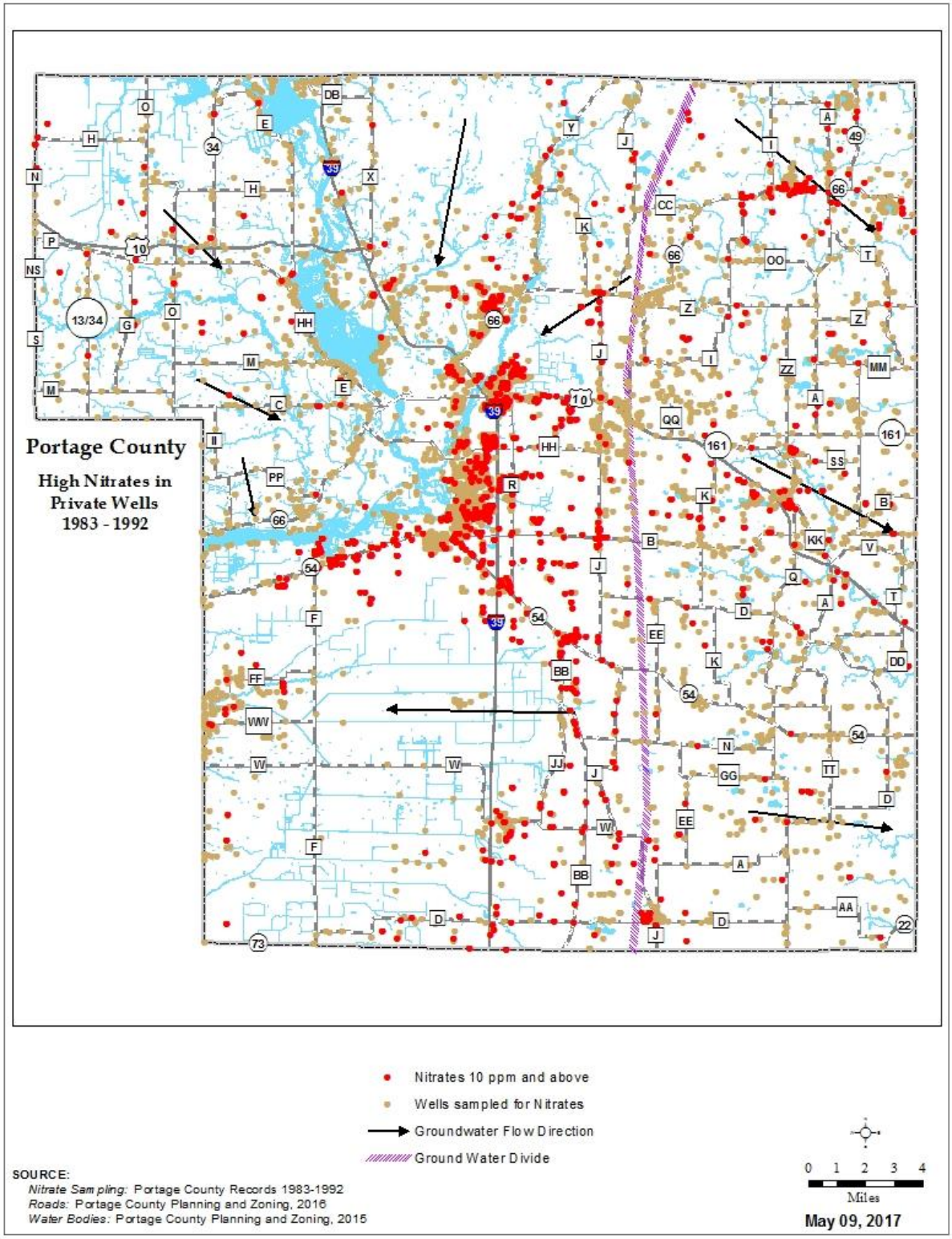

Figure 19. Nitrate Exceedences in Portage County, WI between 1983-1992

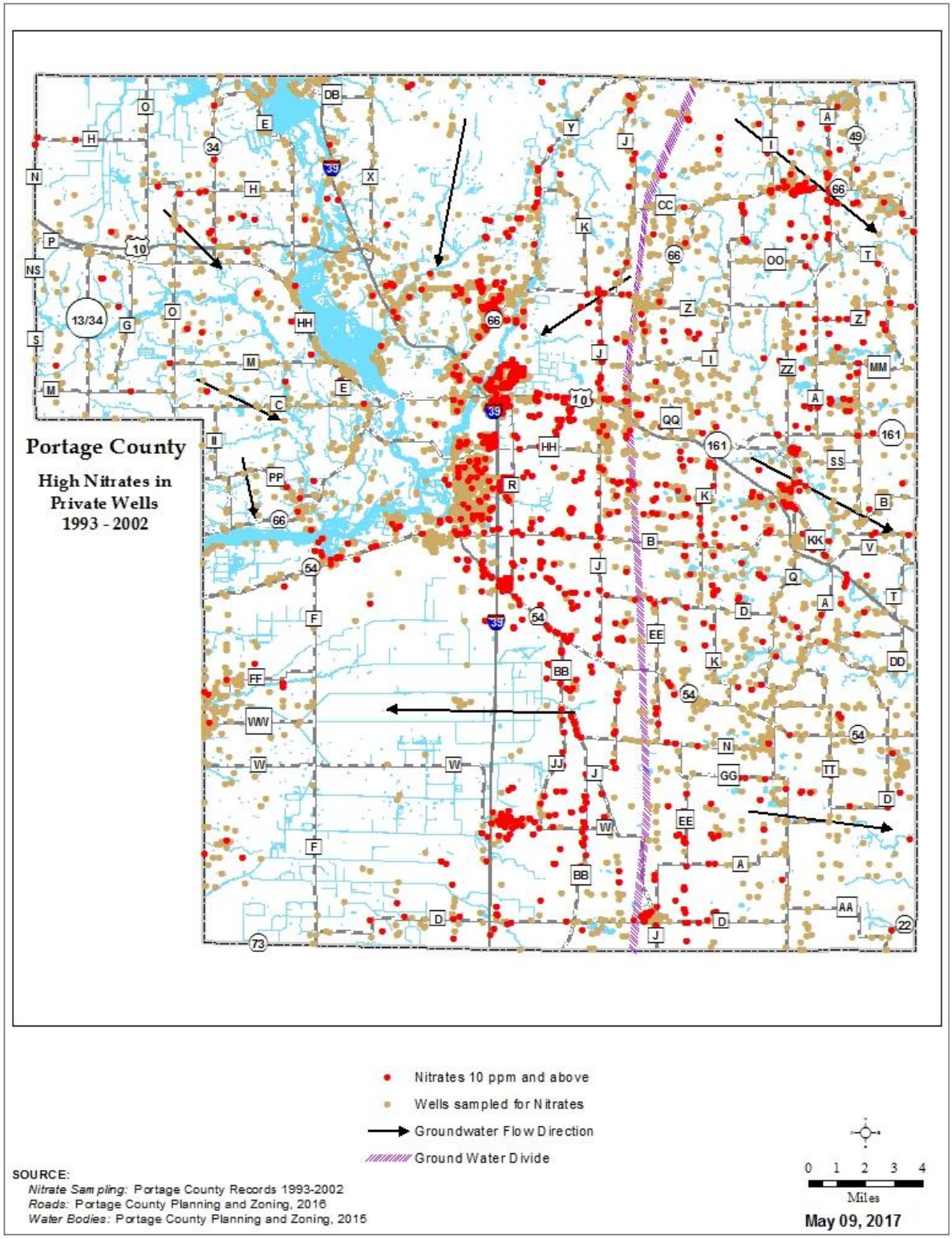

Figure 20. Nitrate Exceedences in Portage County, WI between 1993-2002

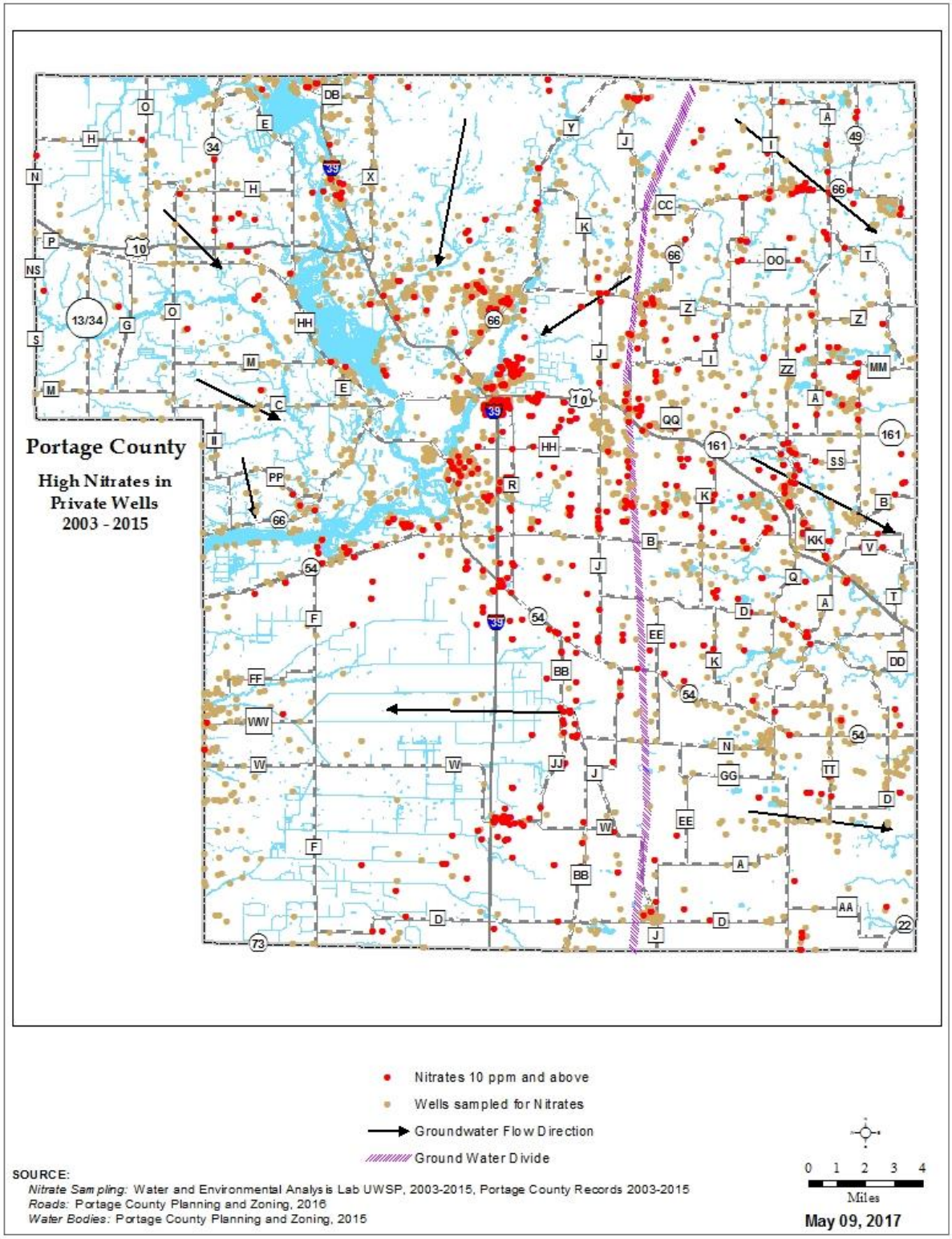

Figure 21. Nitrate Exceedences in Portage County, WI between 2003-2015

Bacteria

Bacteria is one of several contaminants that can affect a drinking water well. Bacteria often travels over the lands surface with rainwater or snowmelt and enters the ground where most is filtered out as the water travels through the soils. However, some strains of bacteria can survive a long time and can reach the groundwater through coarse soils, fractures, sink holes, and improperly constructed or located wells.

Bacteria can be both naturally occurring and human induced. Coliform bacteria are naturally occurring in soil and are found on vegetation and surface waters. While coliform bacteria does not cause illness or health risks for humans, its presence is an indication that a water system is at risk of more serious forms of contamination.

The presence of *Escherichia coli* or *E. coli* bacteria is an indication of fecal contamination of the groundwater. *E. coli* bacteria are present in the intestines of warm blooded animals and are typically found in their fecal matter along with other pathogenic bacteria, viruses, and parasites which can cause illnesses.

Public drinking water systems are required to regularly monitor for total coliform and may also be tested for *E. coli*, *Enterocci*, or *Coliphages* if total coliform is found. Private homeowners are encouraged to test their wells for total coliform and *E. coli* bacteria. Private well systems should be free of all bacteria.

Traditionally it has been difficult to determine the source of bacterial contamination in water. In 2007, methods for determining if bacteria detected in water were derived from human, animal, or other source became more readily available. Currently this microbial source tracking (MST) includes tests for *Rhodococcus coprophilus* (indicative of grazing animal manure), *Bifidobacteria* (indicative of human waste, and *Bacteroides* (indicative of recent fecal contamination by either humans and/or grazing animals). A more recently developed analysis can detect bovine adenoviruses that indicate bovine fecal contamination of groundwater. The WIDNR has been using these MST's to determine the sources of fecal contamination in private wells.

Volatile Organic Chemicals

Household and industrial solvents, gasoline, and fuel oil are common examples of volatile organic chemicals (VOC's). Pollutants in this category include benzene, toluene, dichlorethane, trichloroethylene, xylene, and others. Instances of this type pollution are relatively rare, usually cover small areas, and frequently are related to accidental discharges. Most are due to old spills around gas stations, dry cleaners, industrial sites, and pipelines, and may be present near current salvage yards. The Wisconsin Bureau of Remediation and Redevelopment maintains an online database of information about investigations and clean-up of contaminated soil or groundwater in Wisconsin. The specific information in the database includes investigations and clean-ups of contaminated soil and/or groundwater, spills, superfund sites, and sites receiving WIDNR funding assistance. According to this database there are currently 31 open cases being investigated or cleanups, 668 closed cases, and another 242 historic sites in Portage County.

Most VOC contaminated sites have been addressed by the property owner (with other grant programs) or have low enough contaminant levels to be candidates for natural attenuation. Excavated soils (from contaminated sites) containing low levels of these contaminants are generally landspread to allow the soil to provide final treatment. According to an analysis done using the County GIS, only an area of cropland in Pine Grove meets the State code criteria for landspreading of petroleum contaminated soils. No sites have been recently approved in the County for this type of land application.

In addition to known point sources of contamination, organic chemicals from cleaning and other household chemicals are routinely discharged to groundwater through private onsite wastewater treatment systems (POWTS). Some POWTS, which incorporate pretreatment, will do a better job of treating for these contaminants than standard systems. These contaminants can also be present in stormwater runoff from roads, parking lots, and other paved surfaces. Stormwater must be adequately treated by discharging to properly constructed retention-infiltration basins. Percolation of stormwater through topsoil lined basins can trap organic contaminants, as well as some others that may be present. Discharge of stormwater to drywells or unlined basins, can allow these contaminants to be flushed into the groundwater.

Chloride

Chloride can enter groundwater from fertilizers (such a potassium chloride), animal waste, septic systems, and road salt. Natural background levels of chloride are estimated to be below 10 mg/L in Portage County. The drinking water standard for chloride has been set at 250 mg/L, which is only based on an aesthetic taste of the water.

While elevated chloride concentrations pose no significant health risk, they are an important indication of human impacts. A summary of 2,148 private well samples in Portage County between 2000 and 2010 indicated that approximately 60% of the sampled wells had chloride concentrations above 10 mg/L and 15% had a concentration greater than 50 mg/L (Portage County State of the Groundwater Report, 2010).

Pesticides

The term "pesticide" includes herbicides, insecticides, nematocides, fungicides, and other compounds used to control organisms such as insects, weeds, and fungi. Very little of the County's agricultural land, irrigated or non-irrigated, does not receive pesticides as many farmers utilize pesticides to maximize yield on acreage planted. When pesticides are applied to the land they can stick to plants and soils, breakdown, be transformed, and/or move to groundwater. The amount of pesticide that is able to enter groundwater depends on several variables including specific properties of the soil, plants, and pesticides, as well as the amount of pesticide. Pesticides posing the greatest threat to groundwater are those that dissolve and travel easily in groundwater, have high toxicity levels, do not breakdown easily, and are not easily attracted to soil particles (please see Appendix B for a listing of the most common pesticide ingredients that travel easily in water and have a toxicity level of concern).

Pesticides were first detected in Portage County groundwater in the 1980's. Over 90 different pesticide products were reported as being used in Wisconsin in 1996. In 2013 the GCAC Continuous Assessment Subcommittee completed an assessment of pesticides sold and detected in groundwater in Portage County. The Committee examined the active ingredients in the pesticides sold and found 38 active ingredients along with their major metabolites. (See Table 10) Pesticide application rates vary substantially among crops; averaging about 0.8 pounds (as active ingredient) per acre for soybeans, 2 to 3 pounds per acre for field corn, and around 13 pounds per acre on potatoes. Source: Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) 2008.

Pesticides are also used around homes - on lawns and gardens. The most commonly used pesticide around households is the 2,4-D contained in "weed and feed" lawn fertilizer formulations. Also used around households are malathion, carbaryl, and diazinon. At label application rates, 1.75 pounds of 2,4-D can be applied on a home lawn with two applications permissible per year. Actual usage is less. In a survey of

two subdivisions with fairly well manicured lawns, only about half of households used a weed and feed formulation on their lawns, and then only once per year[20].

The split between pesticides applied for agricultural compared to nonagricultural purposes is not precisely known, but a perspective may be gained by using the following comparison suggested by a former DATCP official (James Vanden Brook, former Groundwater Unit Leader). The herbicide 2,4-D is likely the most commonly used, nonagricultural pesticide. In the US, 16 times more 2,4-D is used in agriculture than on turf. Because 2,4-D makes up only 0.2% of the agricultural pesticides used in Wisconsin, it follows that home and other turf use of 2,4-D is only about 1/10,000 of the total agricultural pesticide use. While this analysis is imperfect, and neglects other less commonly used household pesticides, it demonstrates relative magnitudes of pesticide use.

Data is currently unavailable to determine the amounts of specific pesticide residues ("residues" means the parent pesticide, plus its related breakdown products) present in Portage County groundwater. With the exception of atrazine and aldicarb, very few wells have been sampled for many of the pesticides that can be expected to leach to groundwater. It is reasonable to expect, based on widespread detection of residues of soluble pesticides such as atrazine, alachlor, and aldicarb that other leachable pesticides have been reaching groundwater where they have been used.

Atrazine, historically one of the most commonly used pesticides in the County, is also one of the most widespread known pesticide problems. It has been detected in over 40% of Portage County wells (WI Well Water Viewer). About 3% of wells are known to exceed the health standard of 3.0 parts per billion. This has led to the establishment of several atrazine prohibition areas (Figure 19) in the County, where atrazine cannot presently be used. While Atrazine use within the County is decreasing, it is still present in the groundwater.

Alachlor ESA, one of the degradation products of the pesticide alachlor, is most likely a pollutant in County groundwater. A DATCP study found that 27% of wells tested in Wisconsin contained this compound (Vanden Brook, J. et al, 2002). Alachlor and metolachlor residues have been detected in Stevens Point well number 10 and Whiting wells numbers 1 and 7 (UW-Stevens Point and DATCP). The Water and Environmental Analysis Lab (WEAL) at UWSP have detected Chloroacetanilide herbicide metabolites (alachlor ESA/OA, metolachlor ESA/OA, and acetochlor ESA/OA) in private and municipal well samples, only one sample has exceeded drinking water standards. Wisconsin NR 140 has established drinking water standards for Acetochlor, Alachlor, Metaoachlor and their breakdown products. To view the specific drinking water standards visit http://docs.legis.wisconsin.gov/code/admin_code/nr/100/140.pdf#page=6.

In September 2013 the Portage County GCAC Continuous Assessment Subcommitte (CAS) conducted a review of pesticides used in Portage County. In order to have some understanding of what pesticides are common in Portage County, the CAS summarized the most commonly sold active ingredients in pesticides in Portage County. Information for the specific amounts of pesticides applied to crops in Portage County is not available. The pounds sold is meant to be used as a surrogate to identify commonly used pesticides in the County. It should be recognized that some of the pesticides sold in Portage County will be exported to outside of the County. Table 10 lists the ten most common pesticides in Portage County. The full list of all pesticides sold in the County is listed in Appendix C.

[20] Mechenich, C. Shaw B.H., Nowak, P., and Madison, F. 1991. Chemical Use and Attitudes about Groundwater in Two Portage County, Wisconsin Subdivisions. Central Wisconsin Groundwater Center, Stevens Point, Wisconsin.

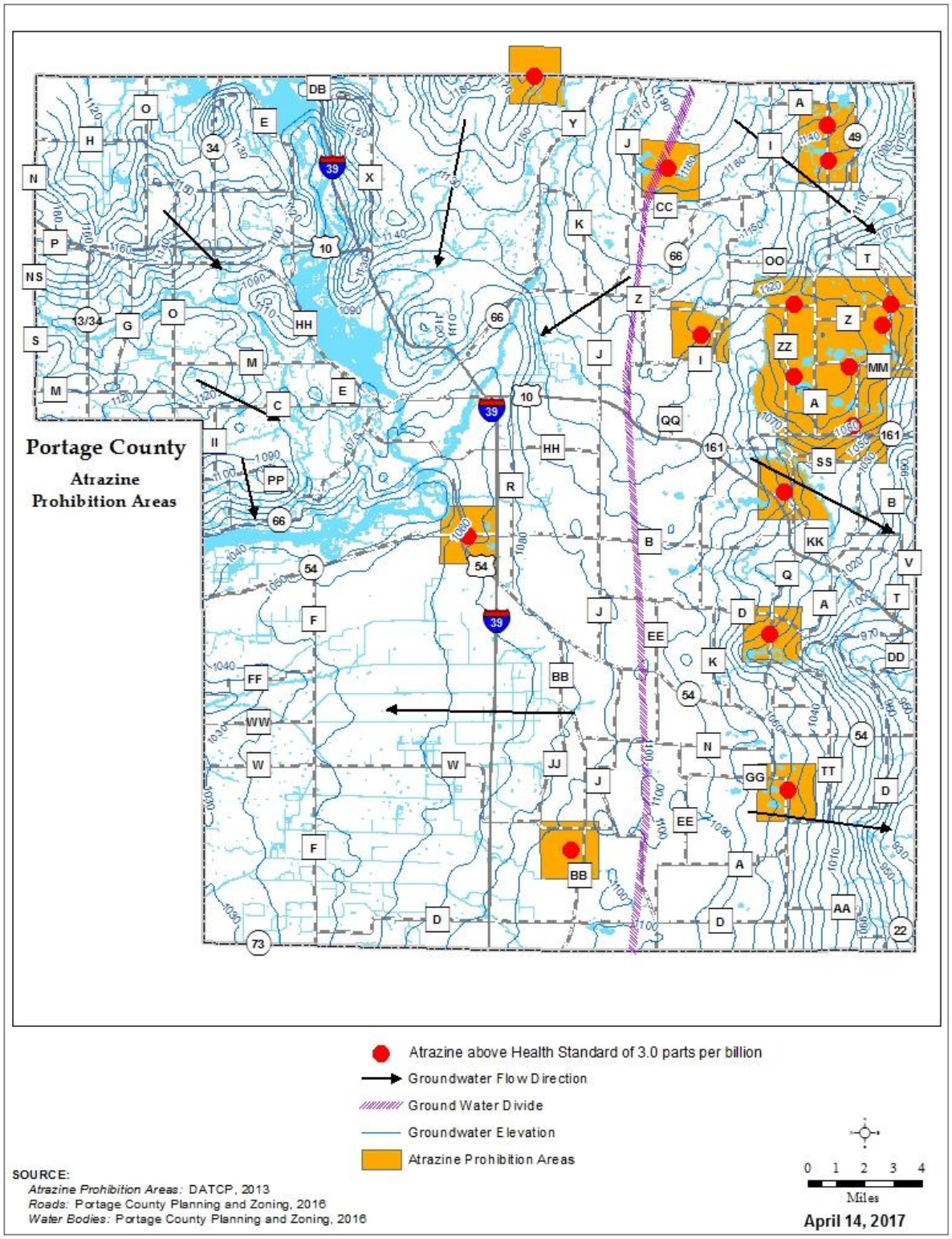

Figure 22. Atrazine prohibition areas in Portage County, WI.

Table 10. Ten most common pesticide active ingredients sold in Portage County in 2009**.**

Active Ingredient	Amount sold in 2009
Metam Sodium	2,437,001 lbs
Chlorothalonil	174.031 lbs
Mancozeb	108,880 lbs
Glyphosate	118,462 lbs
Chloropicrin	100,063 lbs
S-Metolachlor &Metolachlor	93,675 lbs
Imidacloprid	58,781 lbs
Atrazine	55,756 lbs
1,3-Dichloropropene	35,746 lbs
Benzene, pentachloronitro	32,264 lbs

Source: Groundwater Citizen Advisory Committee Assessment Subcommittee. 2013

Please see Appendix C for the complete reference to Pesticides used in Portage County

Pharmaceuticals and Personal Care Products

Pharmaceuticals and personal care products is an emerging area of concern in groundwater quality. The list of pharmaceuticals that may be found in groundwater is long and can include antibiotics, pain killers, tranquilizers, birth control, hormone replacement, lipid regulators, beta blockers, anti-inflammatories, chemotherapy, antidiabetics, veterinary drugs, and many more. There is also a related category called "personal care products" that refer to sunscreen, cosmetics, perfumes, soaps, insect repellants, and others. It is estimated that the amount of pharmaceuticals and personal care products entering the environment each year is comparable to the amount of pesticides used.

These substances can potentially reach groundwater through discharges of treated wastewater through land (soil) treatment systems (either POWTS or where municipal treated wastewater is used to recharge groundwater), biosolids landspreading, and infiltration of polluted surface water.

There is little research or testing on either pharmaceuticals or personal care products in groundwater in Portage County. The UWSP Center for Watershed Science and Education recently completed a study examing the sources of nitrate contamination in the Town of Hull. In that study, they were able to identify several wells impacted by personal care products including caffeine, artificial sweetners, and the antibiotic sulfamethoxazole (SMX). SMX is a strictly human antibiotic. The caffeine and sweetners are also thought to be from human sources.[21] In 2003 a WIDNR and DATCP funded study[22] examined a variety of antibiotics in wastewater effluent. Two antibiotics, tetracycline and sulfamethoxazole were found in all of the treated

[21] McGinley, P.M, DeVita, W.M, Nitka, A.L. 2016. Evaluating chemical Tracers in Suburban Groundwater as Indicators of Nitrate-Nitrogen Sources. A Final Report Prepared for the Wisconsin department of Natural Resources

[22] Kathikeyan, K.G., Bleam, W.F. 2003. Occurrence of Antibiotics in Wastewater Effluents and Their Mobility in Soils. A case study for Wisconsin, Final report to DNR and DATCP

wastewater effluents tested. In 2005 a University of Wisconsin funded study[23] found that under certain conditions, some antibiotics, such as the sulfonamide antibiotics, have the potential to be mobile underground. Other studies have examined the factors that affect antibiotic mobility in the subsurface.

Currently the WIDNR is examining the results of these research studies and many others to determine whether current state groundwater protection regulations are adequate to address the potential adverse impacts of these substances. These studies are also helping to evaluate the effectiveness of wastewater treatment processes for removing these substances, develop monitoring strategies, and assure that the tools and techniques that are in place are adequate for assessing the occurrence of these substances.

Manure Storage Structures

There are currently 76 permitted manure storage structures in Portage County (Figure 20). The animal manure, often including the barnyard runoff and milkhouse wastewater is stored (ideally for six months or longer) until soil and crop conditions allow proper application to maximize nutrient availability and prevent runoff to surface waters. These structures are very well constructed, watertight concrete, steel tanks, or clay lined manure pits. The threat to groundwater is minimal provided these structures are properly maintained and managed, and the manure applied correctly. Other storage structures were built prior to current ordinance and standards, and groundwater protection is not as certain. The Land Conservation Division (located in the Portage County Planning and Zoning Department) encourages farmers with older storage structures to upgrade (or abandon) them, sometimes offering cost sharing to accomplish the goal. While the map shows all of the manures storage structures in the County, not all of them are currently being used.

Biosolids Landspreading

Biosolids, formerly referred to as sludge, are byproducts of manufacturing (food, paper) and sewage treatment processes. Also included is the septage pumped from septic and holding tanks. These materials have variable concentrations of useful soil amendments, which when properly applied and incorporated into the soil, can be utilized by agricultural crops. These materials also contain varying levels of potential groundwater contaminants. Potentially hazardous components of biosolids include heavy metals such as cadmium, chromium, lead, and mercury, pathogenic bacteria and viruses, nutrients such as nitrogen and phosphorus, and high salt content. These materials may contaminate groundwater, if applied in excess of the land's ability to seasonally or cumulatively assimilate the materials, or if site conditions exist that encourage leaching of the materials out of the active soil zone, such as in sandy soils under irrigation.

A significant acreage, widely distributed throughout the County, has been approved by the WIDNR for land application of over a dozen different types of biosolids. Because the sites are reviewed by WIDNR staff, based on the information submitted by each individual biosolids applicator, several sites in Portage County have been approved for application of biosolids by several haulers for the spreading of several different materials on the same site. This situation could result in over application and discharge of contaminants to groundwater. None of the approved sites are presently required to have monitoring wells, although some private wells in the vicinity of municipal biosolids spreading sites are tested. WIDNR does

[23] Pederson, J.A., Karthikeya, K.G. 2005. Fate of Representative Fluoroquinolone, Macrolide, Sulfonamide, and Tetracycline Antibiotics in Subsurface Environments. Final Report to UWS.

have the authority to require whatever groundwater monitoring and plant tissue analysis that is deemed necessary.

Municipal sewage treatment plant biosolids, while highly pretreated for removal of pathogens and nutrients, is closely regulated by WIDNR staff, and tested prior to land application by the licensed sewage treatment plant operator employed by the city or village. Septic and holding tank waste, by contrast, is not tested prior to application even though it may be treated with lime to kill pathogens prior to land application. Biosolids from food processing (Whey, vegetable byproducts) and paper production have individualized nutrient and contaminant makeup, and are generally regulated based on the most limiting groundwater contamination standard. Nutrient management plans are required to provide for plant uptake of the available nutrients. Typically biosolids loading rates are calculated based on specific biosolid nitrogen content, crop nitrogen needs, and site specifics. Biosolids can be applied at a maximum loading rate that will meet the total nitrogen requirement of the crop. However, at maximum loading rates, WIDNR requires farmers to track nitrogen loading to prevent leaching. Most biosolid loading rates are based on 30% of the total nitrogen need of the crop, because, at this level WIDNR does not require nitrogen tracking.

Spray Irrigation of Wastewater

Spray irrigation of wastewater from food processing operations is a common method of treatment and disposal utilizing vegetation, which is harvested to remove nutrients, and the active soil zone over a wide area. Food processing wastewater has significant levels of nutrients, such as forms of nitrogen, dissolved solids, and oxygen demanding materials. The wastewater may also contain any other materials associated with the agricultural product, though pesticide regulations prohibit applications of chemicals to crops too close to harvest.

There are three spray irrigation systems currently under permit by the WIDNR in Portage County: Foremost Farms, McCain Foods, and Del Monte. Mullins Cheese, which is permitted in Marathon County, also sprays on land in Portage County. Extensive groundwater quality monitoring is required as a provision of the WIDNR permits. Typical test parameters include groundwater elevation, organic nitrogen, ammonia nitrogen, nitrate-nitrite nitrogen, total dissolved solids, BOD5, COD, pH, conductivity, and chlorides. Sampling frequency ranges from biweekly to quarterly. Specific testing requirements vary with the WPDES permit.

Landfills

Landfills have been around as long as people have lived in Portage County. The locations of many of the smaller, private dumps are unknown. The amount of the materials deposited in these was small, and the toxicities of the materials were likely fairly low as compared to current solid waste. The locations of several dozen landfills, including the former Portage County Landfill and municipal landfills are known (Figure 25) All landfills in the County have been closed. Sampling from private wells near these old landfills has not shown widespread deterioration of groundwater, but no systematic sampling has been conducted to date. To view this landuse as well as others you can visit the Portage County online mapping service at https://gissrv2.uwsp.edu/cnr/gwc/pw_web/.

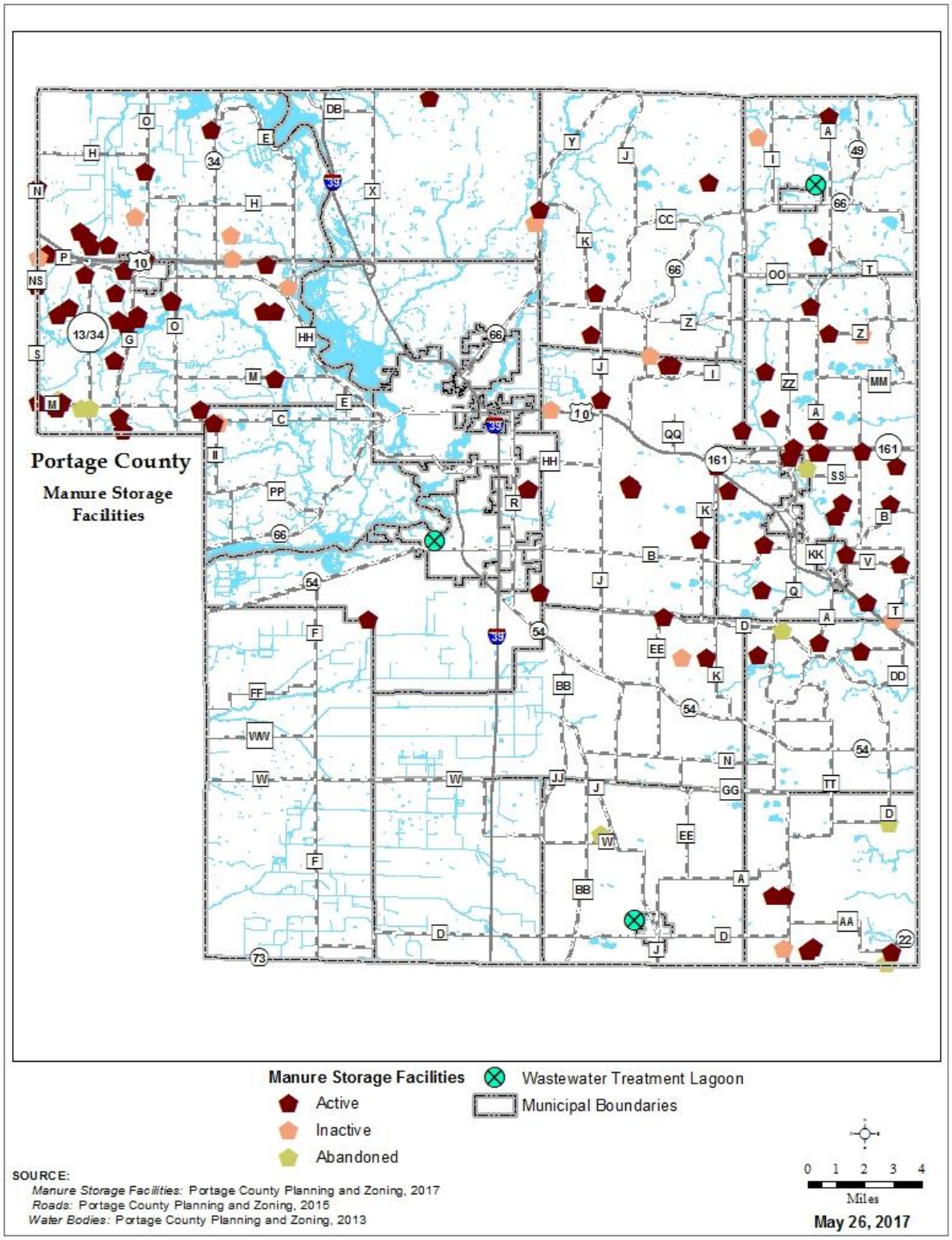

Figure 23. Manure storage facilities and wastewater lagoons located in Portage County, WI.

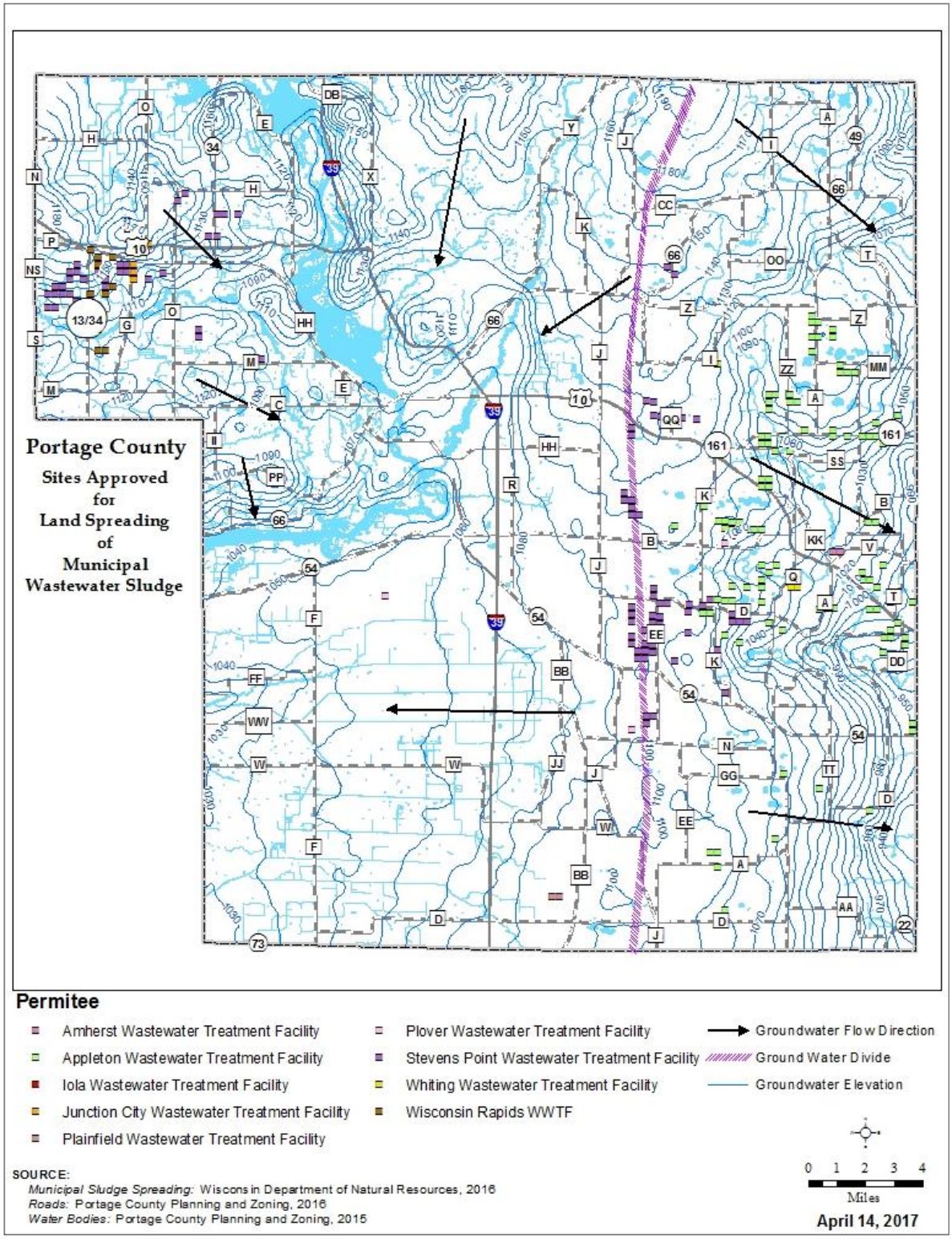

Figure 24. WIDNR approved sites for landspreading of municipal wastewater biosolids in Portage County, WI

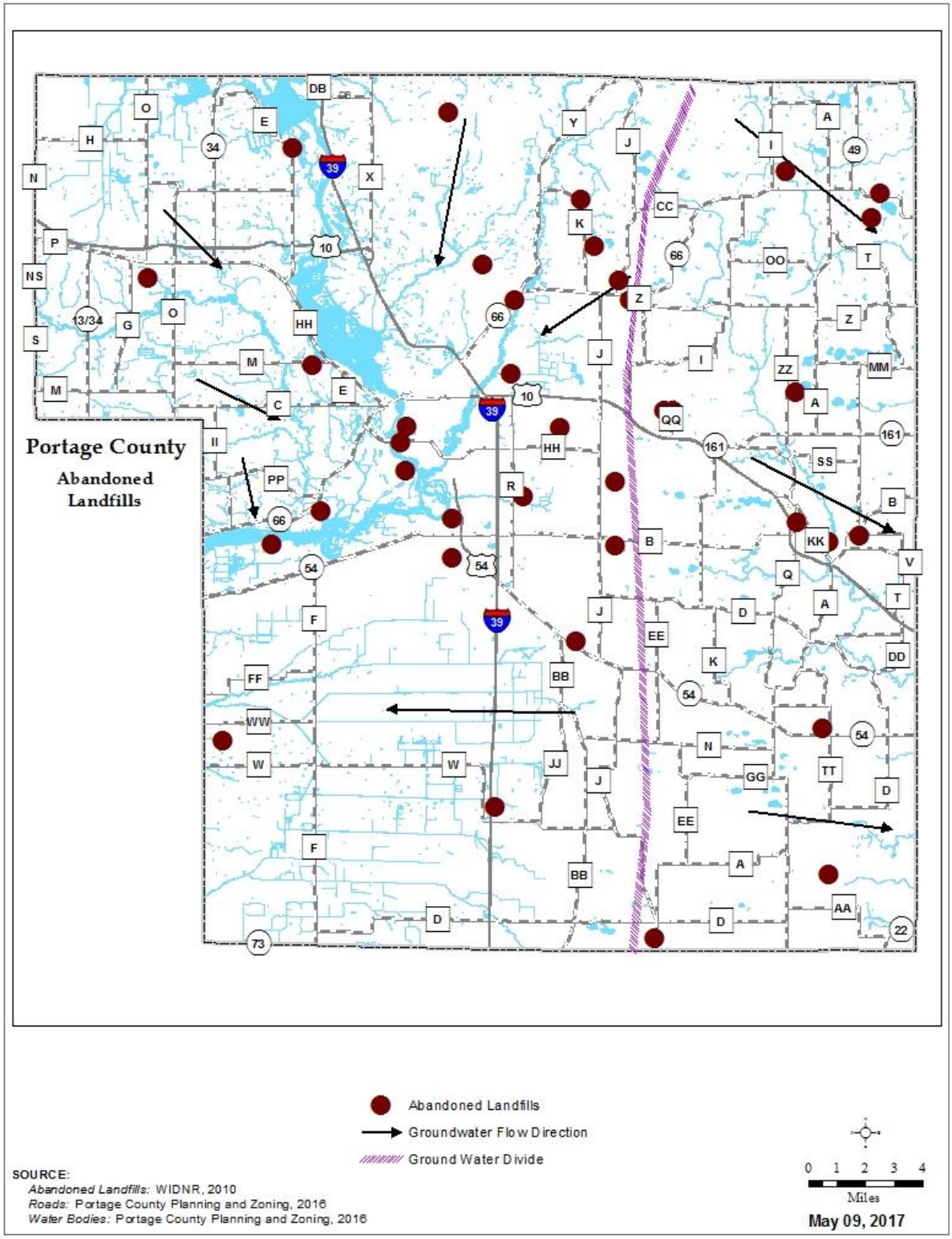

Figure 25. Abandoned Landfills in Portage County, WI

F. CLIMATE AND PRECIPITATION

Climate is the long term average of weather conditions for a specific location, in this case Portage County. A location's climate is determined through statistical analyses of weather data collected over a long period of time. Analyses of long term temperature and precipitation data between 1950 and 2006 have shown that the climate and precipitation patterns in Wisconsin and Portage County are changing towards warmer and wetter conditions[14]. These changes could have impacts on our groundwater in a variety of ways.

Studies assessing long term temperature trends in Wisconsin show that annual average temperatures in Portage County have increased 0.5 to 1.5^{O} F from 1950-2006[14]. The greatest warming is occurring in the winter and spring seasons, with nighttime temperatures increasing more than daytime. Portage County has seen average winter temperatures increase from 2-4° F and average spring temperatures increase 1 to 2.5^{O} F. Due to the temperature changes, across the state there have been milder winters (fewer subzero nights and fewer extended subzero stretches) and an earlier onset of "spring"[14] (the date at which temperatures have reached 50° for 10 consecutive days).

Studies have shown that the time between the last spring freeze and the first autumn freeze has increased between 16 and 24 days in Portage County[14].

Using a climate model, state climatologists estimate that the warming trend will not only continue but could increase considerably by the middle of this century. It is estimated that Portage County will see a 6.5^{O} F increase in annual average temperature between 1988 and 2055[14].

As temperature has increased, so too has precipitation. Across Wisconsin as a whole, precipitation has increased 10% (3.1 inches) from 1950-2006[24]. These increases have occurred primarily in southern and western WI, while northern WI has seen decreased precipitation. In Portage County the change in precipitation from 1950-2006 has been 0-0.5 inches in winter and spring, 1-2.5 inches in the summer and 0.5-1.5 inches in the fall[14].

Future amounts and when precipitation falls throughout the year are more difficult to predict than temperatures. However, there is consensus amongst climate models that the intensity and magnitude of precipitation events will likely increase. By the mid-21st Century it is estimated that Wisconsin will likely experience 2-3 more intense rainfalls per year and that the magnitude of these events may increase by 10%[14].

Changes in total annual precipitation, changes in seasonal distribution of precipitation, increased frequency of intense rainfall events and increased average temperatures could all affect groundwater resources in Portage County.

Changes to groundwater recharge rates would be one of the likely impacts of a changing climate and precipitation in the County. An increase in precipitation (as predicted by climate models) would normally indicate an increase in groundwater recharge and a rise in groundwater levels. However, changes in temperature and changes to land and water use may offset any increase to recharge rates. A decrease in precipitation could lead to decreasing groundwater levels.

How precipitation infiltrates the ground can depend on factors such as soil moisture, soil type, vegetation, and frost, all of which could be affected by changes in temperature and changes in the seasonal distribution of precipitation. The predicted more frequent large-precipitation events would also affect recharge. These

[24] Wisconsin's Changing Climate: Impacts and Adaptation. 2011. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

types of events can lead to increased runoff and even groundwater flooding in areas where recharge occurs quickly, depth to groundwater is shallow and there is little topographic relief.

Changes in climate and precipitation could also influence how groundwater is used in Portage County. Increased temperatures during the growing season could lead to increased evapotranspiration by plants and crops. This coupled with potentially no significant increase in precipitation amounts during the summer could lead to an increased number of dry days and/or dry soil conditions and potentially increased reliance on irrigation systems to support agriculture. Demands on municipal water systems would also be expected to increase with higher temperatures.

G. PUBLIC PERCEPTION OF GROUNDWATER CONCERNS IN PORTAGE COUNTY

In order to develop an effective and equitable management plan it is important to understand the needs, wants, and concerns of the stakeholders that the plan will affect. From September 2014 to January 2015 Portage County Executive Patty Dreier held nine Groundwater Listening Sessions throughout Portage County. Over 150 individuals attended these sessions and contributed their thoughts on groundwater quality and quantity in Portage County. Participants were asked to answer three strategic questions regarding groundwater:

- What's going well with water?
- What's not going well with water?
- What ideas do you have to guide the future of water resources in Portage County?

The individual responses to each question (some 475, total) were grouped into common themes by the County Executive to be reflective of the dialogue heard/gathered from all nine listening sessions.

To view all of the individual responses please visit:
http://www.co.portage.wi.us/News/Full%20Color%20Groundwater%20Summary%20Document%20Feb%202015.pdf

What's going well with water?

- Food production (feeding people)
- Improvement
- Cycles
- Agriculture and economy (Value)
- Conservation and technology and best management practices
- Resources to learn and help
- Abundance
- Recreation and beauty
- Testing
- Good quality and resources
- Coming together to discuss and address

What's not going well with water?

- Differing values
- Residents private wells and property values negatively affected
- Overuse/use by agriculture
- Overuse/use by others (non-agriculture)
- Land/water use practices
- Climate effects and other trends
- Lack of monitoring
- Lack of regulatory oversight or a plan
- Lack of understanding
- Politics
- Lack of education/awareness/involvement
- Lakes and streams negatively affected
- Contamination or quality

What ideas do you have to guide the future of water resource in Portage County?

- How to approach
- Education (Research/Science)
- Innovation
- Monitoring/Assessment
- Balance
- Regulation
- Plans and Management

In April 2015 the Portage County Executive hosted a Groundwater Summit in which invited participants and members of the community took all of the feedback to the three questions asked during the listening sessions and condensed them into four action strategies that are meant to help guide groundwater management in Portage County. A list of all participants in the Groundwater Summit can be found in Appendix D.

The four strategies identified include:

1.) Set goals

2.) Educate/market/conduct communication campaign

3.) Build trust in the baseline of knowledge

4.) Establish incentives for sustainable use

These four action strategies have been further distributed to individuals, professionals, and organizations to provide additional feedback.

H. Concerns

Based on the information, discovery, and discussion in sections A through G above, GCAC identified three areas of concern where groundwater management efforts should be focused; groundwater quantity, groundwater quality, and coordinated groundwater management efforts across political boundaries. These concerns and their general objectives are summarized in the following paragraphs. These concerns are not prioritized, as they are all important. To see the specific goals, objectives and actions associated with each concern please see Appendix A

Concern 1: Groundwater Quantity

Maintaining sufficient and sustainable groundwater quantities in Portage County is essential to support the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism, the health of groundwater dependent surface water and their ecosystems, and the monetary value of property taxes generated by waterfront property owners.

Most areas of the County have thick unconsolidated deposits that serve as a very effective aquifer and allow for efficient groundwater recharge and use. This easily accessible groundwater resource supports 100% of domestic water use, 87% of irrigation water, and 68% of industrial water use in Portage County. The northwest portion of the County has crystalline bedrock near the surface that naturally limits the amount of groundwater that municipalities, industries, agriculture and private wells are able to pump.

Since groundwater is relatively easy to access and pump, Portage County pumps more groundwater than any other County in Wisconsin and has one of the highest densities of high capacity wells in the state. The economic drivers in the County are dependent on available groundwater. It is expected that groundwater uses and needs across all sectors will stay the same or continue to grow into the future, placing additional burdens on the groundwater resources.

Additionally because of the hydrology of Portage County, surface waters found throughout the County depend on groundwater to support lake levels and healthy stream and river flows. There are diverse and dynamic ecosystems that rely on adequate water levels in surface waters for their survival. The surface waters of Portage County provide important habitat, as well as recreational opportunities and aesthetic beauty for County residents and guests.

It is crucial for management efforts to include the long term monitoring of groundwater levels throughout Portage County in order to have a better understanding of our groundwater resources and to make informed management decisions. Currently Portage County monitors four USGS long-term hydrograph wells on a monthly basis and has a citizen monitoring program for lake levels on nine local lakes and a stream baseflow monitoring program at eight stream locations (see page 16).

Groundwater conservation measures are of the utmost importance in order to maintain adequate groundwater quantity for current and future water needs.

Goal

Maintain sufficient and sustainable groundwater quantities in Portage County to support the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism, the health of groundwater dependent surface water and their ecosystems, and the monetary value of property taxes generated by waterfront property owners.

Objectives

- Continue and expand current groundwater level monitoring strategies to establish a consistent baseline of groundwater level information throughout Portage County that can be used for future management decisions;
- Promote groundwater recharge that is consistent with sound water quantity management wherever possible in Portage County;
- Establish and maintain working partnerships and collaborations wherever possible in order to achieve groundwater quantity goals;
- Improve communication and information about groundwater quantities in Portage County;
- Implement groundwater conservation strategies to reduce water usage in Portage County.

Concern 2: Groundwater Quality

It is important that we strive to maintain and improve groundwater quality in Portage County to support the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism and the health of groundwater dependent surface water and their ecosystems.

For the same reasons that groundwater quantity is important, groundwater quality is important, especially for human hygiene and consumption. The human and natural communities rely on clean groundwater.

The same geology that allows for the ease of groundwater pumping in the County also allows for the relative ease of groundwater contamination. The sandy soils found in most of the County allow water and contaminants to infiltrate from the surface to the groundwater relatively quickly. Once contaminants become part of the groundwater, they are able to travel with groundwater into surface waters.

The natural groundwater quality in most areas of Portage County is generally good. Iron and manganese are two common naturally occurring metals, that become a nuisance when present at too high of a concentration. Other naturally occurring concerns include radon, corrosive water, and microorganisms (bacteria, viruses, etc.). These naturally occurring concerns are things that Portage County should continue monitor and be aware of.

Nitrates and pesticides are two of the most common human influenced groundwater quality issues. Over the last 25 years, on average 19% of voluntarily tested wells in Portage County exceed the state and federal drinking water standard of 10 parts per million (ppm) nitrates. This is more than twice the state average of

9% exceedance in tested wells[25]. Common sources of nitrate include agricultural sources, septic systems, and lawns. Currently four municipalities in Portage County are treating water or have had to replace a well, due to excessive nitrate levels.

Pesticides include herbicides, insecticides, nematocides, fungicides, and other compounds used to control organisms such as insects, weeds, and fungi. Most of the County's agricultural lands, which account for more than half of the land area, receive some type of pesticides. Pesticides are also used on business and residential lawns. Over the last 25 years atrazine, historically one of the most commonly used pesticides, has been detected in over 40% of tested wells in Portage County. Alachlor and metalachlor, and breakdown products of atrazine, have all been detected in Stevens Point and Whiting municipal wells.

Other human influenced groundwater pollutants that are of concern to Portage County groundwater include volatile organic compounds, chloride, and pharmaceuticals and personal care products.

It is the desire of Portage County Board of Supervisors to further examine available water quality data to establish trends in nitrates, and other water quality parameters. Establishing trends spatially and over time will allow Portage County to better understand the current status of water quality in the County and what measures might be taken to improve it.

Old wells that are not properly abandoned can provide a direct conduit from the land's surface to groundwater, making it susceptible to contamination. The County should continue to assist with the proper abandonment of wells, as well as provide information about the importance of this practice.

Long term monitoring of groundwater quality is essential to understand the current status of groundwater quality and serve as a basis to make informed management decisions. It is also important that homeowners not on municipal water understand the importance of testing their well water in order to be aware of any changes in water quality seasonally and over time.

In order to help protect municipal water sources wellhead protection areas have been established. These protection areas list land uses compatible with groundwater protection in the five and ten year recharge areas. We should strive to extend this wellhead protection to all municipal wells

Goal

Maintain and improve groundwater quality in Portage County to support the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism, and the health of groundwater dependent surface water and their ecosystems.

Objectives

- Develop a monitoring strategy for drinking water quality in Portage County to establish a consistent baseline of information that can be used for future management decisions;

[25] Wisconsin Well Water Quality Viewer, 2015 http://gissrv2.uwsp.edu/cnr/gwc/pw_web/

- Establish a baseline of what pesticides are being used in Portage county and how prevalent they are in local drinking water;
- Evaluate the presence and importance of other contaminants in groundwater in Portage County;
- Improve communication and information about groundwater quality in Portage County;
- Continue to administer and as needed revise County ordinances that protect groundwater quality in Portage County;
- Establish and maintain working partnerships and collaborations wherever possible in order to achieve groundwater quality goals.

Concern 3: Coordinated efforts for groundwater management across political boundaries

Groundwater resources in Portage County are not confined within the political boundaries of the County. In order to manage groundwater resources, efforts must be made to work cooperatively with surrounding Counties, municipalities, and other agencies in order maintain adequate groundwater quantity and quality for everyone who relies on it.

Goal

Create an environment that allows for continuous communication and facilitates the accomplishment of the water quality and quantity goals.

Objectives

- Support efforts outside of Portage County that promote comprehensive groundwater management;
- Create and maintain collaborations and partnerships that facilitate communication and groundwater management;
- Develop and distribute comprehensive groundwater information and educational materials.

Appendix A

Goals, Objectives, and Actions of the Groundwater Management Plan

Appendix A

Goal 1: Maintain sufficient and sustainable groundwater quantities in Portage County to support the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism, the health of groundwater dependent surface water and their ecosystems, and the monetary value of property taxes generated by waterfront property owners

Objective 1.1: Continue and expand current groundwater level monitoring strategies to establish a consistent baseline of groundwater level information throughout Portage County that can be used for future management decisions				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Maintain current lake level and stream baseflow monitoring sites in Portage County	Po Co Water Resource Specialist, Volunteers, WIDNR, UWSP, GCAC	Ongoing	2015/2016 monitoring sites maintained	WIDNR, UWSP,
Establish a long-term groundwater quantity monitoring strategy that includes where monitoring will take place, how monitoring will occur, what is monitored etc.	Po Co Planning and Zoning Dept, Po Co County Board, GCAC	Ongoing	An established monitoring plan	N/A
Maintain support for monitoring efforts from Portage County and staff	Po Co Planning and Zoning Dept, Po Co County Board, GCAC	Ongoing	Monitoring program continues	N/A
Add new stream baseflow and lake level monitoring sites	Po Co Water Resource Specialist, Volunteers, WIDNR, UWSP, GCAC	Annually	New sites added as needed	WIDNR, UWSP
Establish precipitation monitoring sites throughout Portage County	Po Co Water Resource Specialist, WIDNR, UWSP, GCAC	2017/2018	Network of precipitation monitoring protocols established	WIDNR, Community Foundation Grants, USGS, UWSP
Continue to monitor USGS hydrograph wells in cooperation with USGS and UWSP	Po Co Water Resource Specialist, USGS, UWSP	Ongoing	Continue monitoring three hydrograph wells	USGS
Establish a plan for data management	Po Co Water Resource Specialist, USGS, UWSP data analytics major and UWSP GIS Dept.	Ongoing	A data management plan	N/A

Objective 1.1 cont.: Continue and expand current groundwater level monitoring strategies to establish a consistent baseline of groundwater level information throughout Portage County that can be used for future management decisions				
Data will be maintained in a database stored on the County Servers. Lake level and streamflow data will also be submitted to the WIDNR SWIMS database. Data will be shared with the public via the Portage County website, Regular reports will be given to GCAC, Planning & Zoning Committee, Land & Water Conservation Committee, and annual report to all Towns, Villages, and Cities in the County	Po Co Water Resource Specialist, GCAC	Ongoing	Regular reports and maintained databases	N/A
Develop a specific and measurable groundwater quantity goal and actions to achieve it using the results of the established groundwater quality monitoring program	Po Co Water Resource Specialist, GCAC	2018	A specific and measureable goal with actions	N/A

Objective 1.2: Promote groundwater recharge that is consistent with sound water quantity management wherever possible in Portage County				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Explore options for returning wastewater discharge to the basin	Po Co Planning and Zoning, Municipalities, WIDNR, GCAC	Ongoing	Viability and options for returning wastewater to the basin will be shared with GCAC and Portage County Government	N/A
Encourage practices that promote groundwater recharge	Po Co Water Resource Specialist GCAC, WIDNR, EPA, Po Co Land & Water Conservation, Grower Associations	Annually	Provide information, resources, and assistance on practices that increase recharge	N/A
Explore remediation options for identified groundwater losses within the County	Po Co Water Resource Specialist, GCAC, WIDNR, Po Co Land & Water Conservation	Ongoing	Identify sources of water loss in the County and options for remediation. Share information with GCAC and Portage County Government	N/A

Objective 1.2 cont.: Promote groundwater recharge that is consistent with sound water quantity management wherever possible in Portage County				
Meet with the municipalities to discuss impervious surfaces and stormwater management.	Portage County municipalities, Po Co Land & Water Conservation	Annually	Report identifying stormwater management practices utilized in Portage County	N/A
Recommend the use of buffer zones around surface water	Po Co Water Resource Specialist, GCAC, WIDNR, Po Co Land & Water Conservation	Ongoing	Provide information and resources on shoreland buffers	N/A

Objective 1.3: Establish and maintain working partnerships and collaborations wherever possible in order to achieve groundwater quantity goals				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Encourage GCAC to participate in the groundwater quantity objectives and actions in the Portage County Land and Water Resource Management Plan	Po Co Water Resource Specialist, Po Co Land and Water Conservation, GCAC	Ongoing	Work cooperatively to achieve groundwater quantity goals in Land and Water Resource Management Plan	N/A
Provide support and assistance with groundwater quantity objectives and actions in Town, Village, City, and the Portage County Comprehensive Plans	Po Co Water Resource Specialist, Po Co Planning & Zoning, GCAC, Towns, Villages, and Cities	Ongoing	Work cooperatively to achieve groundwater quantity goals in Comprehensive Plans	N/A
Provide support and assistance with groundwater quantity objectives and actions in the Portage County Farmland Preservation Plan	Po Co Water Resource Specialist, Po Co Planning & Zoning, Po Co Land & Water Conservation, GCAC,	Ongoing	Work cooperatively to achieve groundwater quantity goals in the Farmland Preservation Plan	N/A
Coordinate a meeting with the Little Plover River Study partners to follow up on study recommendations and incorporate appropriate recommendations from the study into the Groundwater Management Plan	Po Co Water Resource Specialist, Po Co Land & Water Conservation Dept, GCAC, Little Plover Workgroup, WIDNR, USGS, Grower Associations	2018	Meeting	N/A
Partner with other agencies and organizations inside and outside of Portage County in order to achieve water quantity goals	Po Co Water Resource Specialist, GCAC, Po Co Land & Water Conservation, Grower Associations	Ongoing	Maintain or increase number of projects and partnerships that Portage County is currently working on	N/A
Work with local municipalities to ensure adequate water supplies for their needs	Po Co Water Resource Specialist, GCAC, Villages and Cities	Ongoing	All municipalities have adequate water supplies	USDA Rural Development, Community Block Grant and WIDNR Drinking Water Grant
Continue to work with citizen Science/Volunteers	Po Co Water Resource Specialist, GCAC, Volunteers	Ongoing	Ongoing volunteer partnerships	

Objective 1.4: Improve communication and information about groundwater quantities in Portage County				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Utilize the Portage County website to convey pertinent water quantity information including information sources, updates on legislation, water use information, water level information and more	Po Co Water Resource Specialist, GCAC, Po Co Planning and Zoning	Ongoing	New updated groundwater resources webpage with regularly updated information	N/A
Provide informational/educational programming and materials on water quantity issues in a variety of methods	Po Co Water Resource Specialist, GCAC	Ongoing	Host at least 3 informational/educational programs to a variety of audiences	WAEE Grants, Natural Resources Foundation
Share information on the Little Plover River Study and Model	Po Co Water Resource Specialist, GCAC, WIDNR, USGS, WGNHS, Grower Associations	Ongoing	Information and updates on LPR Study shared via website, printed materials and presentations	N/A
Work with the WIDNR on how we can make high capacity well data and WIDNR water use data more available to the public and easily understandable	Po Co Water Resource Specialist, GCAC, WIDNR	Ongoing	Attend WIDNR water data use symposium and identify new ways to share information	N/A
Have GCAC meet with the Agriculture and Extension Education Committee annually to discuss new agricultural improvements	Po Co Water Resource Specialist, GCAC, UW Extension	Ongoing	Annual meeting with Agricultural and Extension Education Committee	N/A

Objective 1.5: Implement groundwater conservation strategies to reduce water usage in Portage County				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Portage County joins EPA Water Sense Program	Po Co, Po Co Water Resource Specialist, GCAC, EPA	2016	GCAC provides recommendation on joining program to Portage County Government	N/A
Explore Portage County becoming part of Net Blue, a water neutral community growth program	Po Co, Po Co Water Resource Specialist, GCAC	2016/2017	GCAC provides recommendation on joining program to Portage County Government	N/A
Design and implement a program of auditing water use in all Portage County facilities.	Po Co Space and Properties, Po Co Water Resource Specialist GCAC, WIDNR	2018	Establish procedure for auditing all Portage County Facilities	
Use the results of the water audit to identify areas for improvement and specific actions that can be taken	Po Co Space and Properties, Po Co Water Resource Specialist, GCAC	2019	Results from the water use audit and list of recommendations	
Establish a demo site that displays best practices that homeowners can implement and measures the water savings	Po Co Space and Properties, Po Co Water Resource Specialist, GCAC	2017/2018	Establish demo site	
Explore and promote conservation initiatives for homeowners with private wells	Po Co Water Resource Specialist GCAC, Homeowners, WIDNR	Ongoing	List of conservation initiatives available to homeowners and identify which may be used in Portage County	N/A
Create a homeowners guide to groundwater conservation	Po Co Water Resource Specialist GCAC, Homeowners, WIDNR	2019	A homeowners guide	N/A
Host water audits for businesses in Portage County to identify areas of improvement	Po Co Water Resource Specialist GCAC, Stevens Point area businesses, WIDNR	2018	Establish process for auditing businesses	
Promote financial incentives from NRCS for growers to improve irrigation efficiencies (AMA, CSP, EQIP)	Po Co Land and Water Conservation, NRCS, Po Co Water Resource Specialist, GCAC, Grower Assc.	Ongoing	Information available on the website and through printed materials	N/A
Provide information on water conservation practices in agriculture	Po Co Land and Water Conservation, NRCS, Po Co Water Resource Specialist, GCAC, Grower Assc	Ongoing	Information available through the website and printed materials	N/A
Encourage farmer participation in in the WIDNR Agricultural Water Stewards Program	Po Co Land and Water Conservation, WIDNR, Po Co Water Resource Specialist, GCAC, Grower Assc	2016/2017	Information available through the website, printed materials, and individuals being actively recruited	N/A

Objective 1.5 cont.: Implement groundwater conservation strategies to reduce water usage in Portage County				
Research potential sources of incentives for improving industrial efficiencies regarding water use	Po Co Water Resource Specialist, GCAC, WIDNR	Ongoing	List of resources available to businesses to increase industrial water use efficiencies	N/A
Recognize water stewardship and water conservation practices by Portage County businesses, industries, agricultural producers, etc through awards/incentives/public recognition	Po Co Land and Water Conservation, Po Co Water Resource Specialist, Portage County Business Council , Grower Assc	2019/2020	Recognition program	?
Work with UW-Extension Agricultural agents to promote the use of irrigation management plans and programs	Po Co Agricultural Extension Agent, Po Co Water Resource Specialist, GCAC, Grower Assc	Ongoing	Information available through the website and printed materials	N/A

Goal 2: Maintain and improve groundwater quality in Portage County to support the daily living needs of all Portage County residents, a thriving commercial, agricultural, and industrial economy, the quality of life in rural communities, recreational opportunities, tourism, and the health of groundwater dependent surface water and their ecosystems.

Objective 2.1: Develop a monitoring strategy for drinking water quality in Portage County to establish a consistent baseline of information that can be used for future management decisions.				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Establish a long-term groundwater quality monitoring strategy that includes where monitoring will take place, how monitoring will occur, what is monitored etc.	Po Co Planning and Zoning Dept, Po Co County Board, GCAC	Ongoing	An established monitoring plan	N/A
Establish a network of water quality sampling wells	Po Co Water Resources Specialist, GCAC,	2018	Establish a network and protocol for water quality sampling	WIDNR
Establish a private residence water quality sampling program throughout different parts of the County	Po Co Water Resources Specialist, GCAC,	2017	Establish a program for sampling private residences throughout Portage County	Health Dept.
Include the results of water quality sampling program as an addendum to the groundwater management plan.	Po Co Water Resources Specialist, GCAC,	2017	An addendum with sampling program results is added to the management plan	N/A
Follow up testing of private wells within the atrazine prohibition areas	Po Co Water Resources Specialist, GCAC, DATCP, UWSP	2018	Establish program of follow up sampling in Atrazine prohibition area	DATCP
Encourage owners to have comprehensive water testing done	Po Co Water Resources Specialist, GCAC, UW-Extension	Ongoing	Promotional materials developed and shared	Health and Human Services
Examine water quality data in detail to establish trends spatially and over time for water quality parameters	Po Co Water Resources Specialist, GCAC, WIDNR, UW-Extension,	2016	Identified trends in Groundwater quality parameters	N/A
Establish a plan for data management	Po Co Water Resource Specialist, USGS, UWSP data analytics major and UWSP GIS Dept.	Ongoing	A data management plan	N/A

Objective 2.1 cont.: Develop a monitoring strategy for drinking water quality in Portage County to establish a consistent baseline of information that can be used for future management decisions.				
Data will be maintained in a database stored on the County Servers. Appropriate data will be shared with the public via the Portage County website, Regular reports will be given to GCAC, Planning & Zoning Committee, Land & Water Conservation Committee, and annual report to all Towns, Villages, and Cities in the County	Po Co Water Resource Specialist, GCAC	Ongoing	Regular reports and maintained databases	N/A
Develop a specific and measurable groundwater quality goal and actions to achieve it using the results of the established groundwater quality monitoring program	Po Co Water Resource Specialist, GCAC	2018	An specific and measureable goal with actions	N/A

Objective 2.2: Establish a baseline of what pesticides are being used in Portage County and how prevalent they are in local drinking water				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Review pesticide use in Portage County to determine which commonly used pesticides in Portage County should be monitored	Po Co Water Resource Specialist, GCAC, Po Co Land & Water Conservation, FSA, NRCS, Grower Assc	2018/2019	List of pesticides commonly used/sold in Portage County	N/A
Identify pesticides that are not used as extensively throughout the County or used at lower rates but still pose a threat to Portage County's groundwater	Po Co Water Resource Specialist, GCAC, Po Co Land & Water Conservation, FSA, NRCS, Grower Assc	2018/2019	List of pesticides sold/used in Portage County at lower rates but still pose a threat to groundwater	N/A
Establish a systematic monitoring program for identified pesticides	Po Co Water Resource Specialist, GCAC, WIDNR, UWSP, Grower Assc	2018	Establish sites and protocol for monitoring	USDA, WIDNR, Community Foundation
Identify the distribution and concentration of different pesticides in groundwater throughout Portage County	Po Co Water Resource Specialist, GCAC, WIDNR, UWSP, Grower Assc	2018	Map distribution and concentrations of pesticides	N/A
Any chemical products that could contaminate groundwater need to be disclosed upon request	Po Co Water Resource Specialist, GCAC, Grower Assc	Ongoing	N/A	N/A
Data and information will be maintained in a database stored on the County Servers. Appropriate data will be shared with the public via the Portage County website. Regular reports will be given to GCAC, Planning & Zoning Committee, Land & Water Conservation Committee, and annual report to all Towns, Villages, and Cities in the County	Po Co Water Resource Specialist, GCAC	Ongoing	Regular reports and maintained databases	N/A

Objective 2.3: Evaluate the presence and importance of other contaminants in groundwater in Portage County				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Evaluate the presence of naturally occurring radioactivity in drinking water in Portage County	Po Co Water Resource Specialist, Po Co Health and Human Services, GCAC, UWSP	2017	Identify areas of elevated radioactivity	Health related grants
Evaluate the presence of pharmaceuticals and personal care products in groundwater in Portage County	Po Co Water Resource Specialist, Po Co Health and Human Services, GCAC, UWSP	2019	Identify pharmaceuticals and personal care products present in Portage County drinking water	Health related grants
Continue to monitor nitrate concentrations in groundwater throughout Portage County	Po Co Water Resource Specialist, Po Co Health and Human Services, GCAC, UWSP	Ongoing	Identify areas of concern for nitrates and trends in concentrations	Health related grants, WIDNR
Evaluate the presence of arsenic in drinking water in Portage County	Po Co Water Resource Specialist, Po Co Health and Human Services, GCAC, UWSP	2018	Identify areas of elevated arsenic	Health related grants

Objective 2.4: Improve communication and information about groundwater quality in Portage County				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Utilize the Portage County website to convey pertinent water quality information, water testing information, and more	Po Co Water Resource Specialist, GCAC, Po Co Planning and Zoning	2016	New updated groundwater resources webpage with regularly updated information	N/A
Provide informational educational programming on water quality issues	Po Co Water Resource Specialist, GCAC	Ongoing	Host at least 3 informational/educational programs to a variety of audiences	N/A
Work with towns to provide informational nitrate screenings	Po Co Water Resource Specialist, GCAC, Portage County Towns	Ongoing	Provide at least 3 nitrate screenings throughout the County	N/A
Continue to update and share the health effects information of groundwater contaminants; including, endocrine disruption by pesticides and their metabolites and the effects of mixtures	Po Co Water Resource Specialist, GCAC, Po Co Health and Human Services, UWSP, UW-Extension	Ongoing	Informational resources provided through a variety of means	N/A

Objective 2.4 cont.: Improve communication and information about groundwater quality in Portage County				
Provide reports of programming and information to GCAC, Planning & Zoning Committee, Land & Water Conservation Committee, and annual report to the County	Po Co Water Resource Specialist, GCAC	Ongoing	Regular reports provided to committees	N/A

Objective 2.5: Continue to administer and as needed revise County ordinances that protect groundwater quality in Portage County				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Continue to administer the wellhead protection ordinance in unincorporated areas of Portage County	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning, Portage County Municipalities	Ongoing	A continued wellhead protection ordinance that protects municipal drinking water supplies in unincorporated areas	N/A
Continue to administer the County subdivision ordinance with regard to the water testing requirement	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning	Ongoing	A subdivision ordinance that provides clear instructions on sampling requirements for lot subdivision	N/A
Support other County ordinances that protect water quality in Portage County	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning, Po Co Land and Water Conservation	Ongoing	Work cooperatively to support other County ordinances that affect groundwater	N/A
Explore drafting a public health and groundwater protection ordinance for Portage County				
Explore revising the Portage County manure management and storage ordinance				

Objective 2.6: Establish and maintain working partnerships and collaborations wherever possible in order to achieve groundwater quality goals				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Encourage GCAC to participate in the groundwater quality objectives and actions in the Portage County Land and Water Resource Management Plan	Po Co Water Resource Specialist, Po Co Land and Water Conservation, UW-Extension, GCAC	Ongoing	Work cooperatively to achieve groundwater quality goals in Land and Water Resource Management Plan	N/A
Provide support and assistance with groundwater quality objectives and actions in Town, Village, City, and the Portage County Comprehensive Plans	Po Co Water Resource Specialist, Po Co Planning & Zoning, GCAC, Towns, Villages, and Cities, Po Co Land and Water Conservation, UW-Extension	Ongoing	Work cooperatively to achieve groundwater quality goals in Comprehensive Plans	N/A
Partner with other agencies and organizations inside and outside of Portage County in order to achieve water quality goals	Po Co Water Resource Specialist, GCAC, Po Co Land and Water Conservation, UW-Extension	Ongoing	Maintain or increase number of projects and partnerships that Portage County is currently working on	N/A
Assist Land and Water Conservation Division by encouraging nutrient management planning and the use of best management practices	Po Co Water Resource Specialist, GCAC, Po Co Land and Water Conservation, UW-Extension	Ongoing		
Continue to work with citizen Science/Volunteers	Po Co Water Resource Specialist, GCAC, Volunteers	Ongoing	Ongoing volunteer partnerships	
Explore developing a plan that outlines how the County can provide assistance in resolving water quality issues in drinking water	Po Co Water Resource Specialist, GCAC, Po Co Land and Water Conservation, UW-Extension, Villages and Cities	Ongoing	Develop plans that address resolving specific water quality issues	N/A
Explore partnering with other organizations to purchase land/conservation easements around municipal wells to protect drinking water sources	Po Co Water Resource Specialist, GCAC, Po Co Land and Water Conservation, Villages and Cities	Ongoing	Explore possibilities for land/conservation easements around	
Support municipalities and their work to achieve desired water quality	Po Co Water Resource Specialist, GCAC, Po Co Land and Water Conservation, Villages and Cities	Ongoing	Provide support and resources to local municipalities	

Goal 3: Create an environment that allows for continuous communication and facilitates the accomplishment of the water quality and quantity goals.

Objective 3.1: Support efforts outside of Portage County that promote comprehensive groundwater management				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Support legislation that will help to achieve the groundwater quantity and quality goals, objectives, and actions outlined in the Portage County Groundwater Management Plan	Po Co Water Resource Specialist, GCAC, local legislators	Ongoing	Support legislation that will help achieve goals, objectives, and actions in the management plan through letters of support, testimony, and resolutions	N/A
Encourage permitting agencies to consider the cumulative effects of groundwater pumping when permitting high capacity wells	Po Co Water Resource Specialist, GCAC, WNDR	Ongoing		N/A
Explore forming a central sands groundwater compact/agreement to support groundwater management	Po Co Water Resource Specialist, GCAC, local government officials, surrounding Counties	2018	Document outlining how a potential compact/agreement would look and function	N/A

Objective 3.2: Create and maintain collaborations and partnerships that facilitate communication and groundwater management				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Coordinate with federal, state, and local agencies and surrounding Counties as necessary to achieve the goals, objectives, and actions in the groundwater management plan	Po Co Water Resource Specialist, GCAC, WIDNR, USDA, NRCS, UWSP, UW-Extension, surrounding Counties	Ongoing	Maintain and create new partnerships to facilitate work within the County	N/A
Work with partners to develop plans that address specific water related issues that develop within the County	Po Co Water Resource Specialist, GCAC, WIDNR, USDA, NRCS, UWSP, UW-Extension	Ongoing	Develop plans that address specific groundwater resource issues as they develop	N/A
Support groundwater actions in local management and comprehensive plans	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning Dept, Po Co Land and Water Conservation, Local Towns and Villages	Ongoing	Continue to support local management and comprehensive plans	N/A
Work with other departments to ensure that actions in the plan are being accomplished	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning Dept, Po Co Land and Water Conservation, Portage Co Health Dept	Ongoing	Maintain ongoing partnerships and projects, create new partnerships	N/A
Review Portage County ordinances to ensure that they are consistent with the Groundwater Management Plan.	Po Co Water Resource Specialist, GCAC	Ongoing	Provide recommendations to appropriate County Committee on any recommended changes to ordinances.	N/A
Review state statutes to see if they are being followed and enforced in Portage County	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning Dept, Po Co Land and Water Conservation, Local Towns and Villages	Ongoing	Review state statutes	N/A

Objective 3.3: Develop and distribute comprehensive groundwater information and educational materials				
Action	**Potential Partners**	**Timeline**	**Evaluation Tools**	**Potential Funding/Resources**
Provide information to the public on water related issues in a variety of methods	Po Co Water Resource Specialist, GCAC, Po Co Planning & Zoning	Ongoing	Information provided in a variety of methods	N/A
Encourage comprehensive groundwater education across the entire state	Po Co Water Resource Specialist, GCAC, WI Dept. of Education	Ongoing		N/A
Identify future potential groundwater scenarios and formulate potential responses to the scenarios	Po Co Water Resource Specialist, GCAC, UW-Extension, Po Co Emergency Management Services	2017	Participate in an exercise that identifies potential scenarios affecting groundwater in the County and how the County could respond.	N/A

Appendix B

Status of 1988 and 1994 Groundwater Plan Recommendations

Appendix B

Status of Groundwater Management Plan (1988) Recommendations

High Priority: Completed **(YEAR)** or Ongoing

- Designate Groundwater Coordinator **(1988)**
- Support/utilize GIS, maintain land use/water quality databases
- Coordinate intergovernmental discussion on annexation/sewering **(1992)**
- Adopt wellhead protection ordinances **(1993)**
- Encourage hydrogeologic studies of well field recharge areas
- Intensify Agricultural BMP outreach efforts **(1990)**
- Revise County Subdivision Ordinance **(1990)**
- Improve compliance with County Private Sewage System Ordinance
- Revise County Zoning Ordinance **(1993)**
- Adopt Site Plan Review Ordinance
- Expand educational programming in all program areas
- Provide well testing/interpretation, encourage testing
- Investigate Underground Tank Ordinance and update inventory **(1992)**
- Revise waste landspreading criteria
- Encourage State pesticide use reporting program
- Encourage municipal water systems
- Encourage municipal sewer systems
- Support activities of the Central Wisconsin Groundwater Center
- Develop homeowner information packet **(1995)**

Medium Priority: Completed or Ongoing

- Encourage groundwater monitoring in local/State permits
- Develop on-site sewage system inspection standards **(1991)**
- Expand landfill investigations and monitoring
- Support development of a hazardous waste hauler network
- Support “clean sweep” programs as needed
- Investigate possible Hazardous Materials Ordinance **(1998)**
- Support moratoriums for critical products
- Minimize road salt use
- Revise County Development Guide
- Review possible adoption of Private Water Supply Ordinance **(2002)**

Low Priority: Completed or Ongoing

- Encourage recycling
- Support changes in State on-site sewage system code
- Encourage State review of septic system additives
- Consolidate/monitor salt storage sites, review snow dump sites **(1989)**
- Review pipeline proposals for groundwater concerns
- Investigate Sanitary Ordinance for non-regulated wastewaters **(1994)**
- Incomplete:
- Revise County Private Sewage System Ordinance
- Adopt local Septage Ordinance

- Inventory on-site private sewage systems
- Address maintenance criteria for animal waste structures

Status of Groundwater Management Plan (2004) Recommendations Completed (YEAR) or Ongoing

- Private onsite wastewater treatment systems **(ongoing)**
- Drinking water quality for new residences **(ongoing)**
- Assist the public with water quality information **(ongoing)**
- Conduct drinking water education programs for communities **(ongoing)**
- Implement County Groundwater Management Plan recommendations **(ongoing)**
- Wellhead Protection Ordinance **(ongoing)**
- Advise citizens regarding water quality health concerns **(ongoing)**
- Private well inspections (unsafe samples) **(ongoing)**
- Transient Non-community Public Water Systems **(ongoing)**
- Healthy People Portage County – Environmental Health Implementation Team **(ongoing)**
- Maintain and improve County and State groundwater database **(ongoing)**
- Waterborne illness investigations **(ongoing)**
- Water quality partnership with Central Wisconsin Groundwater Center and Environmental Task Force Lab **(ongoing)**
- Determine area with high nitrate and pesticide levels
- Establish well abandonment program in Portage County **(1993)**
- Ongoing public education **(ongoing)**
- Develop a Portage County agricultural pesticide reporting database (A report on pesticides sold in Portage County was completed in **2013**)
- Determine recharge rates and water budgets for all of the County's aquifers
- Develop collaborative partnerships between Portage County agencies (**ongoing)**
- Negotiate with corporate food processors regarding pesticides and nutrients required for grower contracts
- Support statewide pesticide reporting database
- Encourage organic and sustainable agriculture
- Court businesses that can utilize groundwater friendly crops
- Negotiate conservation easements-buy land

Appendix C

Summary of Pesticides Sold in Portage County in 2009

Appendix C

Table 1. Summary of Pesticides Sold in Portage County in 2009 Based on Total (>3000 Pounds) or Previously Detected in Groundwater

Active Ingredient	2009 Dealer Pounds	Major Metabolites	EPA Code	K_{OW}	K_{oc} (ml/g)	Water Solubility mg/l	Soil DT 50	Water DT50	Movement Rating	Water Quality Standard (mg/l)	Water Quality Standard Source	EPA Carcinogen?	2007 WI DATCP GW Testing?		2008 UW Stevens Point Testing?		USGS Study	
													Samples Analyzed	Detections	Samples Analyzed	Detections	Samples Analyzed	Detections
Metam Sodium	2437001		39003		17.8	578,290	7	2.2	Moderate			B2, probable						
		methylisothiocyanate	68103			8940	2.94					B2, probable						
Chlorothalonil	174031		81901		850	0.81	22	Stable	Low	0.15	USEPA 1/10000 risk (EPA, 2009)	B2, probable						
		4-hydroxy-2,5,6-trichlorisophalonitrile (SDS 3701)			380		387											
		2-amido-3,5,6-trichlo-4-cyanobenzenesulphonic acid			10		121											
		3-carbamyl-2,4,5-trichlorobenzoic acid			77		103											
Mancozeb	108880		14504	2000	998	6.2	0.1	1.3	Low	0.035	EPA, 2012 Human Health Benchmarks	B2, probable						
		ethylenethiourea			70	20000	0.5			0.06	EPA, 2009, 1/10000 cancer risk	B2, probable						
		ethyleneurea			41		6.2											
		ethylene bisisothiocyanate	481200		281		0.33											
Glyphosate-isopropylammonium & Glycine, N-(phosphonomethyl)-potassium salt	118462		103601 & 103613	0.0005		11600	22-96	35	Extremely Low	0.7	EPA MCL and MCLG	D, Unlikely (glyphosate)						
		Aminomethylphosphonic Acid																
		Glyoxylate																
		methylamine																
		formylphosphonate																
Chloropicrin	100063		81501		65	10000	0.3-1		Extremely Low			Not listed?						
S-Metolachlor & Metolachlor	93675		108800 & 108801		226.1	488	15	Stable	High	0.1	EPA, 1995 Reregistration Report Lifetime health advisory level (EPA, 1995), MA standard, WHO 0.01 mg/l, compare to (EPA, 2009) level of 3.5	C, possible carcinogen					920	27
		Metolachlor oxanilic acid																
		Metolachlor ethane sulfonic acid			9		132											
Imidacloprid	58781		129099		225	610	191	Stable		0.399	EPA, 2012 Human Health Benchmarks	Unlikely						
		1-[(6-chloro-3-pyridinyl)methyl]N-nitro-1H-imidazol-2-amine																
		6-chloronicotinic acid[1]																
Atrazine	55756		80803		100	35	125	86	High	0.003	USEPA MCL and MCLG	Not likely	398	22	49	3	1008	191
		6-deisopropyl atrazine			142	670							398	9	49	1	1071	22
		deethylatrazine			72	3200	45						398	40	49	13	1300	143
		2-hydroxyatrazine											398	28				

Active Ingredient	2009 Dealer Pounds	Major Metabolites	EPA Code	K_{OW}	K_{oc} (ml/g)	Water Solubility mg/l	Soil DT 50	Water DT50	Movement Rating	Quality Standard (mg/l)	Water Quality Standard Source	EPA Carcinogen?	2007 WI DATCP GW Testing?		2008 UW Stevens Point Testing?		USGS Study	
													Samples Analyzed	Detections	Samples Analyzed	Detections	Samples Analyzed	Detections
1,3-Dichloropropene	35746		29001		33.7	2485	9.3	4	Moderate	0.0004	Wisconsin groundwater enforcement standard (preventive action limit 0.00004 mg/l)	B2, probable						
		3-chloroallyl alcohol			9		0.5											
		3-chloroacrylic acid					19.8											
Benzene, pentachloronitro-	32264		56502	316228		0.44	15-60	Stable		0.7	EPA, 2012 Human Health Benchmark based on Rfd of 0.010	C, Possible						
		pentachloroaniline																
		pentachlorobenzene																
Diquat	24785		32201		2E+06	718000	1000	Stable		0.02	USEPA MCL/MCLG	E, Unlikely						
EPTC	23057		41401		300	370	6-18	300	Low	0.175	USEPA reference level (EPA, 2008) Regulatory support document for CCL 2, EPA OGWDW, June 2008. EPA decided not to regulate with a primary drinking water	Unlikely (EPA, 2008)	398	0	49	0	109	1
Maleic hydrazide potassium salt	20734		51503		45	144000	3	Stable	High	4	EPA Lifetime health advisory (EPA, 2009), No EPA MCL	E, Unlikely (EPA, 1994 RED Facts)						
Pendimethalin	18976		108501		15744	0.33	90	Stable	Very Low	0.02	WHO standard No MCL by USEPA	C, Possible	398	0				
Diuron	11342		35505		1067	35.6	75	Stable	Moderate	0.2	1/10000 cancer risk, no MCL available	Likely to be						
		1-(3,4-dichlorophenyl)-3-methylurea			928	490												
		3,4-dichlorophenyl urea			694	940												
Metribuzin	9761		101101		38	1165	11.5	Stable	High	0.07	Wisconsin groundwater enforcement standard (preventive action limit 0.014 mg/l)	D, unclassifiable, ambiguous	398	0	49	3	471	6
		desaminometribuzin																
		diketo-metribuzin																
		desminodiketometribuzin																
Halosulfuron-methyl	8342		128721		124	1650	23-51	14		0.7	Chronic lifetime HHBP from EPA	Not Likely						
		3-chlorosulfonamide acid																
		3-chlorosulfonamide ester																
2,4-D & 2,4-D Amine	13194		30063		100	100	34-333	1	Moderate	0.07	USEPA MCL/MCLG	D, not classifiable	398	2				
Captan	6773		81301		97	5.2	0.8	0.6	Very Low	0.91	EPA, 2012 Human Health Benchmarks	Not likely at low doses, likely at high						
		tetrahydrophthalimide			8		10											
		tetrahydrophthalamic acid			4		9											

Active Ingredient	2009 Dealer Pounds	Major Metabolites	EPA Code	K_{ow}	K_{oc} (ml/g)	Solubility mg/l	Soil DT 50	Water DT50	Movement Rating	Standard (mg/l)	Water Quality Standard Source	EPA Carcinogen?	2007 WI DATCP GW Testing?		2008 UW Stevens Point Testing?		USGS Study	
													Samples Analyzed	Detections	Samples Analyzed	Detections	Samples Analyzed	Detections
Boscalid	6444		128008	912	809	4.6	200	Stable		1.526	EPA, 2012, Human Health Benchmarks	Suggestive evidence						
Copper sulfate pentahydrate	6089		24401							1.3	EPA copper action level	D, unlikely (Copper)						
Mesotrione	5713		122990		80	160	5	Stable		0.0067	Lowest drinking water level of concern (infants) in EPA factsheet (June 2001); No EPA MCL or MCLG			check these				
		Methylsulfonyl-2-nitrobenzoic acid			6													
		2-amino-4-methylsulfonylbenzoic acid			70													
Sodium bentazon	5552		103901	0.35	116	570	40-365	30	High	0.3	Wisconsin groundwater enforcement standard (NR140); preventive action limit 0.060 mg/l	E, evidence of noncarcinogenicity	398	2				
Acetochlor	5450		121601		156	282	14	Stable		0.007	Wisconsin groundwater enforcement standard (NR140); Wisconsin preventive action limit 0.0007 mg/l	B2, probable carcinogen	398	0	49	0		
		acetochlor ethanesulfonic acid (esa)								0.23	Wisconsin groundwater enforcement standard (NR140) for ESA + OXA; preventive action limit 0.046		398	16	49	1		
		acetochlor oxanilic acid (oa)								0.23	Wisconsin groundwater enforcement standard (NR140) for ESA + OXA; preventive action limit 0.046		398	3	49	2		
		acetochlor sulfinylacetic acid																
Thiophanate-methyl	5373		102001		207	20	0.6	36	Very Low	0.187	EPA, 2012 Human Health Benchmarks	Likely to be carcinogenic						
		carbendazim			225	8	40			0.175	EPA, 2012 Human Health Benchmarks							
		allophanate																
Pyraclostrobin	4812		99100				3-136	30		0.238	EPA, 2012 Human Health Benchmarks	not yet evaluated						
Phosmet	4316		59201		3212	15.2	3.1	0.3	Low	0.042	EPA, 2012 Human Health Benchmarks							
Mefenoxam	4049		113502		163		60	1000				not likely to be carcinogenic						
Bromacil	3830		12301		32	815	60	Stable	Very High	0.07	Lifetime mg/l EPA, 2009	C, possible carcinogen			9	0		
Metiram	3792		14601		500000	2	1	0.7	Extremely Low	0.003	EPA, 2012 Human Health Benchmarks	B2, probable carcinogen based on						
		ethylenethirourea								0.06	EPA, 2009 1/10000 cancer risk	B2, probable carcinogen						
		ethylene bisisothiocyanate sulphide																
		carbimid																
Paraquat	3787		61601		1E+06		620-644	stable	Extremely Low	0.03	lifetime mg/l, EPA, 2009	E, evidence of noncarcinogenicity						
Simazine	3600		80807			5	60	96	High	0.004	Wisconsin groundwater enforcement standard, preventive action limit 0.0004 mg/l	C, possible human carcinogen	398	0	49	0	547	17
		6-deisopropyl atrazine			142	670												
		2-hydroxy-4,6-bis(ethlyamino)-S-triazine			5	32.8												

Active Ingredient	2009 Dealer Pounds	Major Metabolites	EPA Code	K_{OW}	K_{oc} (ml/g)	Water Solubility mg/l	Soil DT 50	Water DT50	Movement Rating	Water Quality Standard (mg/l)	Water Quality Standard Source	EPA Carcinogen?	2007 WI DATCP GW Testing?		2008 UW Stevens Point Testing?		USGS Study	
													Samples Analyzed	Detections	Samples Analyzed	Detections	Samples Analyzed	Detections
S-dimethenamid	3566		120051		223			30		0.05	Wisconsin groundwater enforcement standard, preventive action limit 0.005 for Dimethenamid /Dimethenamid-P	Not listed (Dimethenamid 50/50 s/r is	398	0	9	0		
		ethane sulfonic acid											398	0				
		oxanilic acid											398	0				
Rimsulfuron	3559		129009	0.035	47	7300	24.3	7.2		5.726	EPA, 2012 Human Health Benchmarks	E, evidence of non-carcinogenicit						
		N-4,6--dimethoxy-2-pyrimidinyl)-N-(3-(ethylsulfonyl)-2-Pyridinyl)urea			61		337											
		N-[3-(ethylsulfonyl)-2-pyridinyl]-4,6-dimethyoxy-2-pryrimidinamine					144											
		30(ethylsulfonyl)-2-pyridinesulfonamide			40		655											
Trifluralin	3310		36101		8765	0.221	181	Stable	Very Low	0.0075	Wisconsin groundwater enforcement standard; preventative action limit 0.00075 mg/l	C, possible carcinogen			49	0		
		3-nitro-N2,N2-dipropyl-5-(trifluoromethyl)benzene-1,2-diamine			13600	1.41												
Pyrimethanil	3242		288201		301	121	55	Stable		1.19	EPA, 2012 Human Health Benchmarks	C, possible carcinogen						
		2-amino-4,6-dimethylpyrimidine			144	40000	85.5											
Diazinon	3002				1000	60	40		Low			not likely to be carcinogenic						
Alachlor	692		90501	1230		240	14	0.5	Moderate	0.002	Wisconsin groundwater enforcement standard and EPA MCL (MCLG = 0)	Likely carcinogenic at high doses,	398	1	49	0	993	33
		Alachlor ethane sulfonic acid (ESA)											398	100	49	34		
		Alachlor oxanillic acid (OA)											398	13	49	5		
		2-methyl-4-chlorophenol																

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Carcinogenicity obtained from
EPA, 2009. 2009 Edition of the Drinking Water Standards and Health Advisories. EPA 822-R-09-011
Pesticide Action Network Databased (pesticideinfo.org)
EPA Office of Pesticide Programs, Chemicals evaluated for carcinogenic potential.
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Appendix D

Portage County Groundwater Summit Participants

Appendix D

PORTAGE COUNTY GROUNDWATER SUMMIT

April 29, 2015

1. Sherry Zei
2. Kevin Masarik
3. Barb Gifford
4. Kristy SeBlonka
5. Sandy Van Asten
6. Tamas Houlihan
7. Dave Mangin
8. Nick Homan
9. Ed Burns
10. Bill McKee
11. Lisa Shirek
12. Simran Sandhu
13. Cale Jakusz
14. Justin Isherwood
15. Paul Onan
16. Phil Dopp
17. Dick Okray
18. Stu Grimstad
19. Ken Feltz
20. Karen Hannon
21. Steve Kerlin
22. Jake Barnes
23. Anne Graham (?)
24. Bob Smail* (DNR, Water Use)
25. Denise Schmidt* (Public Service Commission, Water Conservation Coordinator)
26. Gary Garske* (Portage County Public Health)
27. Ken Schroeder* (UW-Extension Ag Agent/Ag Economic Study)
28. Steve Bradley* (County Conservationist/Lake Management)
29. Ray Schmidt* (Volunteer Groundwater Advisor)
30. Julie Ammel* (USDA/NRCS grants/tools)
31. Joel Lemke* (City of Stevens Point Public Utilities Director)
32. Byron Shaw* (Soil and Water Resources Scientist)
33. Jeff Schuler+
34. Jami Gebert+

*consultant experts

+co-facilitators

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