MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION

GUIDANCE

LOCATING PRIORITY AREAS FOR SEPTIC SYSTEM INVESTIGATIONS

This document provides recommendations for prioritizing septic system evaluations in watersheds that are impaired by *E. coli*, as a supplement for Michigan's Statewide *E. coli* Total Maximum Daily Load (TMDL).

Other resources available on the Michigan Department of Environmental Quality's (MDEQ) *E. coli* TMDL Web site include:

- The MDEQ *E. coli* Pollution and Solution Mapping System
- Conducting a Subwatershed-Scale Source Survey - Field Inventories
- Conducting a Subwatershed-Scale Source Survey - Remote Sensing

Introduction

The MDEQ has provided an online interactive mapping system to help interested stakeholders locate *E. coli* sources. Additionally, the MiWaters Site Explorer can provide you with compliance information and access to public documents for National Pollutant Discharge Elimination System, groundwater, biosolids, and other permitting systems. These are all tools in the source assessment toolbox.

Investigating failing septic systems is a time consuming and expensive process, so prioritizing actions is a worthwhile effort. Finding and fixing problems will ultimately involve a partnership with the local health department and MDEQ. The local health department holds the authority to investigate complaints about septic systems, illicit connections, and issuing permits for repairs and replacement systems. The MDEQ is responsible for all point sources of sanitary wastewater discharging to surface water or groundwater systems that discharge more than 10,000 gallons per day, and also enforces Part 31, which prohibits the discharge of raw sewage to surface waters of the state. Septic system investigations are another tool to build knowledge of sources, best used in conjunction with the *E. coli* TMDL Mapping System, MiWaters Site Explorer, windshield surveys (driving the watershed and identifying issues), remote sensing, and monitoring water quality (*E. coli* and microbial source tracking techniques).

Although septic failures and illicit connections can happen anywhere, several factors increase the risk of septic system failures. The spatial distribution of the factors below within your watershed may help prioritize efforts:

- Housing age
- Building lot size
- Housing density
- Soil types
- Water table levels (seasonal and average)
- Proximity to surface water

Recommended steps are (covered in detail below):

1) Establish goals and limitations
2) Gather water quality data
3) Meet with your local health department
4) Acquire spatial (GIS) data
5) Analyze data and combine with local knowledge to select priority areas for the "Next Steps"
6) Next steps

Details:

1) Establish Goals and Limitations
   Typically the ultimate goal is to meet the *E. coli* water quality standard (Michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/GLWARM/TMDL-Ecoli/ecoli-water-quality-standard.pdf); however, interim improvements in water quality are a more achievable goal and septic systems are usually only part of the pollution problem. Goals may be specific or general, and include the education of homeowners, surveying homeowners to narrow down potential problems, identifying target areas for work, the elimination of contamination by septic systems in a small area, etc. The MDEQ also recommends setting a spatial target area that is reasonable for the resources that are available to the investigators. Consideration should be given for demonstrating success by monitoring before and after the project, if in-stream improvements are the goal.

2) Gather Water Quality Data (any available *E. coli* data and source tracking information)

   a. *E. coli* concentration data collected from feeder tributaries across various weather/flow conditions can help you locate areas to prioritize for septic system investigations by indicating certain types of sources. High levels of *E. coli* during dry weather or low flow conditions is an indication that failing septic systems or illicit connections are likely an issue. High *E. coli* during wet weather could be from a variety of runoff-driven sources, including failing septics (especially surface failures or illicit connections to storm sewers or field tiles that do not normally flow constantly). If there are areas in your watershed that seem to have high *E. coli* all of the time, regardless of weather, when other areas have high *E. coli* only during wet weather, this may be a good place to prioritize.
   b. Microbial source tracking data are based upon comparing the DNA fingerprint of a sample to the fingerprint of a known bacteria source (e.g., cows, horses, humans). The results can tell you whether or not the sample contains the selected marker (e.g., human bacteroides), and for an additional fee, the lab may be able to tell you how much of the identifiable bacteria in your sample is from that specific marker (e.g., of all the bacteroides in the sample, 10% of the total is from human bacteroides).
   c. Canine scent tracking for human sources is another method of source tracking, where a trained canine signals the presence or absence of human sewage in samples either on site or in a scent-neutral location. One study found that the canine detections (positive results) of human sewage were confirmed by DNA analysis in

70-100% of the storm water samples (Van De Werfhorst, 2014). The benefit of this approach is that it is cost-effective, and it is easy to investigate positive responses while you are already in the area by essentially following the positive responses all the way to the source. If desired, the findings of the canine may be confirmed with DNA microbial source tracking techniques.

d. Caffeine concentrations are sometimes used to identify locations where human sewage may be entering surface water. Researchers have determined the relationship between caffeine and fecal coliforms is a 'modest correlation' (R^2 = 0.558) (Sauvé et al., 2012).

3) Meet with Your Local Health Department (and other local agencies)

Before visiting a health department, you will want to make an appointment. Make them aware of your plans to begin investigating septic systems. Share the *E. coli* data you have collected with them, and be clear about your goals and processes. Local health departments maintain septic installation and repair permits and can help determine areas served by sanitary sewers.

It is helpful to know in advance if their records are digital or paper, and how they are organized (often it is by township and section, or by street address). A permit may give you information such as street address, the location of the system in a drawing of the property layout, the year it was built or last repaired/inspected, and solutions to problems that were found on the site in the past. The absence of a permit for a property may indicate that the septic system is very old, or the home may not have a treatment system. If the site is not connected to a sanitary sewer, then an illicit connection to a field tile, ditch, or surface water is a possibility that should be investigated. Both septic system permits, as digitized points, and homes served by sanitary sewer (points) or sewered area (polygons) are helpful to look for gaps where treatment systems may be old and failing, or absent.

Another source of information for sewered areas is a local sanitary wastewater treatment facility, such as a municipal or commercially-operated wastewater treatment plant or stabilization lagoon. Figure 1 shows an example of a map generated using the results of a trip to the local health department to pull permits. In this example, it was decided to pull all septic permits in a portion of a subwatershed upstream of a lake, with the aid of the local health department. This section of the creek has an extensive monitoring history showing high *E. coli* during all types of weather. The resulting map shows homes with no septic permit (but with a well permit) as an "X," and homes with a septic permit as a "★." Homes that are visible in the aerial image but have no symbol, have neither a well nor septic permit on file. The investigator plans to visit each home with an "X" or no symbol as first priority to determine how their waste is being treated. Homes with a ★ are second priority, since they have a system, but it may still be aging and failing.

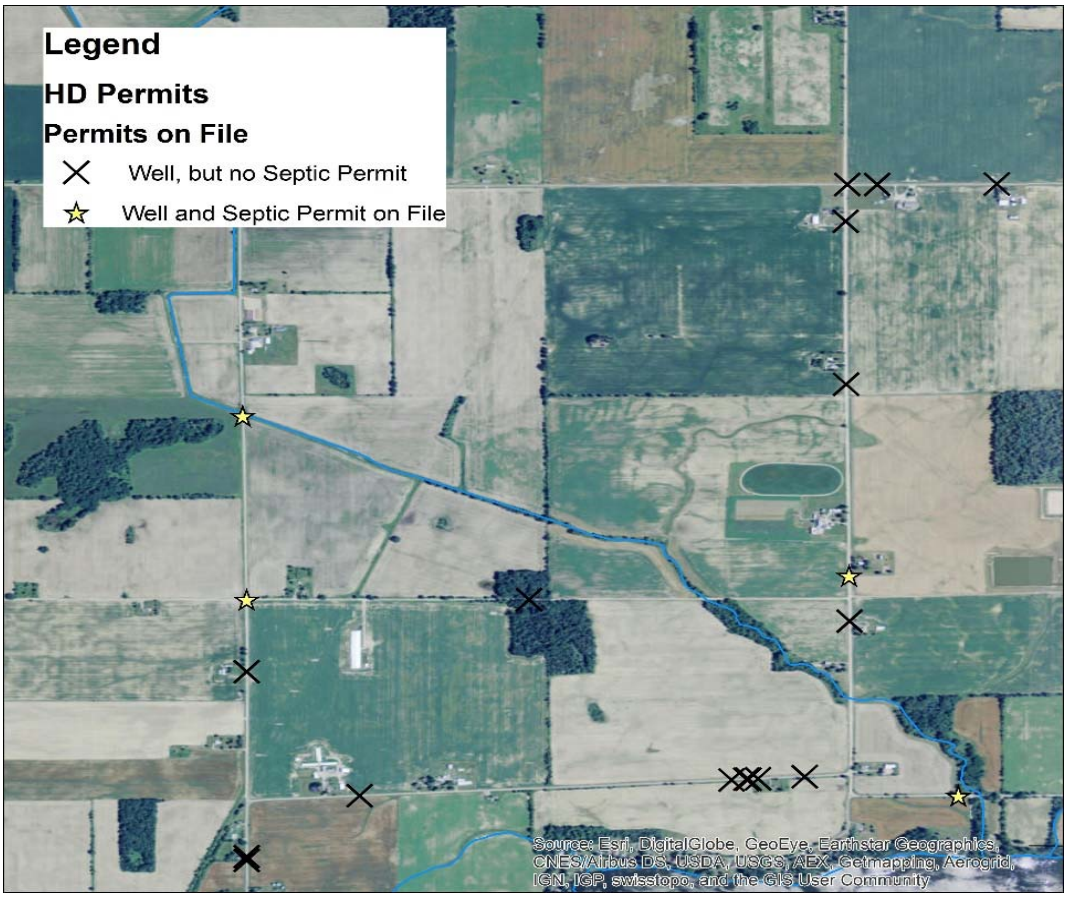

Figure 1. This map shows homes with septic system permits on file with the local health department, and homes with no septic record.

4) Acquire Spatial (GIS) Data.
If using mapping software that allows you to add layers, acquire spatial data and overlay the desired layers.

The Michigan Center for Geographic Information (CGI) maintains a data library of free data for Michigan http://gis-michigan.opendata.arcgis.com/, housing both county and statewide data. Layers that may be useful include:

- Aerial Imagery: Aerial imagery from online interactive sources and Web sites may be sufficient. Historic images are available from the Michigan CGI Data Library, and other sources. These tend to be lower resolution but can be useful to get more information on land use changes than land cover spatial coverage might otherwise provide. Color infrared imagery, in particular, has been used to locate failing septic systems in several studies. Infrared cameras visually record subtle differences in temperature or color and can detect ground failure, seasonal failures, and seasonal stress, as well as illicit connections (Roper, 2008).

- Hydric Soils: These are areas where wetlands exist either presently or in the presettlement era. Homes located on hydric soils may have septic systems located in areas with a high water table or in a flood plain. These homes would be more likely to have unsuitable soils for traditional septic systems. This information can be obtained from the "Potential Wetland Restoration" shapefile located in the county level data section of the Michigan CGI Data Library. This layer shows areas that have hydric soils, but are no longer wetlands, as "rank 2."

- Water Table Depth: Available from the Michigan CGI Data Library at county and statewide levels. Homes located in an area with a shallow groundwater table would require more expensive alternative or mounded systems to protect against contaminating the groundwater.

- County Level Soils Data (SSURGO): Available by county, SSURGO data is a complex soil layer that connects with a database to yield information about water table, soil horizons, agricultural prospects, and seasonal high water tables (and much, much more). Both the spatial layer and database are necessary and can be downloaded from www.nrcs.usda.gov. This layer may be helpful to determine areas where septic systems may be contaminating surface water and groundwater due to excessive drainage (such as sandy areas), in addition to areas with high water tables or poorly drained soils. Hydric soil locations can be extracted from this dataset.

- Parcel Data: Parcel data shows property boundaries, lot sizes, and ownership of the lot. Usually available at the local or county level only. Contact your local governmental agencies to check availability and accessibility of these data. Small parcels may indicate that there is limited room for a septic system. In the absence of parcel data, U.S. Census data at the block level can give you the number and density of housing units in an area.

- U.S. Census Housing Unit and Population Data at the Block Level: Census block level data is available from the Michigan CGI Data Library, but the shapefiles of the blocks contain only the boundaries of the block and an identification number. The shapefile must be joined with tables in order to display any information. Because of this, GIS analyses are required. The tables are available to the public via the U.S. Census Bureau's data download site, https://data.census.gov/cedsci/. Density of housing units or population can be determined by finding the area of the census block and dividing the census data by the area. This can be used to establish an average lot size to help find high density housing areas in a large watershed where looking at aerial imagery would not be practical.

- Other Useful Background Layers Available from the Michigan CGI Data Library would include: public land surveys (townships, sections, and quarter quarters), county boundaries, rivers (hydrography lines), lakes (hydrography polygons), land cover data, and watershed boundaries (12-digit hydrologic unit code (HUC) level).

5) Analyzing data: Several scenarios of prioritizing for the "next steps" are outlined below, but the ultimate decision on how to use the data is up to the user.

- Figure 2 - In a 12-digit HUC level subwatershed, *E. coli* data for the three main tributaries shows a dry weather problem at all three sites, and canine scent tracking data found positive hits for human sewage at most road crossings. If canines had indicated that human sewage was a source to only one of the three sites, then that subwatershed would have been the focus of further investigations. The investigator's time is limited, so it is decided to choose the tributary with the fewest homes, in order to determine how practical and effective the process will be. Within that subwatershed, the investigator will pull septic system permits and then visit each site with a questionnaire if the septic system is older than ten years or there is no record of a system.

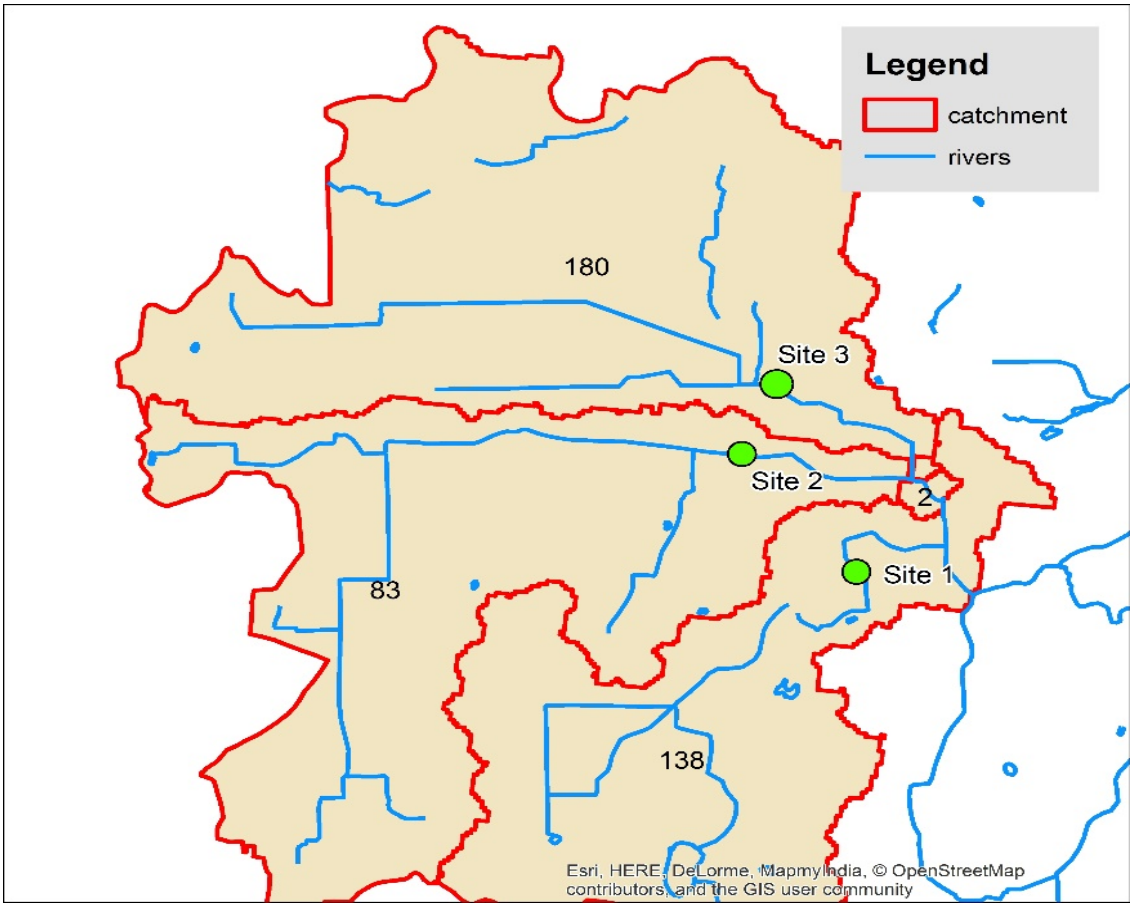

Figure 2. The number of housing units per subwatershed (shown in black text) might be used to determine, or limit the scope of, the investigation if resources are limited.

- Figure 3 - In a 12-digit HUC level subwatershed, *E. coli* data for the main stem river exceeds water quality standards during low flows indicating a septic system issue. There is no data for the tributaries. Based only on lost wetlands and agricultural land cover spatial data, the investigator chooses to focus on the

homes in areas that are now in agriculture, but were formerly wetland. The investigator knows from local knowledge that there are many old homes in this area and the fields are tiled for agriculture. Within these subwatersheds, the investigator will pull septic system permits and then visit each site with a questionnaire if the septic system is older than ten years or there is no record of a system.

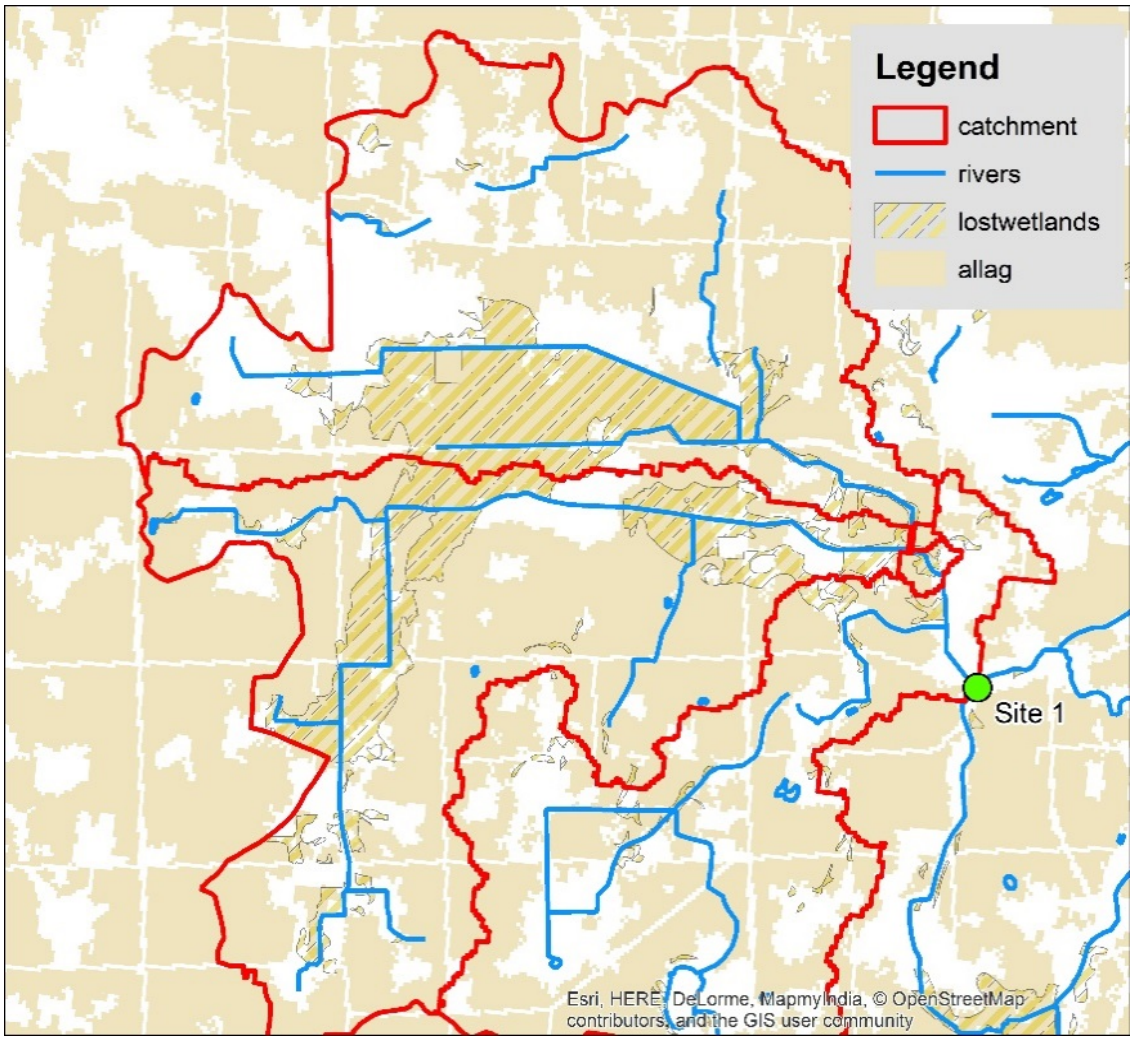

Figure 3. The area that was formerly wetland, but is now in agriculture, could be a potential area to target for illicit connections to field tiles. Overlaying these layers on aerial imagery would help to determine homes to target for field visits.

6) Next Steps: In the target (priority) area, next steps can include educational mailings to residents, in-person or mailed surveys on septic system use and maintenance, walking the tributaries looking for illicit connections, and inspections by the health department if warranted. Illicit connections are hazardous to human health, and if found, should be reported to the local health department or the MDEQ (via MiWaters complaint submission form).

References

Roper, W. E. (2008). Color Infrared Survey for Identification of Failing Onsite Treatment Systems, George Mason University.

Sauvé, S., Aboulfadl, K., Dorner, S., Payment P., Deschamps, G., and M. Provost. (2012). "Fecal coliforms, caffeine and carbamazepine in stormwater collection systems in a large urban area." Chemosphere. 2012 Jan;86(2):118-23 **86**(2): 118-123.

Van De Werfhorst, L.M., Reynolds, S., Reynolds, K., and Holden, PA. (2014). "Canine scent detection and microbial source tracking of human waste contamination in storm drains." Water Environ Res. **86**(6): 550-558.