IPP PFAS Initiative Regional Information Meetings

March 2018

PFAS

- What they are
- Why they are important
- Where you may find them
- DEQ WRD requirements
- Sampling and Analysis
- Resources and Information

Agenda

9:30 a.m. – Meeting Start

1. Welcome and Introduction
2. PFAS and its Impact on POTWs and Receiving Streams
3. WRD Requirements for POTWs with IPPs
4. Question & Answer

10:45 a.m. – BREAK

5. PFAS Monitoring and Analysis
6. Where to go for Resources and Assistance
7. Question & Answer

12:00 p.m. – Adjourn

PFAS AND POTWS

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What's in a Name?

- ***PFAS*** *– Per and Polyfluoroalkyl Substances*
- Also called **PFCs** for Perfluorinated Compounds
- But **PFCs** can also mean **Perfluorocarbons** associated with greenhouse gases--confusing
- **PFAS** and **PFOS** sound similar: also confusing
- Discussion on epa.gov https://www.epa.gov/pfas/basic-information-about-and-polyfluoroalkyl-substances-pfass#use

PFAS—
Class of Manufactured Chemicals

- **PFAS** – Per and Polyfluoroalkyl Substances
- Synthetic, used extensively for 70 years
- Useful properties: oil- and water-resistance
- **Emerging** pollutants: science about the chemicals and impacts is being developed

Environmental and Health Concerns

- Widespread wildlife and human exposure
- Human Health concerns
- Most studied chemicals are PFOS and PFOA

PFAS and Consumer Products

Stain and water-repellants for fabrics, leather, and carpets

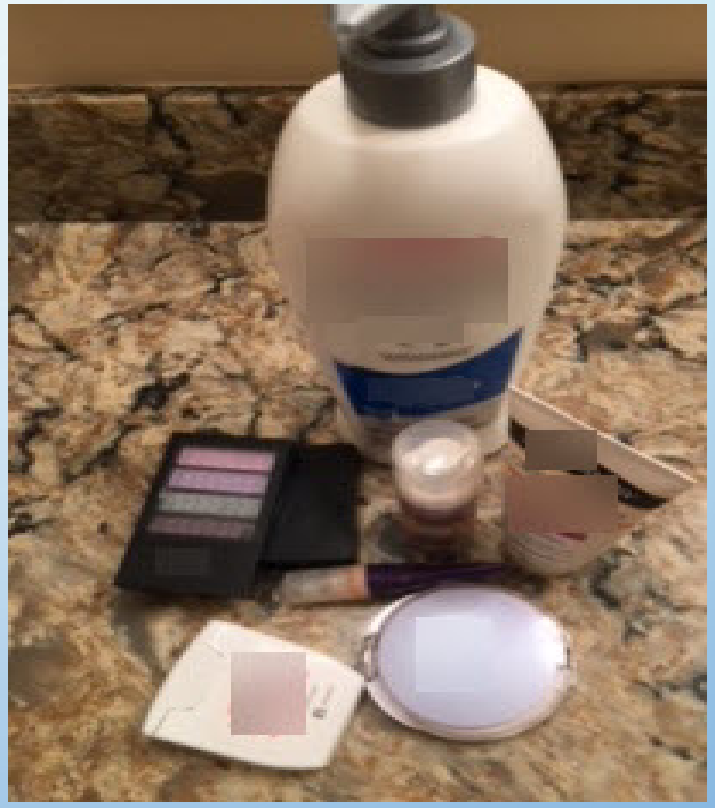
PFAS and Consumer Products

Used in Non-stick coatings:

- cooking pans
- auto polishes and waxes
- food wrappers and cartons

PFAS and Consumer Products

- Personal care items
  - Cosmetics
  - dental floss
  - lotions
  - sunscreen

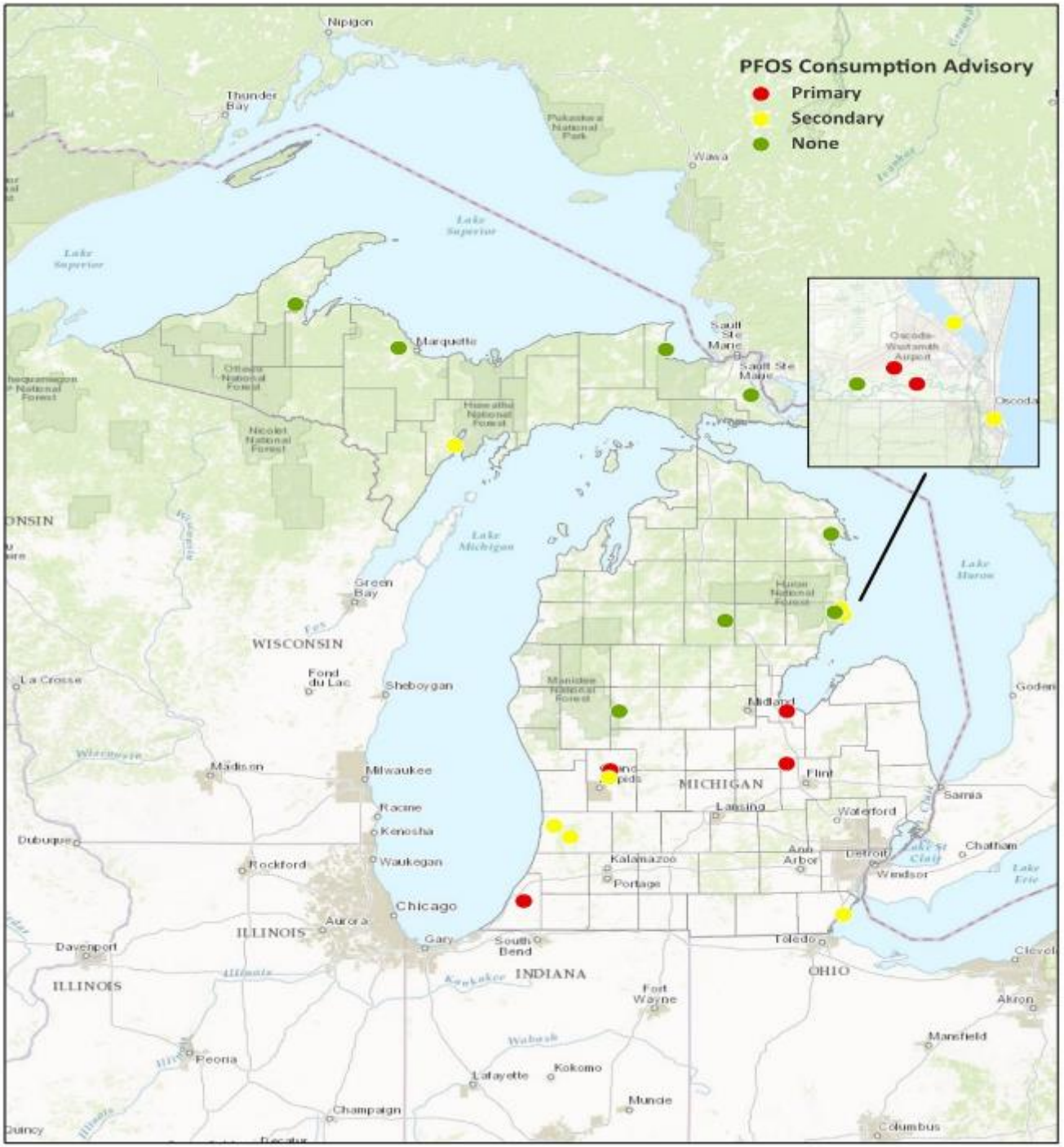


PFAS of Concern: PFOA

- **PFOA**: perfluorooctanoic acid (also called “C8”)
  - Non-stick coatings
  - Stain- and water-repellant treatment
- Human health exposure: food and drinking water, occupational exposure
- National voluntary phase out, but may still be found

PFAS of Concern: PFOS

- PFOS = Perfluorooctane Sulfonate
  - Persistent and Bioaccumulative
  - Human health concerns
  - Associated Fish Consumption Advisories
  - Banned from some uses
  - Manufacture in US stopped voluntarily


PFOS Consumption Advisory
Primary
Secondary
None
Nipigon
Thunder Bay
Wawa
Lake Superior
Marquette
Sault Ste Marie
Ottawa National Forest
Hiawatha National Forest
Nicolet National Forest
Lake Michigan
Lake Huron
Huron National Forest
Manistee National Forest
Green Bay
WISCONSIN
Fond du Lac
Sheboygan
La Crosse
Madison
Milwaukee
Racine
Kenosha
Waukegan
Dubuque
Rockford
Chicago
Aurora
Gary
South Bend
ILLINOIS
INDIANA
Davenport
Peoria
Kalamazoo
Portage
Ann Arbor
Detroit
Windsor
Flint
Midland
Lansing
MICHIGAN
Waterford
Sarnia
Chatham
Lake St Clair
Lake Erie
Toledo
OHIO
Fort Wayne
Akron
Mansfield
Lafayette
Kokomo
Muncie
Champaign
Columbus
Oscoda-Wurtsmith Airport
Oscoda

PFOS and Fish Consumption Advisories

Flint River

(downstream of Mott Dam)

Type of Fish	Chemicals of Concern	Size of Fish (length in inches)	MI Servings per Month*
Carp	PCBs	Any	Limited▲
Largemouth Bass	PFOS	Any	6 Per Year
Smallmouth Bass	PFOS	Any	6 Per Year

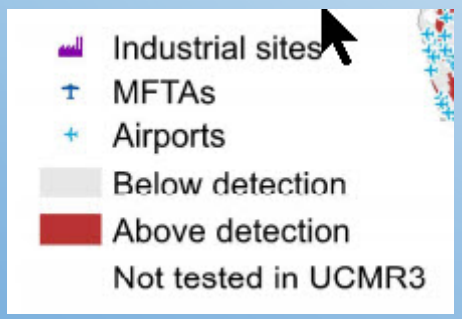
PFOS can't be reduced by trimming and cooking. Do not double MI Servings.

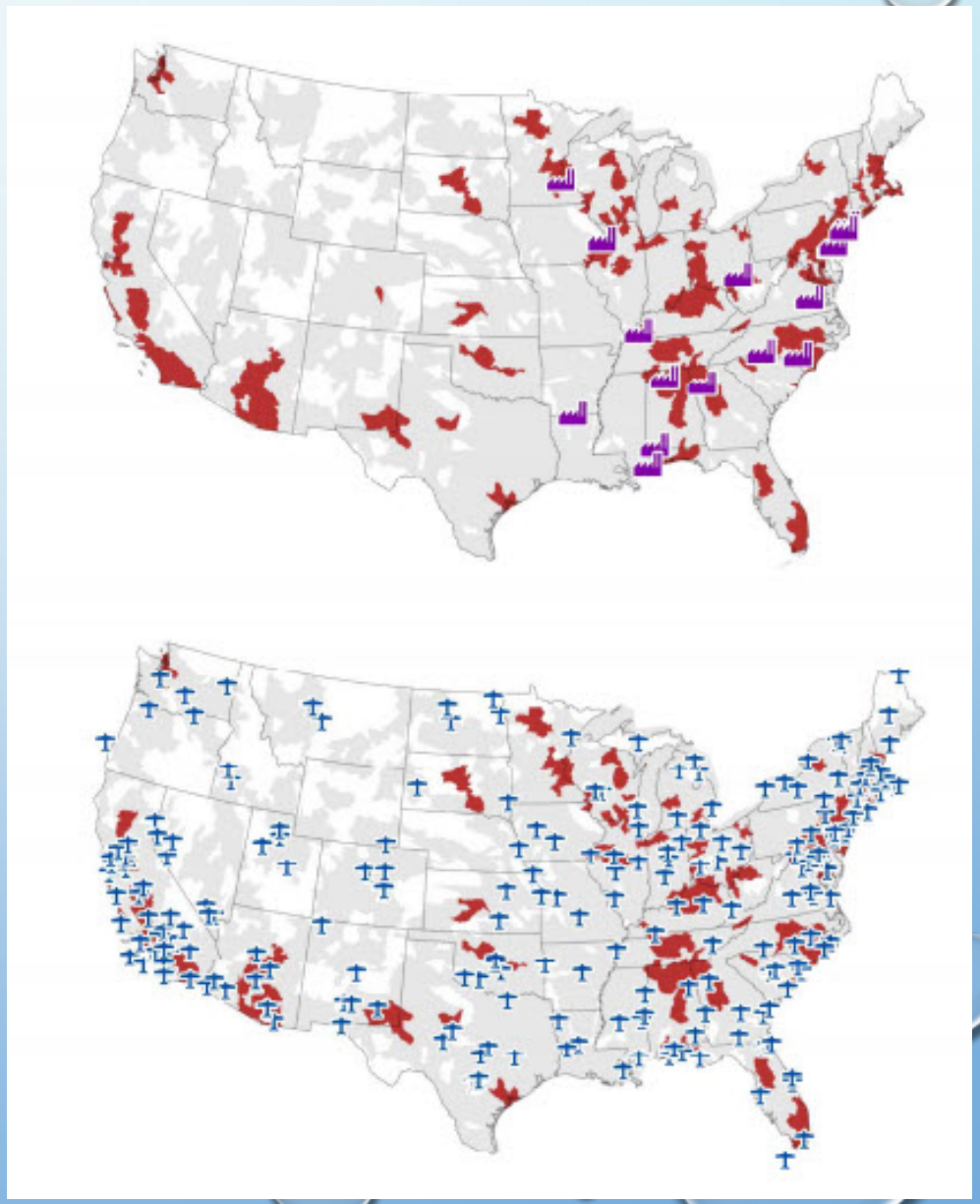
National Study, ACS, 2016

- PFOS/PFOA found greater than EPA lifetime health advisory (70 ng/l) in public drinking water sources for 6 million US residents
- Number of PFOS/PFOA manufacturers, military fire training areas, and **WWTPs** in watersheds were significant predictors of PFAS detection in public water supplies.

ACS Study, 2016

- Industrial sites, military sites, and WWTPs are associated with public water sources with detectable PFAS





Sources of PFOS & PFOA for WWTPs

- Fume suppressants/demisters/wetting agents for plating tanks
- Leather and fabric treaters, tanneries
- Paper and packaging manufacturers
- Manufacturers of parts with PTFE coatings (bearings, wire, etc)
- Landfills (leachate)
- Centralized Waste Treaters
- AFFF fire fighting foam

PFOS and Platers

- Used by electroplaters as a demister/defoamer (air pollution control) since mid-1990s; also wetting agent
- Used primarily for tanks with hexavalent chromium
- Banned from electroplating tanks from Sept 2015
- Manufacture largely phased out in US
- Potential source of PFOS to POTWs, surface waters

Other Sources of PFOS

- Landfill leachate (esp. from industrial wastes)
- Paper and packaging manufacturers
- Tanneries and Leather/Fabric Treaters
- Potentially Manufacturers of parts with PTFE coatings (bearings, wire, etc.)
- Centralized Waste Treaters accepting above wastes
- Groundwater Cleanup wastewaters from contaminated sites w/PFOS
- AFFF (aqueous film-forming foam for fire suppression)

PFOS and POTWS

- Very soluble, heavy
- Passes through conventional POTW processes
- Accumulates in biosolids: water portion (biosolids mostly water) and/or solids?
- Still learning about what happens to PFAS in various environments

Questions about PFAS

- Can replacement chemicals (often PFAS) break down and/or become PFOS or PFOA?
- Are replacement chemicals safe?
- What concentrations of PFAS are safe?
- Where should we expect to find PFOS?

DEQ is working with EPA and industry on the answers to these questions

Statewide, Multi-media Action

Michigan.gov

BUSINESS | EDUCATION | HEALTH | GOVERNMENT | SAFETY

SOM / ENVIRONMENTAL HEALTH

Taking Action, Protecting Michigan

Governor's Directive Creates The PFAS Action Response Team

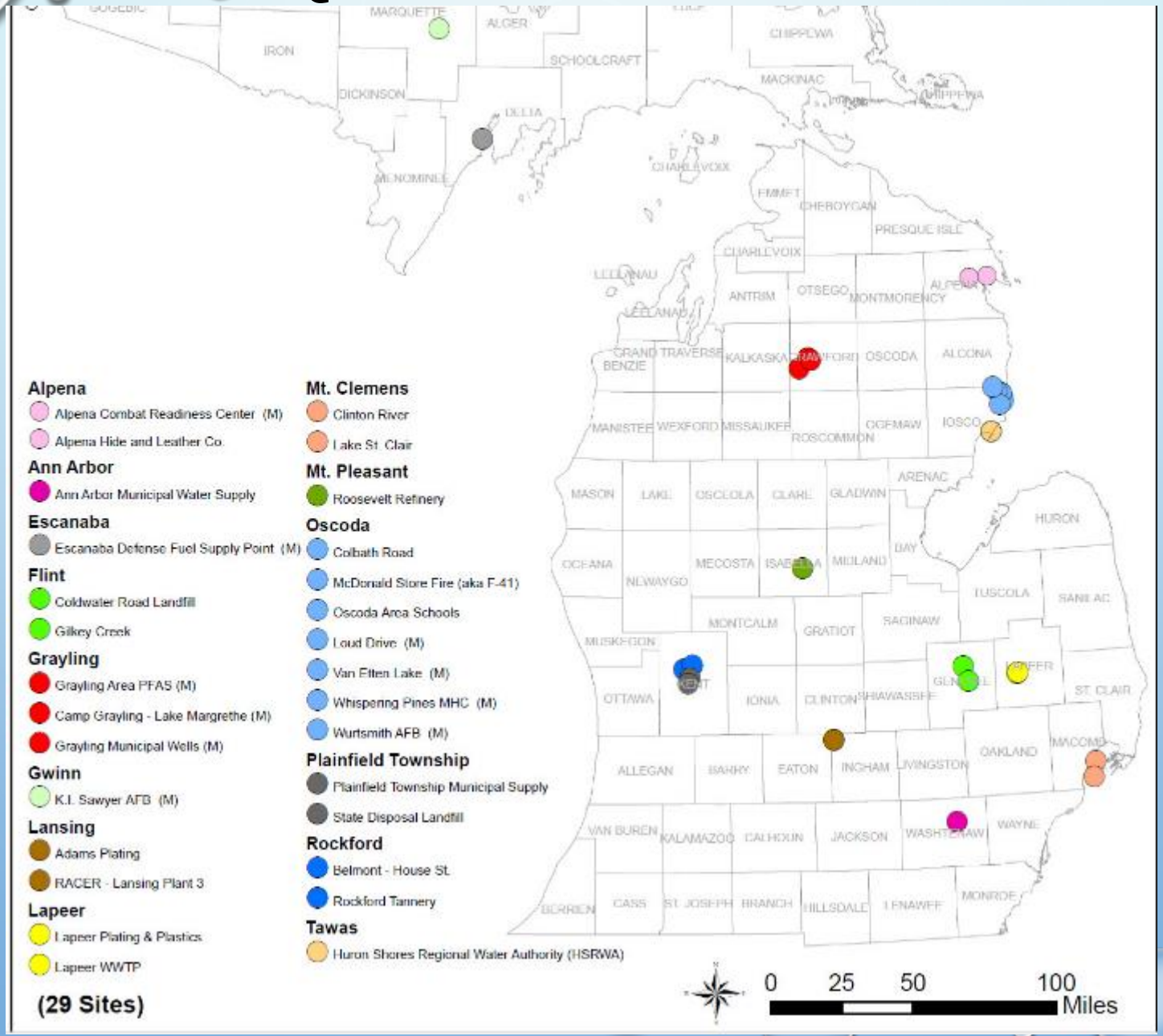
What You Need to Know About PFAS Contamination

Perfluoroalkyl and polyfluoroalkyl substances (PFAS), also known as PFCs, have been classified by the US Environmental Protection Agency as an emerging contaminant on the national level. PFAS are a suite of chemicals historically used in thousands of applications throughout the industrial, food, and textile industries. They are incredibly stable, breaking down very slowly in the environment, and are highly soluble, easily transferring through soil to groundwater. PFAS contamination has been identified in several locations across the state of Michigan as a result of use in multiple industries across the State. PFAS is used in firefighting foams, food packaging, cleaning products, and various other products. It is also used by many industries such as plating, tanneries, or clothing manufacturers, where waterproofing may be required or a protective film is needed in a manufacturing process.

Governor Snyder and the State of Michigan are taking action to address this issue in a proactive and innovative way. Ten state departments, in coordination with local and federal officials across Michigan, are working together to ensure that the public health and safety of residents is protected while ensuring our environmental heritage is secure for generations of Michiganders to come.

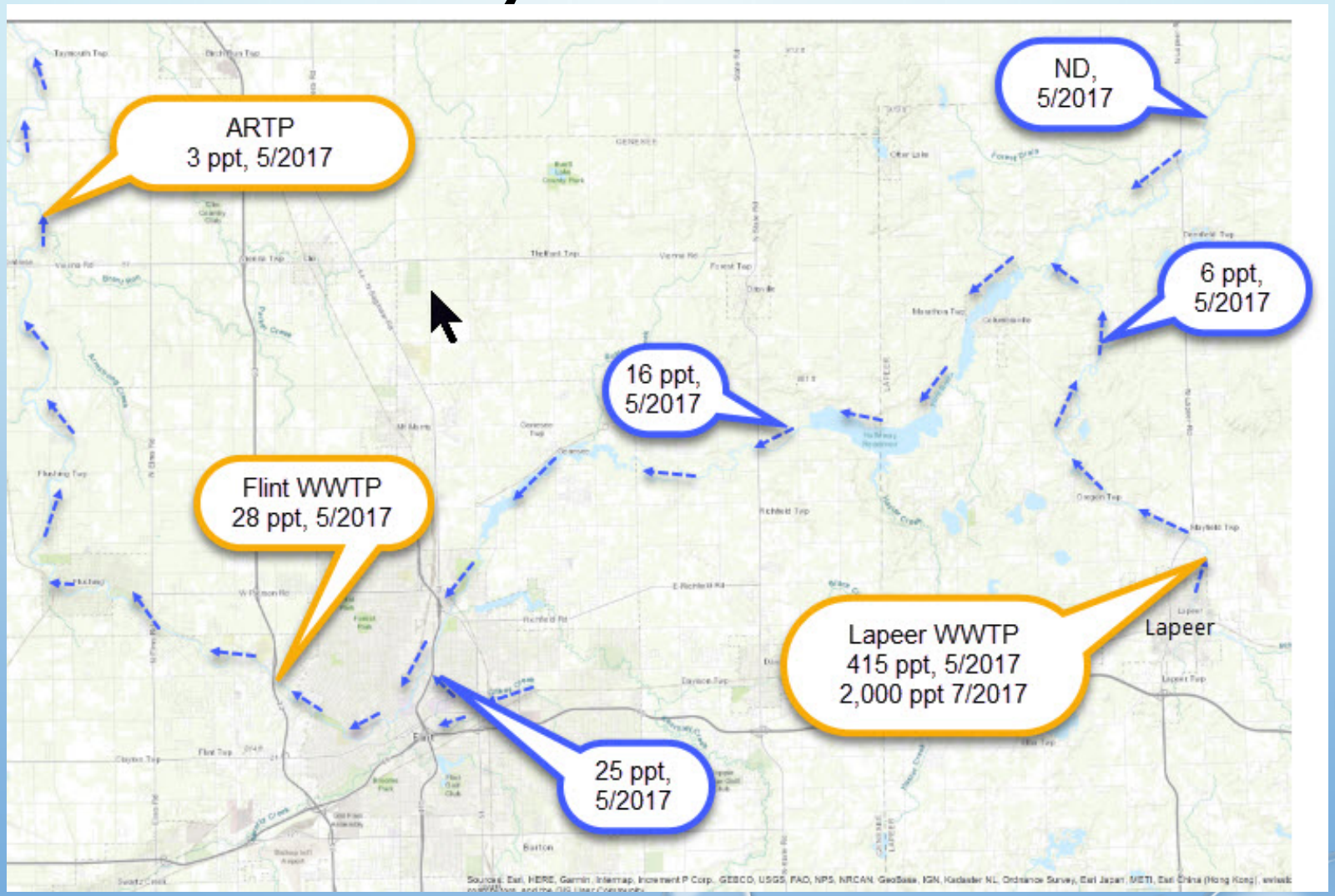
This site is intended to serve as the main resource for public information on PFAS contamination in Michigan. It will be updated regularly as additional facts about the issue and locations impacted becomes available.

DEQ Confirmed PFAS Sites



Case Study: Flint River PFOS

Case Study: Flint River PFOS



Lapeer WWTP

- DEQ found PFOS in discharge in June 2017
- Worked with City to find the source
- City working with source to eliminate PFOS

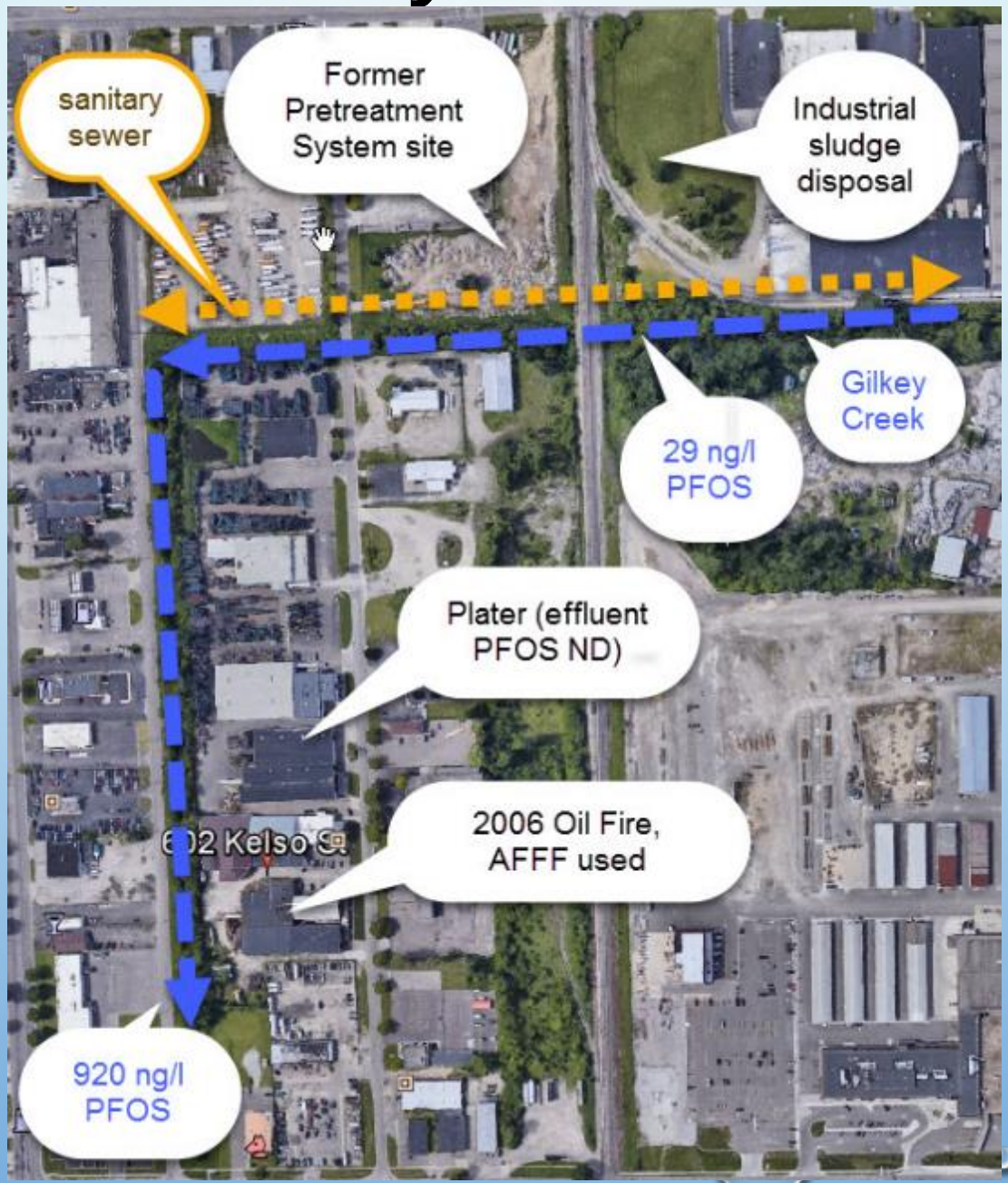
Potential Source: Chrome Platers

- PFOS-containing demister in etch baths, electroplating tanks
- Discontinued use in 2013, prior to ban
- Tanks, pits not changed or cleaned since

Gilkey Creek

- Elevated PFOS, tributary Flint River
- POTW effluent elevated, but not as high as Lapeer
- Gilkey Creek not downstream WWTP
- Took samples upstream and downstream of plater, process wastewater from plater, soils, etc.

Gilkey Creek



Water Resources Division (WRD) Strategy

- Monitor PFAS in surface waters, fish
- Coordinate with other divisions
- Identify potential sources from info
- Eliminate or minimize sources

WRD Strategy

- Identify/control sources through existing regulatory programs, including **NPDES permits**
- Sample PFAS at **select WWTPs** with routine monitoring
- Sample **direct dischargers** with potential for PFAS

NPDES Requirement: Industrial Pretreatment Program (IPP)

- **For POTWs w/IPPs**: require **source evaluation** and **follow up**
- To ensure are not passing through PFOS or PFOA greater than water quality standards
- To prevent interference with management of biosolids
- Current permit requirement, new pollutants

PFAS Letter

March 12, 2018

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PFAS Letter Overview

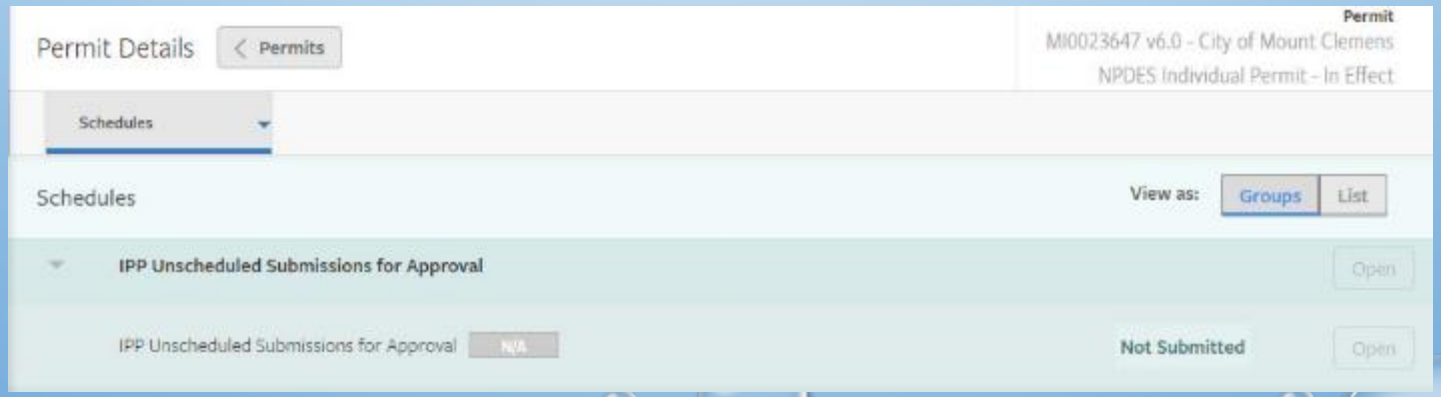
- Conduct Initial Screening
- Develop a Monitoring Plan
- Perform Source Monitoring
- Reduce/Eliminate PFOS & PFOA Sources
- Evaluate Impacts
- Submit Interim Report
- Continue Source Reduction & Monitoring
- Submit Summary Report

PFAS Letter

- Conduct Initial Screening of IUs
  - Metal finishers
  - Landfills
  - Contaminated sites
  - CWTs
  - Other PFAS sources
- Document findings

PFAS Letter

- Develop a Monitoring Plan
  - Decide to monitor **all** probable sources by June 29, 2018? Go forth! No DEQ preapproval required
  - Want to do something different? Or need an extension? Submit for DEQ approval by May 1, 2018.



PFAS Letter

- Perform Source Monitoring
  - Sample discharge from probable sources identified in monitoring plan
  - Sampling protocol will be discussed in detail during next presentation

PFAS Letter

- Reduction & Elimination of Sources
  - Product substitution
  - Operational controls
  - Pretreatment
  - Clean-up

PFAS Letter

- Evaluating Potential Impacts to POTW
  - Effluent monitoring if sources are discharging PFOS and/or PFOA to POTW
  - Report to DEQ if effluent values are above WQS within 10 days

	HNV (nondrinking)	HNV (drinking)	FCV	FAV	AMV
PFOS (ng/L)	12	11	140,000	1,600,000	780,000
PFOA (ng/L)	12,000	420	880,000	15,000,000	7,700,000

  - Additional monitoring may be required

PFAS Letter

- Interim Report
  - Summarize evaluation and data collected
  - Provide documentation
  - Submit report in MiWaters

DUE JUNE 29, 2018

PFAS Letter

- Continue Source Reduction & Monitoring
  - Conduct follow-up monitoring of sources and at WWTP
- DEQ may require additional monitoring or specific actions based on interim report

PFAS Letter

- Summary Report
  - Results of any additional monitoring data: WWTP effluent, biosolids, or source monitoring
  - Summary of PFOS and/or PFOA source reduction and/or elimination efforts
  - Submit report in MiWaters

DUE OCTOBER 26, 2018


Questions?

Sampling and Analysis of PFAS

- Use your SOPs for sampling. Safety first!
- Plan for each site/situation
- Avoid Cross Contamination
- Analysis Issues:
  - ASTM D7979
  - EPA Method 537 (modified)
  - Analytes
- Laboratories

Sampling and Analysis of PFAS: Your Monitoring Plan

- **Purpose:** screening, confirmation, enforcement?
- **Where** to sample (effluent, in-house sources, collection system?)
- **Order** of sampling
  - Least contaminated first, PFAS first
- **Type** of Sample (grab if representative)
- **How** to sample: Plan for each site/situation

Sampling and Analysis of PFAS: Your Monitoring Plan

- Preservation (ice)
- Transportation/shipping
- Laboratory
- Method of analysis
- Modify as needed—Safety first!
- Document any deviations from the plan

How to Sample: Avoid Cross Contamination

- Sample in lab-supplied sample bottle if possible
- Be careful of
  - what you wear
  - sampling equipment
  - what you touch
  - what touches the sample

Avoid Cross Contamination: What to Wear?

- Cotton or synthetic clothing without stain- or water-resistant coatings
- PVC or wax-coated clothing, neoprene
- Well-laundered clothing
- Powderless nitrile gloves
- Polyurethane and PVC boots or PFAS-free overboots
- Safety First! Use common sense

Avoid Cross Contamination: What Not to Wear

- Clothing with stain- or water-resistant coatings
- New clothing
- Clothing laundered with fabric softener
- Latex and/or powdered gloves
- Boots with water-resistant coatings if possible
- Day of sampling: no lotions, cosmetics or most sunscreens, most insect repellent, dental floss
- Safety First! Use common sense

Avoid Cross Contamination: Gear

- Clothing/Gear generally ok if made with:
  - Polyurethane
  - Polyvinyl chloride (PVC)
  - Rubber
  - Neoprene
  - Uncoated Tyvek® Material

Avoid Cross Contamination: Sampling Equipment

- Bottles: HDPE or polypropylene
  - Laboratory-provided preferred
- Thin HDPE sheeting, HDPE pipe
- Sample sticks: uncoated, un-taped metal. Avoid tape, non-stick coatings (metal spring, rubber bands, zip tie ok to hold bottle)
- Ice (regular ice double bagged--LDPE-Ziploc®)
- Decon: lab-supplied DI water, Alconox®, Liquinox®

Avoid Cross Contamination: What you touch/what touches sample

- No fast food in staging or sample areas—wash hands after eating
- Water and hydration drinks ok in staging area
- Wash hands after putting on boot covers, before gloving up for sampling
- If storing samples on, cover vehicle seats/carpet with cotton or HDPE sheeting
- Use aluminum clipboards
- Use ballpoint pens and loose plain paper

Avoid Cross Contamination: Equipment

- PFAS are sticky—least handling is best
- Use peristaltic or stainless-steel submersible pumps (when necessary—grabs better)
- HDPE, PP, silicone materials, and stainless steel generally ok as sampling equipment (e.g., tubing, spoons, or bowls)

Avoid Cross Contamination: Don't Use

- Plastic clipboards, binders, spiral notebooks
- Waterproof field books
- Decon 90
- Chemical or Blue Ice
- Teflon® lined caps, tubing, etc.
- Aluminum foil
- Glass jars, LDPE

QA/QC: Equipment Blanks, Field Blanks, Duplicates

- Not required for screening samples
- Once source is found, good for verification
- May be necessary for compliance and enforcement actions down the road
- If sampling equipment is used, verify with equipment blanks prior to sampling
- Use lab-certified PFAS-free water

Test Methods

- EPA: in external validation process for ASTM D7979 LC/MS/MS; isotope dilution method thereafter?
- DOD specifications: isotope dilution method
- Common for "EPA Method 537(mod)" to mean isotope dilution method
- Concern: "modified" can vary widely
- QA/QC important

Analytes

- There are over 3,000 PFAS
- Which ones to request results?
- Most laboratories have established their own lists; each different
- DEQ is establishing a standard list; we'll post at www.Michigan.gov/IPP

Analytes

- If other PFAS are known and of concern, you may request your lab to analyze for those as well
- Otherwise, request recommended analytes (DEQ's draft minimum analytes)

Recommended Analytes List (DRAFT)

PFAS Substance[1]	Acronym	Fluorinated Carbon Chain Length	Molecular Formula	CAS Registry Number	Minimal Analyte List[2]
Perfluorobutanoic Acid	PFBA	C_4	C_3F_7COOH	375-22-4	X
Perfluoropentanoic Acid	PFPeA	C_5	C_4F_9COOH	2706-90-3	X
Perfluorohexanoic Acid	PFHxA	C_6	$C_5F_{11}COOH$	307-24-4	X
Perfluoroheptanoic Acid	PFHpA	C_7	$C_6F_{13}COOH$	375-85-9	X
Perfluorooctanoic Acid	PFOA	C_8	$C_7F_{15}COOH$	335-67-1	X
Perfluorononanoic Acid	PFNA	C_9	$C_8F_{17}COOH$	375-95-1	X
Perfluorodecanoic Acid	PFDA	C_{10}	$C_9F_{19}COOH$	335-76-2	X
Perfluoroundecanoic Acid	PFUnDA	C_{11}	$C_{10}F_{21}COOH$	2058-94-8	X
Perfluorododecanoic Acid	PFDoDA	C_{12}	$C_{11}F_{23}COOH$	307-55-1	X
Perfluorotridecanoic Acid	PFTrDA	C_{13}	$C_{12}F_{25}COOH$	72629-94-8	X
Perfluorotetradecanoic Acid	PFTeDA	C_{14}	$C_{13}F_{27}COOH$	376-06-7	X
Perfluorobutane Sulfonic acid	PFBS	C_4	$C_4F_9SO_3H$	375-73-5	X
Perfluoropentane sulfonic acid	PFPeS	C_5	$C_5F_{11}SO_3H$	2706-91-4	X
Perfluorohexane Sulfonic acid	PFHxS	C_6	$C_6F_{13}SO_3H$	355-46-4	X
Perfluoroheptane Sulfonic acid	PFHpS	C_7	$C_7F_{15}SO_3H$	375-92-8	X
Perfluorooctane Sulfonic acid	PFOS	C_8	$C_8F_{17}SO_3H$	1763-23-1	X
Perfluorononane sulfonic acid	PFNS	C_9	$C_9F_{19}SO_3H$	474511-07-4	X
Perfluorodecane Sulfonic acid	PFDS	C_{10}	$C_{10}F_{21}SO_3H$	335-77-3	X
Perfluorooctane sulfonamide	FOSA	C_8	$C_8F_{17}SO_2NH_2$	754-91-6	X
4:2 Fluorotelomer sulfonic acid	4:2 FTSA	C_4	$_4F_9CH_2CH_2SO_3$	757124-72-4	X
6:2 Fluorotelomer sulfonic acid	6:2 FTSA	C_6	$_6F_{13}CH_2CH_2SO_3$	27619-97-2	X
8:2 Fluorotelomer sulfonic acid	8:2 FTSA	C_8	$_8F_{17}CH_2CH_2SO_3$	39108-34-4	X
N-Ethyl perfluorooctane sulfonamidoacetic acid	EtFOSAA	C_8	$C_8F_{17}SO_2N(C_2H_5)CH_2COOH$	2991-50-6	X
N-Methyl perfluorooctane sulfonamide	N-MeFOSA	C_8	$C_8F_{17}SO_2NH(CH_3)$	31506-32-8	X

1. Branched and linear isomers should both be reported

2. This list is based upon a draft EPA list that is likely to change in the future and it is also based upon contaminants found by MDEQ in Michigan's environment as of 3/1/2018. It should not be assumed that this list is a permanent, exhaustive lists and updates as the science of PFAS contamination and analysis continues to evolve.

Laboratories

- No DEQ certification for wastewater laboratories
- Choose a Lab with good QA/QC
- Starting point: DOD ELAP accredited laboratories for “EPA 537 Mod”

HTTP://WWW.DENIX.OSD.MIL/EDQW/ACCREDITATION/ACCREDITEDLABS/

IPP PFAS Resources and Assistance

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Overview

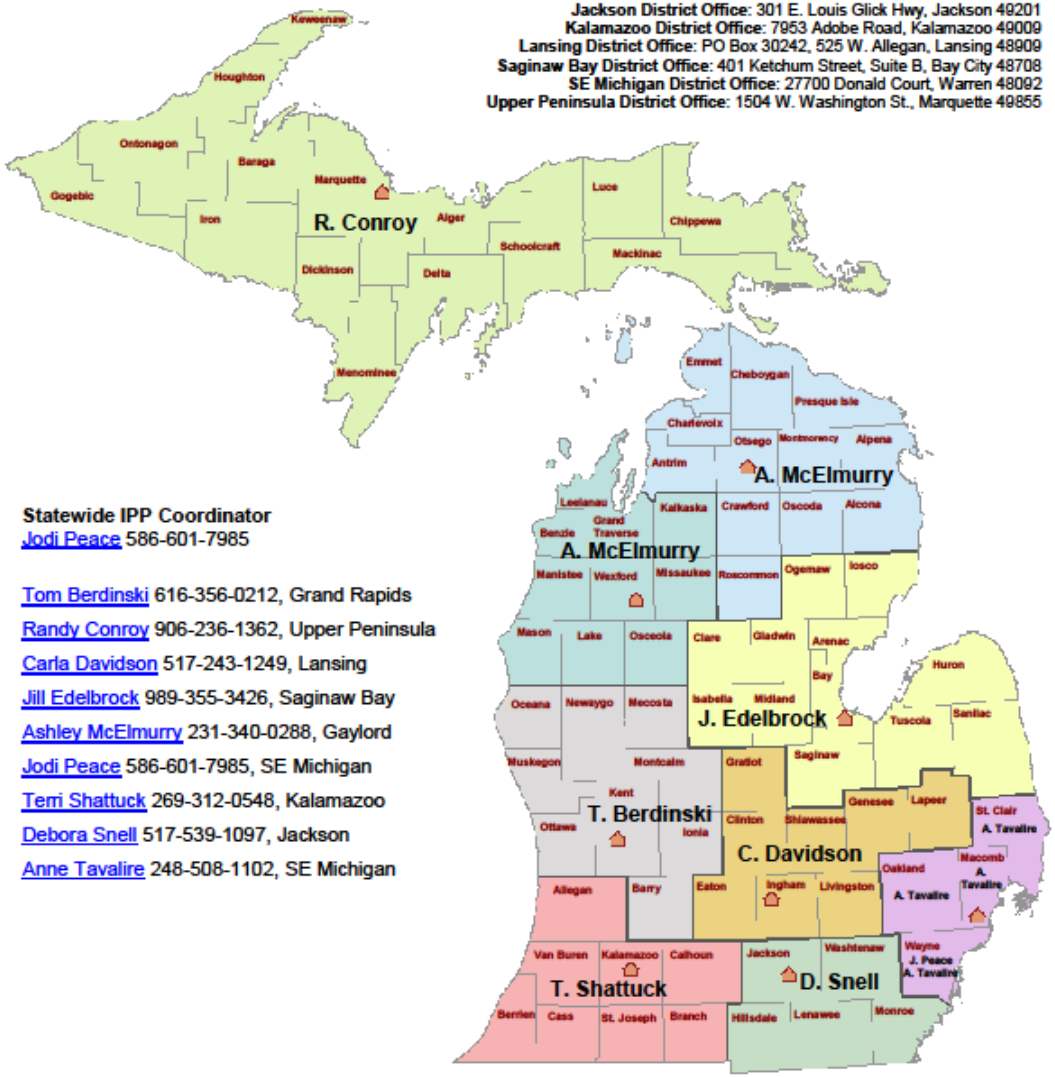
- To identify useful resources to assist POTW staff in the IPP PFAS effort
  - DEQ staff resources
  - Useful websites

District IPP Staff

Industrial Pretreatment Program (IPP) Staff

www.mi.gov/ipp

Cadillac District Office: 120 W. Chapin St, Cadillac 49601
Gaylord Field Office: 2100 West M-32, Gaylord 49735
Grand Rapids District Office: 5th Fl. 350 Ottawa Ave NW, Grand Rapids 49503
Jackson District Office: 301 E. Louis Glick Hwy, Jackson 49201
Kalamazoo District Office: 7953 Adobe Road, Kalamazoo 49009
Lansing District Office: PO Box 30242, 525 W. Allegan, Lansing 48909
Saginaw Bay District Office: 401 Ketchum Street, Suite B, Bay City 48708
SE Michigan District Office: 27700 Donald Court, Warren 48092
Upper Peninsula District Office: 1504 W. Washington St., Marquette 49855



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9/13/2017

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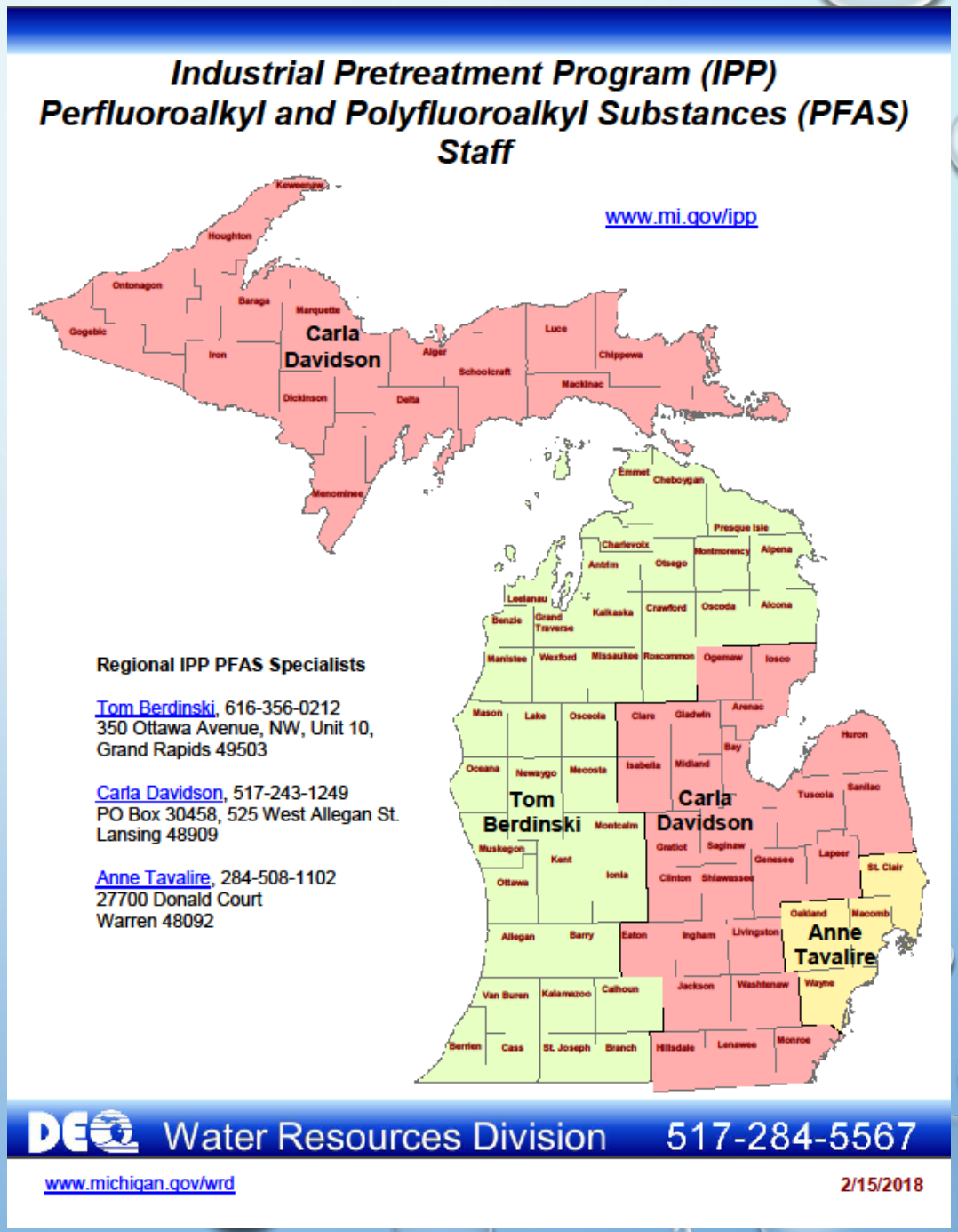
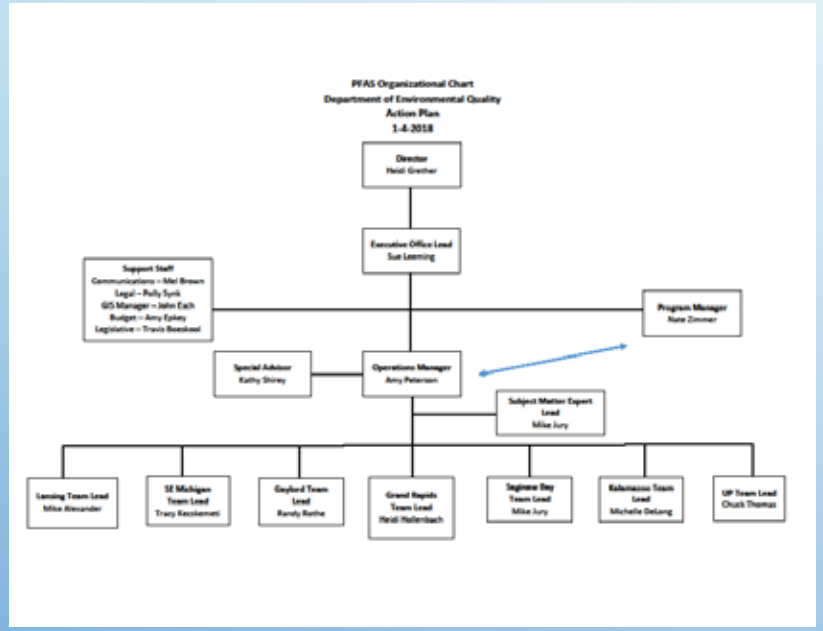
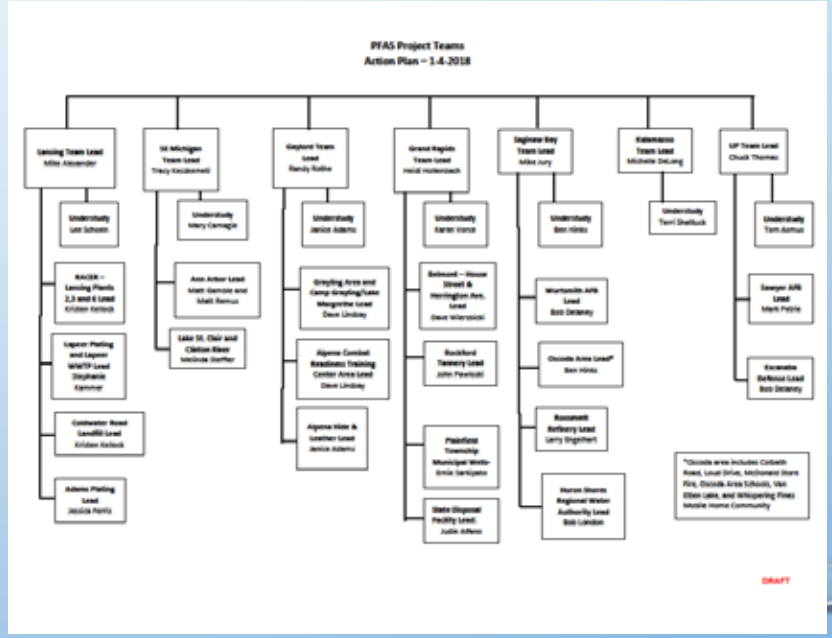


MORE DEQ RESOURCES

PFAS ORGANIZATIONAL CHART
DEPARTMENT OF ENVIRONMENTAL QUALITY
ACTION PLAN





Useful Website Resources

* DEQ IPP and EPA PFAS websites

* PFAS history, uses & sources websites

* Other PFAS websites of interest

DEQ IPP AND EPA PFAS WEBSITES

DEQ Industrial Pretreatment

http://www.michigan.gov/deq/0,4561,7-135-3313_71618_3682_3683_3721---,00.html

Several links to useful PFAS resources, more in the future including IPP PFAS FAQs, sampling guidance and more

Per- and Polyfluoroalkyl Substances (PFASs): What EPA is Doing

https://www.epa.gov/pfas/and-polyfluoroalkyl-substances-pfass-what-epa-doing

Overview of laws and regulations (including test methods) that are applicable as well as a sidebar on sites around the country – Also, the "Emerging Contaminant Fact Sheet – PFOS and PFOA"

PFAS History, Uses and Sources

Interstate Technology Regulatory Council

https://pfas-1.itrcweb.org

"History and Use of Per- and Polyfluoroalkyl Substances (PFAS)"

Table 4-1. Potential major manufacturing sources of PFAS releases to the environment

Sector	Example Uses	References
Textiles & Leather	Factory- or consumer-applied coating to repel water, oil, and stains. Applications include protective clothing and outerwear, umbrellas, tents, sails, architectural materials, carpets, and upholstery.	Rao and Baker 1994; Hekster, Laane, and de Voogt 2003; Brooke, Footitt, and Nwaogu 2004; Poulsen et al. 2005; Prevedouros et al. 2006; Walters and Santillo 2006; Trudel et al. 2008; Guo et al. 2009; USEPA 2009a; Ahrens 2011; Buck et al. 2011; UNEP 2011; Herzke, Olsson, and Posner 2012; Patagonia 2015; Kotthoff et al. 2015; ATSDR 2015
Paper Products	Surface coatings to repel grease and moisture. Uses include non-food paper packaging (for example, cardboard, carbonless forms, masking papers) and food-contact materials (for example, pizza boxes, fast food wrappers, microwave popcorn bags, baking papers, pet food bags).	Rao and Baker 1994; Kissa 2001; Hekster, Laane, and de Voogt 2003; Poulsen et al. 2005; Trudel et al. 2008; Buck et al. 2011; UNEP 2011; Kotthoff et al. 2015; Schaider et al. 2017
Metal Plating & Etching	Corrosion prevention, mechanical wear reduction, aesthetic enhancement, surfactant, wetting agent/fume suppressant for chrome, copper, nickel and tin electroplating, and post-plating cleaner.	USEPA 1996; USEPA 1998; Kissa 2001; Prevedouros et al. 2006; USEPA 2009b; UNEP 2011; OSHA 2013; KEMI 2015; Danish EPA 2015
Wire Manufacturing	Coating and insulation.	Kissa 2001; van der Putte et al. 2010; ASTSWMO 2015
Industrial Surfactants, Resins, Molds, Plastics	Manufacture of plastics and fluoropolymers, rubber, and compression mold release	Kissa 2001; Renner 2001; Poulsen et al. 2005; Fricke and Lahl 2005;

PFAS History, Uses and Sources

KEMI – Swedish Chemicals Agency

https://www.kemi.se/global/rapporter/2015/report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf

"Occurrence and use of highly fluorinated substances and alternatives"

6.2.6 *Metal (hard- and decorative-chrome plating)*

Fluorine-based surfactants are used as wetting agents in hard chrome plating processes[28] because they effectively reduce surface tension. During chrome plating hydrogen gas and oxygen gas are released from the chromium bath, drawing chromium vapour with them into the surrounding air.

The use of PFOS in non-decorative hard chrome plating is authorized under the Stockholm Convention[29]. PFOS-related substances reduce surface tension in the chromium (VI) bath and form a barrier over the bath, thereby inhibiting the release of chromium vapour (the Swedish Chemicals Agency 2004). Other wetting agents are broken down more or less rapidly under the conditions prevailing in the chromium bath (which are strongly corrosive and oxidizing). Chromium (VI) is carcinogenic and therefore its emission is regulated in order to protect workers from exposure in the work environment.

Examples of areas in which hard chrome plated metal is used are wheel bearings and couplings for the rail industry, hydraulic cylinders and moulds for the plastics and rubber industries. Before 2010 circa 200 kg PFOS was used each year by the hard chrome plating industry in Sweden. Now usage is circa 180 kg/year. According to information (Glas 2013) there are seven hard chrome plating facilities in Sweden, three of which use PFOS. Non-decorative hard chrome plating accounts for 95 percent of the market. Because of internationalization of the machine industry over recent decades, a number of companies have disappeared from the sector.

PFAS History, Uses and Sources

United Nations Environment Programme

https://www.oecd.org/env/ehs/risk-management/PFC_FINAL-Web.pdf

"Synthesis Paper on Per- and Polyfluorinated Chemicals (PFCS)"

Table 2: Overview of major historical and current uses of polymeric per- and polyfluoroalkyl substances (PFASs). It should also be noted that some uses may be obsolete and replaced by (non)fluorinated alternatives, which are discussed in Chapter 3. AR-AFFF = alcohol-resistant aqueous fire-fighting foams, FFFPs = film-forming fluoroprotein; FP = fluoroprotein foam.

Industry branch	Polymers	
1. Automotive	raw materials for components such as low-friction bearings & seals[9]	lubricants[8]
2. Aviation, aerospace & defense	insulators;[10] "solder sleeves";[10]	
3. Cable & wiring	coating for weathering, flame and soil resistance[9]	surface-treatment agent for conserving landmarks[8]
4. Construction	coating of architectural materials (fabrics, metals, stone, tiles, etc.);[8] additives in paints	

OTHER WEBSITES OF INTEREST

- **HUMAN HEALTH RELATED WEBSITES**:
  - MICHIGAN.GOV ENVIRONMENTAL **HEALTH "FREQUENTLY ASKED PFAS QUESTIONS"**
    - HTTP://WWW.MICHIGAN.GOV/SOM/0,4669,7-192-45414_45929_83470_83473-452154--,00.HTML
  - NATIONAL INSTITUTES OF HEALTH'S **"PFCS"**
    - HTTPS://WWW.NIEHS.NIH.GOV/HEALTH/MATERIALS/PERFLOURINATED_CHEMICALS_508.PDF
  - AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY **"PFAS EXPOSURE", "PFAS HEALTH EFFECTS" AND "PFAS FREQUENTLY ASKED QUESTIONS"**
    - HTTPS://WWW.ATSDR.CDC.GOV/PFAS/INDEX.HTML

OTHER WEBSITES OF INTEREST

- **PFAS STUDIES AND WEBSITES**:
  - MICHIGAN'S TOXICS STEERING GROUP **"PERFLUORINATED COMPOUNDS IN MICHIGAN – CURRENT STATE OF KNOWLEDGE AND RECOMMENDATIONS FOR FURTHER ACTIONS"**
    - HTTP://WWW.MICHIGAN.GOV/DEQ/0,4561,7-135-3307_29693_32185---,00.HTML
  - ENVIRONMENTAL SCIENCE AND TECHNOLOGY SEARCH **"PFAS"**
    - HTTPS://PUBS.ACS.ORG/JOURNAL/ESTHAG
  - EPA REGION 5 **"PFOS CHROMIUM ELECTROPLATER STUDY"** (2009)
    - HTTPS://WWW.IN.GOV/IDEM/CTAP/FILES/PLATING_CHROMIUM_PFOS_STUDY.PDF

OTHER WEBSITES OF INTEREST

- **PFAS TREATMENT TECHNOLOGIES AND BIOSOLIDS INFORMATION:**

  - AMERICAN WATER WORKS ASSOCIATION **"PERFLUORINATED COMPOUNDS – TREATMENT AND REMOVAL"**
    - WWW.AWWA.ORG

  - NORTHEAST BIOSOLIDS AND RESIDUALS **ASSOCIATION "PFAS IN BIOSOLIDS"**
    - WWW.NEBIOSOLIDS.ORG


Questions?