Health Consultation

PFOS DETECTIONS IN THE
CITY OF BRAINERD, MINNESOTA

CITY OF BRAINERD, CROW WING COUNTY, MINNESOTA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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HEALTH CONSULTATION

PFOS DETECTIONS IN THE CITY OF BRAINERD, MINNESOTA

CITY OF BRAINERD, CROW WING COUNTY, MINNESOTA

Prepared By:
Minnesota Department of Health
Under Cooperative Agreement with the
The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

FOREWORD

This document summarizes public health concerns regarding perfluorochemical contamination in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary to do such an evaluation:

- Evaluating exposure: MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

- Evaluating health effects: If there is evidence that people are being exposed—or could be exposed—to chemical substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

- Developing recommendations: In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with individual sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning people of the danger, and will work to resolve the problem.

- Soliciting community input: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us.*

Please write to:	Community Relations Coordinator Site Assessment and Consultation Unit Minnesota Department of Health 625 Robert Street N. / Box 64975 St. Paul, MN 55164-0975
OR call us at:	(651) 201-4897 *or* 1-800-657-3908 (toll free call—press "4" on your touch tone phone)
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I. Summary of Background and History

Summary

In the spring of 2007, the Minnesota Pollution Control Agency (MPCA) initiated a study of perfluorochemicals (PFCs) in influent, effluent, and sludge at public and private wastewater treatment plants (WWTPs) across the state of Minnesota. The study was done to determine if PFCs were present in these waste streams and could therefore be a source of PFCs to the broader environment. The study was also partly in response to the detection of elevated levels of PFOS in fish tissue in Lake Calhoun in Minneapolis, an urban lake with no known nearby PFC disposal sites or other obvious source of PFCs. PFOS has been shown to be toxic to the liver, thyroid, and to produce developmental effects in animal studies, and the presence of PFOS in fish in Lake Calhoun and other Minnesota lakes has resulted in the issuance of fish consumption advisory by the Minnesota Department of Health (MDH) to limit human exposure to PFOS.

MDH was asked for assistance by Brainerd Public Utilities (BPU) in evaluating the results of the MPCA study, which showed elevated levels of PFOS at the BPU WWTP (see below). The results of MDH's evaluation show that the discharge of PFOS containing treated water from the WWTP represents no apparent public health hazard at this time as PFOS levels in the river water and fish appear to be low.

Background

Starting in April 2007, the MPCA collected samples from 28 public and private wastewater treatment plants for analysis for 13 PFCs by Axys Analytical Services, British Columbia, Canada. Samples of influent (n=32), effluent (n=28), and sludge (n=23) were analyzed. The plants were located in all parts of the state. The survey was designed to provide as broad a range of data as possible across Minnesota. The sampling locations and data from the study, divided into three geographical regions, are presented in Appendix 1. Many of the plants located in rural areas had very low or non-detectable concentrations of PFCs, while plants located in larger urban areas consistently had detections of multiple PFCs. Other areas under study by the MPCA that could serve as potential sources of PFCs in the environment include land disposal facilities, ambient surface water, groundwater, and ambient air.

Several of the plants had elevated levels of individual or multiple PFCs that could reasonably be attributed to local sources, including known PFC contamination in nearby wells (e.g. Marathon-Ashland refinery in St. Paul Park, Washington County – an area where groundwater and drinking water wells have been impacted by nearby PFC manufacturing and waste disposal) or the known use of PFC containing products at a facility (e.g. MSP International Airport – where PFC-containing fire fighting foams have been used in emergency response). The most notable exception was perfluorooctane sulfonate (PFOS) found in the influent, effluent, and sludge from the City of Brainerd WWTP (operated by Brainerd Public Utilities, or BPU). The plant also serves the adjacent City of Baxter. The cities of Brainerd and Baxter are located about 135 miles northwest of St. Paul, along the Mississippi River. This plant had the highest detections of PFOS in all three media of any of the wastewater treatment plants tested. The April 2007 PFOS concentrations at Brainerd were as follows:

- Influent: 0.811 micrograms per liter (µg/L)
- Effluent: 1.51 µg/L

- Sludge: 861 micrograms per kilogram (µg/kg)

These values are higher than any levels previously reported in scientific literature, although the data are limited (see below). PFOS is one of the more well-studied PFCs, from an environmental and toxicological standpoint, and has been a focus in Minnesota in drinking water and fish tissue due to its toxicity in animal studies and ability to bioaccumulate in wildlife and humans.

BPU has continued to collect samples from the WWTP, and from several locations within the collection system to monitor PFOS levels. The sample results have varied somewhat; this is not unexpected given the number of factors that likely affect daily wastewater flow rates into the system. Grab sample data for PFOS at the BPU treatment plant are as follows:

Table 1: PFOS Levels at the BPU WWTP, µg/L

Location	**7/24/2007**	**8/13/2007**	**10/25/2007**	**11/14/07**
Influent	0.954	0.121	0.598	0.326
Effluent	0.544	0.189	0.814	0.335

The MPCA announced the preliminary findings of the wastewater treatment plant study in a press release issued on July 20, 2007. The PFOS levels found at the Brainerd WWTP were described in the press release as significantly higher than other plants in the study. As a result, the MPCA Citizen's Board postponed a decision on a request by the City of Brainerd for a permit to expand their WWTP. The city applied for the permit because of growing demands on their wastewater treatment capacity – a result of local population growth and an expanding industrial base. Subsequently, the City of Brainerd (through BPU) initiated an investigation to determine the source(s) of the PFOS detected at the treatment plant. BPU staff requested assistance from MDH staff in analyzing drinking water samples, and in evaluating possible sources of PFOS to the WWTP.

The initial BPU investigation (implemented by Barr Engineering Company, Minneapolis, MN) involved the collection of 35 samples of wastewater from the treatment plant and numerous locations spread throughout the city. The samples were collected using new polyethylene bailers which were lowered into the waste stream (typically through an open manhole in the case of samples collected in the city), filled, and then decanted into sample containers provided by the laboratory. The samples were analyzed by MPI Research (formerly Exygen Research) of State College, PA for the presence of 13 PFCs, including PFOS. The sample locations are shown in Figure 1, while the data are presented in Appendix 2. Both were provided to MDH by Barr Engineering Company staff. The detection limits achieved by the MPI Research laboratory were very low, and the data quality appears to be good.

The results from samples collected at the treatment plant itself were generally consistent with the MPCA results for PFOS and other PFCs. Results for samples taken in the wastewater collection system, away from the WWTP and out in the city, were more variable. PFOS was detected in five samples, four of which were at concentrations ranging from 0.08 to 1.18 µg/L. The fifth sample, collected at a manhole on 10th Street, just south of Madison Street in an industrial park (location 17 in Figure 1) had a PFOS concentration of 49.8 µg/L.

Subsequent investigations have tentatively identified the sources of some of the minor detections of PFOS to the wastewater treatment system as a metal working facility, a printing shop, and a state-owned hospital facility. The likely major source is described in the following section.

PFC Investigations at Keystone Automotive

Keystone Automotive, a chrome plating operation specializing in automobile bumpers, is located in the industrial park adjacent to the manhole at sample location 17. Representatives from Keystone Automotive contacted BPU staff to inform them that the company used a legal surfactant product that likely contained PFOS in their operations. The product is added to a chrome plating bath to reduce surface tension, which in turn helps reduce emissions of hexavalent chromium from the plating solution. Hexavalent chromium can be released into the air with the bursting of bubbles formed below the surface of the tank solutions during electroplating. This is important from a worker safety and environmental standpoint, as hexavalent chromium is toxic through both inhalation and dermal contact, and is considered a human carcinogen (ATSDR 2000). The location of Keystone Automotive, relative to this sample location and the BPU treatment plant, is shown in Figure 1. Photographs of the chrome plating tank at Keystone Automotive are shown in Figure 2.

The product used by Keystone Automotive was identified as Fumetrol™ 140 Mist Suppressant (Atotech USA, Rock Hill, SC). Available Material Safety Data Sheets (MSDS) for the product indicate that it contains an “organic fluorosulfonate” between 1% and 7% by weight. The company reported using 16 fluid ounces per day of the product in their chrome plating tank to maintain surface tension (and hence hexavalent chromium emissions) below EPA required limits (K. Anderson, Keystone Automotive, personal communication 2007). This amount of product used (approximately 30 gallons per year), coupled with the reported average water flow rate through the facility of approximately five gallons per minute (5 gpm), would appear to be responsible for the majority of the PFOS found in samples at the BPU treatment plant.

The initial response to the determination that the chrome plating bath at Keystone Automotive was the most likely source of PFOS in the BPU wastewater treatment system was the installation of a temporary granular activated carbon (GAC) filter on the facility’s wastewater stream. The filter was constructed in a plastic tub, and consisted of 550 pounds of GAC. GAC is effective at removing PFOS from drinking water, and has been successfully used to remove PFCs from the wastewater stream at the 3M-Cottage Grove facility (MDH 2005). The intent of the filter was to serve as a temporary measure while other mist suppressant products (that reportedly did not contain PFOS) were obtained from the company’s suppliers and tested.

MDH staff consulted with 3M staff, due to their experience with GAC treatment for PFCs, to try to determine if the filter system would be effective in removing PFOS from the wastewater stream, and if so, for how long it would be effective. Based on calculations done by 3M staff that initially assumed a PFOS influent concentration of 50 µg/L (the PFOS level in the July sample collected at the manhole near Keystone Automotive), 3M estimated that the system would effectively remove PFOS for a period of approximately 17½ days (G. Hohenstein, 3M, personal communication 2007).

Samples were collected by BPU staff at Keystone Automotive after the initial single GAC filter had been in operation for approximately six days. The results showed an influent PFOS concentration to the GAC filter of 185 µg/L, and an effluent PFOS concentration after the GAC filter of 210 µg/L. The influent PFOS concentration was 3.7 times higher than that used in the calculations made by 3M and as a result, the time to PFOS breakthrough of the filter would have been something less than five days instead of 17½ days. Clearly the GAC filter was not removing the PFOS, and was in fact serving as a reservoir of PFOS and releasing it back into the wastewater stream. It must be stated that 3M staff based their calculations on data from treatment systems at their own facilities. The wastewater stream at Keystone Automotive is much different in terms of its composition, pH, and other factors which can significantly affect the adsorption of PFOS onto the activated carbon. The addition of the second GAC unit in series with the first likely resulted in only a temporary reduction in PFOS levels.

In early September 2007, Keystone Automotive switched to a different mist suppressant, MSP 28™ (also from Atotech USA). While the MSDS from the manufacturer/distributor of this product does not describe its composition, it reportedly does not contain PFOS or other PFCs. Initial testing has shown it to be effective at meeting the surface tension limits established by EPA. It has been slightly more costly, however than the previous product used by Keystone Automotive, mainly because higher quantities have been needed to meet surface tension limits.

Because PFOS continued to be detected at the BPU WWTP at elevated concentrations even after Keystone Automotive switched products, BPU has worked with Keystone Automotive to try to identify where PFOS remains within their facility. The process involved sampling at the location where the Fumetrol™ 140 Mist Suppressant was used (the chrome plating tank), and moving downstream to include the rinse tanks. Initial samples were collected in October 2007 and analyzed by MPI Research. The chrome plating tank solution had a PFOS concentration of 1,650 µg/L, while the final (of four) rinse tank had a PFOS concentration of 306 µg/L. The lower photograph in Figure 2 shows bumpers being moved from the chrome plating bath to the rinse tanks. Drippage of plating fluid from the bumpers into the rinse tanks can be seen, which is likely responsible for the detection of PFOS in the rinse tanks.

Additional samples were collected in November 2007 for analysis of 13 PFCs by MPI Research, and the results are shown in Appendix 3. A number of different plating solutions were sampled in addition to the chrome plating tanks. These other plating solutions (nickel, copper) are located "upstream" of the chrome plating tank in the process line and were generally low in PFOS, 1.25 µg/L or less. The chrome plating tank solution had a PFOS concentration of 823 µg/L. The level of another PFC, perfluorobutane sulfonate (PFBS, a four-carbon PFC) was 176,000 µg/L in this tank. PFOS was detected at a concentration of 33,000 µg/L in the Electroclean tank solution. The high PFBS and PFOS levels in these two samples are almost certainly estimates, as the samples were diluted and levels this high would normally be outside the calibration range of the instruments used for the analysis. A sample of the replacement fume suppressant product, MSP 28™, showed low levels of PFCs, including PFOS at a concentration of 0.437 µg/L.

To help verify and expand on the findings of the November samples, several additional samples were collected at Keystone Automotive by BPU staff in December 2007 for analysis at the MDH Public Health Laboratory in St. Paul, Minnesota. The samples were analyzed for seven PFCs, and the results are shown in Table 2. Multiple dilutions were required for some samples due to the high concentrations of PFCs; the sample results have been adjusted accordingly so that the data are comparable. Formal report limits were also elevated due to the dilutions used.

Table 2: Dec. 2007 Keystone Automotive Samples Analyzed by MDH, µg/L

Sample Location	PFBA	PFPeA	PFBS	PFHxS	PFOS
Chrome Tank	nd	nd	97,039	19.11	1,635
Soak Tank	11.96	8.05	84.6	nd	373
ElectroClean Tank	38.67	19.04	136	nd	2,757
Floor Drain water	nd	nd	48	nd	278
New Soak Solution	nd	nd	nd	nd	nd
New ElectroClean Solution	nd	nd	nd	nd	2.16

nd = not detected (<30 µg/L).

Two of the samples (new soak solution and new ElectroClean solution) were of stock solutions made up in the company laboratory, and were not from the process area. One showed a low level of PFOS, 2.16 µg/L. The floor drain receives water used to clean parts removed from the final rinse tank, and discharges to the on-site wastewater treatment system. The rinse tanks become contaminated with PFOS (and PFBS) from the carryover of chrome plating solution on automobile bumpers or other products to the rinse tanks (as shown in Figure 2). While the expectation was that the PFOS concentration in the chrome tank should have dropped after the switch was made to the low-PFC containing MSP 28™ in September, 2007, the MDH results for the chrome tank are similar to the initial sample collected in October and analyzed by MPI Research, and higher than the November sample. Such variability may be normal, as no systematic study of this type of operation has been conducted, no standard sampling protocol exists, and very little is known about the behavior of PFOS in plating baths.

It may take some time for the PFOS (and PFBS) to be flushed through the plating tanks and piping at the Keystone Automotive facility. The process could be accelerated by removing and cleaning what appears to be the main source of PFOS, the chrome solution tank. PFOS is likely bound in part to organic matter and sludge in the tank, which could be contributing to the continuing detections of PFOS. The tanks are reportedly cleaned and the sludge thermally treated (and metals recovered) at an out-of-state hazardous waste treatment facility every five years; the company is reportedly at the mid-point of this cycle (K. Anderson, Keystone Automotive, personal communication 2008). Thermal treatment at a high temperature has the capability of destroying PFCs. In the meantime, Keystone Automotive continues to be the main contributor of PFOS to the Brainerd wastewater collection and treatment system.

<u>Drinking Water Samples</u>

When the PFOS detections in the BPU WWTP were first announced, there was immediate concern that the city's drinking water could be contaminated, as potable water used for drinking, cooking, bathing, etc. likely makes up a large portion of the water entering the WWTP. MDH staff moved quickly to collect samples from the city drinking water treatment plant for analysis at the MDH laboratory. Samples were collected on July 25, 2007; no PFCs were detected in the samples. Samples were collected from the Brainerd drinking water plant and the drinking water treatment plant in the adjacent City of Baxter at about the same time by the City of Brainerd for analysis at MPI Research. No PFOS or PFOA was detected in any of the five samples from the two plants; trace amounts of two other PFCs were found in some of the samples.

After processing, sludge generated at the BPU WWTP is land applied on agricultural fields at several locations near the city. Because of the high levels of PFOS detected in sludge samples collected at the plant, and the high mobility of PFOS in the environment, BPU officials collected samples from two residential wells located near the agricultural fields for analysis by the MDH laboratory. No PFCs were detected in either well. Crop samples (alfalfa, corn) were also collected from the fields and submitted to the MDH laboratory for future analysis. The MDH laboratory has not yet developed methodology for extracting PFCs from solid matrices, so the samples are being stored (frozen) until such a time as they can be analyzed. PFOS does not degrade naturally, so even an extended period of storage should not significantly affect any PFOS that could be contained in the plants.

Mississippi River Fish and Surface Water Data

In August 2007, Minnesota Department of Natural Resources (DNR) staff, at the request of MPCA staff, collected samples of four species of fish in the Mississippi River for analysis of the fillets for 13 PFCs, including PFOS. The fish were collected approximately ¼ mile below the BPU WWTP outfall to the river (shown in Figure 1), which would be about at river mile 1001 (L. Solem, MPCA, personal communication 2008). The samples were analyzed by Axys Analytical Laboratory in British Columbia, Canada. No other PFCs besides PFOS were detected in any of the fish samples. Summary statistics (provided by the MPCA) for PFOS in the 15 fish samples are presented in Table 3.

Table 3: Average PFOS Concentration, Mississippi River Fish, µg/kg

	Bluegill	Smallmouth Bass	Northern Pike	Walleye
Mississippi River, Brainerd area	10 (2)*	13 (5)	7 (3)	9 (5)

* average PFOS concentration (# fish).

These levels of PFOS are significantly lower than the threshold value used by MDH to consider issuing contaminant-specific fish consumption advice, which is currently 38 µg/kg of PFOS in edible fish tissue. This threshold is based on a reference dose derived from a toxicological study conducted in monkeys (Seacat et. al 2002) that is also the basis for MDH drinking water criteria for PFOS (see below).

The average PFOS levels found by the MPCA are comparable to levels reported in carp in the upper Mississippi River by Ye et al. (2007) in an as-yet unpublished study conducted by EPA. That study, which measured PFOS levels in carp fillets in three sections of the Mississippi River, reported a median PFOS level of 8.1 µg/kg in nine carp collected at river mile 937. This site is located between the cities of Brainerd and St. Cloud, Minnesota and was intended as a "background" location. Higher median levels (25.9 and 40.2 µg/kg) were found in carp fillets from further down the Mississippi River (in an area known as Pool 2), in the vicinity of St. Paul at river miles 833 and 816, respectively. These samples were collected near identified sources of PFC discharge to the Mississippi River, such as landfills and the 3M-Cottage Grove facility. Samples of carp fillets collected by the MPCA in 2005 from Pool 2 of the Mississippi River and analyzed for PFCs showed a higher median level of PFOS, 175 µg/kg (McCann et. al 2007). Samples collected further downstream in 2005 by the MPCA in Lake Pepin (Pool 4) had a median PFOS level of 50 µg/kg.

In October, 2007, MPCA staff collected surface water samples from the Mississippi River at several locations above, at, and below the BPU WWTP outfall to the river for analysis for PFCs. PFOS was reportedly not detected in surface water samples collected above and below the BPU WWTP outfall. PFOS was detected at approximately 0.1 µg/L in samples of river water collected right at the point of the WWTP outfall (see Figure 1). The river was reportedly near flood stage at the time the samples were collected, and rapid dilution may explain why PFOS was not detected below the WWTP.

Site Visit

On Monday, February 11, 2008 MDH staff conducted a site visit at Keystone Automotive, located at 2110 10th Street South in Brainerd, Minnesota. The purpose of the site visit was to observe the facilities plating operation, especially the chrome plating area. Keystone Automotive is reportedly one of the largest chrome bumper repair and plating facilities in the Unites States.

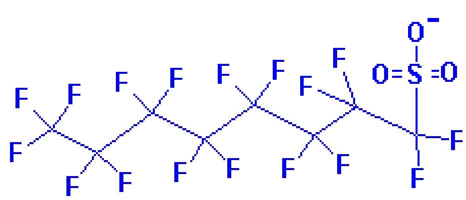
Keystone Automotives' main business is the repair and re-plating of chrome automobile parts, including bumpers, headlight fixtures, and other "shiny" parts for vintage and modern vehicles. The electroplating process consists of the layering of copper, nickel, and chrome on the parts in successive operations. Following each plating solution (copper, nickel, and chrome) are cleaning solution baths and/or rinse tanks to remove the plating solutions. The rinse tanks consist of four tanks in series. Water flow is from the final rinse tank back towards the first rinse tank, and ultimately to the electroplating tank and on-site wastewater treatment plant. Parts are moved on racks between the various plating baths and rinse tanks.

The chrome plating solution is orange in color, and the "foam" layer on the surface of the chrome plating solution is a result of the use of the surfactant-based fume suppressant (see Figure 2). Drippage (or carry-over) of plating solution from the bumpers into the rinse tanks can be seen in Figure 2 as well. After the plating process is complete, the racks of parts are removed, cleaned with a spray hose (which drains into a floor drain), dried, buffed and wrapped for shipment to the customer.

MDH staff also toured the wastewater treatment plant operated by BPU, which is located at 7933 Highland Scenic Road in Brainerd. The purpose of the tour was to observe the basic plant layout, and the locations where PFC samples were collected. A schematic of the plant was provided by BPU staff.

II. Discussion

Perfluorooctane sulfonate (PFOS; $C_8F_{17}SO_3^-$) based products were produced by 3M in the United States until 2002. 3M ended production over concerns about the mobility and persistence of PFOS in the environment, bioaccumulation of PFOS by animals, and long half-life in humans (3M 2000). PFOS is still manufactured elsewhere in the world, however.



Chemical Structure of Perfluorooctane sulfonate, PFOS

The carbon-fluorine bond is a high-energy bond, one of the strongest known among organic molecules. As a result, the chemical structure of PFOS makes it extremely resistant to natural breakdown, and it is persistent once released to the environment. The structure of PFCs in general makes them excellent surfactants. The word surfactant is an acronym for 'surface active agent' - a molecule that lowers surface tension in a liquid. This property in particular helps make PFOS-based mist suppressants effective at reducing hexavalent chromium emissions from chrome plating tanks.

On the basis of its physical properties, PFOS is essentially non-volatile, and would not be expected to evaporate from water (OECD 2002). In soil-water mixtures, PFOS has a strong tendency to remain in water due to its solubility (typically 80% remains in water and 20% in soil). PFOS is expected to be mobile in water at equilibrium (3M 2003).

PFOS has been detected in the blood plasma and tissues of wildlife from across the globe, including seals, otters, dolphins, aquatic birds, bald eagles, polar bears, freshwater and saltwater fish, and reptiles (Giesy and Kannan 2001). This landmark study showed that PFOS is widely distributed in the global environment. Levels of PFOS were higher in fish-eating and predatory animals than in their typical prey, indicating that PFOS bioconcentrates as it moves up the food chain. Bald eagles from the Midwestern U.S. showed the highest levels of PFOS in blood plasma in the study, and mink from the Midwestern U.S. showed the highest levels in tissue (liver).

Estimated bioconcentration factors (BCF) for PFOS in fish range from 200 to 1,500 in carp and 1,124 to 4,013 in bluegills (OECD 2002). For benthic invertebrates, a BCF of approximately 1,000 for PFOS has been estimated by Kannan et al. (2005). A study by Martin et al. (2004) in Lake Ontario demonstrated that PFOS could be found throughout the food web in the lake, at all trophic levels, and that contaminated sediment was a major source. These studies clearly demonstrate that low levels of PFOS in water and sediment have the ability to become concentrated in fish populations. The study by Kannan et al. (2005) also suggests that a considerable amount of PFOS is transferred to the next generation through the eggs of fish. Other PFCs do not appear to bioconcentrate as significantly as PFOS, which may be due to a positive relationship between the hydrophobicity of various surfactants such as PFCs and their ability to bioconcentrate (Tolls and Sijm 1995).

A decreasing gradient of PFOS levels in aquatic invertebrates and two species of fish in an estuary and the North Sea was observed with distance from the port of Antwerp, Belgium (Van de Vijver et al. 2003; Hoff et al. 2003). 3M operated a manufacturing plant in Antwerp for many years where PFOS was made.

The BPU WWTP had the highest level of PFBS ($C_4F_9SO_3^-$) in WWTP effluent samples collected by the MPCA (see Appendix 1). According to information from 3M (3M 2004), PFBS is persistent in the environment, is not metabolized in living organisms, but unlike PFOS, does not bioconcentrate or accumulate in organisms. It is non-volatile, very soluble in water, and does not partition to sediments. It has shown very low toxicity in animal studies, including reproductive and developmental studies.

PFC Studies at Wastewater Treatment Plants

Previous studies of PFCs at wastewater treatment plants in the Twin Cities metro area (Oliaei et al. 2006), Iowa (Boulanger et al. 2005), six cities around the southeast United States (3M 2001), Kentucky and Georgia (Loganathan et al. 2007), New York state (Sinclair and Kannan 2007), the Pacific Northwest (Schultz et al. 2006) and Denmark (Bossi et al. 2007) have identified the presence of low levels of PFOS in WWTP influent, effluent, and sludge. Table 4 shows the ranges of PFOS reported in the various studies; single values represent one location.

Table 4: Range of PFOS Levels Reported in WWTP Influent, Effluent, and Sludge

Study	WWTP Location	Influent, ug/L	Effluent, ug/L	Sludge, ug/kg
Logonathan et al. 2007	Rural Kentucky Urban Georgia	0.007 - 0.016 0.0025 -0.0079	0.008 - 0.028 0.0018 - 0.013	8.2 – 110 38 – 77
Sinclair & Kannan 2006	New York State (6 locations)	Not reported	0.003 – 0.068	< 10 - 65
Boulanger et al. 2007	Iowa	0.40[1]	0.026	Not reported
3M 2001	6 Cities, SE US	Not reported	0.041 – 5.29[2]	60 - 3,120[2]
Oliaei et al. 2006	St. Paul, MN	0.053	0.081	37 - 397
Schultz et al. 2006	NW US	0.015	0.018	53
Bossi et al. 2007	Denmark (6 loc.)	<0.0015 - 0.01	<0.0015 – 0.18	4.8 – 74.1
MPCA 2007	Statewide median	0.0353	0.0305	24.6

[1]Estimated concentration due to analytical problem.
[2]Maximum value is for the Decatur, Alabama WWTP.

In the 3M six-city study (3M 2001), four cities where PFCs were manufactured or used (supply cities), and two control cities in the southeastern United States were targeted for evaluation of various media for PFCs, including WWTP effluent and sludge. One of the cities in the study, Decatur, Alabama was the location of a 3M manufacturing plant for PFOS-containing products until 2002. The PFOS data for the Decatur WWTP are much higher than WWTP data for other cities in this study, or in other published studies. If the results for the Decatur WWTP are removed, the data from the various published studies generally fall within the same range. Median values in the statewide study conducted by the MPCA also fall within the same general range. Clearly, a major source of PFOS in wastewater such as the 3M plant in Decatur or the discharge from Keystone Automotive in Brainerd can significantly increase PFOS levels at an individual WWTP. Conversely, the finding of elevated levels of PFOS in WWTP influent, effluent, or sludge is an indicator that a local source is likely present.

According to the 3M study (3M 2001) and other published reports, PFOS readily adsorbs to soil/sediment/sludge matrices. Due to the acidic nature of PFOS, once adsorbed, it forms strong bonds with sludge particles and does not readily desorb. This chemical interaction or partitioning to solids in wastewaters is typical of many organic contaminants and may explain the relatively higher levels of PFOS in WWTP sludge compared to the concentration of PFOS in the wastewater at the same plant.

Levels of other PFCs analyzed for in the various studies described above were generally much lower or not detected, with the exception of perfluorooctanoic acid (PFOA), a PFC still used in various industrial and commercial applications. PFOA does not appreciably bioconcentrate in fish or other animals in the aquatic environment (Kannan et al. 2005).

Use of PFOS-Containing Fume Suppressants in the Metal Plating Industry

On October 9, 2007 EPA published a proposed expanded “Significant New Use Rule” (SNUR; 40 CFR Part 721.9582) in the Federal Register (72 FR 57222) regarding perfluoroalkyl sulfonates not already covered in previous rules under the Toxic Substances Control Act (TSCA). The proposed rule requires manufacturers and importers to notify EPA at least 90 days before beginning to manufacture or import the chemicals listed in the SNUR. The SNUR lists four exemptions from the rule for specific uses of PFOS containing compounds, including:

- Use as an ant-erosion additive in fire-resistant phosphate ester aviation hydraulic fluids;
- Use as a component of a photoresist substance, etchant or anti-reflective coating in the semiconductor and electronic device industries;
- Use is coatings for surface tension, static discharge, and adhesion control for analog and digital imaging films, papers, and printing plates; and
- Use as a fume/mist suppressant in metal finishing and plating baths.

The first three exemptions had been described in previous SNURs; the final exemption was new. Exemptions to SNURs are presumably granted by EPA because alternative products are not available, are too costly, or are not effective. In the case of the metal plating industry, a comment submitted to EPA (presumably from industry) and included in the October 9, 2007 federal register notice stated that “the releases of (PFOS) associated with the industry are comparably of much less concern than those related to nickel and hexavalent chromium which result when (PFOS) fume suppressants are not used.” In its response to the comment, EPA acknowledged this fact and stated that it had included an exemption for this use in the rule, but “encourages the continued exploration for possible substitutes.” Clearly there are costs and benefits associated with the use of PFOS containing mist suppressants in the metal plating industry. The proposed expanded SNUR was to become final in November 2007.

In a memorandum from the regional administrator of EPA Region 5 (which includes Minnesota) to officials at EPA headquarters, Region 5 described the use of PFOS containing mist suppressants in the metal plating industry and made several recommendations for further action (EPA 2007). EPA has estimated that no more than eight metric tons of PFOS containing compounds are used per year in the U.S. in the metal plating industry, but that specific amounts used or released by metal platers are not reported. In the memorandum, EPA Region 5 recommended that EPA consider PFOS in a residual risk assessment of the chrome plating industry already being conducted, that EPA consider delaying the final implementation of the expanded SNUR to gather additional information, that further investigation of the discharge of PFOS from the metal plating industry to local wastewater plants be conducted, and that any additional PFOS compounds in the plating industry be identified and included in the expanded SNUR. Nevertheless, the SNUR became final in November, 2007.

In a report on PFOS prepared in part for the Environment Agency for England and Wales, consultants to that Agency evaluated the environmental risks associated with current uses of PFOS (RPA 2004). The report estimated that 10,000 kilograms (10 metric tons) of PFOS were used per year in chromium plating in the European Union (EU), by far the largest use of PFOS in any industrial sector. The report went on to identify this use as a potential risk to the freshwater and marine food chains, and proposed that the use of PFOS containing mist suppressants be phased out in favor of alternative methods of reducing hexavalent chromium emissions.

The switch to a mist suppressant (MSP 28™) with a very low level of PFOS (0.437 µg/L), seems to be working for Keystone Automotive, meeting surface tension requirements to limit hexavalent chromium emissions (K. Anderson, Keystone Automotive, personal communication 2007). The effect (either positive or negative) of the residual presence of the previous, PFOS-containing product on the performance of the current product is unclear, however. If this product continues to be effective, at a similar cost to the PFOS containing product, it appears that based on this facility there is an alternative that may be acceptable to the industry at large.

With the switch in products, levels of PFOS in wastewater from the Keystone Automotive facility should decline over time. Removing the contents of the chrome plating tank, which appears to be the main source of PFOS, would speed up the process. The PFOS contained in the tank would likely be destroyed during thermal treatment of the sludge from the tank. Cleaning out the remaining tanks all at one time may not be advisable, as it could generate a "slug" of PFOS to the BPU WWTP and ultimately to the Mississippi River that could have deleterious effects on microorganisms in the treatment plant and aquatic organisms in the river near the outfall of the treatment plant.

Evaluation of Toxicity and Exposure

PFOS is well absorbed orally, but is not absorbed well through inhalation or dermal contact (OECD 2002). Exposure to high levels of PFOS is acutely toxic in test animals. Chronic exposure to PFOS at high doses results in liver toxicity and mortality, with a steep dose-response curve for mortality in rats and primates (OECD 2002; Seacat et. al 2002). Indications of toxicity observed in 90-day rat studies include increases in liver enzymes and other adverse liver effects, gastrointestinal effects, blood abnormalities, weight loss, convulsions, and death. Various reproductive studies of rats followed for two generations showed postnatal deaths and other developmental effects in offspring of female rats exposed to relatively low doses of PFOS (OECD 2002). These studies demonstrate that exposure to PFOS can result in adverse effects on the offspring of rats exposed while pregnant. Further information on the toxicity of PFOS, including a list of the various studies reviewed by MDH to establish reference doses, drinking water values and fish consumption advice can be found on the MDH website at http://www.health.state.mn.us/divs/eh/groundwater/perfluorohrls.html.

A completed exposure pathway exists when people come into contact with contaminated soil, sediments, water, air, or other environmental media. For a completed exposure pathway to represent a public health hazard, the concentration of contaminants must exceed levels of health concern and the exposure must be frequent or intense enough for the body to absorb the contaminants at levels that could increase the risk of adverse health effects.

At Keystone Automotive, there is little potential for exposure to PFOS except for staff who may have added the PFOS-containing fume suppressant directly to the chrome plating tank. Minor exposure could have occurred through dermal contact or incidental ingestion during that process. Because plating solutions typically are very corrosive and are electrified, direct contact with the solutions themselves by other employees is minimal, and protective equipment is worn.

There is also little potential for exposure to PFOS at the BPU WWTP. Employees at such facilities typically do not come into contact with wastewater for any length of time, and protective equipment is typically worn. Sludge from the WWTP does contain high levels of PFOS because of its affinity for binding with sludge. The application of the sludge on local agricultural fields does not appear to have impacted the nearest drinking water wells, perhaps because the PFOS is bound tightly enough to prevent significant leaching. It is not clear, however if crops grown on the fields have taken up PFOS from the sludge, as this issue has not been widely studied. If crops do absorb PFOS from soils, PFOS could be entering the human foodchain if the crops are eaten directly, or more likely fed to animals that are in turn used to provide milk or meat.

It is also possible that direct human contact with soil where the sludge has been incorporated could be of potential health concern, depending on the level of PFOS in the soil. The MPCA has established a Soil Reference Value (SRV) for PFOS of 2,000 ug/kg for PFOS based on a residential exposure scenario (MPCA 2007a). An SRV represents the concentration of a contaminant in soil at or below which normal dermal contact, inhalation, and/or ingestion are unlikely to result in an adverse human health effect. They are typically used to evaluate if contaminant levels in shallow soil could pose a long-term human health risk. The PFOS level in the sludge from the BPU WWTP was 861 ug/kg. If sludge containing this level of PFOS was applied repeatedly to the same field, the concentrations could exceed the SRV over time.

Human exposure to PFOS originating from the Keystone Automotive facility could also occur when the discharge from the BPU WWTP enters the Mississippi River. Exposure could occur through direct contact or ingestion during swimming or wading, or through ingestion of PFOS contaminated fish. Based on water and fish samples collected by the MPCA, however, it appears that the PFOS is quickly diluted to non-detectable levels in the river (based on one sample event) and that levels of PFOS in fish are well below current MDH guidelines for issuing contaminant-specific fish consumption advice. Additional data would be helpful to determine if levels of PFOS in the river or local fish population changes over time, or with changing river conditions. Sediment data would also be useful.

<u>Child Health Considerations</u>

ATSDR recognizes that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances at waste disposal sites. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Opportunities for exposure by children to PFOS at the Keystone Automotive facility, the Brainerd wastewater treatment plant, or sanitary sewer system should be minimal. Some exposure to PFOS or related compounds could occur in the Mississippi River near the WWTP outfall, although the exposure would be brief based on surface water data. Exposure to PFOS from the consumption of fish from the Mississippi River near Brainerd appears to be below levels of health concern.

III. Conclusions

The presence of PFOS at Keystone Automotive and the BPU WWTP poses no apparent public health hazard directly to employees of either facility or the general public. The discharge of PFOS containing treated water from the WWTP also represents no apparent public health hazard at this time as PFOS levels in the river water and fish appear to be low. An alternate surfactant product is currently being used by Keystone Automotive and levels of PFOS in wastewater from their facility and at the BPU WWTP are expected to drop over time. Further sampling would be helpful, however. The land spreading of sludge from the BPU WWTP represents an indeterminate public health hazard. This indeterminate conclusion is based on the fact that little is known about the levels of PFOS in agricultural fields where the sludge is applied, and the uptake of PFOS by crops in the fields (and potential entry into the foodchain) has not been studied.

IV. Recommendations

1. To more quickly reduce PFOS levels in wastewater coming from their facility, Keystone Automotive should consider implementing the cleanout of the chrome plating tank ahead of the normal five year schedule.
2. BPU should continue to monitor PFOS levels at the WWTP.
3. Employees of Keystone Automotive and BPU should limit their exposure to PFOS contaminated plating solutions, wastewater, and sludge.
4. One set of additional samples of water, sediments, and fish should be collected from the Mississippi River near the BPU WWTP outfall in 2008 to characterize PFOS levels over time.
5. The MDH Public Health Laboratory should analyze the crop samples obtained from the agricultural fields where sludge from the BPU WWTP was applied to determine if the crops have taken up PFOS from the soils.
6. Soil samples from the agricultural fields should be collected for analysis for PFCs.

V. Public Health Action Plan

MDH’s Public Health Action Plan for the site will consist of:

1. A letter to the EPA, MPCA, city and county authorities, and industry representatives with a copy of this report advising them of these conclusions and recommendations;
2. Review of any additional available data;
3. Working with the MPCA and the chrome plating industry in Minnesota to determine if other businesses use PFOS-containing surfactant products, and to encourage the use of PFOS-free products or alternative plating processes where possible;
4. Working with the MPCA on a follow-up investigation of other WWTPs in Minnesota, including those whose customers include chrome plating shops; and
5. Working with the EPA on similar efforts in Region 5 and nationwide.

VI. References

3M 2000. Correspondence from William A. Weppner, 3M Company, to Charles Auer, US Environmental Protection Agency. June 16, 2000.

3M 2001. Environmental Monitoring – Multi-City Study Executive Summary. 3M Environmental Laboratory, June 25, 2001.

3M 2003. Environmental and Health Assessment of Perfluorooctane Sulfonate Acid and its Salts. 3M Company, St. Paul, Minnesota. August 20, 2003.

3M 2004. Ecotoxicology, Environmental Fate and Health Testing of Perfluorobutane Sulfonate. 3M Company, St. Paul, Minnesota. April 26, 2004.

ATSDR 2000. Toxicological Profile for Chromium. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Atlanta, GA. September 2000.

Bossi, R., Strand, J., Sortkjaer, O., and Larsen, M.M. 2007. Perfluoroalkyl compounds in Danish wastewater treatment plants and aquatic environments. Environment International (2007), doi:10.1016/j.envint.2007.10.002.

Boulanger, B., Vargo, J.D., Schnoor, J.L., and Hornbuckle, K.C. 2005. Evaluation of perfluorooctane surfactants in a wastewater treatment system and in a commercial surface protection product. Environmental Science and Technology 39: 5524-5530.

EPA 2007. Memorandum from Mary A. Gade, Regional Administrator Region 5 to James B. Gulliford, Assistant Administrator Office of Prevention, Pesticides, and Toxic Substances, Robert J. Meyers, Acting Assistance Administrator Office of Air and Radiation, and Benjamin Grumbles, Assistant Administrator Office of Water. U.S. EPA, Region 5, Chicago, IL. October 11, 2007.

Giesy, J.P., and Kannan, K. 2001. Global distribution of perfluorooctane sulfonate in wildlife. Environmental Science and Technology 35: 1339-1342.

Hoff, P.T., Van de Vijver, K., Van Dongen, W., Esmans, E.L., Blust, R., and De Coen, W.M. 2003. Perfluorooctane sulfonic acid in bib (*Trisopterus luscus*) and plaice (*Pleuronectes platessa*) from the western scheldt and the Belgian North Sea: distribution and biochemical effects. Environmental Toxicology and Chemistry 22: 608-614.

Kannan, K., Tao, L., Sinclair, E., Pastva, S.D., Jude, D.J., and Giesy, J.P. 2005. Perfluorinated compounds in aquatic organisms at various trophic levels in a great lakes food chain. Archives of Environmental Contamination and Toxicology 48: 559-566.

Loganathan, B.G., Sajwan, K.S., Sinclair, E., Kumar, K.S., and Kannan, K. 2007. Perfluoroalkyl sulfonates and perfluorocarboxylates in two wastewater treatment facilities in Kentucky and Georgia. Water Research (2007), doi:10.1016/j.waters.2007.06.045.

Martin, J.W., Whittle, D.M., Muir, D.C.G., and Mabury, S.A. 2004. Perfluoroalkyl contaminants in a food web from Lake Ontario. Environmental Science and Technology 38: 5379-5385.

McCann, P., Kelly, J., and Solem, L. 2007. Perfluorochemicals in Fish Fillets from Minnesota. Minnesota Department of Health, St. Paul, MN, Minnesota Pollution Control Agency, St. Paul, MN. http://www.health.state.mn.us/divs/eh/fish/pfcposter.pdf.

MDH 2005. Health Consultation on Perfluorochemical Releases at the 3M Cottage Grove Facility. Minnesota Department of Health, St. Paul, Minnesota, February 18, 2005.

MPCA 2007a. Soil Reference Values (SRVs) for PFOA and PFOS. Memorandum from Emily Hansen, MPH to Kathryn Sather, May 8, 2007.

OECD 2002. Hazard Assessment of Perfluorooctane Sulfonate (PFOS) and its Salts. Organization for Economic Cooperation and Development. November 21, 2002.

Oliaei, F., Kriens, D., and Kessler, K. 2006. Investigation of Perfluorochemical (PFC) Contamination in Minnesota Phase One. Report to Senate Environment Committee, February 2006.

RPA 2004. Perfluorooctane Sulphonate: Risk Reduction Strategy and Analysis of Advantages and Drawbacks. Final Report prepared for the Department for Environment, Food, and Rural Affairs, and the Environment Agency for England and Wales. Risk & Policy Analysts, Ltd, in association with BRE Environment. August 3, 2004.

Seacat, A.M., Thomford, P.J., Hansen, K.J., Olsen, G.W., Case, M.T., Butenhoff, J.L. 2002. Subchronic toxicity studies on perfluorooctane sulfonate potassium salt in cynomolgus monkeys. Toxicol Sciences, 68: 249-64.

Schultz, M.M., Higgins, C.P., Huset, C.A., Luthy, R.G., Barofsky, D.F., and Field, J.A. 2006. Fluorochemical mass flows in a municipal wastewater treatment plant. Environmental Science and Technology 40: 7350-7357.

Sinclair, E., and Kannan, K. 2006. Mass loading and fate of perfluoroalkyl surfactants in wastewater treatment plants. Environmental Science and Technology 40: 1408-1414.

Tolls, J., and Sijm, D.T.H.M. 1995. A preliminary evaluation of the relationship between bioconcentration and hydrophobicity for surfactants. Environmental Toxicology and Chemistry 14: 1675-1685.

Van de Vijver, K.I., Hoff, P.T., Van Dongen, W., Esmans, E.L., Blust, R., and De Coen, W.M. 2003. Exposure patterns of perfluorooctane sulfonate in aquatic invertebrates from the western scheldt estuary and the southern North Sea. Environmental Toxicology and Chemistry 22: 2037-2041.

Ye, X., Schoenfuss, H.L., Jahns, N.D., Delinsky, A.D., Strynar, M.J., Varns, J., Nakayama, S., Helfant, L., and Lindstrom, A.B. 2007. Perfluorinated compounds in common carp (*Cyprinus carpio*) fillets from the upper Mississippi River. Submitted to Environment International.

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CERTIFICATION

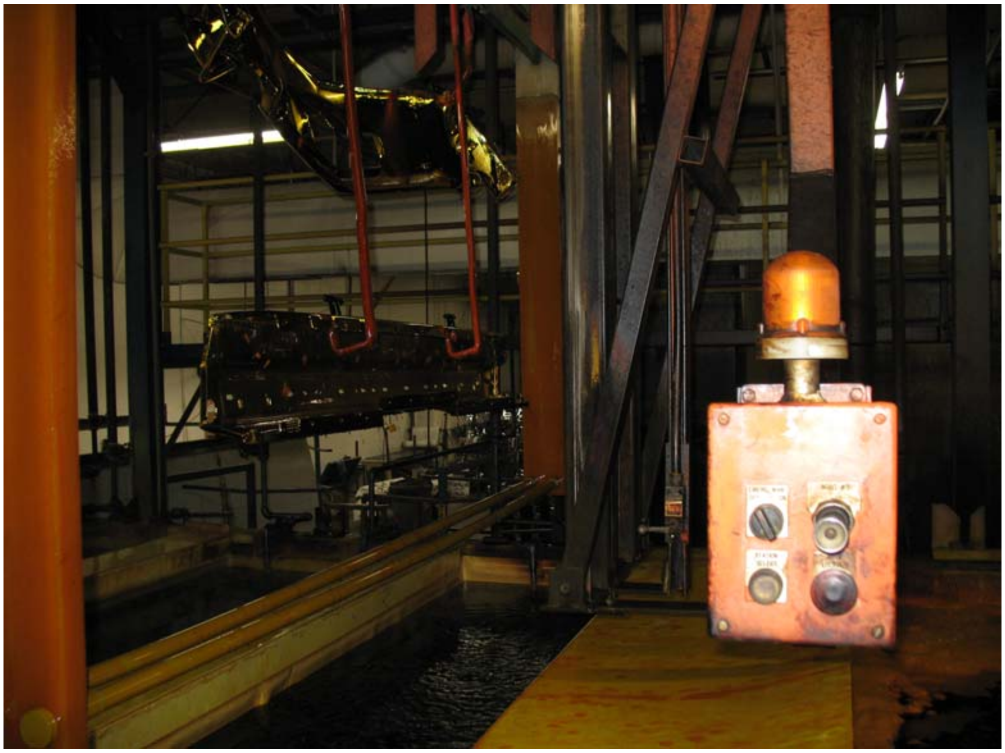
This Brainerd PFOS Detections Health Consultation was prepared by the Minnesota Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

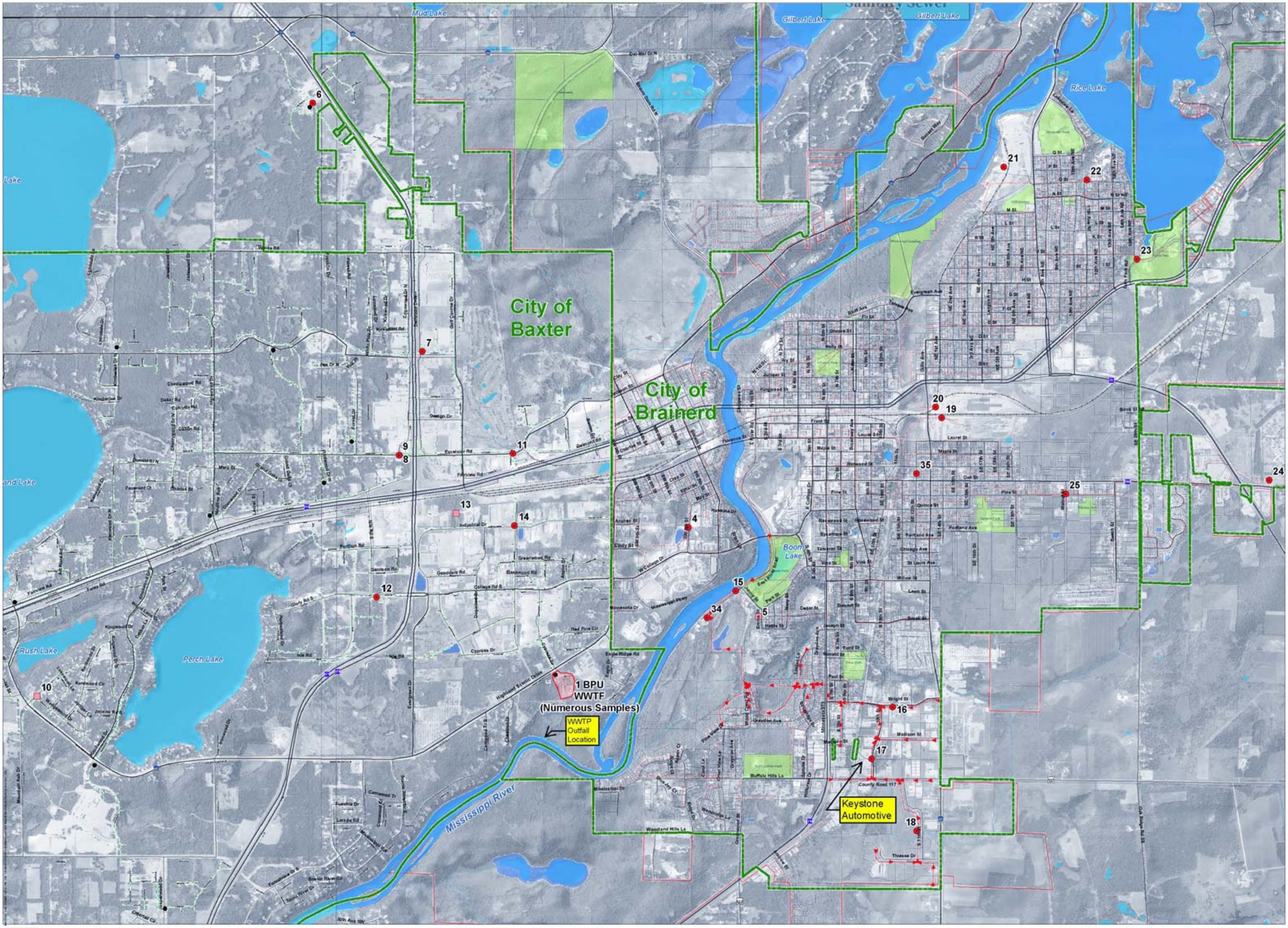
Trent LeCoultre
Technical Project Officer, SPS, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Alan Yarbrough
Chief, State Program Section, SSAB, DHAC, ATSDR

Figure 2
Keystone Automotive Chrome Plating Tank





City Boundaries

Sanitary Sewer Flow Direction

PFC Sample Locations (with Map ID)

- Sewer Lift Station or Major M.H.
- Water Supply

0 400 800 1,600 2,400 3,200 4,000
Feet

Figure 1
(Prepared by Barr Engineering)

PFC SAMPLING LOCATIONS
Collected July 24, 25, and 26th, 2007

Appendix 1: MPCA 2007 WWTP Sampling Data - Influent, ug/L

REGION	PLANT NAME	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
North	Alexandria	0.012	< 0.00439	0.00898	0.00459	0.0304	< 0.00495	< 0.00479	< 0.00560	< 0.00429	0.0156	0.0322	0.0219	< 0.00391
North	BoiseCascade	0.362	< 0.00428	< 0.00441	< 0.00441	< 0.00408	< 0.00482	< 0.00467	< 0.00546	< 0.00418	< 0.00467	< 0.00943	< 0.00943	< 0.00381
North	Brainerd	< 0.0116	< 0.00439	0.00847	0.00488	0.00993	< 0.00494	< 0.00478	< 0.00560	< 0.00428	0.109	0.0459	0.811	< 0.00390
North	Fergus Falls	0.033	< 0.00419	< 0.00432	< 0.00432	0.00508	< 0.00472	< 0.00457	< 0.00534	< 0.00409	< 0.0145	< 0.00924	0.0147	< 0.00373
North	Hibbing	0.0202	< 0.00415	< 0.00428	< 0.00428	0.0611	0.00944	< 0.00452	< 0.00529	< 0.00405	< 0.0133	0.0164	< 0.0179	< 0.00369
North	Paynesville	0.038	< 0.00439	< 0.00453	< 0.00453	< 0.00418	< 0.00495	< 0.00479	< 0.00560	< 0.00429	< 0.00958	< 0.00968	< 0.00968	< 0.00391
North	Thief River F	< 0.0138	< 0.00423	< 0.00437	< 0.00557	0.0436	0.00536	< 0.00462	< 0.00540	< 0.00413	< 0.0129	< 0.00933	< 0.00933	< 0.00377
North	WLSSD	0.0718	< 0.00921	0.00584	0.0073	0.014	< 0.00480	< 0.00465	< 0.00544	< 0.00416	< 0.0148	< 0.00939	< 0.00939	< 0.00379
Central	DodgeCenter	0.0833	< 0.00276	< 0.00285	< 0.00285	0.00627	< 0.00311	< 0.00301	< 0.00352	< 0.00270	< 0.00602	0.00714	0.019	< 0.00246
Central	Flint Hills	0.0402	< 0.00176	0.0172	< 0.00167	0.00908	< 0.00619	< 0.00619	< 0.00619	< 0.00619	0.0316	0.0275	0.0546	< 0.00619
Central	Hutchinson	0.037	< 0.00390	< 0.00402	< 0.00402	0.00495	< 0.00439	< 0.00425	< 0.00497	< 0.00381	0.0758	0.0115	0.0808	< 0.00347
Central	Marathon-Ashland	1.02	0.0626	0.0448	0.015	0.02	0.00421	< 0.00407	< 0.00407	< 0.00407	0.18	0.131	0.256	< 0.00407
Central	Maynard	0.026	0.00413	0.00499	< 0.00270	0.00851	< 0.00295	< 0.00286	< 0.00334	< 0.00256	< 0.00572	< 0.00578	< 0.00578	0.00443
Central	Melrose	< 0.012	< 0.00438	< 0.00452	< 0.00452	0.00518	< 0.00493	< 0.00478	< 0.00559	< 0.00428	< 0.00956	< 0.00966	< 0.00966	< 0.00390
Central	Metro - Eagle Point	0.656	0.0313	0.0229	0.00559	0.0171	< 0.00413	< 0.00413	< 0.00413	< 0.00413	0.0671	0.0199	< 0.00828	< 0.00413
Central	Metro - Seneca	0.11	< 0.00338	0.00931	< 0.00348	0.0287	0.00853	< 0.00368	< 0.00431	< 0.00330	0.118	0.187	0.171	< 0.00301
Central	Metro - Main Plant	0.0581	0.00858	0.0129	0.00652	0.021	< 0.00438	< 0.00438	< 0.00438	< 0.00438	0.0388	0.0124	0.0353	< 0.00438
Central	Metro - Main Plant	0.0868	0.00909	0.0141	0.00664	0.0218	< 0.00414	< 0.00414	< 0.00414	< 0.00414	0.0327	0.0141	0.0349	< 0.00414
Central	MSP Airport	0.0235	0.0188	0.0539	0.0313	0.12	0.0181	0.0828	0.00661	0.00802	0.00717	0.0285	0.0238	0.00582
Central	MSP Airport	0.0411	0.0632	0.108	0.0518	0.148	0.0304	0.115	0.0125	0.013	0.018	0.0749	0.393	< 0.00253
Central	Montivedeo	0.0329	< 0.00317	< 0.00327	< 0.00327	0.00947	0.00682	0.00774	< 0.00404	< 0.00310	< 0.00691	< 0.00828	< 0.00699	< 0.00282
Central	St. Cloud	< 0.012	< 0.00441	0.00681	0.00681	0.0165	< 0.00496	< 0.00480	< 0.00562	< 0.00430	< 0.0112	0.0215	< 0.00971	< 0.00392
Central	Willmar	0.0457	< 0.00370	< 0.00381	< 0.00381	0.00725	0.00487	< 0.00403	< 0.00472	< 0.00361	< 0.00807	< 0.00815	< 0.00815	< 0.00329
South	Austin	0.0196	0.00351	0.00295	< 0.00242	0.00439	< 0.00252	< 0.00244	< 0.00362	< 0.00219	< 0.00489	< 0.00494	< 0.00939	< 0.00199
South	Austin	0.0221	0.00263	0.00335	< 0.00268	0.00646	< 0.00292	< 0.00283	< 0.00331	< 0.00253	< 0.00566	0.00803	0.00652	< 0.00231
South	Morton	< 0.004	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	0.0212	< 0.00806	< 0.00806	< 0.00403
South	Morton	<0.004	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	0.00938	< 0.00811	< 0.00811	< 0.00405
South	Owatonna	0.0352	0.00929	0.0154	< 0.00385	0.0195	< 0.00420	< 0.00407	< 0.00476	< 0.00365	< 0.00814	< 0.00823	< 0.00823	< 0.00332
South	Pipestone	0.0189	0.0524	< 0.00257	< 0.00257	0.00332	0.0034	< 0.00272	< 0.00318	< 0.00244	< 0.00544	< 0.00550	< 0.00550	< 0.00222
South	Red Wing	0.0977	< 0.00379	0.00959	< 0.00391	0.0135	0.00665	< 0.00414	< 0.00484	< 0.00370	< 0.0132	< 0.00836	< 0.00836	< 0.00337
South	Rochester	0.0368	< 0.00404	0.00506	< 0.00417	0.0177	< 0.00455	< 0.00441	< 0.00515	< 0.00394	< 0.00881	0.0104	< 0.00107	< 0.00359
South	Worthington	0.0619	< 0.00390	< 0.00402	< 0.00402	0.00428	< 0.00439	< 0.00425	< 0.00497	< 0.00380	< 0.00850	< 0.00859	< 0.00859	< 0.00347
	No. of Detects	26	11	18	10	28	10	3	2	2	13	16	13	2
	Mean	0.1188	0.0241	0.0197	0.0140	0.0242	0.0098	0.0685	0.0096	0.0105	0.0557	0.0405	0.1479	0.0051
	Std. Dev.	0.2101	0.0180	0.0217	0.0107	0.0326	0.0064	0.0246	0.0025	0.0027	0.0428	0.0406	0.1612	0.0013
	Median	0.0391	0.0093	0.0095	0.0067	0.0138	0.0067	0.0828	0.0096	0.0105	0.0327	0.0207	0.0353	0.0051
	Max.	1.84	0.063	0.108	0.0518	0.148	0.0304	0.115	0.0125	0.013	0.18	0.187	0.811	0.00582

Appendix 1: MPCA 2007 WWTP Sampling Data - Effluent, ug/L

REGION	PLANT NAME	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
North	Alexandria	0.0324	0.0049	0.0115	0.00278	0.0132	0.00531	< 0.00287	< 0.00336	< 0.00257	0.0173	0.0408	0.0184	< 0.00235
North	BoiseCascade	0.0683	< 0.00426	< 0.00439	< 0.00439	0.00499	< 0.00480	< 0.00464	< 0.00543	< 0.00416	< 0.00929	< 0.00939	< 0.00939	< 0.00379
North	Brainerd	0.0503	< 0.00249	0.0123	0.00625	0.019	0.0141	< 0.00271	< 0.00317	< 0.00243	0.107	0.0106	1.51	< 0.00221
North	Fergus Falls	0.0182	0.00273	0.0105	0.00307	0.00903	0.0103	< 0.00281	< 0.00329	< 0.00252	0.0081	< 0.00568	< 0.00568	< 0.00229
North	Hibbing	0.022	0.0481	0.0307	0.00824	0.0635	0.0314	0.00733	< 0.00329	< 0.00252	0.0072	0.00857	0.0128	< 0.00229
North	Paynesville	0.0756	0.0149	0.0196	0.0106	0.0335	0.0093	< 0.00453	< 0.00530	< 0.00406	< 0.00906	0.0108	< 0.00916	< 0.00370
North	Thief River Falls													
North	WLSSD	0.0311	0.00318	0.00653	0.00348	0.0142	0.00848	< 0.00276	< 0.00323	< 0.00247	0.0162	< 0.00558	0.016	< 0.00225
Central	DodgeCenter	0.0234	0.00988	0.0048	< 0.00257	0.00756	< 0.00281	< 0.00272	< 0.00318	< 0.00244	< 0.00544	< 0.00550	< 0.00550	< 0.00222
Central	Flint Hills	0.148	< 0.00991	0.0236	0.00686	0.01	< 0.00259	< 0.00259	< 0.00259	< 0.00259	< 0.00517	0.045	0.0575	0.00521
Central	Hutchinson	0.035	0.0405	0.0402	0.00487	0.0318	< 0.00293	0.0037	< 0.00332	< 0.00254	0.0266	0.0129	0.0426	< 0.00232
Central	Marathon-Ashland	0.0793	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.0125	< 0.0125	< 0.0125	< 0.00626
Central	Maynard	0.027	0.00455	0.00782	0.00337	0.015	< 0.00310	< 0.00300	< 0.00351	< 0.00269	< 0.00601	< 0.00607	< 0.00607	0.00257
Central	Melrose	0.0136	< 0.00260	< 0.00268	< 0.00268	0.00354	0.00422	< 0.00283	< 0.00331	< 0.00254	< 0.00567	< 0.00573	< 0.00573	< 0.00231
Central	Metro - Eagle Point	0.565	0.0212	0.0276	0.00657	0.0225	0.00438	0.00353	< 0.00257	< 0.00257	0.0296	0.0219	< 0.00514	< 0.00257
Central	Metro - Seneca	0.0424	0.0401	0.0393	0.0133	0.0641	0.00792	0.004	< 0.00328	< 0.00251	0.0398	0.0531	0.0585	< 0.00229
Central	Metro - Main Plant	0.12	0.016	0.0274	0.015	0.0505	0.0152	0.00756	< 0.00264	< 0.00264	0.0257	0.0265	0.11	< 0.00264
Central	Metro - Main Plant	0.0752	0.0125	0.0259	0.015	0.0504	0.0121	0.00668	< 0.00256	< 0.00256	0.022	0.0257	0.0874	< 0.00256
Central	MSP Airport													
Central	Montivedeo	0.0178	0.0365	0.0147	0.00286	0.0265	0.00378	0.00329	< 0.00330	< 0.00252	< 0.00564	0.00955	< 0.00570	< 0.00230
Central	St. Cloud	0.0437	0.00566	0.0239	0.00432	0.0271	0.0102	< 0.00281	< 0.00328	< 0.00251	0.0124	0.0277	0.00684	< 0.00229
Central	Willmar	0.0368	< 0.00257	0.00499	0.00274	0.00586	< 0.00290	< 0.00281	< 0.00328	< 0.00251	< 0.00561	< 0.00567	< 0.0114	< 0.00229
South	Austin	0.0215	0.00512	0.00527	< 0.00265	0.00599	< 0.00290	< 0.00281	< 0.00328	< 0.00251	< 0.00561	< 0.00567	< 0.00654	< 0.00229
South	Morton	< 0.00260	< 0.00260	< 0.00260	< 0.00260	0.00338	< 0.00260	< 0.00260	< 0.00260	< 0.00260	< 0.00520	< 0.00520	< 0.00520	< 0.00260
South	Morton	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00891	< 0.00891	< 0.00891	< 0.00445
South	Owatonna	0.0179	0.0398	0.0209	0.00373	0.0321	< 0.00288	0.00433	< 0.00327	< 0.00250	< 0.00558	< 0.00564	< 0.00679	< 0.00228
South	Pipestone	0.0503	0.00605	0.00816	0.00415	0.0187	0.00441	< 0.00293	< 0.00342	< 0.00262	< 0.00585	< 0.00592	0.0101	0.00295
South	Red Wing	0.0536	0.00879	0.0302	0.00497	0.0227	< 0.00476	< 0.00461	< 0.00539	< 0.00413	0.0139	0.0202	< 0.0121	< 0.00376
South	Rochester	0.0313	0.0792	0.0288	0.0456	0.0399	0.00801	0.00544	< 0.00330	< 0.00252	< 0.00564	0.0109	0.0153	0.00303
South	Worthington	0.0149	0.00736	0.00344	< 0.00266	0.00604	< 0.00290	< 0.00281	< 0.00329	< 0.00252	< 0.00563	< 0.00569	< 0.00569	< 0.00230
	No. of Detects	26	20	23	20	26	15	9	0	0	12	14	12	4
	Mean	0.0659	0.0204	0.0186	0.0084	0.0231	0.0099	0.0051			0.0272	0.0232	0.1621	0.0034
	Std. Dev.	0.1030	0.0194	0.0127	0.0089	0.0186	0.0070	0.0026			0.0217	0.0153	0.2790	0.0013
	Median	0.0359	0.0112	0.0196	0.0049	0.0189	0.0085	0.0043			0.0197	0.0211	0.0305	0.0030
	Max.	0.565	0.0792	0.0402	0.0456	0.0641	0.0314	0.00756			0.107	0.0531	1.51	0.00521

not sampled

Appendix 1: MPCA 2007 WWTP Sampling Data - Sludge, ug/kg

REGION	PLANT NAME	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA	% Moisture
North	Alexandria	< 4.59	< 4.59	< 4.59	< 4.59	17.3	18.7	13.8	9.76	< 4.59	< 9.18	< 9.18	99	14.2	90.1
North	BoiseCascade	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.389	< 0.389	< 0.389	< 0.194	17.2
North	BoiseCascade	0.254	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.382	< 0.382	< 0.382	< 0.191	50.6
North	BoiseCascade	< 0.401	< 1.15	< 0.849	< 0.299	< 0.266	0.45	< 0.201	< 0.201	< 0.201	< 0.818	< 0.703	< 0.713	< 0.201	0.37
North	Brainerd	< 0.869	< 0.677	3.47	0.877	3.68	20.1	3.99	5.9	2.22	< 11.3	2.77	861	2.98	95
North	Fergus Falls	2.74	< 1.33	3.15	< 0.727	4.04	62.7	6.16	11.8	1.43	< 1.45	< 1.45	21.4	3.52	98.1
North	Hibbing	< 1.80	< 0.799	< 0.778	< 0.752	2.48	2.67	1.72	2.04	2.17	< 2.04	< 1.50	8.18	< 0.752	93.9
North	Paynesville														
North	Thief River F														
North	WLSSD	6.75	< 1.85	< 1.85	< 1.85	4.43	4.12	4.72	4.24	< 1.85	< 4.14	< 3.69	18.7	11.5	98
Central	DodgeCenter		1.33	< 0.624	< 0.624	5.6	7.6	18.8	5.16	3.91	< 1.32	2.46	24.6	6.87	95.8
Central	Flint Hills														
Central	Hutchinson		29.4	13	4.73	54.6	10.1	57.2	6.16	11.6	5.6	3.99	304	10.8	97.9
Central	Marathon-Ashland														
Central	Maynard														
Central	Melrose	1.56	< 0.595	< 0.676	< 0.532	2.17	6.69	2.82	3.29	0.976	< 1.09	< 1.38	3.94	3.28	94.4
Central	Metro - Eagle Point	2.47	0.617	2.7	< 0.590	6.02	2.21	20.7	4.65	4.65	< 1.25	< 2.58	22.4	4	95.3
Central	Metro - Seneca		< 0.493	1.12	0.548	6.8	3.59	10.7	3.81	2.19	< 3.23	< 3.26	141	4.53	94.9
Central	Metro - Main Plant	7.27	4.52	6.58	< 2.73	24.5	23.3	36.9	19.2	19.2	< 5.46	< 8.33	267	16.3	98.7
Central	Metro - Main Plant	10.6	3.72	9.8	< 3.31	22.9	14.3	29.7	15.3	13.6	< 6.62	< 15.0	261	12.3	98.7
Central	MSP Airport														
Central	Montivedeo		4.17	2.88	1.03	19	22.4	73.5	15.6	13	< 2.39	3.45	39.7	28	96.7
Central	St. Cloud	< 0.792	< 1.03	4.55	< 0.792	7.32	4.89	15.7	3.86	1.39	< 5.32	3.59	20.4	2.4	96.6
Central	Willmar		< 0.958	1.85	1.29	3.1	5.87	2.24	1.93	< 0.936	< 6.28	< 6.34	< 6.34	< 2.56	97.5
South	Austin		< 0.770	< 0.817	< 0.794	1.06	3.89	1.92	< 0.982	< 0.752	< 5.05	< 5.09	< 5.09	< 2.05	96.8
South	Morton														
South	Owatonna		4.48	17	3.05	32.1	4.13	89.1	3.55	11.7	< 4.23	< 3.95	30.8	17.4	96.1
South	Pipestone														
South	Red Wing		< 0.941	2.97	< 0.970	3.14	2.86	2.93	< 1.20	< 0.919	< 6.17	< 6.22	< 6.22	< 2.51	97.4
South	Rochester	1.65	< 0.633	0.952	< 0.633	3.76	3.31	6.29	2.64	2.06	< 3.21	4.83	21.2	3.88	93
South	Worthington		4.46	< 2.38	< 2.38	3.24	< 2.60	3.86	< 2.95	< 2.25	< 5.05	< 5.09	8.88	3.72	98.9
	No. of Detects	8	8	13	6	20	20	20	17	14	1	6	17	16	
	Mean	4.16	6.59	5.39	1.92	11.36	11.19	20.14	6.99	6.44	5.60	3.52	126.66	9.11	
	Std. Dev.	3.33	6.05	4.50	1.14	13.05	13.52	24.31	5.51	5.58	1.14	1.60	188.25	7.28	
	Median	2.605	4.32	3.15	1.16	5.02	5.38	8.50	4.65	3.07	5.60	3.52	24.60	5.70	
	Range	<1.8-7.27	<0.19-29.4	<0.19-17	<0.19-3.05	<0.19-54.6	<0.19-62.7	<0.19-89.1	<0.19-19.2	<0.19-19.2	<0.38-5.6	<0.38-4.83	<0.38-861	<0.19-28	

not sampled

Appendix 2

PRELIMINARY Summary of PFC Monitoring in the Cities of Brainerd and Baxter
Prepared for Brainerd Public Utilities

Map ID	City	Sample Location Information	Sample Date	Sample Time	MPI Research Analytical Results - LC/MS/MS - Units in ug/L (ppb), unless noted otherwise							
	City of Brainerd WWTP Samples				PFOS	PFBA	PFPeA	PFHxA	PDHpA	PFOA	PFNA	PFDA
1	Brainerd/Baxter	WWTP Facility - Early Influent (in lab building)	7/24/2007	11:20	0.830	ND	ND	NQ	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Influent Late	7/24/2007	17:41	0.799	ND	0.261	ND	ND	0.108	ND	ND
1	Brainerd/Baxter	WWTP Facility - Influent (MPCA Split)	7/25/2007	11:05	0.954	ND	0.335	ND	ND	ND	ND	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/24/2007	17:20	NQ	ND	0.412	NQ	ND	0.0818	ND	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/25/2007	11:35	ND	ND	0.533	ND	ND	0.118	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier	7/24/2007	17:30	0.938	ND	0.260	ND	ND	0.0564	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier - Field Duplicate	7/24/2007	17:30	0.947	ND	0.283	ND	ND	0.0720	ND	ND
1	Brainerd/Baxter	WWTP Facility - RBC Effluent	7/24/2007	17:35	1.26	ND	ND	ND	ND	0.0537	ND	ND
1	Brainerd/Baxter	WWTP Facility - Early Effluent	7/24/2007	11:15	0.544	ND	ND	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent (MPCA Split)	7/25/2007	11:05	0.870	ND	ND	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Effluent Late	7/24/2007	17:40	1.11	ND	ND	ND	ND	0.0648	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent @ Outfall (MPCA Split)	7/25/2007	11:25	0.857	ND	ND	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Sludge, **units in ng/g**	7/24/2007	11:05	1183	ND	ND	NQ	ND	NQ	6.71	ND
1	Brainerd/Baxter	WWTP Facility - Sludge (MPCA Split), **units in ng/g**	7/25/2007	11:10	1040	ND	ND	NQ	ND	4.84	7.38	ND
	City of Brainerd Water Treatment Plant Samples											
5	Brainerd	Brainerd WTP Effluent - Unfluoridated Tap	7/24/2007	11:50	ND	ND	ND	0.0271	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Influent Water	7/26/2007	9:10	ND	ND	ND	ND	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Effluent Finished H20	7/26/2007	9:15	ND	ND	ND	ND	ND	ND	ND	ND
	City of Baxter Water Treatment Plant Samples											
13	Baxter	Baxter WTP - Baxter #1 Water Plant	7/24/2007	14:30	ND	0.0864	ND	1.097	ND	ND	ND	ND
10	Baxter	Baxter WTP @Mtn Ash Dr/Highland Scenic	7/24/2007	13:45	ND	ND	ND	ND	ND	ND	ND	ND
	Other City of Brainerd Samples											
15	Brainerd	Manhole @ East River Rd & Emma	7/24/2007	15:00	ND	ND	0.317	0.0774	ND	0.0490	ND	ND
34	Brainerd	Main Pump Station Inside Building Trench Floor	7/25/2007	11:55	1.17	ND	0.368	ND	ND	ND	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th	7/24/2007	11:30	ND	ND	0.253	0.141	ND	ND	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th Field Duplicate	7/24/2007	11:30	ND	ND	0.200	0.126	ND	0.0433	ND	ND
16	Brainerd	Wright St. East of So. 10th	7/24/2007	15:10	ND	ND	ND	0.0333	ND	NQ	ND	ND
17	Brainerd	Manhole on 10th St. south of Madison Street	7/24/2007	15:20	49.8	ND	ND	0.0918	ND	0.0270	ND	ND
18	Brainerd	South Industrial Park Lift	7/24/2007	15:40	ND	ND	0.857	NQ	ND	0.0413	ND	ND
19	Brainerd	South side of tracks - BNSF Old Machine Shop	7/24/2007	15:55	ND	ND	0.987	0.0552	ND	0.0381	ND	ND
20	Brainerd	North side of tracks - BNSF Repair Shop	7/24/2007	16:05	ND	ND	0.656	0.0289	ND	0.0923	0.118	ND
21	Brainerd	Southwest corner of property - Wausau	7/24/2007	16:20	ND	ND	ND	NQ	ND	0.0415	ND	ND
22	Brainerd	10th Ave. & O St. Lift Station	7/24/2007	16:40	ND	ND	0.128	ND	ND	0.0467	ND	ND
23	Brainerd	Lum Park Lift Station	7/24/2007	16:45	1.18	ND	ND	ND	ND	0.0381	ND	ND
24	Brainerd	State Hospital Lift Station	7/24/2007	16:55	0.218	ND	ND	ND	ND	0.0712	0.122	ND
25	Brainerd	Walnut & Pine Lift Station	7/24/2007	17:10	0.0803	ND	0.140	ND	ND	NQ	ND	ND
35	Brainerd	Manhole on SE 12th north of Oak St.	7/25/2007	14:45	ND	ND	ND	0.0394	ND	ND	ND	ND
	Other City of Baxter Samples											
6	Baxter	Forest Rd & Edmunds Dr.	7/24/2007	13:00	ND	ND	0.158	0.0673	ND	NQ	ND	ND
7	Baxter	East side of 371 - Ford Store near Body Works	7/24/2007	13:20	ND	ND	0.270	NQ	ND	ND	ND	ND
8	Baxter	In front of Northern Bank @ Edgewood	7/24/2007	13:25	ND	ND	0.564	ND	ND	ND	ND	ND
9	Baxter	West stream of Edgewood and Excelsior	7/24/2007	13:30	ND	ND	0.586	ND	ND	NQ	ND	ND
11	Baxter	Excelsior & Cypress Lift Station	7/24/2007	14:00	ND	ND	0.586	NQ	ND	0.0345	ND	ND
12	Baxter	Wal-Mart Lift Station @ Elder & Glory	7/24/2007	14:20	ND	ND	1.11	NQ	ND	0.0611	ND	ND
14	Baxter	West of Industrial Park Rd & Cypress Dr	7/24/2007	14:40	ND	ND	2.37	0.0989	ND	0.0408	ND	ND

ND = Not detected. Response less than 0.0125 ug/L.
NQ = Not quantifiable. Response between 0.0125 and 0.025 ug/L.
NOTE: Laboratory batch QA/QC passed applicable criteria. However final lab data review is on-going.

Prepared by Barr Engineering

Appendix 2

PRELIMINARY Summary of PFC Monitoring in the Cities of Brainerd and Baxter
Prepared for Brainerd Public Utilities

Map ID	City	Sample Location Information	Sample Date	Sample Time	MPI Research Analytical Results - LC/MS/MS - Units in ug/L (ppb), unless noted otherwise				
	City of Brainerd WWTP Samples				PFUnA	PFDoA	PFBS	PFHS	FOSA
1	Brainerd/Baxter	WWTP Facility - Early Influent (in lab building)	7/24/2007	11:20	ND	ND	0.294	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Influent Late	7/24/2007	17:41	ND	ND	NQ	ND	ND
1	Brainerd/Baxter	WWTP Facility - Influent (MPCA Split)	7/25/2007	11:05	ND	ND	0.304	ND	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/24/2007	17:20	ND	ND	ND	NQ	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/25/2007	11:35	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier	7/24/2007	17:30	ND	ND	0.242	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier - Field Duplicate	7/24/2007	17:30	ND	ND	0.239	ND	ND
1	Brainerd/Baxter	WWTP Facility - RBC Effluent	7/24/2007	17:35	ND	ND	0.227	ND	ND
1	Brainerd/Baxter	WWTP Facility - Early Effluent	7/24/2007	11:15	ND	ND	0.241	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent (MPCA Split)	7/25/2007	11:05	ND	ND	0.248	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Effluent Late	7/24/2007	17:40	ND	ND	0.340	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent @ Outfall (MPCA Split)	7/25/2007	11:25	0.141	ND	0.278	ND	ND
1	Brainerd/Baxter	WWTP Facility - Sludge, **units in ng/g**	7/24/2007	11:05	NQ	ND	21.3	ND	ND
1	Brainerd/Baxter	WWTP Facility - Sludge (MPCA Split), **units in ng/g**	7/25/2007	11:10	NQ	ND	17.6	ND	ND
	City of Brainerd Water Treatment Plant Samples								
5	Brainerd	Brainerd WTP Effluent - Unfluoridated Tap	7/24/2007	11:50	ND	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Influent Water	7/26/2007	9:10	ND	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Effluent Finished H20	7/26/2007	9:15	ND	ND	ND	ND	ND
	City of Baxter Water Treatment Plant Samples								
13	Baxter	Baxter WTP - Baxter #1 Water Plant	7/24/2007	14:30	ND	ND	ND	ND	ND
10	Baxter	Baxter WTP @Mtn Ash Dr/Highland Scenic	7/24/2007	13:45	ND	ND	ND	ND	ND
	Other City of Brainerd Samples								
15	Brainerd	Manhole @ East River Rd & Emma	7/24/2007	15:00	ND	ND	ND	ND	ND
34	Brainerd	Main Pump Station Inside Building Trench Floor	7/25/2007	11:55	ND	ND	0.311	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th	7/24/2007	11:30	ND	ND	ND	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th Field Duplicate	7/24/2007	11:30	ND	ND	ND	NQ	ND
16	Brainerd	Wright St. East of So. 10th	7/24/2007	15:10	ND	ND	ND	ND	ND
17	Brainerd	Manhole on 10th St. south of Madison Street	7/24/2007	15:20	ND	ND	19.1	ND	ND
18	Brainerd	South Industrial Park Lift	7/24/2007	15:40	ND	ND	ND	ND	ND
19	Brainerd	South side of tracks - BNSF Old Machine Shop	7/24/2007	15:55	ND	ND	ND	ND	ND
20	Brainerd	North side of tracks - BNSF Repair Shop	7/24/2007	16:05	NQ	ND	ND	ND	ND
21	Brainerd	Southwest corner of property - Wausau	7/24/2007	16:20	ND	ND	ND	ND	ND
22	Brainerd	10th Ave. & O St. Lift Station	7/24/2007	16:40	ND	ND	ND	ND	ND
23	Brainerd	Lum Park Lift Station	7/24/2007	16:45	ND	ND	ND	ND	ND
24	Brainerd	State Hospital Lift Station	7/24/2007	16:55	ND	ND	ND	ND	ND
25	Brainerd	Walnut & Pine Lift Station	7/24/2007	17:10	ND	ND	ND	NQ	ND
35	Brainerd	Manhole on SE 12th north of Oak St.	7/25/2007	14:45	ND	ND	ND	ND	ND
	Other City of Baxter Samples								
6	Baxter	Forest Rd & Edmunds Dr.	7/24/2007	13:00	ND	ND	ND	ND	ND
7	Baxter	East side of 371 - Ford Store near Body Works	7/24/2007	13:20	ND	0.104	ND	ND	ND
8	Baxter	In front of Northern Bank @ Edgewood	7/24/2007	13:25	ND	ND	ND	ND	ND
9	Baxter	West stream of Edgewood and Excelsior	7/24/2007	13:30	ND	ND	ND	ND	ND
11	Baxter	Excelsior & Cypress Lift Station	7/24/2007	14:00	ND	ND	ND	ND	ND
12	Baxter	Wal-Mart Lift Station @ Elder & Glory	7/24/2007	14:20	ND	ND	ND	ND	ND
14	Baxter	West of Industrial Park Rd & Cypress Dr	7/24/2007	14:40	0.210	ND	ND	ND	ND

ND = Not detected. Response less than 0.0125 ug/L.
NQ = Not quantifiable. Response between 0.0125 and 0.025 ug/L.
NOTE: Laboratory batch QA/QC passed applicable criteria. However final lab data review is on-going.

Prepared by Barr Engineering

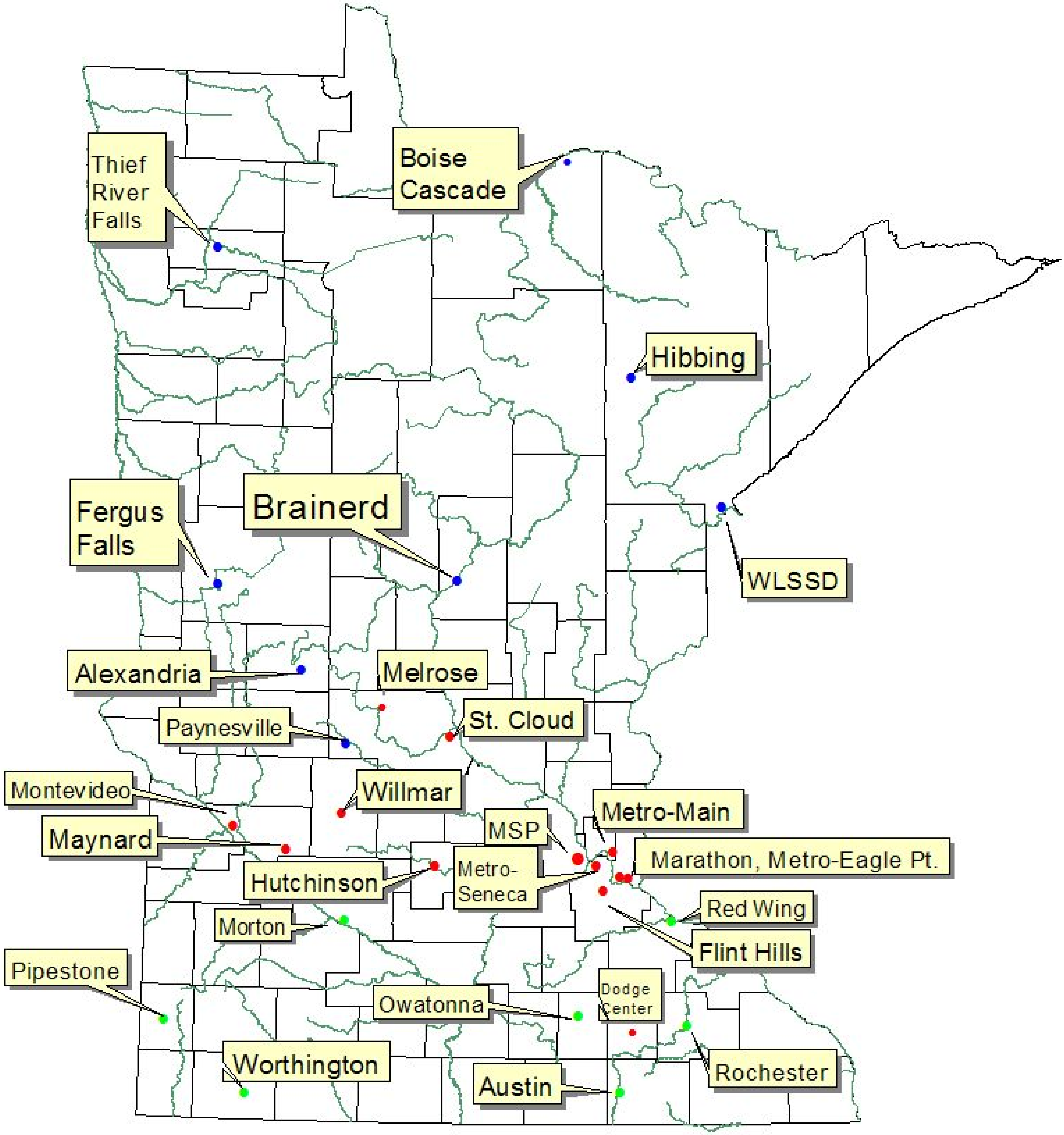
Appendix 3: PFC Data for Keystone Automotive, 11/14/07
Samples Analyzed by MPI Research (ug/L)

Sample ID	C4 Acid Perfluorobutanoic Acid	C5 Acid Perfluoropentanoic Acid	C6 Acid Perfluorohexanoic Acid	C7 Acid Perfluoroheptanoic Acid	C8 Acid Perfluorooctanoic Acid	C9 Acid Perfluorononanoic Acid	C10 Acid Perfluorodecanoic Acid
Bright nickel solution Bn4	0.479	ND	NQ	ND	ND	ND	ND
Semi bright nickel solution SBN	0.0572	ND	0.0989	ND	ND	ND	ND
Copper Tank	ND	ND	0.878	ND	ND	ND	ND
Clarifier of DMP waste treatment system*	ND	ND	ND	ND	ND	ND	ND
Chrome solution*	86.4	4.25	488	ND	ND	ND	ND
Last Chrome Rinse*	ND	ND	ND	ND	ND	ND	ND
AC-326 acid solution*	ND	ND	22.5	ND	ND	ND	ND
Electroclean solution--Electrodet SE*	58.1	31.3	12.6	ND	ND	19.9	ND
Soak clean solution--A69-CH*	32.2	18.1	6.40	ND	ND	ND	ND
Rust inhibitor-Koretard 322	0.0280	ND	0.160	ND	ND	ND	ND
Chrome surfactant--MSP-28	0.542	2.22	ND	ND	ND	0.0302	0.520

Sample ID	C11 Acid Perfluoroundecanoic Acid	C12 Acid Perfluorododecanoic Acid	PFBS Perfluorobutane-sulfonate	PFHS Perfluorohexanesulfonate	PFOS Perfluorooctane-sulfonate	FOSA Perfluorooctane-sulfonamide
Bright nickel solution Bn4	ND	ND	2.31	0.0694	0.476	ND
Semi bright nickel solution SBN	ND	ND	3.78	0.118	0.818	ND
Copper Tank	ND	ND	0.280	ND	1.25	ND
Clarifier of DMP waste treatment system*	ND	ND	70.9	ND	96.1	ND
Chrome solution*	ND	ND	176,000	20.1	823	ND
Last Chrome Rinse*	ND	ND	595	ND	247	ND
AC-326 acid solution*	ND	ND	ND	ND	ND	ND
Electroclean solution--Electrodet SE*	ND	ND	348	3.01	33,000	ND
Soak clean solution--A69-CH*	ND	ND	656	ND	823	ND
Rust inhibitor-Koretard 322	ND	ND	ND	ND	0.282	ND
Chrome surfactant--MSP-28	0.0324	0.443	ND	ND	0.437	ND

ND = Not detected = Response less than 0.0125 ug/L (0.025 ug/L for C8 Acid).
NQ = Not quantifiable = Response between 0.0125 ug/L and 0.025 ug/L.

^ Sample diluted 100 times prior to analysis, therefore, ND = Response less than 1.25 ug/L.



MPCA 2007 WWTP Sample Locations