PERFLUOROCARBON (PFC)-CONTAINING FIREFIGHTING FOAMS AND THEIR USE IN MINNESOTA

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1.0 INTRODUCTION

1.1 Purpose

Delta Consultants (Delta) has worked under contract with the Minnesota Pollution Control Agency (MPCA) investigating perfluorochemicals in Class B firefighting foams and their use in Minnesota. Previous information regarding this investigation was presented in the following reports:

- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use In Firefighting Training in Minnesota, dated June 30, 2008 (the June 2008 Report); and,
- Addendum to PFC-Containing Firefighting Foams and Their Use In Firefighting Training in Minnesota, dated October 22, 2008 (the October 2008 Addendum Report);
- Firefighting Training Area Site Reconnaissance, Pine Bend Flint Hills Refinery, Marathon Refinery, Burnsville Fire Training Center, and Site Access for 21 Fire Departments, dated April 3, 2009 (the April 2009 Report);
- Report of Site Reconnaissance and Sampling at Select Firefighting Foam Training Areas in Minnesota, dated June 30, 2009 (the June 2009 Report); and,
- Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota, dated February 10, 2010 (the February 2010 Report).

This report condenses the previous reports and includes PFC sampling conducted by others at the following fire foam training and fire sites:

- Duluth Air National Guard Base at the Duluth International Airport;
- Western Area Fire Training Academy (WAFTA) in St. Bonifacius;
- Up North Plastics in Cottage Grove; and,
- Kings Cover Marina in Hastings.

1.2 Background

As a part of an overall investigation of PFCs in Minnesota, the MPCA and Minnesota Department of Health (MDH) started looking at firefighting foams as a possible source of PFCs in the environment. In 2008 PFCs were researched as a constituent of firefighting foams. Municipal fire departments, fire departments at major oil refineries and airports, and fire training schools in the State were surveyed regarding their use of Class B firefighting foams. Additionally, various persons in the State with fire fighting knowledge and experience were interviewed. A survey questionnaire mailed out to the fire departments concentrated on the use of firefighting foams in training based on the assumption that training areas where firefighting foams were discharged repeatedly at the same location would be at greater risk for the introduction of PFCs into the environment via the breakdown of the foam. The firefighting training sites were then ranked for their potential

to release PFCs to sensitive environments based on a number of criteria: the types and amounts of foam used in training, the frequency of the training events, the environmental setting of the firefighting training site, and the presence of nearby water supply wells. The results of the research, survey and training site ranking were presented in the June 2008 and October 2008 Addendum Reports. Both reports are available on the MPCA website at www.pca.state.mn.us/cleanup/pfc/index.html. A brief summary of the research and survey findings are presented in Sections 6.0 and 7.0 of this report.

Based on the site ranking, twenty-one firefighting training sites were chosen for further investigation. The additional investigation included site reconnaissance, sampling of the groundwater and/or soil, and/or additional interviews. Information and data collected at these "priority" sites were documented in the April 2009, June 2009 and February 2010 Reports. These reports are also available on the MPCA website.

During the course of the PFC-Firefighting Foam investigation it was decided that the locations of several fires where large quantities of PFC-containing foams were utilized would also be investigated for the possible release of PFCs to the environment. Information and data collected at the River Grove Marina in Inver Grove Heights, and the Kandiyohi County Landfill in New London, were included in the above-referenced reports. Reports of PFC sampling related to firefighting foam conducted by the MPCA and other consultants at the Duluth Air National Guard Base in Duluth, the WAFTA site in St. Bonifacius, the Up North Plastics facility in Cottage Grove, and the Kings Cove Marina in Hastings, are available at the MPCA. The investigation activities and results for all of these sites are discussed in Sections 6.0 and 7.0 of this report.

2.0 PFCs in FIREFIGHTING FOAM

Perflourocarbons or perfluorochemicals (PFCs) are a class of man-made chemicals derived from hydrocarbons, where the hydrogen atoms have been replaced by fluorine atoms. PFCs are characterized by chains of carbon atoms of varying lengths to which fluorine atoms are strongly bonded, making PFCs durable and hard to break down (1). PFCs have been used since the 1950s to produce industrial and consumer products that are heat and stain resistant, water repellant, and film-forming (2). PFCs have been used in a variety of products including stain-resistant fabrics and carpet, coatings for food packaging, non-stick cookware, and firefighting foams (2)(3)(4).

2.1 Chemistry of PFCs

The PFC class of chemicals includes three groups of PFCs pertinent to the discussion of PFCs in firefighting foam: perfluorocarboxylates, perfluorinated sulfonates, and fluorotelomer sulfonates (5).

Perfluorocarboxylates are fully fluorinated carbon molecules with a carboxylate group on the end of the chain. Perfluorinated sulfonates are fully fluorinated carbon molecules with a sulfonate group on the end of the chain. Fluorotelomer sulfonates are partially fluorinated molecules. Examples of the PFC chemicals within each group are described in Table A, below.

TABLE A - PFC CHEMICALS

Chemical Group	Chemical Acronym	Chemical Name	CAS Registry No.	No. of Fluorinated Carbon Chains
Perfluorinated carboxylic acids	PFBA	perfluorobutanoic acid	375-22-4	4
	PFPeA	perfluoro-n-pentanoic acid	2706-90-3	5
	PFHxA	perfluorohexanoic acid	307-24-4	6
	PFHpA	perfluoroheptanoic acid	375-85-9	7
	PFOA	perfluorooctanoic acid	335-67-1	8
	PFNA	perfluorononanoic acid	375-95-1	9
	PFDA	perfluorodecanoic acid	335-76-2	10
	PFUnA	perfluoroundecanoic acid	2058-94-8	11
	PFDoA	perfluorododecanoic acid	307-55-1	12
	PFTA	perfluorotridecanoic acid	not determined	not determined
Perfluorinated sulfonates	PFBS	perfluorobutane sulfonate	29420-49-3	4
	PFHxS	perfluorohexane sulfonate	355-46-4	6
	PFOS	perfluorooctane sulfonate	1763-23-1	8
Fluorotelomer sulfonates	6:2 FtS	1-octanesulfonic acid, 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluoro-, ammonium salt	--	6
	8:2 FtS	--	--	8

PFCs are made using one of two methods: the Simons electro-chemical fluorination (ECF) developed by 3M; or, a telomerization process (6).

2.1.1 ECF Process

The ECF process used by 3M generates fully fluorinated compounds in branched- and straight-chains with both even and odd numbers of perfluorocarbons (6)(7). The chemical of interest in the ECF process is perfluorooctanesulfonyl fluoride (POSF), $C_8F_{17}SO_2F$. The final degradation product of POSF and its derived products include perfluorinated sulfonates and perfluorinated carboxylic acids (8). While perfluorinated carboxyl acids are associated with both the ECF process and the telomerization process (see Section 2.1.2), perfluorinated sulfonates only result from the ECF process (9).

2.1.2 Telomerization Process

The telomerization process creates fluorinated telomers that are different from ECF-made fluorinated molecules in that they only have an even number of fluorinated carbon atoms and the molecule is predominantly straight-chained (6)(7). In addition, the fluorotelomerization process inserts an ethyl group between the fluoroalkyl chain and the functional group on the end, which differentiates the atom from an ECF-process fluorinated molecule. Fluorotelomer sulfonates are made using a telomerization process, and perfluorinated carboxylic acids may be present in the final product as a result of unreacted or partially reacted starting materials or intermediate (10).

2.2 PFCs in Firefighting Foam

There are several classes of fires, depending on the material that is burning. Class B fires involve the burning of flammable liquids such as gasoline, fuel oil, cleaning fluids and solvents. Aqueous film-forming foam (AFFF) was developed in the 1960s for use on Class B fires. AFFF has a fluorochemical-based surfactant that rapidly forms a film across the fire surface, which prevents the release of flammable fuel vapors and excludes oxygen from the fuel surface (11).

3M was the original manufacturer of fluorochemical-based AFFF in the 1960s, using the ECF process. As indicated in Section 2.1.1, PFCs made using the ECF process can contain or degrade to perfluorinated sulfonates and perfluorinated carboxylic acids. As part of 3M's voluntary production phase out of PFOS chemicals, they stopped manufacturing PFOS-based AFFF in 2002.

DuPont, Ansul, Chemguard and other firefighting foam manufacturers use telomer-based fluorochemical surfactants in their AFFF. The telomer-based foams are not made with, and do not break down to, PFOS. According to the Fire Fighting Foam Coalition (www.fffc.org), telomer-based firefighting foams contain predominantly (75 to 80%) six-chain carbon fluorosurfactants (6:2 FtS), with varying percentages of eight-chain or higher homologues (8:2 FtS). While telomer-based surfactants are not made with PFOA, low levels of PFOA may be present as a byproduct (13).

Class B AFFF is typically purchased in five-gallon buckets. These foam concentrates are mixed into the water using an in-line eductor or other proportioning/mixing device. The foam concentrate/water solution can then be fed through one of two types of discharge devices, either a nozzle-aspirated foam system (NAFS) or a compressed air foam system (CAFS). Both systems produce a finished foam that is a combination of water, air and foam concentrate. Class B AFFF concentrates may or may not have expiration dates included on the product container, but foam manufacturers Chemguard and Ansul indicate that Class B foam should have a shelf life of 20 to 25 years if stored properly.

Class A firefighting foams, used to extinguish wood and grass fires, are detergent-based foams with a hydrocarbon-based surfactant, not a fluorochemical-based surfactant (14). Class A foams are not known to contain PFCs and are not considered a source of PFCs.

Training foams are similar to Class A and Class B foams but are made specifically for fire training exercises and do not contain chemical components for firefighting performance. Training foams are available from most manufacturers and are generally less expensive because they do not contain (costly) fluorinated surfactant components. Training foams are not made with PFCs.

2.3 The USEPA and PFOA and PFOS

In 1999 the U.S. Environmental Protection Agency (USEPA) began an investigation into PFOS after receiving data from 3M that PFOS was persistent, bioaccumulative and unexpectedly toxic (15). Ultimately 3M ceased production of PFOS-based chemistry in 2002, including the production of PFOS-based firefighting foams.. 3M also identified PFOA in human blood as part of their PFOS studies (15), and in June 2000 the USEPA expanded their investigation to include other PFCs, including PFOA.

In 2002 and 2007 the USEPA published significant new use rules (SNURs) under the Toxic Substances Control Act (TSCA) to limit the manufacture or import of perfluoroalkyl sulfonate chemicals, including PFOS and PFHxS. According to the initial 2002 SNUR, 3M was the only manufacturer in the U.S. of PFOS-based chemicals included in the SNUR.

In January 2006, USEPA and eight major PFC manufacturing companies (3M/Dyneon, Arkema, Inc., AGC Chemicals/Asahi Glass, Ciba Specialty Chemicals, Clariant Corporation, Daikin, E.I. duPont de Nemours and Company, and Solvay Solex) created the 2010/15 PFOA Stewardship Program. The companies committed to reduce facility emissions and product content of PFOA, PFOA precursor chemical, or PFOA-related homologues by 95 percent by 2010, and to work toward eliminating emissions and product content by 2015. As part of the program the companies submit annual reports on their progress toward reaching the goals. Information regarding the 2010/15 PFOA Stewardship Program is available at www.regulations.gov in docket EPA-HQ-OPPT-2006-0621.

Members of the Fire Fighting Foam Coalition that make telomer-based AFFF agents are in position to meet the goals of the PFOA Stewardship Program before 2015 by using C6-based fluorosurfactants that provide the same fire protection characteristics as C8-based foams. Incorporating these new fluorosurfactants in AFFF will require some reformulation and perhaps re-approval of most Class B foams between 2010 and 2015 (16).

3.0 USE OF FIREFIGHTING FOAMS IN MINNESOTA

In order to gain an understanding of the organizations in Minnesota that utilize firefighting foam, the types and quantities of firefighting foam being used, and the locations where the foams are being used in training exercises, the websites of firefighting organizations were reviewed, individuals commonly known to be involved in or associated with firefighting in Minnesota were interviewed, and the users of firefighting foams in Minnesota were surveyed regarding their foam use.

3.1 Interviews with Minnesota Firefighting Organizations

Several individuals commonly known to be involved in or associated with firefighting in Minnesota were interviewed regarding the use of firefighting foams in Minnesota. The interviews were presented in the June 2008 Report. Key findings of these interviews are as follows: the two oil refineries in Minnesota—the Marathon Oil refinery in St. Paul Park and the Flint Hills Resources Pine Bend refinery in Rosemount—have their own dedicated fire departments; that the Minnesota Department of Natural Resources (MDNR) trains firefighters at the Minnesota Interagency Fire Center in Grand Rapids using training foam; the Minnesota State Colleges and Universities (MNSCU) system has sixteen schools with firefighting training programs, and they switched from the use of AFFF to soap-based foams for training in approximately 2004; and that generally AFFF is not used for training exercises because its too expensive.

3.2 Survey Mailing to Minnesota Firefighting Organizations

Questionnaires regarding the use of firefighting foam were mailed to 785 fire departments in Minnesota in April and May 2008. The questionnaire surveyed the departments on current and historical types and amounts of firefighting foam used in firefighting and fire training, the locations of the fire training areas, and the fate of the spent training foam. In addition to municipal fire departments, questionnaires were mailed to the following potential firefighting foam users in Minnesota:

- All of the airports with dedicated fire departments: Minneapolis-St. Paul International Airport (MSP); Rochester International Airport; and, the Duluth International Airport.
- The following 16 colleges with firefighter training programs: Itasca Community College in Grand Rapids; Alexandria Technical College; St. Cloud Technical College; Minnesota West Community College in Marshall; Ridgewater College in Willmar; South Central College in North Mankato; Riverland Community College in Austin; Pine Technical College in Pine City; Hennepin Technical Colleges in Plymouth and Eden Prairie; Northland Community Colleges in Thief River Falls and East Grand Forks; Central Lakes College in Brainerd; Minnesota State Community College in Moorhead; Mesabi Range Community College in Virginia; and, Lake Superior Technical College in Duluth. Southwest State University in Marshall, Minnesota indicated that they do not offer a firefighting training program and that their program is only a business administration program for fire chiefs and captains.
- 2 petroleum refineries; and,
- Camp Ripley in Little Falls.

Completed questionnaire surveys were presented in the June 2008 Report and October 2008 Addendum Report.

3.3 Survey Results

Results of the completed surveys received from the municipal fire departments, airports, firefighting training schools, refineries, and Camp Ripley are presented in Sections 3.3.1 through 3.3.5.

3.3.1 Survey Results - Municipal Fire Departments

A total of 522 completed questionnaires were received from the 785 municipal fire departments that were surveyed, a response rate of 66%. Copies of the completed questionnaires were included in the June 2008 Report and October 2008 Addendum Report. The following general findings and statistics were ascertained from the questionnaires:

- Fifty-two (or 10%) of the responding municipal fire departments do not use firefighting foam at all.
- Of the responding municipal fire departments that utilize firefighting foam, 243 (or 52%) use only Class A foams.
- Of the remaining 227 responding municipal fire departments that utilize Class B firefighting foams, approximately 50% do not train with Class B foam but only use Class B foam for fire response.
- Of the municipal fire departments that train with Class B foam, 28% of the departments train at multiple or different locations for every training session, or at live burns only. Thus there is not one specific training location.
- The remaining municipal fire departments that train with Class B foam repeatedly at the same location were ranked based on the potential for PFCs to enter sensitive environments. The ranking criteria are discussed in Section 5.0.

3.3.2 Survey Results – Airports

Of the seven airports operated by the Metropolitan Airports Commission, (Crystal, Lake Elmo, Flying Cloud, Anoka County-Blaine, St. Paul, Lakeville and Minneapolis-St. Paul International (MSP), only MSP has its own fire department. Other MAC airports are served by the municipal fire departments in which they are located. Currently the MSP fire department trains with foam at the Lake Superior College Emergency Response Training Center (ERTC) in Duluth. Prior to 2001 training with 3M-brand Class B foam was conducted at two different locations on the northwest portion of the airport.

The Rochester Airport Fire Department also trains with foam at the ERTC facility in Duluth. However, the Federal Aviation Administration (FAA) requires annual testing of fire equipment. The foam equipment tests require a short burst of foam to show that the fire trucks are functioning properly. Less than 5 gallons of Chemguard-brand Class B foam is used annually for equipment testing.

The City of St. Cloud Fire Department is responsible for fire response at the St. Cloud Airport. The St. Cloud Fire Department trains with Chemguard-brand Class B foam at two locations, including the fire station near the airport.

The 148th Fighter Wing of the Minnesota Air National Guard is responsible for fire and emergency services at the Duluth International Airport. The unit no longer trains at the airport with firefighting foam. The MPCA is investigating two former fire training areas at the Duluth Airport for PFCs.

3.3.3 Survey Results - Firefighting Training Schools

Survey questionnaires were returned by all sixteen MNSCU firefighting training schools. Only two of the schools hold training exercises on campus with Class B foam: Lake Superior College in Duluth; and, Northland College in East Grand Forks.

3.3.4 Survey Results - Petroleum Refineries

Both the Marathon Refinery in St. Paul Park and the Flint Hills Resources Pine Bend Refinery in Rosemount have their own in-house fire departments, and both refineries have on-site fire fighting training facilities where spent Class B foam is collected and routed through their in-house wastewater treatment plants. The fire department at the Marathon Refinery uses approximately 50 to 100 gallons of Ansul-brand ThunderStorm Class B foam per semi-annual training event; prior to 2000 they used 3M-brand foam. Other municipal departments train at the Marathon Refinery fire training area, using foam provided by the Marathon Refinery fire department. Fire foam training at the Pine Bend Refinery in Rosemount takes place approximately 20 to 25 times during the training season from April through November, and approximately 5 to 10 gallons of Ansul –brand ThunderStorm Class B foam is used per training event. The Pine Pend Refinery fire department used 3M-brand Class B foam historically, and has a stockpile of approximately 50,000 gallons of 3M-brand foam on hand. Other area municipal departments train at the refinery training grounds with foam provided by the refinery.

The former Conoco-Phillips oil refinery in Wrenshall, Minnesota ceased operation in the early 1980s. The City of Wrenshall Volunteer Fire Department indicated that the refinery had their own fire fighting equipment, but that the Wrenshall Fire Department responded to any fire calls. The department trained at the Wrenshall refinery with Class B foam when it was in operation.

3.3.5 Survey Results - Camp Ripley

The Fire and Emergency Services Coordinator for Camp Ripley indicated that his position at Camp Ripley had been created in approximately 2007, and he was not familiar with historical firefighting practices at Camp Ripley. No firefighting training with foam is currently being conducted at Camp Ripley.

4.0 RANKING OF FIREFIGHTING FOAM TRAINING SITES

The training sites where Class B firefighting foam is or was used on more than one occasion were ranked in order to identify those with the highest potential to release PFCs to sensitive environments. The sites were ranked according to the criteria listed in Section 4.1. A relative numerical score was assigned for each criterion that was meant to reflect the relative importance of each parameter with respect to its potential to release PFCs to the environment, and the sensitivity of the environmental receptors.

4.1 Ranking Criteria

The criteria are listed below in brief; a more detailed description of the ranking criteria were presented in the June 2008 Report. The following criteria were considered in ranking training sites on their potential to release PFCs to sensitive environments:

1) Brand of foam used for training. Due to the known content of PFOS and PFOA in firefighting foams manufactured by 3M, training sites where 3M foams were currently or formerly used in training were ranked higher.
2) Amount of foam used in training.
3) Proximity to nearby surface waters.
4) Proximity to nearby wetlands.
5) Proximity to karst geological areas.
6) Proximity to wellhead protection areas (WPA) and/or source water assessment areas (SWAA).
7) The presence of water supply wells nearby.

Since spent training foam are released to the ground or go to a storm sewer at most training sites, the final destination of the spent foam was not considered as a ranking criteria.

4.2 Ranking Results

A total of 80 municipal fire departments' training sites, 3 airport fire departments, 2 firefighting training schools, and 3 petroleum refineries were ranked. Rankings for the municipal fire departments are presented in **Table 1, *Class B Foam Use Ranking Summary, Minnesota Municipal Fire Departments***, and rankings for the training schools, airports, and refineries are presented in **Table 2, *Class B Foam Use Ranking Summary, Minnesota Airport and Refinery Fire Departments and Training Schools***. Individual profiles for each of the ranked sites were included in the June 2008 Report and October 2008 Addendum Report.

Total scores assigned to the firefighting foam training sites ranged from 7 to 33. The highest scores were assigned to sites generally located in a wellhead protection or source water protection area and/or a karst

area, had water supply wells located within ¼-mile, a wetland and/or surface water body located within ¼-mile of the training site, and 3M foams are or were used for training. A total of 21 sites were considered for follow-up investigations, as listed below:

- *Minneapolis/St. Paul International Airport former training areas*: MSP Airport is located in a WPA and an active karst area, with up to 40 gallons of foam used annually for training. From 1983 through 2001, fire foam training with 3M-brand Class B foam was conducted east of Cargo Road near the present location of the glycol management facility. Foam training prior to 1983 took place at an area located northeast of the current FedEx facility. Both the pre- and post-1983 former fire foam training areas were re-worked and excavated to some extent during construction associated with the addition of a new airport runway in 2001. Storm water from this area of the airport drains to a holding pond near the southwest corner of the MSP Airport.
- *Marathon Refinery, St. Paul Park:* Marathon Refinery is located in an active karst area near the Mississippi River, with approximately 250 gallons of Ansul-brand foam used annually for training. The Marathon Refinery historically used 3M-brand Class B foams through approximately 2000. Fire foam training is conducted at fire training grounds located near the southwest corner of the refinery. Spent foam and water is routed to an on-site waste water treatment plant.
- *Flint Hills Pine Bend Refinery, Rosemount:* Pine Bend refinery is located in a transition karst area, with approximately 300 gallons of Ansul-brand foam used annually for training. Foams manufactured by 3M were historically used in training. Fire foam training is conducted at fire training grounds near the southwest corner of the refinery. Spent foam is collected into a lined holding area from which it is pumped out and disposed through an on-site waste water treatment plant.
- *Kenyon Fire Department foam training area:* Bi-annual training with 3M-brand foam is conducted on Slee Street, between Cross and Pine Streets at the east end of town. The training area is located in a SWAA and an active karst area.
- *Claremont Fire Department training and foam demonstration areas:* Annual to bi-annual training with 3M-brand foam is conducted on a paved surface in front of the fire station on Front Street, where spent foam and water drain to a storm sewer. In the fall of 2008 a fire foam demonstration was held behind the station. The fire station is located in a SWAA and a transition karst area.
- *Harmony Fire Department foam training areas:* Foam training has occurred at two locations: historically in front of the fire station on Main Avenue South, and more recently at the municipal tree/brush dump south of the fire station. Foam training with Ansul-brand foam takes place annually or less. Both areas are located in a SWAA and an active karst area.
- *Bemidji Fire Department foam training site:* Annual training is conducted with five gallons or less 3M-brand foam at the Bemidji Regional Airport. The airport is located in a WPA with surface waters and wetlands adjacent to the airport and shallow municipal wells located nearby.
- *Fridley Fire Department training site:* Historically, training with 3M-brand firefighting foam took place at the North Metro Fire Training Center on 71st Avenue in Fridley. A training structure was built in 1994/1995 over a burn pit that had been used for foam training. The training center is located in a WPA and a transition or covered karst area.
- *Burnsville Fire Department training site:* The Burnsville Fire Department has trained three times with Ansul-brand foam at the ABLE Fire Training Center since it was built in 1989, and the last training exercise was in 2004. The fire training center is located at the southeast corner of the intersection of Cliff Road and River Ridge Boulevard in Burnsville. The training center is located in a WPA and appears to be situated in an active karst area. Municipal wells are located nearby.
- *Goodview Fire Department training area:* Occasional training (approximately six times in the last twenty years) is conducted on a paved area in front of the fire station located at 4140 W. 5th Street. Spent foam and water drain to a storm sewer which discharges into the backwaters of the

Mississippi River. The fire station and the discharge area are located in a WPA and an active karst area.

- *North St. Paul Fire Department training site:* Semi-annual training with 3M-brand foam takes place at the North St. Paul Public Works facility on 1st Street North. The site is located in a WPA and covered karst area.
- *Richfield Fire Department:* The Richfield Fire Department historically trained occasionally with 3M foam behind the Richfield Ice Arena, located at 636 East 66th Street. The ice arena is located in a WPA and covered karst area, with municipal wells nearby. Surface runoff from the training area would drain to nearby Legion Lake.
- *Rochester Fire Department:* Historically, annual training with 3M-brand foam took place in a parking lot near the northwest corner of the Olmsted County Fairgrounds in Rochester. The site is located in a WPA and active karst area.
- *Luverne Fire Department:* A one-time fire foam demonstration took place in approximately 2005 at the Luverne municipal tree/brush dump. A burn pan was used, and the soils around the burn pan were cleaned up with a payloader afterwards. The site is located in a WPA, and a shallow municipal water supply well located nearby.
- *Lake Superior College Emergency Response Training Center (ERTC):* The potential exists for historical use of 3M or other brand foams at the ERTC from approximately 1994 through 1996. Training foam has been used at the facility since 1996. An on-site wetland is located adjacent to the foam training area, and the St. Louis River nearby. This site was selected for sampling after inquiries received by the MPCA regarding this facility.

Although originally identified as priority sites, additional information collected during follow-up activities that clarified foam use precluded the following sites from sampling: Pierz Fire Department; Cottage Grove Fire Department; Alexandria Fire Department; Myrtle Fire Department; Preston Fire Department; two training sites used by the Brooklyn Center Fire Department; and South Central College in Mankato. Since the MPCA conducted a PFC investigation at the former fire training area at the Duluth International Airport, no further investigation was conducted for this project. Additional inquiries regarding the fire training areas utilized by the Maynard and Hutchinson Fire Departments found that the Maynard Fire Department only uses Class A foam, and the Hutchinson Fire Department did not train with Class B foam at the former training location on the Crow River.

4.3 Additional Foam Discharge Sites

During the course of the PFC/Firefighting Foam project, additional incidents of firefighting foam discharge were brought to the attention of the MPCA. Further investigation was made into foam use at the following sites:

- *Kings Cove Marina, Hastings[(a)]:* In October 2002 a fire at the Kings Cove Marina destroyed several boats which were dry-docked at the west end of the marina. Several fire departments responded to the fire with various brands of Class B foam, apparently including approximately 305 gallons of 3M foam. This firefighting event may have released firefighting foam directly to the Mississippi River. Fish tissue sampling by the MPCA has identified PFCs in fish collected from the Mississippi River in the Hastings area.
- *River Grove Marina, Inver Grove Heights:* A fire occurred on a docked boat at the River Grove Marina on September 26, 2009. The Inver Grove Fire Department responded to the fire with, in

part, Ansul-brand Class B foam, which was discharged onto the burning boat and docks on the Mississippi River.

- *Kandiyohi County Landfill, New London:* A fire occurred at the Kandiyohi County Landfill over several days at the end of October 2009. Several fire departments responded to the fire, and approximately 545 gallons of 3M Class B foam was used on the fire.
- *Crystal Airport:* The Brooklyn Center Fire Chief related that several fire departments responded to a large hangar fire at the Crystal Airport in 2006. Interviews with responding departments found that Class B foam was not used at the hangar fire, but had been used at several plane crash sites at the airport.
- *Up North Plastics, Cottage Grove*[(a)]*:* A fire occurred at the business of Up North Plastics in December 2002. Its been estimated that upwards of 4,000 gallons of foam were used to extinguish the fire. Spent foam migrated into ditches and wetlands north of the facility, and to a storm sewer outlet south of the facility across Jamaica Road. Up North Plastics property is located within an area being investigated to identify sources of PFCs found in private wells in the Langdon and River Acres neighborhoods of Cottage Grove.
- *Western Area Fire Training Academy (WAFTA), St. Bonifacius*[(a)]*:* The WAFTA training facility was operated from 1974 through 1990, at the site of a former Nike Missile launch facility. The site was being investigated by the MPCA for other contaminants when, in May 2006, fourteen monitoring wells were sampled for PFCs. PFCs were detected in several of the wells.
- *Duluth International Airport*[(a)]*:* The Duluth Air National Guard Base and the Duluth Air Force Base both historically used two fire training areas located on the northeast side of the Duluth International Airport for Class B foam training.

(a) Further investigation and subsequent sampling at these sites was conducted by consultants other than Delta on behalf of the MPCA. Since firefighting foams were discharged at these sites, they are being included in this report.

5.0 SITE RECONNAISSANCE AND SAMPLE COLLECTION

Generally, the same or similar procedures were followed for site reconnaissance and sampling at the municipal fire department foam training areas. These procedures were presented in previous reports that detail specific site investigations. The sites where sampling was not conducted by Delta, or were not included in previous reports, are discussed in sections 5.1 through 5.5.

5.1 Sample Collection at the Kandiyohi County Landfill

Groundwater samples were collected for PFC analysis from two existing wells at the Kandiyohi County Landfill. Monitoring well DMW-1A is located upgradient of the C&D portion of the landfill where the fire occurred, and DMW-3 is located approximately 300 to 350 feet away in a roughly downgradient direction. The wells at Kandiyohi County Landfill were sampled on two occasions, in January and May 2010. Soil borings were not advanced at the landfill and soil samples were not collected.

5.2 Sample Collection at WAFTA

Groundwater samples were collected for PFC analysis from fourteen existing wells at the WAFTA site. The groundwater sampling was conducted in May 2006 by ENSR Corporation and is summarized in their report, *Phase II Site Investigation at Former Nike Missile Base MSP-70/Western Area Fire Training Academy,* dated October 2006. Monitoring well MW-4 was situated within the former fire training area, and the other wells were located side-gradient and downgradient of the training area. Monitoring well BG-4 was situated furthest downgradient of the training area, near the southeast corner of the WAFTA site. Soil samples were not collected for PFC analysis at WAFTA. The MPCA followed-up in 2008 and 2009 with sampling of nearby residential water wells for PFCs.

5.3 Sample Collection at the Kings Cove Marinas

At site of the fire at Kings Cove Marina in Hastings, two surface water and two sediment samples were collected from the adjacent Mississippi River where spent foam accumulated. One surficial soil sample was collected where foam was discharged on land. Sampling at Kings Cove Marina was conducted by West Central Environmental Consultants (WCEC). A data report detailing the sampling at Kings Cove Marina was submitted to the MPCA by WCEC on March 8, 2010.

5.4 Sample Collection at Duluth International Airport

Six soil borings were advanced within two former fire foam training areas at the Duluth International Airport for the purpose of collecting groundwater samples only. The sampling was conducted in October 2007 by BB&E, LLC, as presented in their *Groundwater Sampling Report, Duluth Air National Guard Base* dated December 19, 2007. Soil samples were not collected for PFC analysis at the fire training areas. The MPCA is following up with sampling of residential water wells in the area for PFCs.

5.5 Sample Collection at Up North Plastics

Five surficial soil samples were collected from the storm water ditch to which spent foam and water from the Up North Plastics fire reportedly drained. Four sediment and two surface water samples were also collected from a pond at the end of the storm water ditch. Groundwater samples were collected from three irrigation wells which are located at distances up to 1.5 miles away from the Up North Plastics facility. Sampling associated with the Up North Plastics fire was conducted by WCEC in July 2009. WCEC submitted a data report dated September 22, 2009, to the MPCA detailing this sampling.

6.0 SAMPLING RESULTS

Soil and sampling results are summarized in **Table 4, *Soil and Sediment Analytical Results, PFCs***. Groundwater and surface water sampling results are summarized in **Table 5, *Groundwater and Surface Water Analytical Results, PFCs***. The amount of foam used in training or at a fire response, and the foam

brands and the last known approximate date of training or date of foam discharge at a fire, are included on the tables.

Samples were submitted to either Axys Analytical Services LTD (Axys) or MPI Research for analysis of PFCs. Duplicate samples were collected at select sites and submitted to both laboratories for comparison purposes. Samples collected at the WAFTA site were analyzed by the MDH and by Exygen Research, which later became Axys. The laboratories used for analysis are noted in Tables 4 and 5.

According to research, one important factor for the transport of anionic perfluorinated surfactants in soil is the organic content of the soil; soil partition coefficients were found to be linearly related to organic carbon content, and sorption of the anionic perfluorinated surfactants to soil particles increased with increasing perfluorinated chain length (17). Therefore, soil samples collected for PFC analysis at select sites were also submitted to Pace Analytical Services for laboratory analysis of total organic carbon (TOC) via EPA Method SW9060.

6.1 Laboratory Analytical Results, Soil and Sediment Sampling

Laboratory analysis detected PFCs in 52 of the 80 soil and sediment samples analyzed for this project (see **Table 4**). The highest PFC concentrations detected in soil or sediment samples were found in the soil samples collected at the Bemidji Airport and the Richfield Ice Arena, and the sediment sample collected from the on-site wetland at the Lake Superior College ERTC. The Bemidji Fire Department trains annually with foam at the Bemidji Airport. Training with Class B foam ceased at the ERTC in 1996, and Class B foam training by the Richfield Fire Department stopped in 1999. 3M-brand Class B foam was used, or was likely used, at all three sites.

Class B foam manufactured by 3M was used, or was likely used (based on the date of foam use and the popularity of the foam) at all of the sites sampled as part of this project, except for the following: the ABLE fire training center in Burnsville; the fire foam training areas in Luverne and Harmony; the River Grove Marina fire; and, the storm sewer associated with the Goodview Fire Station. While PFOS is associated with 3M-brand foam, PFOS was detected in the soil at the sites in Burnsville, Luverne and Goodview. However, the PFOS detected in the storm water sediment sample collected in Goodview may or may not be associated with foam use at the Goodview Fire Station since storm water runoff is collected from numerous points along the storm sewer. Ansul-brand foam was used for training at the Burnsville site, however, the Burnsville Assistant Fire Chief indicated that the use of 3M-brand foam cannot be absolutely ruled out. The Harmony Fire Department indicated they train with Ansul-brand foam. The brand of foam used at the Luverne site for demonstration is unknown.

Analytical data for all of the soil and sediment samples indicates that perfluorinated sulfonates, especially PFOS, are present at higher concentrations than perfluorinated carboxylic acids. PFOS was the PFC

compound detected most often in the soil/sediment samples, with PFOS detected in 45 of the 80 samples analyzed. The next most-detected compounds were PFHxS and PFOA, which were detected in 36 of the soil/sediment samples. These trends are illustrated in **Graph 1**, ***Soil and Sediment PFC Concentrations***.

For the purpose of analyzing PFC concentrations trends with depth and with elapsed time between the last foam use and sampling date, PFOS soil concentration data were compared from the fire foam training sites where 3M-brand foam was used. This included PFOS data from foam training sites in Bemidji, Claremont, Rochester, Richfield, and Fridley. No trends were apparent in analyzing PFOS concentrations at shallow (0 to 4 feet bgs) and deep (4 to 8 feet bgs) depths, and no trends were apparent in comparing PFOS concentrations, and PFOS concentration increases/decreases with depth, to the length of elapsed time between the sampling and the last foam training. This lack of data trend may be due to the varying amounts of foam and water used, and different types of soils, and bare soil or grassy training sites versus paved training areas.

No trends are apparent between PFC compound concentrations and TOC concentrations. As expected, TOC concentrations are higher in the shallower soil samples.

6.2 Soil Laboratory Results versus State PFC Soil Reference Values

The MDH has defined soil reference values (SRVs) for a number of chemical compounds, which are soil contaminant concentrations above which an unacceptable risk to human health is predicted, dependent upon different exposure scenarios. The SRVs may or may not apply to the foam training areas or the fire sites; they are presented in this report for comparison purposes only.

Tier 1 SRVs assume that human exposure to contaminants is chronic and occurs in a residential site setting. Tier 2 SRVs assume contaminant exposures for industrial and recreational property uses. The MPCA has defined soil Tier 1 Residential SRVs, Tier 2 Recreational SRVs, and Tier 2 Industrial SRVs for only the following PFC compounds:

	Tier 1 Residential SRV	*Tier 2 Recreational SRV*	*Tier 2 Industrial SRV*
PFOS	2,100 ng/g	2,600 ng/g	14,000 ng/g
PFOA	2,100 ng/g	2,500 ng/g	13,000 ng/g
PFBA	77,000 ng/g	94,000 ng/g	500,000 ng/g

ng/g: nanograms per gram, which is equivalent to parts-per-billion.

None of the PFC concentrations detected in soil or sediment samples collected for this project met or exceeded any of the MPCA SRVs.

6.3 Groundwater and Surface Water Sampling Results

Laboratory analysis detected PFCs in 68 of the 72 groundwater and surface water samples analyzed for this project (see **Table 5**). Groundwater or surface water samples with the highest PFOS concentrations were found in samples collected at the WAFTA site. Water samples with the highest PFOA concentrations were collected at MSP Airport, WAFTA, and Duluth International Airport. Class B foams made by 3M were used, or were likely used based on the date of foam use, at all of these sites in the past.

The PFC compounds most often detected in groundwater and surface water samples were perfluorinated carboxylic acids. PFOA was detected in 59 of the 72 water samples collected during this project, and PFBA was detected in 58 water samples. PFHxA and PFPeA were detected in 55 and 53 of the water samples, respectively. This trend is illustrated in **Graph 2**, ***Groundwater and Surface Water PFC Concentrations.***

PFCs were detected in surface waters near the following fire foam training areas or fire sites where Class B foam was used: Richfield; MSP Airport; Goodview; River Grove Marina; Lake Superior College ERTC; Kings Cove Marina; and Up North Plastics. With the exception of Lake Superior College ERTC, the sampled bodies of water receive storm water runoff from areas other than the foam training or foam discharge sites. The PFCs detected in the surface waters may be attributed to the firefighting foam, or they may be from an unidentified source. At the ERTC in Duluth, it appears that only runoff from the fire training area enters that wetland.

At sites where 3M-brand foam were not used (the ABLE fire training center in Burnsville; the fire foam training areas in Luverne and Harmony; and, the storm sewer associated with the Goodview Fire Station), PFOS was detected in the groundwater or surface water. As discussed in Section 2.2, PFOS is associated with firefighting foams made by 3M. The source of PFOS at the ABLE fire training center in Burnsville, and at the training areas in Luverne and Harmony, is not known. The storm sewer outlet sampled in Goodview collects storm water from a large area where other sources of PFOS may exist.

6.4 Groundwater PFC Concentrations Versus Minnesota HRLs

The MDH has defined drinking water standards or values for the following PFC compounds: PFOS, PFOA, PFBA, and PFBS. The State drinking water Health Risk Limit (HRL) for both PFOS and PFOA in drinking water is 300 nanograms per liter (ng/L), which is equivalent to parts-per-trillion. The chronic exposure Health Based Value (HBV) for both PFBA and PFBS is 7,000 ng/L. The HBVs are developed by the MDH as interim guidance until a HRL can be established. A Risk Assessment Advice (RAA) for perfluorohexane sulfonate (PFHxS) does not specify numerical health-based limits or values.

The PFOS HRL was exceeded in at least one groundwater sample collected from the following sites:

- WAFTA

- Marathon Refinery
- Bemidji Airport
- ABLE fire training center in Burnsville
- MSP Airport

The PFOA HRL was exceeded in at least one groundwater sample collected from the following sites:

- MSP Airport
- WAFTA
- Duluth Airport
- ABLE fire training center in Burnsville
- Richfield Ice Arena

The surface water sample collected from the on-site wetland at the Lake Superior College ERTC had PFOS and PFOA concentrations that exceeded the drinking water HRLs. The HBVs for PFBA and PFBS were not exceeded in any of the water samples collected during this project.

6.5 State Surface Water Criteria for PFCs

The MPCA has developed site-specific ambient surface water quality criteria for only two PFC compounds, PFOA and PFOS. PFOA and PFOS criteria haven been developed for the surface waters of Lake Calhoun and for a portion of the Mississippi River, in accordance with Minnesota Rules, Chapter 7050.0218, *Methods for Determination of Criteria for Toxic Pollutants, for which Numerical Standards Not Promulgated.* Ambient surface water quality criteria have not been developed for any of the surface water bodies sampled as part of this project.

6.6 Ambient Groundwater Concentrations in Minnesota

In October 2007, ambient groundwater samples were collected by the MPCA from springs and monitoring wells in rural Minnesota for analysis of thirteen PFC compounds, including PFOA and PFOS. Sampling data is presented in the MPCA document *PFCs in Minnesota's Ambient Environment: 2008 Progress Report.* Twenty-two groundwater samples were analyzed for PFCs. The only PFC compound detected was PFBA, which was detected in thirteen samples at concentrations ranging from 2.43 ng/l to 63 ng/l.

In November-December 2006 and November 2007, the MPCA collected twenty-six ambient groundwater samples in urban areas of Minnesota, excluding those in Washington County where PFCs in groundwater are linked releases at historic 3M dumps. The samples were analyzed for nine PFC compounds, including PFOA and PFOS. Every PFC analyte was detected in at least one groundwater sample. Detected PFBA concentrations ranged from 1.34 ng/l to 468 ng/l. PFOA concentrations ranged from 1.1 ng/l to 24.8 ng/l. PFOS concentrations ranged from 2.39 ng/l to 31 ng/l.

In comparing groundwater sampling results from those sites sampled during this project in the rural areas of Minnesota (Harmony, Luverne, Bemidji, and Kandiyohi County) the PFBA concentrations as well as the number of other PFC analytes detected were considered. The PFC concentrations detected in groundwater at the firefighting foam training sites in Harmony, Luverne and Bemidji cannot be attributed to ambient concentrations. At the Kandiyohi County Landfill, where only low levels of PFBA have been detected in the well sample collected downgradient of the site of the fire, the PFBA concentrations may or may not be due to ambient levels.

Ambient concentrations of PFBA, PFOA and PFOS in groundwater found at urban locations were compared to the data collected at the remaining firefighting training sites or fire sites. The PFC concentrations detected in groundwater at the sites in Richfield, Fridley, Burnsville, and at MSP Airport, Duluth Airport, WAFTA, Marathon Refinery, and MW-3 at the Flint Hills Resources Pine Bend Refinery cannot be attributed to ambient concentrations. The PFBA, PFOA and PFOS concentrations detected in groundwater samples collected at the North St. Paul training area and the Crystal Airport, and in the upgradient groundwater samples (B-5, B-6 and B-7) at MSP Airport and the upgradient sample (MW-1) at the Pine Bend Refinery may or may not be due to ambient levels.

7.0 RECEPTOR SURVEYS AND ASSESSMENT OF RISK

The execution of receptor surveys and an evaluation of potential risks associated with PFC impacts identified during this project was not part of the scope of work, with one exception: a water well receptor survey was conducted around the former firefighting foam training area in Richfield due to the known presence of private wells in the area (see Section 7.2). The MPCA is not aware of anyone drinking water that has been impacted with PFCs above drinking water criteria due to the use of firefighting foam. The chemicals associated with firefighting foams of most concern at this time are PFOS and PFOA. According to the Minnesota Department of Health, nearly all people have some amount of PFCs in their blood. Studies by the Center for Disease Control and Prevention (CDC) published in 2007 found that PFOS, PFOA and PFHxS were detected in approximately 98% of the population (18). Research relied upon by the MDH in setting HRLs for drinking water indicates the health concerns associated with exposure to PFOS are effects on the liver and thyroid; health concerns related to PFOA are effects on the liver, slowed development in fetuses, reduced number of red blood cells, and changes to the immune system (19). While less is known about the potential health effects of telomerized compounds, the fact that they are showing up in more locations where firefighting foams are being used may mean that more study is warranted.

7.1 MDH Municipal Well Sampling

One of the risks associated with PFCs in groundwater is to human health should a potable water well be drawing water from impacted groundwater. There are municipal supply wells located near several of the "priority" sites where groundwater impacted by PFCs have been identified, including Bemidji, Luverne, Burnsville, and Richfield. The MPCA and MDH have worked together to identify public supply wells that may be at risk due to their proximity to firefighting foam training areas or large fire sites where Class B foam was discharged. The MDH has sampled supply wells near several fire foam training areas in the "priority" cities and elsewhere, and while low levels of some PFC compounds were detected in municipal well water samples, none of the concentrations have exceeded the HRLs or HBVs.

7.2 Well Receptor Survey, Richfield

As presented in the February 2010 Report, a water well survey was conducted in the area adjacent to or within one-quarter mile to the east, south and southeast of, the former Richfield fire foam training area at the Richfield Ice Arena, in reference to the easterly or potential southeasterly groundwater flow direction. The survey included a search of the MDH County Well Index (CWI), and walking and mailing surveys to identify private water wells. The survey identified several sealed and abandoned water supply wells and groundwater monitoring wells in the survey area. No active wells, other than the municipal wells which were being sampled by MDH, were identified within ¼-mile downgradient of the former fire training area.

7.3 Well Receptor Survey, WAFTA

A groundwater receptor survey conducted by ENSR Corporation identified several water supply wells within one-half mile of the WAFTA site. Sampling of the nearby water wells by the MPCA in 2008 and 2009 did not identify PFCs in any of the wells.

7.4 Well Information, Duluth International Airport

According to the *Groundwater Sampling Report* by BB&E, LLC, there are no drinking water wells in the immediate area of the former firefighting foam training areas, and there are no plans to install water supply wells on airport property. The nearest residential water supply wells identified in a groundwater receptor survey conducted in association with this site are located approximately 1.25 miles away. The residential wells are currently being sampled for PFCs under the oversight of the MPCA.

8.0 FINDINGS AND RECOMMENDATIONS

8.1 PFCs in Class B Foam

Based on the literature review, interviews with knowledgeable persons, and survey of firefighting foam manufactures, the surfactant in Class B firefighting foams contain PFCs. The Class B foams manufactured by 3M prior to 2002 using the ECF manufacturing process contain, or break down to, perfluorinated

sulfonates. Class B foams made by other manufacturers using a telomerization process contain, or break down to, fluorotelomer sulfonates and perfluorinated carboxylic acids.

8.2 Class B Foam Use in Minnesota

Based on the survey of Minnesota firefighting organizations, and assuming that the 66% response rate by municipal fire departments is representative of the entire State, approximately 10% of the municipal fire departments do not use firefighting foam at all, approximately 58% of the municipal fire departments use only Class A foams, approximately 15% of the municipal fire departments use Class B foam for fire response but do not train with Class B foam, and approximately 15% of the municipal fire departments use and train with Class B foam.

The two active oil refineries in the State have their own fire departments and their own on-site fire training areas where Class B foam is used in training and as needed for extinguishing fires.

Of the sixteen MNSCU firefighting training schools, only two of the schools hold training exercises or held training exercises on campus with Class B foam: Lake Superior College ERTC in Duluth; and, Northland College in East Grand Forks.

Firefighting training with Class B foam is no longer conducted at MSP Airport or the Duluth International Airport. Training at these airports with 3M-brand Class B foam was conducted in the past.

Firefighting training with Class B foam at the WAFTA site in St. Bonifacius ceased in 1990. Firefighting foam is not used in training exercises at the SCALE Regional Public Safety Training Facility in Jordan, which opened in 2008. Firefighting foam training is not conducted at Camp Ripley.

Class B foams have been used, and will continue to be used on Class B fires across the State in order to protect public safety, the safety of firefighters, and property. Class B foams are not classified as a hazardous substance, nor has the MPCA or other regulatory entity placed any restrictions on the use of Class B foams.

8.3 Sampling Findings

This project has identified PFCs in soil, sediments, surface water and groundwater at locations where various brands of Class B firefighting foams were used. PFCs were found in soils and groundwater at sites where several years have passed since the last training event or since foam was discharged at a fire. PFC compounds associated with 3M's ECF manufacturing process (i.e. perfluorinated sulfonates) were detected at training sites where 3M-brand foams were not used.

Groundwater is impacted with PFOA and/or PFOS at concentrations exceeding the State drinking water HRLs at the following sites:

- WAFTA site in St. Bonifacius
- Marathon Refinery in St. Paul Park
- Bemidji Regional Airport
- ABLE fire training center in Burnsville
- MSP Airport
- Duluth International Airport
- Richfield Ice Arena

While these locations have PFOA and/or PFOS concentrations in groundwater that exceed the State drinking water Criteria, at this time the MPCA is not aware of anyone drinking water contaminated with PFCs due to the use of firefighting foams that exceed drinking water criteria. Sampling of private water wells in the area of the WAFTA and Duluth International Airport firefighting foam training sites did not detect PFCs in any of the wells. A groundwater receptor survey conducted in the area of the Richfield Ice Arena did not identify any active private water wells.

The PFC concentrations in soils at all sites where samples were collected are all well below the current clean-up criteria.

Firefighting foam training sites with minimal use of Class B foams exhibited low levels of PFCs in groundwater, but concentrations are not exceeding current standards. Therefore, those training sites ranked lower than the 21 "priority" sites do not appear to be a risk to human health or the environment and will not be subject to further action at this time, unless additional information is obtained that would change the ranking of a site.

8.4 State Recommendations on the Use of Class B Firefighting Foam

The MPCA, in conjunction with the Minnesota Department of Public Safety and the Minnesota State Colleges and Universities, has prepared a "Best Practices Today for Class B Firefighting Foam" document, a copy of which is included in **Appendix A**. The Best Practices document recognizes the importance of the use of Class B firefighting foam to fight Class B fires-- it protects the public, it protects the firefighters working to protect us, and it protects property. The Best Practice document presents information and recommendations on the use of foam on fires and spills, foam training, foam types, firefighters' health, and foam disposal, and includes the following recommendations:

- Use Class B foams as necessary on Class B fires, but use Class A foams for Class A fires.
- Use training foam, and not Class B foam, in training exercises if possible. Training foams do not appear to contain PFCs.
- Training with Class B foams in wellhead protection areas or near public or private water supply wells should be avoided whenever possible.

8.5 Recommendations for Further Assessment

While the MPCA is not aware of anyone drinking water contaminated with PFCs above drinking water criteria associated with firefighting foam use, several sites still warrant some additional investigation. Based on the information presented in this report and previous reports, following are recommendations for further assessment with regards to PFCs at firefighting foam training sites or fire sites where Class B foam was used:

1. Conduct groundwater receptor surveys to evaluate risk at the following sites where PFOA and/or PFOS concentrations in groundwater exceeded the State HRLs:
    - Marathon Refinery in St. Paul Park
    - Bemidji Regional Airport
    - ABLE fire training center in Burnsville
    - MSP Airport
2. Conduct a groundwater receptor survey to evaluate risk in the area of the Lake Superior College ERTC due to elevated PFOS and PFOA concentrations in the wetland adjacent to the training area.
3. Continue to monitor groundwater for PFCs at the existing monitoring well located downgradient of the fire site at the Kandiyohi County Landfill. Since the foam discharge occurred less than one year ago, it may take time for potential PFC impacts to migrate through the soil to the water table, and to migrate with groundwater to the location of well DMW-3. Consider installing a monitoring well closer to the site of the fire if site activities and land use nearer the fire site are conducive to the presence of a monitoring well.
4. At the time of sampling at Crystal Airport, there was no water in Shingle Creek. Since PFCs were detected in a sediment sample collected on the down stream side of Crystal Airport, but none were detected upstream, water samples should be collected at or near the locations of the previous sediment samples to test for PFCs in Shingle Creek adjacent to Crystal Airport.
5. Follow up with inquiries, and sampling if warranted, at any large fires that occur or have occurred where Class B foams are used extensively.

9.0 REMARKS

The recommendations contained in this report represent Delta's professional opinions based upon the currently available information and are arrived at in accordance with currently accepted professional standards. This report is based upon a specific scope of work requested by the client. The contract between Delta and its client outlines the scope of work, and only those tasks specifically authorized by that contract or outlined in this report were performed. This report is intended only for the use of Delta's client and anyone else specifically identified in writing by Delta as a user of this report. Delta will not and cannot be liable for unauthorized reliance by any other third party. Other than as contained in this paragraph, Delta makes no express or implied warranty as to the contents of this report.

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Date: June 30, 2010

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TABLES

TABLE 1

CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

		SITE RANKING CRITERIA								
Department	**Training Location**	**Foam Type: 3M current or former use in training =8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**OVERALL SITE RANKING**	**Notes**
Richfield	Richfield ice arena, 636 E. 66th St.	8	6	3	3	2	3	5	30	sampled soil, groundwater, surface water, upgradient groundwater
Fridley	300 71st Av., Fridley (North Metro Fire Training Center)	8	2	3	3	4	3	5	28	sampled soil, groundwater, sediment
Luverne	Tree dump 1/2 mile south of city on Hwy 75, east side of road.	8	6	3	3	0	3	5	28	sampled soil, groundwater
North St. Paul	No. St. Paul Public Works, 2303 1st St. N.	8	6	3	1	2	3	5	28	sampled soil, groundwater, surface water
Brooklyn Center	Fire station #1 6250 Brooklyn Blvd.	8[(a)]	6	1	1	4	3	5	28	follow-up site visit indicated no Class B foam training.
	Fire station #2 6500 Dupont Av. N.	8[(a)]	6	1	1	4	3	5	28	follow-up site visit indicated no Class B foam training.
Preston	Fillmore County Fairgrounds Fillmore St. & Cty. Hwy. 12, Preston	8	2	3	3	5	3	4	28	follow-up interview indicated one-time training at specified location only.
Kenyon	Fire station, 714 2nd St.	8	2	3	1	5	3	5	27	sampled soil
Cottage Grove	Fire Station 2, 8641 80th St. S.	8	2	3	3	5	1	5	27	follow-up interview indicated training with Class A foam only.
Bemidji	Bemidji Airport (Class B)	8	4	3	3	0	3	5	26	follow-up interview indicated foam brand unknown; sampled soil, groundwater
Northfield	City street shop, 1710 Riverview Drive.	8	2	3	3	5	3	1	25	haven't trained with foam in 10-15 years, and only trained when new equipment purchased.
Rochester	2021 41st St. NW	8	2	1	1	5	3	5	25	sampled soil
Burnsville	ABLE Fire Training Center Cliff Rd & River Ridge Blvd.	0	4	3	3	5	3	5	23	sampled soil, groundwater
Claremont	Front of fire hall on Front St.	8	2	1	0	4	3	5	23	sampled soil
Clearbrook	Tank farm on south edge of town.	8[(a)]	4	3	3	0	3	2	23	Fire Chief wasn't sure the type of foam used. Spent foam caught on floating lids at tank farm.
Linwood Twp	Behind fire station, 22870 Typo Creek Dr., Stacy	8	4	3	3	0	3	2	23	
Littlefork	Fire hall, McPherson & 3rd Av	8[(a)]	2	3	3	0	3	4	23	follow-up attempts unsuccessful
St. Clair	City of St. Clair	8[(a)]	6	3	1	2	3	0	23	follow-up attempts unsuccessful
Alexandria	Various, including VoTech, Magellan tank farm, live burns.	8[a]	2	3	1	0	3	5	22	historical training with Class B foam at Magellen tank farm only.
Golden Valley	7800 Golden Valley Road	0	6	3	1	4	3	5	22	
Hutchinson	205 3rd Av. SE	8	4	1	1	0	3	5	22	no on-site foam training, historically trained with foam at 3M facility in town.
	1300 Adams St. SE	8	4	3	1	0	3	2	21	

TABLE 1

CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

		SITE RANKING CRITERIA								
Department	**Training Location**	**Foam Type: 3M current or former use in training =8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**OVERALL SITE RANKING**	**Notes**
Myrtle	Myrtle ballfield	8[(a)]	2	1	0	5	1	5	22	follow-up interview indicated use of Class A foam only.
Perham	Near parking entrance of Prairie Winds Middle School	8[(a)]	4	1	1	0	3	5	22	various brands Class B foam, more training with class A than Class B. Switched to POK stick last year.
Pierz	Intersection of 25 and 27, Pierz	8	2	3	3	0	1	5	22	follow-up interview indicated one-time training at specified location only.
St. Paul	1683 Energy Park Dr., St. Paul	8	4	1	1	5	3	0	22	
Crosslake	Joint City/County maintenance facility, 13870 Whipple.	8[(a)]	2	3	3	0	3	2	21	training location confirmed with City, could not confirm type of foam used.
Fairmont	City shop park lot, 417 E. Margaret St.	8	6	3	3	0	1	0	21	
Goodview	Across street from fire station, 4140 W. 5th St.	0	2	3	3	5	3	5	21	sampled surface water, sediment
Mankato	Fire Sta. #1, 300 Madison Av.	8	4	1	0	5	1	2	21	
Marshall	Marshall Merit Center, Cty Rd 33 (1001 W. Erie Rd.)	8[(a)]	6	3	3	0	1	0	21	
Harmony	Fire hall, Main Av. S. and Brush dump, east of intersection of 139 & Gordon Rd.	0	2	3	3	5	1	5	19	sampled soil and groundwater
Hugo	5223 140th St. N.	0	2	3	3	4	3	4	19	
	4630 Fable Rd. Ct. N.	0	2	3	3	4	3	5	20	
Minneapolis	25 37th Ave. NE	8	2	3	1	4	1	0	19	
Rosemount	14700 Shannon Pkwy	8	2	1	1	2	3	2	19	
Winona	Central Fire Sta., 451 E. 3rd.	0	2	3	1	5	3	5	19	
	Technical College, 1250 Homer Rd.	0	2	3	3	5	3	0	16	
Cannon Falls	Cannon Valley fair grounds, Cannon Falls	0	2	3	3	5	1	4	18	
Lanesboro	Lanesboro ball park parking lot, County Road 8	0	2	3	3	5	1	4	18	
Loretto	259 Medina St. N.	8	2	1	1	0	1	5	18	
Plymouth	Fire Station, 13250 Co. Rd. 6	0	2	1	1	2	1	5	12	
	Fire Station, 3300 Dunkirk Ln.	0	2	3	3	2	3	5	18	
	Fire Station, Old Rockford Rd.	0	2	3	3	2	3	5	18	
Waconia	7550 Airport Rd.	0	4	3	3	0	3	0	13	
	26 Maple St. S.	0	4	3	1	0	3	5	16	
	8075 Paradise Lane	0	4	3	3	0	3	5	18	
Montevideo	Fire station, 103 Canton Av.	8	2	3	3	0	1	0	17	

TABLE 1

CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

		SITE RANKING CRITERIA								
Department	**Training Location**	**Foam Type: 3M current or former use in training =8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**OVERALL SITE RANKING**	**Notes**
Apple Valley	Fire Sta. #1, 15000 Hayes Rd.	0	2	1	3	2	3	5	16	
	Apple Valley central maintenance facility, 6442 140th St. W.	0	2	1	3	2	3	4	15	
Elysian	Fire hall, 212 E. Main	0	2	3	3	2	1	5	16	
Norwood	City vacant lot at South & Rush Streets	0	2	1	3	2	3	5	16	
Paynesville	City airport	0	2	3	3	0	3	5	16	
Pelican Rapids	2nd Av. NW & 4th St.	0	2	3	3	0	3	5	16	
St. Cloud	Open field near Sta. 2 700 41st Av N.	0	6	3	1	0	1	5	16	
	Sta. 4, 1550 45th Av SE	0	6	1	3	0	1	4	15	
Waldorf	Main Street	0	6	1	1	2	1	5	16	
Buffalo Lake	315 N. Main St., at Main & Church Sts.	8	2	1	1	0	1	2	15	
Hamburg	181 Broadway	0	2	3	3	2	3	2	15	
Lake Johanna	Varies, mostly at Station 3, 5545 Lexington Ave.	0	4	3	3	2	3	0	15	
Richmond	Industrial lot, 3 lots west of Main & 191st Av, on the north side of Main.	0	2	3	3	0	3	4	15	
Sartell-LeSauk	Fire hall, 220 4th Ave. S.	0	2	3	3	0	3	4	15	
Silver Lake	Public Works storage area, 305 E. Main St.	0	2	3	3	0	3	4	15	
Upsala	110 W. Elm Av., Upsala	0	4	3	3	0	3	2	15	
Welcome	NE corner of Dugan St. S. and Mill St.	0	2	1	3	0	3	5	14	
Albert Lea	Frank Av., near dog pound	0	2	1	1	2	3	4	13	
Cass Lake	Railroad ROW by 8 Railroad St. NW, Cass Lake	0	4	1	1	0	3	4	13	
Glenville	High school football field	0	2	3	1	4	3	0	13	
New York Mills	City utility gravel parking lot, west side of town, between Centennial Dr. W. and Hwy. 10.	0	2	3	3	0	3	2	13	
Pine River	Fair grounds	0	2	1	1	0	1	5	10	
	School grounds on 1st Street	0	2	3	3	0	1	4	13	
Waseca	Waseca Cty Fairground, area of grand stand.	0	4	1	1	2	1	4	13	

TABLE 1

CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

		SITE RANKING CRITERIA								
Department	**Training Location**	**Foam Type: 3M current or former use in training =8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**OVERALL SITE RANKING**	**Notes**
Cloquet	Gravel pit next to city garage at 410 Armory Road	0	2	1	3	0	1	5	12	
Maynard	Mable St. & Sherman	0	2	1	1	0	3	5	12	follow-up interview indicated use of Class A foam only.
Newfolden	Fire hall	0	2	3	1	0	1	5	12	
Randall	At lot across the street from the fire station.	0	2	0	3	0	3	4	12	
Alborn	Albrook School, 7427 Seville Rd., Saginaw (demonstration)	0	2	1	3	0	1	0	7	
	Alborn Fire Hall, 6390 Hwy. 7, Alborn (training & demo).	0	2	3	3	0	3	0	11	
Appleton	Appleton Public Works bldg. 427 S. Munsterman St.	0	4	1	3	0	3	0	11	
Dilworth	Fire hall, 709 1st Av NW	0	2	3	1	0	3	2	11	
Evansville	East end of town, (new) Council Circle.	0	2	1	3	0	1	4	11	
Hibbing	2320 Brooklyn Dr.	0	2	1	1	0	3	4	11	
Hoyt Lakes	Triple ballfields or near Hoyt Lakes fire hall, 123-1/2 Kennedy Memorial Dr.	0	2	3	3	0	3	0	11	
Mapleton	Street in front of fire hall, 103 3rd Av NE	0	2	1	0	2	1	5	11	
Northrop	Behind fire hall, 211 N. Bridgeman	0	2	0	1	0	3	5	11	
Dunnell-Lake Fremont	Old ball diamond, N. Seeley Av., Dunnell	0	2	1	1	0	1	4	9	
Ellsburg	Fire hall, 1763 Melrude Rd., Melrude, MN	0	2	3	3	0	1	0	9	
Porter	Fire hall, 301 Lone Tree Street	0	4	3	1	0	1	0	9	
Tyler	Corner of Bradley & Applebee	0	6	1	1	0	1	0	9	
Blackhoof	3148 Cty. Rd. 5, Barnum	0	2	1	1	0	3	0	7	
Breckenridge	1312 Minnesot Av.	0	4	1	1	0	1	0	7	
Wolverton	Gravel road in front of fire hall, 301 Hwy 75, Wolverton	0	2	3	1	0	1	0	7	

Notes:
(a) Foam type or training use not specified, 3M foam use for training assumed.
WPA: Wellhead Protection Area
SWAA: Source Water Assessment Area

DELTA

TABLE 2

CLASS B FOAM USE RANKING SUMMARY

MINNESOTA AIRPORT AND REFINERY FIRE DEPARTMENTS AND TRAINING SCHOOLS

Delta Project No. 19382DEL08

				Site Ranking Criteria							
Entity	**Location**	**Training Location**	**Notes**	**Foam Type: 3M current or former use in training=8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**Site Ranking**
Alexandria Technical College	1601 Jefferson St. Alexandria	Various locations	Foam provided by various fire departments.	Foam training at various locations, foam provided by other fire departments. Site not ranked.							
Central Lakes College	501 W. College Drive, Brainerd	Various fire departments		Multiple training locations, site not ranked.							
Hennepin Technical College	13100 Collegeview Dr. Eden Prairie	Parking lots of school		Use of Class A and training foam only; no Class B foam use. Site not ranked.							
Hennepin Technical College	1820 Xenium Ln. N. Plymouth	Hennepin Technical College, 13100 College View Dr., Eden Prairie		Class A foam use only, site not ranked.							
Itasca Community College	1831 E. Hwy. 169 Grand Rapids	Not applicable		Foam not used in training, site not ranked.							
Lake Superior College	11501 Hwy 23 Duluth	On-site	Training foam type Kidde Trainol. Other departments train with Trainol.	8	2	3	3	0	1	0	17
Mesabi Range College	1001 Chestnut St. Virginia	Various fire departments and on-site.		Class A foam use only, site not ranked.							
Minnesota State Community & Technical College	2900 28th Av. S. Moorhead	Various fire departments; no training with foam on campus.	Foams supplied by local fire departments.	Multiple training locations, site not ranked.							
Minnesota West Comm & Tech College	607 W. Main St., #100 Marshall	Various fire departments: Granite Falls, Luverne, Jackson, Lake Wilson, and Merit Center in Marshall	Training foam type unknown.	Multiple training locations, site not ranked.							
Northland College	1101 Hwy 1 East Thief River Falls	Various fire departments	Foam training done at off-site locations using other departments' foam.	Class A foam use only, multiple training locations; site not ranked.							
Northland College	2022 Central Av. NE East Grand Forks	Two grassy areas and a parking lot on campus.	Stopped using Class B protein foam more than 5 years ago.	0	6	1	1	0	0	0	8
Pine Technical College	900 4th St. SE Pine City	Various house burns, training as requested.	Foam supplied by other fire departments.	Class A foam use only, multiple training locations; site not ranked.							

TABLE 2

CLASS B FOAM USE RANKING SUMMARY

MINNESOTA AIRPORT AND REFINERY FIRE DEPARTMENTS AND TRAINING SCHOOLS

Delta Project No. 19382DEL08

Entity	Location	Training Location	Notes	Site Ranking Criteria							Site Ranking
				Foam Type: 3M current or former use in training=8	Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6	Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0	Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0	Karst Area: Active=5; Transition=4; Covered=2; No=0	Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0	WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0	
St. Cloud Technical College	1540 Northway Drive St. Cloud	Various fire departments		Multiple training locations, site not ranked.							
South Central College	1920 Lee Blvd North Mankato	On-site (10%) and at various fire departments (90%).	Training with various foam brands, whatever the trainee dept. has on hand and whatever is least expensive.	es that there is no on-site training with Class B foam.							
Ridgewater College	2101 NW 15th Av Willmar	Off-site at various fire departments: Litchfield, Ortonville, Prinsburg, Morris		Class A foam use only, multiple training locations; site not ranked.							
Riverland Community College	1900 8th Av NW Austin	Have not trained in many years, recall one training event in Preston, MN.	Foam brands not specified.	Class A and training foam use only, multiple training locations; site not ranked.							
Flint Hills Resources, Pine Bend Refinery Fire Dept.	Rosemount	SW corner of refinery site, 1255 Clayton Blvd.	3M Foams (FC 600F, FC 602, ATC 3x3, FC 603) no longer used for training. Ansul Thunderstorm FC600A used for training. Other departments train on site.	8	6	1	1	4	3	0	23
Marathon Petroleum Refinery	St. Paul Park	Refinery fire training grour	Switched from 3M to Ansul Thunderstorm foam in ~2000. Use ~250 gallon foam for training; non-training foam use varies. Site located in Special Well Construction Area.	8	6	3	3	5	3	2	30
Former Wrenshall Refinery	Highway 1, Wrenshall	Per Wrenshall Fire Chief, historic training with foam on-site.		8[(b)]	6[(c)]	3	3	0	3	2	25[(c)]
Camp Ripley	15000 Hwy 115 Little Falls	No on-site training with foam.	Class A foam type Fire-Trol Fire Foam 103B	No on-site training with foam, Class A foam use only; site not ranked.							

TABLE 2

CLASS B FOAM USE RANKING SUMMARY

MINNESOTA AIRPORT AND REFINERY FIRE DEPARTMENTS AND TRAINING SCHOOLS

Delta Project No. 19382DEL08

				Site Ranking Criteria							
Entity	**Location**	**Training Location**	**Notes**	**Foam Type: 3M current or former use in training=8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**Site Ranking**
Metropolitan Airports Commission at Minneapolis/St. Paul Airport	MSP	Trained until recently at Humphrey remote ramp or de-icing pad. Plugged drains, collected spent foam for off-site disposal	Ansul 3% used for training. Historic use of military protein foam in 1960s/1970s. Historic use of 3M foam through ~2000. Class A foam type 1% Lorcon.	8	6	3	3	5	3	5	33
Rochester Airport Fire Dept.	Rochester	Various on-site locations as selected by FAA Inspector, usually a runway. "Short bursts" of foam required in training by FAA. Firefighters train at facility in Duluth.		0	2	3	3	5	3	0	16
Minnesota Air National Guard - Duluth International Airport	Duluth	No current on-site training with foam.	Active site investigation for PFCs at former fire training site under direction of MPCA. 3M foam still used in fire response.	8[(b)]	6	3	3	0	3	0	23

Notes:

(a) Foam type or training use not specified, 3M foam use for training assumed.

(b) 3M foam not currently used in training, but currently used in fire response. Site ranked based on use of foam in fire response.

(c) Ranking assumes maximum use of 3M foam in training exercises.

WPA: Wellhead Protection Area

SWAA: Source Water Assessment Area

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TABLE 3

Sample Collection Summary
Minnesota Firefighting Foam Training and Discharge Sites
Delta Project No. 19382DEL08

Site	# Borings Advanced	Sampled Media							Notes
		Boring Soil Samples	Surface Soil Samples	Groundwater from Borings	Groundwater from Existing Well	Upgradient Groundwater	Sediment	Surface Water	
MSP Airport Minneapolis, MN	7			X	X	X	X	X	Soil samples not collected from borings.
Marathon Refinery St. Paul Park	0				X	X			Sampled existing wells only, no borings advanced.
Flint Hills Resources Pine Bend Refinery Rosemount	0				X	X			Sampled existing wells only, no borings advanced.
Kenyon Fire Department Training Site Slee Street Kenyon	2	X							Groundwater not encountered in borings.
Claremont Fire Department Training Site Claremont Fire Station, Behind	2	X							Groundwater not encountered in borings.
Claremont Fire Department Training Site Claremont Fire Station, Front	1	X							Groundwater not encountered in borings.
Harmony Fire Department Training Sites Harmony Municipal Tree/Brush Dump	2	X		X					
Harmony Fire Department Training Sites Harmony Fire Station	2	X							Groundwater not encountered in borings.
Bemidji Fire Department Training Site Bemidji Regional Airport	2	X		X					
Fridley Fire Department Training Site North Metro Fire Training Center Fridley	2	X		X			X		Sediment sample collected from an on-site wetland.
Burnsville Fire Department Training Site ABLE Fire Training Center Burnsville	3	X		X					Groundwater collected from boring B-3 only.
Goodview Fire Department Training Site Storm Sewer Discharge Point Goodview	0						X	X	Samples collected at storm sewer discharge point only.
No. St. Paul Fire Department Training Site No. St. Paul Public Works Facility	2	X	X	X					
Richfield Fire Department Training Site Richfield Ice Arena	4	X		X		X		X	
Rochester Fire Department Training Site Olmsted County Fairgrounds Rochester	2	X							Groundwater not encountered in borings.
Luverne Fire Department Training Site Municipal Tree/Brush Dump Luverne	3	X		X					
Lake Superior College ERTC Duluth	0		X				X	X	Samples collected at underground pipe discharge point and from on-site wetland.
River Grove Marina Inver Grove Heights	0						X	X	
Kandiyohi County Landfill New London	0				X	X			Sampled existing wells only, no borings advanced.
Crystal Airport Crystal	2	X	X	X			X		
Kings Cove Marina Hastings	0		X				X	X	
Up North Plastics Cottage Grove	0		X				X	X	Samples collected along storm water ditch and associated pond.
WAFTA St. Bonifacius	0				X				Sampled existing wells only.
Duluth International Airport Former Fire Training Areas	6			X					Soil samples not collected from borings.

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TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Harmony Fire Dept. Training Area, Tree/Brush Dump																
Training Frequency:	Annual or less since ~2006															
Last Training Event[(1)]:	2008															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	variety, including Ansulite															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Harmony B-1 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.191	< 0.191	< 0.191	< 0.0955
Harmony B-1 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.201	< 0.201	< 0.201	< 0.101
Harmony B-2 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.189	< 0.189	< 0.189	< 0.0947
Harmony B-2 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.192	< 0.192	< 0.192	< 0.0962
Harmony Fire Dept. Training Area, Harmony Fire Station																
Training Frequency:	Annual or less, 1994 thru 1999															
Last Training Event[(1)]:	1999															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	variety, including Ansulite															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Harmony B-3 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0977	**0.2**	< 0.0977	**0.161**	< 0.0977	**0.125**	< 0.0977	< 0.0977	< 0.0977	< 0.195	< 0.195	< 0.195	< 0.0977
Harmony B-3 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.190	< 0.190	< 0.190	< 0.0950
Harmony B-4 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0989	**0.253**	**0.133**	**0.15**	< 0.0989	< 0.0989	< 0.0989	< 0.0989	< 0.0989	< 0.198	< 0.198	< 0.198	< 0.0989
Harmony B-4 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.200	< 0.200	< 0.200	< 0.100

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Burnsville Fire Dept. Training Area, ABLE Fire Training Center																
Training Frequency:	3 times since 1989															
Last Training Event[(1)]:	2004															
Foam Usage per Training Event:	5-10 gallons															
Foam Brand:	Ansul															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Burnsville B-1 SL 0-4'	0-4 ft.	4/24/2009	Axys	**1.73**	**5.32**	**3.27**	**6.72**	**11.4**	**10.2**	**4.37**	**0.537**	**0.542**	< 0.192	**2.63**	**102**	< 0.0962
Burnsville B-1 SL 4-8'	4-8 ft.	4/24/2009	Axys	**0.132**	**1.54**	**1.77**	**8.46**	**14.8**	< 0.0956	< 0.0956	< 0.0956	< 0.0956	< 0.191	**11**	**1.62**	< 0.0956
Burnsville B-2 SL 0-4'	0-4 ft.	4/24/2009	Axys	**0.796**	**3.08**	**1.69**	**1.05**	**5.78**	**7.92**	< 0.0992	< 0.0992	< 0.0992	< 0.198	< 0.198	**2.8**	< 0.0992
Burnsville B-2 SL 4-8'	4-8 ft.	4/24/2009	Axys	**1.83**	**4.81**	**3.97**	**4.14**	**0.355**	< 0.0985	< 0.0985	< 0.0985	< 0.0985	< 0.197	**1.2**	< 0.197	< 0.0985
North St. Paul Fire Dept. Training Area, Public Works Facility																
Training Frequency:	semi-annual, 5-10 times total															
Last Training Event[(1)]:	2008															
Foam Usage per Training Event:	5-10 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
No St Paul B-1 SL 0-4'	0-4 ft.	5/6/2009	Axys	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.185	< 0.185	< 0.185	< 0.0926
No St Paul B-1 SL 4-8'	4-8 ft.	5/6/2009	Axys	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.200	< 0.200	< 0.200	< 0.0998
No St Paul B-2 SL 0-4'	0-4 ft.	5/6/2009	Axys	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.191	< 0.191	< 0.191	< 0.0954
No St Paul B-2 SL 4-8'	4-8 ft.	5/6/2009	Axys	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.196	< 0.196	< 0.196	< 0.0978
No St Paul B-3 SL 0-2'	0-2 ft.	5/6/2009	Axys	< 0.0972	< 0.0972	< 0.0972	< 0.0972	**0.107**	< 0.0972	< 0.0972	< 0.0972	< 0.0972	< 0.194	< 0.194	**0.623**	< 0.0972

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Richfield Fire Dept. Training Area, Richfield Ice Arena																
Training Frequency:	occasional															
Last Training Event[(1)]:	1999															
Foam Usage per Training Event:	30-40 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Richfield B-1 0-4'	0-4 ft.	5/7/2009	Axys	< 0.0932	**0.226**	**0.191**	**0.433**	**1.36**	**1.44**	**0.095**	< 0.0932	< 0.0932	< 0.186	**1.26**	**104**	**0.21**
Richfield B-1 4-8'	4-8 ft.	5/7/2009	Axys	**0.322**	**1.43**	**0.905**	**0.592**	**1.11**	**1.89**	< 0.0966	< 0.0966	< 0.0966	< 0.193	**1.44**	**102**	< 0.0966
Richfield B-2 0-4'	0-4 ft.	5/7/2009	Axys	**0.464**	**1.33**	**1.07**	**0.85**	**2.32**	**5.03**	**0.306**	< 0.186	< 0.186	< 0.373	**13**	**401**	**0.47**
Richfield B-2 4-8'	4-8 ft.	5/7/2009	Axys	**1.04**	**4.52**	**4.7**	**3.28**	**5.02**	**4.83**	< 0.379	< 0.379	< 0.379	< 0.757	**32.2**	**666**	< 0.379
Richfield B-3 0-4'	0-4 ft.	5/7/2009	Axys	< 0.0942	< 0.0942	**0.314**	**0.309**	**1.49**	< 0.0942	< 0.0942	< 0.0942	< 0.0942	< 0.188	**21.9**	**56.4**	< 0.0942
Richfield B-3 4-8'	4-8 ft.	5/7/2009	Axys	**0.173**	**0.439**	**1.02**	**0.283**	**0.336**	< 0.104	< 0.104	< 0.104	< 0.104	**0.57**	**2.35**	**9.33**	< 0.104
Richfield B-4 0-8'	0-8 ft.	10/8/2009	Axys	< 0.0956	< 0.0956	< 0.0956	< 0.0956	**0.129**	< 0.0956	< 0.0956	< 0.0956	< 0.0956	< 0.191	**0.236**	**4.52**	< 0.0956
Kenyon Fire Dept. Training Area, Slee Street																
Training Frequency:	bi-annual															
Last Training Event[(1)]:	2004															
Foam Usage per Training Event:	< 5 gallons															
Foam Brand:	variety, including 3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Kenyon B-1 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0963	< 0.0963	< 0.0963	**0.111**	< 0.0963	< 0.0963	< 0.0963	< 0.0963	< 0.0963	< 0.193	< 0.193	< 0.193	< 0.0963
Kenyon B-1 SL 0-4'	0-4 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Kenyon B-1 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.189	< 0.189	< 0.189	< 0.0944
Kenyon B-1 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Kenyon B-2 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.187	< 0.187	< 0.187	< 0.0937
Kenyon B-2 SL 0-4'	0-4 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Kenyon B-2 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.189	< 0.189	< 0.189	< 0.0943
Kenyon B-2 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Claremont Fire Dept. Training Area, Back of Fire Station																
Training Frequency:	1 time															
Last Training Event[(1)]:	Fall 2008															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Claremont B-1 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.181	< 0.181	**0.308**	< 0.0907
Claremont B-1 SL 0-4'	0-4 ft.	5/15/2009	MPI	**0.413**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**0.773**	<0.2	<0.2
Claremont B-1 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.193	**0.224**	**0.321**	< 0.0966
Claremont B-1 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Claremont B-2 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0936	< 0.0936	**0.385**	< 0.0936	**0.154**	< 0.0936	< 0.0936	< 0.0936	< 0.0936	**0.491**	**1.65**	**24.7**	**0.129**
Claremont B-2 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.192	< 0.192	**0.25**	< 0.0958
Claremont Fire Dept. Training Area, Front of Fire Station																
Training Frequency:	annually or less															
Last Training Event[(1)]:	approximately 2007															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Claremont B-3 SL 0-4'	0-4 ft.	5/15/2009	Axys	**0.114**	**0.167**	**0.427**	**0.232**	**0.174**	< 0.0912	< 0.0912	< 0.0912	< 0.0912	**2.39**	**5.25**	**3.46**	< 0.0912
Claremont B-3 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.187	**0.561**	**0.988**	< 0.0935

TABLE 4

Soil and Sediment Analytical Results, PFCs
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				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Luverne Fire Dept. Training Site, Tree/Brush Dump																
Training Frequency:	1 time															
Last Training Event[(1)]:	2005															
Foam Usage per Training Event:	5 gallons															
Foam Brand:	unknown															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Luverne B-1 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.192	< 0.192	< 0.481	< 0.241
Luverne B-1 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-1 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.196	< 0.196	< 0.490	< 0.245
Luverne B-1 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-2 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.191	< 0.191	**0.481**	< 0.239
Luverne B-2 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-2 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.200	< 0.200	< 0.500	< 0.250
Luverne B-2 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-3 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.195	< 0.195	< 0.487	< 0.244
Luverne B-3 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-3 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.197	< 0.197	< 0.492	< 0.246
Luverne B-3 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fridley Fire Dept. Training Site, North Metro Fire Training Center																
Training Frequency:	occasional															
Last Training Event[(1)]:	1994/1995															
Foam Usage per Training Event:	< 5 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Fridley B-1 SL 0-4'	0-4 ft.	5/27/2009	Axys	**0.242**	**0.422**	**0.413**	**0.27**	**0.291**	**0.144**	< 0.100	< 0.100	< 0.100	< 0.201	**1.25**	**43**	< 0.100
Fridley B-1 SL 4-8'	4-8 ft.	5/27/2009	Axys	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.201	< 0.201	**2.45**	< 0.101
Fridley B-2 SL 0-4'	0-4 ft.	5/27/2009	Axys	**1.34**	**1.67**	**2.78**	**0.735**	**0.699**	< 0.102	< 0.102	< 0.102	< 0.102	**3.01**	**23.4**	**3.48**	< 0.102
Fridley B-2 SL 4-8'	4-8 ft.	5/27/2009	Axys	**0.601**	**1.13**	**1.53**	**0.335**	**0.493**	< 0.0950	< 0.0950	< 0.0950	< 0.0950	**1.32**	**14.2**	**1.31**	< 0.0950
Fridley B-3 Sediment 6"	0.5 ft.	5/27/2009	Axys	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.193	< 0.193	**18.3**	< 0.0966

TABLE 4

Soil and Sediment Analytical Results, PFCs
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				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Rochester Fire Dept. Training Area, Olmsted County Fairgrounds																
Training Frequency:	annual															
Last Training Event[(1)]:	2001/2002															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Rochester B-1 SL 0-4'	0-4 ft.	5/28/2009	Axys	**0.207**	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.196	**0.361**	**0.559**	< 0.0979
Rochester B-1 SL 4-8'	4-8 ft.	5/29/2009	Axys	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.191	< 0.191	< 0.191	< 0.0957
Rochester B-2 SL 0-4'	0-4 ft.	5/28/2009	Axys	**0.142**	< 0.0999	**0.173**	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.200	**1.7**	**1.12**	< 0.0999
Rochester B-2 SL 4-8'	4-8 ft.	5/29/2009	Axys	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.190	< 0.190	< 0.190	< 0.0949
Goodview Fire Station, Storm Drain Outflow																
Training Frequency:	6 times in 20 years															
Last Training Event[(1)]:	2004/2005															
Foam Usage per Training Event:	5 gallons															
Foam Brand:	Ansul															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Goodview Sed-1	0-6 in.	10/19/2009	Axys	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.177	< 0.177	**0.332**	< 0.0883
Bemidji Fire Dept. Training Area, Bemidji Airport																
Training Frequency:	annual															
Last Training Event[(1)]:	2008/2009															
Foam Usage per Training Event:	5 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Bemidji B-1 SL 0-4'	0-4 ft.	11/5/2009	Axys	< 0.0951	< 0.0951	**0.216**	< 0.0951	**0.118**	< 0.0951	< 0.0951	< 0.0951	< 0.0951	< 0.190	**3.12**	**55.7**	**0.112**
Bemidji B-1 SL 4-8'	4-8 ft.	11/5/2009	Axys	< 0.0913	< 0.0913	< 0.0913	< 0.0913	**0.498**	< 0.0913	< 0.0913	< 0.0913	< 0.0913	**0.267**	**3.98**	**56**	< 0.0913
Bemidji B-2 SL 0-4'	0-4 ft.	11/5/2009	Axys	**0.184**	**0.322**	**1.44**	**0.143**	**1.31**	**0.099**	< 0.0933	< 0.0933	< 0.0933	< 1.87	**13.9[(2)]**	**1200[(2)]**	**18.5**
Bemidji B-2 SL 4-8'	4-8 ft.	11/5/2009	Axys	< 0.276	< 0.276	**0.411[(2)]**	**0.917[(2)]**	**19.6[(2)]**	< 0.276	< 0.276	< 0.276	< 0.276	**0.957[(2)]**	**147[(2)]**	**606[(2)]**	< 0.276

TABLE 4

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				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
River Grove Marina Fire, Inver Grove Heights																
Date of Foam Discharge:	9/26/2009															
Foam Usage	15 gallons															
Foam Brand:	Ansul															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
River Grove Sed-1	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333
River Grove Sed-2	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333
River Grove Sed-3	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333
Lake Superior College ERTC																
Training Frequency:	unknown, 1994-1996															
Last Training Event[(1)]:	1996															
Foam Usage per Training Event:	unknown															
Foam Brand:	3M or other															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
ERTC SS-1	0-6 in.	11/25/2009	Axys	< 0.0998	**0.205**	**0.794**	**0.139**	**0.495**	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.200	**3.49**	**83.5**	**4.54**
ERTC Sed-1	0-6 in.	11/25/2009	Axys	< 0.0917	< 0.0917	< 0.0917	< 0.0917	**0.225**	< 0.0917	< 0.0917	< 0.0917	< 0.0917	< 0.183	**1.2**	**57.5**	**6.52**
ERTC Sed-2	0-6 in.	11/25/2009	Axys	**0.218**	**0.536**	**1.72**	**0.268**	**1.26**	**0.184**	**0.101**	**0.174**	< 0.0933	**1.47**	**19.6**	**538**	**181**
MSP Airport																
Training Frequency:	unknown															
Last Training Event[(1)]:	2001															
Foam Usage per Training Event:	5-10 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
MSP Sed-1	0-6 in.	1/19/2010	Axys	< 0.484	< 0.484	< 0.484	< 0.484	**1.8**	**1.89**	**17.3**	**2.5**	**15.6**	< 0.968	< 0.968	**8.84**	**3.55**

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Crystal Airport																
Date of Foam Discharge:	June 2009															
Foam Usage per Training Event:	unknown															
Foam Brand:	Fire Aide 2000															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Crystal B-1 SL 0-4'	0-4 ft.	1/20/2010	Axys	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.972	< 0.972	< 0.972	< 0.486
Crystal B-1 SL 4-8'	4-8 ft.	1/20/2010	Axys	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.985	< 0.985	< 0.985	< 0.493
Crystal B-2 SL 0-4'	0-4 ft.	1/20/2010	Axys	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.977	< 0.977	< 0.977	< 0.488
Crystal B-2 SL 4-8'	4-8 ft.	1/20/2010	Axys	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.979	< 0.979	< 0.979	< 0.490
Crystal SS-1	2 ft.	1/20/2010	Axys	< 0.498	**0.929**	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.996	< 0.996	< 0.996	< 0.498
Crystal Sed-1	0-6 in.	1/20/2010	Axys	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 1.03	< 1.03	< 1.03	< 0.513
Crystal Sed-2	0-6 in.	1/20/2010	Axys	**0.467**	**1.16**	< 0.404	**0.491**	**0.654**	**0.412**	**0.863**	**1.17**	**2.47**	< 0.807	**1.03**	**7.1**	**1.45**
Kings Cove Marina, Hastings Fire																
Date of Foam Discharge:	October 2002															
Foam Usage	305 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Kings Cove Marina Soil	Surficial	12/3/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	**1.11**	**2.07**	**10.4**	<0.667	<0.667	<0.667	<0.333
Kings Cove Marina Sed 1	Surficial	12/3/2009	MPI	<0.333	<0.333	<0.333	<0.333	**0.841**	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	**1.34**	<0.333
Kings Cove Marina Sed 2	Surficial	12/3/2009	MPI	<0.333	<0.333	**0.773**	<0.333	**0.736**	<0.333	<0.333	<0.333	<0.333	<0.667	**4.44**	**6.12**	<0.333

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Up North Plastics, Cottage Grove Fire																
Date of Foam Discharge:	12/1/2002															
Foam Usage	4,000 gallons or more															
Foam Brand:	unknown															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Up North Plastics Soil 1	Surficial	7/16/2009	Axys	**2.45**	**0.419**	**0.682**	**0.189**	**1.18**	**0.342**	**0.642**	**2.46**	**1.27**	**0.296**	**20.6**	**258**	**8.91**
Up North Plastics Soil 2	Surficial	7/16/2009	Axys	**0.985**	< 0.0982	**0.205**	**0.115**	**0.381**	< 0.0982	< 0.0982	**0.341**	**0.343**	< 0.196	**2.07**	**59.1**	**2.99**
Up North Plastics Soil 3	Surficial	7/16/2009	Axys	**0.203**	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.202	< 0.202	< 0.202	< 0.101
Up North Plastics Soil 4	Surficial	7/16/2009	Axys	< 0.0964	< 0.0964	**0.233**	< 0.0964	**0.172**	< 0.0964	**0.097**	**1.88**	< 0.0964	< 0.193	**3.91**	**355**	**16.5**
Up North Plastics Soil 5	Surficial	7/16/2009	Axys	**3.82**	**0.628**	**0.477**	**0.266**	**8.29**	< 0.0964	< 0.0964	**0.122**	**0.128**	**0.199**	**0.712**	**7.48**	**0.428**
Up North Plastics Sed 1	Surficial	7/16/2009	Axys	**0.659**	< 0.0965	< 0.0965	< 0.0965	**0.406**	< 0.0965	< 0.0965	< 0.0965	< 0.0965	< 0.193	< 0.193	**1.15**	< 0.0965
Up North Plastics Sed 2	Surficial	7/16/2009	Axys	**3.37**	**0.195**	**0.19**	< 0.110	**0.957**	**0.113**	< 0.110	**0.165**	**0.713**	**0.284**	**1.65**	**104**	**0.782**
Up North Plastics Sed 3	Surficial	7/16/2009	Axys	**14.2**	**1.94**	**1.32**	**0.608**	**14.6**	< 0.104	< 0.104	< 0.104	**0.188**	< 0.207	**0.764**	**16.3**	< 0.104
Up North Plastics Sed 4	Surficial	7/16/2009	Axys	**2.35**	**0.265**	**0.143**	< 0.119	**1.49**	< 0.119	**0.331**	**0.657**	**1.24**	< 0.238	**0.596**	**13.6**	**0.325**
Up North Plastics Sed Dup	Surficial	7/16/2009	Axys	**1.25**	< 0.102	< 0.102	< 0.102	**0.726**	< 0.102	< 0.102	< 0.102	< 0.102	< 0.204	< 0.204	**1.67**	< 0.102

Notes:

PFC results are in nanograms per gram (ng/g), which is equivalent to parts per billion.
PFC compounds soil results reported on a dry weight basis.
Bolded type indicates detection above the laboratory method detection limit.
Non-detect results presented as less than the laboratory detection limit.
Axys: Axys Analytical Services LTD
MPI: MPI Research
(1) Last training event prior to sampling, dates are approximate
(2) Results based on analysis of a dilution of the sample extract.

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TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			4	5	6	7	8	9	10	11	12	4	6	8	8
Health-Based Limits:			7000[2]	ND	ND	ND	300[3]	ND	ND	ND	ND	7000[2]	RAA[4]	300[3]	ND
Harmony Fire Dept. Training Area, Tree/Brush Dump															
Training Frequency:	Annual or less since ~2006														
Last Training Event[1]:	2008														
Foam Usage per Training Event:	5 gallons or less														
Foam Brand:	variety, including Ansulite														
Sample ID	**Sample Date**	**Laboratory**													
Harmony B-1 GW	4/23/2009	Axys	**7.3**	**3.27**	**2.67**	< 2.49	**7**	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	**8.33**	< 2.49
Harmony B-2 GW	4/23/2009	Axys	**9.04**	**2.52**	< 2.46	< 2.46	**6.92**	< 2.46	< 2.46	< 2.46	< 2.46	< 4.92	< 4.92	**6.74**	< 2.46
North St. Paul Fire Dept. Training Area, Public Works Facility															
Training Frequency:	semi-annual, 5-10 times total														
Last Training Event[1]:	2008														
Foam Usage per Training Event:	5-10 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
No St Paul B-1 GW	5/6/2009	Axys	**137**	**13.3**	**13.2**	**8.83**	**13.8**	< 3.49	< 3.49	< 3.49	< 3.49	< 6.99	**14.1**	< 6.99	< 3.49
No St Paul B-2 GW	5/6/2009	Axys	**145**	**15.5**	**14.1**	**8.22**	**13.2**	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	**14.8**	< 5.01	< 2.50
Richfield Fire Dept. Training Area, Richfield Ice Arena															
Training Frequency:	occasional														
Last Training Event[1]:	1999														
Foam Usage per Training Event:	30-40 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Richfield B-1 GW	5/7/2009	Axys	**1070**	**3470**	**3500**	**819**	**50.3**	< 18.8	< 18.8	< 18.8	< 18.8	**737**	**76.2**	< 37.7	< 18.8
Richfield B-2 GW	5/7/2009	Axys	**1240**	**4890**	**4170**	**1920**	**1330**	< 91.4	< 91.4	< 91.4	< 91.4	< 183	< 183	< 183	< 91.4
Richfield B-3 GW	5/7/2009	Axys	**201**	**331**	**888**	**217**	**458**	< 66.7	< 66.7	< 66.7	< 66.7	**293**	**689**	< 133	< 66.7
Legion Lake SW-1	8/27/2009	Axys	**4.02**	<7.21	< 2.51	**3.55**	**5.69**	**3.63**	**3.92**	< 2.51	< 2.51	< 5.02	< 5.02	**13.2**	< 2.51
*Richfield B-4 GW 29 ft.	10/8/2009	Axys	**228**	**10.3**	**10.3**	**5.43**	**38.7**	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	**71.4**	< 4.96	< 2.48

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000[2]**	**ND**	**ND**	**ND**	**300[3]**	**ND**	**ND**	**ND**	**ND**	**7000[2]**	**RAA[4]**	**300[3]**	**ND**
Luverne Fire Dept. Training Site, Tree/Brush Dump															
Training Frequency:	1 time														
Last Training Event[1]:	2005														
Foam Usage per Training Event:	5 gallons														
Foam Brand:	unknown														
Sample ID	**Sample Date**	**Laboratory**													
Luverne B-1 GW 8 ft.	5/22/2009	Axys	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.05	**18.1**	< 5.05	< 2.53
Luverne B-1 GW 8 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0[5]	<25.0	<25.0
Luverne B-2 GW 12 ft.	5/22/2009	Axys	< 2.55	< 2.55	**3.78**	< 2.55	**2.73**	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	**22.8**	**18.4**	< 2.55
Luverne B-2 GW 12 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	**25.1**	<25.0[7]	<25.0
Luverne B-3 GW 12 ft.	5/22/2009	Axys	< 2.53	**3.99**	**11.3**	< 2.53	**3.39**	< 2.53	< 2.53	< 2.53	< 2.53	< 5.07	**21.4**	**20.1**	< 2.53
Luverne B-3 GW 12 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0[6]	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	**28.8**	<25.0[8]	<25.0
Fridley Fire Dept. Training Site, North Metro Fire Training Center															
Training Frequency:	occasional														
Last Training Event[1]:	1994/1995														
Foam Usage per Training Event:	< 5 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Fridley B-1 GW	5/27/2009	Axys	**37.6**	**34**	**27.1**	**23.2**	**32.7**	< 4.27	< 4.27	< 4.27	< 4.27	**15.2**	**98.9**	**21.9**	< 4.27
Fridley B-2 GW	5/27/2009	Axys	**88.3**	**97.2**	**166**	**59.5**	**86.8**	< 5.39	< 5.39	< 5.39	< 5.39	**182**	**1330**	**35**	< 5.39
MSP Airport															
Training Frequency:	unknown														
Last Training Event[1]:	2001														
Foam Usage per Training Event:	5-10 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
MSP Airport B-1 GW	5/29/2009	Axys	**279**	**909**	**1640**	**317**	**988**	**42**	< 41.2	< 41.2	< 41.2	**332**	**3090**	< 82.5	< 41.2
MSP Airport B-2 GW	5/29/2009	Axys	**190**	**507**	**817**	**198**	**958**	< 48.8	< 48.8	< 48.8	< 48.8	**286**	**2920**	< 97.6	< 48.8
MSP Airport B-3 GW	5/29/2009	Axys	**151**	**148**	**477**	< 135	**12000**	< 135	< 135	< 135	< 135	< 269	**21200**	**281**	< 135
MSP Airport B-4 GW	5/29/2009	Axys	< 1250	< 1250	**3140**	**5830**	**286000**	< 1250	< 1250	< 1250	< 1250	< 2500	**145000**	< 2500	< 1250
*MSP Airport B-5 GW	1/19/2010	Axys	**103**	**81.3**	**168**	**17.5**	**7.29**	< 2.63	< 2.63	< 2.63	< 2.63	160	110	< 5.26	< 2.63
*MSP Airport B-6 GW	1/19/2010	Axys	**58.6**	**60.4**	**187**	**44.6**	**11.2**	< 2.55	< 2.55	< 2.55	< 2.55	**64.1**	**204**	**11**	< 2.55
*MSP Airport B-7 GW	1/19/2010	Axys	**130**	**233**	**114**	< 2.53	**3.77**	< 2.53	< 2.53	< 2.53	< 2.53	**7.77**	< 5.05	< 5.05	< 2.53
CWN-14A GW	1/19/2010	Axys	**40.9**	**32.3**	**42.2**	**17.8**	**19.1**	< 2.54	< 2.54	< 2.54	< 2.54	< 5.07	**19.3**	**15.6**	< 2.54
CWN-15A GW	1/19/2010	Axys	**72**	**15.3**	**20.2**	**7.27**	**56.9**	< 2.75	< 2.75	< 2.75	< 2.75	**9.45**	**202**	< 5.50	< 2.75
Signature MW-2 GW	1/19/2010	Axys	**83.7**	**96.8**	**162**	**69.7**	**79.5**	< 6.57	< 5.40	< 5.40	< 5.40	**151**	**1780**	**953**	< 5.40
MSP SW-1	1/19/2010	Axys	**46.8**	**46**	**82.1**	**24.6**	**50.1**	**13.4**	**13.9**	< 2.46	< 2.46	**46.5**	**184**	**39**	< 2.46

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000[2]**	**ND**	**ND**	**ND**	**300[3]**	**ND**	**ND**	**ND**	**ND**	**7000[2]**	**RAA[4]**	**300[3]**	**ND**
Marathon Refinery															
Training Frequency:	semi-annual														
Last Training Event[1]:	2009														
Foam Usage per Training Event:	50-100 gallons														
Foam Brand:	Ansul, historical use of 3M														
Sample ID	**Sample Date**	**Laboratory**													
Marathon MW-101	8/20/2009	MPI	**183**	**403**	**150**	**12.4**	**36.7**	<2.5	<2.5	<2.5	<2.5	**479**	**3710**	**93.2**	<2.5
*Marathon MW-912	8/20/2009	MPI	**462**	**298**	**51.5**	**21.8**	**17.5**	<2.5	<2.5	<2.5	<2.5	**37.0**	**1580**	**731**	<2.5
Marathon SP-11	8/20/2009	MPI	**182**	**458**	**171**	**52.2**	**35.6**	**20.7**	<2.5	<2.5	<2.5	**369**	**4910**	**5770**	<2.5
Marathon MW-172	8/20/2009	MPI	**59.8**	**245**	**154**	**25.1**	**15.5**	**11.4**	<2.5	<2.5	<2.5	**49.0**	**1220**	**1330**	<2.5
Marathon MW-156	8/20/2009	MPI	**220**	**1730**	**527**	**200**	**73.1**	**26.9**	<2.5	**2.58**	<2.5	**462**	**10500**	**14900**	<2.5
Marathon MW-156 Dupl.	8/20/2009	MPI	**221**	**1660**	**534**	**184**	**81.4**	**23.7**	<2.5	**2.93**	<2.5	**502**	**8930**	**11700**	**2.62**
Burnsville Fire Dept. Training Area, ABLE Fire Training Center															
Training Frequency:	3 times since 1989														
Last Training Event[1]:	2004														
Foam Usage per Training Event:	5-10 gallons														
Foam Brand:	Ansul														
Sample ID	**Sample Date**	**Laboratory**													
Burnsville B-3 GW 44.5 ft.	8/27/2009	Axys	**146**	**422**	**281**	**447**	**1260**	**81.7**	**17.8**	< 2.52	< 2.52	**12.8**	**279**	**522**	< 2.52
Goodview Fire Station, Storm Drain Outflow															
Training Frequency:	6 times in 20 years														
Last Training Event[1]:	2004/2005														
Foam Usage per Training Event:	5 gallons														
Foam Brand:	Ansul														
Sample ID	**Sample Date**	**Laboratory**													
Goodview SW-1	10/19/2009	Axys	< 2.53	< 2.53	**4.78**	< 2.53	**4.49**	**2.56**	**2.82**	< 2.53	< 2.53	< 5.06	< 5.06	**8.19**	< 2.53
Bemidji Fire Dept. Training Area, Bemidji Airport															
Training Frequency:	annual														
Last Training Event[1]:	2008/2009														
Foam Usage per Training Event:	5 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Bemidji B-1 GW 15 ft.	11/5/2009	Axys	**4.14**	**3.85**	**14.5**	**3.75**	**49**	< 2.50	< 2.50	< 2.50	< 2.50	**19.1**	**227**	**483**	< 2.50
Bemidji B-2 GW 15 ft.	11/5/2009	Axys	**21.1**	**55.5**	**340**	**33.8**	**200**	< 12.2	< 12.2	< 12.2	< 12.2	**129**	**1490**	**789**	< 12.2

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000[2]**	**ND**	**ND**	**ND**	**300[3]**	**ND**	**ND**	**ND**	**ND**	**7000[2]**	**RAA[4]**	**300[3]**	**ND**
River Grove Marina Fire, Inver Grove Heights															
Date of Foam Discharge:	9/26/2009														
Foam Usage	15 gallons														
Foam Brand:	Ansul														
Sample ID	**Sample Date**	**Laboratory**													
River Grove SW-1	11/18/2009	MPI	**3.54**	<2.5	<2.5	<2.5	**2.79**	<2.5	<2.5	<2.5	<2.5	**4.00**	<2.5	<2.5	<2.5
*River Grove SW-2	11/18/2009	MPI	**4.23**	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	**3.43**	<2.5	<2.5	<2.5
Lake Superior College ERTC															
Training Frequency:	unknown, 1994-1996														
Last Training Event[1]:	1996														
Foam Usage per Training Event:	unknown														
Foam Brand:	3M or other														
Sample ID	**Sample Date**	**Laboratory**													
ERTC SW-1	11/25/2009	Axys	**257**	**537**	**1790**	**348**	**991**	**31.8**	**3.45**	< 2.51	< 2.51	**1870**	**9390**	**11300**	**360**
Kandiyohi County Landfill Fire															
Date of Foam Discharge:	10/1/2009														
Foam Usage	545 gallons														
Foam Brand:	3M, Ansul														
Sample ID	**Sample Date**	**Laboratory**													
Kandiyohi DMW-1A	1/12/2010	Axys	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 4.87	< 4.87	< 4.87	< 2.43
Kandiyohi DMW-3	1/12/2010	Axys	**6.1**	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.01	< 5.01	< 5.01	< 2.51
Kandiyohi DMW-1A	5/4/2010	Axys	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.99	< 4.99	< 4.99	< 2.49
Kandiyohi DMW-3	5/4/2010	Axys	**11**	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Crystal Airport															
Date of Foam Discharge:	June 2009														
Foam Usage	unknown														
Foam Brand:	Fire Aide 2000														
Sample ID	**Sample Date**	**Laboratory**													
Crystal B-1 GW 5.5 ft.	1/20/2010	Axys	**16.2**	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	< 5.12	< 2.56
Crystal B-2 GW 6 ft.	1/20/2010	Axys	**37.3**	< 2.50	< 2.50	< 2.50	**2.65**	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	**5.27**	< 2.50

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflouorooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000[2]**	**ND**	**ND**	**ND**	**300[3]**	**ND**	**ND**	**ND**	**ND**	**7000[2]**	**RAA[4]**	**300[3]**	**ND**
Flint Hills Resources Pine Bend Refinery															
Training Frequency:	20-25 times per year														
Last Training Event[1]:	2009														
Foam Usage per Training Event:	20-25														
Foam Brand:	Ansul, historical use of 3M														
Sample ID	**Sample Date**	**Laboratory**													
*FHR Pine Bend MW-1	1/21/2010	Axys	**179**	**12.5**	**10.1**	< 2.45	**4.63**	< 2.45	< 2.45	< 2.45	< 2.45	**8.67**	**25.9**	**28.5**	< 2.45
FHR Pine Bend MW-3	1/21/2010	Axys	**310**	**136**	**251**	**43.7**	**49.1**	< 2.48	< 2.48	< 2.48	< 2.48	**181**	**516**	**245**	< 2.48
FHR Pine Bend MW-111	1/21/2010	Axys	**156**	**7.58**	**3.62**	< 2.42	**3.92**	< 2.42	< 2.42	< 2.42	< 2.42	< 4.84	< 4.84	< 4.84	< 2.42
Kings Cove Marina, Hastings Fire															
Date of Foam Discharge:	October 2002														
Foam Usage	305 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Kings Cove Marina SW-1	12/3/2009	MPI	**180**	**10.2**	**9.87**	**3.41**	**25.8**	< 2.5	< 2.5	< 2.5	< 2.5	**17.5**	**17.8**	**13.7**	< 2.5
Kings Cove Marina Dup (SW-1)	12/3/2009	MPI	**177**	**10.0**	**8.83**	**2.95**	**22.9**	< 2.5	< 2.5	< 2.5	< 2.5	**18.7**	**17.9**	**13.4**	<2.5
Kings Cove Marina SW-2	12/3/2009	MPI	**170**	**9.93**	**10.5**	**3.05**	**25.4**	< 2.5	< 2.5	< 2.5	< 2.5	**16.8**	**19.1**	**16.2**	< 2.5
Duluth International Airport															
Training Frequency:	unknown														
Last Training Event:	pre-2007														
Foam Usage per Training Event:	unknown														
Foam Brand:	3M and/or Chemguard														
Sample ID	**Sample Date**	**Laboratory**													
Duluth Intl. Airport GWS-1	10/2007	Axys	**2310**	**7160**	**13000**	**1340**	**4800**	< 45.7	< 45.7	< 45.7	< 45.7	**2000**	**626**	< 91.3	< 45.7
Duluth Intl. Airport GWS-2	10/2007	Axys	**482**	**1090**	**3590**	**534**	**4640**	**13.1**	< 12.4	< 12.4	< 12.4	**913**	**3440**	< 24.8	< 12.4
Duluth Intl. Airport Dup (GWS-2)	10/2007	Axys	**496**	**1250**	**4370**	**522**	**4250**	< 12.6	< 12.6	< 12.6	< 12.6	**953**	**3320**	< 25.2	< 12.6
Duluth Intl. Airport GWS-3	10/2007	Axys	**1900**	**6940**	**10800**	**1760**	**6790**	**88.5**	< 43.6	< 43.6	< 43.6	**2020**	**1690**	**98.8**	< 43.6
Duluth Intl. Airport GWS-4	10/2007	Axys	**1110**	**4780**	**11500**	**2000**	**8780**	< 31.9	< 31.9	< 31.9	< 31.9	**1630**	**4070**	< 63.8	< 31.9
Duluth Intl. Airport GWS-5	10/2007	Axys	**6.25**	**1.66**	**3.06**	**1.96**	**6.18**	< 0.991	< 0.991	< 0.991	< 0.991	**2.87**	**33.5**	**3.41**	< 0.991
Duluth Intl. Airport GWS-6	10/2007	Axys	**694**	**1750**	**2750**	**497**	**1500**	**14.8**	< 10.3	< 10.3	< 10.3	**776**	**1880**	< 20.6	< 10.3

TABLE 5

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			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000[2]**	**ND**	**ND**	**ND**	**300[3]**	**ND**	**ND**	**ND**	**ND**	**7000[2]**	**RAA[4]**	**300[3]**	**ND**
WAFTA, St. Bonifacius															
Training Frequency:	unknown														
Last Training Event:	6/12/1905														
Foam Usage per Training Event:	unknown														
Foam Brand:	unknown														
Sample ID	**Sample Date**	**Laboratory**													
WAFTA BG-2	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	**1000**	NA	NA	NA	NA	< 500	**200[J]**	< 500	NA
WAFTA BG-4	5/11/2006	MDH	**800[J]**	**3200**	**2300**	NA	**2100**	NA	NA	NA	NA	< 500	**2100**	**2200**	NA
WAFTA MW-1	5/11/2006	MDH	< 1000	< 1000	**300[J]**	NA	**7400**	NA	NA	NA	NA	< 500	**200[J]**	< 500	NA
WAFTA MW-2	5/11/2006	MDH	**2400**	**8900**	**7800**	NA	**7900**	NA	NA	NA	NA	**600**	**9900**	**9500**	NA
WAFTA MW-3	5/10/2006	MDH	< 1000	< 1000	**300[J]**	NA	< 1000	NA	NA	NA	NA	**200[J]**	**5100**	**22000**	NA
WAFTA MW-4	5/10/2006	MDH	**9900**	**42000**	**30000**	NA	**43000**	NA	NA	NA	NA	**1500**	**42000**	**118000**	NA
WAFTA MW-4	5/10/2006	Exygen	**14100**	**66300**	**43600**	NA	**41100**	NA	NA	NA	NA	**1820**	**43800**	**114000**	NA
WAFTA MW-5	5/10/2006	MDH	< 1000	**200[J]**	**300[J]**	NA	**700[J]**	NA	NA	NA	NA	< 500	**700**	**2100**	NA
WAFTA MW-5	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	**1460**	NA
WAFTA MW-7	5/11/2006	MDH	**1200**	**3800**	**3400**	NA	**1000**	NA	NA	NA	NA	**200[J]**	**2300**	**3900**	NA
WAFTA MW-8	5/10/2006	MDH	**90[J]**	**400[J]**	**300[J]**	NA	**100[J]**	NA	NA	NA	NA	< 500	< 500	**1300**	NA
WAFTA MW-8	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	< 1000	NA
WAFTA MW-9	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-10	5/10/2006	MDH	**700[J]**	**2000**	**2000**	NA	**2300**	NA	NA	NA	NA	**500**	**12000**	**27000**	NA
WAFTA MW-10	5/10/2006	Exygen	< 1000	**3350**	**3320**	NA	**2270**	NA	NA	NA	NA	< 1000	**11600**	**18400**	NA
WAFTA MW-11	5/10/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-11	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	< 1000	NA
WAFTA MW-12	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-13	5/10/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	**300[J]**	< 500	NA

TABLE 5
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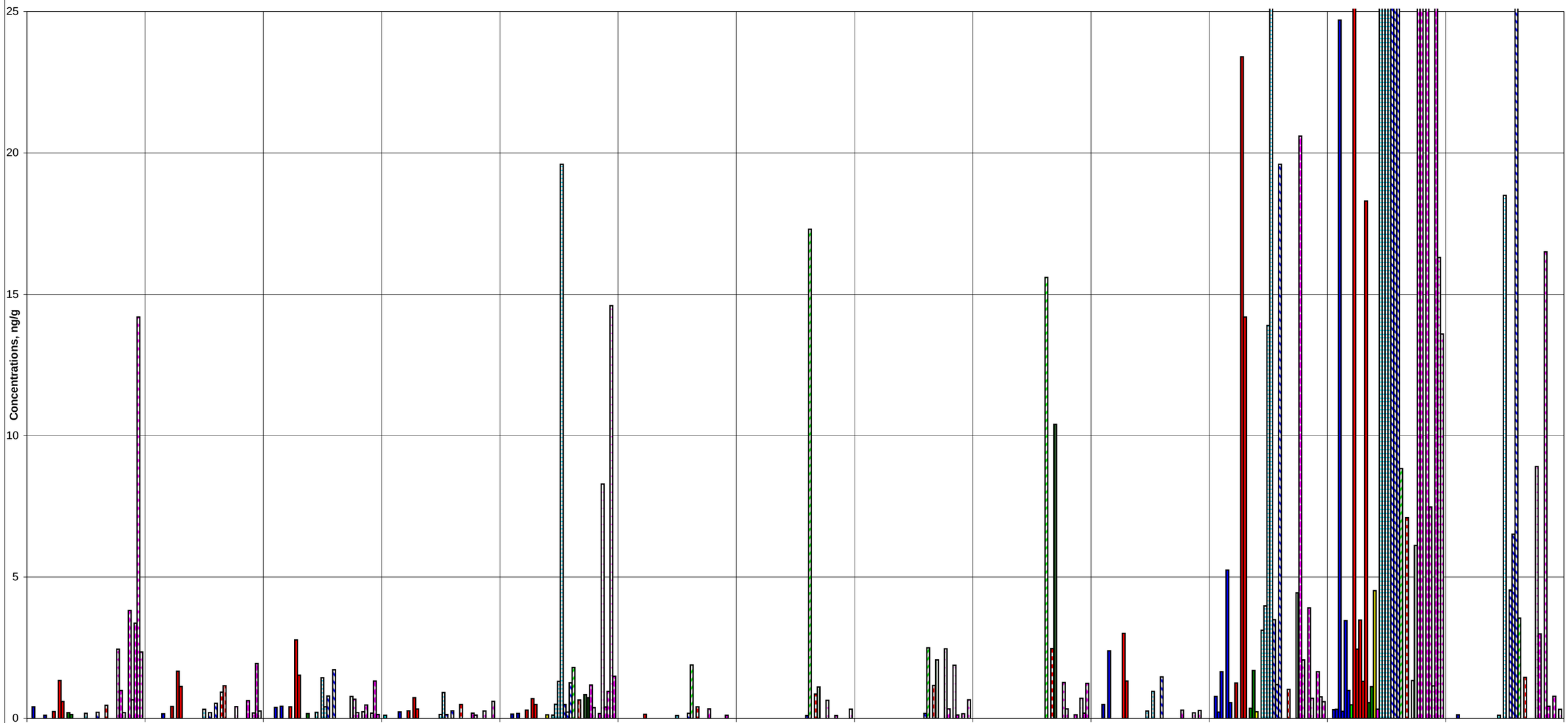
			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000[2]**	**ND**	**ND**	**ND**	**300[3]**	**ND**	**ND**	**ND**	**ND**	**7000[2]**	**RAA[4]**	**300[3]**	**ND**
Up North Plastics Fire															
Date of Foam Discharge:	December 2002														
Foam Usage	4,000 gallons or more														
Foam Brand:	uknown														
Sample ID	**Sample Date**	**Laboratory**													
Up North Plastics SW-1	7/16/2009	Axys	**1230**	**64.3**	**34.5**	**12**	**242**	< 2.52	< 2.52	< 2.52	< 2.52	**20.7**	**32.4**	< 5.04	< 2.52
Up North Plastics SW-2	7/16/2009	Axys	**436**	**36.1**	**26.9**	**9.43**	**78.3**	**3.37**	< 2.53	< 2.53	< 2.53	**9.42**	**7.4**	< 5.06	< 2.53
Up North Plastics SW Dup	7/16/2009	Axys	**572**	**39.4**	**28.1**	**9.92**	**87.5**	< 2.50	< 2.50	< 2.50	< 2.50	**10.3**	**10.8**	**7.64**	< 2.50
Up North Plastics Zywiec Irrigation Well 1	7/29/2009	MDH	**1242.3**	**51.4**	0	NA	0	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Zywiec Irrigation Well 2	7/29/2009	MDH	**447**	0	0	NA	0	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Zywiec Irrigation Well 3	7/29/2009	MDH	**2133.6**	**106.2**	**61**	NA	**55**	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Smallidge	7/29/2009	MDH	**1046.3**	**51.6**	0	NA	**53.3**	NA	NA	NA	NA	0	0	0	NA

Notes:
All results and standards are in nanograms per liter (ng/L), which is equivalent to parts per trillion.
Axys: Axys Analytical Services LTD
MPI: MPI Research
MDH: Minnesota Department of Health Environmental Laboratory.
Exygen: Exygen Research
Bolded type indicates detection above the laboratory method detection limit.
Highlighted concentrations exceed the HBV or HRL.
(1) Last training event prior to sampling, dates are approximate
(2) Health-Based Value (HBV) for chronic exposure defined by the Minnesota Department of Health.
(3) Health Risk Limit (HRL) for drinking water defined by the Minnesota Department of Health.
(4) Risk Assessment Advise (RAA) set by the Minnesota Department of Health for PFHxS does not specify numeric values.
ND: No health-based limit defined.
(5) Manually Calculated Result is 18.9
(6) Manually Calculated Result is 17.1
(7) Manually Calculated Result is 23.3
(8) Manually Calculated Result is 21.7
(J) Analyte positively identified, result is below reporting limit and is estimated.
*Sample collected upgradient of fire foam training or discharge area, intended to act as "background" sample.
NA: Not analyzed

DELTA

GRAPHS

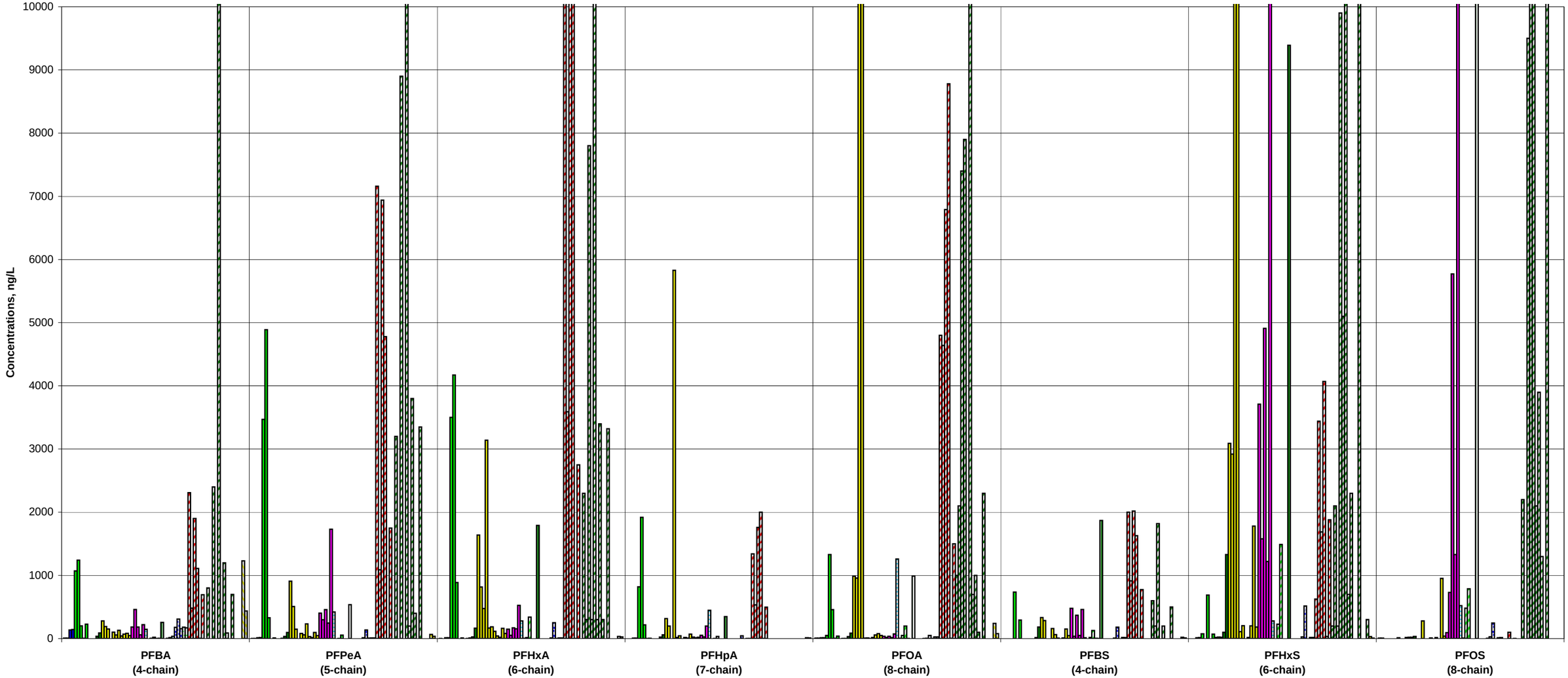
GRAPH 1
Soil and Sediment PFC Concentrations



NOTE: The PFHxS, PFOS, and/or PFOSA concentrations for the following samples are greater than 25 ng/g: Fridley B-10-4'; Bemidji B-1 1-4' and 4-8', and B-2 0-4' and 4-8'; ERTC SS-1, Sed-1, Sed-2; Up North Plastics Soil 1, Soil 2, Soil 4, and Sed 2.

Kenyon B-1 SL 0-4'	Claremont B-1 SL 0-4'	Claremont B-1 SL 4-8'	Claremont B-2 SL 0-4'	Claremont B-2 SL 4-8'	Claremont B-3 SL 0-4'	Claremont B-3 SL 4-8'
Luverne B-2 SL 0-4'	Fridley B-1 SL 0-4'	Fridley B-1 SL 4-8'	Fridley B-2 SL 0-4'	Fridley B-2 SL 4-8'	Fridley B-3 Sediment 6"	Rochester B-1 SL 0-4'
Rochester B-2 SL 0-4'	Richfield B-4 0-8'	Goodview Sed-1	Bemidji B-1 SL 0-4'	Bemidji B-1 SL 4-8'	Bemidji B-2 SL 0-4'	Bemidji B-2 SL 4-8'
ERTC SS-1	ERTC Sed-1	ERTC Sed-2	MSP Sed-1	Crystal SS-1	Crystal Sed-2	Kings Cove Marina Soil
Kings Cove Marina Sed 1	Kings Cove Marina Sed 2	Up North Plastics Soil 1	Up North Plastics Soil 2	Up North Plastics Soil 3	Up North Plastics Soil 4	Up North Plastics Soil 5
Up North Plastics Sed 1	Up North Plastics Sed 2	Up North Plastics Sed 3	Up North Plastics Sed 4			

GRAPH 2
Groundwater and Surface Water PFC Concentrations



Note: The PFBA, PFOA, PFHxS, and/or PFOS concentrations for the following samples are greater than 10,000 ng/L: MSP Airport B-3, MSP Airport B-4, Marathon MW-156, ERTC SW-1, WAFTA MW-3, WAFTA MW-4, and WAFTA MW-10.

Harmony B-1	Harmony B-2	No St Paul B-1	No St Paul B-2
Richfield B-1	Richfield B-2	Richfield B-3	Legion Lake SW-1
Richfield B-4	Luverne B-1	Luverne B-2	Luverne B-3
Fridley B-1	Fridley B-2	MSP Airport B-1	MSP Airport B-2
MSP Airport B-3	MSP Airport B-4	MSP Airport B-5	MSP Airport B-6
MSP Airport B-7	MSP Airport CWN-14A	MSP Airport CWN-15A	MSP Airport Signature MW-2
MSP SW-1	Marathon MW-101	*Marathon MW-912	Marathon SP-11
Marathon MW-172	Marathon MW-156	Burnsville B-3	Goodview SW-1
Bemidji B-1 GW	Bemidji B-2 GW	River Grove SW-1	River Grove SW-2
ERTC SW-1	Kandiyohi DMW-1A	Kandiyohi DMW-3	Crystal B-1
Crystal B-2	FHR Pine Bend MW-1	FHR Pine Bend MW-3	FHR Pine Bend MW-111
Kings Cove Marina SW-1	Kings Cove Marina SW-2	Duluth Intl. Airport GWS-1	Duluth Intl. Airport GWS-2
Duluth Intl. Airport GWS-3	Duluth Intl. Airport GWS-4	Duluth Intl. Airport GWS-5	Duluth Intl. Airport GWS-6
WAFTA BG-2	WAFTA BG-4	WAFTA MW-1	WAFTA MW-2
WAFTA MW-3	WAFTA MW-4	WAFTA MW-5	WAFTA MW-7
WAFTA MW-8	WAFTA MW-9	WAFTA MW-10	WAFTA MW-11
WAFTA MW-12	WAFTA MW-13	Up North Plastics SW-1	Up North Plastics SW-2

APPENDIX A

Best Practices Today for Class B Firefighting Foam

Best Practices Today for Class B Firefighting Foam

- Perfluorochemicals (PFCs) are a group of chemicals developed by 3M Corp for use in products to make them water repellent, stain-resistant, slippery and longer lasting.
- PFCs are not natural and do not seem to break down in the environment. Once in the environment, they may be taken up by living things, and build up (bioaccumulate) within the tissue of plants, animals and people.
- Scientists have been surprised to find PFCs in approximately 98% of all humans, including people in remote areas who have never had contact with the modern world. Studies in Minnesota have shown PFCs to be present in some ground and surface waters, air, soil and fish. Studies are underway to see if PFCs create health or developmental problems in people.
- PFCs are used in Class B firefighting foams to increase their effectiveness and make them long lasting.
- The Minnesota Pollution Control Agency (MPCA) is working on a study to understand the potential of firefighting foam as a source of PFCs in the environment. Soil and groundwater at approximately 20 firefighting training sites will be evaluated for PFCs. Minnesota Department of Health is sampling some municipal wells near foam training sites.
- Results from this work will be able late in 2009. MPCA, MnSCU Fire/EMS/Safety Center, and Fire Marshal's Office have developed guidelines for the training and use of Class B fire fighting foam until more answers on foam are known.

<u>Use of foam on fires and spills</u>

First, Class B firefighting foam has been a lifesaver. It is meant for flammable liquid fires and flammable liquid pools, or for combustible liquid fires. So use it if you have a flammable liquid like gasoline on fire or a big gasoline pool in a place where it could ignite or where it would do damage if it did ignite. Don't automatically use it for a diesel fuel spill, unless the diesel fuel is on fire or the situation is endangering life and property. Don't automatically blanket non-leaking flammable liquid tanks unless the situation really calls for it.

Second, don't use Class B foam on car fires, ordinary structure fires, wildland fires, or other inappropriate situations. Class A foams are meant for those situations, Class A foams are not thought to contain PFCs.

Foam training

Foam training sessions should include discussion of when foam use is necessary, when it can be helpful for safety, and when its use is inappropriate.

If possible, use training foams in training. Training foams are not thought to contain PFCs. Class B foam training should not be done near surface waters or storm sewer inlets which would allow foam to quickly drain to water.

PFCs can quickly pass through soil to groundwater. If your city has municipal wells your city water superintendent will have a map of the "well head protection area" which shows where the city's wells draw their water from. Training in those protection areas or in areas near private wells should be avoided. Train on soil where possible, and pick organic soils as opposed to sandy and gravelly soils if possible. That will increase the likelihood that PFCs in the foam are retained in the soil and don't quickly wash through to groundwater.

Foam types

There are many types of PFCs. Apparently all the AFFF type Class B foams have some PFC content of various types. Ethanol resistant AFFF foams apparently also contain types of PFCs. Class A foams are not thought to contain PFCs.

Firefighters' Health

Use foams to protect the public, your firefighters, and valuable property. There is no current concern that PFCs can enter firefighters' bodies by occasional skin contact or inhalation during firefighting or training.

Disposal

At this time the best disposal of Class B foams is to use it appropriately on Class B flammable liquid spills and fires. Liquids can't be put into the garbage. If Class B foam is sent down the sanitary sewer it will go to the city's wastewater treatment plant and the PFCs in the foam probably will pass straight on through to the river or lake without being broken down. So for now, the best advice is to store it safely where the containers won't get damaged until it gets used or until there are better disposal options available. That likely will be quite some time.

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