MCL Derivation Factors

Health Effect Endpoint	Identify a health effect/outcome/hazard that is shared between humans and animal models.
Animal Serum Dose (ng/mL)	Identify the lowest dose from animal studies that the most sensitive and human-relevant health outcome occurs.
Total Uncertainty Factor HUF x AUF x MF	Rodents are not humans, but are decent models. Uncertainty factors address key differences in a protective manner.
Target Serum Dose (ng/mL)	**_Not a clinical number or threshold_**. This threshold is what should not be exceeded from exposure from multiple sources, based on the animal extrapolation. If human studies existed that provided a **_measured_** dose and duration that causes a health outcome, NHDES would use that information for this part of the assessment instead of animal data. EPA, ATSDR and other state agencies have concluded there is **_currently_** insufficient human data for this purpose.
Human Half-life (years)	Time required for blood concentrations of each PFAS to be reduced by half.
Dosimetric Adjustment Factor (L/kg/d)	Converts the blood concentration to an externally administered dose. This factor relies on the half-life to address concern for the bio-accumulative property of PFAS.
Reference Dose (ng/kg/d)	The daily amount of a specific chemical that is not expected to adversely affect human health. ATSDR refers to MRLs instead of RfDs.
Relative Source Contribution	This is a % (20-80%) that accounts for typical exposure to certain environmental sources. (e.g. water, food, air, dust, personal care products, clothing).
Water Ingestion Rate	Assumed _daily_ water intake rate based on standardized estimates: Example using Dr. Ali's weight (150lb, 68 kg) Lactating woman 95th percentile: 3.7 L, 1 gallon Typical adult (NJ DWQI estimate): 2.0 L, 0.5 gallon Infant (ATSDR): 9.7 L, 2.6 gallons Infant 95th percentile: 16.2 L, 4.3 gallons Adult 95th percentile (ATSDR): 2.7 L, 0.7 gallon Infant rates require consideration in toxicokinetic models. NHDES is currently reviewing this based on recent publication (January 10, 2019).
MCL/AGQS ppt (ng/L)	**The proposed standard assuming the above criteria are _constant_.**

From NHDES report (01/2019) Table 1: Summary of MCL Derivation Factors

	PFOA*	PFOS*	PFHxS	PFNA
Health Effect Endpoint	Altered Liver Size/Function	Delayed Development	Impaired Reproduction	Altered Liver Size/Function
Animal Serum Dose (ng/mL)	4,351[a]	6,260[b]	27,200[c]	4,900[d]
Total Uncertainty Factor HUF x AUF x MF[e]	100 10 x 3 x 3	100 10 x 3 x 3	300 10 x 3 x 10	300 10 x 3 x 10
Target Serum Dose (ng/mL)	43.5	62.6	90.7	16.3
Human Half-life (years)	2.7[f]	3.4[f]	5.3[f]	2.5[g]
Dosimetric Adjustment Factor (L/kg/d)	$1.20E^{-04}$	$1.28E^{-04}$	$1.03E^{-04}$	$1.52E^{-04}$
Reference Dose (ng/kg/d)	5.2	8.0	9.3	2.5
Relative Source Contribution[h]	40%	50%	50%	50%
Water Ingestion Rate[i]	0.055 L/kg d	0.055 L/kg d	0.055 L/kg d	0.055 L/kg d
MCL/AGQS ppt (ng/L)	**38**	**70**[j]	**85**	**23**

[a] Loveless et al., 2006, NJ DWQI 2017, increased relative liver weight in mice;
[b] Luebker et al., 2005a, EPA 2016b, reduced pup weight and developmental delays in rats;
[c] Chang et al., 2018, reduced litter size in mice;
[d] Das et al., 2015, NJ DWQI 2018, increased relative liver weight in mice;
[e] HUF (Human-to-Human Uncertainty) x AUF (Animal-to-Human Uncertainty) x MF (Modifying Factor)
[f] Li et al., 2017, serum-derived half-life estimates from men and women exposed to PFAS via drinking water;
[g] Zhang et al., 2013, ATSDR 2018, urine-derived half-life from community exposure to PFNA;
[h] The RSC was derived using NH-specific blood data from high-exposed populations of Pease and Southern NH. This was calculated using the subtraction method described in the EPA 2000 Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. Details about this approach are summarized in Appendices 4-7;
[i] EPA 2011 Exposure Factors Handbook, lactating women 95th percentile;
[j] PFOS rounded down to 70 ppt from 73 ppt, per the current EPA Health Advisory for PFOS.

Comparison of PFOA Numbers

	NHDES	EPA	ATSDR	NJ DWQI
Health Effect Endpoint	Altered Liver Size/Function	Developmental bone effects and delayed growth	Developmental bone effects and behav. changes	Altered Liver Size/Function
Animal Serum Dose (ng/mL)[A]	4,351	38,000 (*estimated*)	8,290 (*estimated*)	4,351
Total Uncertainty Factor HUF x AUF x MF	100 10 x 3 x 3	300 10 x 3 x **10^B**	300 10 x 3 x **10^B**	300 10 x 3 x 10
Target Serum Dose (ng/mL)	43.5	126.7	27.6	14.5
Human Half-life (years)	2.7	2.3	3.8	2.3
Dosimetric Adjustment[C] Factor (L/kg/d)	$1.20E^{-04}$	$1.40E^{-04}$	$1.09E^{-04}$ See comment	$1.40E^{-04}$
Reference Dose or MRL (ng/kg/d)	5.2	20.0	3.0	2.0
Relative Source Contribution[D]	40%	20%	100% See comment	20%
Water Ingestion Rate[E]	0.055 L/kg d	0.054 L/kg d	0.143-0.039 L/kg d	0.029 L/kg d
MCL/AGQS ppt (ng/L)	**38**	**70**	**21-78**	**14**

A. *Estimated* refers to computer modeling for the average blood concentration using measured blood concentrations.
B. EPA and ATSDR applied an **UF of 10** for converting LOAEL to NOAEL. A LOAEL is the lowest observable adverse effect level, a NOAEL is the no observable adverse effect level. NJ applied an additional 10 due to concern for delayed mammary duct development.
C. **Dosimetric Adjustment Factor** is derived using the half-life number. ATSDR does not explicitly state this number, the number above is estimated based on their calculations.
D. ATSDR did not account for **RSC** in their online example estimate of MCLs derived from their MRLs.
E. NHDES & EPA assumed **water consumption rate** of a lactating woman at the 95th and 90th percentile, respectively. NJ assumed a typical adult. ATSDR made estimates with an adult and an infant.

Comparison of PFOS Numbers				
	NHDES	**EPA**	**ATSDR**	**NJ DWQI**
Health Effect Endpoint[A]	Delayed Development	Delayed Development	Delayed Development	Immuno-suppression
Animal Serum Dose[B] (ng/mL)	6,260 (*estimated*)	6,260 (*estimated*)	7,430 (*estimated*)	674
Total Uncertainty Factor HUF x AUF x MF	100[C] 10 x 3 x 3	30 10 x 3 x 1	300[C] 10 x 3 x 10	30 10 x 3 x 1
Target Serum Dose (ng/mL)	62.6	208.7	24.8	22.5
Human Half-life (years)	3.4[f]	5.4	5.5	5.4
Dosimetric Adjustment[D] Factor (L/kg/d)	$1.28E^{-04}$	$0.81E^{-04}$	$0.81E^{-04}$ See comment	$0.81E^{-04}$
Reference Dose or MRL (ng/kg/d)	8.0	20.0	2.0	1.8
Relative Source Contribution[E]	50%	20%	100% See comment	20%
Water Ingestion Rate[F]	0.055 L/kg d	0.054 L/kg d	0.143-0.039 L/kg d	0.029 L/kg d
MCL/AGQS ppt (ng/L)	**70[G]**	**70**	**14-52**	**13**

A. NHDES, EPA and ATSDR used the same study.
B. *Estimated* refers to computer modeling for the average blood concentration using measured blood concentrations.
C. NHDES and ATSDR applied an _**UF of 3 and 10**_, respectively, for concern about immunotoxicity at a lower dose.
D. **Dosimetric Adjustment Factor** is derived using the half-life number. ATSDR does not explicitly state this number, the number above is estimated based on their calculations.
E. ATSDR did not account for **RSC** in their online example estimate of MCLs derived from their MRLs.
F. NHDES & EPA assumed **water consumption rate** of a lactating woman at the 95th and 90th percentile, respectively. NJ assumed a typical adult. ATSDR made estimates with an adult and an infant.
G. This is 70 ppt to not exceed the current EPA health advisory and also represents a PFOA + PFOS combination.

Comparison of PFHxS Numbers				
	NHDES	**EPA**	**ATSDR**	**NJ DWQI**
Health Effect Endpoint	Impaired Reproduction	Not evaluated	Thyroid follicular cell damage	Not evaluated
Animal Serum Dose[A] (ng/mL)	27,200	-	73,220 (*estimated*)	-
Total Uncertainty Factor HUF x AUF x MF	300 10 x 3 x 10	-	30 10 x 3 x 1	-
Target Serum Dose (ng/mL)	90.7	-	2,440.7	-
Human Half-life (years)	5.3	-	8.5	-
Dosimetric Adjustment[C] Factor (L/kg/d)	$1.03E^{-04}$	-	$0.82E^{-04}$ See comment	-
Reference Dose or MRL (ng/kg/d)	9.3	-	20.0	-
Relative Source Contribution[D]	50%	-	100% See comment	-
Water Ingestion Rate[E]	0.055 L/kg d	-	0.143-0.039 L/kg d	-
MCL/AGQS ppt (ng/L)	**85**	**-**	**140-517**	**-**

A. *Estimated* refers to computer modeling for the average blood concentration using measured blood concentrations.
B. NHDES applied an ***UF of 10*** for concern about the lack of more robust studies and suspected endocrine effects.
C. **Dosimetric Adjustment Factor** is derived using the half-life number. ATSDR does not explicitly state this number, the number above is estimated based on their calculations.
D. ATSDR did not account for **RSC** in their online example estimate of MCLs derived from their MRLs.
E. NHDES assumed **water consumption rate** of a lactating woman at the 95th. ATSDR made estimates with an adult and an infant.

Comparison of PFNA Numbers

	NHDES	EPA	ATSDR	NJ DWQI
Health Effect Endpoint	Altered Liver Size/Function	Not evaluated	Developmental delays	Altered Liver Size/Function
Animal Serum Dose[A] (ng/mL)	4,900	-	6,800 (*estimated*)	4,900
Total Uncertainty Factor HUF x AUF x MF	300 10 x 3 x 10	-	300 10 x 3 x 10	1,000[B] 10 x 3 x 10 x 3
Target Serum Dose (ng/mL)	16.3	-	22.7	4.9
Human Half-life (years)	2.5	-	2.5	Estimated a ratio (200:1)
Dosimetric Adjustment[C] Factor (L/kg/d)	$1.52E^{-04}$	-	$1.32E^{-04}$ See comment	n/a
Reference Dose or MRL (ng/kg/d)	2.5	-	3.0	Did not derive
Relative Source Contribution[D]	50%	-	100% See comment	50%
Water Ingestion Rate[E]	0.055 L/kg d	-	0.143-0.039 L/kg d	Not stated, used a ratio
MCL/AGQS ppt (ng/L)	**23**	**-**	**21-78**	**13**

A. *Estimated* refers to computer modeling for the average blood concentration using measured blood concentrations.
B. NJ DWQI applied an **_UF of 10_** for extrapolation to a long-term exposure, and an additional factor of **_3_** for the limited database. NJ DWQI did not apply this to PFOA, despite using the same critical effect with a similar exposure duration.
C. **Dosimetric Adjustment Factor** is derived using the half-life number. ATSDR does not explicitly state this number, the number above is estimated based on their calculations. ATSDR assumed 2.5 years = 900 days, NHDES assumed 2.5 years = 913 days.
D. ATSDR did not account for **RSC** in their online example estimate of MCLs derived from their MRLs.
E. NHDES assumed **water consumption rate** of a lactating woman at the 95th. ATSDR made estimates with an adult and an infant.