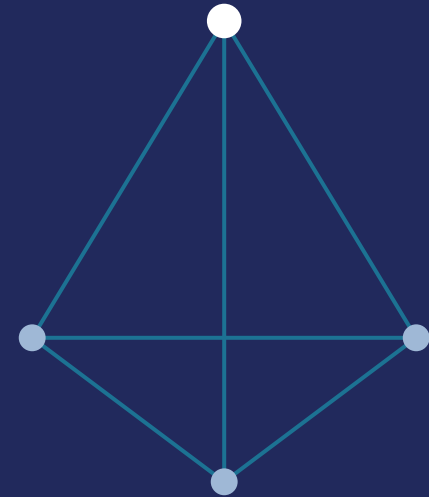


Perchlorate: A Final Number, Please

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- Beyond Science and Decisions: From Problem Formulation to Risk Assessment
October 26 & 27, 2026



Agenda

01

Chemistry, sources & health effects

The mode of action that anchors every assessment

02

Five risk assessments, 2004–2026

TERA · NRC/EPA IRIS · Interim HA · two proposed rules

03

Regulating under the SDWA

The three-part test and EPA's reversals

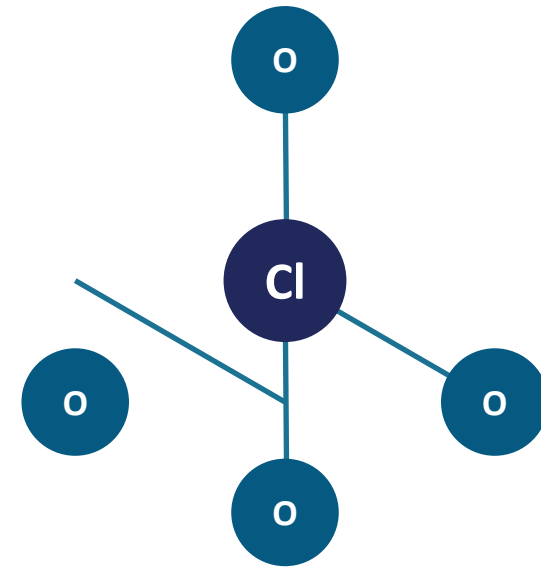
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Where things stand today

The 2026 proposed rule and what it means

Chemistry of Perchlorate

- ClO_4^- : one chlorine atom bound to four oxygen atoms in a tetrahedral configuration
- Does not exist on its own — always paired with a cation such as ammonium, magnesium, or potassium
- Highly water-soluble, which drives its mobility as a drinking-water contaminant



ClO_4^- — tetrahedral perchlorate ion

Sources and Contamination Pathways

NATURAL

- Forms naturally in the atmosphere
- Found at low levels in rain and snow
- Found at high levels in certain rock and mineral deposits

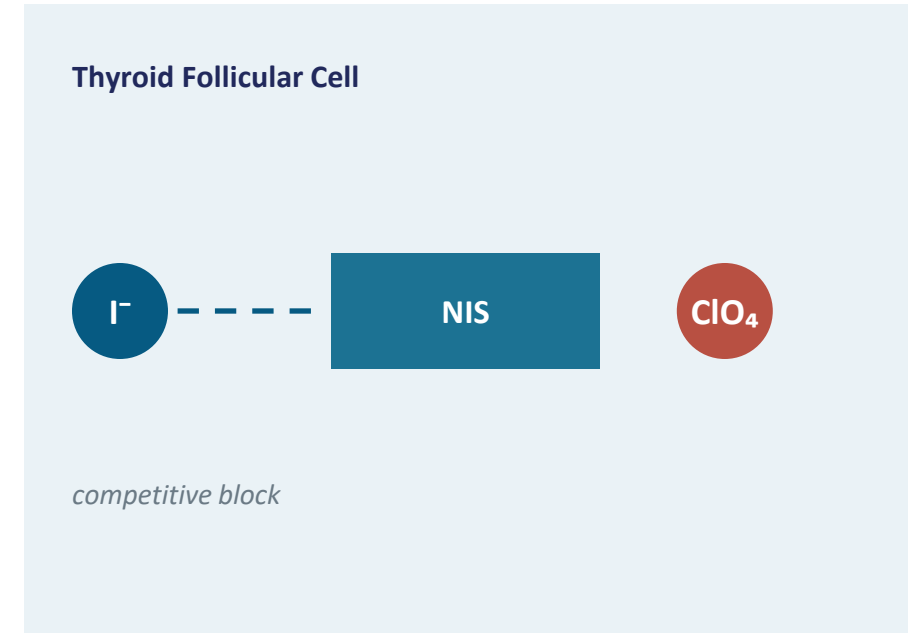
MANUFACTURED

- Oxidizer in solid fuels for rockets, missiles, and fireworks
- Airbag initiators in vehicles
- Matches and signal flares

Bottom line: low-level presence across many U.S. drinking water supplies, but the major concern is concentrated contamination at military bases and facilities from extensive manufactured use.

Mechanism of Action: Effects on the Thyroid

- Perchlorate competitively binds the sodium/iodide symporter (NIS), inhibiting iodide uptake into the thyroid gland
- At sufficiently high exposure: ↓ T3 and T4, ↑ TSH
- In adults, these effects are reversible once hormone levels are restored



Why Sensitive Populations Drive the Assessment

- Thyroid hormone is critical for normal growth and neurodevelopment in fetuses, infants, and young children
- Poor iodide uptake and impaired maternal thyroid function have been linked to delayed development and decreased learning capacity in offspring
- Unlike adults, these developmental effects from fetal/neonatal exposure are not simply reversed
- However, for these effects to occur, a pregnant woman must be exposed to high levels of perchlorate AND be iodine deficient, a situation that rarely occurs in the U.S. today.

Pregnant women, fetuses & infants

the consistent sensitive subpopulation across every assessment that follows

The RfD as Regulatory Linchpin

- An RfD is the technical basis for both drinking water regulation and health guidance
- Health guidance is used when perchlorate is detected in drinking water supplies
- The same RfD underlies cleanup standards at contaminated military sites

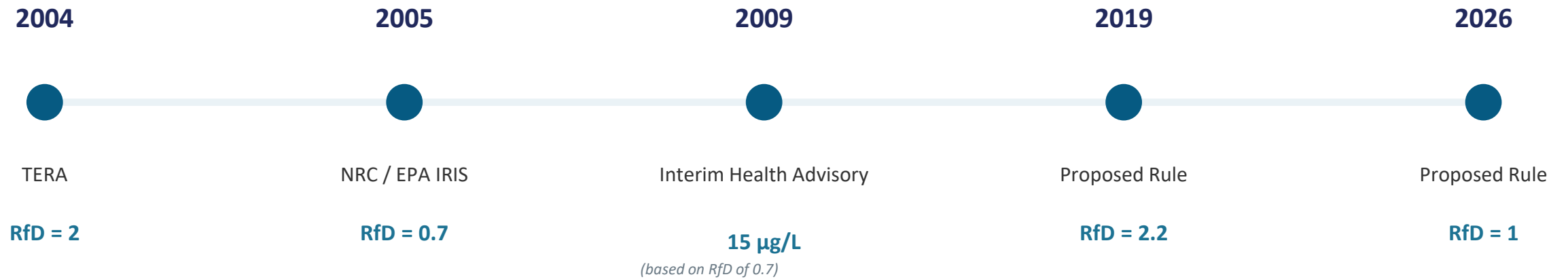
Without a settled RfD, there is no consistent basis for either drinking water regulation or site cleanup — which is exactly what has been at stake in every reversal we'll cover.

An Unusually Rich Human Dataset

- Unlike most chemicals, a plethora of both animal and human data exist for perchlorate. Some of the human data is because potassium perchlorate has been used clinically to treat hyperthyroidism - a disease in which the thyroid accumulates excess iodine.
- Since the 2000s, every major risk assessment has been anchored on human data — epidemiological and clinical — rather than animal extrapolation

That's the backdrop for what follows: five assessments, the same broad evidence base, five different conclusions.

Five Assessments, One Trajectory



RfD in µg/kg-day unless noted. Note all the RfDs are in the same range — 0.7–2.2 µg/kg-day.

2004 — TERA (Strawson et al.)

'04

2 µg/kg-day

Reference Dose (RfD)

6 µg/kg-day

Point of Departure (POD)

3Uncertainty Factor (UF)
*to protect against sensitive subpopulations***CRITICAL STUDY**

Crump et al. (2000) — Northern Chile, an area with high naturally occurring perchlorate in drinking water. Three towns compared: 100–120 µg/L, 5–7 µg/L, and non-detect (<4 µg/L). No evidence that concentrations as high as 120 µg/L suppressed thyroid function.

Published as: Strawson et al. (2004), Regulatory Toxicology and Pharmacology 39:44–65.

2005 — National Research Council / EPA IRIS

'05

0.7 $\mu\text{g/kg-day}$

RfD — adopted by EPA into IRIS

7 $\mu\text{g/kg-day}$

Point of Departure (POD)

10Uncertainty Factor (UF)
*to protect against sensitive subpopulations***CRITICAL STUDY**

Greer et al. (2002) — healthy men and women administered perchlorate at doses from 7 to 500 $\mu\text{g/kg-day}$ for 14 days. No effect on thyroid iodide uptake reported at 7 $\mu\text{g/kg-day}$.

Paradigm shift: NRC used inhibition of iodide uptake — a precursor effect, not an adverse effect per se — as the point of departure, departing from traditional practice of anchoring PODs to adverse effects.

2009 — EPA Interim Drinking Water Health Advisory

'09

15 µg/L

Interim Health Advisory (non-enforceable)

DEFINITION

Health Advisories are technical guidance for federal, state, and local officials and public water system managers — not legally enforceable federal standards. This value translates the 2005 NRC/EPA RfD into a drinking-water concentration.

$$HA = (0.7 \text{ µg/kg-d} \times 70 \text{ kg} \times 0.62) / (10 \times 2 \text{ L/day}) = 15 \text{ µg/L}$$

0.7 = NRC/EPA RfD · 70 kg = adult body weight · 0.62 = relative source contribution from drinking water (pregnant women) · 10 = uncertainty factor · 2 L/day = adult water consumption

2019 — Proposed Drinking Water Regulation

'19

2.2 µg/kg-day

RfD

56 µg/L

MCLG / MCL (proposed)

6.7 µg/kg-day

Point of Departure (POD)

based on a 2% decrease in mean IQ in children

3

Uncertainty Factor (UF)

to protect against sensitive subpopulations

CRITICAL STUDY

Korevaar et al. (2016) — effects of perchlorate on maternal T4 levels and child IQ in ~3,600 mother/child pairs. First use of neurobehavioral effects (IQ reduction) as the critical endpoint, rather than thyroid hormone change.

POD based on a 2% decrease in mean IQ in children.

$$\text{MCL} = (2.2 \text{ µg/kg-d} \times 0.80) / 0.032 \text{ L/kg-day} = 56 \text{ µg/L}$$

0.032 L/kg-day = drinking water intake, women ages 15–44 · 0.80 = relative source contribution from drinking water

January 2026 — Proposed Drinking Water Regulation

'26

1 µg/kg-day

RfD

20 µg/L

MCLG / MCL (proposed)

3.1 µg/kg-day

Point of Departure (POD)

*based on a 1% decrease in mean IQ in children***3**

Uncertainty Factor (UF)

to protect against sensitive subpopulations

CRITICAL STUDY

Same critical study as 2019 — Korevaar et al. (2016) — but EPA moved to a more conservative benchmark response: a 1% decrease in mean IQ (vs. 2% in 2019).

POD based on a 1% decrease in mean IQ in children.

$$\text{MCL} = (1 \text{ } \mu\text{g/kg-d} \times 0.80) / 0.035 \text{ L/kg-day} = 20 \text{ } \mu\text{g/L}$$

0.035 L/kg-day = drinking water intake, women of reproductive age · 0.80 = relative source contribution from drinking water

The Five Assessments, Side by Side

Source	Critical Study	Endpoint	RfD (µg/kg-d)	Resulting Level
2004 TERA	Crump et al. 2000	Thyroid hormone change (no effect observed)	2	—
2005 NRC / EPA IRIS	Greer et al. 2002	Iodide uptake inhibition (precursor effect)	0.7	—
2009 Interim HA	(derived from NRC/EPA RfD)	—	0.7	15 µg/L (HA)
2019 Proposed Rule	Korevaar et al. 2016	IQ decrement (2%)	2.2	56 µg/L (MCLG/MCL)
2026 Proposed Rule	Korevaar et al. 2016	IQ decrement (1%)	1	20 µg/L (MCLG/MCL)

Same broad evidence base throughout — what moves the RfD is study/endpoint selection and benchmark response, not new data alone.

Regulating Under the Safe Drinking Water Act

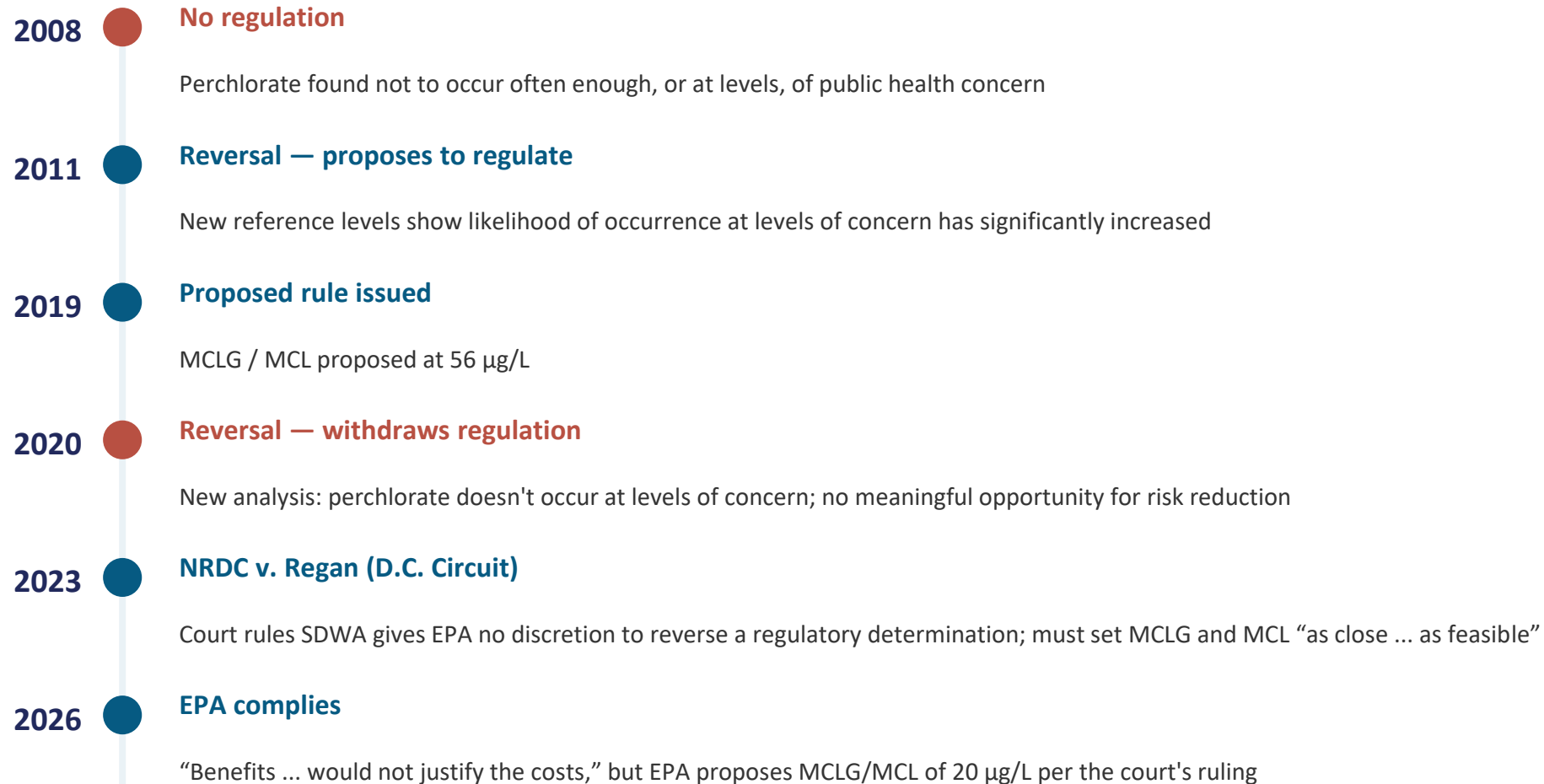
To regulate a contaminant in drinking water, EPA must find that it meets three criteria:

- 1 May have an adverse effect on the health of persons
- 2 Is known to occur — or is highly likely to occur — in public water systems often enough, and at levels, of public health concern
- 3 In the sole judgment of the Administrator, regulation presents a meaningful opportunity for health risk reduction for persons served by public water systems

If EPA decides to regulate a contaminant, EPA must first set a Maximum Contaminant Level Goal (MCLG) (a non-enforceable health goal) and then a Maximum Contaminant Level (MCL), the enforceable regulation, set as close to the MCL as feasible.

Criterion 1 has been settled since EPA's 2002 Toxicological Review Document **documented adverse health effects in humans. Criteria 2 and 3 are where EPA has reversed course repeatedly.**

Two Decades of Reversal



Benefits of Regulation — and Its Practical Limits

BENEFITS

- Other Federal Agencies and States look to the EPA for drinking water standards that they can use for specific actions, such as cleaning up contaminated soil and military sites.
- Consistent perchlorate standard means that states can stop expending resources deriving their own standards.
- Ends the litigation cycle.

PRACTICAL LIMIT

Likely limited benefit for the general population: drinking-water perchlorate levels are very low in the U.S., and the population genuinely affected — low-iodide pregnant women — is not a widespread problem domestically.

Key Takeaways

1

The RfD has ranged 0.7–2.2 $\mu\text{g}/\text{kg}\text{-day}$ over 20+ years — the same broad evidence base, different PODs, endpoints, and uncertainty factors

2

The shift from thyroid-hormone (precursor) endpoints to IQ/neurodevelopmental endpoints reflects evolving scientific judgment, not new data alone

3

NRDC v. Regan (2023) now binds EPA to regulate once it has made an affirmative determination — regardless of the agency's own cost-benefit conclusion

4

The 2026 proposed rule (MCLG/MCL = 20 $\mu\text{g}/\text{L}$) is a product of that court order, not EPA's independent risk-benefit judgment