

Evaluation of TKN Limit Reduction from 100 to 50 mg/L

This Appendix provides the technical and regulatory rationale for considering a reduction in the TKN concentration limit for non-domestic discharges under the City’s Sewer Use Bylaw from 100 mg/L to 50 mg/L.

It integrates findings from the City of Saskatoon 2020-2024 River Health Study, the Canadian Council of Ministers of the Environment (CCME) Model Sewer Use Bylaw, and federal data from the National Pollutant Release Inventory (NPRI) and Wastewater Systems Effluent Regulations (WSER).

The goal is to assess whether the proposed reduction aligns with treatment capacity, aquatic life protection, and national best practices.

Background

The City’s WWTP receives wastewater from domestic, commercial, and industrial sources. TKN represents the combined concentration of organic nitrogen and ammonia nitrogen, both of which contribute to the total nitrogen load entering the treatment process.

The current bylaw limit of 100 mg/L TKN was established based on historical norms across Canadian municipalities. However, analysis of local and national data indicates that this limit no longer aligns with modern treatment performance standards or environmental protection objectives.

The current WWTP Permit to Operate requires an effluent ammonia concentration of 6 mg/L during the summer and 16 mg/L during the Winter, with future amendments anticipated to reduce the limit to below 6 mg/L on a year-round basis.

The CCME Model Sewer Use Bylaw recommends a TKN influent limit of 50 mg/L, citing the need for municipalities to tailor bylaw limits to local treatment capacity and receiving-water quality objectives.

WWTP Treatment Performance and Capacity

Historical WWTP data show an average 60% TKN removal efficiency.

Year	Influent	Effluent	% of Treatment Efficiency
2014	32.0	16.0	50%
2015	36.0	13.0	64%
2016	41.0	12.0	71%
2017	42.8	17.1	60%
2018	44.5	18.0	60%
2019	45.5	13.7	70%
2020	46.1	13.2	71%
2021	48.2	21.2	56%

Year	Influent	Effluent	% of Treatment Efficiency
2022	51.5	28.7	44%
2023	54.0	22.0	59%
2024	53.4	22.6	58%
Average Treatment efficiency			60%

Under the existing 100 mg/L bylaw limit:

- An influent concentration of 100 mg/L produces an expected effluent of ~40 mg/L, exceeding permit requirements.
- Reducing influent TKN to 50 mg/L would yield an estimated effluent concentration of ~20 mg/L, closer to compliance and more stable under variable flow conditions.

Treatment efficiency is non-linear; higher influent loads cause oxygen and nitrification bottlenecks, reducing ammonia removal efficiency, especially during winter low-flow and low-temperature periods.

This demonstrates that the current 100 mg/L limit allows nitrogen loadings beyond the WWTP's effective treatment capacity, particularly during cold-weather operating conditions. Thereby increasing risk to both permit compliance and aquatic life during sensitive conditions.

National and Regulatory Context

The NPRI (ECCC, 2024) identifies wastewater treatment systems as Canada's largest controlled source of ammonia discharges to water. Ammonia is listed as toxic to aquatic life under federal environmental criteria. The Wastewater Systems Effluent Regulations (WSER) under the Fisheries Act set a maximum un-ionized ammonia concentration of 1.25 mg/L (as N) and prohibit the discharge of effluent that is acutely lethal to fish. Together with the E2 Environmental Emergency Regulations (2019), these frameworks emphasize the importance of preventive ammonia management at the treatment and pre-treatment stages. Reducing ammonia loadings upstream through source control directly supports compliance with federal standards and mitigates environmental risk downstream.

Findings from the 2020–2024 Aquatic Life and River Health Study

The City's aquatic life study assessed effluent quality, river water chemistry, and benthic invertebrate community health between 2020 and 2024. The Permit to Operate (PTO) limit represents the regulatory effluent established by the Water Security Agency, which the WWTP must not exceed to remain in compliance. The Effluent Discharge Objective (EDO) is a performance-based target established by the City to provide an operational buffer below the regulatory limit.

Parameter	Unit	PTO Limit	EDO Limit	2020–2024 WWTP Effluent Data (Min-Max)
Ammonia Total (Jul 1–Sep 30)	mg/L	6.0	5.9	0.17 – 31.2

Parameter	Unit	PTO Limit	EDO Limit	2020–2024 WWTP Effluent Data (Min-Max)
Ammonia Total (Oct 1–Jun 30)	mg/L	17.0	6.4	10.7 – 35.1
Ammonia, Un-ionized at 15°C	mg/L	1.24	–	0.17 – 45.8

Key observations:

- **Total ammonia** concentrations exceeded both the PTO and EDO limits at various times during the monitoring period. Indicating that the WWTP is operating at the edge of its ammonia treatment capacity.
- Winter effluent ammonia reached **35.1 mg/L**, more than double the 17 mg/L limit.
- **Un-ionized ammonia**, which is toxic to aquatic organisms, reached **45.8 mg/L** at 15°C, far exceeding the acute toxicity threshold (1.24 mg/L).
- Summer ammonia levels also exceeded the 6 mg/L permit limit, indicating that the WWTP experiences consistent seasonal challenges.
- The solution requires a combination of upstream control and process optimization, lowering TKN at the source and ensuring the WWTP is designed and operated to meet future ammonia standards.

While the South Saskatchewan River remained well oxygenated and the benthic community exhibited resilience. HDR's Recommendation based on the result from the river study is to reduce total ammonia EDO for summer and winter to 1.6 mg/L and 4.2 mg/L, respectively. These results confirm that ammonia management is critical to ensuring ongoing compliance and aquatic life protection.

Regulatory and Comparative Context

To assess the appropriateness of lowering Saskatoon's TKN bylaw limit, a scan of Canadian municipalities was completed. The table below summarizes the TKN, or equivalent nitrogen limits identified in current sewer use bylaws across Western and Central Canada.

Jurisdiction	TKN Limit (mg/L)	Notes
City of Saskatoon (Current)	100	Based on historical standard; exceeds typical national guideline
CCME Model Sewer Use Bylaw	50	Recommended national default; adjustable based on capacity and water quality objectives
EPCOR (Edmonton)	50	
City of Regina	50	
Calgary	50	
Winnipeg	60	Bylaw includes Limit for total nitrogen.
Lloydminster	20	Bylaw includes limit for ammonia
Toronto	100	

Jurisdiction	TKN Limit (mg/L)	Notes
Region of Durham	100	
Peel Region	100	
Guelph	100	
Ottawa	100	

Risk Identification

A risk-based evaluation was completed to assess the potential impacts of maintaining current influent nitrogen levels. The table below outlines the key environmental, operational, regulatory, and financial risks associated with increasing ammonia concentrations in influent and effluent.

This assessment highlights the importance of implementing proactive source control measures, updating bylaw limits, and ensuring that the WWTP maintains sufficient treatment capacity to meet future regulatory and environmental requirements.

Risk Category	Description	Implications
Environmental	<ul style="list-style-type: none"> Ammonia (especially NH₃) is toxic to aquatic organisms. Administration is expecting the permit to operate to include a year-round average ammonia concentration limit below 6mg/L, which the plant can not currently meet. 	<ul style="list-style-type: none"> Risk of non-compliance with environmental discharge standards. Threat to aquatic ecosystems.
Operational & Infrastructure	<ul style="list-style-type: none"> Influent ammonia has increased 72% since 2013, now averaging 37 mg/L.- High ammonia requires energy-intensive nitrification. Limited capacity. 	<ul style="list-style-type: none"> Plant cannot meet new limits. Requires \$25M–\$42M capital upgrade to ensure compliance.
Regulatory & Legal	<ul style="list-style-type: none"> Current permit: 6 mg/L (summer), 16 mg/L (winter). Revised limit: below 6 mg/L year round expected soon. 	<ul style="list-style-type: none"> Non-compliance could trigger fines, enforcement, or restrictions.
Financial	<ul style="list-style-type: none"> No cost recovery for ammonia dischargers. One major industrial contributor identified. Ammonia treatment consumes 35% of plant energy. 	<ul style="list-style-type: none"> Ratepayers bear the cost. Upgrading costs are not offset by industrial surcharges.

Importance of Source Control in Ammonia Management

Effective ammonia management must begin at the source. While industrial users are not the sole contributors to nitrogen loading, they represent a manageable and consistent input where proactive control can have measurable benefits.

Source control is the foundation of a three-tiered ammonia management strategy:

1. Source Reduction – Implementing a 50 mg/L TKN limit reduces nitrogen mass entering the Plant, stabilizing influent and minimizing high-load events that challenge treatment performance.
2. Treatment Optimization – Ensuring the WWTP maintains optimal nitrification conditions (oxygen levels, solids retention time, alkalinity) to maximize removal efficiency.
3. Capacity and Compliance Planning – Aligning plant design capacity with long-term regulatory trends (anticipated below 6 mg/L year-round ammonia limit) and population growth.

This approach allows the City to exercise due diligence under the Fisheries Act and Wastewater Systems Effluent Regulations, both of which identify un-ionized ammonia as a deleterious substance.

By strengthening control at the source, the City can:

- Maintain influent within the WWTP's design capacity;
- Prevent costly downstream compliance issues;
- Protect aquatic life in the South Saskatchewan River; and
- Demonstrate proactive, responsible environmental stewardship.

Source control is therefore not a single measure but part of a continuous, system-wide effort that integrates industrial regulation, municipal treatment optimization, and long-term infrastructure planning.