Cold Weather Ammonia Removal

Mark Prein
Welcome to Charlevoix the Beautiful
PERMIT NO. MI0057737

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY

AUTHORIZED TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251
and 41, and Michigan Executive Order 2009-45,

City of Charlevoix
210 State Street
Charlevoix, Michigan 49720

is authorized to discharge from the City of Charlevoix Wastewater Treatment Plant located at
15116 Lakeshore Drive
Charlevoix, Michigan 49720

designated as Charlevoix WWTP

to the receiving water named Lake Michigan in accordance with effluent limitations, monitoring requirements,
and other conditions set forth in this permit.

This permit is based on a complete application submitted on March 31, 2009.

This permit takes effect on June 1, 2011. The provisions of this permit are severable. After notice
and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its
term in accordance with applicable laws and rules. On its effective date this permit shall supersede NPDES Permit No. MI0057737, expiring October 1, 2009.

This permit and the authorization to discharge shall expire at midnight, October 1, 2014. In order to receive
authorization to discharge beyond the date of expiration, the permittee shall submit an application which
contains such information, forms, and fees as are required by the Michigan Department of Environmental
Quality (Department) by April 4, 2014.

Issued April 1, 2011

Original Permit Signed by Michael Bray
Michael J. Bray, Acting Chief
Permits Section
Water Resources Division

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PERMIT NO. MI0057737

PART I

Section A. Limitations and Monitoring Requirements

1. Final Effluent Limitations, Monitoring Point 001A

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit,
the permittee is authorized to discharge treated municipal wastewater from Monitoring Point 001A through
Outfall 001. Outfall 001 discharges to Lake Michigan. Such discharge shall be limited and monitored by the
permittee as specified below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum Limits for Quantity or Loading</th>
<th>Maximum Limits for Quality or Concentration</th>
<th>Monitoring Frequency</th>
<th>Sample Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monthly (reported)</td>
<td>Daily (reported)</td>
<td>Units</td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Carbonaceous Biochemical Oxygen Demand (COD)</td>
<td>210</td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>250</td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Ammonia Nitrogen (as N)</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Effective Date until 9/30/2014</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Beginning 10/1/2014</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>10/1 – 4/30</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Beginning 12/1/2014</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>12/1 – 3/31</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>4/1 – 4/30</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus (as P)</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>FAC Coliform Bacteria</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Total Residual Chlorine</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Total Mercury</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>12-Month Rolling Average</td>
<td></td>
<td></td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Total Mercury</td>
<td>0.000058</td>
<td></td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>CBOD, Minimum % Removal</td>
<td></td>
<td></td>
<td>Monthly</td>
<td></td>
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<tr>
<td>Total Suspended Solids Minimum % Removal</td>
<td>85</td>
<td></td>
<td>Monthly Calculation</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td></td>
<td></td>
<td>5/Week</td>
<td></td>
</tr>
</tbody>
</table>
## Project Need – NPDES Permit

### Maximum Limits for Quantity or Loading

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monthly</th>
<th>7-Day</th>
<th>Daily</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>(report)</td>
<td>(report)</td>
<td>MGD</td>
<td></td>
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</table>

### Maximum Limits for Quality or Concentration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monthly</th>
<th>7-Day</th>
<th>Daily</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonaceous Biochemical Oxygen Demand (CBOD₅)</td>
<td>210</td>
<td>330</td>
<td></td>
<td>lbs/day</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>250</td>
<td>380</td>
<td></td>
<td>lbs/day</td>
</tr>
</tbody>
</table>

### Monitoring Frequency and Sample Type

- **Flow**: Daily, Report Total Daily Flow
- **Carbonaceous Biochemical Oxygen Demand (CBOD₅)**: 5/Week, 24-Hr Composite
- **Total Suspended Solids**: 5/Week, 24-Hr Composite

### Ammonia Nitrogen (as N)

- **Effective Date until 9/30/2014**
  - 5/1 – 9/30
  - Beginning 10/1/2014
    - 5/1 – 9/30
    - 10/1 – 4/30
  - Beginning 12/1/2015
    - 5/1 – 9/30
    - 10/1 – 11/30
    - 12/1 – 3/31
    - 4/1 – 4/30
- **Units**: mg/l
- **Frequency**: Weekly, 24-Hr Composite

### Total Phosphorus (as P)

- **Units**: mg/l
- **Frequency**: 5/Week, 24-Hr Composite

### Fecal Coliform Bacteria

- **Units**: ct/100 ml
- **Frequency**: 5/Week, Grab
PERMIT NO. MI0057737

PART I

Section B. Schedule of Compliance

1. Schedule of Compliance

The permittee shall achieve compliance with the final effluent limitations for monitoring point 001 specified in Part I.A.1., in accordance with the following schedule. All submittals shall be to the Department.

a. On or before July 1, 2011, the permittee shall complete pump and other plant maintenance to allow concurrent operation of both halves of the treatment plant, as necessary, to meet limits in Part I.A.1. Alternative treatment improvements leading to reduced ammonia or toxicity control may be approved by the Department.

b. On or before August 1, 2011, the permittee shall submit a monitoring and study plan to evaluate treatment operations and/or causes of chronic ammonia toxicity problems.

c. On or before September 1, 2011, the permittee shall acquire a consultant/engineer to assist with long-term treatment improvement and chronic ammonia toxicity reduction.

d. On or before September 1, 2013, the permittee shall submit data analysis and a description and evaluation of options considered in correcting the ammonia toxicity problem, including a detailed description of the selected alternative(s). A schedule for acquisition and implementation of the selected alternative(s) shall be included.

e. On or before 10/1/2015, the permittee shall complete construction of corrective facilities, or implementation of other approved remedies.

f. On or before 12/1/2015, the permittee shall attain and maintain an operational level necessary to meet the limits specified in Part I.A.1.
City of Charlevoix

INFLUENT AND EFFlUENT BOD, MG/L

- Influent BOD Monthly Average Day mg/L
- Final Effluent BOD Monthly Average Day mg/L
- 2011 MDEQ BOD Limits mg/L
City of Charlevoix

ACTIVATED SLUDGE FOOD TO MICRO-ORGANISM (F/M) RATIO

Both Aeration Tanks in Operation From April 11, 2011 to October 9, 2011 and From October 21, 2011 to End of Year
City of Charlevoix
INFLUENT TEMPERATURE AND
EFFLUENT AMMONIA LIMITS, MG/L

2011 MDEQ Ammonia Limits mg/L
Influent Temperature Monthly Average Day

DATE
Dec-08 Mar-09 Jul-09 Oct-09 Jan-10 May-10 Aug-10 Nov-10 Feb-11 Jun-11 Sep-11 Dec-11 Apr-12 Jul-12 Oct-12

TEMPERATURE, °F
0 10 20 30 40 50 60 70 80

MG/L
0 5 10 15 20 25
City of Charlevoix
INFLUENT AND EFFLUENT AMMONIA, MG/L

Final Effluent Ammonia Monthly Average Day mg/L
Influent Ammonia Monthly Average Day mg/L
2011 MDEQ Ammonia Limits mg/L
Prelim. Calc. Site Specific Ammonia Limits mg/L
Temperature Impact on Treatment

Figure 20.22  Rate of nitrification at various temperatures compared with the rate at 30°C
pH Impact on Nitrification

Figure 20.21 Percent of maximum rate of nitrification at constant temperature versus pH

WEF MOP11, fifth addition
**Discharge Permit Negotiations**

- Identified four proposed modifications to Permit
  - Reduce or Eliminate the Ammonia
  - Multiple Discharge Points
  - Shift the Permit Time Limits
  - Discharge Location Specific Conditions

- WET Testing Methodology Impacts!
- Next Permit Cycle
Ammonia Challenge

• Issues
  • Cold Wastewater
  • Limited growth rate/washout
  • Tankage
  • Alkalinity
  • Seasonal Flows

• Solutions
  • Air Stripper
  • Increase wastewater temperature
  • Increase/retain biomass
Temperature

• Issue
  • Cold Wastewater
  • Slows Ammonia removal

• Solutions
  • Prevent heat loss
  • Increase Temperature
    • Heat wastewater
    • Heat recovery
  • Work around
Temperature

• Issue
  • Cold Wastewater
  • Slows Ammonia removal

• Solutions
  • Prevent heat loss
    • Cover – Primary Tanks
  • Increase Temperature
    • Heat wastewater Heat recover
  • Work around
    • MBR
    • Attached Growth
MBR vs. Attached Growth

- MBR
  - Zenon/GE
  - Koch
  - Evoqua
  - Ovivo
  - Lots of Others

- Attached Growth
  - Infilco Degremont
  - Kruger
  - Biowater
  - Water World
  - Lots of Others
Pros Vs. Cons

**MBR - Pros**
- Smaller Footprint
- Very high MLSS, option
- High quality effluent

**Cons**
- Higher electric cost
- Higher chemical costs
- More complicated

**Attached Growth**
- Increase biomass
- Media adjustable
- Many configurations
- Operator friendly

**Cons**
- Settling, potential
- Biomass loss
- More tankage
- Clarifiers remain/add

Life Cycle Costs
Attached Growth Process
Process Selection

• Pros/Cons Results
  • Why not select MBR
    • More aggressive
    • Additional costs and O&M
    • More operator intensive
  • Accomplish goal with less equipment
  • Have the space for the Attached Growth Process
Process Selection

• Pros/Cons Results
  • Why not select MBR
    • More aggressive
    • Additional costs and O&M
    • More operator intensive
  • Accomplish goal with less equipment
  • Have the space for the Attached Growth Process

Note the use of Attached Growth terminology
Attached Growth Options

Mobile Media

• MBBR – Moving Bed Biofilm Reactor
• CMFF – Complete Mix Fixed Film (Biowater)
• IFAS – Integrated Fixed Film Activated Sludge
• CFAS – Combined Fixed Film Activated Sludge (Biowater)
• CFIC – Continuous Flow Intermittent Cleaning (Biowater)
And some more options

Lagoon - EDI

Lagoon – Nelson Env.

Brentwood
Process Selection

- Why select IFAS/CFAS vs MBBR
  - Better settling
  - Clarifier Needs
  - Better control of Activated Sludge
  - Treatment flexibility – Huge swings in flows
# Cost Estimate

## City of Charlevoix

### Wastewater Treatment Plant

<table>
<thead>
<tr>
<th>Plant Unit</th>
<th>Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Basic Plant Improvements</td>
<td>$5,695,000</td>
</tr>
<tr>
<td>2. Additional Aeration Tanks</td>
<td>$200,000</td>
</tr>
<tr>
<td>3. Complete Advanced Treatment System</td>
<td>$1,650,000</td>
</tr>
<tr>
<td>4. Process Requirements</td>
<td>$350,000</td>
</tr>
<tr>
<td>5. Piping Systems</td>
<td>$500,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$8,395,000</strong></td>
</tr>
</tbody>
</table>

Contingency, Legal, Engineering, and Fiscal: $2,500,000

**Project Total**: $10,895,000
Funding

• $11 Million Dollar Project
• State S-2 Planning Grant (90%)
  • State: $63,900; City: $24,900*
    • Includes 10% match and In-Eligible work.
• Rate Increase
  • 24.5% for three years
• Outreach program
• Unanimous community support
• State S-2 Design Grant (90%)
  • State: $812,700; City: $90,300
• SRF Project Plan and Funding
Primary Covers
Bioreactor
Bioreactor Internals
Bioreactor Internals
Media Install
City of Charlevoix
MODIFIED AMMONIA PERMIT LIMIT, MG/L

Note: Permit June 2011
Permit November 2015
City of Charlevoix
INFLUENT AND EFFLUENT BOD, MG/L

Influent BOD Monthly Average Day mg/L
Final Effluent BOD Monthly Average Day mg/L
MDEQ BOD Limits mg/L

DATE
City of Charlevoix

INFLUENT AND EFLLUENT pH

DATE

Influent pH Monthly Average Day
Effluent pH Monthly Average Day


pH

7.0
7.5
8.0
8.5
9.0
City of Charlevoix

INFLUENT AND EFFlUENT AMMONIA, MG/L

- Influent Ammonia Monthly Average Day mg/L
- Final Effluent Ammonia Monthly Average Day mg/L
- 2011 MDEQ Ammonia Limits mg/L

DATE

Jan-10 | Mar-10 | May-10 | Jul-10 | Sep-10 | Nov-10 | Jan-11 | Mar-11 | May-11 | Jul-11 | Sep-11 | Nov-11
City of Charlevoix

INFLUENT AND EFFLUENT AMMONIA AND MDEQ LIMITS, MG/L

Influent Ammonia Monthly Average Day mg/L
Final Effluent Ammonia Monthly Average Day mg/L
MDEQ Ammonia Limits mg/L

[Graph showing data trends with dates from January 2015 to May 2016, indicating changes in ammonia levels and permit dates.]
Operational Improvements/Savings

• Process
  • Anoxic BOD reduction
  • Oxygen credit
  • Alkalinity recover
• Sludge Tank
• Chemical
  • Ferric – Flow paced
  • Alkalinity addition eliminated
  • No chlorine for disinfection
  • Eliminate De-chlorination system
City of Charlevoix
ENERGY USAGE, KWH

MONTH | KWH | 2015, Pre-Project | 2016, Post-Project
---|---|---|---
January | 70000 | 
February | 70000 | 
March | 90000 | 
April | 70000 | 
May | 70000 |
# Monthly Energy Cost Savings

<table>
<thead>
<tr>
<th>Month</th>
<th>2015, Pre-Project</th>
<th>2016, Post-Project</th>
<th>Monthly Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>$ 9,015.60</td>
<td>$ 7,647.20</td>
<td>$ 1,368.40</td>
</tr>
<tr>
<td>February</td>
<td>$ 8,866.00</td>
<td>$ 7,114.80</td>
<td>$ 1,751.20</td>
</tr>
<tr>
<td>March</td>
<td>$ 9,614.00</td>
<td>$ 6,776.00</td>
<td>$ 2,838.00</td>
</tr>
<tr>
<td>April</td>
<td>$ 8,426.00</td>
<td>$ 6,564.80</td>
<td>$ 1,861.20</td>
</tr>
<tr>
<td>May</td>
<td>$ 7,906.80</td>
<td>$ 7,075.20</td>
<td>$ 831.60</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$ 8,650.40</strong></td>
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Note: Costs based on $0.11/KWH
Questions?