Chemical Profile of Swift Current Wastewater Treatment Plant Discharge and Its Potential Effects

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Aim of Presentation

- Introduction to Swift Current, SK
- Why Swift Current Wastewater Treatment Plant?
- Androgenicity and estrogenicity
- Chemical composition of Wastewater
Project Overview

- Swift Current Wastewater Treatment Plant is a point discharge of chemical contaminants into the South Saskatchewan River
- Construct a chemical profile for Swift Current Creek to monitor the fate and potential effects of pollutants from WWTP
- Prescreen samples with cell bioassays
- Use high resolution Orbitrap LC/MS to identify and quantify target chemicals based on bioassay findings
<table>
<thead>
<tr>
<th>Site</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>Railroad Bridge</td>
</tr>
<tr>
<td>Site 2</td>
<td>Influent</td>
</tr>
<tr>
<td></td>
<td>Effluent</td>
</tr>
<tr>
<td>Lagoon</td>
<td>Lagoon</td>
</tr>
<tr>
<td>Site 5</td>
<td>4.2 km Downstream</td>
</tr>
<tr>
<td>Site 8</td>
<td>21 km Downstream</td>
</tr>
<tr>
<td>Site 10</td>
<td>51 km Downstream</td>
</tr>
<tr>
<td>Site 11</td>
<td>73 km Downstream</td>
</tr>
<tr>
<td>Site 12</td>
<td>93 km Downstream</td>
</tr>
</tbody>
</table>
Swift Current WWTP

- The Swift Current Wastewater Treatment Plant was opened in 2006
- The plant carries out complete secondary treatment and UV disinfection before discharging effluent to Swift Current Creek
Questions to Address

- Are chemicals from the WWTP currently an issue of concern in the South Saskatchewan River – if so which chemicals are of greatest concern or potential concern?

- What are the potential future issues associated with WWTP contaminants in the context of predicted changes in the hydrology, land use and chemical loadings to the river?
Analysis Approach

Sample Collection  
Sample Preparation  
Cell Bioassay  
Chemical Analysis
Sample Preparation

- Filtration using GF/C
- Extract 2L of each sample through Oasis® HLB
- Elute with 5 mL of MeOH and 5 mL of 1:1 Hexane:DCM
- Reduce under N₂ to near dryness
- Reconstitute with 250 μL Isooctane
Cell Bioassay

- Quick and cost-efficient
- Assess total and mixed activities, including effects of unknown chemicals
- Only measures toxic equivalencies
- MDA and T47D cell lines are used to measure (anti)-androgenetic and (anti)-estrogenetic effects respectively
MDA Assay Results

Androgenicity in Swift Current Creek

Mean Androgenicity Fold Change

Sample Site

Duncarn Dam  Site 1  Site 2  Influent  Effluent  Lagoon  Site 5  Site 8  Site 10  Site 11  Site 12  Sask Landing  Blank

F_{11, 348} = 9.609, P < 0.001
MDA Assay Results Cont.
T47D Assay Results

Estrogenicity in Swift Current Creek

$F_{5, 66} = 8.68, P < 0.001$
Orbitrap

- Preliminary measurements in both positive and negative ion mode
- Use C18 column with either ACN or MeOH mobile phase
- Run full scan (i.e. m/z = 100 – 1000 amu) at 70-150,000 mass resolution
Chemicals of Interest

- Atrophine
- Propanil
- Miconazole
- Nifuroxazide
- Nicotine
- Pipermethystim
- Progestosterone
- Bupirimite
- Josamycin
- EPN
- Clophanadin
- Phosphamidon
- TCEP
- DEHP
- Isoxcarbophos
- Diazepam
- Enalapril
- Phthalate
- Isopropcarb
- Pyrazon
- Metalaxyl
- Naproxen
- Deet
- Carboxine
- Fluorazifop
- Indoxacarb
- Estrone
- Morphine
- Haloxyfop-EE
- Isoprocarb
- Metalaxyl
- Naphtalamine
- Chlorpyrifos
- Pindolol
- Bifenoxy
- Difluobenzuron
- Carbamazepin
- Fenpropidin
- Caffeine
- Neburon
- Cinosulfuron
- Fenoxycarb
- Triamethoprim
- Bifenoxy
- Galaxide
- Isomer
- Nitrate
- Cyproconazole
- Pravastatin
DEET in Wastewater

**INFLUENT**

**LAGOON**

<table>
<thead>
<tr>
<th></th>
<th>Peak Area</th>
<th>% of INF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent</td>
<td>34616038939</td>
<td></td>
</tr>
<tr>
<td>Lagoon</td>
<td>194761680</td>
<td>0.56</td>
</tr>
<tr>
<td>Effluent</td>
<td>140961652</td>
<td>0.41</td>
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</tbody>
</table>
Orbitrap Results

Chemical Contaminants In Swift Current Wastewater

Estimated Total Concentration of Contaminants (ng/mL)

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>APR, 2011</th>
<th>July 18, 2011</th>
<th>August 29, 2011</th>
<th>January 9, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent</td>
<td></td>
<td>60</td>
<td>40</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Effluent</td>
<td></td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Lagoon</td>
<td></td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

The diagram shows the estimated total concentration of chemical contaminants in Swift Current wastewater for different locations and dates.
Orbitrap Results

Types of Contaminants in Swift Current Wastewater

Estimated Total Concentration of Contaminants (ng/mL)

- APR, 2011
- July 18, 2011
- August 29, 2011
- January 9, 2012

- Influent
- Effluent
- Lagoon

PH
PE
OM
LSD
Conclusion

- WWTP effluents show a significant decrease in androgenicity compared to influents
- Lagoon expresses same baseline level of androgenicity
- Influent, lagoon and Site 5 in close proximity to WWTP demonstrate estrogenic activity, but diminishes down the creek
- Composition of chemicals detected by LC-MS varies throughout the year
Acknowledgements

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  - Dr. Henry He

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Thank you!

Questions?

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