

# THE PHARMACEUTICAL CONTENT OF LANDFILL LEACHATE

*a preliminary evaluation*

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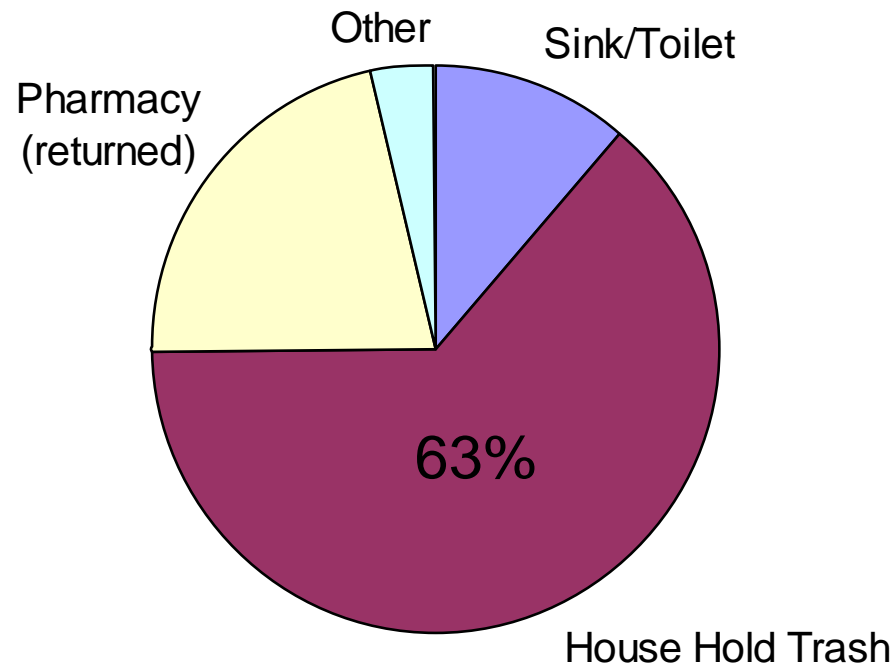
# Pharmaceuticals (PPCPs) in the environment

- Research demonstrates WWTPs receive and discharge a wide array of pharmaceuticals
- The pharmaceutical content of wastewater results largely from two sources
  - human excretions
  - flushing unused medicines

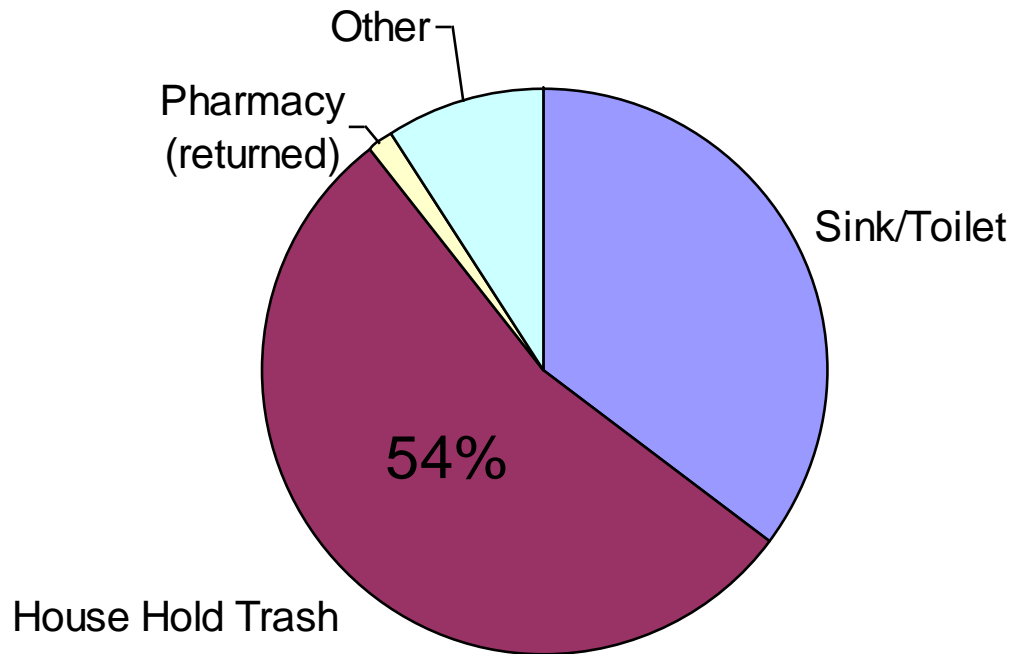
# Not all PPCPs go down the drain

- Federal government and pharmaceutical industry recommends the disposal of unused pharmaceuticals with household trash
- Expect mass PPCPs discarded with household trash to increase as fewer PPCPs are flushed

**Disposal methods for pharmaceuticals  
United Kingdom Study (Bound and Voulvoulis, 2005)**



# Disposal methods for pharmaceuticals United States Study (Kuspis and Krenzelok, 1996)



# Research literature

- Each year ~ 1,040 tons of active pharmaceuticals enter U.S. Landfills (Musson and Townsend, 2009)
- Several studies have detected pharmaceuticals in contaminated groundwater downgradient of unlined landfills (Ahel and Jelcic, 2000, Barnes et. al., 2004, Buszka et. al. 2009)
- *Limited data about pharmaceuticals in municipal solid waste landfill leachate*

# Significance of pharmaceutical content of landfill leachate?

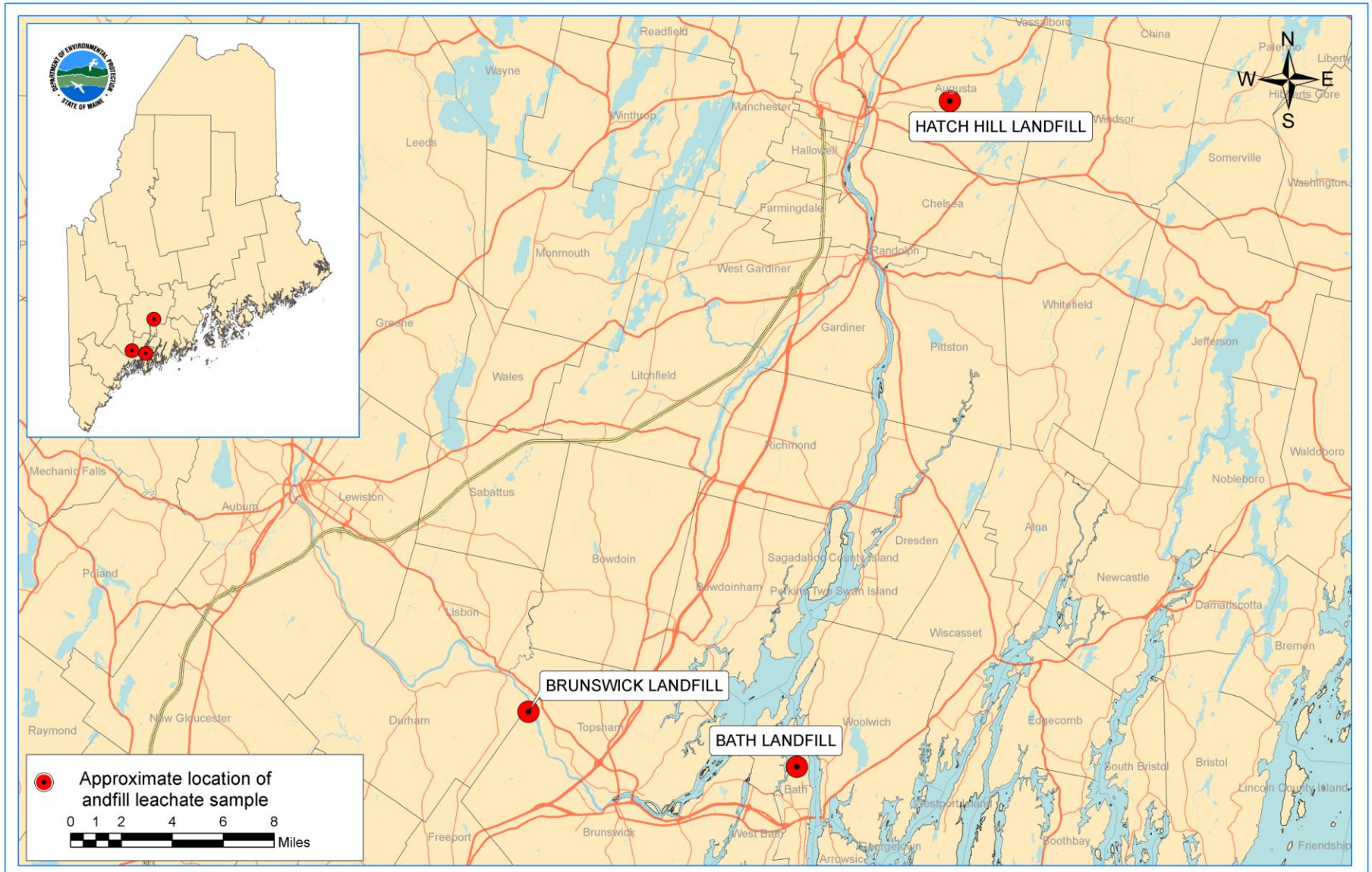
- If landfill leachate contains pharmaceuticals, it contributes to the pharmaceutical content of Maine's surface water and groundwater
- So, here's the big Question???
  - Pharmaceuticals certainly find (found) their way to landfills, but can we detect them in landfill leachate?

# Do Maine's municipal solid waste landfills generate leachate containing PPCPs?

- Sampled three municipal solid waste landfills - *the criteria*
  - The landfills all have engineered liner systems with leachate collection
  - They all received significant quantities of household waste
  - Received little or no municipal waste water sludge



# Landfill locations



# October 2009 landfill evaluation

- City of Augusta's Hatch Hill landfill
  - Primexpand III – ~20 acre landfill cell
    - 21,045,000 gallons/year
- City of Bath's municipal landfill
  - Leach-MH – ~6 acre landfill cell
    - 20,876,000 gallons/year
- Town of Brunswick's municipal landfill
  - MH-P1 – 16.2 acre landfill cell
    - 16,972,000 gallons/year

# Brunswick municipal landfill

*DEP Database Plug*

DEP data available via  
Google Earth projects

Leachate passes through three lagoons before discharge to the Androscoggin River

©2009 Google

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# Sampling techniques

- Samples collected using peristaltic pump and new tubing
- Collected field parameters (pH, Specific conductance, and turbidity)
- Each sample consisted of four, 1-Liter HDPE bottles supplied by laboratory
- Stored on ice initially, then frozen before shipment to AXYS Analytical Services Ltd. of Sidney, British Columbia

# Analytical techniques

- Laboratory filtered samples before analysis (1.6  $\mu\text{m}$ )
  - **eliminated an important fraction?**
- AXYS used a liquid chromatographic mass spectrometric method
  - MLA-075 and MLA-072, Based on USEPA Method 1694
- Samples analyzed for 135 PPCPs

# *Costs?*



*\$1,600 per sample*

# Large variety of PPCPs found in the **3** municipal landfill leachates

- 47 PPCPs or breakdown products detected
  - Antibiotics, steroids, antidepressants, high blood pressure, heart, asthma and several pain medications. *Some are known or suspected endocrine disruptors*
  - Plus....DEET, caffeine, nicotine and its metabolite,
  - Twenty compounds common among the three leachate samples



# AUGUSTA LANDFILL

Parameter Name	Concentration (ng/L)	Description
Acetaminophen	117,000	Pain medication
DEET	60,100	insect repellent
Ibuprofen	23,200	pain, analgesic
Metformin	14,800	oral anti-diabetic drug
Cotinine	11,000	nicotine metabolite
Caffeine	8,460	stimulant
Erythromycin-H2O	2,990	antibiotics
Naproxen	2,000	pain or inflammation caused by arthritis
Benzoyllecgonine	1,200	cocaine metabolite
Valsartan	718	High BP
Methylprednisolone	647	suppression of inflammation
Albuterol	604	Asthma
Norfloxacin	449	synthetic chemotherapeutic
Amphetamine	419	ADHD, weight control
Carbamazepine	371	anticonvulsant and mood stabilizing drug
Ciprofloxacin	269	second generation fluoroquinolone antibacterial
Atenolol	195	High BP
Metoprolol	173	High BP
Gemfibrozil	172	drug used to lower lipid levels
Sulfadiazine	153	sulfa derivative topical antibacterial



## BATH LANDFILL

Parameter Name	Concentration (ng/L)	Description
DEET	30,400	insect repellent
Ibuprofen	21,900	pain, analgesic
Acetaminophen	2,750	Pain medication
Cotinine	1,510	nicotine metabolite
Sarafloxacin	882	quinolone antibiotic drug
Valsartan	612	High BP
Naproxen	524	pain or inflammation caused by arthritis
Caffeine	426	stimulant
Amphetamine	161	ADHD, weight control
Gemfibrozil	151	drug used to lower lipid levels
Cimetidine	149	ulcer and acid reflux
Lincomycin	73	lincosamide antibiotic
Benzoyllecgonine	68	cocaine metabolite
Carbamazepine	63	anticonvulsant and mood stabilizing drug
Sulfamethazine	58	veterinary antibacterial drug in food animals
Sulfadimethoxine	52	antibiotic of the sulfonamide class
Flumequine	43	first generation fluoroquinolone antibacterial
Atenolol	37	High BP
Meprobamate	34	anxiety
Erythromycin-H2O	31	antibiotics

# BRUNSWICK LANDFILL

Parameter Name	Concentration (ng/L)	Description
DEET	30,000	insect repellent
Bisphenol A	25,200	plasticizer
Ibuprofen	11,600	pain, analgesic
Cotinine	3,390	nicotine metabolite
Caffeine	3,190	stimulant
Sarafloxacin	1,260	quinolone antibiotic drug
Carbamazepine	556	anticonvulsant and mood stabilizing drug
Amphetamine	415	ADHD, weight control
Sulfanilamide	415	a sulfonamide antibacterial
Valsartan	413	High BP
Erythromycin-H2O	289	antibiotics
Lincomycin	278	lincosamide antibiotic
Gemfibrozil	277	drug used to lower lipid levels
Sulfathiazole	255	a sulfonamide used in urinary tract infection
Naproxen	163	pain or inflammation caused by arthritis
Sulfadimethoxine	107	antibiotic of the sulfonamide class
Albuterol	88	Asthma
Benzoyllecgonine	70	cocaine metabolite
Cimetidine	60	ulcer and acid reflux
Atenolol	59	High BP

# Expect the unexpected

(ng/L)	Augusta Landfill	Bath Landfill	Brunswick Landfill
Cocaine	57.1	1.6	4.0
Benzoylecgonine	1,200	68	70
Bisphenol-A	< 7,520	<7,400	25,200

# Are nanograms levels significant?

- Low concentrations translate to hundreds of pounds when one considers annual leachate production rates
- PPCPs currently discharged with an unknown degree of treatment
- Documented impact on environment ...impact on health likely but uncertain

# Summary

- Landfill leachate contains a wide range of PPCPs
- Filtering the samples likely reduced PPCP concentration
- Numerous PPCPs detected in all three samples, while.....
- Some PPCPs present in a single leachate
- Maine's unlined closed landfills are likely sources too.....

# Next Steps?

- Collect more samples for characterization and analyze the entire sample
- USGS Research – Preparing a National survey to characterize landfill leachate
  - Maine DEP will participate
- Evaluate PPCPs in contaminated groundwater downgradient of unlined/closed municipal landfills

# Next Steps (cont.)

- Evaluate alternatives to PPCP disposal in landfills
  - Legislation requiring manufacturers to establish accessible, free collection and disposal programs?

Thanks very much

Questions, comments

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