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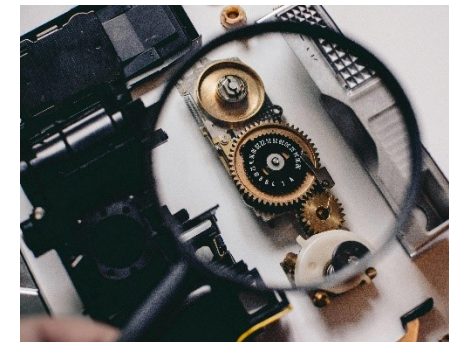
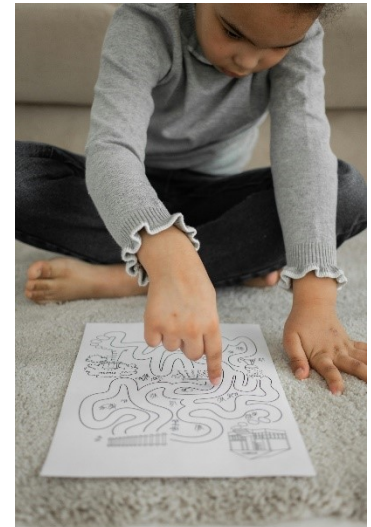
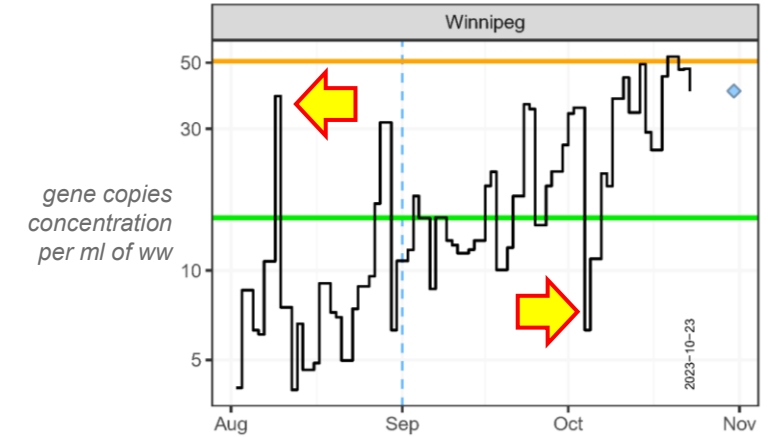
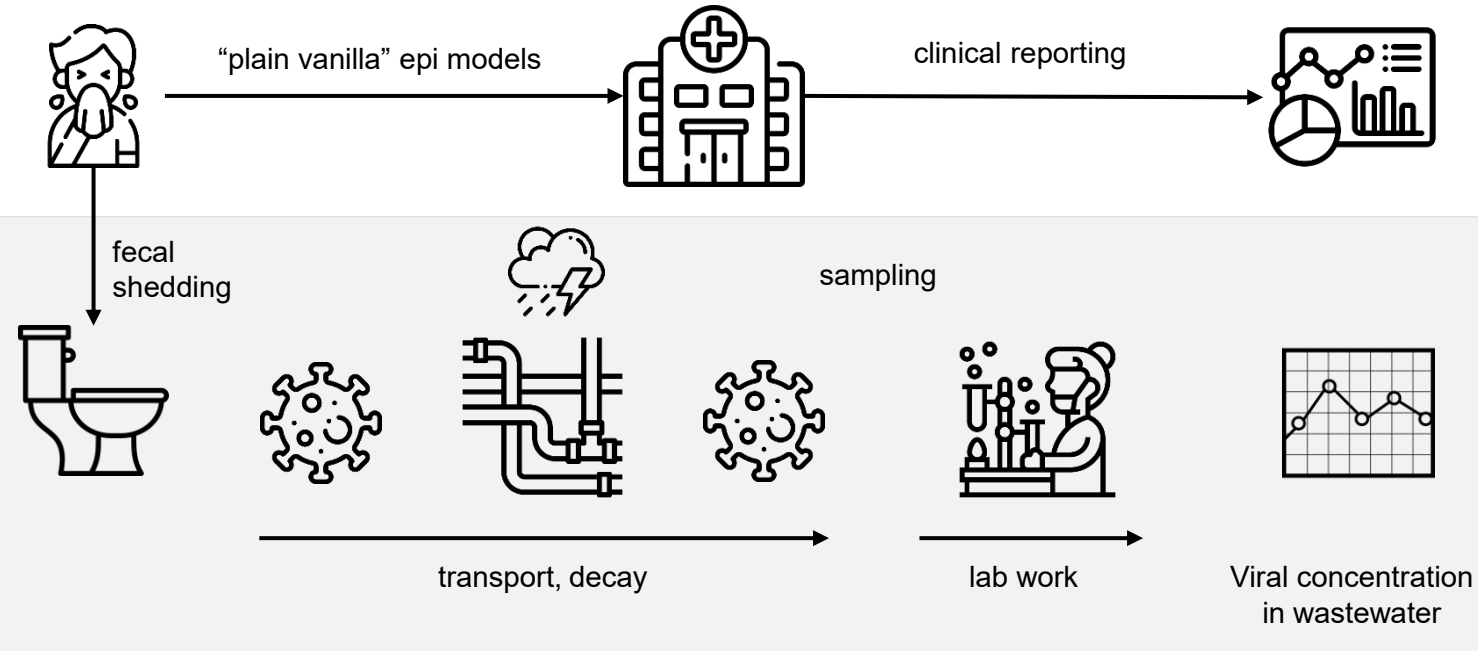
# Academic collaborations to improve wastewater-based modelling at PHAC

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CANMOD – BIRS Banff  
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# Wastewater: A New Data Stream



- Wastewater-based epidemic modelling is a “new” field
- Understanding viral concentration in ww is at crossroads of:
  - Epidemiology
  - Civil engineering
  - Chemistry
  - Biology / biophysics
- Many knowledge gaps
- Exploration

# Reaching Out for Help

## Why do we seek outside help

- Lack of expertise
- Lack of time
- Lack of resources
- Access to data

## Mutual benefits

- Academic brings expertise
- PHAC brings practical questions
- Publications / open source
- Funding

## Collaboration vehicles

- Contracts
- FSWEF
- COOP
- Grants & Contributions
- NSERC/CIHR grants



# Examples of Academic / PHAC Collaborations in Wastewater-Based Epidemic Modelling

# FPCA-Based Regression for Trends Analysis

## Question

“Can we control the observed viral concentration in wastewater for multiple covariates (rain, temperature, pH, TSS, etc.)?”

**Goal:** Support trend analysis of ww signal across Canada

**When:** Jun-Dec 2021

## Who

- University of Calgary – Department of statistics
- Dr. Xiaotian Dai ; Prof. X. Lu ; Prof T. Chekouo

**Vehicle:** Contract

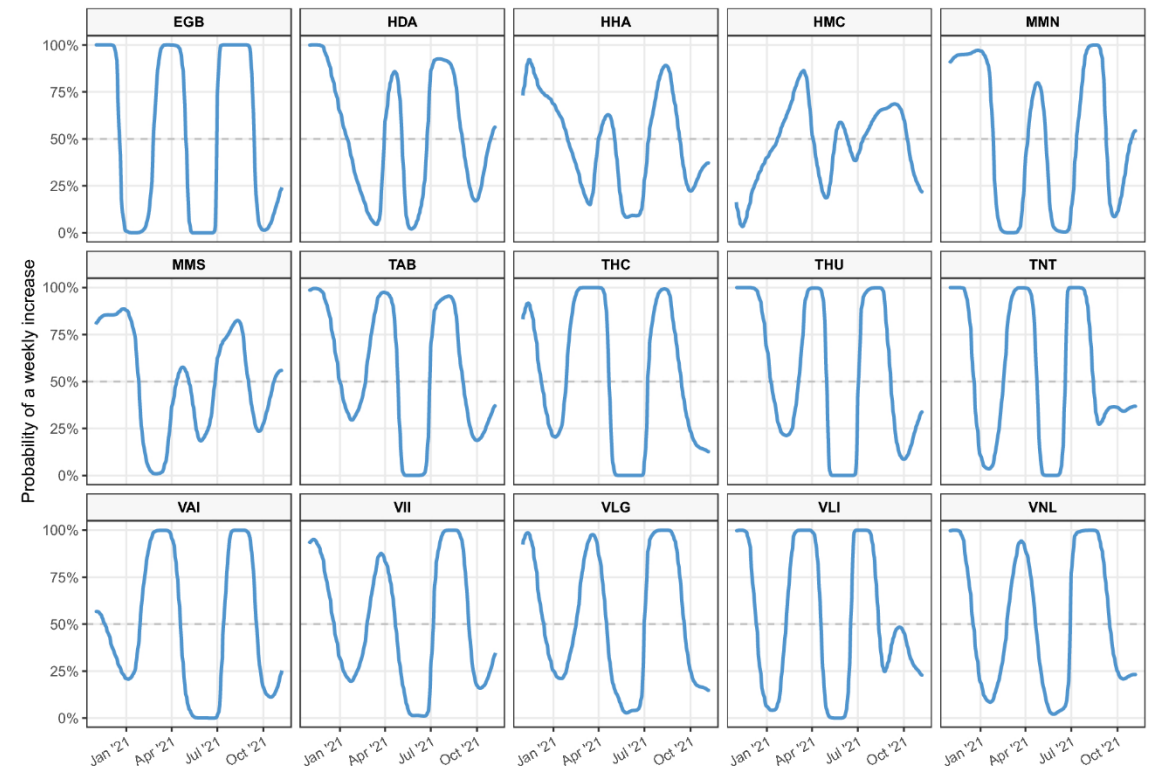
## Deliverables

- Draft manuscript ([eventually published](#) in Sci. Rep.)
- R code implementing the statistical model

Regression based on functional principal components analysis:

$$Y_{ik}(T_{it}) = Y_{itk} = \mu(T_{it}) + \sum_{p=1}^P \sum_{l_p=1}^{L_p} b_{l_p} \{X_{ip}^*(T_{it}) \phi_{l_p}(T_{it})\} + \sum_{l_0=1}^{L_0} \xi_{il_0} \phi_{l_0}(T_{it}) + \varepsilon_{itk}$$

$$\text{Proba}(\hat{Y}_i(T_{it}) > \hat{Y}_i(T_{i,t-7}))$$



# Fate of SARS-CoV-2 in Wastewater and Sewage System

## Question

“How are SARS-CoV-2 RNA concentrations affected by the wastewater environment during its journey between shedding and sampling locations?”

**Goal:** Better parameterization of wastewater-based epidemic model ; better modelling

**When:** Jan 2023 – Mar 2024

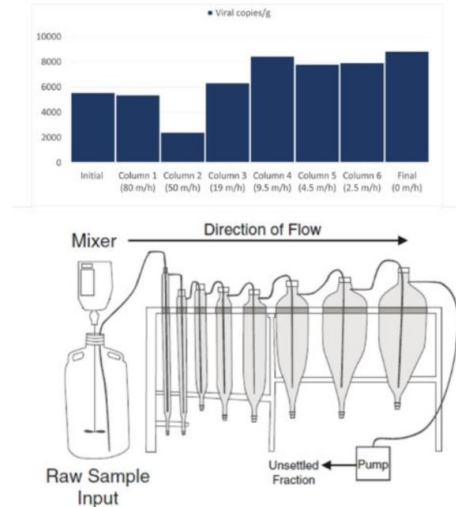
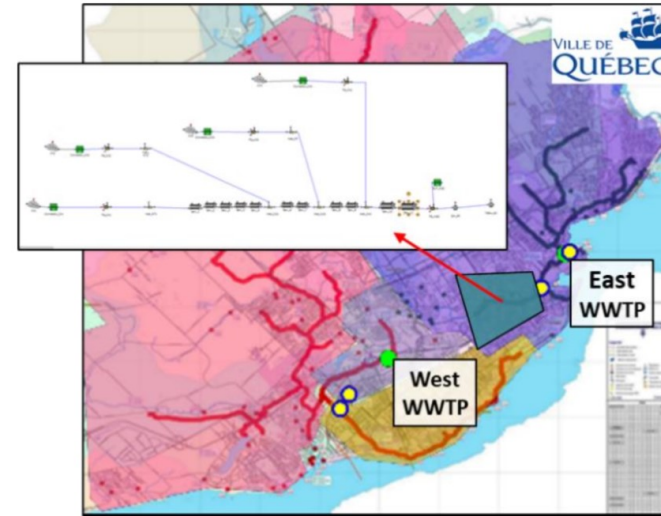
## Who

- Université Laval – Civil Engineering & Water Engineering
- Prof. Peter Vanrolleghem ; Dr. Sovanna Tik

**Vehicle:** Grants and Contributions

## Deliverables

- Manuscripts
- Data



# Assessing Uncertainty for PCR Measurements

## Question

“Can we quantify the uncertainty of PCR-based viral concentration in wastewater from NML’s surveillance program?”

**Goal:** Improve input data quality for models ; support trends analysis

**When:** Jan-Apr 2023

## Who

- University of Waterloo – Civil & Environmental Engineering
- Prof. Philip Schmidt; Liam Kusalik (student)

**Vehicle:** COOP

## Deliverables

- R package implementing new model (from published paper)
- <https://github.com/phac-nml-phrsd/ecurve>

**Traditional** log-linear regression model

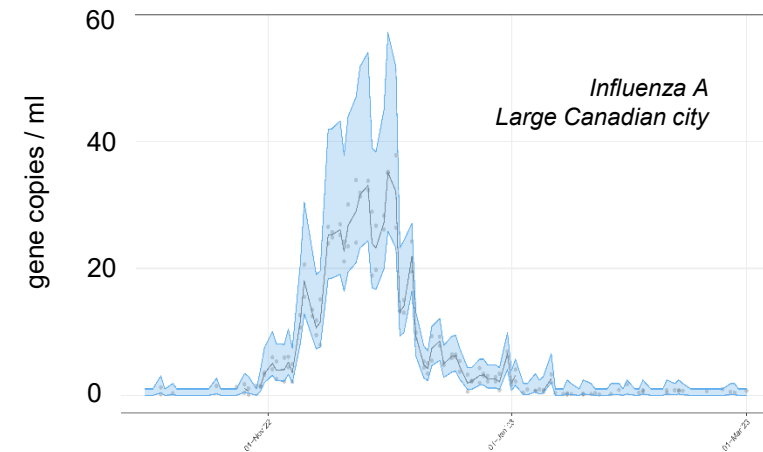
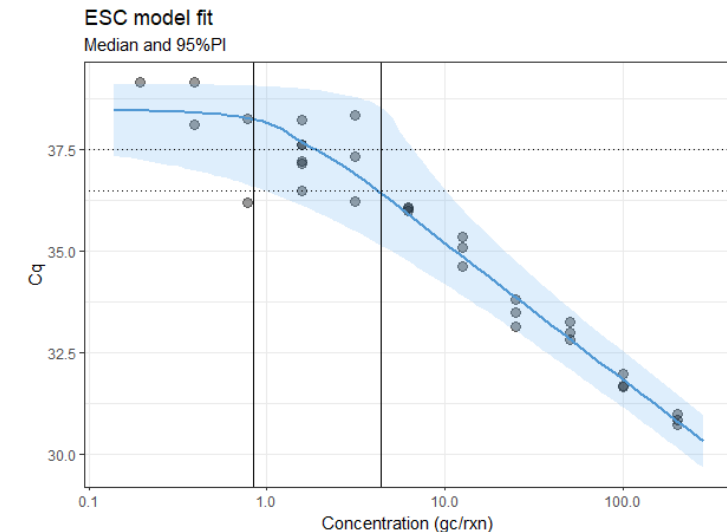
$$C_t \sim \text{int} + \text{slope} * \log(N_0)$$

$N_0$  : initial number of target genes in sample

**Enhanced standard curve** (hierarchical) model

$$N_0 \sim \text{Poisson}(\lambda)$$

$$C_t \sim \text{Norm}(\text{int} + \text{slope} * \log(N_0), \sigma^2)$$



# In-Silico Simulations of Sewer Dynamics

## Question

“Can we build a simplified model of the sewer system for a large city, to better understand the impacts of flows dynamics and environment on viral concentration in wastewater?”

**Goal:** Simulate fate of viral particles to better understand concentration observations

**When:** Sep-Dec 2023

## Who

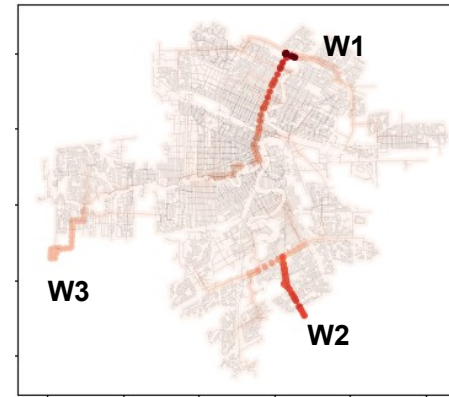
- York University – Civil Engineering
- Prof. Usman Khan; Everett Sneider (student)

**Vehicle:** Contract

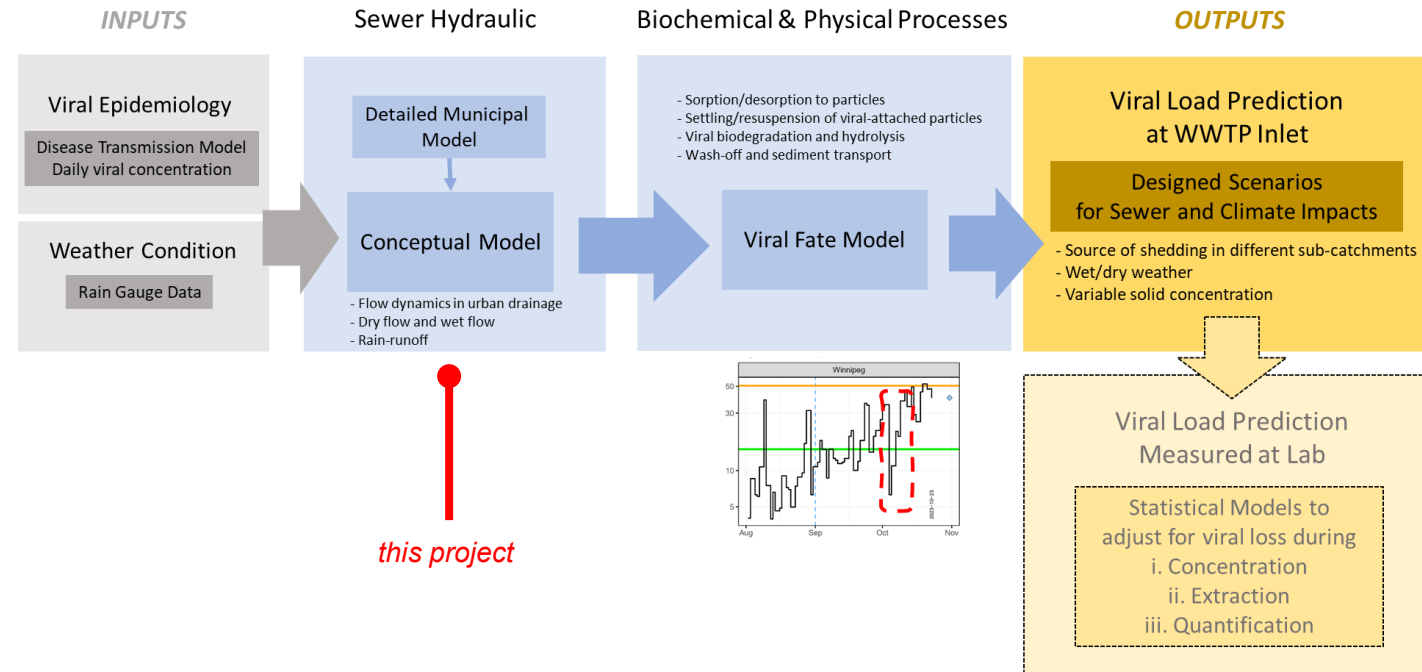
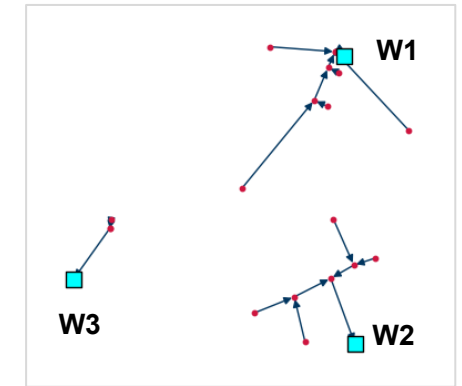
## Deliverables

- Simplified sewer model of the city
- Python code
- Documentation

Full detailed sewer model



Simplified sewer model





# Quantifying Viral Lineages from Wastewater Samples

## Question

“Can we have a user-friendly tool that provides robust estimates of viral lineages proportions in wastewater samples?”

**Goal:** Data for lineage modelling; support surveillance

**When:** Jan-Mar 2024

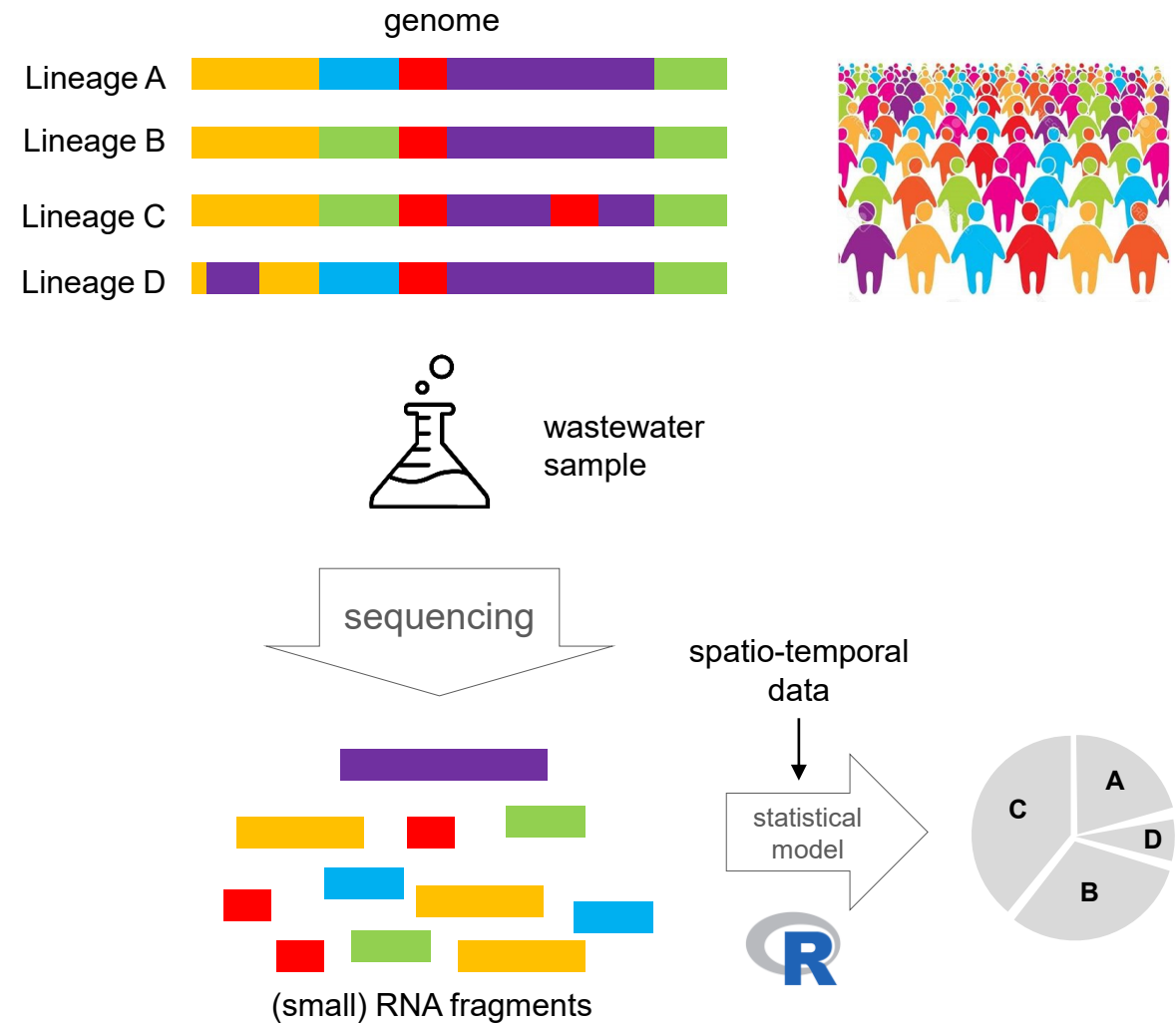
## Who

- Laurier University – Department of Statistics
- Prof. Devan Becker ; student (TBH)

**Vehicle:** Contract

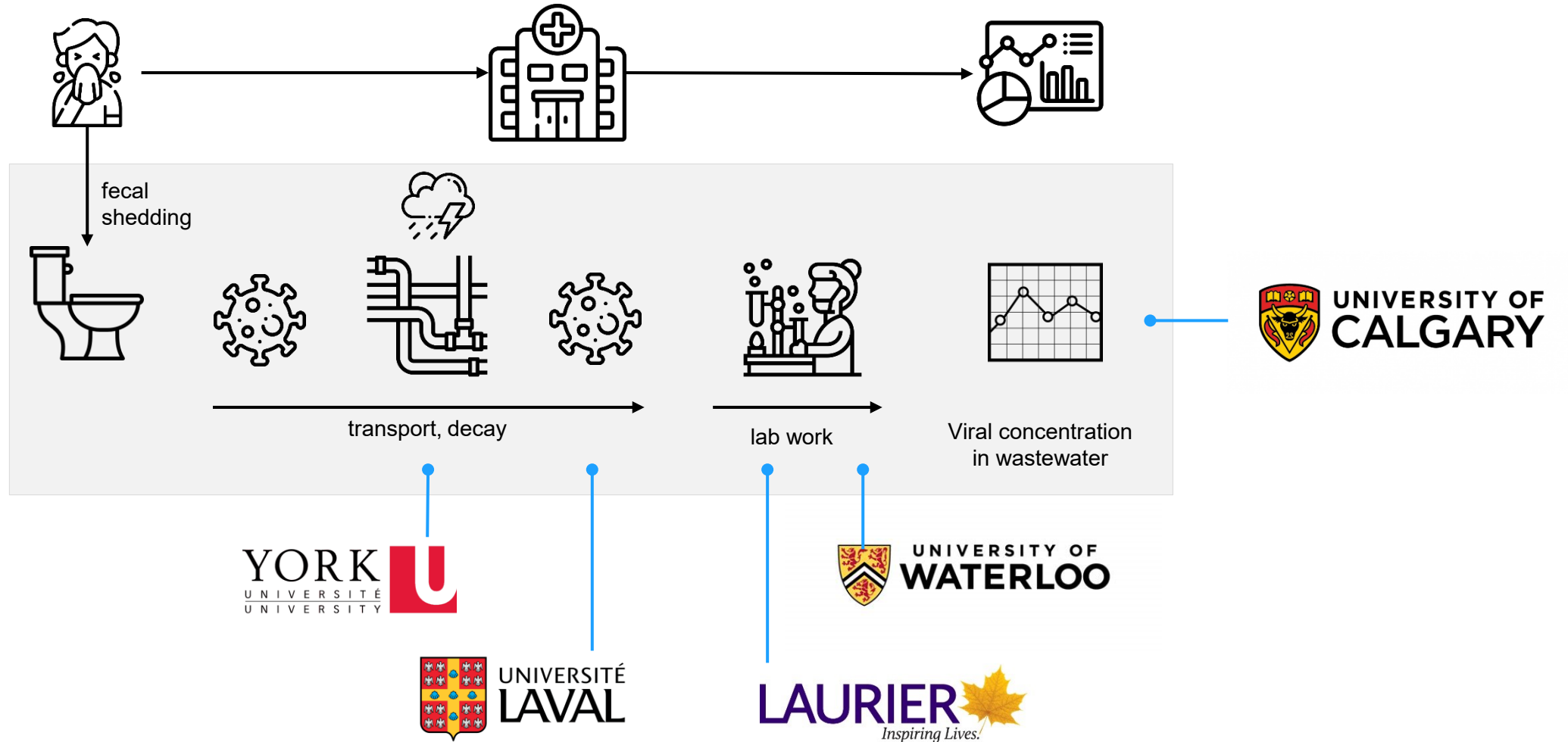
## Deliverables

- Documented R package
- Model description



# Summary

# Overview of Collaborations



# Summary

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- Viral concentration in wastewater is a new data stream
- Many knowledge gaps in this new field (for epi modeller)
- PHAC is doing a deep dive (too deep?)
- Need academic expertise (not only wastewater)
- Aligned research interests academia / PHAC
- Fruitful collaborations
- Diverse formats to collaborate

*Thanks for  
your attention!*

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