Sanitary Sewer Design

- sanitary sewers collect and transport domestic and industrial wastes via gravity flow
  - the ultimate destination of all transported waste is a **treatment facility**
- wastewater collection systems are different than water distribution systems.
  Sanitary sewer conduits:
  - do not flow under pressure
  - flow is unsteady and non-uniform
  - transport substantial loads of floating, suspended and soluble wastes
- as a result, it is important to size sanitary sewer conduits to flow under open channel flow conditions while transporting water-borne wastes with minimal deposition
  - **domestic** or sanitary wastewater refers to waste discharged from residential, business, commercial and institutional uses
    - the volume of waste discharged from residential areas varies considerably (225 - 450 litres per person per day)
  - **industrial** wastewater generally refers to waste discharged from manufacturing sites
    - industrial discharge significantly different from sanitary waste typically requires some level of **on-site pretreatment**
Extraneous flows (infiltration and inflow)

- **infiltration** refers to groundwater entering the sanitary sewer network
  - through defective joints, cracked pipes, manholes connections, etc.
  - depends on:
    - the soil permeability
    - quality of construction
    - condition (age) of the conduits and joints
    - level of local groundwater, etc.

- **inflow** refers to water discharged to the sewer pipes from sources other than sanitary or industrial waste
  - discharge from foundation drains, roof leaders, etc.
  - note: the connection of foundation drains to **new** sanitary sewers is discouraged by the MOE.
  - in Ontario, all new sewer construction must be of the **separate** type
  - to the greatest extent possible, all forms of storm and groundwater flows should be excluded
  - **combined** sewer systems will not be permitted
Region of Waterloo Design Guidelines for Municipal Services

**Design flows**

- sanitary sewer flows are to be determined using the following design criteria:

**Residential**

- average flow:
  - 0.35 m³/c/d or
  - 0.004 l/s per capita
- population density varies with land use
- use actual or projected populations (based on zoning or otherwise)
- for preliminary design use:

<table>
<thead>
<tr>
<th>Housing Type</th>
<th>People per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single family lot</td>
<td>3.4 people/unit</td>
</tr>
<tr>
<td>Semi-detached lot</td>
<td>3.1 people/unit</td>
</tr>
<tr>
<td>Town house</td>
<td>3.1 people/unit</td>
</tr>
<tr>
<td>Apartments</td>
<td>2.1 people/unit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing Type</th>
<th>Units per Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single family lot</td>
<td>7 units/ha</td>
</tr>
<tr>
<td>Semi-detached lot</td>
<td>14 units/ha</td>
</tr>
<tr>
<td>Town house</td>
<td>30 units/ha</td>
</tr>
<tr>
<td>Apartments</td>
<td>62 units/ha</td>
</tr>
</tbody>
</table>
Peaking Factors

- Peaking factors are to be used to establish the peak design flow.
- Common peaking formulae include the Babbitt and Harmon formulae.
- In Waterloo, peak the average flow using the Harmon Formula:

\[ M = 1 + \frac{14}{4 + \sqrt{P}} \]

Where \( P \) = population in 1000’s.

- The minimum allowable peaking factor is 2.

**Industrial**
- average flow = 0.50 l/s/ha
- use actual flows for large known discharges
- use peaking factor of 1.8

**Commercial**
- average flow
  - core = 1.16 l/s/ha
  - shopping mall = 0.3 l/s/ha
  - general = 0.6 l/s/ha
- use higher design flows for point sources known to have significantly greater flows than the average design allowance
- use actual flows for known discharges
- use a peaking factor of 2.5

**Other Flow Rates**
- schools
  - 86.4 m³/ha·d
  - 1.0 l/s/ha
  - use peaking factor of 2.5
**Infiltration**

• incorporate an infiltration allowance of 0.15 l/s/ha

**Domestic Sewage Flows**

• the peak domestic sewage flow can be computed using:

\[
Q = \frac{PqM}{86.4} + IA
\]

where
- \(Q\) = peak design flow (l/s)
- \(P\) = population in 1000’s
- \(q\) = average daily per capita domestic flow (l/c/d)
- \(M\) = peaking factor
- \(I\) = extraneous flows (l/ha·s)
- \(A\) = gross tributary area (ha)
**Design Sheets**

- design flow calculations for sanitary sewers shall be completed on sanitary sewer design sheets.

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**SANITARY SEWER DESIGN SHEET**

![Sanitary Sewer Design Sheet Table](image)

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**Minimum Pipe Size**
- the minimum pipe size diameter is **200 mm**.

**Manning's n**
- the value of Manning’s n shall be 0.013 for all pipe materials

**Pipe Gradient**
- the minimum gradient for 200mm sanitary sewer pipe shall be 0.50 %
- the minimum gradient for the first reach of permanent dead-end sewers shall be **1.0 %**

**Pipe Depth**
- sanitary sewers should be located at sufficient depth to receive sewage from basements by gravity drainage (ie inverts are normally 0.9-1.5 m below basement floor levels
- the pipe obvert should be a minimum of 2.8 metres below the final road grade

**Clearance to Sewers**
- the clear separation between watermains and sewers shall be as per MOE requirements
  - 0.5 m vertical separation
  - 2.5 m horizontal separation
Pipe Velocities

- the **minimum velocity** allowed for sanitary sewer mains is 0.6 m/s
- in the case where the flow depth is less than 30% of the pipe diameter, the actual flow velocity should be calculated using a **hydraulic elements chart** and the pipe slope increased in order to achieve adequate self-cleaning velocities

- the maximum allowable velocity is 3.0 m/s under peak theoretical flows

**Maintenance Holes**
- shall be located at all junctions, changes in grade, material, size or alignment
- the maximum spacing for maintenance holes is based on the sewer diameter
  - less than or equal to 450 mm 90m
  - less than or equal to 900 mm 120m
  - greater than 900 mm at the approval of the Chief Municipal Engineer
- a drop inlet maintenance hole must be provided if a drop in excess of 0.9 m occurs between any invert and the lowest invert

**Inlet Drops**
- where pipes enter and leave inline or at angles between 0° and 45°, the minimum drop from invert to invert across the maintenance hole shall be 0.030 m
- where pipes enter and leave at angles between 45° and 90°, the minimum drop from invert to invert across the maintenance hole shall be 0.060 m

let's return to our existing development located north of our study area
we could adopt the following sanitary sewer pipe network
In order to account for the extraneous flows and allocate the proper sewage to each length of pipe, we would define the “contributing” drainage areas. It is typical to idealize the contributing areas according to the property boundaries.
we could then assign a **drainage area** and **population** to each contributing area.

and finally...a **spreadsheet design approach** could be used to establish the size and grade of each sanitary sewer pipe.