

1 SWMMCanada: An Open-Source Service for Generating Ready-to-Run 2 Urban Drainage Models Across Canada

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9 ABSTRACT

10 Urban stormwater modelling is often slowed more by data preparation than by the simulation
11 itself, because rainfall, terrain, land cover, soil, and pipe network data usually come from
12 different agencies, formats, projections, and data structures. This software paper presents
13 SWMMCanada, an open source and standardized model building service that makes
14 Canadian urban hydrological modelling easier in the AI era. Users draw an area on a map,
15 and SWMMCanada automatically gathers open data, prepares the required geospatial layers,
16 and generates a complete EPA SWMM model that is ready to run. It builds the drainage
17 network in one of two ways. In eight Canadian cities that publish their storm network, it uses
18 the real municipal pipes with their measured inverts and diameters. Anywhere else in Canada,
19 it synthesizes a network from the street map. Beyond the current EPA SWMM, DHI MIKE+,
20 and InfoWorks ICM exports, additional modelling platforms can be connected by reading
21 from the same model-ready datastore. SWMMCanada main contribution is to provide a
22 reliable, repeatable, and transparent starting model that can feed downstream agentic
23 modelling tools such as Agentic SWMM and Agentic MIKE Plus for simulation, calibration,
24 uncertainty analysis, and decision support.

25 **Keywords:** Stormwater modelling; EPA SWMM; MIKE+; InfoWorks ICM; Open data;
26 Reproducibility; Urban drainage; automation workflow

27 HIGHLIGHTS

- 28 • SWMMCanada turns any area in Canada into a complete EPA SWMM model that is ready
29 to run, using only public open data, so the modeller no longer has to gather and line up data
30 from many portals by hand.
- 31 • The builder works in two modes. It uses eight cities' published storm networks, with their
32 real inverts and diameters, where they exist, and builds a network from the street map
33 everywhere else. Subcatchments are drawn from the terrain only where the slope is steep
34 enough to trust, and from an honest nearest-inlet layout otherwise.
- 35 • Every build is repeatable and easy to check, through a model-ready datastore (GeoPackage,
36 netCDF, and a JSON provenance record), a validation report, and an export to EPA SWMM,
37 MIKE+, or ICM. The Victoria and Ottawa models both run in EPA SWMM 5.2 with zero
38 engine errors, which gives the agentic modelling tools a reliable starting model.

39 1. INTRODUCTION

40 For most urban stormwater studies, the real work is not the simulation, rather than building the
41 model. Before a physics-based engine such as the U.S. EPA Storm Water Management Model
42 (SWMM) can run (Rossman & Simon, 2022), the modeller has to find and line up a rainfall
43 time series, a terrain model, land-cover and soil layers, and, hardest of all, the drainage network
44 itself. Each layer comes from a different agency, in a different file format, map projection, and
45 data layout. In Canada, the climate data comes from ECCC, the terrain and land cover come
46 from NRCan, and the pipe networks come from dozens of separate city open-data portals. None
47 of these share a common interface. So, the setup work is done by hand, it is hard to check as
48 well as hard to reproduce. Two modellers who start from the same area usually build two
49 different models, and by the time the model runs, it is no longer clear where each parameter
50 comes from. For many users, the main barrier to fast and repeatable urban drainage modelling
51 is not the physical simulation itself, but the preprocessing required to assemble model-ready
52 data.

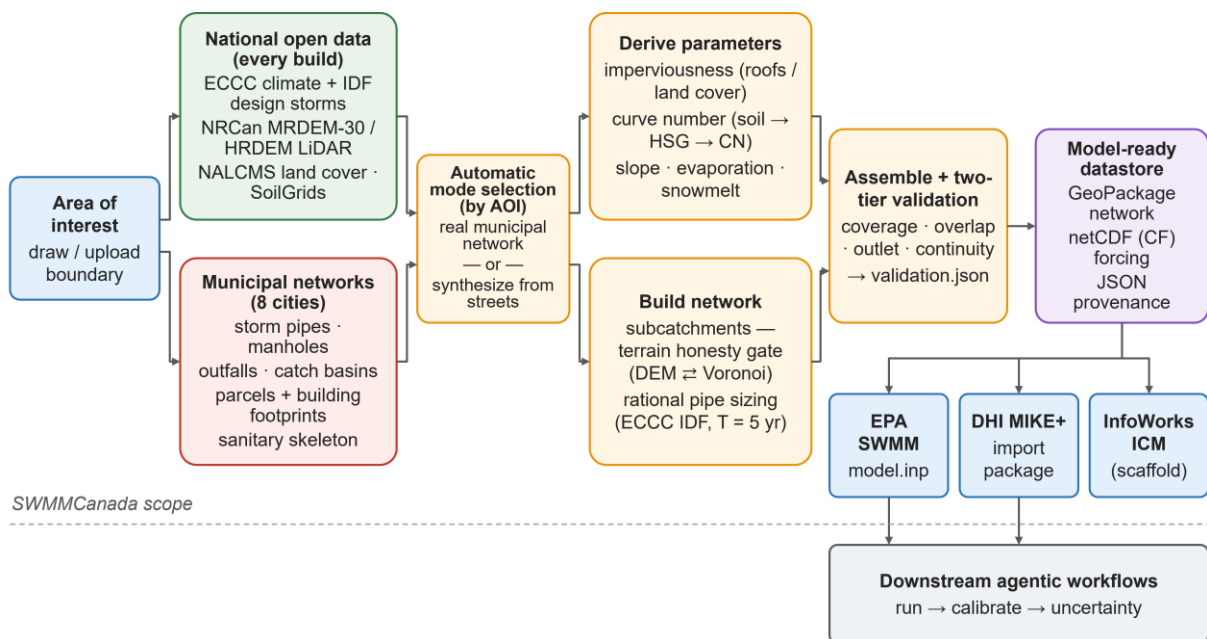
53 Other modelling communities have already tackled this problem with reproducible, user-
54 friendly workflows. Chawanda et al. (2020) wrapped catchment-model setup into simple
55 workflows built for reproducible SWAT+ studies. Gan et al. (2020) tied hydrologic modelling
56 web services to online data sharing, so that models can be prepared, stored, and run in one
57 shared place. These fit the wider push toward research data that is findable, accessible,
58 interoperable, and reusable (FAIR). Urban drainage modelling in Canada, though, still has no
59 automatic way to go from open data to a model. Commercial tools such as PCSWMM and
60 MIKE+ still need a lot of manual work in the user interface to set a model up (Zhang & Valeo,
61 2022). Newer methods such as automatic SWMM calibration (Ahmadi et al., 2025) assume
62 that a runnable model already exists. The step that makes that model from raw open data is the
63 missing piece.

64 At current AI age, Agentic AI has made it possible to drive modelling software with plain
65 language. These are systems that use external tools to get a job done, rather than just holding a
66 conversation (Acharya et al., 2025; Xu et al., 2025). Using the Model Context Protocol (MCP)
67 (Anthropic, 2024) and reusable Agent Skills (Anthropic, 2025), the companion Agentic
68 SWMM workflow (Zhang & Valeo, 2026) runs the SWMM engine, calibrates it against
69 measurements, and reports uncertainty, all through steps that can be checked. But an agent is
70 only as good as the model it is handed. If the data-gathering step is itself unclear or hard to
71 repeat, then it does not matter how careful the agent is afterward. This is why we split the work
72 in two. SWMMCanada is the first half, and it is deliberately not agentic. It takes open data in
73 and gives a complete, runnable model out. Keeping this first half simple, fixed, and self-
74 documenting is exactly what lets the agentic second half, which runs, calibrates, and analyses,
75 stay repeatable. The purpose of SWMMCanada is not to replace modellers or engineering
76 judgement. Its purpose is to identify the parts of urban drainage modelling that can be
77 automated and standardized in the current AI era, especially the repeated work of finding,
78 cleaning, aligning, and converting open data into model-ready form. By removing this
79 bottleneck, SWMMCanada makes model building faster, easier, and more repeatable, while
80 leaving calibration, interpretation, and design decisions to the modeller.

81 This paper presents SWMMCanada (as shown in Figure S1), an open-source service (MIT
 82 licence) with a live demo in the browser. Its main contributions are: (i) an automatic pipeline
 83 that turns any Canadian area into a ready-to-run EPA SWMM model, using only free open data
 84 with no API keys; (ii) a two-mode network builder that combines eight real-city adapters with
 85 a street-based fallback; (iii) a terrain check that keeps the subcatchment shapes honest about
 86 what the terrain data can actually support; (iv) a model-ready datastore that feeds several export
 87 targets (EPA SWMM, DHI MIKE+, InfoWorks ICM) from one source; and (v) end-to-end
 88 tests that show zero-error EPA SWMM builds on two cities with very different data. Together,
 89 these make SWMMCanada the repeatable foundation for our agentic SWMM and MIKE+ tools.

90 2. METHODOLOGY

91 The whole pipeline is shown in Figure 1. A user draws or uploads a boundary. SWMMCanada
 92 then pulls the open data for that area, picks a way to build the network, works out the model
 93 parameters, assembles and checks the model, and writes a model-ready datastore. From that
 94 datastore it exports to one or more target engines. The service is a Python backend (geopandas,
 95 swmm-api, FastAPI) with a React and MapLibre web frontend. Every step is fixed and records
 96 what it did.



97
 98 **Figure 1.** The SWMMCanada model-building pipeline, from a drawn area to a runnable model and the
 99 agentic tools downstream.

100 2.1 Getting the open data

101 Like the real operation procedure, in the SWMMCanada Workflow, every model file building
 102 starts with national open data, pulled live over free public APIs without API keys needed. Daily
 103 rainfall and temperature come from the nearest usable ECCC climate station. Design-storm
 104 curves for pipe sizing come from the ECCC Engineering Climate IDF dataset (662 stations).
 105 Terrain comes from NRCan: it uses 1 to 2 m LiDAR wherever a quick test read shows the
 106 LiDAR really covers the area, and falls back to the 30 m national model everywhere else. Land
 107 cover for imperviousness comes from NALCMS 2020, and soil comes from ISRIC SoilGrids,

108 or a local HYSOGs raster if preferred (Poggio et al., 2021). Measured streamflow from ECCC
 109 HYDAT is there for optional checking. In the eight cities that publish a storm network, a small
 110 per-city adapter reads the city's ArcGIS REST services directly. Table 1 lists the data sources.
 111 All of them are free and open, and most are under the Open Government Licence (OGL).

112 **Table 1.** Open-data sources used by SWMMCanada.

Dataset	Provider	Used for	Licence
GeoMet climate (daily)	ECCC / MSC	Rainfall + temperature (raingage)	OGL, Canada
Engineering Climate IDF	ECCC	Design-storm intensities for pipe sizing	ECCC end-use (open)
MRDEM 30 m	NRCan, CanElevation	Terrain: slope, flow direction	OGL, Canada
HRDEM LiDAR 1 to 2 m	NRCan, CanElevation	High-resolution terrain (where available)	OGL, Canada
NALCMS 2020	CEC / NRCan	Land cover: imperviousness	Free use w/ attribution
SoilGrids / HYSOGs	ISRIC	Soil: hydrologic soil group, curve number	CC BY 4.0
HYDAT hydrometric	ECCC, Water Survey	Observed streamflow (optional check)	OGL, Canada
OpenStreetMap	OSM contributors	Street graph for built-from-streets networks	ODbL
Municipal storm networks (8 cities)	City open-data portals	Real storm pipes, nodes, outfalls, parcels	OGL / municipal ToU

113

114 **2.2 Picking the build mode automatically**

115 SWMMCanada decides how to build the network from where the drawn area falls. The user
 116 sets nothing. If the area is inside one of the eight real-network cities, that is Victoria, Ottawa,
 117 Calgary, Surrey, London, Kitchener/Waterloo, Kelowna, or Regina, it uses that city's real storm
 118 pipes, with their measured invert elevations, diameters, manholes, and outfalls. Anywhere else
 119 in Canada, it builds a sensible network from the OpenStreetMap street graph. Both modes then
 120 give the same things downstream: subcatchments, rainfall, and a shareable datastore. Where a
 121 city also publishes a separate sanitary network, that network is carried in the same model as a
 122 second tagged system, which is the start of future dual-drainage work.

123 **2.3 Drawing subcatchments and the terrain check**

124 Subcatchments are seeded on the real drainage inlets (catch basins) where a city publishes them,
 125 and their shapes follow the real property lot lines where parcels are available. For
 126 subcatchments seeded on junctions, which happens in build-from-streets mode and as the
 127 fallback when there are no catch basins, SWMMCanada draws the basins from a prepared
 128 terrain model. It fills the low spots, burns the OpenStreetMap streets into the surface so that
 129 city water follows the roads, and cuts a basin to each manhole with pyflwdir. A terrain-drawn
 130 basin is only as good as the terrain data behind it, so this step has a check. Basins are drawn
 131 from the terrain only where the slope is clearly above the terrain model's own noise: above 4.0%
 132 on the 30 m national model, whose accuracy of about 1 to 2 m makes gentler readings just
 133 noise, or above 1.0% under LiDAR, whose finer accuracy of about 0.1 to 0.2 m makes small
 134 city slopes real. Below the limit, and any time a terrain result fails the checks, it falls back to

135 the honest nearest-inlet layout. The check writes its reading into the validation report, so a
136 rough service area is never mistaken for a true terrain-drawn catchment.

137 **2.4 Sizing pipes for built-from-streets networks**

138 Where the network is built from streets, pipes are sized with the rational method, $Q = C i A$,
139 over the upstream subcatchment area that drains to each pipe (as shown in Equation 1-5). The
140 runoff coefficient C comes from imperviousness (0.9 for impervious, 0.2 for pervious). The
141 design intensity i is read from the nearest ECCC IDF station at the pipe's time of concentration
142 (a 10-minute inlet minimum plus travel at 1 m per second), for a 5-year storm by default.
143 Diameters are the Manning full-flow size, rounded up to the next commercial size (300 mm to
144 3.0 m). If the IDF data cannot be reached, sizing falls back to a fixed 30 mm per hour, noted in
145 the record, rather than failing the build. Real-network cities keep their own published diameters.
146 These built-from-streets diameters are first-pass estimates for plausibility, not certified designs,
147 and they are labelled that way.

$$148 \quad Q_{\text{pipe}} = \frac{i_{\text{IDF}}(5, t_c)}{360} \sum_j C_j A_j \quad (1)$$

$$149 \quad C_j = 0.9 f_{\text{imp},j} + 0.2(1 - f_{\text{imp},j}) \quad (2)$$

$$150 \quad t_c = 10 + \frac{L}{60} \quad (3)$$

$$151 \quad Q_{\text{full}}(D) = \frac{1}{n} \left(\frac{\pi D^2}{4} \right) \left(\frac{D}{4} \right)^{2/3} S^{1/2} \quad (4)$$

$$152 \quad D_{\text{req}} = \left(\frac{Q n 4^{5/3}}{\pi S^{1/2}} \right)^{3/8} \quad (5)$$

153

154 **2.5 Rainfall, evaporation, and snow**

155 Rainfall is taken from the nearest ECCC station with real precipitation over the chosen dates.
156 Trace amounts are set to zero so the raingage never returns a bad value, and the series is written
157 as the SWMM rainfall time series and raingage. A daily evaporation series is worked out with
158 the Hargreaves method (FAO-56; Allen et al., 1998) from the station's daily minimum,
159 maximum, and mean temperature, and written to the SWMM evaporation series. Snowmelt is
160 turned on by default whenever there is a temperature series. It uses one urban snow pack with
161 standard degree-day settings. Above the 0 degree C dividing temperature, nothing builds up,
162 so summer runs are unaffected. The snowmelt settings are first-pass defaults and are flagged
163 for calibration before any cold-season use.

164 **2.6 The model-ready datastore and multiple export targets**

165 Instead of writing one model file straight away, SWMMCanada builds a model-ready datastore.
166 This is a GeoPackage of the network, a netCDF (CF-1.8) file of the rainfall and climate, and a
167 JSON provenance record. Every export target reads from this one datastore. So the same
168 assembled model can come out as an EPA SWMM 5.2 model.inp (with a manifest.json), a DHI
169 MIKE+ Collection System import package (node, link, and catchment shapefiles, rainfall, and
170 a field-mapping sheet that spells out every approximation), or an InfoWorks ICM package (still
171 a scaffold). Reading everything from one datastore is what lets a single build serve several
172 engines, and it is what the planned Agentic MIKE+ tool is built on.

173 **2.7 Checking the model and keeping its record**

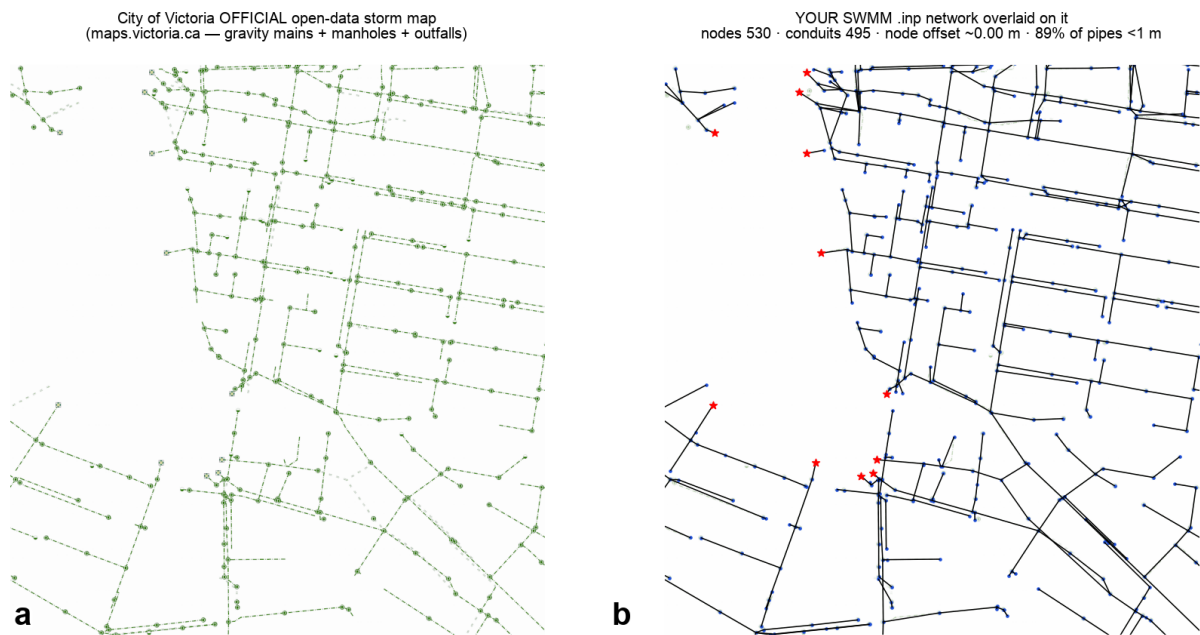
174 Every model comes with a validation.json, and it is checked before the model file is written.
175 The checks come in two levels. An Error means the subcatchment model is not sound and the
176 build stops. A Warning means the model runs but is rough. The checks make sure that
177 subcatchments have a real outlet and a valid shape, that they cover the area with no blank holes
178 and little overlap, that they stay inside the drawn area, that the total area is kept, and that inlets
179 drain to sensible nodes. The report also writes down which way the subcatchments were drawn,
180 what that is based on (a nearest-inlet or nearest-node service area, which is not a terrain-drawn
181 catchment unless the terrain check allowed one), and a confidence level. This way, how honest
182 the model is stays attached to the model instead of being assumed.

183 **3. RESULTS AND DISCUSSION**

184 We test SWMMCanada end-to-end on two Canadian cities whose published data is built very
185 differently. Victoria publishes the full pipe layout, and Ottawa does not. We then look at how
186 the terrain check behaves on flat ground versus a hillside. Every model was built automatically
187 from open data and run in the EPA SWMM 5.2.4 engine.

188 **3.1 Staying true to the real city data (Victoria)**

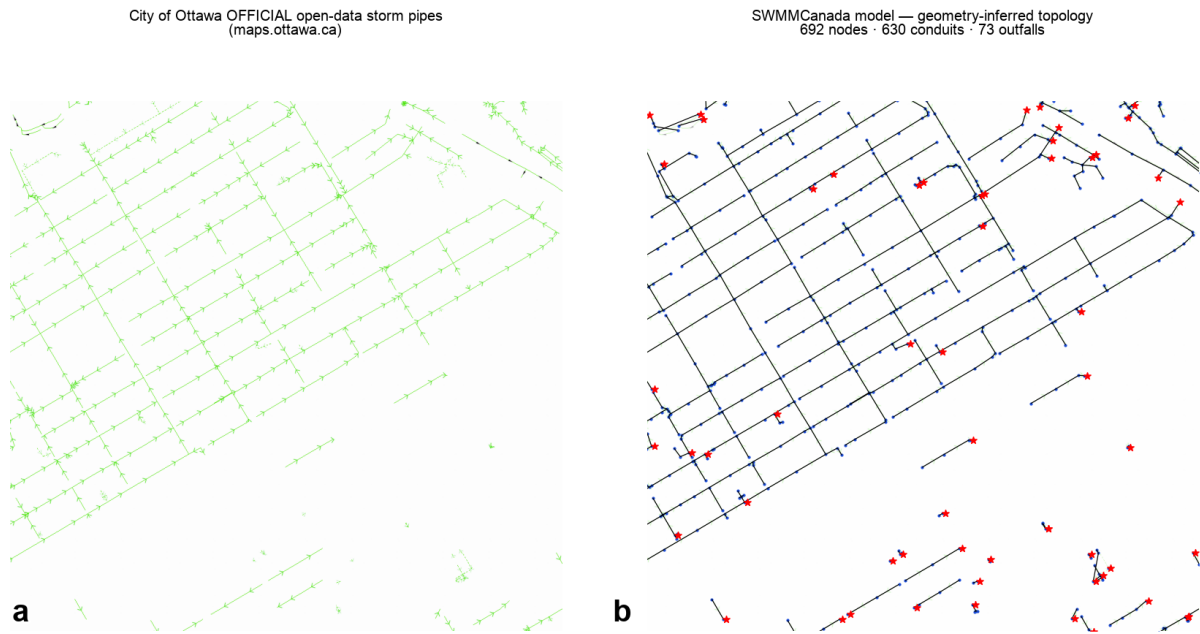
189 Victoria publishes its storm mains with upstream and downstream node IDs, invert elevations,
190 diameters, and materials. So the built network is a faithful copy of the city's own data (Figure
191 2). The node positions are an exact copy of the source manholes and outfalls (0 m offset). 89%
192 of the conduits sit within 1 m of the real pipe centreline, and 95% within 5 m. The small
193 difference is just the straight node-to-node line standing in for a curved pipe. The
194 subcatchments use the catch-basin and parcel method. Drainage units are seeded on the real
195 catch basins, and imperviousness comes from the real building footprints and road right-of-
196 way. This gives 732 subcatchments with a realistic mean imperviousness of about 68% and
197 downtown-level detail, far finer than a 30 m land-cover grid would give.



199 **Figure 2.** The Victoria built storm network (right) laid over the City of Victoria official open-data storm
 200 map (left). The conduits (black), junctions (blue), and outfalls (red stars) line up with the published pipes.

201 **3.2 End-to-end EPA SWMM runs (Victoria and Ottawa)**

202 Both downtown models run in EPA SWMM 5.2.4 with zero engine errors (Table 2). For
 203 Victoria (1.36 km²; 519 junctions, 495 conduits, 11 outfalls), runoff continuity is 0.00% and
 204 flow-routing continuity is +0.06%. Ottawa (2.6 km²; 619 junctions, 630 conduits, 73 outfalls)
 205 publishes inverts and diameters but no node IDs. So the layout is rebuilt by snapping pipe ends
 206 to shared nodes, with a sink added for each disconnected piece so the network always balances
 207 (Figure 3). Its runoff continuity is -0.05% and flow-routing continuity is -5.1%. The larger
 208 Ottawa flow-routing figure is an honest first-version limit, not an engine failure. About 16% of
 209 Ottawa's inverts were published as zero and filled in from slopes and neighbours, and its
 210 manholes carry no ground elevation, so the junction depths use a default. A separate live
 211 central-Ottawa build (1.7 km², 1 to 7 June 2022) with evaporation on runs with zero errors,
 212 runoff and flow-routing continuity of -0.024% and -0.044%, and about 4.1 mm per day of mean
 213 evaporation. The main end-to-end result is that the same shared assembler handles both a full-
 214 layout city and a layout-inferred city, and both run clean.



215 **a** **b**
 216 **Figure 3.** The Ottawa built storm network (right, with the layout inferred from the pipe geometry) tracing
 217 the same pipe grid as the City of Ottawa official open-data storm pipes (left).

218 **Table 2.** End-to-end validation of automatically built models run in EPA SWMM 5.2.4. Victoria publishes
 219 the full node layout; Ottawa's layout is inferred from the pipe geometry.

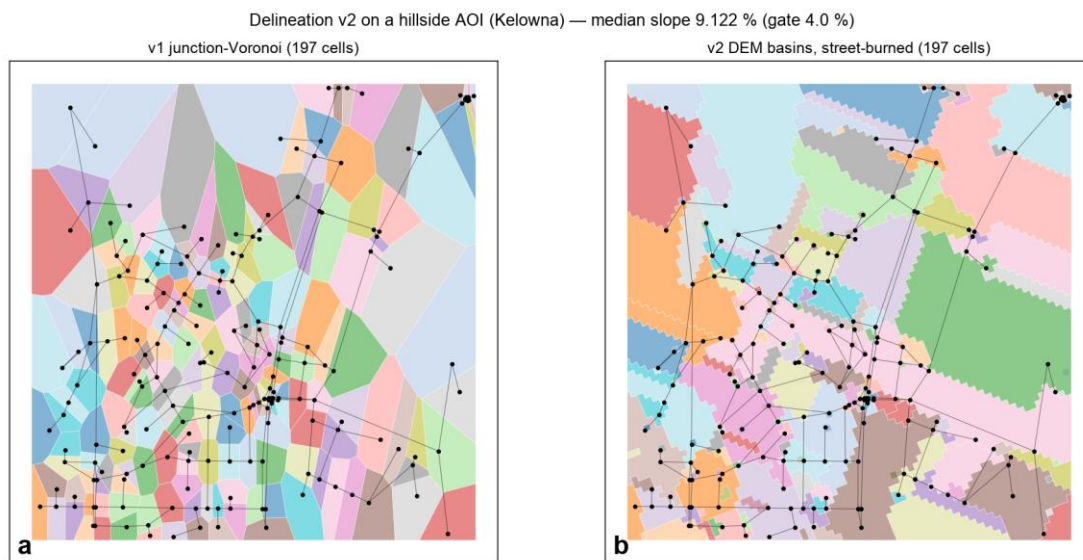
Metric	Victoria, BC	Ottawa, ON
Source topology	Explicit node IDs	Inferred from pipe geometry
Area (downtown)	1.36 km ²	2.6 km ²
Junctions / conduits / outfalls	519 / 495 / 11	619 / 630 / 73
Subcatchments	732	2,461
Rainfall to surface runoff	11.8 mm to 6.8 mm	19.4 mm to 12.5 mm
EPA SWMM 5.2 errors	0	0

Runoff continuity	0.00%	-0.05%
Flow-routing continuity	+0.06%	-5.1%
Node position offset	0 m (exact copy)	n/a (no node IDs)
Conduits within 1 m of real centreline	89% (95% within 5 m)	n/a

220

221 3.3 Terrain check for flat and hillside areas

222 The terrain check keeps the subcatchment shapes honest about what the terrain data can support
 223 (Figure 4). Over seven downtown test areas, the median slope runs from 1.1% to 3.3% on the
 224 30 m model, all inside the terrain's noise. So the check correctly keeps the honest nearest-inlet
 225 layout. Downtown Ottawa, for example, at 1.26% slope, keeps 442 nearest-inlet cells with zero
 226 errors and full coverage. A Kelowna hillside area at 9.12% slope is above the limit, so it is
 227 drawn instead as 197 street-guided terrain basins, again with zero errors and 0.0% left
 228 uncovered, giving boundaries that follow the land instead of plain polygons. The check also
 229 adapts to the data: where LiDAR is available, its finer accuracy lowers the limit, so a central-
 230 Ottawa area that resolves to the city's 1 m LiDAR reads 2.52% slope, clears the 1.0% LiDAR
 231 limit, and upgrades from nearest-inlet cells to 442 terrain basins. The verdicts on the built-in
 232 city test areas are locked by baseline tests, so any future change has to show up in a reviewed
 233 difference rather than quietly making coverage worse.



234

235 **Figure 4.** Subcatchments on a Kelowna hillside area that clears the terrain check. Street-guided terrain basins
 236 (right) with land-following boundaries replace the plain nearest-inlet cells used on flat ground.

237 4 Discussion

238 SWMMCanada is built to keep what is measured separate from what is approximated. In a real-
 239 network city, the pipes, the terrain, the climate, the roofs and parcels, and the values worked
 240 out from them by standard methods (imperviousness, curve number, slope, evaporation) all
 241 come from real data. The two things to keep in mind are how the subcatchments are split up,
 242 which is by nearest-inlet service area rather than a surveyed catchment, except where the terrain
 243 check allows a terrain-drawn basin, and, outside the eight cities, the built-from-streets network

244 itself. Writing these down in every validation.json, instead of handing over one flat model, is
245 what lets a user apply the right judgement.

246 A built model is grounded in real data and ready to run, but it is on purpose not calibrated. No
247 parameter is fitted to measurements, which is true of any auto-built model no matter how real
248 its inputs. Calibration against gauged flow, for example from ECCC HYDAT, is needed before
249 results are used for design. That is exactly the job the downstream Agentic SWMM tool handles
250 (Zhang & Valeo, 2026). This is the plan behind the split. SWMMCanada gives a fixed,
251 repeatable, engine-clean starting model, and the agentic tools take it the rest of the way to
252 calibrated results with uncertainty. Because every build comes out through the one datastore,
253 the same model reaches EPA SWMM, MIKE+, and (as a scaffold) ICM without redoing the
254 data work. And adding a new real-network city is just one small adapter that fetches the city's
255 layers and maps its fields onto the shared assembler.

256 **5. CONCLUSIONS**

257 SWMMCanada turns any area in Canada into a complete EPA SWMM stormwater model that
258 is ready to run, straight from public open data. This removes the by-hand, many-portal data-
259 gathering step that has kept fast, repeatable urban drainage modelling out of reach. It uses eight
260 real-city adapters plus a street-based fallback, keeps the subcatchment shapes honest with a
261 terrain check, and records the source and the checks for every build. The downtown Victoria
262 and Ottawa models, built automatically and put together very differently, both run in the EPA
263 SWMM 5.2 engine with zero errors and continuity within tolerance. Because every model
264 comes out through one shared datastore with several export targets, SWMMCanada is upstream
265 infrastructure that does not tie you to one engine. And because it is fixed and easy to check, it
266 is the repeatable foundation that the Agentic SWMM and Agentic MIKE+ tools build on.
267 Future work will add more real-network cities, carry inverts through terrain-based profiles to
268 tighten the layout-inferred models, grow the tagged sanitary systems into full dual-drainage
269 models, and finish the other export targets.

270 **ABBREVIATIONS**

271 AOI, area of interest; CN, curve number; CRS, coordinate reference system; CS, collection
272 system; DEM, digital elevation model; DSM/DTM, digital surface/terrain model; ECCC,
273 Environment and Climate Change Canada; FAIR, findable, accessible, interoperable, reusable;
274 HRDEM, High Resolution Digital Elevation Model; HSG, hydrologic soil group; HYSOGs,
275 Hydrologic Soil Groups; ICM, InfoWorks Integrated Catchment Model; IDF, intensity-
276 duration-frequency; LiDAR, light detection and ranging; MCP, Model Context Protocol;
277 MRDEM, Medium Resolution Digital Elevation Model; NALCMS, North American Land
278 Change Monitoring System; NRCan, Natural Resources Canada; OGL, Open Government
279 Licence; SWMM, Storm Water Management Model.

280 **DATA AND CODE AVAILABILITY STATEMENT**

281 SWMMCanada is open source under the MIT licence. The source code is at
282 <https://github.com/Zhonghao1995/SWMMCanada> and is archived on Zenodo (concept DOI
283 <https://doi.org/10.5281/zenodo.21058544>). A live frontend builder in the browser is at
284 <https://swmm.h2ox.me/>. All input datasets are third-party open data, listed in Table 1. For the

285 subsequent natural-language-driven model post-processing workflow, please refer to:
286 <https://github.com/Zhonghao1995/agentic-swmm-workflow>.

287 **GENERATIVE AI USE DISCLOSURE**

288 The author used generative AI tools to help draft this manuscript and to polish its language.
289 The models used were Claude Code (Opus 4.8) and Fable 5. All content, data, and technical
290 descriptions were reviewed, verified, and corrected by the author, who takes full responsibility
291 for the final text.

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296 **CONFLICT OF INTEREST**

297 The author declares that there are no financial interests or personal relationships that could be
298 seen as competing interests.

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334

335 Appendix



336

337 **Figure S1.** SWMMCanada web interface showing an automatically generated real-network stormwater
338 model for downtown Victoria, British Columbia.

339

Project structure

```

backend/swmmcanada/      # Python pipeline: open data -> SWMM model
  geo/                   AOI parsing, station selection, CRS
  acquire/               ECCC climate · NRCan DEM (MRDEM + HRDEM LiDAR) · NALCMS land cover · SoilGrids soil · HYD
  sources/               live data adapters (climate, DEM incl. 1 m LiDAR auto-select, ECCC IDF design storms, lan
    cities/              base.py (shared assembler) + 8 real-network adapters (victoria · ottawa · calgary · surre
  network/               street-graph synthesis · DEM subcatchments behind a terrain honesty gate (Voronoi fallback
  derive/                clip + zonal stats -> subcatchment parameters
  build/                 assemble + validate the SWMM .inp
  datastore/             model-ready datastore (GeoPackage + netCDF + JSON)
  export/                model exporters reading the datastore: SWMM · MIKE+ CS import package · ICM (scaffold)
  api/                   FastAPI async tasks API
  pipeline.py            build_from_aoi · build_from_<city> (8 real-network cities)

frontend/src/           # React + Vite + MapLibre web app
  components/            MapPanel.tsx (map + draw AOI) · ControlPanel.tsx (build, layers, download)
  lib/api.ts             backend client (submit, poll, preview, download)
  store.ts               Zustand state · types.ts shared types

```

340

341 **Figure S2.** Project Structure.