Overview of the Automatic Overland Flow Delineation Tool (AOFD)

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Dual-drainage concept: Sewer Network + Overland Network

(Djordjević et al., 2005)

- **Sewer system** (manholes and pipes): 1D
- **Overland system** (depressions and flow paths): 1D or 2D:

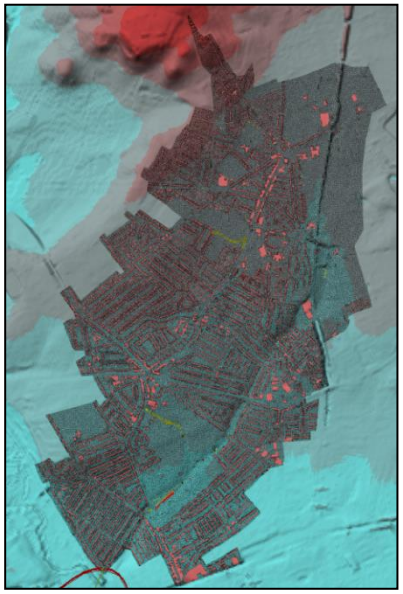
  ✓ **2D overland flow modelling:** Surface divided into small elements (squares or irregular triangles). In general, long computational time, not suitable for real time forecasting.

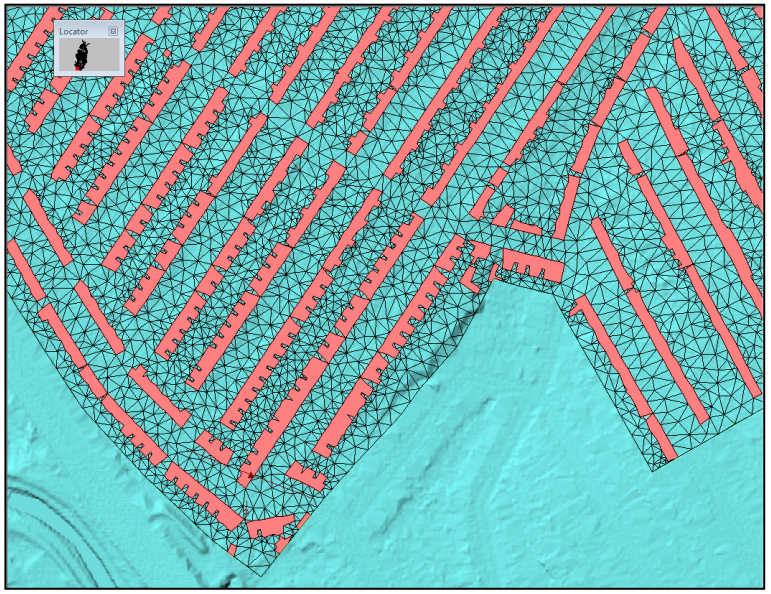
  ✓ **1D overland flow modelling:** Overland system consists of **nodes** (ponds) and **links** (flow paths). It can be created manually or **using the AOFD tool, based upon an accurate DEM (Digital Elevation Model) of the area**. Fast, suitable for real time applications.

Djordjević, S. et al. (2005). SIPSON - Simulation of interaction between pipe flow and surface overland flow in networks. *Water Science and Technology,* **52** (5), 275-283.

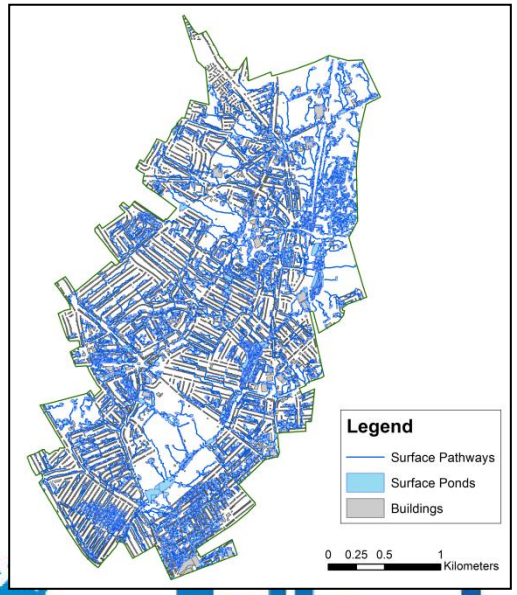
Investing in Opportunities
This project has received European Regional Development Funding through INTERREG IV B.
INTERREG IVB

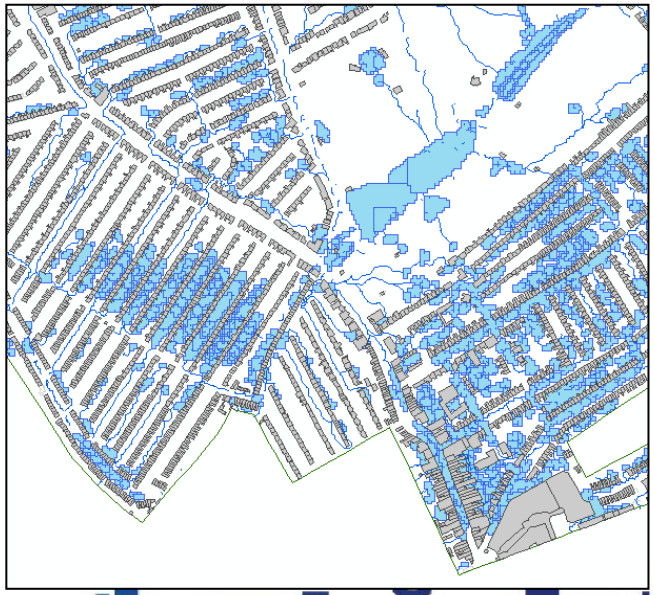
2D model of the surface





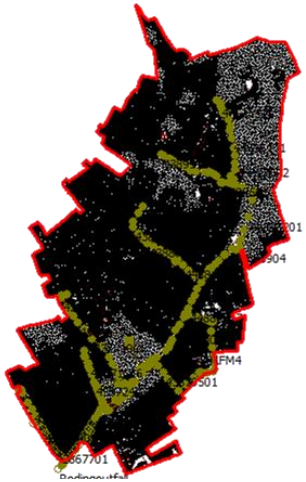
1D model of the surface



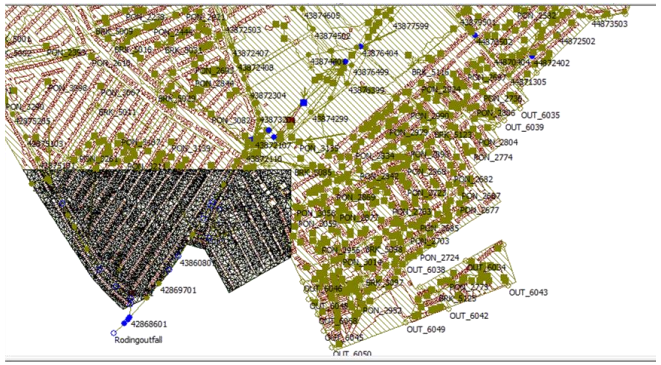


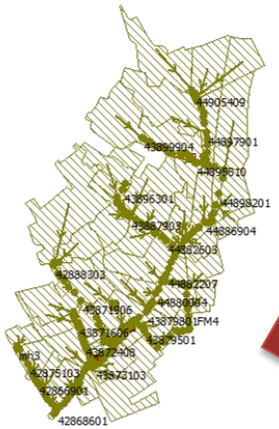
HYBRID MODELS

1D / 2D simulation

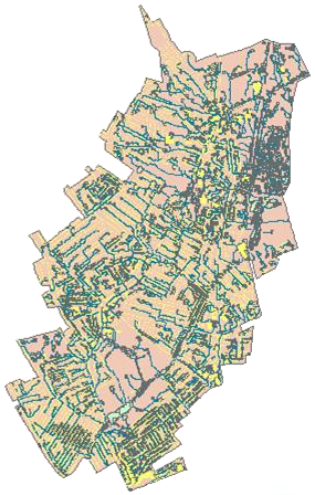


HYBRID MODELS:
1D overland model in most part of the catchment with nested 2D overland model in areas more prone to flooding and where more detail is needed





1D Sewer Simulation

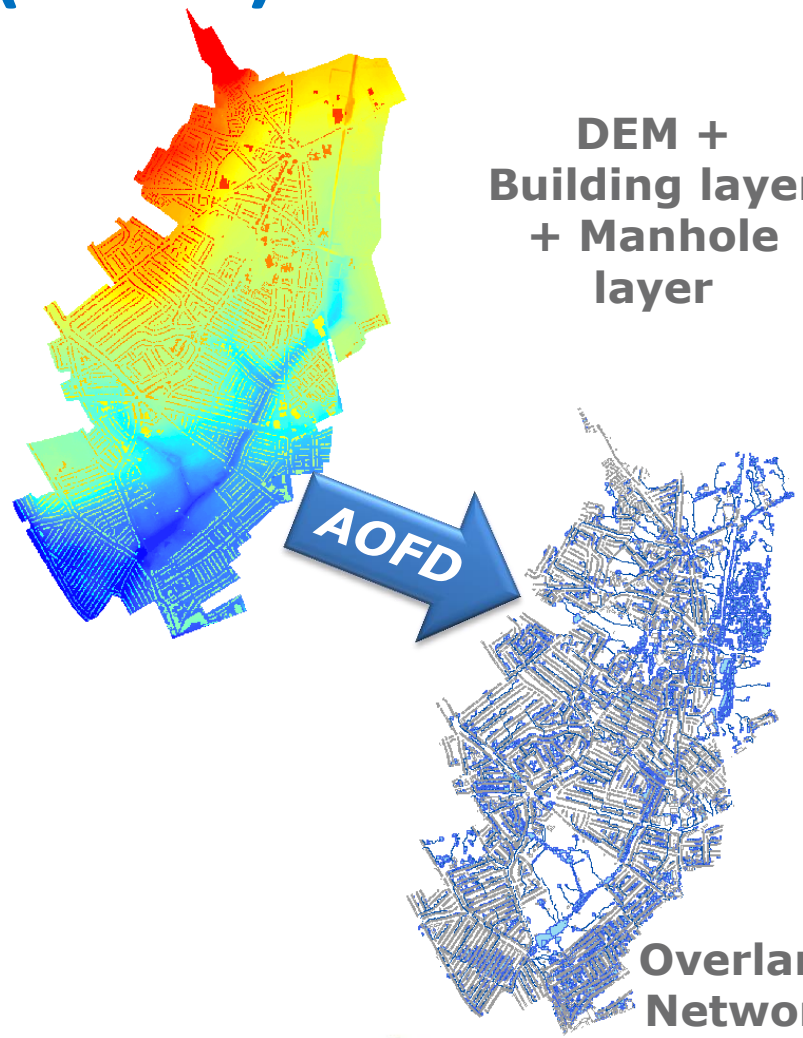


1D / 1D simulation

Hybrid
1D/1D + 1D/2D

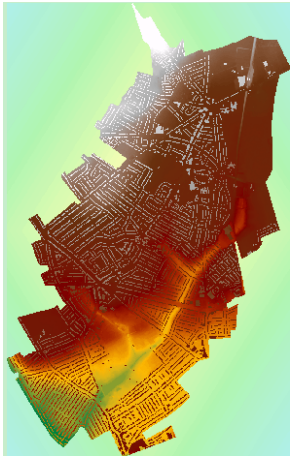
Automatic Overland Flow Delineation (AOFD) Tool

- GIS tool which automatically analyses and generates 1D model of the overland network based on DEM
- Takes into account processes such as pond forming, flow through preferential pathways and surface drainage capacity
- Takes into account interactions with sewer system

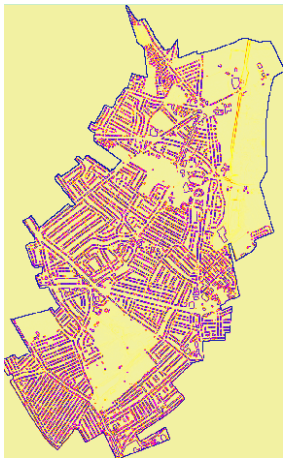


Inputs of AOFD

DEM

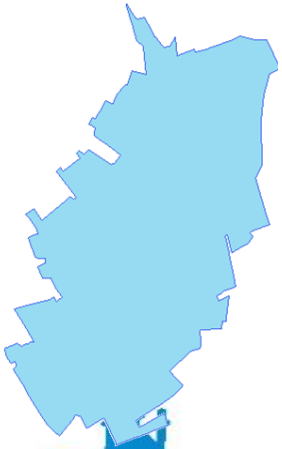


Slope



Aspect

Boundary

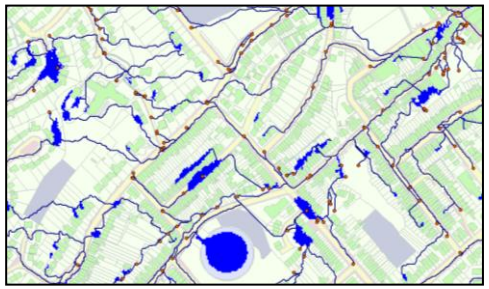


Buildings

Manholes

Output of AOFD

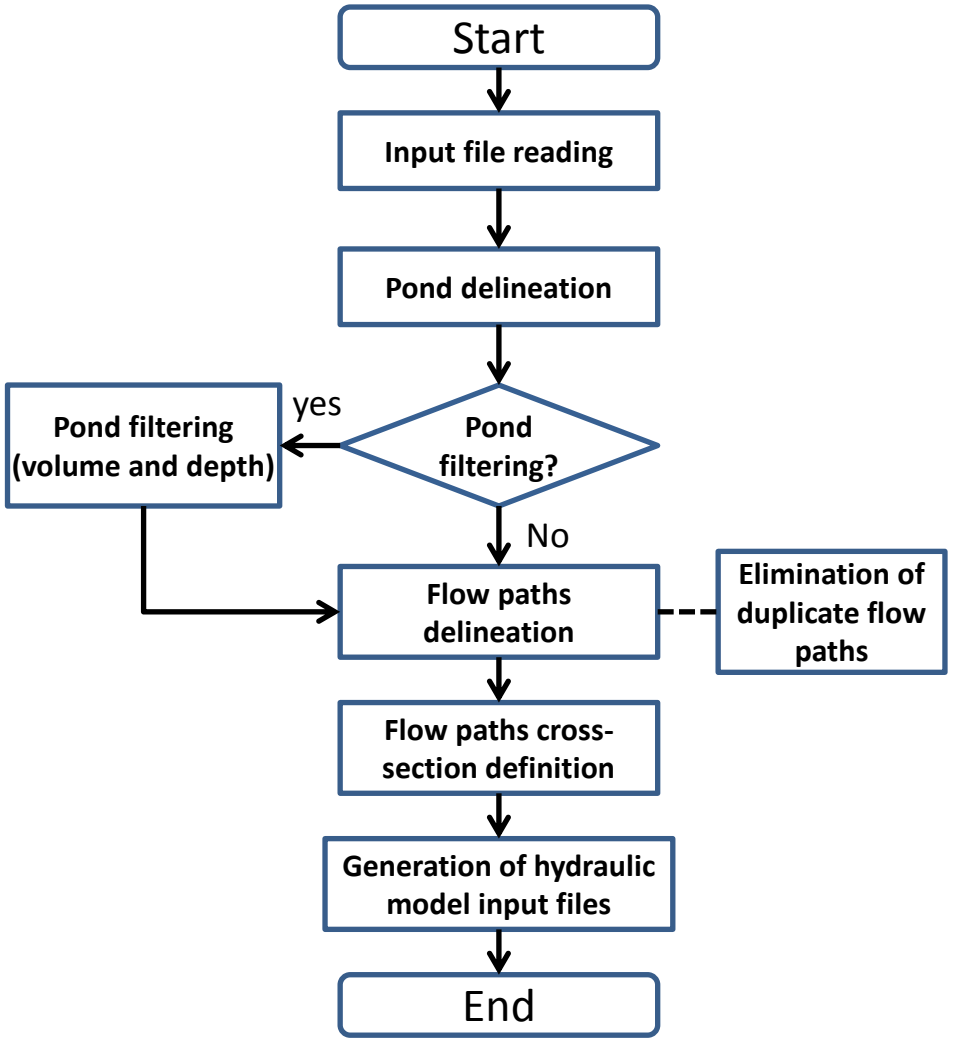
- Set of shapefiles which contain the information about the elements that constitute the 1D model of the overland network:
  - Ponds (local depressions) = nodes with associated storage capacity
  - Flow pathways = links with computed geometry



- These files can be imported into several hydraulic simulation software and can be easily coupled with 1D models of the sewer system, thus allowing for the creation of 1D-1D dual drainage models

AOFD is not a hydraulic simulation engine!

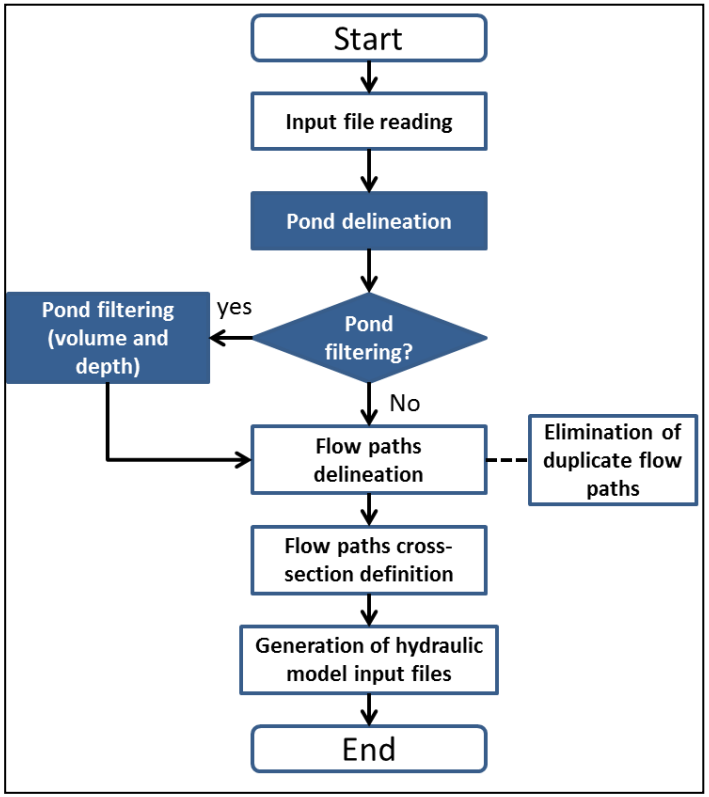
AOFD Algorithm

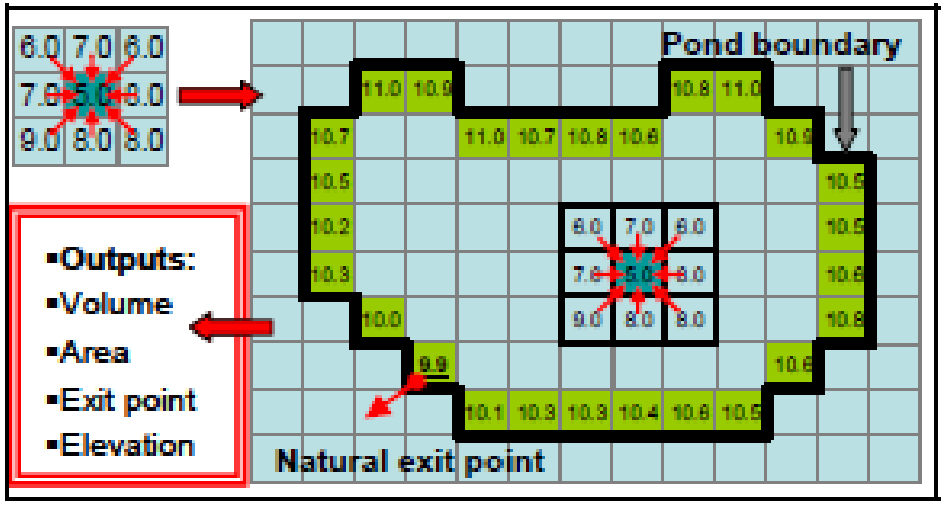


Maksimović, Č. et al. (2009). Overland flow and pathway analysis for modelling of urban pluvial flooding. *Journal of Hydraulic Research,* **47** (4), 512-523.

1. Pond delineation:

- Identification of sinks
- Quantification of surface storage (depth-volume relationship)
- Determination of natural exit point of pond
- Based on DEM, using iterative “grow-up” method



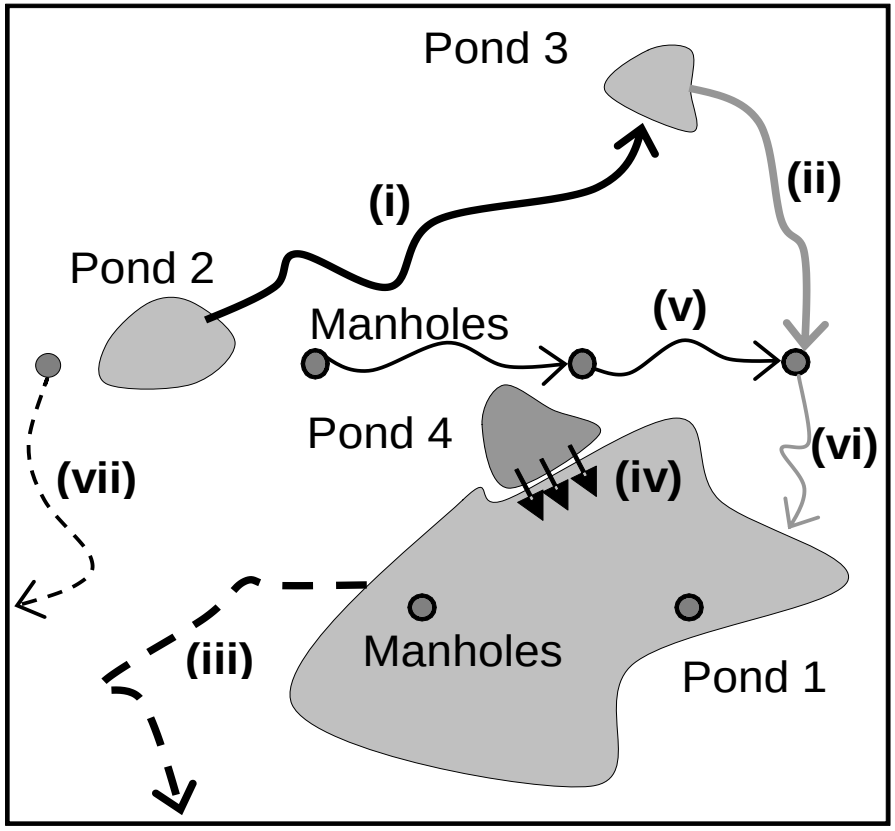


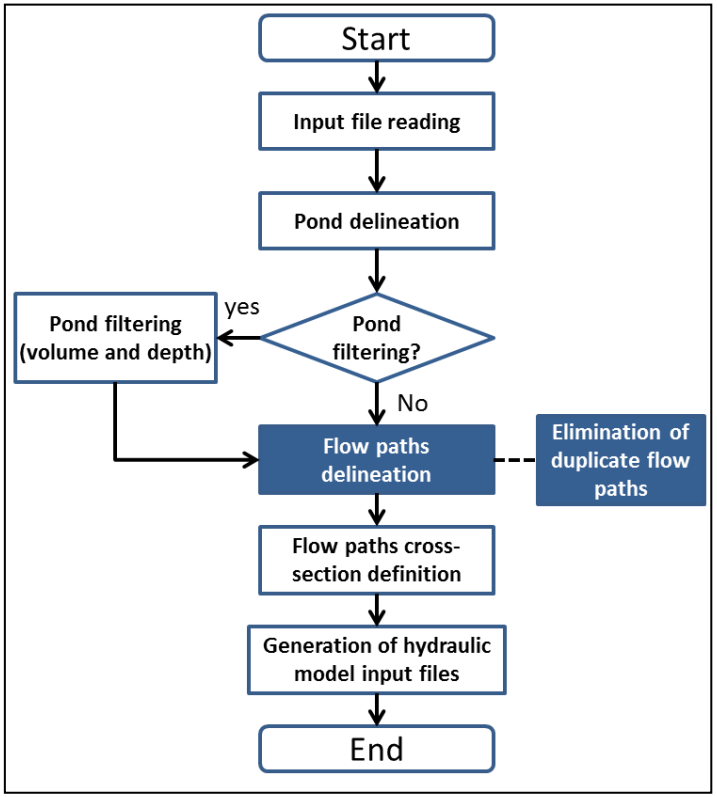
Pond filtering?

- It is advisable to remove small ponds
- User may define filtering threshold.

2. Pathway delineation

- Connection between nodes (ponds & manholes) is identified
- Based on DEM, using “rolling ball” algorithm



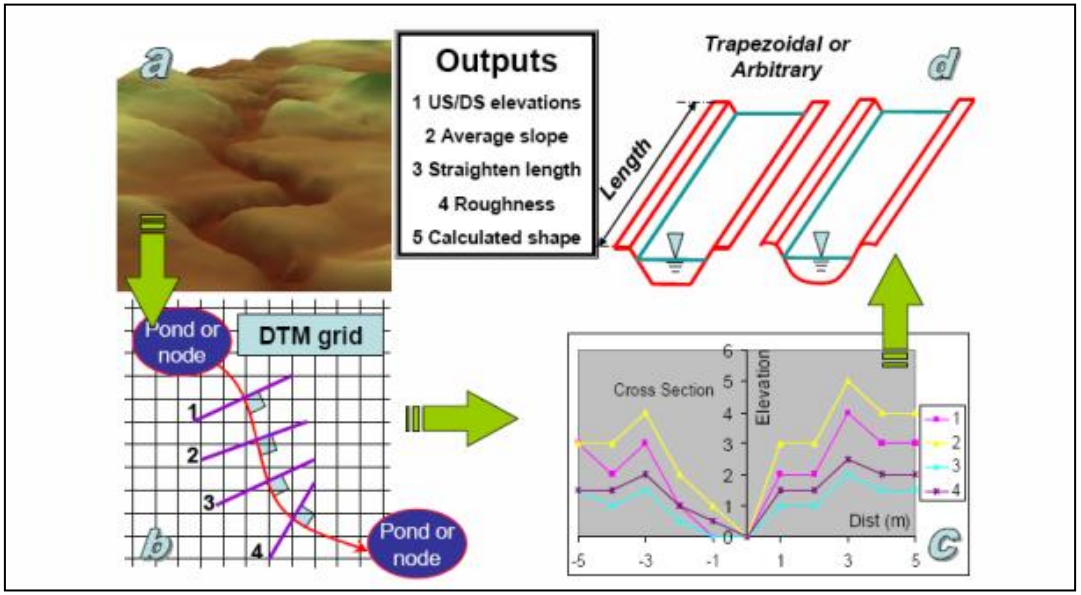


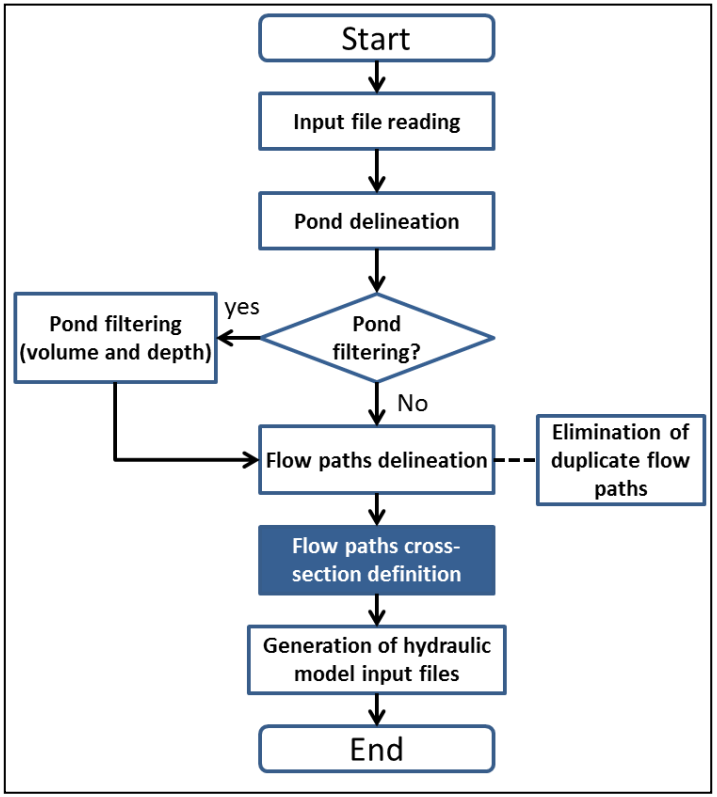
Elimination of duplicates / merging of pathways:

If two or more pathways are closer than a given value (normally grid size), they are merged

3. Estimation of pathways' cross-section

- Geometry of the open channel (user can choose between trapezoidal and arbitray cross-section)
- Upstream/downstream elevations
- Actual length of the pathway
- Average slope



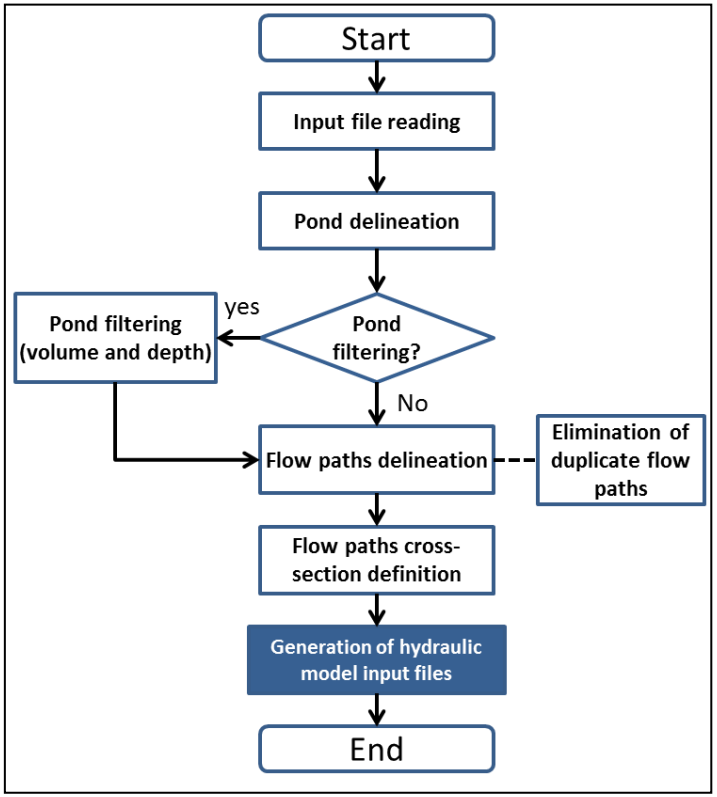


Methodology:

- Equi-distant cross sections are drawn along each pathway
- Arbitrary shape: elevation at each offset distance from centre
- Trapezoidal shape: find geometry of trapezoid that fits H(m)-A(m^2) curve

4. Creation of surface flow network and generation of hydraulic model input files

- Parameters regarding interaction between sewer system and overland network are established by user
- Pathway roughness is assigned by user
- AOFD generates shapefiles of ponds and pathways



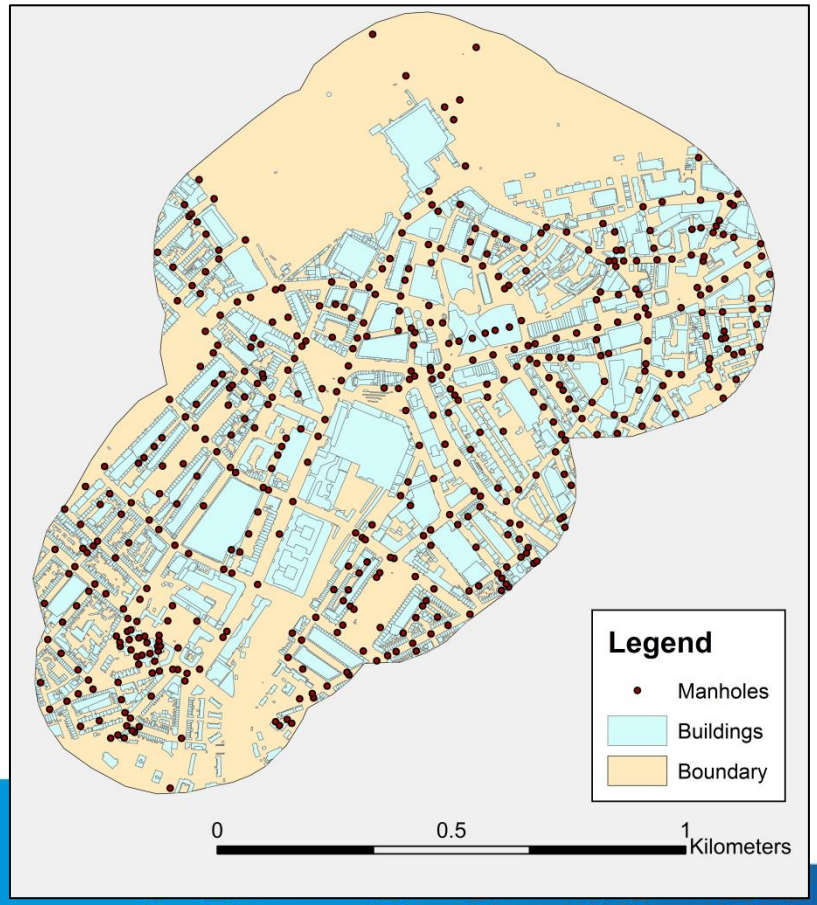
1D Overland Network of Cranbrook Catchment

Exercise

Executing the AOFD tool and creating a 1D1D dual-drainage model

STEP 1: Checking input data

- You have been provided with the following input dataset:



TestData_Victoria_5m

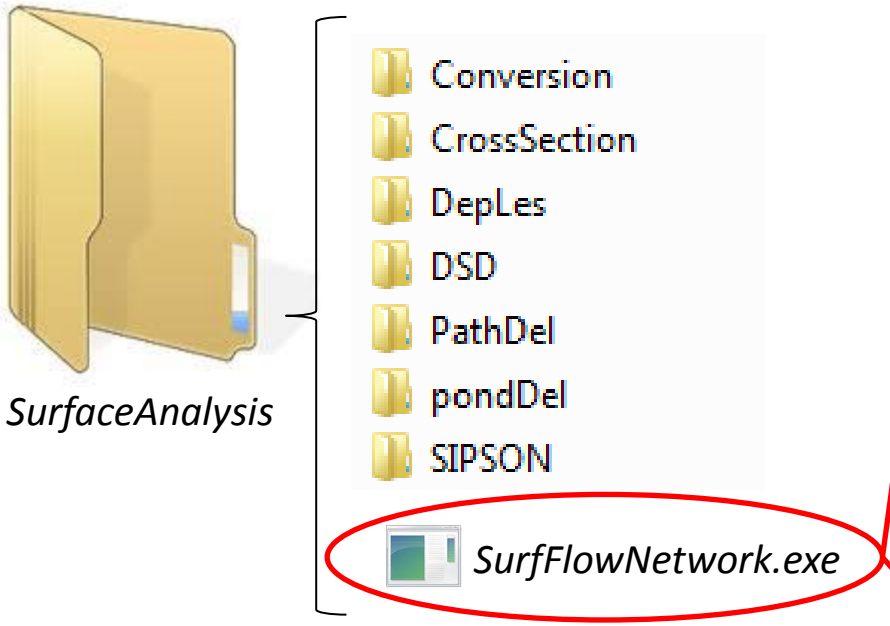
Project File: *VS5.pro*

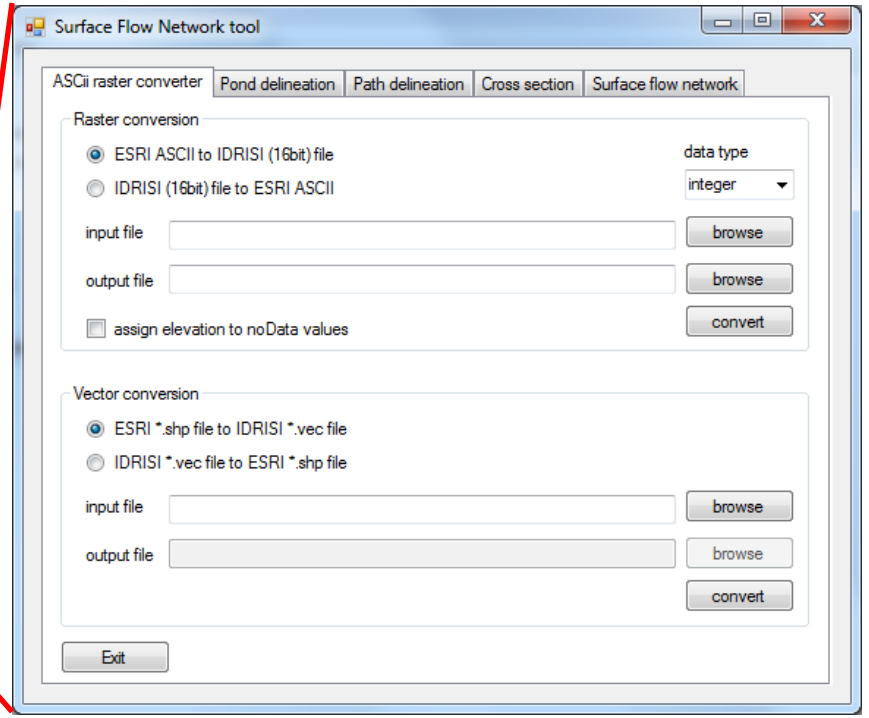
InputData

- DEM
- Terrain slope
- Terrain aspect
- Catchment boundary
- Cover layer
- Buildings
- Manholes

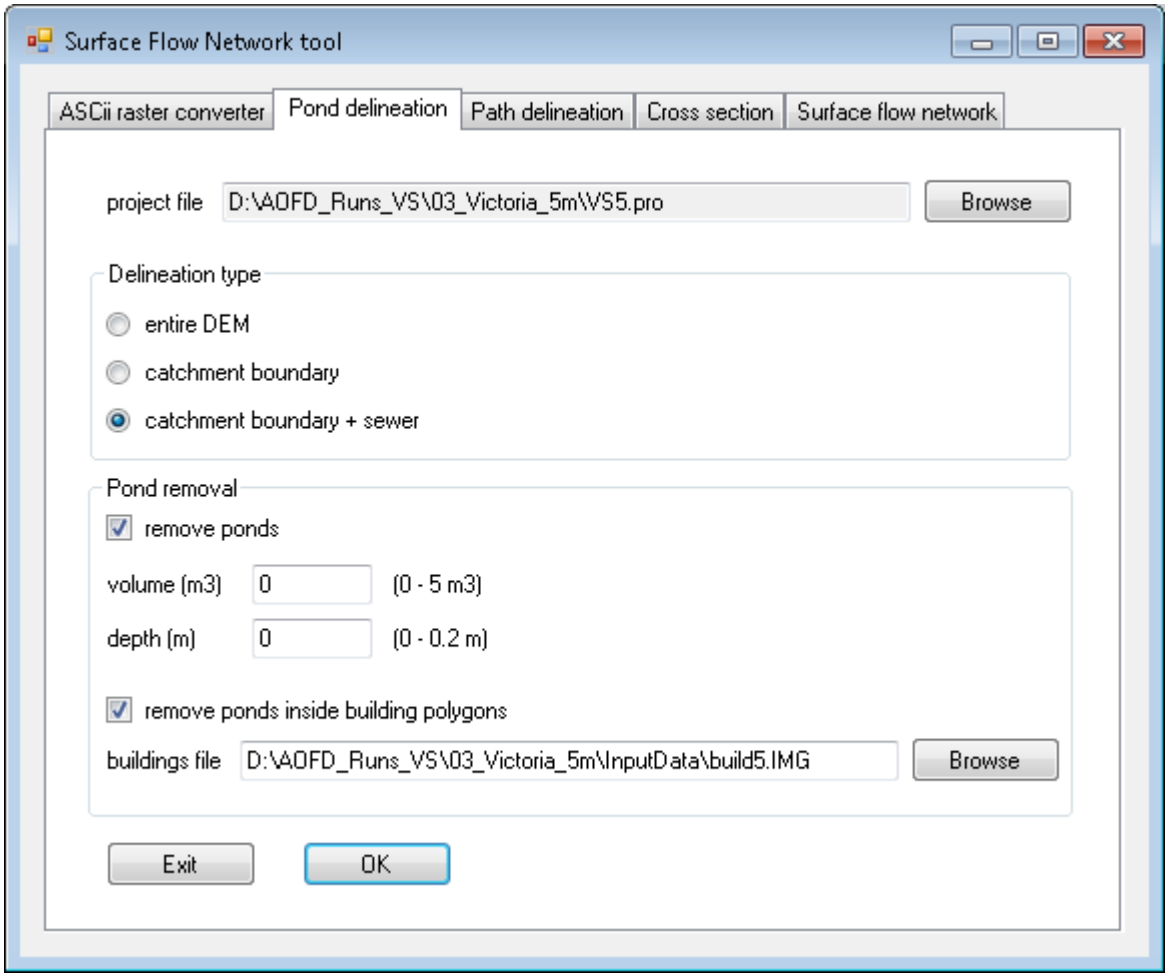
STEP 2: Launching the AOFD tool

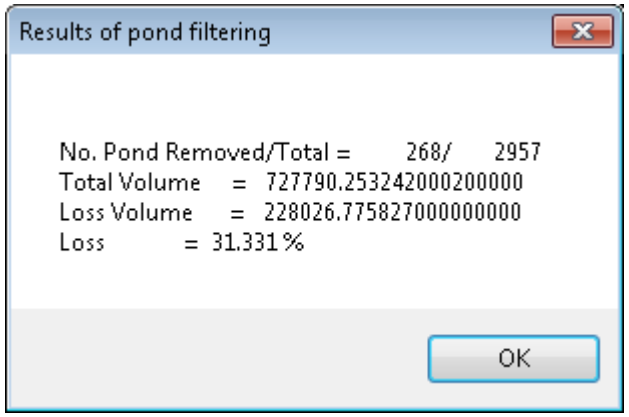
- You have been provided with a folder that contains the AOFD software:



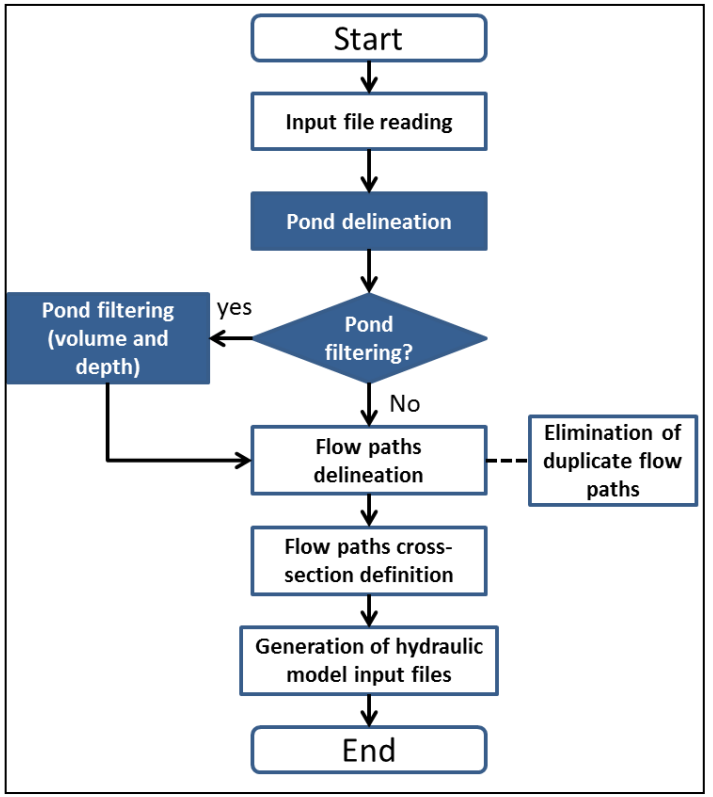


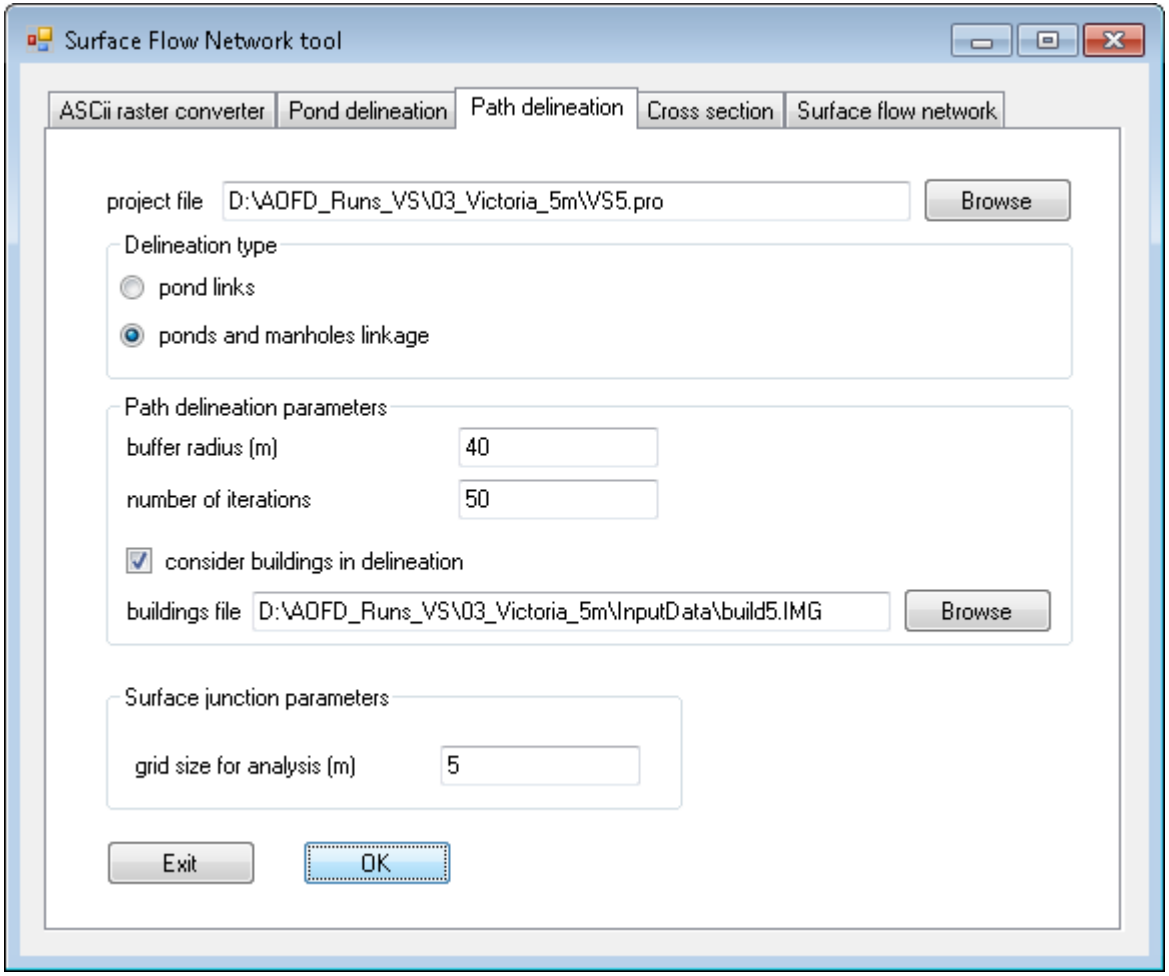
STEP 3: Executing the AOFD tool



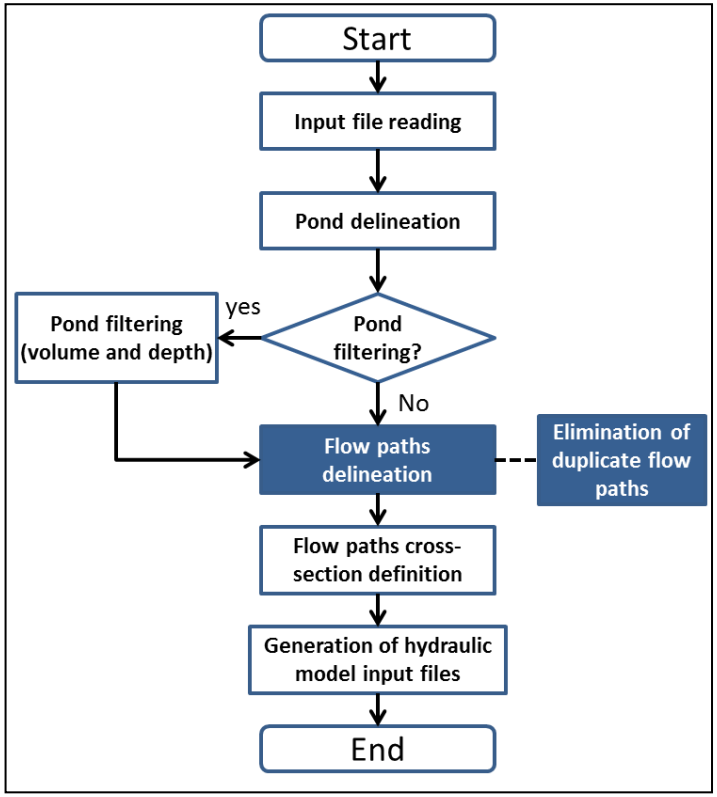


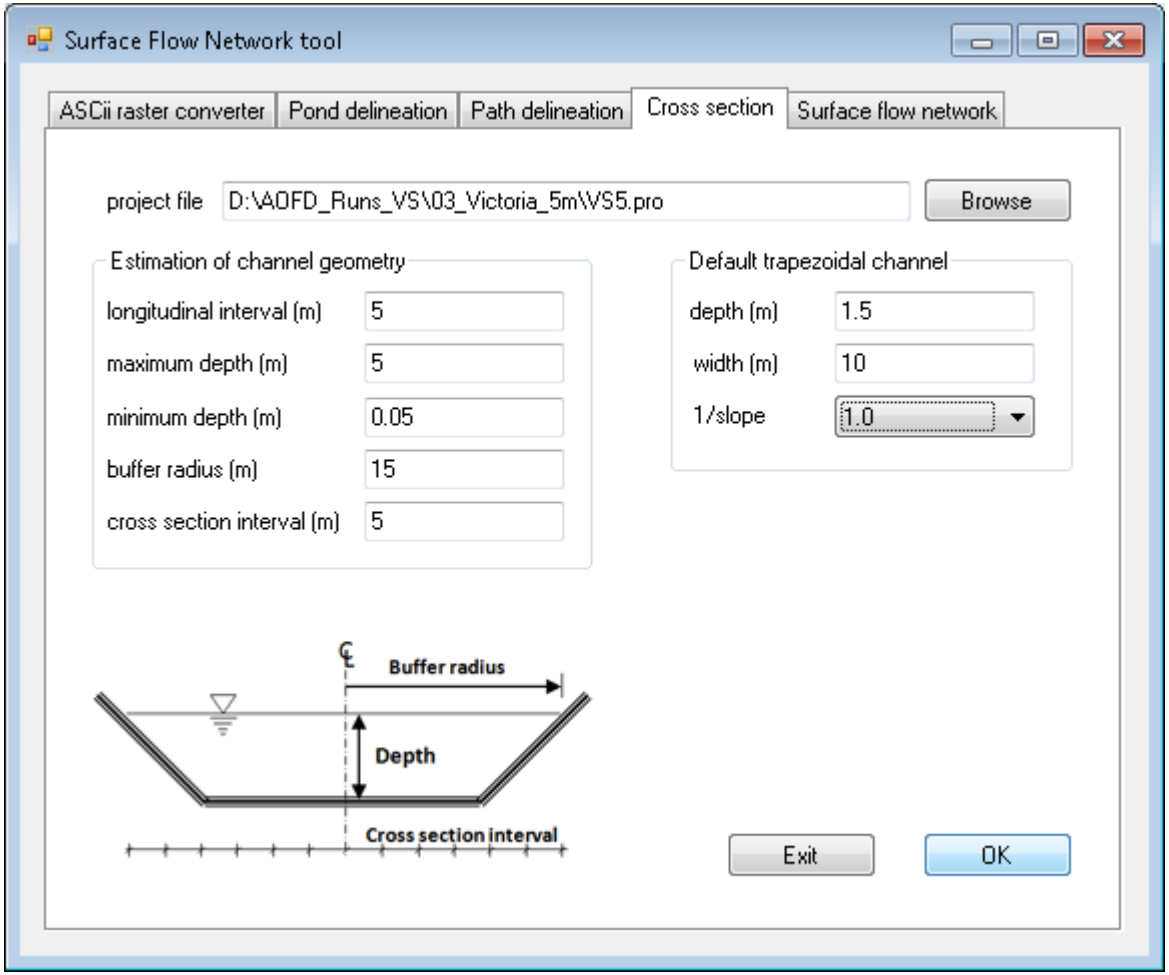
1. Pond delineation



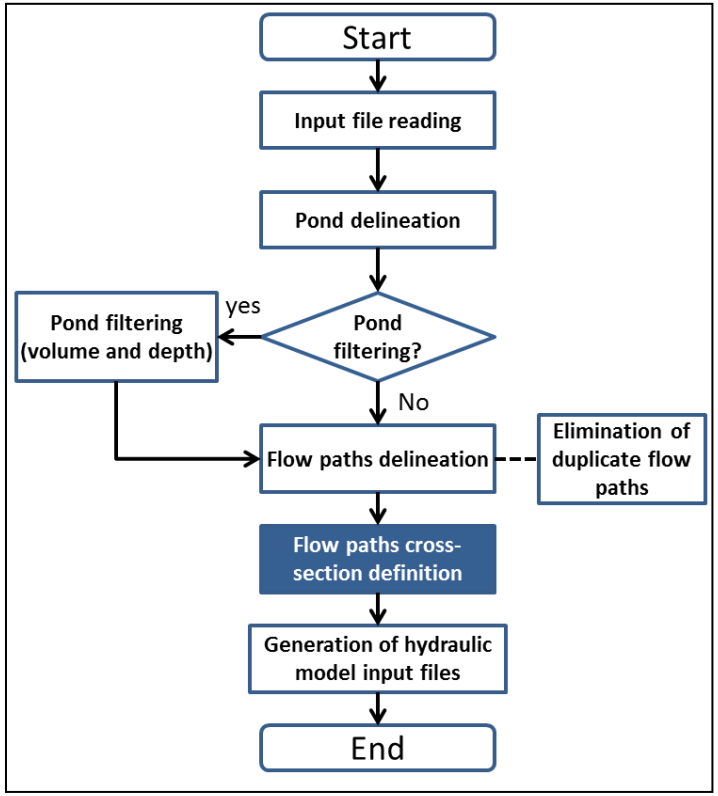


2. Flow path delineation

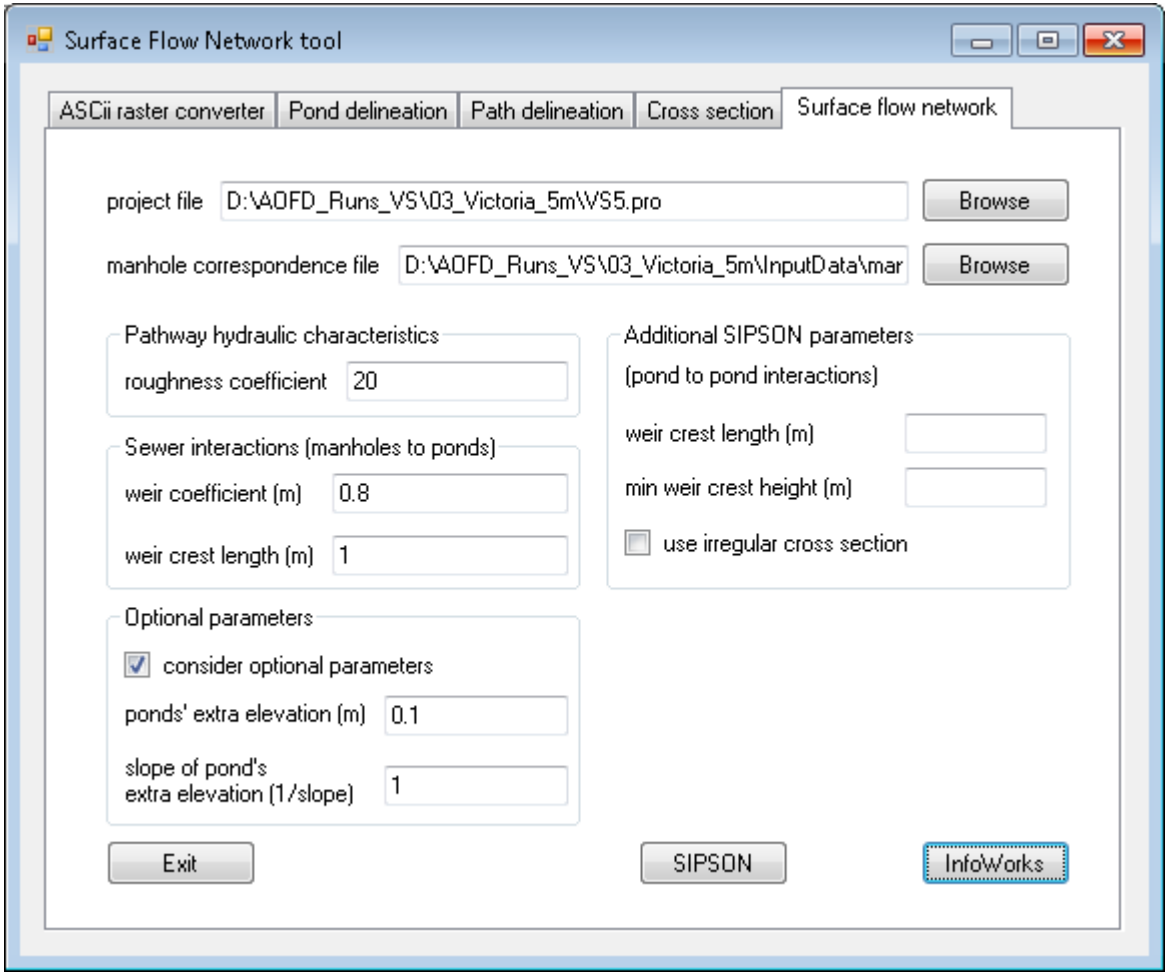


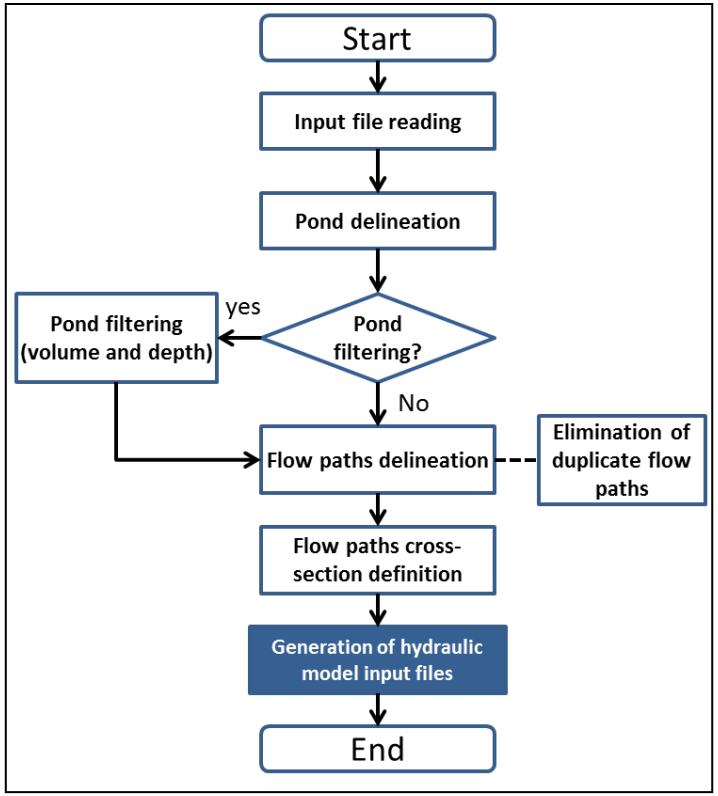


3. Pathways' cross section

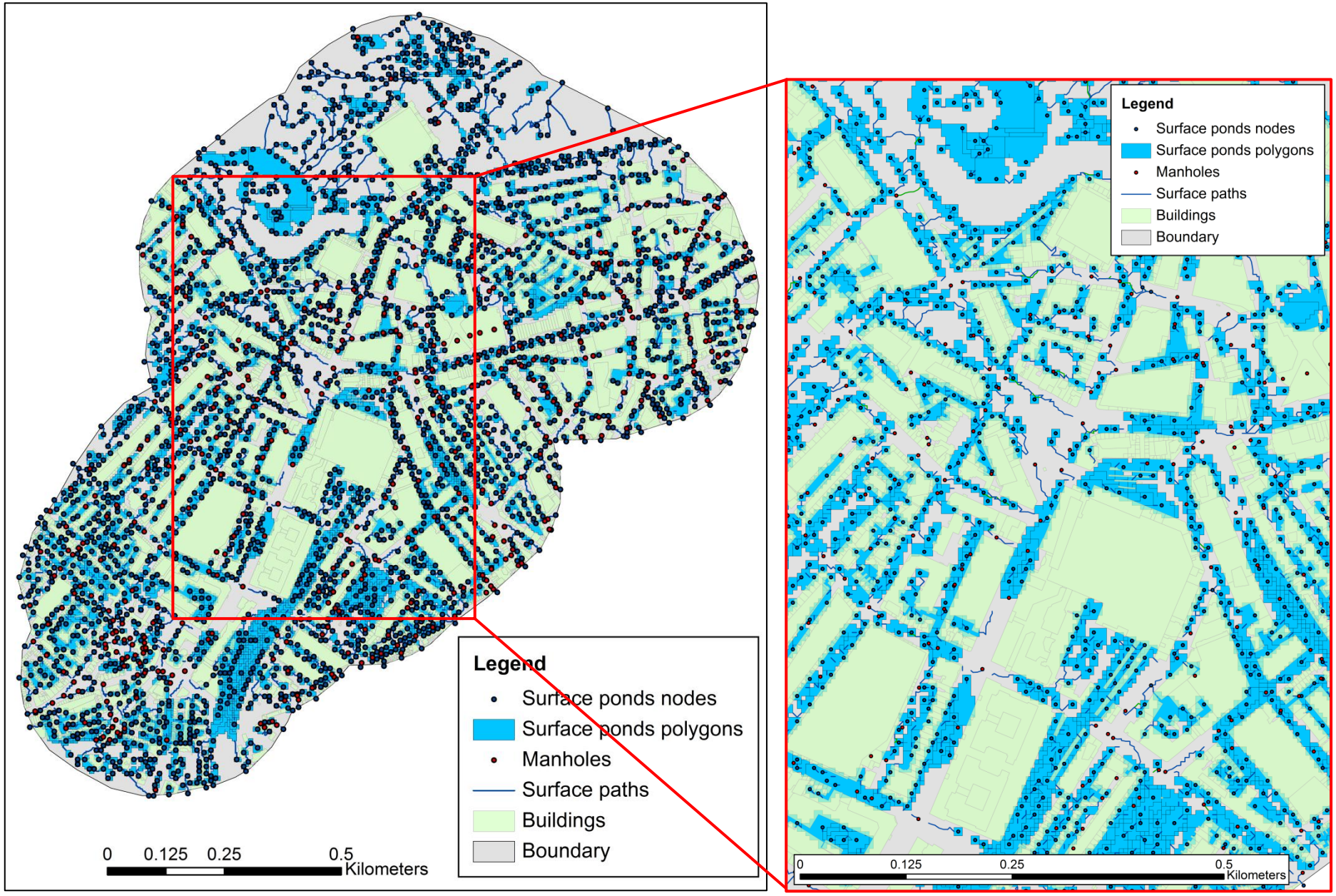


4. Creation of surface flow network and generation of hydraulic model input files





AOFD output files (in DSD folder)



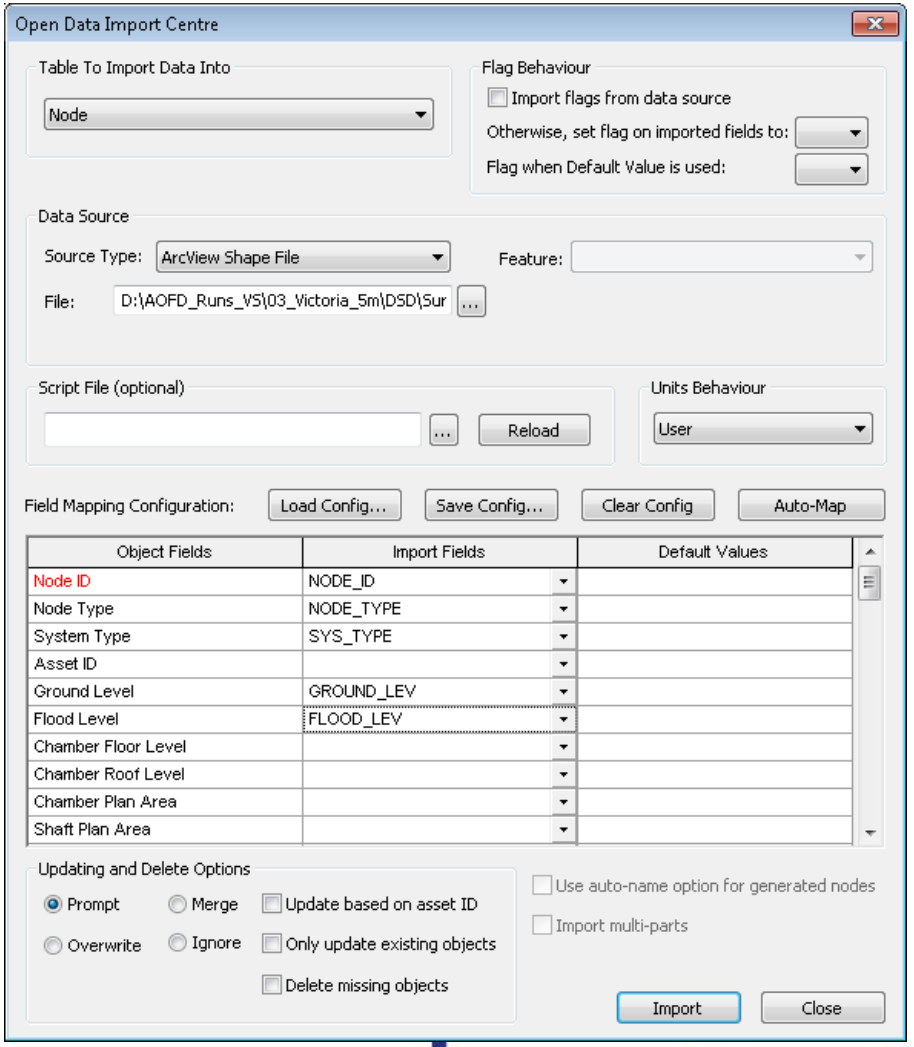
STEP 4: Importing AOFD output files into InfoWorks CS

i. Open and checkout the model of the sewer network

ii. Open the Data Import Centre (under the Network menu)

iii. Import the output files of the AOFD tool taking into account the tables and corresponding object fields

iv. Checks and manual editing is needed (e.g. to remove lose paths and make sure the connection with the sewer system is correct).




OUT_5003
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PON_0855
PON_0992
OUT_5077
BRK_4017
OUT_5012
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PON_0268
PON_0397
PON_1014
BRK_4020
PON_1288
OUT_5044
BRK_4005
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PON_1746
OUT_5014

Limitations of 1D overland flow models

- Data preparation and model setup is time-consuming
- 1D model of the surface may be inaccurate in areas with multi-directional flow paths (i.e. flat areas and areas where expected flow depths are high)
- Visualisation – this can be improved by post-processing data
- As any other models, 1D1D models need calibration (especially of manholes and gullies, the parameters of which determine the volume of water that is exchanged between the surface and sewer system)