Geo-processing Approaches for Urban Water Supply and Drainage Systems' Data Rehabilitation

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Introduction

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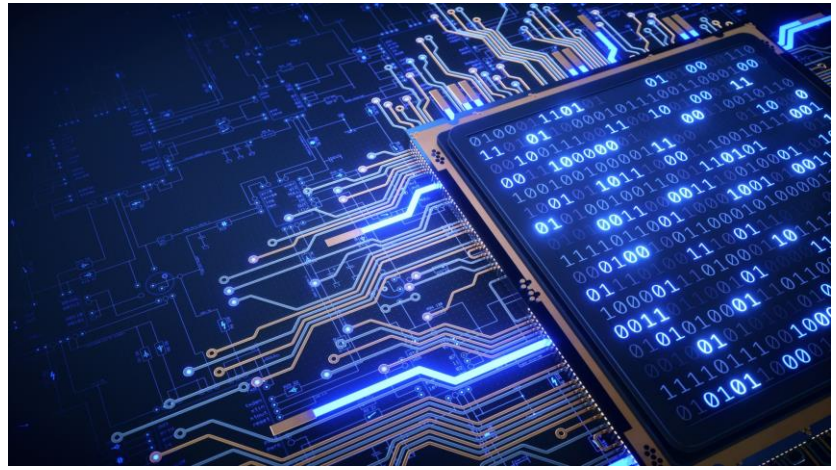
Efficiency and sustainability are primary goals of Modern Cities

Integrated Urban Water Management (IUWM) methods have become increasingly widespread. The target is becoming The Water-Sensitive City (WSC).

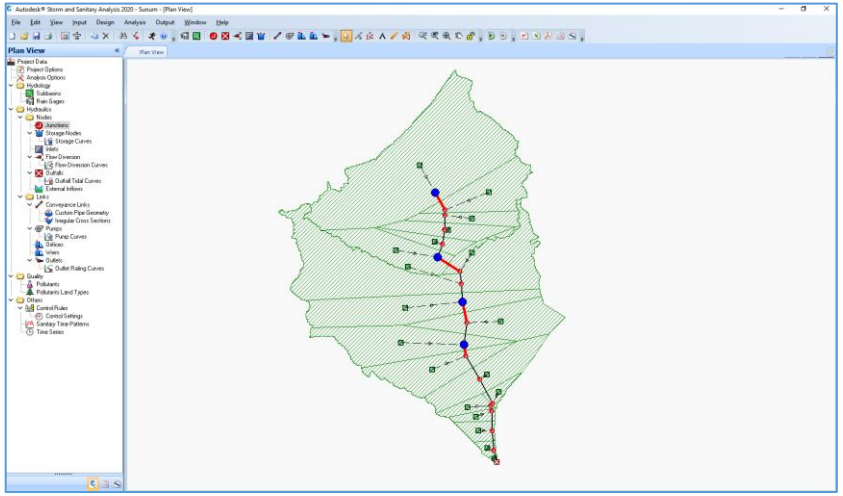
This goal requires to make complex calculations for the analysis of efficiency of these techniques.

Introduction

The multidimensional analysis capabilities of hydrodynamic modeling software must be used.



Accurate and comprehensive physical data are critical



To obtain reliable simulation results from hydrodynamic models,

Physical datasets must be correct, complete and up to date.

Introduction

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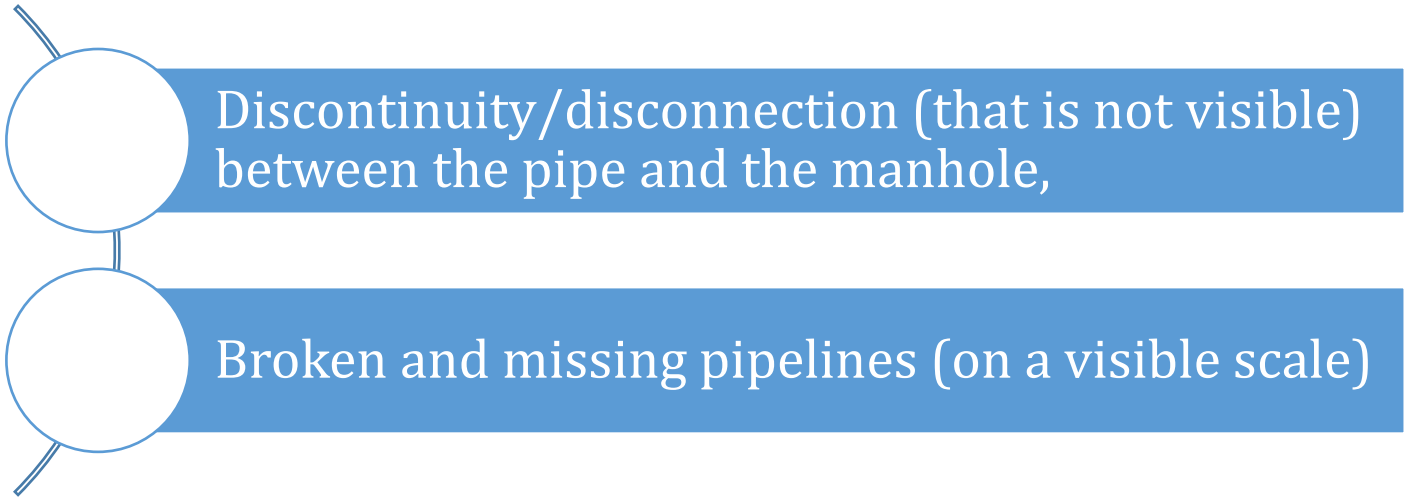
Identification of problematic spots in urban networks depends on precise, accurate, and up-to-date GIS databases.

Low input data quality can significantly affect the accuracy of simulation results

Methodology

2 main problems were identified in this study:



The identified problems are classified and resolved according to the developed methodology.

Methodology

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A. GIS Data Quality Improvement Approaches

The Data have been subjected to 2 types of geoprocessing analysis and evaluation in GIS applications

A) Spatial Analysis

- Intersect analysis
- Near analysis
- Select by location
- Select by attribute
- Buffer

B) Topological Analysis

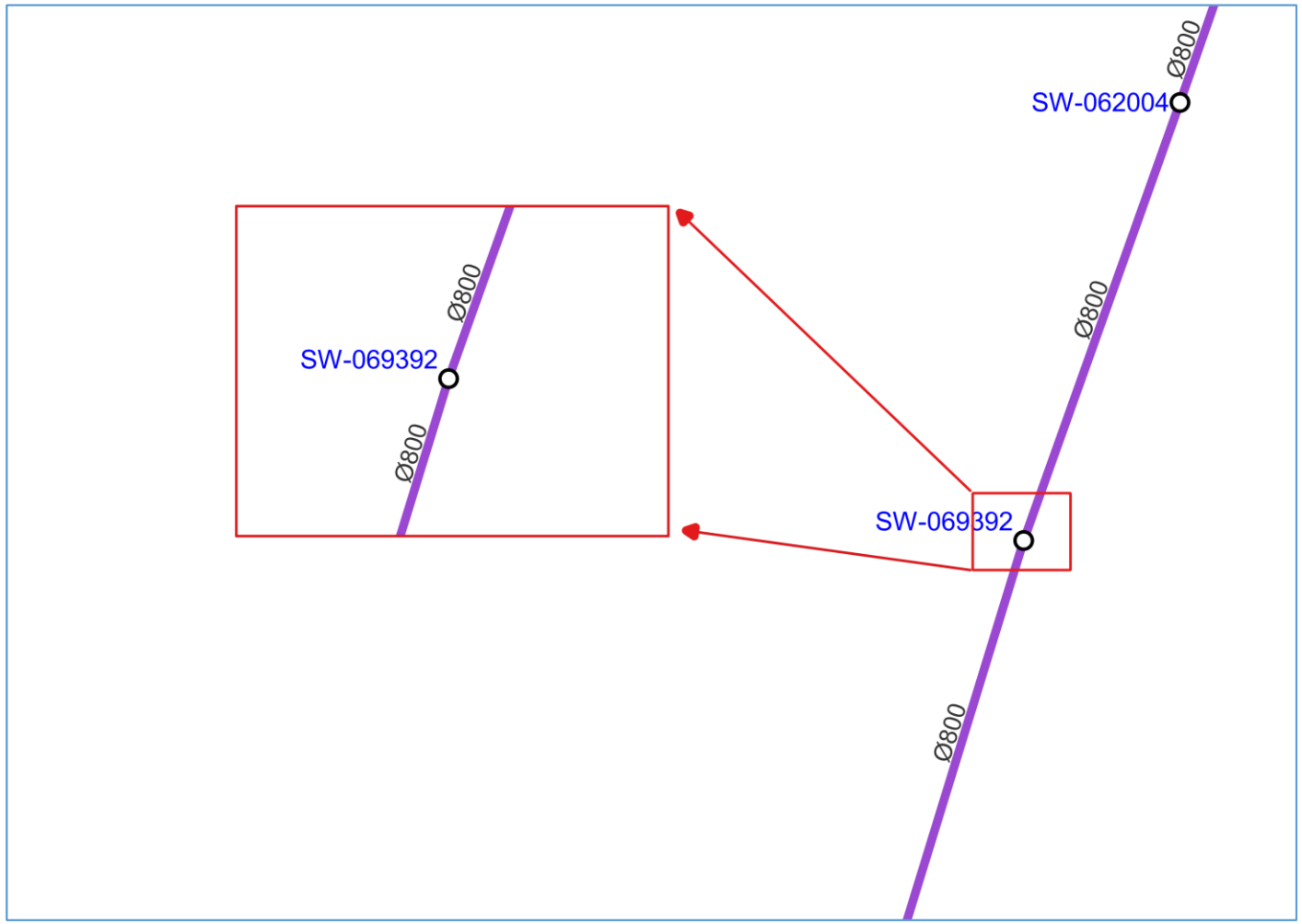
- Point-Line Relation Topological
- Must be Covered by Endpoints
- Must be Covered by Line (Snap, extend, trim)
- Point-Point Relation Topological

Methodology

Non-Connected Manholes with the Line

wastewater and stormwater lines rely on the gravitational movement of water.

it is essential to ensure manhole line-manhole continuity in both plan and profile from the upstream point to the final downstream point.



Methodology

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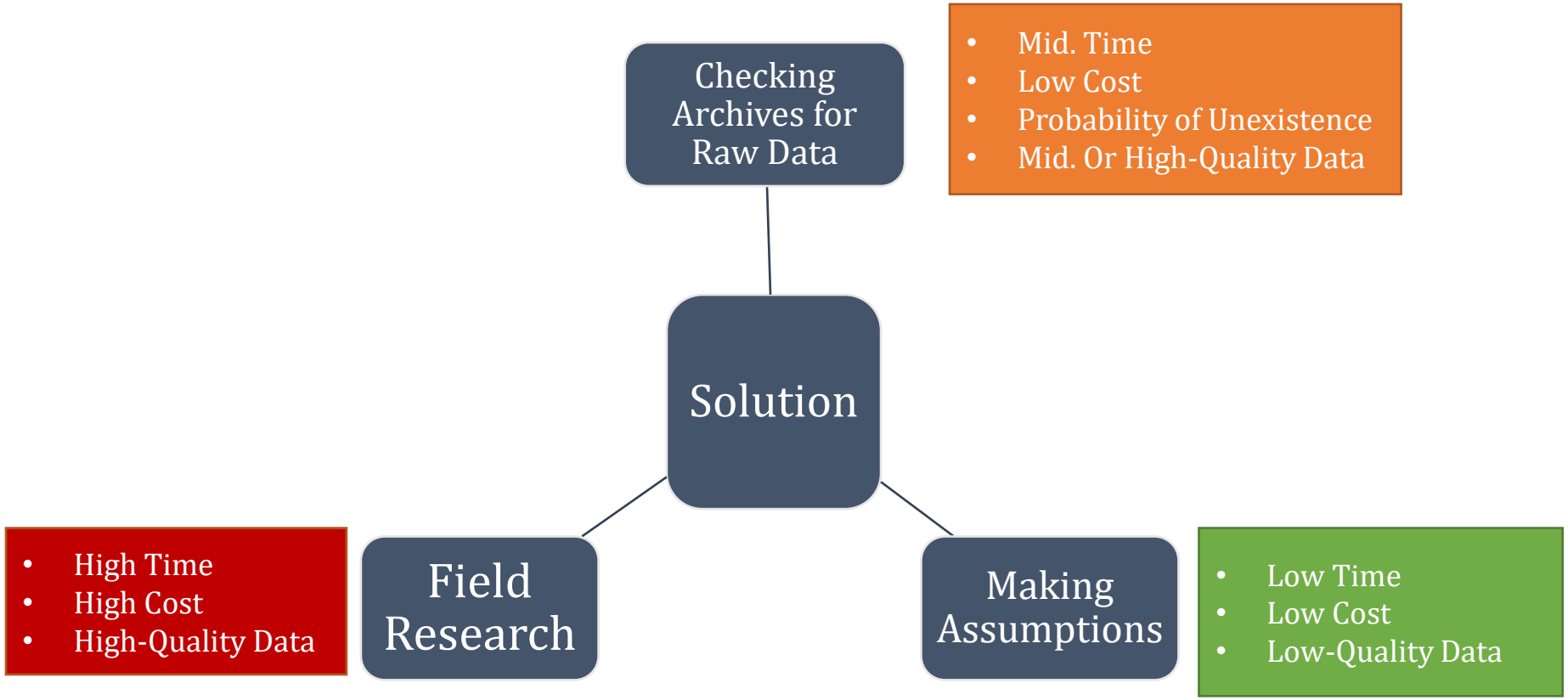
B. Disconnected Lines and Missing data (Visible errors)



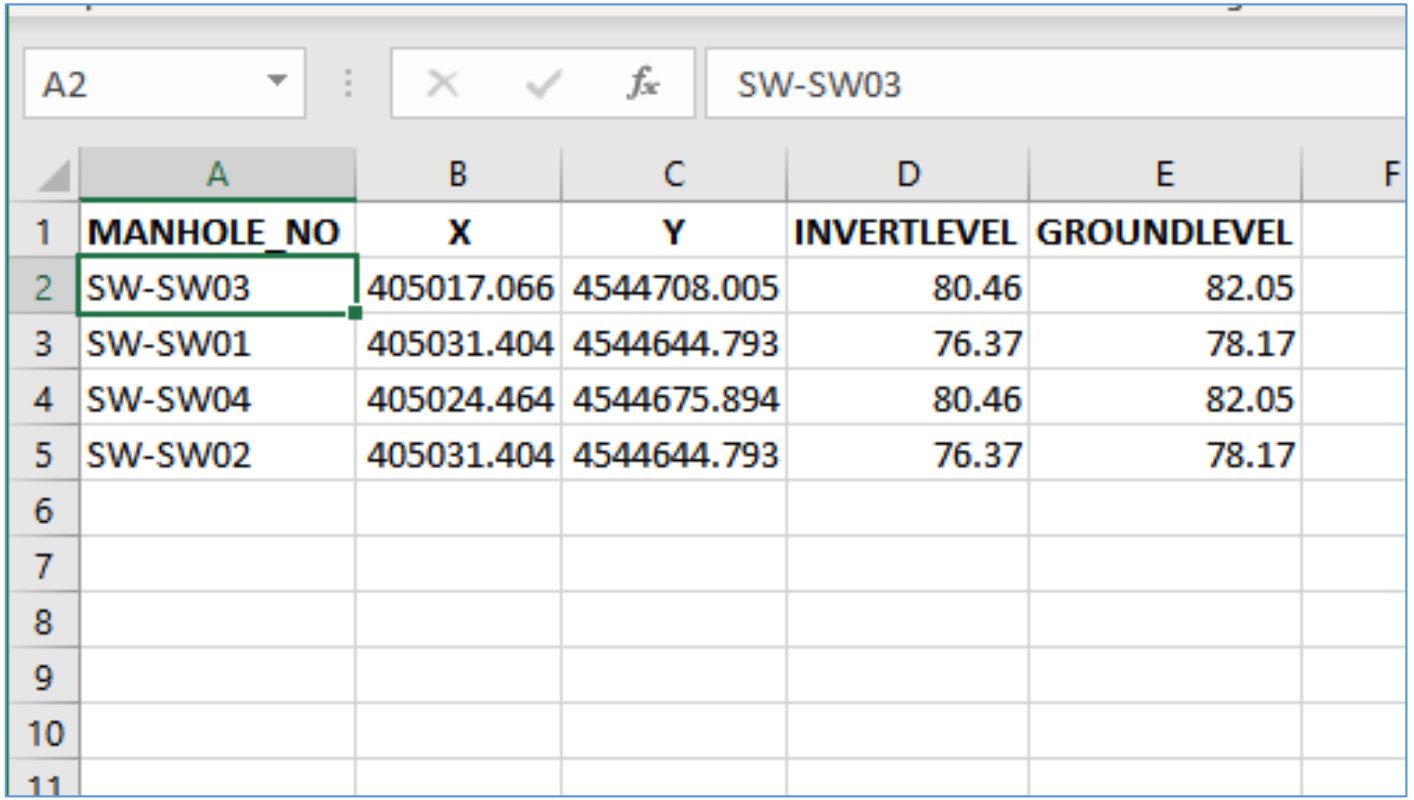
- In some cases, certain lines in the GIS database may not accurately represent their real-world counterparts.
- Some missing data can be found at CAD files. These files must be converted to GIS format for complete the data.

Methodology

Adding CAD Data to GIS

There are multiple methods to transfer data from CAD to GIS.

it may be advantageous to use middleware (like Macro or Lisp) that we develop ourselves.



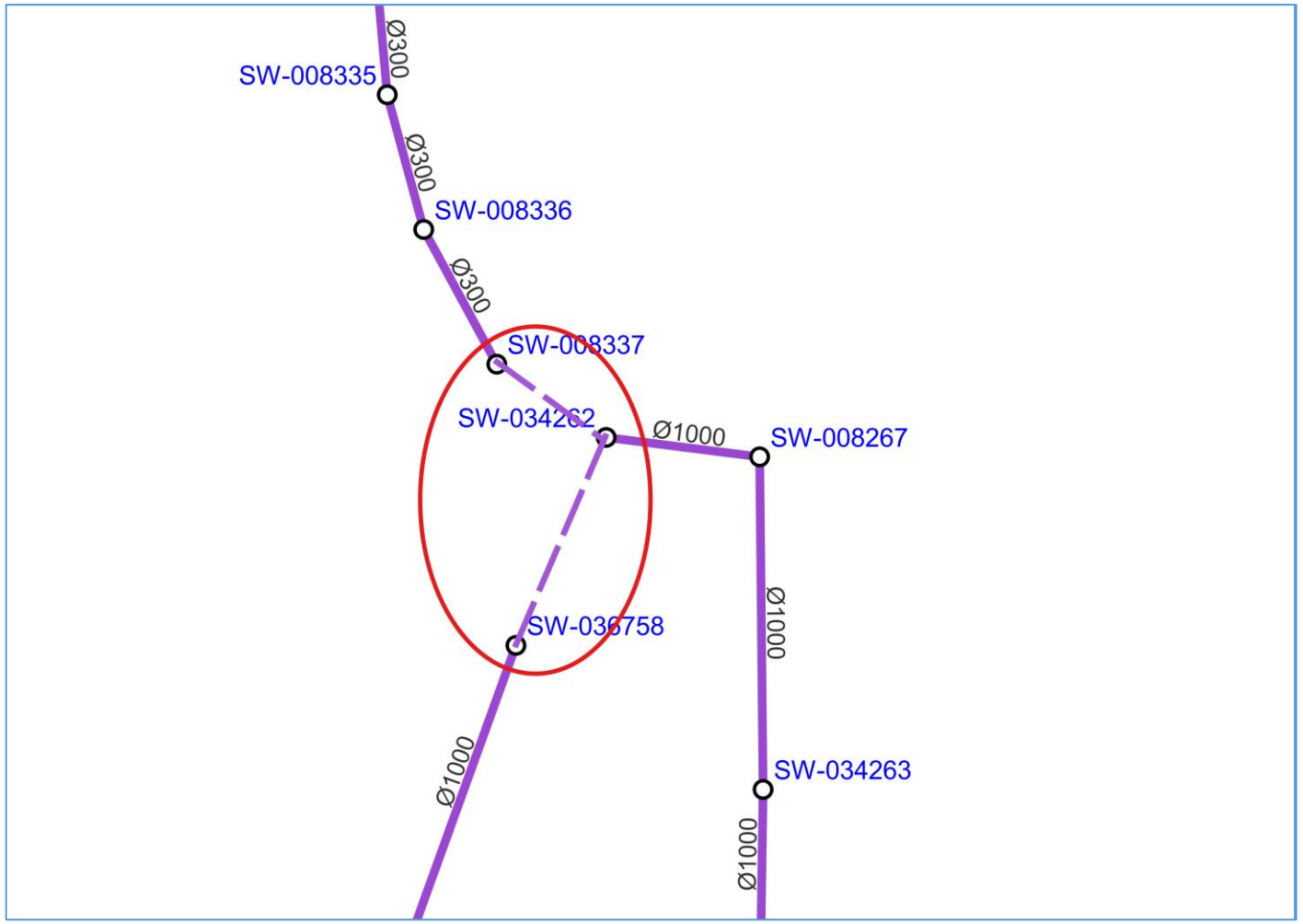
A2 | SW-SW03

	A	B	C	D	E	F
1	**MANHOLE_NO**	**X**	**Y**	**INVERTLEVEL**	**GROUNDLEVEL**	
2	SW-SW03	405017.066	4544708.005	80.46	82.05	
3	SW-SW01	405031.404	4544644.793	76.37	78.17	
4	SW-SW04	405024.464	4544675.894	80.46	82.05	
5	SW-SW02	405031.404	4544644.793	76.37	78.17	
6						
7						
8						
9						
10						
11						

Type of Error & Proposed Solutions

1. Disconnection of Points and Lines:
This error occurs when a line is missing in the upstream-downstream route.

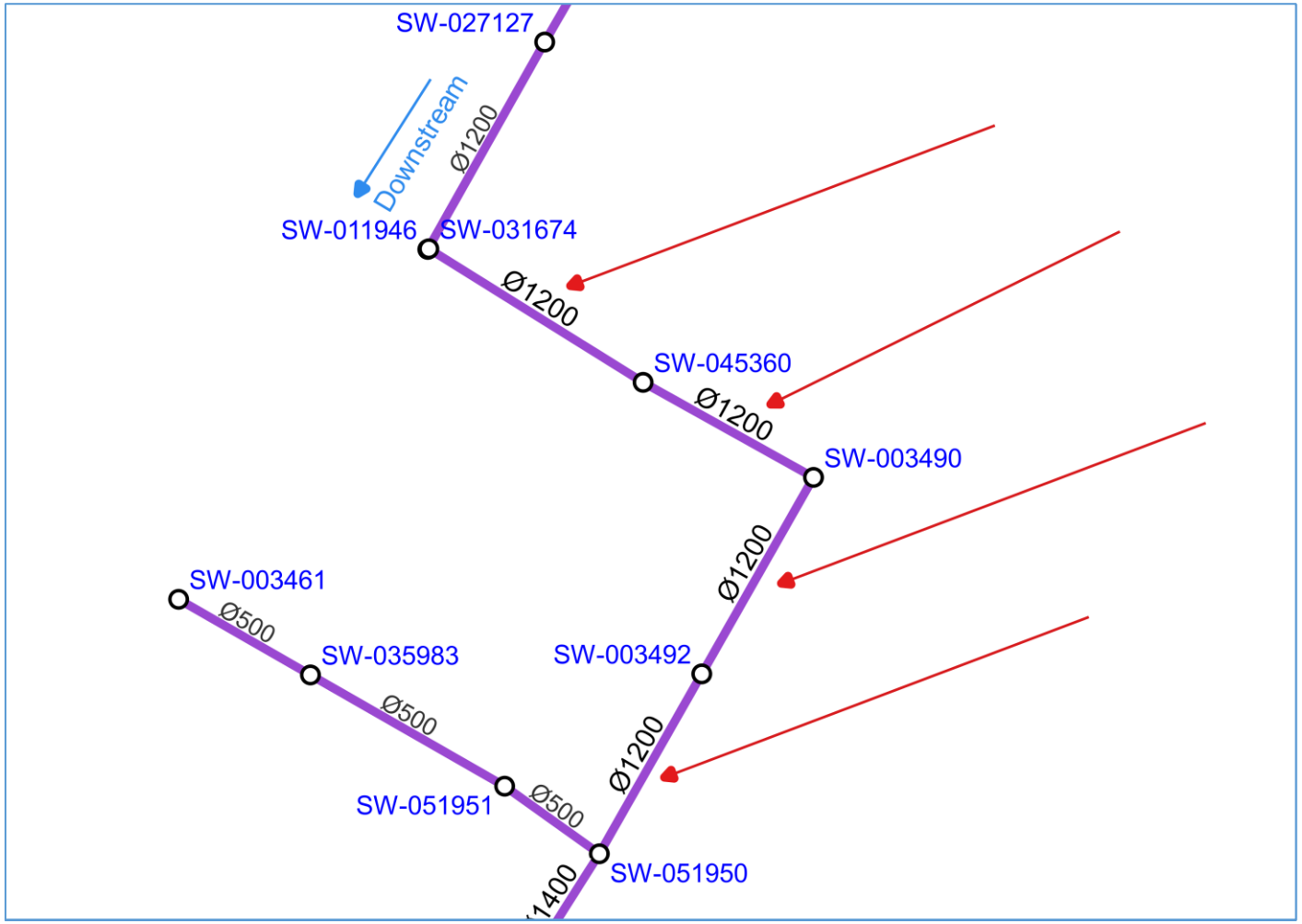
The completion process takes into account estimated information about the systems, topographical bases,
and current maps obtained in one-on-one meetings with administrative units.



Type of Error & Proposed Solutions

3. Indeterminate Cross-Section Dimensions of Lines:
This error occurs when cross-section dimensions are undefined or empty in the attribute table.

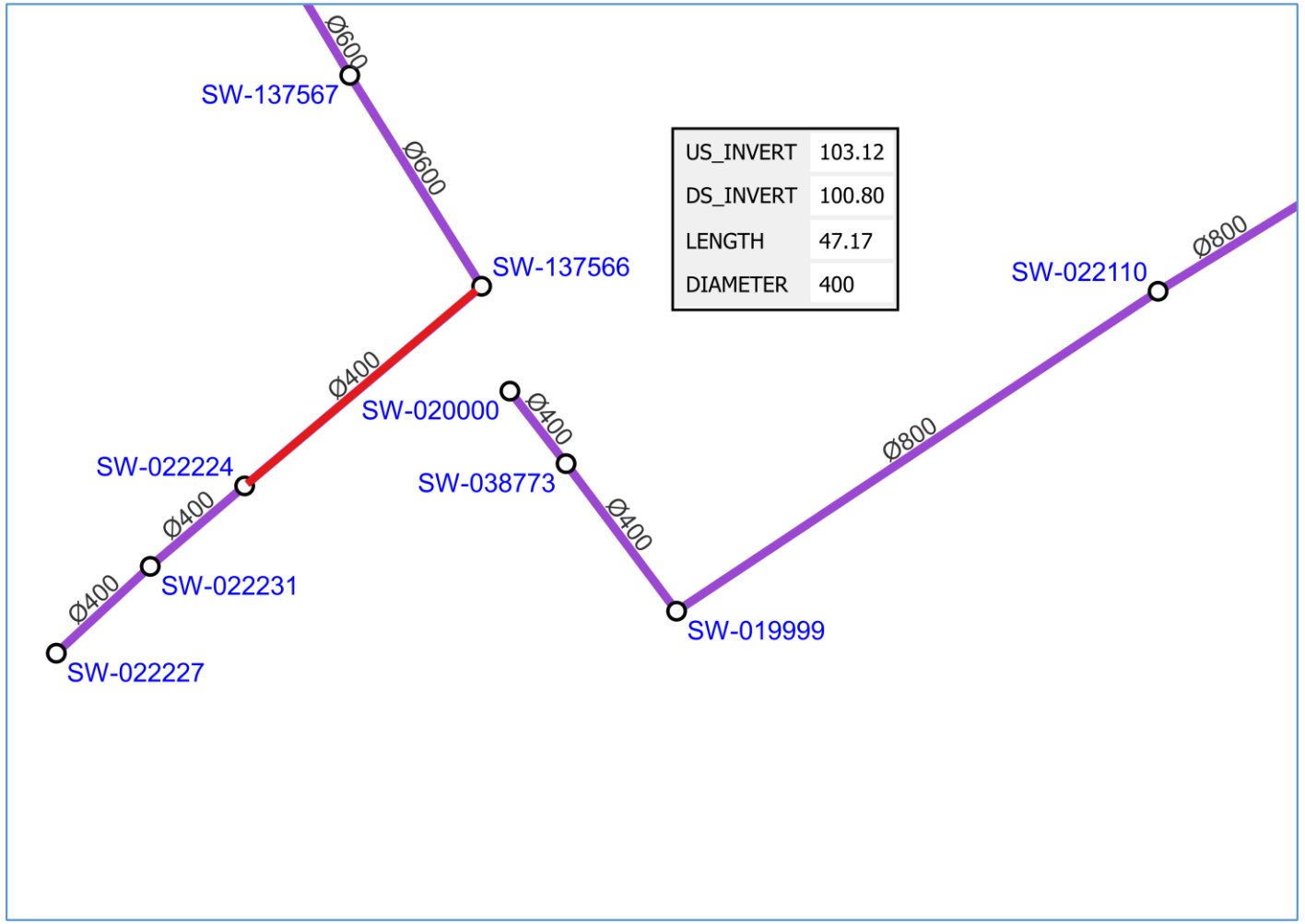
The deficiency is completed by assuming that it is the same size as the previous line.



Type of Error & Proposed Solutions

4.Undefined Invert Elevations of Lines: This error represents lines that are not determined, defined as 999.99, or as the same as manhole ground elevations.

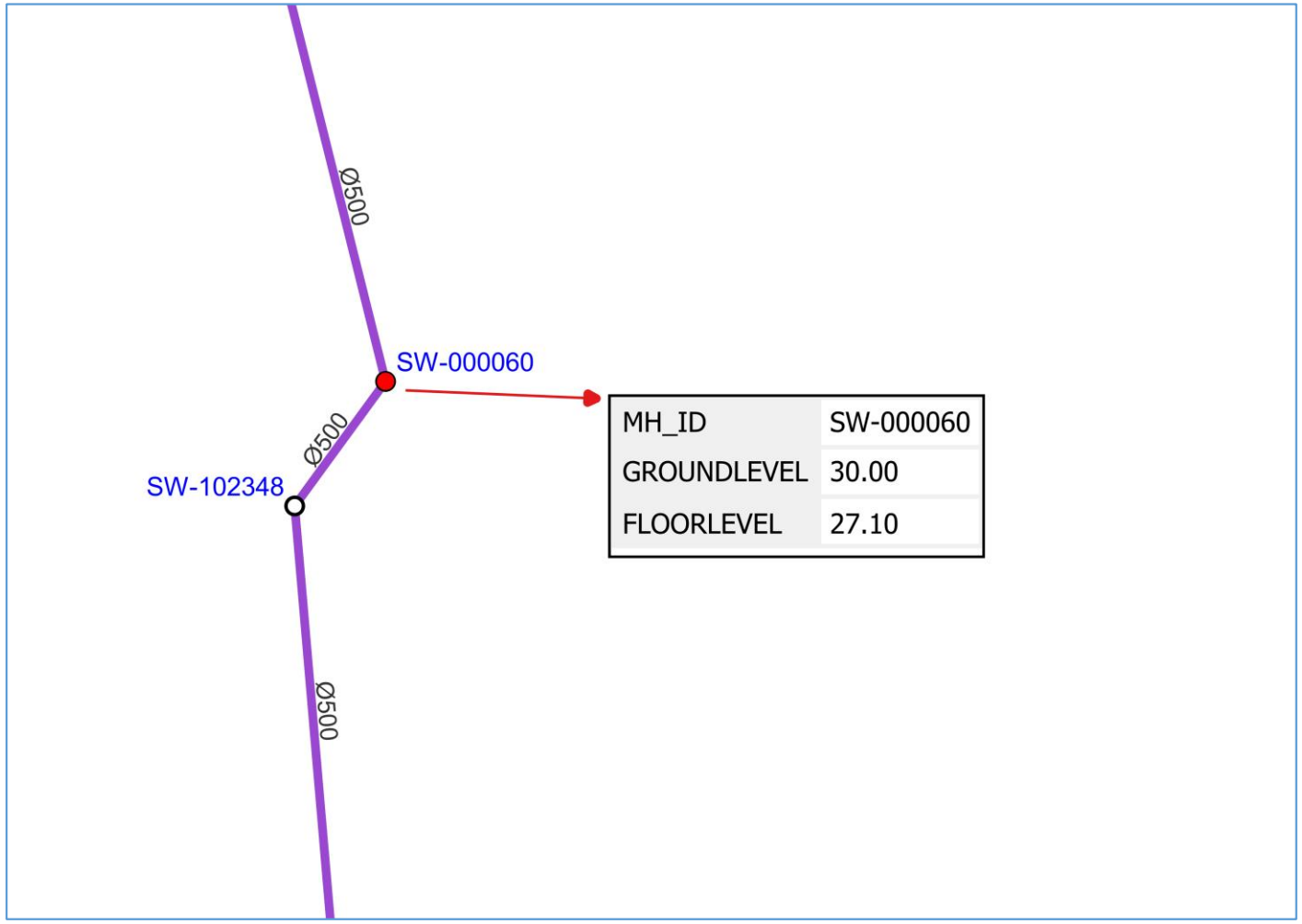
The deficiency is completed by considering the invert levels of the previous/next pipe and manhole.



Type of Error & Proposed Solutions

5.Undefined Ground Level of Manholes:
This error represents manholes that are not determined, defined as 999.99 for manhole ground elevations.

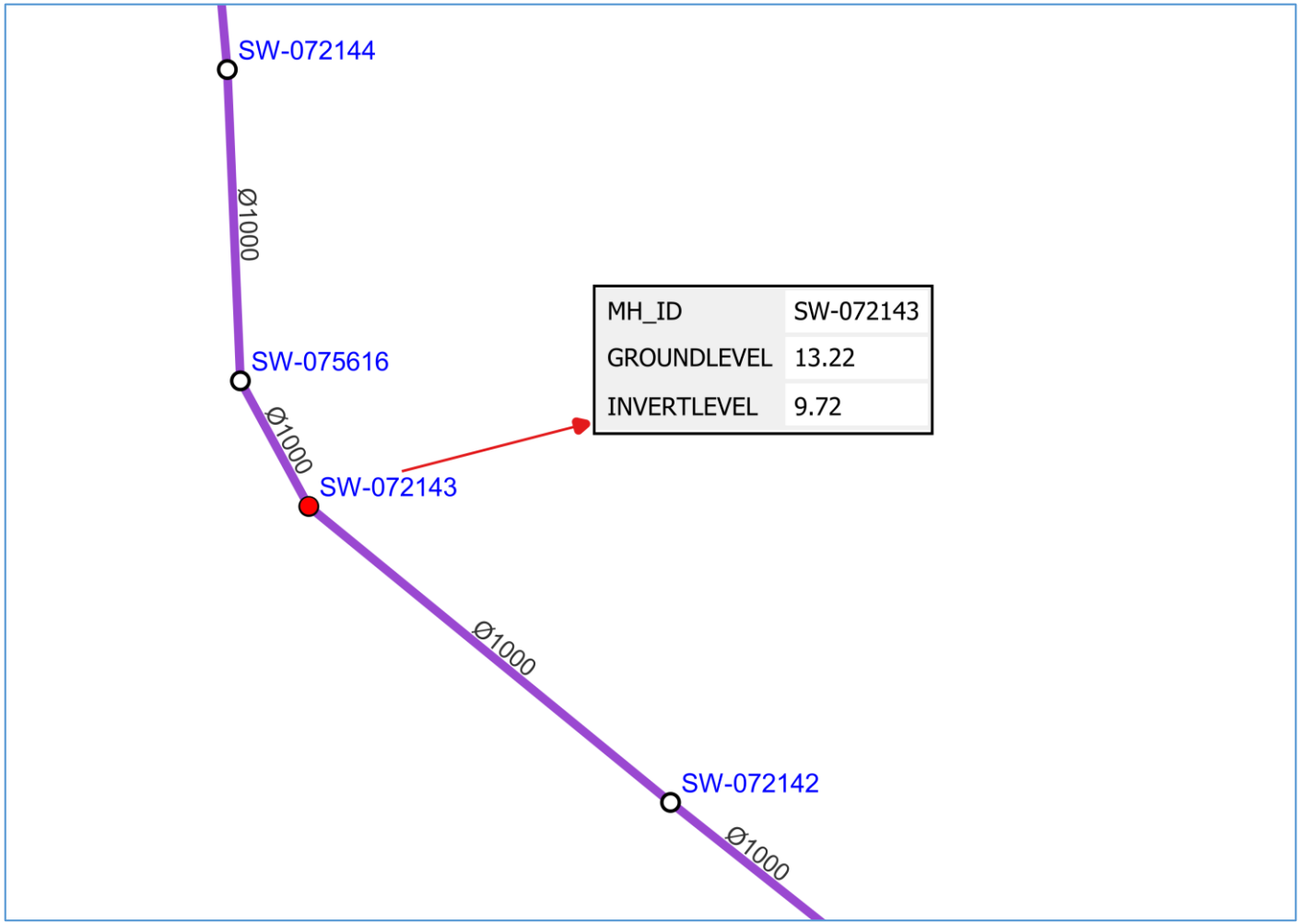
The missing data completed with the Digital Elevation Model (DEM).



Type of Error & Proposed Solutions

6. Manhole Ground Level and Base Level Being Equal:
This error occurs when the manhole floor level is incorrectly the same as the ground level.

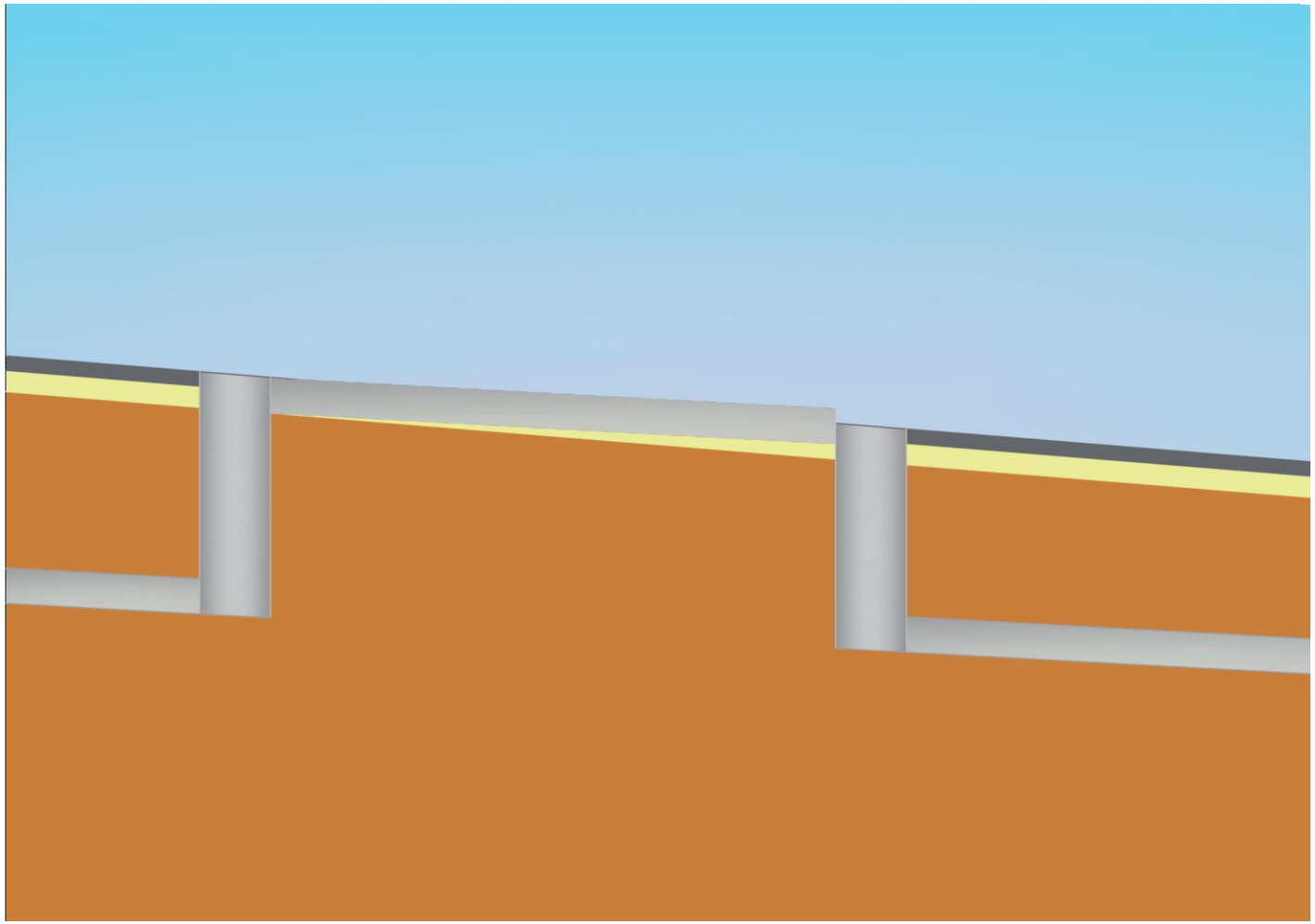
The deficiency is completed by considering the invert levels of the previous/next pipe and manhole.



Type of Error & Proposed Solutions

7. Pipe ridge elevation > ground elevation:
This error occurs when the pipe ridge elevation is above the ground.

The invert level and diameter compatibility at the beginning and end of the pipes is checked.
If these conditions are not met, the ground level is checked, and the arrangement is made accordingly.



Type of Error & Proposed Solutions

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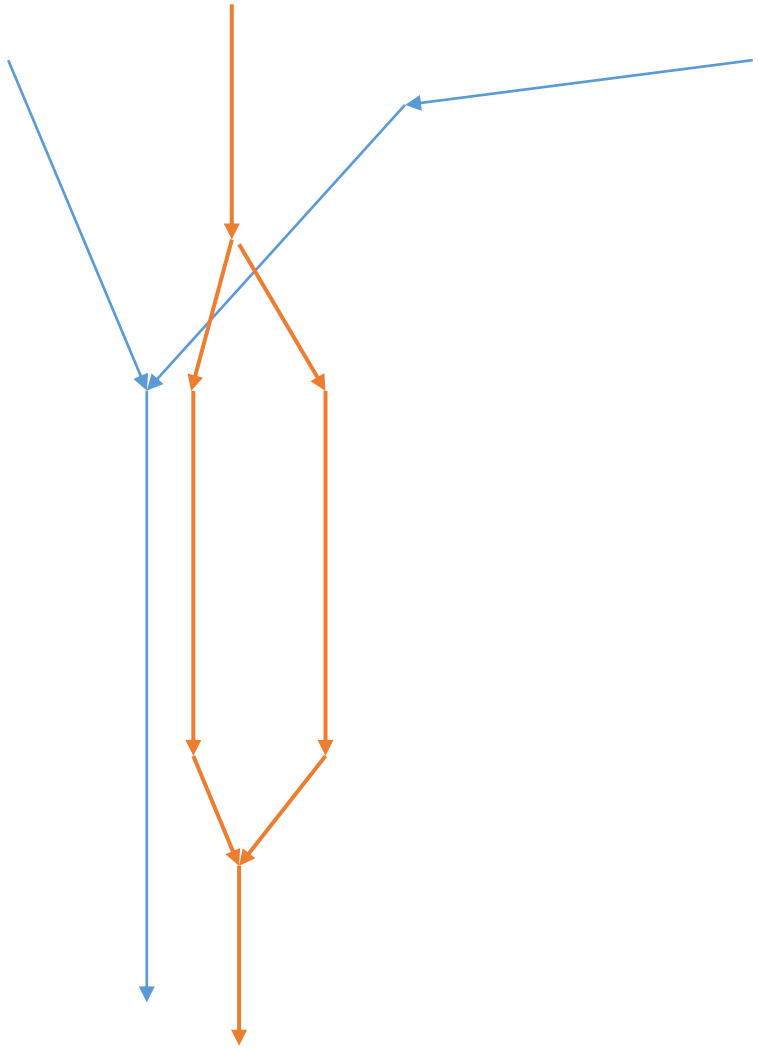
8. Two lines output from one manhole:
Wastewater and Stormwater networks have principle of collecting. Therefore, multiple lines combine into a single collector, generally.

If the capabilities of the modeling software used can solve this situation, it is used exactly, otherwise, it is reduced to a single line with same capacity.

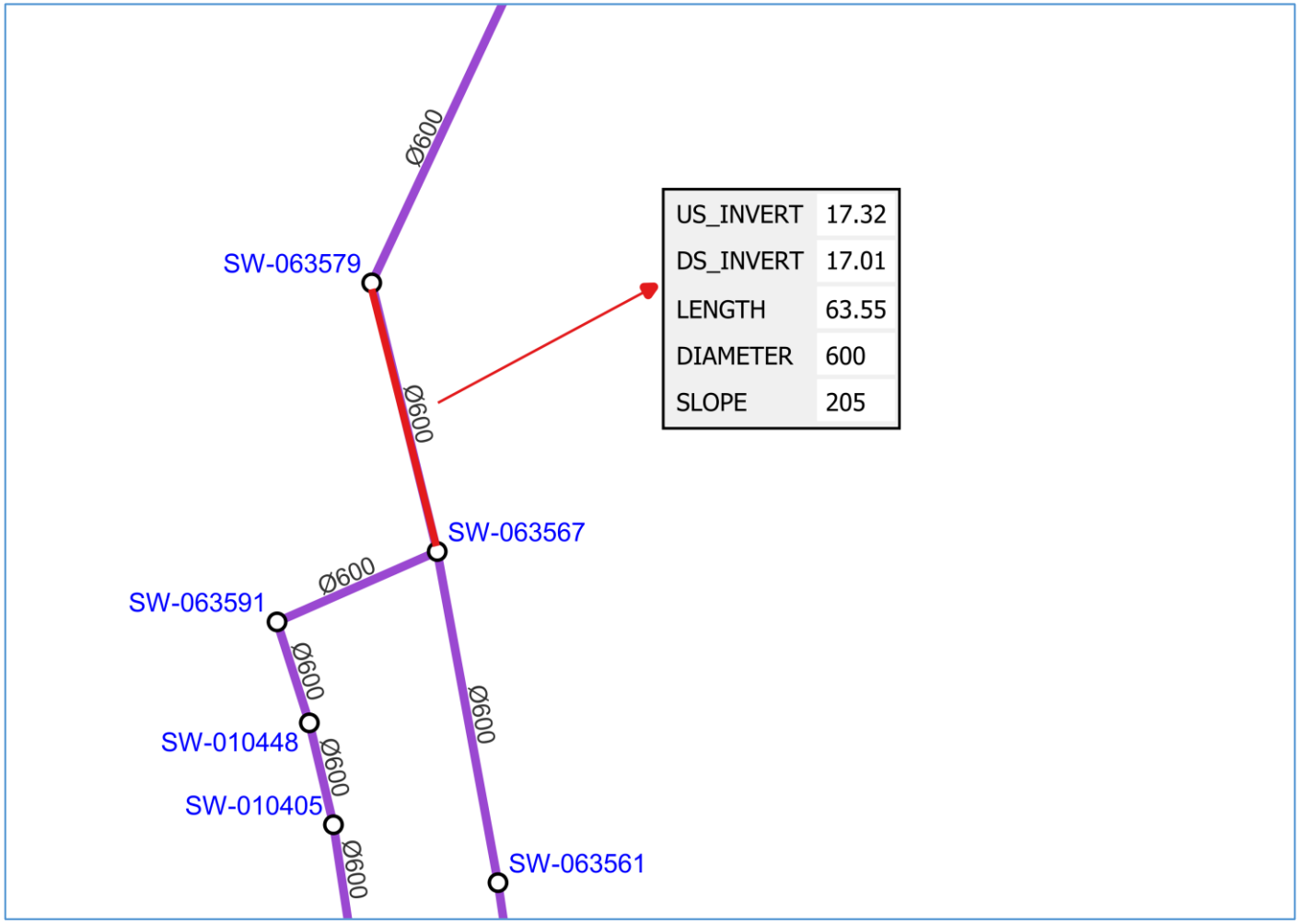


Type of Error & Proposed Solutions

9. Reverse Slope of The Lines:
The elevation of the stream on the upstream side of the line is lower than that on the downstream side.

10. Zero-Slope Lines:
These are the lines with equal stream elevations upstream and downstream.

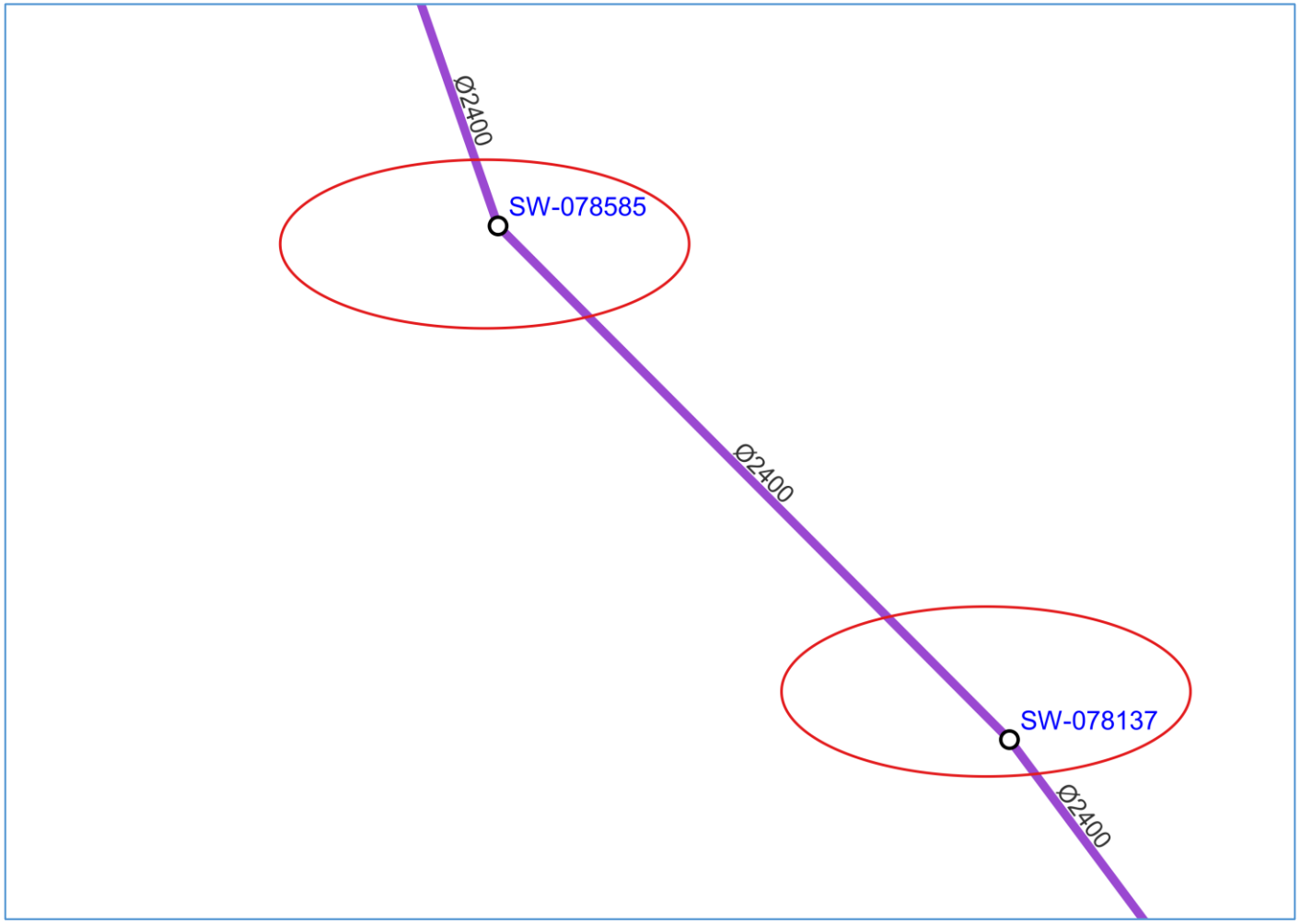
The deficiency is completed by considering the invert levels of the previous/next pipe and manhole.



Type of Error & Proposed Solutions

12. Multiple points at close range represented by a single manhole:
Large cast-in-place manholes represented by multiple point objects with the same characteristics.

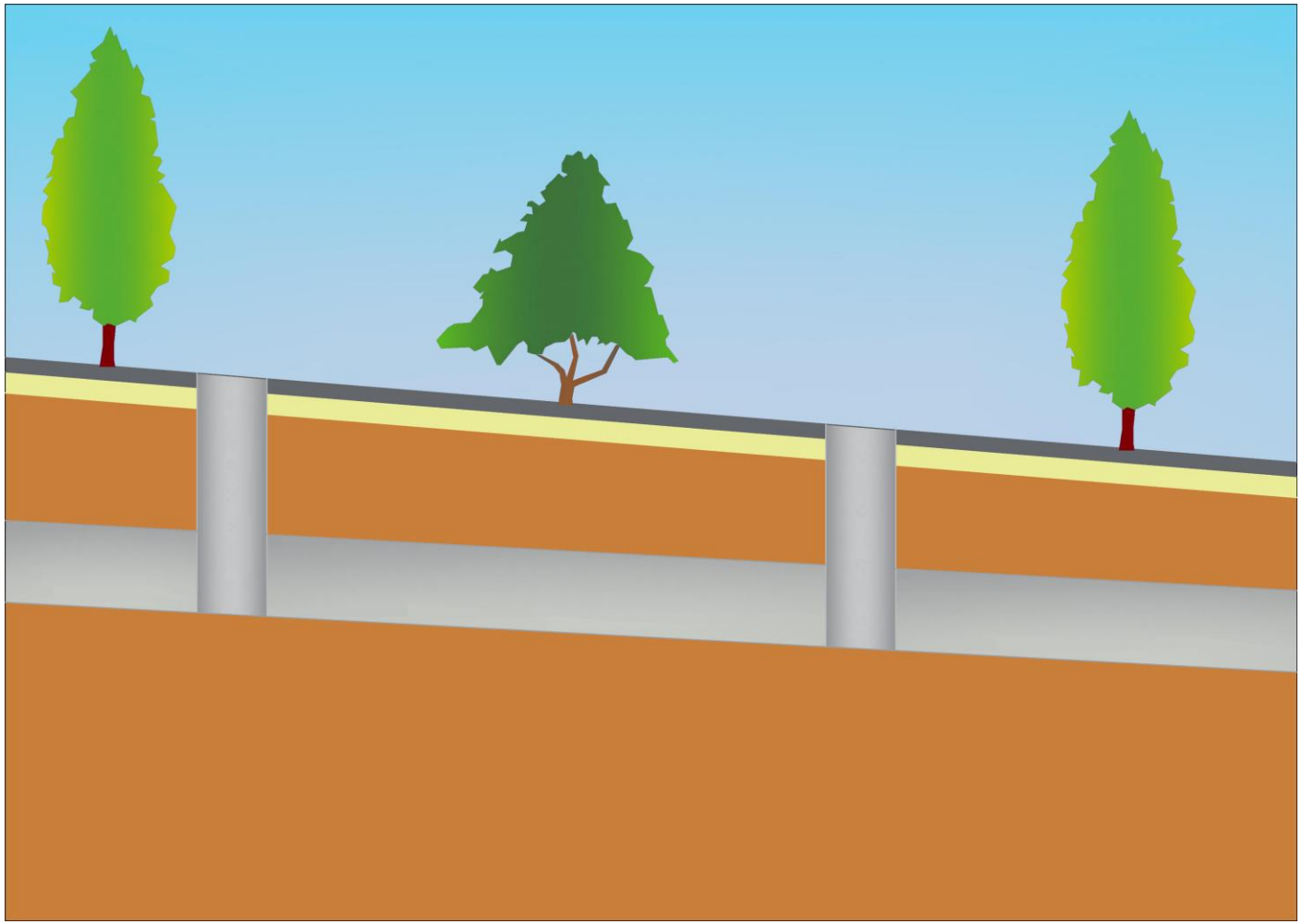
These points are defined with a single point for the hydraulic model base.



Type of Error & Proposed Solutions

13. Small section lines between large section lines:
Small section lines connecting two large section lines.

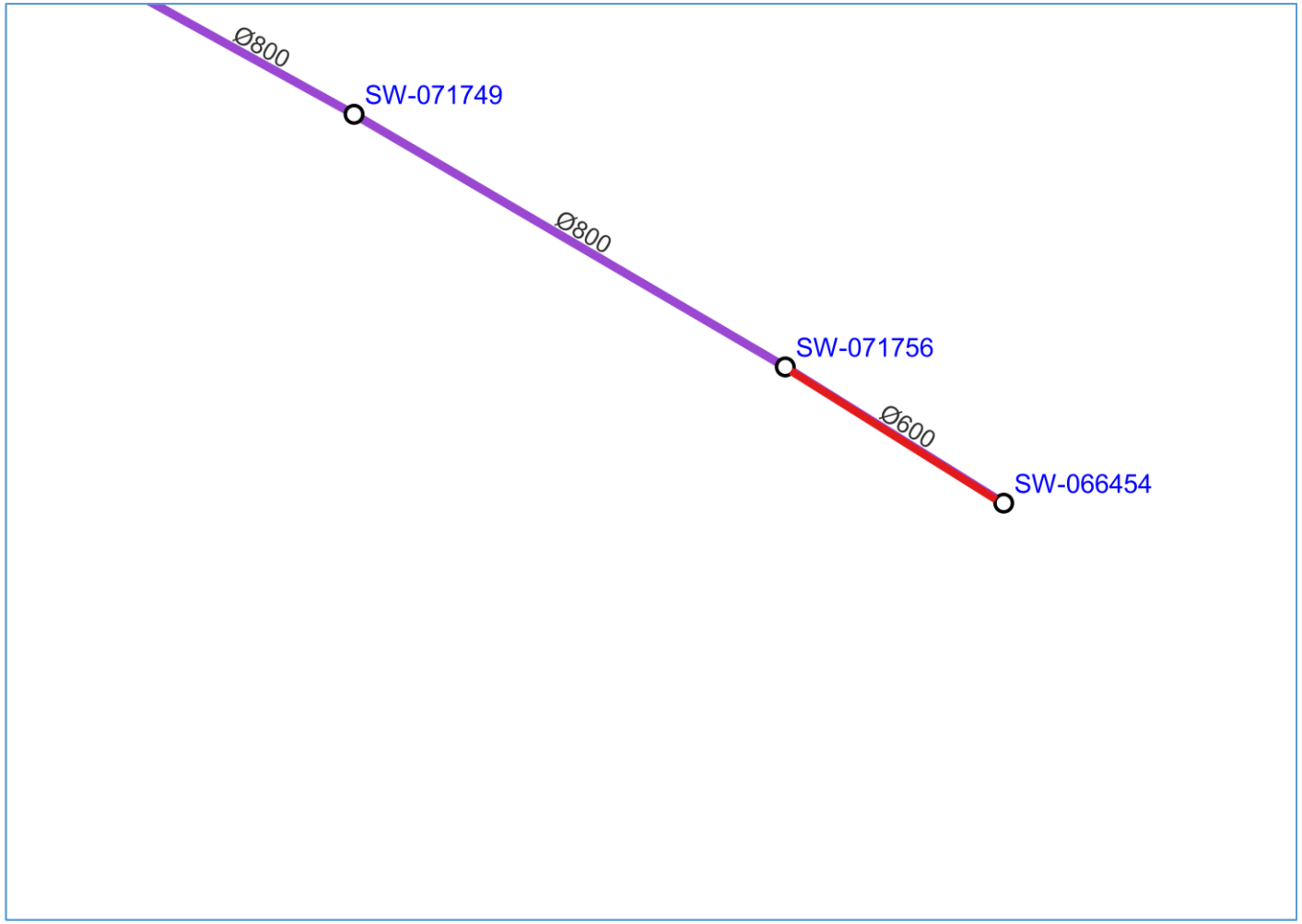
if the difference between the dimensions is huge, the diameter is considered as large as next line ; otherwise, it is preserved.



Type of Error & Proposed Solutions

14. Repeating or crossing lines on the same route:
It is the situation where there are lines of different or the same size on the same axis or road.

The larger diameter line or the newly constructed line is preserved



Conclusion

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The editing and arrangement of data help to ensure the quality of the model and avoid errors.

The correction and validation of input data are also critical stages that enable the model to represent the real-world system accurately.

GIS benefits with the integration of multiple data sources and efficient visualization of analysis results, aiding decision-making processes related to system design and management.

Future Works

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- This methodology will be transformed to a plug-in with a user-friendly interface. In this way, faster data correction and completion will be achieved.
- On the next level, it’s planned to use AI (artificial intelligence) to complete the issues. This will reduce the amount of false acceptance caused by human interaction.

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