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Swiss Agency for Development and Cooperation SDC Introduction to Epanet

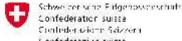


Objective:

Introduction to Epanet (water supply simulation software) using a geo-referenced map.

Part 1

Refreshing of basic hydraulics concept used in Epanet



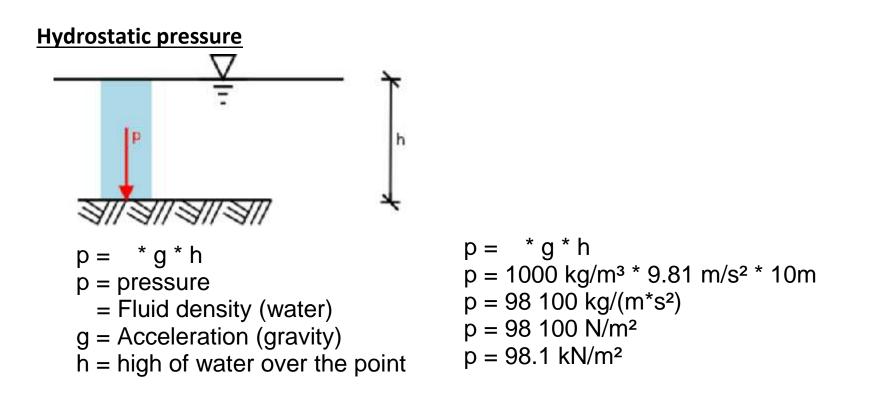
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Introduction to Epanet



Basic hydraulic knowledge for Epanet



Units:

 $p = 98100 \text{ N/m}^2 = 98100 \text{ Pa} = 0.981 \text{ bar} = 32.819 \text{ foot of water} = 10.0034 \text{ m of water}$



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Basic hydraulic knowledge for Epanet

Relative and absolute pressure

pabs = pA + * g * h
Absolute pressure: pabs
Atmospheric pressure: pA
hydrostatic pressure: * g * h



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Introduction to Epanet



Basic hydraulic knowledge for Epanet

Flow and velocity in round pipes Water under pressure (full pipe)

The pipe must be filled $v = Q / A = 4 * Q / (* d^{2})$ Q=v*A

```
v = velocity (m / s)
Q = Flow (m<sup>3</sup>/s)
A = Surface of the section of the pipe (m2)
d = Diameter (m) (d in Epanet (mm)
                                                     \overline{v} = \frac{d}{t}
                                                                       Q = \frac{V}{t} = \frac{Ad}{t} = A\overline{v}
```



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Equation of continuity

Q = v / A = const v = velocity m / s $Q = flow en m^3 / s$ $A = Pipe section transversal m^2$





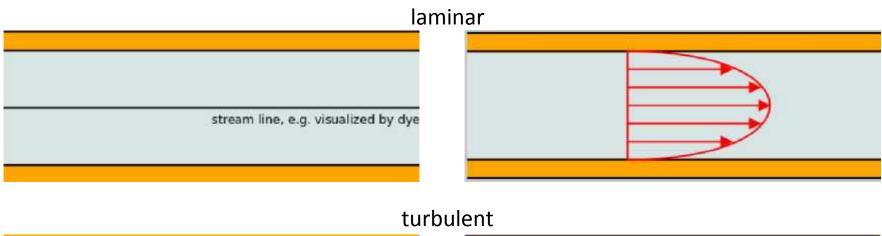
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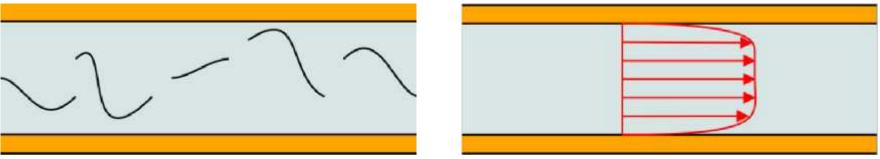
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Basic hydraulic knowledge for Epanet

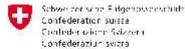
Flow types: laminar - turbulent





EPANET considers both types of flows!





Introduction to Epanet



Basic hydraulic knowledge for Epanet

Reynolds number (Re) is used to numerically describe the type of flow

laminar transition For flow in a pipe or tube, the Reynolds number is generally defined as.[11] turbulent $\operatorname{Re} = \frac{\rho \mathbf{v} D_H}{\mu} = \frac{\mathbf{v} D_H}{\nu} = \frac{\mathbf{Q} D_H}{\nu A}$ where: D_H is the hydraulic diameter of the pipe; its characteristic travelled length, L, (m). laminar: Re <2000 Q is the volumetric flow rate (m³/s). A is the pipe cross-sectional area (m²). v is the mean velocity of the fluid (SI units: m/s). transition : 2000 < Re < 4000 μ is the dynamic viscosity of the fluid (Pa·s = N·s/m² = kg/(m·s)). • ν is the kinematic viscosity ($\nu = \mu/\rho$) (m²/s). turbulent Re> 4000
 ρ is the density of the fluid (kg/m^s).

The simulation with turbulent flow are different than laminar flow



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<u>Viscosity</u>

A liquid with high viscosity resists deformation (i.e. Honey).

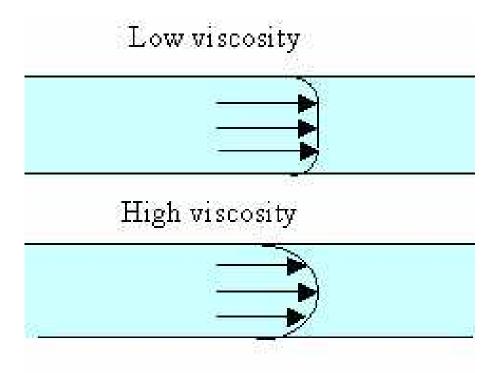
Viscosity of water depends on the temperature

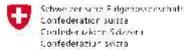
-- with 20 ° C: = 1,01 * 10-6 m² / s

-- with 10 ° C: = 1,31 * 10-6 m² / s

FOR EPANET:

If water temperature is not around 20°C you could consider it in Epanet in the parameter of the "relative viscosity"





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Basic hydraulic knowledge for Epanet

Relative viscosity in Epanet

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Temperatura agua	Viscosidad relativa al agua de 20°C	Temperatura aguu	Viscosidad relativa al agua de 20°C	Temperatura agua	Viscosidad relativa al agua de 20°C	Temperatura agua	Viscosidad relativa al agua de 20°C		
1	1.77	26	0.87	51	0.586	76	0.436		
2	1.666	27	0.852	52	0.58	77	0.43		
3	1.612	28	0.833	53	0.574	78	0.424	i o docort d	situation
4	1.558	29	0.815	54	0.568	79	0 419		
5	1.504	30	0.796	55	0.562	80	0.413	during day	1
6	1.463	31	0.782	56	0.556	81	0.407		-
7	1.421	32	0.767	57	0.55	82	0.401	Matar	Rel.
8	1.38	33	0.753	58	0.544	83	0.395	Water	Viscosity
9	1.338	34	0.738	59	0.538	84	0.389	Temp.	-
10	1.297	35	0.724	60	0.532	85	0.383	°C	to water
11	. 1.265	36	0.709	61	0.526	86	0.377		of 20°C
12	1.232	37	0.695	62	0.52		0.371	26	0.87
13	1.2	38	0.68	63	0.514	88	0.365	20	0.87
14	1.167	39	0.666	64	0.508		0.359	27	0.852
15	1.135	40	0.651	65	0.502	90	0.353		
16	1.108	41	0.646	66	0.496	91	0.347	28	0.833
17	1.081	42	0.64	67	0.49	92	0.341		
18	1.054	43	0.634	68	0.484	93	0.335		
19	1.027	44	0.628	69	0.478	94	0.329		
20	1	45	0.622	70	0.472	95	0.323		
21	0.978	46	0.616	71	0.466	96	0.317		
22	0.956	47	0.61	72	0.46	97	0.311		
23	0.933	48	0.604	73	0.454	98	0.305		
24	0.911	49	0.598	74	0.448	99	0.299		
25	0.889	50	0.592	75	0.442	100	0.293		



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Basic hydraulic knowledge for Epanet

Friction loss along pipes

Energy is dissipated due to friction of water (particle)



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Basic hydraulic knowledge for Epanet

Friction loss, Darcy-Weisbach

$$HL = f \times \frac{L}{D} \times \frac{V^2}{2g}$$

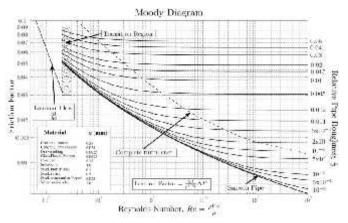
hf = friction loss mm

f = friction parameter (non dimension) (Darcy) -> Moody Diagram

I = length of pipe m

d = diameter of pipe en m

g = 9,81 m / s ²





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Basic hydraulic knowledge for Epanet

Friction loss, Hazen-Williams

$$H_{L} = \frac{4.727LQ^{1.852}}{C^{1.852}d^{4.871}}$$

where:

- HL = friction loss m
- Q = flow m3/s
- L = length of pipe m
- d = Diameter of pipe m
- C = coefficient (Hazen-Williams C-factor) no dimension



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Friction loss, Chezy-Manning

$$H_{I} = \frac{4.66n^{2}LQ^{2}}{d^{5.33}}$$

Where

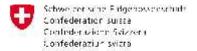
HL = friction loss m

Q = flow

L = length of pipe m

d = diameter of pipe m

n = friction coefficient of Manning no dimension



Introduction to Epanet



Basic hydraulic knowledge for Epanet

$$H_{L} = \frac{4.727 L Q^{1.852}}{C^{1.852} d^{4.871}}$$

The **Hazen-Williams formula** is the most commonly used headloss formula in the US. It cannot be used for liquids other than water and was originally developed for turbulent flow only.

$$HL = f \times \frac{L}{D} \times \frac{V^2}{2g}$$

The **Darcy-Weisbach formula** is the most theoretically correct. It applies over all flow regimes and to all liquids.

$$H_L = \frac{4.66n^2 LQ^2}{d^{5.33}}$$

The **Chezy-Manning formula** is more commonly used for open channel flow.



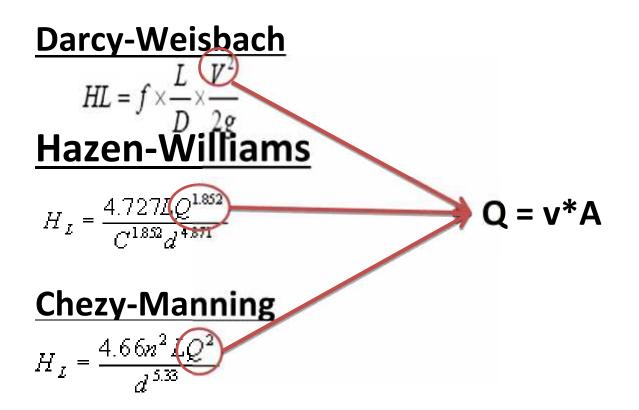
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EPANET

Basic hydraulic knowledge for Epanet





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Friction loss

Roughness Coefficients for New Pipe

Material Cast Iron	Hazen-Williams C (unitless) 130 - 140	Darcy-Weisbach (mm) 0.25908	Manning's n (unitless) 0.012 - 0.015
Concrete or Concrete Lined	120 - 140	0.3048 - 3.048	0.012 - 0.017
Galvanized Iron Plastic Steel Vitrified Clay	120 140 - 150 140 - 150 110	0.01524 0.001524 0.04572 0	0.015 - 0.017 0.011 - 0.015 0.015 - 0.017 0.013 - 0.015



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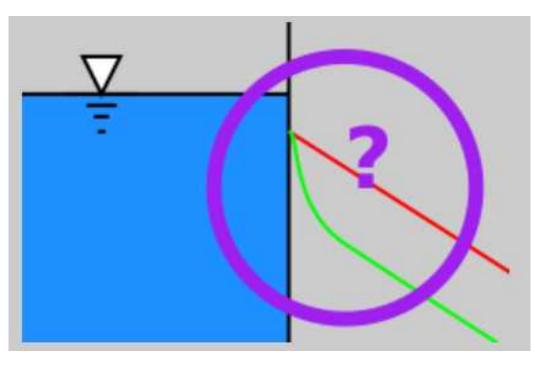
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Minor losses or local losses

Minor losses

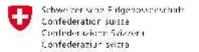
i.e. Bends, fitting, valves, etc.

Below the coefficient to consider in the setup of Epanet:



FITTING	LOSS COEFFICIENT
Globe valve, fully open	10.0
Angle valve, fully open	5.0
Swing check valve, fully open	2.5
Gate valve, fully open	0.2
Short-radius elbow	0.9
Medium-radius elbow	0.8
Long-radius elbow	0.6
45 degree elbow	0.4
Closed return bend	2.2
Standard tee - flow through run	0.6
Standard tee - flow through branch	1.8
Square entrance	0.5
Exit	1.0

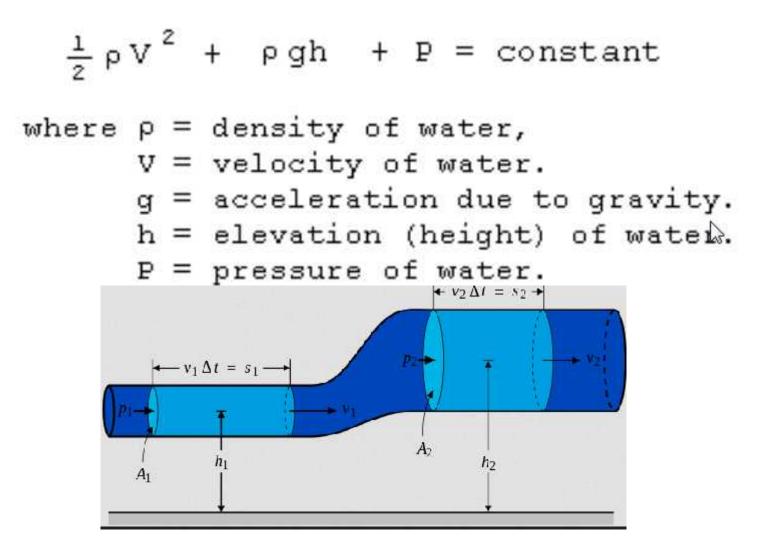




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Basic hydraulic knowledge for Epanet

BERNOULLI'S EQUATION







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Flow classification: stable / unstable

stable flow doesn't change over the time unstable flow changes over the time

I.e. Parameter that could change:

Speed

Flow

Pressure



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Flow classification: stable / unstable

EPANET simulates ONLY constant flow

Water hammer is an example of unstable flows in pipe The simulation over time allows to analyse different flows in the pipe (pattern)



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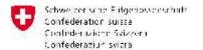




Fire fighting, fire water

In urban setting think about water for fire fighters

A regulation might exist



Introduction to Epanet

Fire fighting, fire water

Planungsrichtwerte für die Brandbekämpfung

Art der Bebauung	Risiko bezogen auf die Art der Bebauung		Q [l/min] 1)	Löschreserve [m ³] 2)
Einzelobjekte, z.B.		184		
Einzelnes Wohnhaus	klein	14-15	600-900	20-100
Einzelnes landwirtschaftliches Gut	mittel	47	1000	20-100
Weiler, kleiner Ort in offener Bauweise	gross	76D	1200	20-100
Dorfgebiet, z.B.				
Dorf mit offener Bauweise	klein	15	1500	150
Dorf mit teilweise geschlossener Bauweise	mittel	26	1800	200
Dorf mit Gewerbezone	gross	37	2200	300
Stadtgebiet, z.B.				
Städtische Quartiere	klein	190	2400 🛰	300
Städtische Überbauung mit Gewerbezone	mittel	97	2800	400
Stadtgebiet mit Warenhäusern, Hotels etc.	gross	14 V	3200	500
Industrie und Grossbetriebe, z.B.				
Sachwert bis 5 Mio., Umweltgefährdung normal 3)	klein	lia.	3600	600
Sachwert bis 50 Mio., Umweltgefährdung erhöht 3)	mittel		4800 -	700
Sachwert über 50 Mio., Umweltgefährdung gross 3)	gross	20	5400	800



3) vgl. Brandschutzrichtlinie Sprinkleranlagen der VKF



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Introduction to Epanet

Basic hydraulic knowledge for Epanet



Limitation of Epanet

With Epanet is not possible to simulate open channels

Typical open channels:

river

Sewer



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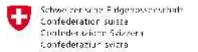
Basic hydraulic knowledge for Epanet



Epanet doesn't have plugins

Thanks





Introduction to Epanet



Part 2, developing a simple network with Epanet and run a simple analysis

Objectives:

We develop a very simple water supply composed by:

- 1. Source (spring)
- 2. Pump from spring to "elevated" reservoir (25m3)
- 3. Gravity distribution to the village (or refugees camp)
- 4. Distribution points in the village with a given demand

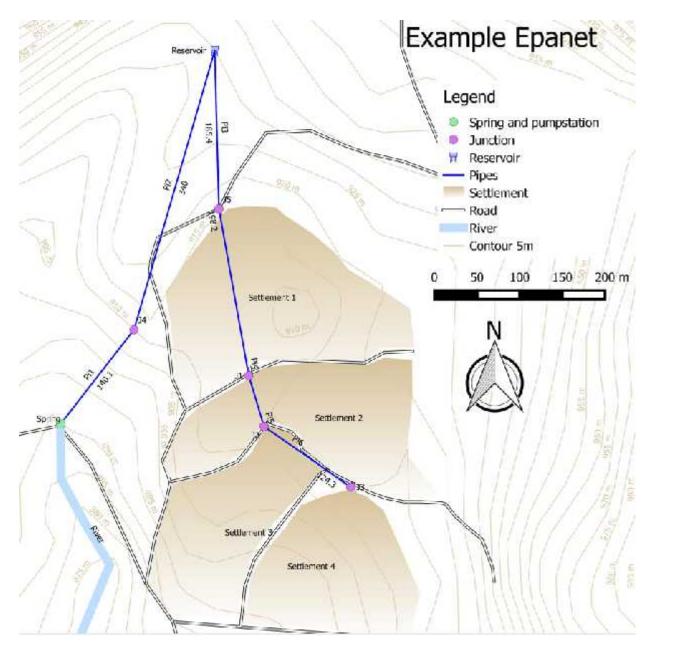
Existing data

- 1. Spring yield and ground elevation
- 2. Pump performance data
- 3. Nodes location and elevation
- 4. Type and length of pipe
- 5. Elevation, type and size of reservoir
- 6. Average water demand at water distribution points over 24 hr (daily water consumption)

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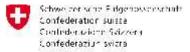
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Necessary data related to the Epanet network

Junction	Elevation (m)	Information
J1	913	Settlement 2; 20 families; 4'000 l/d; 0.0463 l/s
J2	912	Settlement 3; 40 families; 8'000 l/d; 0.0926 l/s
J3	915	Settlement 4; 60 families; 12'000 l/d; 0.139 l/s
J4	910	No demand; joint control valve
J5	916	Settlement 1; 50 families; 10'000 l/d; 0.115 l/s
TOTAL		170 families, 850 individuals, 34'000 l/d, 0.395 l/s
		Round reservoir, 25.1 m3, 4m diameter, 2.5m wall height, ground elevation 930m
Tank	930	(inlet), Elevation overflow 932m.
Spring (R1)	890	Good water quality, seasonal variation on yield, max 15m3/h min 11m3/h
		NB 32-200.1/207 A-F-A-BAQE (6m3/h, h=70m)
		located few meter from spring (see Grundfos webcaps for selection,
Pump (Pu1)	890	www.grundfos.com)
Pipes uPVC		
Pi1		140.1 m (from pump)
Pi2		340.0m
Pi3		185.4m
Pi4		198.2m
Pi5		62.5m
Pi6		124.3m



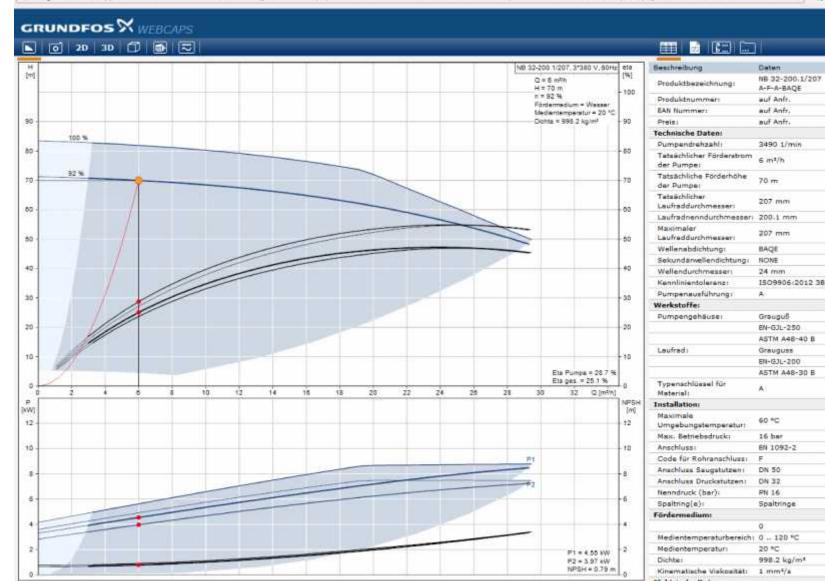
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Pump specification



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4



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			uPVC pipes	5		
Code	ND	Pressure	IntD	С	Pressure	Thickness
	(mm)	Bar	(mm)		m H2O	mm (max)
P20-16	20	16	17.0	140	162.56	1.5
P25-12	25	12.5	22.0	140	127	1.5
P25-16	25	16	21.2	140	162.56	1.9
P32-10	32	10	28.8	140	101.6	1.6
P32-12	32	12.5	28.2	140	127	1.9
P32-16	32	16	27.2	140	162.56	2.4
P40-6	40	6.3	37.0	140	64.01	1.5
P40-10	40	10	36.2	140	101.6	1.9
P40-12	40	12.5	35.2	140	127	2.4
P40-16	40	16	34.0	140	162.56	3
P50-6	50	6.3	46.8	140	64.01	1.6
P50-10	50	10	45.2	140	101.6	2.4
P50-12	50	12.5	44.0	140	127	3
P50-16	50	16	42.6	140	162.56	3.7
P63-5	63	6	59.2	140	60.96	1.9
P63-6	63	6.3	59.0	140	64.01	2
P63-10	63	10	57.0	140	101.6	3
P63-12	63	12.5	55.4	140	127	3.8
P63-16	63	16	53.6	140	162.56	4.7
P75-5	75	6	70.6	140	60.96	2.2
P75-6	75	6.3	70.4	140	64.01	2.3
P75-10	75	10	67.8	140	101.6	3.6
P75-12	75	12.5	66.0	140	127	4.5
P75-16	75	16	63.8	140	162.56	5.6
P90-5	90	6	84.6	140	60.96	2.7
P90-6	90	6.3	84.4	140	64.01	2.8
P90-10	90	10	81.4	140	101.6	4.3
P90-12	90	12.5	79.2	140	127	5.4
P90-16	90	16	76.6	140	162.56	6.7
P110-6	110	6.3	104.6	140	64.01	2.7
P110-10	110	10	101.6	140	101.60	4.2
P110-12	110	12.5	99.4	140	127	5.3
P110-16	110	16	96.8	140	162.56	6.6
P125-6	125	6.3	118.8	140	64.01	3.1
P125-10	125	10	115.4	140	101.60	4.8
P125-12	125	12.5	113.0	140	127	6

It is important to know the type/brand and their properties of the pipes you are using.

Providers usually have that information.



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Water supply schema example

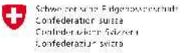


Download and installation of Epanet

1.Download Epanet at http://epanet.de/2.Install Epanet (works in Windows, Apple, Linux) in several languages

Epanet is free program, developed (v1 2003), no plugins possible.

There are many other similar programs like WaterCad (commercial), Branch (open source in DOS), WatDis (free with plugins in CD) and others.



Introduction to Epanet



Basic main configuration of Epanet

Defaults / ID labels

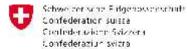
1.Open Epanet

2.Select Project | Default

3.ID labels

Set the parameters accordantly

Reservoirs R Fanks T Pipes Pi Pumps Pu /alves Va	Object	ID Prefix	
Tanks T Pipes Pi Pumps Pu /alves Va	Junctions	J	
Pipes Pi Pumps Pu /alves Va	Reservoirs	R	
Pumps Pu /alves Va Patterns I	Tanks	T	
/alves Va ⁹ atterns	Pipes	Pi	
Patterns	Pumps	Pu	
	Valves	Va	
Curves	Patterns		
1.00000000	Curves		
D Increment 1	D Increment	1	



Introduction to Epanet



Program configuration

Defaults / Properties

4. Select the default parameter as per convenience

Property	Default Value	
Node Elevation	910	
Tank Diameter	4	
Tank Height	2.5	
Pipe Length	100	
Auto Length	Off	
Pipe Diameter	45.2	
Pipe Roughness	140	



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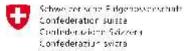


Program configuration

Defaults / Hydraulics

5. In the windows "Hydraulics" select "Flow Units" with the unity you prefer i. LPS (liter per second)

Option	Default Value	
Flow Units	LPS	*
Headloss Formula	H-W	
Specific Gravity	1	
Relative Viscosity	1	
Maximum Trials	40	
Accuracy	0.001	
If Unbalanced	Continue	
Default Pattern	1	
Demand Multiplier	1.0	-
Z Save as defaults for		



Introduction to Epanet



Program configuration

Defaults / Hydraulics

6. Select the head loss formula you prefer

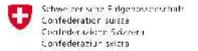
- a) Hazen-Williams (H-W) b) Darcy-Weisbach (D-W)
- c) Chezy-Manning (C-M)

The Hazen-Williams formula is the most commonly used head loss formula in the US. It cannot be used for liquids other than water and was originally developed for turbulent flow only.

The Darcy-Weisbach formula is the most theoretically correct. It applies over all flow regimes and to all liquids.

The Chezy-Manning formula is more commonly used for open channel flow.

Option	Default Value	
Flow Units	LPS	-
Headloss Formula	→ (H-W)	
Specific Gravity	1	
Relative Viscosity	1	
Maximum Trials	40	
Accuracy	0.001	
If Unbalanced	Continue	
Default Pattern	1	
Demand Multiplier	1.0	,



Introduction to Epanet



Help

Program configuration

7. Put the relative viscosity in relation to the average temperature $\sqrt{}$

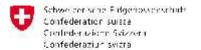
Save all as default for all projects

Temperatura agua	Viscosidad relativa al agua de 20°C						
1	1.72	26	0.87	51	0.586	76	0.436
2	1.666	27	0.852	52	0.58	77	0.43
3	1.612	28	0.833	53	0.574	78	0.424
4	1.558	29	0.815	54	0.568	79	0.419
5	1.504	30	0.796	55	0.562	80	0.413
6	1.463	31	0.782	56	0.556	81	0.407
7	1.421	32	0.767	57	0.55	82	0.401
8	1.38	33	0.753	58	0.544	83	0.395
9	1.338	34	0.738	59	0.538	84	0.389
10	1.297	35	0.724	60	0.532	85	0.383
11	1.265	36	0.709	61	0.526	86	0.377
12	1.232	37	0.695	62	0.52	87	0.371
13	1.2	38	0.68	63	0.514	88	0.365
14	1.167	39	0.666	64	0.508	89	0.359
15	1.135	40	0.651	65	0.502	90	0.353
16	1.108	41	0.646	66	0.496	91	0.347
17	1.081	42	0.64	67	0.49	92	0.341
18	1 054	43	0.634	68	0.484	93	0.335
19	1.027	44	0.628	69	0.478	94	0.329
20	1	45	0.622	70	0.472	95	0.323
21	0.978	46	0.616	71	0.466	96	0.317
22	0.956	47	0.61	72	0.46	97	0.311
23	0.933	48	0.604	73	0.454	98	0.305
24	0.911	49	0.598	74	0.448	99	0.299
25	0.889	50	0.592	75	0.442	100	0.293

ID Labels Properties		
Option	Default Value	
Flow Units	LPS	
Headloss Formula	H-W	
Specific Gravity		
Relative Viscosity	1.081	
Maximum Trials	40	
Accuracy	0.001	
lf Unbalanced	Continue	
Default Pattern	1	
Demand Multiplier	1.0	121

OK

Cancel



Introduction to Epanet



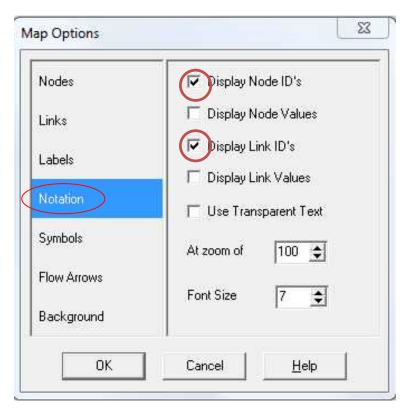
Configuration of map (layout)

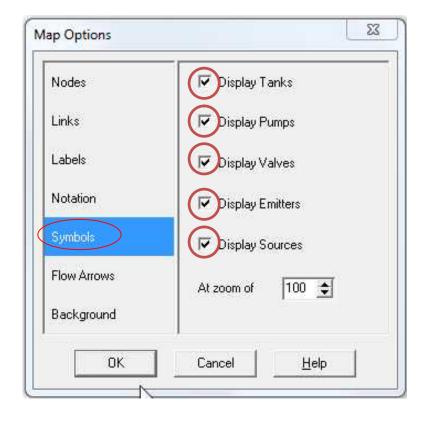
1.Select View | Options.

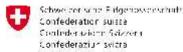
2.Select Notation (it displays the name of the items like link, joints, pump, reservoir, etc.)

3.Select **Symbols** (it displays all the icons of the network)

4. Rest of option are self explaining



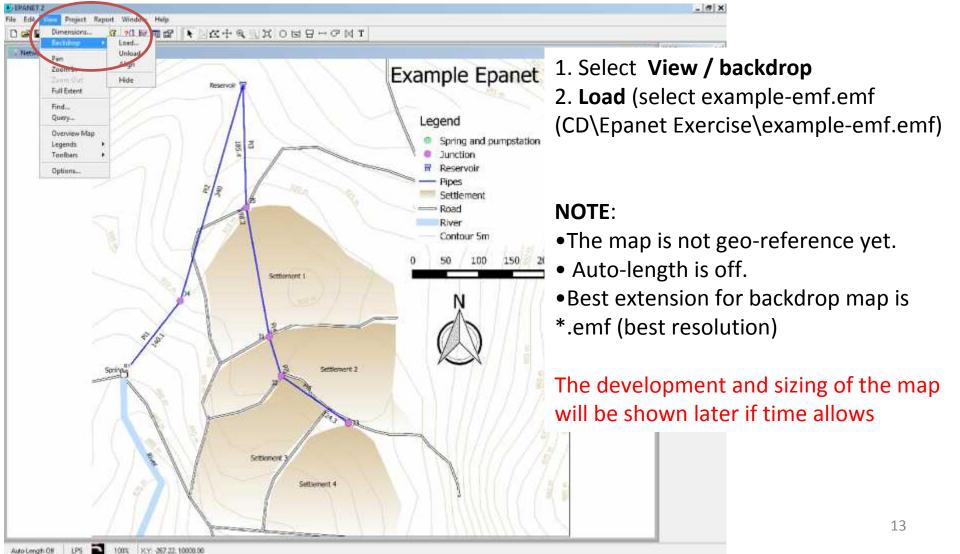




Introduction to Epanet



Insert the backdrop map





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Introduction to Epanet



Drawing the FPANET J File Edit View Project Report Window Help DEEBENXA G NEEDE N CAHQUE OFFORT network LAS BROWLES × Network Map SIC XI 1. Add "reservoir Dala Map Example Epanet Fiecervair: • at the spring. 12 Legend Spring and pumpstation Junction Reservoir (if the toolbar is not a X II Pipes Settlement visible View -> Road River Toolbars ->Map). Contour 5m 100 150 200 m Settlement 1 Settlement 2 Settlement 3 Settlement 4 14 Auto-Length 07 LPS 1001 X.Y 3794 54, 9964 37

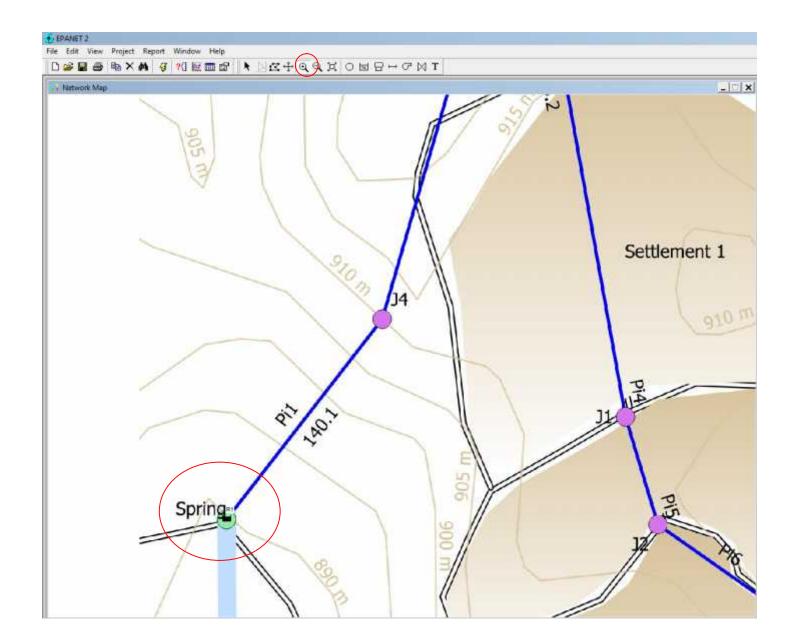


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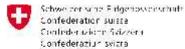
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<u>Drawing the</u> <u>network</u> Eventually zoom in



Introduction to Epanet



Drawing the network

1. Click twice on the R1 and the parameters setup of the spring (reservoir) appears

Coordinates do not play a role yet Important you put the elevation (*Total Head) (in meter) of the outlet of the spring.

(considering the dropdown in case of a BH)

Reservoir R1	
Property	Value
*Reservoir ID	R1
X-Coordinate	663.20
Y-Coordinate	3411.95
Description	Sping "Brenno"
Tag	
*Total Head	830
Head Pattern	
Initial Quality	
Source Quality	
Net Inflow	#N/A
Elevation	#N/A
Pressure	#N/A
Quality	#N/A



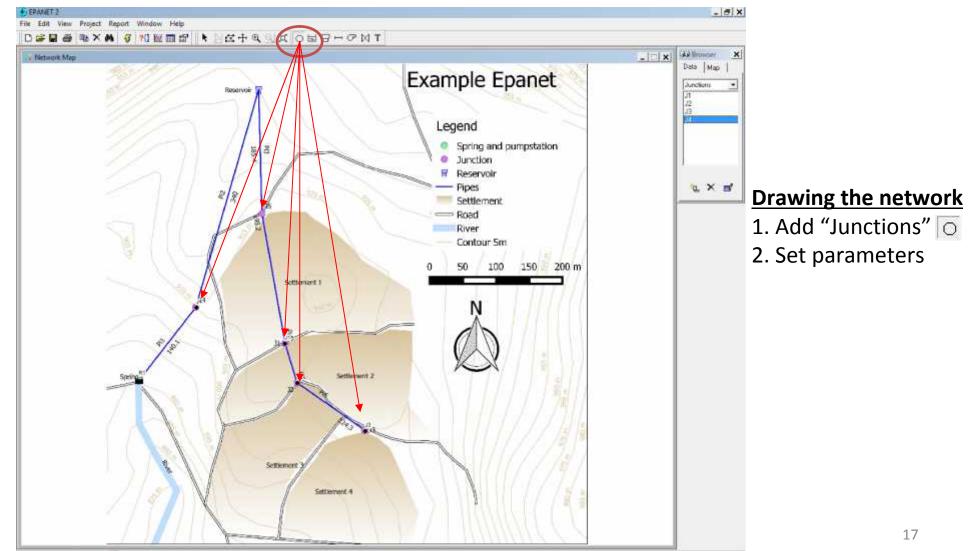


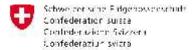
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Introduction to Epanet







Drawing the network

Introduction to Epanet



2. Set parameters for the junctions

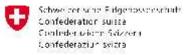
lunction /I	
Troperty	Vale
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o Charlindic	1000.52
~Coordinate	4152.40
Description	Shirement 2
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'E exclion	513
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leical Circlity	
Souce Qualto	
oulvalDa arc	W/4
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Fiercure	-4/6
Luaily	-N/o

Junction .2	×
Property	Value
Cunatur ID	d5
NEcrecipate	0000 01
Y-Cocicinate	337232
Эеранэ. ст	Sottomeri S
Tag	
Elevation	312
Sase Demand	1 1925
Demond Faller	
Demand Caleccie:	1
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alial Qualty	
Source Clusiky	
Actual Demand	₩.eA
Total Here	# 572
Treisure	ms-vA
Judia	W.o.A.

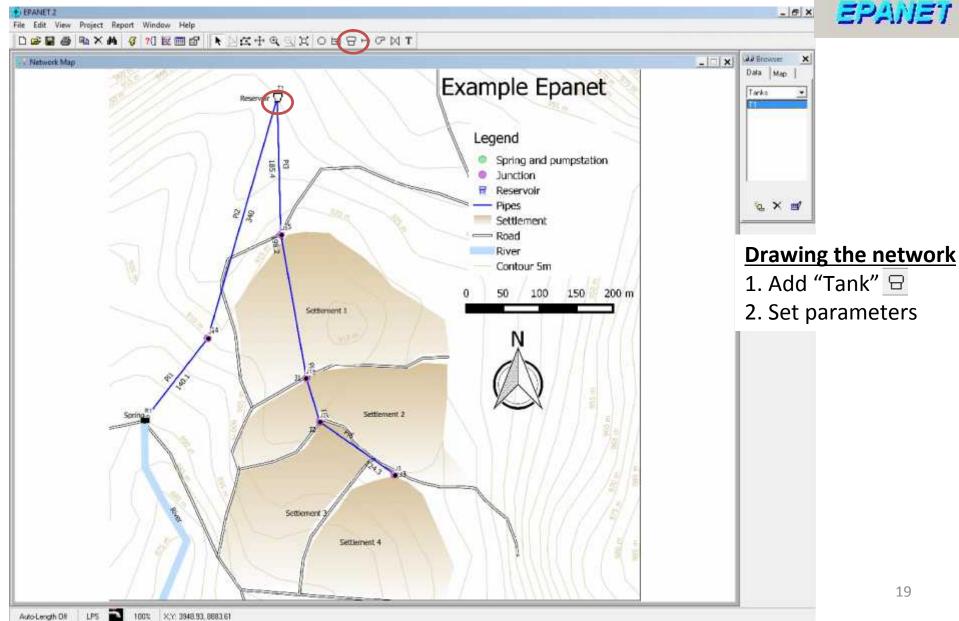
Toperty	Value
110-11-1-1-	dis.
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e Cardinan	5000 5
~Coordinate	13/37
Description	Sottemen 4
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1E existion	315
Babelie and	1 1339
Contane Politiem	
Elemenic Categories	1
Ennia Delli	
leical Circity	
Source Queli:,	
octual Canand	W.0A
TotalFood	#1.02
Fiercure	m -75
Lua Av	W. 74

Jonchon M	
Fickelly	Value
Stunction IC	14
>/-Coordinate	1854 58
Y-Coordinata	4933 32
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DemanJ Pattern	
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Accus Demand	邮站
Luta Head	曲。这
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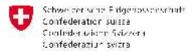
unction 15	
Prontily	Vaua
Nunction IE	35
X-Coordinate	3230,08
Y-Coordinate	6589392
Description	Sattlemant 1
lay	
'Eleval u	516
Sass Demaric	11115
Demand Pallain	
Domand Categorics	i.
Finalles Coolf	
ntial Quality	
Source Quality	
Achun Demerc	=\0/A
Total Head	TN/A
Tressure	7970
Quality	-10/4



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Drawing the network

2. Set parameters for the reservoir

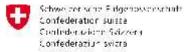
Initial water level in the reservoir 1m

Volume of round tank:

2m X 2m X 3.14 X 2m (height) =25.13m3

Tank T1	X
Property	Value
*Tank ID	T1
X-Coordinate	3161.67
Y-Coordinate	9478.59
Description	
Tag	
*Elevation	930
*Initial Level	1
*Minimum Level	0
*Maximum Level	2
*Diameter	4
Minimum Volume	
Volume Curve	
Mixing Model	Mixed
Mixing Fraction	
Reaction Coeff.	
Initial Quality	
Source Quality	
Net Inflow	#N/A
Elevation	#N/A
Pressure	#N/A
Quality	#N/A

Ev. fire reserve!



File Edit View Project Report Window Help

EPANET 2

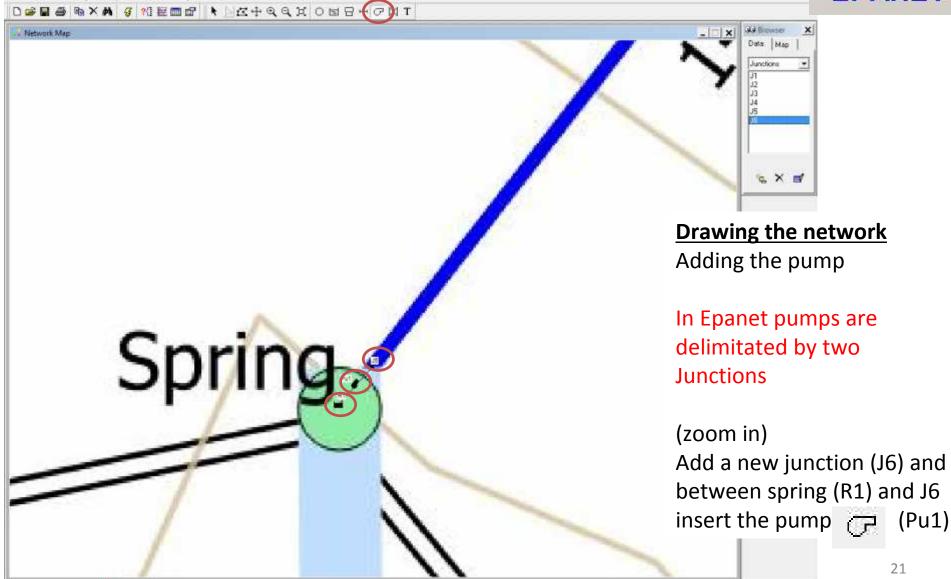
Auto-Length DIT

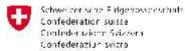
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Introduction to Epanet



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Introduction to Epanet



Adding the Pump

Insert parameter for the Junction (J6) and Pump

Erowser >	Junction J6	Junction J6 X		
sta Mey	Property	Value		
unctions 💌	*Junction ID	J6		
1 2 3	X-Coordinate	796.41		
- 4 E	Y-Coordinate	3445.66		
	Description			
	Tag			
	*Elevation	890		
🍬 🗙 🛃	Base Demand	0		
	Demand Pattern			
Browser 📝	Demand Categories	1		
'umps 💌	Emitter Coeff.			
ni	Initial Quality			
	Source Quality			
	Actual Demand	#N/A		
	Total Head	#N/A		
	Pressure	#N/A		
🙇 x 🛃	Quality	#N/A		

Pump Pu1	×
Property	Value
*Pump ID	Pu1
*Start Node	B1
*End Node	J6
Description	NB 32-200.1/207 A-F-A-BAQE (6m3/h, h=70m)
Tag	
Pump Curve	
Power	
Speed	
Pattern	
Initial Status	Open
Effic. Curve	
Energy Price	
Price Pattern	
Flow	#N/A
Headloss	#N/A.
Quality	#N/A
Status	#N/A



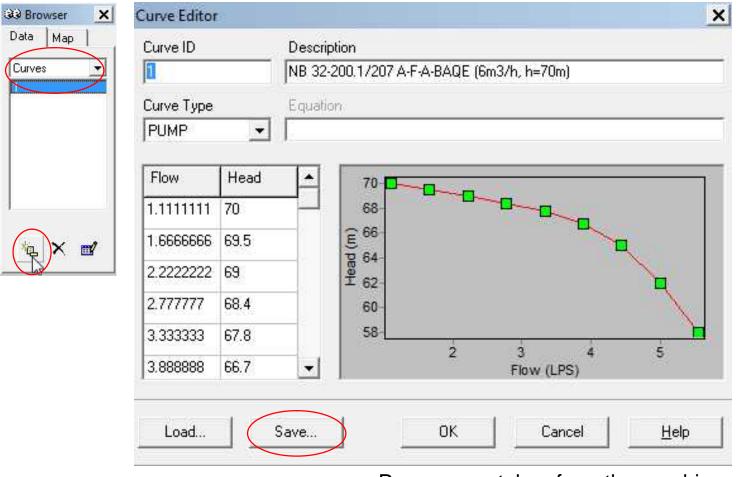
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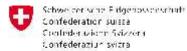
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Create the Pump curve 1



Pump curve taken from the graphic Curve can be saved for future use



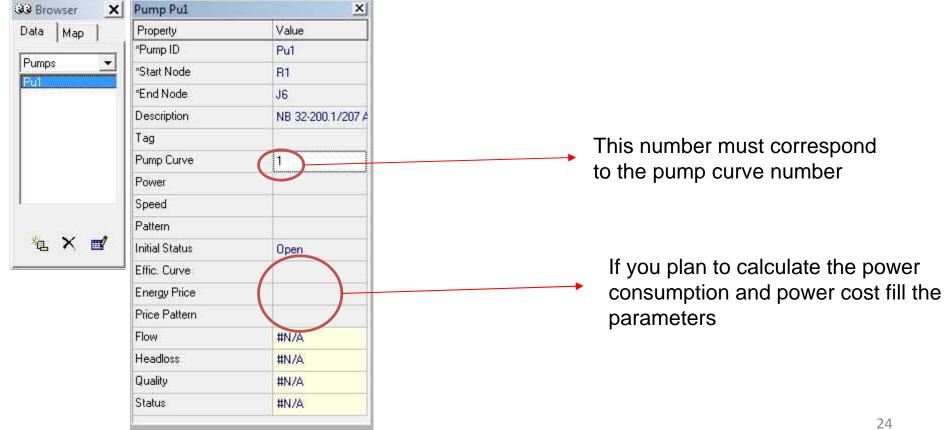
Introduction to Epanet

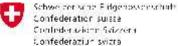


Drawing the network

Adding the Pump

Insert the parameters for pump (Pu1)





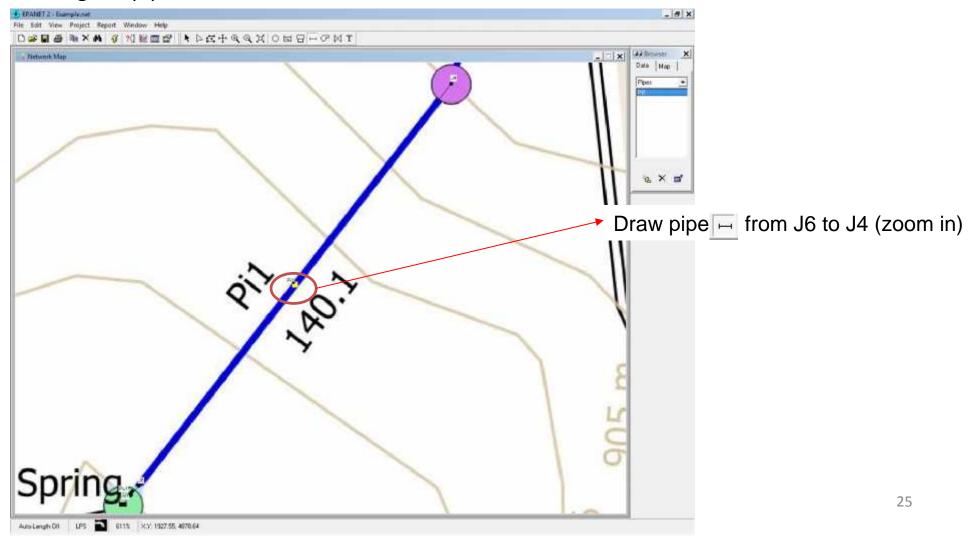
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Drawing the network Adding the pipes





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Introduction to Epanet



Drawing the network

Adding the pipes Insert parameters for pipe (Pi1)

👀 Browser 🛛 🗙	Pipe Pi1	x	
Data Map	Property	Value	
Pipes 👻	*Pipe ID	Pi1	
	*Start Node	J6	
	*End Node	J4	
	Description	uPVC pipe, P63-10	Length given
	Tag		
	*Length	140.1	Estimate the diameter with
	*Diameter	57	
J	*Roughness	140	Q=vA v=Q/A, A=Q/v (v ~ 1-2 m/s)
	Loss Coeff.	0	
[™] a × ∎∕	Initial Status	CV	Roughness depends on type/age of pipe
	Bulk Coeff.		and used formula
	Wall Coeff.		
	Flow	#N/A	
	Velocity	#N/A	Check value restricting flow to one
	Unit Headloss	#N/A	direction
	Friction Factor	#N/A	direction
	Reaction Rate	#N/A	
	Quality	#N/A	Note: Firefighters' regulation Might limit the
	Status	#N/A	size 26
	1		

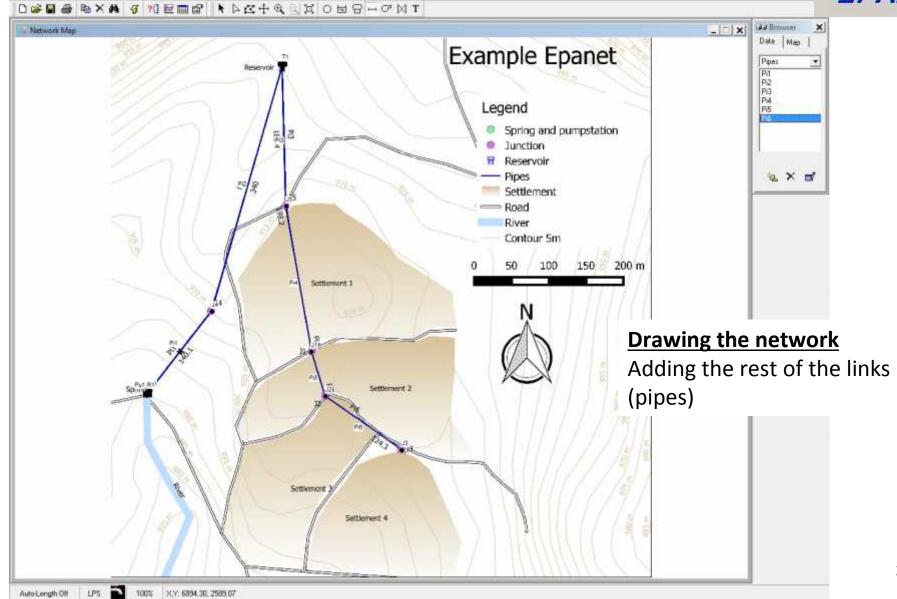


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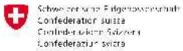
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EPANET 2 - Example.net File Edit View Project Report Window Help









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Drawing the network Insert parameters for pipes

Pipe Pi1	125.0
Property.	Value
*Pipe ID	Pi1
*Start Node	J6
*End Node	J4
Descripton	uPVC pipe, P63
Tag	
*Length	140.1
*Diameter	57
*Roughness	140
Loss Coeff.	0
Inital Status	CV

Pipe P4	finanza i	×
Property	Value	_
*Ppe ID	Pi4	2
*S:art Node	J5	_
*End Node	J1	
Description	P50-10	
Tag		Ī
*Length	198.2	Į.
*Diameter	45.2	
*Roughness	140	Ì
Loss Coeff.	n	l
Initial Status	Open	1

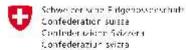
Pipe Pi2	
Piopeity	Value
*Pipe ID	Pi2 ·
*Start Node	J4 –
*End Node	T1
Description	uPVC, P63-10
Tag	
*Length	340
*Diameter	57
*Roughness	140
Loss Coeff.	n
Initial Status	CV .

Pipe Pi5		×
Property	Vaue	
*Pipe ID	PiE	3
*Start Noce	JT	_
*End Node	J2	ľ
Description	uPVC P50-10	
Tag		1
*Lergth	62.5	1
*Diameter	45.2	1
*Roughness	140	
Loss Coett.	0	1
Initial Status	Open	i.

Pipe Pi3		×
Property	Value	
*Pipe IC	P3	đ
*Start Node	T1	_
*End Node	J5	
Description	uPVC P63-10	
Tag		
^Length	185.4	
*Diameter	57	
*Noughness	140	
Loss Ccoff.	0	
Initial Status	Open	0

Piopeity	Value	
*Pipe ID	Pi6	4
*Start Node	J2	-
*End Node	J3	
Description	uPVC P40-10	1
Tag		
*Length	124.3	1
*Diameter	36.2	
*Roughness	140	
Loss Coeff.	0	
Initial Status	Open	

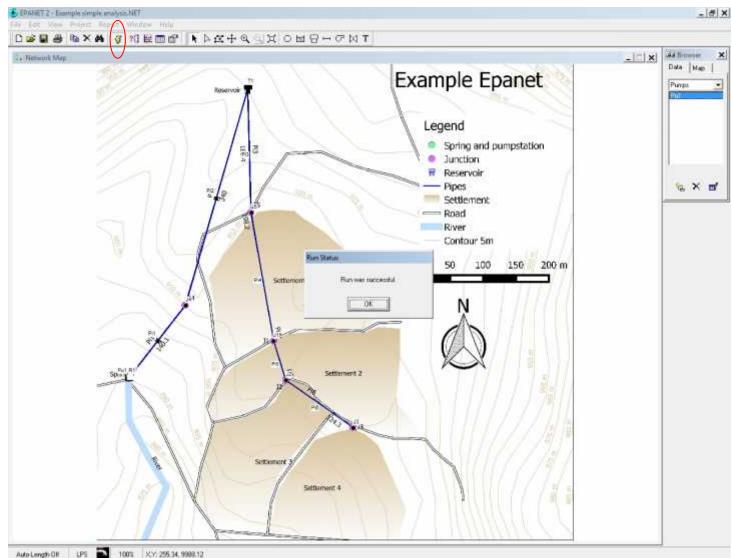
28



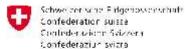
Introduction to Epanet



Running the system (single analysis)



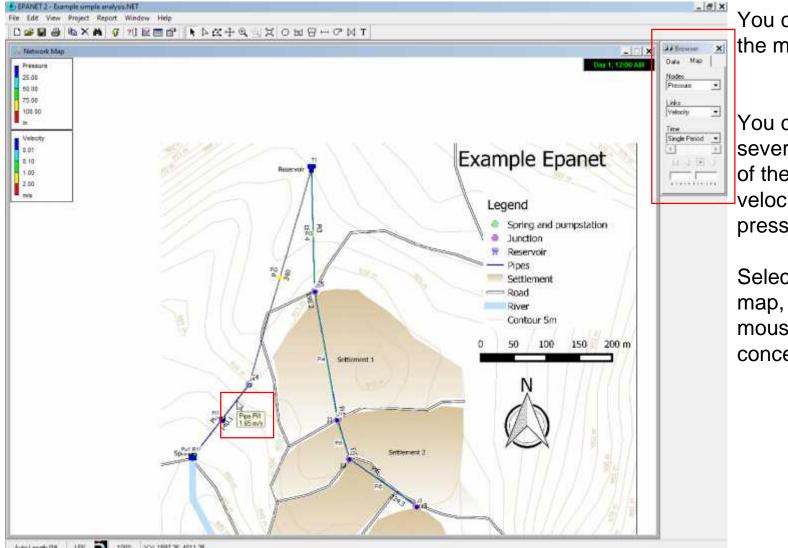
If system desn't work, error message will be displayed and source of error explained



Introduction to Epanet



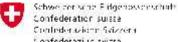
Running the system (single analysis) 3



You can display / hide the map in view menu.

You can display several characteristics of the system i.e. velocity in pipes and pressure at junctions.

Select the browser on map, and fly with the mouse over the concerned item.



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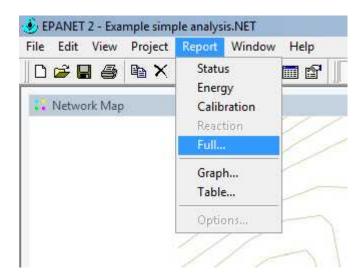
Introduction to Epanet

Example simple analysis - Notepad



Running the system (single analysis) &

Read the full report for full understanding of the system

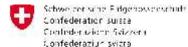


File Edit Format View Help 18.06.2015 14:58:46 Face 1 * FPANFI * uydraulic and water quality analysis for pipe vetworks 4 version 2.0 **********************

Input File: Example simple analysis. NET

L ink ID	Start Node	En				Length	Di an	eter	
r if.	16	14				140.1		57	
ri2	-4	τ1				340			
r 13	11	75				185.4		57	
114	5	11				198.2		45.2	
1:15	11.	12				62.5		45.2	
F16	17	13				174.3		76.7	
FUT	RL	79	ŝ.			#N/A		#N/A	PUM
Energy usage:									
Pump	Usage Factor E	Avg. ffic.	Kw /m	i-hr Is	A1 K)	(g.	Peak KW	/6	Cost
Pul	100.00	/5.00	0	. 24	\$.	61	3.61		0.0
					De	mand Cha Cal Cost	urge: .i		0.0
Node Results;									
TviHit!						Quality	63 - E		
מד	10				811				
11	0.0	15 93 19 91 4 93 10 94	0.67	1	7.67	0.00	2		
17	0.0	9 91	0.61	1	8.67	0.00			
10	0.1	4 90	0.52	1	5.52	0.00	8		
14	0.0	0 94	8.52	2	8.52	0.00	51		
J5					4.88	0.00			
36	0.0	0 95	5.74	6	5.74	0.00	ALVIN N		
RI	-4.2	0 89	0.00		9.00	0.00	Rese	rvorr	
ті	3.8	1 93	1.00		1.00	0.00	Tank		
Page 2 Link Results;				1422-00	202343			20.522	2011
L ink TD	Flo iP	w Velo S	cityt "/	In L H	read for m/kim	is SLa	Lus		
e it	4.2			5	1.54	Oper	1		
r 12	4.2	0	1.65	5	1.54	Oper	1.		
113	0.3	0	0.15		0. 64	oper	10		
+14	0.7		0.17		1.04	oper			
H15	0.2		0.14		0.74	open			
F16	0.1	4	0.13		D.85	oper			
PUL	4.2	0	0.00	-6	5.74	open	Fump		

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Introduction to Epanet



Running the system (single analysis)

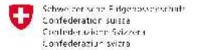
The single analysis helps you to identify the main characteristics and ev. misstakes on the system, but doesn't give you a realistic overview of the behaviour of your system over time.

An analysis over time (i.e. 3 days; 72 hs) helps you to understand better the system.

For such analysis, we need to develop pattern (behaviour changes over time)

This after the break

Thanks



Introduction to Epanet

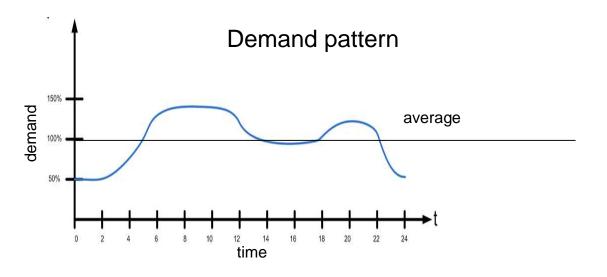


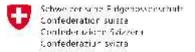
1

Part 3, developing a simulation over time with Epanet

The network previously developped was simulated in a single time period. The demand and the pump behaviour was considered as constant over time. A rather unrealistic situation!

In reality, the demand varies during the day (i.e. with peak's demand in the morning between 6 and 12 and afternoon from 18 to 22) and the pump works only max 6 hours in a day.





Introduction to Epanet

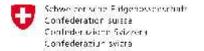


Simulation over a time

• Epanet allows simulation of constant flow, only

•Therefore, a simulation over longer time with different constant flows allows to analyse different behaviours of the same network.

For this purpose we have to create time pattern.
 Pattern for the demand
 Pattern for the pump's running times

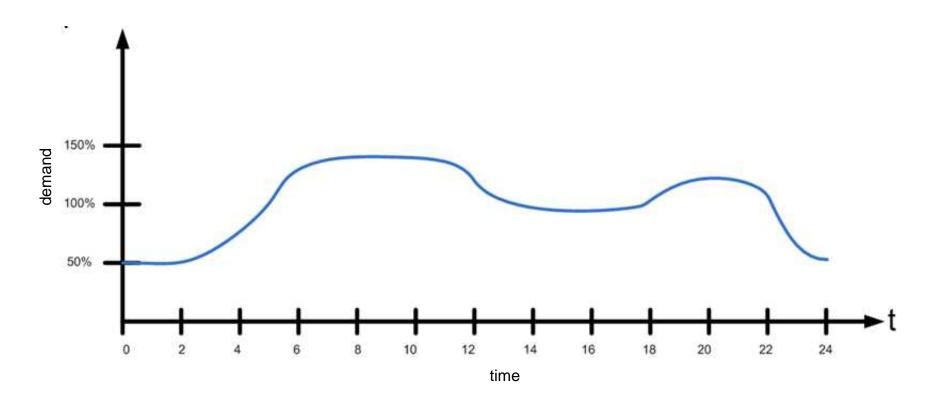


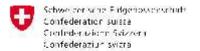
Introduction to Epanet

Simulation over a time



For our demand example, a 2 hours long pattern is used (24hr / 2 = 12 hrs period time. With this pattern you can modify the behaviours max 12 times during the day.





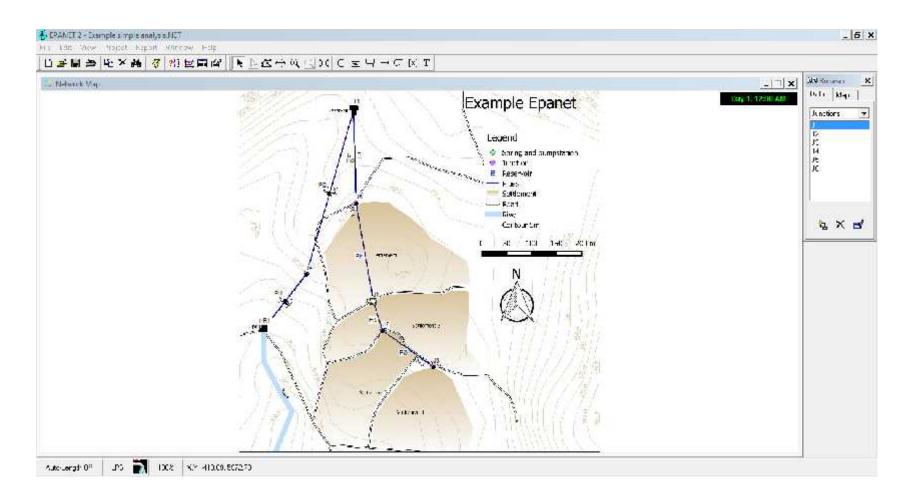


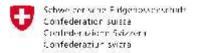
4

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Simulation over a time

Open with Epanet your previous exercise and save it with a different name, i.e. example time analysis.

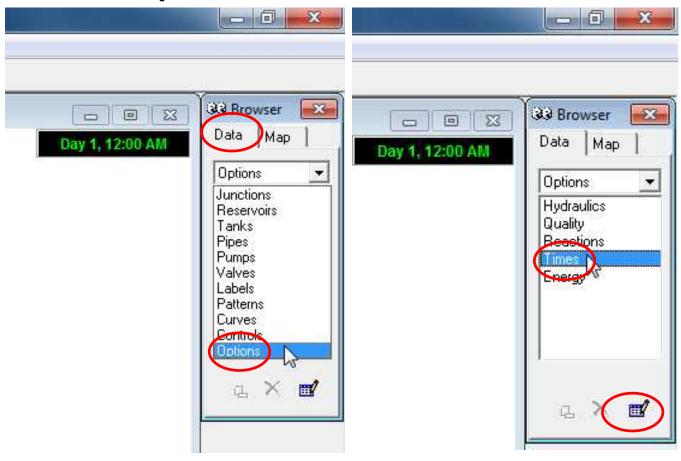




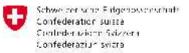
Introduction to Epanet

Simulation over a time (Pattern Time Step)

1. Select **Options - Times** from **Data Browser -> Edit**









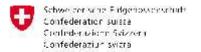
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Simulation over a time

3. Write 2 for the value of "Pattern Time Step"

Every 2 hours the behaviour changes. It can be from 1 to 12

Times Options	X
Property	Hrs:Min
Total Duration	72
Hydraulic Time Step	1:00
Quality Time Step	0:05
Pattern Time Step	2
Pattern Start Time	0:00
Reporting Time Step	1:00
Report Start Time	0:00
Clock Start Time	12 am
Statistic	None



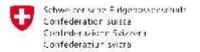
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Simulation over a time



4. Write **72 (hours, 3 days) in "Total Duration"** field. This will be the period length of the simulation.

Times Options	
Property	Hrs:Min
Total Duration	72
Hydraulic Time Step	1:00
Quality Time Step	0:05
Pattern Time Step	2
Pattern Start Time	0:00
Reporting Time Step	1:00
Report Start Time	0:00
Clock Start Time	12 am
Statistic	None



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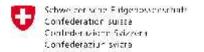
Simulation over a time

Develop the time pattern

1. Select in the Browser / Patterns and add a new pattern

¥9 Brows Data ∤	ier Map	×
Patterns		
	× -	Q



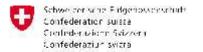


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Simulation over a time

The Pattern Editor will appear, with per default pattern ID 1. You can add a description (optional)

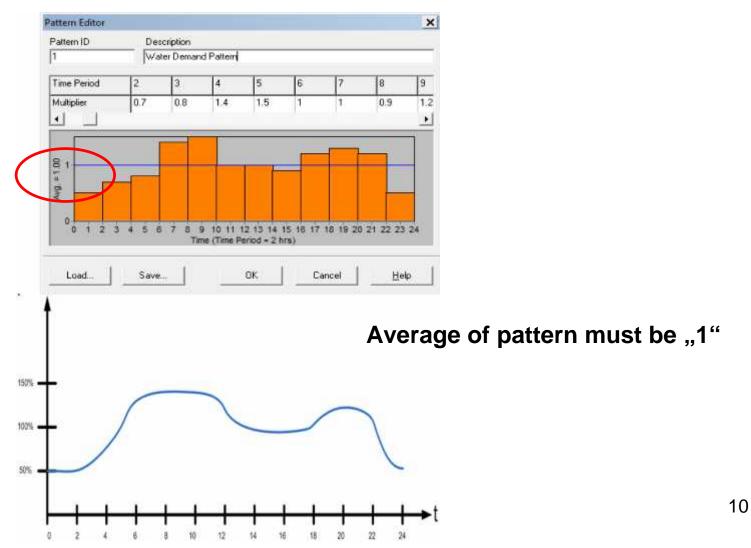




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Simulation over a time

You will add the multiplier of the demand in function of the estimated behaviour





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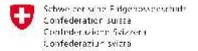
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Introduction to Epanet



For each junction where there is a demand you must specify the pattern J1, J2, J3 and J5 $\,$

Junction J1		X	Junction J2		×	Junction J3		x	Junction J5		×
Property	Vaue		Property	Value		Property	Value		Process	Value	
*Juncton ID	1.	*	"Juncturi ID	.12	-	Nunction IL	J3		"lunction ID	.5	
X-Conicinate	3699.52	-	X-Upoicinate	3960 81		X-Coorcinate	5369.51		X-Coordinale	3230.06	
Y-Coolcinate	4192.40		Y'-Coorcinate	3372.92		Y Cooicinato	2070 71		Y-Coordnale	6835.30	
Description	Settlement 2		Description	Settlement 3		Description	Setilement 4		Description	Settlemen: 1	
Tag			Tec			Tag			Tag		
*Elevation	010		^≓ evation	512		"Elevation	មាច		*Elovation	910	
Ease Demand	2.0463		Ecse Domand	C 0020		Dase Demand	0.389		Blase Elemend	U 1° 57	
Liemand -'a:tein	1		Demand Partein		10	Jemand Pattern	1	_	Deman, ^e allein		1
Demand Dategories	T		Domand Catogories	Ţ		Demand Categories	T		Domane Categories	$\mathbf{\nabla}$	
Emitter Coeff			Emiter Coeff.			≃miltei Coelt.	1		Emilter Coefi.		
Initial Quality			Incial Quality			nitial Quality			Initial Quality		
Source Quality		- 1	Scurce Quality		+1	Source Quelity		-1	Source Quality		-

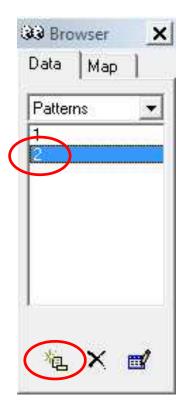


Introduction to Epanet



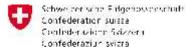
Pattern for the pumping time

We assume that the pump pumps once a day for 6 hours. It starts at 8.00 and stops at 14.00. Add a second Pattern for the pump (Pattern 2)



Average must not be 1 as like the demand

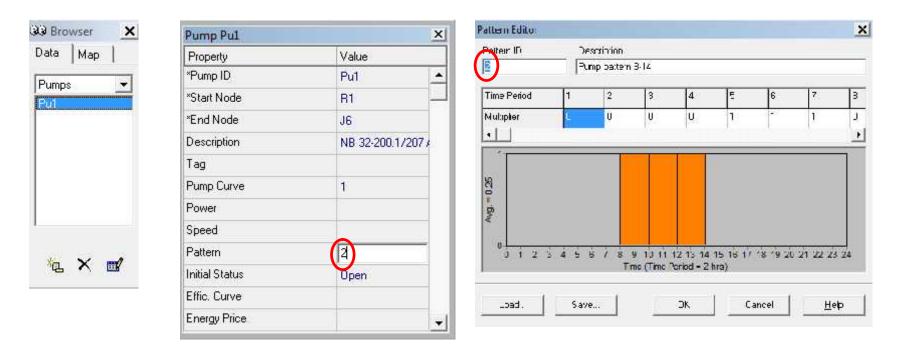
Pattern ID		escription	wa 11					
2	Pu	mp pattern	8-14					
Time Period	3	4	5	6	7	8	9	10
Multiplier	0	0	1	1	1	0	0	0
ALC: NO				•		0	0	- P.
Avg. = 0.25])





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Insert the pattern n° at the pump parameter





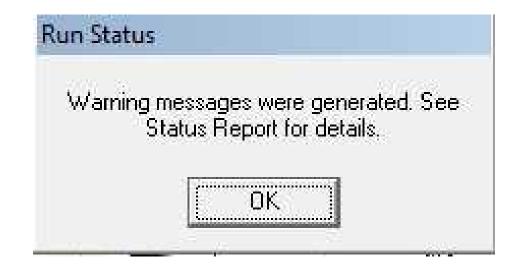
Schweiden sone Filgenossenschaft Confederation suisse Confinder widen Svizzena Confiederazion Svizzena

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Introduction to Epanet







OK to see the error



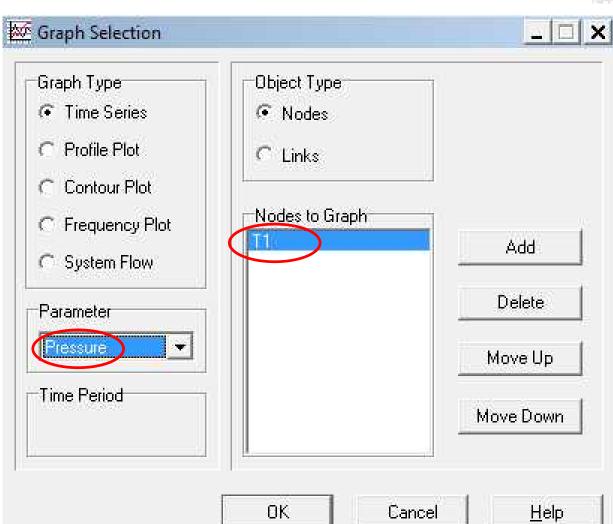
Schweizer sone Eidgenossenschaft Confederation Suizze Confinderations Suizzera Confiederazion Svizze

Introduction to Epanet

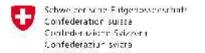
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Look at the graph for the tank T1 clicking



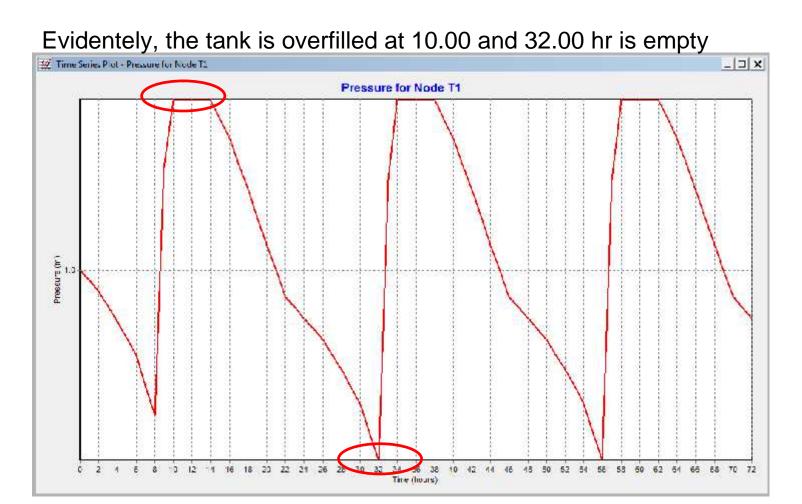




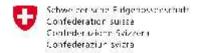


Introduction to Epanet





In this case, either you make a bigger tank or or change the pump Pattern.

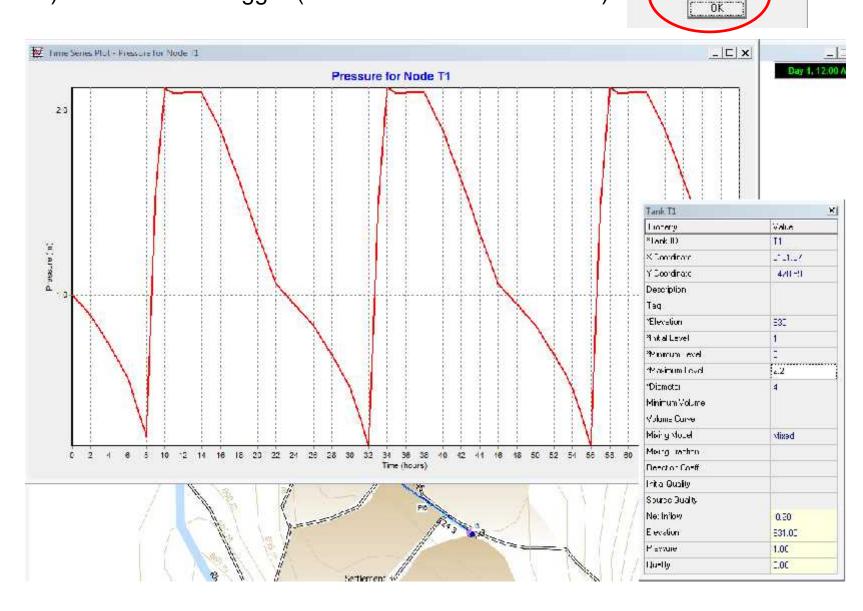


Introduction to Epanet

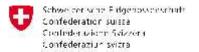
Burr was au acessiul



A) Make the tank bigger (Hmax 2.2m Volume 27.6m3)



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Introduction to Epanet

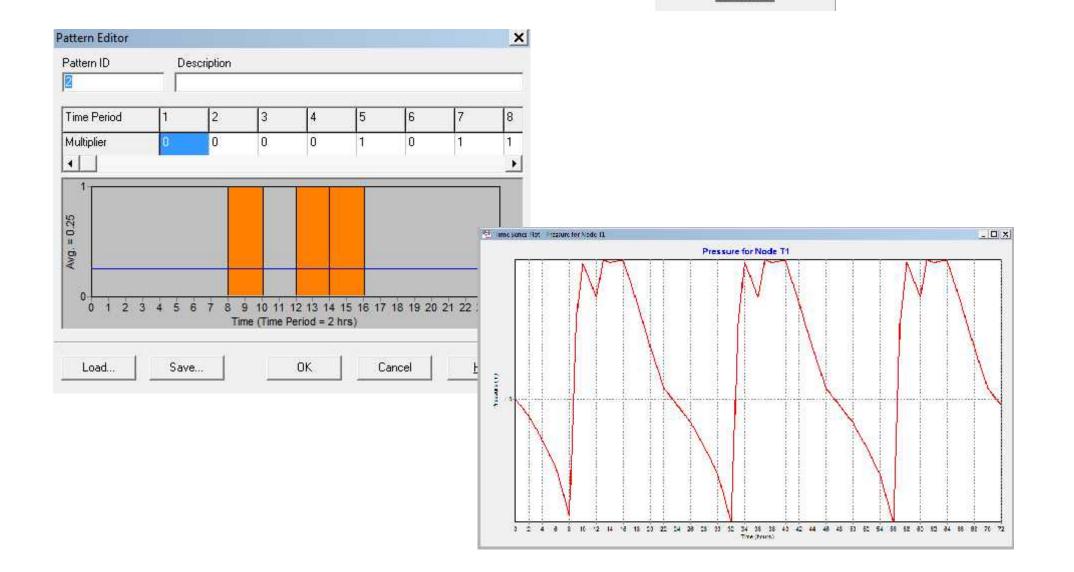
Run Status

Burr was au prezalul

OK



B) Change the pattern of the pump





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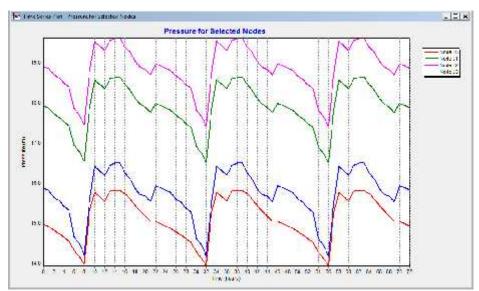
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Introduction to Epanet

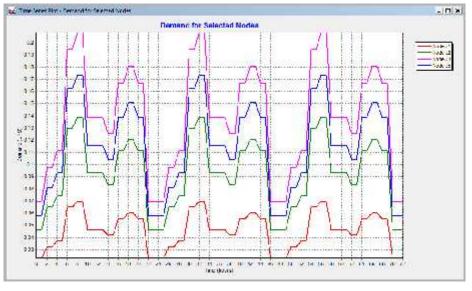


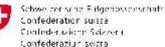
Each element of the network can be analized over time, grafically or with report/tables

Pressure behaviour at Junctions



Demand behaviour at Junctions





Introduction to Epanet

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Page 1	19.06.2	015 08:56:49
*	FPANEL	*
8	Everaulic and water quality	
8	enalysis for pipe Networks	8
k and the and the sta	Version 2.0	eranon erandik
*******	********************	*****

Imput File: Example Line analysis. NET

Link - Node Table:

Link ID	Start Noce	En: No:		Leng	th Dia m	neter mm
Pil Pi2 Pi3 Pi3 Pi4 Pi5 Pi5 Pu1]Ь]4]]5]1 17 к1	34 T1 35 31 32 13		140 185 193 62 174	40 .4 .2 .5	5/ 5/ 57 45.2 45.2 16.7 #N/A Pump
inengy usad	10:					
Punp	nactor t	Avg.	Kw tir /u3	AND. Kw	E chak Kw	Card /day
Pu1	25.00	75.00	0.32	1.56	5.12	0.00
				Demand Total C		0.00

Node Results at 0:00 Hrs:

Node ID	Demand LPS	Head M	Pressure	Quality
11	C. 02	930, 91	17.91	0.00
J1 J2	C. 05	930.90	18.90	0.00
13	0.07	930.87	15.87	0.00
14	0.00	911.00	21.00	0.00
15	0.06	930. 07	14.97	0.00
16	0.00	00.156	41.00	0.00
01	0.00	890.00	0.00	0.00 Reservoir
T1	0.20	931.00	1.00	0.00 Tank

2

Page 2 Link Results at 0:00 Hrs:

ink Flow VelocityUnit Headloss Status					
	Link	FOW	VelocityUnit	Headloss	Status
D IPS m/s m/km	L I HR.	E CW			Status

ID	LPS	m/s	m/ km		
Pil	0.00	0.00	0.00	Open	
Piz	0.00	0.00	0.00	Open	
PiJ	0.20	0.08	0.18	Cpen	
P14 P15	0.14	0.09	0.29	Open	
P15	0.12	0.07	0.21	open	
P16	0.07	0.07	0.24	open	
Pul	0.00	D. 00	0.00	Closed Pump	

Node Results at 1:00 Hest

Mode	Designated	Hend	Enclosupe	Quality.
TD	1 P5	m	11	

Full report

Table report III Network Table - Nodes at 8:00 Hrs Demand Head Pressure

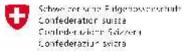
Node ID	LPS	m	m	
June J1	0.07	929.54	16.54	0.00
June J2	0.14	929.44	17.44	0.00
June J3	0.21	929.22	14.22	0.00
June J4	0.00	955.70	45.70	0.00
June J5	0.17	929.98	13.98	0.00
June J6	0.00	966.20	76.20	0.00
Resvr R1	-5.14	890.00	0.00	0.00
Tank T1	4.55	930.23	0.23	0.00



- 0 ×

Quality

20



Introduction to Epanet

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Note:

Valves 🕅 are not installed in this example. Valves need to be installed between two Junctions Epantet considers 6 types of valves:

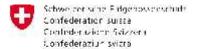
- •PRV Pressure Reducing Valve
- •PSV Pressure Sustaininb Valve
- •PBV Pressure Breaker valve
- •FCV Flow Control Valve
- •TCV Throttle Control Valves
- •GPV General Purpose Valve

For setting and info about the use and parameters of the valves see Epanet user manual

Flow control valve are included in the parameter of the pipes

Pipe Pi2	×
Property	Value
*Pipe ID	Pi2
*Start Node	J4
*End Node	T1
Description	uPVC, P63-10
Tag	
*Length	340
*Diameter	57
*Roughness	140
Loss Coeff.	0
Initial Status	
Bulk Coeff.	
Wall Coeff.	





Introduction to Epanet



Note: Fire Water request:

To determine the maximum flow available at a particular pressure, set the emitter coefficient at the node to a large value (e.g., 100 times the maximum expected flow) to the node's elevation. After running the analysis, the available fire flow equals the actual demand reported for the node minus any consumer demand that was assigned to it.

Each country might have its own regulation!

Wasserbedarf gemäss Schweiz. Feuerwehrverband

Wasserbedarf für die Brandbekämpfung gemäss Schweiz. Feuerwehrverbund:

Gefährdungskladse	- 161.	Kat	Oberbeuungsart.	sart Anz. Rohre		Erforderliche Wasserlieferung Inn 3.5 bar		Min. Lösch- reserve
				50.	¥0	Umin	Std	m3
Kleinrisiken	1	1	Einzelnes Wohnhaus	2	10	600	74	30
Einzelobjekte		2	Einzeines landwirtschaft- liches Gut	2-3	12.5	750	1	50
		3	Weiler mt offener Bau- weise	3	15	900	11/2	100
		4	Kleines Dorf mit offener Bauwoise	4	20	1200	11/2	125
Mittelrisiken	8	6	Dorf mit effener Bauwel- se	5	25	1500	17/4	160
Wohn- and Gewerbe- zone	2	6	Dorf mit teilweise ge- schlossener Bouweise	6	30	1800	2	200
		7	Städtische Quartiere und Dörfer mit Gewerbezo- nen	8	40	2400	2%	300
Grossrisiken	m	8	Städtische Überbauung	10	50	3000	$2^{t}h$	450
lefthrdungsklasse	KI.	Kat	Oberbauungsart	Anz. Robre	Erlorde Wasserl bei 3.	etoning	Eh- satz- dauer	Min. Löszh- teserve
				SB.	89	Vinin		m3
Seschlossone Über- wuungen - Städte		9	Stadtgebiete, Warenhäu- ser, Grosshotels, Thea- ter, Spitälor, Industriezs- nen ohne Sondernisiko	12	60	3600	810 2 ³ /4	600
		10	Stadigebieto mit hoher Brandgefährdung, wie Altstadt, Hochhäuser, Industriezonen mit Son- derrisiken (Chomiebo- triebe, Lagenduser usw.)	16	80	4800	3	800

Script, Zurcher Hochschule für Angewanhte Wissenshaften, Wintertur Trinkwasserversorgung, Page 29

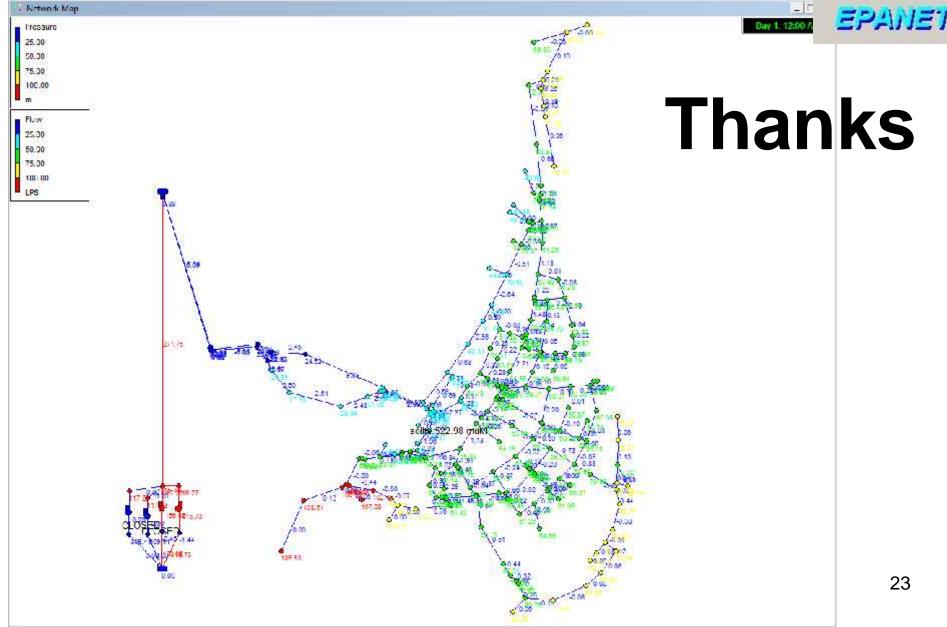


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Introduction to Epanet







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Backdrop map for Epanet

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Objective:

Produce a back drop map for Epanet

•A map is existing, you want to make the backdrop and introduce it (not geo – referenced) in Epanet



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Geo-reference Epanet with qGis

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• Scan the map and save it in *. Jpeg format.

 Open it with Irfanview* and save it as *.emf format (you might use other software)

emf format = Enhanced Windows Metafile

metafiles work better since they will not loose resolution when re-scaled.

*Irfanview = Free software at <u>www.irfanview.com</u> (available in CD, software folder)

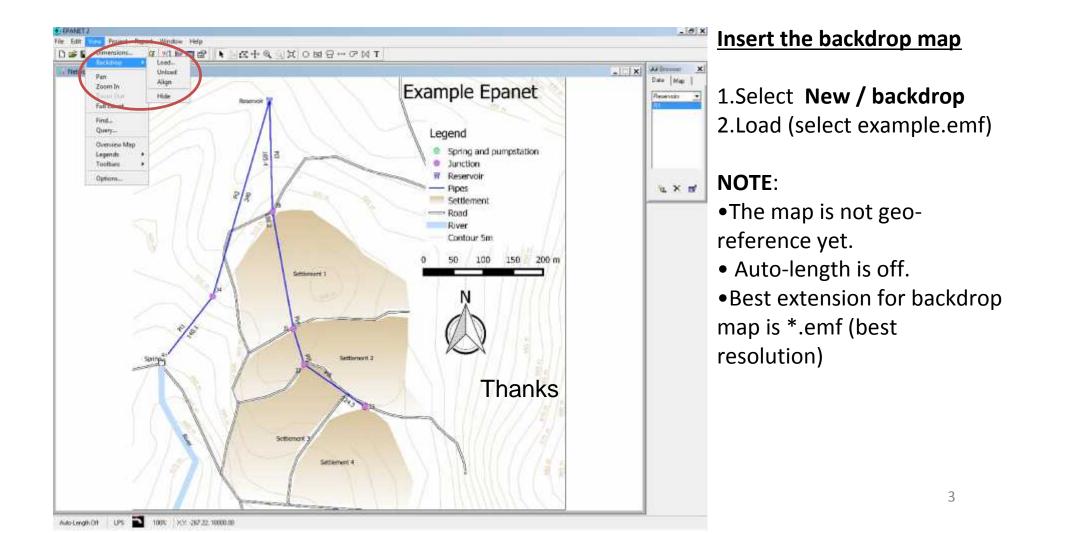


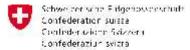
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Introduction to Epanet







Geo-reference backdrop map in Epanet

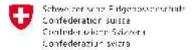


Introduce a geo-referenced backdrop map in Epanet and use auto-length on for drawing the network

- You have the map with scale bar on paper and scanned.
- •You do not have shape files and do not know how to use GIS (time to learn it *©*).

• You want to use the back drop map and draw the junctions and pipes direct into Epanet using **auto-length on** without typing (knowing) the exact coordinates of the points and the length of the pipes.

•Elevation of the junctions is either known or the map has contour lines.

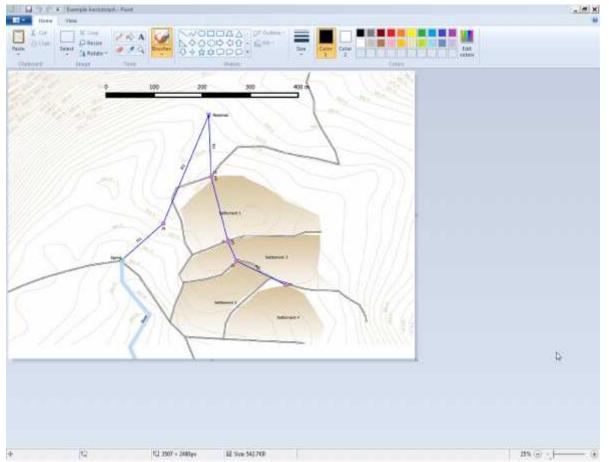


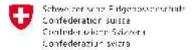
Geo-reference backdrop map in Epanet

Step1

Open the scanned map with any raster graphic editor (i.e. MS paint, Photoshop)

The scale bar **MUST** be visible

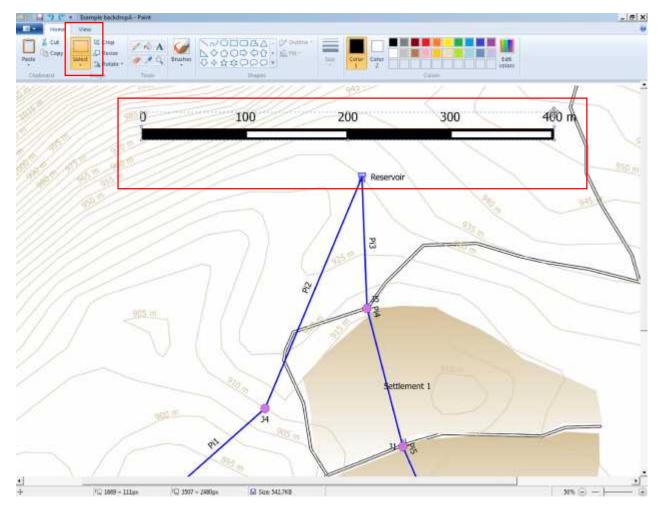


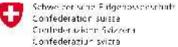


Geo-reference backdrop map in Epanet

Step2

Select with select tool the scale bar as precise as you can (zoom in as best you can) and copy the selection (alt ctrl c).

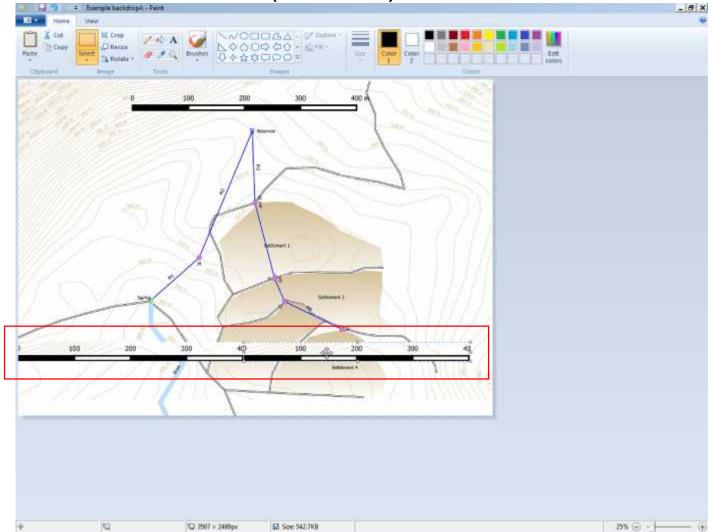


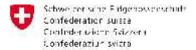


Geo-reference backdrop map in Epanet

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<u>Step3</u> Paste the selection (alt ctrl v) as shown below

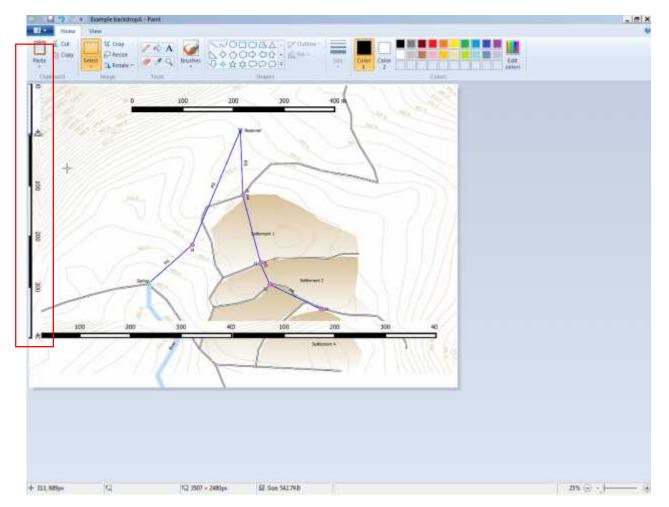


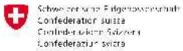


Geo-reference backdrop map in Epanet

Step4

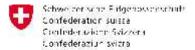
Rotate the selected scale bar of 90° and paste it as below Now you have the dimension of the map (x=800m X y=500m)





Geo-reference backdrop map in Epanet

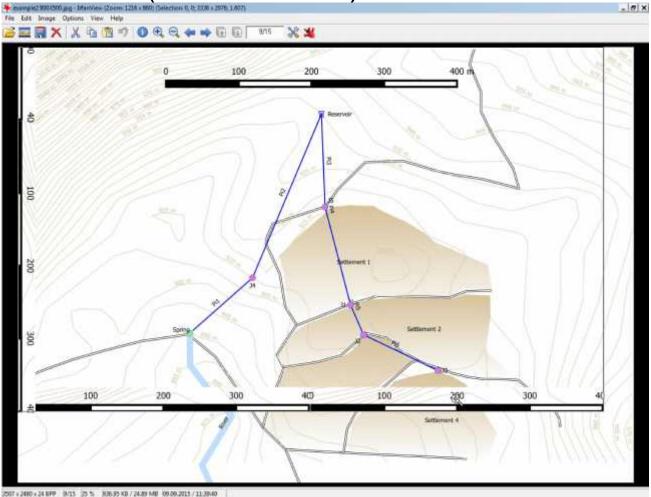
<u>Step5</u> Save the image

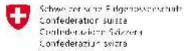


Geo-reference backdrop map in Epanet

Step6

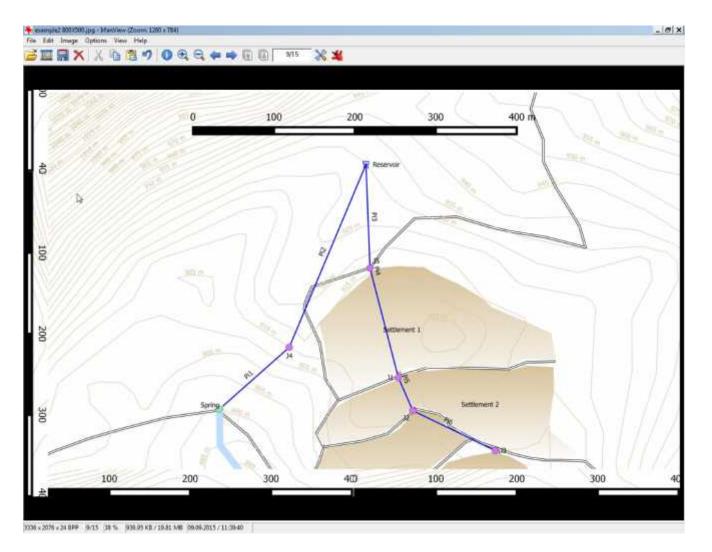
Open the image with irfanview and crop it exactly as the dimensions (800m x 500m)



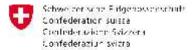


Geo-reference backdrop map in Epanet

Save it in *.emf format

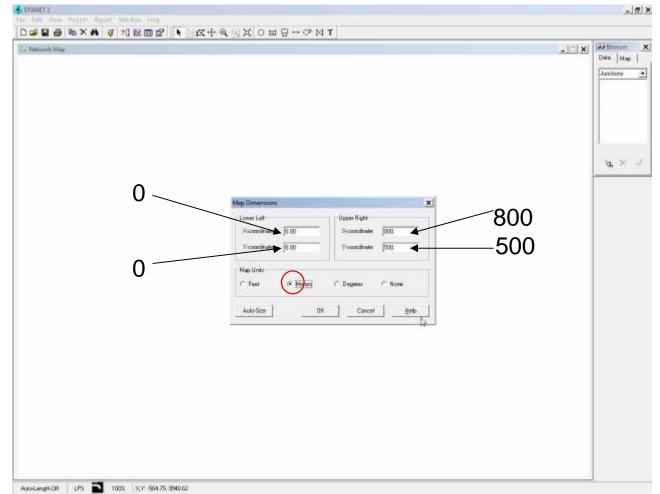


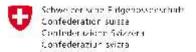
8



Geo-reference backdrop map in Epanet

<u>Step8</u> Open Epanet and insert the dimension of the backdrop map in Epanet as seen before (View -> Map Dimension)

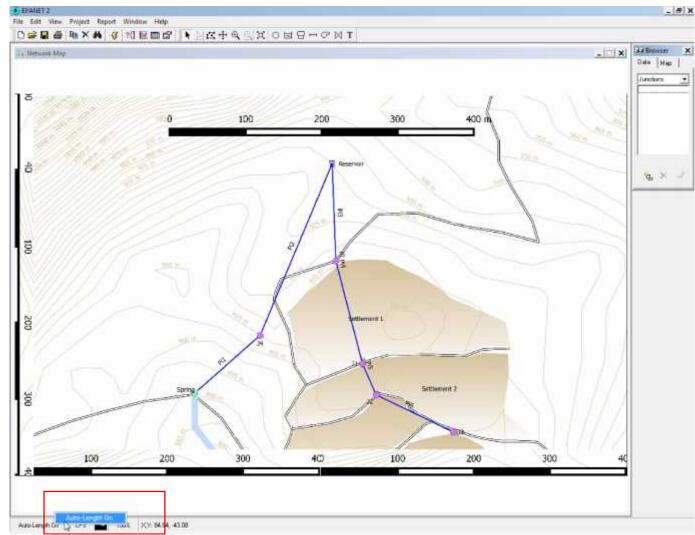


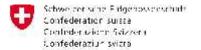


Geo-reference backdrop map in Epanet

Step8

Insert the map and switch auto-length on (right click on left bottom)

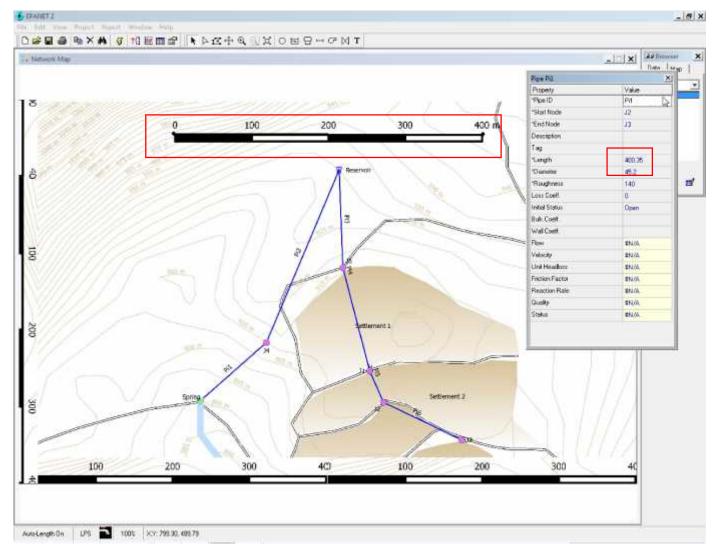


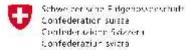


Geo-reference backdrop map in Epanet

Step9

Crosscheck the correctness of the length with a new pipe on the scale bar or a known length.





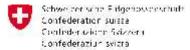
Geo-reference backdrop map in Epanet



•The elevation of the junctions must be known and inserted manually into Epanet at each element.

•This system is not precise, but in case you do not have the shape files it is still a way to make the simulation.

Thanks

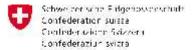


Geo-reference backdrop map in Epanet



Introduce a geo-referenced backdrop map in Epanet and use auto-length for drawing the network

- •You have basic knowledge of GIS (i.e qGis or Global Mapper).
- •You have the map in a GIS software (i.e. qGis) with respective shape files.
- You want to draw the junctions and pipes direct into Epanet using **auto-length on** without typing the exact coordinates of the points and the length of the pipe.
- •You need a software for the transformation of Longitude/Latitude (degrees) coordinates into UTM (meters) coordinates. (i.e. Global Mapper).



Geo-reference backdrop map in Epanet

<u>Step1</u> Install Global Mapper (1) in your PC and Reproduce the map with it.

Needed shape files:

- •Spring.shp
- •Junction.shp
- •Pipesnews.shp
- •Tank.shp
- •Settlement.shp
- •Road.shp
- •Settlement.shp
- •Contour 5m.shp

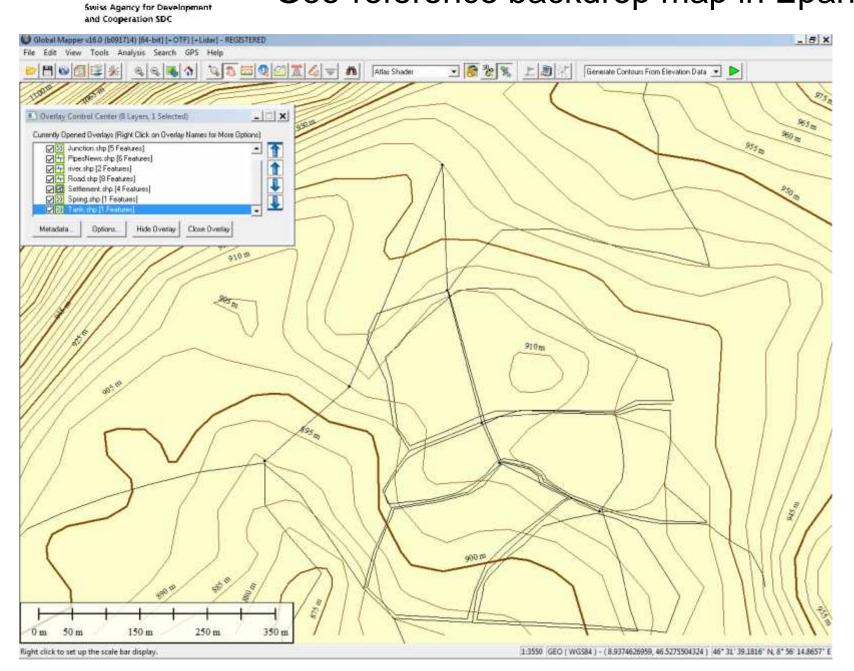
(1)

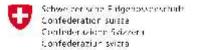
•Global Mapper is a commercial GIS software (<u>http://www.globalmapper.com/</u>)

- •Evaluation is free for 30 days. CD\Software\Global Mapper 15
- •Cracked version available in P2P network

Schweider sinde Filgenbesonschaft Confederation Suizzen Confinderazione Skizzena Confiederazioni svizzen

Geo-reference backdrop map in Epanet

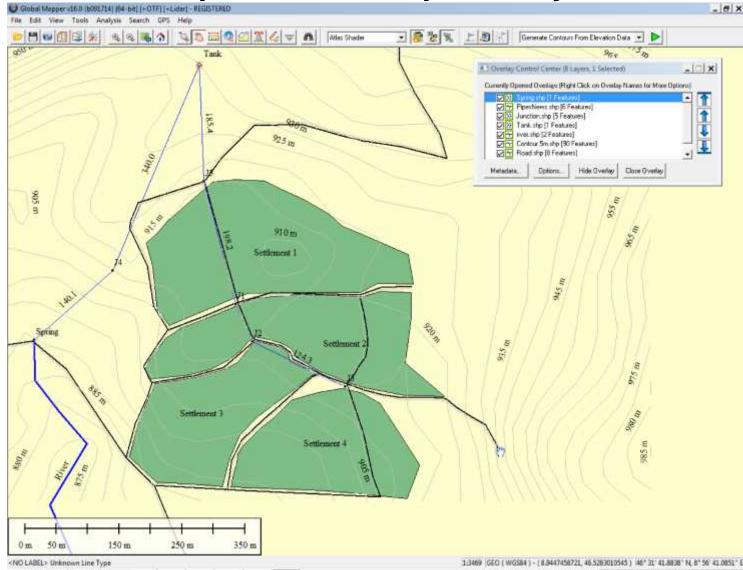


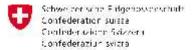


Geo-reference backdrop map in Epanet

Swiss Agency for Development and Cooperation SDC

Make a comprehensive map with style and labels





Geo-reference backdrop map in Epanet

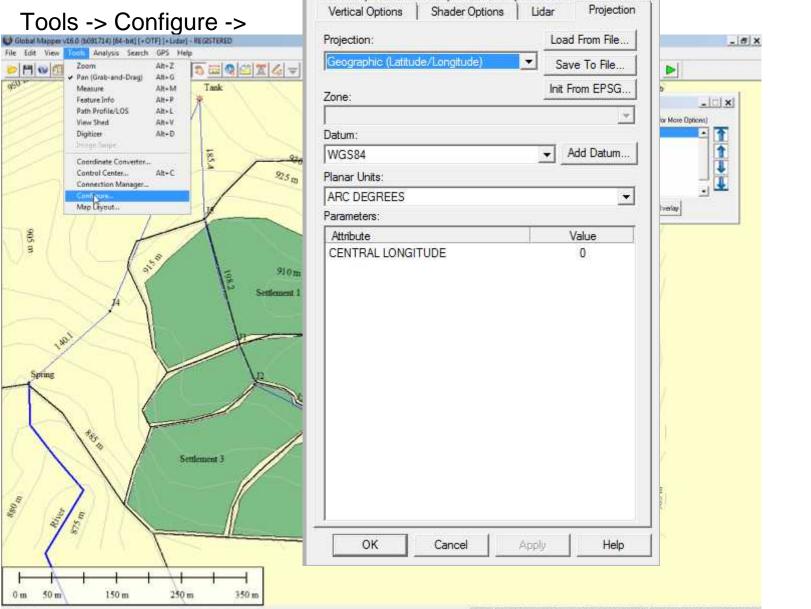


Convert the Global Mapper map

from Geographical Coordinates (Latitude/Longitude) into UTM⁽¹⁾ Coordinates (Meters)

⁽¹⁾ The Universal Transverse Mercator (UTM) <u>conformal projection</u> uses a <u>2-dimensional</u> <u>Cartesian coordinate system</u> to give locations on the surface of the <u>Earth</u>. Like the traditional method of <u>latitude</u> and <u>longitude</u>, it is a <u>horizontal position representation</u>. Schweider sind Fildgebossenschaft Confederation Suizzen Confiderazione Svizzena Confederazioni svizze

Swiss Agency for Development and Cooperation SDC



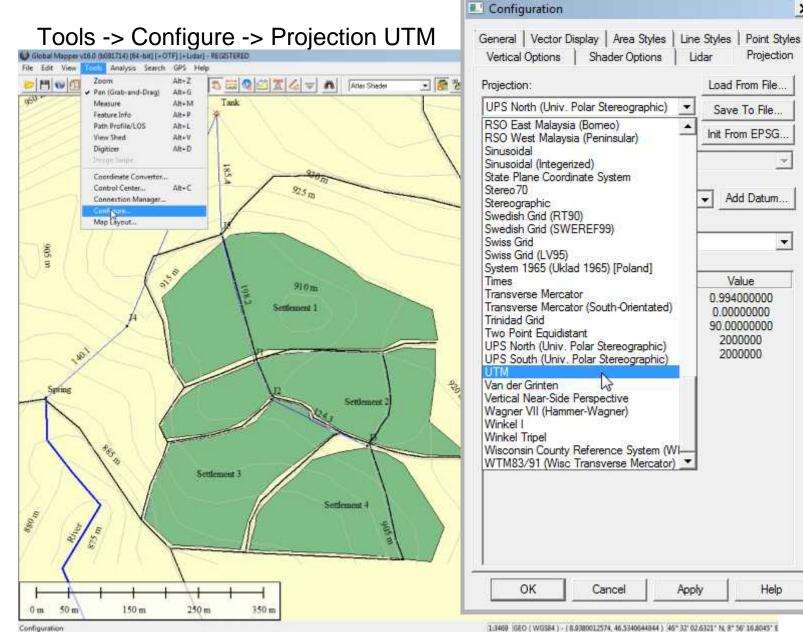
Generation bookdron map in Epanet

General Vector Display Area Styles Line Styles Point Styles

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Geo-reference backdrop map in Epanet

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7

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Projection

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Save To File ...

Init From EPSG.

Add Datum ...

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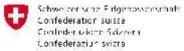
Help

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Geo-reference backdrop map in Epanet

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Tools -> Configure -> Projection -> UTM -> Zone 32 Northern Hemisphere -> Planar Units "Meters" -> OK

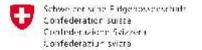
> UTM coordinates Zone: check in WEB Datum: WGS84 Planar unit: Meter

Zone to be defined with Web (Google search "Place UTM Zone" i.e UTM Olivone Zone)



UTM-Koordinaten (WGS81)		32T 195192 5152928
Z. J2T E: 495492	N; 5152920	
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-	Init From EPSG
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WGS84	Add Datum
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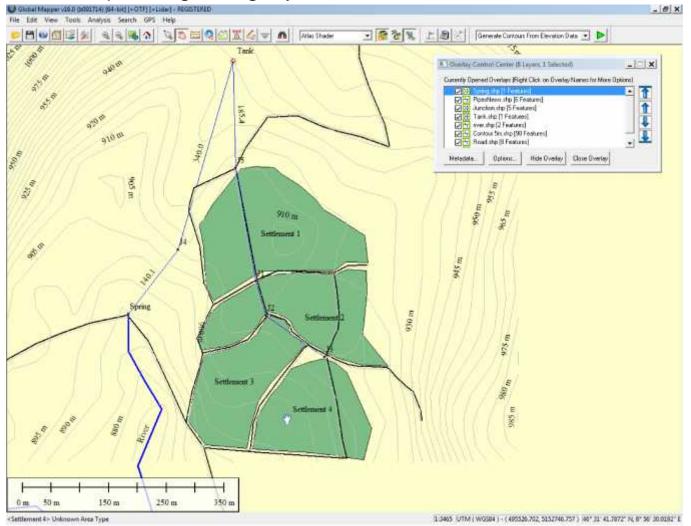


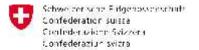
Geo-reference backdrop map in Epanet

Swiss Agency for Development and Cooperation SDC

Tools -> Configure -> Projection -> UTM -> OK

The map changes slightly

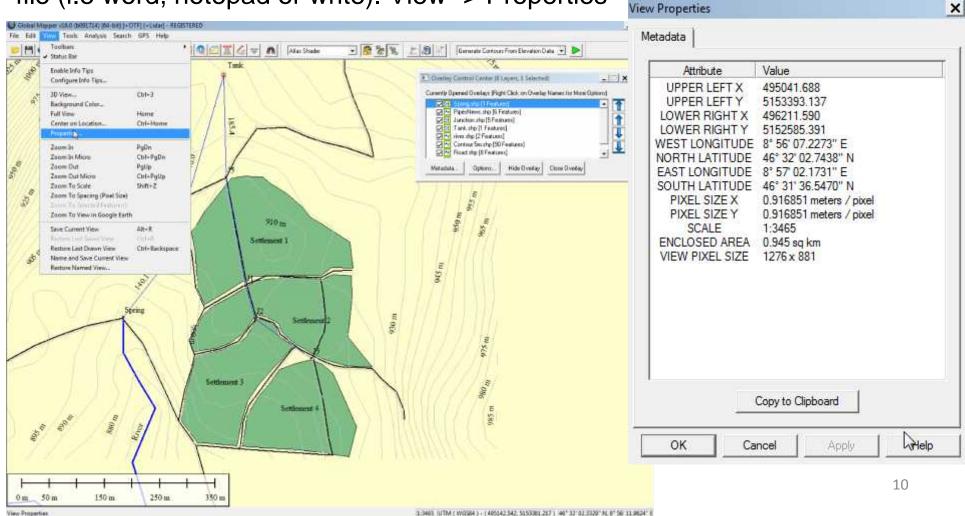


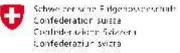


Geo-reference backdrop map in Epanet

Step3

Look at the characteristic of the map, copy to clipboard and save it in a editing file (i.e word, notepad or write). View -> Properties





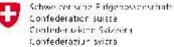
Geo-reference backdrop map in Epanet

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Saved in a text file

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		NORTH LATITUDE=46° 32' 02.7438" N					
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			SOUTH LATITUD	E=46° 31' 36.5470" N			
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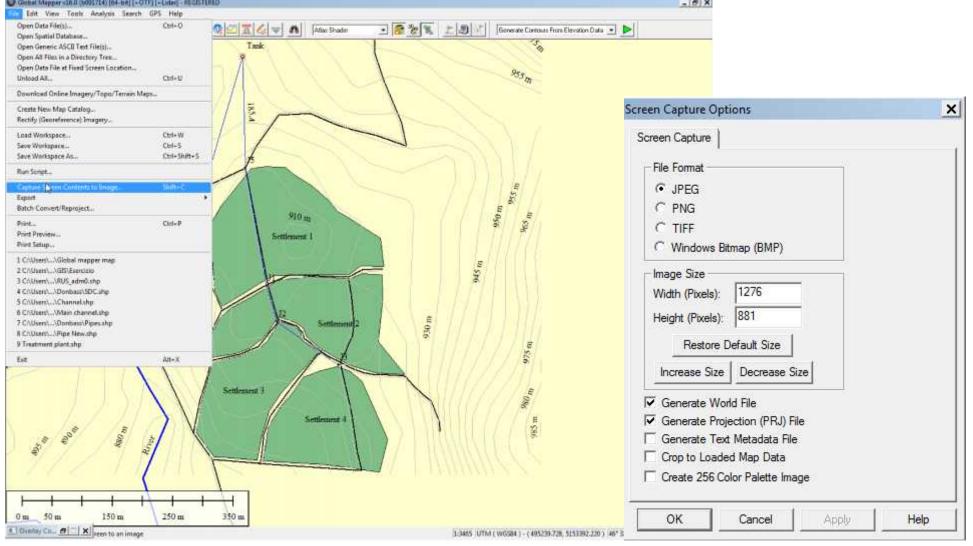
11

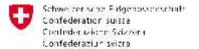


Confederaziur svizra Swiss Agency for Development and Cooperation SDC Geo-reference backdrop map in Epanet

Step4

Capture screen contempt to image (Jpeg) and save it (i.e. MapGlobalMapper.jpg)





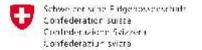
Geo-reference backdrop map in Epanet

<u>Step5</u> Convert image (Jpeg) to *. emf as before

Open it with Irfanview* and save it into *.emf format

emf format = Enhanced Windows Metafile metafiles work better since they will not loose resolution when re-scaled.

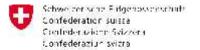
*Irfanview = Free software at www.irfanview.com



Geo-reference backdrop map in Epanet

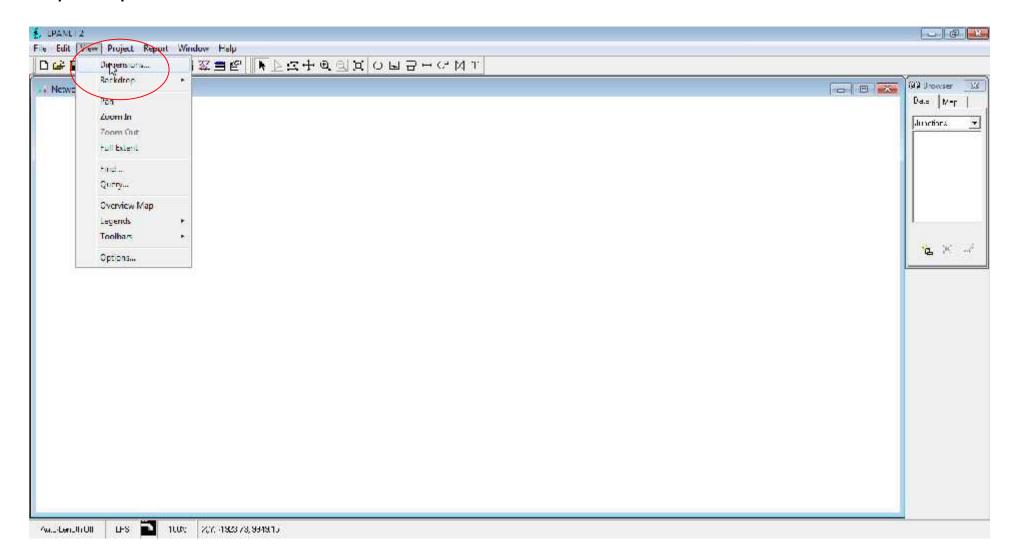
Step6 In Epanet, configure the dimension of you background map

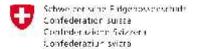
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Geo-reference backdrop map in Epanet

Step6 Open Epanet -> View -> Dimension



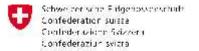


Geo-reference backdrop map in Epanet

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Step6 Open Epanet -> View -> Dimension -> Meter

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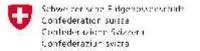


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<u>Step 7:</u>

 Insert map extension coordinates per text file into Epanet (copy&paste)

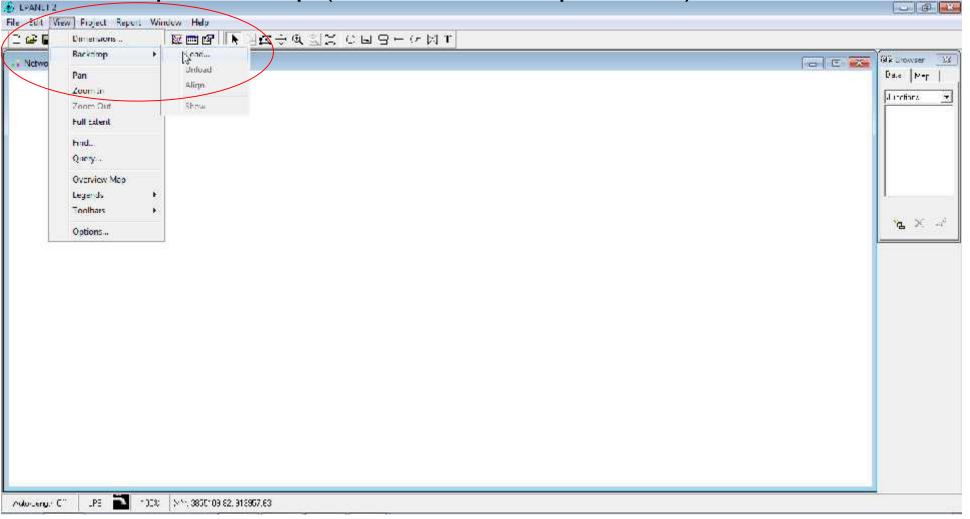
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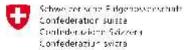


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Step 8:

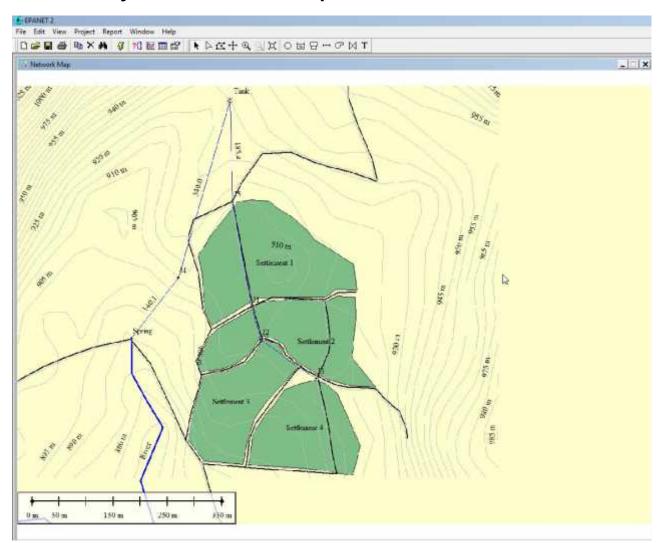
Insert map backdrop (View ->Backdrop -> load)

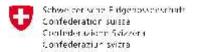




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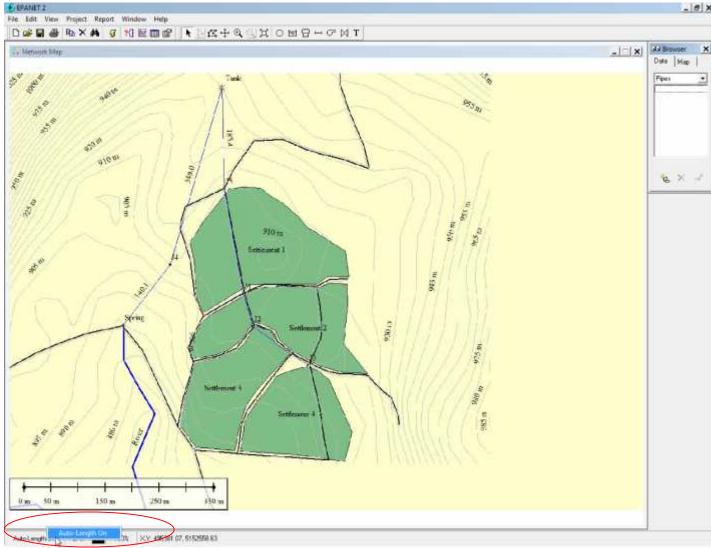
Select your *.emf map

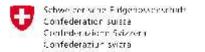




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<u>Step 9:</u> Turn auto length on (with right click)





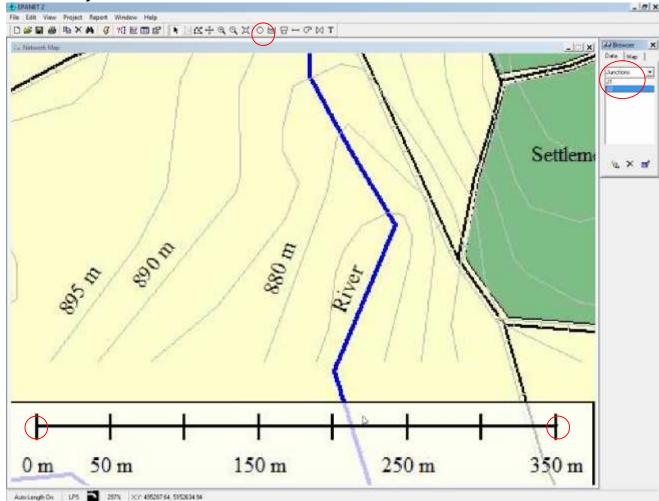
Swiss Agency for Development and Cooperation SDC

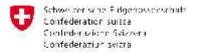
Step 10:

•Verify if your backdrop map is correctly place and if auto-length works.

•Zoom in into the scale bar

•Put 2 junctions at the extremities of the scale bar

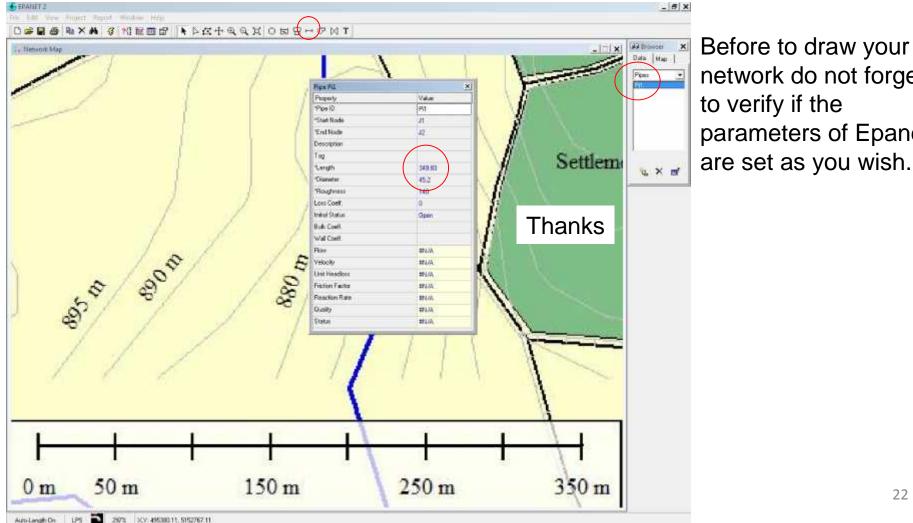




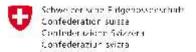
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<u>Step</u> 11:

•Connect the two junctions with a pipe and see the length (it should be around 350m like the scale bar.



network do not forget to verify if the parameters of Epanet are set as you wish.



Use of Epanet within qGis (plug-in GHydraulics)



Introduction of **GHydrauilcs**, the Epanet plug-in for qGIS

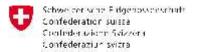
- •You have good knowledge of qGis (free and open source at www.qgis.org)
- You have installed qGis in your PC
- You have displayed the map in qGis
- You have internet connection

NOTE:

This is **not** an introduction of qGis.

•The plugin GHydraulics is not fully functional yet, it has apparently some bugs.

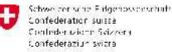
The following presentation is an introduction that will allow you to make a backdropmap.
In the future the plugin might be fully functional.



Use of Epanet within qGis (plug-in GHydraulics)

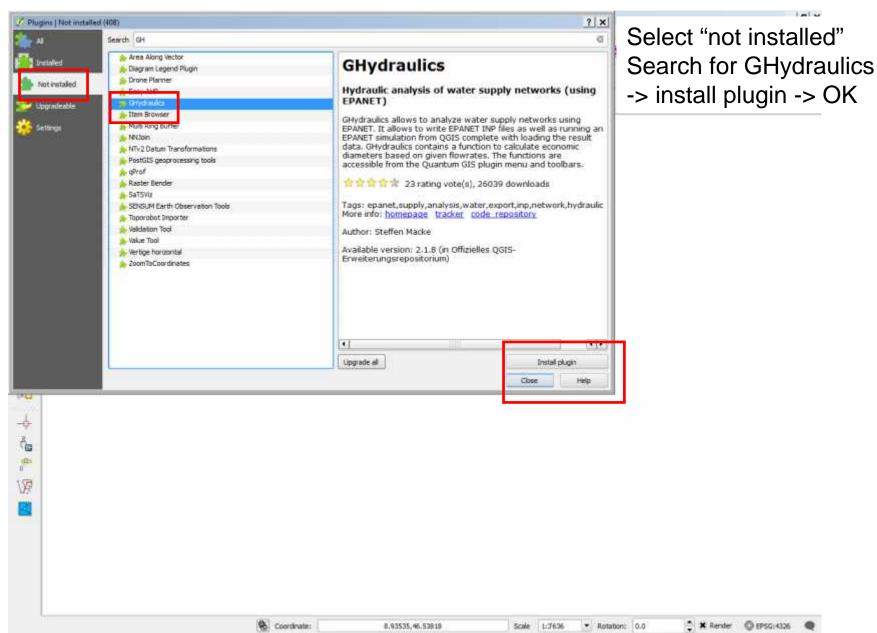
<u>Step1</u> Download and install the Epanet plugin in qGIS (GHydraulics)

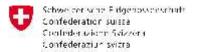
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Use of Epanet within qGis (plug-in GHydraulics)

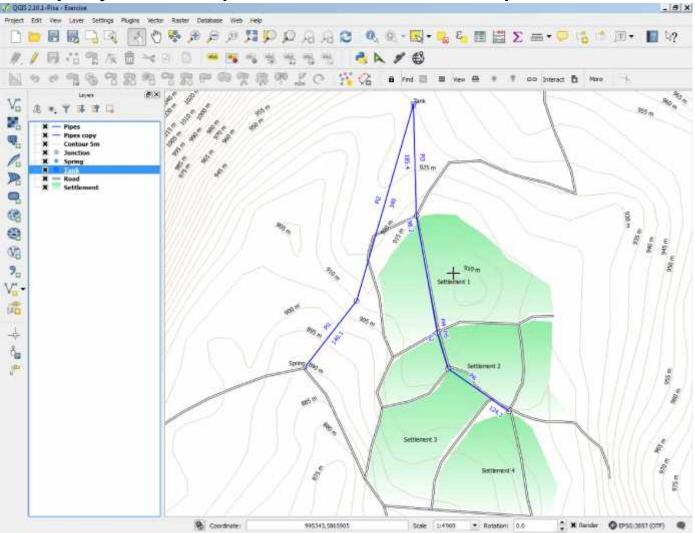
Swiss Agency for Development and Cooperation SDC

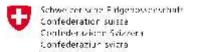




Use of Epanet within qGis (plug-in GHydraulics)

<u>Step2</u> Display the map of the network in qGis (CD -> GIS directory -> Exercise)



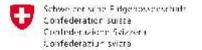


Use of Epanet within qGis (plug-in GHydraulics)

Swiss Agency for Development and Cooperation SDC

<u>Step3</u> Plugins -> GHydraulics -> Settings

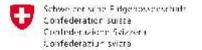
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Use of Epanet within qGis (plug-in GHydraulics)

<u>Step4</u> Drop the concerned unused shape files into the Model Elements

🥳 GHydraulics Settings		? ×
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	Calculate pipe length Write backdrop map	
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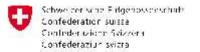


Use of Epanet within qGis (plug-in GHydraulics)

<u>Step4</u> Drop the concerned unused shape files into the Model Elements

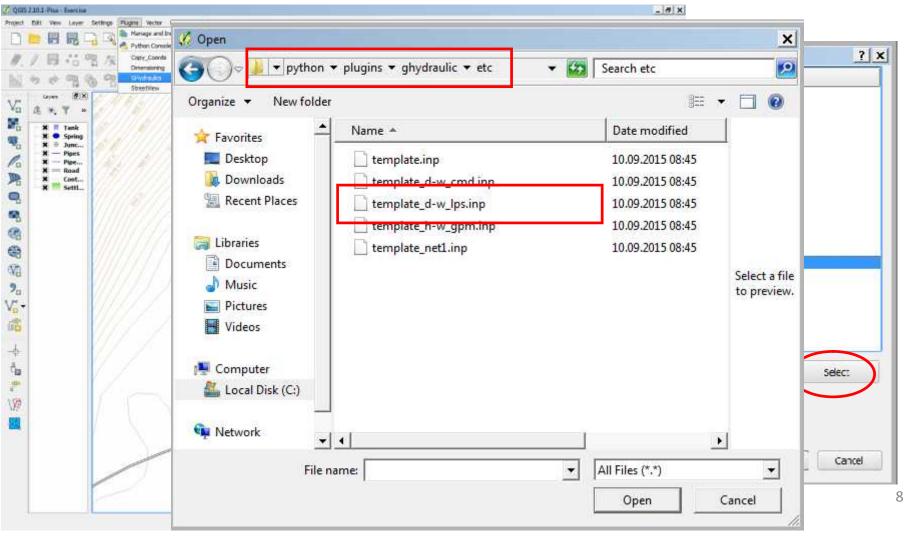
Note: Element "Reservoir" is Currently not working

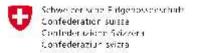
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Use of Epanet within qGis (plug-in GHydraulics)

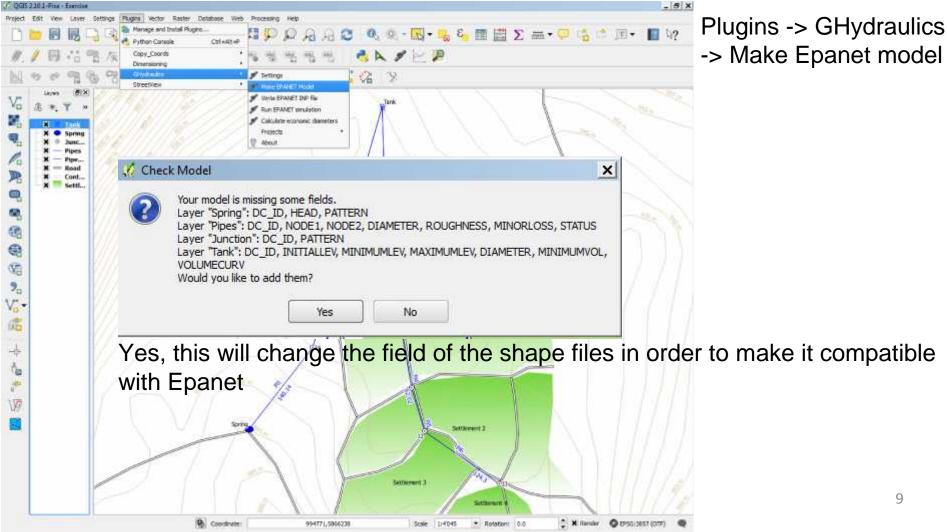
<u>Step5</u> Select the template. Available only D-W cmd, D-W lps, H-W gpm

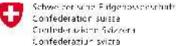




Use of Epanet within qGis (plug-in GHydraulics)

<u>Step6</u> Make Epanet model

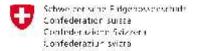




Use of Epanet within qGis (plug-in GHydraulics)

This error is given most probably due to a bug in the plugin

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edang EPANET model	Coordnete: 994794,5866340 Scale 1-4046	• Roteborn 0.0 * ¥ Rander O EPSG:3	857 (CTTP)

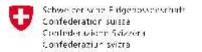


Use of Epanet within qGis (plug-in GHydraulics)

The shape files have been changed automatically and new columns have been added in order to make it compatible with Epanet

<u>Tank</u>

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Use of Epanet within qGis (plug-in GHydraulics)

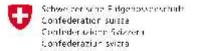
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Spring / Reservoir

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NLEL	NEEL 890 5	ברויכ	INCLE	MUL	MAL

Junctions

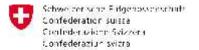
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d T	3] = ▼	info	ELEVATION	DEMAND		PATTERN	lecte
	NULL		913	0.0463		NULL	
	NULL	32	912	0.0926	NULL	NULL	
2	NULL	J3	915	0.1390	NEAL	NULL	
	NULL	J4	910	0.0000	NULL	NULL	
	NULL	35	916	0,1150	MULL	NULL	



Use of Epanet within qGis (plug-in GHydraulics)

Pipes

★ = £							+ Uodat	e All Update Se		
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	NULL Pi2		339.95	NULL	NULL	MULL	NLRL	NULL	NULL	MULI
1	//LALL Pi3		185.36	NULL	NLLL	NULL	NULL	MULL	NULL	NULL
	MELL Pi4		198.15	ALLI	NLEL	MEL	NLUL	ALEI	NERI	NHLI
	NULL PIS		62.02	NULL	NLLL	NULL	MAL	NULL	NULL	NULL
	MML PIG		124.30	MURL	NULL	NUCL	MAL	MAL	NULL	NULL

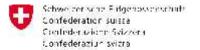


Use of Epanet within qGis (plug-in GHydraulics)

Note:

For automatic length column (in case you do not have it): Open attribute table of Pipes

Update /									c Al Update Se	
ic	7 1	Infc	LENGTH	DC_ID	NODE1	NODE2	DIAMETER	ROUGHNESS	MINORLOSS	STATUS
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	NULL	Pi2	339,95	NULL	INXL	NLAL	NEALL	NULL	NULL	MILL
	AL41	Pi3	185.36	MLEL	IALLL	NERE	AL/LL	MULL	MUL	MLVL
	NULL	Pi4	198.15	MELL	MULL	NERL	NULL	NULL	NULL	NEZZ
	/vL/LL	PI5	62.02	NULL	IALL	NULL	NULL	MAL	NULL	MLEL
	NURL	Pi6	121.30	NEEL	MULL	MAL	NULL	MAI	NUEL	NEEL



Use of Epanet within qGis (plug-in GHydraulics)

Toggle editing mode and click field calculator

	四	т <u>Ш</u>	3	-3					+ Updat	c Al 🗍 Update Sel
	_				- 13			UGHNESS	MINORLOSS	STATUS
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2	NL IL	Pi3	185.36	MLEL	INLEL	AL.U.L	NULL	MULLI	MUL	MLIL
3	NULL	Pi4	198.15	MLEL	NULL	ALAL	NULL	NULL	NULL	NELL
1	NURL	PI5	62.02	NULL	TALL	NULL	NULL	MAL	NULL	MLLL
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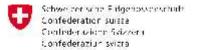
Use of Epanet within qGis (plug-in GHydraulics)

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Only update 0 selected feat	1 C 5	
Create a new field	Update existing	field
Create virtual feld		
output field name LENGTH	d d	
utput field type Decimal nu	rber (real)	
utput field width 10 🌻 P	recision 2	
Expression Function Editor	0569	
xpression	Functions	
= + - / * ^	II () Search	\$length function
\$lergth	Operators Gond tionals	Returns the length of the current feature.
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	Screa Charath	Example
	Slength Sperimet	\$length - 42.4711
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utput preview: 140. 136 4699	37387	

Write "LENGTH", real 10 precision 2 and click twice on Geometry -> \$Length -> OK

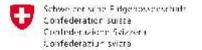
OK Cancel Help



Use of Epanet within qGis (plug-in GHydraulics)

You should get the column "LENGTH" with the automatic length inserted

DC_ID =	8		il.			- Upda	ate All Update Selec
DC_ID 7	NODE1	NODE2	DIAMETER	ROUGHNESS	MINORLOSS	STATUS	LENGTH
p1	Spring	34	150.000000000	150	NULL	NURL	140.14
1 p2]4	Reservoir	150,000000000	150	NULL	NULL	339.95
2 p3	Reservoir	15	150,0000000000	150	NULL	NULL	185.36
p4	35	31	150,000000000	159	NULL	MULL	198, 15
p5]]	32	150.000000000	159	NULL	NULL	62.02
p6	J2	J3	150,000000000	159	NULL	NULL	124.30



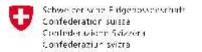
Use of Epanet within qGis (plug-in GHydraulics)

Step7

Fill the missing parameter into the attributes and delete unnecessary columns

<u>Tank</u>

						8
ELEVATION TO DC_ID INITIALL	EV MINIMUMLEV	MAXIMUMLEV	DIAMETER	MINIM	MUMVOL	VOLUMECURV
930 Tank	930 Tank NULL NULL /		NULL	NULL		NULL



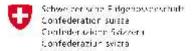
Use of Epanet within qGis (plug-in GHydraulics)

Spring

s.	Attribute table - S	Spring :: Features to	tal: 1, filtered: 1, sele	ected: 0	<u> </u>
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Γ	DC_ID 🗸	HEAD	PATTERN		
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	Show All Features				

Junctions

	ELEVATION V	DEMAND	DC_ID	PATTERN	
0	913	0.0463	J1	NULL	
1	912	0.0926	32	NULL.	5
2	915	0.1390	J 3	NULL	2
3	910	0.0000	34	NULL	2
4	916	0.1150	J5	NULL	-

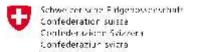


Use of Epanet within qGis (plug-in GHydraulics)

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Pipes

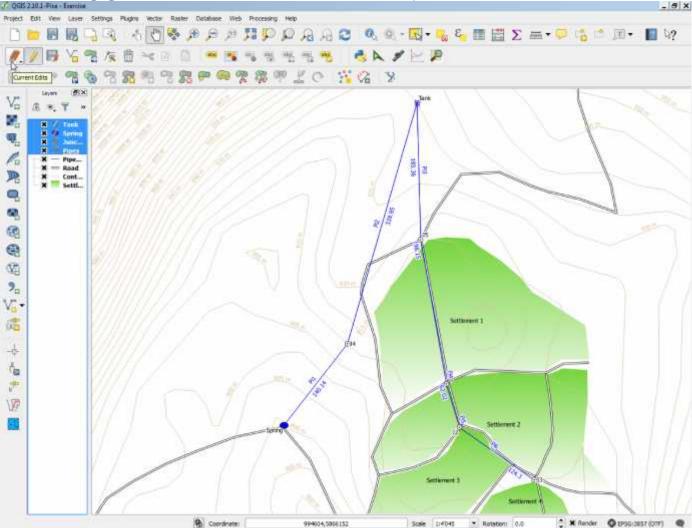
	LENGTH 🗸	DC_ID	NODE1	NODE2	DIAMETER	ROUGHNESS	MINORLOSS	STATUS
	140.14	Pi1	Spring	34	NULL	NULL	NULL	NULL
	339.95	Pi2	34	Tank	NULL	NULL	NULL	NULL
2	185.36	Pi3	Tank	35	NULL	NULL	NULL	NULL
	198.15	Pi4	35	J1	NULL	NULL	NULL	NULL
-	62.02	Pi5	J1	32	NULL	NULL	NULL	NULL
5	124.30	Pi6	32	J3	NULL	NULL	NULL	NULL

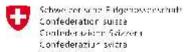


Use of Epanet within qGis (plug-in GHydraulics)

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<u>Step7</u> Un toggle (save) the open layers

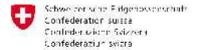




Use of Epanet within qGis (plug-in GHydraulics)

<u>Step8</u> Write Epanet file (to be opened later directly with Epanet)

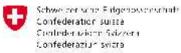
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Crganize 👻 New fold	ler		le 👻 🔞		
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📆 Recent Places	📕 Printout	17.09.2015 13:26	Filefolder		
	Slides & Presentations	17.09.2015 16:26	File folder		
🕞 Libraries	🎍 Software	15.09.2015 09:36	Filefolder		
Documents					
J Music					
Pictures -					
Videos					
Computer					
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File name Exe	erciseEpanetqGis				•
Save as type	ANET INP file (*.inp)				
Save as type Ery	arder mar me (amp,				<u> </u>



Use of Epanet within qGis (plug-in GHydraulics)

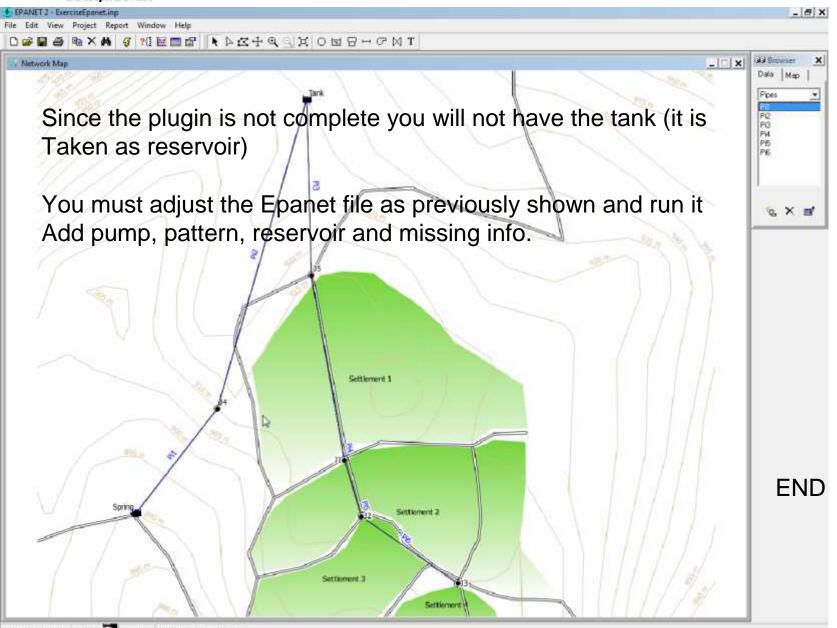
Step10 Open the saved inp file with Epanet (CD Epanet Exercise folder -> ExerciseEpanetqGis)

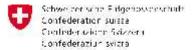
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	-								



Use of Epanet within qGis (plug-in GHydraulics)

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Tools around Epanet

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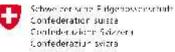


Overview of other tools around Epanet that might be interesting.

NOTE:

Most of those tools are self explanatory and very easy. Just play with them!

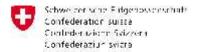
I did not test all of them!



Tools around Epanet

Zonum Solutions at http://www.zonums.com/epanet_cat.html

- Epanet Z: Display Yahoo Maps, Google Maps and VE imagery as a background.
- **EpaElevation**: Find missing elevation of points online.
- Epa2Gis: Transport Epanet projects to a GIS environment using thematic layers.
- Shp2Epa: Create Epanet inp files from ESRI shapefiles. Utilize GIS data as input for Epanet projects.
- Net2Epa: Create Epanet INP files online using Google Maps. Digitize over a Satellite, Map or Hybrid map to create Epanet Network Maps.
- Gpx2Epa: Create Epanet INP files online from data collected with a GPS unit.
- Epa2kmz: Visualize and share Epanet projects on Google Earth.
- Excel2Epa: Create INP Network files for Epanet from data contained on an Excel sheet.
- Kml2Epanet: Utilize Google Earth Imagery to create the network map, then load the project into Epanet. Kml2Epanet converts kml files to inp.



Tools around Epanet

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Qgis plugin qGisEpanet https://github.com/Oslandia/qgis-epanet

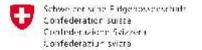
Extends processing framework to models the hydraulic and water quality behavior of water distribution piping systems.

This plugin lets you model hydraulic network for water and run simulations to get water pressure informations and more.

See a demo screencast here : <u>https://vimeo.com/87754967</u>

This plugin looks very professional and complete. It is free but do not have tutorial unless you pay for a training.

In case you have a tutorial or info aout it, pls share with the WASH unit.



Tools around Epanet

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Do you want to see the video of Epanet plugin?

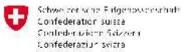
1min 45 sec



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Thanks



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Elevations issues

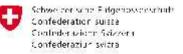


Find the most precise elevation with available tools in the field/office

•GPS

- •Topographic maps / cadaster if available
- •Online maps Google Earth
- •Online tools

•Map analysis (Global Digital Elevation Model Aster GDem)



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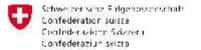
1 Elevation from GPS:

GPS give very imprecise elevations. Do not trust GPS elevation

(+/-23meters with a DOP of 1 for 95% confidence).

i.e. Tank 922m

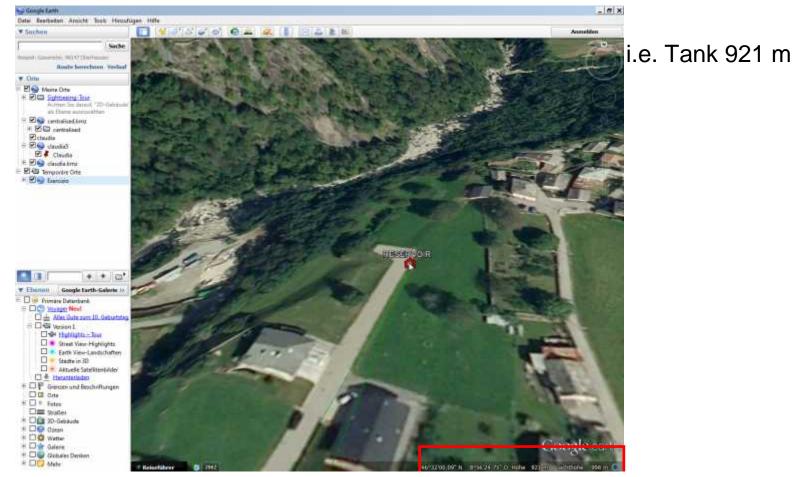


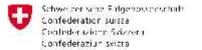


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2 Elevation from Google Earth:

Select your point in Google Earth and look right down the elevation

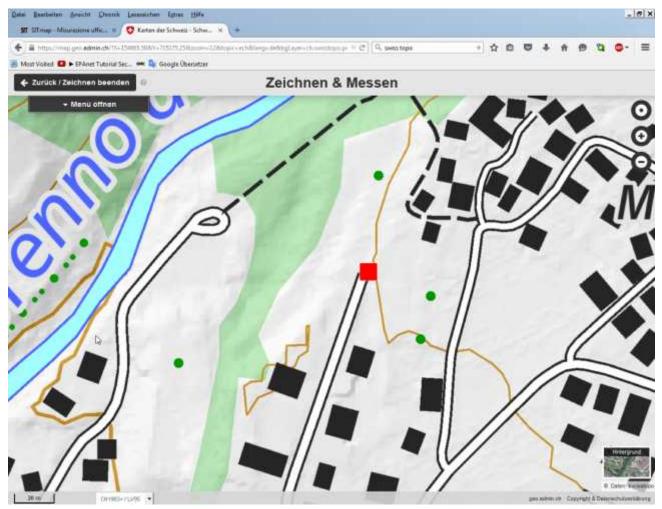




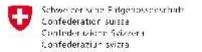
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3 Elevation from topographic maps:

Use topo maps if available (oft online)

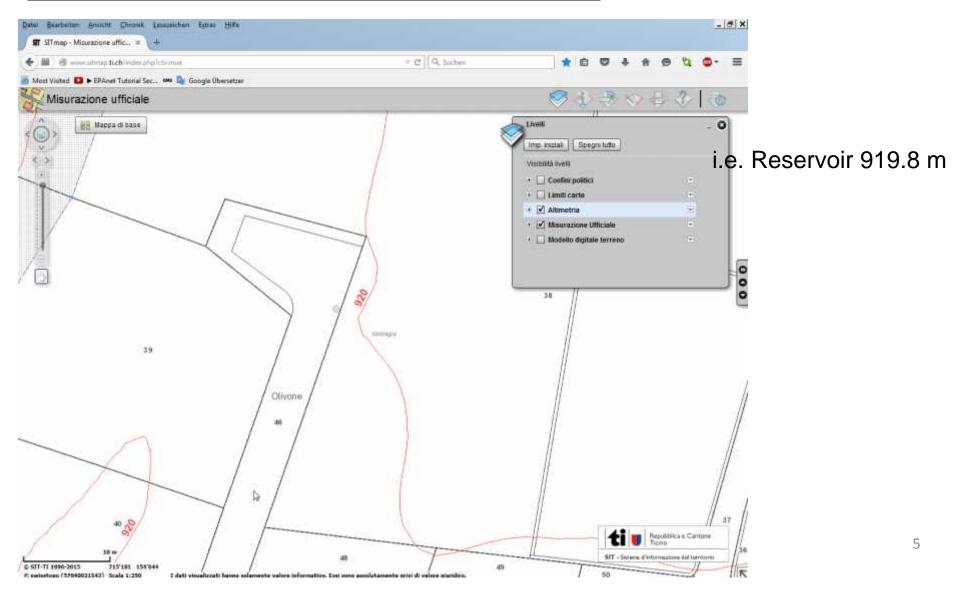


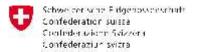
i.e. Tank 919 m



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<u>4 Elevation from cadastre if available:</u>



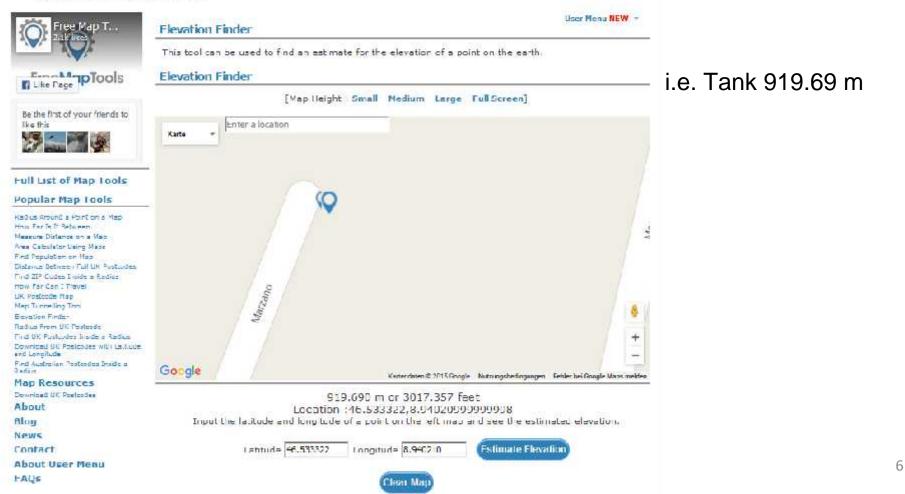


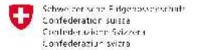
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5 Elevation from online tools: FreeMapTools http://www.

http://www.freemaptools.com/elevation-finder.htm

Maps you can make use of ...



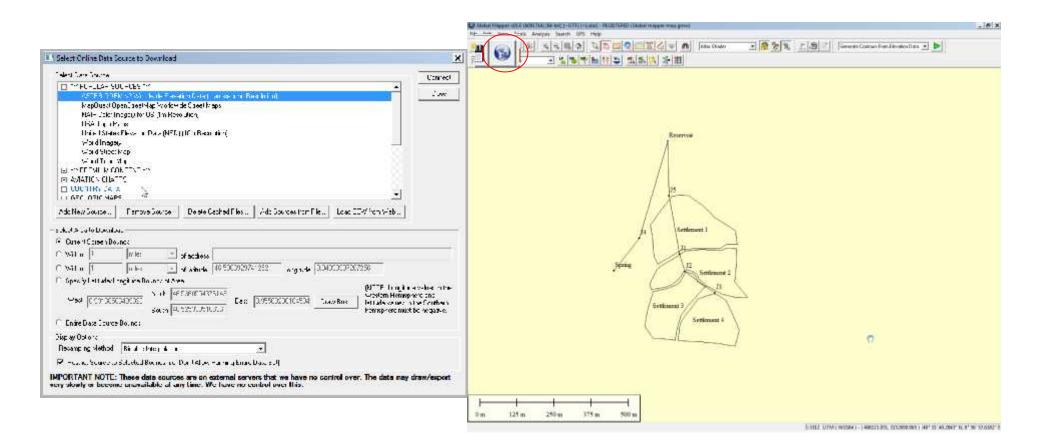


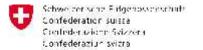
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6 Global Digital Elevation Model Aster GDem

Open Global Mapper Open the shape files of the junctions/reservoir/tanks/settlements Download online data (Aster GDEM) need internet connection without proxy, if proxy (UN, Ambassy) go

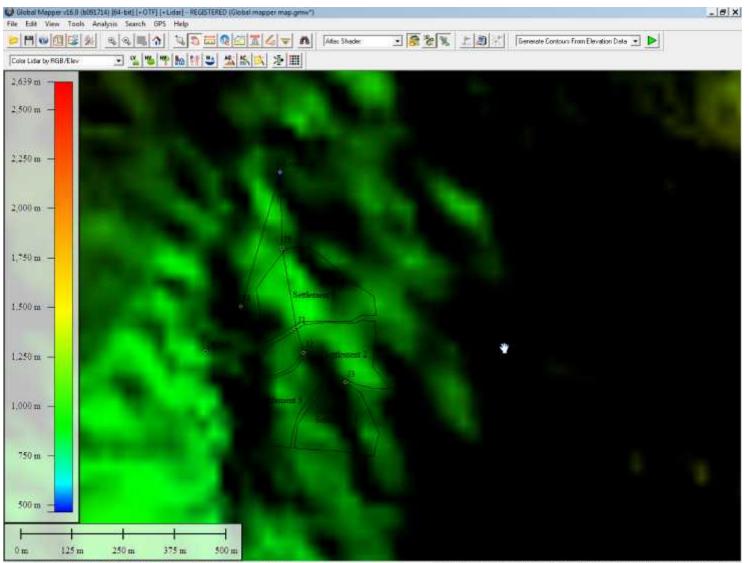
to http://gdem.ersdac.jspacesystems.or.jp/ on in a internet café



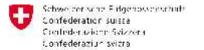


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6 Global Digital Elevation Model Aster GDem

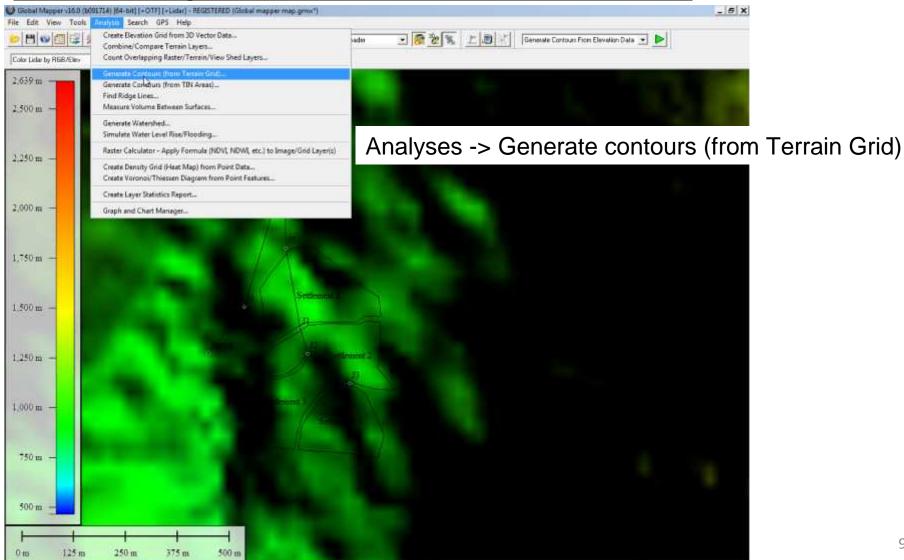


Height = 1003.457 meters (ASTER GDEM v2 Worldwide Elevation Data (1 arc-second Resolution))

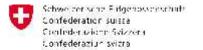


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<u>6 Global Digital Elevation Model Aster GDem</u>



Generate Contours From Elevation Data

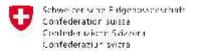


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6 Global Digital Elevation Model Aster GDem

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and the second	lajor Contoure 10
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Contour interval 1m

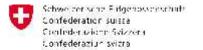


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6 Global Digital Elevation Model Aster GDem

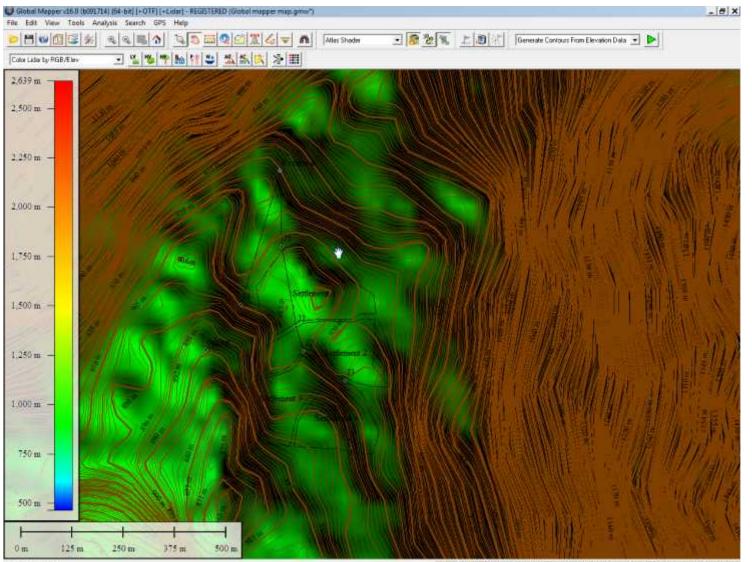
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OK Cancel APPD	Help

Contour bounds

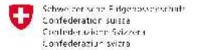


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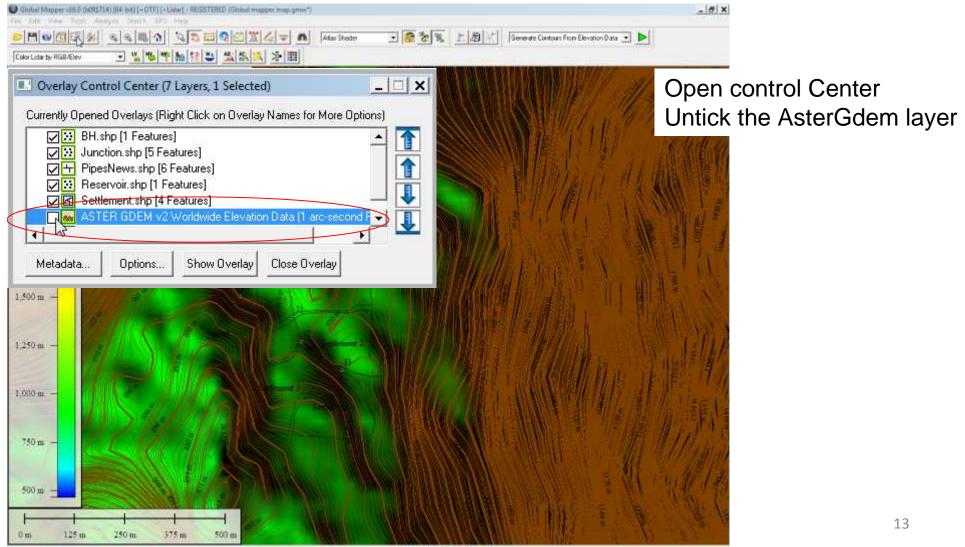


¹⁻⁵³¹² UTM (WGS84) - (495575.348, 5153165.177, 920.773 m) 46" 31" 55.3444" N. 8" 56" 37.2883" E

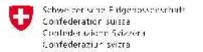


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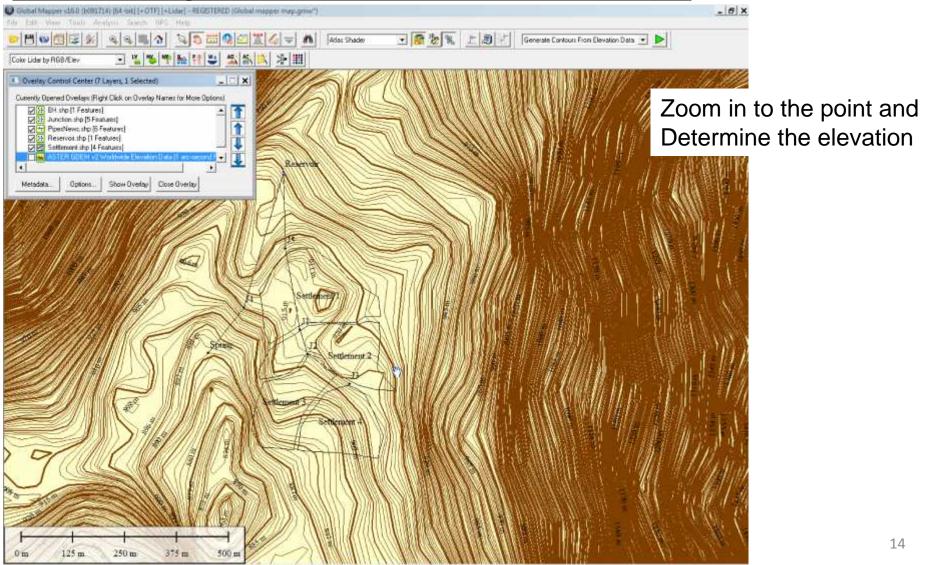


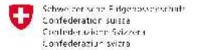
For Help, press FI



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