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International Water Association

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Asset Management

2nd IWA Leading-Edge Conference & Exhibition on

Strategic Asset Management

Hazard identification and risk analysis of water supply systems

Ladislav Tuhovčák, Jan Ručka

LESAM 2007 – Lisbon 17-19 October 2007

Presentation Outline

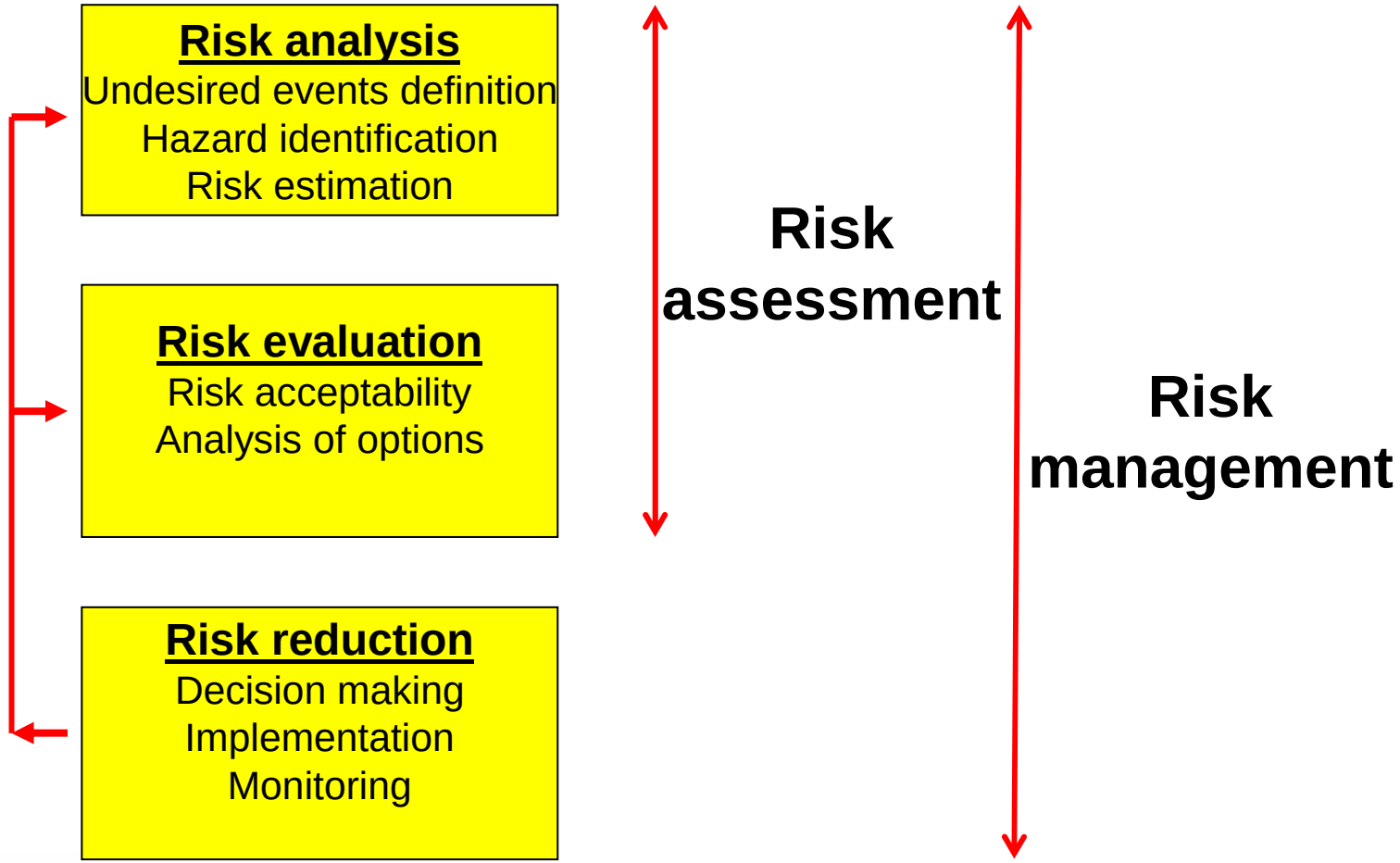
- **Risk - definition, analysis, management**
- **Risk analysis of Water Distribution Systems**
  - **Risk Structuring**
  - **Quantitative / Qualitative Risks**
- **WaterRisk project**
- **Case study**

Risk definition

Risk = **P**robability x **C**onsequences

$$R = P \times C$$

Risk assessment and management



Risk analysis techniques

- **ETA** – Event Tree Analysis
- **FTA** – Fault Tree Analysis
- **HAZOP** – HAZard and OPerability analysis
- **HACCP** – Hazard Analysis and Critical Control Points
- **FMEA / FMECA** – Failure Modes, Effects and Criticality Analysis

RA of WSS – elements of WSS

Subsystems

Water resources

Water treatment

pumping
storage
distribution network

Water distribution

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RA of WSS – origin of hazards

- Natural hazards
- Manmade threads
- Technical disasters

RA of WSS – type of risk

Quantitative – **water quantity**

amount of undelivered water

presence of a sensitive customer

duration of water supply interruption

lack of fire water

Qualitative – **water quality**

insufficient water quality

contamination

number of affected citizens

personal injuries and health problems

WaterRisk – risk structuring

Part of WSS	Hazards	Consequences
Resource	Natural	Health
Treatment	Social	Economical
Distribution	Technical, technological	Socio-economical
		Environmental

Types of risk

Qualitative	Quantitative

WaterRisk

project

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WaterRisk – Identification data

Title: Identification, quantification and management of risks of public water-supply systems

Acronym: **WaterRisk**

Grant provider: National research program II,
Czech Ministry of Education

Registration number: 2B06039

Period: 1.7.2006 - 30.6.2010

Aim of the project:
Design and development of the methodology for implementation of Risk Analysis and Risk Assessment methods to water supply sector in conditions of the Czech Republic with regards to the national and EU legislation and standards.

WaterRisk – Partners

***Project partner-coordinator**:*
Brno University of Technology - Institute of Municipal Water Management,

Project partner:
Vodárenská akciová společnost, a.s. - local water supply utility, Brno

Project partner:
National Institute of Public Health - Centre for the environment hygiene, Specialized research group for water-hygiene, Prague

WaterRisk – Structure

DC 1 – Methodology of risk analysis of the basic parts of the water-supply system from source to tap

PM1 *Risk analysis of water resources*

PM2 *Risk analysis of water-treatment technological processes*

PM3 *Risk analysis of the distribution system and its parts*

DC 2 – Methodology for implementation and application of risk analysis and methodology of critical control points (HACCP) into processes of drinking water treatment and distribution

PM4 *Methodology for creating and implementation of Water Safety Plans into processes of drinking water treatment and distribution for large systems*

PM5 *Methodology for creating and implementation of Water Safety Plans for small systems*

DC 3 – Testing of the invented methodologies on few real water-supply systems

PM6 *Evaluation and testing of risk analysis PMs on few real water-supply systems*

PM7 *Evaluation of the Water Safety Plans methodologies in practice on few real water-supply systems*

DC 4 - Scientific monograph, public website of the project, presentation of the project results

PM8 *Management, presentation and inspection of the works of the project*

WaterRisk –Time schedule

Project period: 1.7.2006 - 30.6.2010

partial goal coordinator	Year / kv. PM	2006				2007				2008				2009				2010			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
DC1 VUT	**PM1**																				
	PM2																				
	PM3																				
DC2 SZU	**PM4**																				
	PM5																				
DC3 VAS	**PM6**																				
	PM7																				
DC4 VUT	**PM8**																				

WaterRisk - methodology of the project

Risk estimation - FMEA

Scale of probability categories

Probability/Frequency

Category	VL	L	M	H	VH

Scale of consequences categories

Consequences

Category	VL	L	M	H	VH

VL – very low, L – low, M – medium, H – high, VH – very high

Risk estimation – Risk assessment matrix

		Consequencies				
		C1	C2	C3	C4	C5
Frequency	P1	very low				
	P2		low			
	P3			average		
	P4				high	
	P5					very high

CASE STUDY

Risk Analysis of Pipe Failure

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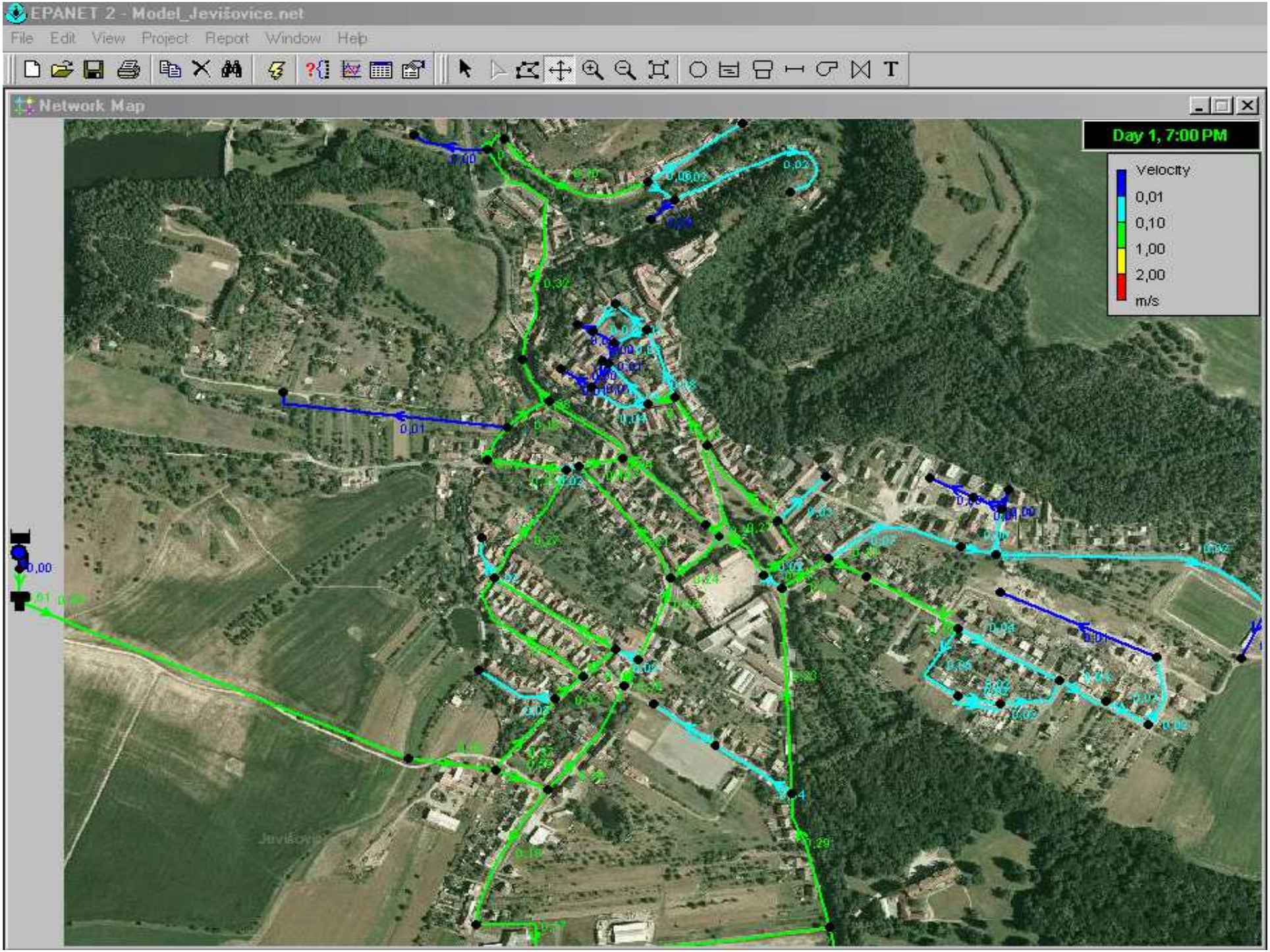
Quantitative risk – Risk of Pipe Failure

➢ Estimation of **Propability** of pipe failure

driving factors

- material, profile, age
- max. hydrostatic pressure
- variation of hydrodynamic pressure during day
- type of land, where is pipe load
- theoretical failure rate
- type of joint
- others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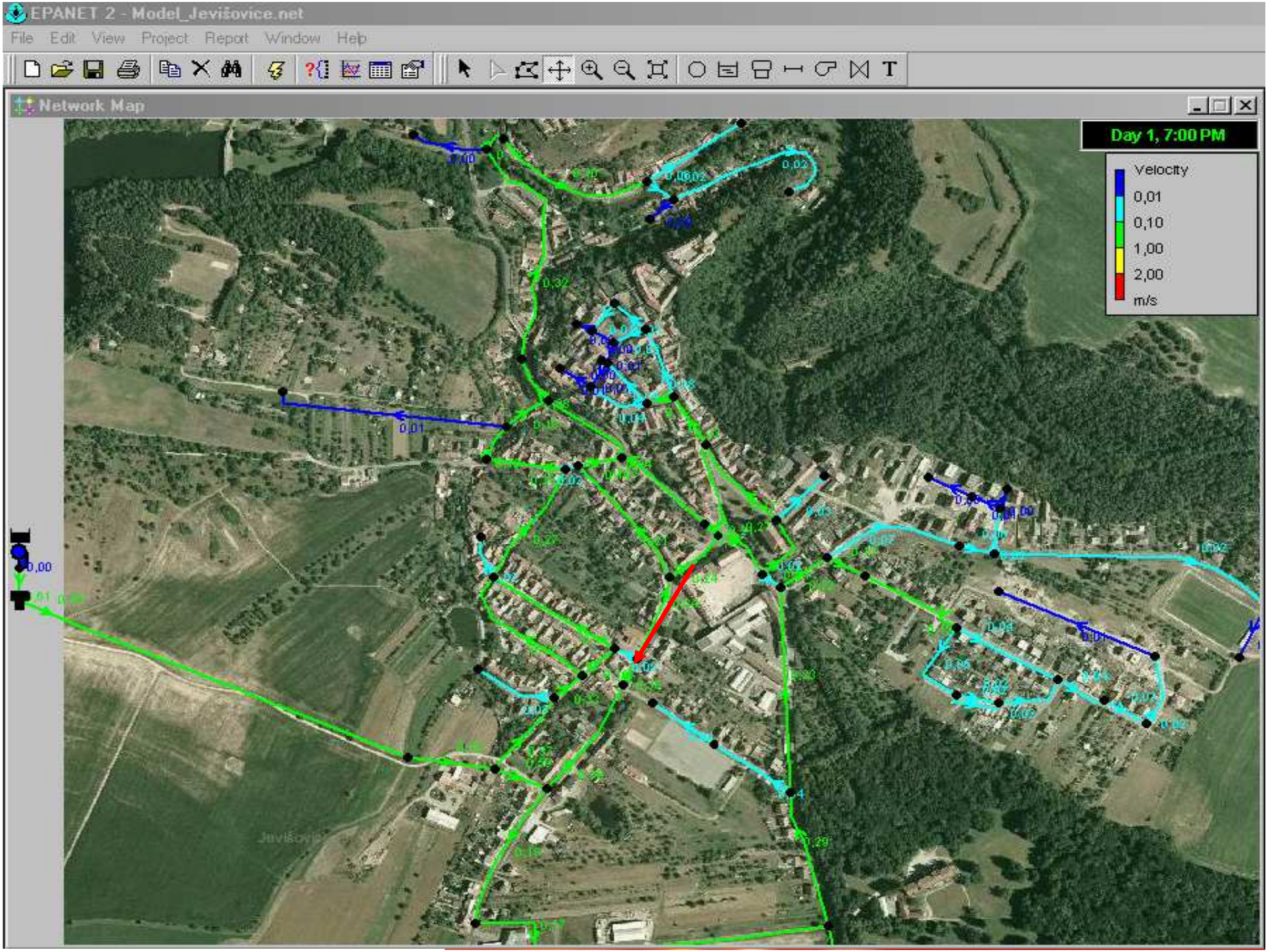
Network Map
Day 1, 7:00 PM
Velocity
0,01
0,10
1,00
2,00
m/s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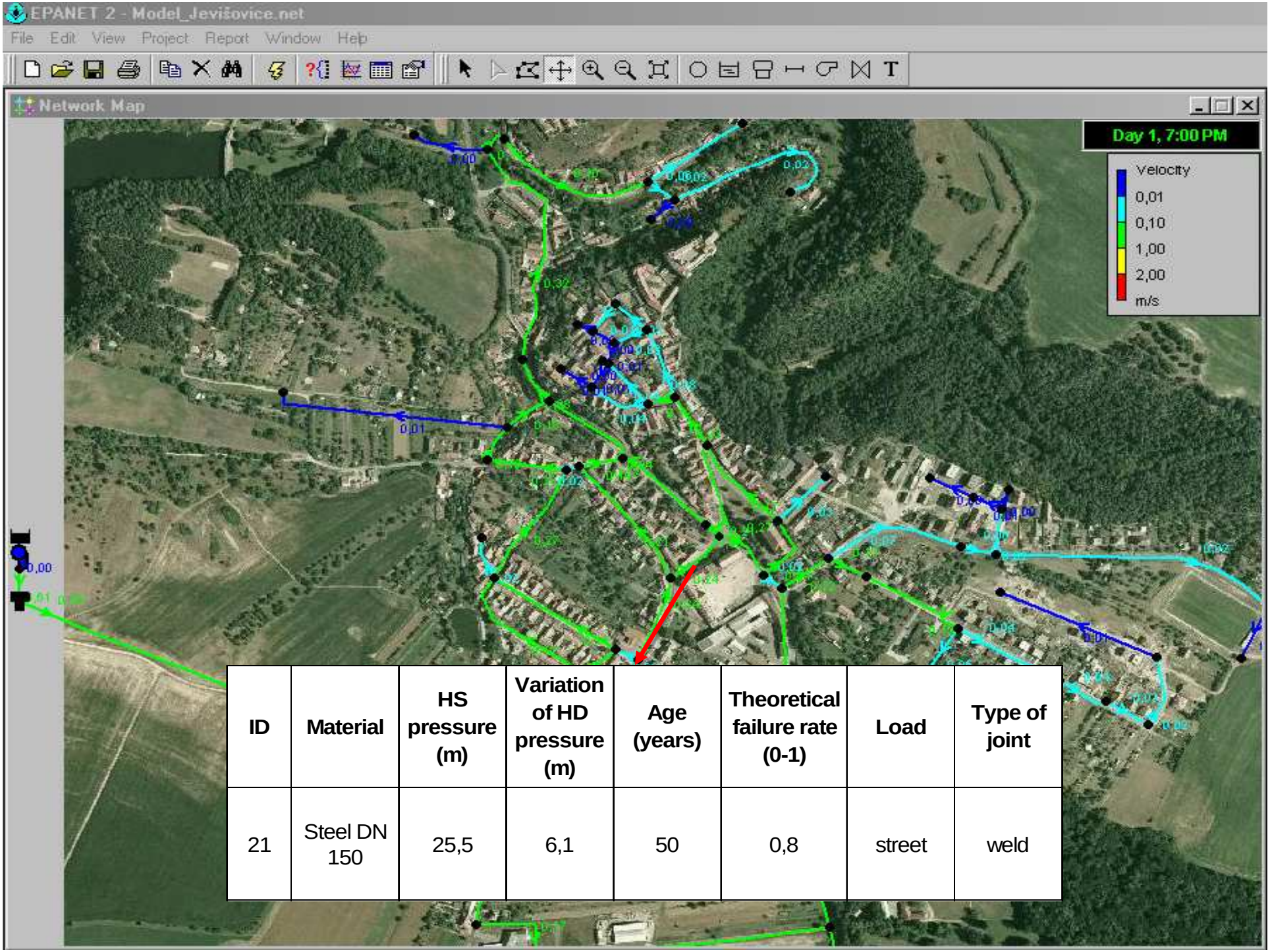


ID	Material	HS pressure (m)	Variation of HD pressure (m)	Age (years)	Theoretical failure rate (0-1)	Load	Type of joint
21	Steel DN 150	25,5	6,1	50	0,8	street	weld

Quantitative risk – Risk of Pipe Failure

➢ Estimation of **Propability** of pipe failure - driving factors

ID	Material/Age		HS pressure	Variation of HD pressure	Load	Theoretic failure rate	Type of joint	P	
	(years)		*(m)*	*(m)*				P = Fi*wi	
weight	0,4		0,2	0,15	0,1	0,1	0,05	1	
21	OC	K5	K1	K3	K5	K4	K4	0,75	P4

Quantitative risk – Risk of Pipe Failure

Estimation of **Consequencies** of pipe failure

Quantitative risk – Risk of Pipe Failure

- Estimation of **Consequencies** of pipe failure

ID	material damages	socio-economic damages	other damages	Human damages	C	
					C = Gi*wi	
weight	0,3	0,3	0,1	0,3	1	
21	K4	K4	K2	K1	0,58	C3

Quantitative risk – Risk of Pipe Failure

- Estimation of **Risk of Pipe Failure**

RISK: R = P x C

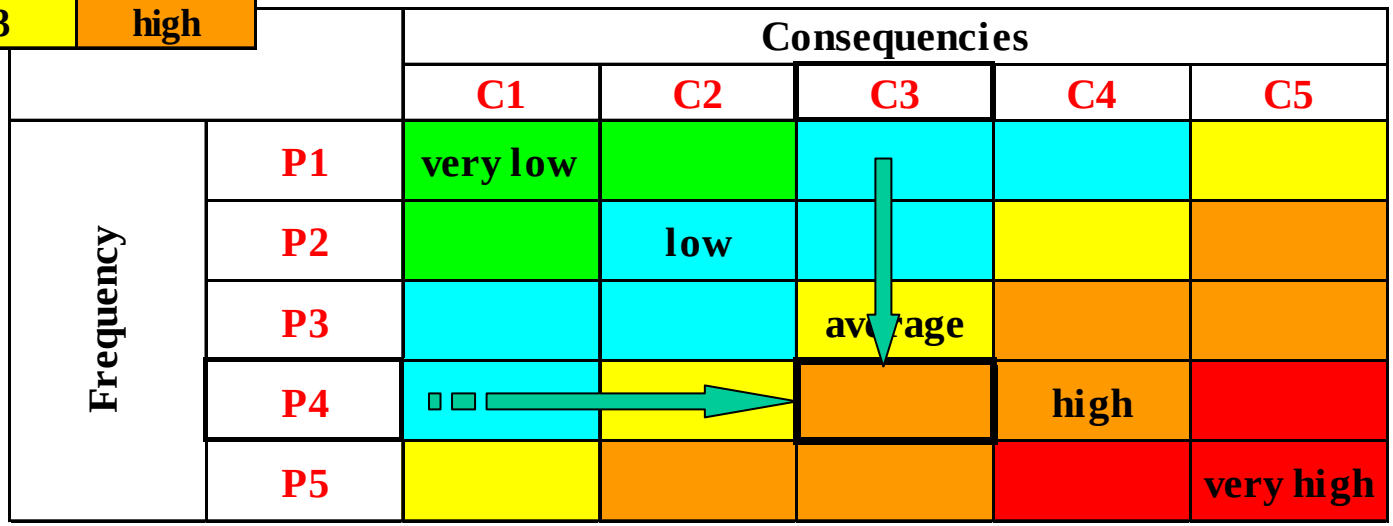
		Consequencies				
		C1	C2	C3	C4	C5
Frequency	P1	very low				
	P2		low			
	P3			average		
	P4				high	
	P5					very high

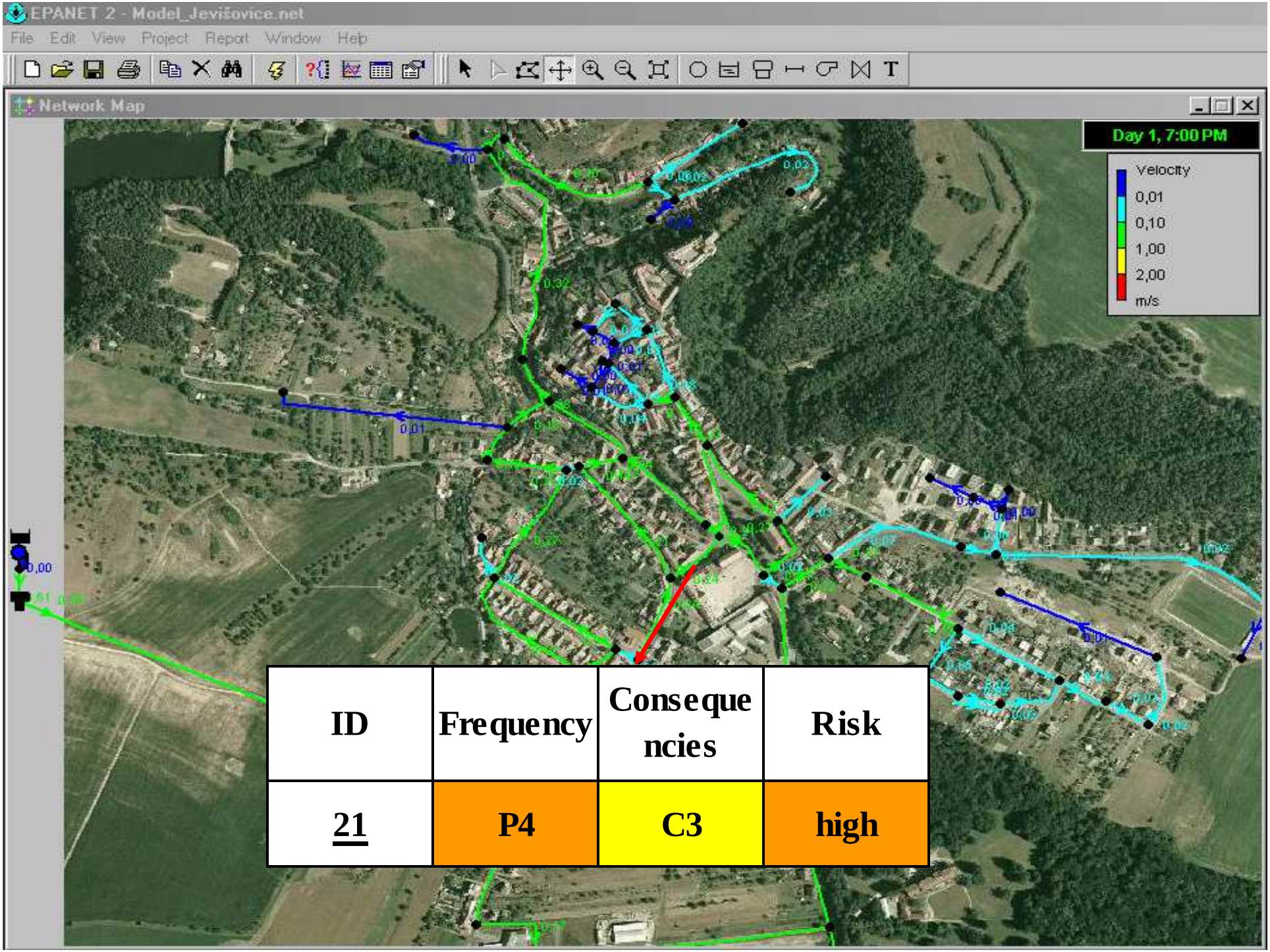
Quantitative risk – Risk of Pipe Failure

- Estimation of **Risk of Pipe Failure**

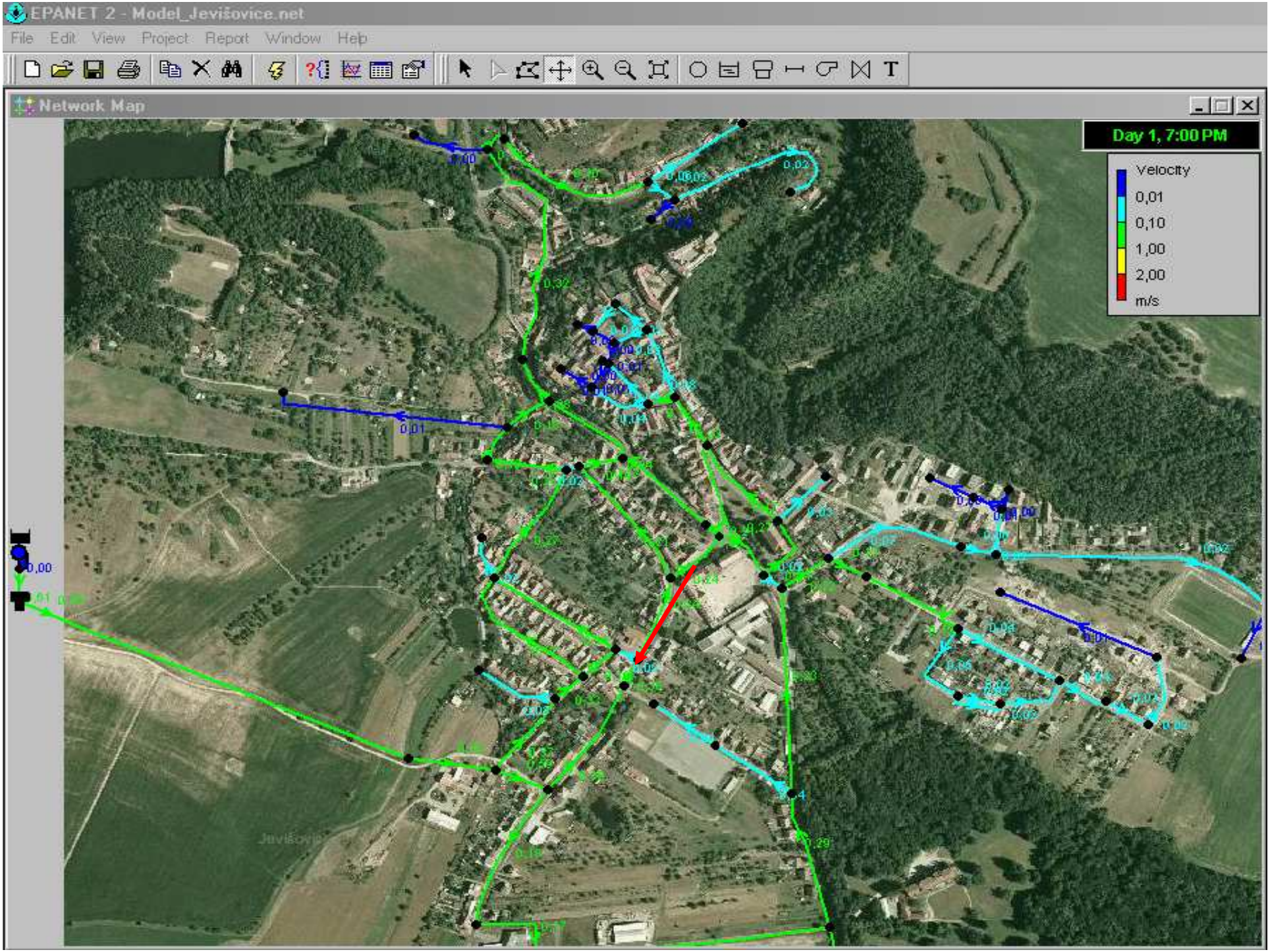
ID	Frequency	Consequencies	Risk
21	P4	C3	high

RISK: R = P x C





ID	Frequency	Consequencies	Risk
21	P4	C3	high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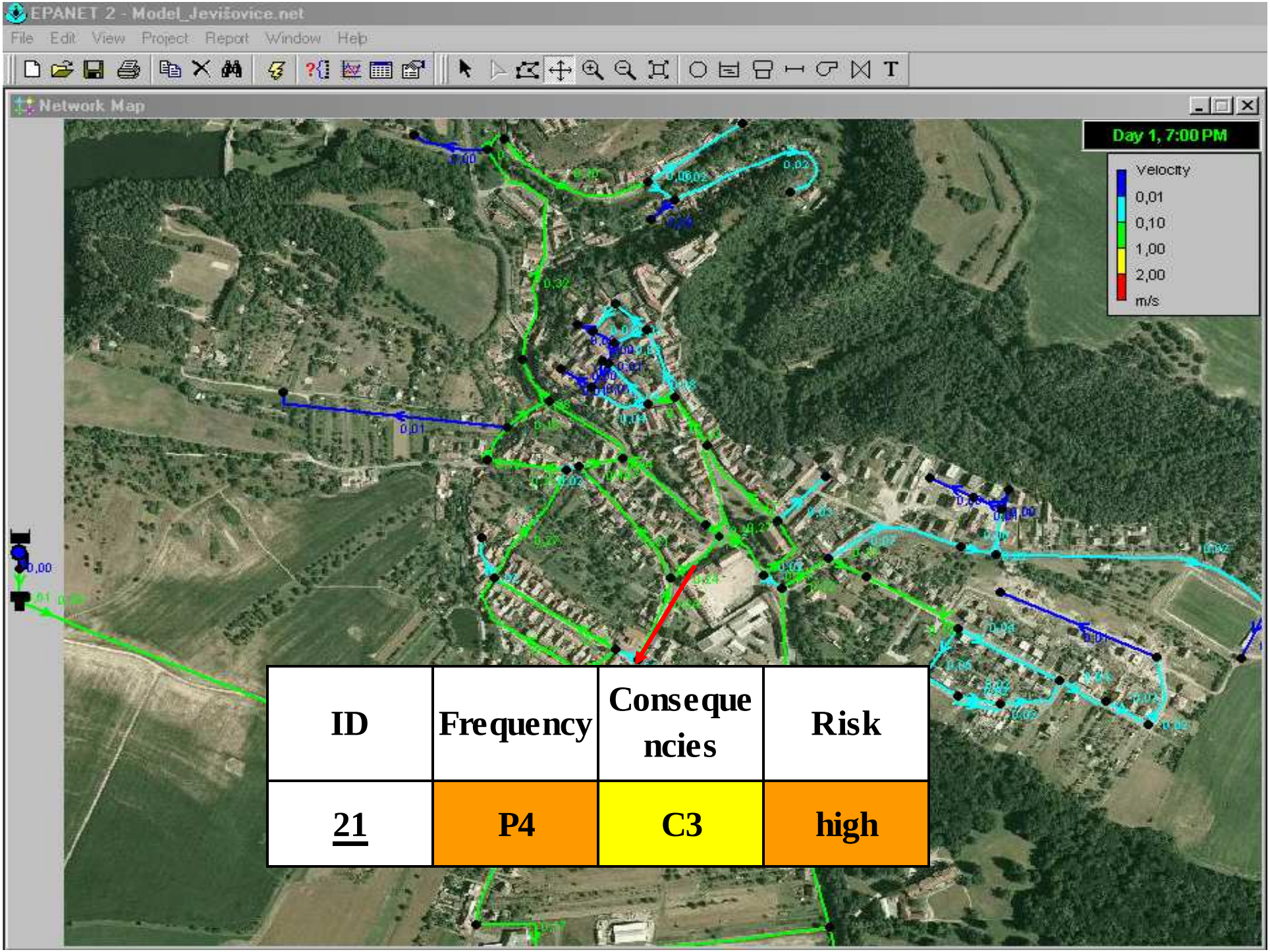

ID	Frequency	Consequencies	Risk
21	P4	C3	high

Thank you for your attention

www.waterrisk.cz