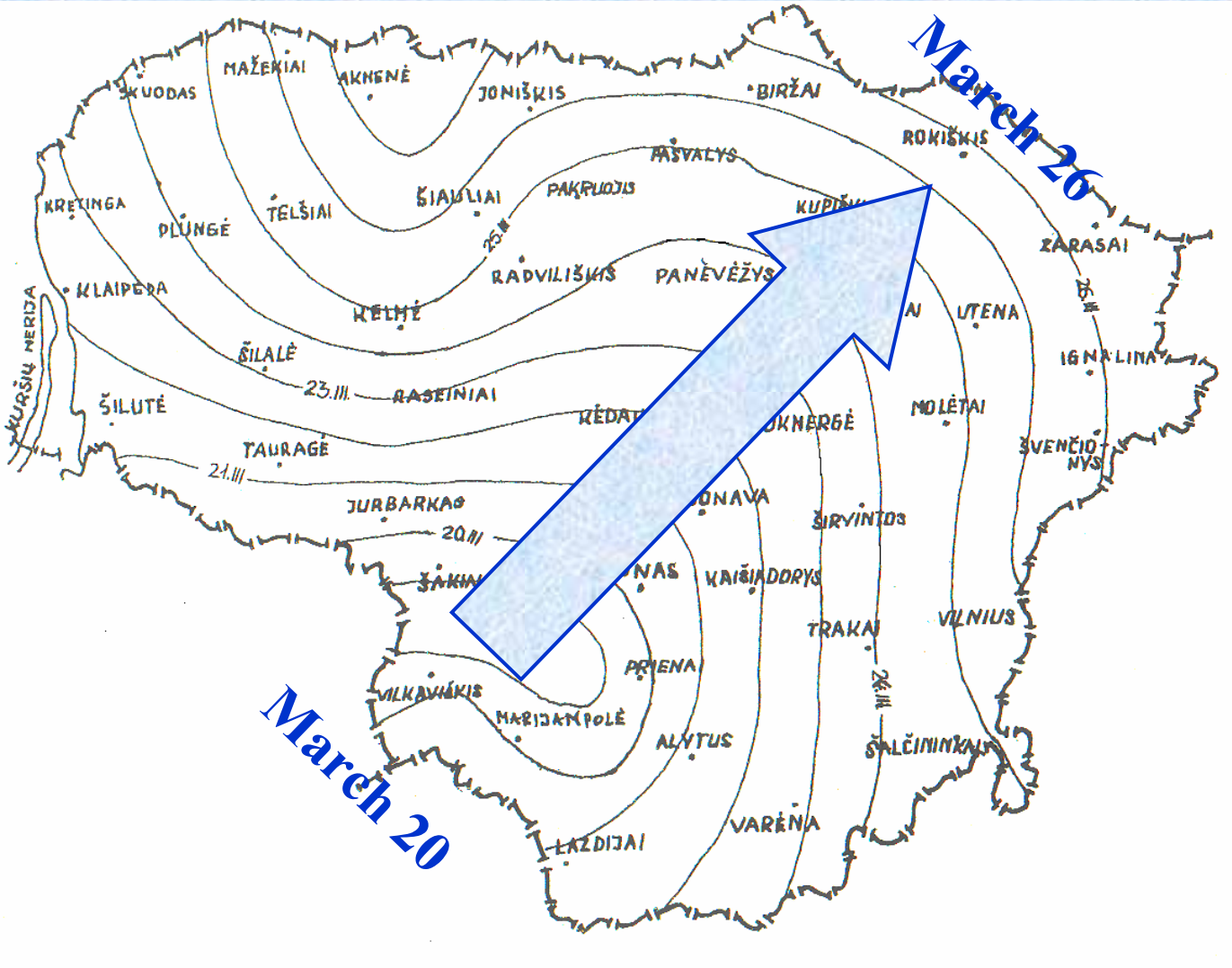
Environmental Aspects of Road De-icing Technologies

Safe and Efficient Winter Maintenance Practices
22-23 September 2005 Riga, Latvia

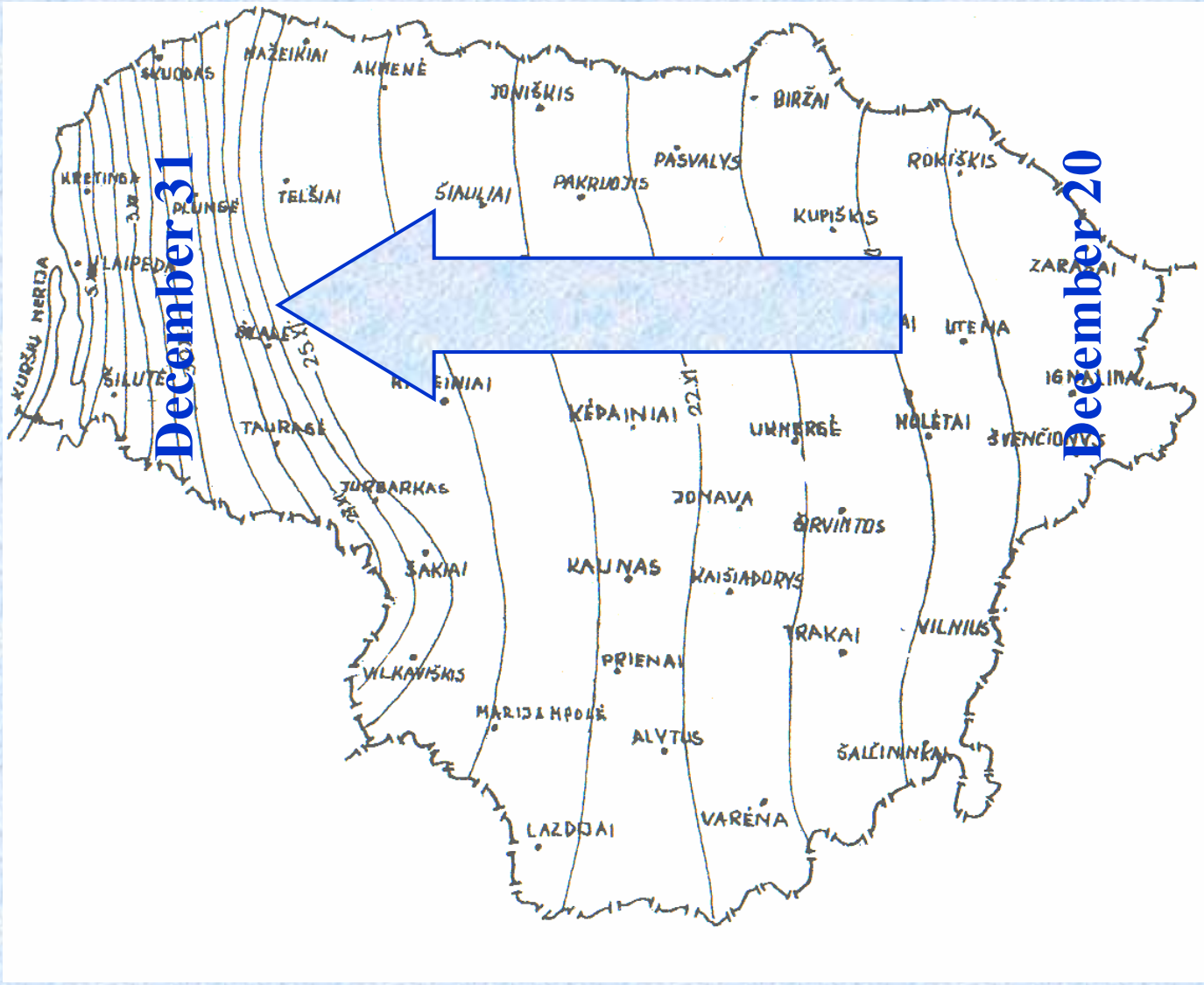
Air Conditions in Lithuania

- the warmest winter month is January
- average monthly air temperature is 5.1°C and it changes from 2.8°C on the sea-coast (in Klaipeda) to -6.8°C in the North East (in Dukstas)
- the coldest month in winter is the second decade of January (-5.6°C)
- absolute maximum air temperature in January is 10.5°C (in Nida)
- absolute minimum air temperature was - 40.5° C (in Varena in 1940)
- the permanent snow cover reaches 5cm (western part of Lithuania) and 20-25cm (northern part of Lithuania)
- the average number of days with fog and precipitation is 40-100 days per year (in different years up to 150 days) and 50-70 % of these days can be observed in the cold period of the year
- the average number of days with glazed frost is 10-15 days per year (in different years up to 50 days) (December-April period)
- the average duration of glazed frost is 12 hours (in some cases - up to 48 hours)
- 10-25 days per year with snowstorms and the average duration of one snowstorm reaches 5-7 hours, and the maximum - 30-40 hours
- from 60 to 80 of the changes of temperatures from negative to positive and vice versus vary every year

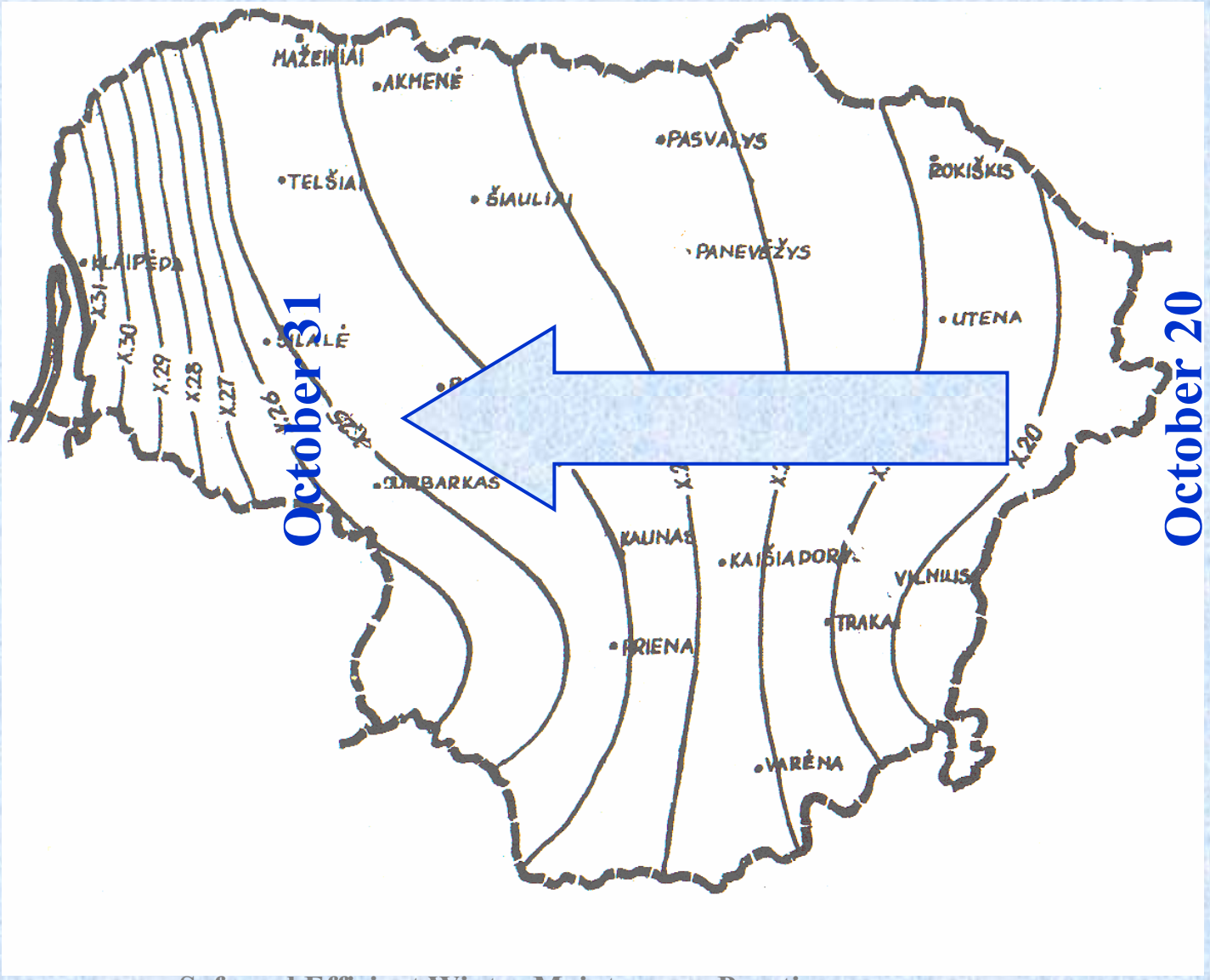
The first date of increment of the average day air temperature over 0°C in Lithuania



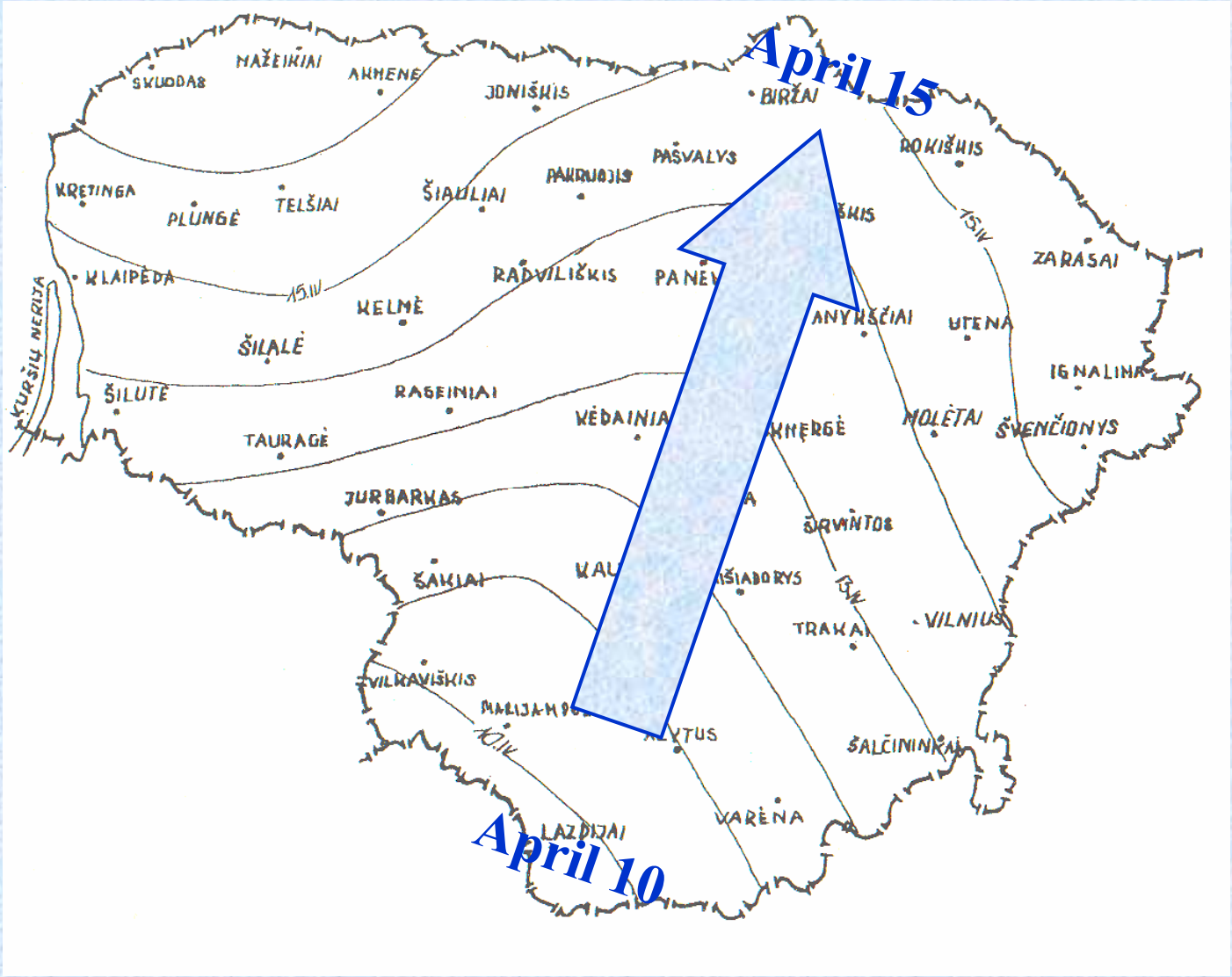
The first date of a drop in average day air temperature over 0°C in Lithuania



The first date of increment of the average day air temperature over +5ºC in Lithuania



The first date of a drop in average day air temperature over +5ºC in Lithuania



Dependence of accident risk level on pavement condition

Pavement condition	Relative risk level
Dry, clear	1,0
Moist, clear	1,3
Coat of compressed snow on pavement	1,5
Sheet of ice on pavement	4,4

Dependence of driving conditions on pavement condition and grip of tyres

Pavement condition	Driving conditions	Grip of tyres when driving speed is 60 km/h.
Dry, clear	Very good	0,7
Moist, clear	Normal	0,5
Wet, dirty	Favourable	0,3
Glazed	Unfavourable	0,1 – 0,2

Characteristics of glazed pavement

Indicator	Type of ice covering		
	Glazed frost	Ice	Frozen Snow
Thickness of layer, cm	0,5-0,1	2-0,8	2
Density of ice, g/cm3	0,5-0,9	0,8-0,9	0,3-0,8
Grip of tyres	0,05-0,15	0,1-0,2	0,2-0,3
Speed of formation	high	normal	slow

Quality requirements of salts according guideline in Lithuania

Requirements of salt	Index	Amount
Particle size distribution	**%**	
>5 mm		**0-5**
4-5 mm		**5-10**
2-4 mm		**20-30**
0,71-2 mm		**30-40**
0,16-0,71 mm		**20-30**
< 0,16 mm		**0-5**
< 0,063 mm		**≤1**
<u>Extra condition</u>: both particles, > 5 mm and < 0,16 mm, put together should be	**%**	**≤ 5**
Moisture content	**%**	**≤ 3**
Amount of insoluble material in water	**%**	**≤ 3**
Amount of chloride calculated like NaCl	**%**	**≥ 93**
Amount of sulphate	**%**	**≤ 2,5**

“Wet Salt” Technology

The “Wet salt” technology is currently used in Lithuania. The main reason - ecological and economical benefit, effective assurance of traffic safety.

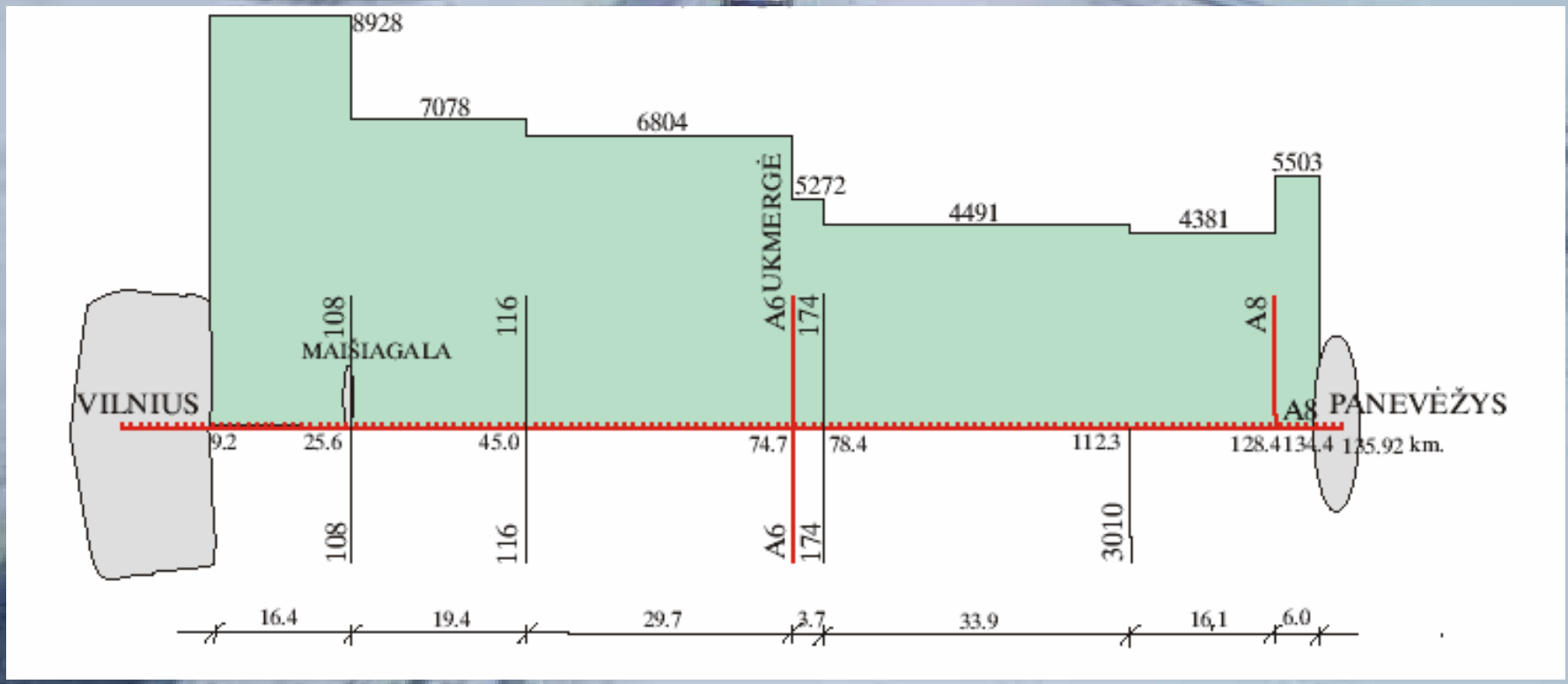
Sodium chloride (NaCl) moistened with the solution of this salt is mostly used for the “wet salt” technology to reduce slippery pavements of roads. Sodium chloride is successfully applied when the air temperature is not more than -7° C. At lower temperatures the effect of salt is very weak and it becomes ineffective (this was proved by the experience of winter 1996). To increase the range of used temperatures of NaCl, this salt shall be moistened with calcium chloride ($CaCl_2$) solution. This gives a very great effect: usage of NaCl is reduced at 25-40%, and the range of temperatures is increased at -18°C, when the application of salt is still effective. However, another problem arises here - calcium chloride salt is 20 times more expensive than sodium chloride salt.

Optimal ration of liquid chlorides, 1/m²

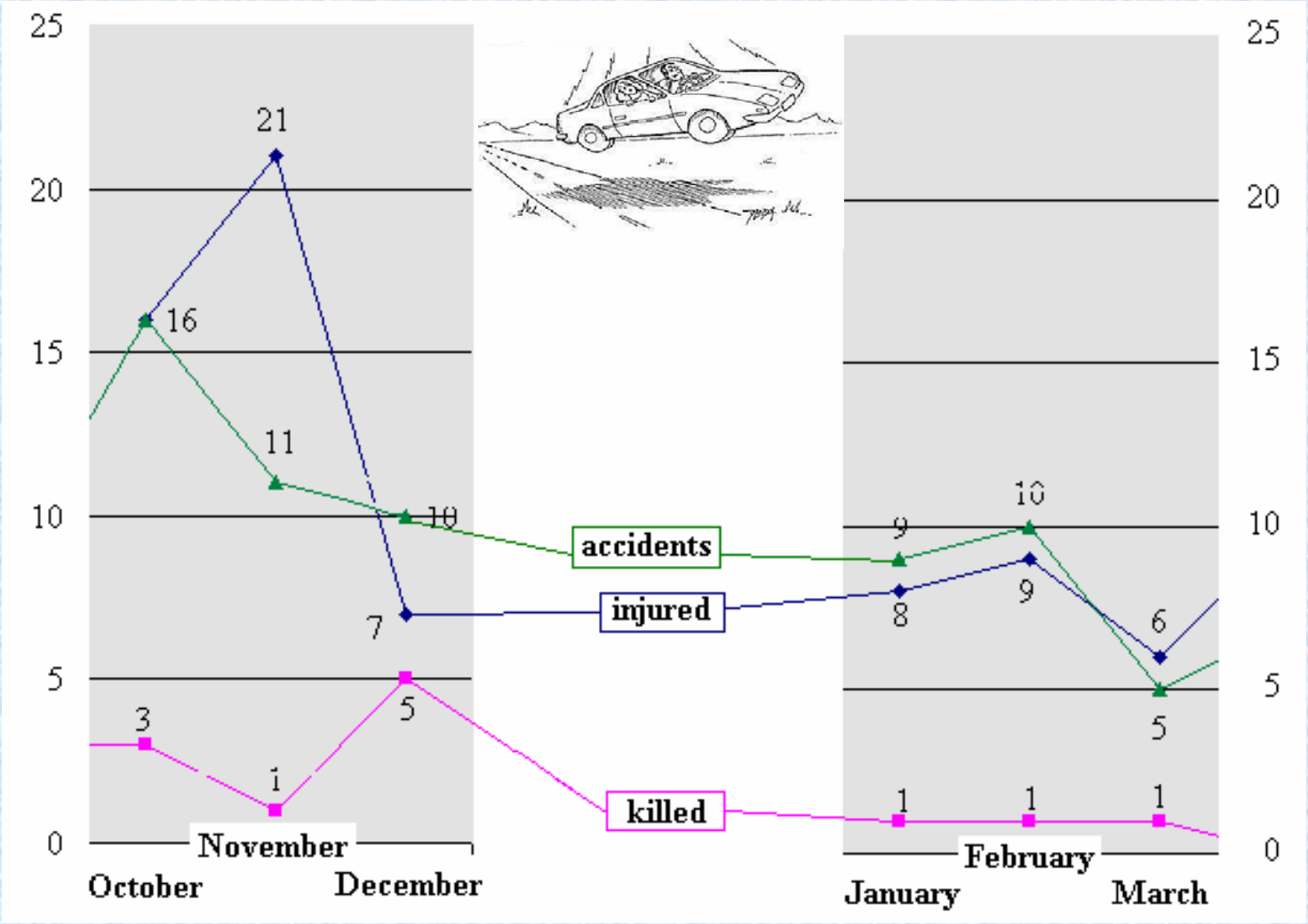
Chemical material	Spreading norm in g/m³ when air temperature °C	Solutions		
		composition of 20-23 % of NaCl	concentrate	composition of 32-38 % of $CaCl_2$
Usage up to °C		-10	-10	-10
Ice	0 – -5	120	100	100
	-5 – -10	200	150	150
	-10 – -15	-	-	-
	-15 – -20	-	-	-
Compressed snow	0 – -5	100	80	80
	-5 – -10	150	120	120
	-10 – -15	-	-	-
	-15 – -20	-	-	-
Light snow	0 – -5	100	80	80
	-5 – -10	120	100	100
	-10 – -15	-	-	-
	-15 – -20	-	-	-

Highway A2 Vilnius - Panevezys

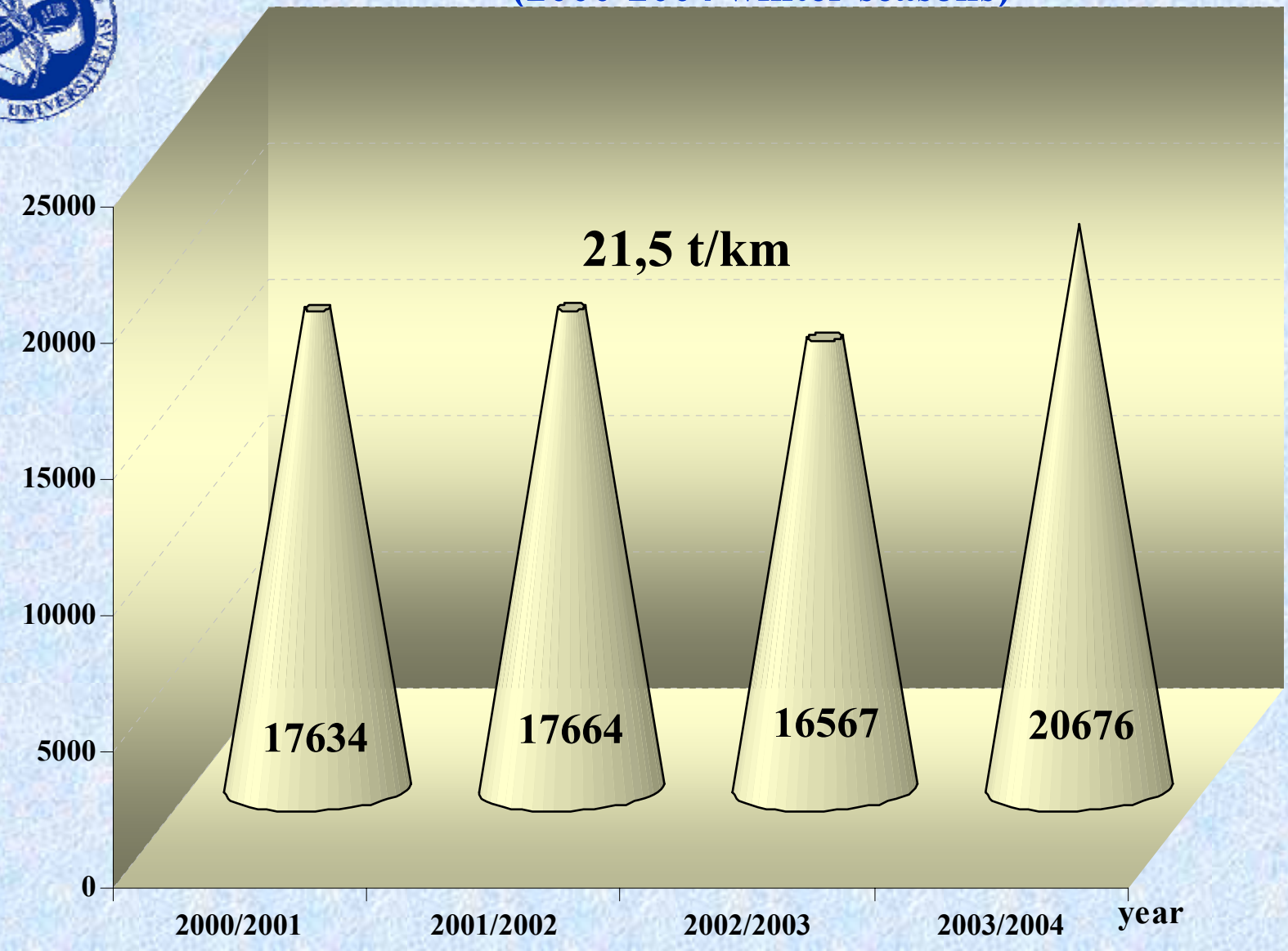
Traffic volume on highway A2 Vilnius – Panevezys (2003)



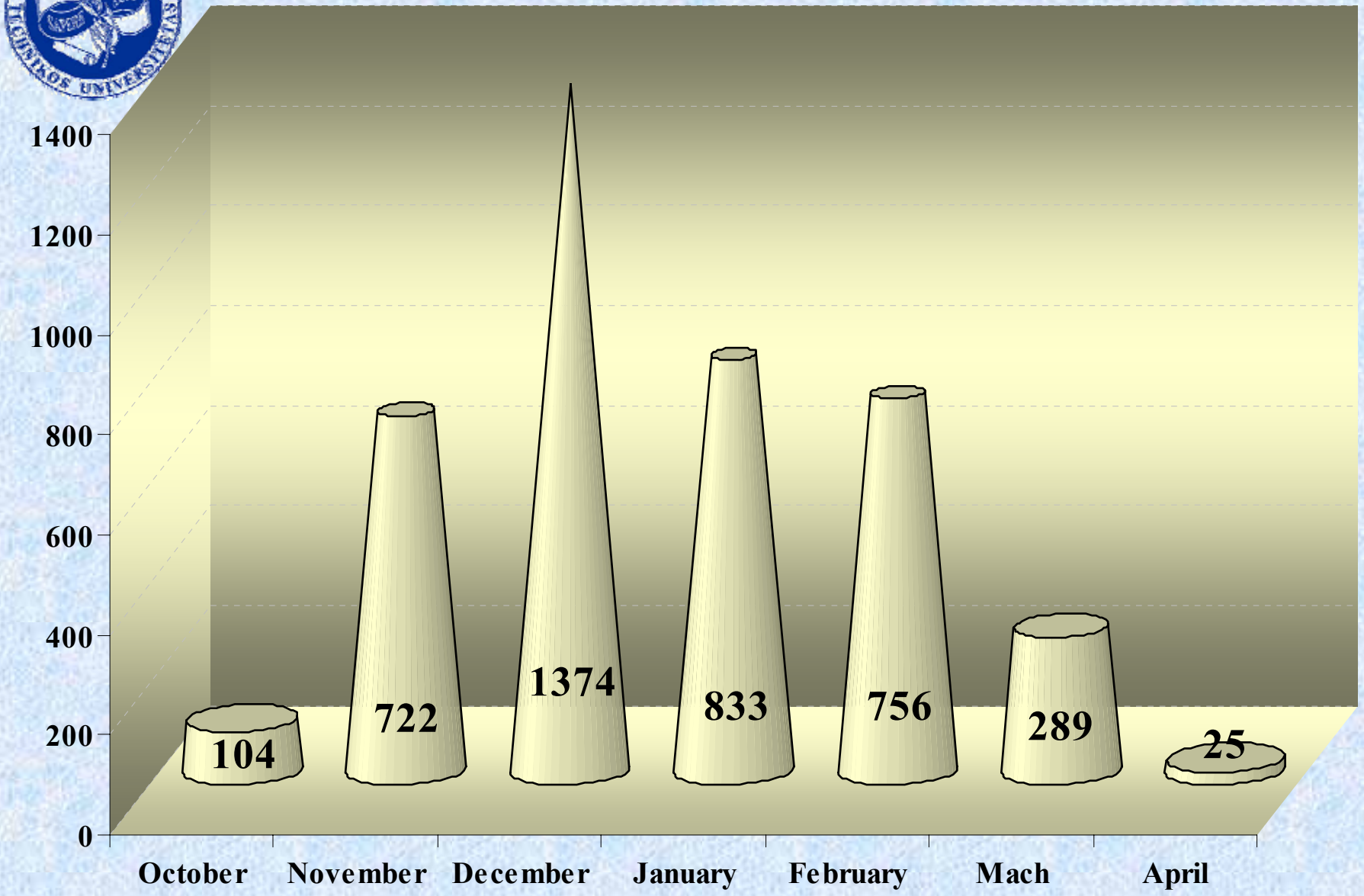
Road accidents on highway A2 Vilnius – Panevezys in winter seasons (2000-2004)



NaCl salt on highway A2 Vilnius – Panevezys (2000-2004 winter seasons)



Demand of NaCl salt on highway A2 Vilnius – Panevezys according months (1998-2004)



Results of NaCl composition (Kaunas)

Requirements	Index	Amount	Result	
Particle size distribution	%			
>5 mm		0-5	0	+
4-5 mm		5-10	3,5	-1,5 ✓
2-4 mm		20-30	28,8	+
0,71-2 mm		30-40	39,9	+
0,16-0,71 mm		20-30	25,9	+
< 0,16 mm		0-5	5,3	+0,3 ✓
< 0,063 mm		≤1	0,0	+
Extra condition: both particles, > 5 mm and < 0,16 mm, put together should be		≤ 5	5,3	+0,3 ✓
Moisture content	%	≤ 3	-	-
Amount of insoluble material in water	%	≤ 3	-	-
Amount of chloride calculated like NaCl	%	≥ 93	-	-
Amount of sulphates	%	≤ 2,5	-	-

Results of NaCl composition (Vievis)

Requirements	Index	Amount	Result	
Particle size distribution	**%**			
>5 mm		**0-5**	**0**	+
4-5 mm		**5-10**	**3,7**	-1,3 ✓
2-4 mm		**20-30**	**28,4**	+
0,71-2 mm		**30-40**	**44,0**	+4,0 ✓
0,16-0,71 mm		**20-30**	**19,1**	-0,9 ✓
< 0,16 mm		**0-5**	**4,50**	+
< 0,063 mm		**≤1**	**0,045**	+
<u>Extra condition:</u> both particles, > 5 mm and < 0,16 mm, put together should be		**≤ 5**	**0,1**	+
Moisture content	**%**	**≤ 3**	-	-
Amount of insoluble material in water	**%**	**≤ 3**	-	-
Amount of chloride calculated like NaCl	**%**	**≥ 93**	-	-
Amount of sulphate	**%**	**≤ 2,5**	-	-

Results of NaCl composition (Ukmerge)

Requirements	Index	Amount	Result	
Particle size distribution	%			
>5 mm		0-5	0,0	+
4-5 mm		5-10	3,5	-1,5
2-4 mm		20-30	27,2	+
0,71-2 mm		30-40	37,5	+
0,16-0,71 mm		20-30	27,5	+
< 0,16 mm		0-5	4,2	+
< 0,063 mm		≤1	0,1	+
Extra condition: both particles, > 5 mm and < 0,16 mm, put together should be		≤ 5	0,1	+
Moisture content	%	≤ 3	0,20	+
Amount of insoluble material in water	%	≤ 3	0,87	+
Amount of chloride calculated like NaCl	%	≥ 93	96,50	+
Amount of sulphate	%	≤ 2,5	0,21	+

Results of NaCl composition (Sirvintai)

Requirements	Index	Amount	Result	
Particle size distribution	%			
>5 mm		0-5	0	+
4-5 mm		5-10	3,3	-1,7 ✓
2-4 mm		20-30	22,5	+
0,71-2 mm		30-40	35,8	+
0,16-0,71 mm		20-30	29,0	+
< 0,16 mm		0-5	9,2	+4,2 ✓
< 0,063 mm		≤1	0,2	+
Extra condition: both particles, > 5 mm and < 0,16 mm, put together should be		≤ 5	0,2	+
Moisture content	%	≤ 3	0,20	+
Amount of insoluble material in water	%	≤ 3	0,85	+
Amount of chloride calculated like NaCl	%	≥ 93	97,75	+
Amount of sulphate	%	≤ 2,5	0,18	+

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