ROADEX

Implementing Accessibility

ROADEX Drainage Research:

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Roadscanners, Finland

ROADSCANNERS

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ROADEX PROJECTS 1998 - 2007

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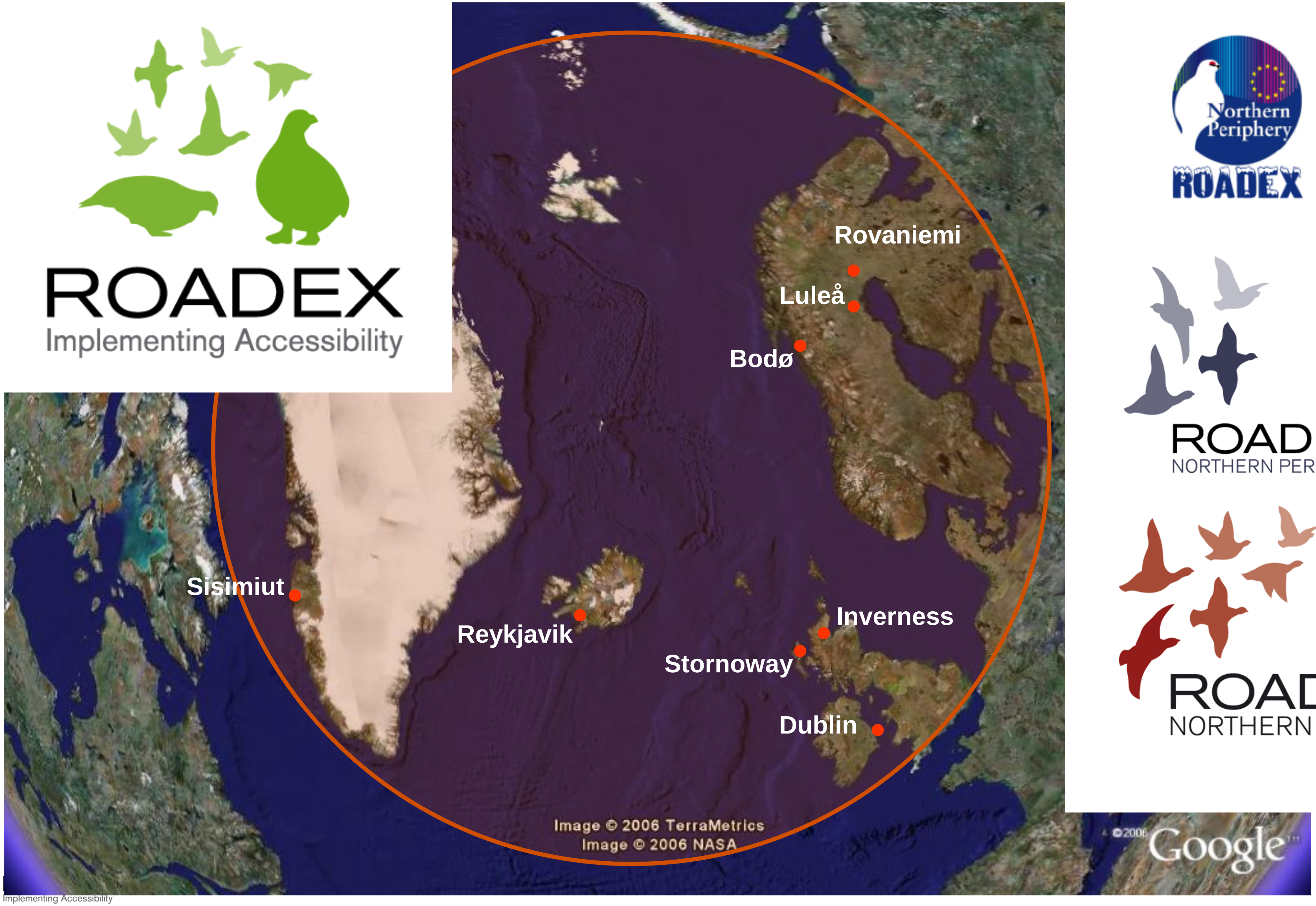


Northern Periphery
ROADEX

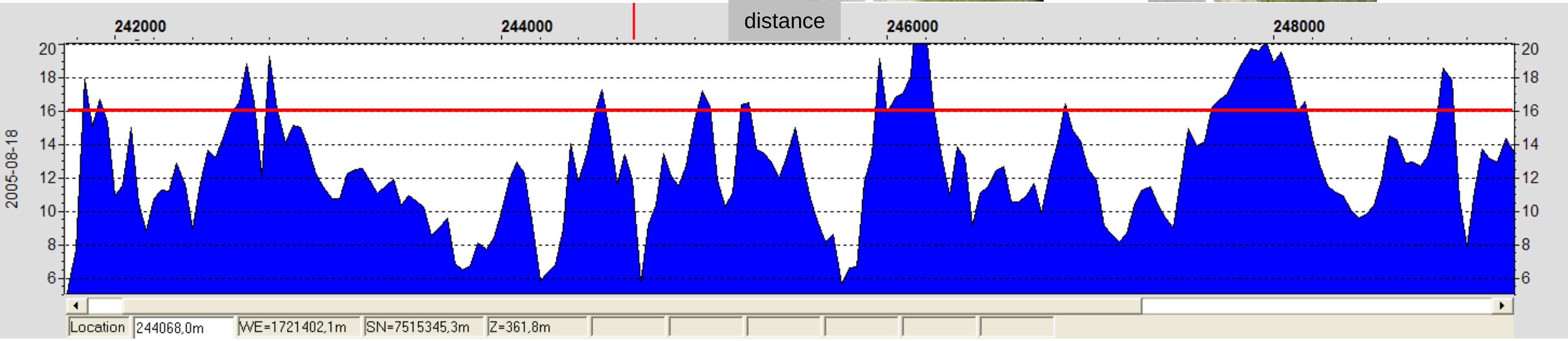
ROADEX II
NORTHERN PERIPHERY

ROADEX III
NORTHERN PERIPHERY

What is Pavement Life Time ?

• *rehabilitation measures needs to be taken when more than 10 % of the rutting or roughness values are higher than the trigger value*

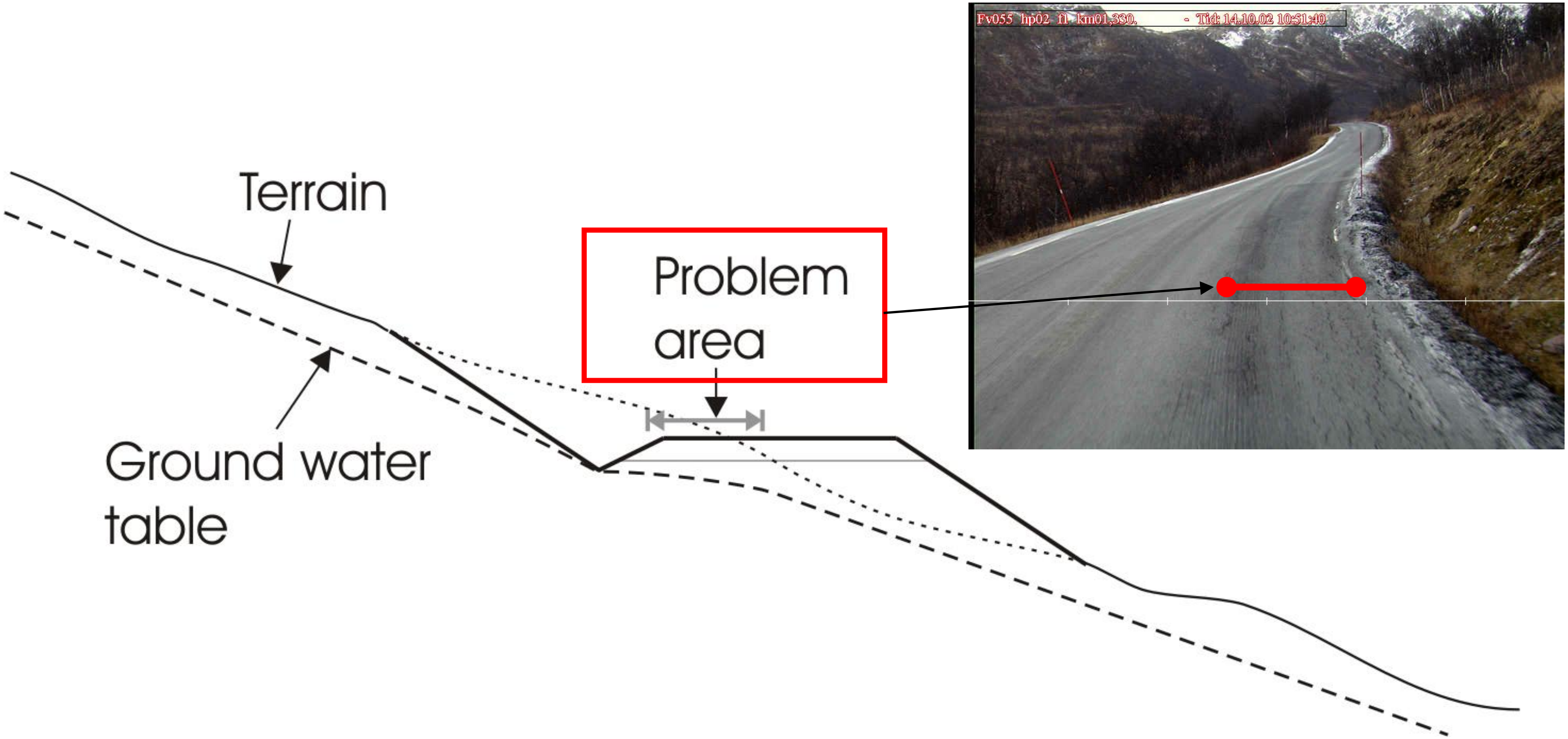
What is Common for these critical sections ?



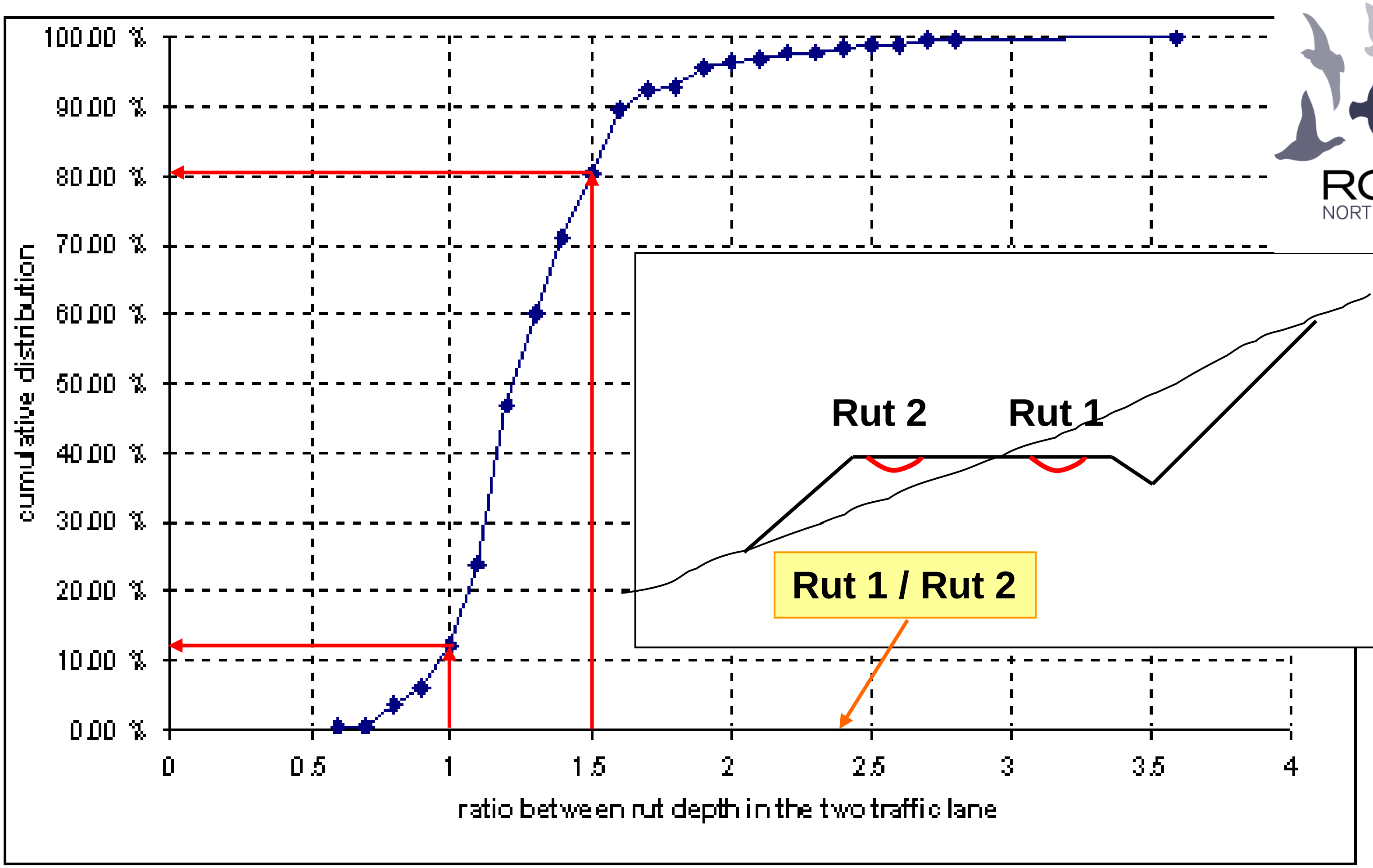
ROADEX Projects have so far shown:

Drainage is a **Major Problem** in NP Area Roads!

Special Drainage Problem in NP Area: Roads on side sloping ground



Cumulative distribution of the ratio for rut depth in the drained and the undrained lane



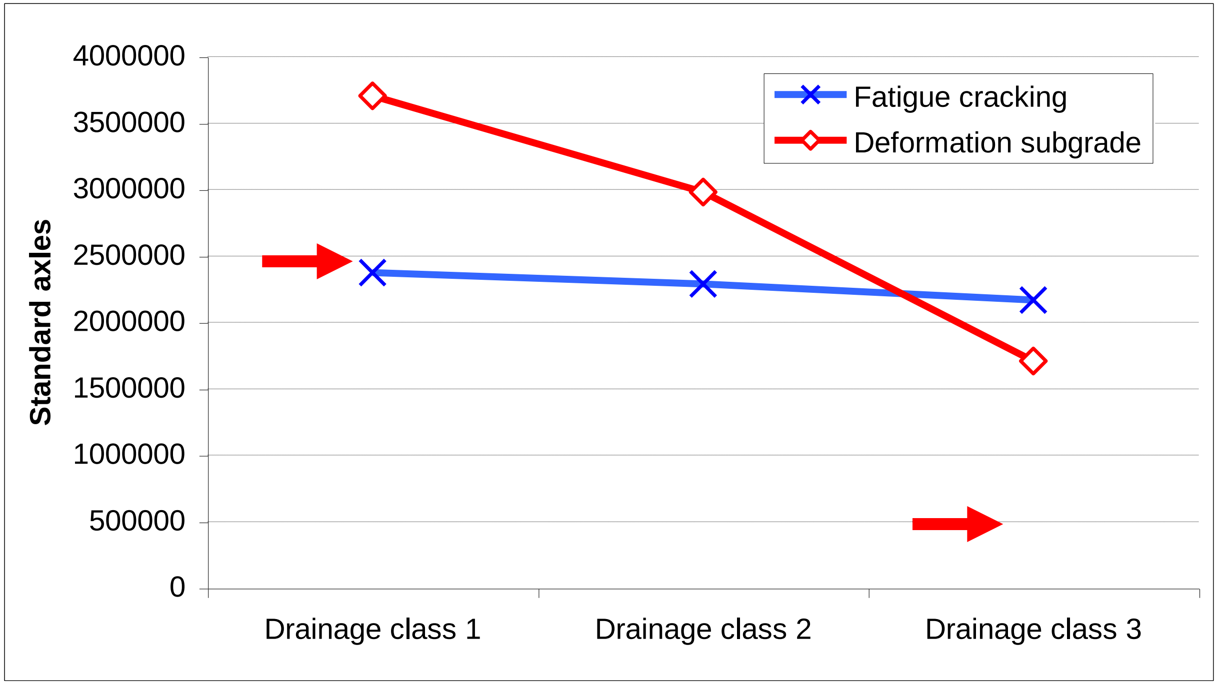
Effect of Poor Drainage on Pavement Performance: Theoretical Calculations:

Test Calculations Based on Swedish Design Guide

Structure
110 mm bituminous wearing course
120 mm bituminous macadam
800 mm old sub-base gravel material
Subgrade: silt

Improving drainage from class 3 to class 1

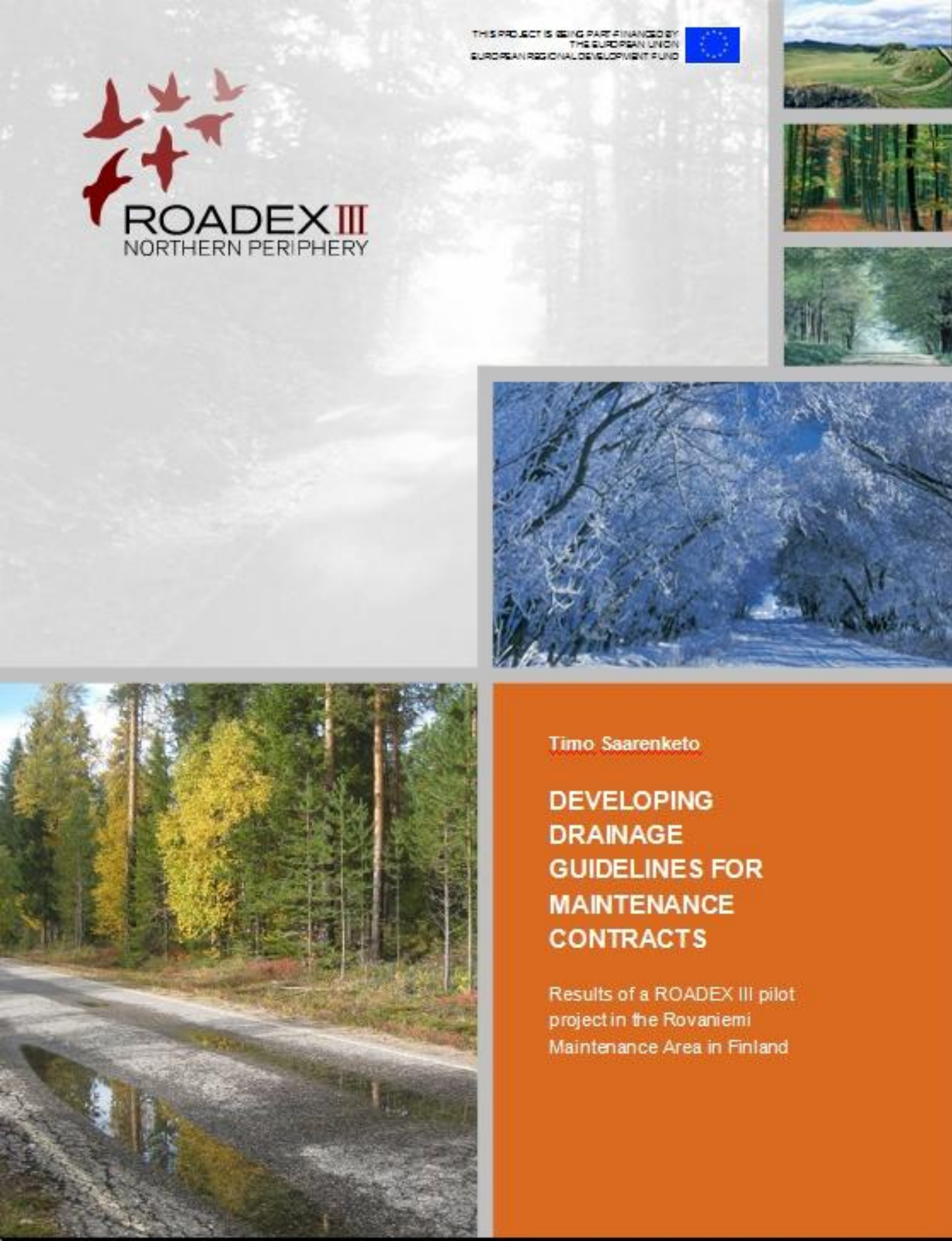
Increase the lifetime by a factor of nearly **2,2**.



Berntsen and Saarenketo 2005

Drainage condition	Drainage classes [1)]	Factor - change in lifetime by improving the drainage system
Group 1 Drainage system does not work at all (or drainage system does not exist). Water susceptible soil in road structure and subgrade. Very high ground water table. Low ground and rocks blocking the ground water flow. Often local spots.	>3	> 2,5
Group 2 Drainage system does not work at all and the soil in road structure and subgrade are less water susceptible then in group 1. Drainage system is working badly because of lack of maintenance (ditches and culverts not cleared) and water susceptible soil in road structure and subgrade.	3	2-2,5
Group 3 Drainage system is working badly because of lack of maintenance. (Ditches and culvert not cleared.) The soil in road structure and subgrade are less water susceptible.	2	1,5-2
Group 4 Drainage system is working unsatisfactory because of lack of maintenance or the maintenance guidelines are not sufficient.	1-2	1-1,5

1)Comparison to the drainage classes in the Swedish design guide.



Roadex III Report

Developing Drainage Guidelines for Maintenance Contracts

Results of a ROADEX III Pilot project in the Rovaniemi Maintenance Area in Finland

Drainage Guidelines – Project Goals:

Implementing New Drainage Policies and Techniques

ROADEX III
NORTHERN PERIPHERY

• new drainage management model for maintenance contracts
• new techniques for drainage analysis in paved roads and gravel roads
• analysing drainage condition in Rovaniemi road network
•standards for the maintenace contract
• calculate the effect of poor drainage for life cycle costs on paved and gravel roads
• how much investements can be used to improve drainage – and still be profitable
• test the new guidelines in the procurement process of Rovaniemi maintenace contracts 2007 - 2012

New RD CamLink system for drainage and distress surveys

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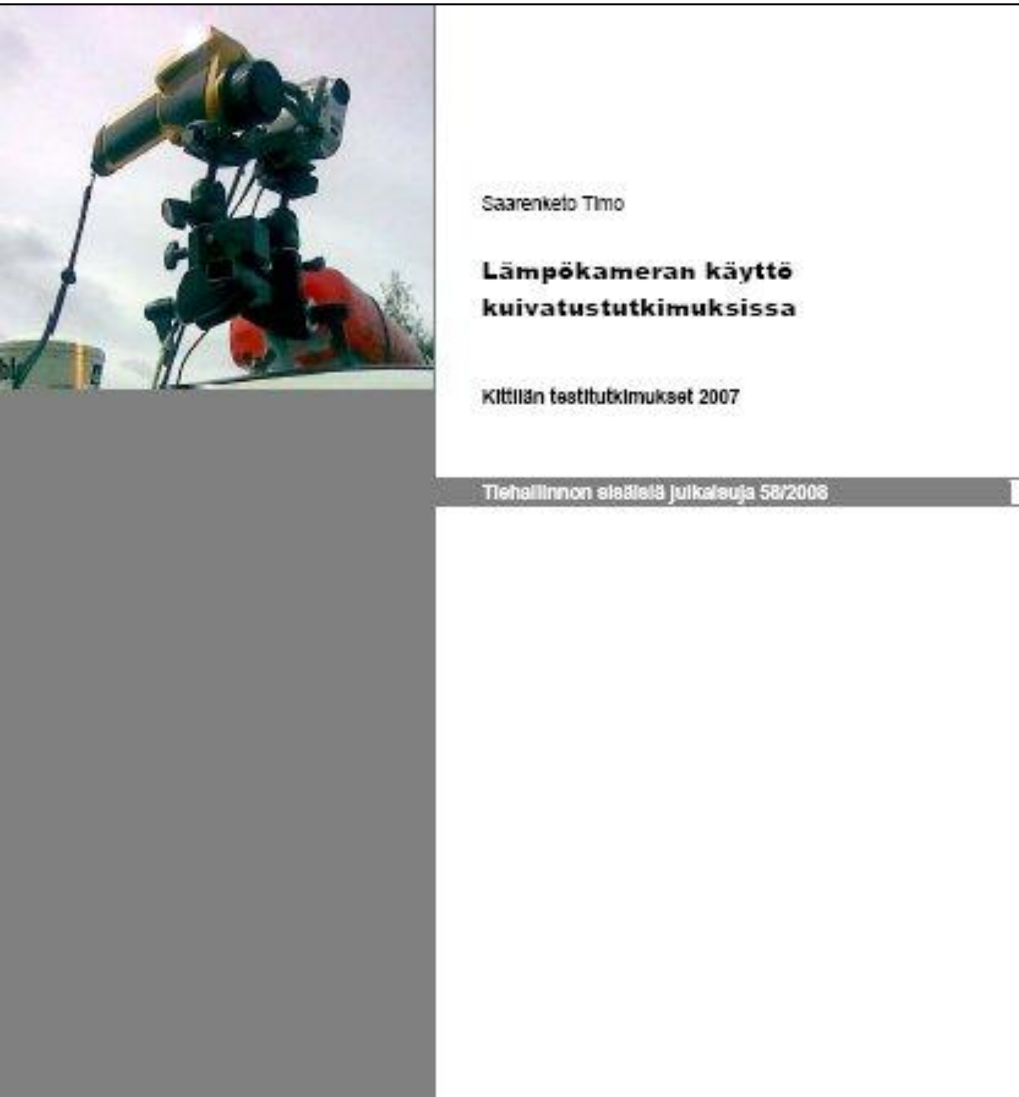
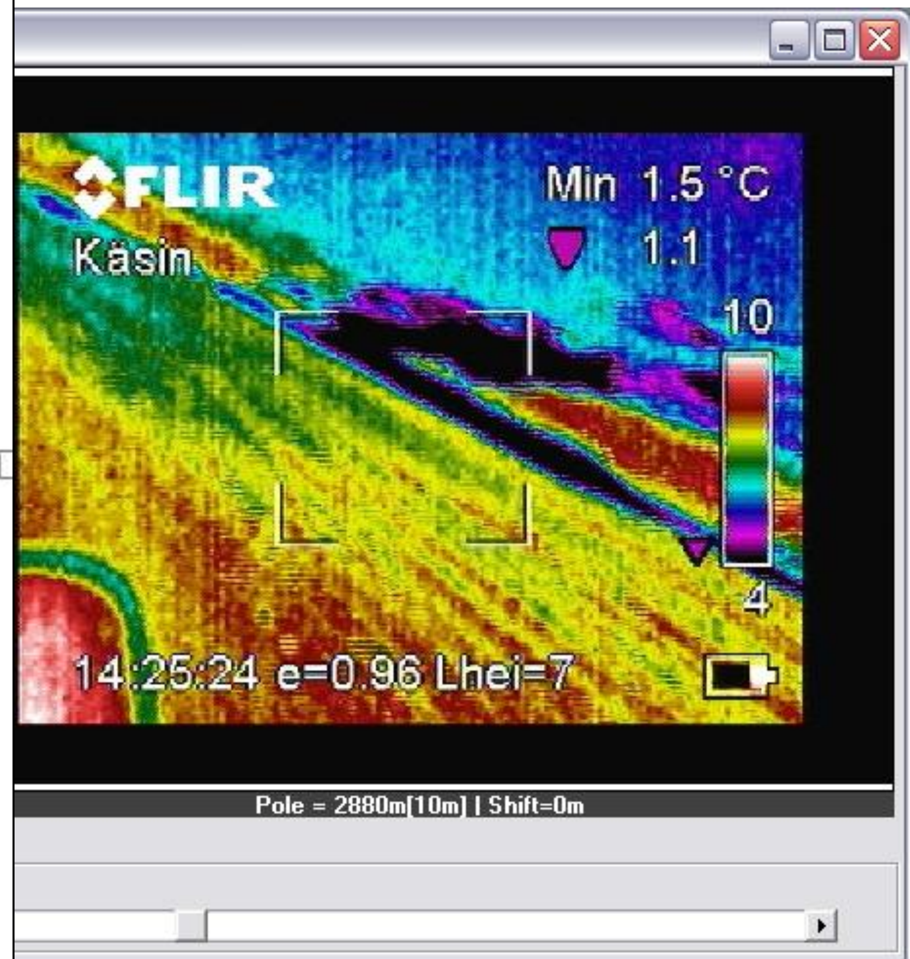
New tests: drainage analysis and thermal cameras


Saarenketo Timo

Lämpökameran käyttö kuivatustutkimuksissa

Kittilän testitutkimukset 2007

Tiehallinnon sisäisiä julkaisuja 58/2008



VISUAL DRAINAGE CONDITION CLASSIFICATION OF PAVED ROADS

Class 1: Good Drainage Condition

Description:
Faultless drainage. Road cross section shape has preserved its form well and water flow from the pavement to ditch has no obstacles. Unrestricted water flow in ditches.

VISUAL DRAINAGE CONDITION CLASSIFICATION OF PAVED ROADS

Class 2: Adequate Drainage Condition

<u>Description:</u>
Small changes in the road cross section form can appear. Road shoulder has small verges or vegetation that prevents good water flow to ditch. Vegetation in ditch restrains water flow and causes dams. Small amount of soil flows from road slopes into ditches and raises the bottom of the ditch, slows the water flow and raises the ground water table.

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VISUAL DRAINAGE CONDITION CLASSIFICATION OF PAVED ROADS

Class 3: Poor Drainage Condition

Description:

Deformations and damages in the road cross section. Road shoulder can have a high verge and/or dense vegetation that causes ponding on the traffic lane or on the shoulder. Vegetation in ditch restrains water flow and causes dams in the ditch. Unstable soil flows from ditch slopes into ditches and blocks the water flow. Clocked culvert or outlet dict prevent the water flow in the ditch.

VISUAL DRAINAGE CONDITION CLASSIFICATION OF GRAVEL ROADS

Class 1: Good Drainage Condition

Description:

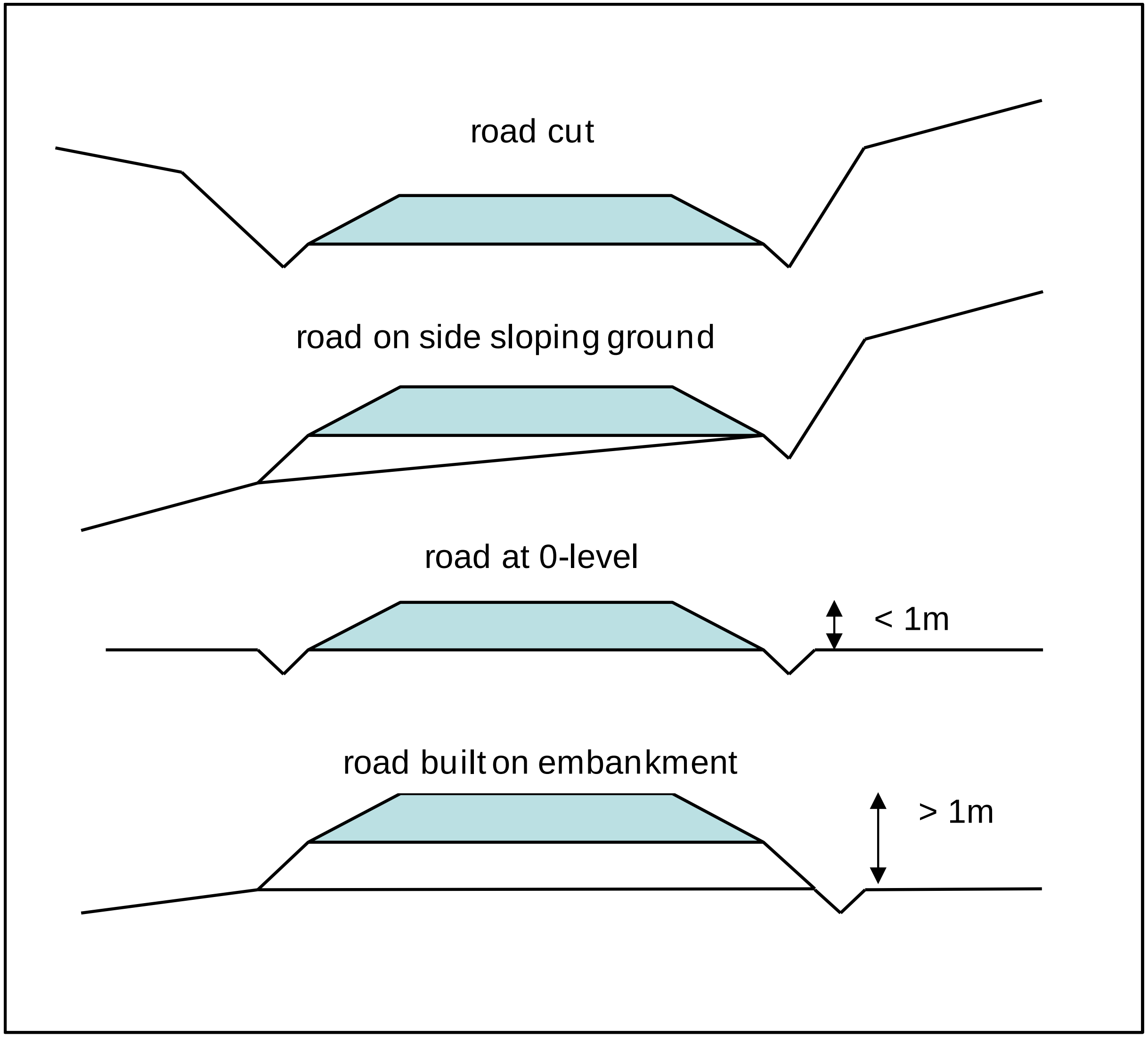
Faultless drainage. Road cross section shape has preserved its form well and water flow from the pavement to ditch has no obstacles. Unrestricted water flow in ditches.

VISUAL DRAINAGE CONDITION CLASSIFICATION OF GRAVEL ROADS

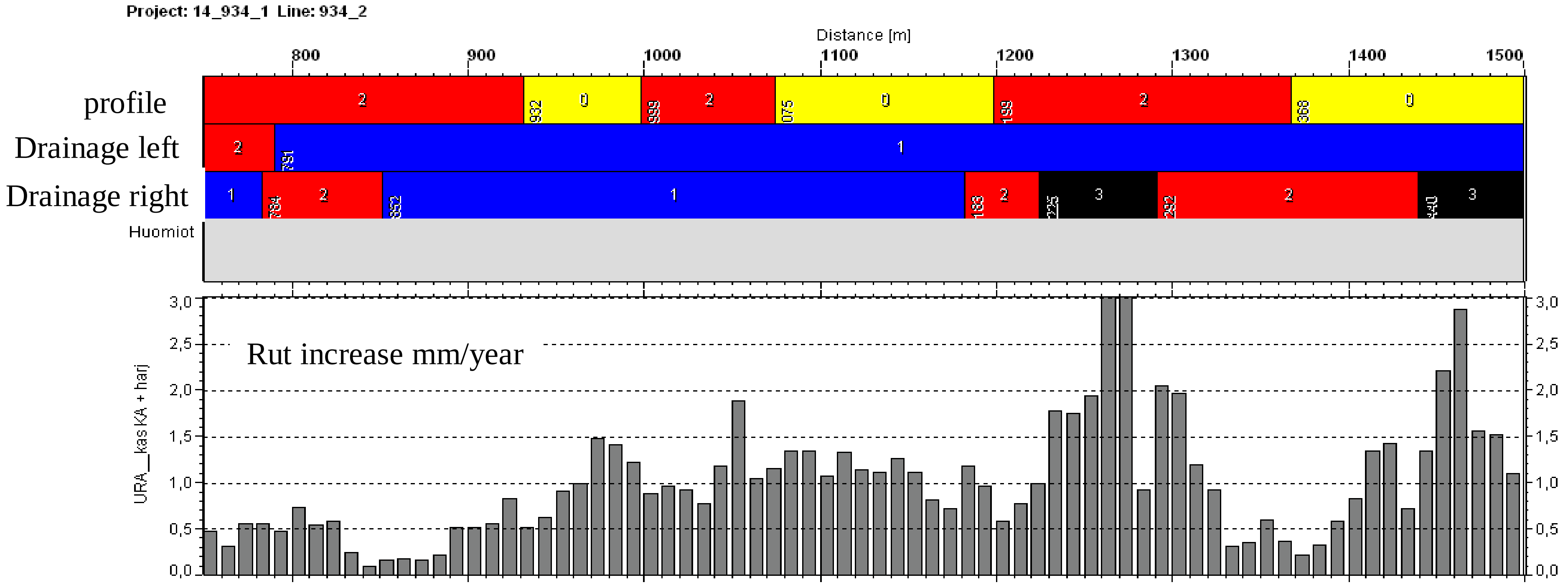
Class 3: Poor Drainage Condition

<u>Description:</u>
Deformations and damages in the road cross section. Road shoulder can have a high verge and/or dense vegetation that causes ponding on the traffic lane or on the shoulder. Vegetation in ditch restrains water flow and causes dams in the ditch. Unstable soil flows from ditch slopes into ditches and blocks the water flow. Clocked culvert or outlet dict prevent the water flow in the ditch.

ROAD CROSS SECTION PROFILE IN DRAINAGE CLASSIFICATION

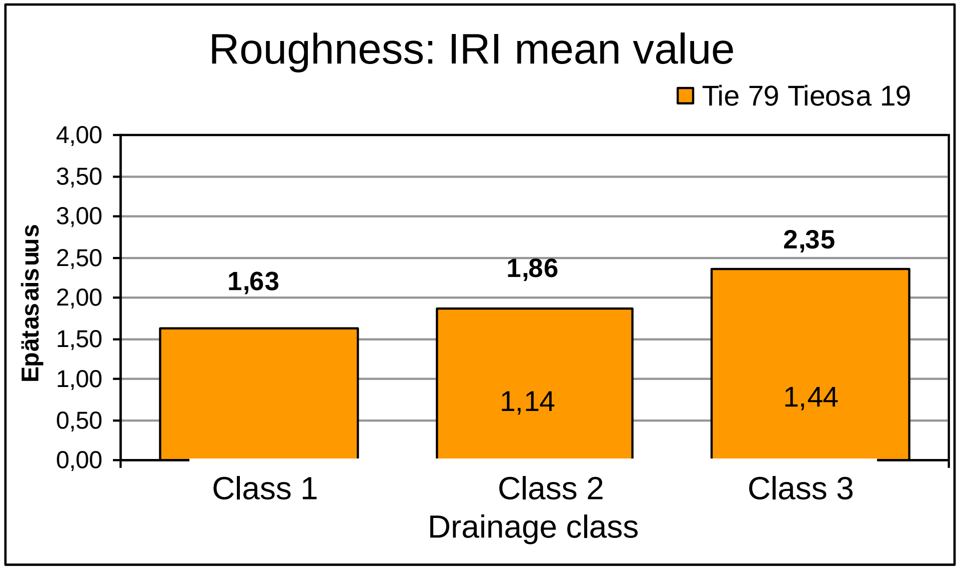


Drainage Analysis Data for Paved Roads

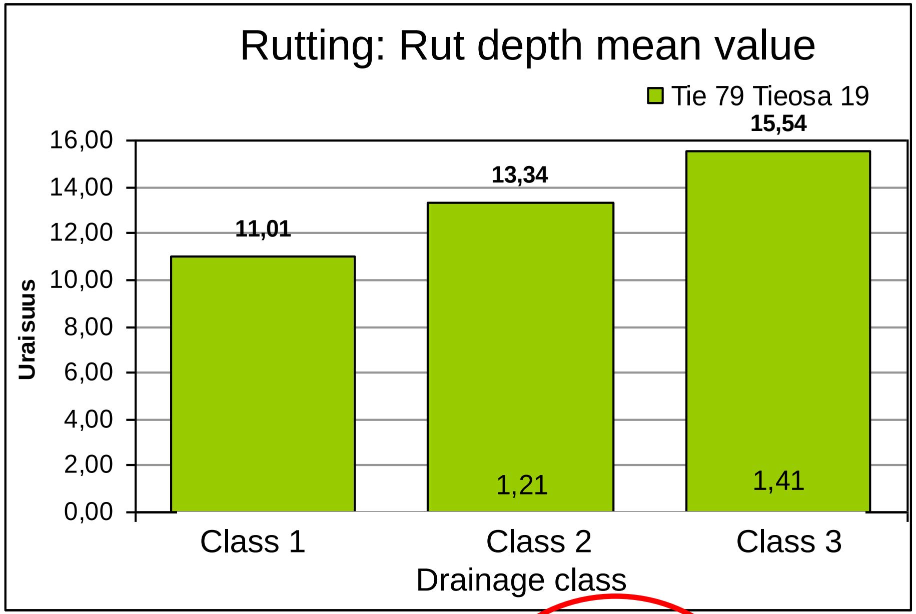


Statistical analysis, example: Rd 79_19

IRI

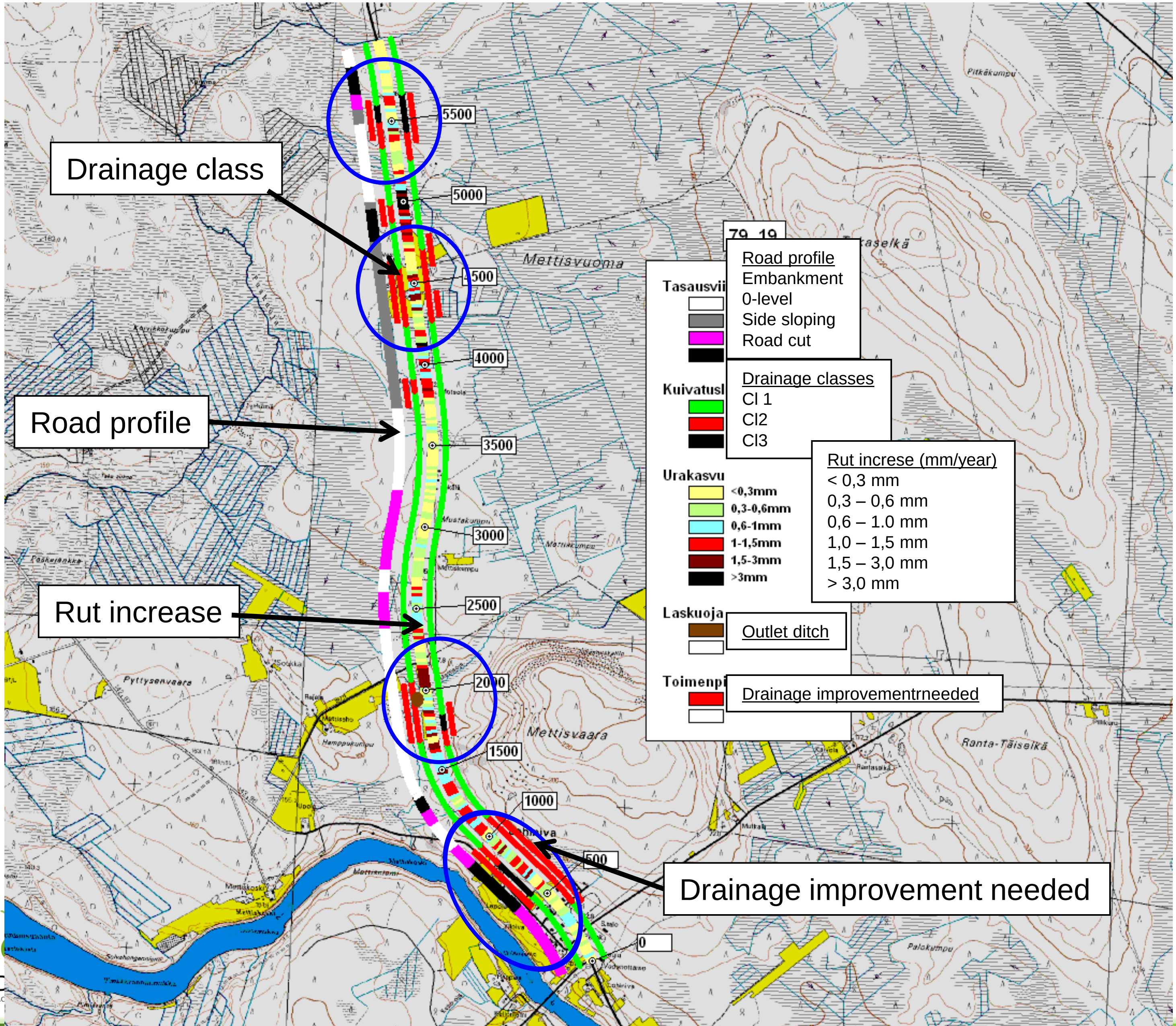


Rutting



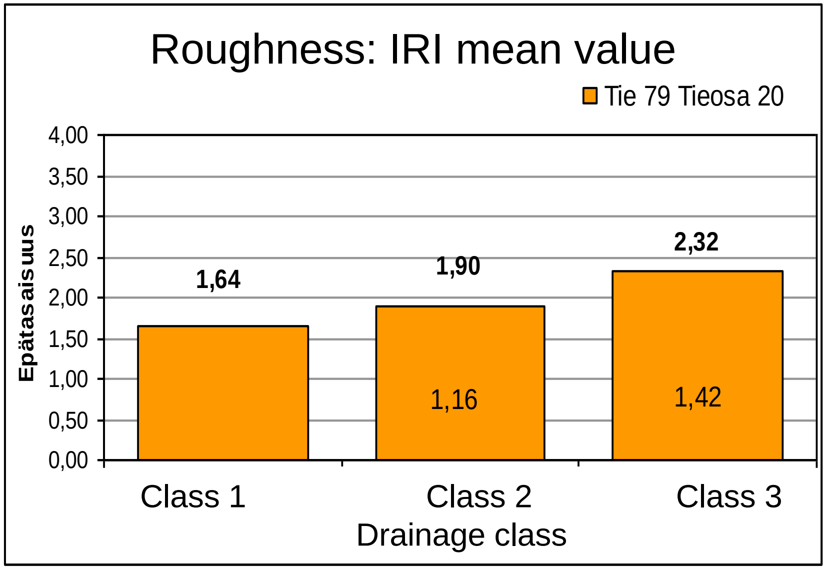
	Class 1	Class 2	Class 3
Drainage Class Distribution:	**63,5 %**	**26,3 %**	**10,2 %**
	3806	1576	610

Drainage Analysis: GIS-maps, road 79_19

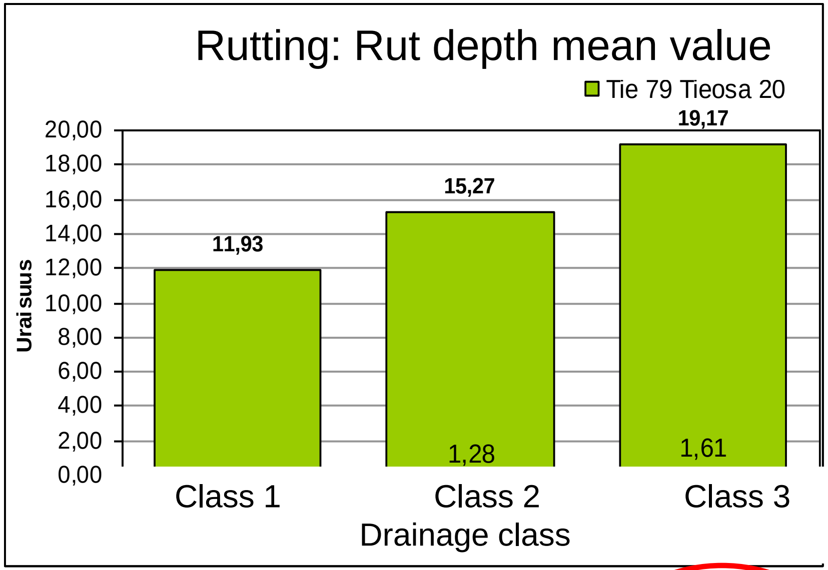


Statistical analysis, example: 79_20

IRI

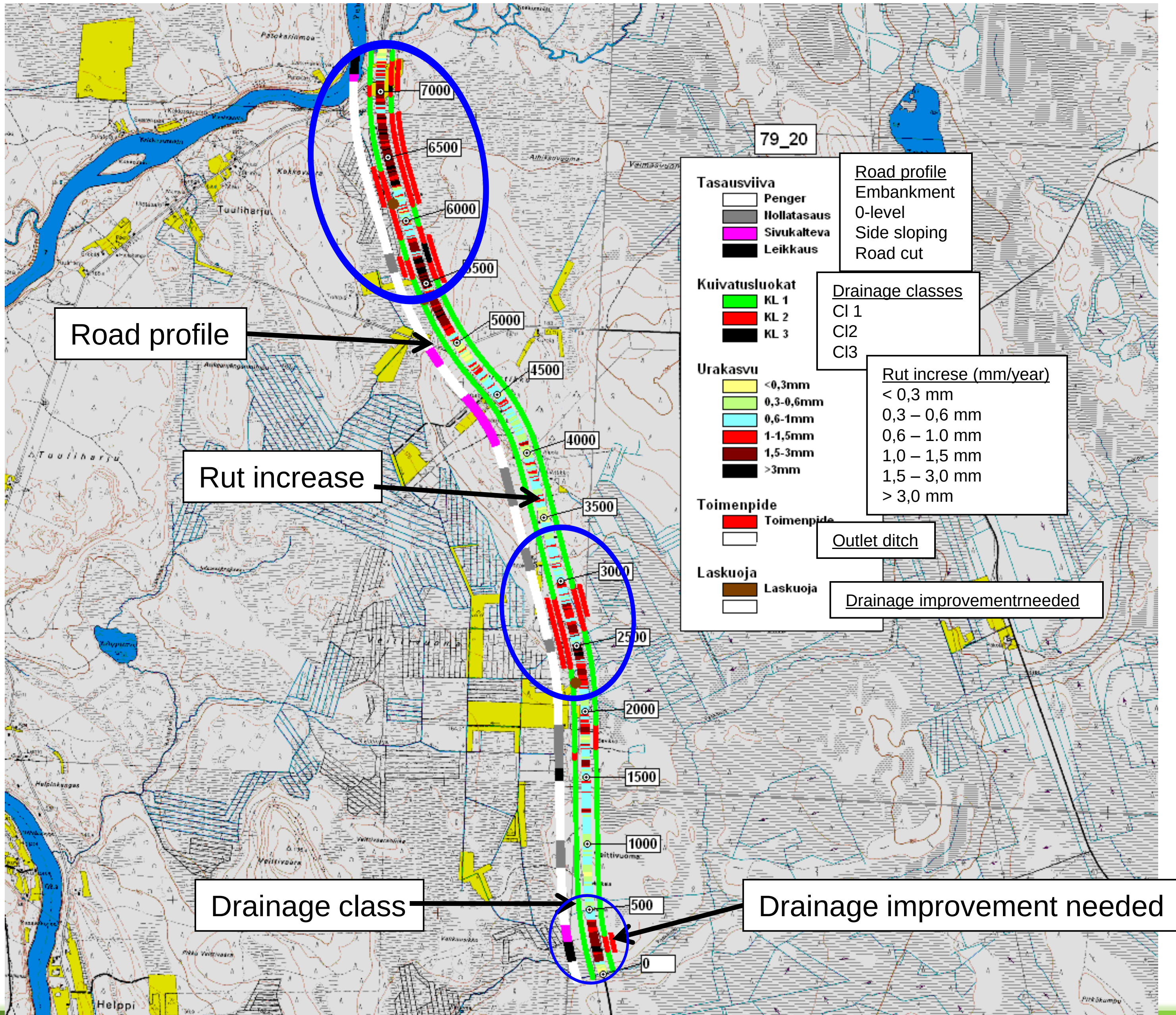


Rutting



	Class 1	Class 2	Class 3
Drainage Class Distribution:	**65,0 %**	**32,3 %**	**2,7 %**
	4755	2360	200

Drainage Analysis: GIS-maps, road 79_20



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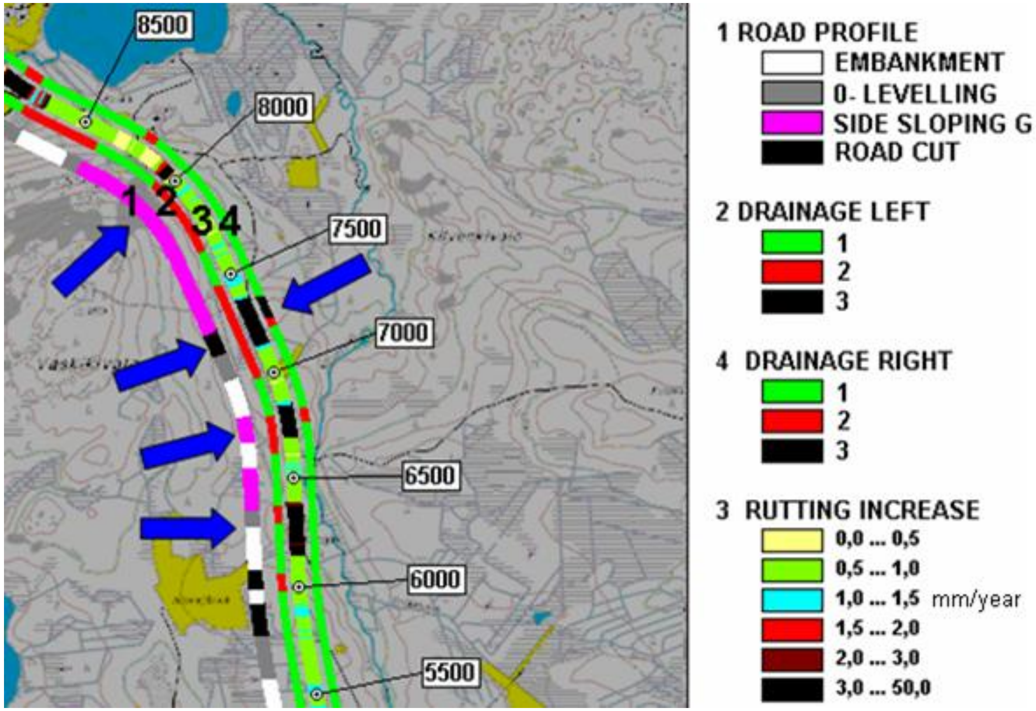
Selecting special drainage maintenance class areas:

a) Good correlation between rutting and drainage problems



b) Good correlation between pavement distress and poor drainage

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Saarenketo Timo

Kuivatus ja Lapin päällystettyjen teiden kunto

Kuivatustutkimuksen loppuraportti

Tiehallinnon sisäisiä julkaisuja 59/2008

TIEHALLINTO
VÄGFÖRVALTNINGEN

Network level drainage analysis in Finland and Sweden:

Lapland

- **Rovaniemi**
- **Kittilä**
- **Kemi**
- **+ several others**

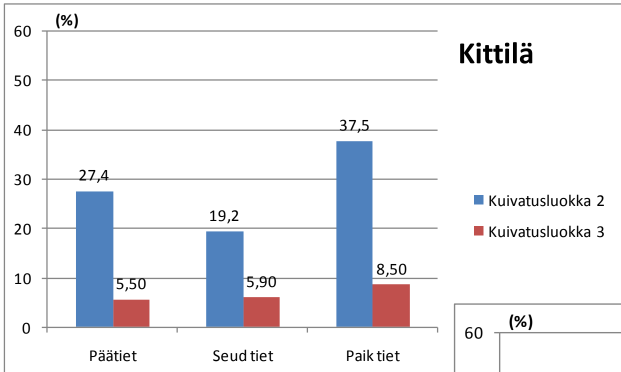
Central- Finland District

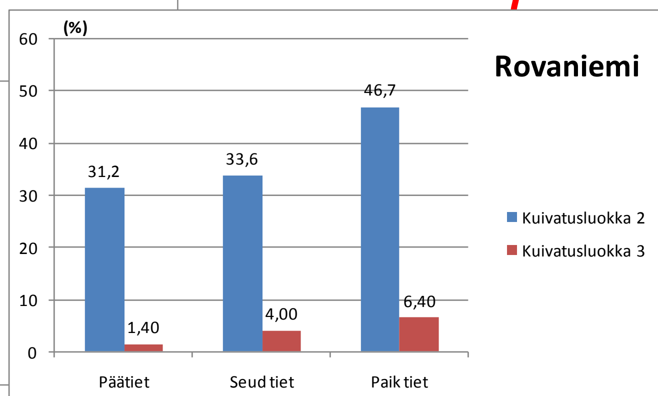
Häme District

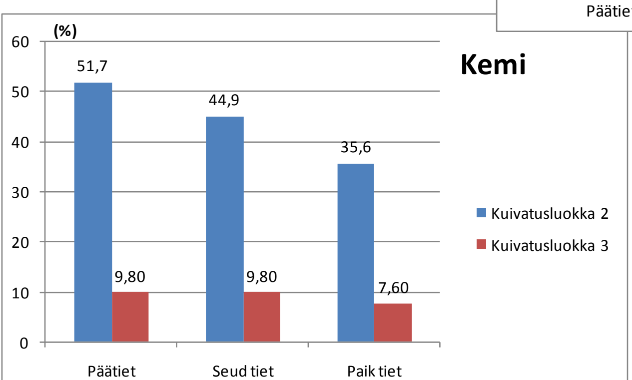
Sweden

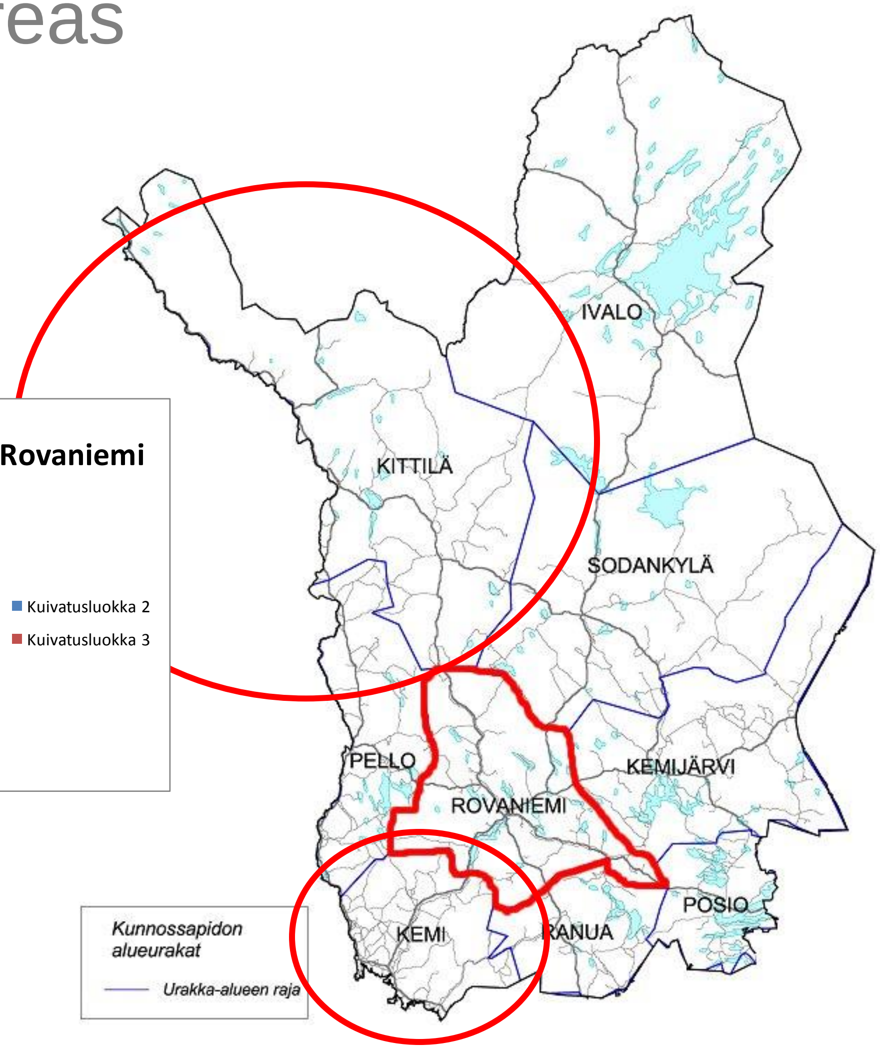
- Skellefteå
- Haparanda – Överkalix
- Kramfors

Drainage Analysis in Rovaniemi, Kittilä and Kemin maintenance areas

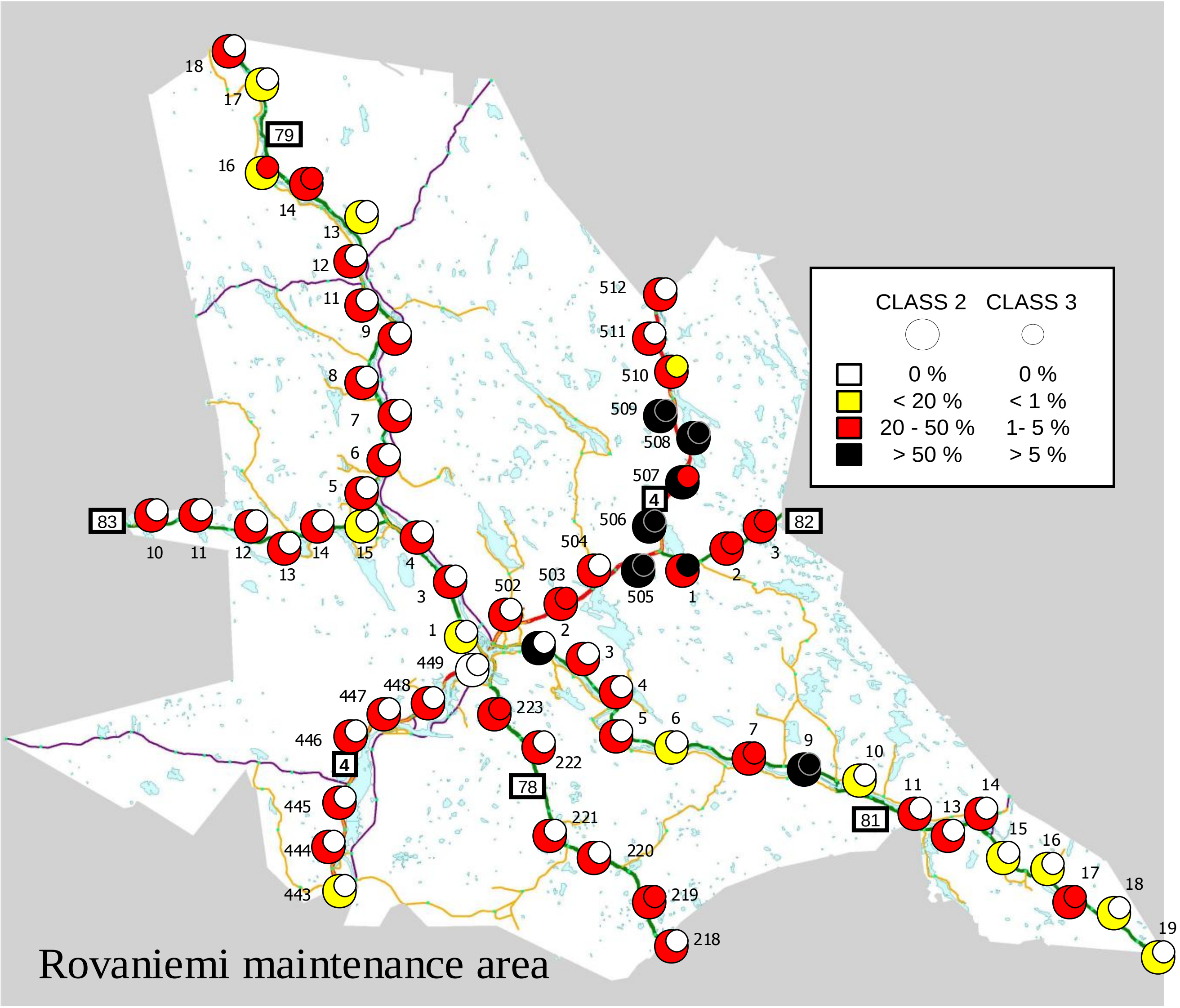








Case Rovaniemi results:



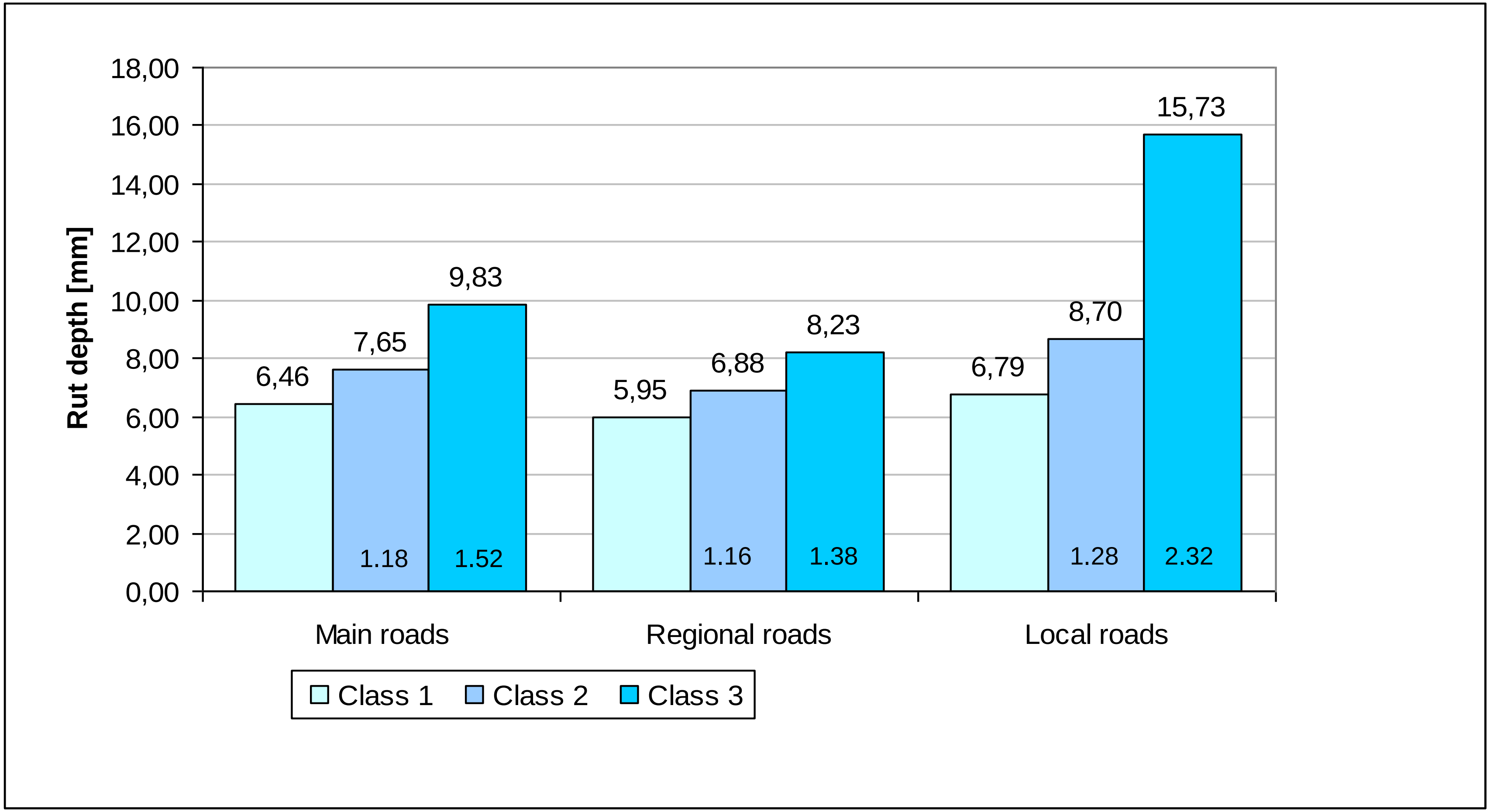
Relative Amount of Class 2 and Class 3 Drainage Problem Sections in Main Roads in Rovaniemi Area

Examples of Drainage Condition in Road 19733

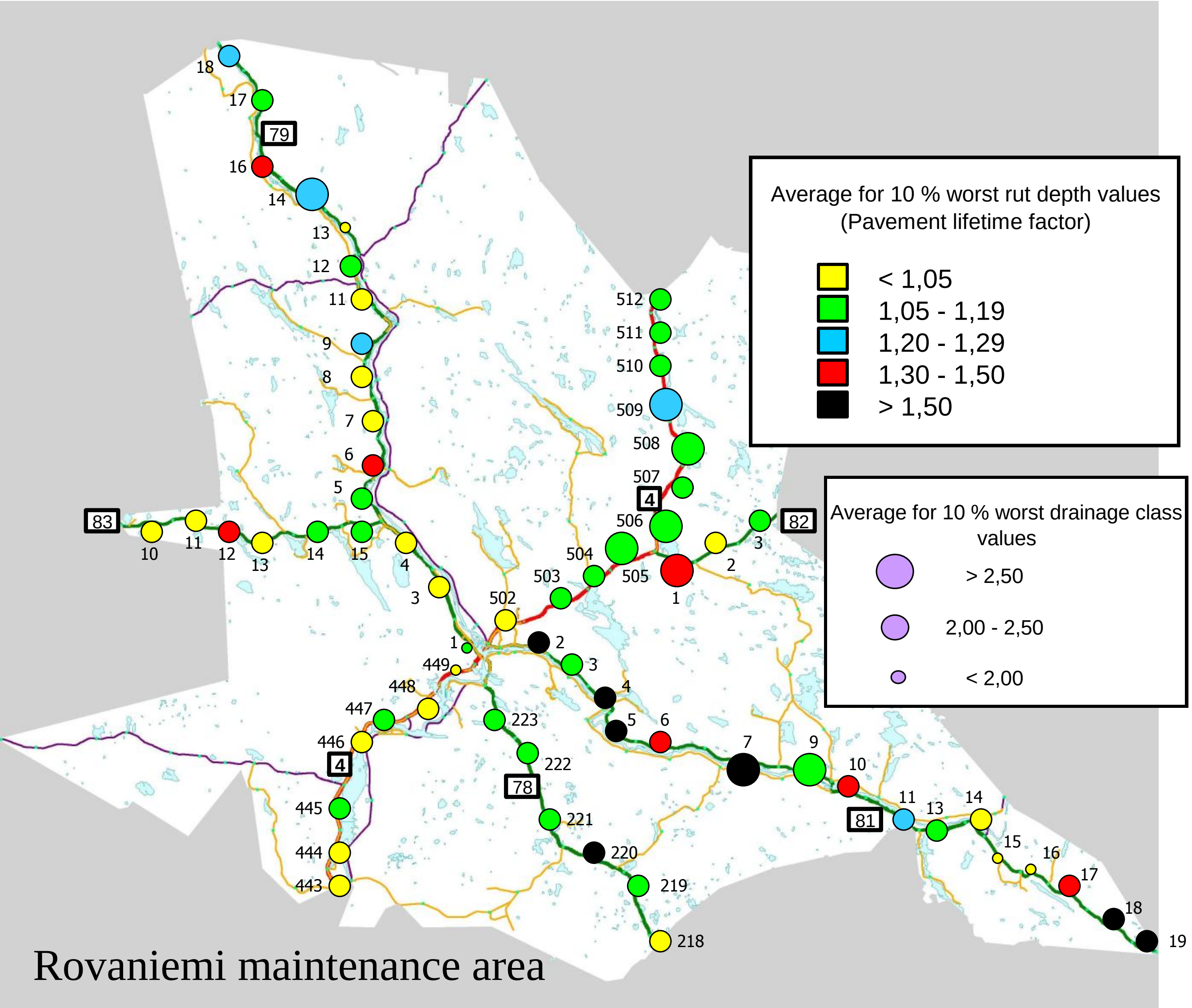
Filled ditch

Clocked outlet ditch

Average Rut Depths in Each Road Class and Drainage Class



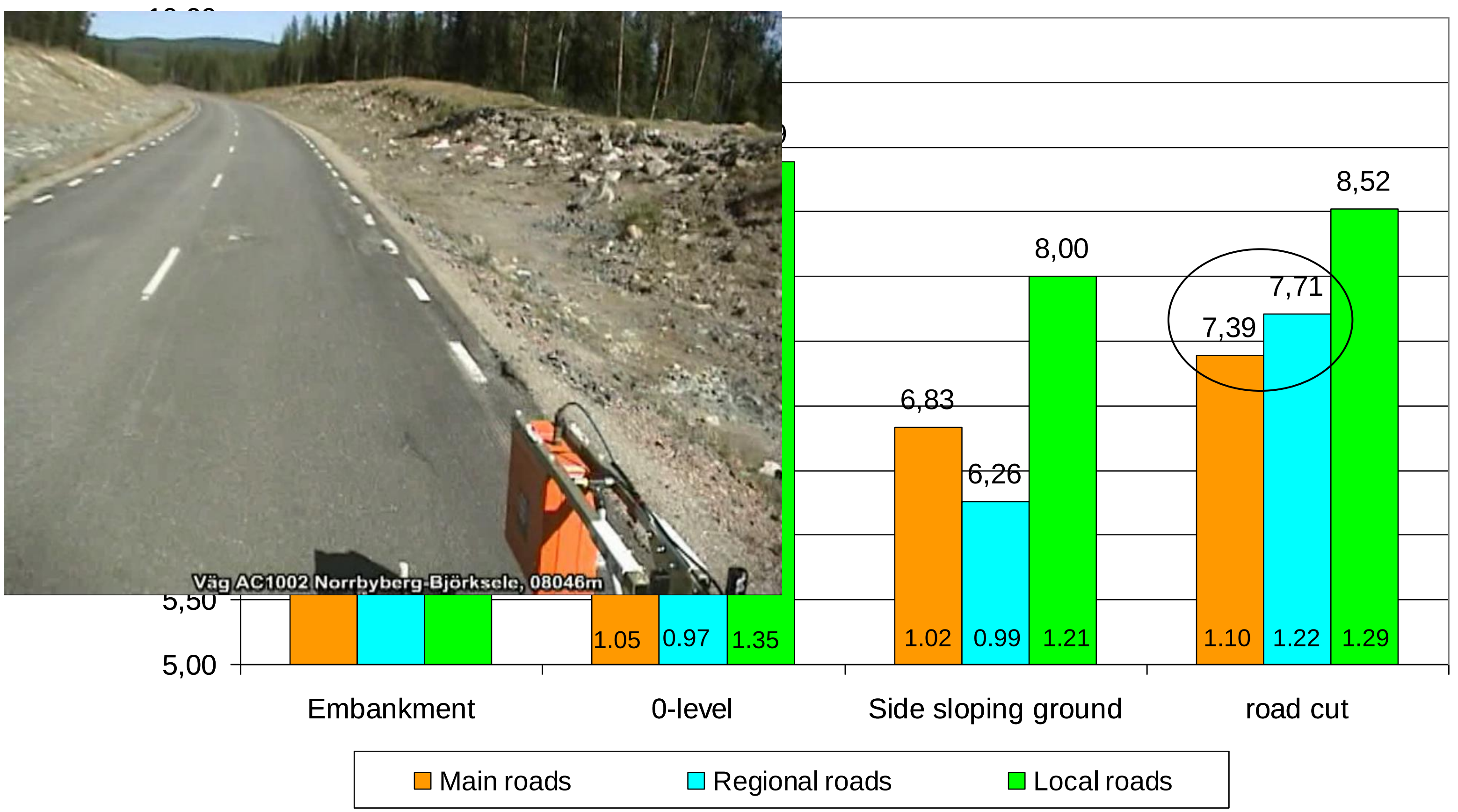
Pavement Life Time Factor and Average Condition of 10 % Worst Drainage Sections on Main Roads in Rovaniemi Area



Case Rovaniemi results:

Average Rut depth in Each Road Profile and in Each Road Class

- and rut depth ratio compared with average rut depth in embankments



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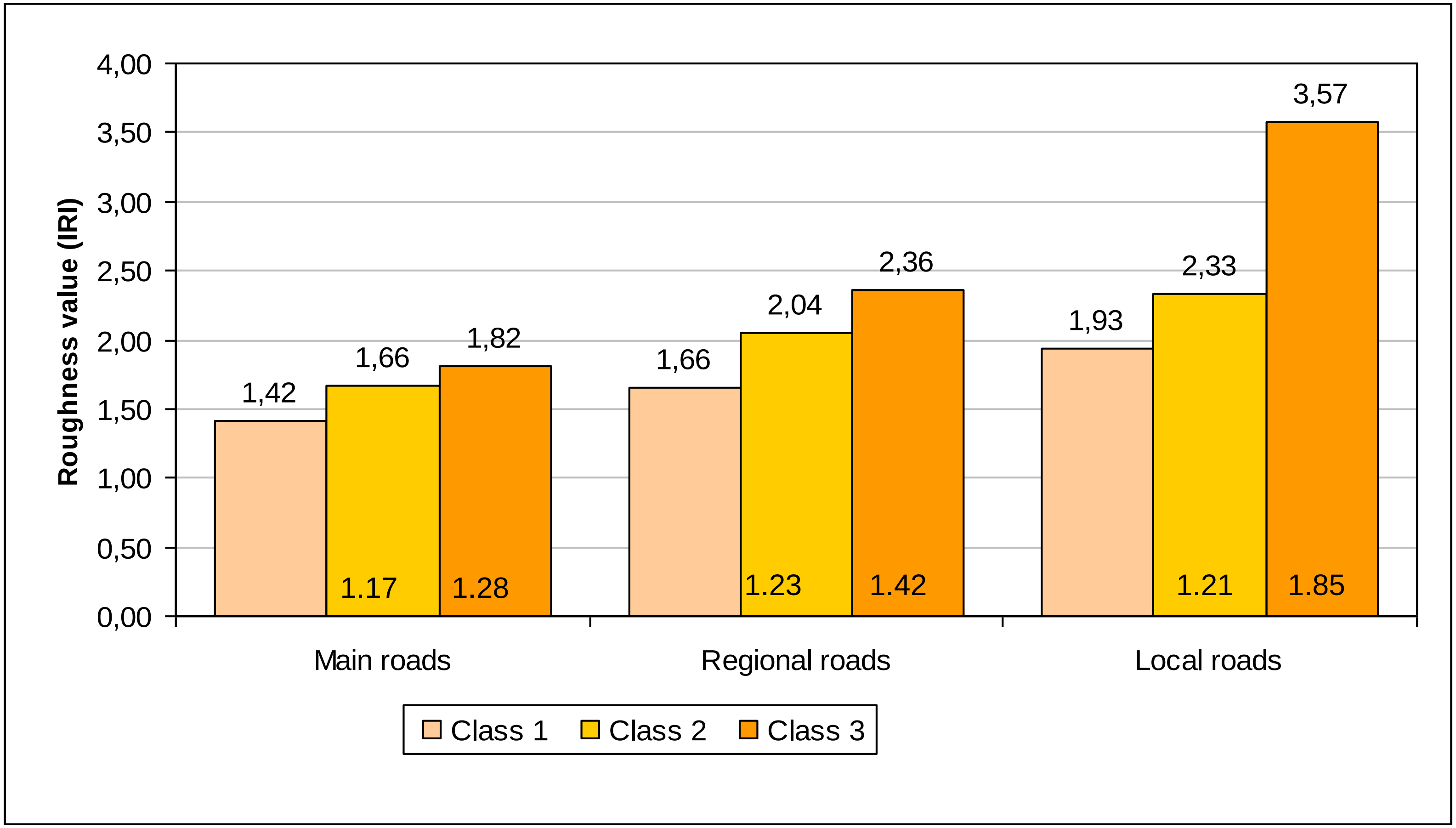
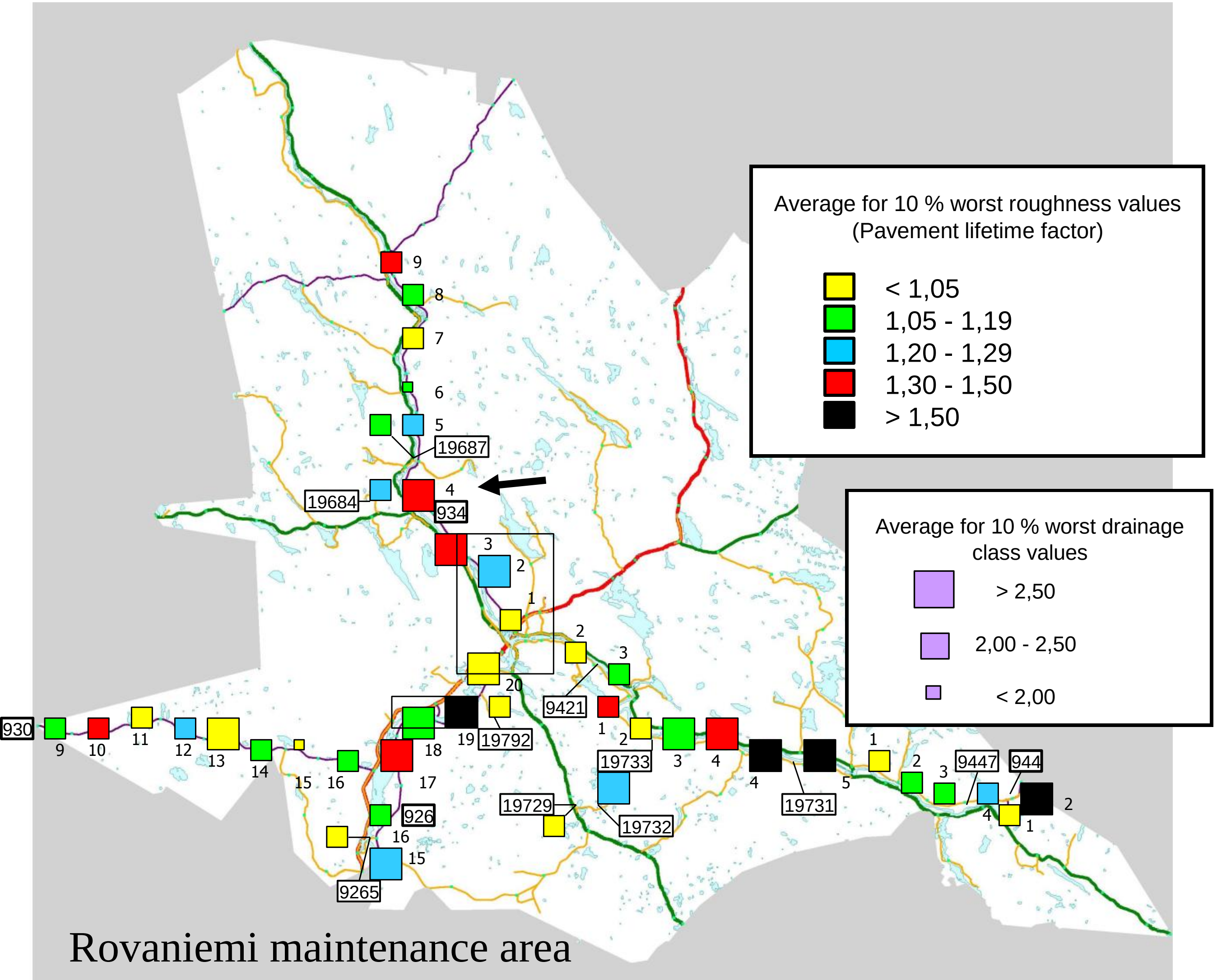
Case Rovaniemi results:

Average IRI Values in Each Road Class and Drainage Class



Case Rovaniemi results:



Pavement Life Time Factor (IRI) and Average Condition of 10 % Worst Drainage Sections on Regional and Local Roads in Rovaniemi Area

Example of Poor Drainage on Roughness and Pavement Distress Growth, Road 934, section 4

Benefits of the Improved Drainage on Paved Roads –

Life Cycle Cost Analysis Results from Rovaniemi Area

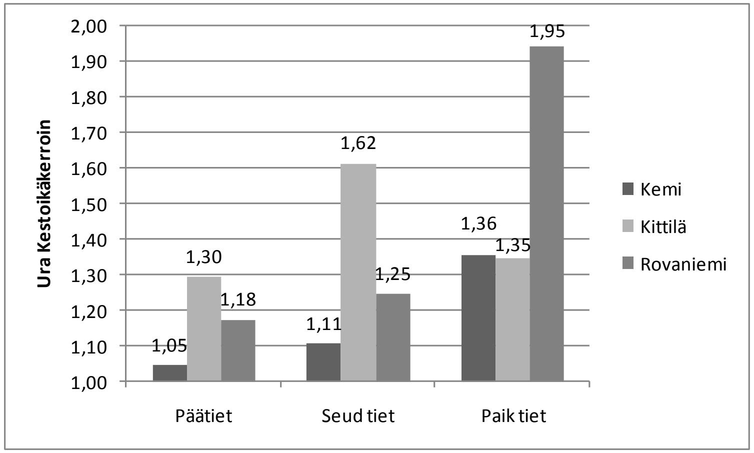
	Main roads (m)	Regional roads (m)	Local roads (m)	Total (m)
Length (m)	382 361	146 719	115 930	645 010
Width (m)	7.2	6.2	5,7	
Paving cost €/m	36	31	27.5	
Average lifetime (years)	10	13	11	
Drainage lifetime factor	1.16	1.19	1.24	
Increased lifetime (years)	11.6	15.5	13.6	

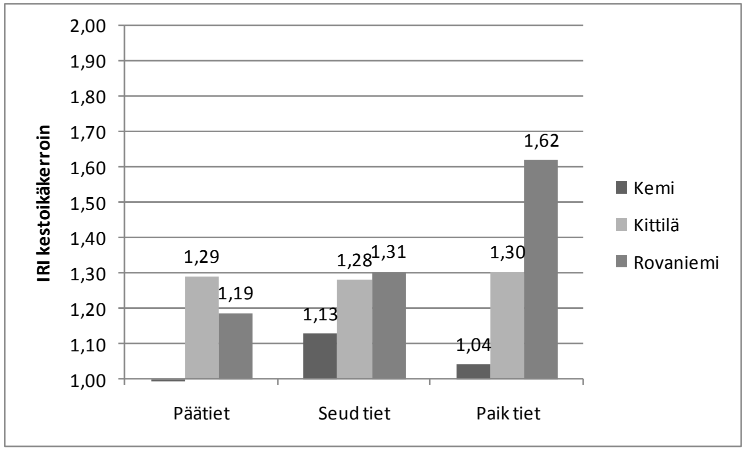
Discount rate: 4 %
Paving cost: 5 €/m2

	Main roads	Regional roads	Local roads	Total
Annual paving costs (€)	1 917 000	517 000	415 000	2 849 000
Costs if drainage improved (€)	1 698 000	461 000	355 000	2 514 000
Savings (€)	219 000	56 000	60 000	**335 000**
Savings (%)	11.4	10.8	14,5	11.8

If , in the LCC analysis, 1,5 longer pavement life time would have been used, the annual paving costs would have dropped in Rovaniemi about 36 % from 312.000 euro down to 199.000 euro (from 11% down to 7 %)

Potential Savings in 3 Maintenance Areas





Kemi	Main roads	Regional roads	Local roads	All roads
Annual paving costs (€)	2044000	1106000	915000	**4065000**
Annual paving cost if drainage improved (€)	1956000	1013000	710000	**3679000**
Savings (€)	88000	93000	205000	**386000**
Savings (%)	4,3	8,4	22,4	**9,5**

Kittilä	Main roads	Regional roads	Local roads	All roads
Annual paving costs (€)	2022000	527000	512000	**3061000**
Annual paving cost if drainage improved (€)	1663000	381000	400000	**2444000**
Savings (€)	359000	146000	112000	**617000**
Savings (%)	17,8	27,7	21,9	**20,2**

Rovaniemi	Main roads	Regional roads	Local roads	All roads
Annual paving costs (€)	1695000	530000	370000	**2595000**
Annual paving cost if drainage improved (€)	1505000	464000	314000	**2283000**
Savings (€)	190000	66000	56000	**312000**
Savings (%)	11,2	12,5	15,1	**12,0**

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DRAINAGE IMPLEMENTATION PROJECTS

WESTERN ISLES

NORWAY

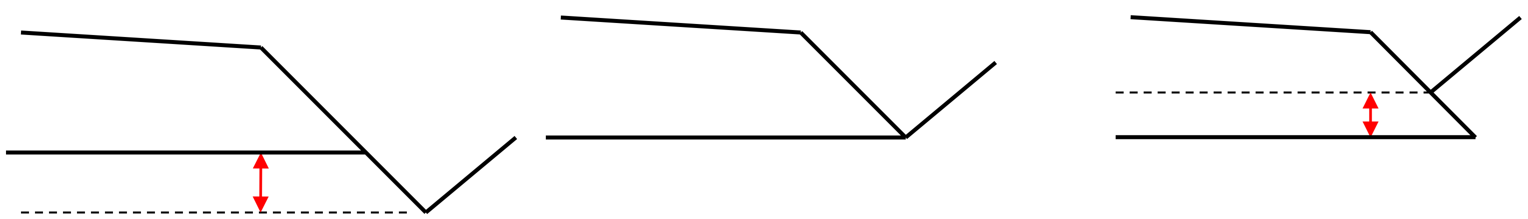
ICELAND

SISIMIUT, GREENLAND

Demonstration project:

Region Norr, Sweden:

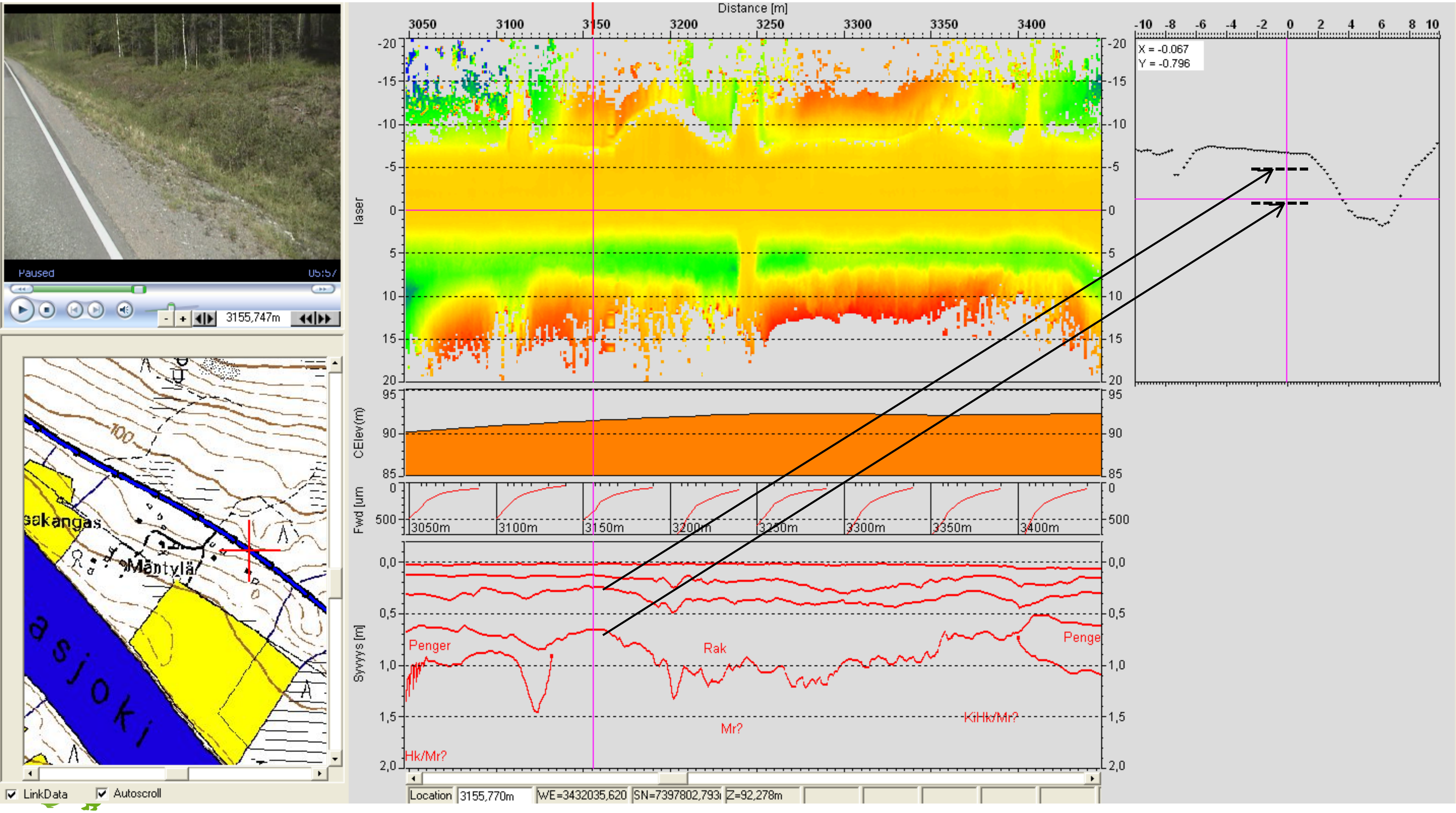
- Testing tools to improve drainage analysis in Umeå Södra maintenance area
  - Tools for outlet ditch inventory
  - Thermal camera development
  - Laser Scanner and GPR; combining road structure and ditch bottom depths
  - Drainage analysis – seasonal tests



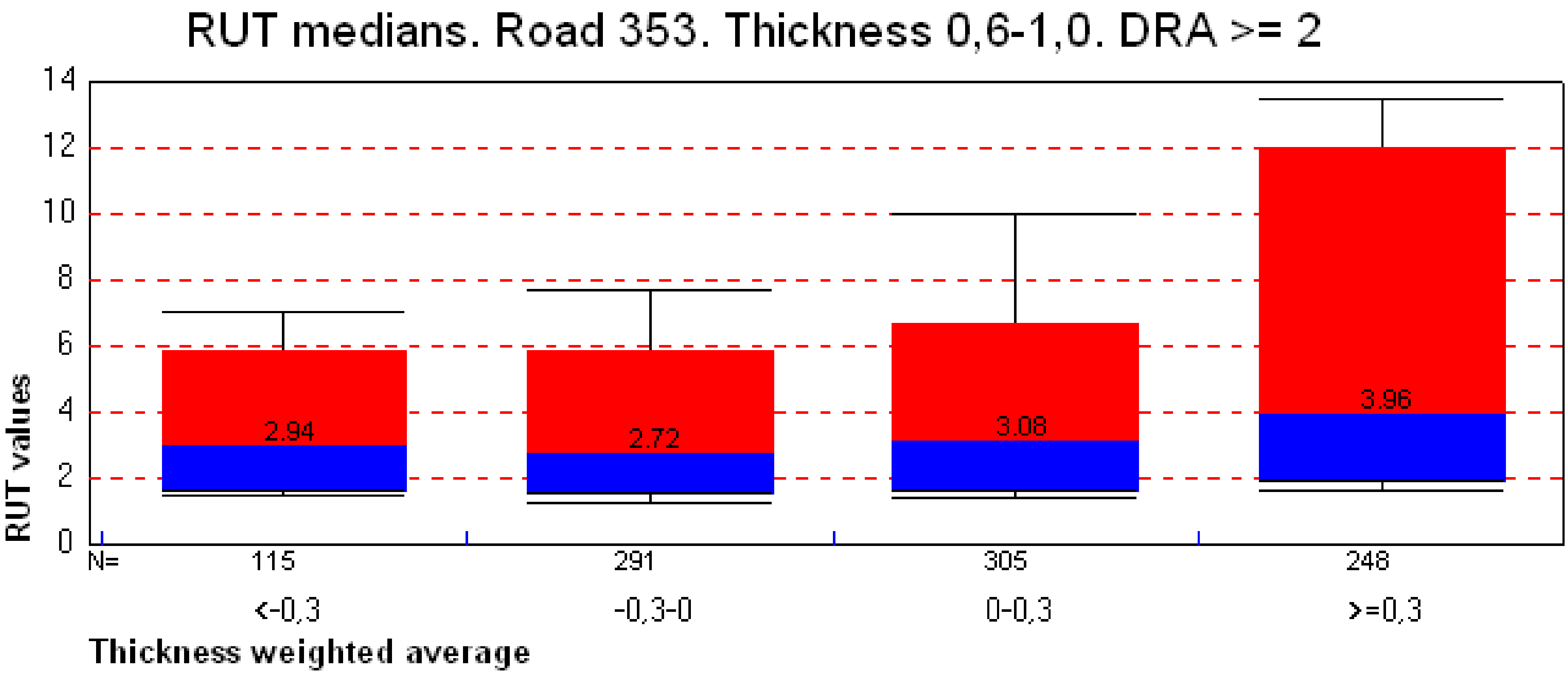
Road Doctor Laser Scanner

RD Cam Link (video cameras + GPS + inventory)
Laser Scanner (+ 3d Inclinometers)
Thermal Cameras

Road Doctor Laser Scanner



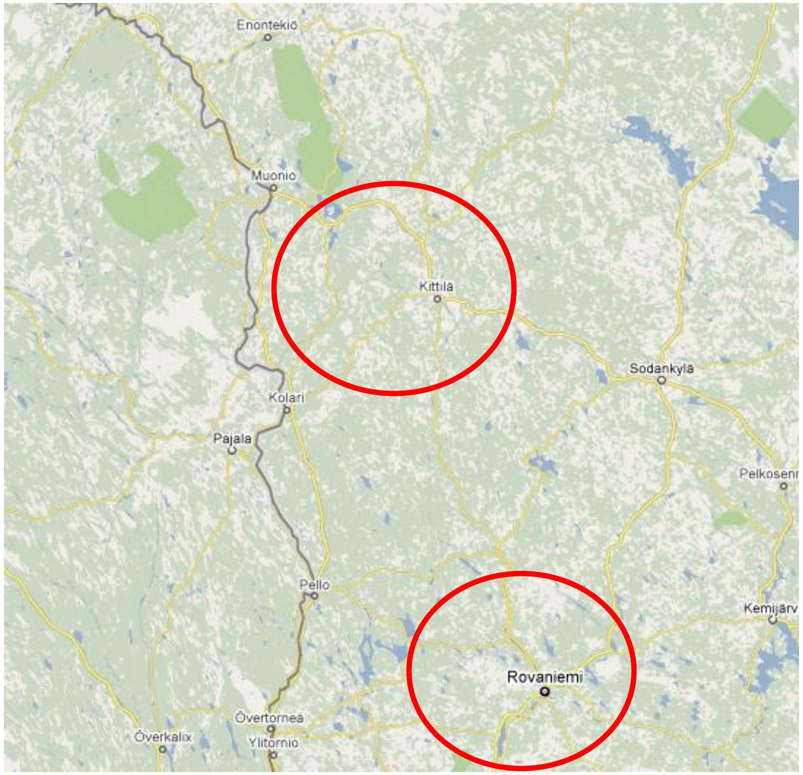
EFFECT OF DITCH DEPTH VS. ROAD STRUCTURE THICKNESS TO ROAD CONDITION



Demonstration project:

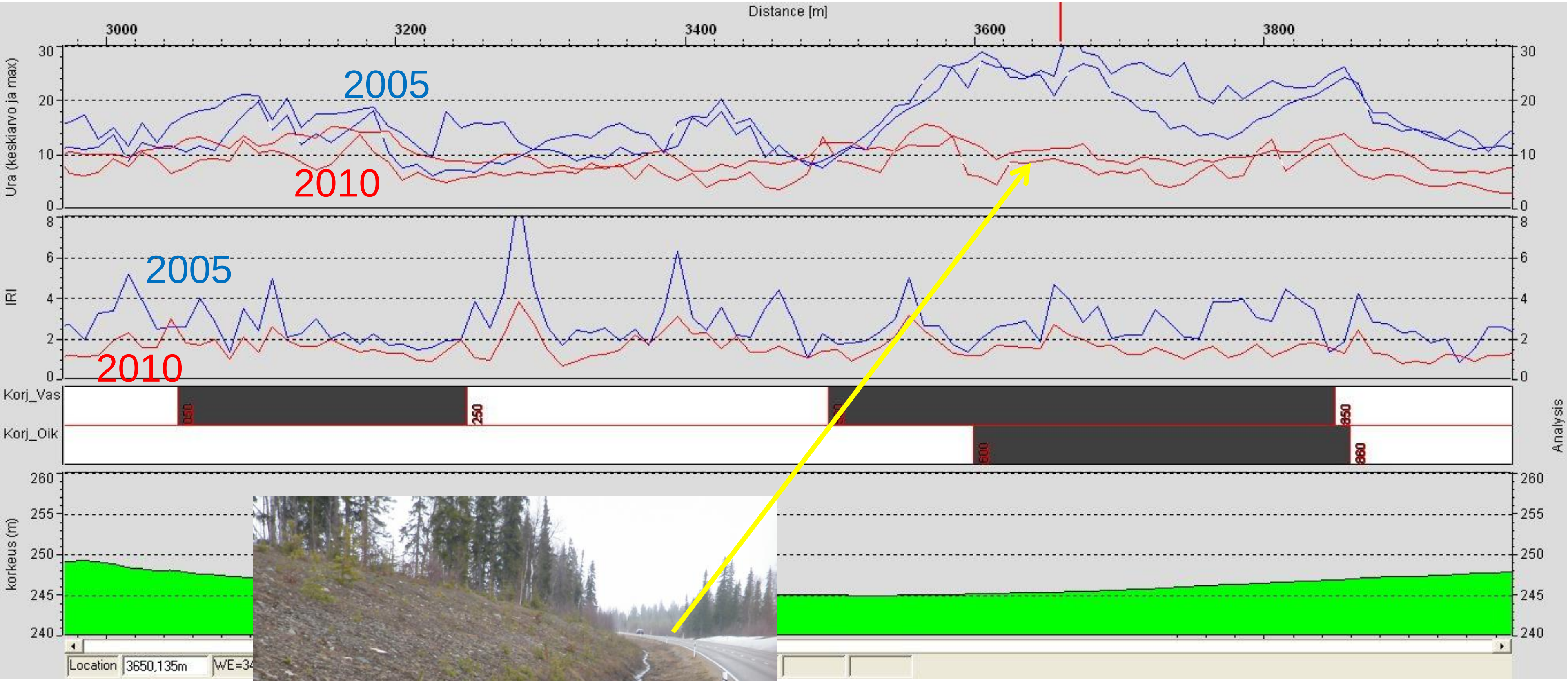
Lapland Region, Finland:

- Follow up, how the new drainage policy works in practise in Rovaniemi and Kittilä maintenance contracts
  - Monitoring the condition of special drainage sections
    - How well contractors have done their job,
    - What is the reason for the failures?
  - Has road deteroration rate (rut increase, roughness, pavement distress) really decreased?
    - And if not, what is the reason



Sections: 78 / 219, 222, 926 / 17, 19 934 / 3, 4

Kittilä Follow Up: Rd 80_10, 3000-4000 m



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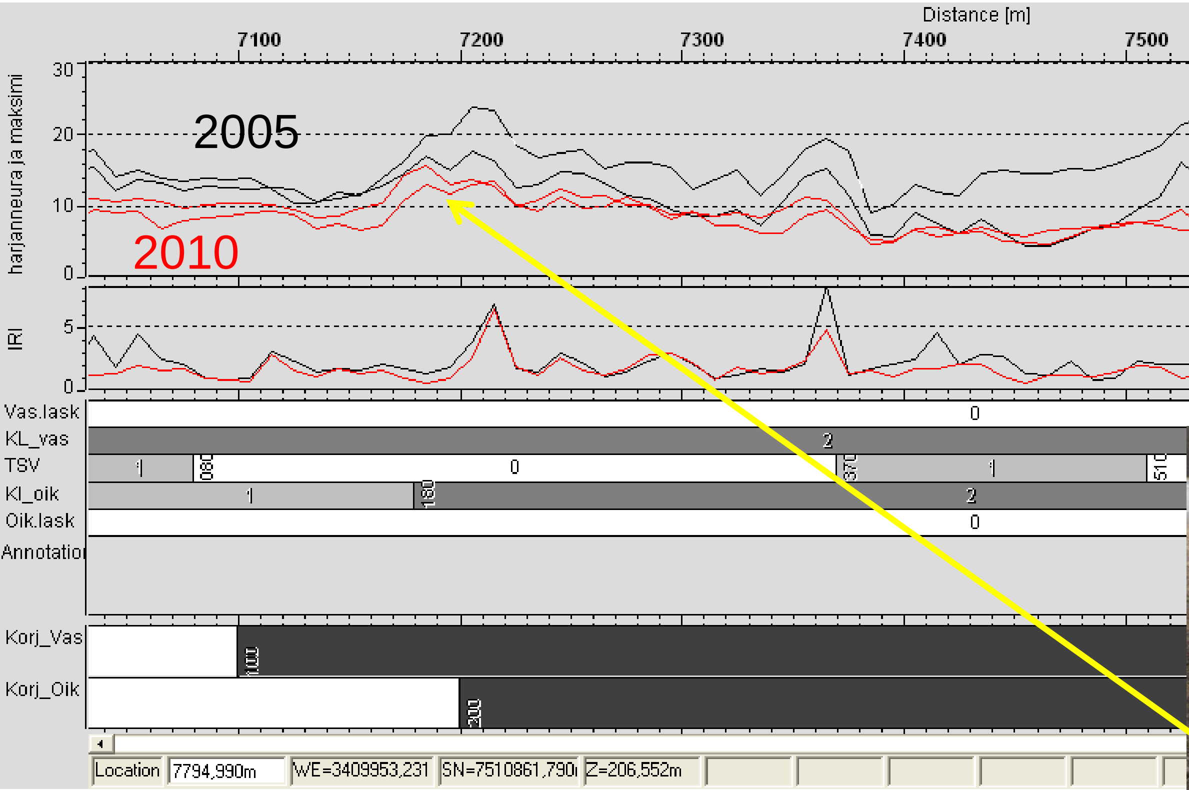
Kittilä Follow Up: Rd 80_10, 7000-8000 m



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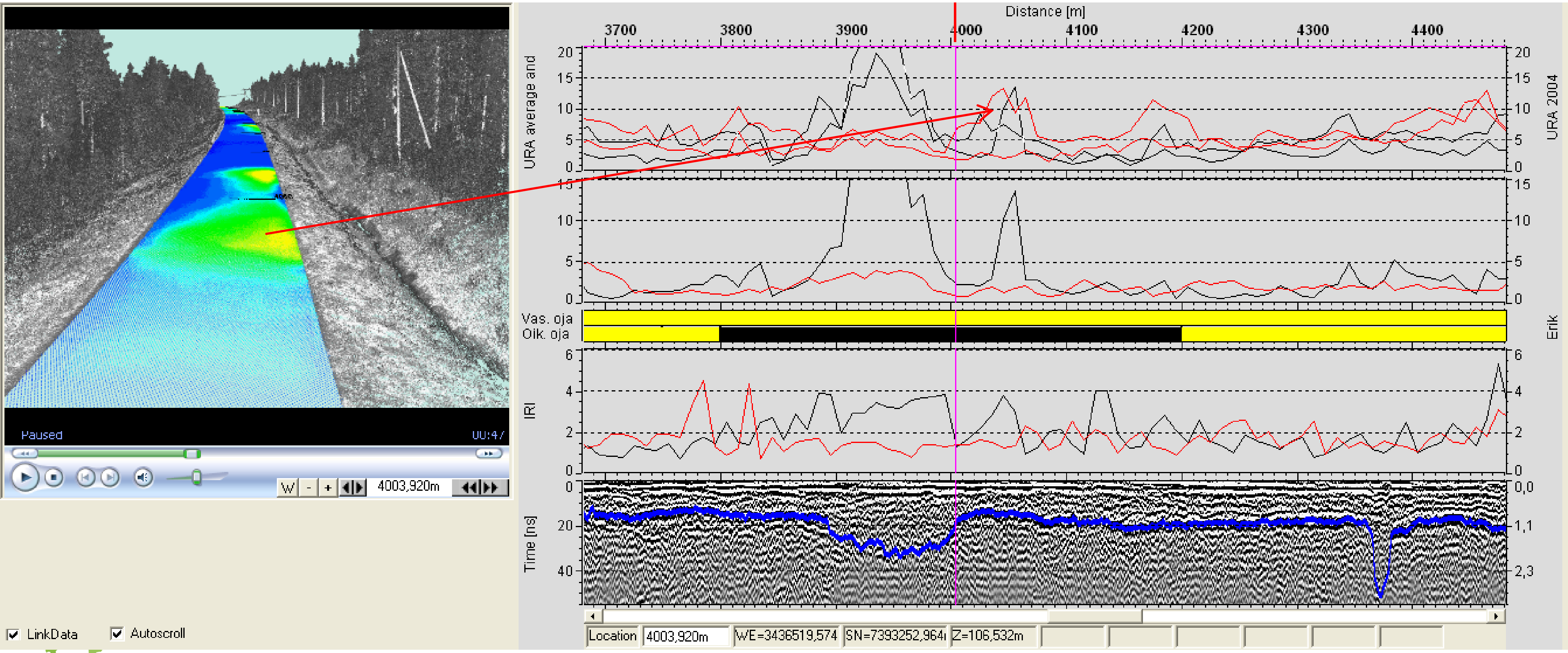
Road 934 Section 3 Special Drainage Maintenance Sections

RUT Depth values and IRI Values 2004 and 2010



Thank You!