ROADEX
Implementing Accessibility

Northern Periphery Programme
2007–2013

Innovatively investing in Europe's Northern Periphery for a sustainable and prosperous future

European Union
European Regional Development Fund

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RISK ASSESSMENT OF ROAD N59, NEWPORT TO MULRANNY, COUNTY MAYO, IRELAND

Demonstration project report

Contents

1. INTRODUCTION

1.1. THE ROADEX PROJECT

The ROADEX Project is a technical co-operation between road organisations across northern Europe that aims to share road related information and research between the partners. The project was started in 1998 as a 3 year pilot co-operation between the districts of Finland Lapland, Troms County of Norway, the Northern Region of Sweden and The Highland Council of Scotland and was subsequently followed and extended with a second project, ROADEX II, from 2002 to 2005, a third, ROADEX III from 2006 to 2007 and a fourth, ROADEX IV from 2009 to 2013.

Figure 1.1 *The Northern Periphery Area and ROADEX IV Partners*

The Partners in ROADEX IV "Implementing Accessibility" comprised public road administrations and forestry organisations from across the European Northern Periphery. These were The Highland Council, Forestry Commission Scotland and Comhairle Nan Eilean Siar from Scotland, The Northern Region of The Norwegian Public Roads Administration, The Northern Region of The Swedish Transport Administration and the Swedish Forest Agency, The Centre of Economic Development, Transport and the Environment of Finalnd, The Greenland Home Rule Government, The Icelandic Public Roads Administration and The National Roads Authority and The Department of Transportation of Ireland.

The aim of the Project was to implement the road technologies developed by ROADEX on to the Partner road networks to improve operational efficiency and save money. The lead partner for the project was The Swedish Transport Administration and the main project consultant was Roadscanners Oy of Finland.

A main part of the Project was a programme of 23 demonstration projects showcasing the ROADEX methods in the Local Partner areas supported by a new pan-regional "ROADEX Consultancy Service" and "Knowledge Centre". Three research tasks were pursued as part of the project: "Climate change and its consequences on the maintenance of low volume roads", "Road Widening" and "Vibration in vehicles and humans due to road condition".

All ROADEX reports are available on the ROADEX website at www.ROADEX.org.

1.2. THE DEMONSTRATION PROJECTS

Twenty three demonstration projects were planned within the ROADEX IV project. Their goal was to take selected technologies developed by ROADEX out on to the local road networks to have them physically used in practice to show what they could achieve. The projects were funded locally by the local Partners, designed and supervised by local staff, and supported by experts from the ROADEX consultancy.

The demonstrations were managed in 6 groups by a nominated lead manager from ROADEX:

D1 - “Drainage Maintenance Guidelines”, lead manager Timo Saarenketo

D2 - “Road friendly vehicles and Tyre Pressure Control”, lead manager Pauli Kolisoja

D3 - “Forest Road policies”, lead manager Svante Johansson

D4 - “Rutting, from theory to practice”, lead manager Pauli Kolisoja

D5 - “Roads on Peat”, lead manager Ron Munro

D6 - “Health and Vibration”, lead manager Johan Granlund

1.3. D5 “ROADS ON PEAT”

The Roads on Peat demonstration projects had two general aims:

1. To demonstrate the ROADEX risk assessment method in planned road rehabilitation works, particularly for those roads involving peat.
2. To give practical support to local road improvement projects in the use of ROADEX methods

For this, two road sections of 10km of public road were identified; the N56 from Drumnaraw to Cashelmore in County Donegal, and the N59 from Newport to Mulranny in County Mayo. This report is an output for the N59 section. A similar report will be issued for the N56 section.

1.4. RISK ASSESSMENT OF ROAD N59

in the risk assessment surveys on the N59 road from Newport to Mulranny section were carried out by Roadscanners Oy in March 2011. The goal of the exercise was to demonstrate the ROADEX risk analysis techniques on Irish roads.

The measurements were performed in cooperation with PMS Pavement Management Services Ltd, which provided the measurement vehicle and driver as well as performing the Falling Weight Deflectometer (FWD) measurements. The exercise was commissioned by the Department of Transport and the National Roads Authority and organised by ROADEX.

2. SURVEY SECTION AND TESTS CONDUCTED

Ground penetrating radar (GPR) data was collected using a GSSI SIR-20 unit with two antennas, an air-coupled 1.0 GHz horn and a 400 MHz ground-coupled antenna (Figure 2.1). A digital video with GPS coordinates was also taken and 307 FWD points were tested, one every 50 metres in the westbound lane.

Figure 2.1 *Measurement van with survey equipment*

Surveys commenced in Newport at the first junction to the filling station "Topaz" on the left side of the N59 road. The survey section length was 15470 m and it ended in Mulranny.

3. PROCESSING AND INTERPRETATION

The GPR data was processed and interpreted with RoadDoctor™ Pro® software. The FWD data and digital video were imported into RoadDoctor™ Pro® for integrated interpretation and risk analysis.

The interpretation carried out mainly follows the two most important interfaces for this survey; the bottom of the bound layers and the interface between the road structure and the subgrade.

Generally the bound layers on road N59 are thin from 0 to 9200 m. From 9200 m to the end of the road section the bound layers are generally quite much thicker except between 11000 and 12000 m.

The overall thickness of the whole road structure varies mainly between 0.5-1.0 m. Also the overall thickness of the whole road structure is generally thinner from 0 to 8000 m and thicker from 8000 m to the end of the road section.

Figure 3.1 shows the depths of the road structures as a GIS map. Appendix 3 presents longitudinal profiles of the interpretations.

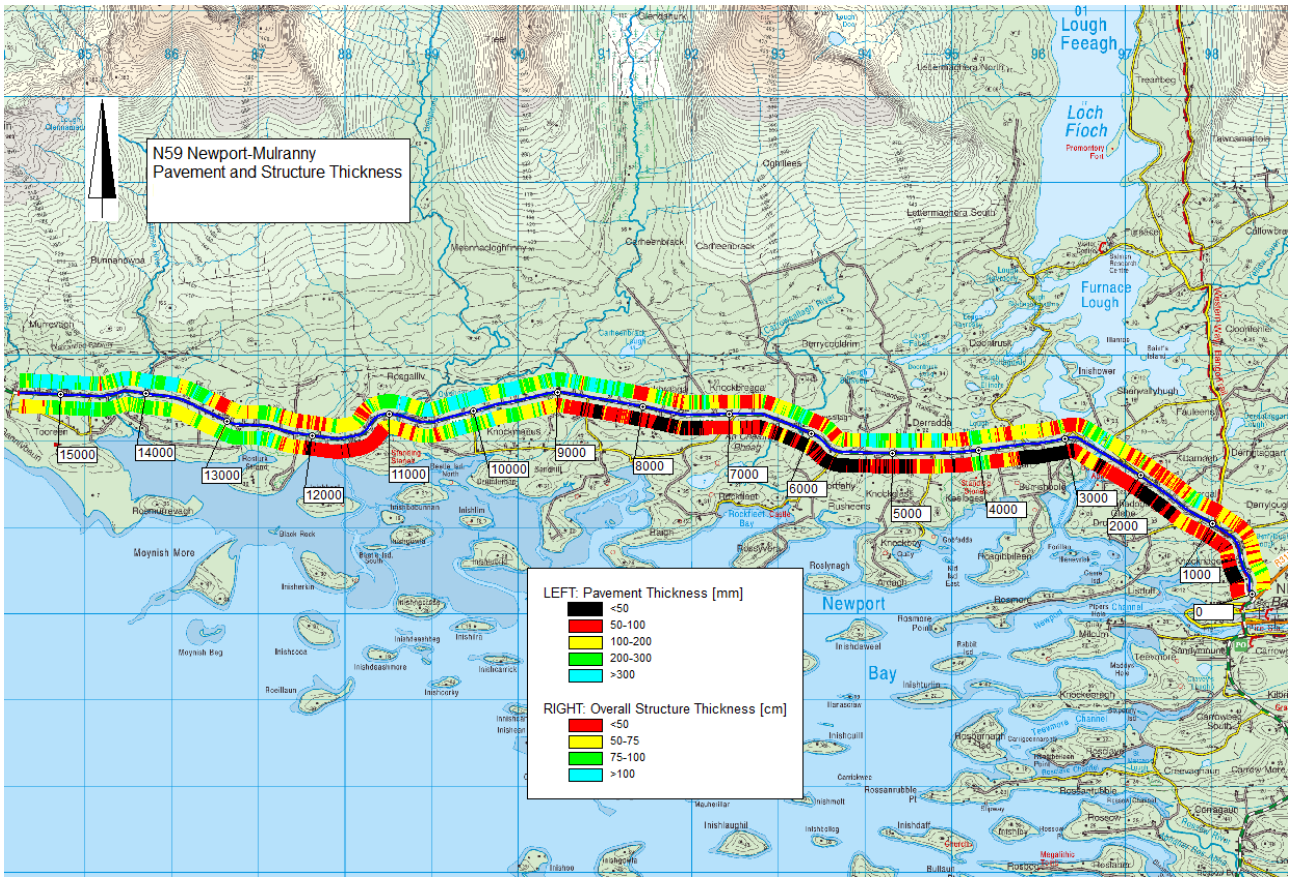


Figure 3.1 *Pavement and structure depths on Road N59*

4. RISK ANALYSIS

4.1. RISK ANALYSIS OF N59

The risk analysis undertaken is based on the deflection indexes calculated from the results of the FWD measurements. In addition, digital video analysis is used in the pavement layer risk evaluation. This method was developed for the B871 Kinbrace-Syre Road in Scotland in 2001 and is explained in greater detail in the ROADEX II project report "Monitoring, communication and information systems & tools for focusing actions" by Saarenketo (2005).

The risk evaluation was carried out through separate analysis of the condition of 1) the surface layers, including the performance of pavement and top part of the base (0-200 mm), 2) the unbound layers and 3) the subgrade. These analyses were based on the FWD data and GPR data.

The risk evaluation was based on the analysis of these individual layers and the risk classification below:

Class	Evaluation
0.	No immediate risk for major pavement failure. Local pavement cracking and an increase in rut depth may occur.
1.	Pavement failure and rutting may occur but only after continued heavy transportation. Initially these failures will focus on sites where the bound layers are deteriorating or are debonded.
2.	Pavement distress (rutting and cracking) will be seen in the road a short time after heavy transport starts, but they should not cause immediate problems for road users.
3.	Severe pavement distress will appear immediately after heavy transport is started (less than 5000 axle loads). These major damages may cause problems for road users.

A statistical summary of the risk evaluation is presented in Figure 4.1. These risk classes are also presented as coloured bars in the GIS map in Appendix 1 as well as in the profile printouts in Appendix 3.

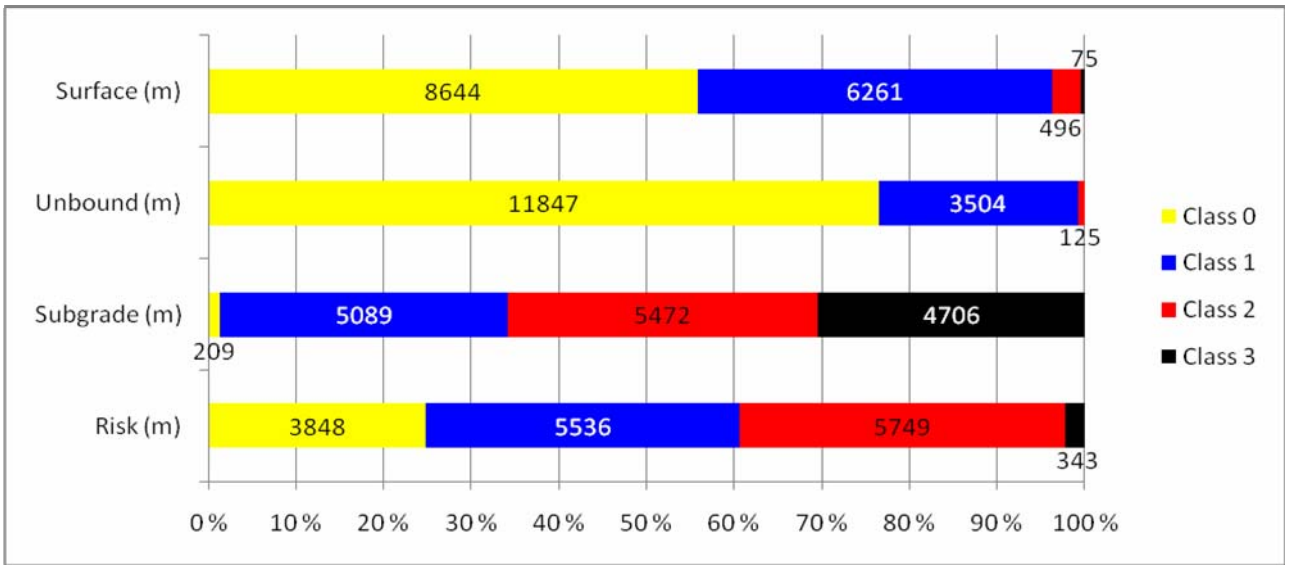


Figure 4.1 *Statistical summary of the risk evaluation*

A Class 2 and Class 3 failure risk was predicted for 6092 m of the road section (approximately 39 % of the total length). Approximately 61 % of the road (9384 m) had a reasonably well working structure with a rating of better than Class 2, i.e. failures only predicted after long continued heavy transportation.

From 0 to 9200 there is a weak soft subgrade combined with thin bound layers and slightly thinner overall structure thickness. The weakest subgrade section is located between 6500 and 9200 m.

From 9200 m to the end of the section the subgrade is generally stronger and the bound layers are thicker than on the first half of the section. The risks for failures on the subgrade level, and on the surface, are therefore much lower.

4.2. SWEDISH BEARING CAPACITY INDEXES

In addition to the risk analyses above Swedish Bearing Capacity (SBC) classes were determined. SBC categories can range from 1-4 where Class 4 indicates the worst condition. On the N59 the bearing capacity class was mainly Class 1 (over 71 % of the total length). The two weakest classes together, Class 3 and Class 4, covered approximately 12 % of the road length. The worst section is located between 6600 and 7800 m.

5. RISKS FOR MODE 1 AND MODE 2 RUTTING

5.1. RISK OF MODE 1 RUTTING

Mode 1 rutting is described as a problem of top layer weaknesses (ROADEX III report, “Managing Rutting in Low Volume Roads” by Dawson & Kolisoja 2006). In this analysis the strain values calculated from the bottom of the bound layers are used as an indicator of risk for Mode 1 rutting. The statistics are presented in Figure 5.1 and a map of Mode 1 rutting risk in Figure 5.2.

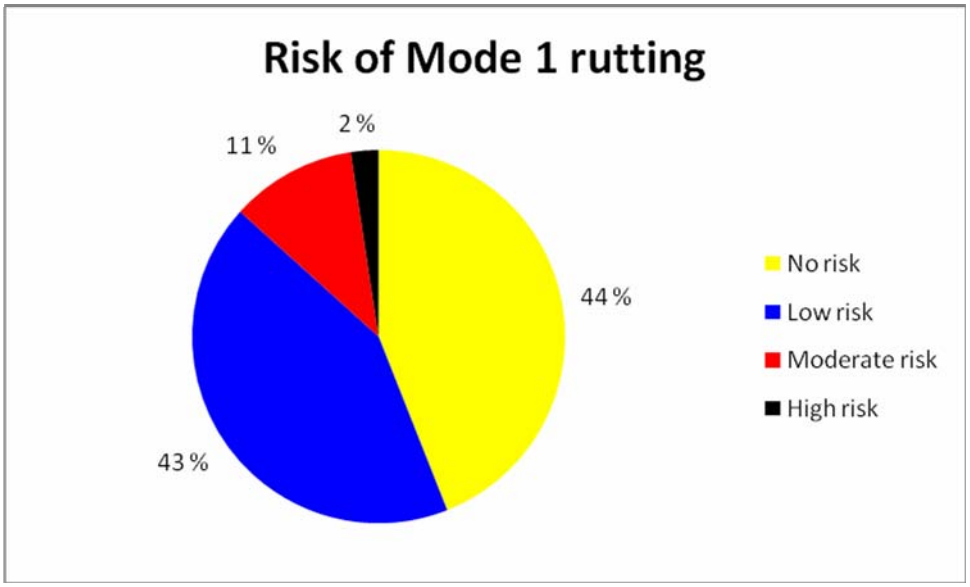


Figure 5.1 *Statistical summary of the Mode 1 rutting risk evaluation*

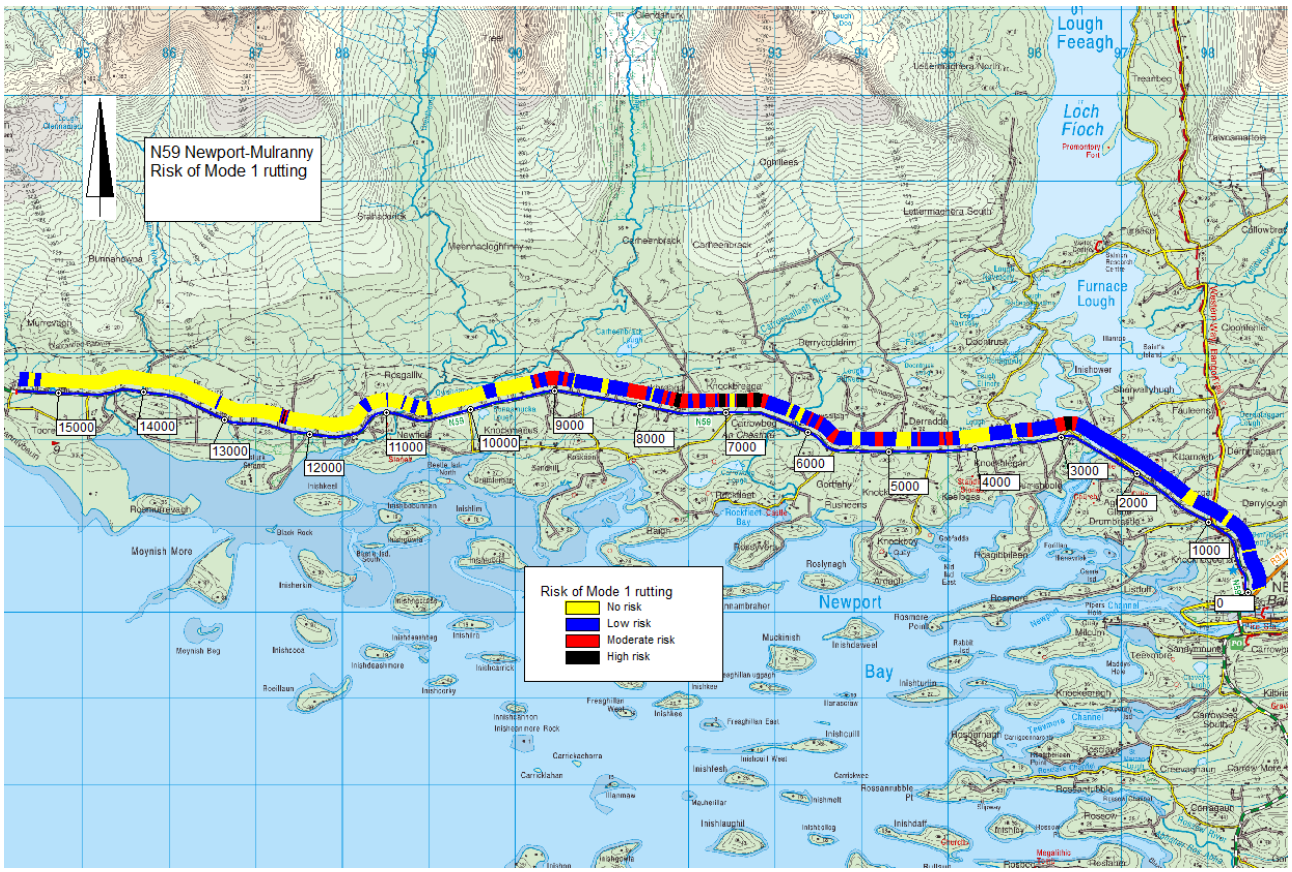


Figure 5.2 *Mode 1 rutting risk shown as a map*

5.2. RISK OF MODE 2 RUTTING

Mode 2 rutting is described as a problem of weak subgrade (ROADEX III report, "Managing Rutting in Low Volume Roads" by Dawson & Kolisoja 2006). In this analysis a combination of subgrade moduli values and BCI calculated from FWD data are used to produce the results of risk for Mode 2 rutting. In Figure 5.3 a statistical summary is presented and in Figure 5.4 a GIS map of Mode 2 rutting risk.

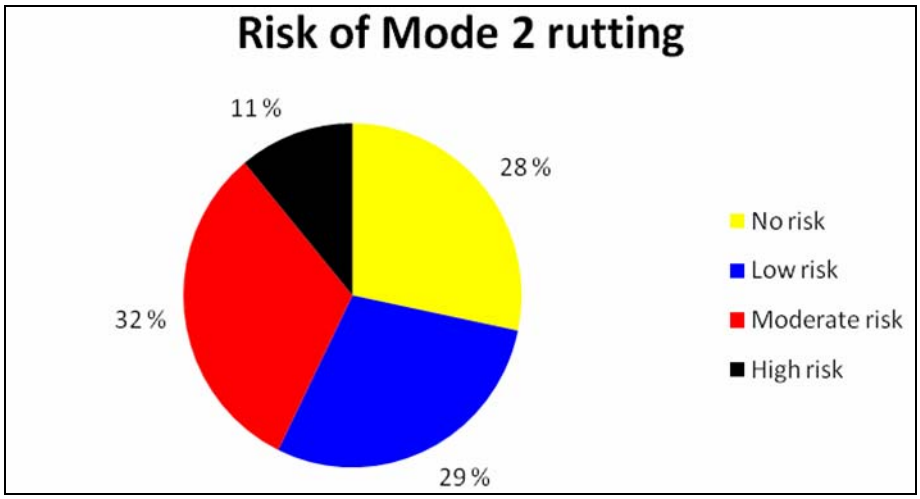


Figure 5.3 *Statistical summary of the Mode 2 rutting risk evaluation*

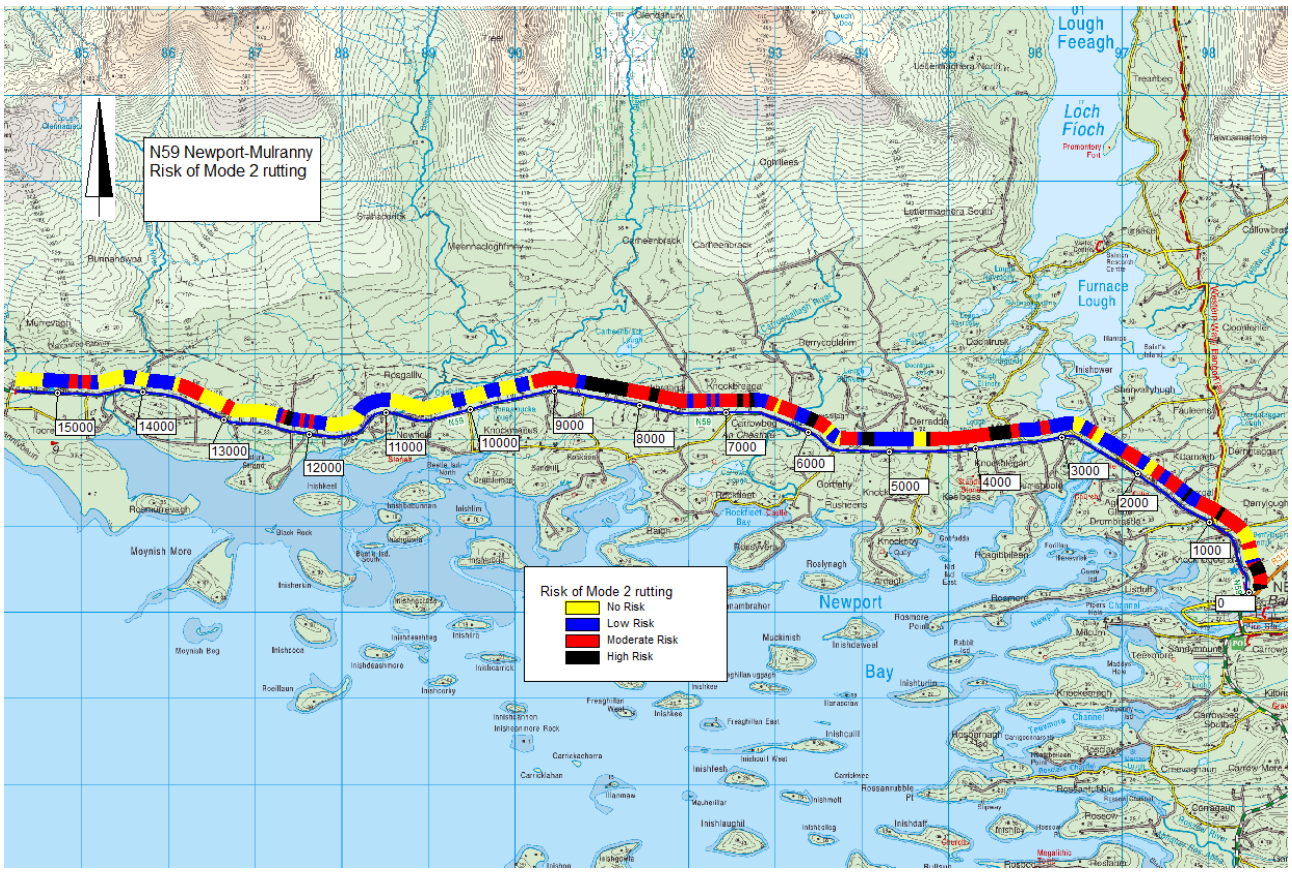


Figure 5.4 *Mode 2 rutting risk shown as a map*

6. SURFACE BEARING CAPACITY

In addition to the risk analysis, the surface bearing capacity [MPa] of the road was calculated using the Odemark feature of the RoadDoctor™ Pro® software. These calculations use the road structure thickness data imported from the GPR survey results.

The first step of this calculation was the back calculation of the FWD data. This was carried out using Elmod 6 software package linked to RoadDoctor™ Pro® software with a “Deflection Basin Fit”, which utilizes Odemark-Boussinesq methods.

The back calculated layer moduli were then used in the calculation of the surface bearing capacity of the road structures. This surface bearing capacity mainly reflects subgrade related problems. In general it can be stated that road stiffness is extremely poor if bearing capacity is <100 MPa and if the value is >200 MPa there should not be an immediate risk of failures. This surface bearing capacity value can also be used to evaluate how much the road has to be strengthened in order to carry heavy trucks (see Table 6.1 and Appendixes 2 and 3).

Table 6.1 *Bearing capacity classification*

Initial BC	**<100 MPa**	**100-120 MPa**	**120-150 MPa**	**150-200 MPa**	**>200 MPa**
Length [m]	2867	1024	1578	1689	8313
Total [m]					15471
% of length	18.53	6.62	10.20	10.92	53.73
Total [%]					100.00

7. CONCLUSIONS

The surveyed length of the N59 road can be divided into two distinct sections.

From 0 - 9200 m the road has a soft subgrade combined with thin bound layers and a slightly thinner overall structure. On this section the road is not performing well in spreading the traffic load over the subgrade.

From 9200 to 15500 m the road is in relatively good condition. The subgrade is generally stronger and the bound layers thicker than on the first half of the section. The risks of failures at the subgrade level, and on the surface, are therefore much lower.

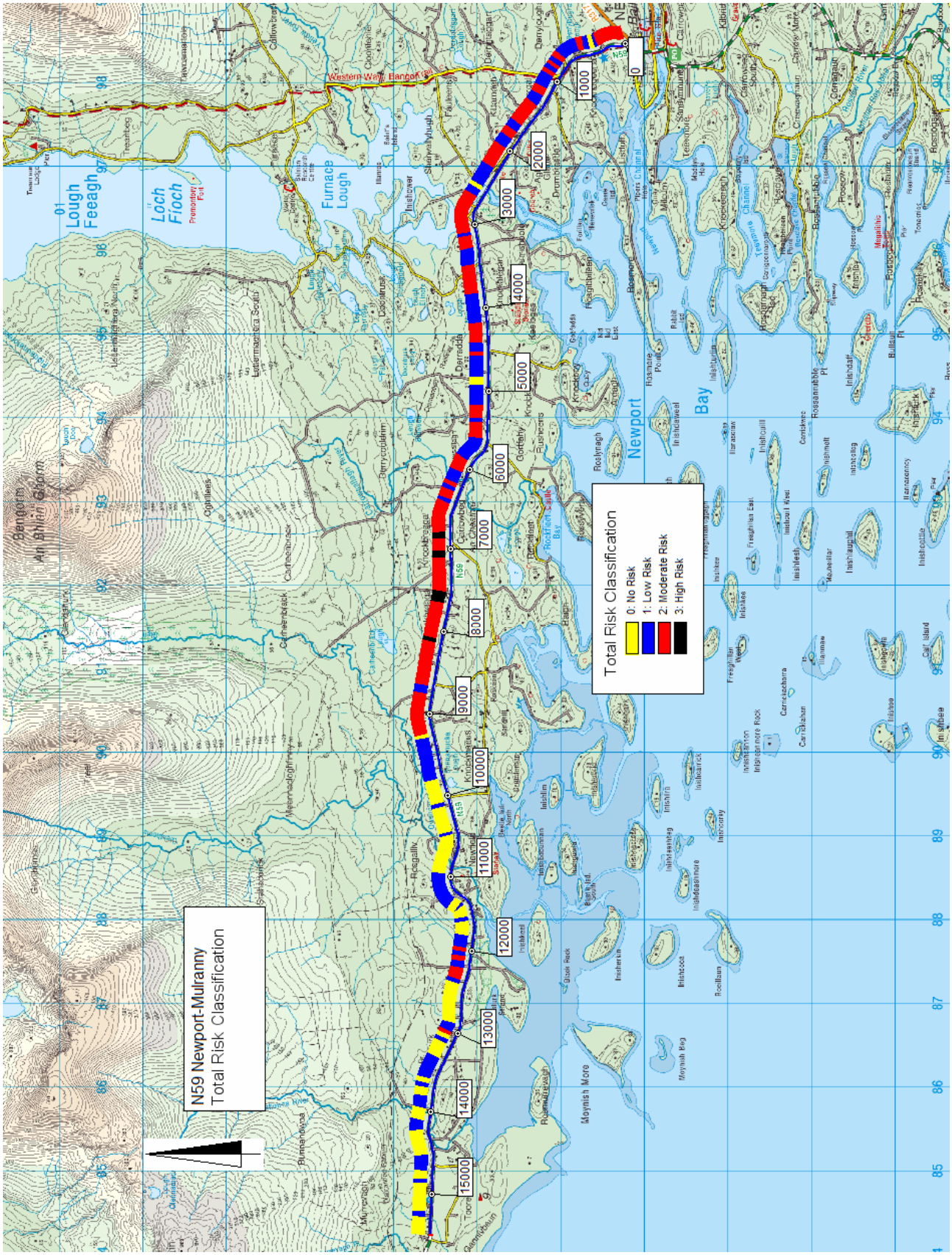
Approximately 61 % of the road has a reasonably well working structure with a total risk rating of Class 0 or Class 1, i.e. failures only predicted after long continued heavy transportation. Approximately 39 % of the road length has a total risk rating of Class 2 or Class 3

Overall the ROADEX risk assessment technique is considered to have worked well for the demonstration exercise and appears suitable for future applications on the Irish public road network.

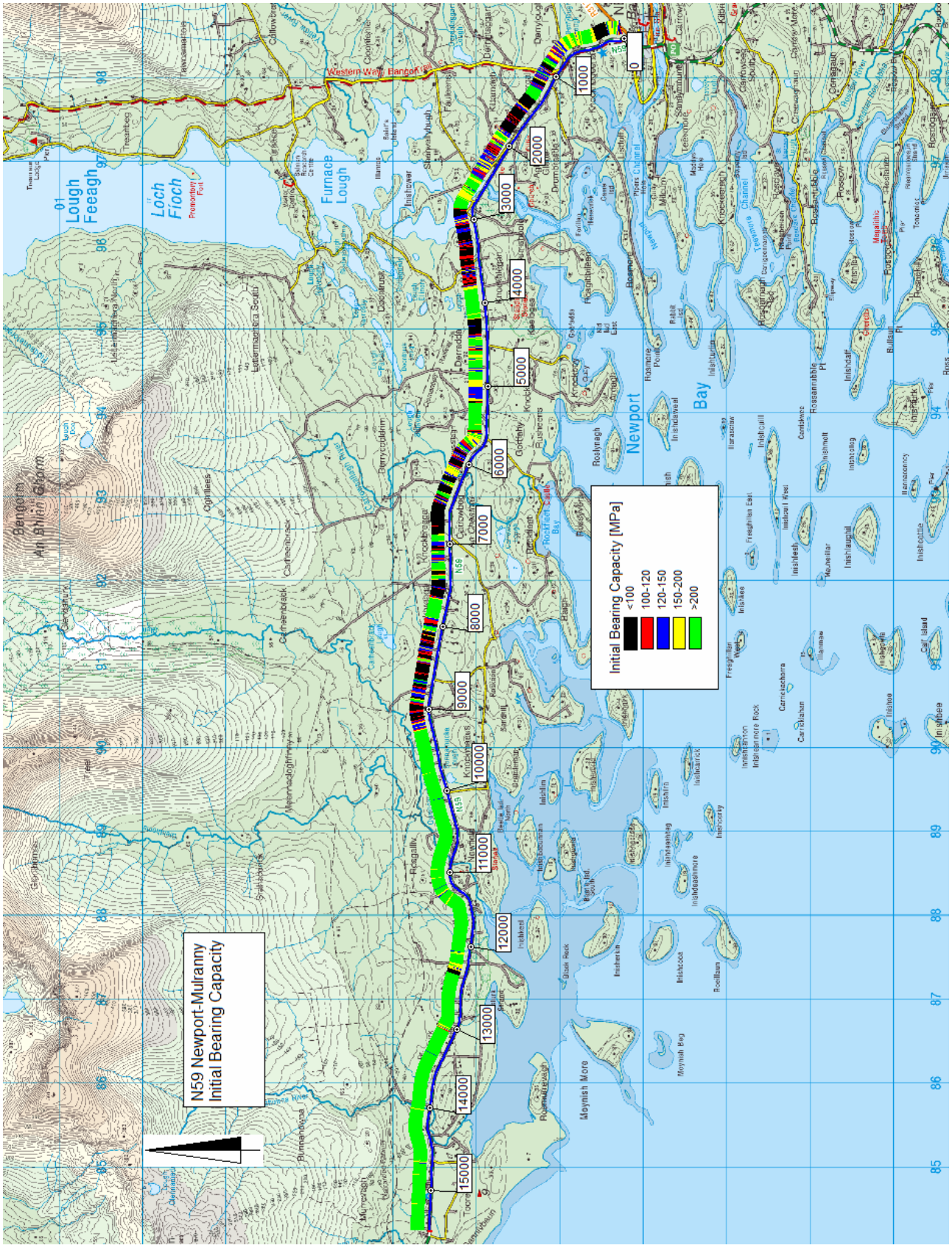
APPENDIXES

APPENDIX 1	Total risk classification shown as a map
APPENDIX 2	Initial bearing capacity shown as a map
APPENDIX 3	Longitudinal profiles

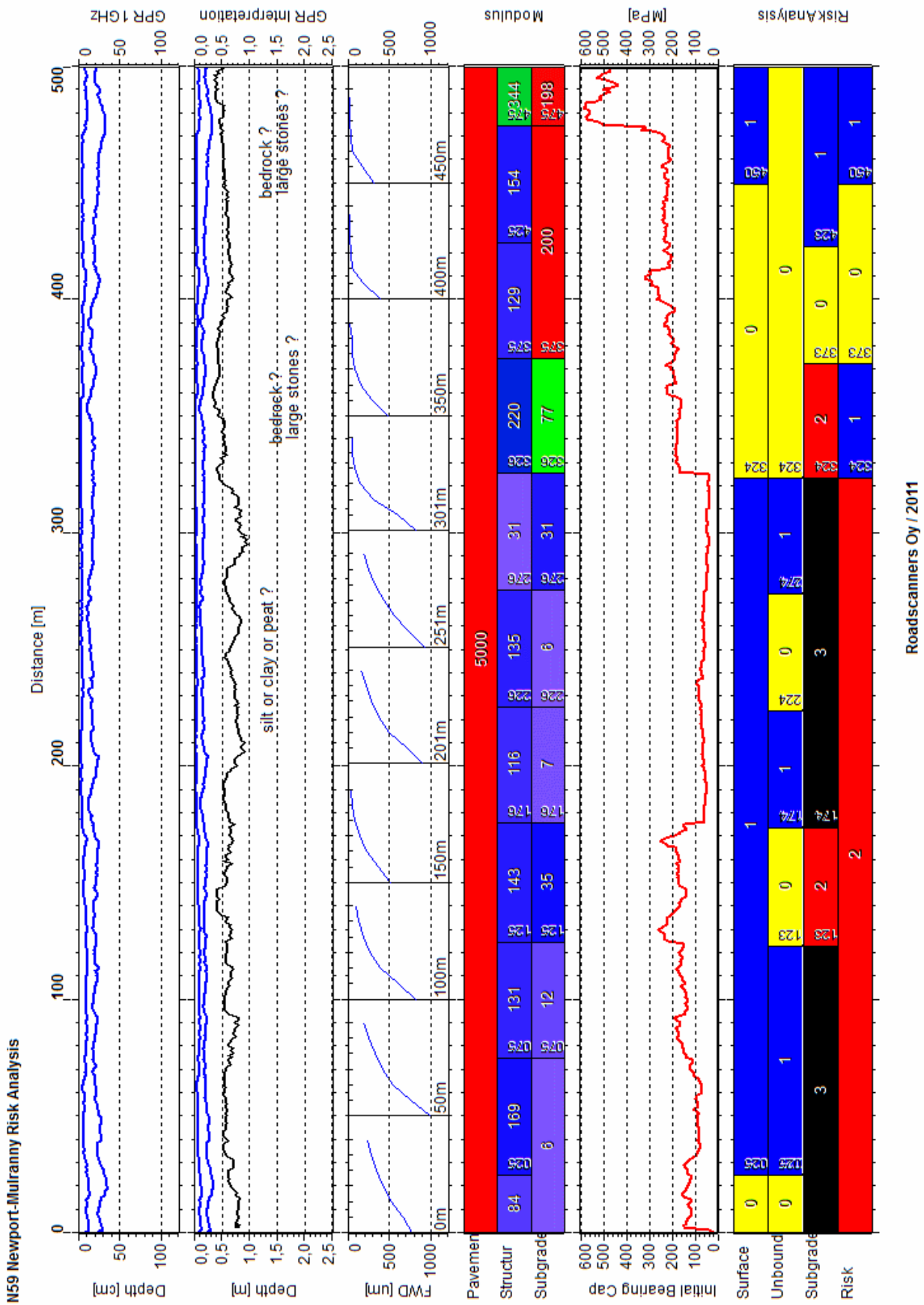
APPENDIX 1


N59 Newport-Mulranny
Total Risk Classification
Total Risk Classification
0: No Risk
1: Low Risk
2: Moderate Risk
3: High Risk
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
Lough Feeagh
Loch Fiach
Furnace Lough
Newport
Bay
Moynish More

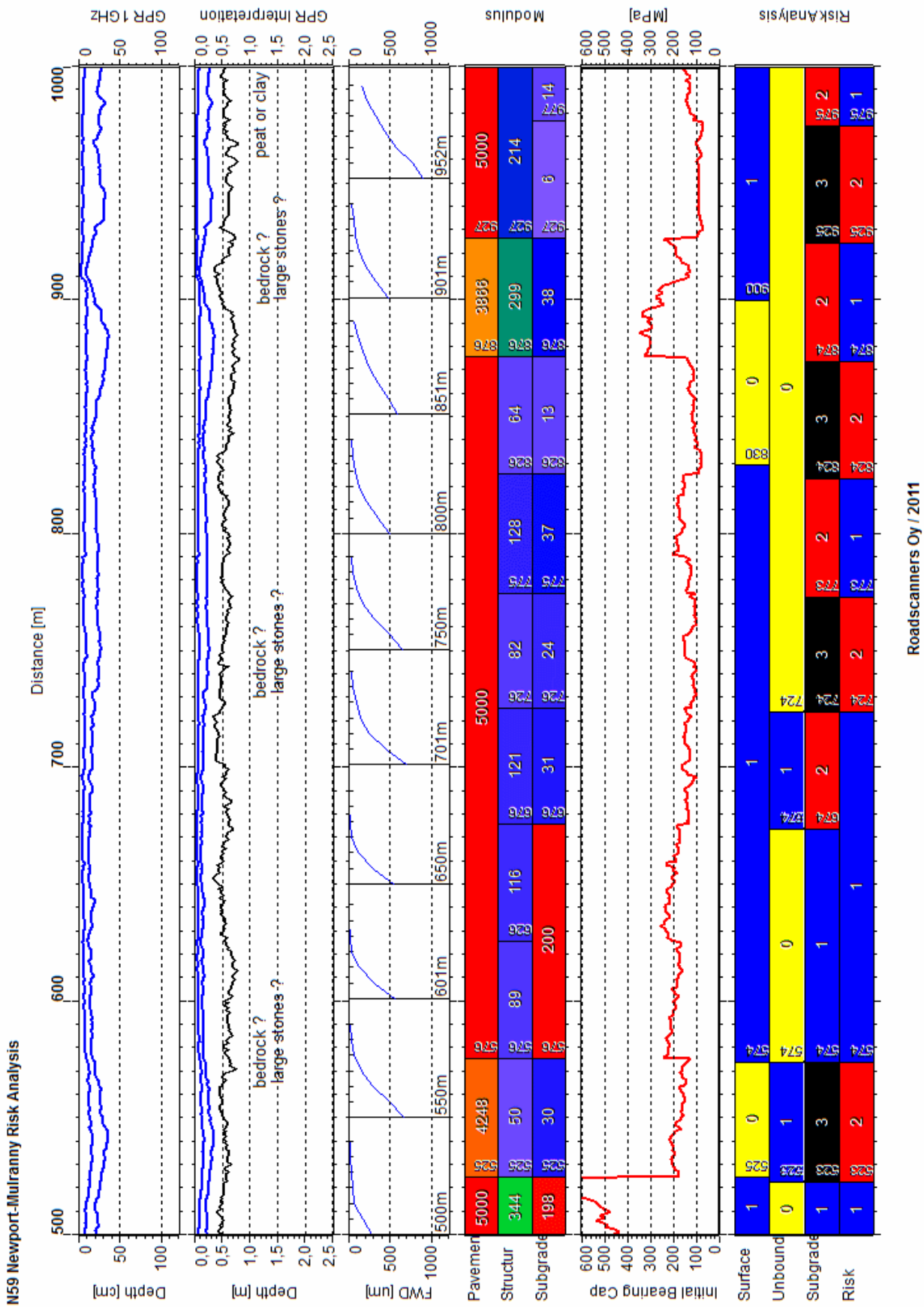
APPENDIX 2


N59 Newport-Mulranny
Initial Bearing Capacity
Initial Bearing Capacity [MPa]
<100
100-120
120-150
150-200
>200
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
Lough Feeagh
Loch Fioch
Furnace Lough
Newport
Bay
Moynish More

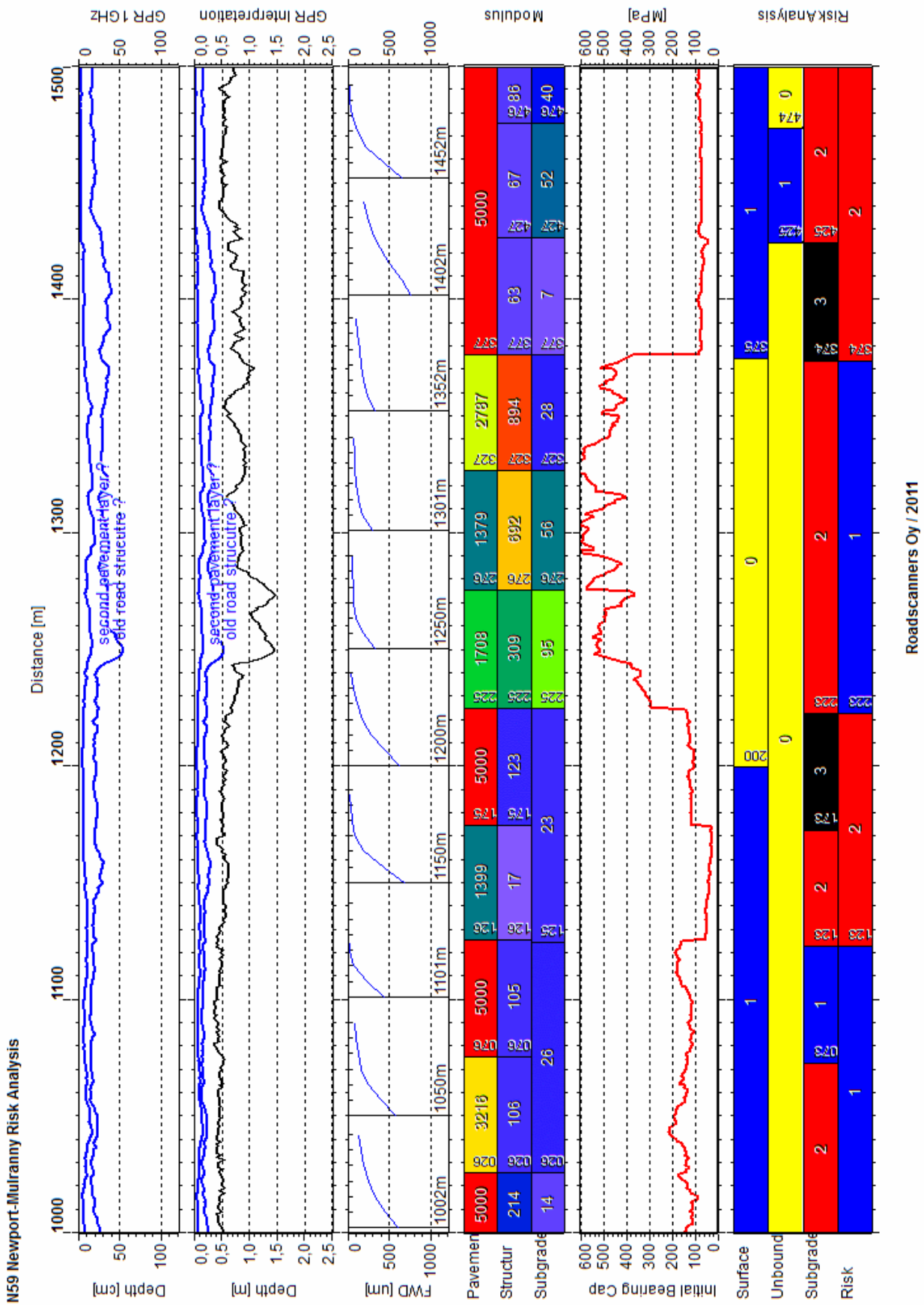
APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
GPR 1 GHz
Depth [cm]
GPR Interpretation
Depth [m]
bedrock ?
large stones ?
bedrock ?
large stones ?
silt or clay or peat ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

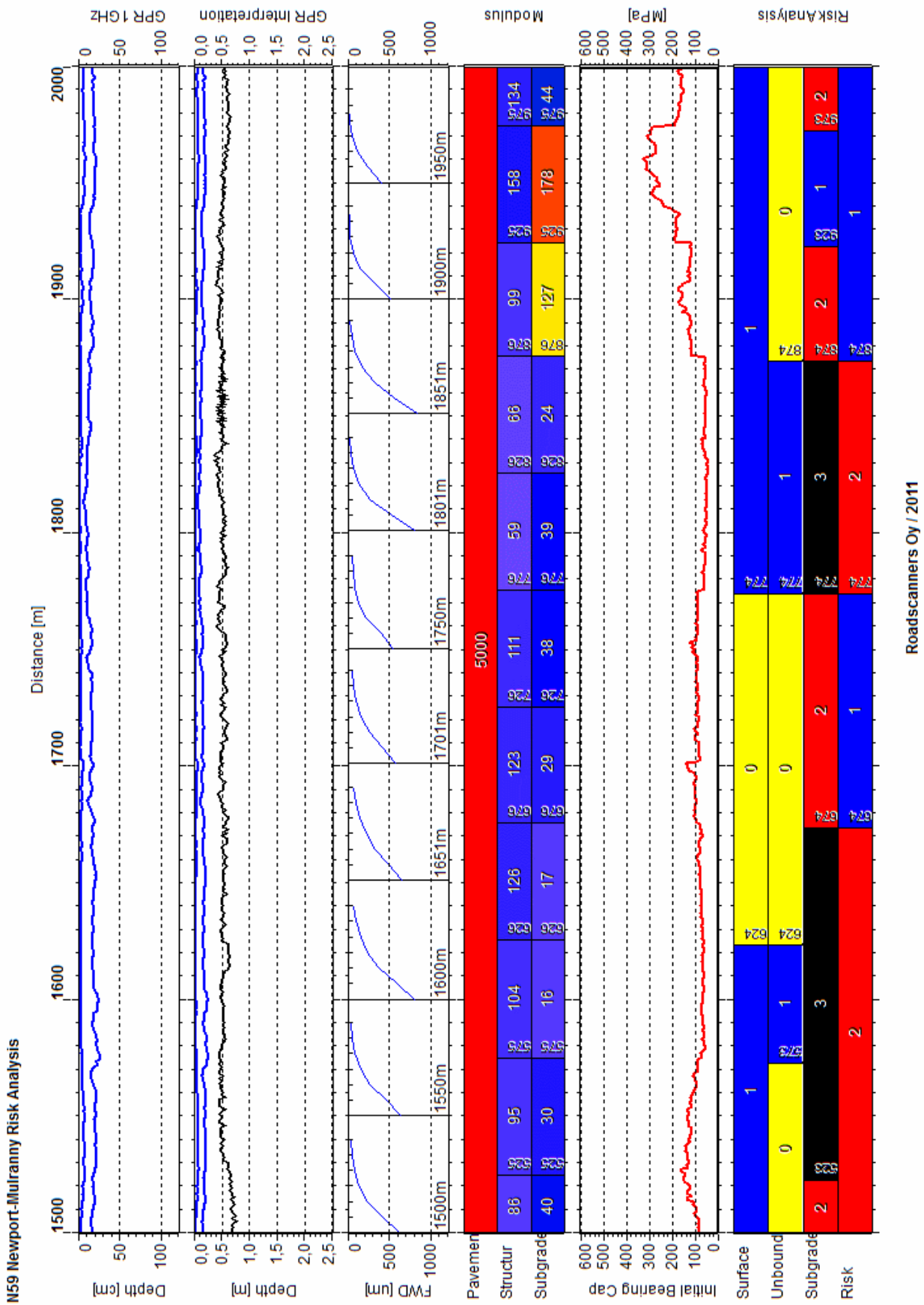
APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
bedrock ?
large stones ?
peat or clay
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

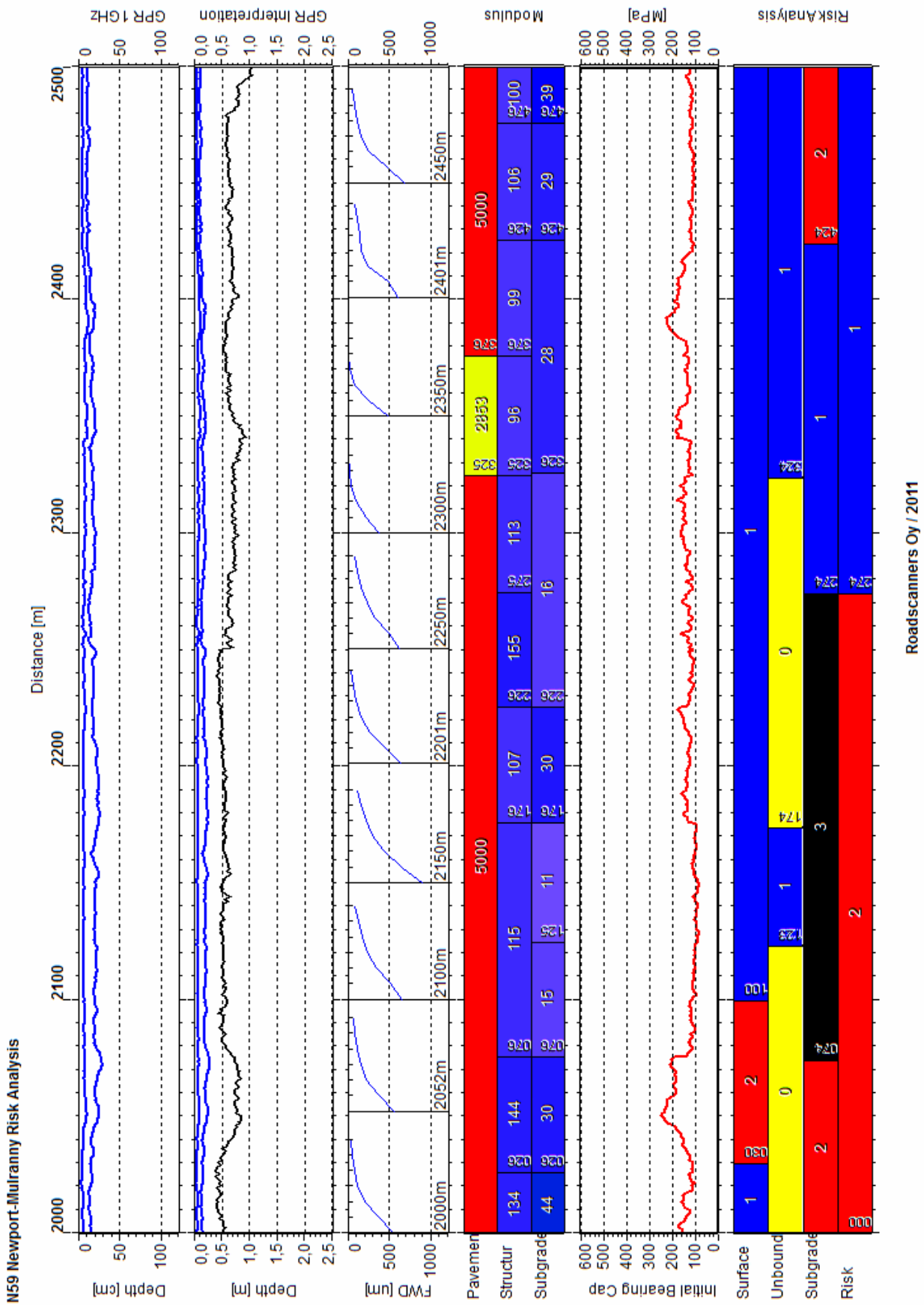
APPENDIX 3


N59 Newport-Mulranny Risk Analysis
GPR 1 GHz
GPR Interpretation
Modulus
Risk Analysis
Distance [m]
Depth [cm]
Depth [m]
FWD [um]
[MPa]
Initial Bearing Cap
Pavement
Structur
Subgrade
Surface
Unbound
Subgrade
Risk
second pavement layer ?
old road structure ?
Roadscanners Oy / 2011

APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
1500
1600
1700
1800
1900
2000
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
FWD [um]
1500m
1550m
1600m
1651m
1701m
1750m
1801m
1851m
1900m
1950m
Pavement
Structur
Subgrade
Modulus
5000
[MPa]
Initial Bearing Cap
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

APPENDIX 3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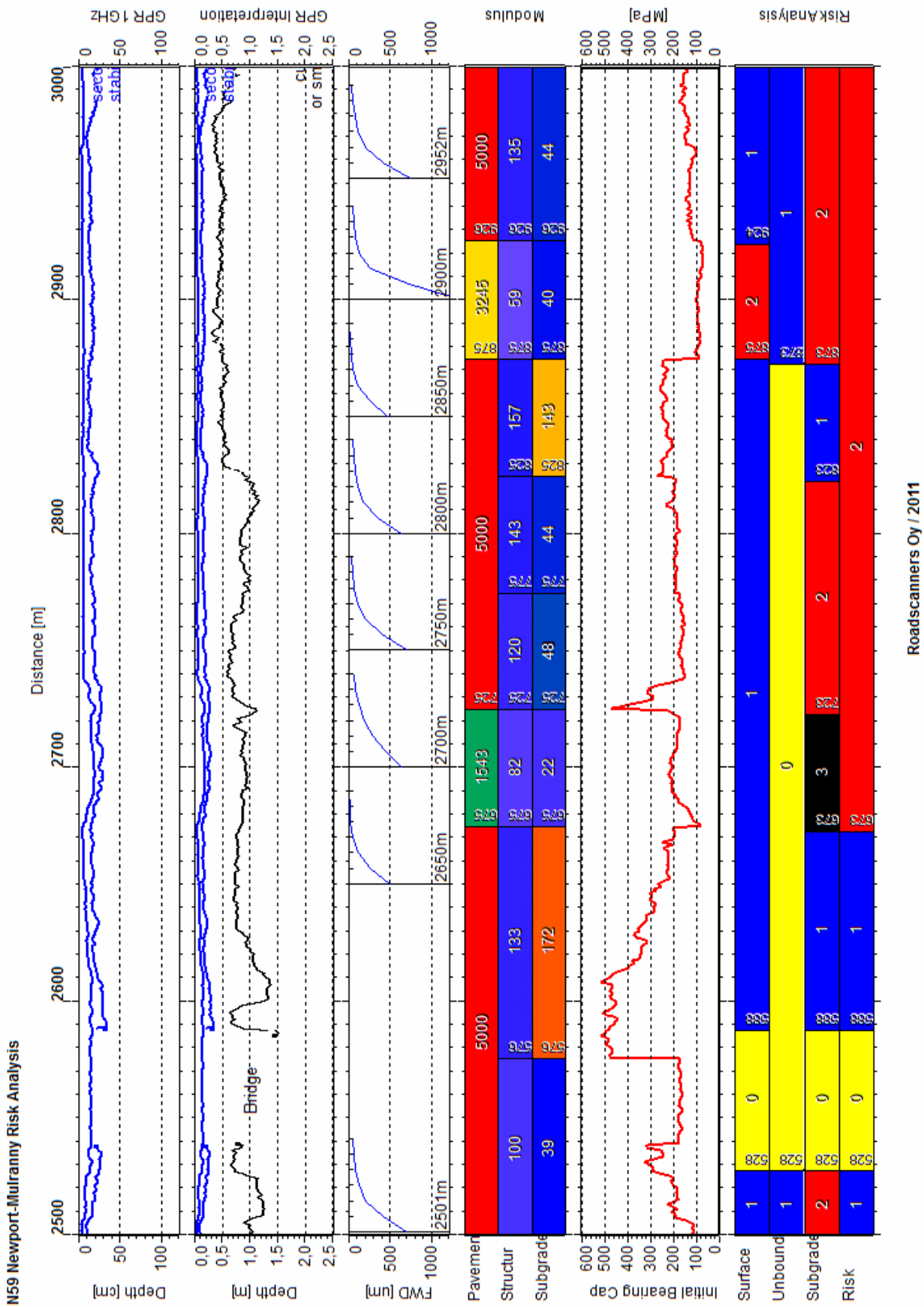
Distance [m]
Depth [cm]
GPR 1GHz
Depth [m]
GPR Interpretation
FWD [um]
Modulus
Pavemen
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

APPENDIX 3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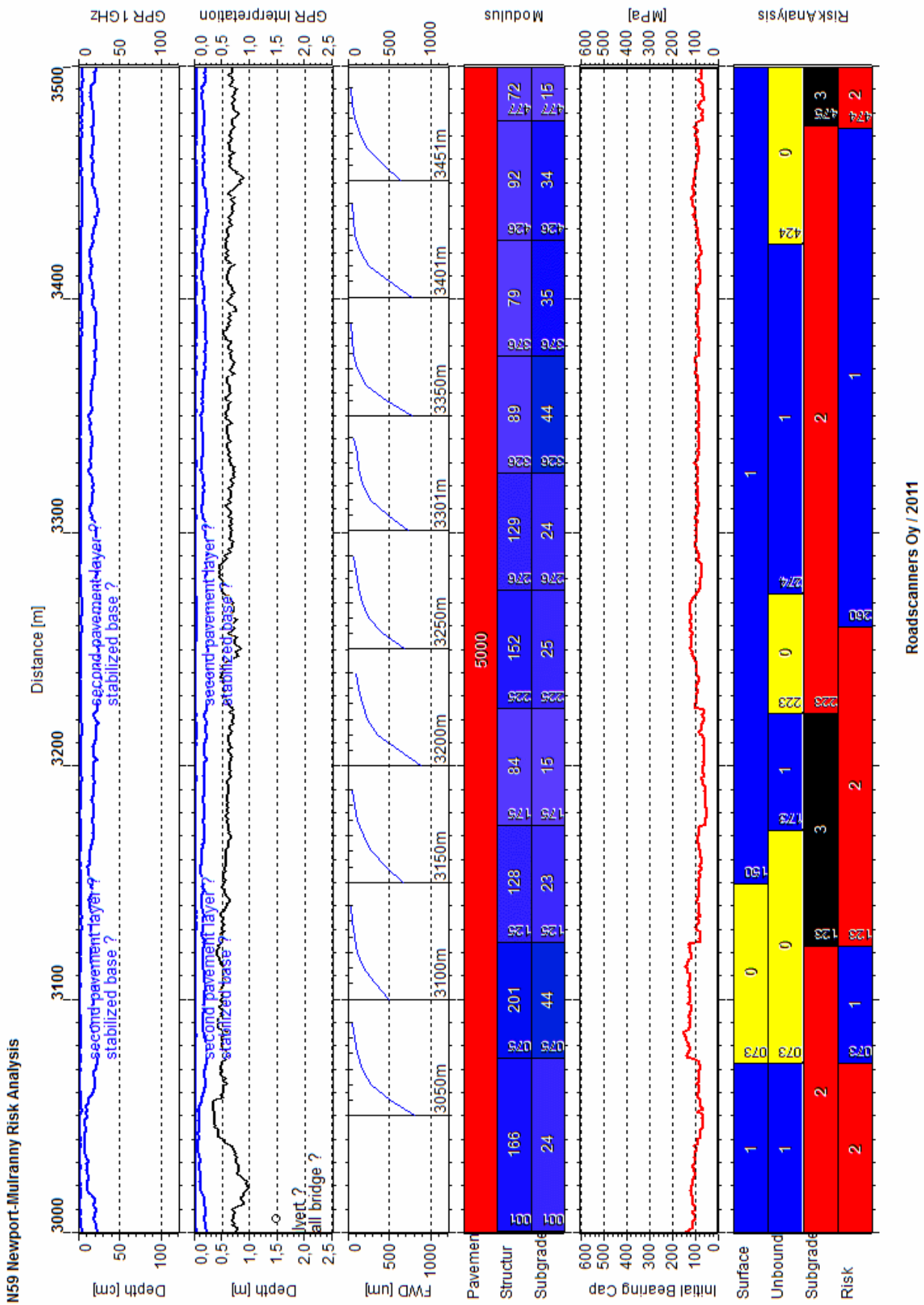
Distance [m]
2500
2600
2700
2800
2900
3000
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
Bridge
FWD [um]
2501m
2650m
2700m
2750m
2800m
2850m
2900m
2952m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

APPENDIX 3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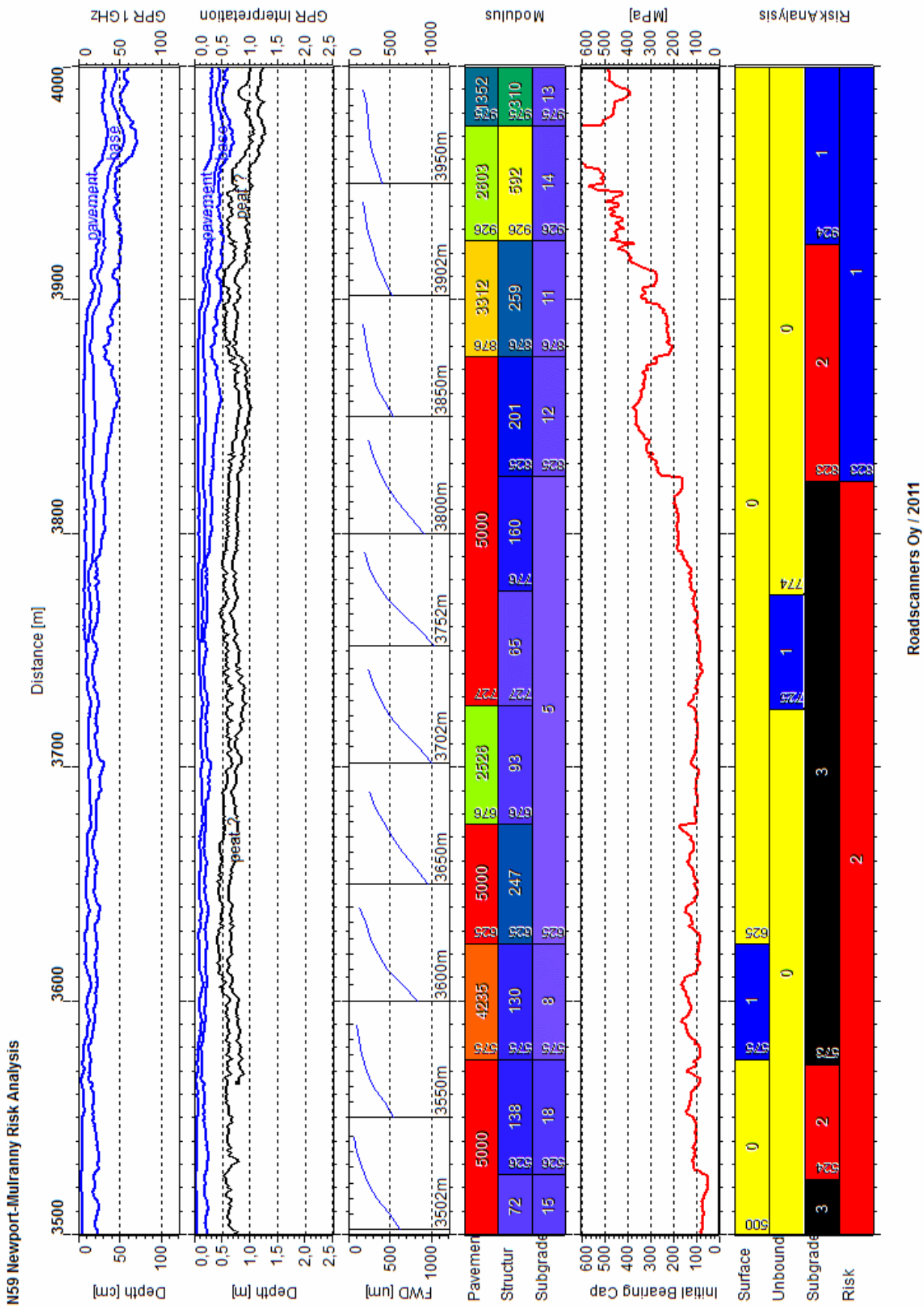
Distance [m]
GPR 1 GHz
Depth [cm]
GPR Interpretation
Depth [m]
second pavement layer ?
stabilized base ?
wet ?
all bridge ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

APPENDIX 3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Distance [m]
GPR 1 GHz
Depth [cm]
GPR Interpretation
Depth [m]
pavement
base
peat 2
peat 7
FWD [um]
Modulus
Pavement
Structur
Subgrade
Initial Bearing Cap
[MPa]
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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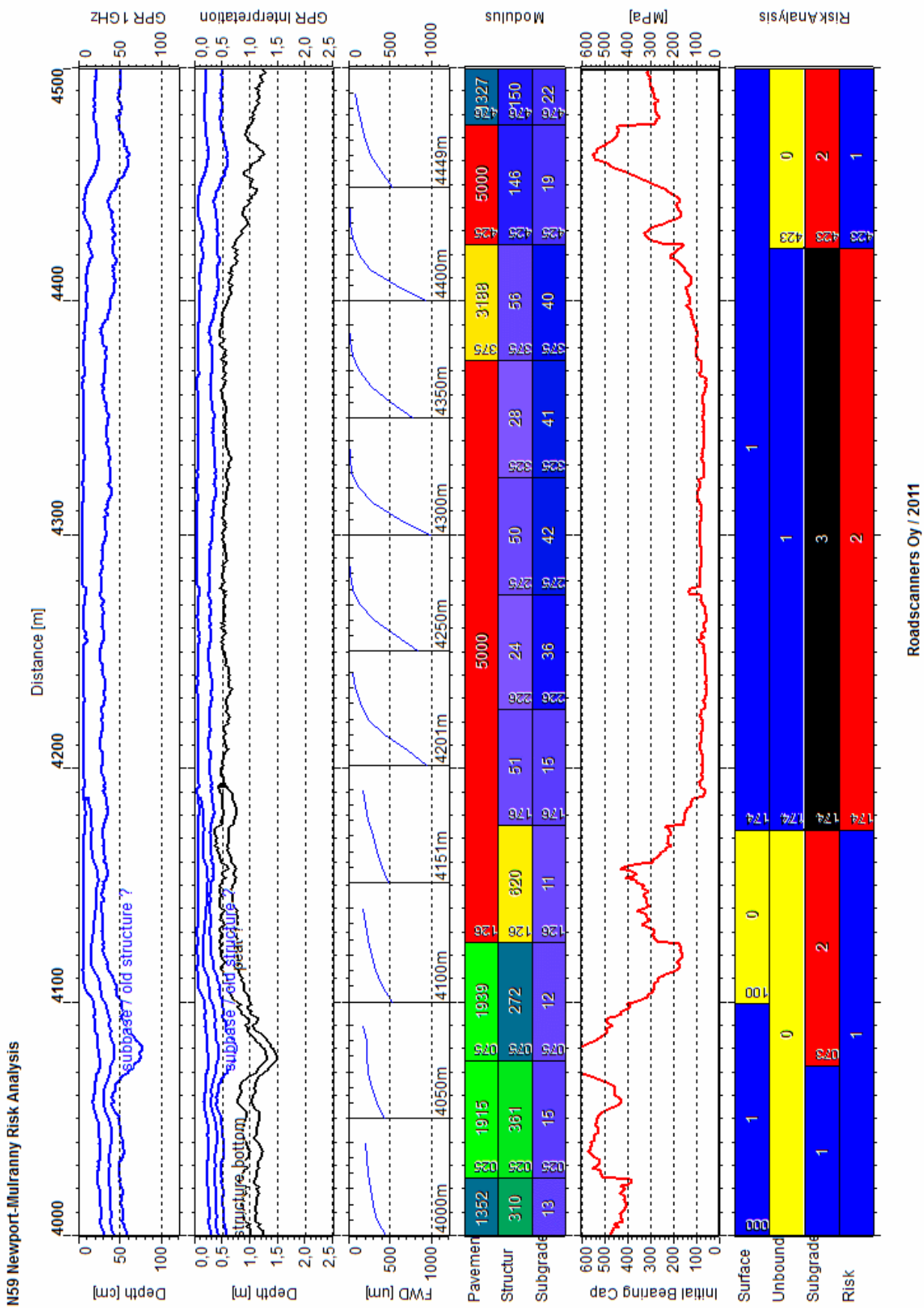
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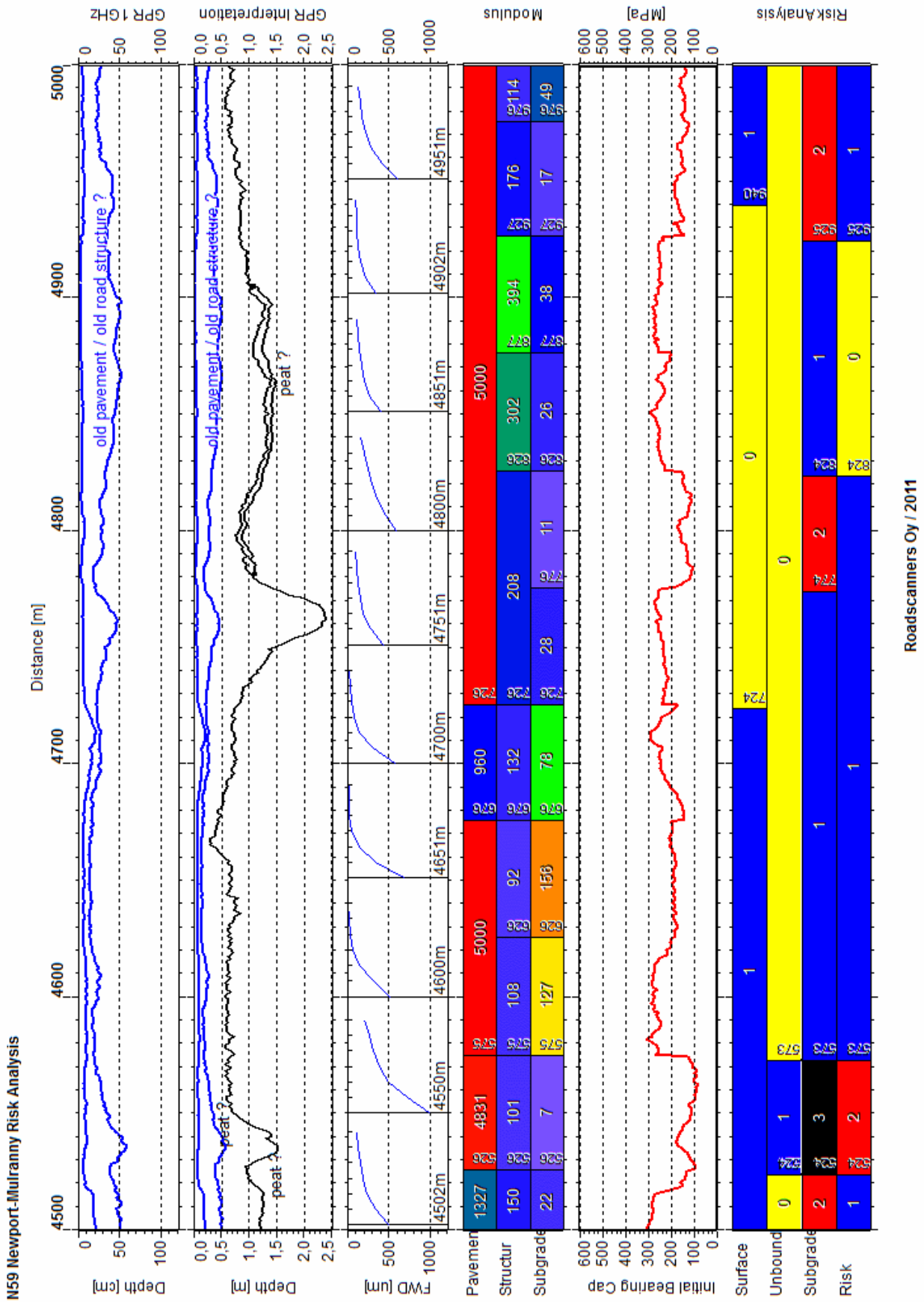
Distance [m]
GPR 1 GHz
Depth [cm]
subbase / old structure ?
GPR Interpretation
Depth [m]
structure bottom
subbase / old structure ?
peat ?
FWD [um]
Modulus
Pavemen
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
GPR 1 GHz
Depth [cm]
old pavement / old road structure ?
GPR Interpretation
Depth [m]
old pavement / old road structure ?
peat ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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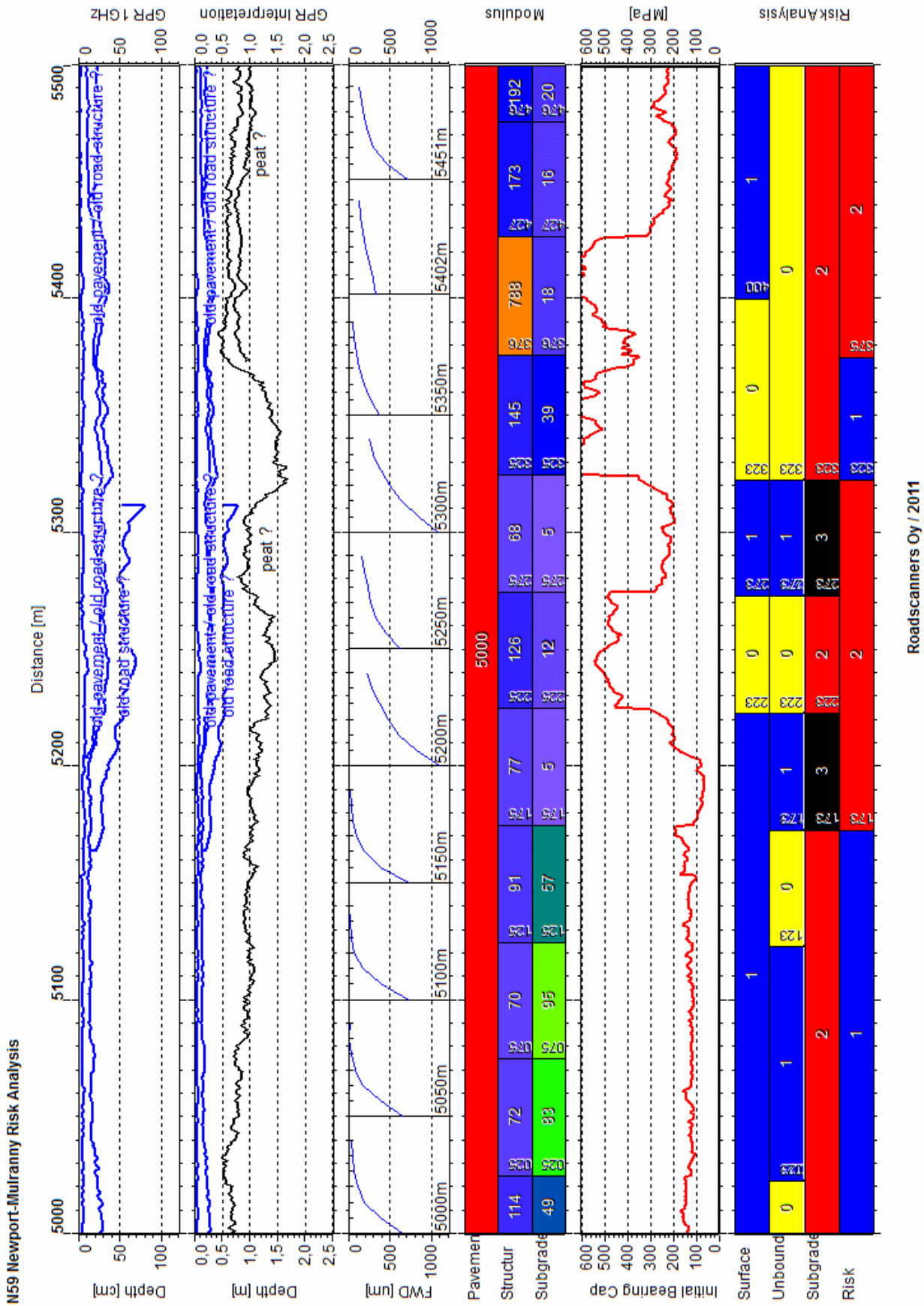
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Distance [m]
GPR 1 GHz
Depth [cm]
old pavement / old road structure ?
old road structure ?
GPR Interpretation
Depth [m]
old pavement / old road structure ?
old road structure ?
peat ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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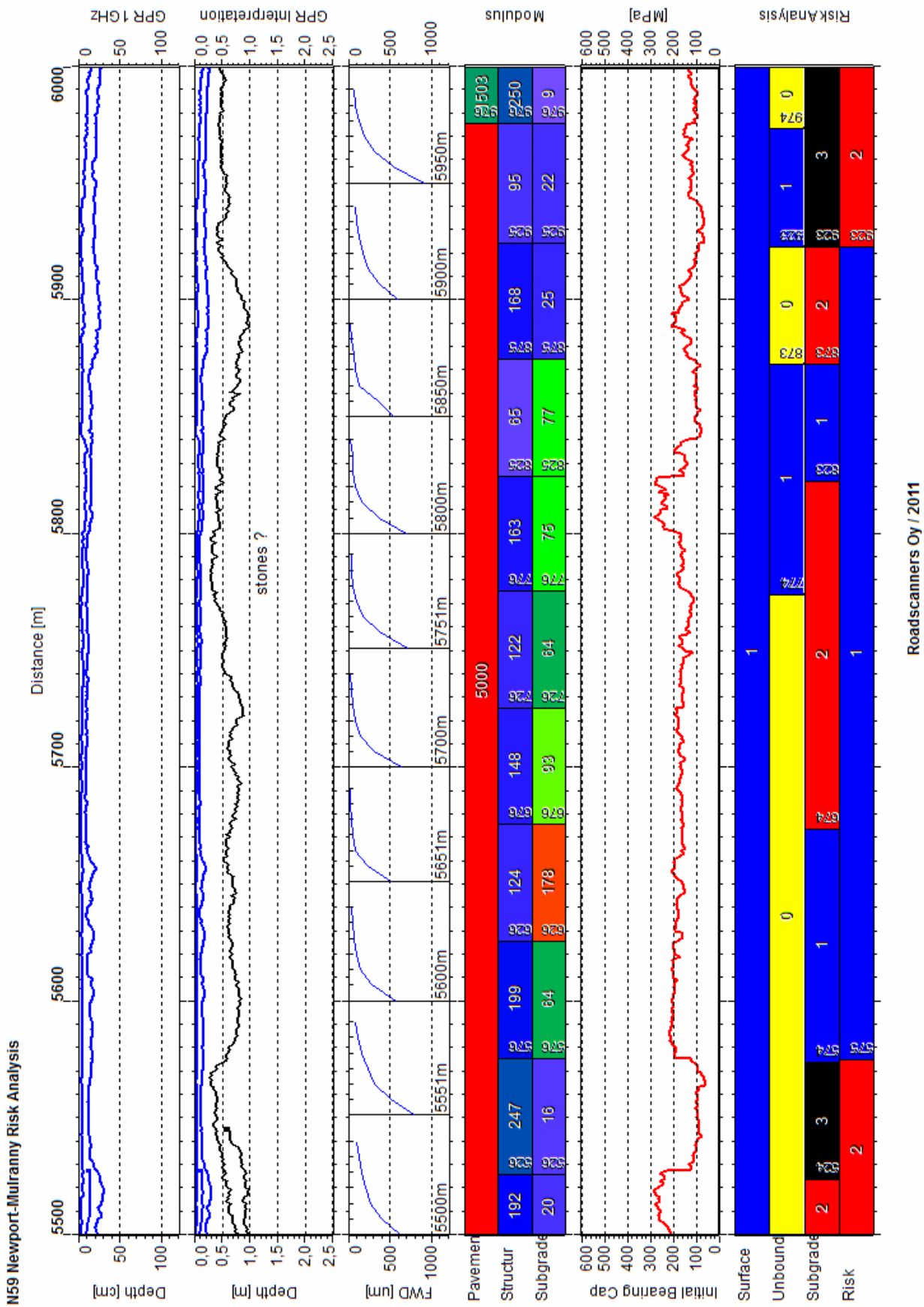
N59 Newport-Mulranny Risk Analysis
Distance [m]
5500
5600
5700
5800
5900
6000
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
stones ?
FWD [um]
5500m
5551m
5600m
5651m
5700m
5751m
5800m
5850m
5900m
5950m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

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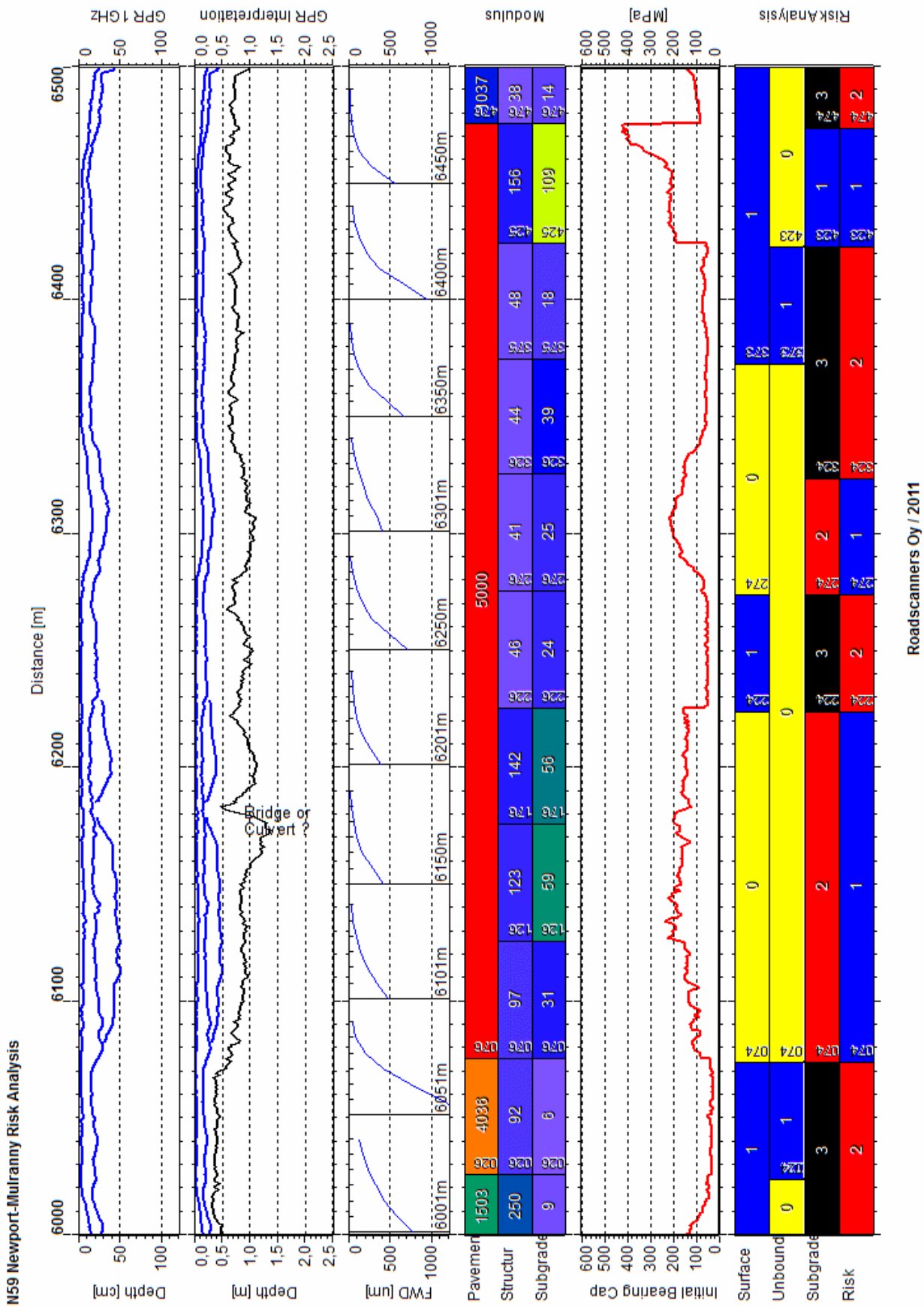
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Distance [m]
GPR 1 GHz
Depth [cm]
GPR Interpretation
Depth [m]
Bridge or Culvert ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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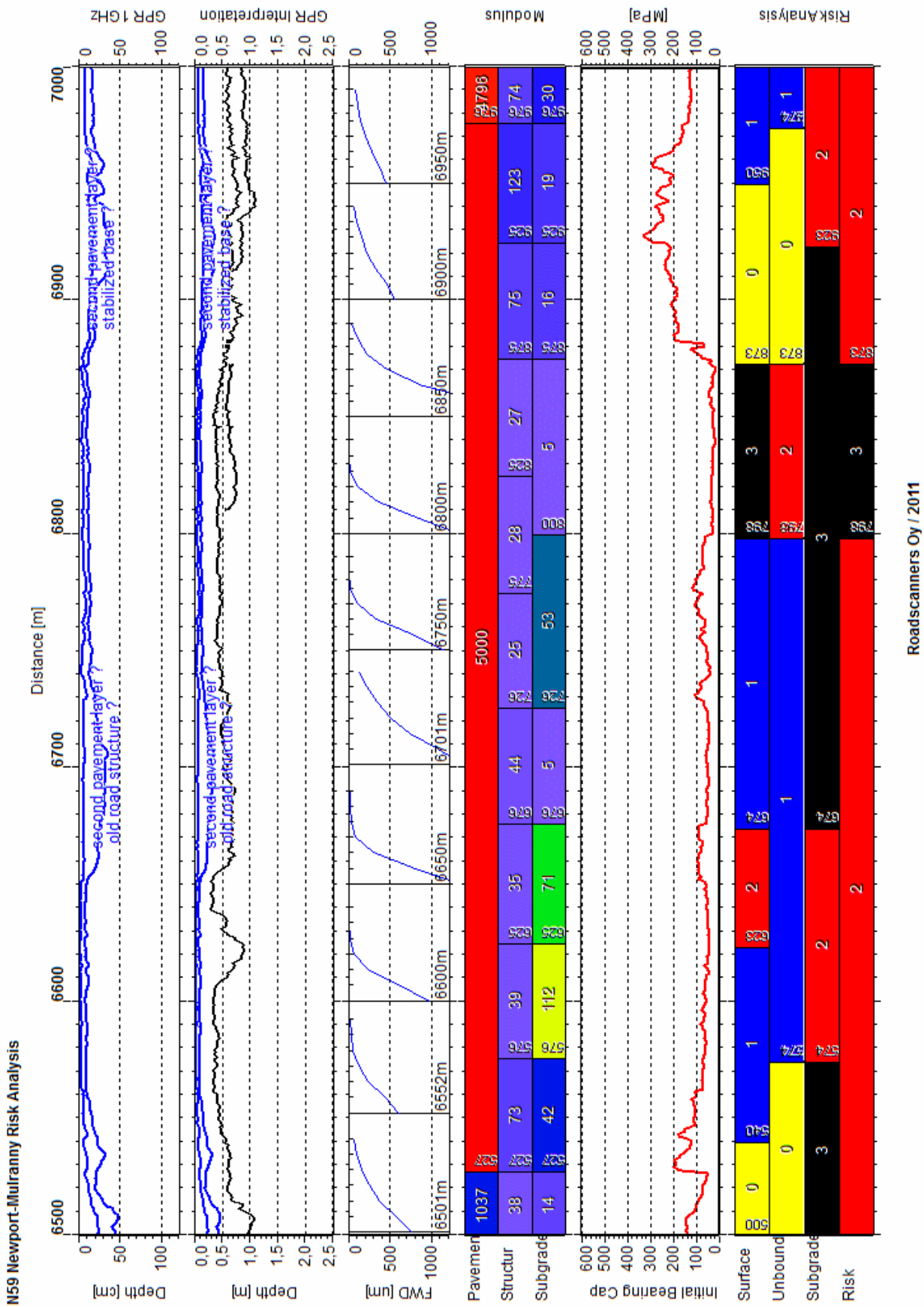
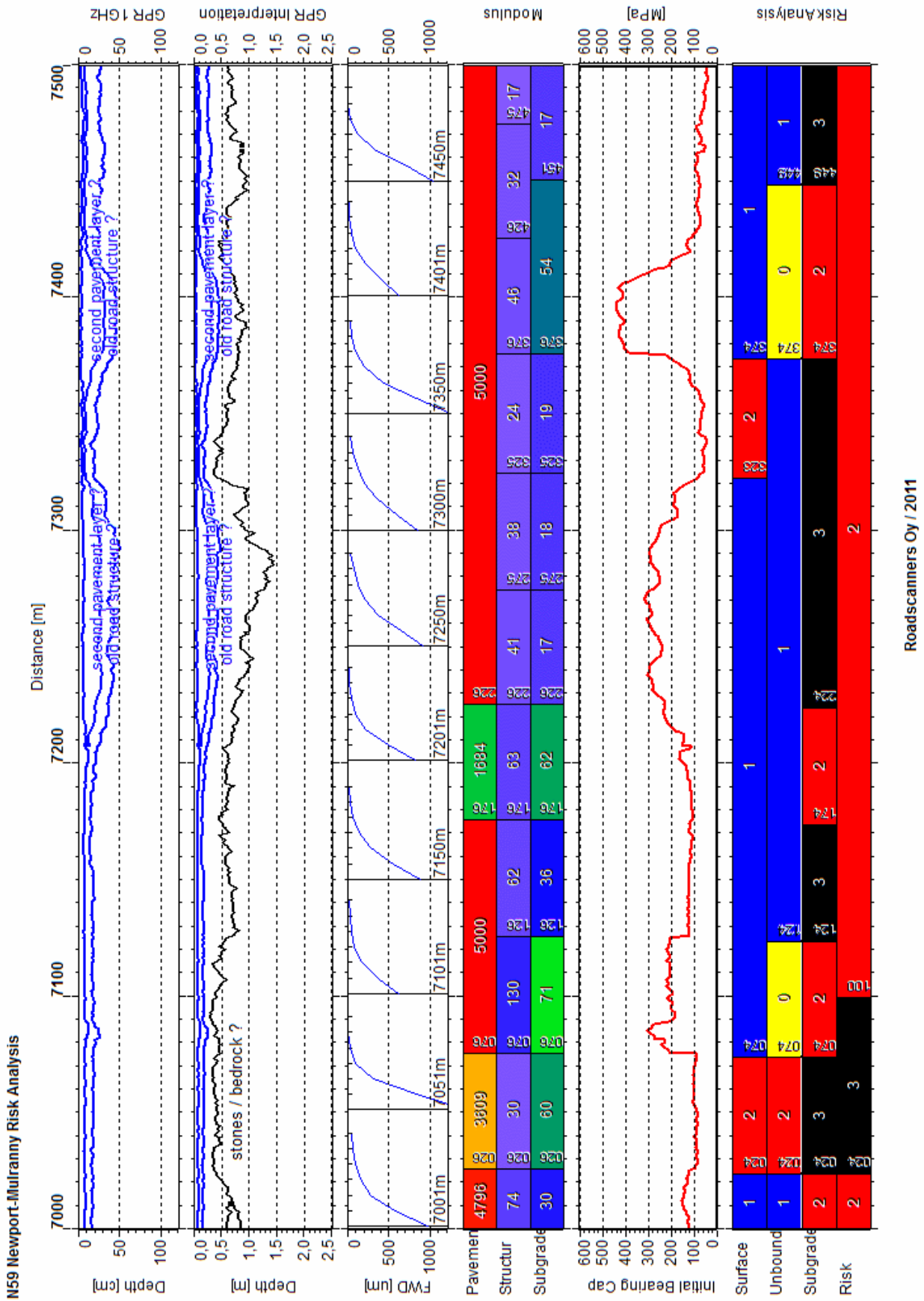
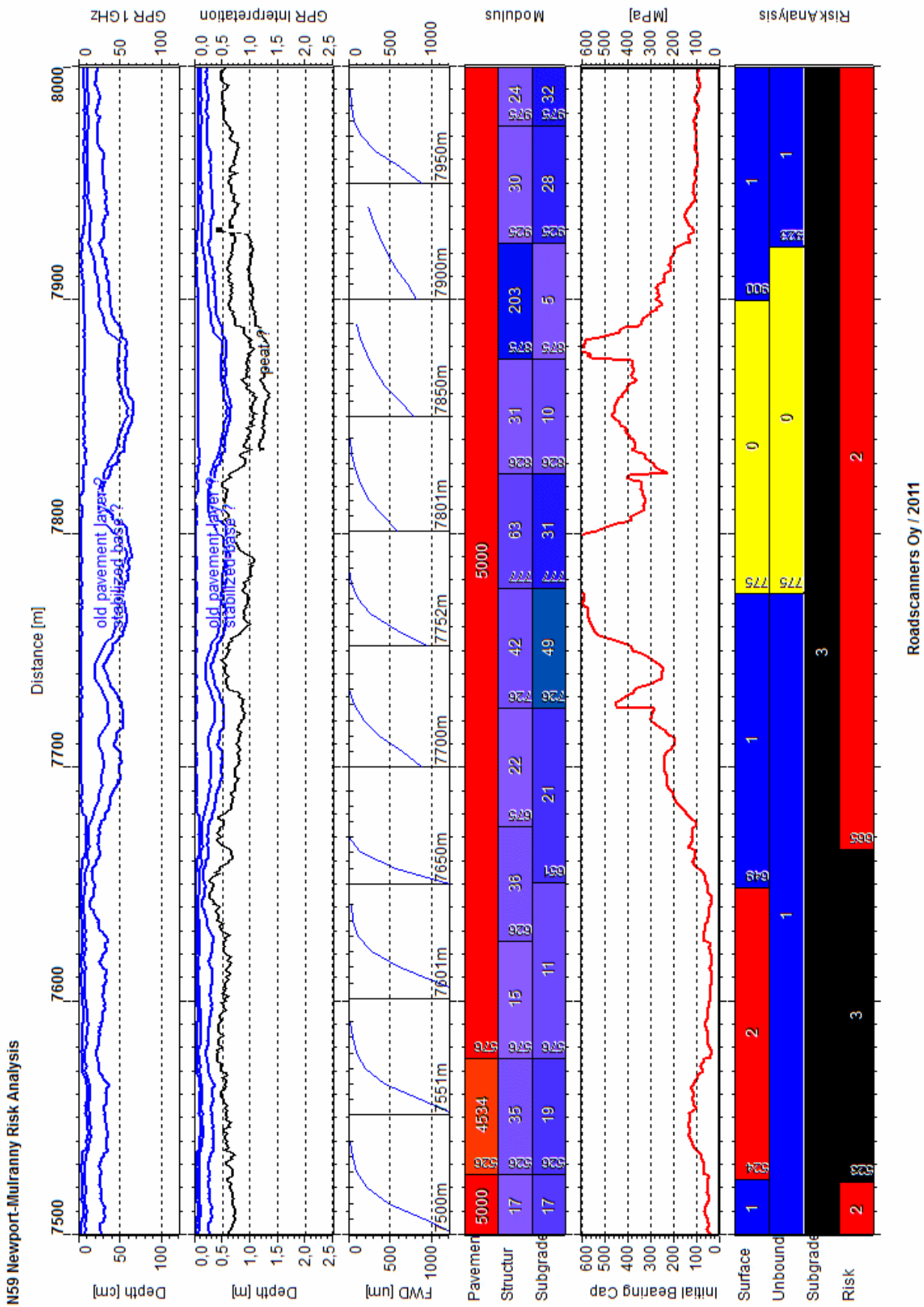

N59 Newport-Mulranny Risk Analysis
Distance [m]
6500
6600
6700
6800
6900
7000
Depth [cm]
second pavement layer ?
old road structure ?
GPR 1 GHz
Depth [m]
second pavement layer ?
stabilized base ?
GPR Interpretation
FWD [um]
6501m
6552m
6600m
6650m
6701m
6750m
6800m
6850m
6900m
6950m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

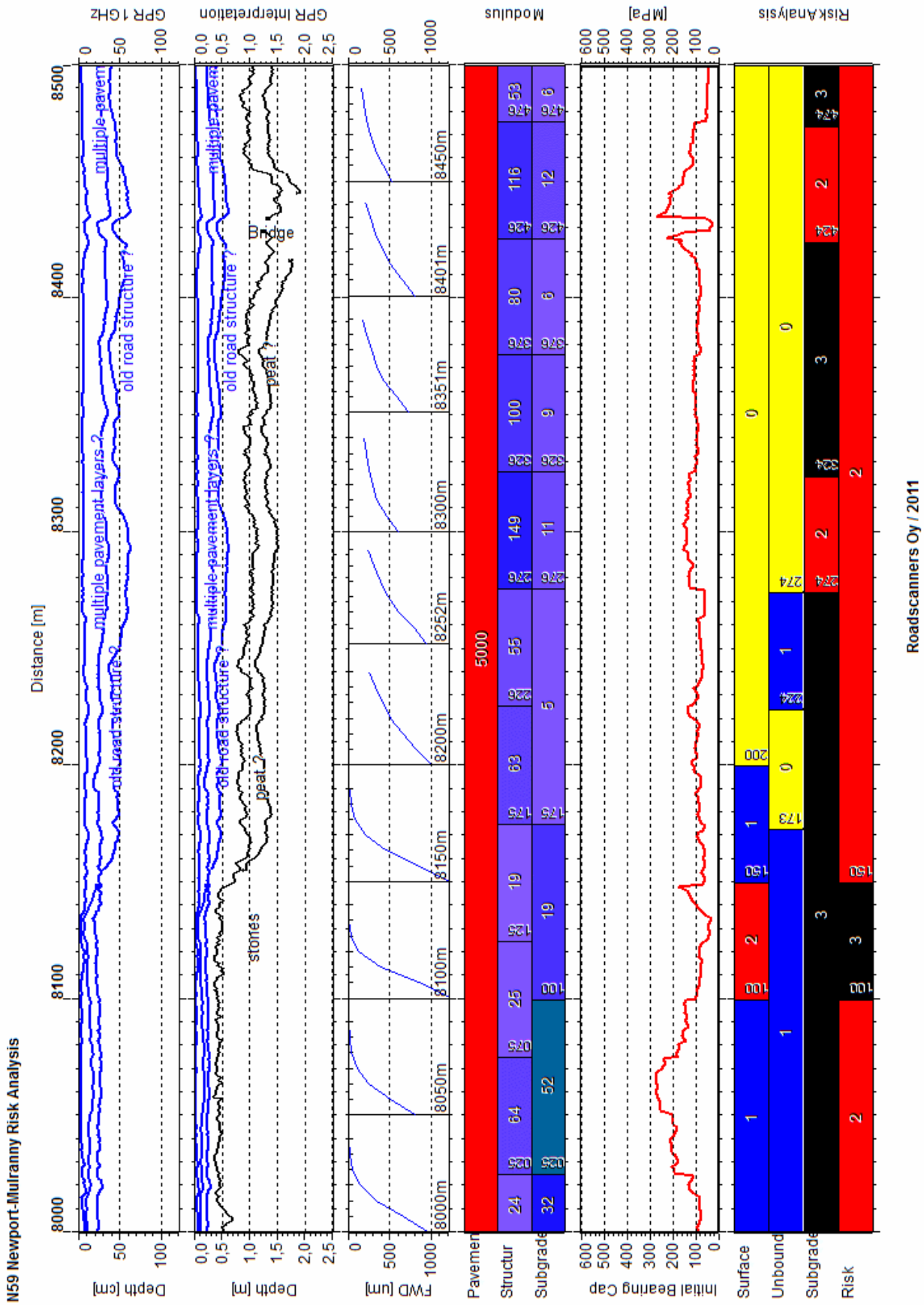
APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
7000
7100
7200
7300
7400
7500
Depth [cm]
GPR 1 GHz
second pavement layer ?
old road structure ?
Depth [m]
GPR Interpretation
second pavement layer ?
old road structure ?
stones / bedrock ?
FWD [um]
7001m
7051m
7101m
7150m
7201m
7250m
7300m
7350m
7401m
7450m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

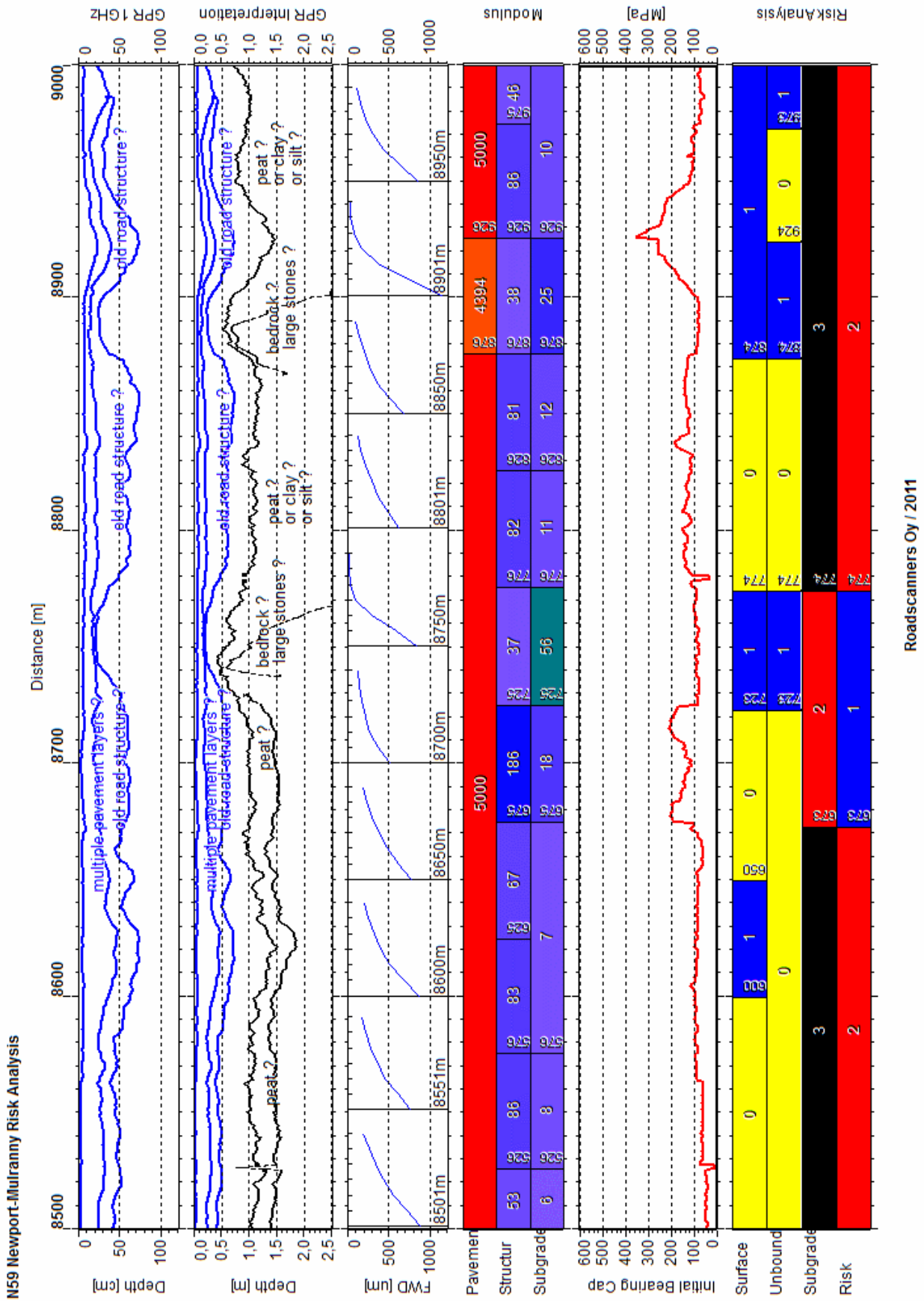
APPENDIX 3


N59 Newport-Mulranny Risk Analysis
GPR 1 GHz
GPR Interpretation
Modulus
Risk Analysis
Distance [m]
Depth [cm]
Depth [m]
FWD [um]
[MPa]
Pavement
Structur
Subgrade
Initial Bearing Cap
Surface
Unbound
Subgrade
Risk
old pavement layer?
stabilized base?
peat?
Roadscanners Oy / 2011

APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
GPR 1 GHz
Depth [cm]
multiple pavem
multiple pavement layers ?
old road structure ?
GPR Interpretation
Depth [m]
Bridge
peat ?
stones
FWD [um]
Modulus
Pavemen
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
GPR 1 GHz
Depth [cm]
multiple pavement layers ?
old road structure ?
GPR Interpretation
Depth [m]
peat ?
bedrock ?
large stones ?
or clay ?
or silt ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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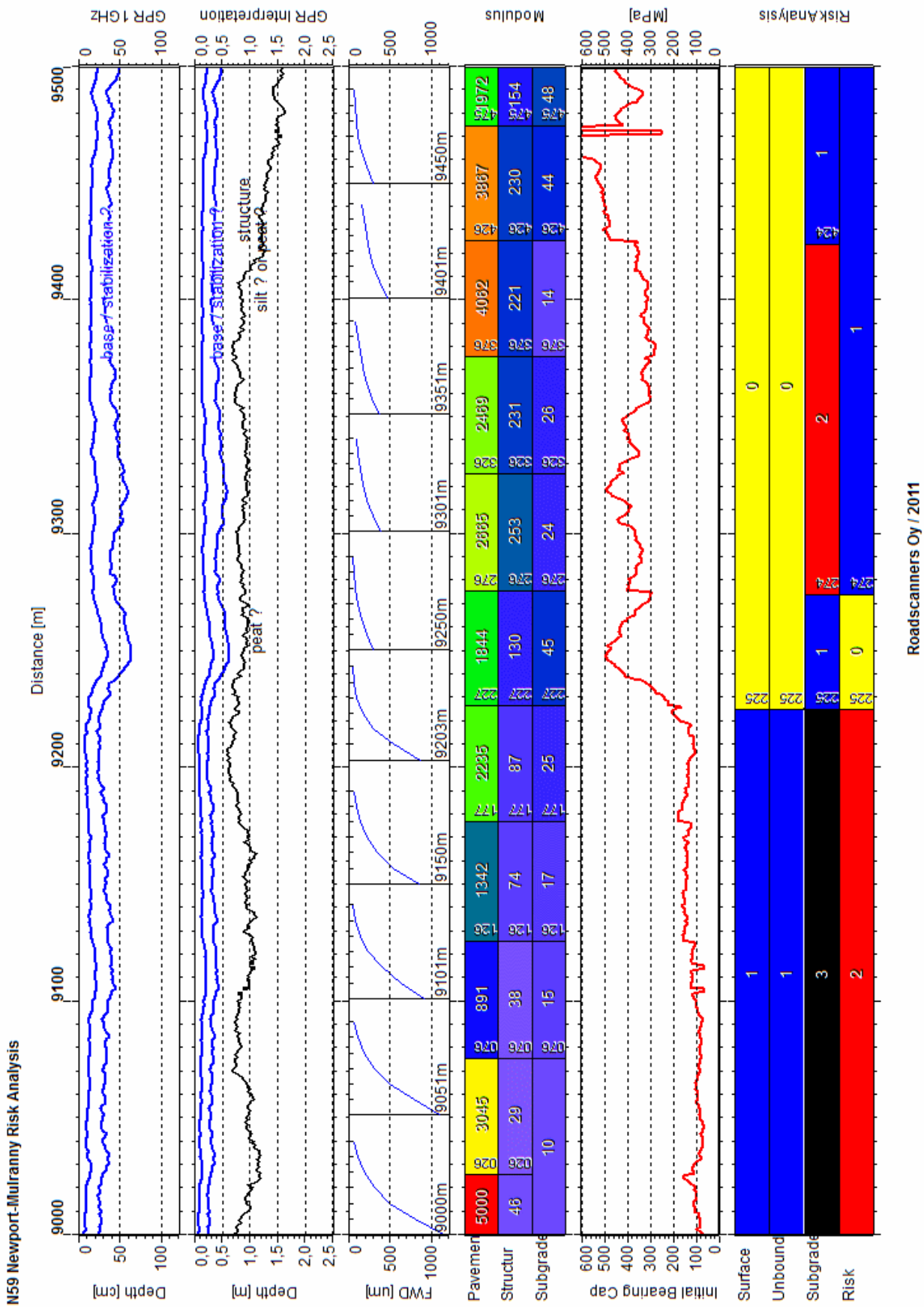
N59 Newport-Mulranny Risk Analysis
Distance [m]
Depth [cm]
GPR 1GHz
base ? stabilization ?
Depth [m]
GPR Interpretation
base ? stabilization ?
structure
silt ? or peat ?
peat ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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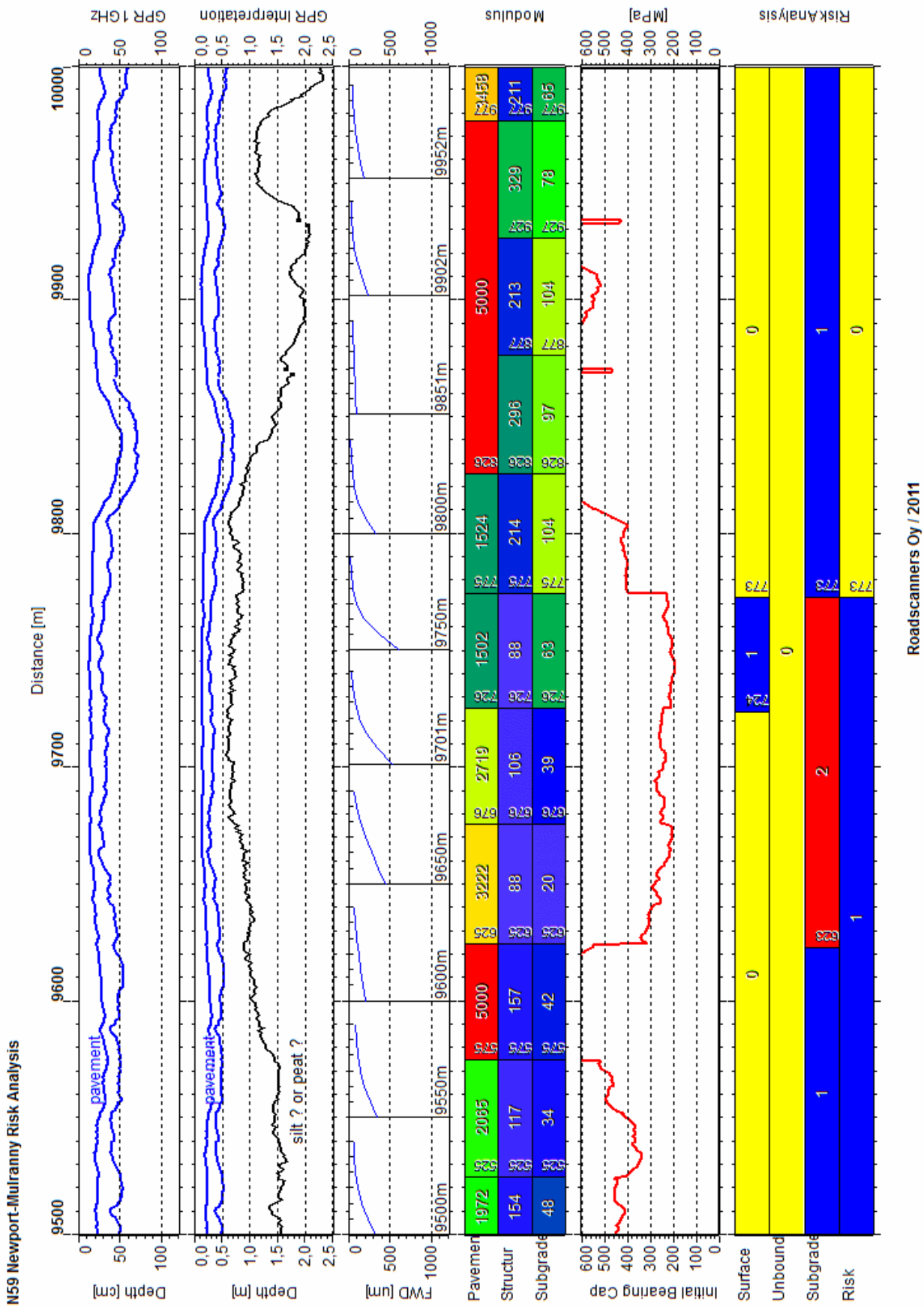
N59 Newport-Mulranny Risk Analysis
Distance [m]
9500
9600
9700
9800
9900
10000
Depth [cm]
GPR 1 GHz
pavement
Depth [m]
GPR Interpretation
silt ? or peat ?
FWD [um]
9500m
9550m
9600m
9650m
9701m
9750m
9800m
9851m
9902m
9952m
Pavement
Structur
Subgrade
Modulus
[MPa]
Initial Bearing Cap
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

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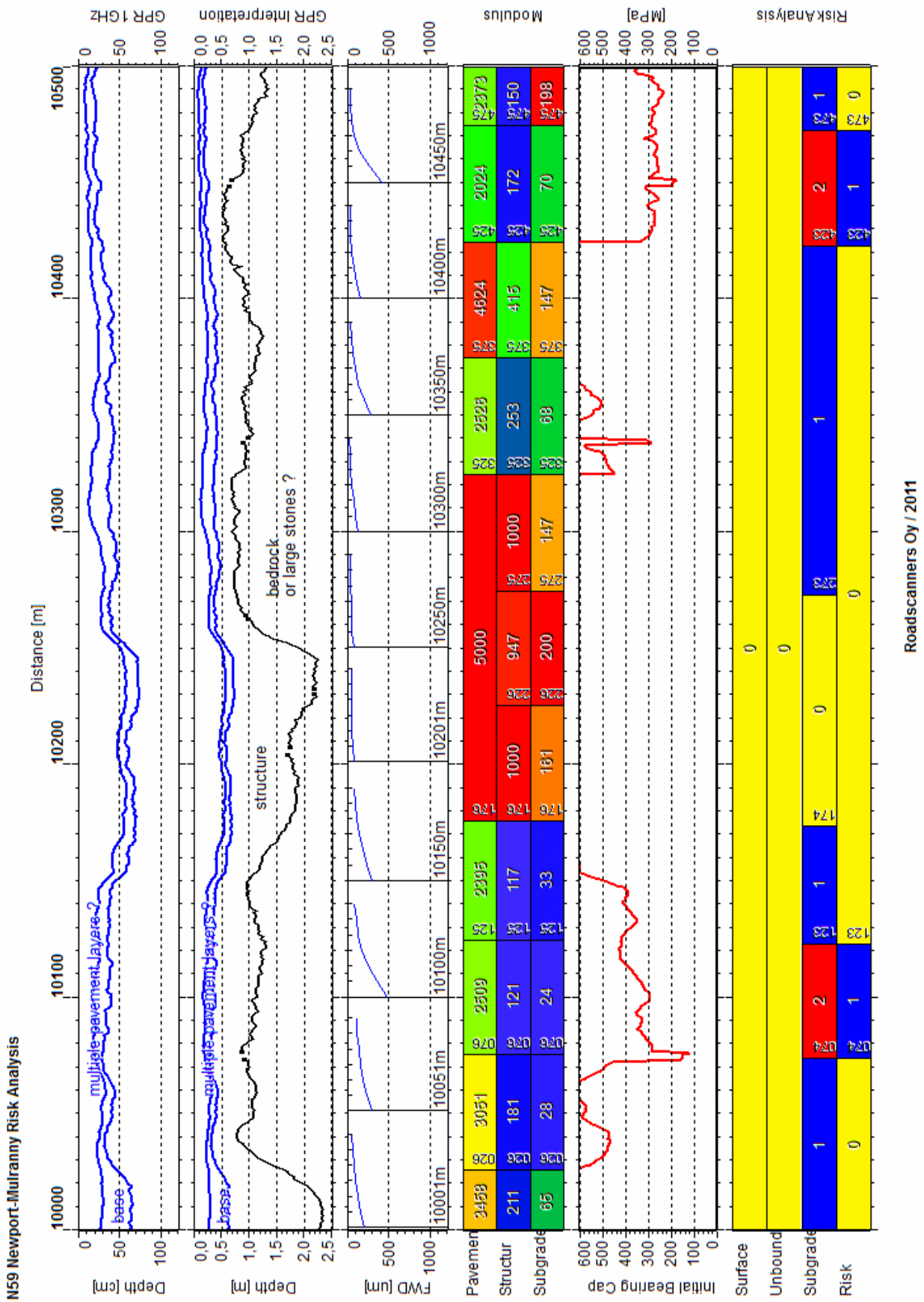
N59 Newport-Mulranny Risk Analysis
Distance [m]
GPR 1 GHz
Depth [cm]
multiple pavement layers ?
base
GPR Interpretation
Depth [m]
structure
bedrock
or large stones ?
FWD [um]
Modulus
Pavemen
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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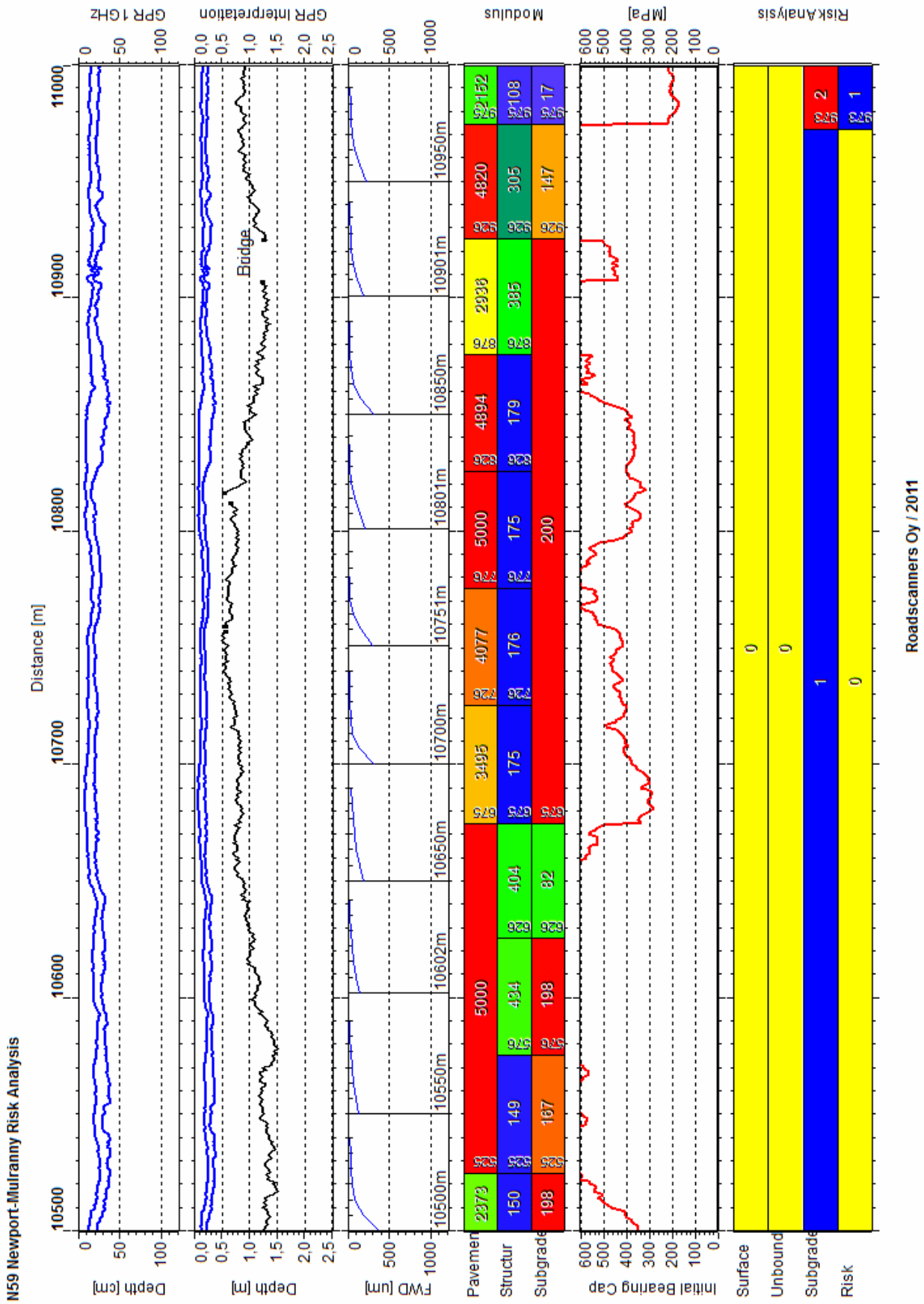
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Distance [m]
10500
10600
10700
10800
10900
11000
Depth [cm]
GPR 1GHz
Depth [m]
GPR Interpretation
Bridge
FWD [um]
10500m
10550m
10602m
10650m
10700m
10751m
10801m
10850m
10901m
10950m
Pavemen
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
RiskAnalysis
Roadscanners Oy / 2011

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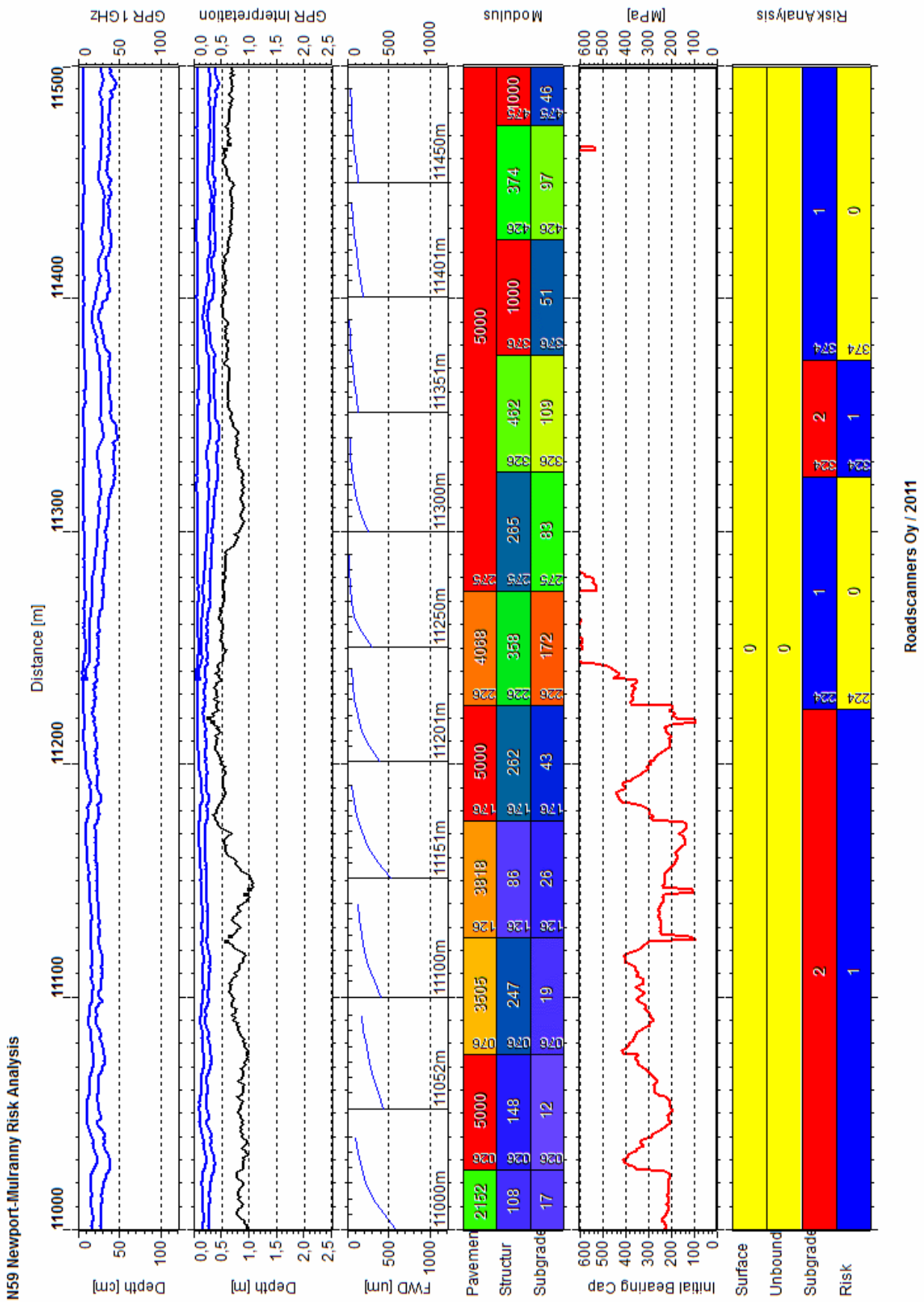
N59 Newport-Mulranny Risk Analysis
Distance [m]
11000
11100
11200
11300
11400
11500
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
FWD [um]
11000m
11052m
11100m
11151m
11201m
11250m
11300m
11351m
11401m
11450m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

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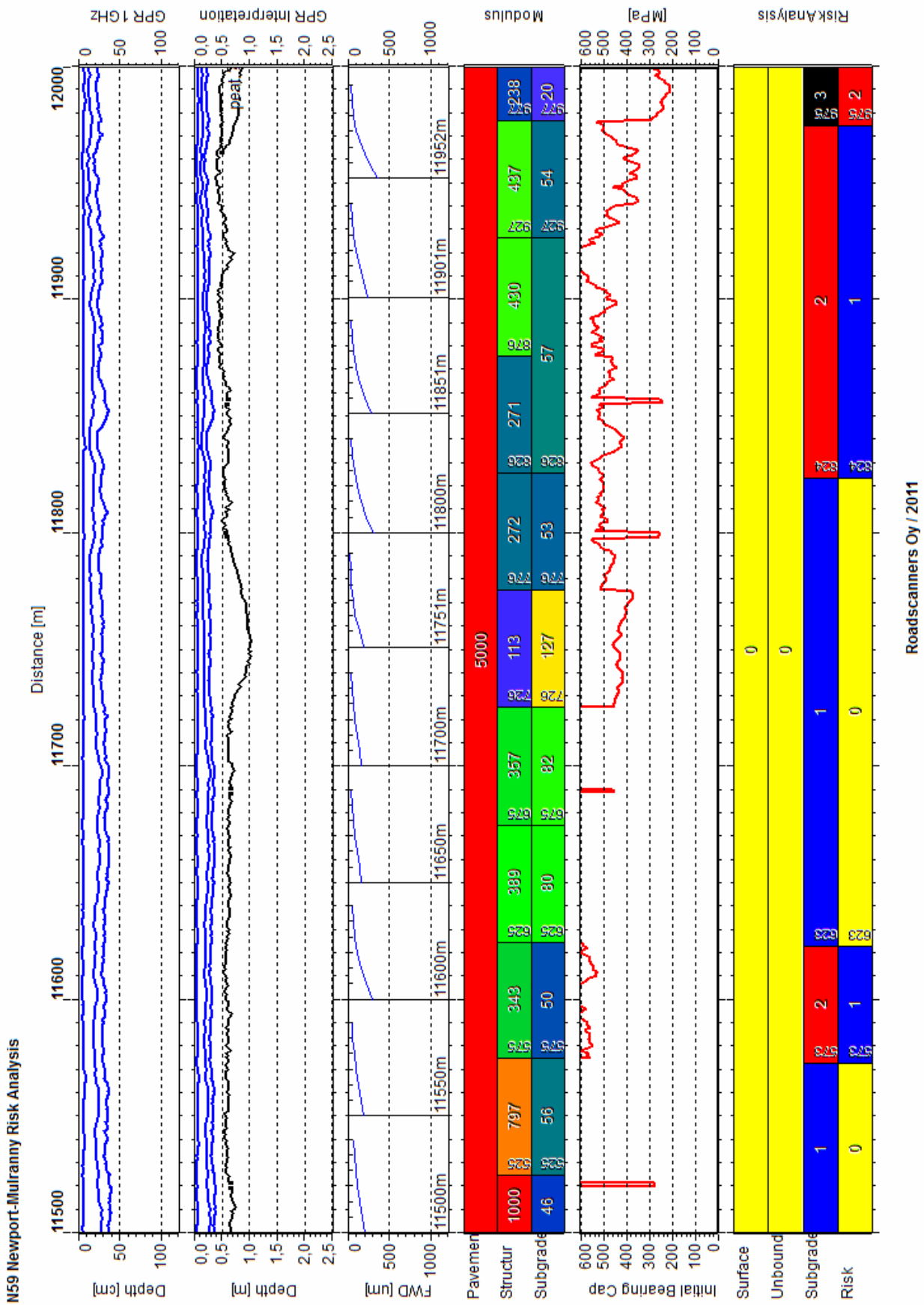
N59 Newport-Mulranny Risk Analysis
Distance [m]
11500
11600
11700
11800
11900
12000
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
peat
FWD [um]
11500m
11550m
11600m
11650m
11700m
11751m
11800m
11851m
11901m
11952m
Pavement
Structur
Subgrade
Modulus
5000
1000
797
348
389
357
113
272
271
430
497
238
46
56
50
80
82
127
53
57
54
20
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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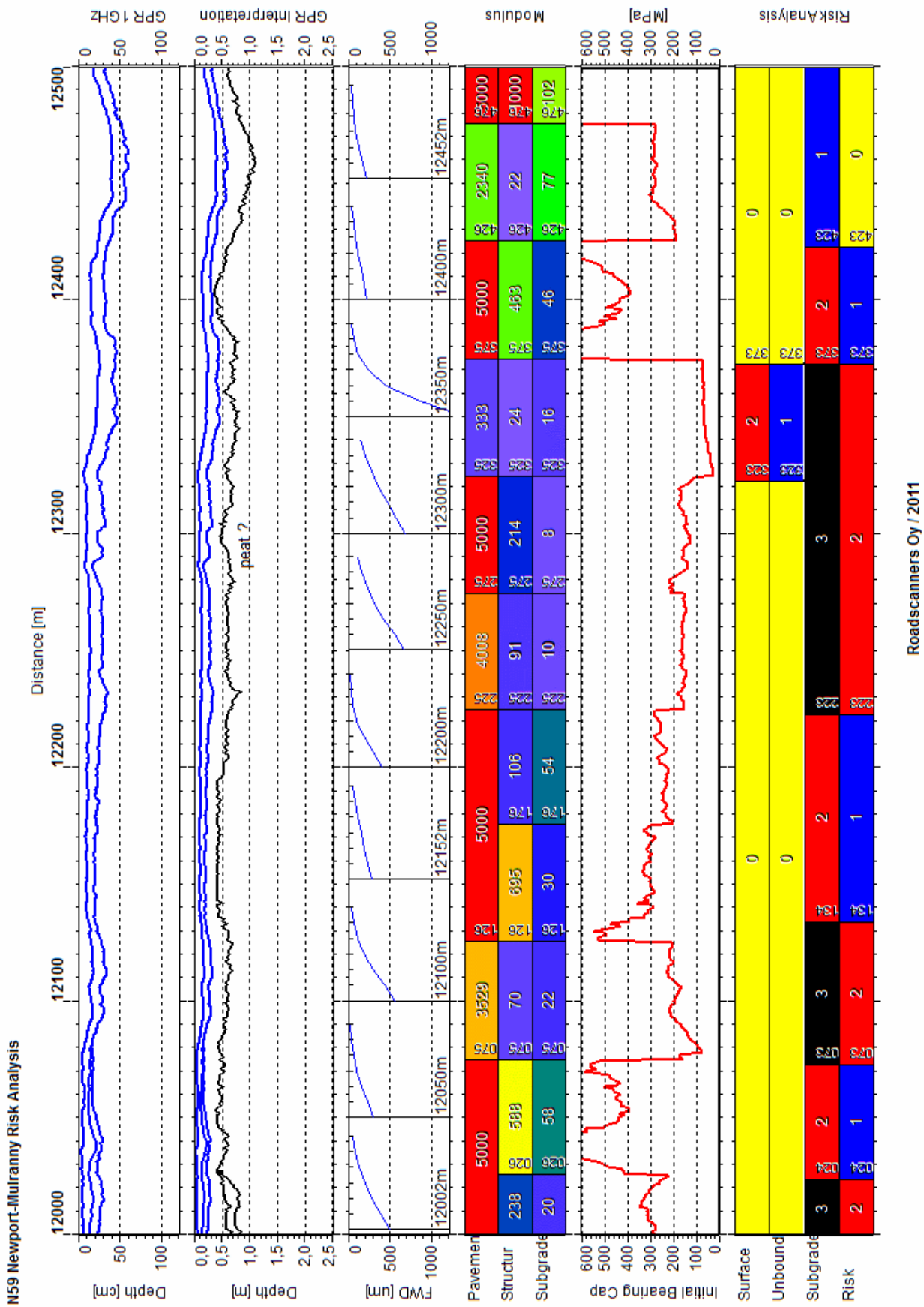
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Distance [m]
12000
12100
12200
12300
12400
12500
Depth [cm]
GPR 1 GHz
Depth [m]
GPR Interpretation
peat ?
FWD [um]
Modulus
Pavement
Structur
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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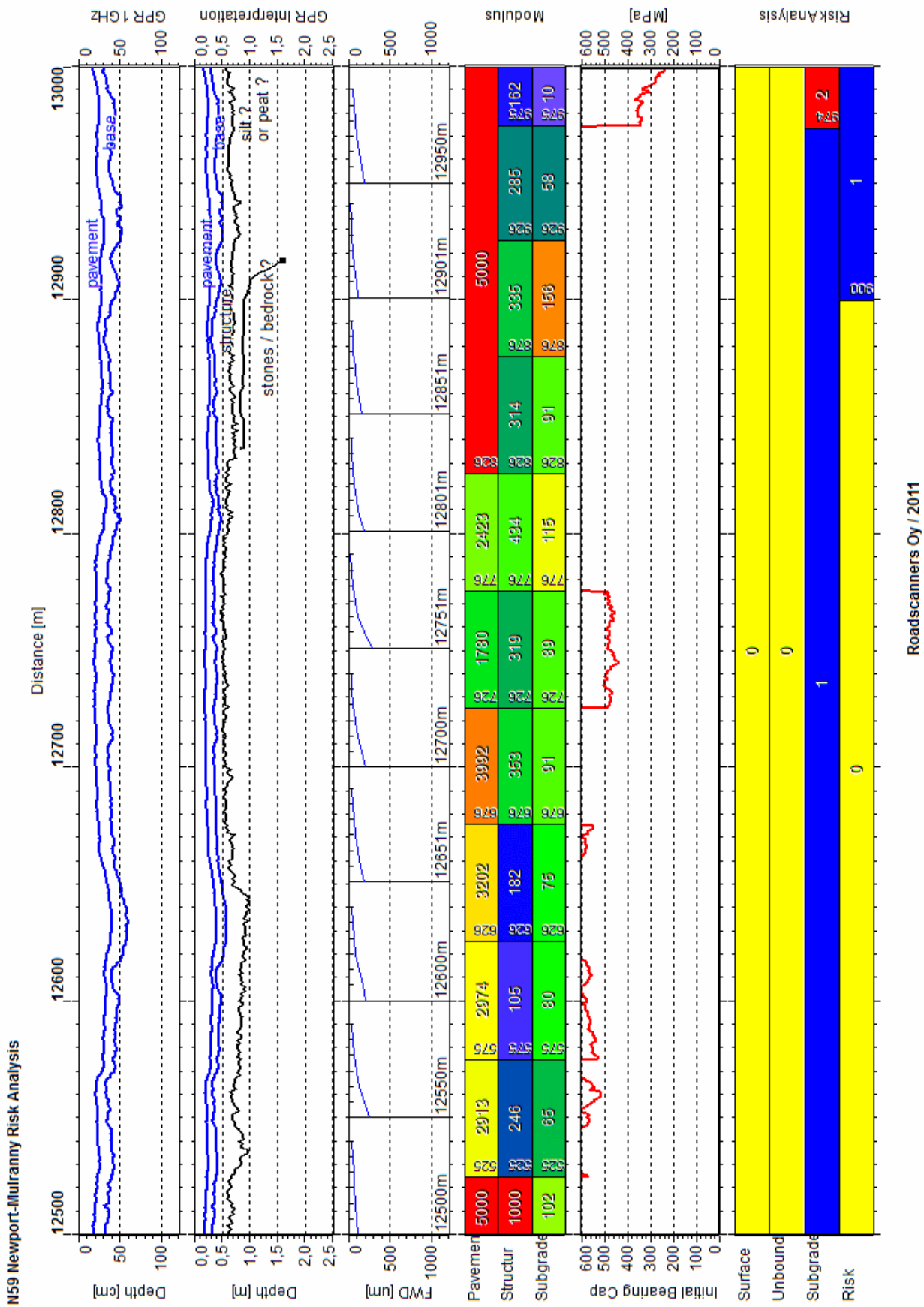
N59 Newport-Mulranny Risk Analysis
Distance [m]
12500
12600
12700
12800
12900
13000
Depth [cm]
GPR 1 GHz
pavement
base
Depth [m]
GPR Interpretation
pavement
base
structure
silt ?
or peat ?
stones / bedrock ?
FWD [um]
12500m
12550m
12600m
12651m
12700m
12751m
12801m
12851m
12901m
12950m
Modulus
Pavement
Structur
Subgrade
Initial Bearing Cap
[MPa]
Risk Analysis
Surface
Unbound
Subgrade
Risk
Roadscanners Oy / 2011

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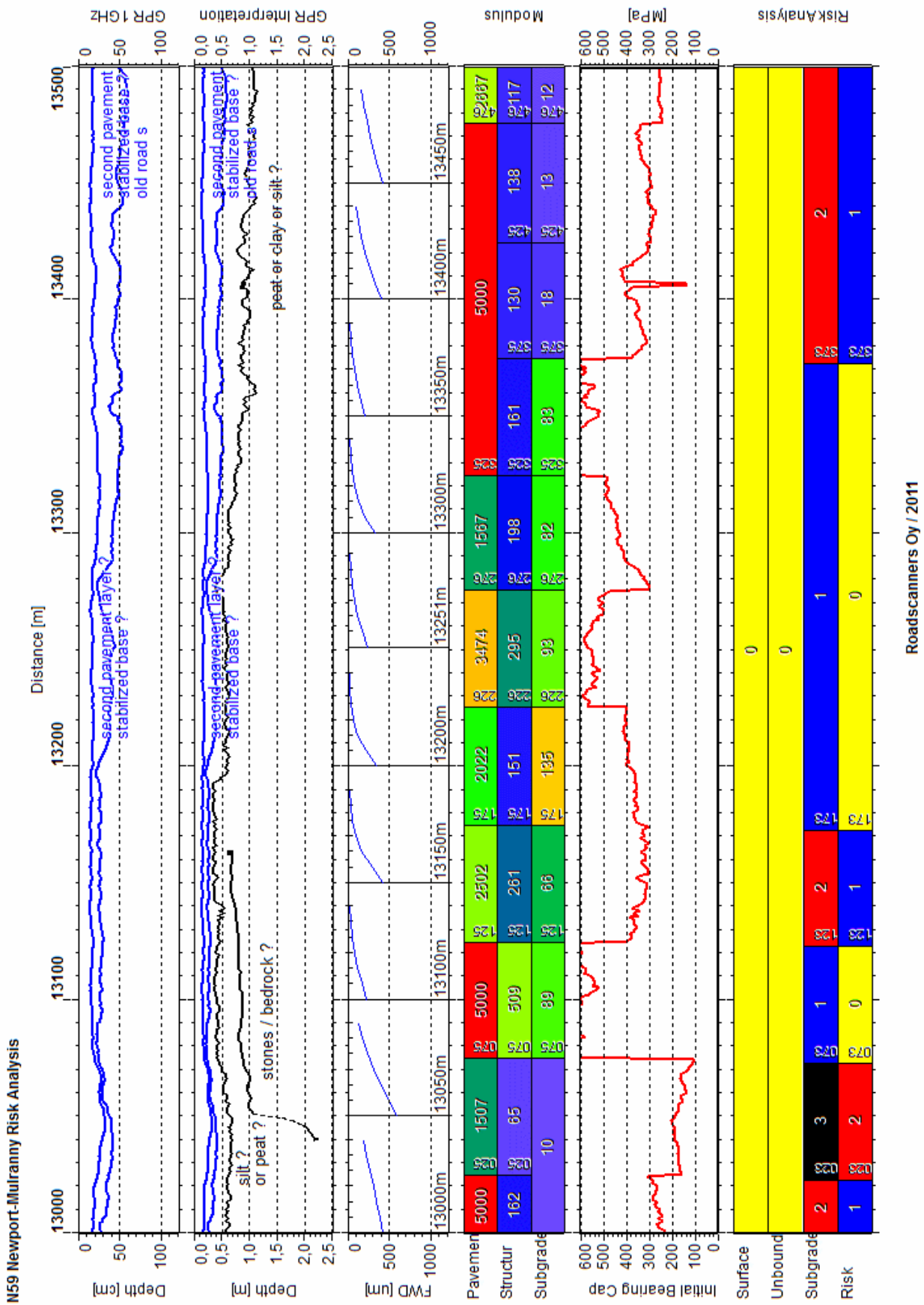
N59 Newport-Mulranny Risk Analysis
Distance [m]
13000
13100
13200
13300
13400
13500
Depth [cm]
GPR 1GHz
second pavement layer ?
stabilized base ?
old road s
Depth [m]
GPR Interpretation
second pavement layer ?
stabilized base ?
old road s
peat or clay or silt ?
silt ?
or peat ?
stones / bedrock ?
FWD [um]
13000m
13050m
13100m
13150m
13200m
13251m
13300m
13350m
13400m
13450m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

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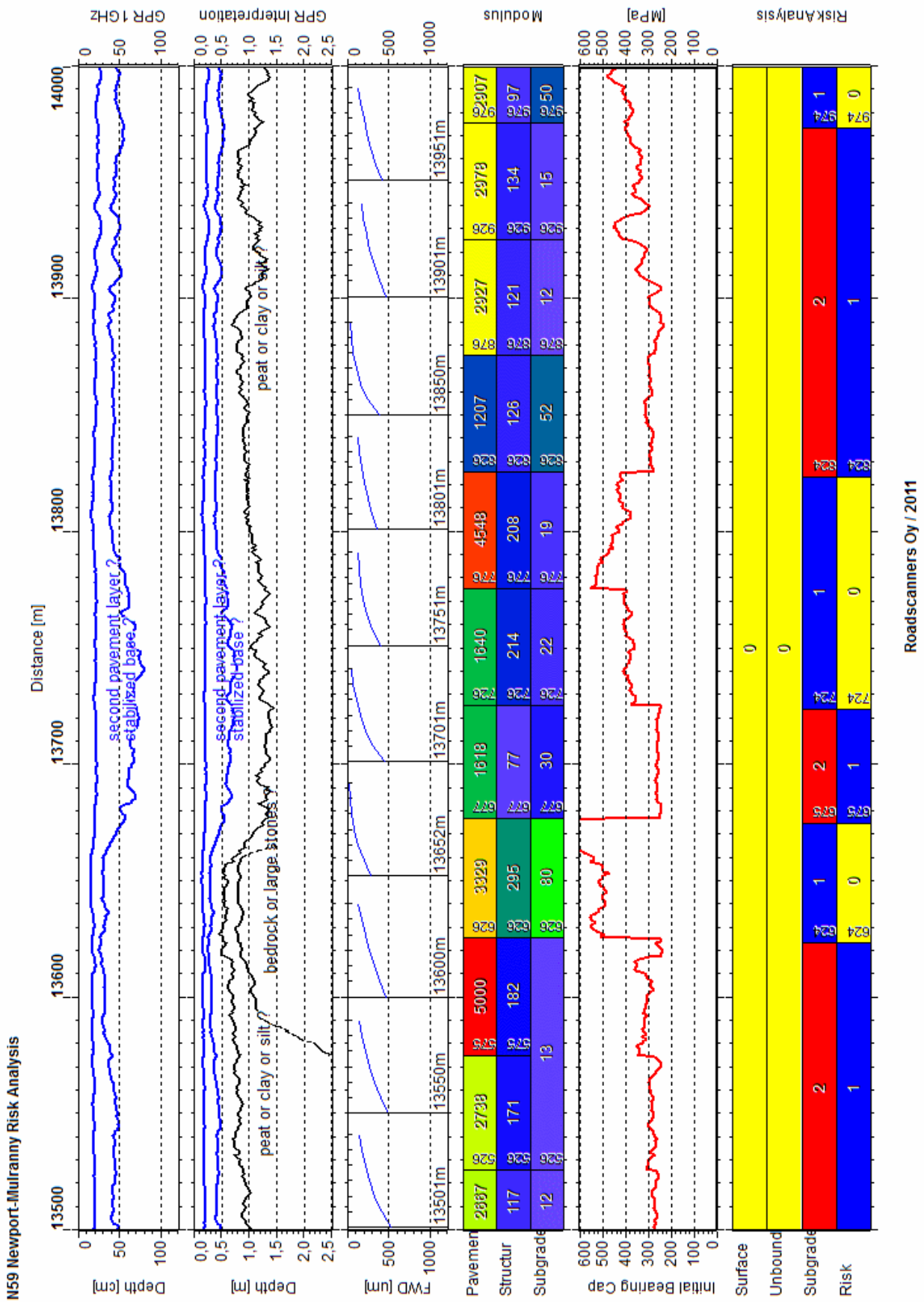
N59 Newport-Mulranny Risk Analysis
Distance [m]
13500
13600
13700
13800
13900
14000
Depth [cm]
GPR 1 GHz
second pavement layer ?
stabilized base ?
Depth [m]
GPR Interpretation
second pavement layer ?
stabilized base ?
peat or clay or silt ?
bedrock or large stones
peat or clay or silt ?
FWD [um]
13501m
13550m
13600m
13652m
13701m
13751m
13801m
13850m
13901m
13951m
Pavement
Structur
Subgrade
Modulus
[MPa]
Initial Bearing Cap
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

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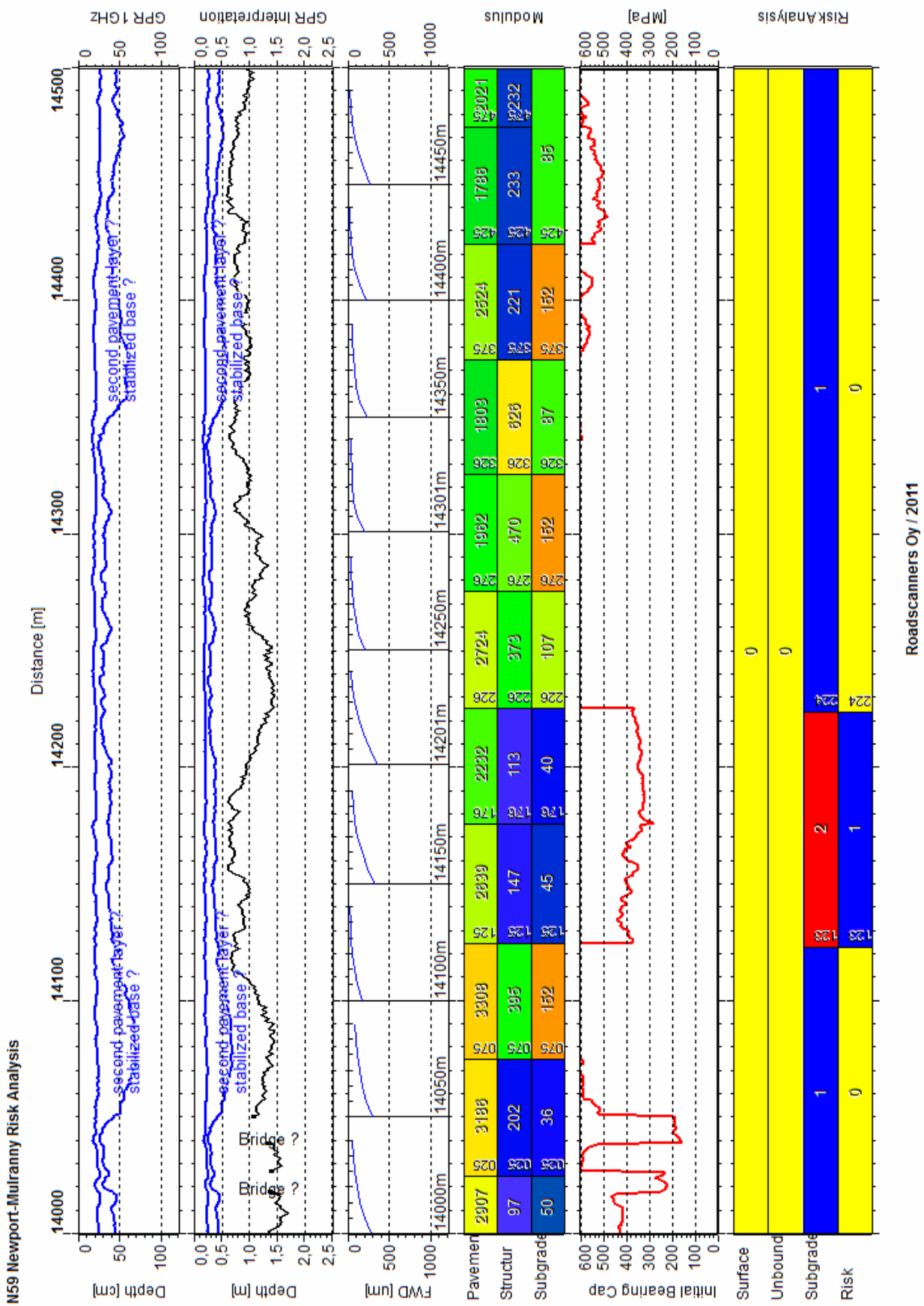
N59 Newport-Mulranny Risk Analysis
Distance [m]
14000
14100
14200
14300
14400
14500
Depth [cm]
GPR 1 GHz
second pavement layer ?
stabilized base ?
Depth [m]
GPR Interpretation
Bridge ?
FWD [um]
14000m
14050m
14100m
14150m
14201m
14250m
14301m
14350m
14400m
14450m
Pavement
Structur
Subgrade
Modulus
Initial Bearing Cap
[MPa]
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

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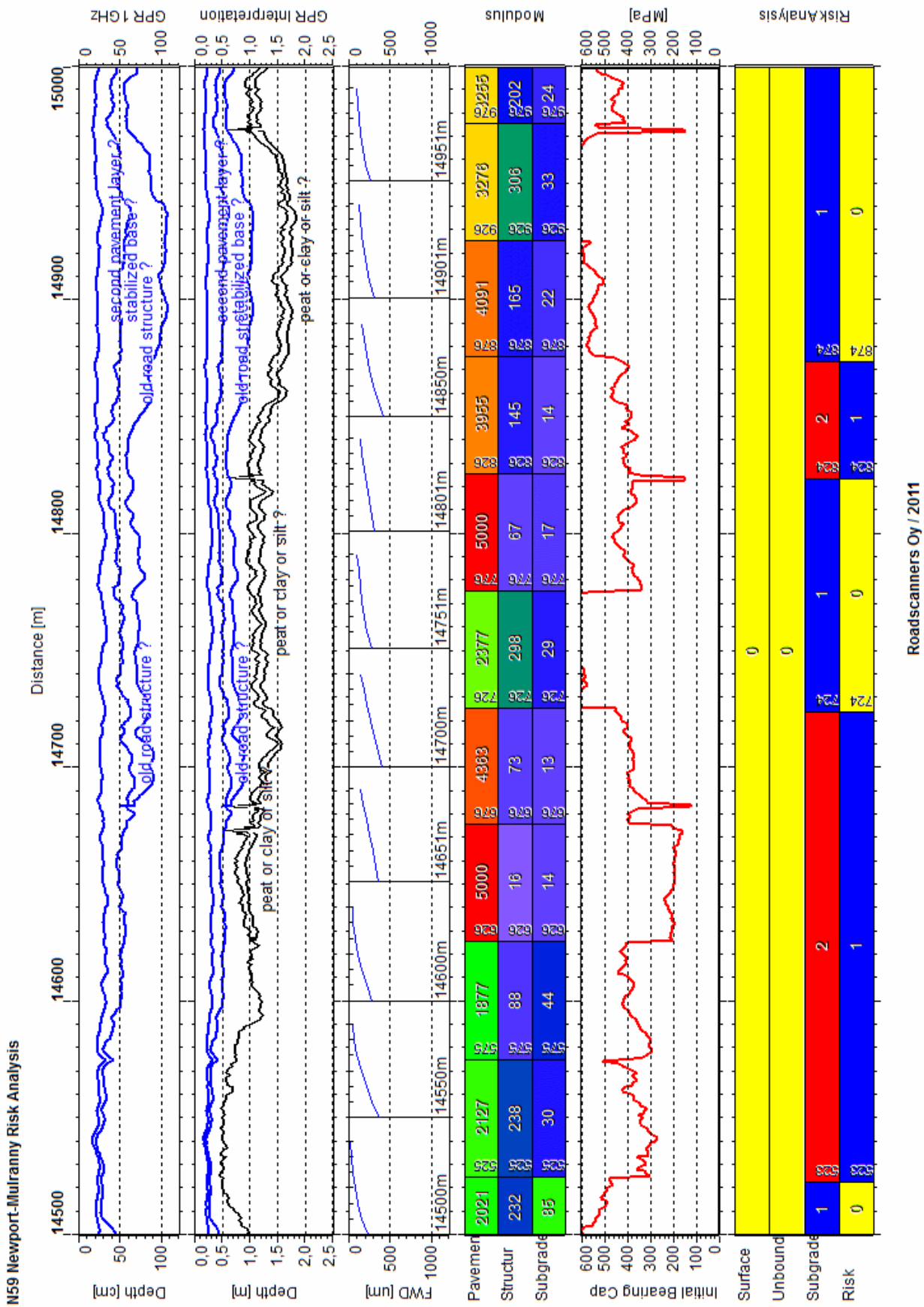
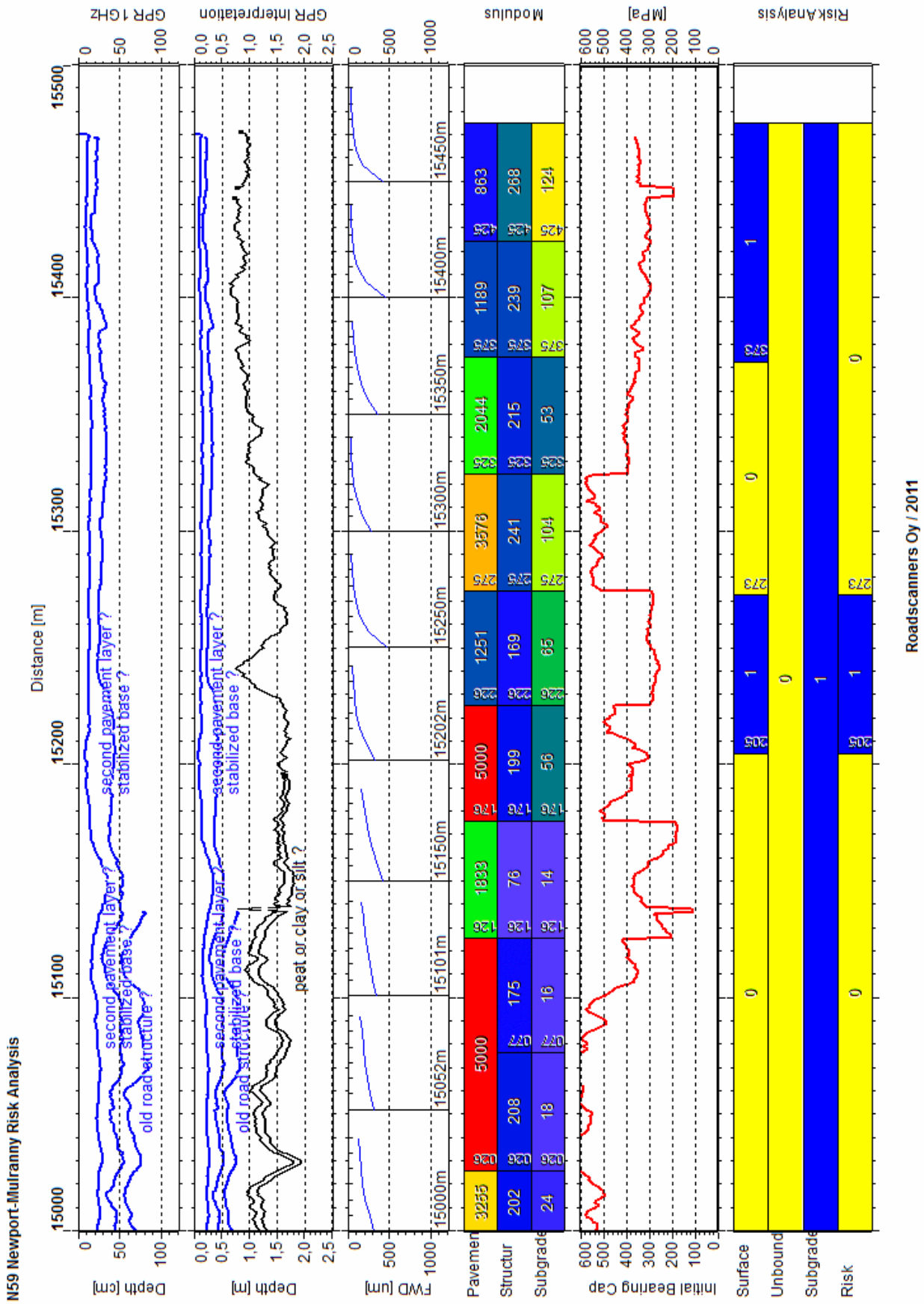

N59 Newport-Mulranny Risk Analysis
Distance [m]
14500
14600
14700
14800
14900
15000
Depth [cm]
GPR 1 GHz
second pavement layer ?
stabilized base ?
old road structure ?
Depth [m]
GPR Interpretation
peat or clay or silt ?
FWD [um]
14500m
14550m
14600m
14651m
14700m
14751m
14801m
14850m
14901m
14951m
Pavement
Structur
Subgrade
Modulus
[MPa]
Initial Bearing Cap
Surface
Unbound
Subgrade
Risk
Risk Analysis
Roadscanners Oy / 2011

APPENDIX 3


N59 Newport-Mulranny Risk Analysis
Distance [m]
Depth [cm]
GPR 1 GHz
second pavement layer ?
stabilized base ?
old road structure ?
Depth [m]
GPR Interpretation
peat or clay or silt ?
FWD [um]
Modulus
Pavement
Structure
Subgrade
[MPa]
Initial Bearing Cap
Risk Analysis
Surface
Unbound
Risk
Roadscanners Oy / 2011

ROADEX
Implementing Accessibility

ROADEX PILOT PROJECT REPORTS (1998–2001)

Road Condition Management in the Northern Periphery
Road Condition Management of Low Traffic Volume Roads in the Northern Periphery
Winter Maintenance Practice in the Northern Periphery,
ROADEX Sub Project B Phase I Extended Summary and Conclusions
Winter Maintenance Practice in the Northern Periphery,
ROADEX Sub Project B Phase I State-of-the-Art Study Report
Generation of 'Snow Smoke' behind Heavy Vehicles

ROADEX II REPORTS (2002–2005)

User Perspective to ROADEX II Test Areas' Road Network Service Level
Permanent deformation
Material Treatment
Managing spring thaw weakening on low volume roads
Socio-economic impacts of road conditions on low volume roads
Dealing with bearing capacity problems on low volume roads constructed on peat
Drainage on low traffic volume roads
Environmental guidelines
Environmental guidelines, pocket book
Road management policies for low volume roads – some proposals
Structural Innovations
Monitoring, communication and information systems & tools for focusing actions

ROADEX III EXECUTIVE SUMMARIES (2006–2007)

Managing Rutting in Low Volume Roads
Treatment of Moisture Susceptible Materials
Design and Repair of Roads Suffering Spring Thaw Weakening
Managing Peat Related Problems on Low Volume Roads
Managing Drainage on Low Volume Roads
Socio-economic Impacts of Road Conditions on Low Volume Roads
Environmental Guidelines & Checklist
Monitoring Low Volume Roads

ROADEX III REPORTS (2006–2007)

Drainage guidelines
Deformation mitigation measures
Health considerations
Road condition management policies
ROADEX III Case Study in Greenland