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RISK ASSESSMENT OF ROAD N56, DRUMNARAW TO CASHELMORE, COUNTY DONEGAL, IRELAND

Demonstration project report

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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 Finland, 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 N56 section. A similar report will be issued for the N59 section.

1.4. RISK ASSESSMENT OF ROAD N56

The risk assessment surveys on the N56 Drumnaraw to Cashelmore 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 200 FWD points were tested, one every 50 metres in the northbound lane.



Figure 2.1 Measurement van with survey equipment

Surveys commenced in Drumnaraw at the N56 junction with the road L1212 to Glen. The survey section length was 10250 m and it ended in Cashelmore.

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 N56 are relatively thick. The overall thickness of the whole road structure varies mainly between 0.5-1.0 m.

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

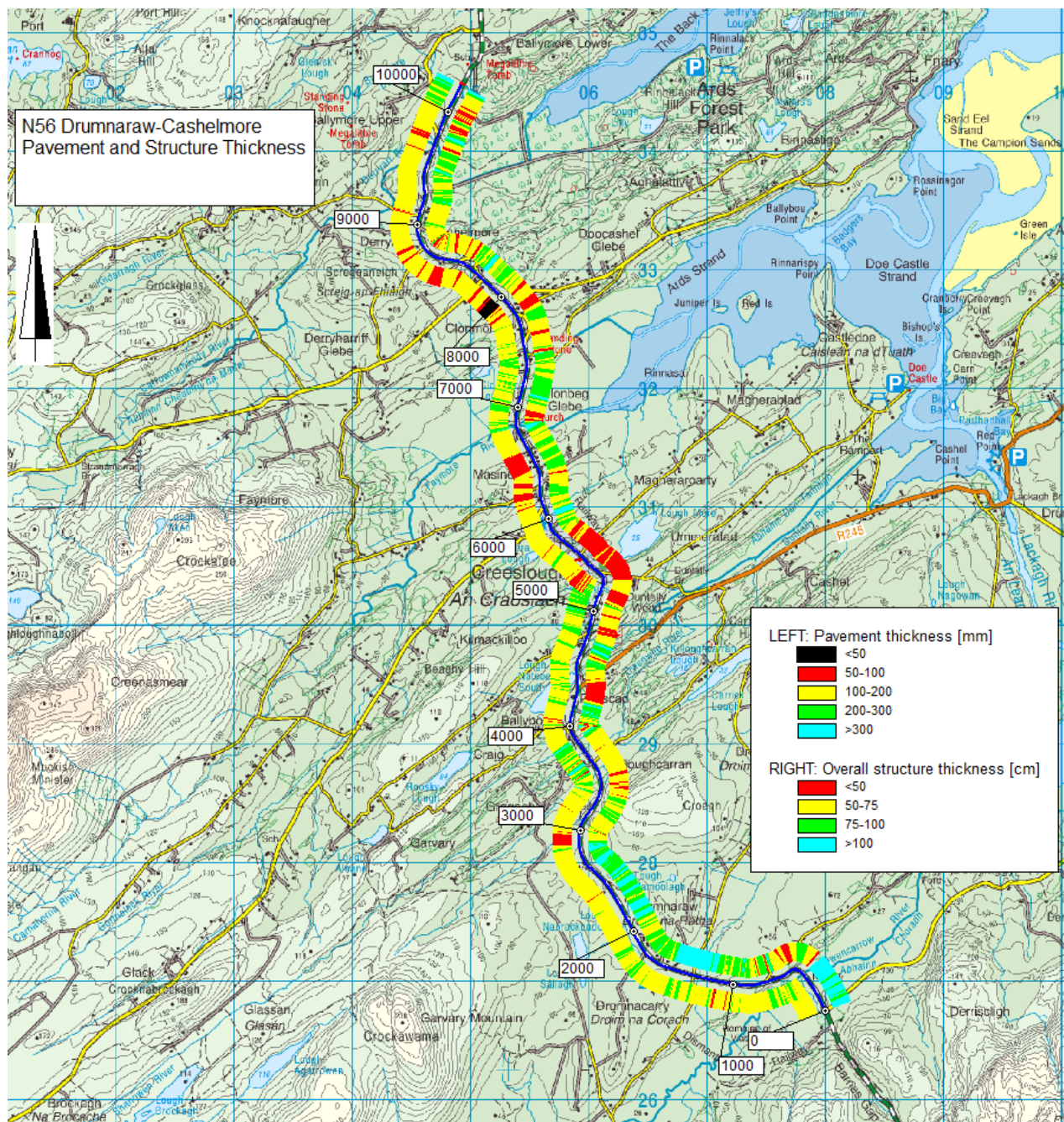


Figure 3.1 Pavement and structure depths on Road N56

4. RISK ANALYSIS

4.1. RISK ANALYSIS OF N56

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 ROADDEX 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.

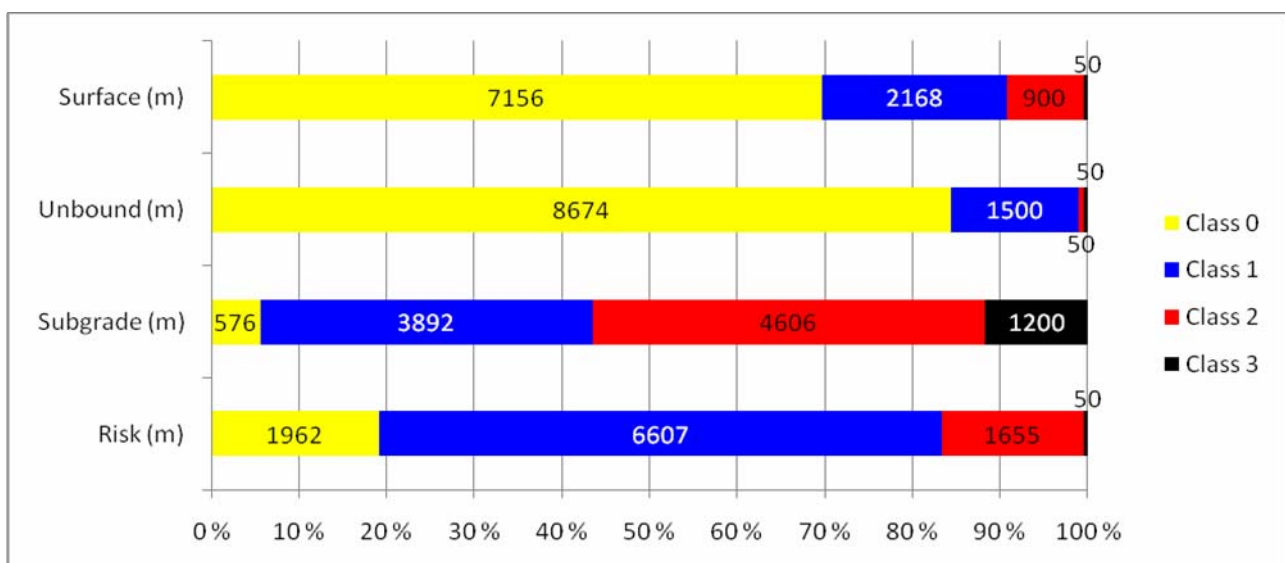


Figure 4.1 Statistical summary of the risk evaluation

A Class 2 and Class 3 failure risk was predicted only for 1705 m of the road section (approximately 16.5 % of the total length). Approximately 83.5 % of the road (8569 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.

The weakest sections along the road are sections from 2400 to 3400 m and from 5400 to 5900 m. Soft subgrade is the main reason for the weak spots. Generally the condition of the bound layers as well as the unbound structural layers is relatively good along the whole surveyed road section.

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 N56 the bearing capacity class was mainly Class 1 (over 80 % of the total length). The two weakest classes together, Class 3 and Class 4, covered only less than 8 % of the road length. The worst section is located between 5350 and 6300 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 (ROADDEX 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.

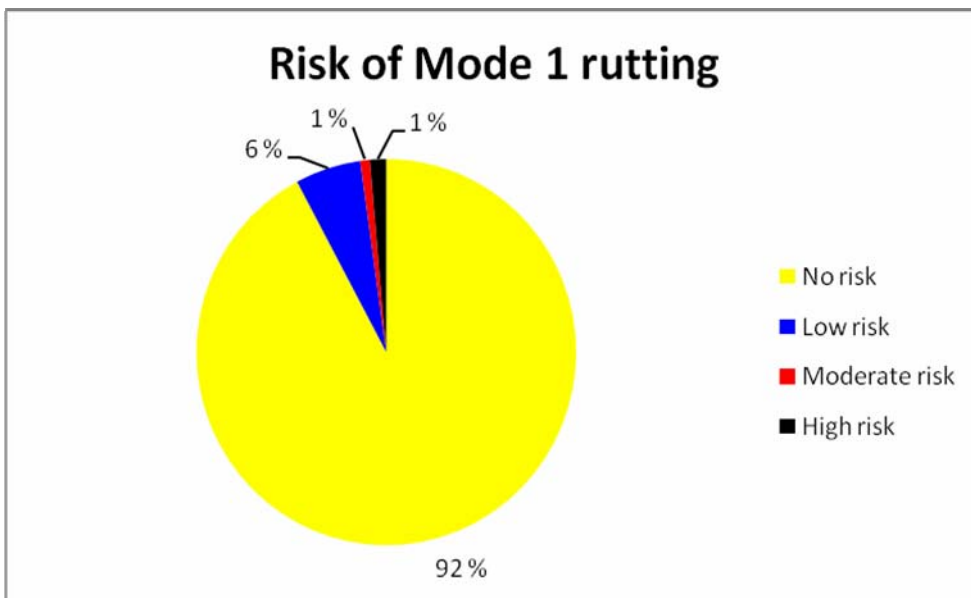


Figure 5.1 Statistical summary of the Mode 1 rutting risk evaluation

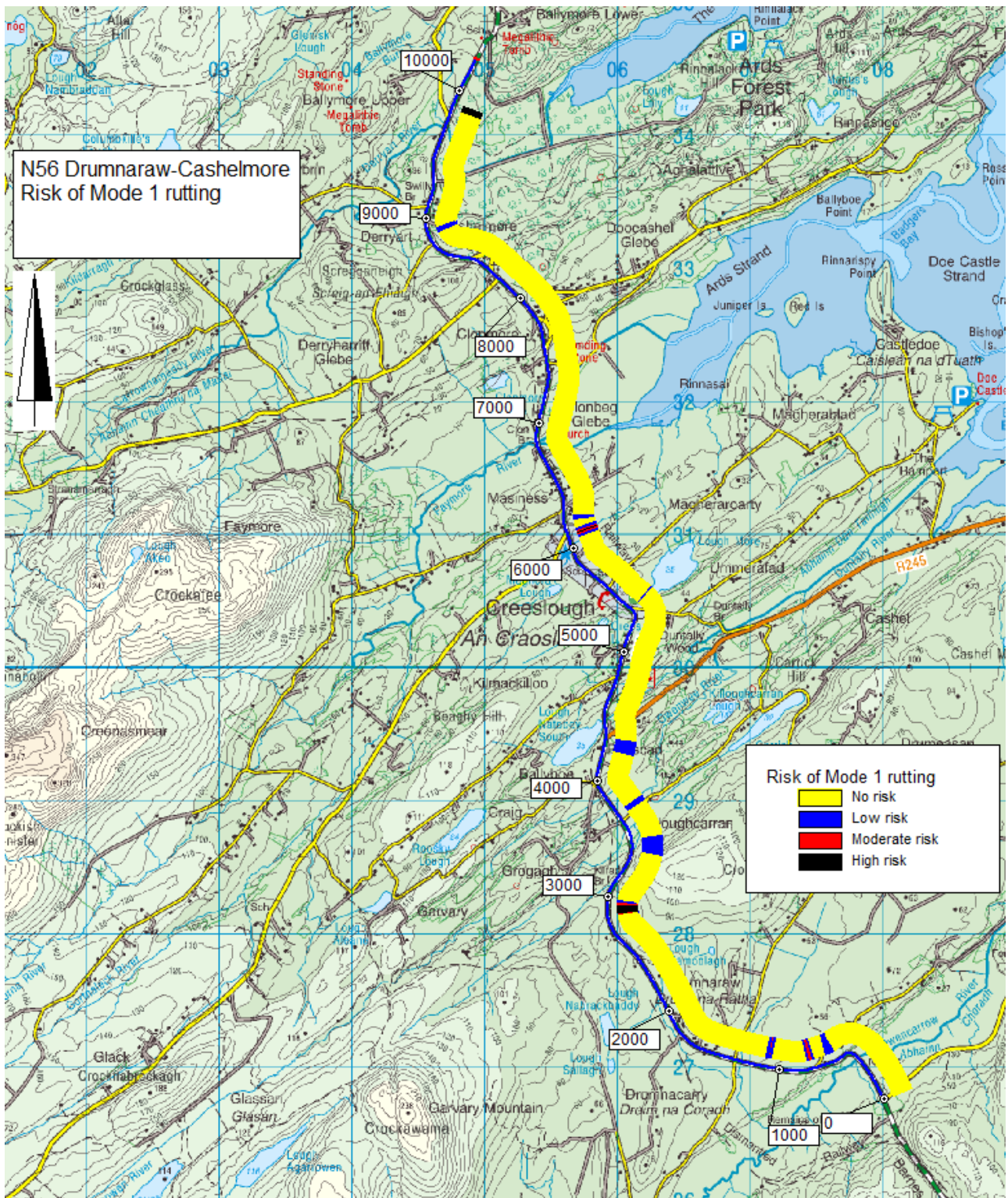


Figure 5.2 Mode 1 rutting risk shown as a map

5.2. RISK OF MODE 2 RUTTING

Mode 2 rutting is described as a problem of weak subgrade ([ROADDEX 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.

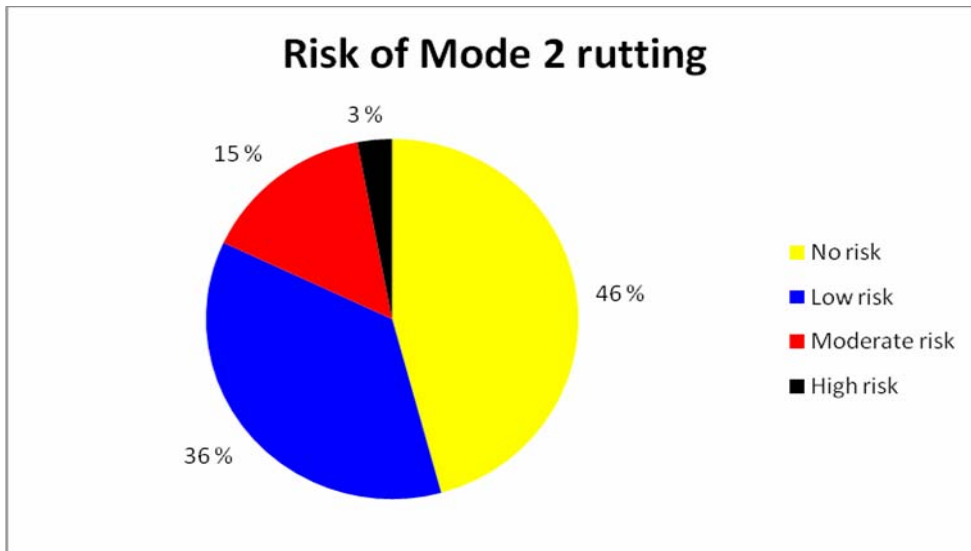


Figure 5.3 Statistical summary of the Mode 2 rutting risk evaluation

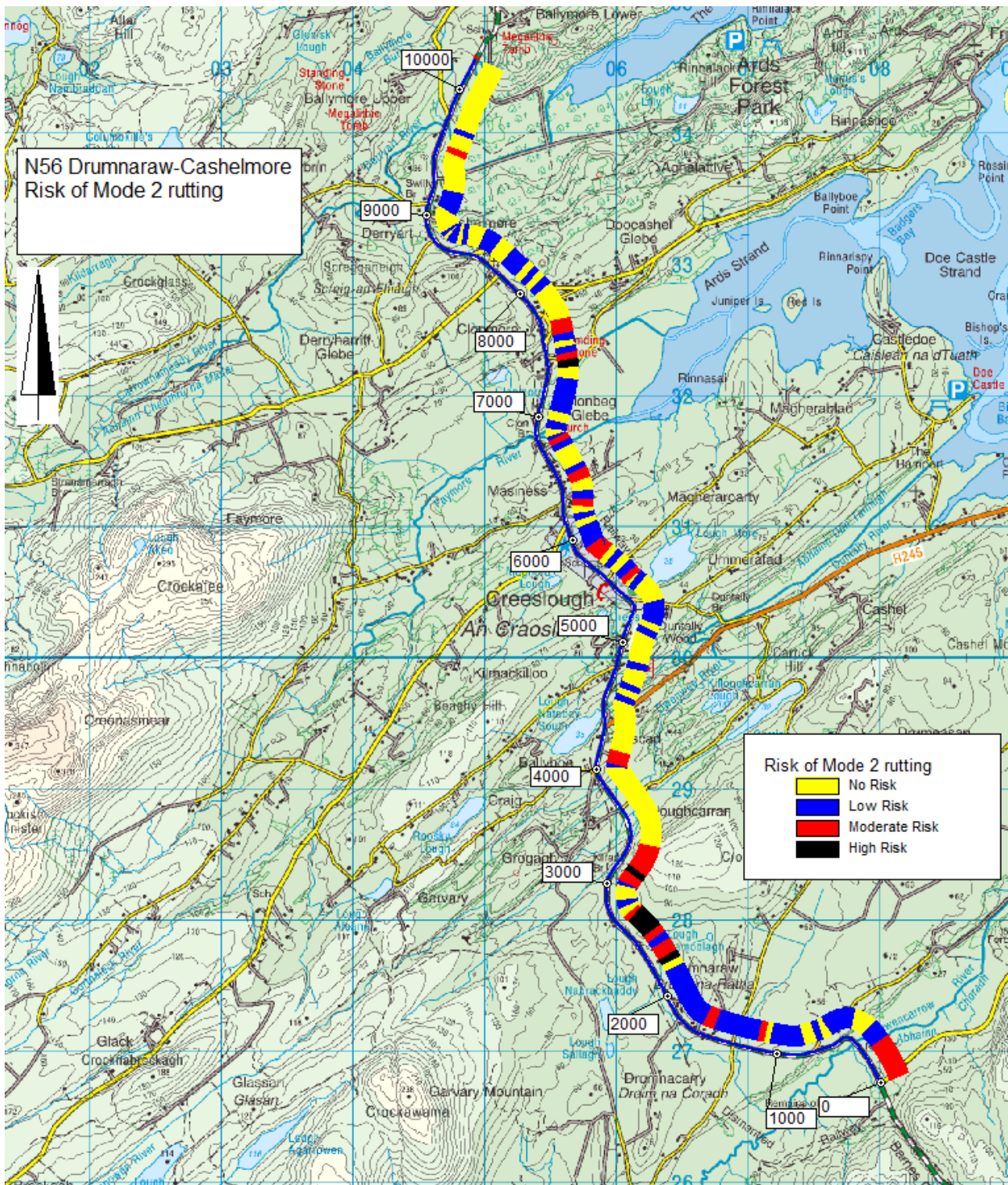


Figure 5.4 Mode 2 rutting risk shown as a map

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]	144	133	303	879	8468
Total [m]					9927
% of length	1.45	1.34	3.05	8.86	85.30
Total [%]					100.00

7. CONCLUSIONS

In general, the surveyed length of the N56 road is in relatively good condition. Approximately 83.5 % of the road surveyed 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 16.5 % of the road section has a total risk rating of Class 2 or Class 3. The main reason for the weak areas is the presence of a soft subgrade. In these locations the road is not spreading the traffic load well enough over the weak subgrade.

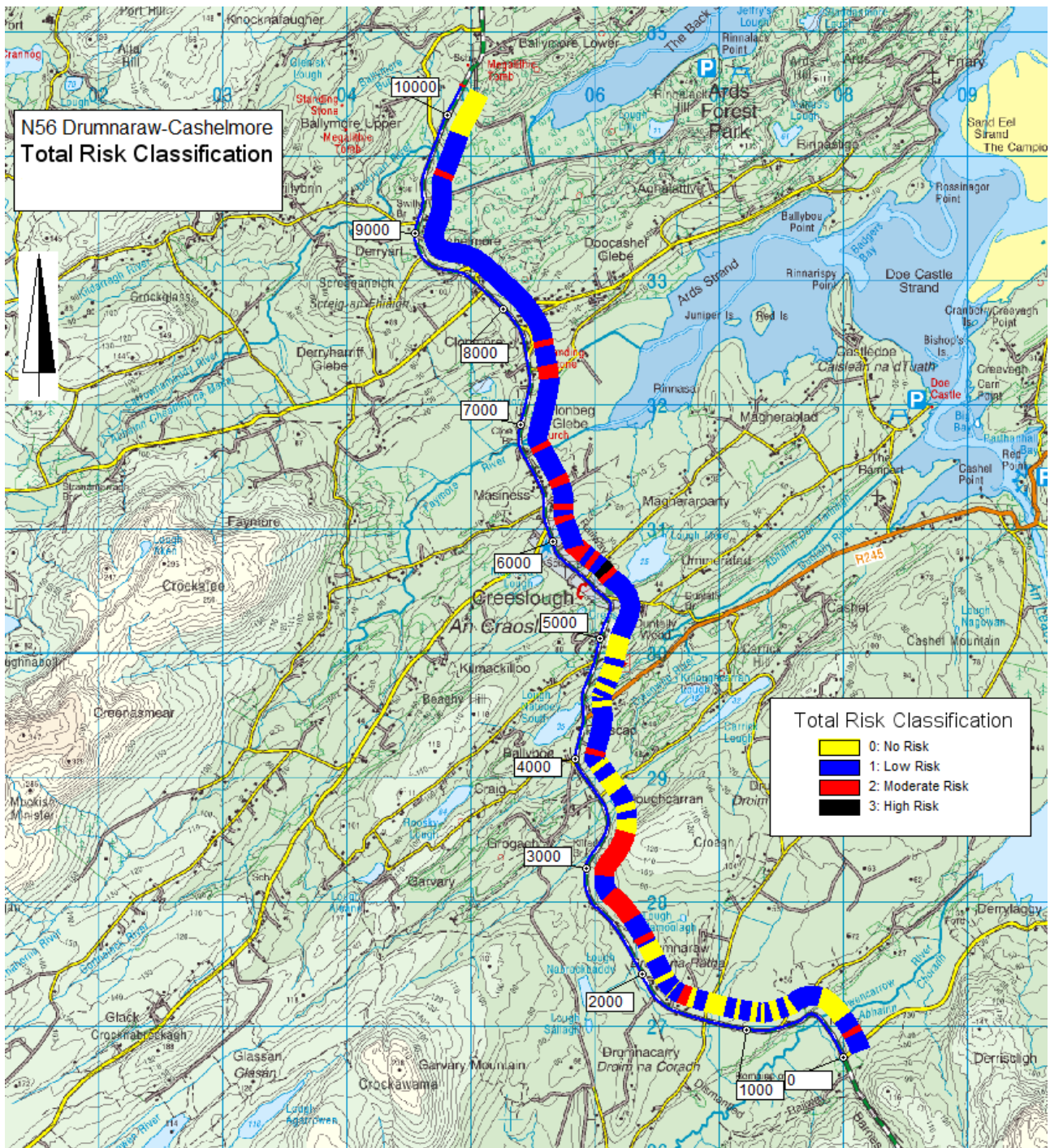
Some short sections with pavement distress are identified, but generally the condition of the bound layers and unbound layers is relatively good along the whole surveyed road section.

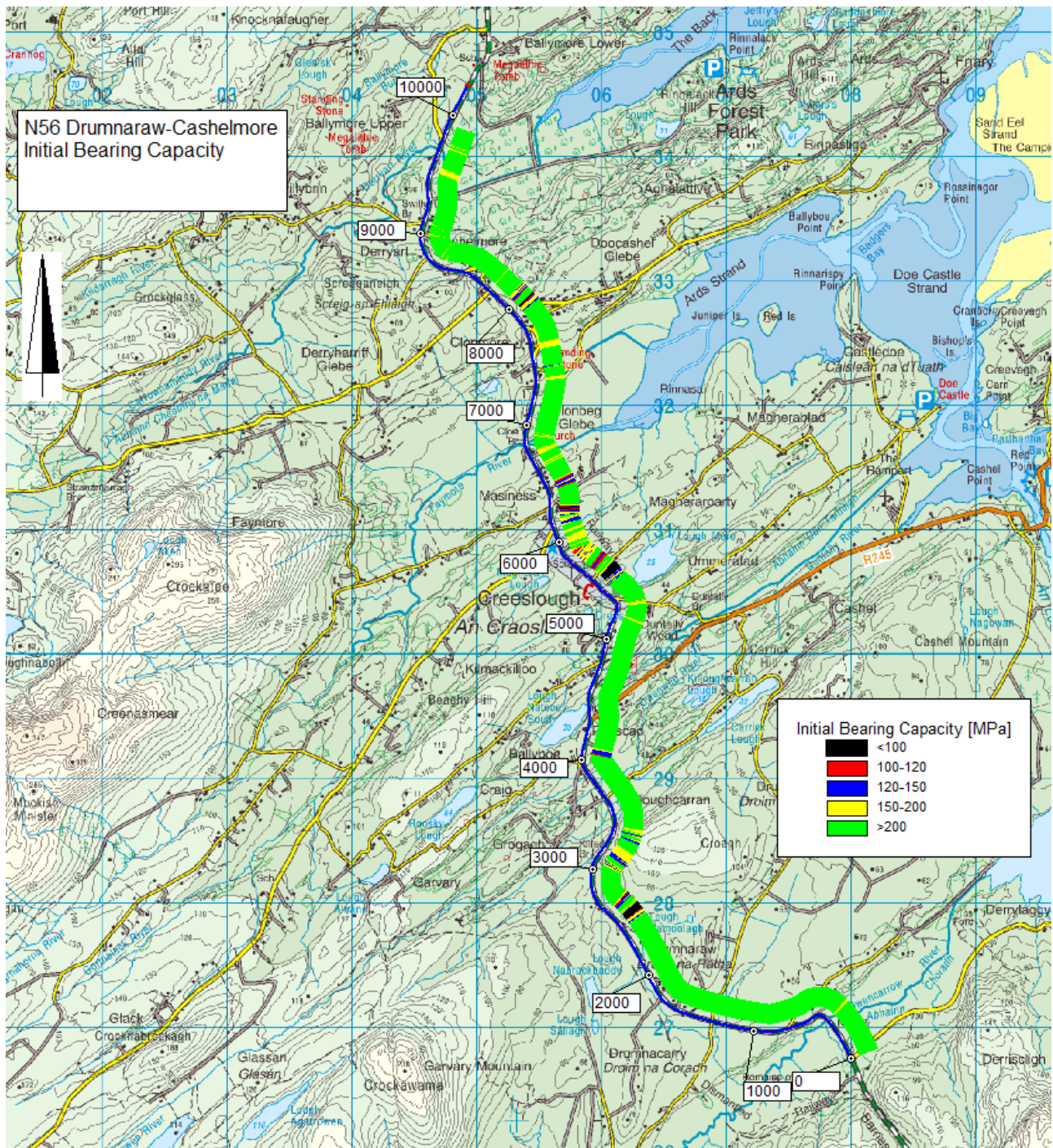
Overall the ROADDEX risk assessment technique is considered to have worked well for the demonstration exercise and appears suitable for future applications on the Irish public road network.

APPENDIXES

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

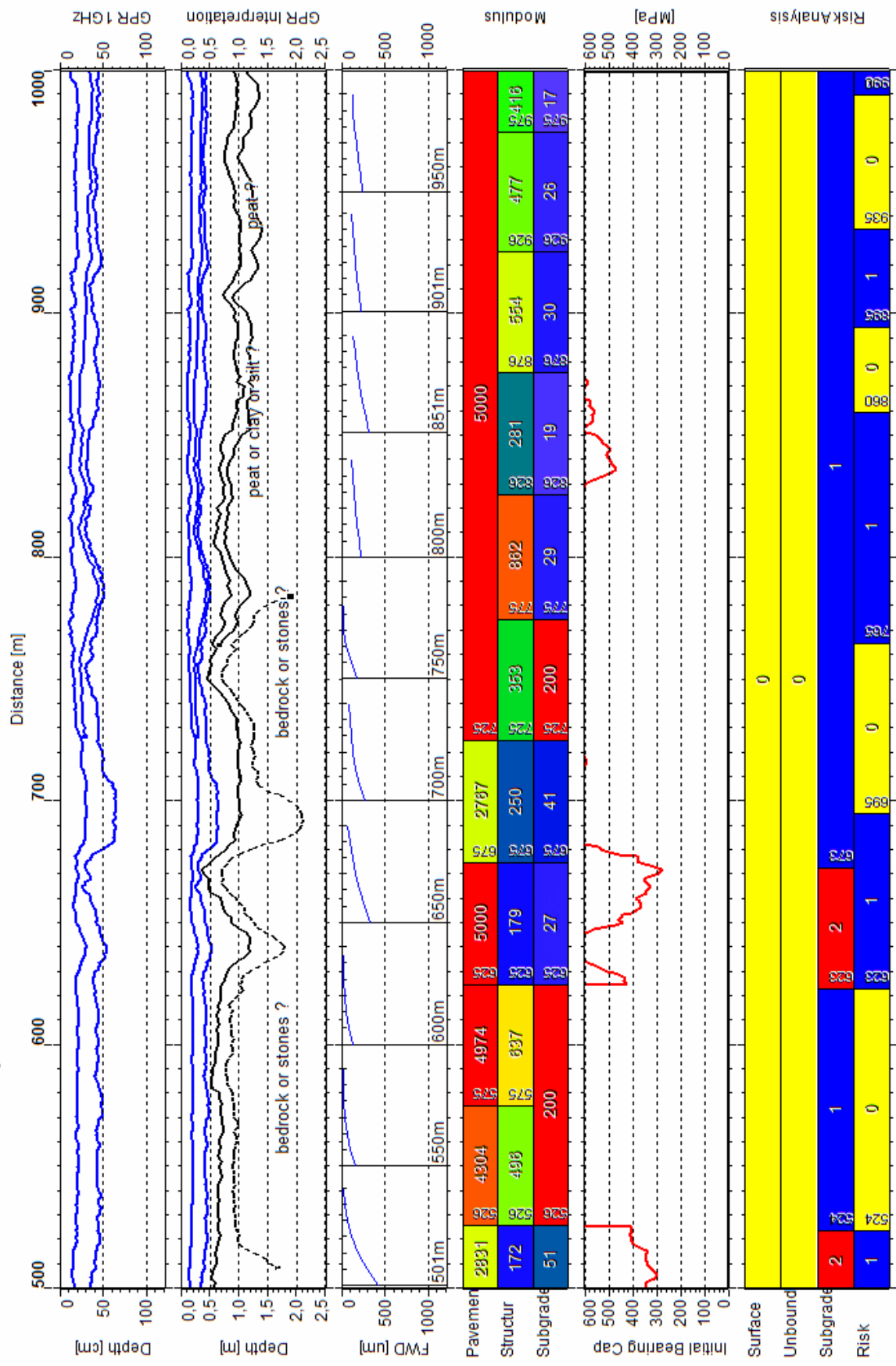
APPENDIX 1





APPENDIX 3

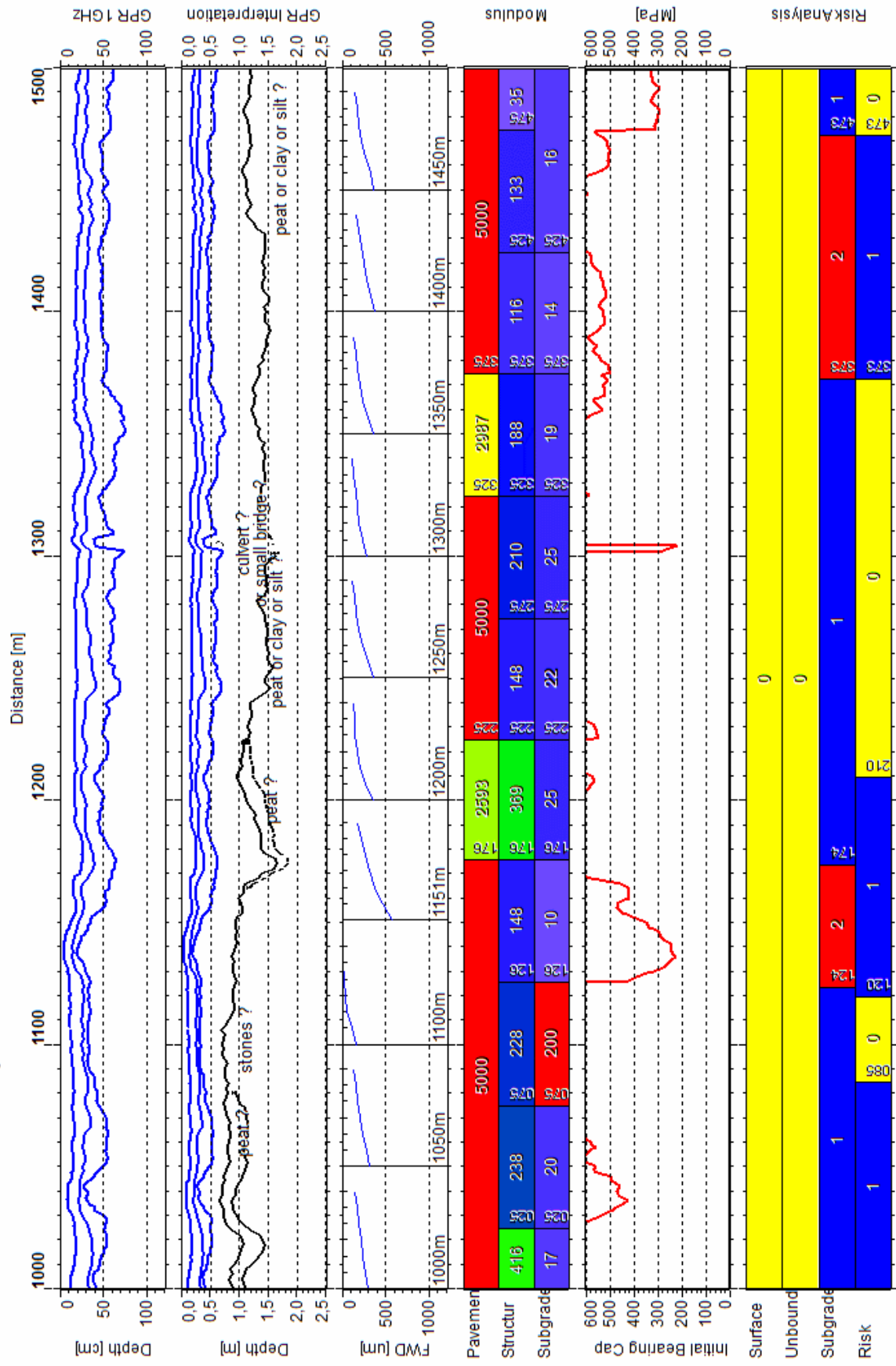
N56 Drumnaraw-Cashelmore Risk Analysis



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APPENDIX 3

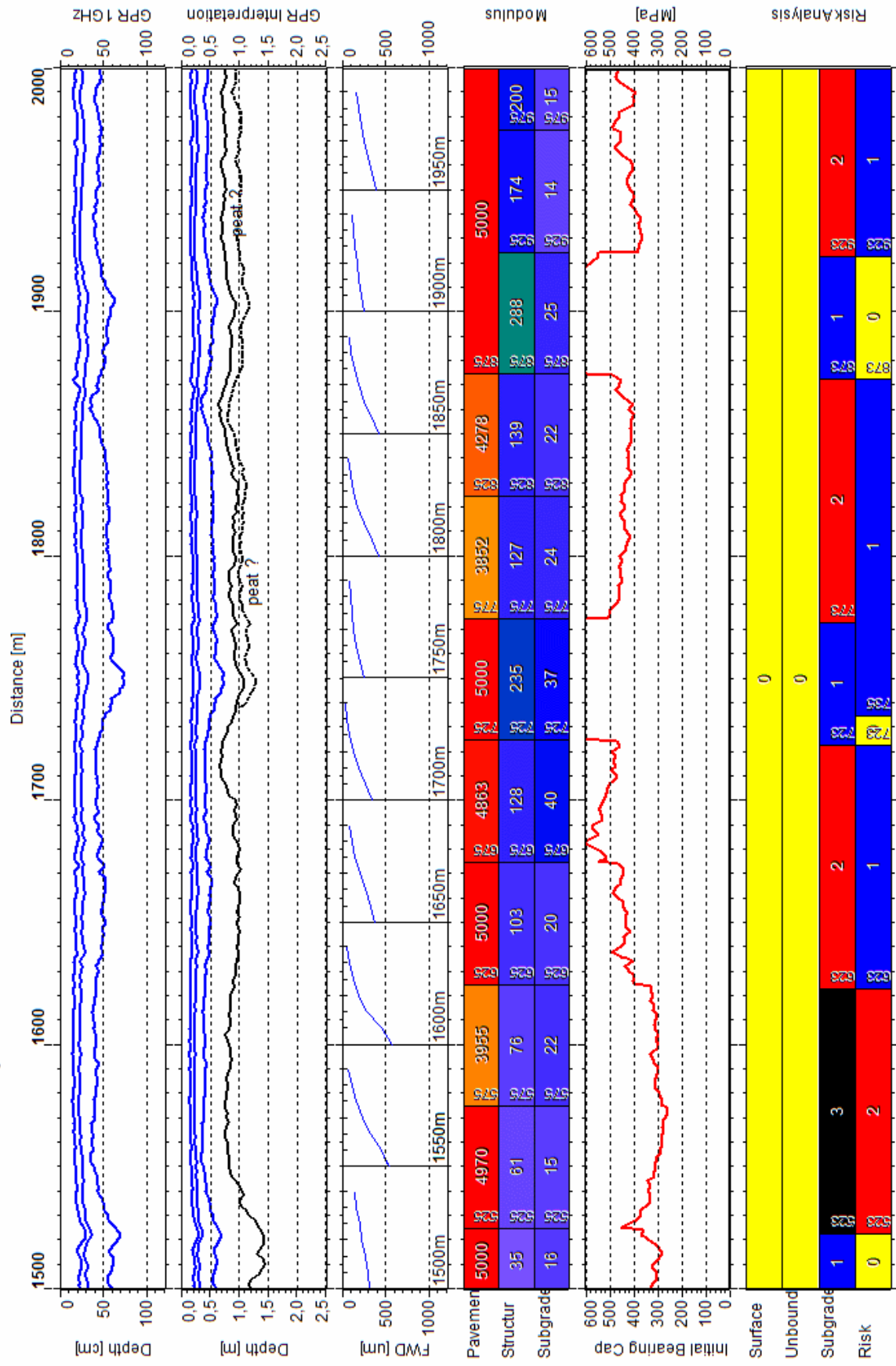
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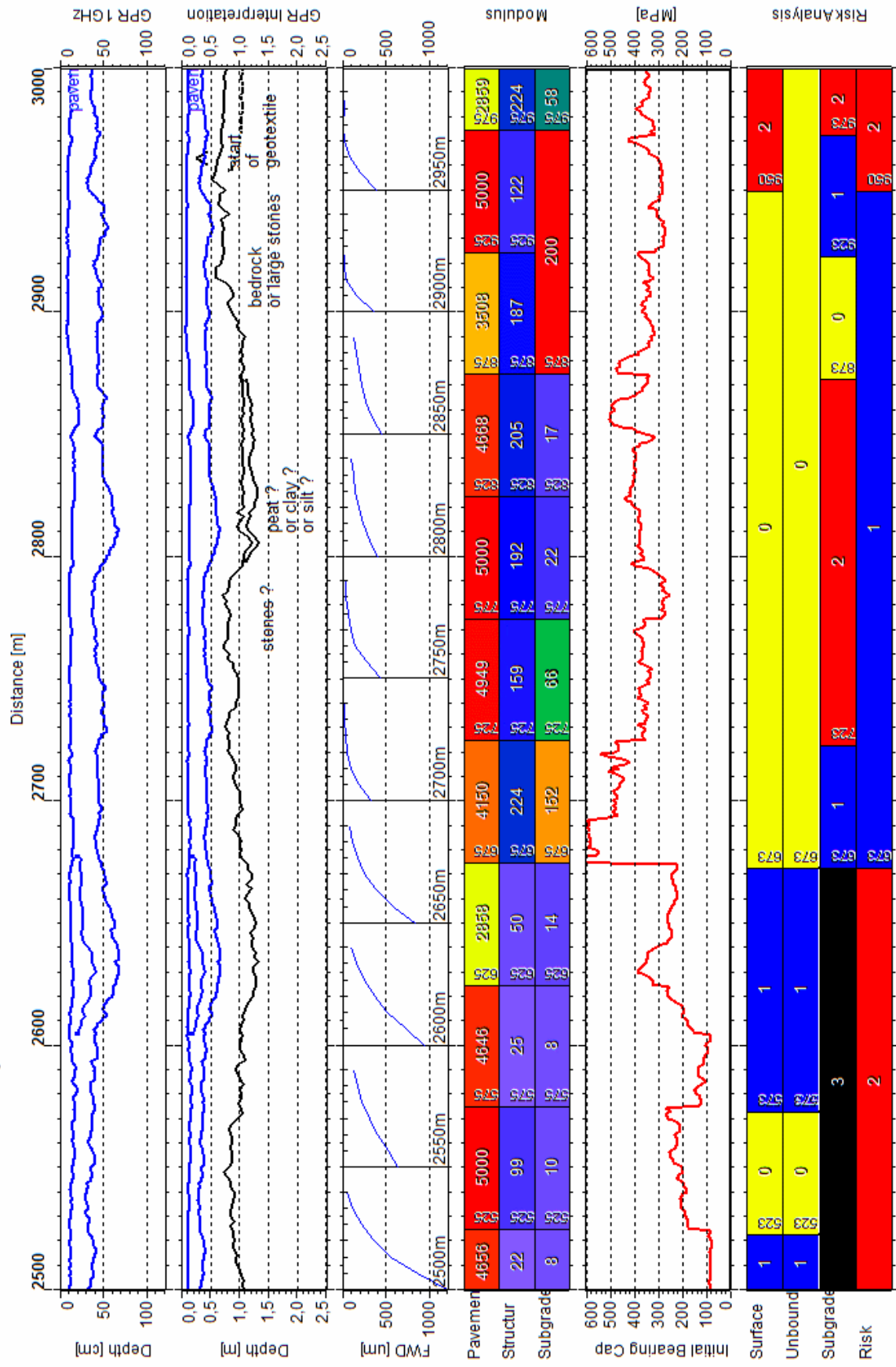
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N56 Drumnaraw-Cashelmore Risk Analysis



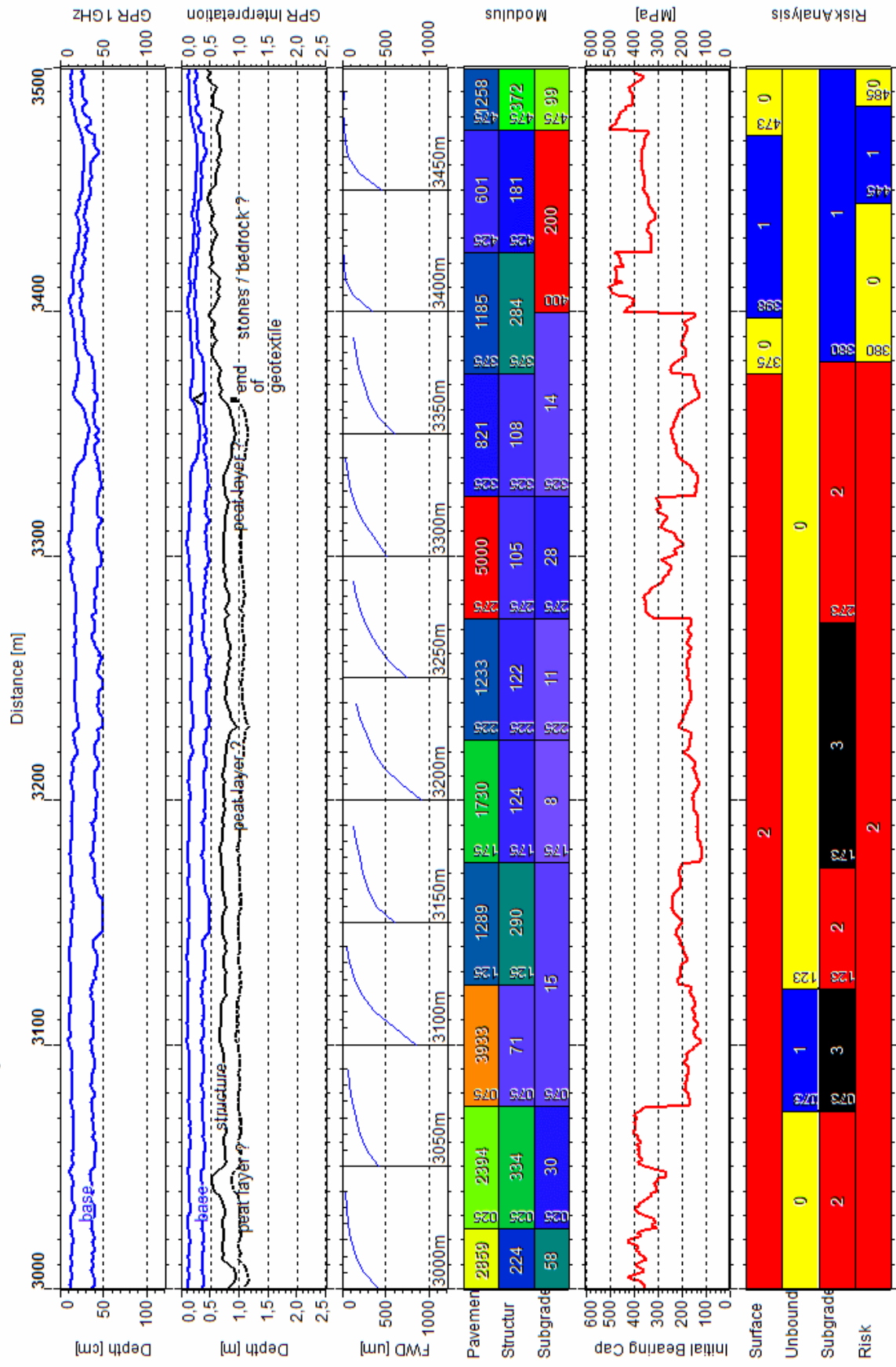
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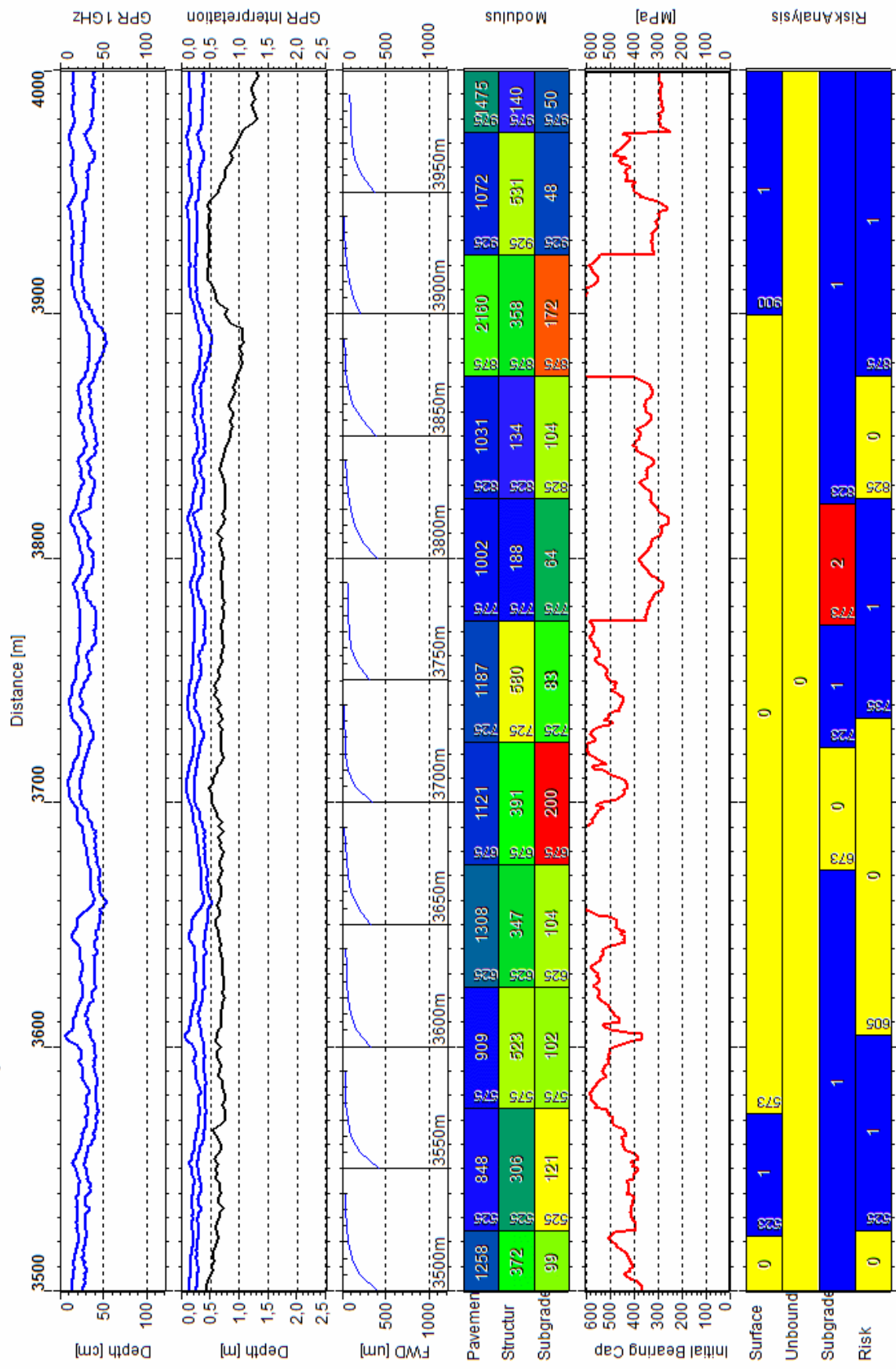
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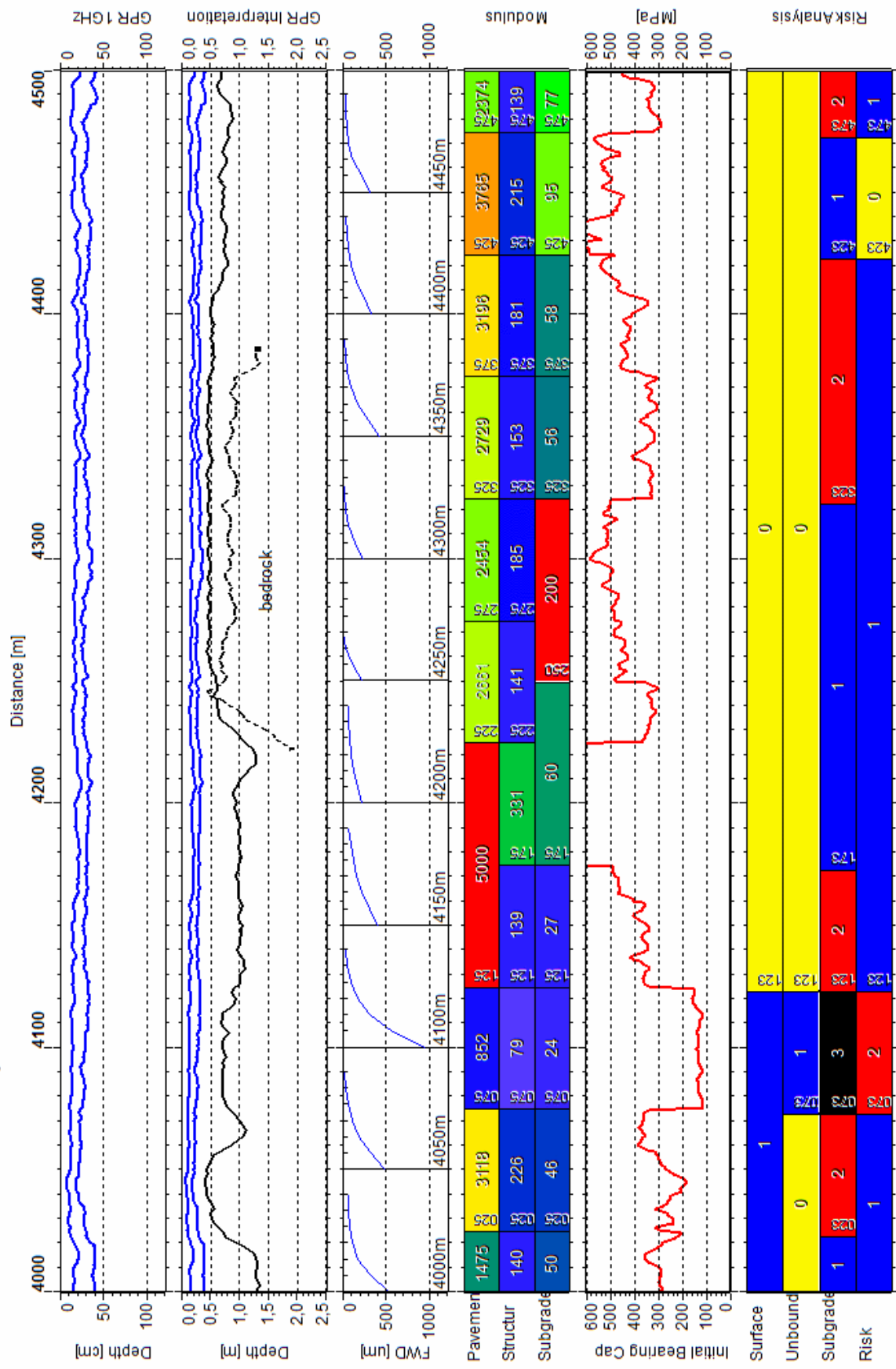
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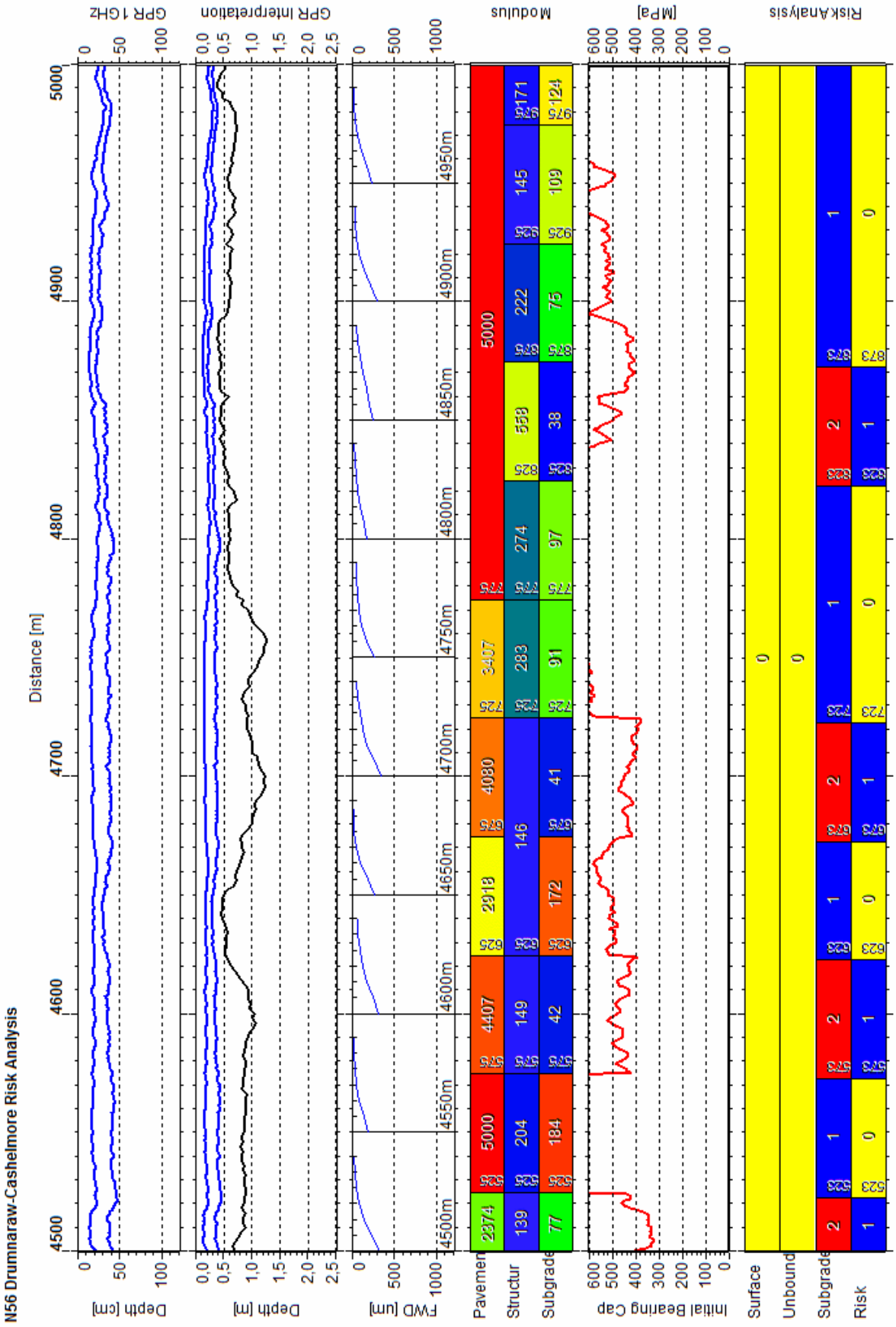


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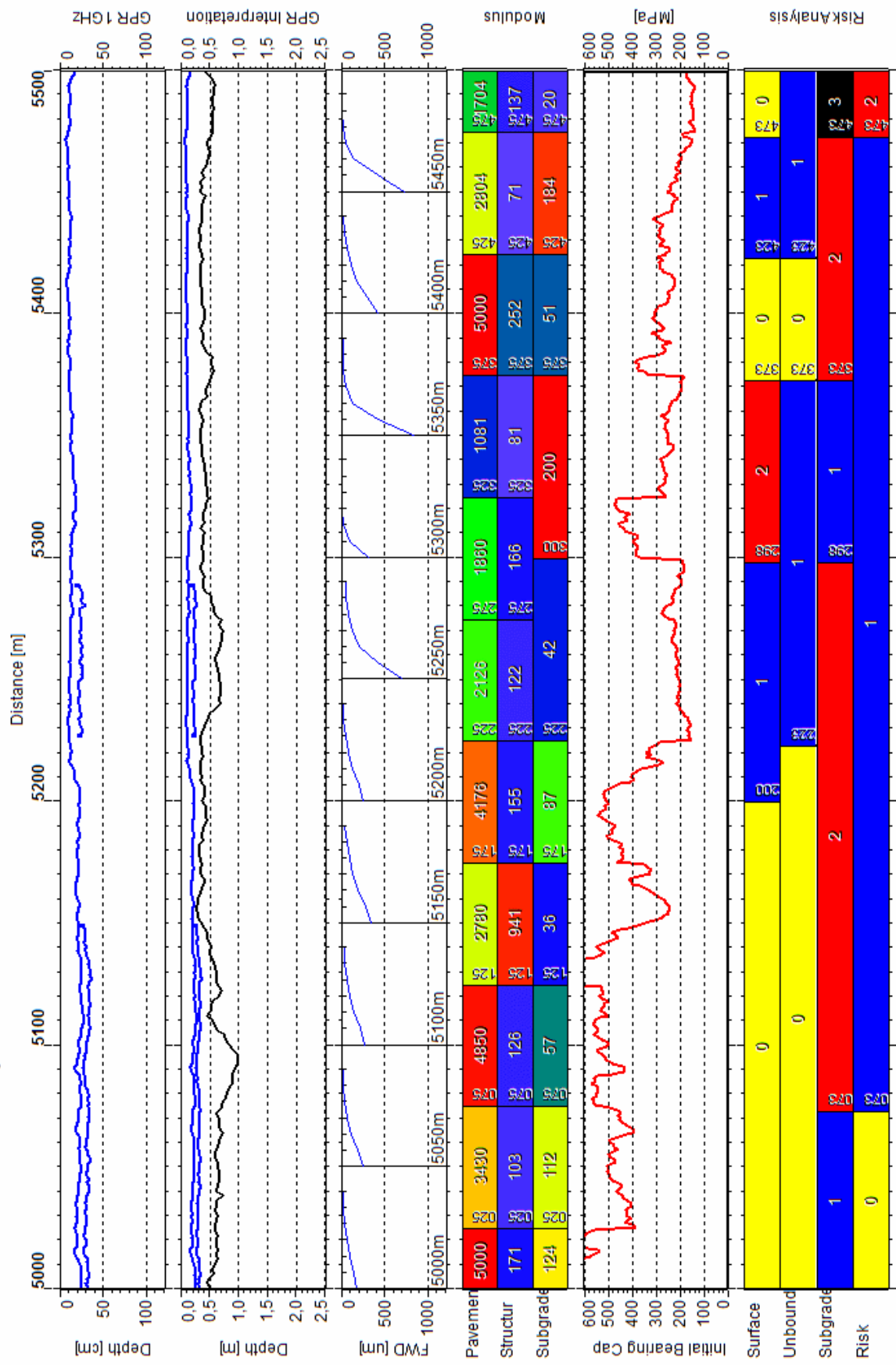
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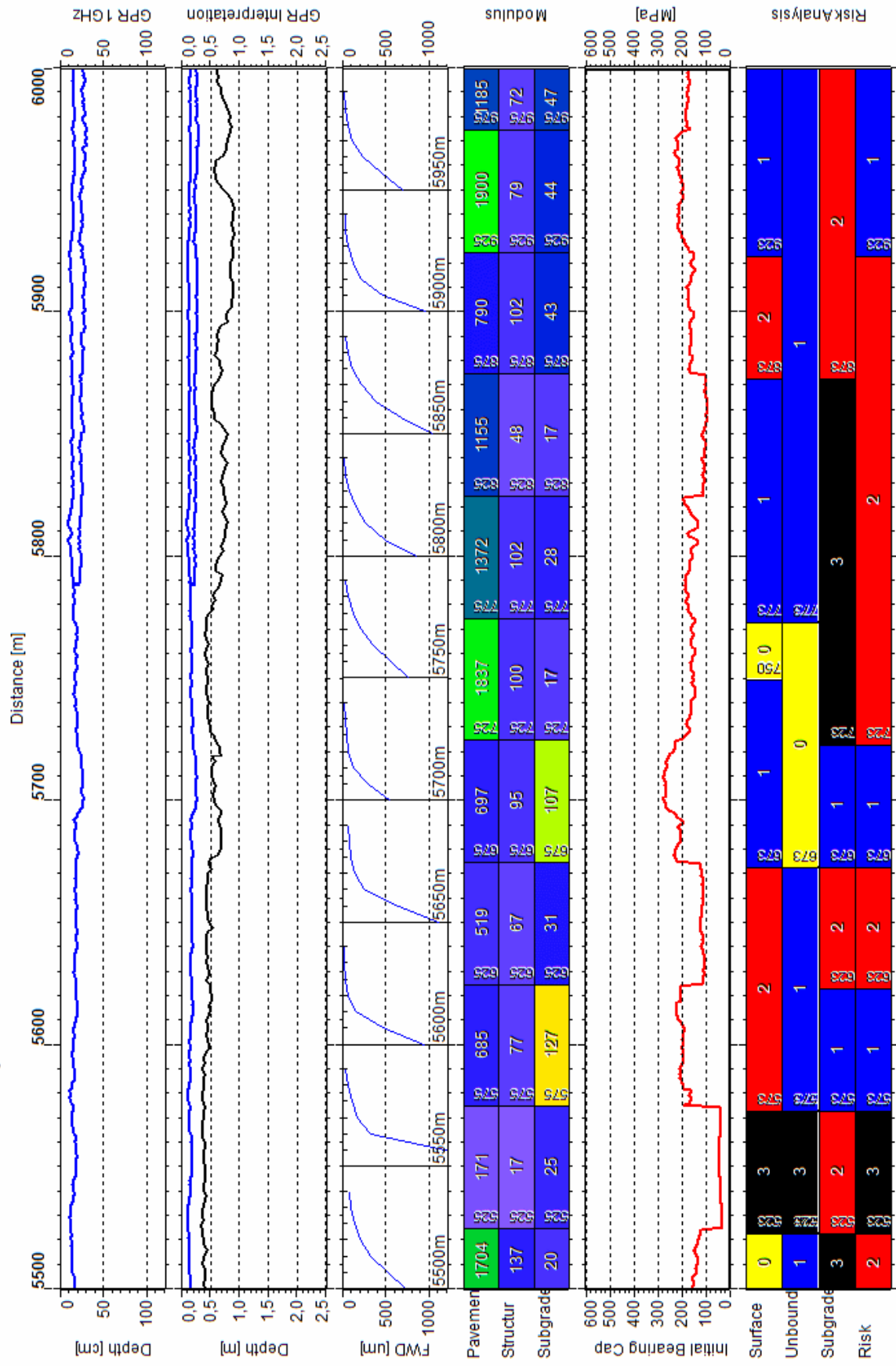
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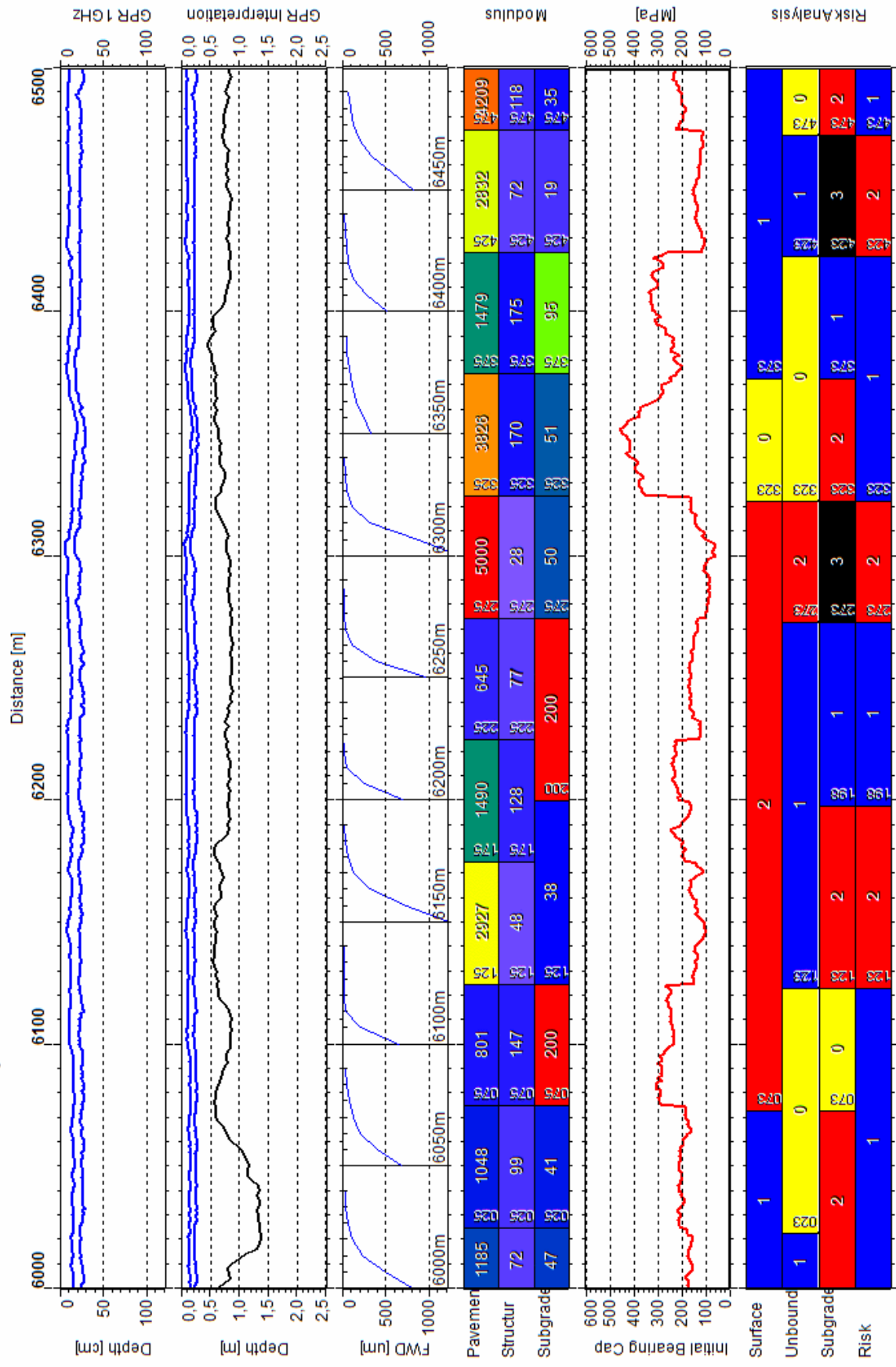
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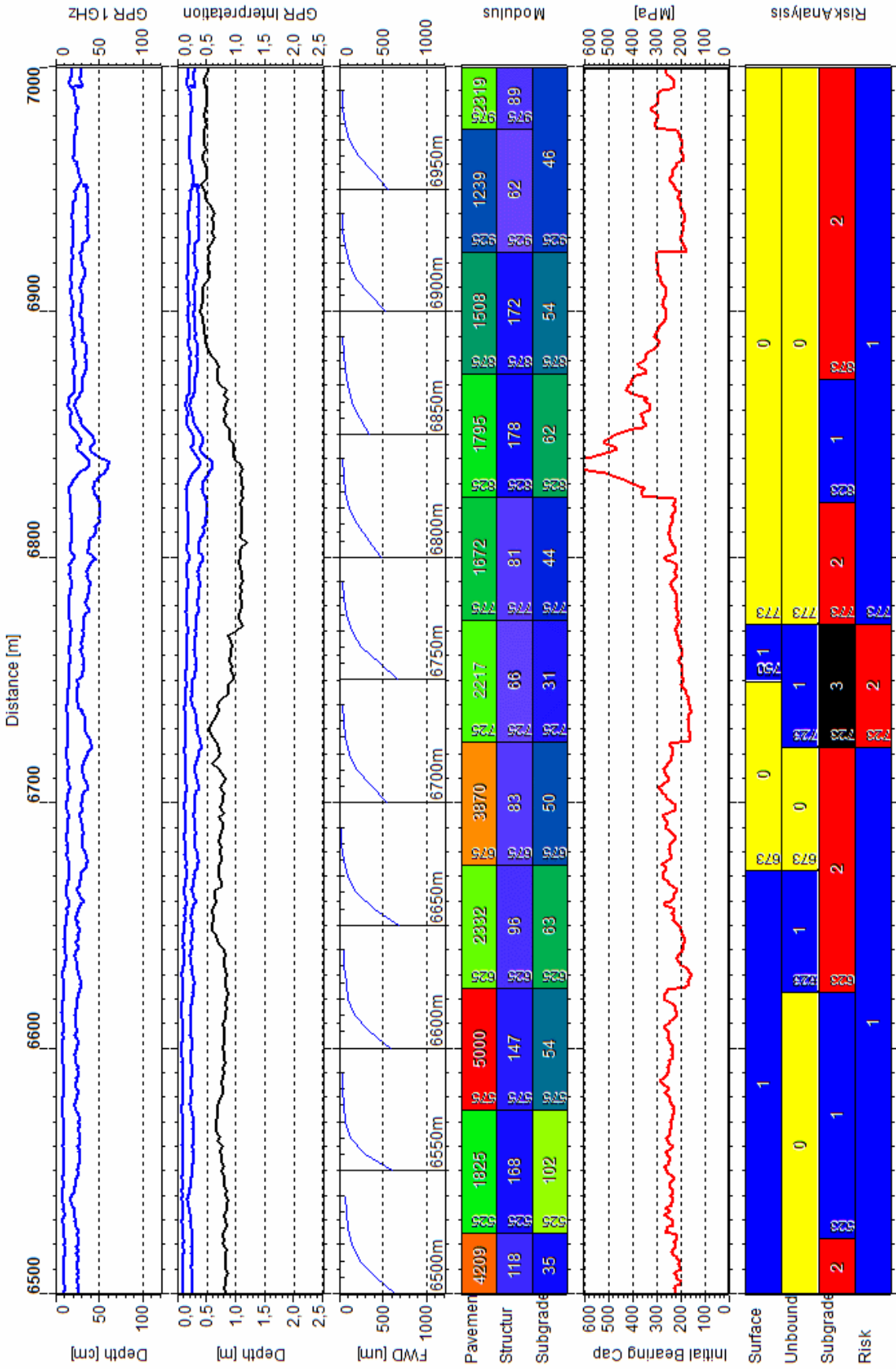


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N56 Drumnaraw-Cashelmore Risk Analysis

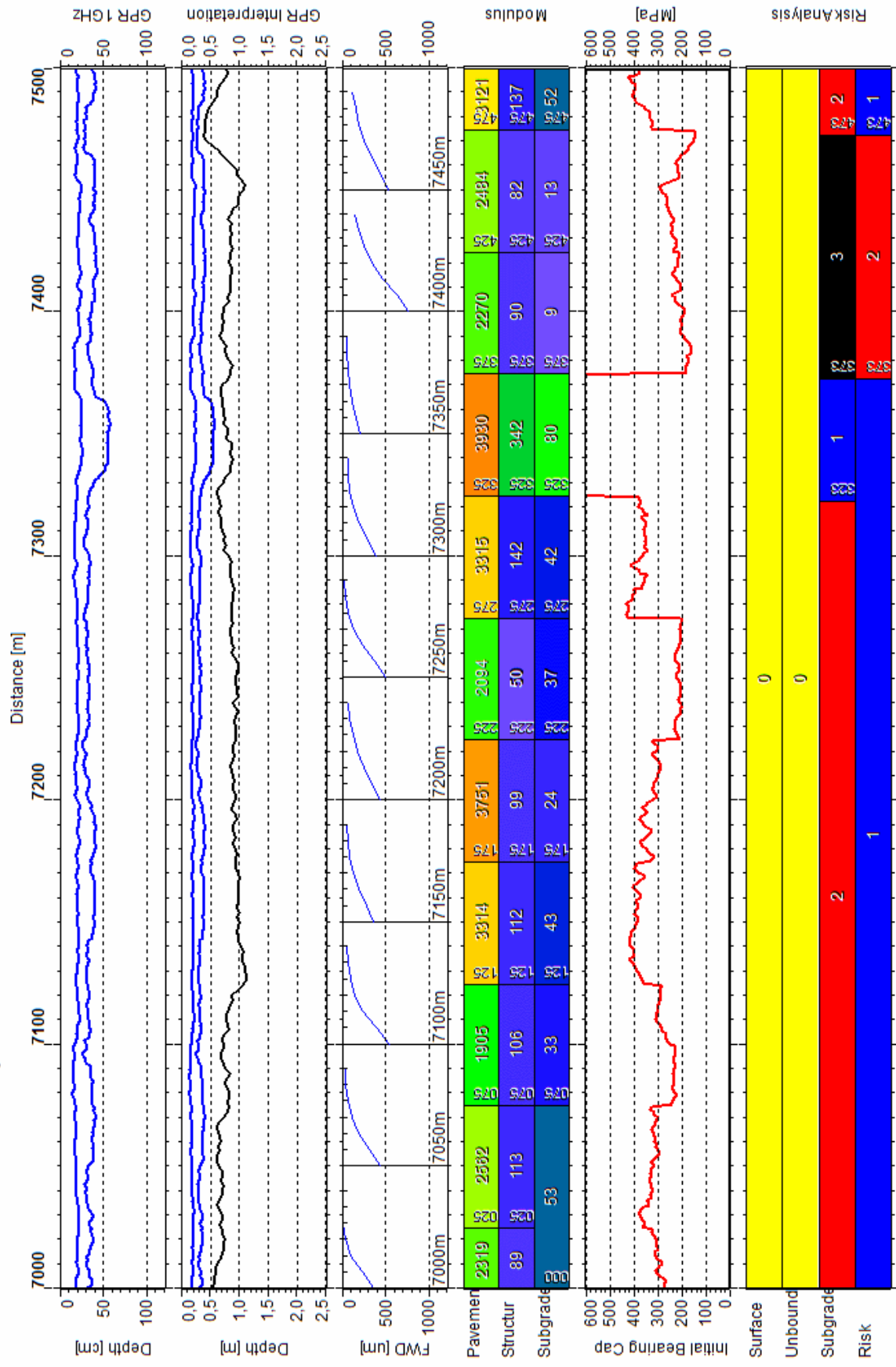


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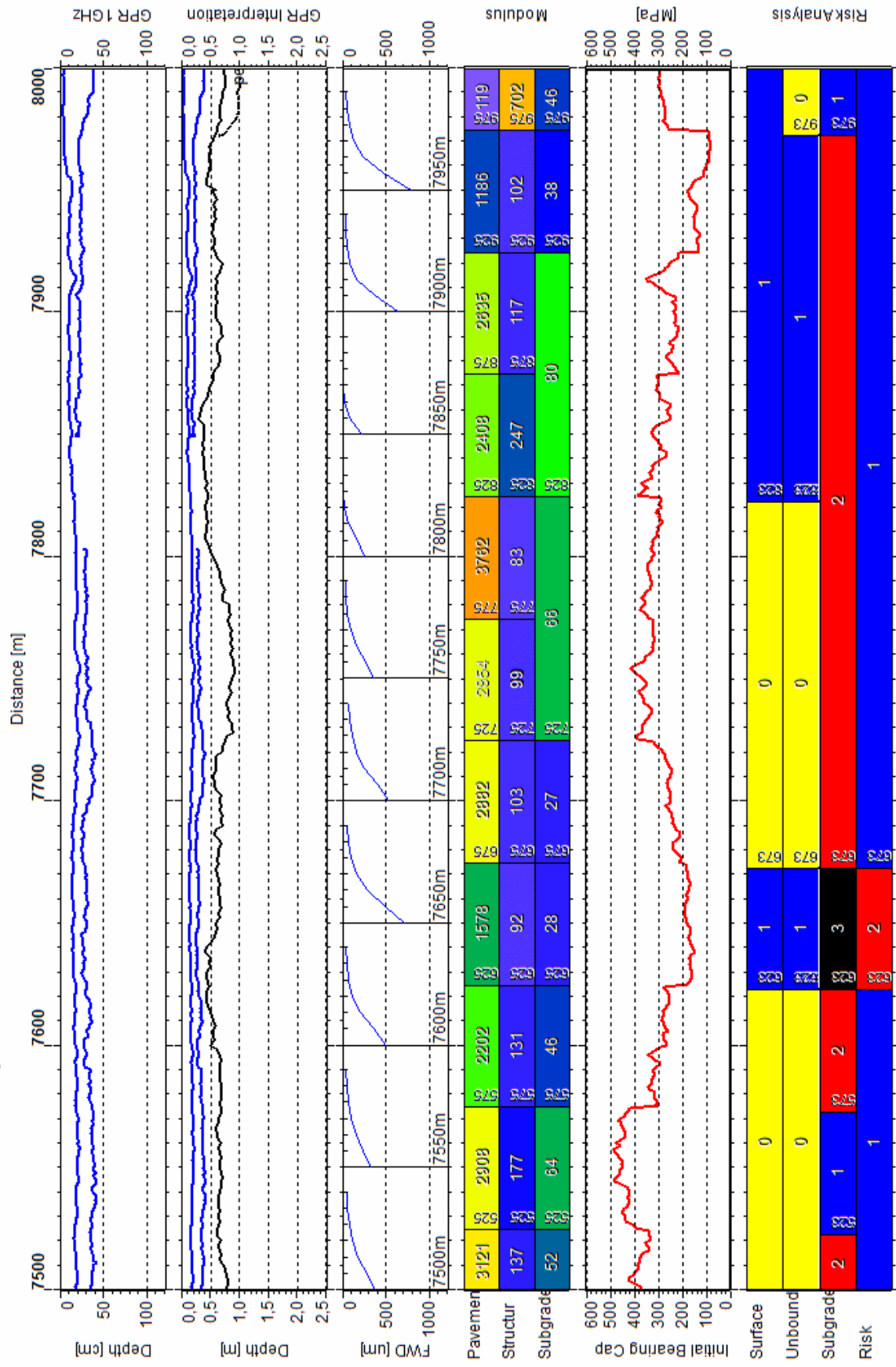
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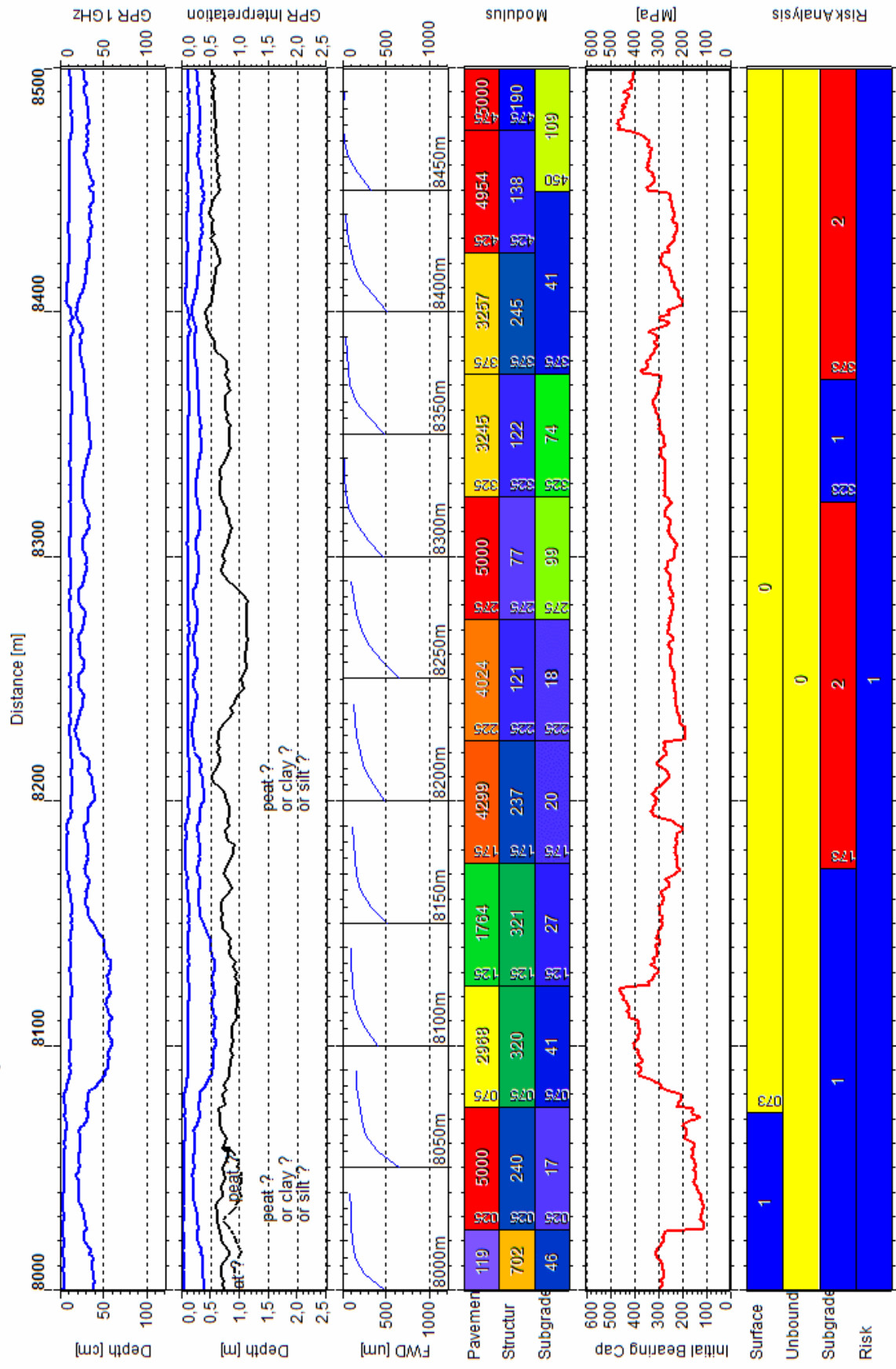
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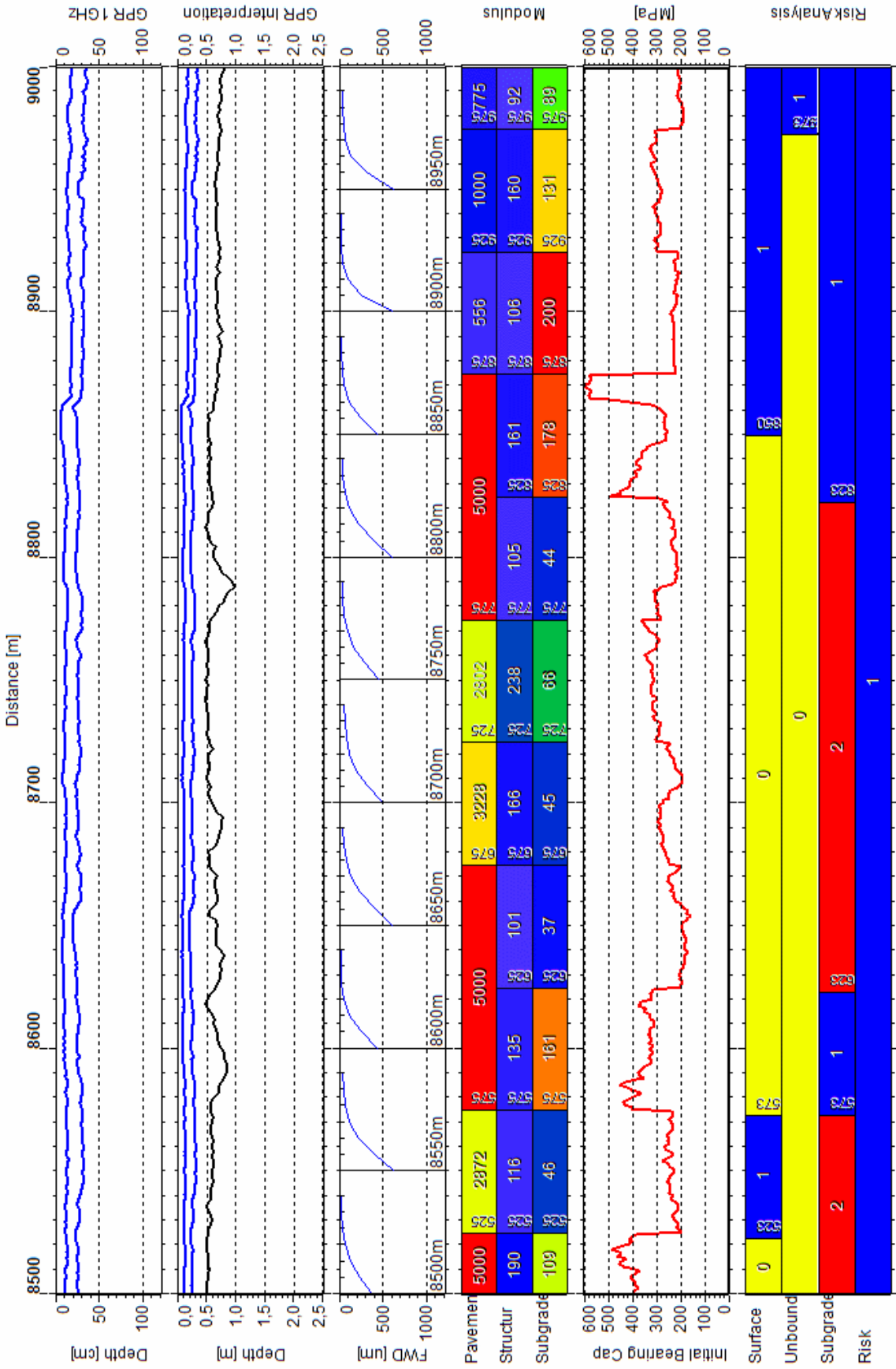
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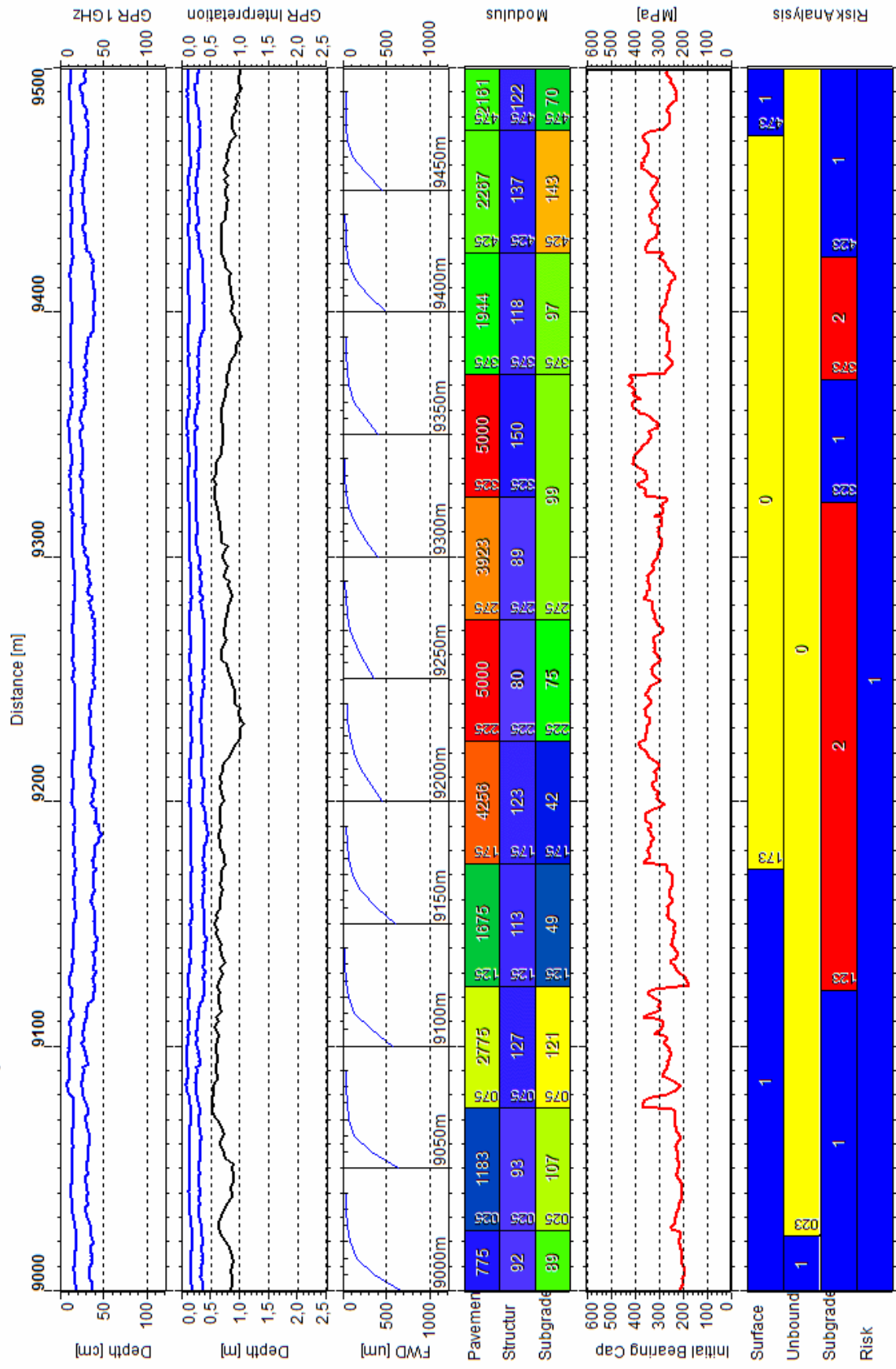


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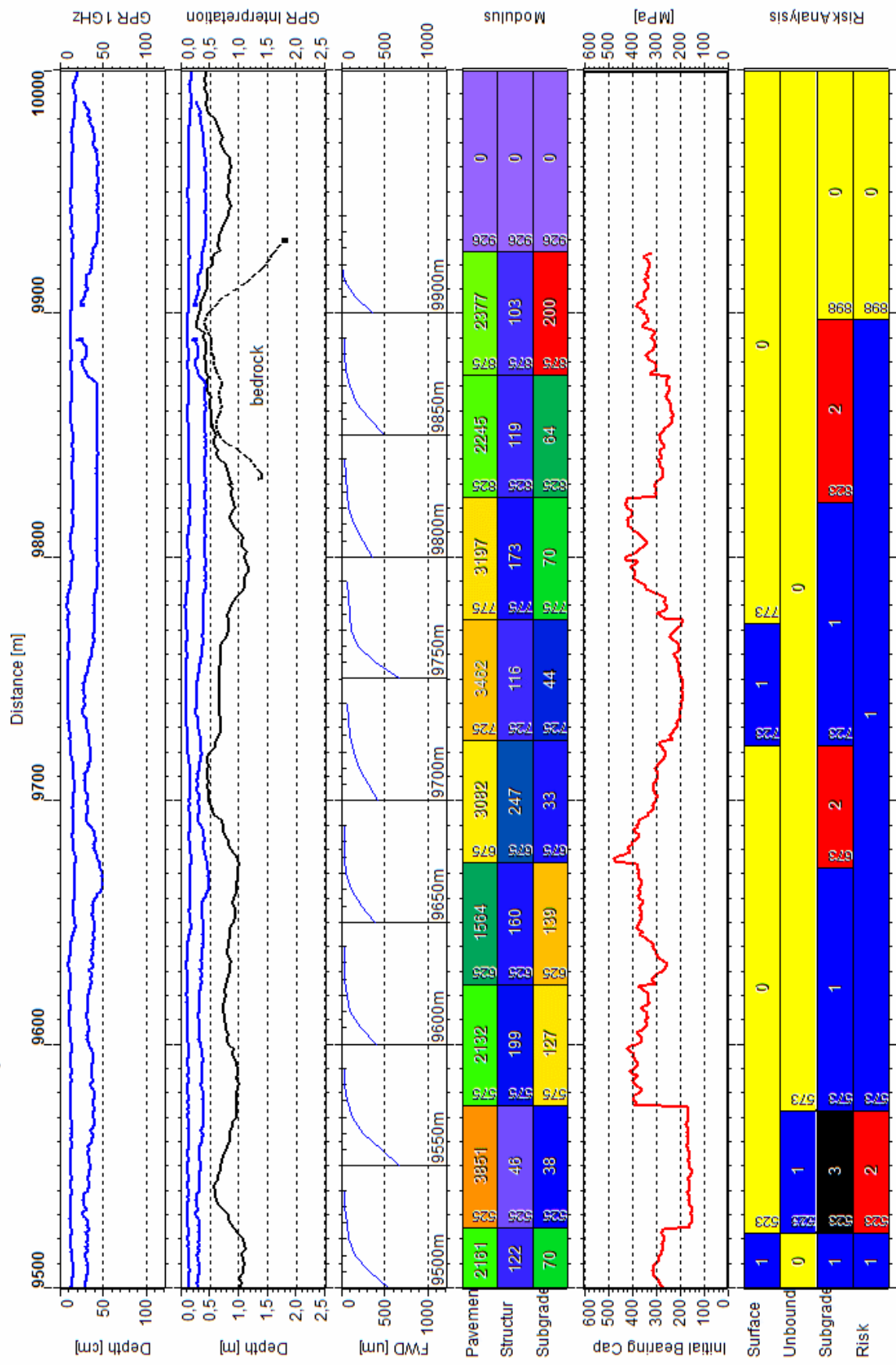
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N56 Drumnaraw-Cashelmore Risk Analysis



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N56 Drumnaraw-Cashelmore Risk Analysis



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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

