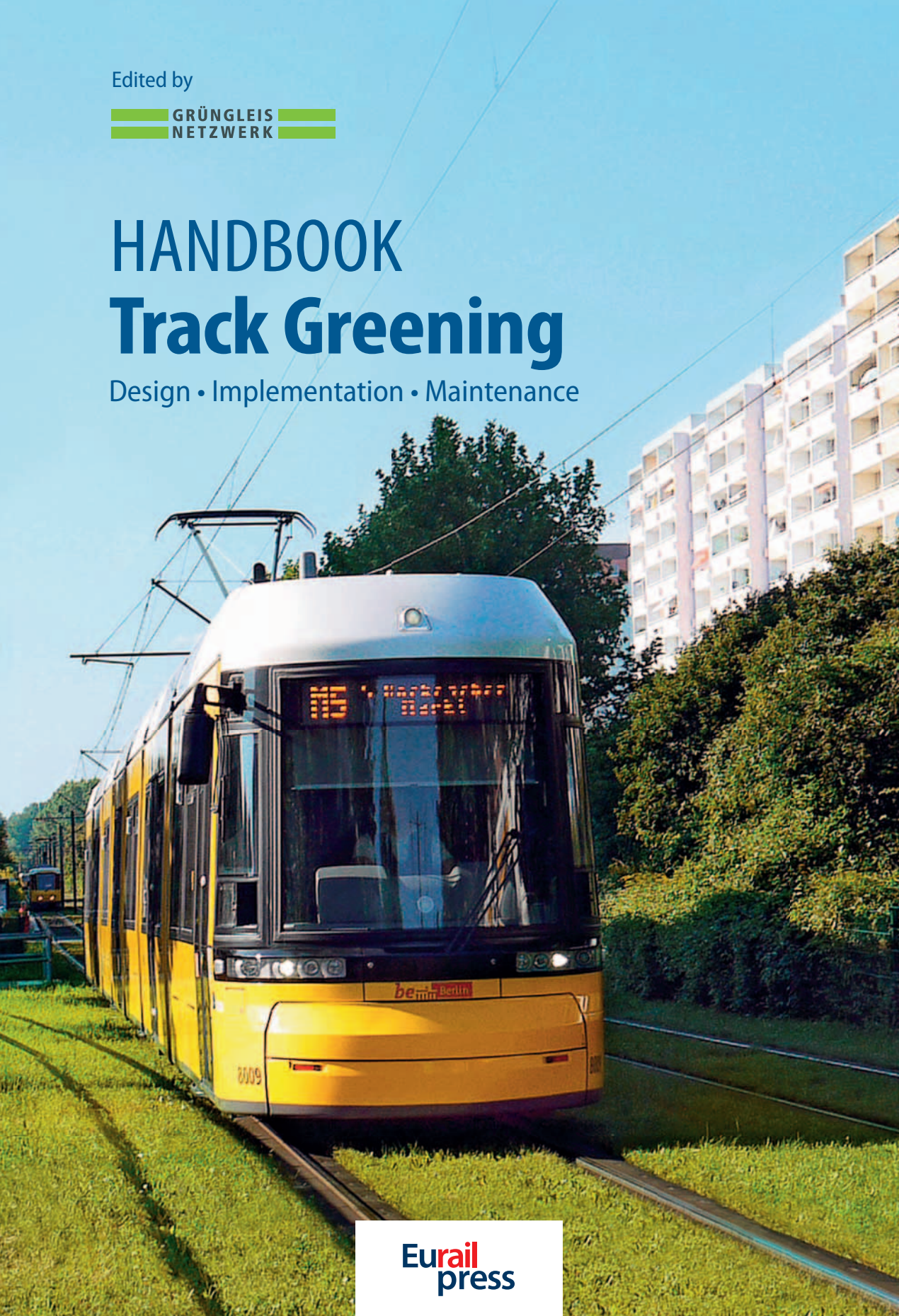


Edited by

GRÜNGLEIS  
NETZWERK

# HANDBOOK Track Greening

Design • Implementation • Maintenance



Eurail  
press

# HANDBOOK TRACK GREENING

Design • Implementation • Maintenance

Edited by



## **The Project**

This Handbook for Track Greening has been produced by the members of Green Track Network (Grüngleisnetzwerk). These members are experts from suppliers, transport operators, academic and scientific institutions covering different aspects of Green Track (track and its component parts, design and construction, vegetation, growing medium, irrigation, sound and vibration).

*Peter Ahrens*, Rheinbahn AG, Düsseldorf

*Frank Dreger*, Berliner Verkehrsbetriebe

*Reinhard Giglmaier*, KRAIBURG STRAIL GmbH & Co. KG, Tittmoning

*Michael Grätz*, SCHMID Ingenieure GmbH, Bau- und Verkehrswesen, Berlin

*Dr. Gerd Grütze*, edilon)(sedra GmbH, Wiesbaden

*Dietmar Haub*, ECO Rain® AG, Hünstetten

*Christian Heimings*, edilon)(sedra GmbH, Wiesbaden

*Susanne Hötzl*, Stuttgarter Straßenbahnen AG

*Dr. Christel Kappis*, Institute of Agricultural and Urban Ecological Projects affiliated to Berlin Humboldt-University (IASP), (Editor of the German handbook edition)

*Thomas Kröger*, Kassel Verkehrs-Gesellschaft AG

*Dr. Friedrich Krüger*, Research Association for Underground Transportation Facilities e.V. – STUVA, Cologne

*Axel Mittelstädt*, ViP – Verkehrsbetrieb Potsdam GmbH

*Karsten Reichenbacher*, Gleiswerkstatt, Karlsruhe (Editor of the German handbook edition)

*Dr. Gerd Reidenbach*, Education and Research Institute for Horticulture, Erfurt

*Dr. Christian Schade*, Niedersächsische Rasenkulturen NIRA GmbH & Co. KG, Groß Ippener

*Manfred Schmitz*, RAIL.ONE GmbH, Neumarkt

*Andrea Scholz*, KRAIBURG STRAIL GmbH & Co. KG, Tittmoning

*Hendrikje Schreiter*, Institute of Agricultural and Urban Ecological Projects affiliated to Berlin Humboldt-University (IASP), (Editor of the German handbook edition)

*Rüdiger Schwartz*, Stuttgarter Straßenbahnen AG

*Ryan Stolpmann*, RAIL.ONE GmbH, Neumarkt

*Thomas Stutz*, Rhein-Neckar-Verkehr GmbH, Mannheim

*Thorsten Utermöhlen*, KRAIBURG STRAIL GmbH & Co. KG, Tittmoning

*Anja Wetzel*, Münchner Verkehrsgesellschaft mbH

## **We also thank the following persons for additional input to this work**

*Walter Burg*, Parks Department Karlsruhe

*Prof. Dr. Swantje Duthweiler*, Weihenstephan-Triesorf University of Applied Sciences

*Ulrich Früh*, TRAVETTO GmbH & Co. KG, Fahrwegsysteme und Gleisbau, Satteldorf

*Oliver Glaser*, ViP – Verkehrsbetrieb Potsdam GmbH

*Dr. Heiner Grüneberg*, Humboldt University Berlin

*Stefan Hegelow*, H.P.H. Landscape GmbH, Berlin  
*Wolfgang Henle*, Staatsschule für Gartenbau und Landwirtschaft Hohenheim, Stuttgart  
*Gerd Hirschelmann*, Verkehrs-Consult Leipzig (VCL) GmbH  
*Ralf Jensen*, OBERMEYER Planen + Beraten GmbH, Karlsruhe  
*Bernd Krupka*, Planungsbüro Bernd W. Krupka, Bad Pyrmont  
*Andreas Neukirch*, Dresdner Verkehrsbetriebe AG  
*Conrad Paul*, L+P Planen, Beraten, Baumanagement für Freiraum und Landschaft, Munich  
*Friedrich Pimpl*, Amt für Grünordnung, Naturschutz und Friedhofswesen, Augsburg  
*Andreas Plamann*, Berliner Verkehrsbetriebe  
*Markus Reinacher*, Mailänder Consult GmbH, Karlsruhe  
*Sascha Ruhnaw*, Mailänder Consult GmbH, Karlsruhe  
*Bernd Schingen*, Leonhard Weiss GmbH & Co. KG, Cologne  
*Dr. Manfred Seyfarth*, Umwelt-Geräte-Technik GmbH, Müncheberg  
*Herbert Sladek*, VDV, Cologne  
*Dr. Walter Stahl*, TU Munich  
 Transport companies: BSAG, SWA, SWU, VAG, VGF

#### Members of the Green Track Network



Contents

**1 Preface ..... 11**

**2 Benefits and Effects of Green Track ..... 13**

**2.1 Urban Design and Visual Appearance of the Tracks ..... 15**

**2.2 Urban Ecology ..... 18**

2.2.1 Improved Stormwater Retention in Green Track ..... 18

2.2.2 Improving the Urban Climate by Evaporation from Green Track and Cooling Effect ..... 19

2.2.3 Bonding of Pollutants ..... 20

**2.3 Noise and Vibration Emissions ..... 21**

2.3.1 General ..... 21

2.3.2 Noise Emissions ..... 21

2.3.3 Vibration Emissions ..... 24

**2.4 Economic Benefits of Track Greening ..... 24**

**3 Types of Green Track and Track Structure Systems for Green Track ..... 27**

**3.1 Types of Green Track ..... 27**

3.1.1 Tracks with Vegetation System to Top of Rail (Tor) Level (High-Level Vegetation) ..28

3.1.2 Tracks with Vegetation System to Foot of Rail Level (Low-Level Vegetation)..... 29

3.1.3 Tracks with Mixed-Level Vegetation System (Special Solutions) ..... 30

**3.2 Track Structure Systems for Green Track ..... 30**

3.2.1 Track Structure System Comprising Sleepers and Ballast ..... 31

3.2.2 Slab Track Systems ..... 31

**3.3 Selected Options for Green Track Systems ..... 32**

3.3.1 Ballasted Track ..... 34

3.3.1.1 Grass Track System ‘Kassel’ ..... 35

3.3.1.2 Grass Track System ‘Dresden’ ..... 37

3.3.2 Slab Track System ..... 39

3.3.2.1 Slab Track System on Permeable Subgrade ..... 39

3.3.2.1.1 System INPLACE ..... 39

3.3.2.1.2 System ‘Concrete Beams with Elastically Supported Rail Base Plates’ ..... 41



|            |  |           |
|------------|--|-----------|
| 3.3.2.1.3  | Grass Track System ‘Freiburg’ .....                              | 43        |
| 3.3.2.1.4  | Grass Track System ‘Bremen’ .....                                | 45        |
| 3.3.2.1.5  | Track panel, System ‘Güsener Balken’ .....                       | 47        |
| 3.3.2.2    | Slab Track System on Non-Permeable Subgrade/with Track Slab..... | 49        |
| 3.3.2.2.1  | System ‘SSB Grass Track’ .....                                   | 49        |
| 3.3.2.2.2  | System ‘RHEDA CITY GREEN’ .....                                  | 51        |
| 3.3.2.2.3  | System ‘edilon’(sedra SDS Grass Track’ .....                     | 53        |
| 3.3.2.2.4  | System ‘edilon’(sedra USTS-INFUNDO’ .....                        | 55        |
| <b>4</b>   | <b>Requirements for Installation of Vegetation Systems.....</b>  | <b>63</b> |
| <b>4.1</b> | <b>Rail Isolation .....</b>                                      | <b>63</b> |
| 4.1.1      | General.....   | 63        |
| 4.1.2      | Different Forms of Rail Insulation .....                         | 64        |
| 4.1.3      | Rail Insulation Requirements .....                               | 64        |
| 4.1.4      | Installation and Removal of Rail Insulation .....                | 65        |
| 4.1.4.1    | One-Piece Rail Insulation Component.....                         | 66        |
| 4.1.4.2    | Multi-Piece Rail Insulation Component.....                       | 68        |
| 4.1.4.3    | Encapsulation of Rail Web and Rail Foot.....                     | 69        |
| 4.1.4.4    | Resilient Polyurethane Trough Fillers .....                      | 70        |
| <b>4.2</b> | <b>Drainage.....</b>   | <b>71</b> |
| <b>4.3</b> | <b>Track Maintenance .....</b>                                   | <b>73</b> |
| 4.3.1      | Accessibility of Rails and Fastenings .....                      | 73        |
| 4.3.2      | Tamping of Track .....   | 73        |
| 4.3.3      | Welding .....  | 73        |
| <b>5</b>   | <b>Types of Greening and Vegetation in Green Tracks .....</b>    | <b>77</b> |
| <b>5.1</b> | <b>Basic Categories .....</b>                                    | <b>77</b> |
| 5.1.1      | Grass Tracks .....   | 77        |
| 5.1.2      | <i>Sedum</i> Tracks .....  | 78        |
| 5.1.3      | Main Differences between Grass and <i>Sedum</i> Tracks .....     | 79        |
| <b>5.2</b> | <b>Green Track Vegetation .....</b>                              | <b>80</b> |
| 5.2.1      | Grass Track Vegetation.....                                      | 80        |
| 5.2.1.1    | Grasses.....   | 80        |
| 5.2.1.2    | Herbaceous .....   | 83        |
| 5.2.2      | <i>Sedum</i> Track Vegetation .....                              | 87        |
| <b>5.3</b> | <b>Application of Vegetation.....</b>                            | <b>90</b> |

|            |  |            |
|------------|--|------------|
| <b>6</b>   | <b>Structure of Vegetation Systems, Requirements on the Functional Layers and Their Installation .....</b> | <b>93</b>  |
| <b>6.1</b> | <b>Vegetation System for Grass Tracks .....</b>  | <b>93</b>  |
| 6.1.1      | General System Structure of Grass Tracks.....  | 93         |
| 6.1.2      | Filter Layer in Grass Tracks .....   | 94         |
| 6.1.2.1    | Substance Groups and Material.....   | 94         |
| 6.1.2.2    | Filter Layer Requirements .....  | 94         |
| 6.1.2.3    | Installation of the Filter Layer.....  | 94         |
| 6.1.3      | Vegetation Base Layer in Grass Tracks .....  | 94         |
| 6.1.3.1    | Substance Groups and Material.....   | 94         |
| 6.1.3.2    | Vegetation Base Layer Requirements.....  | 94         |
| 6.1.3.3    | Installation of the Vegetation Base Layer .....  | 95         |
| 6.1.4      | Vegetation in Grass Tracks .....   | 96         |
| 6.1.4.1    | Substance Groups and Materials .....   | 96         |
| 6.1.4.2    | Requirements on the Vegetation .....   | 96         |
| 6.1.4.2.1  | Requirements on the Seed .....   | 96         |
| 6.1.4.2.2  | Turf Requirements .....  | 97         |
| 6.1.4.3    | Installation of Vegetation .....   | 97         |
| 6.1.4.3.1  | Seeding of Grass.....  | 97         |
| 6.1.4.3.2  | Installation of Turf/Sod .....   | 98         |
| <b>6.2</b> | <b>Vegetation System for <i>Sedum</i> Tracks .....</b>   | <b>100</b> |
| 6.2.1      | General System Structure of <i>Sedum</i> Tracks.....   | 100        |
| 6.2.2      | Levelling Course/Intermediate Layer in <i>Sedum</i> Tracks .....   | 101        |
| 6.2.2.1    | Substance Groups and Materials .....   | 101        |
| 6.2.2.2    | Levelling Course Requirements.....   | 101        |
| 6.2.2.3    | Installation of the Levelling Course .....   | 102        |
| 6.2.3      | Root Barrier in <i>Sedum</i> Tracks .....  | 102        |
| 6.2.3.1    | Substance Groups and Materials .....   | 102        |
| 6.2.3.2    | Root Barrier Requirements .....  | 102        |
| 6.2.3.3    | Installation of the Root Barrier.....  | 102        |
| 6.2.4      | Drainage Layer in <i>Sedum</i> Tracks .....  | 103        |
| 6.2.4.1    | Substance Groups and Materials.....  | 103        |
| 6.2.4.2    | Drainage Layer Requirements.....   | 103        |
| 6.2.4.3    | Installation of the Drainage Layer .....   | 103        |
| 6.2.5      | Vegetation Base Layer in <i>Sedum</i> Tracks .....   | 103        |
| 6.2.5.1    | Substance Groups and Materials.....  | 103        |
| 6.2.5.2    | Vegetation Base Layer Requirements.....  | 104        |

|            |   |            |
|------------|---|------------|
| 6.2.5.3    | Installation of the Vegetation Base Layer .....                               | 104        |
| 6.2.6      | Vegetation in <i>Sedum</i> Tracks .....                                       | 105        |
| 6.2.6.1    | Substance Groups and Materials.....   | 105        |
| 6.2.6.2    | Requirements .....  | 105        |
| 6.2.6.2.1  | Requirements on <i>Sedum</i> Sprouts.....                                     | 105        |
| 6.2.6.2.2  | Vegetation Mat Requirements.....  | 105        |
| 6.2.6.3    | Installation of the Vegetation .....  | 106        |
| 6.2.6.3.1  | Seeding of <i>Sedum</i> Sprouts.....  | 106        |
| 6.2.6.3.2  | Installation of Vegetation Mats .....   | 106        |
| <b>7</b>   | <b>Maintenance of Vegetation Systems in the Track Area .....</b>              | <b>109</b> |
| <b>7.1</b> | <b>Completion Maintenance.....</b>  | <b>109</b> |
| 7.1.1      | Completion Maintenance for Grass Tracks.....                                  | 109        |
| 7.1.1.1    | Completion Maintenance for Seeded Grass.....                                  | 109        |
| 7.1.1.2    | Completion Maintenance for Turf .....   | 110        |
| 7.1.2      | Completion Maintenance for <i>Sedum</i> Tracks .....                          | 112        |
| <b>7.2</b> | <b>Rectification and Plant Maintenance Period .....</b>                       | <b>112</b> |
| 7.2.1      | Necessity and Objectives of Rectification and Plant Maintenance Period .....  | 112        |
| 7.2.2      | Rectification and Plant Maintenance for Grass Tracks.....                     | 112        |
| 7.2.3      | Rectification and Plant Maintenance for <i>Sedum</i> Tracks.....              | 114        |
| <b>7.3</b> | <b>Maintenance Protocol .....</b>   | <b>115</b> |
| <b>8</b>   | <b>Irrigation of Green Tracks.....</b>  | <b>117</b> |
| <b>8.1</b> | <b>Importance of Irrigation .....</b>   | <b>117</b> |
| <b>8.2</b> | <b>Irrigation Systems for Grass Track .....</b>                               | <b>117</b> |
| 8.2.1      | Mobile Irrigation with a Water Tanker Car .....                               | 117        |
| 8.2.2      | Irrigation with Pop-Up Sprinklers.....  | 118        |
| 8.2.2.1    | Requirements on Irrigation Systems with Pop-Up Sprinklers.....                | 118        |
| 8.2.2.2    | Installation of Pop-Up Sprinklers .....                                       | 118        |
| 8.2.2.3    | Maintenance of Pop-Up Sprinklers .....  | 119        |
| 8.2.3      | Irrigation with an Irrigation Mat (Subsurface Textile Irrigation – SSTI)..... | 119        |
| 8.2.3.1    | Irrigation Strategy .....   | 120        |
| 8.2.3.2    | Requirements .....  | 120        |
| 8.2.3.3    | Installation of Irrigation Mats .....   | 120        |
| 8.2.3.4    | Maintenance of Irrigation Mats.....   | 121        |
| <b>8.3</b> | <b>Water Supply for Stationery Irrigation Systems.....</b>                    | <b>122</b> |



|           |  |            |
|-----------|--|------------|
| <b>9</b>  | <b>Implementation Components .....</b>   | <b>125</b> |
| 9.1       | Level Crossings/Intersections .....  | 125        |
| 9.2       | Stops.....   | 127        |
| 9.3       | Fixtures and Installations in the Track Area .....   | 128        |
| 9.4       | Greening within Areas of Special Trackwork .....   | 129        |
| 9.5       | Emergency Vehicular Access to Tracks .....   | 130        |
| 9.5.1     | Gravel Turf.....   | 130        |
| 9.5.2     | Plastic Grass Grid Systems and Concrete Grid Pavers .....  | 131        |
| <b>10</b> | <b>Basis of Design.....</b>  | <b>137</b> |
| 10.1      | General Considerations .....   | 137        |
| 10.2      | Selection Criteria for Vegetation System.....  | 138        |
| 10.3      | Decision Aid for Locally Adapted Vegetation Systems –<br>Requirements Matrix .....               | 141        |
| 10.4      | Preparation of Specifications .....  | 148        |
| <b>11</b> | <b>Final Acceptance and Quality Control Tests .....</b>  | <b>151</b> |
| <b>12</b> | <b>Contractual Limitation Period for<br/>Requirements on Rectification of Deficiencies .....</b> | <b>152</b> |
| <b>13</b> | <b>Potential Problems during Design, Construction and<br/>Maintenance of Green Tracks .....</b>  | <b>153</b> |
| 13.1      | Possible Problems with Issues during Design.....   | 153        |
| 13.1.1    | Water Supply.....  | 153        |
| 13.1.2    | Consideration of Utilisation Parameters.....   | 156        |
| 13.1.3    | Consideration of Location Specific Parameters for Plant Development.....                         | 157        |
| 13.1.4    | System Components.....   | 158        |
| 13.2      | Issues during Construction.....  | 159        |
| 13.3      | Issues during Maintenance.....   | 160        |
| 13.4      | Other Issues.....  | 162        |

14      **References..... 163**

15      **Annex ..... 180**

15.1    Guidelines, Regulations and Standards.....180

15.2    Glossary .....181

15.3    List of Abbreviations .....182

15.4    References.....184

15.5    References for Figures .....188

15.6    Members of the Green Track Network .....190

15.7    Keywords .....198

# 1 Preface

The successful delivery of Green Tram Track requires the integration of knowledge and experience from rail track engineering and horticultural science.

The handbook for track greening provides recommendations and guidance for the design, implementation and maintenance of Green Track for light rail and tram schemes. It is primarily aimed at transit authorities, planning and design consultancies, contractors and at city planners. It has been developed particularly for light rail and tram schemes which are operated in accordance with the German BOStrab (Ordinance on the Construction and Operation of Street Railways) regulations.

In the German context approvals according to BOStrab have to be requested from the competent technical supervisory authority.

Applications for railway lines which are operated in accordance with EBO (Ordinance on the Construction and Operation of Railways) have to be determined on an individual case basis and be inspected and approved by the competent supervisory authority.

The statements made in this book are based on current legislation and guidelines as well as the knowledge and experience of the authors. They are intended as recommendations for professional work under normal circumstances. Individual projects may require further detailed specification.

The application of the designs and management regimes described in this book relate to the applications currently used in Germany, which are compliant with German standards as noted.