Contents

List of Contributors vii
Foreword ix

1 Introduction to Sustainable Winter Road Maintenance 1
   Xianming Shi and Liping Fu

2 A Framework for Life-Cycle Sustainability Assessment of Road Salt Used in Winter Maintenance Operations 7
   Na Cui, Ning Xie, and Xianming Shi

3 Winter Road Operations: A Historical Perspective 23
   Leland D. Smithson

4 Societal and User Considerations for Sustainable Winter Road Operations 45
   David Veneziano and Laura Fay

5 Weather Services for Sustainable Winter Road Operations 59
   Chris Albrecht, Ralph Patterson, and Leigh Sturges

6 The Fundamentals of Plowing, Anti-icing, De-icing and Sanding 82
   Alex Klein-Paste and Rune Dalen

7 Safety Effects of Winter Weather and Road Maintenance Operations 101
   Liping Fu and Taimur Usman

8 Mobility Effects of Winter Weather and Road Maintenance Operations 131
   Liping Fu and Tae J. Kwon

9 Economic Benefits of Winter Road Operations 156
   David Veneziano, Xianming Shi, and Laura Fay

10 Environmental Risks of Snow and Ice Control Materials 180
    Xianming Shi, Sen Du, and Laura Fay
11 Impact of Chemical Deicers on Roadway Infrastructure: Risks and Best Management Practices 211
Gang Xu and Xianming Shi

12 Vehicle Risks of Winter Road Operations and Best Management Practices 241
Mehdi Honarvar Nazari and Xianming Shi

13 Strategic Planning and Management for Sustainable Winter Road Maintenance 273
Matthew Muresan, Tae J. Kwon, Liping Fu, and Xianming Shi

14 Source Control Tactics for Sustainable Winter Road Maintenance 309
Xianming Shi and Liping Fu

15 Reactive Approaches for Environmentally Sustainable Winter Road Operations 334
Xianming Shi, Eric Strecker, and Scott Jungwirth

16 Innovative Winter Maintenance Equipment 358
William H. Schneider IV, William A. Holik, and Mallory J. Crow

17 The Search for “Greener” Materials for Winter Road Maintenance Operations 378
Xianming Shi and Scott Jungwirth

18 Pavement Treatments for Sustainable Winter Road Maintenance 402
Xianming Shi, Jiang Huang, and Zhengxian Yang

19 Performance Measures for Sustainable Winter Road Operations 423
Tina Greenfield

20 Application Guidelines for Optimal Deicing and Anti-icing 443
S.M. Kamal Hossain, Matthew Muresan, and Liping Fu

21 A Look into the Future 472
Liping Fu and Xianming Shi

Index 479