



U.S. Department of the Interior
Bureau of Land Management

Willow Master Development Plan

Environmental Impact Statement

DRAFT

Volume 2: Appendix A

August 2019

Prepared by:
U.S. Department of the Interior
Bureau of Land Management

In Cooperation with:
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Coast Guard
U.S. Department of Transportation
Native Village of Nuiqsut
Iñupiat Community of the Arctic Slope
City of Nuiqsut
North Slope Borough
State of Alaska

Estimated Total Costs Associated with
Developing and Producing this EIS:
\$5,281,000



Mission

To sustain the health, diversity, and productivity of the public lands for the future use and enjoyment of present and future generations.

Cover Photo Illustration: Caribou in the Alpine Development on Alaska's North Slope.
Photo by: Wendy Mahan, courtesy of ConocoPhillips.

Photo copyright 2019 ConocoPhillips Alaska, Inc. BLM is permitted to use this photo and copy for its own use; any other use or copying by any other party is prohibited without the written consent of ConocoPhillips Alaska, Inc.

DOI-BLM-AK-0000-2018-0004-EIS
BLM/AK/PL-19/012+1610+F010

Willow Master Development Plan

Draft Environmental Impact Statement

Volume 2: Appendix A

Prepared by:
U.S. Department of the Interior
Bureau of Land Management
Anchorage, Alaska

In cooperation with:
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Coast Guard
U.S. Department of Transportation
Native Village of Nuiqsut
Iñupiat Community of the Arctic Slope
City of Nuiqsut
North Slope Borough
State of Alaska

August 2019

<p>Estimated Total Costs Associated with Developing and Producing this EIS: \$5,281,000</p>
--

This page intentionally left blank.

LIST OF FIGURES

Figure ES.1. Willow Project Vicinity, North Slope, Alaska.....	1
Figure ES.2. Willow Project Area and Alternatives	2
Figure ES.3. Comparison of Action Alternatives	3
Figure 1.4.1. Willow Development Location	4
Figure 2.4.1. Alternative B: Proponent’s Project.....	5
Figure 2.4.2. Alternative C: Disconnected Infield Roads	6
Figure 2.4.3. Alternative D: Disconnected Access	7
Figure 2.4.4. Option 1: Proponent’s Module Transfer Island.....	8
Figure 2.4.5. Option 2: Point Lonely Module Transfer Island.....	9
Figure 2.5.1. Alternative B Pipeline Schematic.....	10
Figure 2.5.2. Alternative C Pipeline Schematic.....	11
Figure 2.5.3. Alternative D Pipeline Schematic.....	12
Figure 2.5.4. Tiñmiaqsigvik Gravel Mine Site	13
Figure 2.8.1. Comparison of Action Alternatives	14
Figure 3.3.1. Analysis Area for Air Quality	15
Figure 3.3.2. Nuiqsut Monitoring Station Wind Rose	16
Figure 3.4.1. Analysis Area for Soils, Permafrost, and Gravel Resources	17
Figure 3.5.1. Known Contaminated Sites or Spills within 0.5 mile of the Project	18
Figure 3.6.1. Analysis Area for Noise	19
Figure 3.7.1. Visual Resources Analysis Area, Project Viewshed, and Proposed Project Facilities	20
Figure 3.7.2. Visual Resource Inventory Scenic Quality Classes.....	21
Figure 3.7.3. Visual Resource Inventory Sensitivity Levels.....	22
Figure 3.7.4. Visual Resource Inventory Distance Zones.....	23
Figure 3.7.5. Visual Resource Inventory Classes	24
Figure 3.7.6. Visual Resource Management Classes	25
Figure 3.8.1. Watersheds in the Analysis Area for Water Resources	26
Figure 3.8.2. Streams and Floodplains in the Willow Area	27
Figure 3.8.3. Floodplain Detail in the Willow Area	28
Figure 3.8.4. Lakes in the Water Resources Analysis Area.....	29
Figure 3.8.5. Proximity of Water Resources to Shore-based Action Alternatives.....	30
Figure 3.9.1. Analysis Area for Wetlands and Vegetation	31
Figure 3.9.2. Wetlands in the Analysis Area	32
Figure 3.9.3. Land Cover Classes in the Analysis Area.....	33
Figure 3.10.1. Essential Fish Habitat in the Analysis Area	34
Figure 3.10.2. Fish Habitat in the Willow Area.....	35
Figure 3.11.1. Bird Habitat Use and Analysis Area.....	36
Figure 3.11.2. Spectacled Eider Pre-Breeding Density in the Analysis Area.....	37
Figure 3.11.3. Yellow-Billed Loon Density and Nests in the Analysis Area	38
Figure 3.11.4. Yellow-Billed Loon Density and Nests in the Willow Area	39
Figure 3.11.5. Bird Habitat Use in the Willow Area	40
Figure 3.12.1. Analysis Area for Terrestrial Mammals	41
Figure 3.12.2. Annual Ranges of the Central Arctic and Teshekpuk Caribou Herds	42
Figure 3.12.3. Seasonal Distribution of Female Caribou in the Teshekpuk Caribou Herd.....	43
Figure 3.12.4. Movement of GPS-Collared Caribou of the Teshekpuk Caribou Herd 2004–2018	44
Figure 3.12.5. Distribution of Calving Caribou of the Teshekpuk Caribou Herd 1990–2018.....	45
Figure 3.12.6. Mean Caribou Density by Season 2001–2018.....	46

Figure 3.13.1. Polar Bear Dens, Critical Habitat, and Potential Terrestrial Denning Habitat	47
Figure 3.13.2. Polar Bear Potential Terrestrial Denning Habitat in the Willow Area	48
Figure 3.14.1. Map of Surface Land Ownership in the Analysis Area	49
Figure 3.14.2. Map of Subsurface Land Management in the Bear Tooth Unit.....	50
Figure 3.14.3. North Slope Borough Zoning Districts in the Analysis Area	51
Figure 3.16.1. Nuiqsut Contemporary Subsistence Use Areas with Direct Effects Area, All Resources	52
Figure 3.16.2. Nuiqsut Historic and Lifetime Subsistence Use Areas with Direct Effects Area, All Resources	53
Figure 3.16.3. Nuiqsut Caribou Subsistence Use Areas with Direct Effects Area, 2008–2016	54
Figure 3.16.4. Utqiagvik (Barrow) Contemporary Subsistence Use Areas with Direct Effects Area, All Resources	55
Figure 3.16.5. Utqiagvik (Barrow) Lifetime Subsistence Use Areas with Direct Effects Area, All Resources	56
Figure 3.16.6. All Resource Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006	57
Figure 3.16.7. Caribou Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006.....	58
Figure 3.16.8. Caribou Subsistence Use Areas by Alternative, Nuiqsut, 2008–2016.....	59
Figure 3.16.9. Wolf and Wolverine Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006.....	60
Figure 3.16.10. Goose Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006	61
Figure 3.16.11. All Resource Subsistence Use Areas by Alternative, Utqiagvik (Barrow), 1997–2006	62
Figure 3.16.12. Caribou Subsistence Use Areas by Alternative, Utqiagvik (Barrow), 1997–2006.....	63
Figure 3.16.13. Wolf and Wolverine Subsistence Use Areas by Alternative, Utqiagvik (Barrow), 1997–2006	64
Figure 3.16.14. All Resource Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006	65
Figure 3.16.15. Caribou Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006	66
Figure 3.16.16. Caribou Subsistence Use Areas by Module Delivery Option, Nuiqsut, 2008–2016	67
Figure 3.16.17. Wolf and Wolverine Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006	68
Figure 3.16.18. Goose Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006.....	69
Figure 3.16.19. Seal Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006.....	70
Figure 3.16.20. Eider Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006	71
Figure 3.16.21. Fish Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006.....	72
Figure 3.16.22. Moose Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006	73
Figure 3.16.23. All Resource Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1997–2008.....	74
Figure 3.16.24. Caribou Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1997–2008	75
Figure 3.16.25. Wolf and Wolverine Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1997–2008.....	76
Figure 3.16.26. Seal Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1995–2008.....	77
Figure 3.16.27. Goose Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1995–2008.....	78
Figure 3.19.1. Past and Present Actions that may Interact with the Willow Project	79
Figure 3.19.2. Reasonably Foreseeable Future Actions that may Interact with the Willow Project	80

Figure 4.3.1. Drill Site BT1 Reservoir Blowout Oil Fallout.....	81
Figure 4.3.2. Drill Site BT2 Reservoir Blowout Oil Fallout.....	82
Figure 4.3.3. Drill Site BT3 Reservoir Blowout Oil Fallout.....	83
Figure 4.3.4. Drill Site BT4 Reservoir Blowout Oil Fallout.....	84
Figure 4.3.5. Drill Site BT5 Reservoir Blowout Oil Fallout.....	85

This page intentionally left blank.

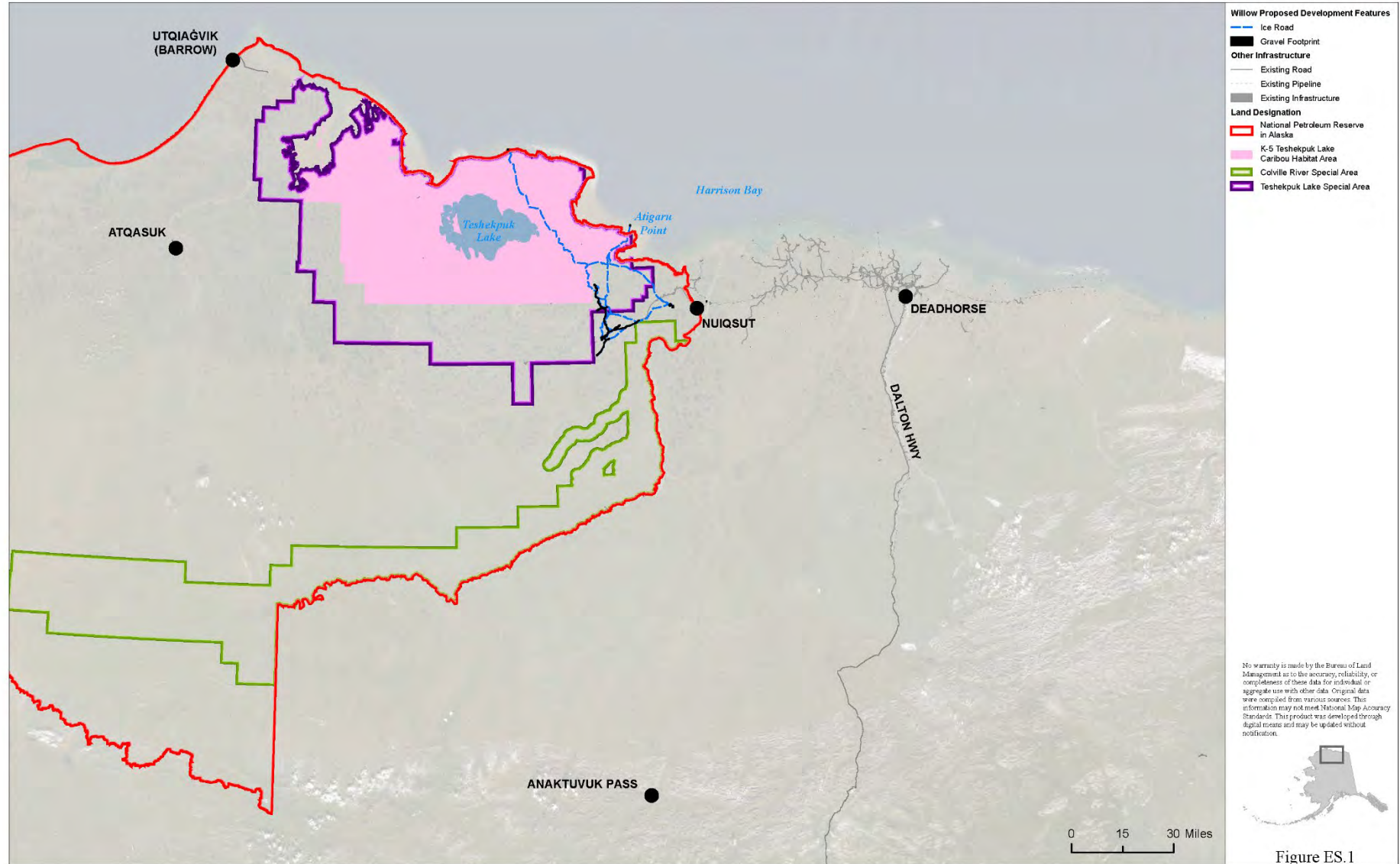


Figure ES.1. Willow Project Vicinity, North Slope, Alaska

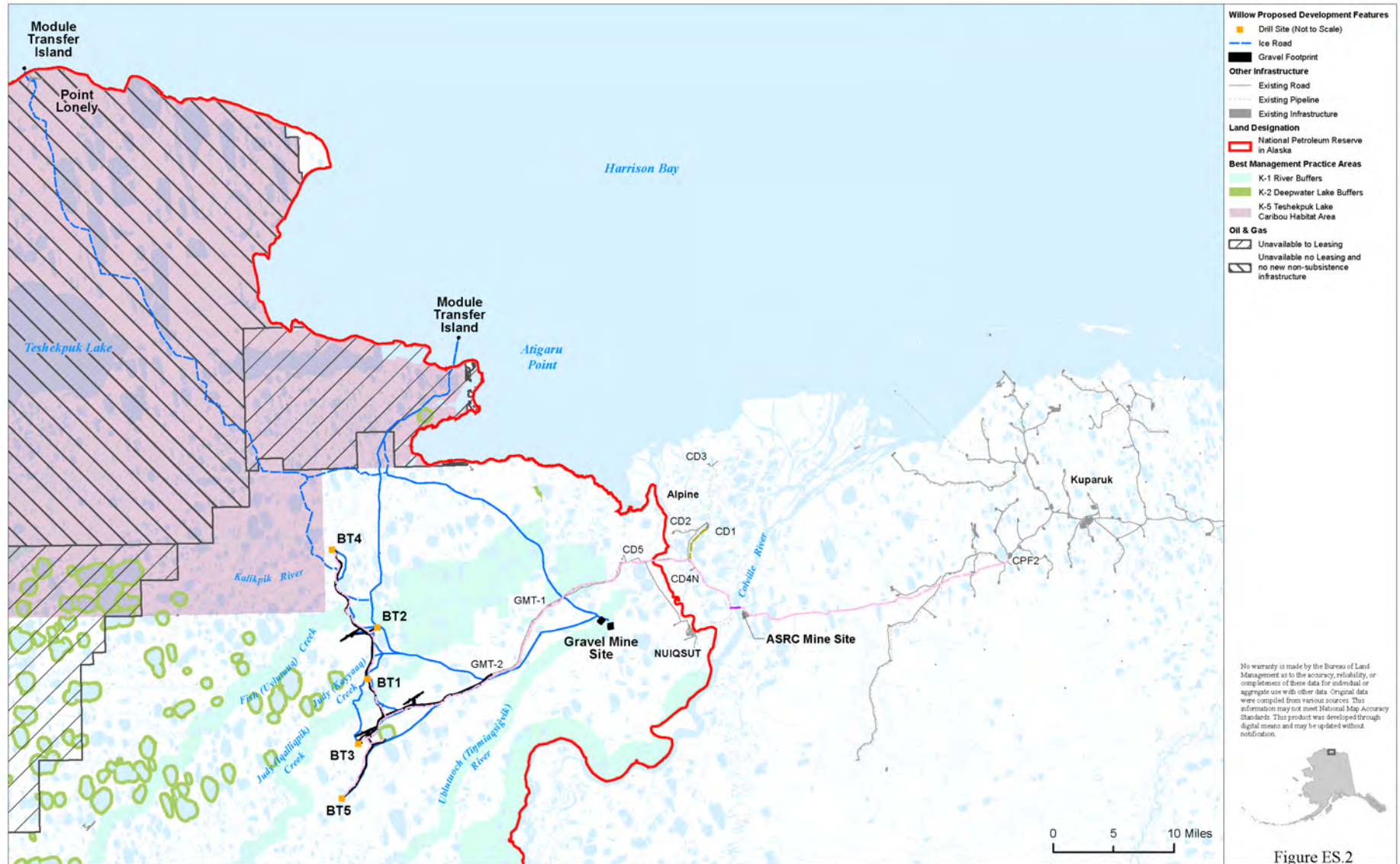


Figure ES.2. Willow Project Area and Alternatives

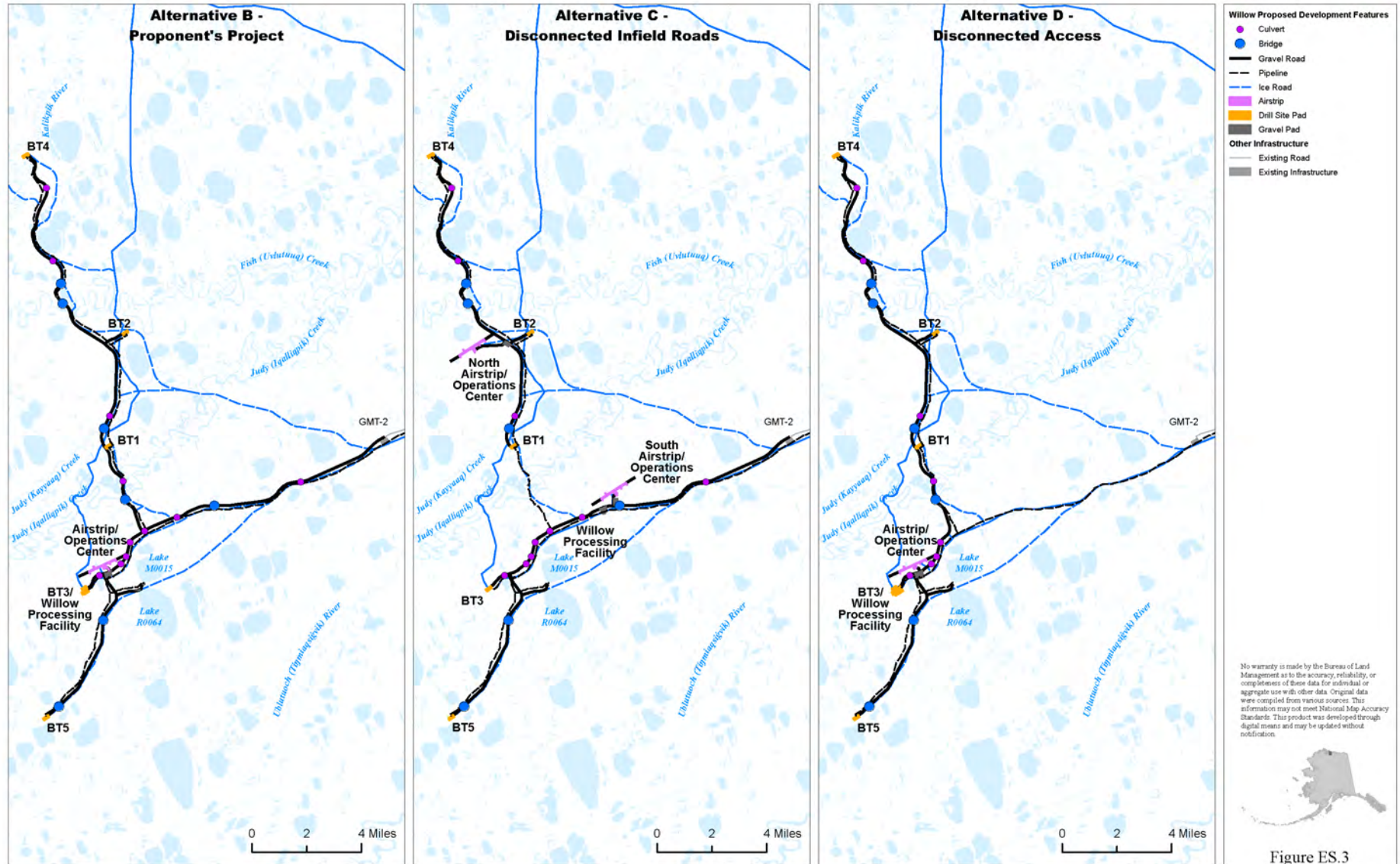


Figure ES.3. Comparison of Action Alternatives

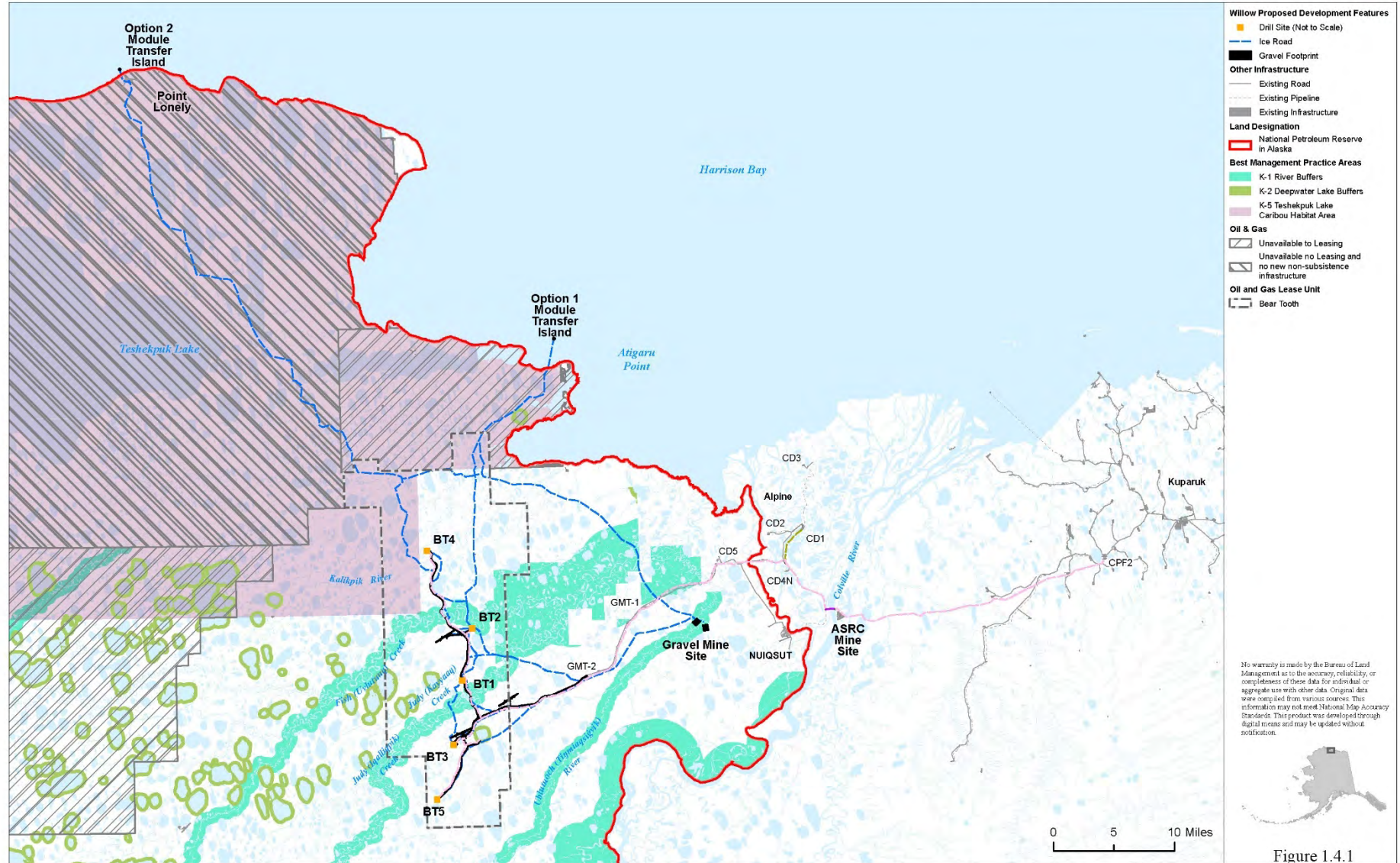


Figure 1.4.1. Willow Development Location

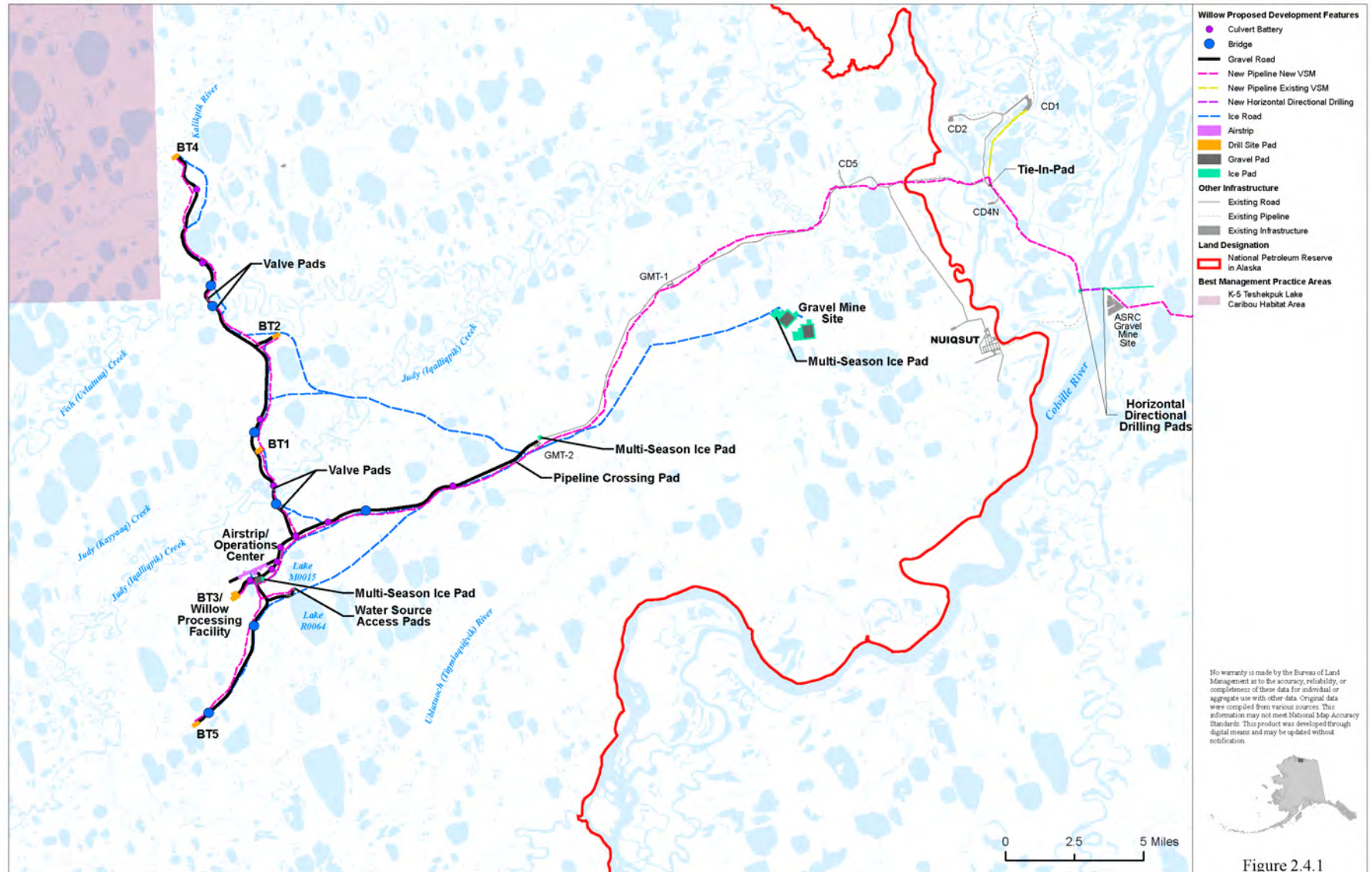


Figure 2.4.1

Figure 2.4.1. Alternative B: Proponent's Project

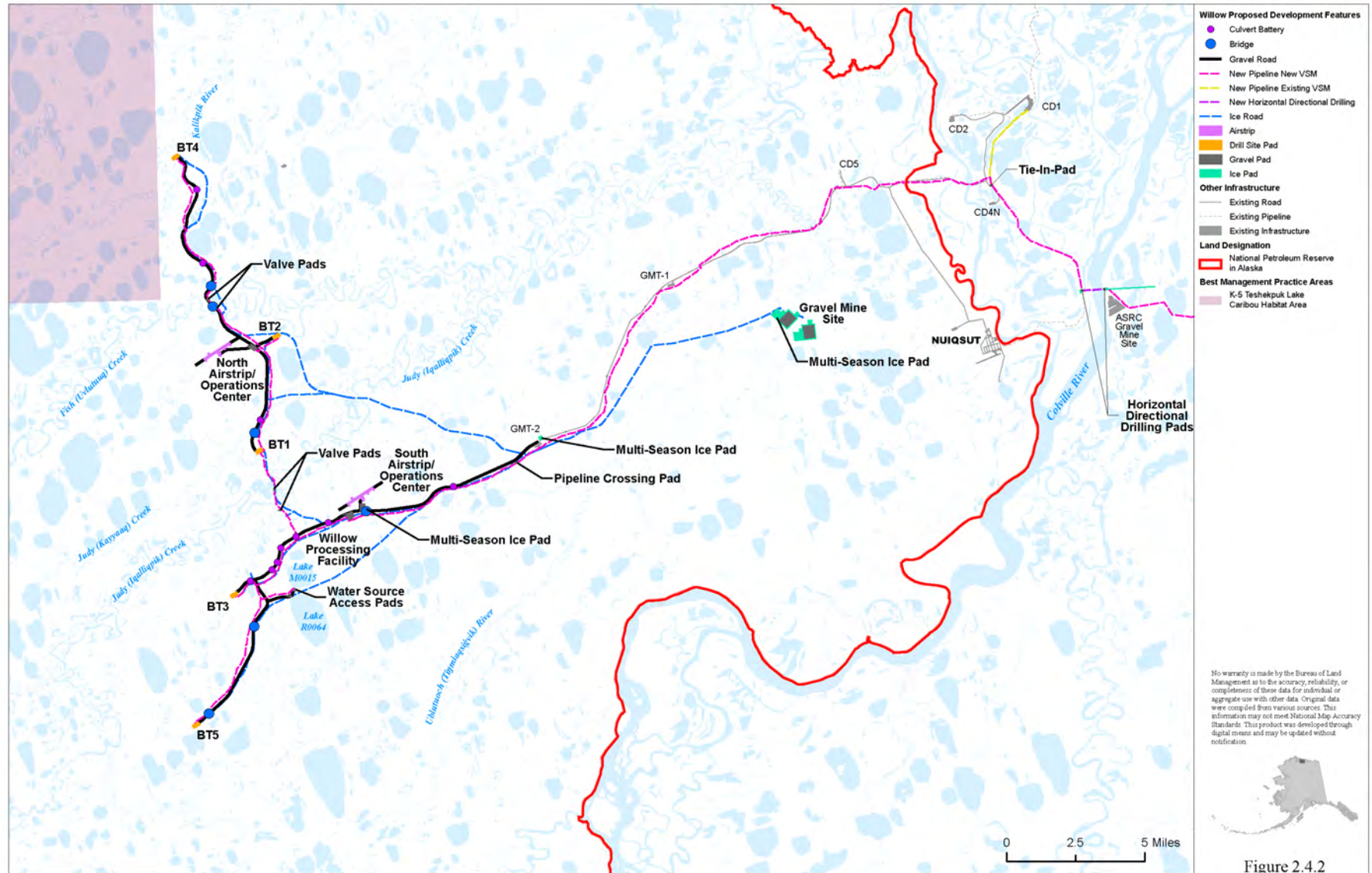


Figure 2.4.2. Alternative C: Disconnected Infield Roads

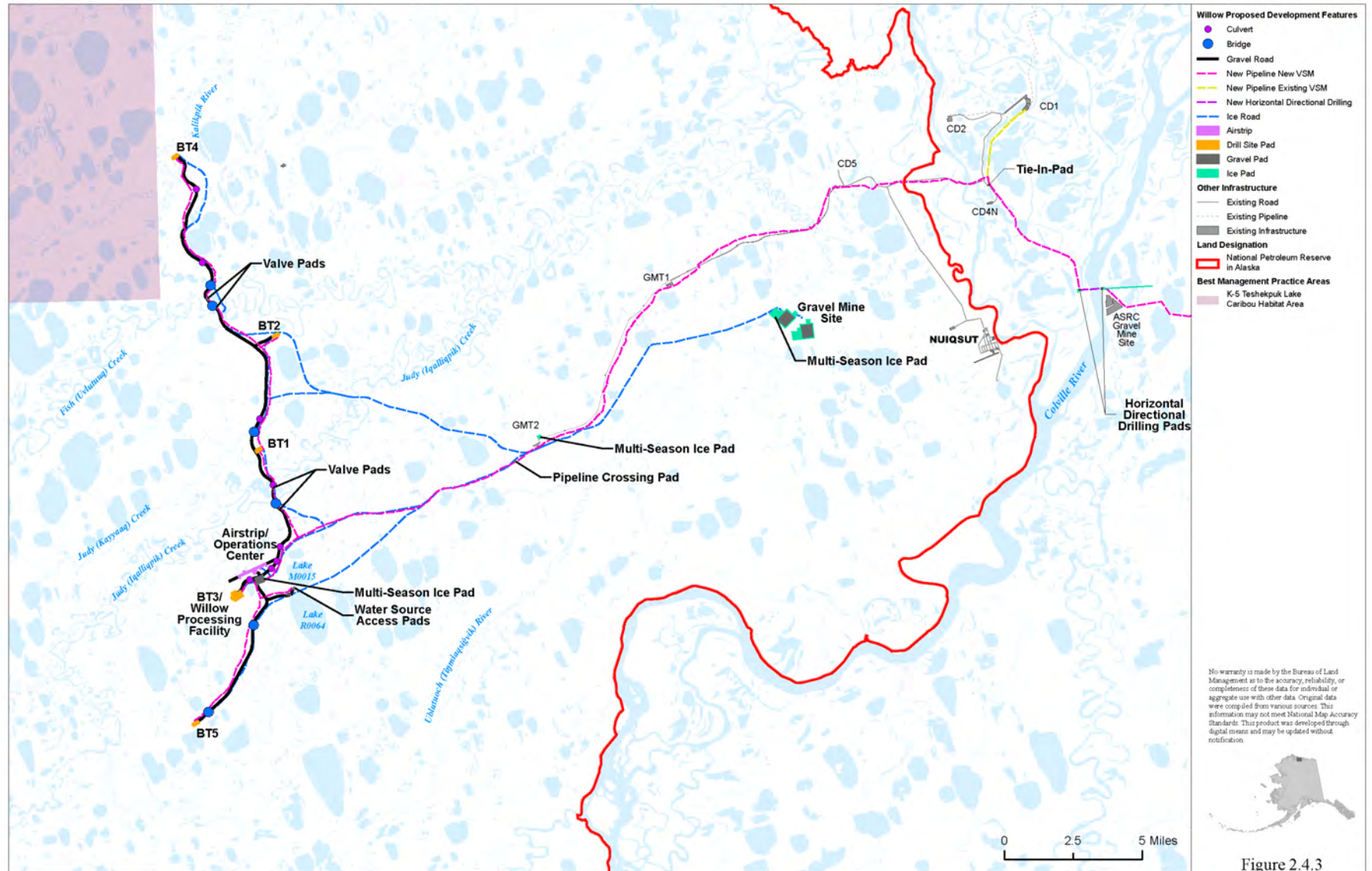


Figure 2.4.3

Figure 2.4.3. Alternative D: Disconnected Access

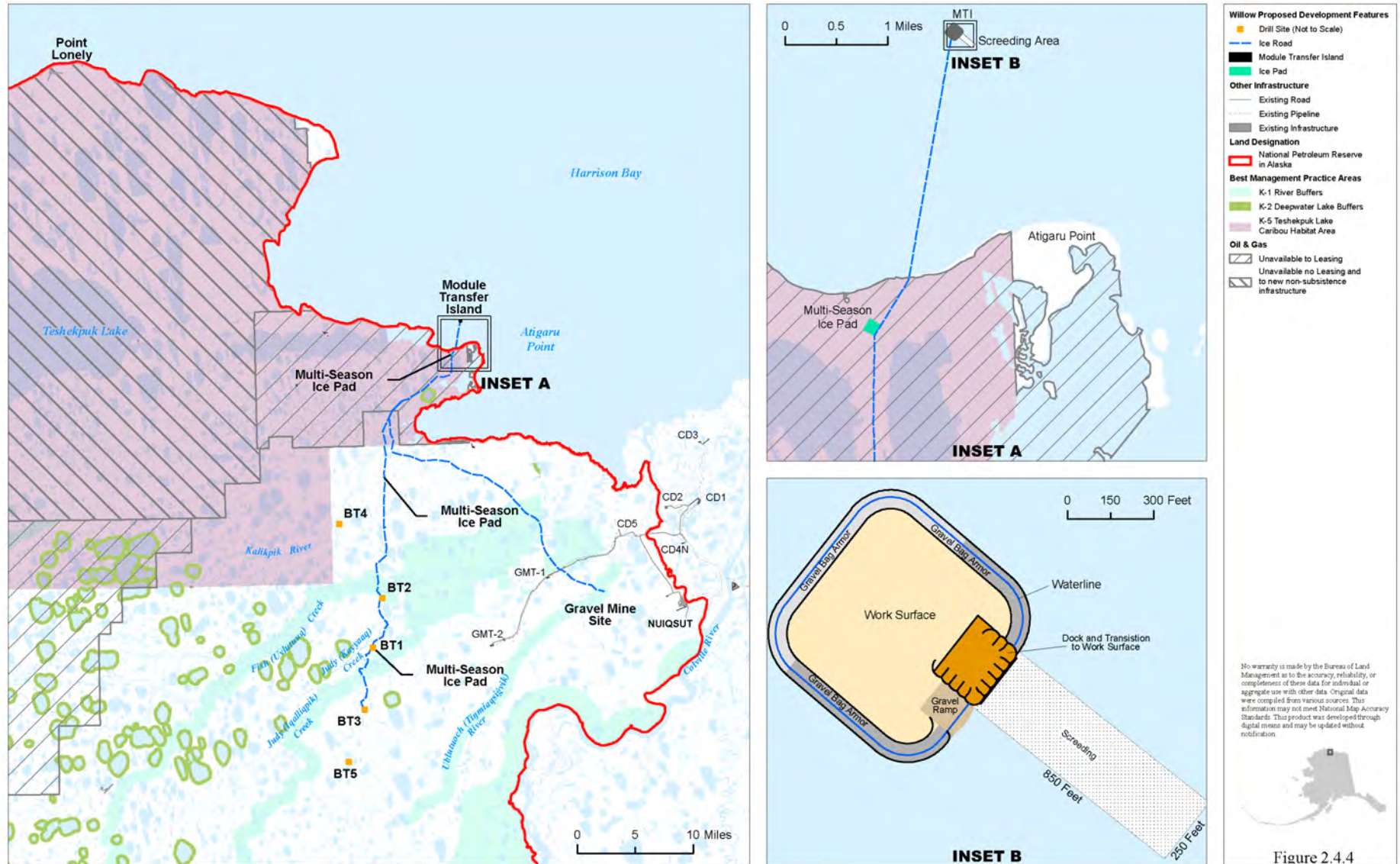


Figure 2.4.4. Option 1: Proponent's Module Transfer Island

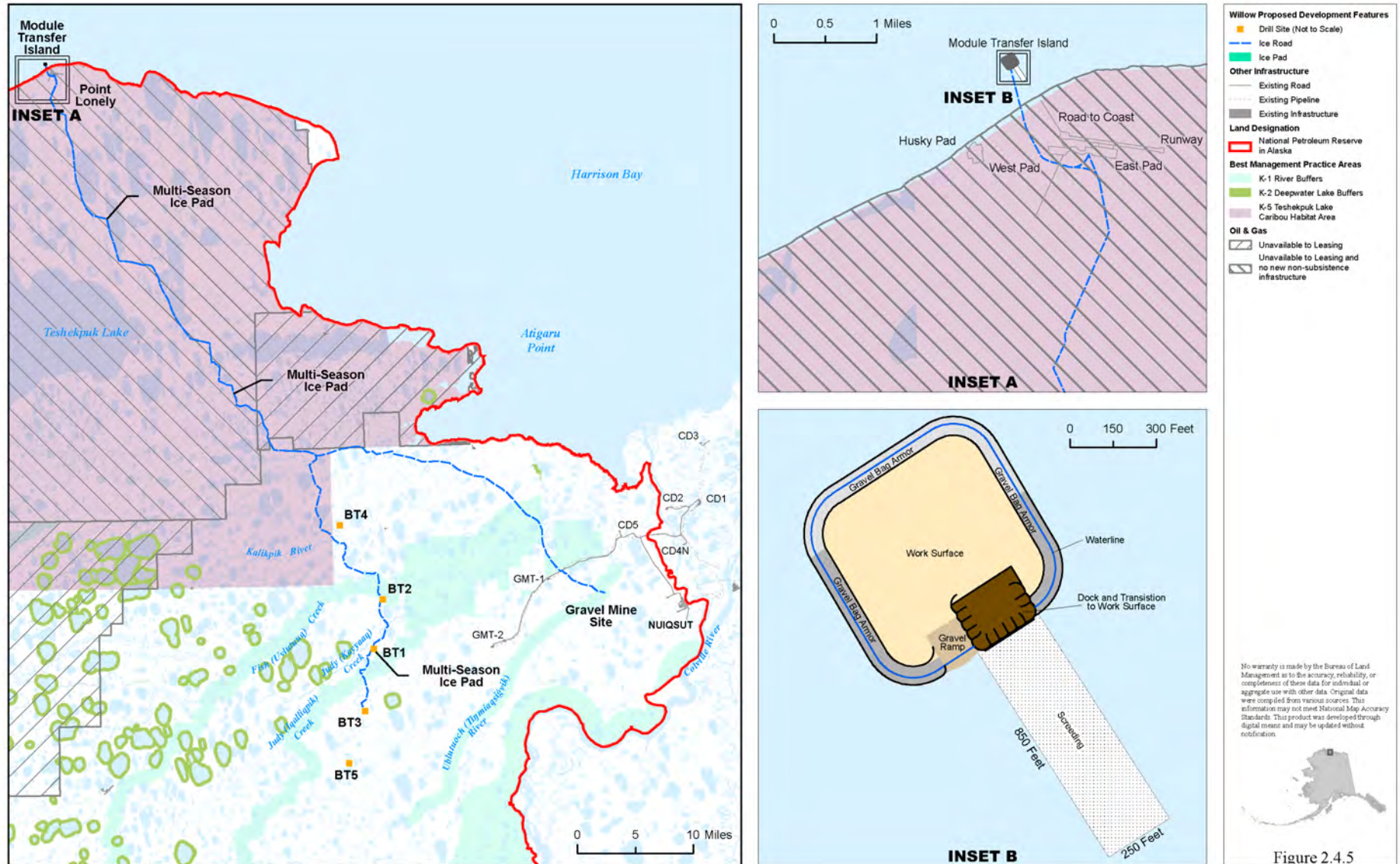


Figure 2.4.5. Option 2: Point Lonely Module Transfer Island

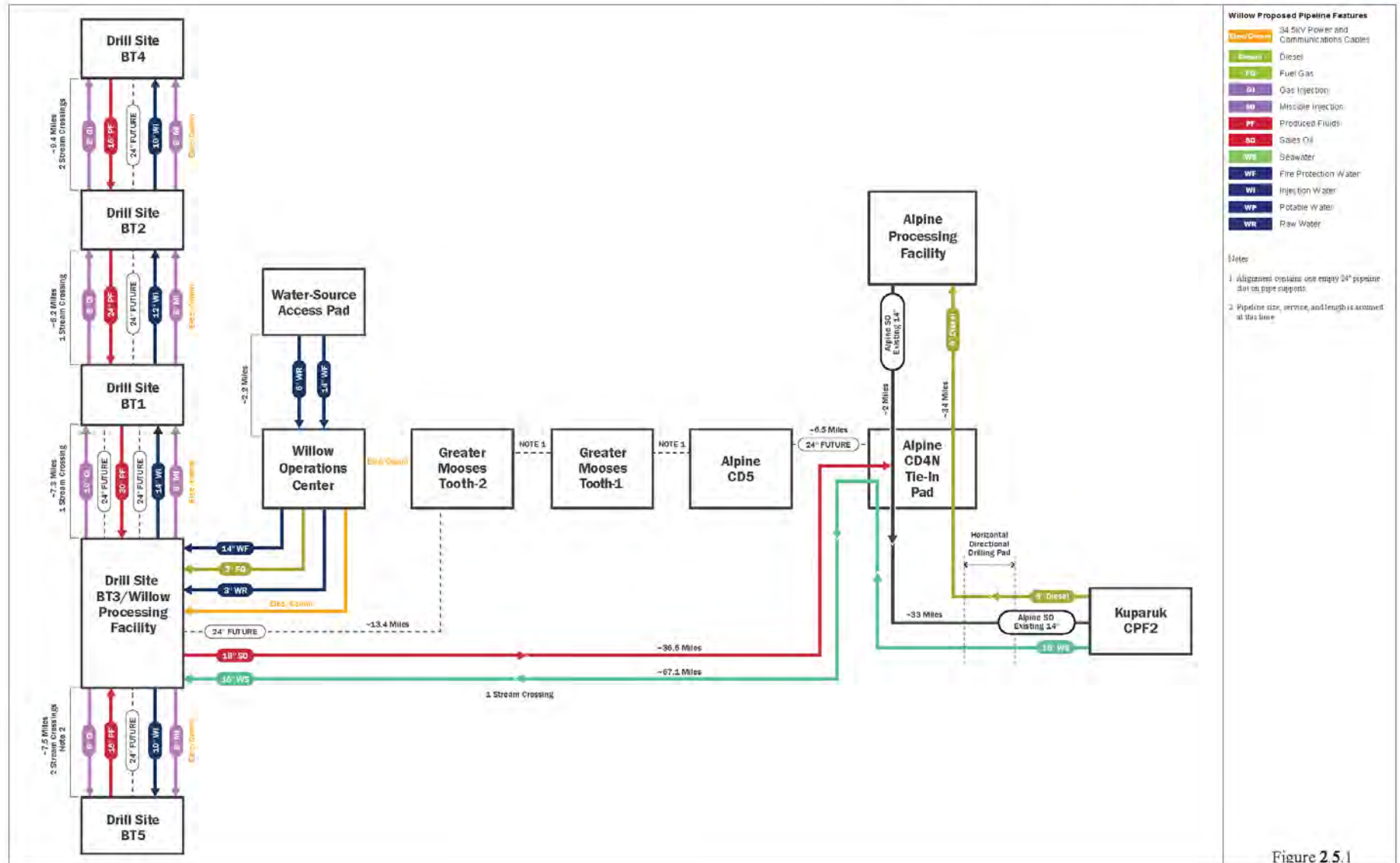


Figure 2.5.1

Figure 2.5.1. Alternative B Pipeline Schematic

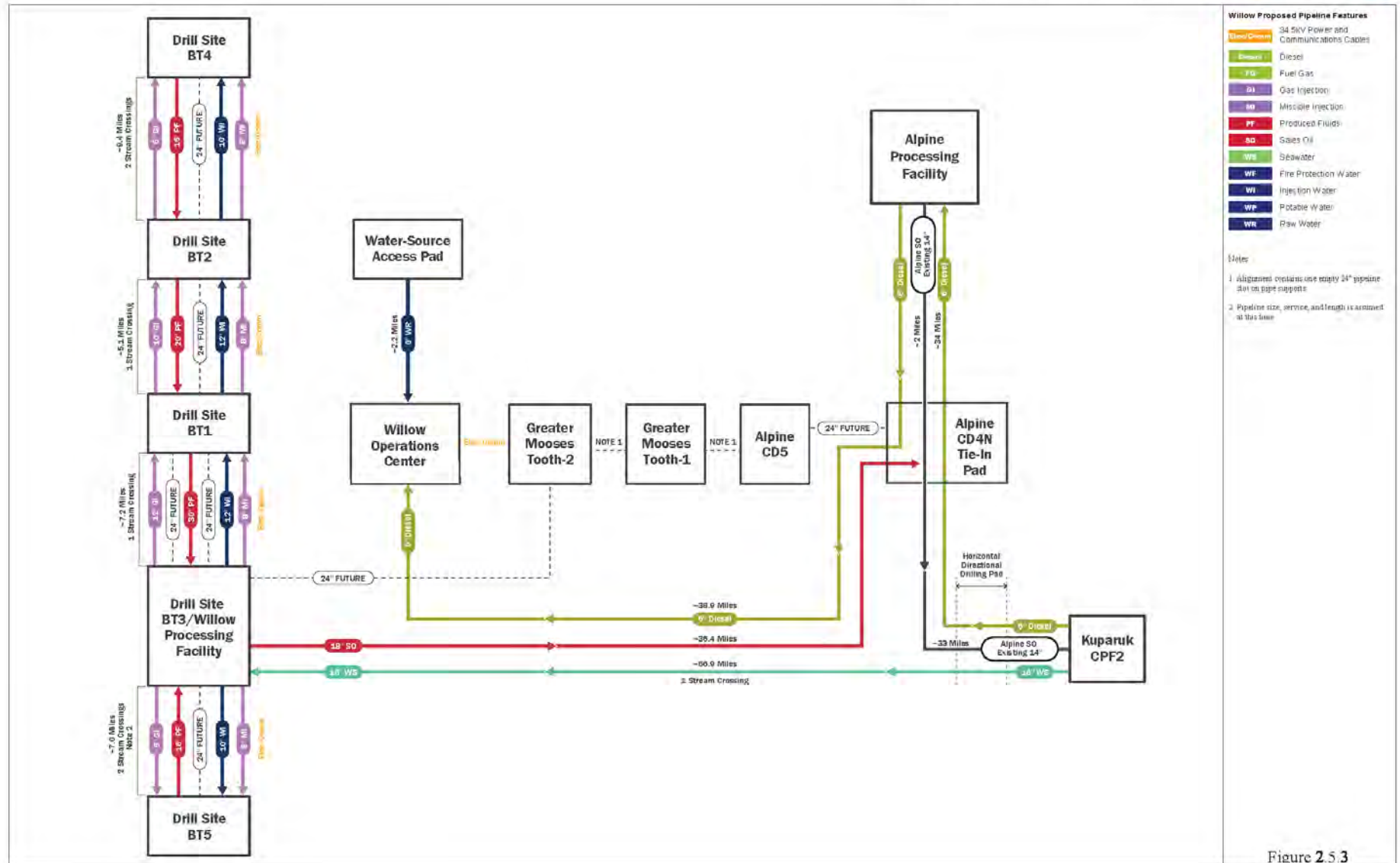


Figure 2.5.3. Alternative D Pipeline Schematic

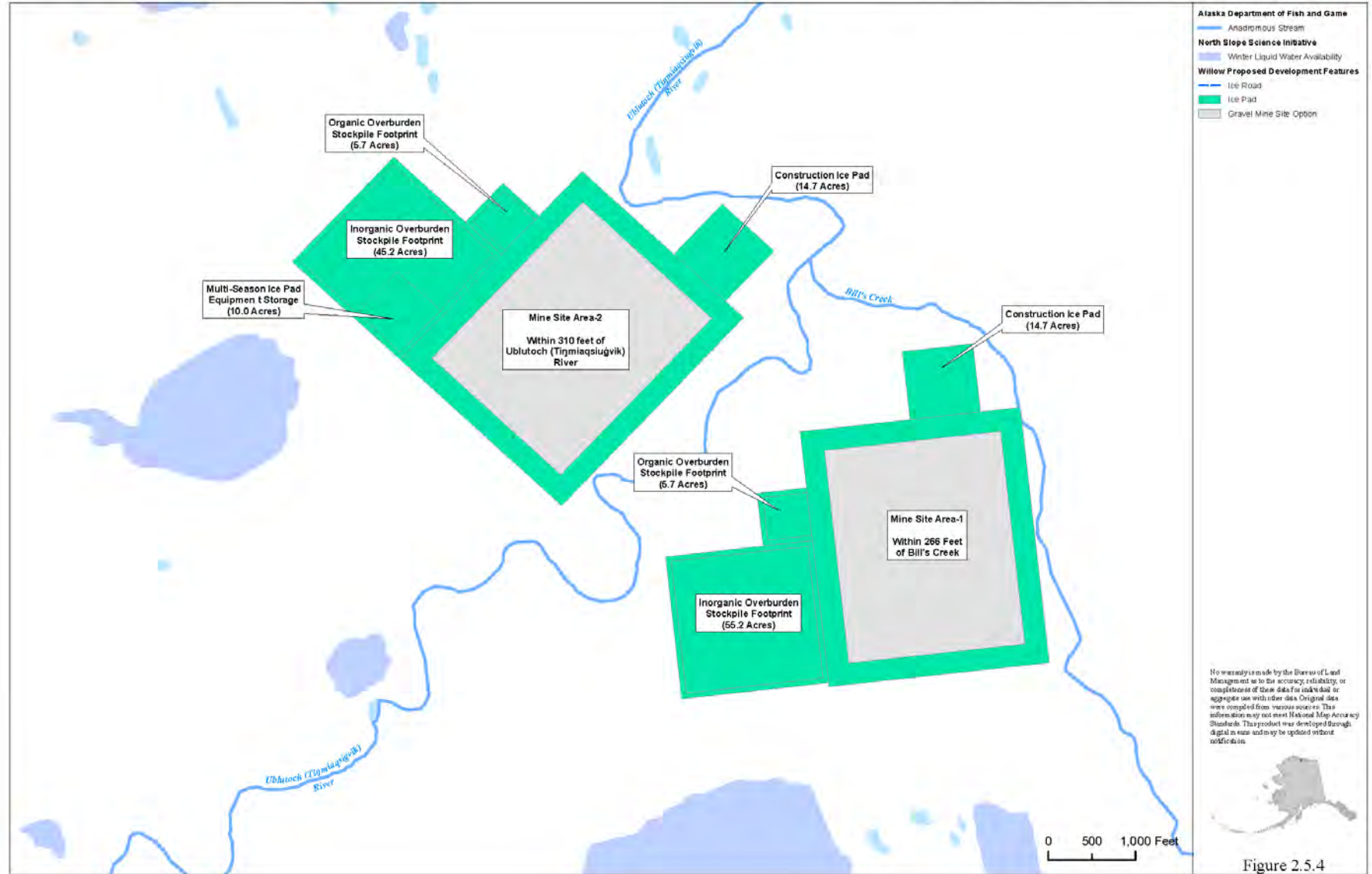


Figure 2.5.4

Figure 2.5.4. Tigmiagsiugvik Gravel Mine Site

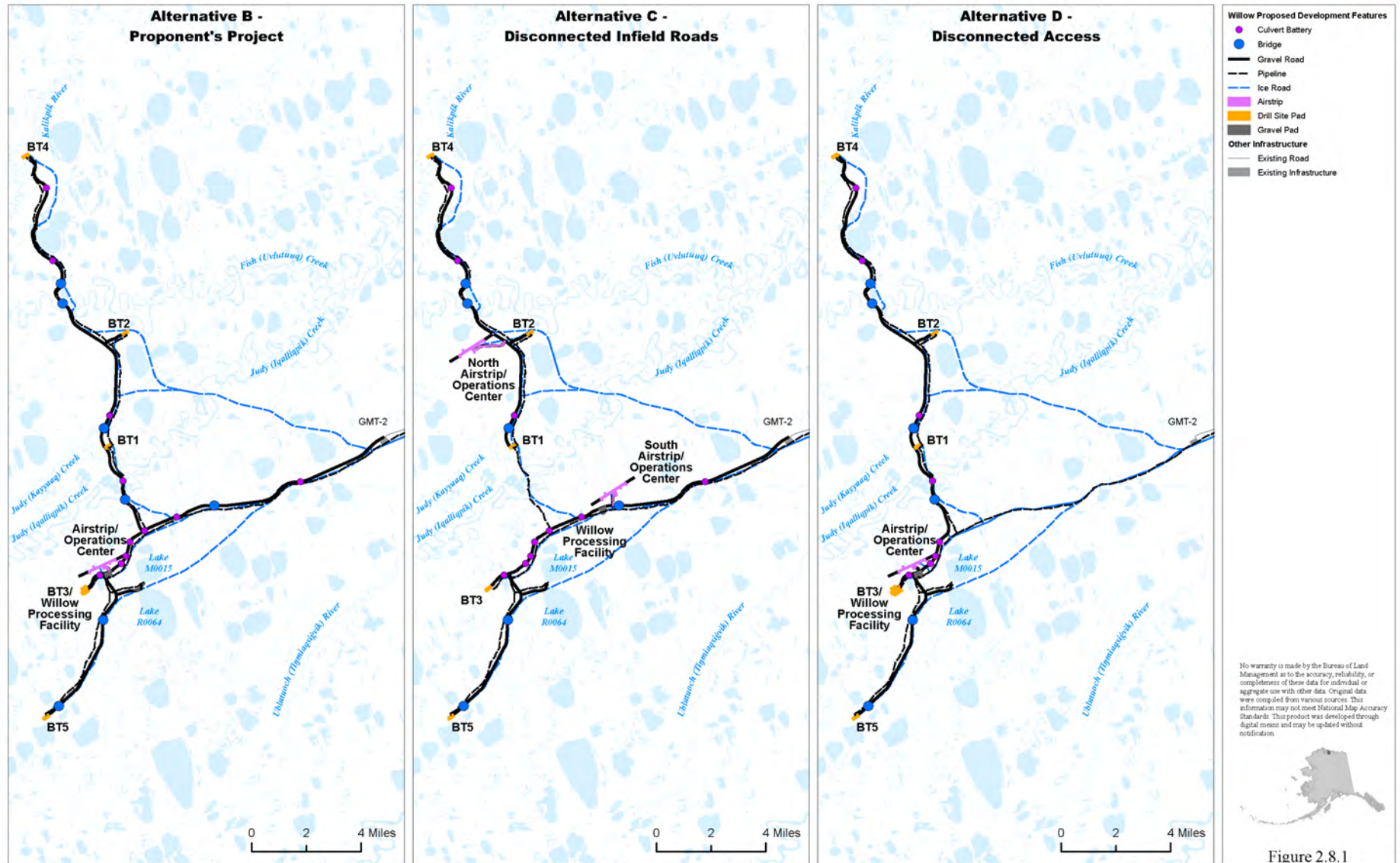


Figure 2.8.1. Comparison of Action Alternatives

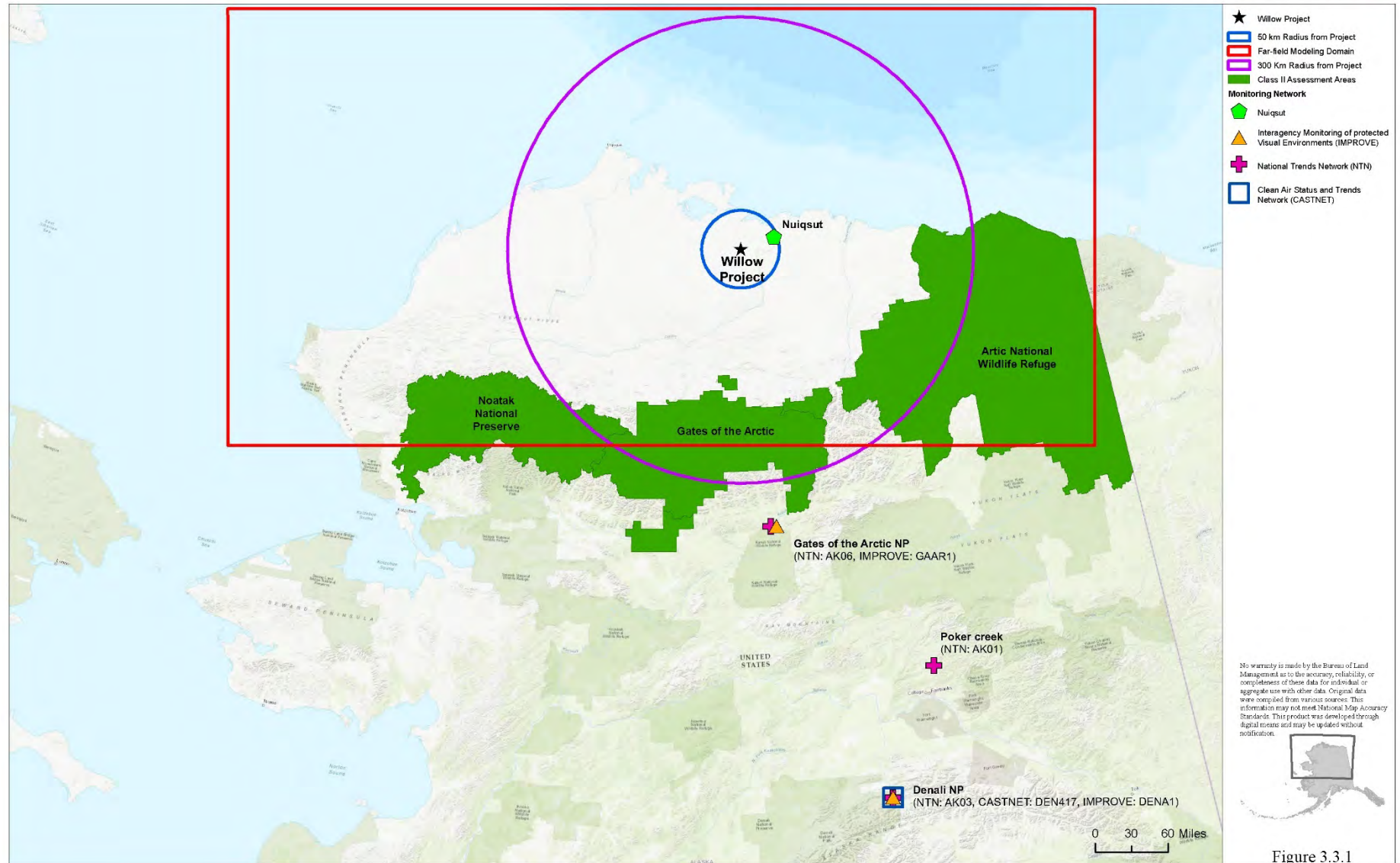


Figure 3.3.1

Figure 3.3.1. Analysis Area for Air Quality

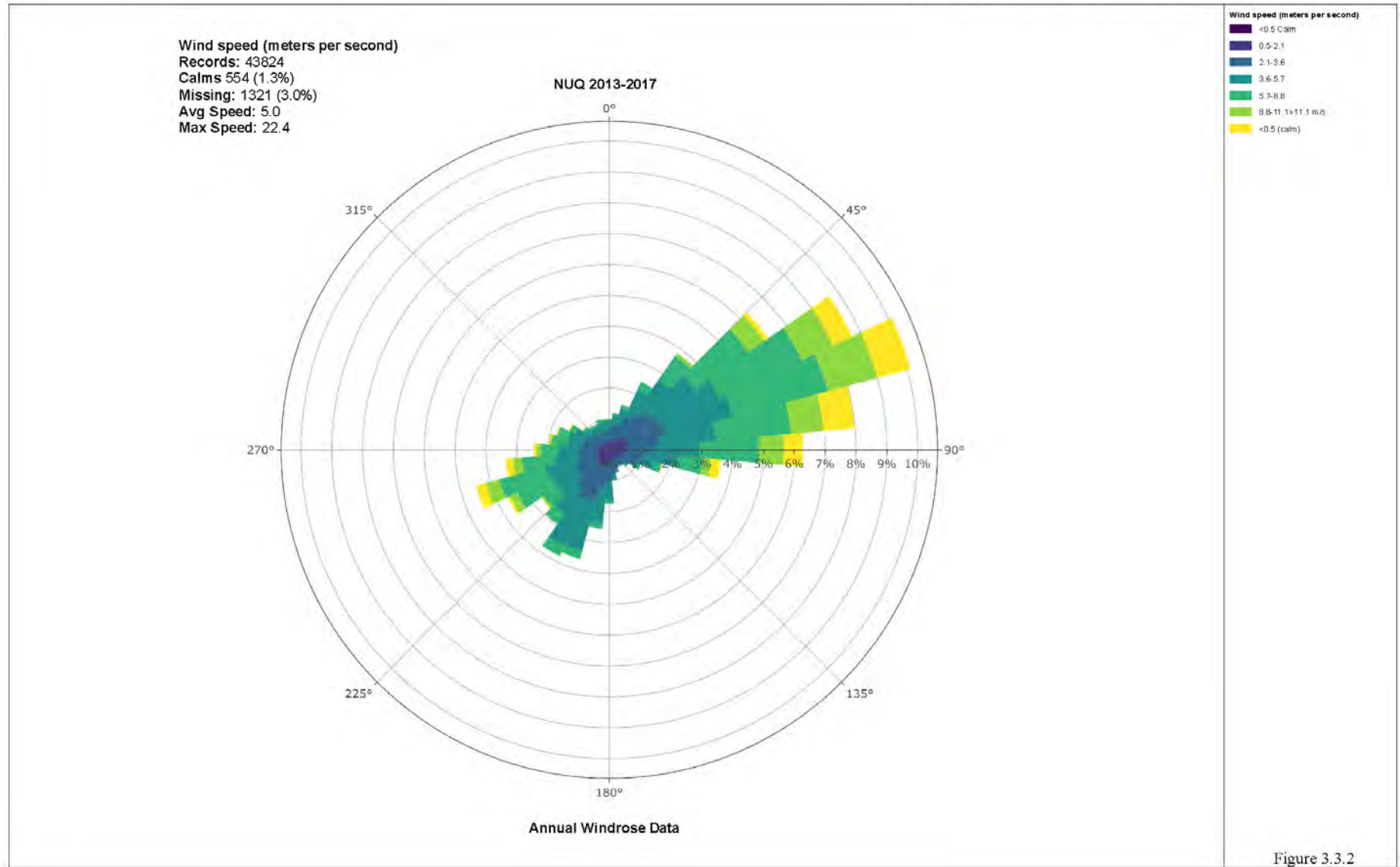


Figure 3.3.2. Nuiqsut Monitoring Station Wind Rose



Figure 3.4.1. Analysis Area for Soils, Permafrost, and Gravel Resources

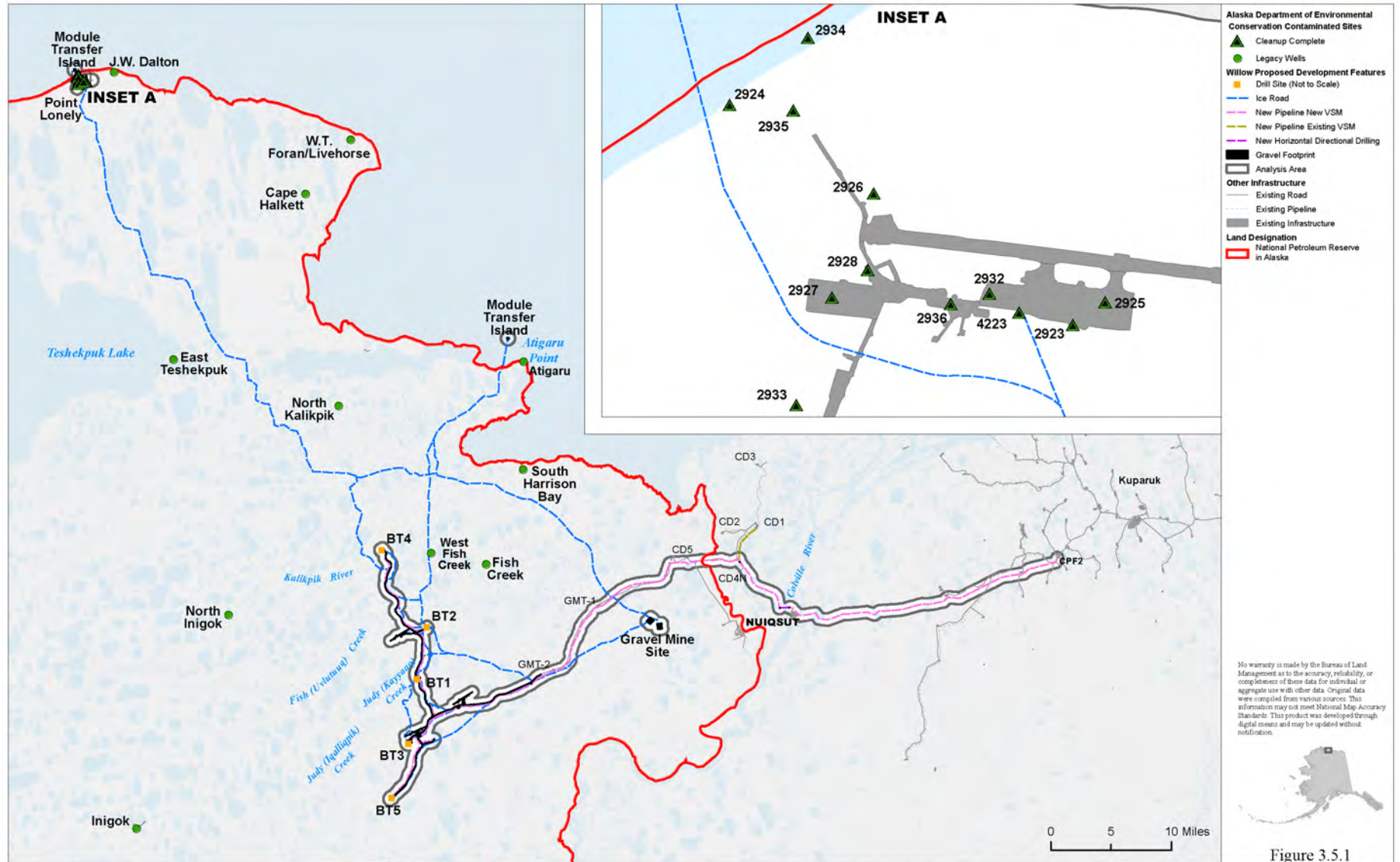


Figure 3.5.1

Figure 3.5.1. Known Contaminated Sites or Spills within 0.5 mile of the Project



Figure 3.6.1

Figure 3.6.1. Analysis Area for Noise

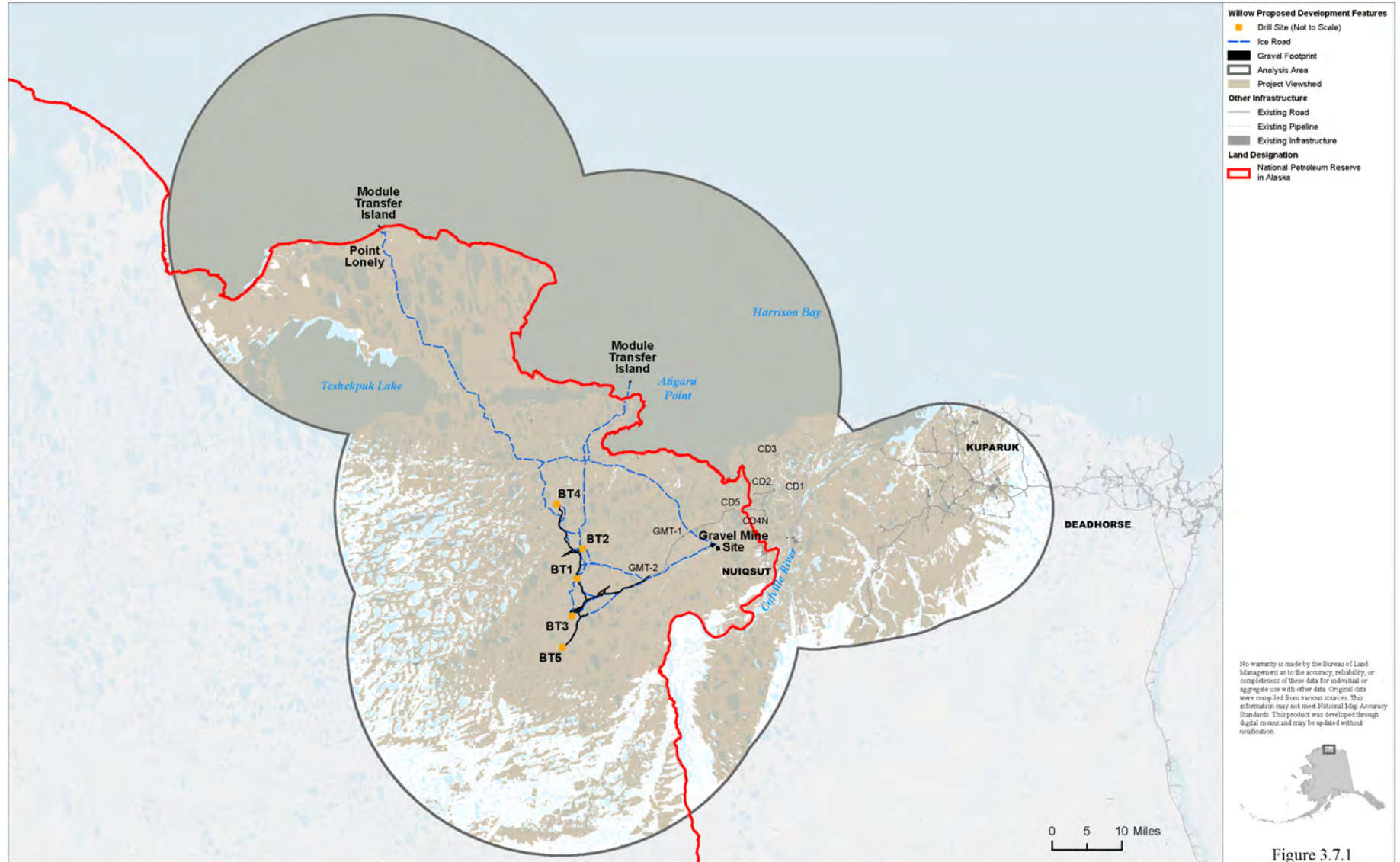


Figure 3.7.1. Visual Resources Analysis Area, Project Viewshed, and Proposed Project Facilities

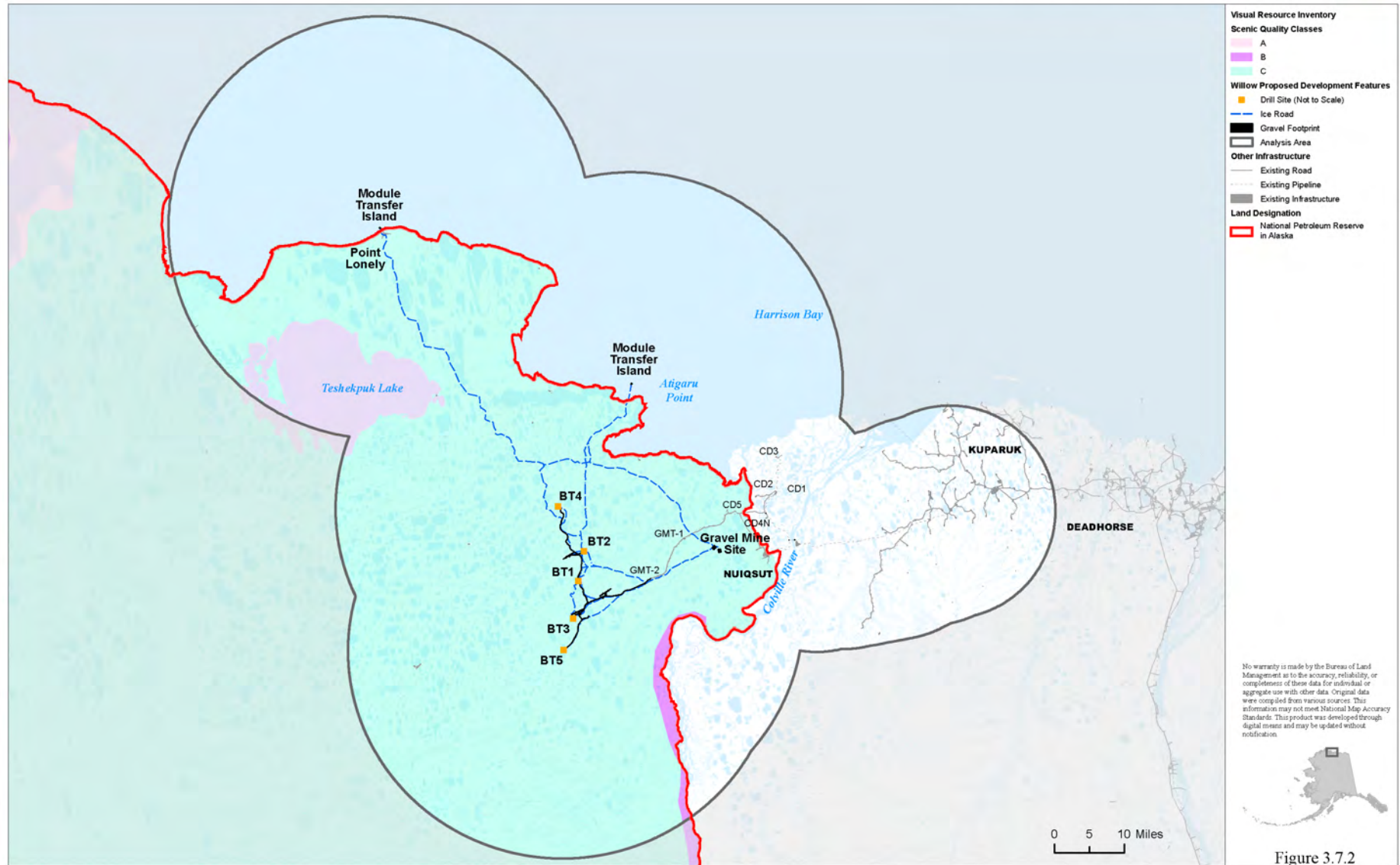


Figure 3.7.2. Visual Resource Inventory Scenic Quality Classes

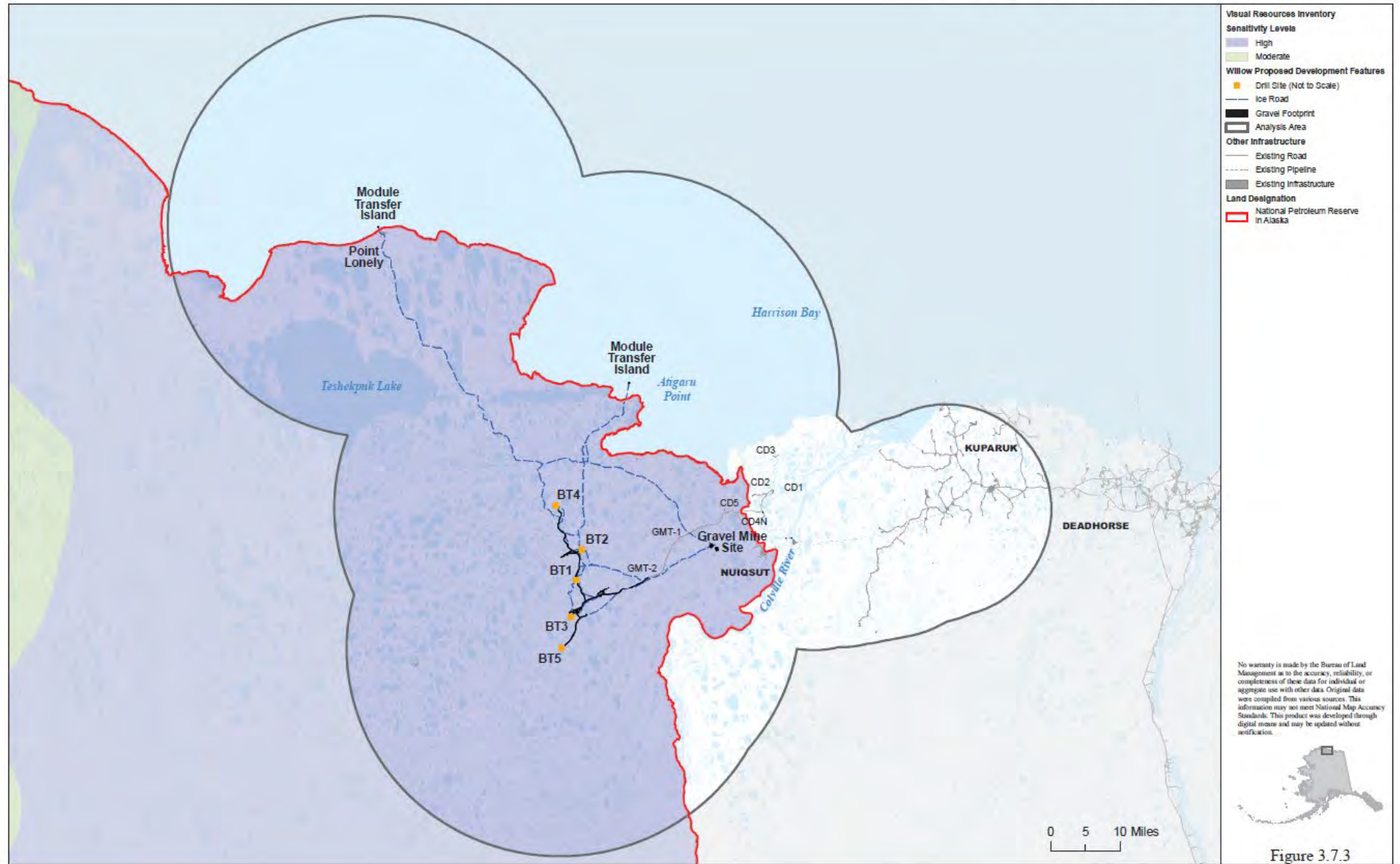


Figure 3.7.3

Figure 3.7.3. Visual Resource Inventory Sensitivity Levels

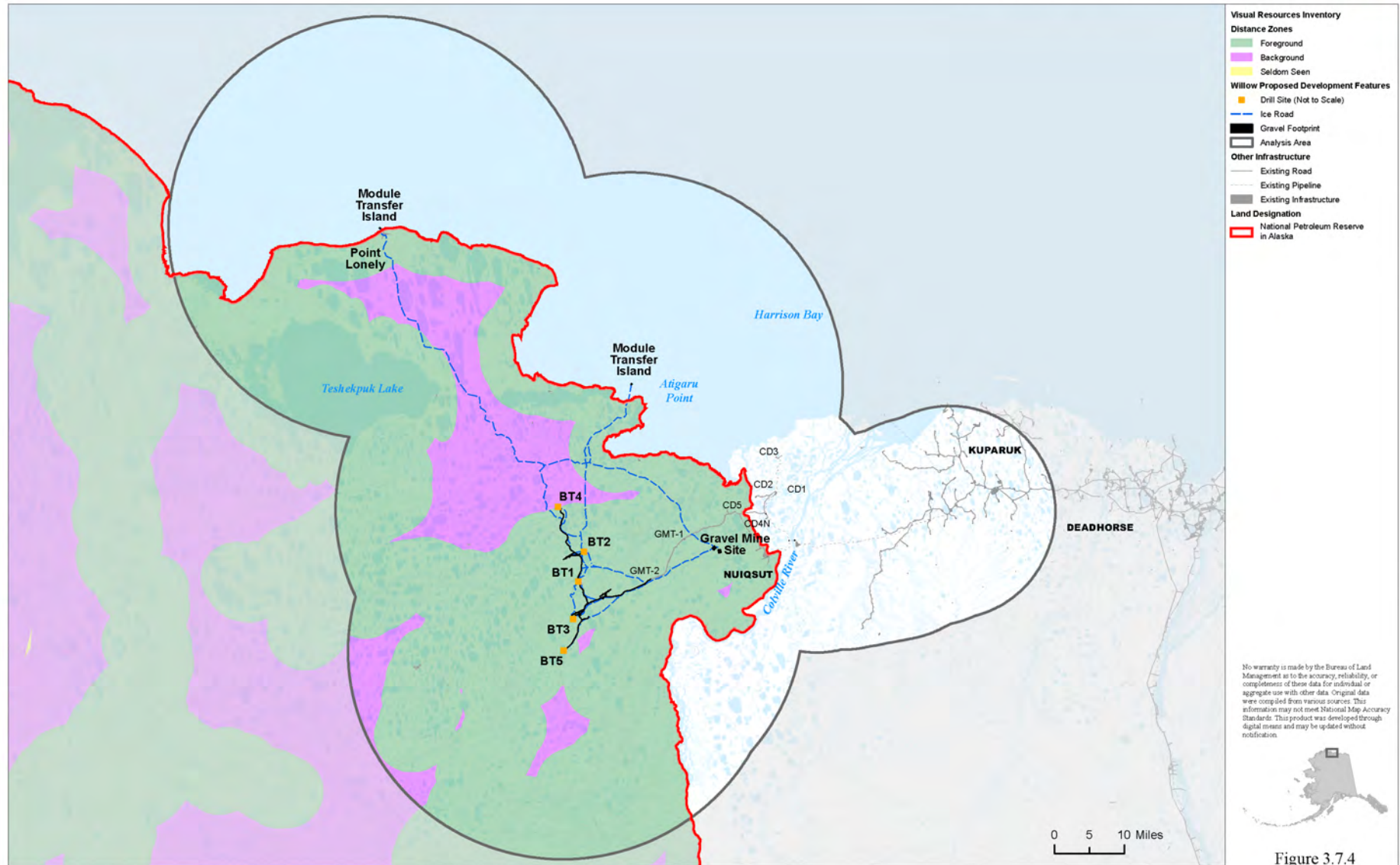


Figure 3.7.4. Visual Resource Inventory Distance Zones

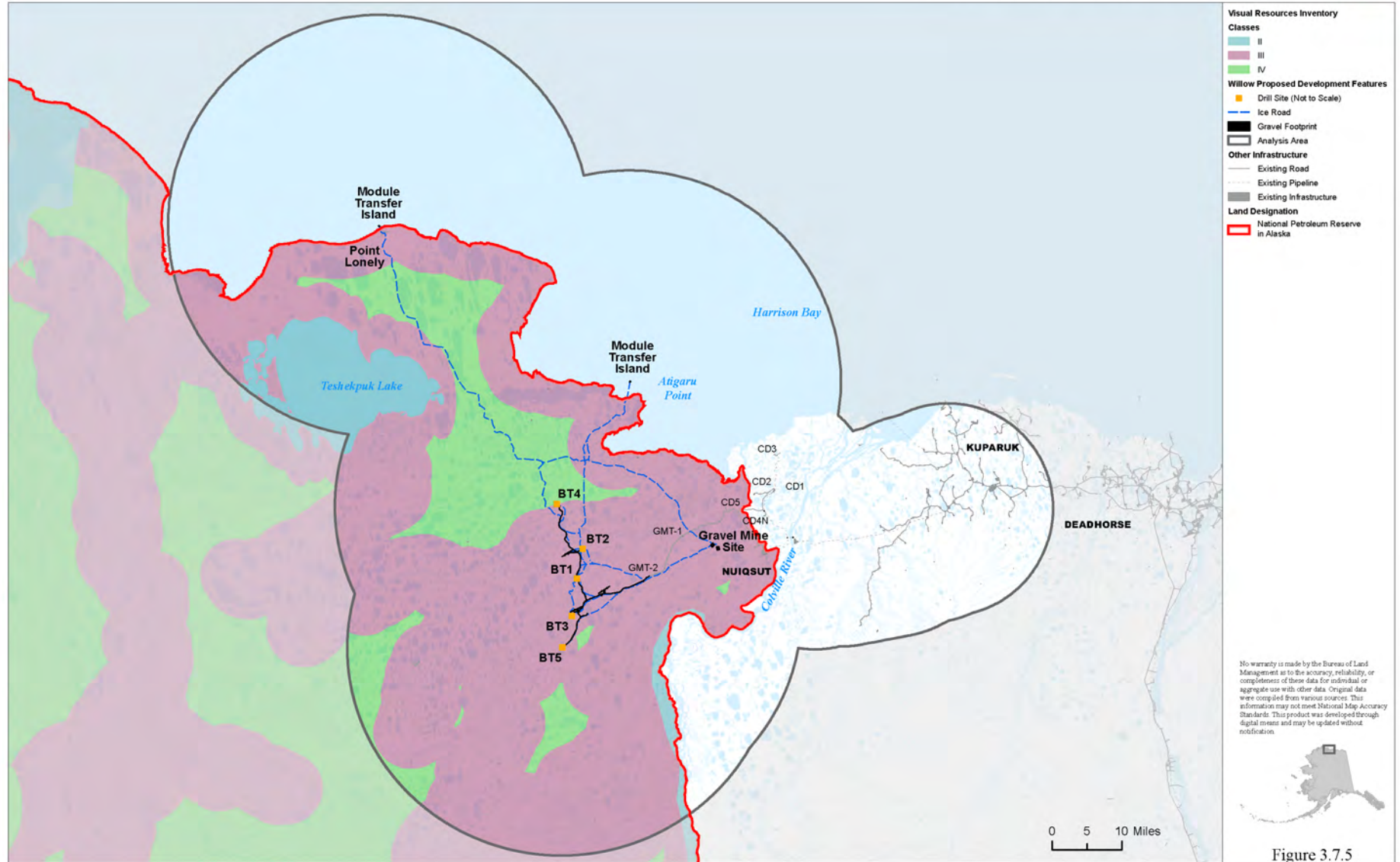


Figure 3.7.5

Figure 3.7.5. Visual Resource Inventory Classes

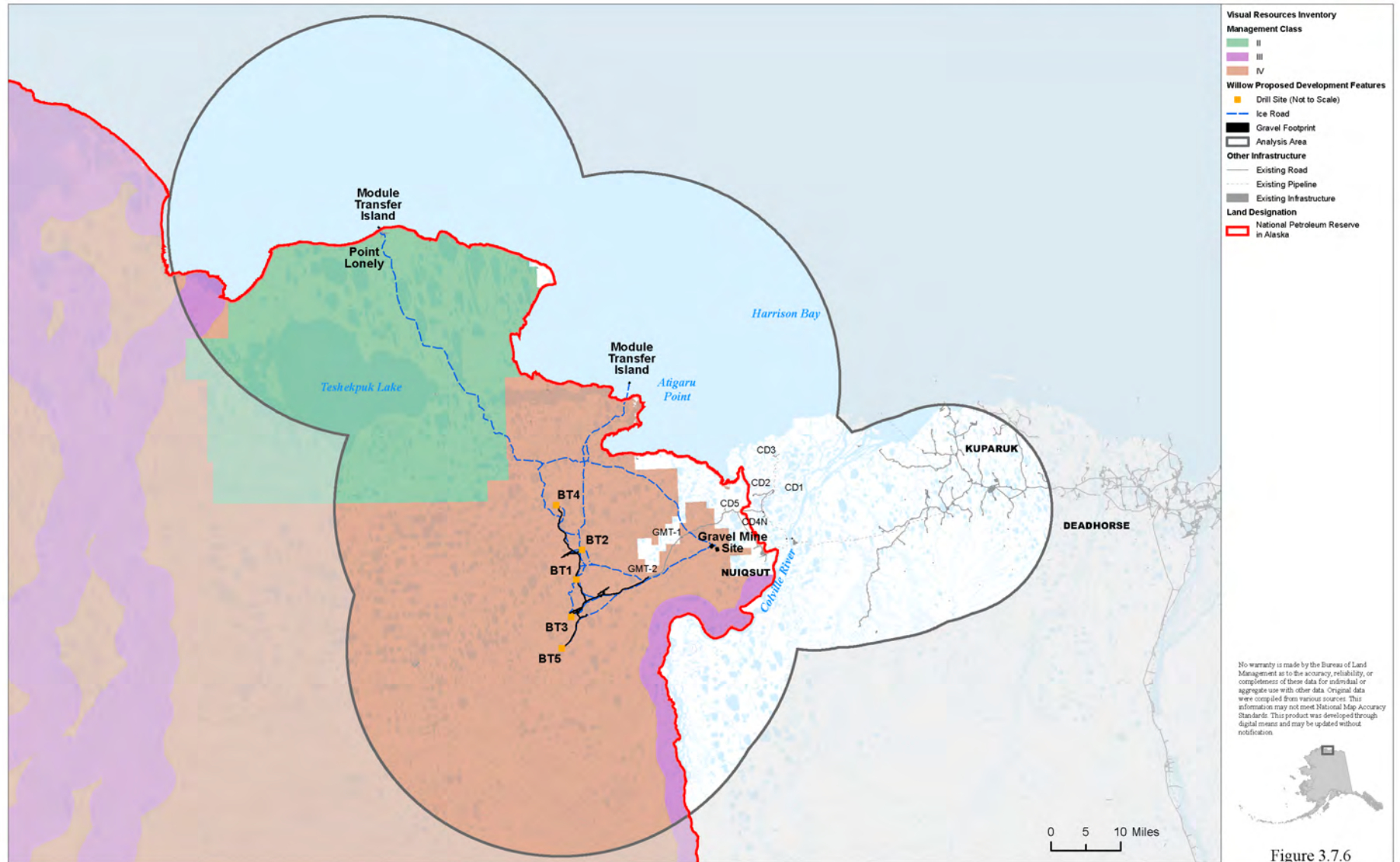


Figure 3.7.6

Figure 3.7.6. Visual Resource Management Classes

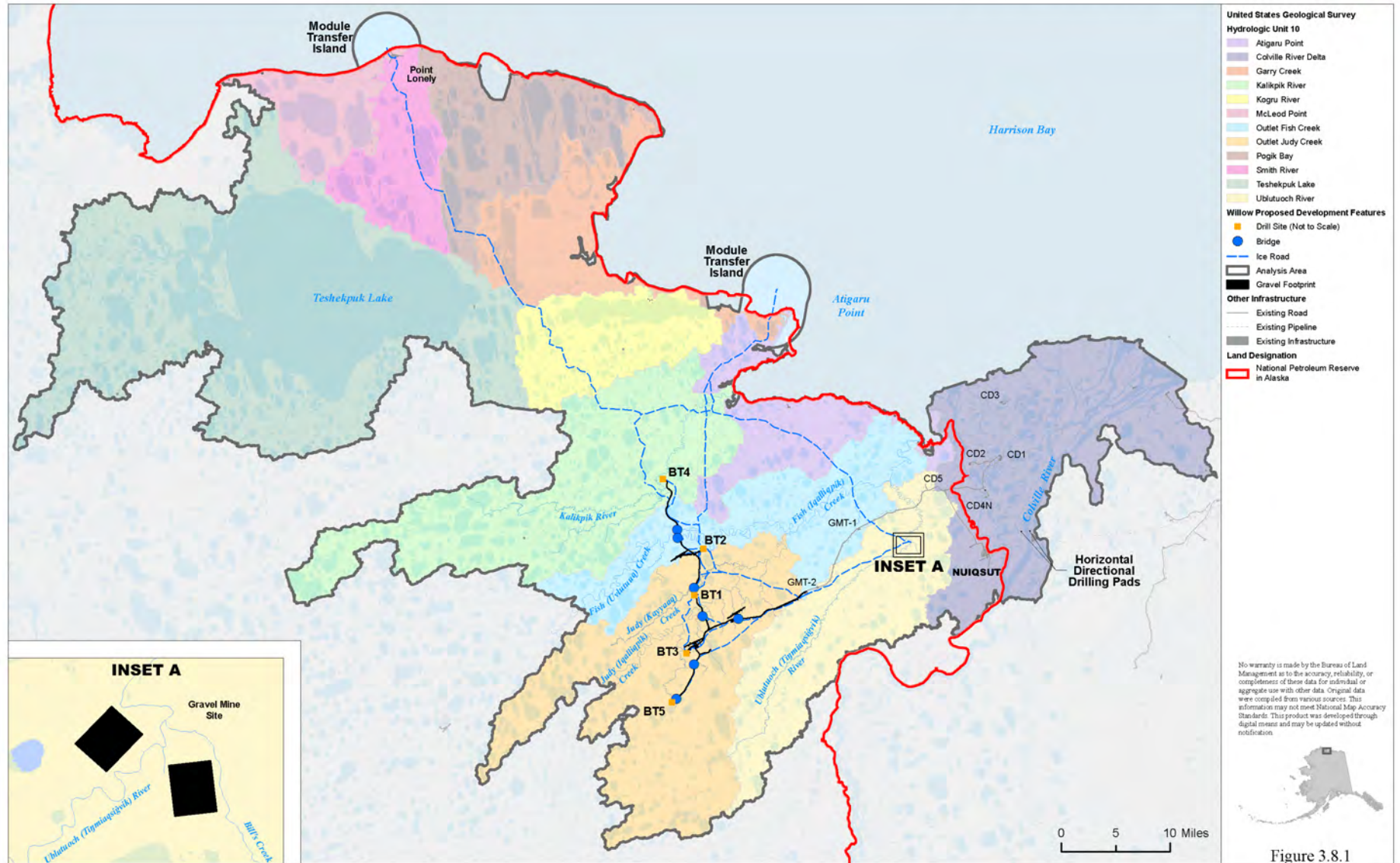


Figure 3.8.1. Watersheds in the Analysis Area for Water Resources

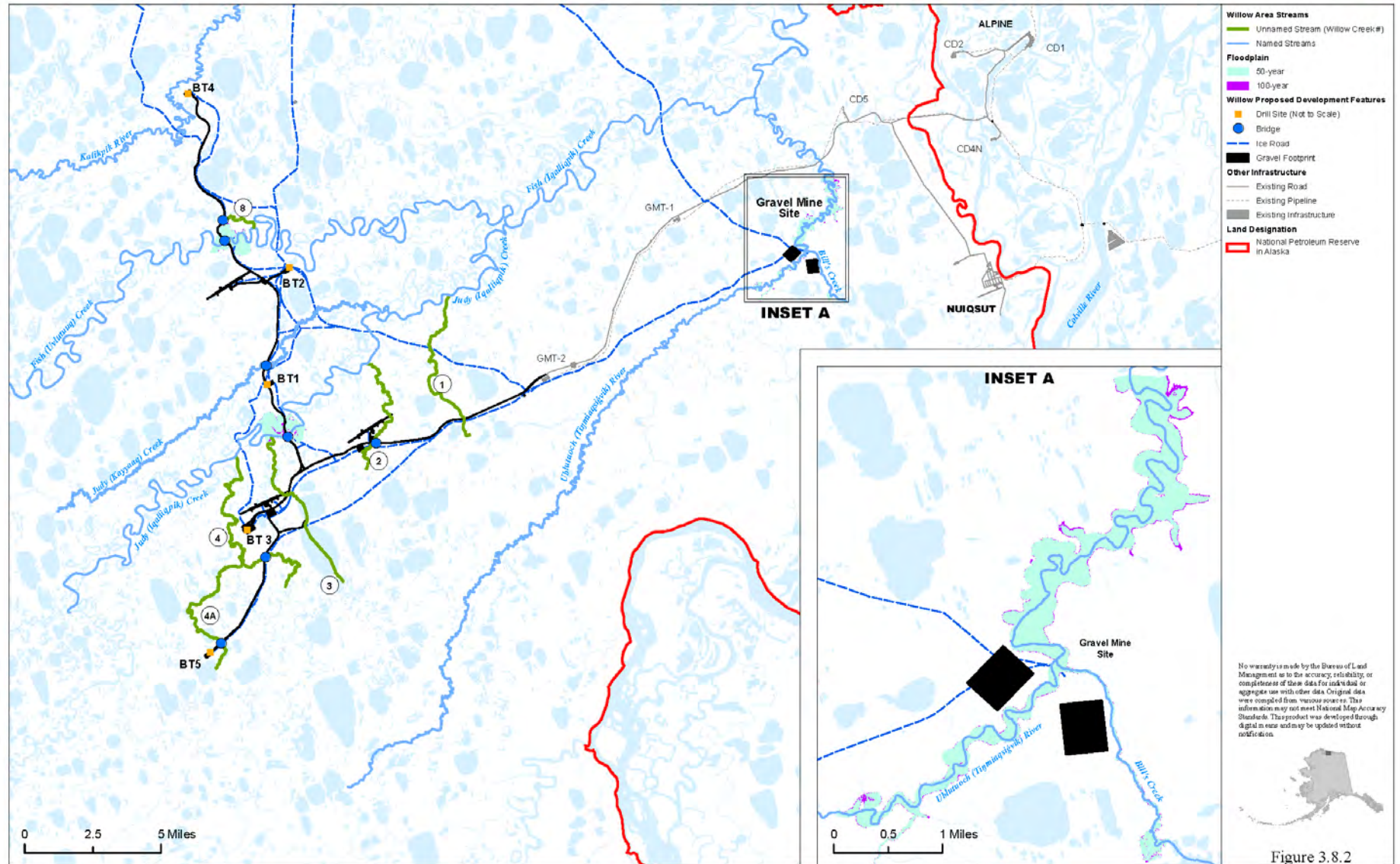


Figure 3.8.2. Streams and Floodplains in the Willow Area

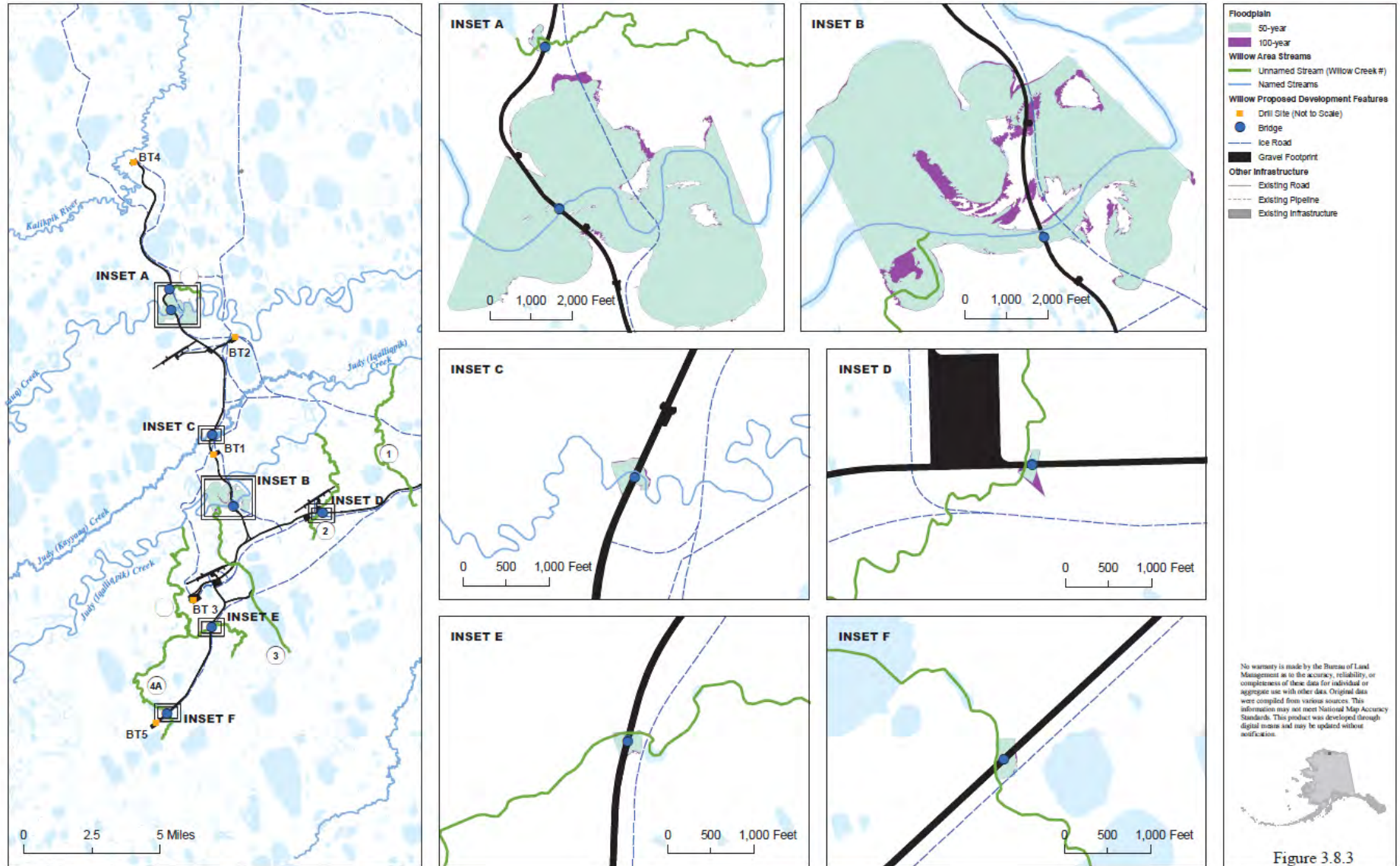


Figure 3.8.3

Figure 3.8.3. Floodplain Detail in the Willow Area

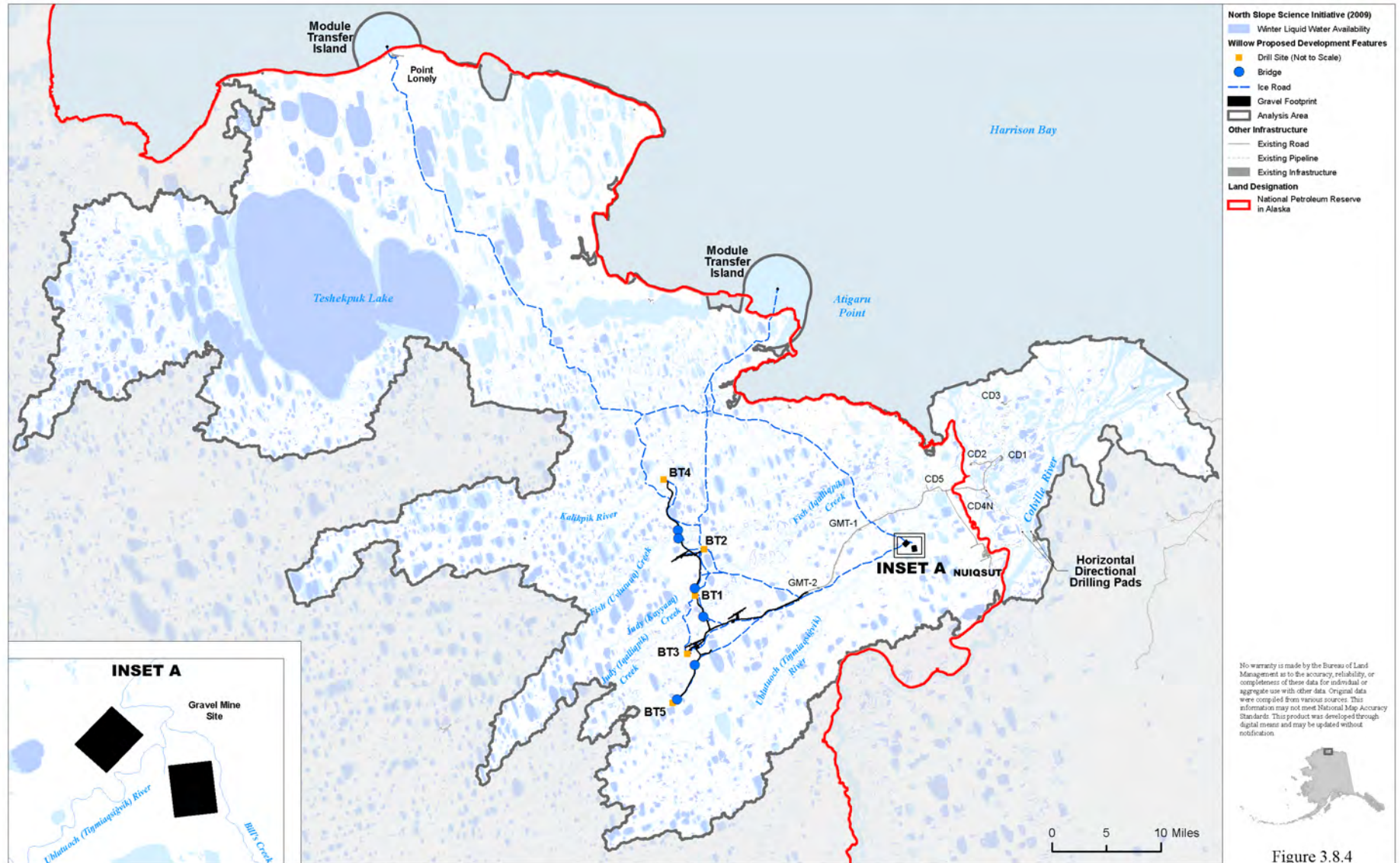


Figure 3.8.4

Figure 3.8.4. Lakes in the Water Resources Analysis Area

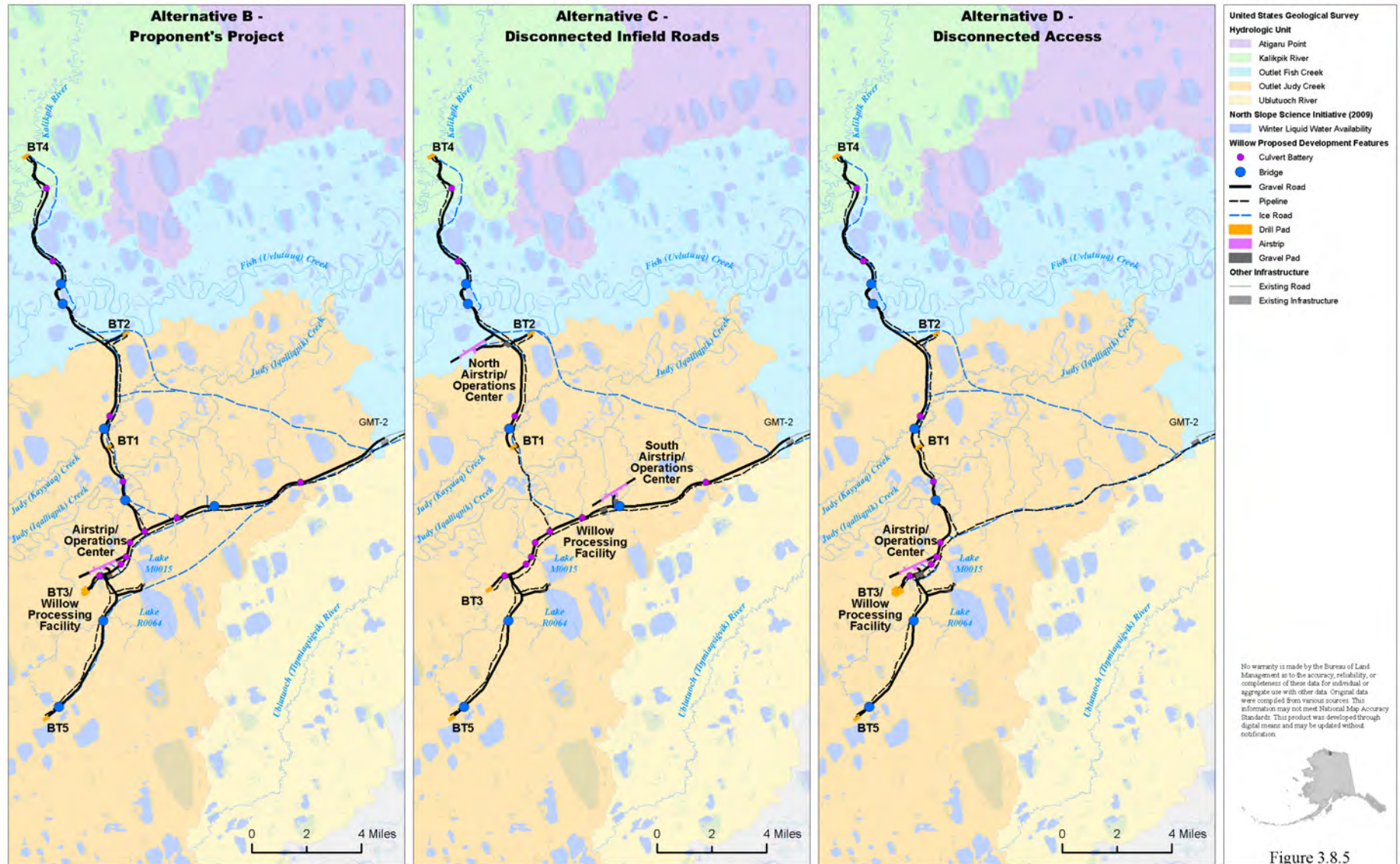


Figure 3.8.5. Proximity of Water Resources to Shore-based Action Alternatives

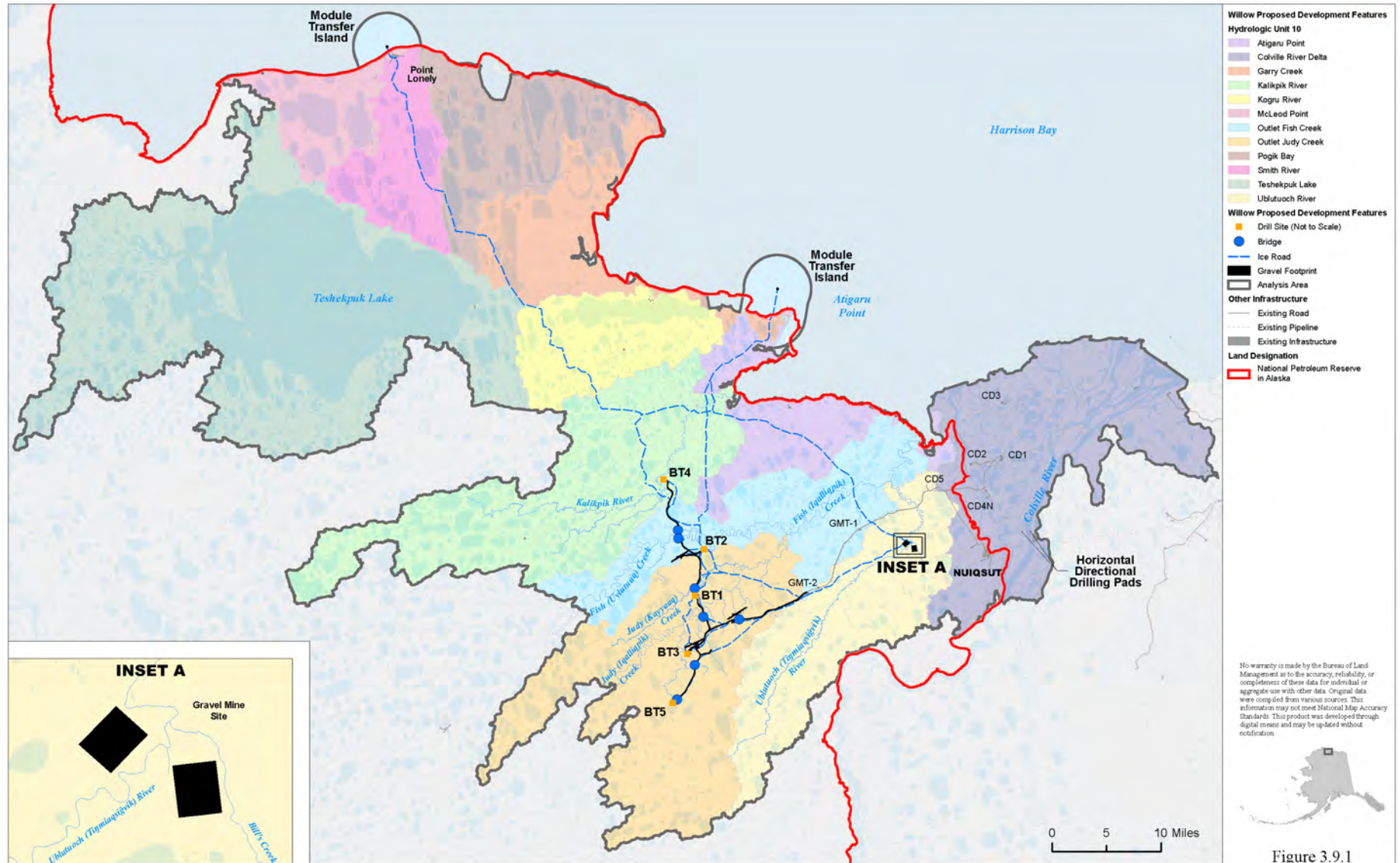


Figure 3.9.1

Figure 3.9.1. Analysis Area for Wetlands and Vegetation

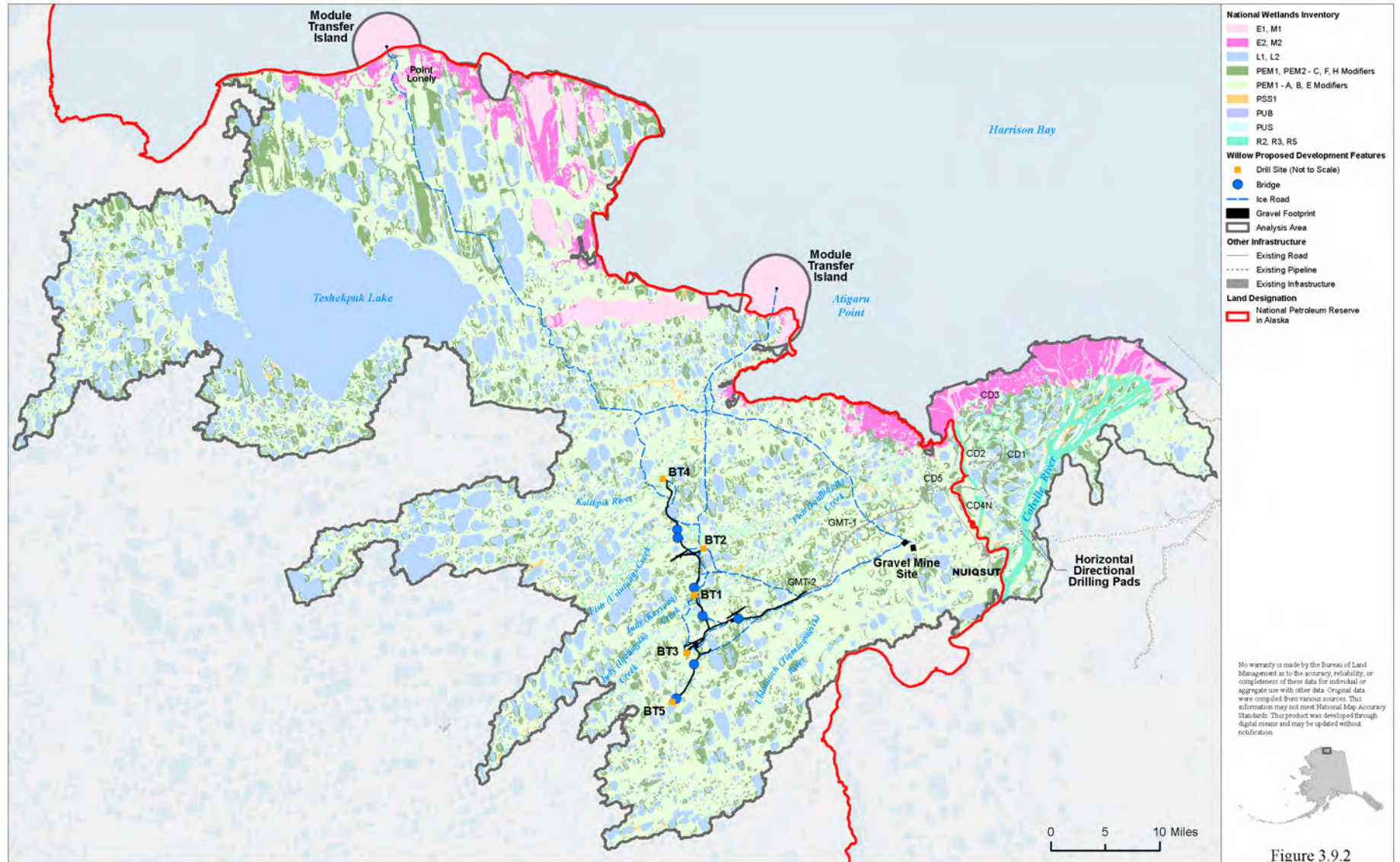


Figure 3.9.2

Figure 3.9.2. Wetlands in the Analysis Area

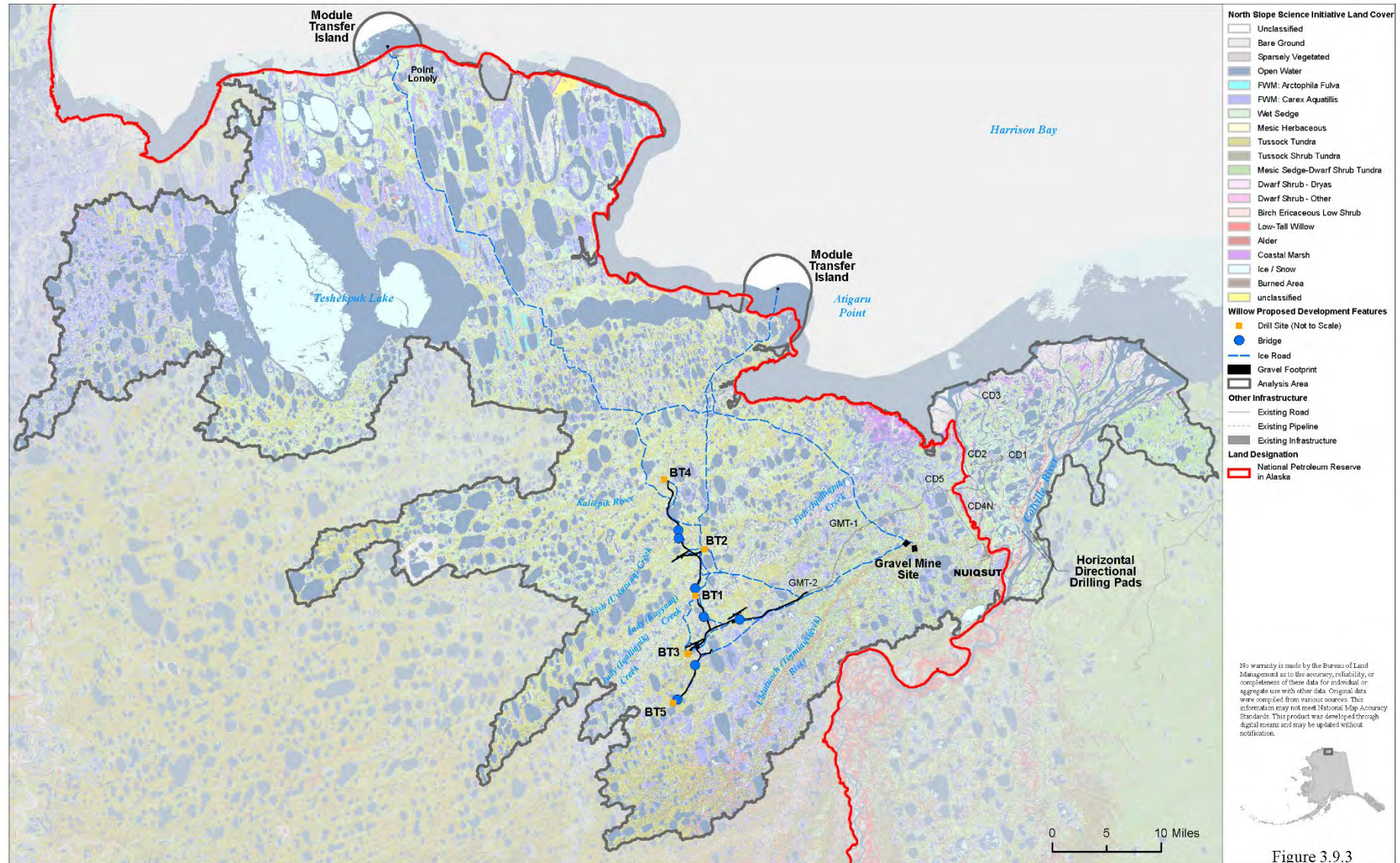


Figure 3.9.3

Figure 3.9.3. Land Cover Classes in the Analysis Area

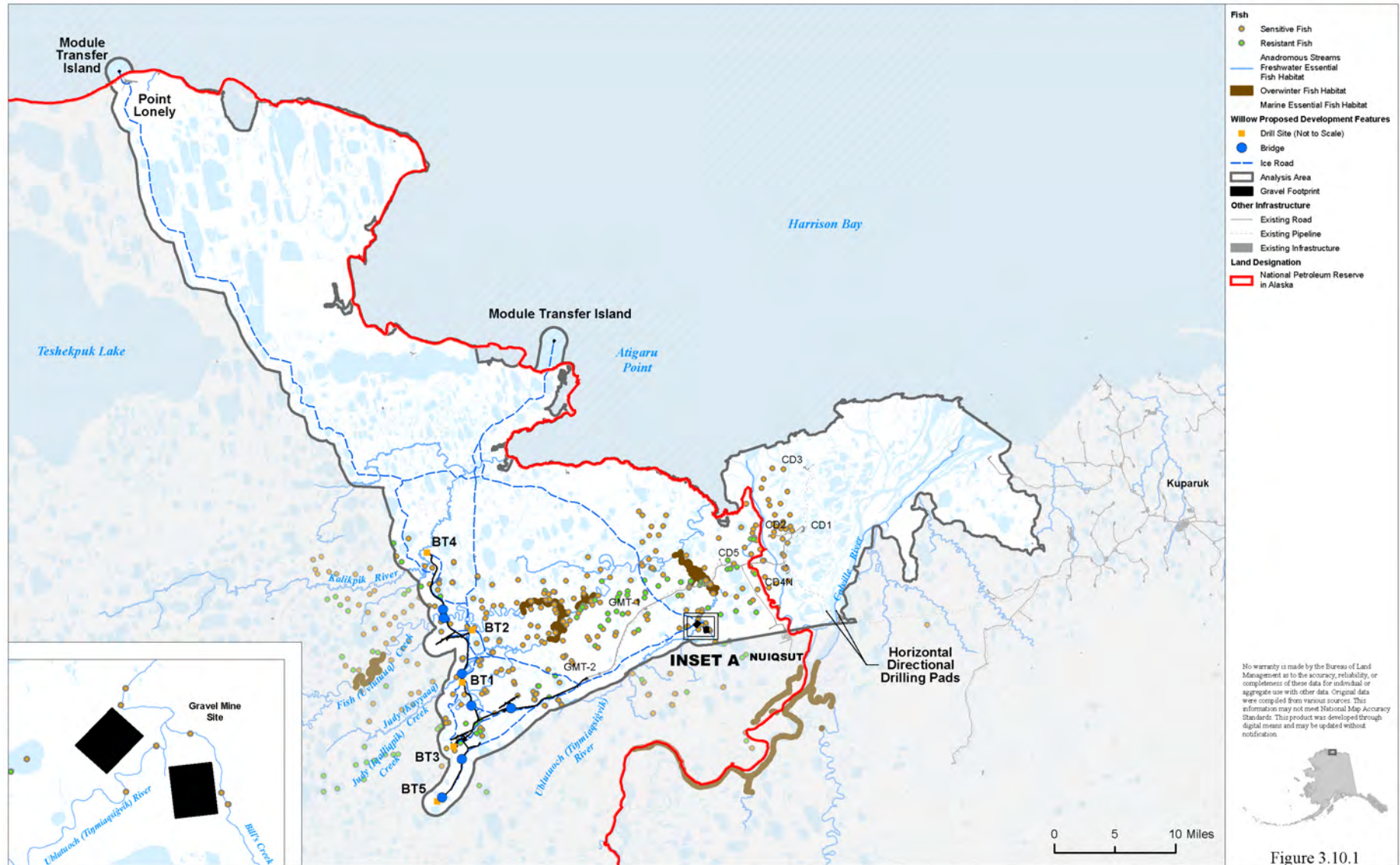


Figure 3.10.1

Figure 3.10.1. Essential Fish Habitat in the Analysis Area

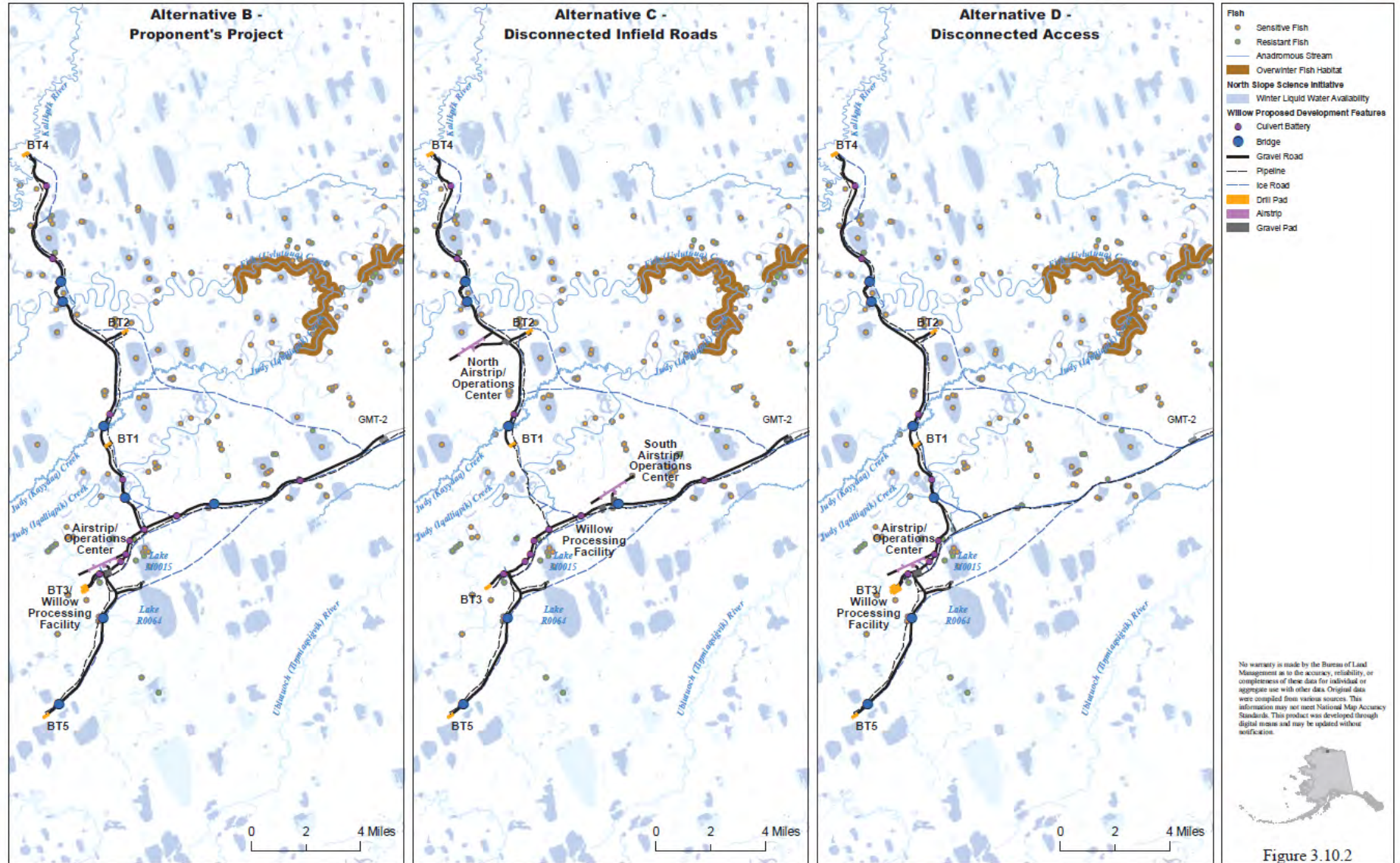


Figure 3.10.2. Fish Habitat in the Willow Area

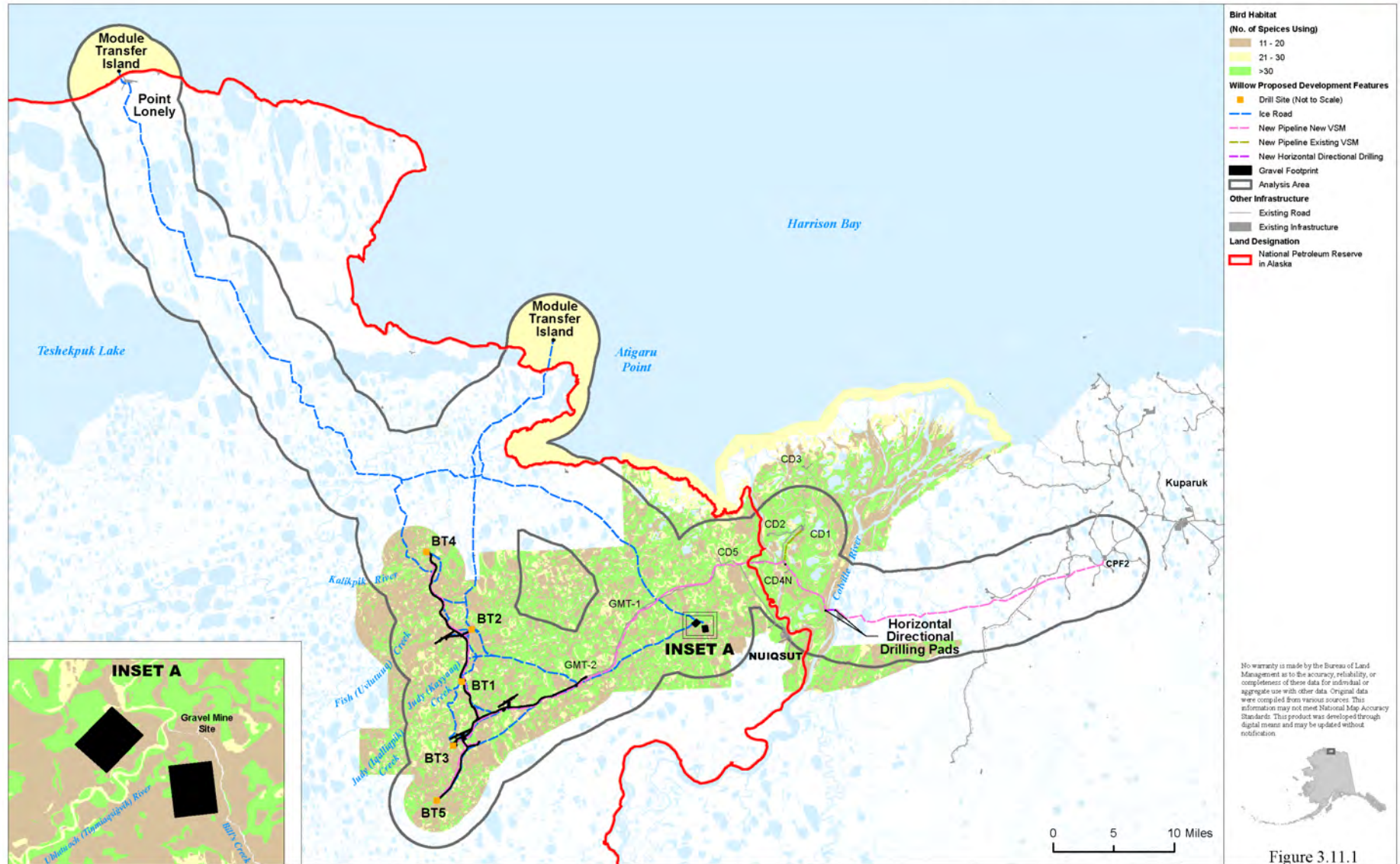


Figure 3.11.1

Figure 3.11.1. Bird Habitat Use and Analysis Area

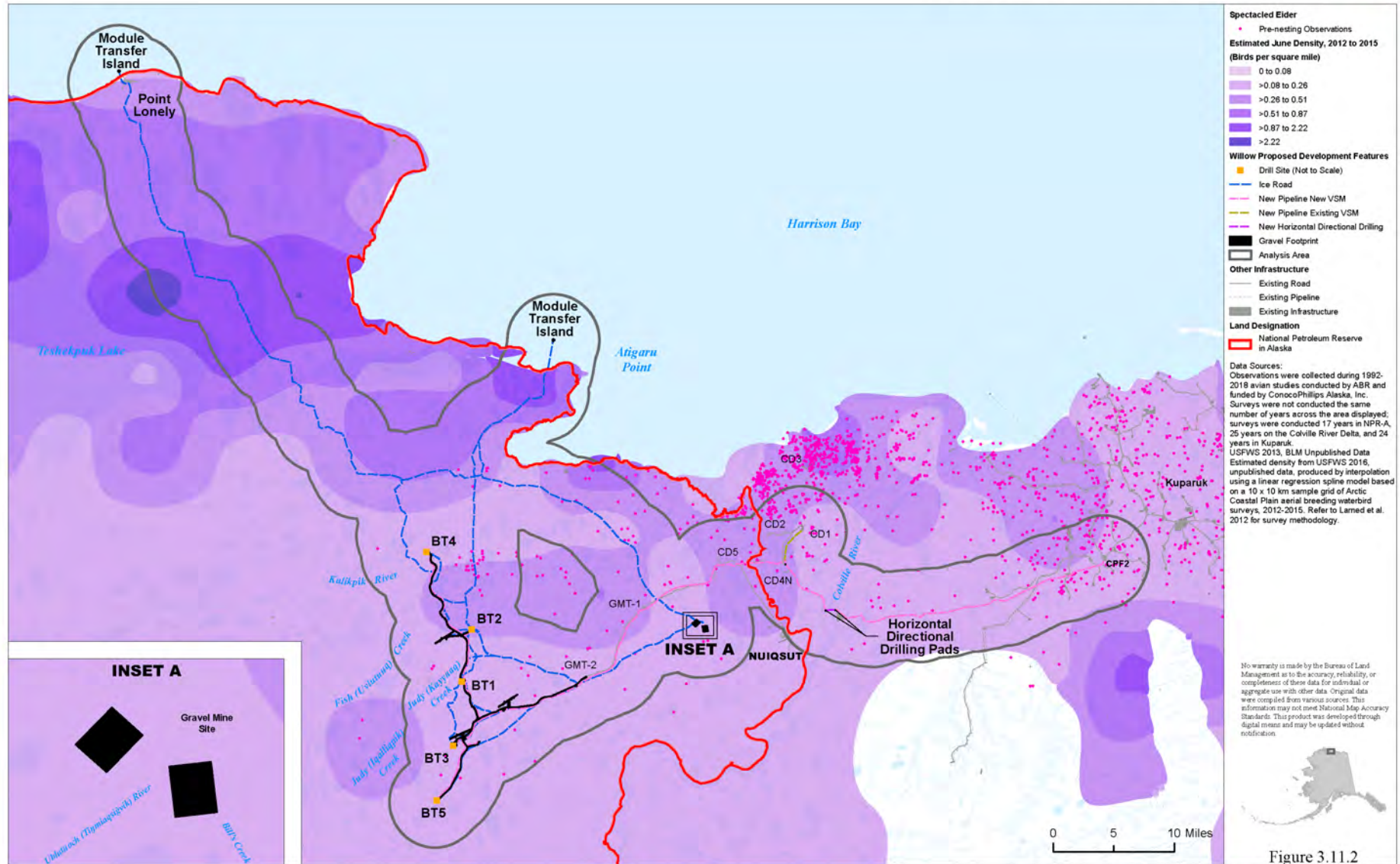


Figure 3.11.2. Spectacled Eider Pre-Breeding Density in the Analysis Area

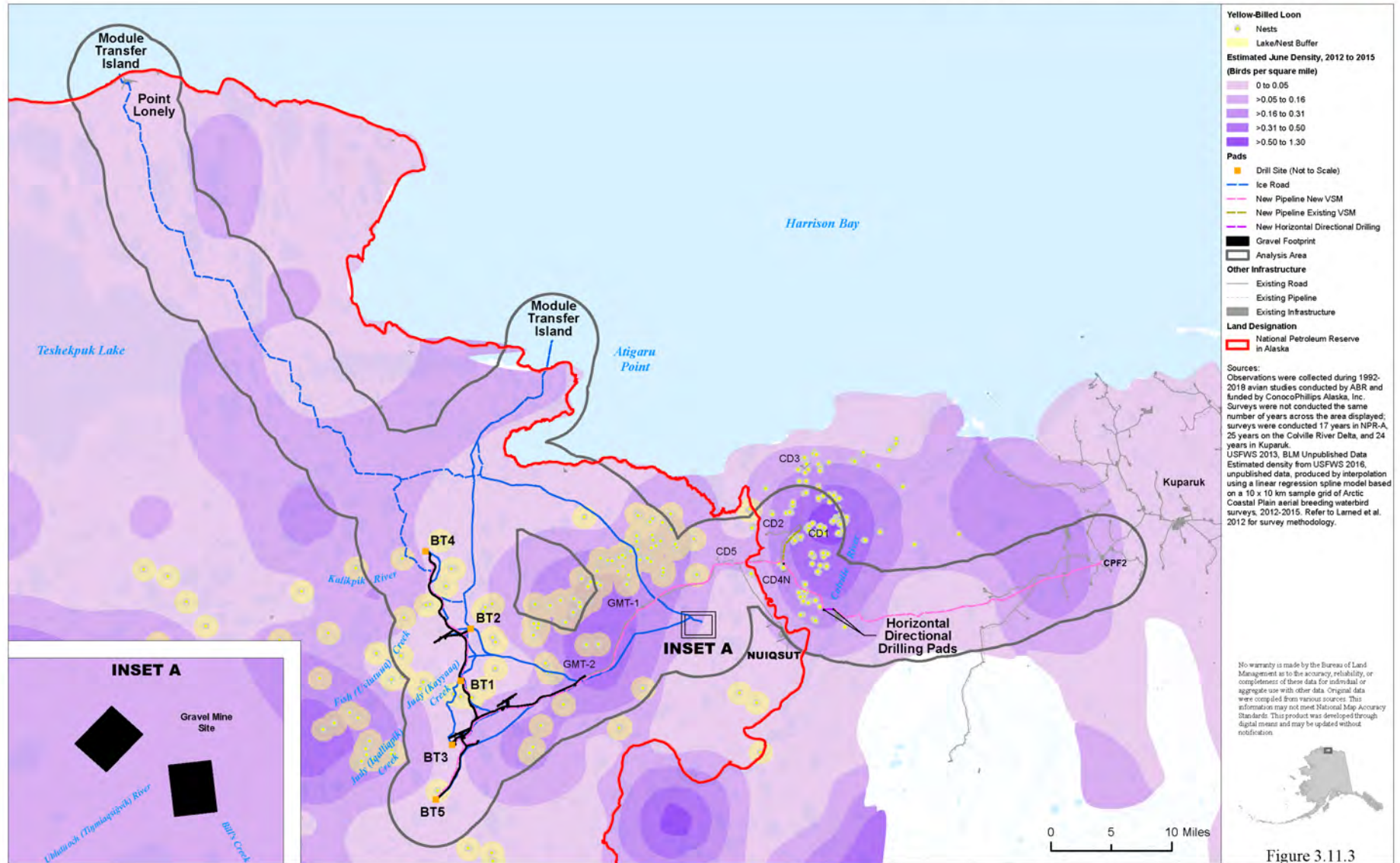


Figure 3.11.3. Yellow-Billed Loon Density and Nests in the Analysis Area

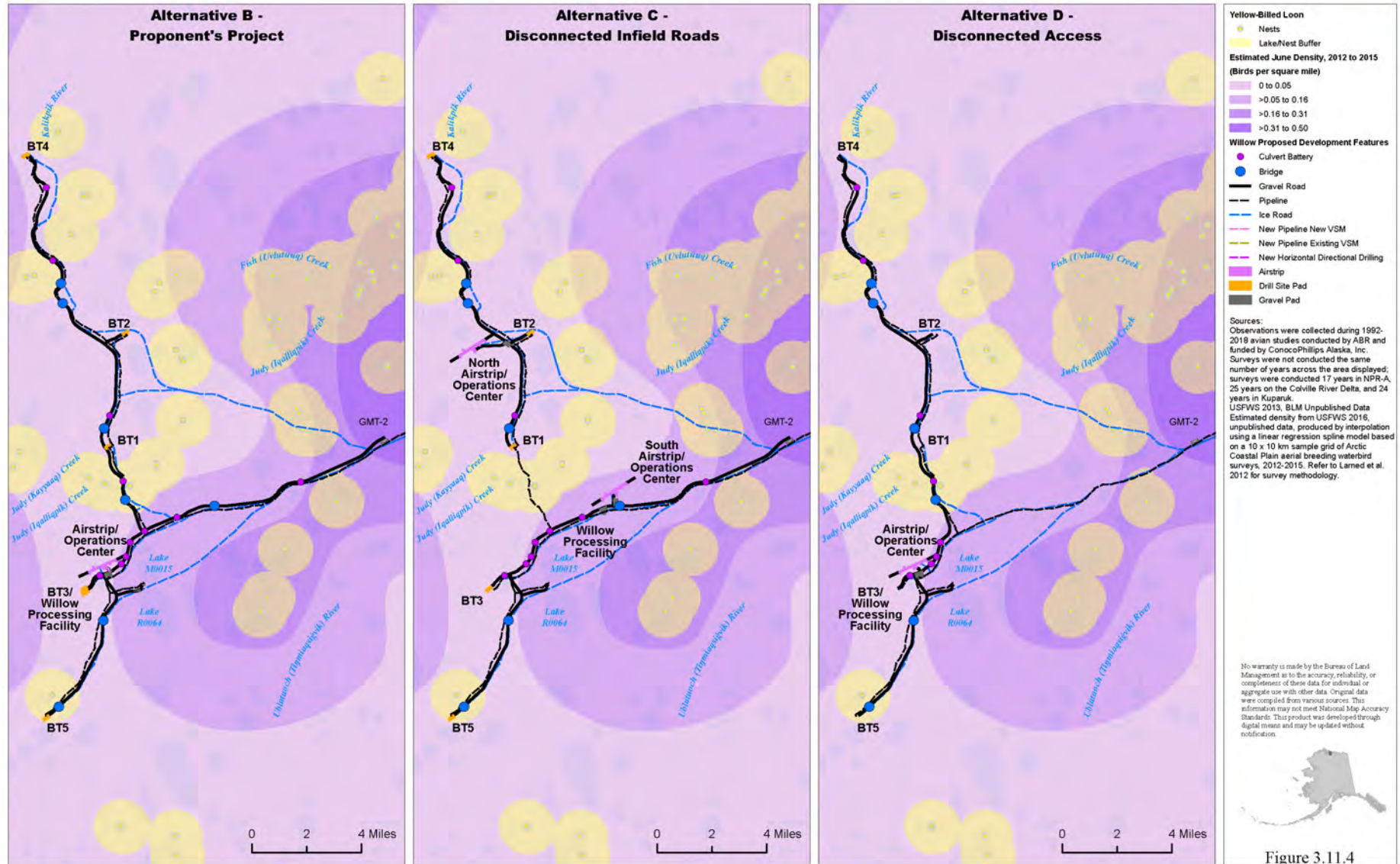


Figure 3.11.4. Yellow-Billed Loon Density and Nests in the Willow Area

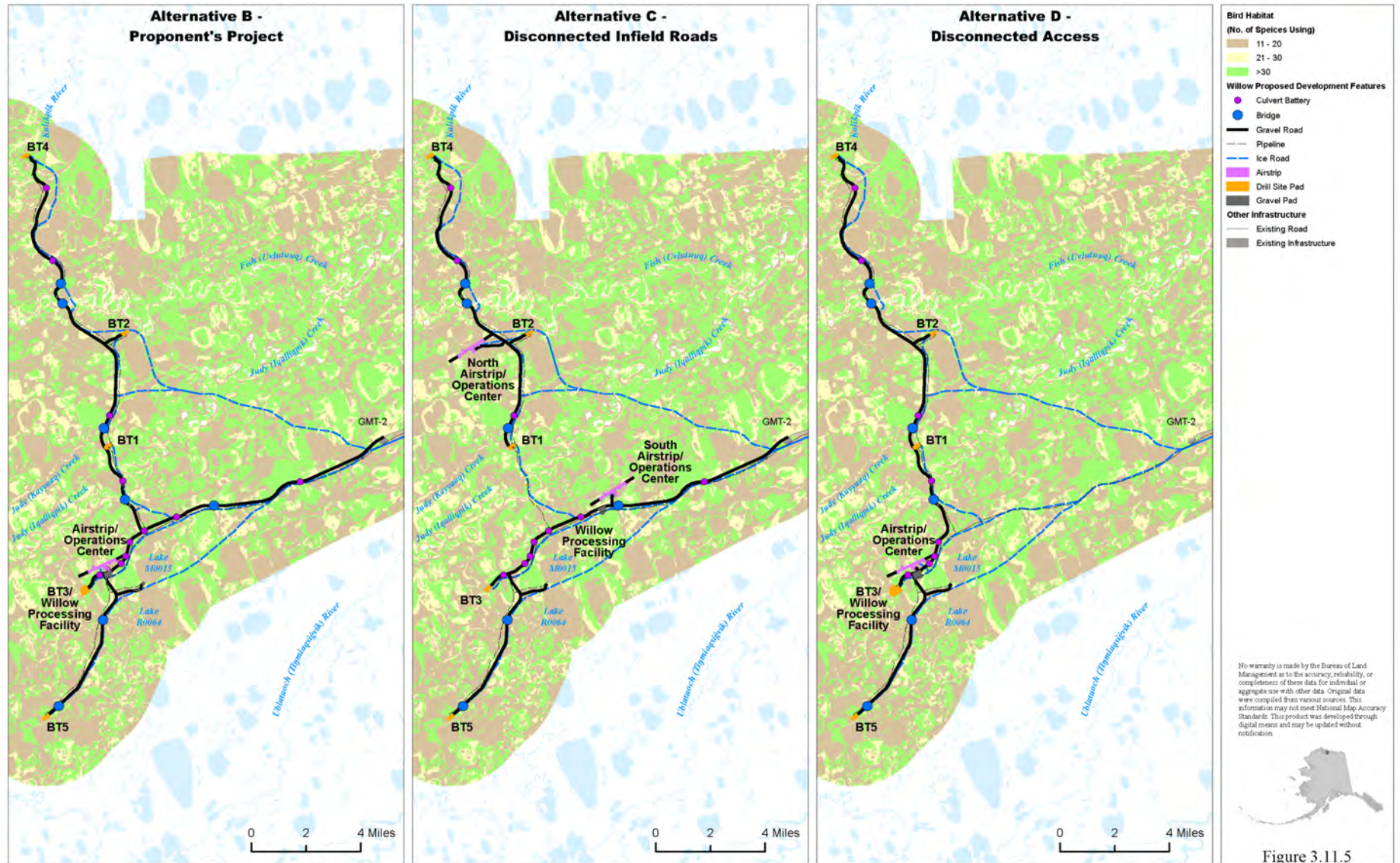


Figure 3.11.5. Bird Habitat Use in the Willow Area

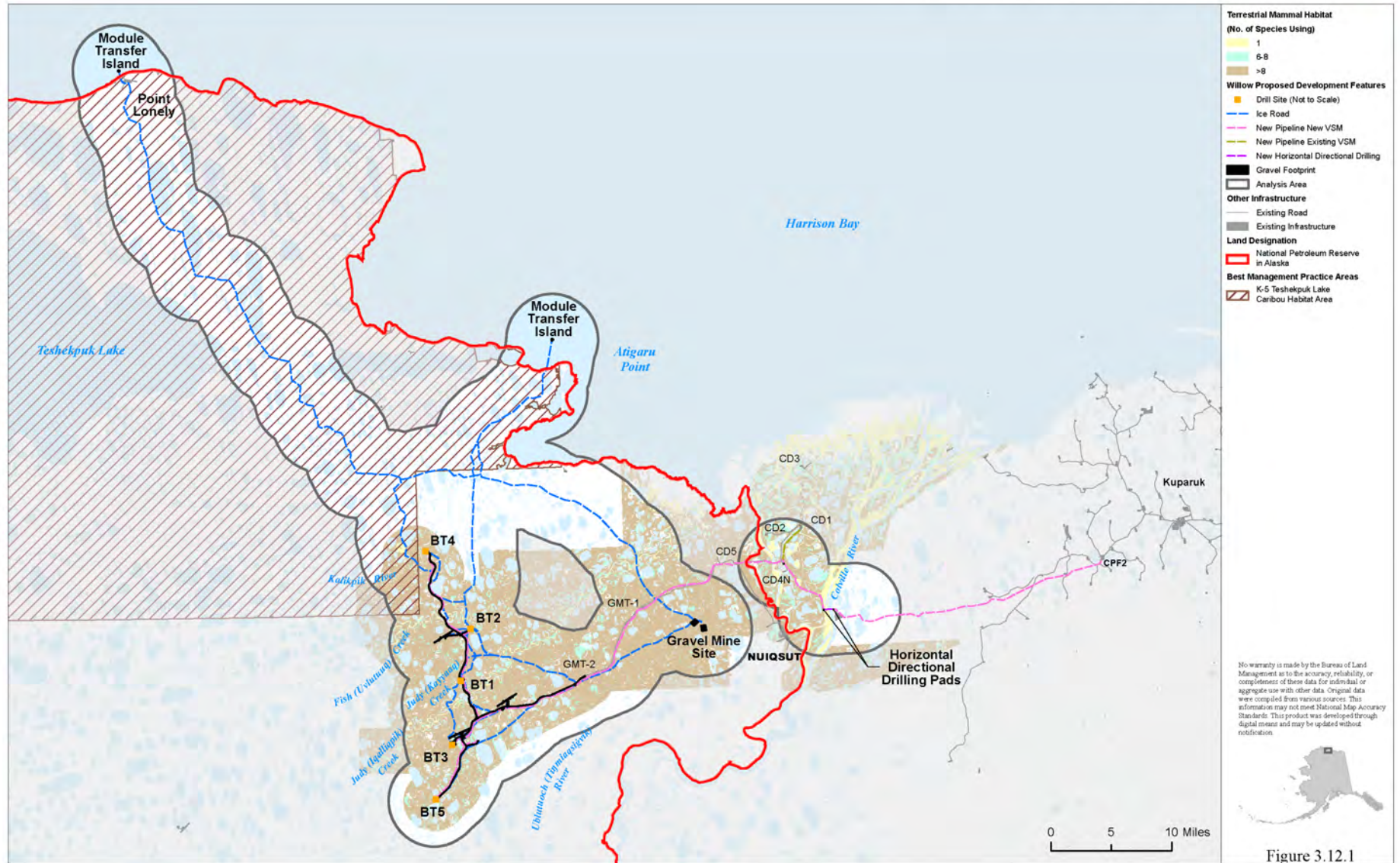


Figure 3.12.1. Analysis Area for Terrestrial Mammals

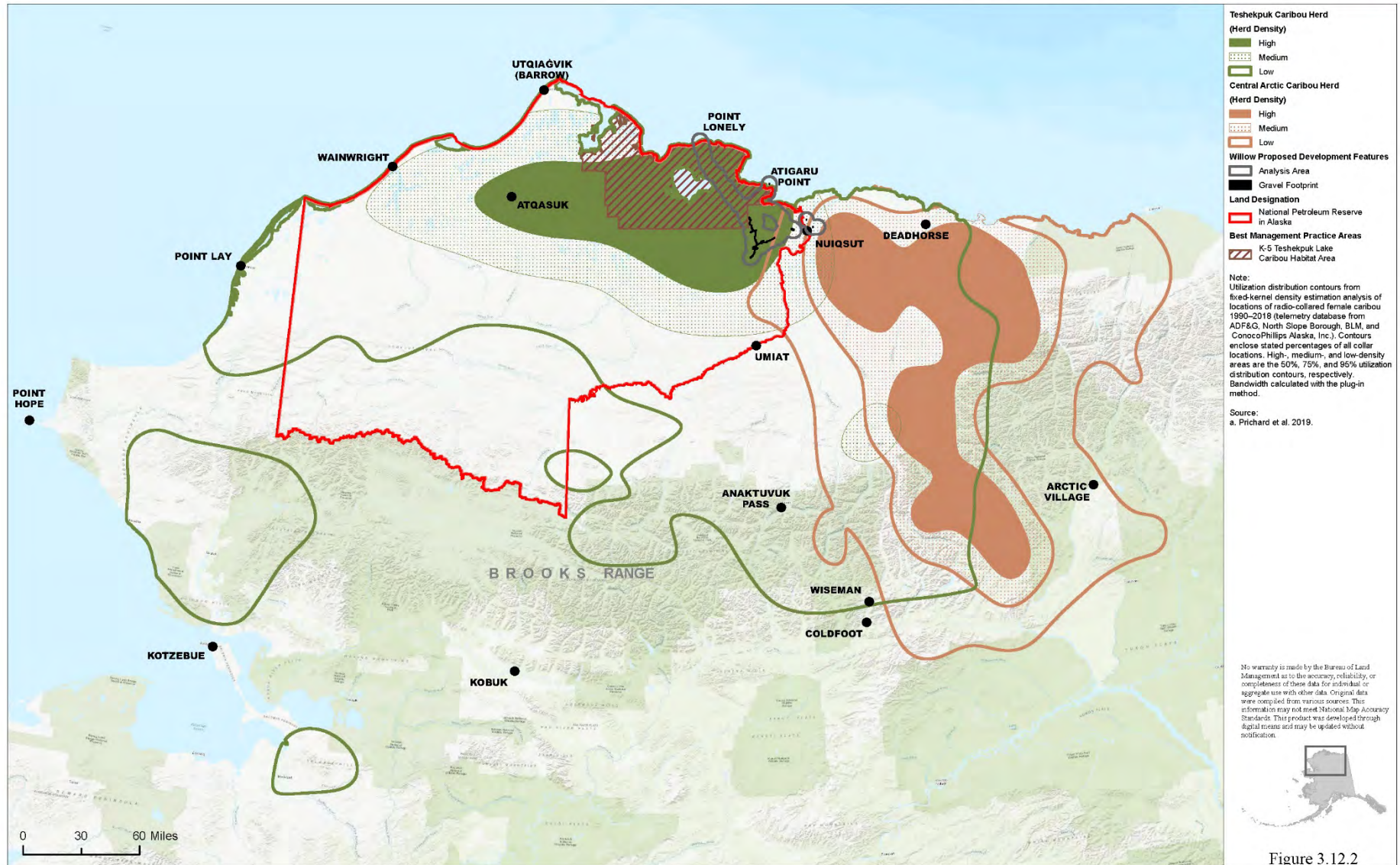


Figure 3.12.2

Figure 3.12.2. Annual Ranges of the Central Arctic and Teshekpuk Caribou Herds

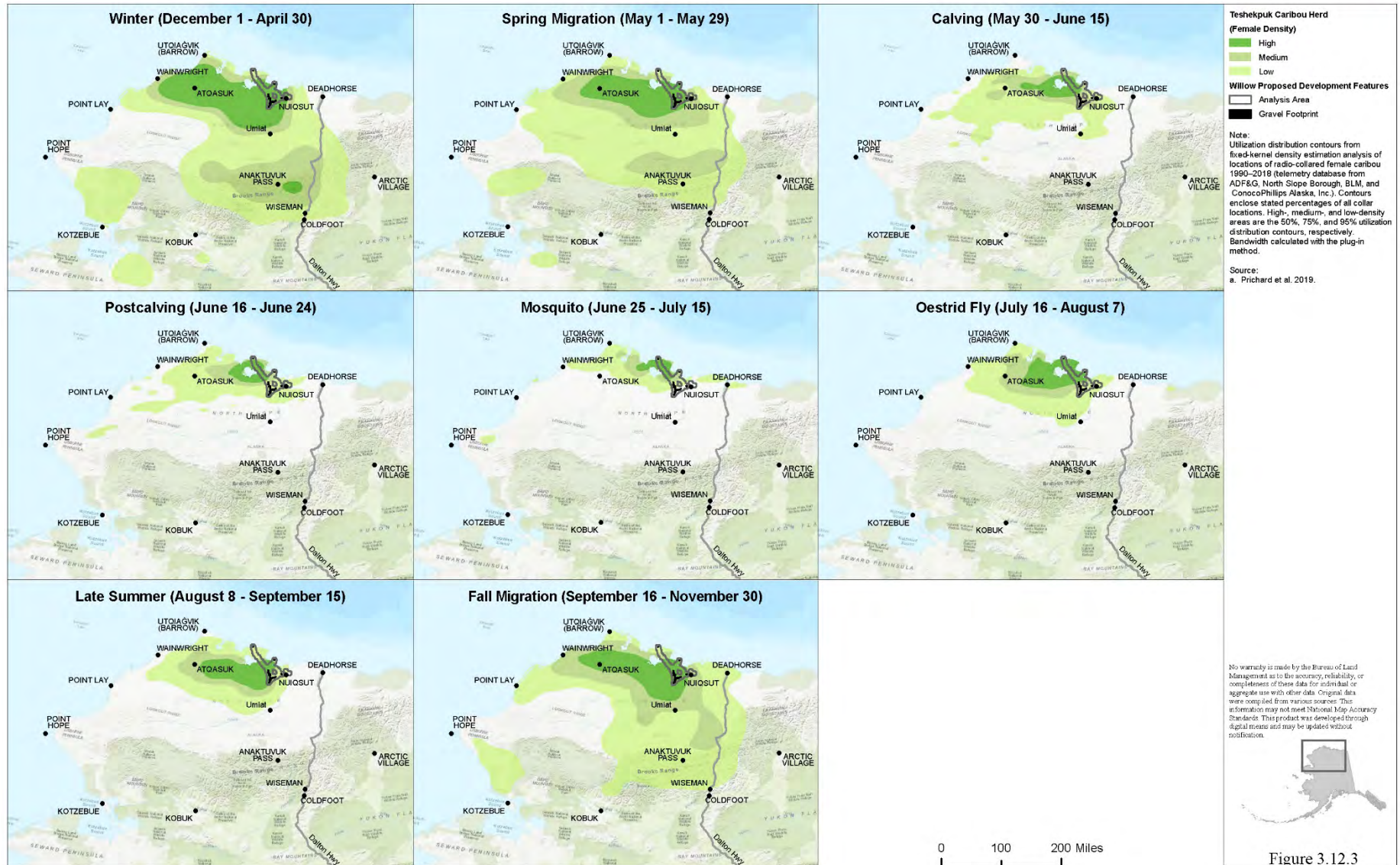


Figure 3.12.3. Seasonal Distribution of Female Caribou in the Teshekpuk Caribou Herd

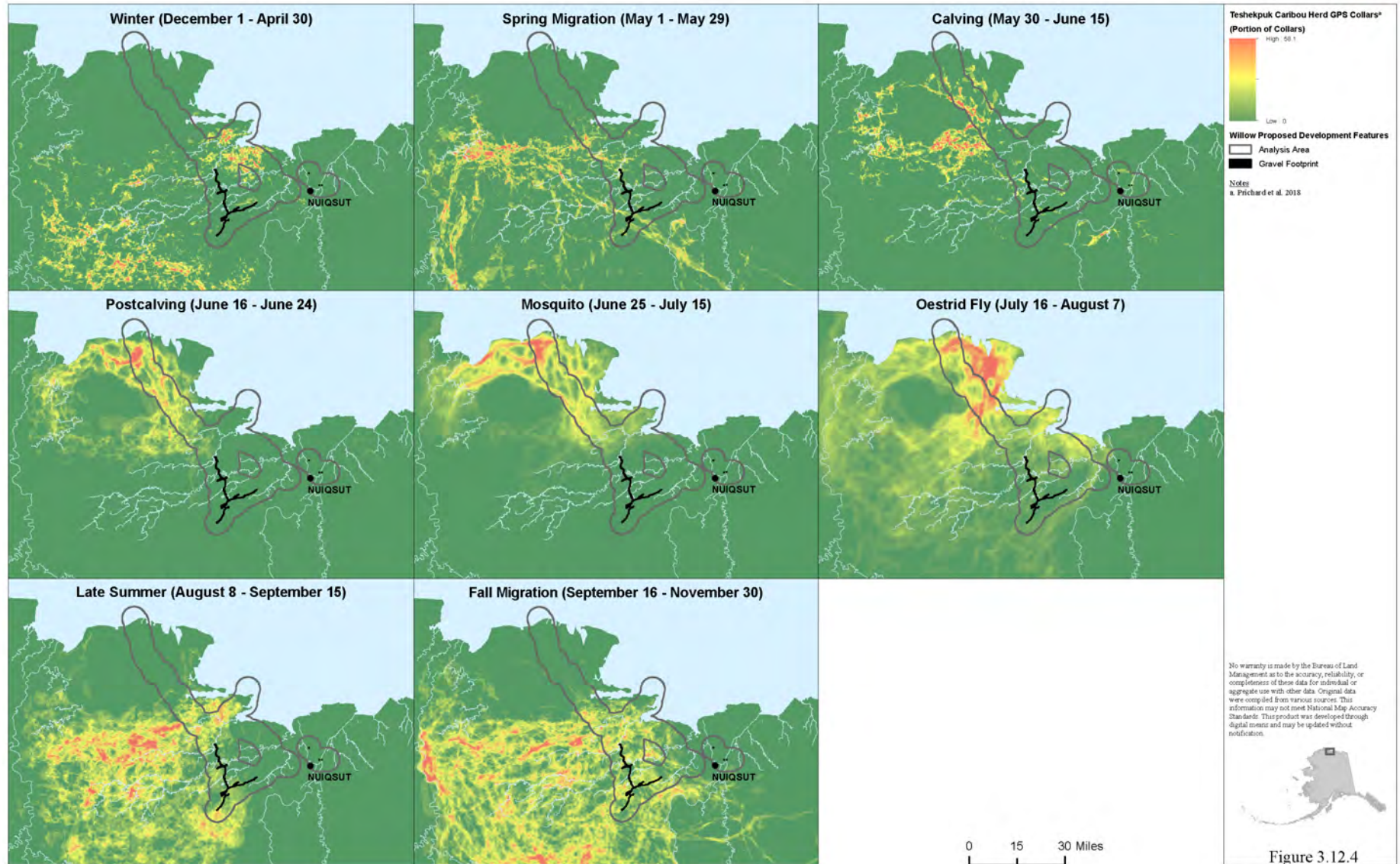


Figure 3.12.4. Movement of GPS-Collared Caribou of the Teshekpuk Caribou Herd 2004–2018

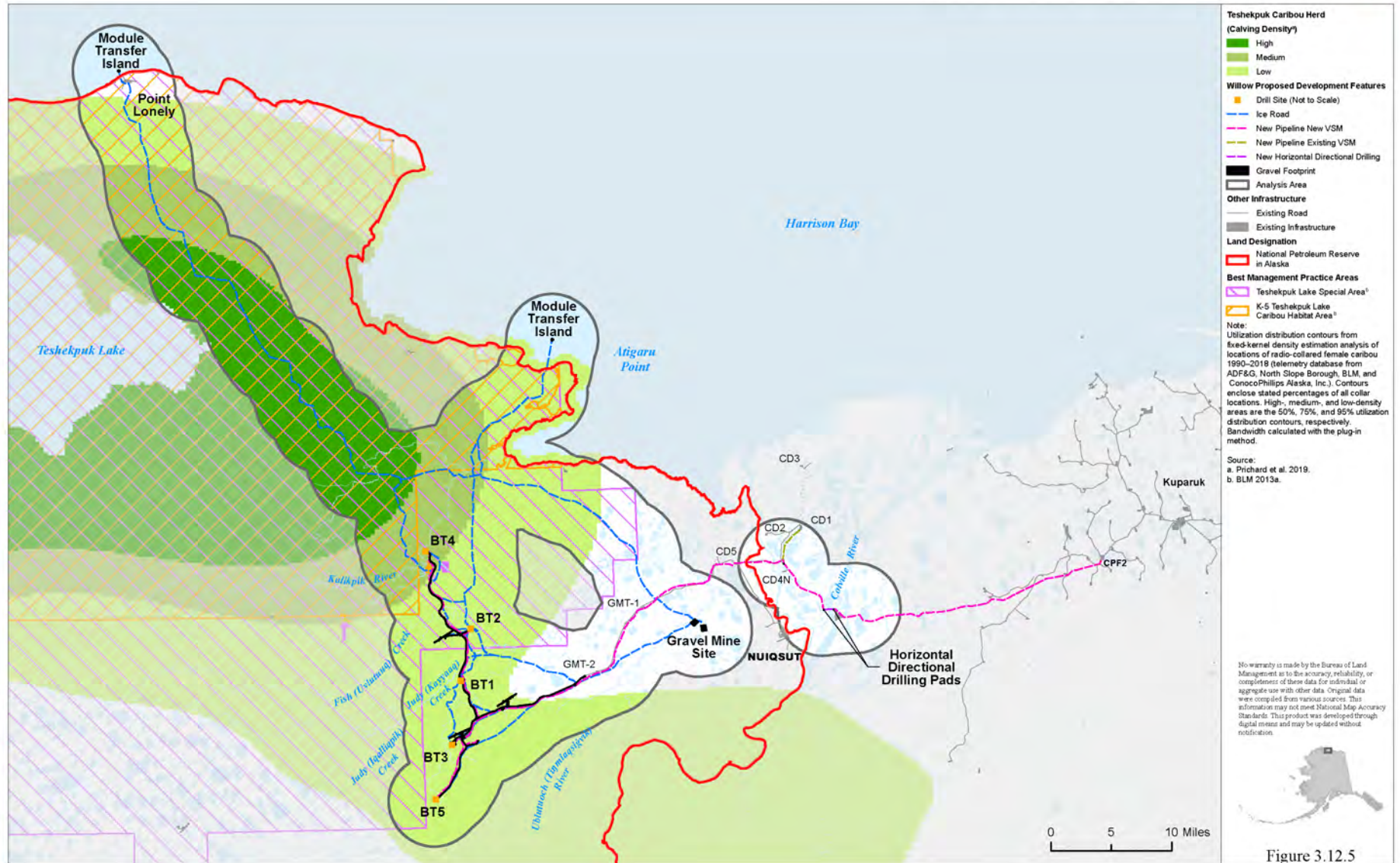


Figure 3.12.5. Distribution of Calving Caribou of the Teshekpuk Caribou Herd 1990–2018

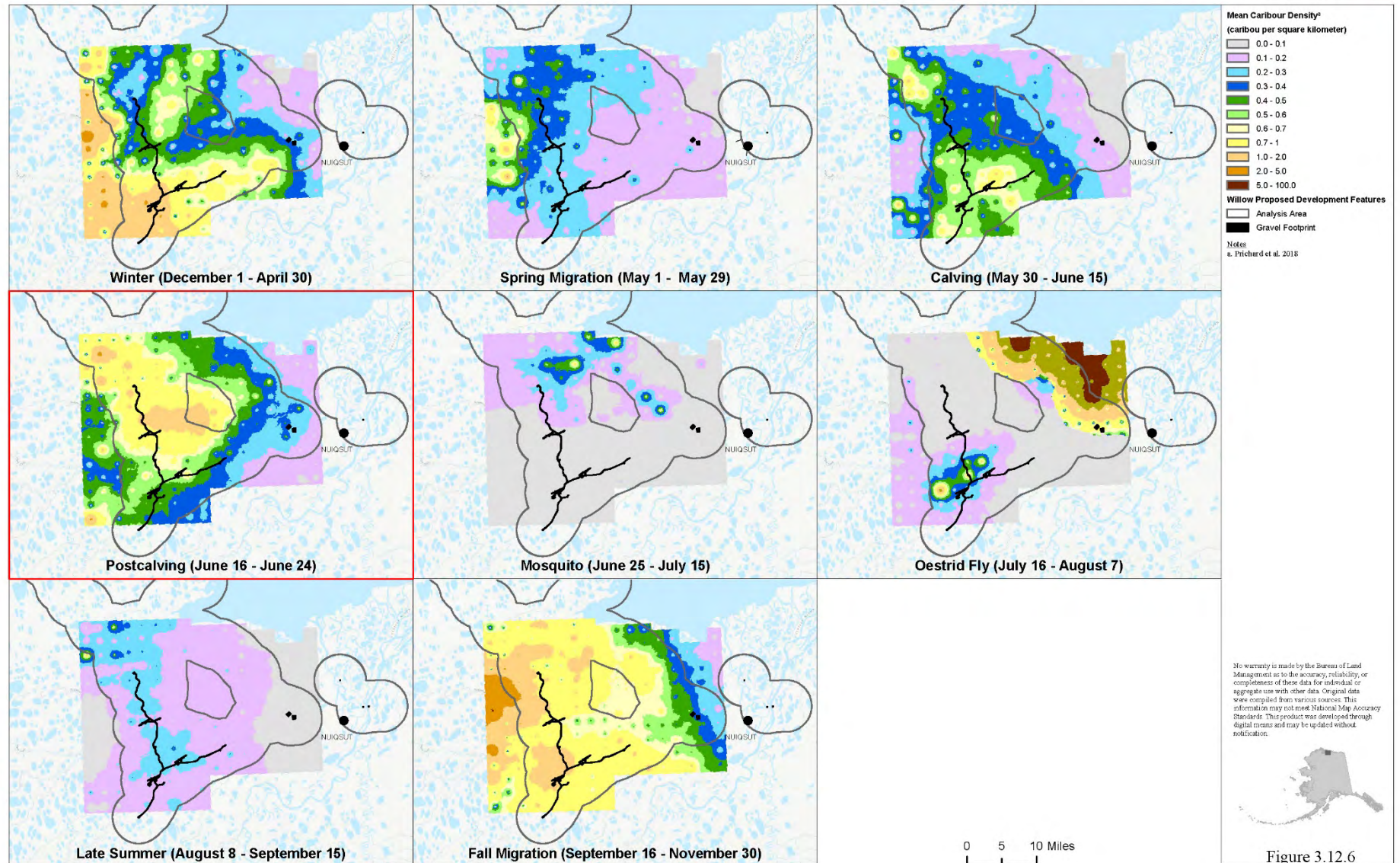


Figure 3.12.6

Figure 3.12.6. Mean Caribou Density by Season 2001–2018

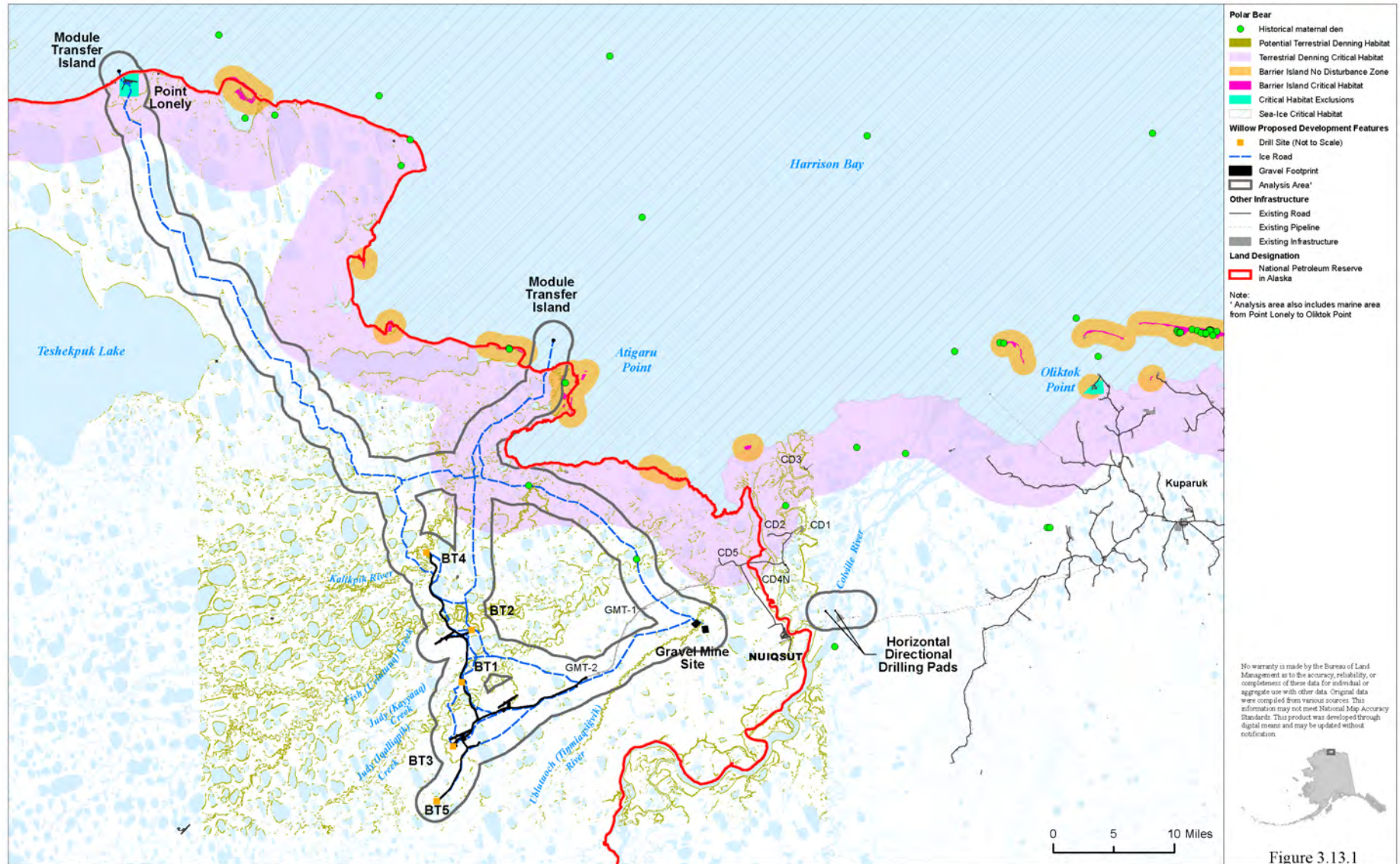


Figure 3.13.1. Polar Bear Dens, Critical Habitat, and Potential Terrestrial Denning Habitat

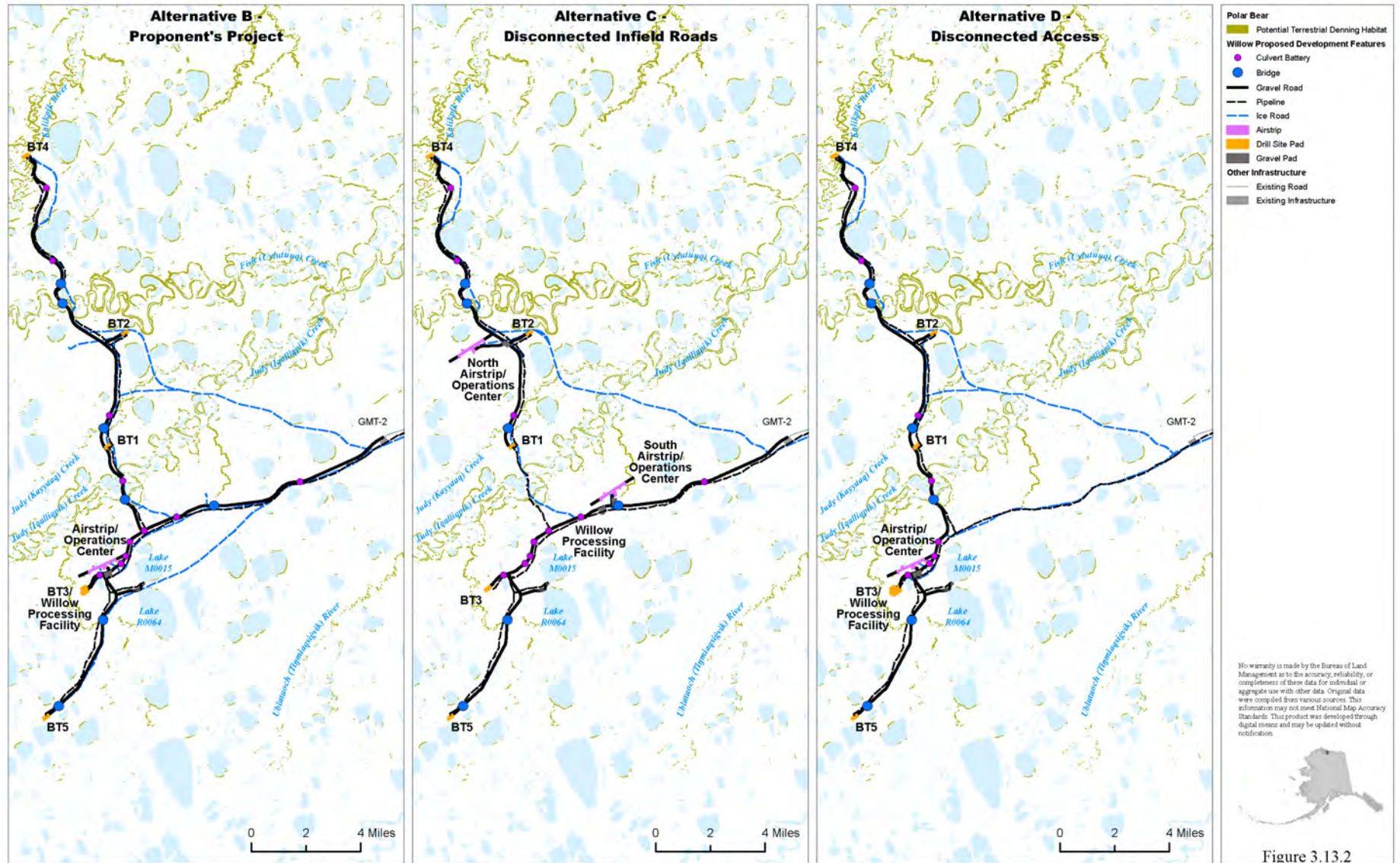


Figure 3.13.2. Polar Bear Potential Terrestrial Denning Habitat in the Willow Area

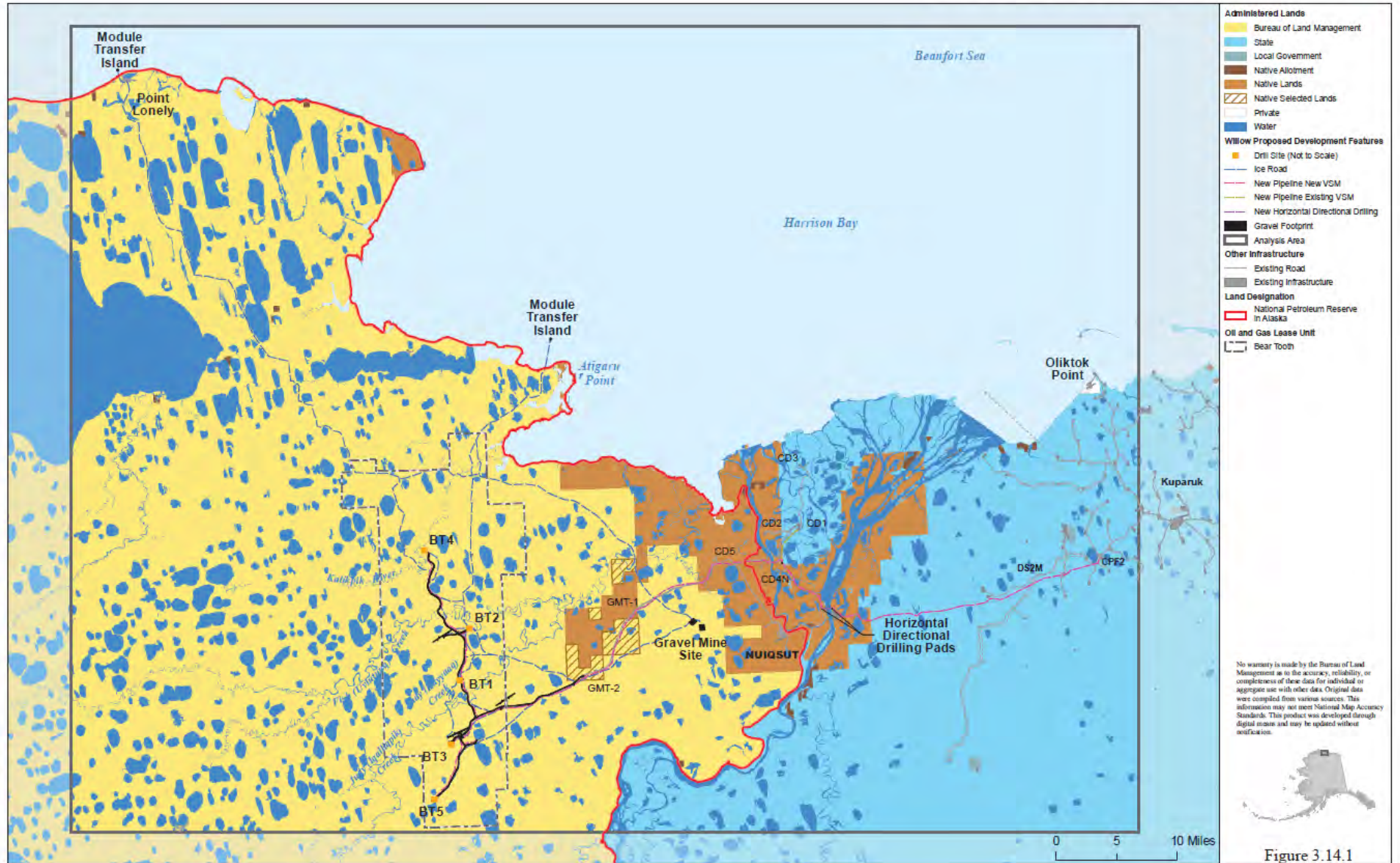


Figure 3.14.1. Map of Surface Land Ownership in the Analysis Area

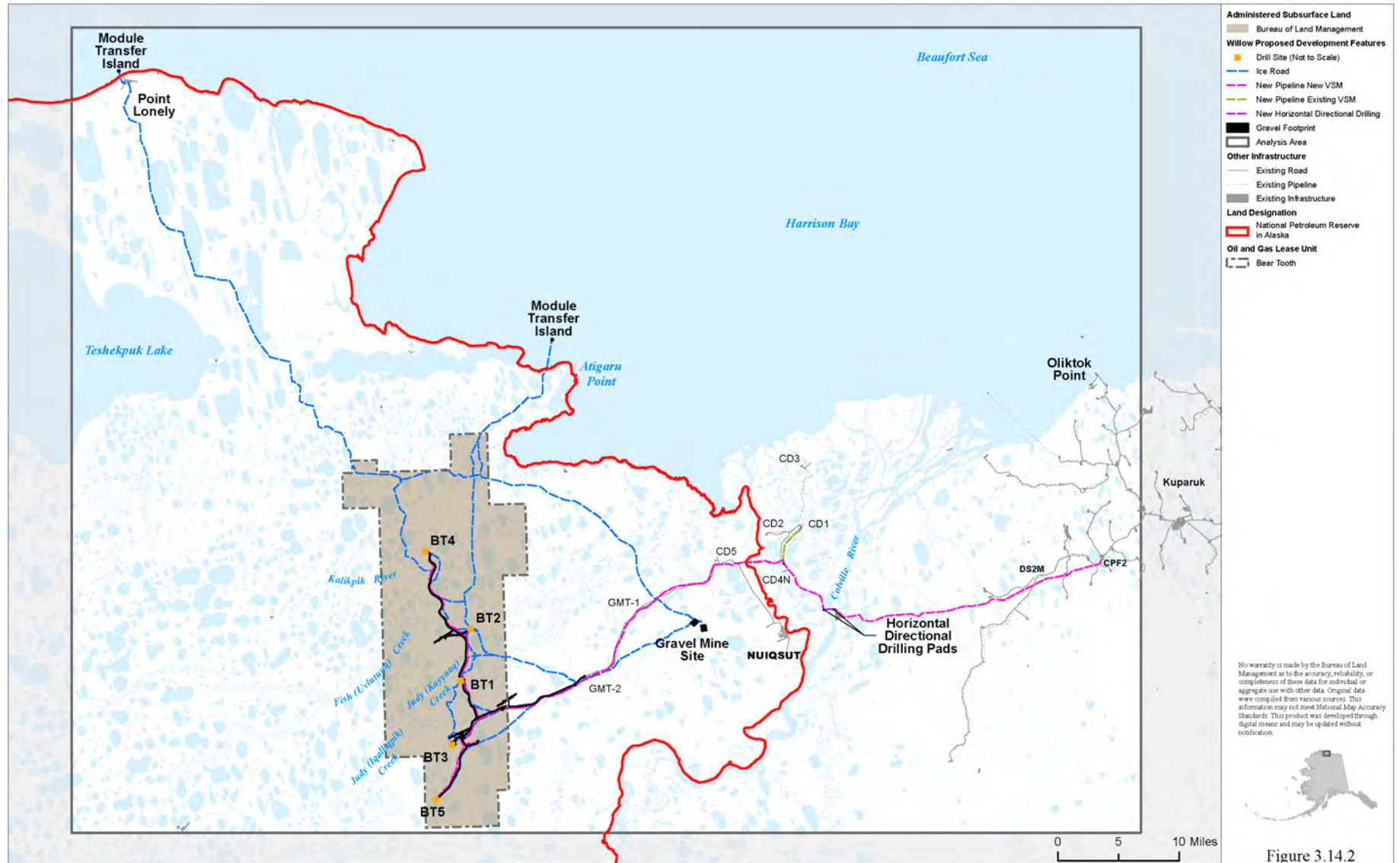


Figure 3.14.2. Map of Subsurface Land Management in the Bear Tooth Unit

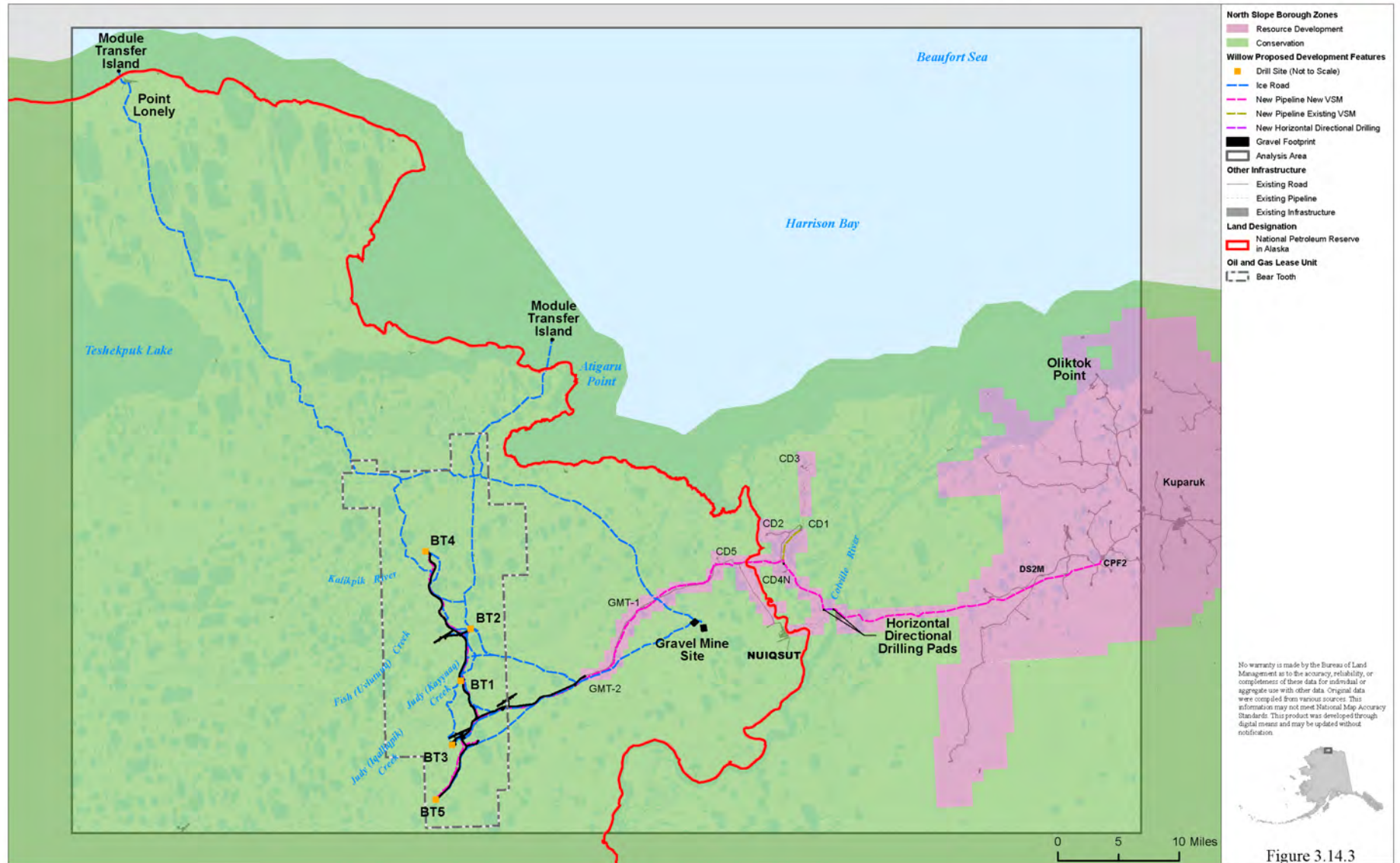


Figure 3.14.3. North Slope Borough Zoning Districts in the Analysis Area

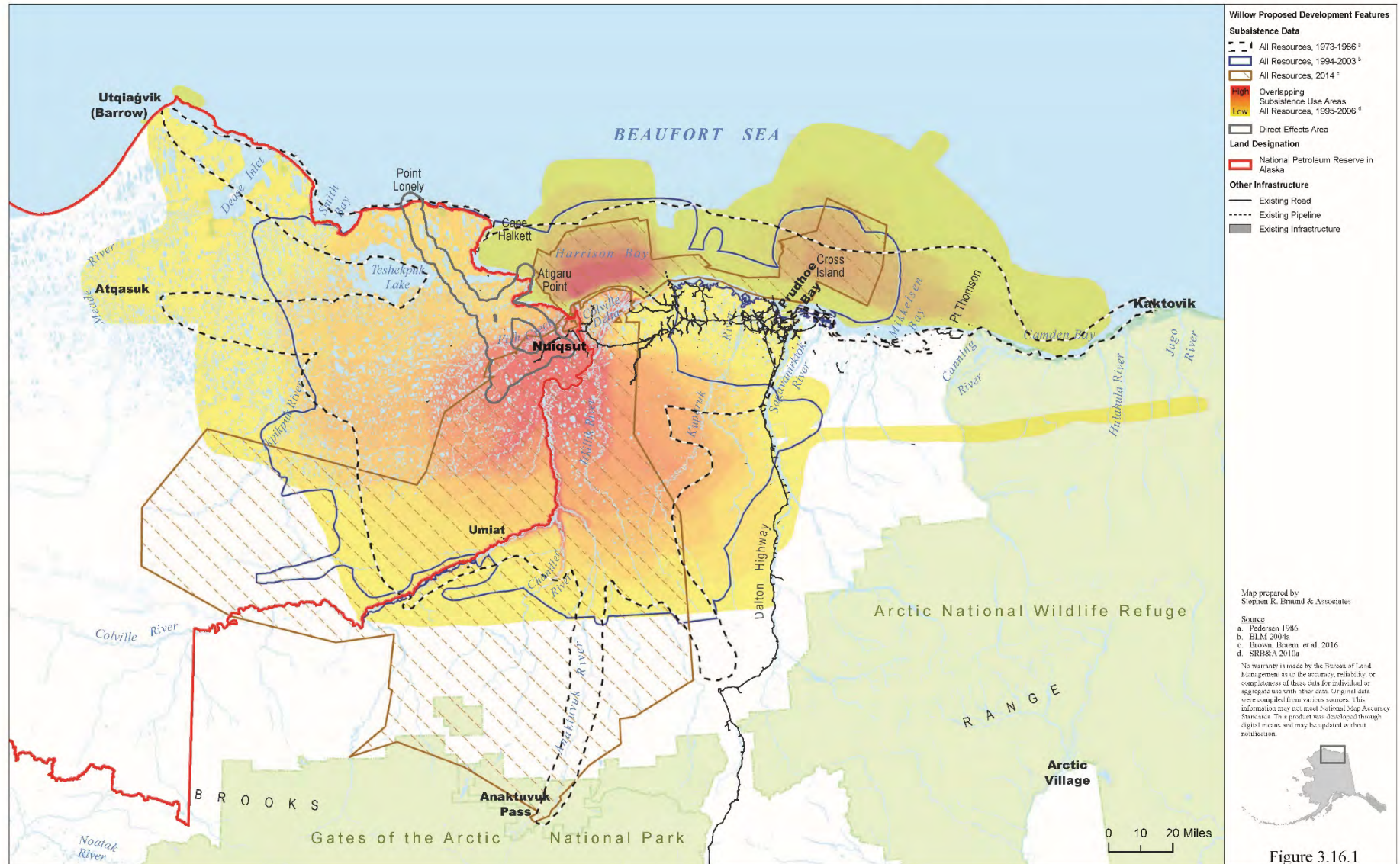


Figure 3.16.1. Nuiqsut Contemporary Subsistence Use Areas with Direct Effects Area, All Resources

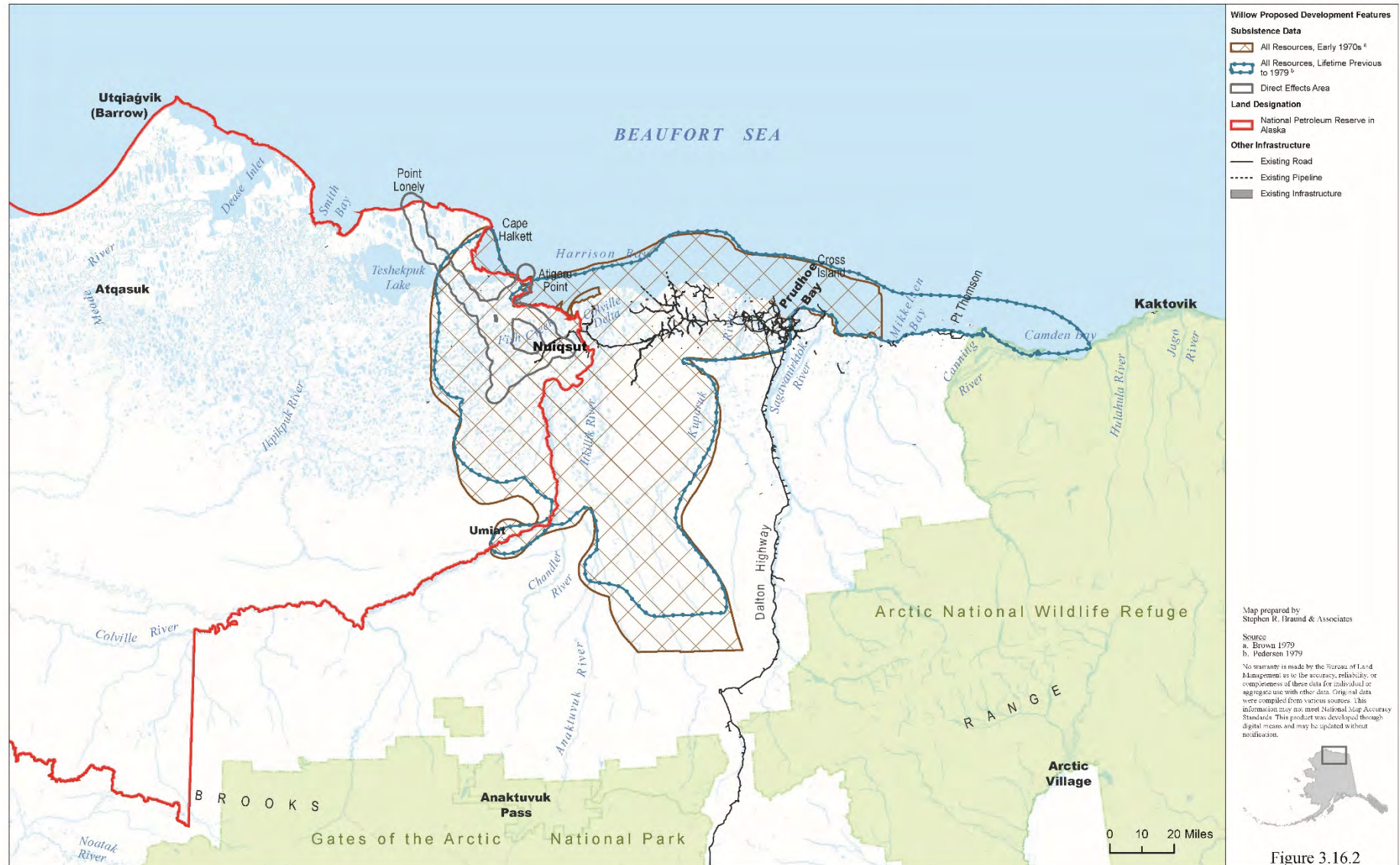


Figure 3.16.2. Nuiqsut Historic and Lifetime Subsistence Use Areas with Direct Effects Area, All Resources

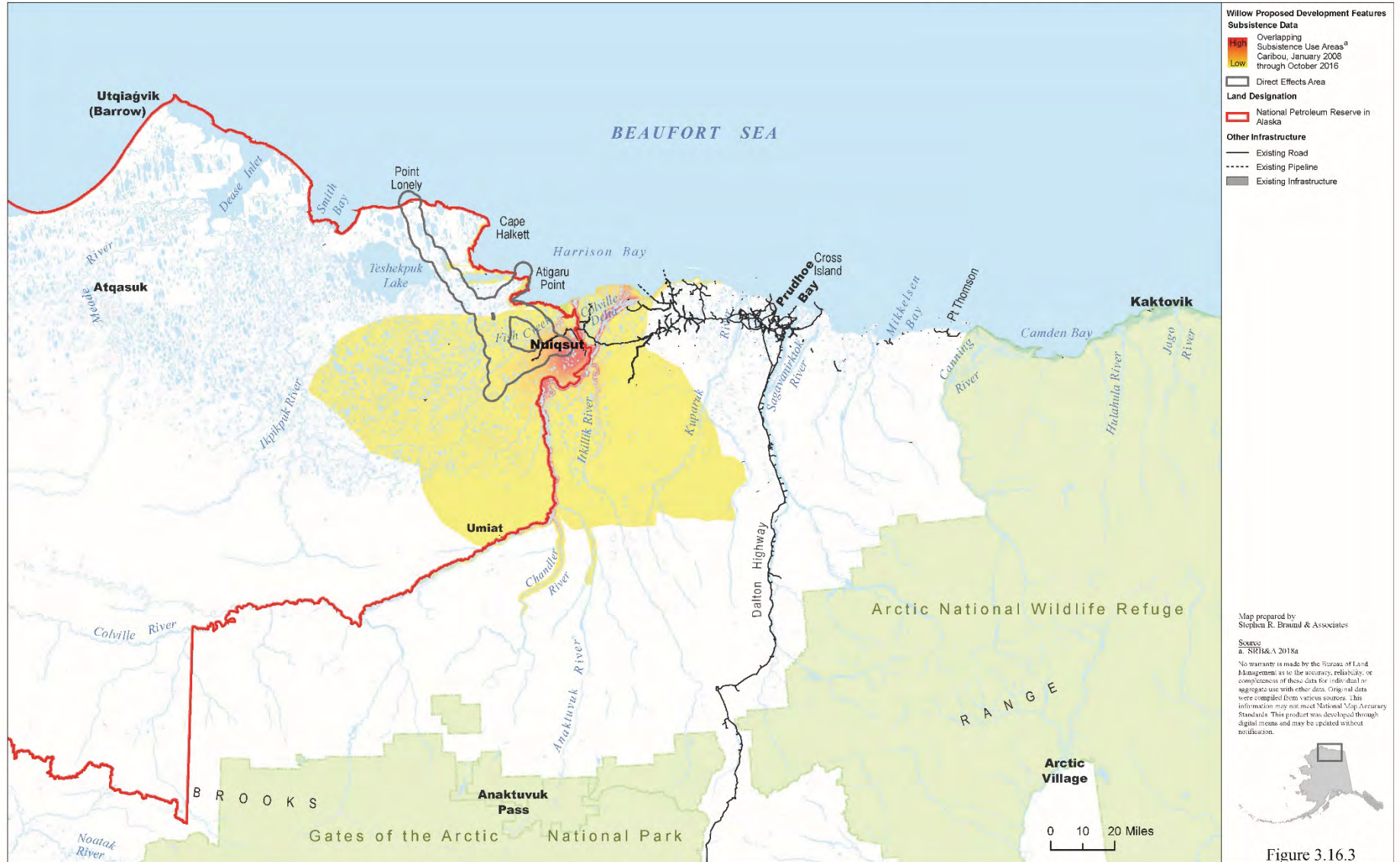


Figure 3.16.3. Nuiqsut Caribou Subsistence Use Areas with Direct Effects Area, 2008–2016

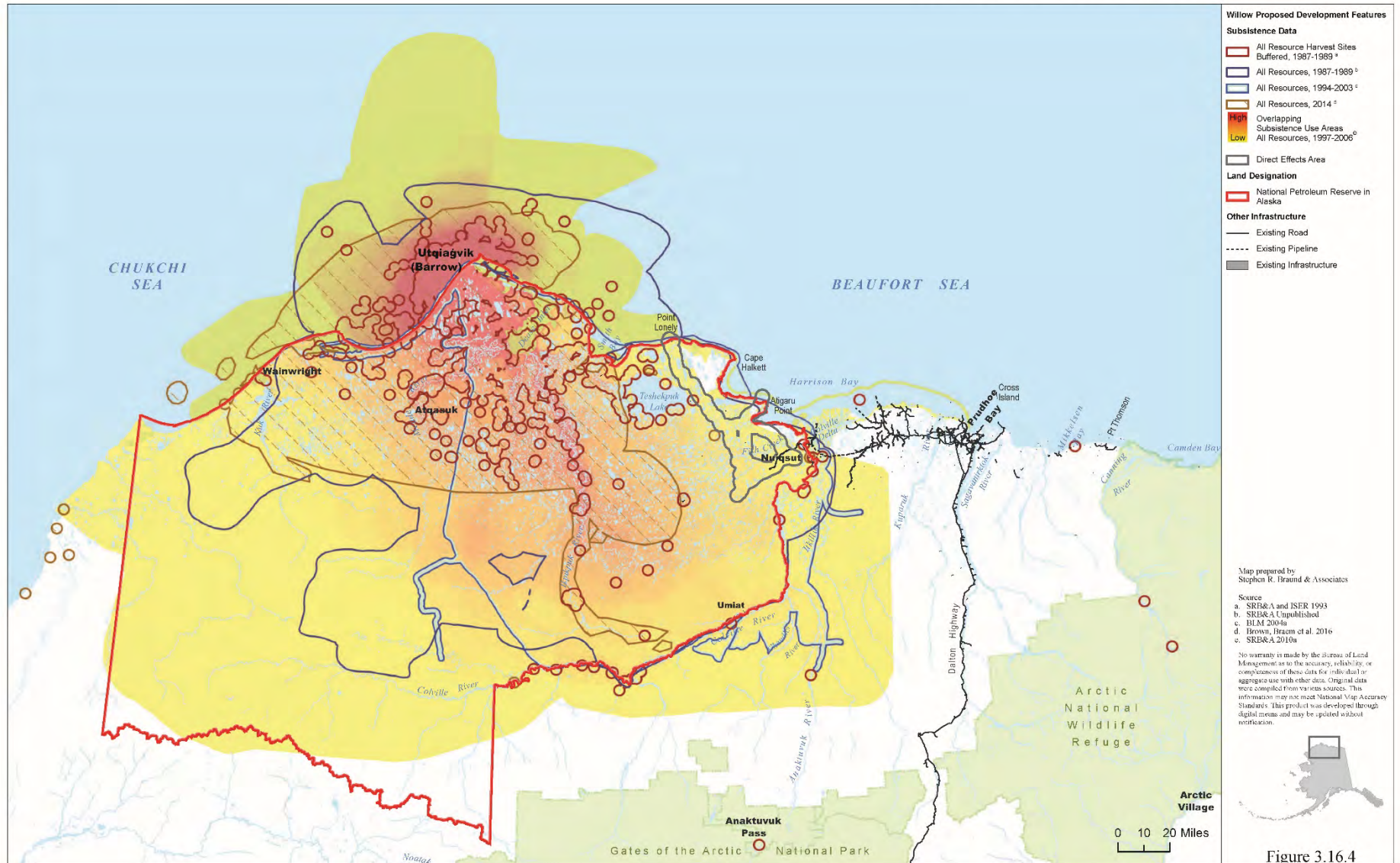


Figure 3.16.4. Utqiagvik (Barrow) Contemporary Subsistence Use Areas with Direct Effects Area, All Resources



Figure 3.16.5. Utqiagvik (Barrow) Lifetime Subsistence Use Areas with Direct Effects Area, All Resources

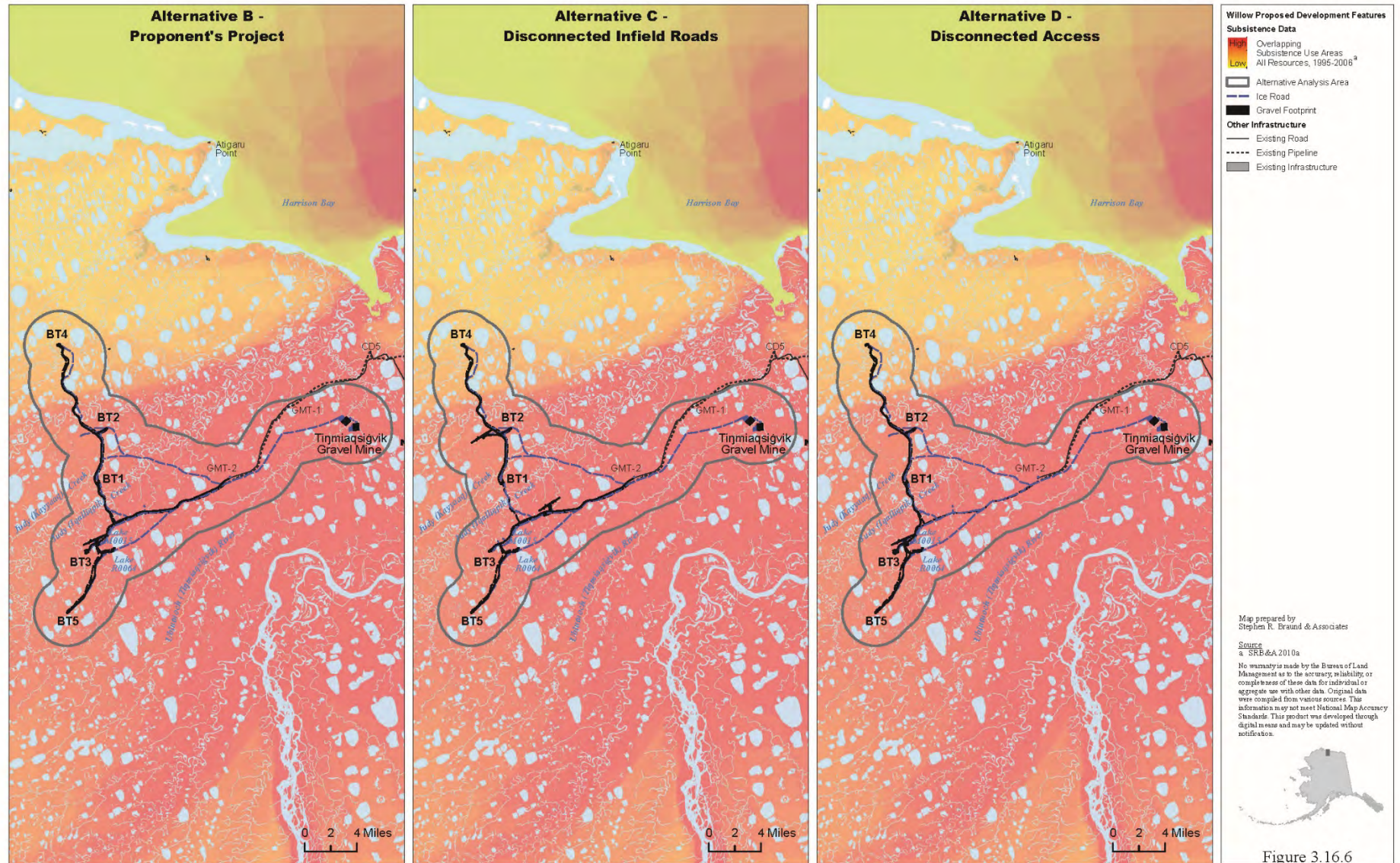


Figure 3.16.6. All Resource Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006

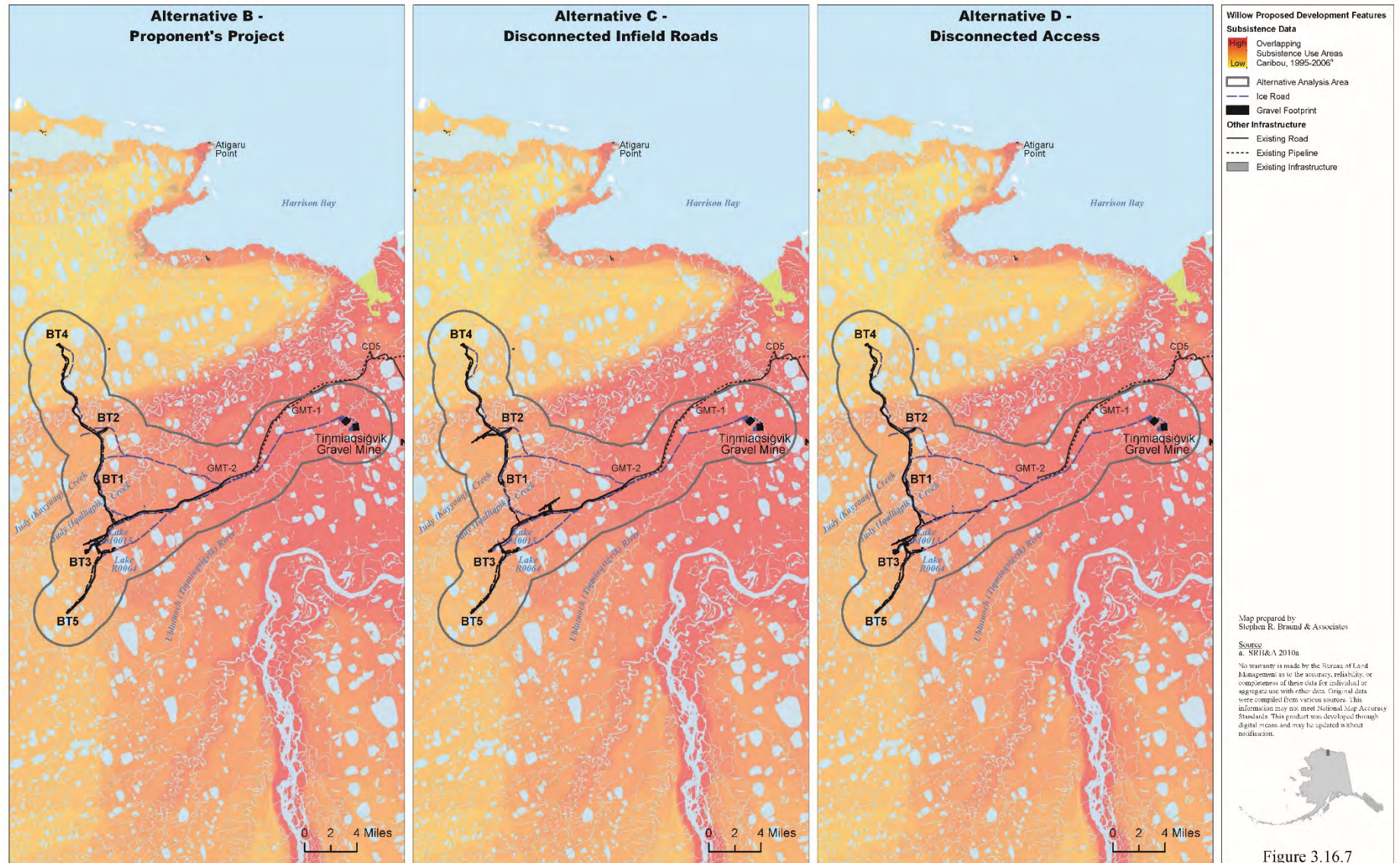


Figure 3.16.7. Caribou Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006

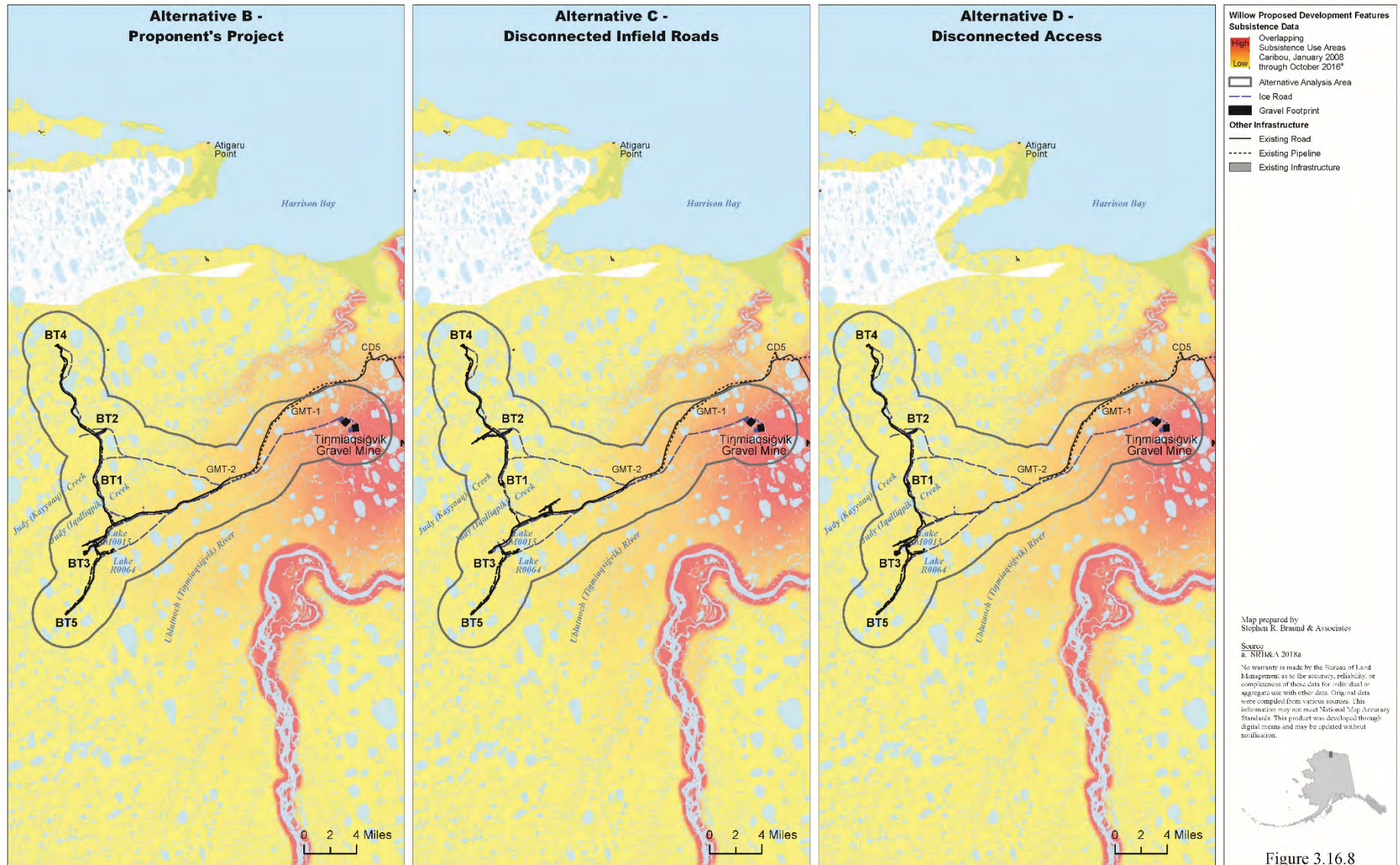


Figure 3.16.8. Caribou Subsistence Use Areas by Alternative, Nuiqsut, 2008–2016

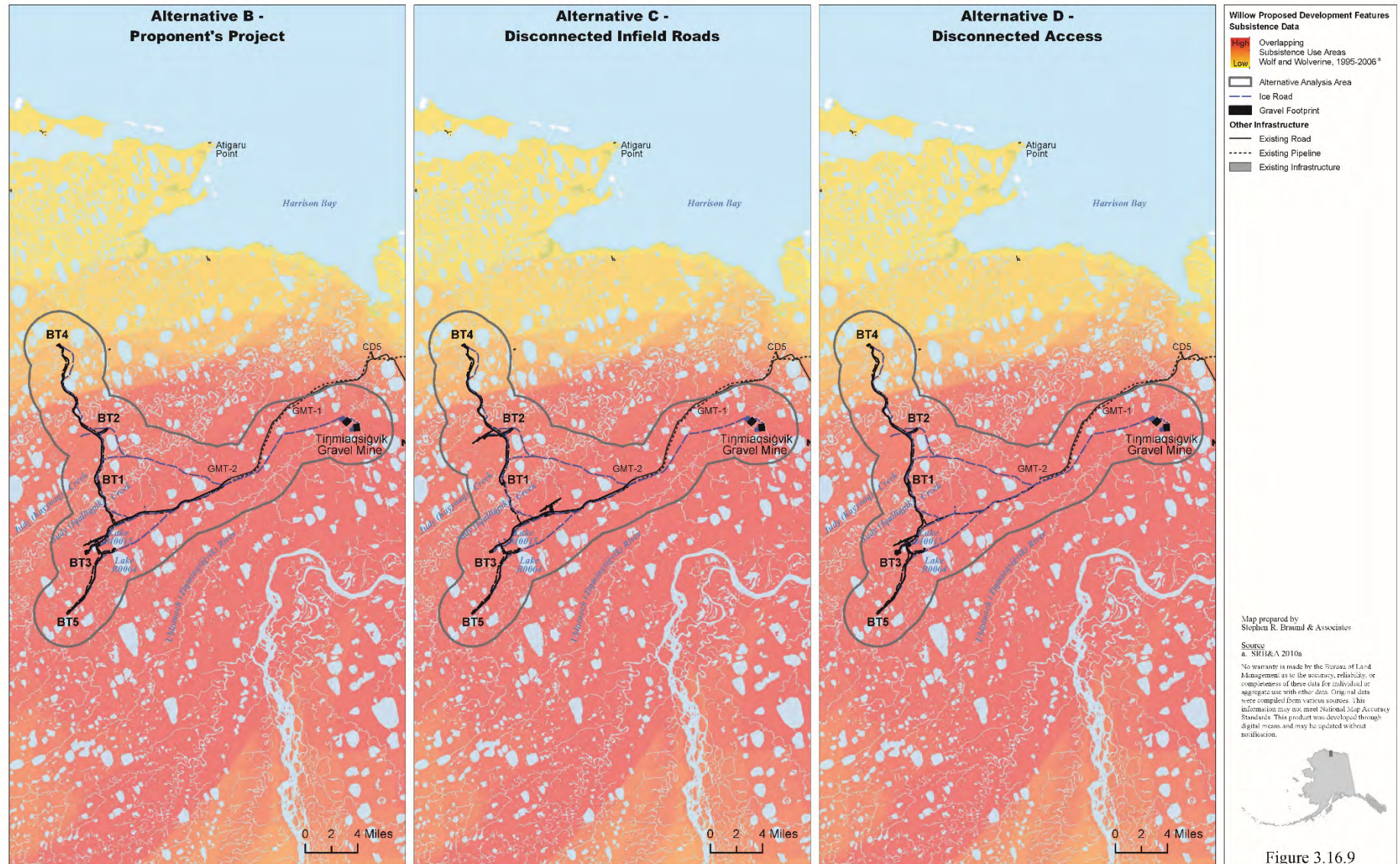


Figure 3.16.9. Wolf and Wolverine Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006

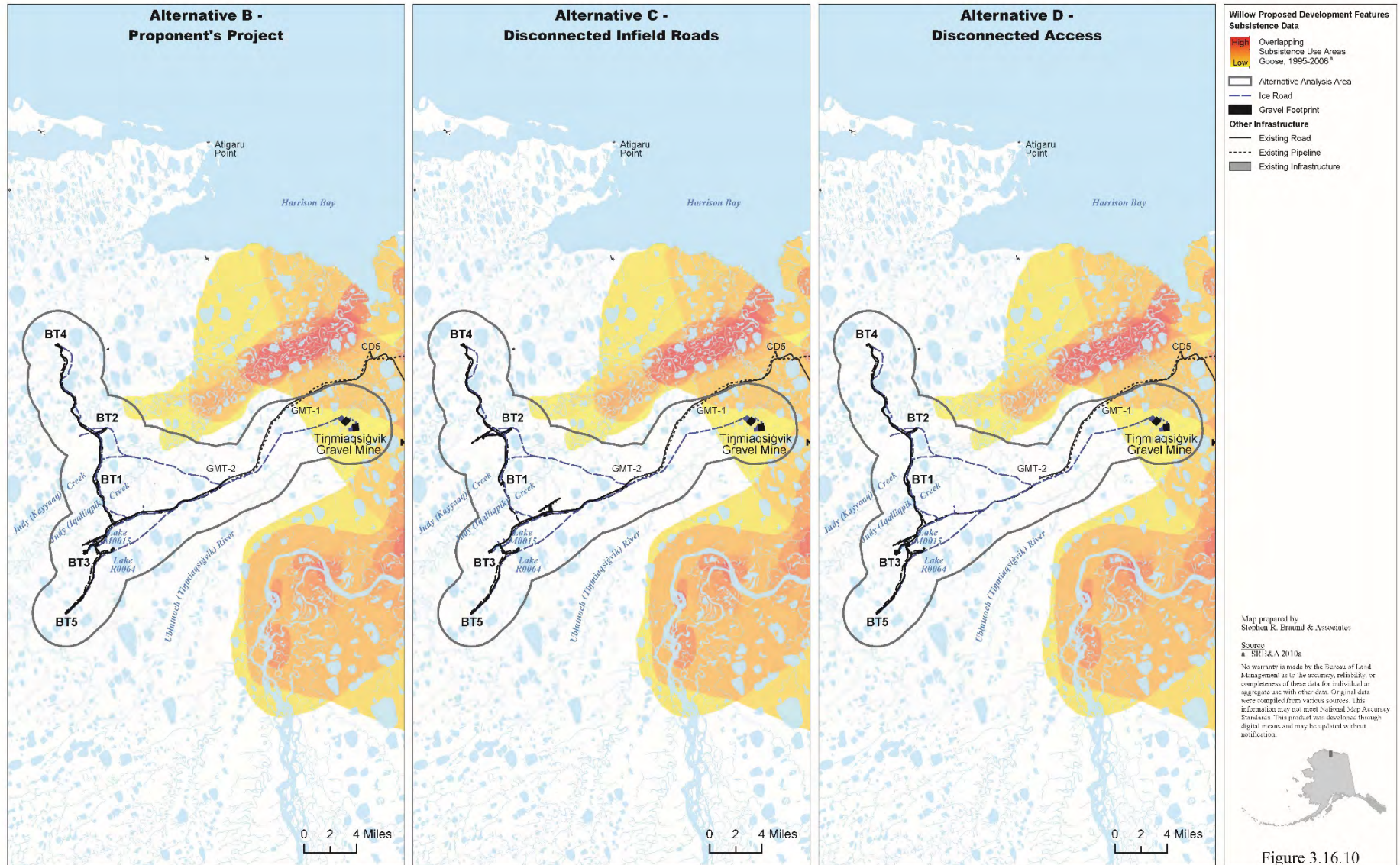


Figure 3.16.10. Goose Subsistence Use Areas by Alternative, Nuiqsut, 1995–2006

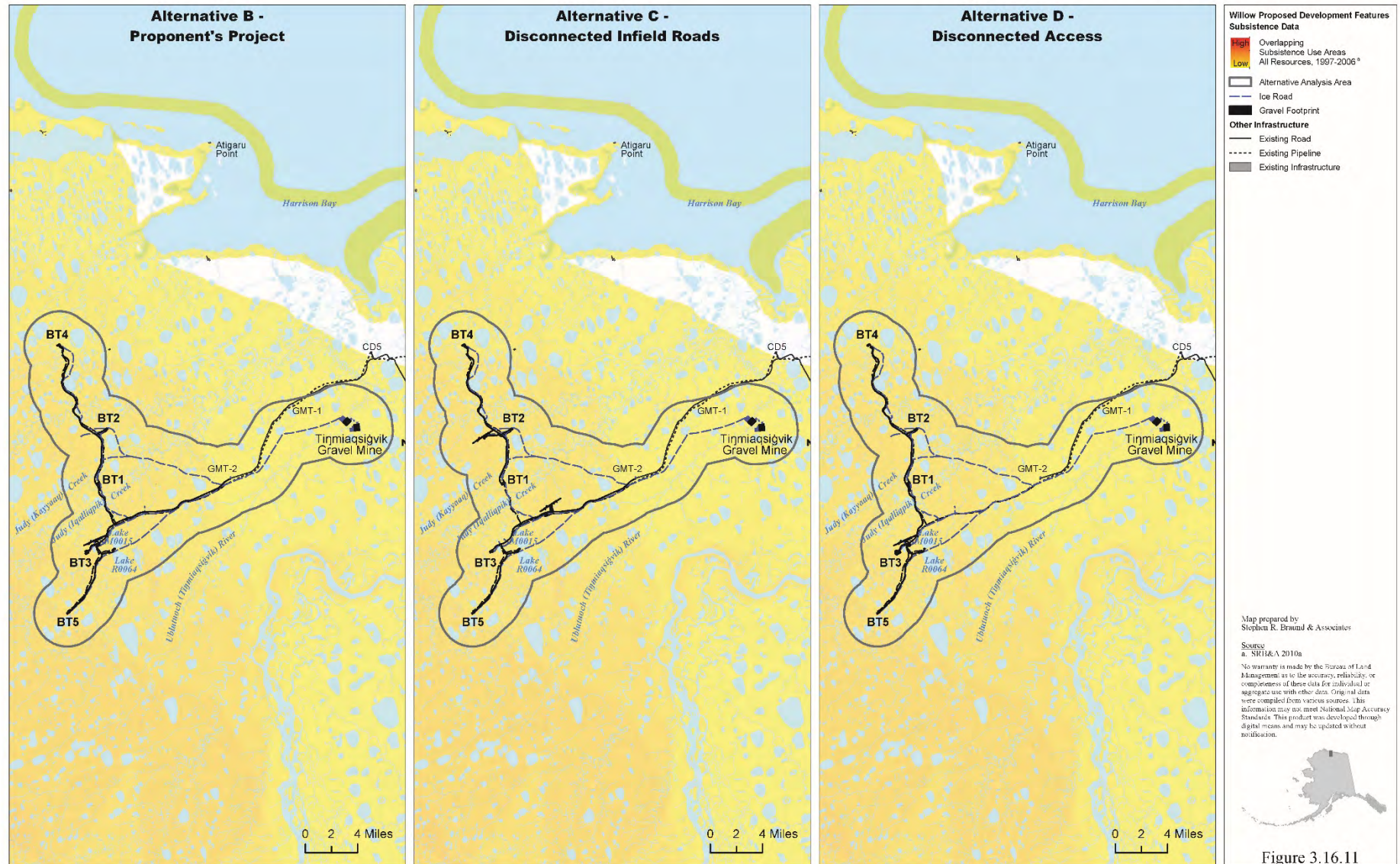


Figure 3.16.11. All Resource Subsistence Use Areas by Alternative, Utqiagvik (Barrow), 1997–2006

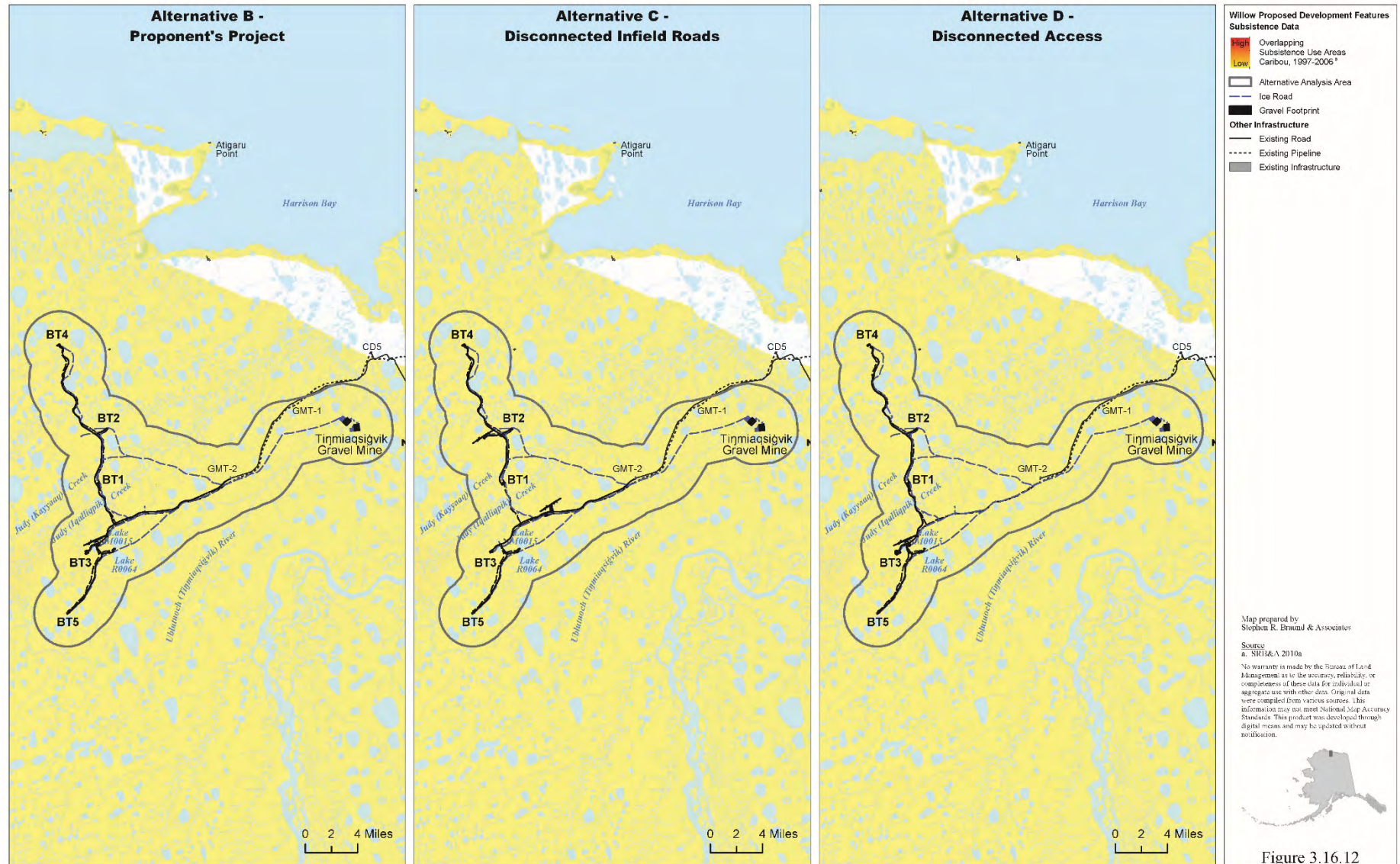


Figure 3.16.12. Caribou Subsistence Use Areas by Alternative, Utqiagvik (Barrow), 1997–2006

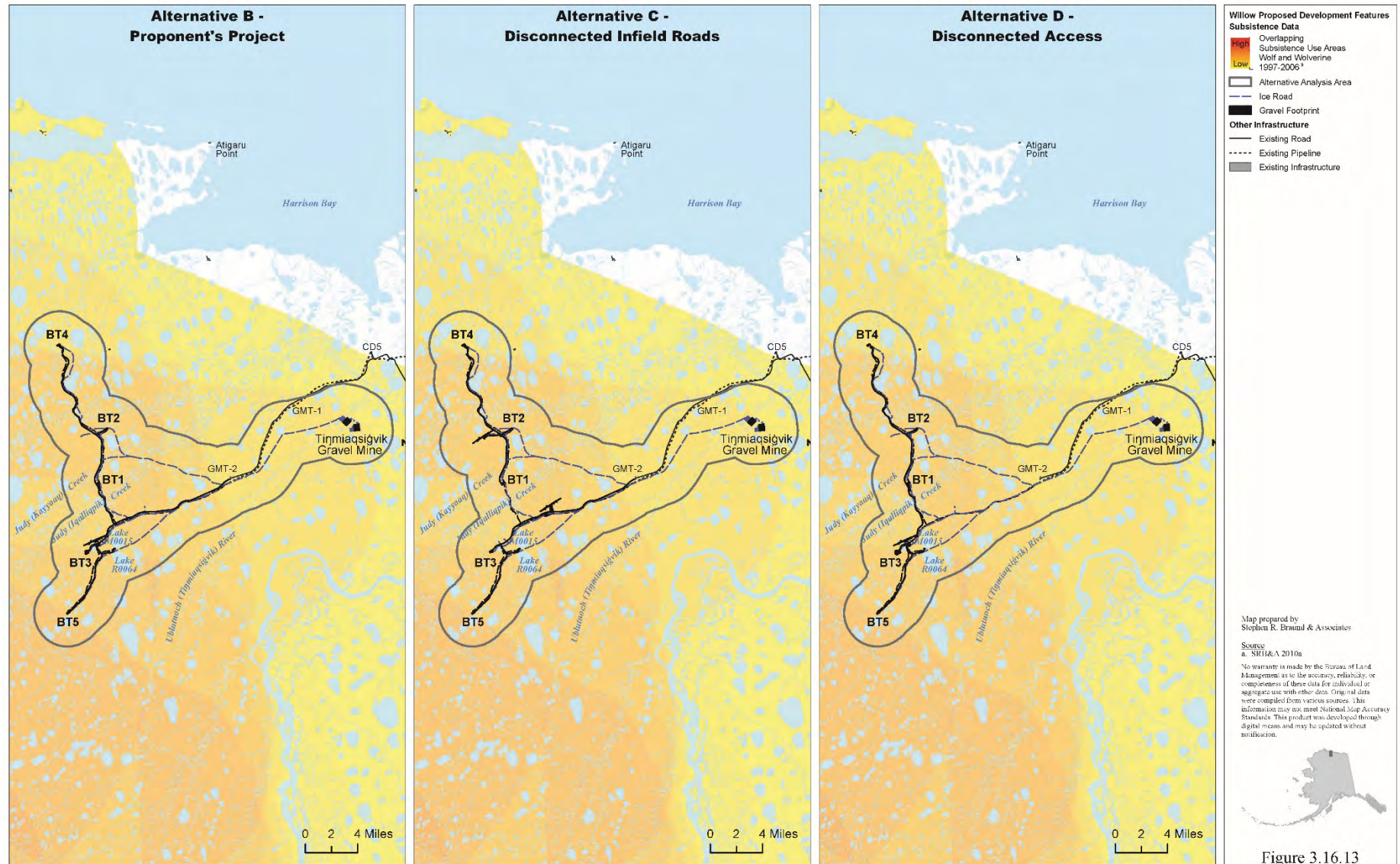


Figure 3.16.13. Wolf and Wolverine Subsistence Use Areas by Alternative, Utqiagvik (Barrow), 1997–2006

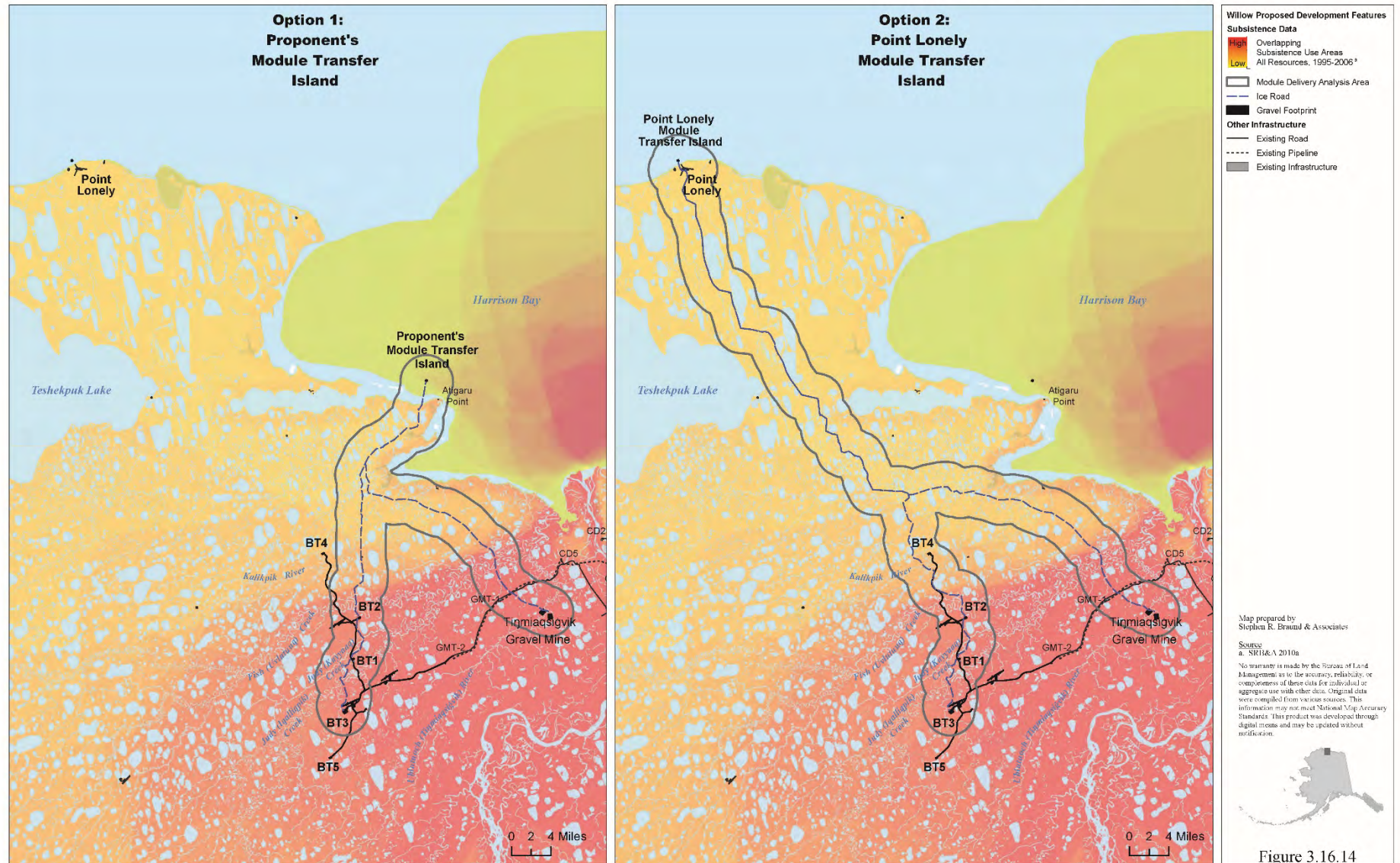


Figure 3.16.14. All Resource Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

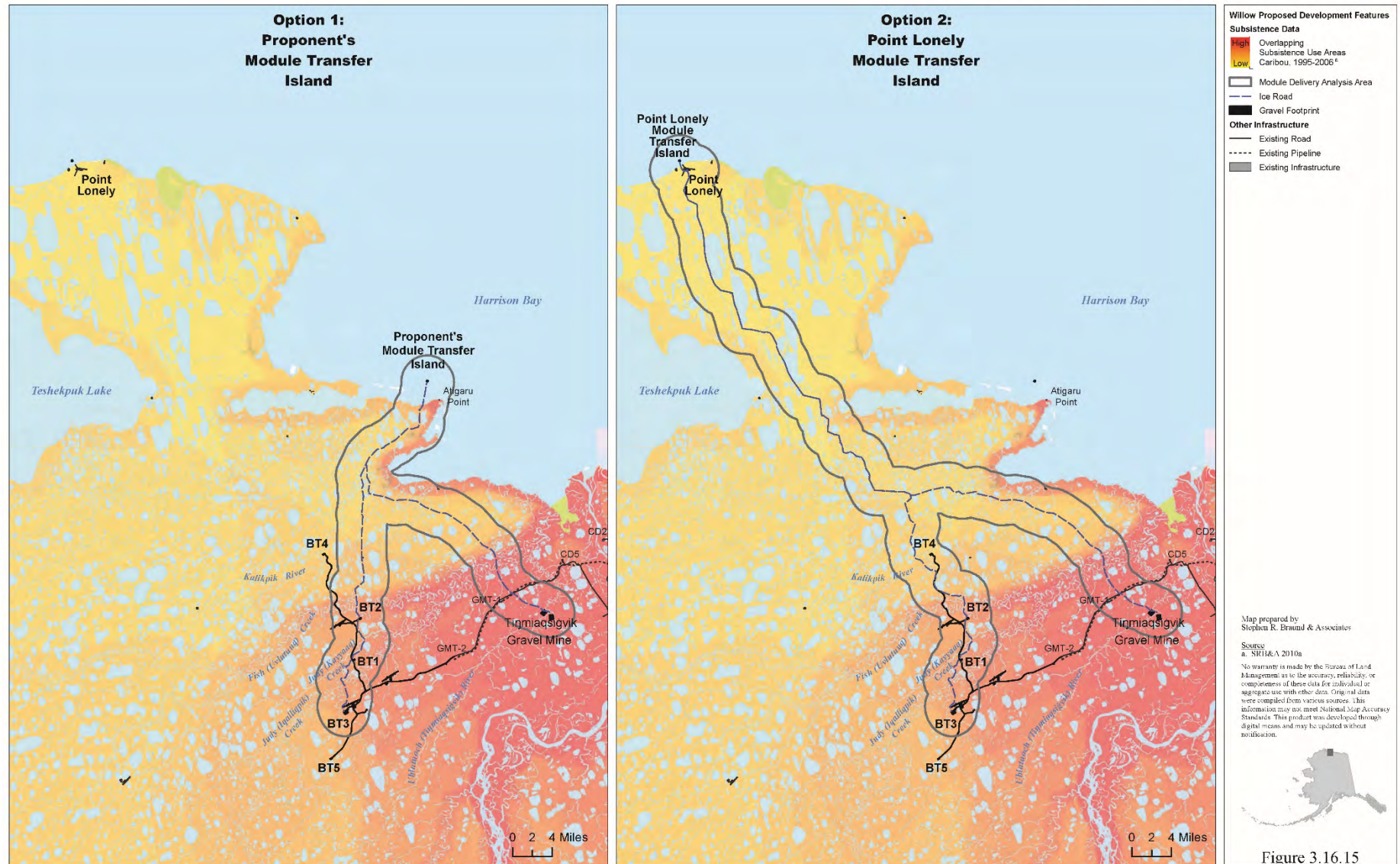


Figure 3.16.15. Caribou Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

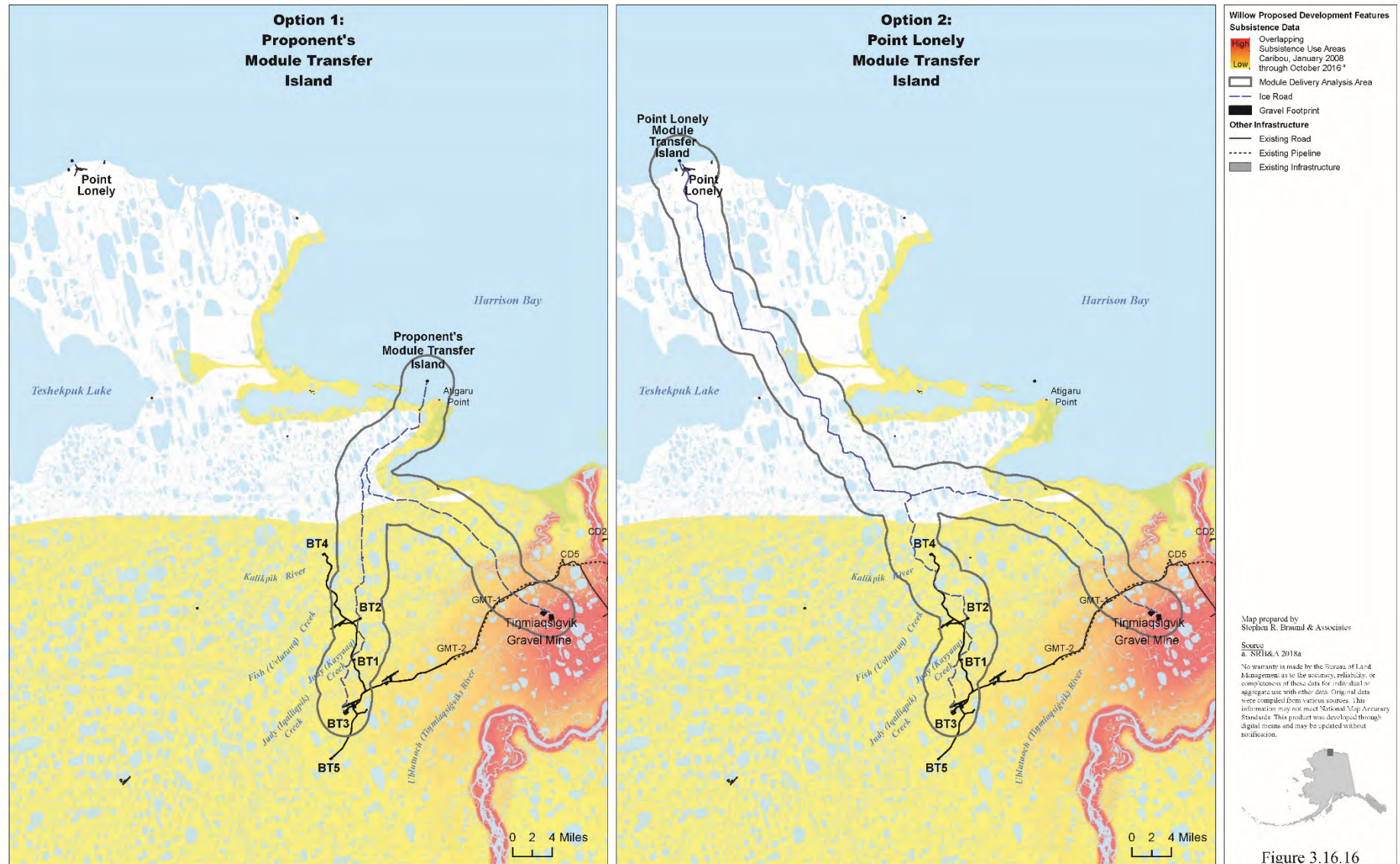


Figure 3.16.16. Caribou Subsistence Use Areas by Module Delivery Option, Nuiqsut, 2008–2016

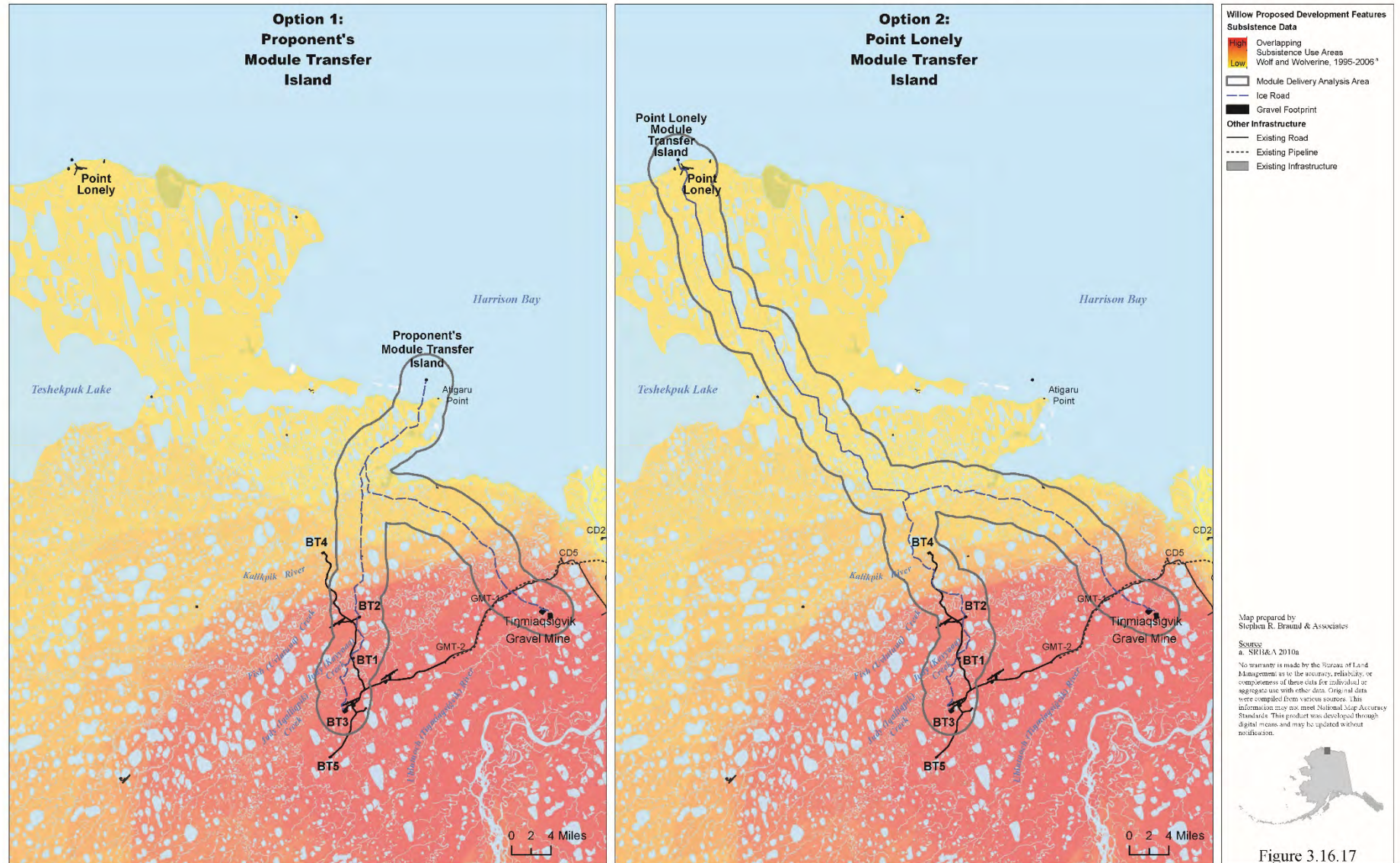


Figure 3.16.17. Wolf and Wolverine Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

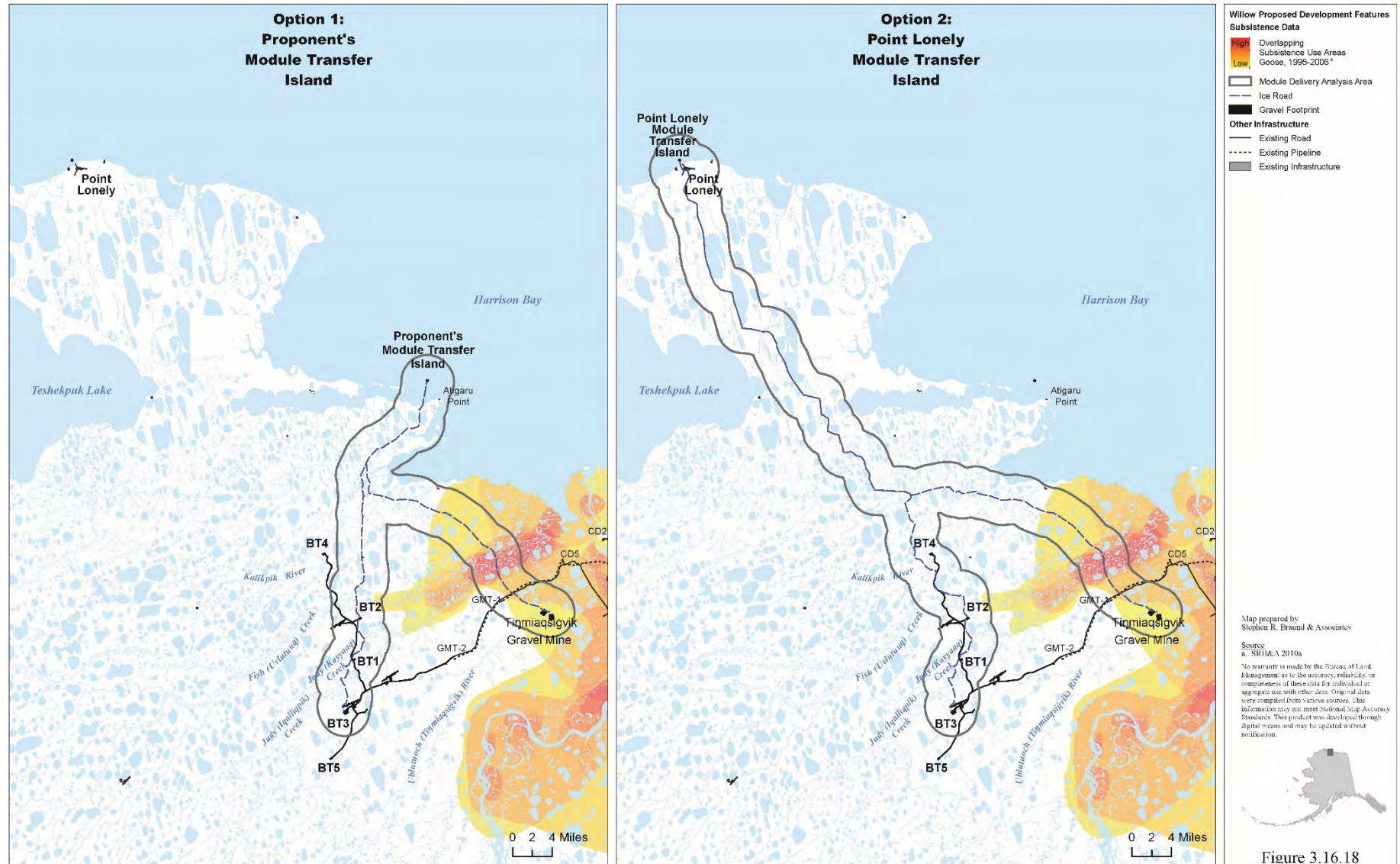


Figure 3.16.18. Goose Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

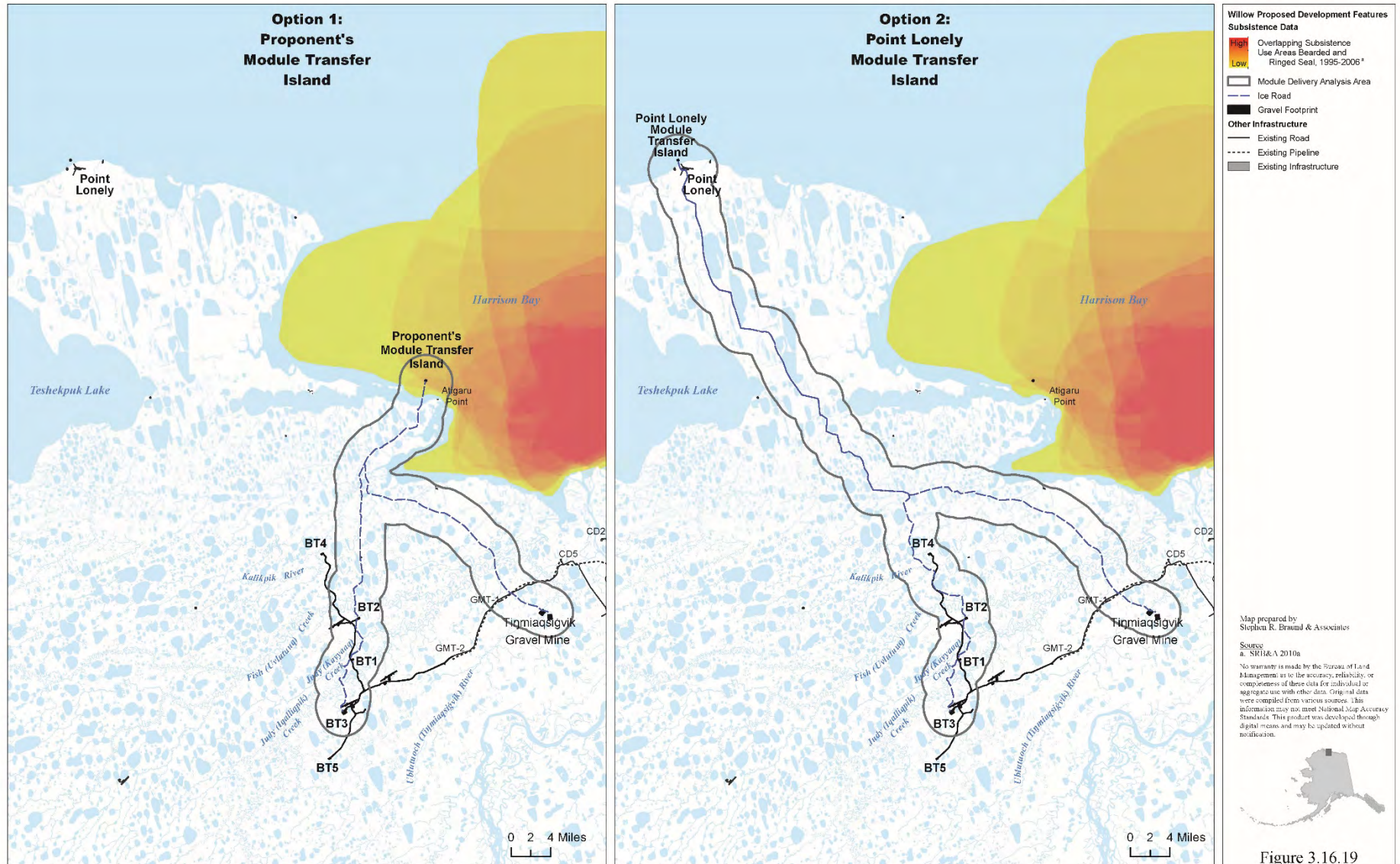


Figure 3.16.19. Seal Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

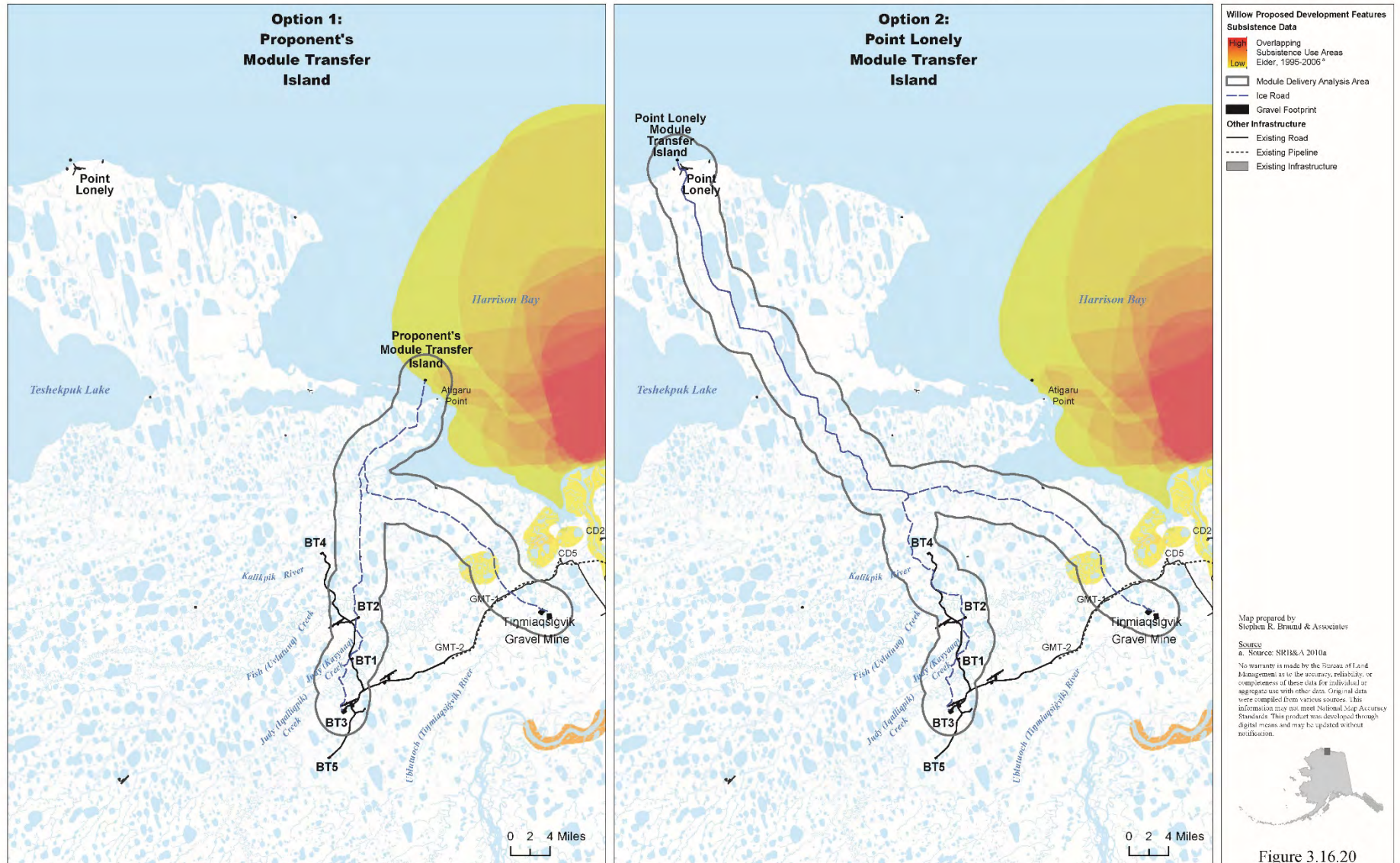


Figure 3.16.20. Eider Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

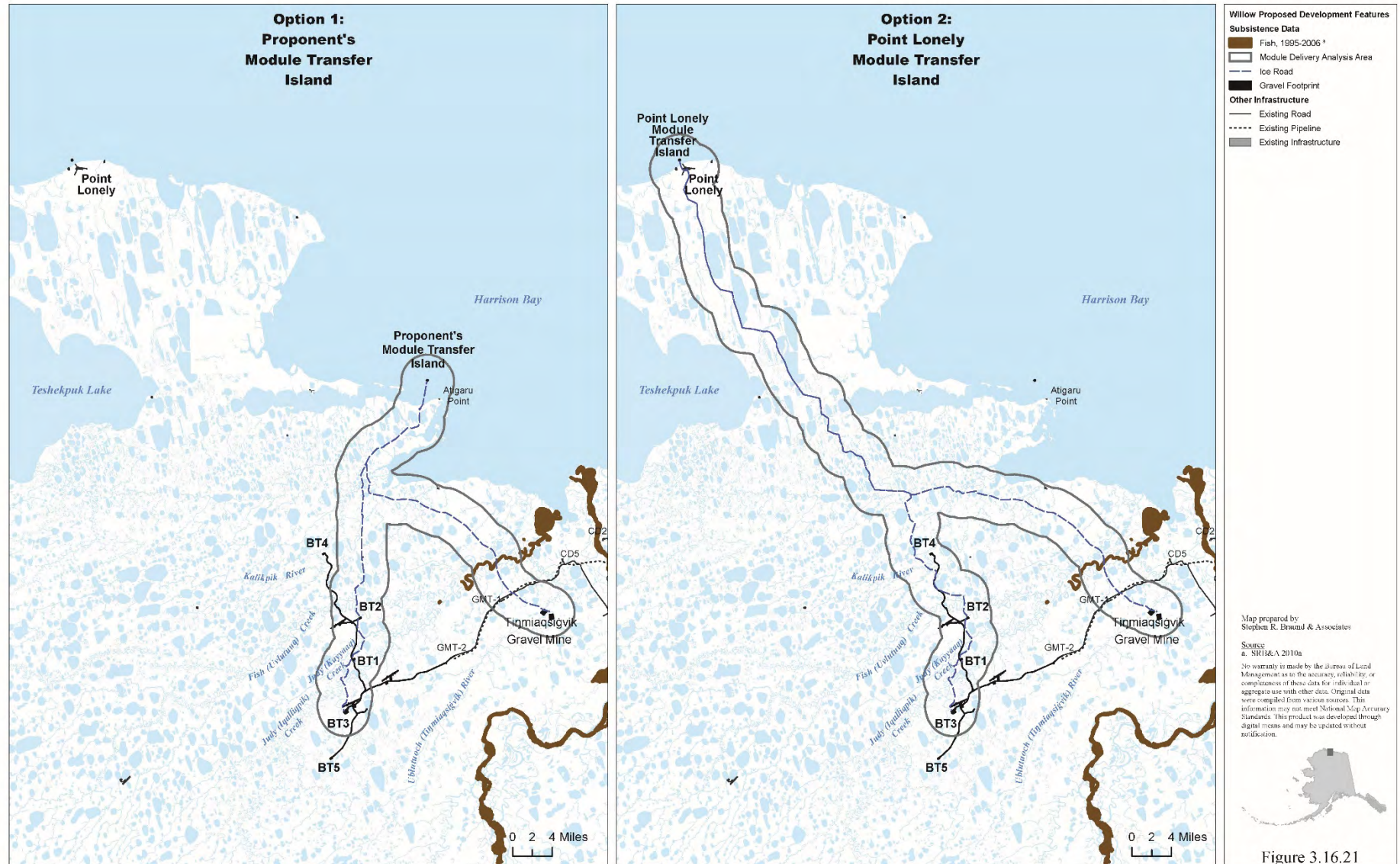


Figure 3.16.21. Fish Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

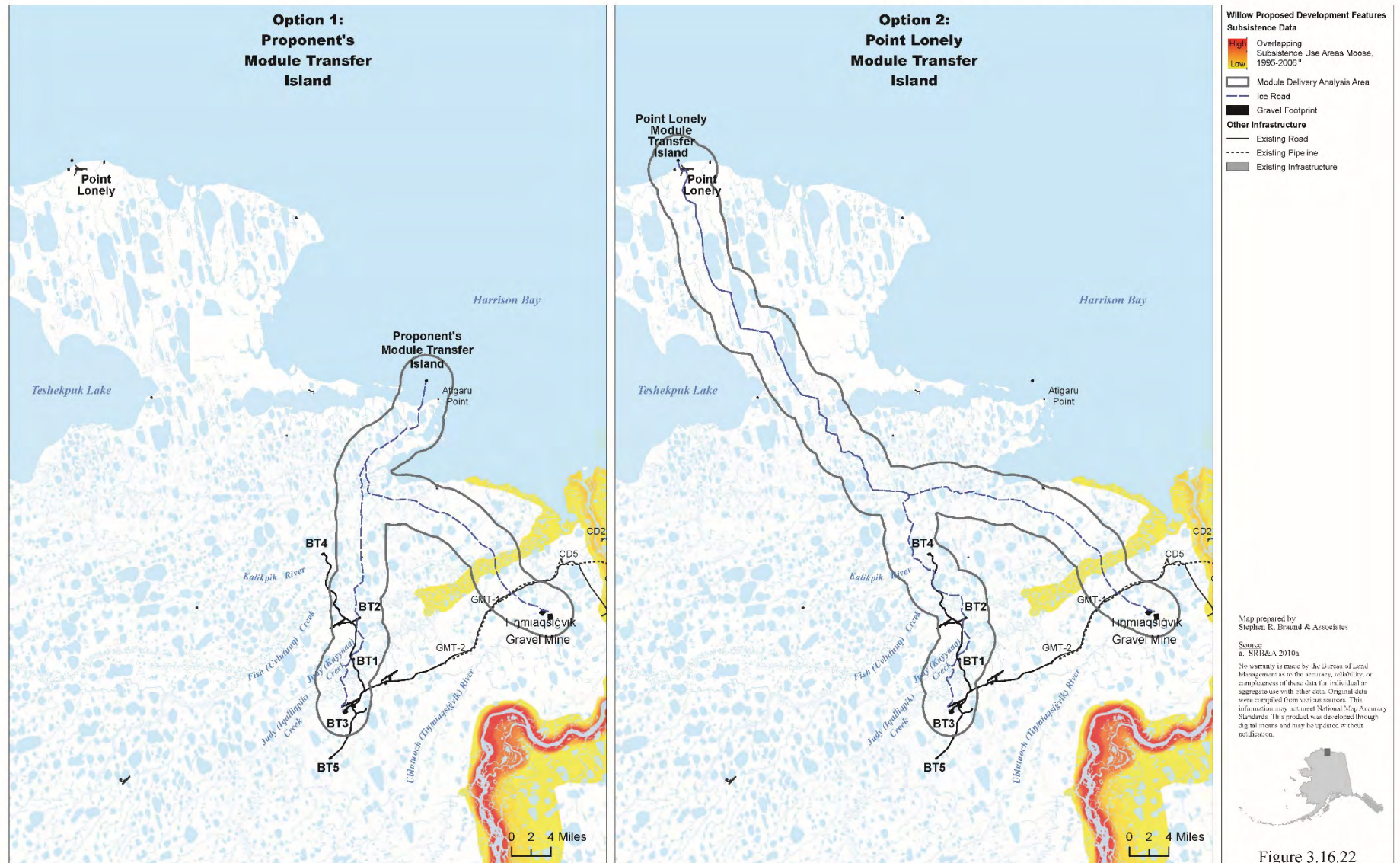


Figure 3.16.22. Moose Subsistence Use Areas by Module Delivery Option, Nuiqsut, 1995–2006

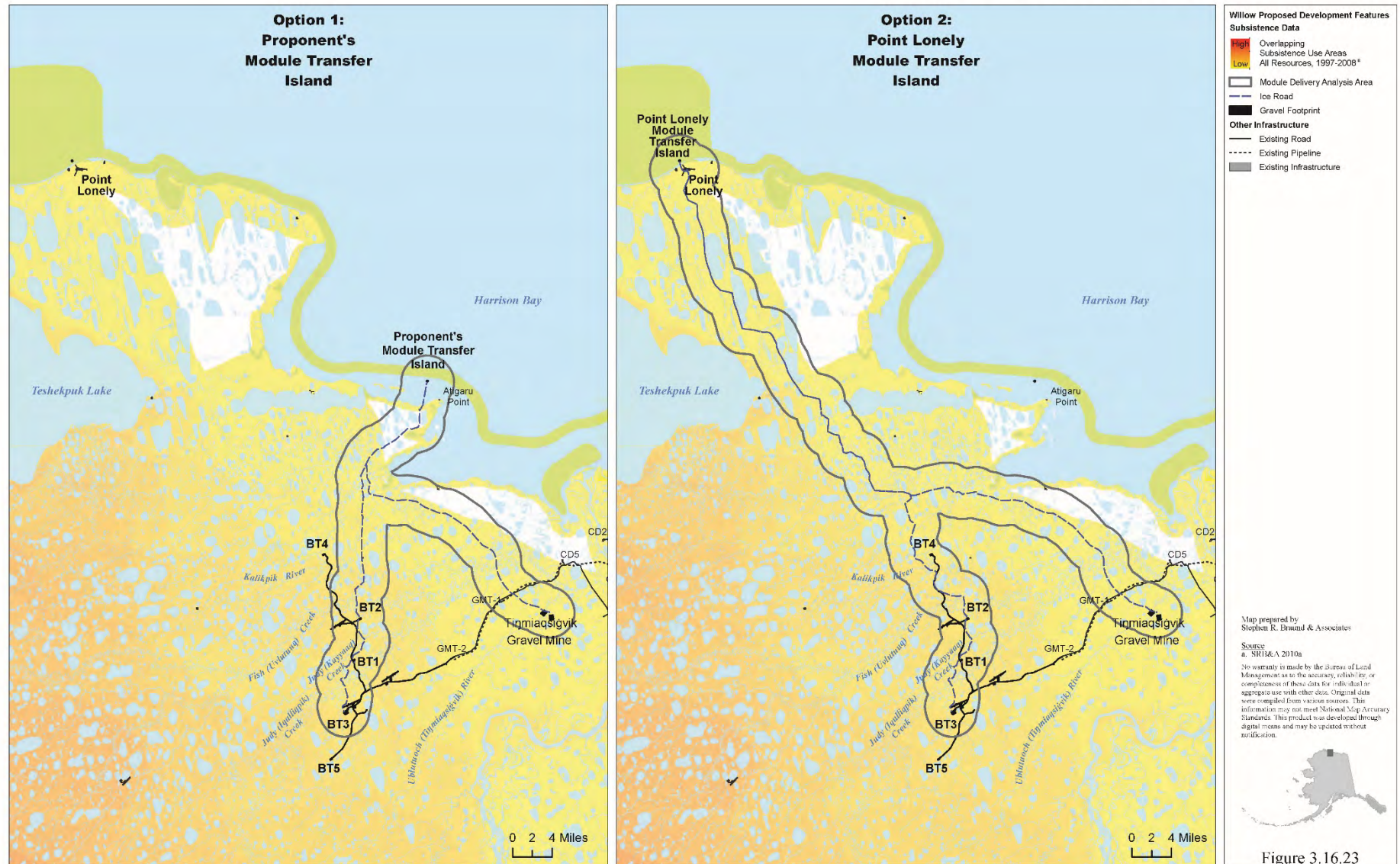


Figure 3.16.23. All Resource Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1997-2008

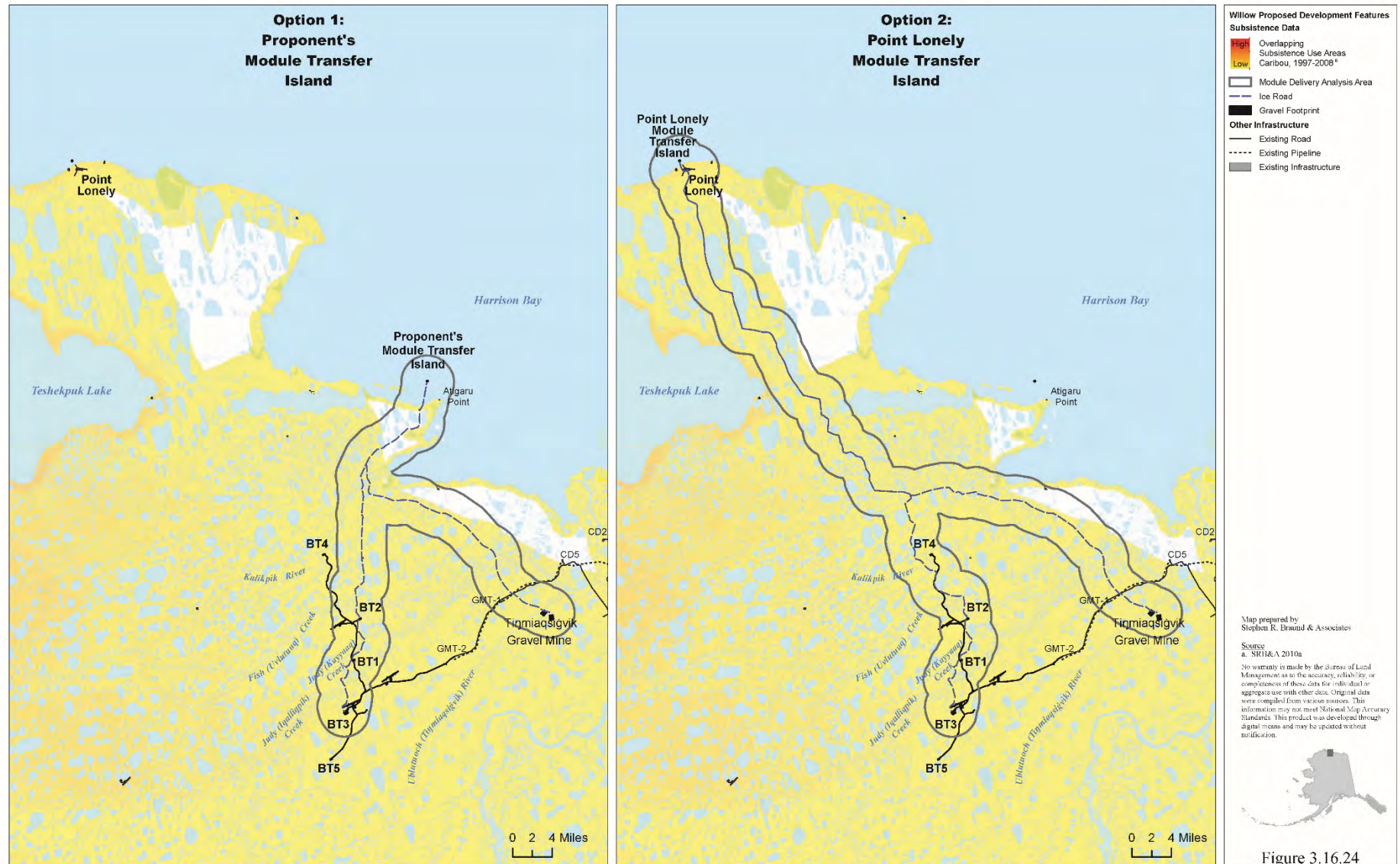


Figure 3.16.24. Caribou Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1997–2008

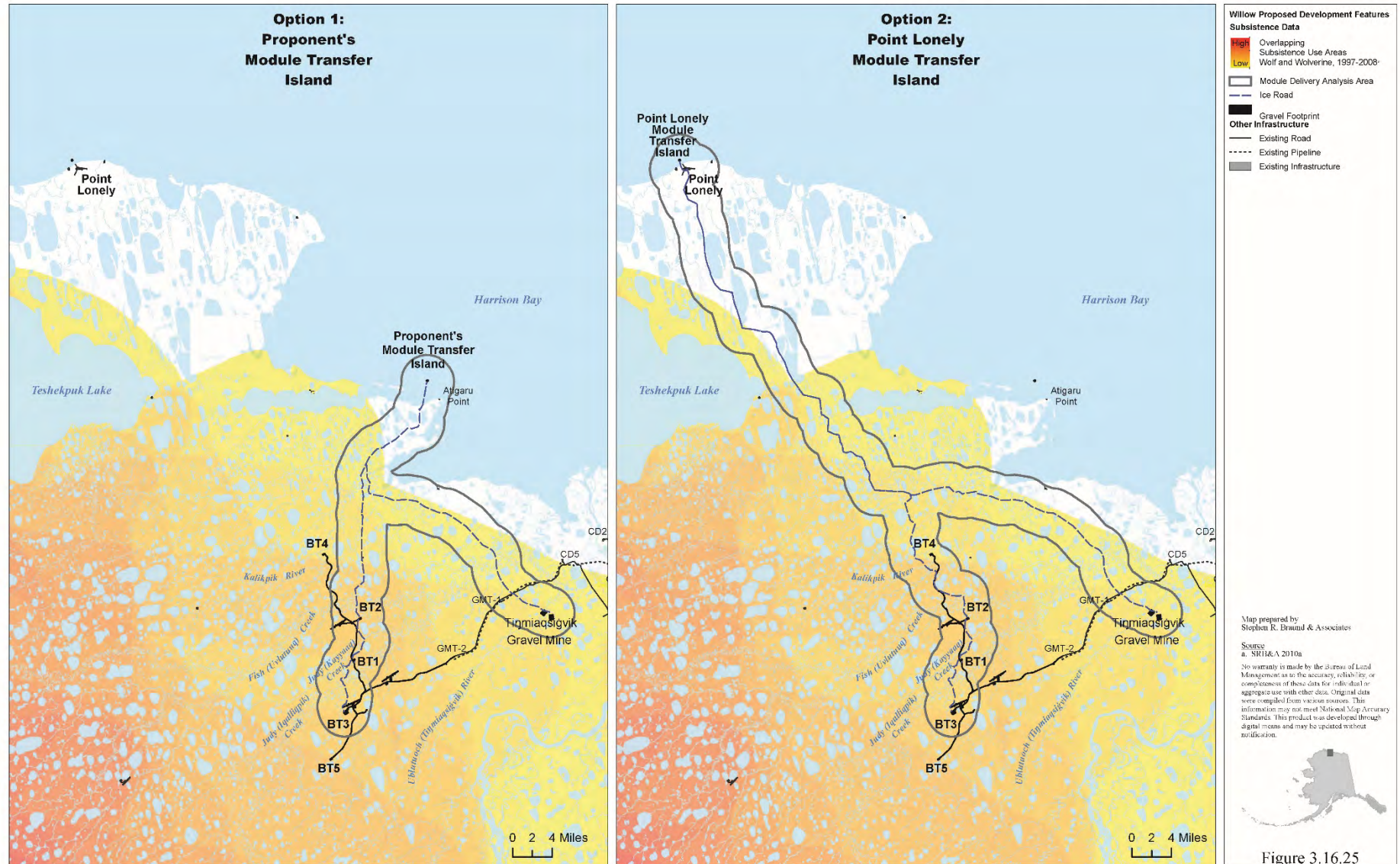


Figure 3.16.25. Wolf and Wolverine Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1997–2008

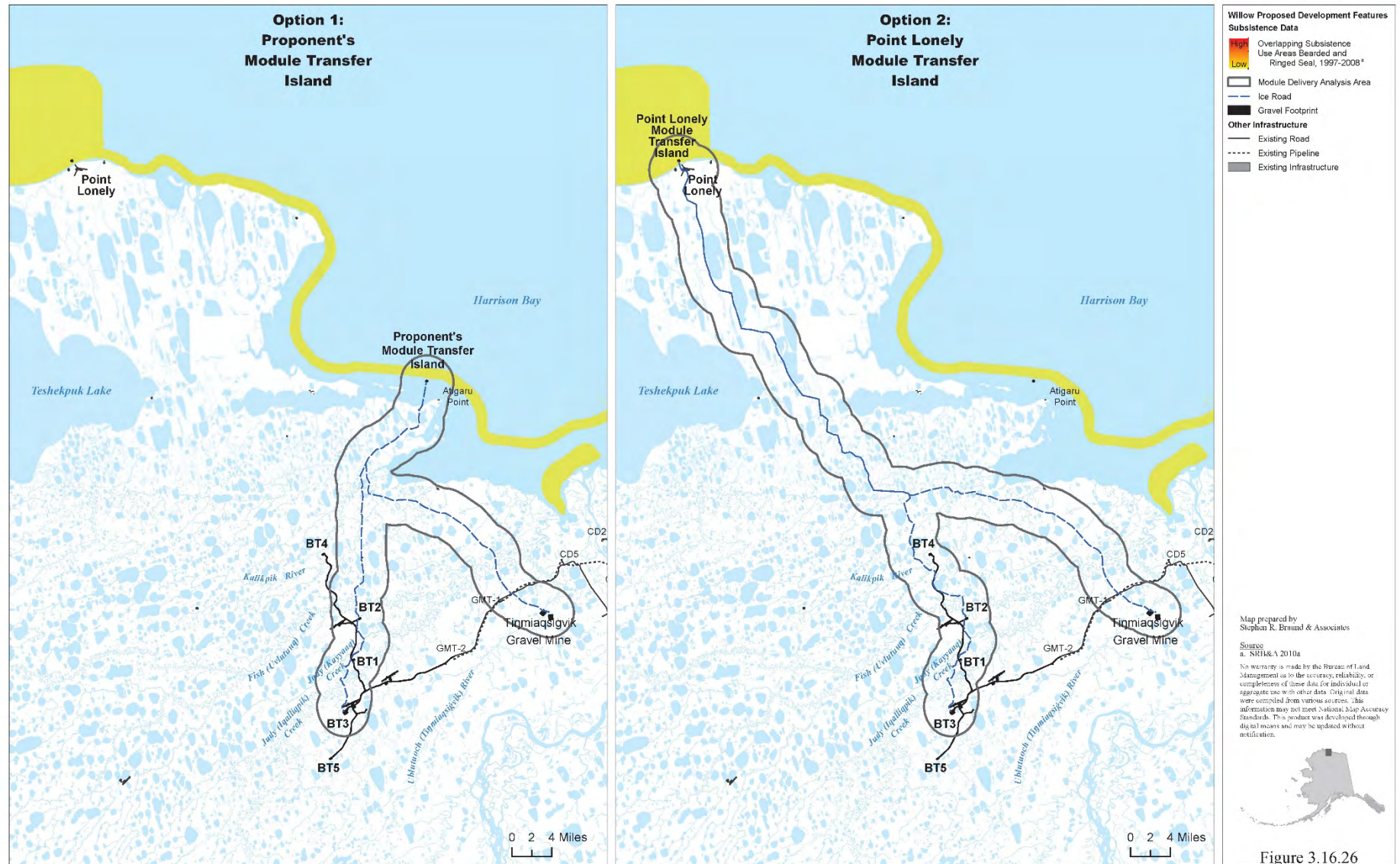


Figure 3.16.26. Seal Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1995–2008

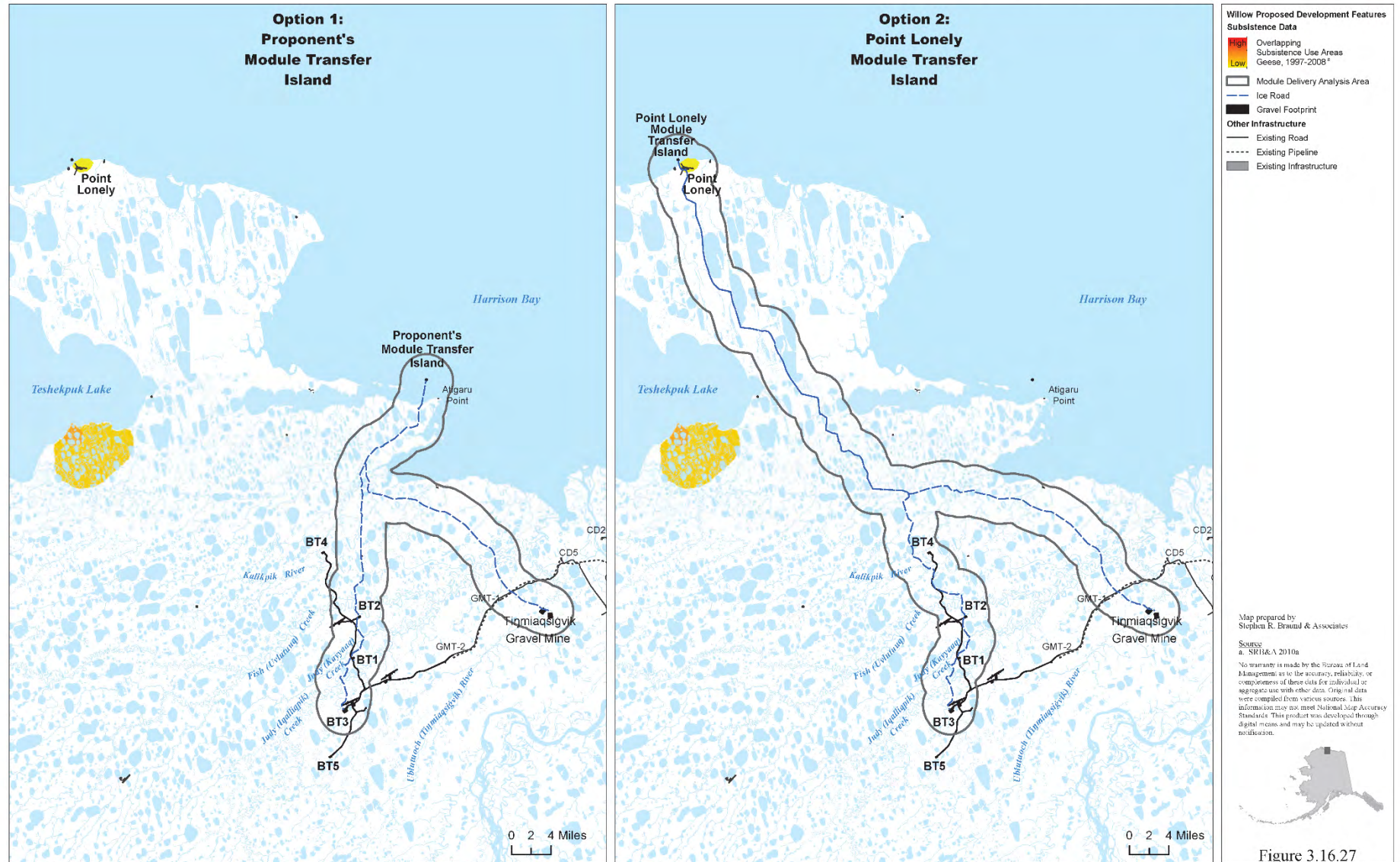


Figure 3.16.27. Goose Subsistence Use Areas by Module Delivery Option, Utqiagvik (Barrow), 1995–2008

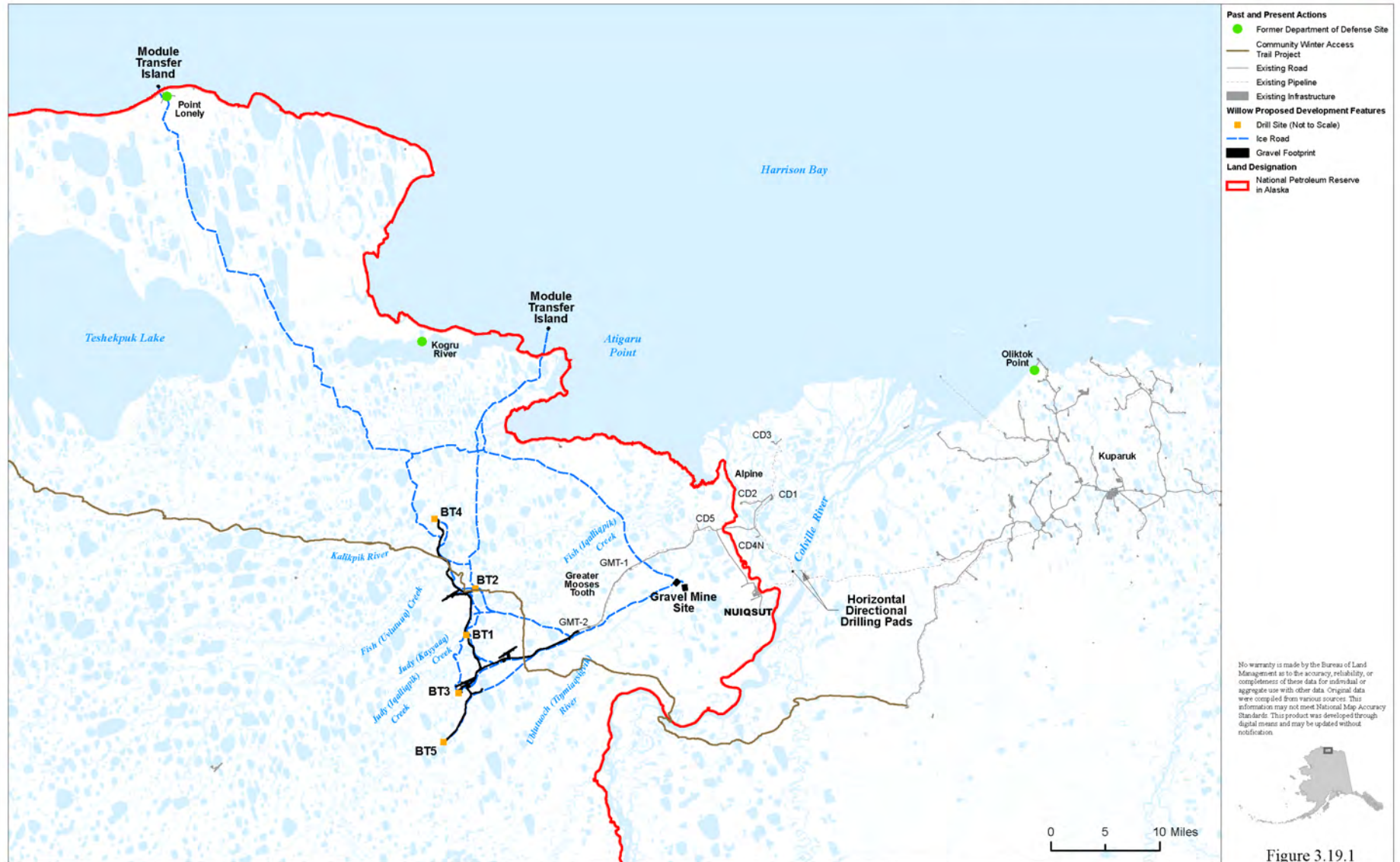


Figure 3.19.1. Past and Present Actions that may Interact with the Willow Project



Figure 3.19.2. Reasonably Foreseeable Future Actions that may Interact with the Willow Project

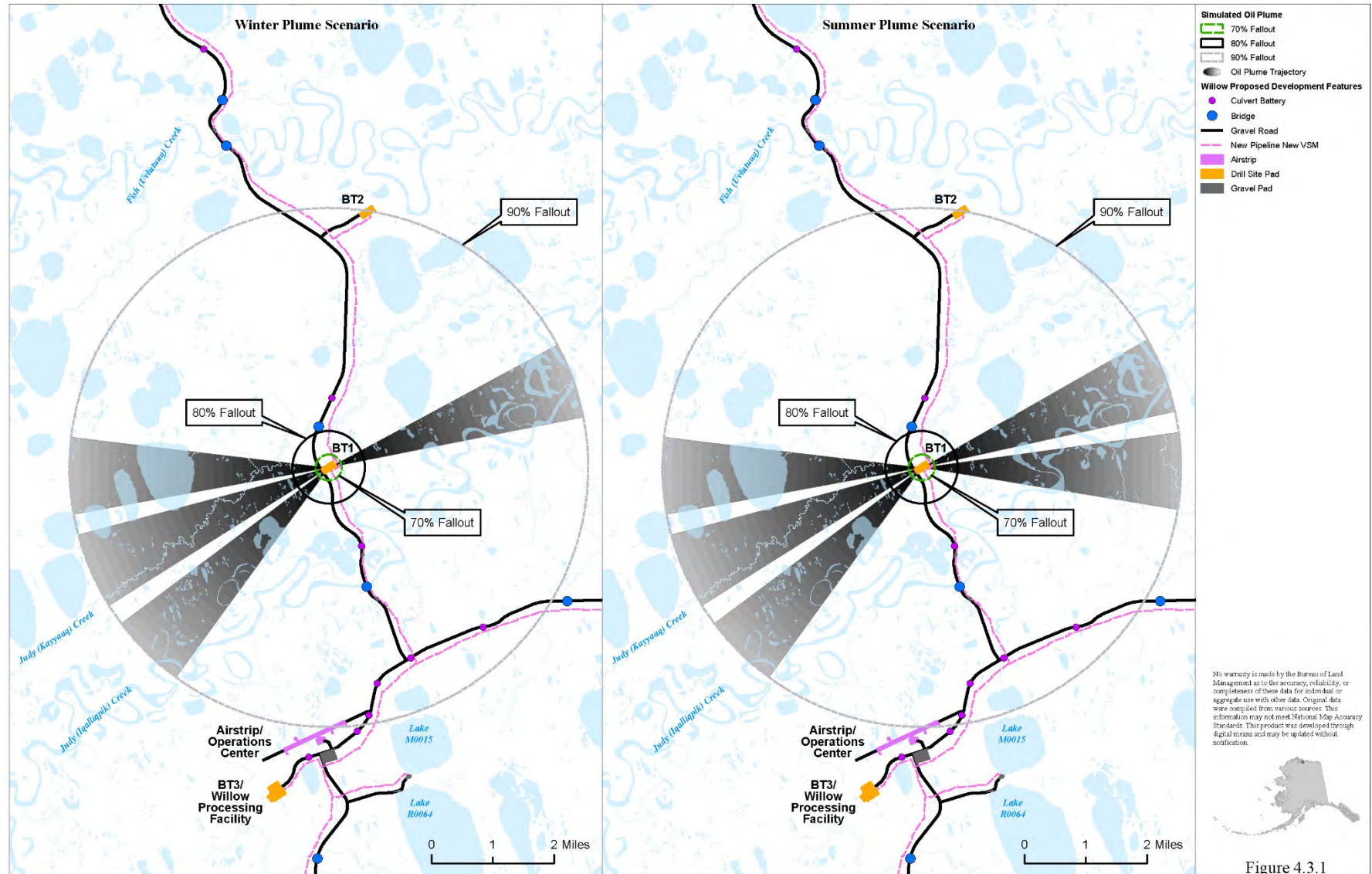


Figure 4.3.1. Drill Site BT1 Reservoir Blowout Oil Fallout

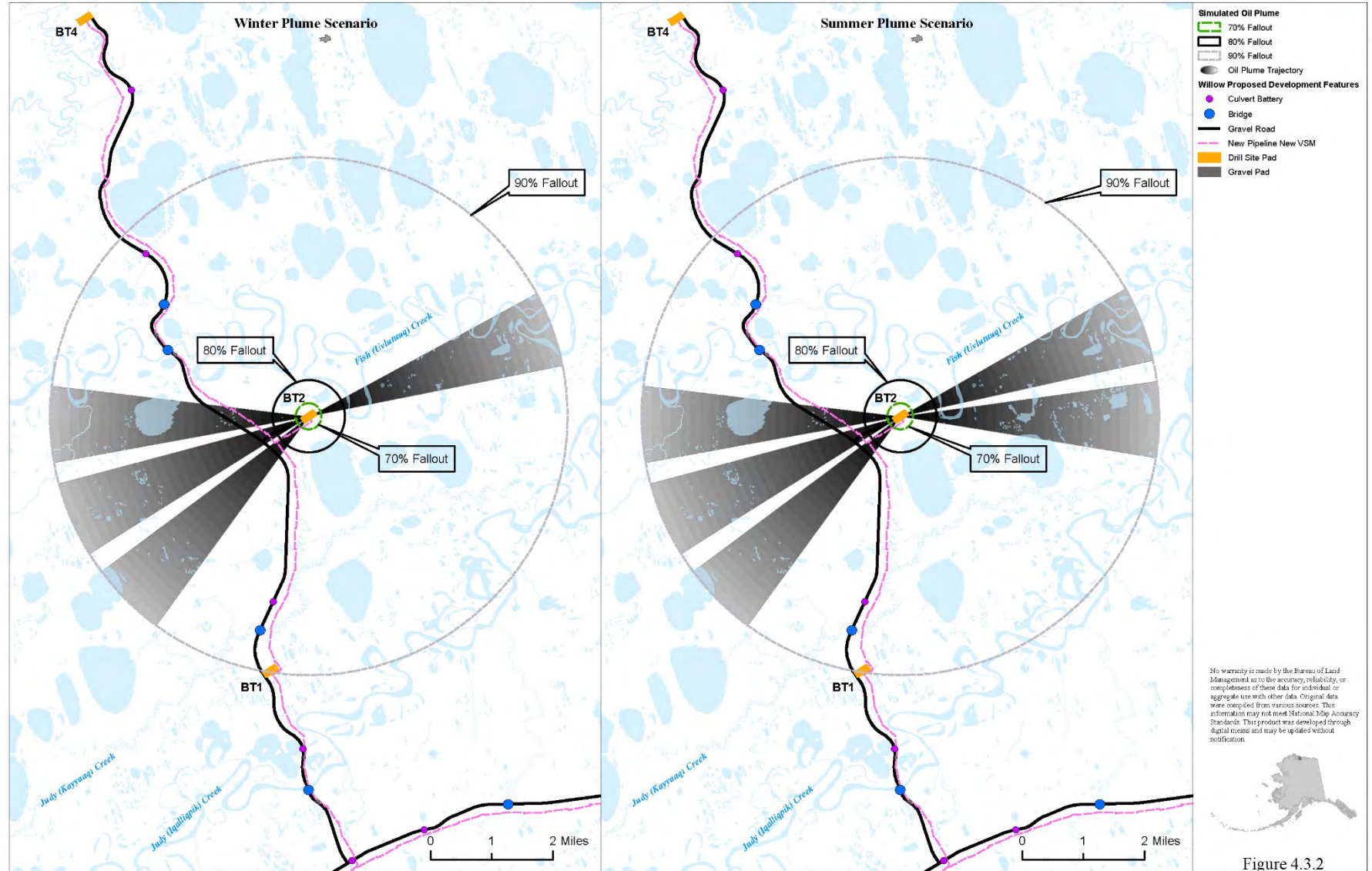


Figure 4.3.2. Drill Site BT2 Reservoir Blowout Oil Fallout

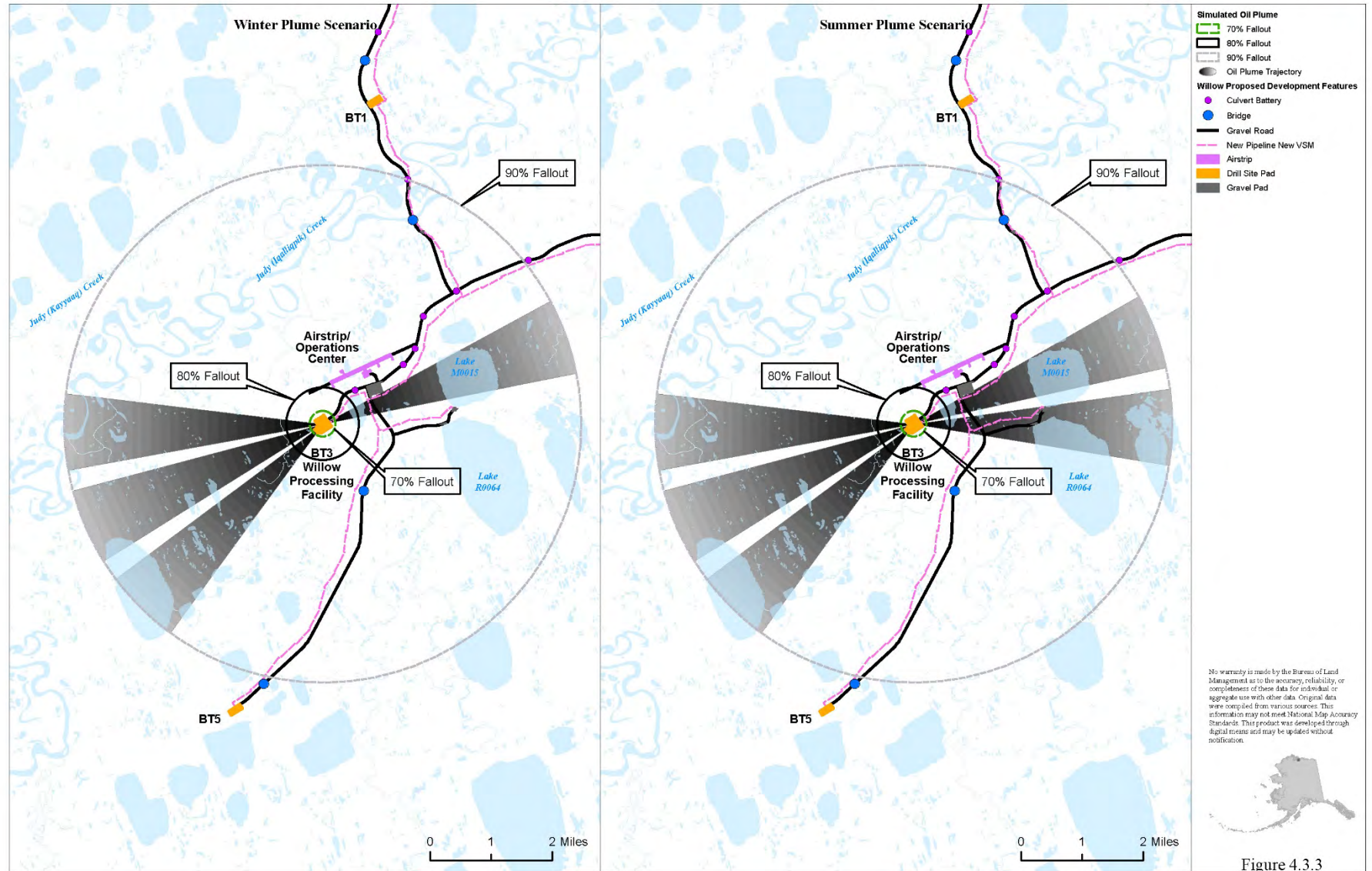


Figure 4.3.3. Drill Site BT3 Reservoir Blowout Oil Fallout

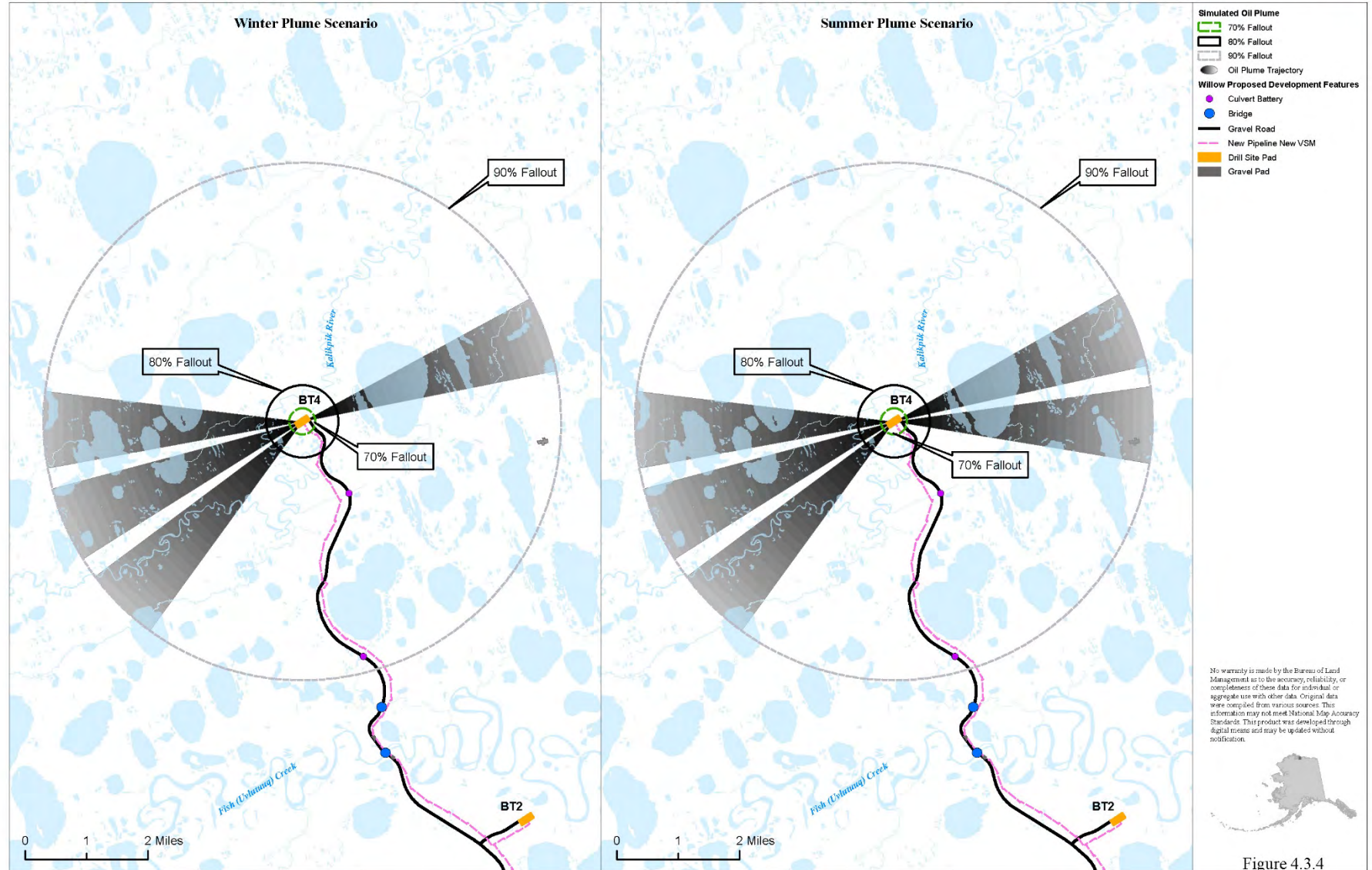


Figure 4.3.4. Drill Site BT4 Reservoir Blowout Oil Fallout

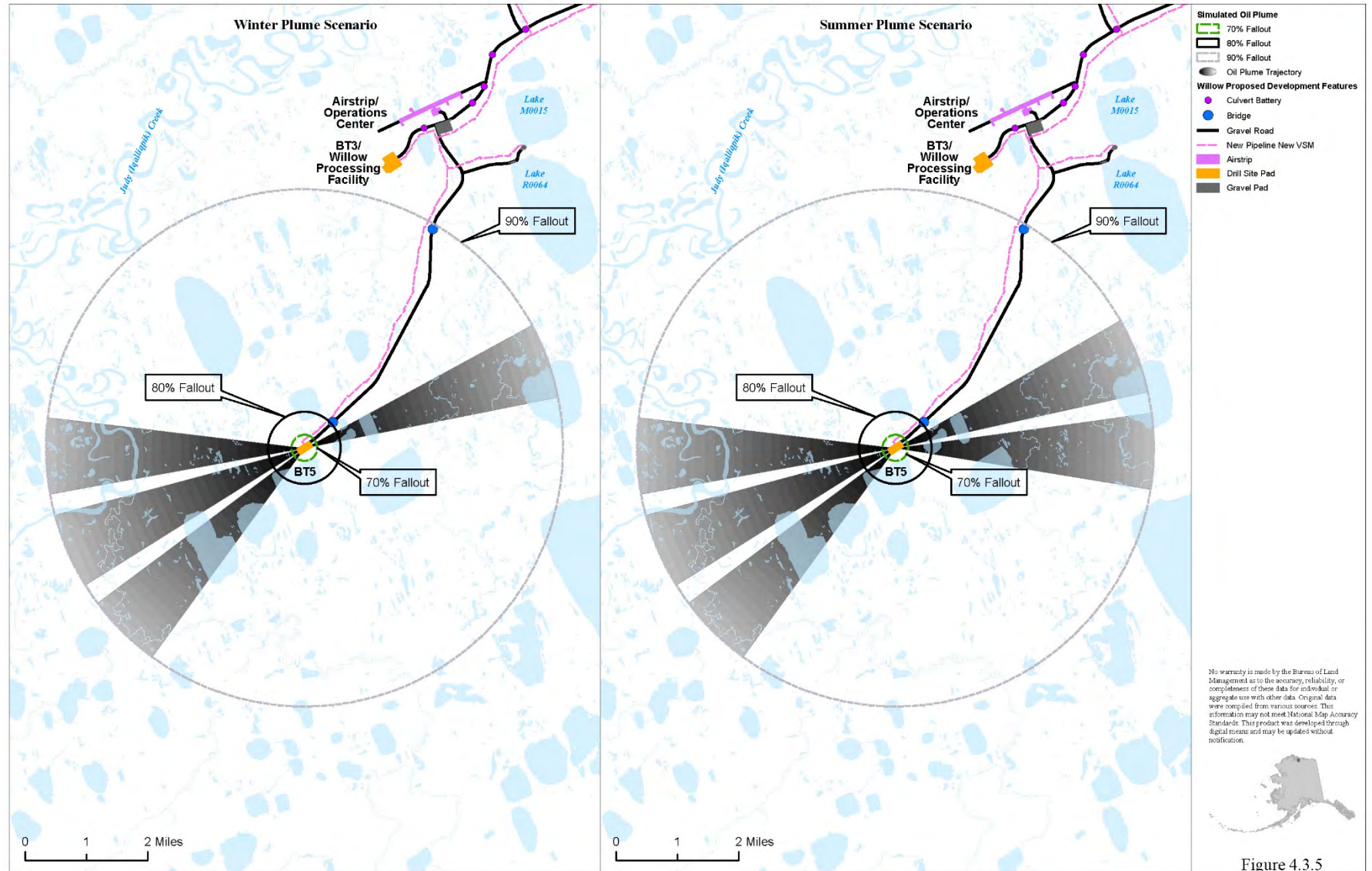


Figure 4.3.5. Drill Site BT5 Reservoir Blowout Oil Fallout