APPENDIX G NOISE ANALYSIS CALCULATION DETAILS

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Pipestone Reroute - 116th Street Entry - Direct Bore Noise Calculations - NSA 1

Direct Bore Entry Point Sound Pressure Level = 82.9 dBA at 10 Feet [1]

Corresponding Sound Power Level = 104 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
83.82	275											
Typical construction spectrum per EEI			**98**	**103**	**106**	**101**	**99**	**96**	**90**	**84**		**104**
Hemispherical Spreading (Distance) =		-47	-47	-47	-47	-47	-47	-47	-47	-47	-47	
Intermediate SPL		-47	51	56	59	54	52	49	43	37	-47	57.5
Atmospheric Absorption (59 F / 70%RH) =		0	0	0	0	0	0	-1	-2	-7	-26	
SPL with Atmos. Absorp.		-47	51	56	59	54	52	48	41	30	-73	57.0
								Additional Reduction due to Atmospheric Absorption (dBA)				**0.4**
Excess Anomalous Attenuation		0	0	0	0	0	0	-1	-1	-1	-1	
HDD SPL with Atmos Absorp and Excess Anomalous Atten		**-47**	**51**	**56**	**59**	**54**	**51**	**48**	**40**	**29**	**-74**	**56.7**
								Additional Reduction due to Excess Anomalous Attenuation (dBA):				**0.4**
								Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):				**0.8**

L50
56.7

Existing Daytime Ambient [2]
36.7

HDD + Ambient
36.7

Potential Increase
0.0

(1) Vereer D24x40 S3 drill - manufacturers' noise estimates.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - 116th Street Entry - Direct Bore Noise Calculations - NSA 1

Direct Bore Exit Point Sound Pressure Level = 82.9 dBA at 10 Feet [1]
Corresponding Sound Power Level = 104 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
76.2	250												
		Typical construction spectrum per EEI		**98**	**103**	**106**	**101**	**99**	**96**	**90**	**84**		**104**
		Hemispherical Spreading (Distance) =	-46	-46	-46	-46	-46	-46	-46	-46	-46	-46	
		Intermediate SPL	-46	52	57	60	55	53	50	44	38	-46	58.3
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	0	0	0	-1	-2	-7	-24	
		SPL with Atmos. Absorp.	-46	52	57	60	55	53	49	42	31	-70	57.9
									Additional Reduction due to Atmospheric Absorption (dBA)				**0.4**
		Excess Anomalous Attenuation	0	0	0	0	0	0	-1	-1	-1	-1	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-46**	**52**	**57**	**60**	**55**	**52**	**49**	**41**	**30**	**-71**	**57.6**
										Additional Reduction due to Excess Anomalous Attenuation (dBA):			**0.3**
										Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):			**0.7**

L50
57.6

Existing Daytime Ambient [2]
36.7

HDD + Ambient
57.6

Potential Increase
20.9

(1) Vereer D24x40 S3 drill - manufacturers' noise estimates.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Pipestone Creek Entry - HDD Noise Calculations - NSA 1

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]
Corresponding Sound Power Level = 115 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
152.4	500											
Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
Hemispherical Spreading (Distance) =	-52	-52	-52	-52	-52	-52	-52	-52	-52	-52	
Intermediate SPL	-52	57	62	65	60	58	55	49	43	-52	63.3
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	0	0	-1	-1	-4	-13	-47	
SPL with Atmos. Absorp.	-52	57	62	65	60	57	54	45	30	-99	62.5
						Additional Reduction due to Atmospheric Absorption (dBA)					**0.7**
Excess Anomalous Attenuation	0	0	0	0	-1	-1	-1	-1	-2	-2	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-52**	**57**	**62**	**64**	**59**	**57**	**53**	**44**	**28**	**-102**	**61.9**
						Additional Reduction due to Excess Anomalous Attenuation (dBA):					**0.7**
						Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):					**1.4**

L50
61.9

Existing Daytime Ambient [2]
36.7

HDD + Ambient
61.9

Potential Increase
25.2

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Pipestone Creek Exit- HDD Noise Calculations - NSA 1

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
158.496	520											
Typical construction spectrum per EEI			**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
Hemispherical Spreading (Distance) =		-52	-52	-52	-52	-52	-52	-52	-52	-52	-52	
Intermediate SPL		-52	45	50	53	48	46	43	37	31	-52	50.9
Atmospheric Absorption (59 F / 70%RH) =		0	0	0	0	0	-1	-1	-4	-14	-49	
SPL with Atmos. Absorp.		-52	45	50	53	47	45	41	33	17	-102	50.2
							Additional Reduction due to Atmospheric Absorption (dBA)					**0.8**
Excess Anomalous Attenuation		0	0	0	0	-1	-1	-1	-2	-2	-2	
HDD SPL with Atmos Absorp and Excess Anomalous Atten		**-52**	**44**	**49**	**52**	**47**	**44**	**40**	**31**	**15**	**-104**	**49.5**
									Additional Reduction due to Excess Anomalous Attenuation (dBA):			**0.7**
									Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):			**1.5**

L50
49.5

Existing Daytime Ambient [2]
36.7

HDD + Ambient
49.7

Potential Increase
13.0

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Entrance- HDD Noise Calculations - NSA 1

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]
Corresponding Sound Power Level = 115 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
100.584	330											
Typical construction spectrum per EEI			**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
Hemispherical Spreading (Distance) =		-48	-48	-48	-48	-48	-48	-48	-48	-48	-48	
Intermediate SPL		-48	61	66	69	64	62	59	53	47	-48	66.9
Atmospheric Absorption (59 F / 70%RH) =		0	0	0	0	0	0	-1	-3	-9	-31	
SPL with Atmos. Absorp.		-48	61	66	69	63	61	58	50	38	-80	66.4
						Additional Reduction due to Atmospheric Absorption (dBA)						**0.5**
Excess Anomalous Attenuation		0	0	0	0	0	0	-1	-1	-1	-2	
HDD SPL with Atmos Absorp and Excess Anomalous Atten		**-48**	**60**	**65**	**68**	**63**	**61**	**57**	**49**	**36**	**-81**	**65.9**

Additional Reduction due to Excess Anomalous Attenuation (dBA): **0.5**

Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA): **1.0**

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

L50
65.9

Existing Daytime Ambient [2]
36.7

HDD + Ambient
65.9

Potential Increase
29.2

Pipestone Reroute - Homestead Crossing Exit- HDD Noise Calculations - NSA 1

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
88.392	290												
		Typical construction spectrum per EEI		**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
		Hemispherical Spreading (Distance) =	-47	-47	-47	-47	-47	-47	-47	-47	-47	-47	
		Intermediate SPL	-47	50	55	58	53	51	48	42	36	-47	56.0
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	0	0	0	-1	-2	-8	-27	
		SPL with Atmos. Absorp.	-47	50	55	58	53	50	47	40	28	-75	55.6
		Additional Reduction due to Atmospheric Absorption (dBA)											**0.4**
		Excess Anomalous Attenuation	0	0	0	0	0	0	-1	-1	-1	-1	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-47**	**50**	**55**	**57**	**52**	**50**	**46**	**39**	**27**	**-76**	**55.2**
		Additional Reduction due to Excess Anomalous Attenuation (dBA):											**0.4**
		Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):											**0.9**

L50
55.2

Existing Daytime Ambient [2]
36.7

HDD + Ambient
55.2

Potential Increase
18.5

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Exit- HDD Noise Calculations - NSA 1

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]

Corresponding Sound Power Level = 115 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)										
Meters	Feet		31	63	125	250	500	1000	2000	4000	8000	16000	dBA
225.552	740												
		Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
		Hemispherical Spreading (Distance) =	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	
		Intermediate SPL	-55	54	59	62	57	55	52	46	40	-55	59.9
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	0	-1	-1	-2	-6	-20	-70	
		SPL with Atmos. Absorp.	-55	54	59	61	56	54	50	40	20	-125	58.8
							Additional Reduction due to Atmospheric Absorption (dBA)						**1.0**
		Excess Anomalous Attenuation	0	0	0	-1	-1	-1	-2	-2	-3	-3	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-56**	**53**	**58**	**61**	**55**	**53**	**48**	**38**	**17**	**-129**	**57.9**

Additional Reduction due to Excess Anomalous Attenuation (dBA): 1.0

Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA): 2.0

L50
57.9

Existing Daytime Ambient [2]
36.7
HDD + Ambient
57.9

Potential Increase
21.2

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Sioux Quartzite Crossing Exit- HDD Noise Calculations - NSA 1

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
335.28	1100											
Typical construction spectrum per EEI			**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
Hemispherical Spreading (Distance) =		-59	-59	-59	-59	-59	-59	-59	-59	-59	-59	
Intermediate SPL		-59	38	43	46	41	39	36	30	24	-59	44.4
Atmospheric Absorption (59 F / 70%RH) =		0	0	0	0	-1	-1	-3	-8	-29	-104	
SPL with Atmos. Absorp.		-59	38	43	46	40	38	33	22	-5	-163	43.0
											Additional Reduction due to Atmospheric Absorption (dBA)	**1.5**
Excess Anomalous Attenuation		0	0	-1	-1	-1	-2	-2	-3	-4	-5	
HDD SPL with Atmos Absorp and Excess Anomalous Atten		**-59**	**38**	**42**	**45**	**39**	**36**	**31**	**18**	**-10**	**-168**	**41.6**
										Additional Reduction due to Excess Anomalous Attenuation (dBA):		**1.4**
										Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):		**2.8**

L50
41.6

Existing Daytime Ambient [2]
36.7

HDD + Ambient
42.8

Potential Increase
6.1

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - 116th Street Entry - Direct Bore Noise Calculations - Pipestone National Monument (Visitor's Center)

Direct Bore Entry Point Sound Pressure Level = 82.9 dBA at 10 Feet [1]

Corresponding Sound Power Level = 104 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
829.056	2720												
		Typical construction spectrum per EEI		**98**	**103**	**106**	**101**	**99**	**96**	**90**	**84**		**104**
		Hemispherical Spreading (Distance) =	-67	-67	-67	-67	-67	-67	-67	-67	-67	-67	
		Intermediate SPL	-67	31	36	39	34	32	29	23	17	-67	37.6
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-4	-7	-21	-73	-258	
		SPL with Atmos. Absorp.	-67	31	36	38	32	29	22	2	-55	-324	34.5
											Additional Reduction due to Atmospheric Absorption (dBA)		**3.0**
		Excess Anomalous Attenuation	-1	-1	-2	-2	-3	-4	-6	-8	-11	-12	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-68**	**30**	**34**	**36**	**29**	**25**	**16**	**-6**	**-66**	**-337**	**31.5**
											Additional Reduction due to Excess Anomalous Attenuation (dBA):		**3.0**
											Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):		**6.1**

L50
31.5

Existing Daytime Ambient [2]
36.7

HDD + Ambient
37.8

Potential Increase
1.1

(1) Vereer D24x40 S3 drill - manufacturers' noise estimates.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - 116th Street Entry - Direct Bore Noise Calculations - Pipestone National Monument (Visitor's Center)

Direct Bore Exit Point Sound Pressure Level = 82.9 dBA at 10 Feet [1]
Corresponding Sound Power Level = 104 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
826.008	2710											
Typical construction spectrum per EEI		**98**	**103**	**106**	**101**	**99**	**96**	**90**	**84**		**104**
Hemispherical Spreading (Distance) =	-67	-67	-67	-67	-67	-67	-67	-67	-67	-67	
Intermediate SPL	-67	31	36	39	34	32	29	23	17	-67	37.6
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-4	-7	-21	-72	-257	
SPL with Atmos. Absorp.	-67	31	36	39	32	29	22	3	-55	-323	34.6
Additional Reduction due to Atmospheric Absorption (dBA)											**3.0**
Excess Anomalous Attenuation	-1	-1	-2	-2	-3	-4	-6	-8	-11	-12	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-67**	**30**	**34**	**36**	**29**	**25**	**16**	**-5**	**-66**	**-336**	**31.6**
Additional Reduction due to Excess Anomalous Attenuation (dBA):											**3.0**
Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):											**6.0**

L50
31.6

Existing Daytime Ambient [2]
36.7

HDD + Ambient
37.9

Potential Increase
1.2

(1) Vereer D24x40 S3 drill - manufacturers' noise estimates.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Pipestone Creek Entry - HDD Noise Calculations - Pipestone National Monument (Visitor's Center)

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]
Corresponding Sound Power Level = 115 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
990.6	3250											
Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
Hemispherical Spreading (Distance) =	-68	-68	-68	-68	-68	-68	-68	-68	-68	-68	
Intermediate SPL	-68	41	46	49	44	42	39	33	27	-68	47.0
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-4	-9	-25	-87	-308	
SPL with Atmos. Absorp.	-68	41	45	48	41	37	30	8	-60	-376	43.5
										Additional Reduction due to Atmospheric Absorption (dBA)	**3.5**
Excess Anomalous Attenuation	-1	-1	-2	-3	-4	-5	-7	-10	-13	-15	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-69**	**39**	**43**	**45**	**38**	**33**	**23**	**-2**	**-73**	**-391**	**40.0**
										Additional Reduction due to Excess Anomalous Attenuation (dBA):	**3.5**
										Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**7.0**

L50
40.0

Existing Daytime Ambient [2]
36.7

HDD + Ambient
41.7

Potential Increase
5.0

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Pipestone Creek Exit- HDD Noise Calculations - Pipestone National Monument (Visitor's Center)

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
1286.256	4220											
Typical construction spectrum per EEI			**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
Hemispherical Spreading (Distance) =		-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	
Intermediate SPL		-71	26	31	34	29	27	24	18	12	-71	32.8
Atmospheric Absorption (59 F / 70%RH) =		0	0	0	-1	-3	-6	-11	-32	-113	-400	
SPL with Atmos. Absorp.		-71	26	31	33	26	22	13	-14	-100	-470	28.5
											Additional Reduction due to Atmospheric Absorption (dBA)	**4.2**
Excess Anomalous Attenuation		-1	-2	-3	-3	-5	-6	-9	-13	-17	-19	
HDD SPL with Atmos Absorp and Excess Anomalous Atten		**-72**	**25**	**29**	**30**	**22**	**16**	**4**	**-26**	**-117**	**-490**	**24.2**
											Additional Reduction due to Excess Anomalous Attenuation (dBA):	**4.3**
											Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**8.6**

L50
24.2

Existing Daytime Ambient [2]
36.7

HDD + Ambient
36.9

Potential Increase
0.2

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Entrance- HDD Noise Calculations - Pipestone National Monument (Visitor's Center)

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]

Corresponding Sound Power Level = 115 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
1283.208	4210												
		Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
		Hemispherical Spreading (Distance) =	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70	
		Intermediate SPL	-70	39	44	47	42	40	37	31	25	-70	44.8
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-3	-6	-11	-32	-113	-399	
		SPL with Atmos. Absorp.	-70	38	43	45	38	34	25	-2	-88	-469	40.5
												Additional Reduction due to Atmospheric Absorption (dBA)	**4.2**
		Excess Anomalous Attenuation	-1	-2	-3	-3	-5	-6	-9	-13	-17	-19	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-72**	**37**	**41**	**42**	**34**	**28**	**16**	**-14**	**-105**	**-489**	**36.2**
												Additional Reduction due to Excess Anomalous Attenuation (dBA):	**4.3**
												Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**8.5**

L50
36.2

Existing Daytime Ambient [2]
36.7

HDD + Ambient
39.5

Potential Increase
2.8

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Exit- HDD Noise Calculations - Pipestone National Monument (Visitor's Center)

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
1167.384	3830												
		Typical construction spectrum per EEI		**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
		Hemispherical Spreading (Distance) =	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70	
		Intermediate SPL	-70	27	32	35	30	28	25	19	13	-70	33.6
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-3	-5	-10	-29	-102	-363	
		SPL with Atmos. Absorp.	-70	27	32	34	28	23	15	-10	-89	-432	29.7
											Additional Reduction due to Atmospheric Absorption (dBA)		**3.9**
		Excess Anomalous Attenuation	-1	-2	-2	-3	-4	-6	-8	-11	-15	-18	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-71**	**26**	**30**	**31**	**23**	**17**	**7**	**-21**	**-104**	**-450**	**25.7**
											Additional Reduction due to Excess Anomalous Attenuation (dBA):		**4.0**
											Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):		**7.9**

L50
25.7

Existing Daytime Ambient [2]
36.7

HDD + Ambient
37.0

Potential Increase
0.3

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Sioux Quartzite Crossing Entrance - HDD Noise Calculations - Pipestone National Monument (Visitor's Center)

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]

Corresponding Sound Power Level = 115 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
1185.672	3890												
		Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
		Hemispherical Spreading (Distance) =	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70	
		Intermediate SPL	-70	39	44	47	42	40	37	31	25	-70	45.5
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-3	-5	-10	-30	-104	-369	
		SPL with Atmos. Absorp.	-70	39	44	46	39	35	27	1	-79	-438	41.5
								Additional Reduction due to Atmospheric Absorption (dBA)					**4.0**
		Excess Anomalous Attenuation	-1	-2	-2	-3	-4	-6	-9	-12	-16	-18	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-71**	**38**	**41**	**43**	**35**	**29**	**18**	**-10**	**-94**	**-456**	**37.4**

	L50
	37.4
	Existing Daytime Ambient [2]
	36.7
	HDD + Ambient
	40.1
	Potential Increase
	3.4

Additional Reduction due to Excess Anomalous Attenuation (dBA):	**4.0**
Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**8.0**

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Sioux Quartzite Crossing Exit- HDD Noise Calculations - Pipestone National Monument (Visitor's Center)

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
1252.728	4110											
	Typical construction spectrum per EEI		**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
	Hemispherical Spreading (Distance) =	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70	
	Intermediate SPL	-70	27	32	35	30	28	25	19	13	-70	33.0
	Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-3	-6	-11	-31	-110	-389	
	SPL with Atmos. Absorp.	-70	27	31	33	27	22	14	-13	-97	-460	28.8
								Additional Reduction due to Atmospheric Absorption (dBA)				**4.2**
	Excess Anomalous Attenuation	-1	-2	-3	-3	-5	-6	-9	-12	-16	-19	
	HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-72**	**25**	**29**	**30**	**22**	**16**	**5**	**-25**	**-114**	**-478**	**24.6**
									Additional Reduction due to Excess Anomalous Attenuation (dBA):			**4.2**
									Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):			**8.4**

L50
24.6

Existing Daytime Ambient [2]
36.7

HDD + Ambient
37.0

Potential Increase
0.3

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - 116th Street Entry - Direct Bore Noise Calculations - Pipestone National Monument (Sundance Area)

Direct Bore Entry Point Sound Pressure Level = 82.9 dBA at 10 Feet [1]

Corresponding Sound Power Level = 104 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
777.24	2550											
Typical construction spectrum per EEI		**98**	**103**	**106**	**101**	**99**	**96**	**90**	**84**		**104**
Hemispherical Spreading (Distance) =	-66	-66	-66	-66	-66	-66	-66	-66	-66	-66	
Intermediate SPL	-66	32	37	40	35	33	30	24	18	-66	38.1
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-3	-7	-20	-68	-242	
SPL with Atmos. Absorp.	-66	32	37	39	33	29	23	4	-50	-308	35.2
										Additional Reduction due to Atmospheric Absorption (dBA)	**2.9**
Excess Anomalous Attenuation	-1	-1	-2	-2	-3	-4	-6	-8	-10	-12	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-67**	**31**	**35**	**37**	**30**	**26**	**17**	**-3**	**-60**	**-319**	**32.4**
										Additional Reduction due to Excess Anomalous Attenuation (dBA):	**2.9**
										Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**5.8**

L50
32.4

Existing Daytime Ambient [2]
36.7

HDD + Ambient
38.1

Potential Increase
1.4

(1) Vereer D24x40 S3 drill - manufacturers' noise estimates.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - 116th Street Entry - Direct Bore Noise Calculations - Pipestone National Monument (Sundance Area)

Direct Bore Exit Point Sound Pressure Level = 82.9 dBA at 10 Feet [1]
Corresponding Sound Power Level = 104 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
768.096	2520												
		Typical construction spectrum per EEI		**98**	**103**	**106**	**101**	**99**	**96**	**90**	**84**		**104**
		Hemispherical Spreading (Distance) =	-66	-66	-66	-66	-66	-66	-66	-66	-66	-66	
		Intermediate SPL	-66	32	37	40	35	33	30	24	18	-66	38.2
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-3	-7	-19	-67	-239	
		SPL with Atmos. Absorp.	-66	32	37	39	33	30	23	5	-49	-305	35.4
												Additional Reduction due to Atmospheric Absorption (dBA)	**2.9**
		Excess Anomalous Attenuation	-1	-1	-2	-2	-3	-4	-6	-8	-10	-12	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-67**	**31**	**35**	**37**	**30**	**26**	**18**	**-3**	**-59**	**-316**	**32.5**
												Additional Reduction due to Excess Anomalous Attenuation (dBA):	**2.8**
												Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**5.7**

L50
32.5

Existing Daytime Ambient [2]
36.7

HDD + Ambient
38.1

Potential Increase
1.4

(1) Vereer D24x40 S3 drill - manufacturers' noise estimates.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Pipestone Creek Entry - HDD Noise Calculations - Pipestone National Monument (Sundance Area)

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]

Corresponding Sound Power Level = 115 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
737.616	2420											
Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
Hemispherical Spreading (Distance) =	-66	-66	-66	-66	-66	-66	-66	-66	-66	-66	
Intermediate SPL	-66	43	48	51	46	44	41	35	29	-66	49.6
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-3	-6	-19	-65	-229	
SPL with Atmos. Absorp.	-66	43	48	51	45	41	35	17	-35	-295	46.8
										Additional Reduction due to Atmospheric Absorption (dBA)	**2.8**
Excess Anomalous Attenuation	-1	-1	-1	-2	-3	-4	-5	-7	-10	-11	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-66**	**42**	**47**	**49**	**42**	**37**	**30**	**10**	**-45**	**-306**	**44.1**
										Additional Reduction due to Excess Anomalous Attenuation (dBA):	**2.7**
										Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**5.5**

L50
44.1

Existing Daytime Ambient [2]
36.7

HDD + Ambient
44.8

Potential Increase
8.1

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Pipestone Creek Exit- HDD Noise Calculations - Pipestone National Monument (Sundance Area)

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
786.384	2580											
Typical construction spectrum per EEI		**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
Hemispherical Spreading (Distance) =	-66	-66	-66	-66	-66	-66	-66	-66	-66	-66	
Intermediate SPL	-66	31	36	39	34	32	29	23	17	-66	37.0
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-3	-7	-20	-69	-244	
SPL with Atmos. Absorp.	-66	31	36	38	32	28	22	3	-52	-311	34.1
										Additional Reduction due to Atmospheric Absorption (dBA)	**2.9**
Excess Anomalous Attenuation	-1	-1	-2	-2	-3	-4	-6	-8	-10	-12	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-67**	**30**	**34**	**36**	**29**	**24**	**16**	**-5**	**-62**	**-322**	**31.2**
										Additional Reduction due to Excess Anomalous Attenuation (dBA):	**2.9**
										Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**5.8**

L50
31.2

Existing Daytime Ambient [2]
36.7

HDD + Ambient
37.8

Potential Increase
1.1

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Entrance- HDD Noise Calculations - Pipestone National Monument (Sundance Area)

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]

Corresponding Sound Power Level = 115 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
771.144	2530												
		Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
		Hemispherical Spreading (Distance) =	-66	-66	-66	-66	-66	-66	-66	-66	-66	-66	
		Intermediate SPL	-66	43	48	51	46	44	41	35	29	-66	49.2
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-3	-7	-19	-68	-240	
		SPL with Atmos. Absorp.	-66	43	48	50	44	41	34	16	-39	-306	46.3
							Additional Reduction due to Atmospheric Absorption (dBA)						**2.9**
		Excess Anomalous Attenuation	-1	-1	-2	-2	-3	-4	-6	-8	-10	-12	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-67**	**42**	**46**	**48**	**41**	**37**	**29**	**8**	**-49**	**-317**	**43.5**

Additional Reduction due to Excess Anomalous Attenuation (dBA): 2.8

Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA): 5.7

L50
43.5

Existing Daytime Ambient [2]
36.7

HDD + Ambient
44.3

Potential Increase
7.6

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Exit- HDD Noise Calculations - Pipestone National Monument (Sundance Area)

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]

Corresponding Sound Power Level = 103 dBA

Distance to Receptor			Octave Band Center Frequency (Hz)									
Meters	Feet	31	63	125	250	500	1000	2000	4000	8000	16000	dBA
600.456	1970											
Typical construction spectrum per EEI		**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
Hemispherical Spreading (Distance) =	-64	-64	-64	-64	-64	-64	-64	-64	-64	-64	
Intermediate SPL	-64	33	38	41	36	34	31	25	19	-64	39.4
Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-1	-3	-5	-15	-53	-187	
SPL with Atmos. Absorp.	-64	33	38	41	35	31	26	10	-34	-251	37.0
Additional Reduction due to Atmospheric Absorption (dBA)											**2.4**
Excess Anomalous Attenuation	-1	-1	-1	-2	-2	-3	-4	-6	-8	-9	
HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-64**	**32**	**37**	**39**	**33**	**29**	**22**	**4**	**-41**	**-260**	**34.7**
Additional Reduction due to Excess Anomalous Attenuation (dBA):											**2.3**
Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):											**4.7**

L50
34.7

Existing Daytime Ambient [2]
36.7

HDD + Ambient
38.8

Potential Increase
2.1

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Homestead Crossing Exit- HDD Noise Calculations - Pipestone National Monument (Sundance Area)

HDD Entry Point Sound Pressure Level = 83 dBA at 50 Feet [1]

Corresponding Sound Power Level = 115 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
600.456	1970												
		Typical construction spectrum per EEI		**109**	**114**	**117**	**112**	**110**	**107**	**101**	**95**		**115**
		Hemispherical Spreading (Distance) =	-64	-64	-64	-64	-64	-64	-64	-64	-64	-64	
		Intermediate SPL	-64	45	50	53	48	46	43	37	31	-64	51.4
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-1	-3	-5	-15	-53	-187	
		SPL with Atmos. Absorp.	-64	45	50	53	47	43	38	22	-22	-251	49.0
												Additional Reduction due to Atmospheric Absorption (dBA)	**2.4**
		Excess Anomalous Attenuation	-1	-1	-1	-2	-2	-3	-4	-6	-8	-9	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-64**	**44**	**49**	**51**	**45**	**41**	**34**	**16**	**-29**	**-260**	**46.7**

Additional Reduction due to Excess Anomalous Attenuation (dBA): 2.3

Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA): 4.7

L50
46.7

Existing Daytime Ambient [2]
36.7
HDD + Ambient
47.1

Potential Increase
10.4

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.

(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).

Pipestone Reroute - Sioux Quartzite Crossing Exit- HDD Noise Calculations - Pipestone National Monument (Sundance Area)

HDD Exit Point Sound Pressure Level = 71 dBA at 50 Feet [1]
Corresponding Sound Power Level = 103 dBA

Distance to Receptor Meters	Feet		Octave Band Center Frequency (Hz) 31	63	125	250	500	1000	2000	4000	8000	16000	dBA
694.944	2280												
		Typical construction spectrum per EEI		**97**	**102**	**105**	**100**	**98**	**95**	**89**	**83**		**103**
		Hemispherical Spreading (Distance) =	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	
		Intermediate SPL	-65	32	37	40	35	33	30	24	18	-65	38.1
		Atmospheric Absorption (59 F / 70%RH) =	0	0	0	-1	-2	-3	-6	-17	-61	-216	
		SPL with Atmos. Absorp.	-65	32	37	39	33	30	24	6	-43	-281	35.5
												Additional Reduction due to Atmospheric Absorption (dBA)	**2.6**
		Excess Anomalous Attenuation	-1	-1	-1	-2	-3	-3	-5	-7	-9	-10	
		HDD SPL with Atmos Absorp and Excess Anomalous Atten	**-66**	**31**	**35**	**37**	**31**	**26**	**19**	**0**	**-52**	**-292**	**32.8**
												Additional Reduction due to Excess Anomalous Attenuation (dBA):	**2.6**
												Total Reduction for Both Atmos. Absorp. And Excess Anomalous Atten. (dBA):	**5.3**

L50
32.8

Existing Daytime Ambient [2]
36.7

HDD + Ambient
38.2

Potential Increase
1.5

(1) Burge and Kitech. 2009. "Methods for predicting and evaluating noise from horizontal directional drilling (HDD) equipment". Proceedings of InterNoise 2009.
(2) Existing ambient condition based on National Park Service baseline ambient noise monitoring at the Pipestone National Monument (Sundance Grounds).