Appendix F

Packer Testing Calculations

BEHAVIOR	PRESSURE STAGES	LUGEON PATTERN	DESCRIPTION	REPRESENTATIVE LUGEON VALUE
LAMINAR	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Water Pressure, P $0.50P_{MAX}$ $0.75P_{MAX}$ $1.00P_{MAX}$	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Lugeons	All Lugeon values about equal regardless of the water pressure	Average of Lugeon values for all stages
TURBULENT	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Water Pressure, P $0.50P_{MAX}$ $0.75P_{MAX}$ $1.00P_{MAX}$	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Lugeons	Lugeon values decrease as the water pressures increase. The minimum Lugeon value is observed at the stage with the maximum water pressure	Lugeon value corresponding to the highest water pressure (3rd stage)
DILATION	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Water Pressure, P $0.50P_{MAX}$ $0.75P_{MAX}$ $1.00P_{MAX}$	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Lugeons	Lugeon values vary proportionally to the water pressures. The maximum Lugeon value is observed at the stage with the maximum water pressure	Lowest Lugeon value recorded, corresponding either to low or medium water pressures (1st, 2nd, 4th, 5th stage)
WASH-OUT	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Water Pressure, P $0.50P_{MAX}$ $0.75P_{MAX}$ $1.00P_{MAX}$	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Lugeons	Lugeon values increase as the test proceeds. Discontinuities' infillings are progressively washed-out by the water	Highest Lugeon value recorded (5th stage)
VOID FILLING	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Water Pressure, P $0.50P_{MAX}$ $0.75P_{MAX}$ $1.00P_{MAX}$	1st Stage 2nd Stage 3rd Stage 4th Stage 5th Stage Lugeons	Lugeon values decrease as the test proceeds. Either non-persistent discontinuities are progressively being filled or swelling is taking place	Final Lugeon value (5th stage)

Lugeon pattern progression and determiniation of representative Lugeon value (Houlsby, 1976).

	WATER PRESSURE TEST IN BEDROCK			SEA-1Z	

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.: 2
Location:	Bergen, NY	Client:	Waste Management	Ground
Performed By:	G. Combes	Date:	9/18/2013	Surface
Calculated By:	M. Cummings	Date:	9/19/2013	Elevation: 671.6
Checked By:	R. Frappa	Date:	9/19/2013	Datum: NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	45 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	55 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	14.6 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	3.0	38.0	12.7	1.7	1.5E-03	3.0E-03	117
30	3.0	36.0	12.0	1.6	8.1E-04	1.6E-03	61
45	3.0	70.0	23.3	3.1	1.3E-03	2.6E-03	100
30	3.0	55.0	18.3	2.5	1.4E-03	2.8E-03	106
15	3.0	40.0	13.3	1.8	1.7E-03	3.3E-03	125

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon,

$$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$

per Weaver and Bruce, Dam Foundation Grouting, 2007

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	WATER PRESSURE TEST IN BEDROCK		SEA-1Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	1
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/18/2013	Surface	
Calculated By:	M. Cummings	Date:	9/19/2013	Elevation:	671.6
Checked By:	R. Frappa	Date:	9/19/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	55 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	65 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	14.6 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Dolomitic Shale	$m = \sqrt{K_h/K_v}$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	3.0	18.0	6.0	0.8	6.5E-04	1.3E-03	49
30	3.0	38.0	12.7	1.7	8.8E-04	1.7E-03	67
45	3.0	55.0	18.3	2.5	9.6E-04	1.9E-03	73
30	3.0	41.0	13.7	1.8	9.7E-04	1.9E-03	74
15	3.0	28.0	9.3	1.2	1.1E-03	2.1E-03	81

Test Notes: Washout

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * L \ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK		SEA-2A

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.: 3
Location:	Bergen, NY	Client:	Waste Management	Ground
Performed By:	M. Cummings	Date:	9/9/2013	Surface
Calculated By:	M. Cummings	Date:	9/11/2013	Elevation: 667.3
Checked By:	R. Frappa	Date:	9/11/2013	Datum: NGVD

Packer Installation Details   **Test Interval Details**

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	22 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	32 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	11.0 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt\ (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	3.0	40.0	13.3	1.8	1.6E-03	3.2E-03	124
30	3.0	65.0	21.7	2.9	1.6E-03	3.2E-03	124
45	2.0	45.0	22.5	3.0	1.1E-03	2.3E-03	87
30	3.0	36.0	12.0	1.6	8.1E-04	1.6E-03	62
15	3.0	39.0	13.0	1.7	1.6E-03	3.1E-03	120

Test Notes: Turbulent Flow

Notes:

1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

    per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK		SEA-2A

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	2
Location:	Bergen, NY	Client:	Waste Management	Ground
Performed By:	M. Cummings	Date:	9/9/2013	Surface
Calculated By:	M. Cummings	Date:	9/11/2013	Elevation:	667.3
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	32 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	42 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	11.0 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = \text{sqrt}(K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	3.0	39.0	13.0	1.7	1.6E-03	3.2E-03	125
30	3.0	63.0	21.0	2.8	1.7E-03	3.3E-03	127
45	2.0	50.0	25.0	3.3	1.4E-03	2.7E-03	106
30	3.0	57.0	19.0	2.5	1.5E-03	2.9E-03	110
15	3.0	40.0	13.3	1.8	1.7E-03	3.3E-03	129

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D}+\sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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	WATER PRESSURE TEST IN BEDROCK			SEA-2A	

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	1
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	M. Cummings	Date:	9/9/2013	Surface	
Calculated By:	M. Cummings	Date:	9/11/2013	Elevation:	667.3
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	
Packer pressure:	100 psi	
Gauge height:		
(above ground surface)	2.8 ft	
Estimated depth to water table:		
(below ground surface)	11.0 ft	

Depth to top of test zone:		
(below ground surface)	42 ft	
Depth to bottom of test zone:		
(below ground surface)	52 ft	
Length, L:	10 ft	
Borehole diameter, D:	3.8 in	

Rock type at test interval: Shale

$m = sqrt (K_h/K_v)$: 2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	3.0	34.0	11.3	1.5	1.4E-03	2.8E-03	109
30	3.0	42.0	14.0	1.9	1.0E-03	2.0E-03	77
45	2.0	65.0	32.5	4.3	2.5E-03	4.9E-03	187
30	3.0	40.0	13.3	1.8	9.5E-04	1.9E-03	73
15	3.0	30.0	10.0	1.3	1.2E-03	2.4E-03	93

Test Notes: Dilation Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK	SEA-3Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	4
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	M. Cummings	Date:	8/26/2013	Surface	
Calculated By:	M. Cummings	Date:	9/4/2013	Elevation:	666.8
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	
Packer pressure:	100 psi	
Gauge height:		
(above ground surface)	2.8 ft	
Estimated depth to water table:		
(below ground surface)	15.3 ft	

Depth to top of test zone:	
(below ground surface)	20 ft
Depth to bottom of test zone:	
(below ground surface)	26 ft
Length, L:	6 ft
Borehole diameter, D:	3.8 in

Rock type at test interval: Shale

$m = \text{sqrt}(K_h/K_v)$: 2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	2.0	26.0	13.0	1.7	2.1E-03	4.2E-03	181
30	3.0	53.0	17.7	2.4	1.8E-03	3.5E-03	150
45	3.0	64.0	21.3	2.9	1.5E-03	3.0E-03	130
30	3.0	61.0	20.3	2.7	2.1E-03	4.1E-03	178
15	2.0	35.0	17.5	2.3	3.1E-03	6.1E-03	261

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1 + (\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

   per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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	WATER PRESSURE TEST IN BEDROCK		SEA-3Z	

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	3
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	M. Cummings	Date:	8/26/2013	Surface	
Calculated By:	M. Cummings	Date:	9/4/2013	Elevation:	666.8
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	26 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	36 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	15.3 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	2.0	23.0	11.5	1.5	1.3E-03	2.5E-03	96
30	3.0	51.0	17.0	2.3	1.2E-03	2.3E-03	88
45	3.0	56.0	18.7	2.5	8.9E-04	1.8E-03	68
30	3.0	55.0	18.3	2.5	1.3E-03	2.5E-03	96
15	3.0	36.0	12.0	1.6	1.3E-03	2.6E-03	101

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK	SEA-3Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	2
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	M. Cummings	Date:	8/26/2013	Surface	
Calculated By:	M. Cummings	Date:	9/4/2013	Elevation:	666.8
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	36 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	46 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	15.3 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt\ (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	3.0	42.0	14.0	1.9	1.7E-03	3.3E-03	127
30	3.0	49.0	16.3	2.2	1.1E-03	2.2E-03	87
45	3.0	59.0	19.7	2.6	9.9E-04	1.9E-03	75
30	3.0	49.0	16.3	2.2	1.1E-03	2.2E-03	87
15	3.0	35.0	11.7	1.6	1.3E-03	2.6E-03	100

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK				SEA-3Z	

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	1
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	M. Cummings	Date:	8/26/2013	Surface	
Calculated By:	M. Cummings	Date:	9/4/2013	Elevation:	666.8
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	75 psi	(below ground surface)	46 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	58 ft
Estimated depth to water table:		Length, L:	12 ft
(below ground surface)	15.3 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = \sqrt{(K_h/K_v)}$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
30	2.0	36.0	18.0	2.4	1.2E-03	2.3E-03	86
45	2.0	48.7	24.4	3.3	1.2E-03	2.4E-03	90
30	2.0	30.5	15.3	2.0	9.2E-04	1.8E-03	67

Test Notes: Dilation Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK		SEA-4A

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	1
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	M. Cummings	Date:	9/9/2013	Surface	
Calculated By:	M. Cummings	Date:	9/11/2013	Elevation:	675.8
Checked By:	R. Frappa	Date:	9/11/2013	Datum:	NGVD

Packer Installation Details | Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	42 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	3.7 ft	(below ground surface)	52 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	25.4 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt\ (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	2.0	30.0	15.0	2.0	1.5E-03	3.0E-03	115
30	2.0	37.0	18.5	2.5	1.2E-03	2.4E-03	92
45	2.0	46.0	23.0	3.1	1.1E-03	2.2E-03	86
30	2.0	36.0	18.0	2.4	1.2E-03	2.3E-03	88
15	2.0	31.0	15.5	2.1	1.6E-03	3.1E-03	120

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon,

$$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$

per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK		SEA-5Z	

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	3
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/23/2013	Surface	
Calculated By:	M. Cummings	Date:	9/23/2013	Elevation:	656.9
Checked By:	R. Frappa	Date:	9/23/2013	Datum:	NGVD

Packer Installation Details   Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	23 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	33 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	10.7 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	2.0	16.0	8.0	1.1	9.2E-04	1.8E-03	70
30	2.0	25.0	12.5	1.7	8.5E-04	1.7E-03	65
45	2.0	30.0	15.0	2.0	7.2E-04	1.4E-03	55
30	2.0	24.0	12.0	1.6	8.2E-04	1.6E-03	62
15	2.0	15.0	7.5	1.0	8.6E-04	1.7E-03	65

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK	SEA-5Z

Project:	Mill Seat LF South Expansion	Project No.: 1328270	Test No.: 2
Location:	Bergen, NY	Client: Waste Management	Ground
Performed By:	G. Combes	Date: 9/23/2013	Surface
Calculated By:	M. Cummings	Date: 9/23/2013	Elevation: 656.9
Checked By:	R. Frappa	Date: 9/23/2013	Datum: NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	
Packer pressure:	100 psi	
Gauge height:		
(above ground surface)	2.8 ft	
Estimated depth to water table:		
(below ground surface)	10.7 ft	

Depth to top of test zone:	
(below ground surface)	32 ft
Depth to bottom of test zone:	
(below ground surface)	42 ft
Length, L:	10 ft
Borehole diameter, D:	3.8 in

Rock type at test interval: Shale

$m = sqrt\ (K_h/K_v)$: 2.24

Applied Water Pressure, P (psi)	Time Interval At This Pressure (min)	Total Volume of Water (gal)	Average Flow Rate, q (gal/min)	Average Flow Rate, q (ft³/min)	Coefficient of Permeability, K (cm/sec)	Coefficient of Permeability, K (ft/min)	Lugeons (L)
15	2.0	21.0	10.5	1.4	1.3E-03	2.5E-03	97
30	2.0	33.0	16.5	2.2	1.2E-03	2.4E-03	92
45	2.0	42.0	21.0	2.8	1.1E-03	2.2E-03	84
30	2.0	34.0	17.0	2.3	1.3E-03	2.5E-03	96
15	2.0	22.0	11.0	1.5	1.3E-03	2.7E-03	102

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1 + (\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon,

$$L = \frac{q(ft^3/min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$

per Weaver and Bruce, Dam Foundation Grouting, 2007

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	WATER PRESSURE TEST IN BEDROCK		SEA-5Z	

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	1
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/23/2013	Surface	
Calculated By:	M. Cummings	Date:	9/23/2013	Elevation:	656.9
Checked By:	R. Frappa	Date:	9/23/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	42 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	52 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	10.7 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	2.0	0.0	0.0	0.0	5.6E-07	1.1E-06	0
30	2.0	0.7	0.4	0.0	2.3E-05	4.5E-05	2
45	2.0	0.6	0.3	0.0	1.4E-05	2.7E-05	1
30	2.0	0.0	0.0	0.0	3.2E-07	6.4E-07	0
15	2.0	0.0	0.0	0.0	5.6E-07	1.1E-06	0

Test Notes: Laminar Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

   per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK		SEA-6Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	4
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/13/2013	Surface	
Calculated By:	M. Cummings	Date:	9/16/2013	Elevation:	669.70
Checked By:	R. Frappa	Date:	9/16/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	30 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	40 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	15.8 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	$m = sqrt (K_h/K_v)$:	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	2.0	25.0	12.5	1.7	1.4E-03	2.8E-03	106
30	2.0	36.0	18.0	2.4	1.3E-03	2.5E-03	95
45	2.0	45.0	22.5	3.0	1.1E-03	2.2E-03	86
30	2.0	36.0	18.0	2.4	1.3E-03	2.5E-03	95
15	2.0	25.0	12.5	1.7	1.4E-03	2.8E-03	106

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $L = \dfrac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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	WATER PRESSURE TEST IN BEDROCK		SEA-6Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	3
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/13/2013	Surface	
Calculated By:	M. Cummings	Date:	9/16/2013	Elevation:	669.70
Checked By:	R. Frappa	Date:	9/16/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	Depth to top of test zone:	
Packer pressure:	100 psi	(below ground surface)	40 ft
Gauge height:		Depth to bottom of test zone:	
(above ground surface)	2.8 ft	(below ground surface)	50 ft
Estimated depth to water table:		Length, L:	10 ft
(below ground surface)	15.8 ft	Borehole diameter, D:	3.8 in
Rock type at test interval:	Shale	m = sqrt (K$_h$/K$_v$):	2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	2.0	26.0	13.0	1.7	1.5E-03	3.0E-03	116
30	2.0	36.0	18.0	2.4	1.3E-03	2.6E-03	100
45	2.0	45.0	22.5	3.0	1.2E-03	2.4E-03	91
30	2.0	37.0	18.5	2.5	1.4E-03	2.7E-03	103
15	2.0	26.0	13.0	1.7	1.5E-03	3.0E-03	116

Test Notes: Turbulent Flow

Notes:

1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

     per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK		SEA-6Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	2
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/13/2013	Surface	
Calculated By:	M. Cummings	Date:	9/16/2013	Elevation:	669.70
Checked By:	R. Frappa	Date:	9/16/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	
Packer pressure:	100 psi	
Gauge height:		
(above ground surface)	2.8 ft	
Estimated depth to water table:		
(below ground surface)	15.8 ft	

Depth to top of test zone:		
(below ground surface)	50 ft	
Depth to bottom of test zone:		
(below ground surface)	60 ft	
Length, L:	10 ft	
Borehole diameter, D:	3.8 in	

Rock type at test interval: Shale

$m = \text{sqrt } (K_h/K_v)$: 2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft^3/min)	(cm/sec)	(ft/min)	(L)
15	3.0	27.0	9.0	1.2	9.9E-04	1.9E-03	75
30	3.0	38.0	12.7	1.7	8.6E-04	1.7E-03	65
45	3.0	49.0	16.3	2.2	8.1E-04	1.6E-03	61
30	3.0	40.0	13.3	1.8	9.1E-04	1.8E-03	69
15	3.0	28.0	9.3	1.2	1.0E-03	2.0E-03	78

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/\min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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WATER PRESSURE TEST IN BEDROCK	SEA-6Z

Project:	Mill Seat LF South Expansion	Project No.:	1328270	Test No.:	1
Location:	Bergen, NY	Client:	Waste Management	Ground	
Performed By:	G. Combes	Date:	9/13/2013	Surface	
Calculated By:	M. Cummings	Date:	9/16/2013	Elevation:	669.1
Checked By:	R. Frappa	Date:	9/16/2013	Datum:	NGVD

Packer Installation Details

Test Interval Details

Type of packer:	Pneumatic	
Packer pressure:	100 psi	
Gauge height:		
(above ground surface)	2.8 ft	
Estimated depth to water table:		
(below ground surface)	15.8 ft	

Depth to top of test zone:
(below ground surface) 60 ft
Depth to bottom of test zone:
(below ground surface) 70 ft
Length, L: 10 ft
Borehole diameter, D: 3.8 in

Rock type at test interval: Dolostone

$m = sqrt (K_h/K_v)$: 2.24

Applied Water Pressure, P	Time Interval At This Pressure	Total Volume of Water	Average Flow Rate, q		Coefficient of Permeability, K		Lugeons
(psi)	(min)	(gal)	(gal/min)	(ft³/min)	(cm/sec)	(ft/min)	(L)
15	3.0	14.0	4.7	0.6	4.8E-04	9.5E-04	37
30	3.0	19.0	6.3	0.8	4.0E-04	7.8E-04	30
45	3.0	24.0	8.0	1.1	3.6E-04	7.1E-04	28
30	3.0	18.0	6.0	0.8	3.8E-04	7.4E-04	29
15	3.0	12.0	4.0	0.5	4.1E-04	8.1E-04	31

Test Notes: Turbulent Flow

Notes:
1. Water pressure, p, was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was measured with a flow meter.
3. Hc represents the total head of water in feet at the midpoint of the test section length,

$$H_C = \frac{p}{.433} + h - h_f$$

4. Hydraulic Conductivity,

$$K_h = \frac{q*Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi*L*H_C}$$

per Lambe & Whitman, Soil Mechanics, 1969, p. 285, case G, constant head test.

5. Lugeon, $$L = \frac{q(ft^3/min)*(142)}{H_c(ft)*L(ft)*(0.01076)*(0.433)}$$ per Weaver and Bruce, Dam Foundation Grouting, 2007

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