HATCH

Sample Photographs

Borehole Name:	BH17-EBC-9	Mary River Expansion Study Stage 2
Location:	17 W 503548.47 7976371.396	
Completion Date:	October 29, 2017	Baffinland Iron Mines

BH17-EBC-9

18.3 | 18.6 | 18.9 | 19.2 | 19.5 | 19.8

BH17-EBC-9

19.8 | 20.1 | 20.4 | 20.7 | 21.0 | 21.3

BH17-EBC-9

21.3 | 21.6 | 21.9 | 22.3 | 22.6 | 22.9

BH17-EBC-9

22.9 | 23.2 | 23.5 | 23.8 | 24.1 | 24.4

BH17-EBC-9

24.4 | 24.7 | 25.0 | 25.3 | 25.6 | 25.9

BH17-EBC-9

25.9 | 26.2 | 26.5 | 26.8 | 27.1 | 27.4

HATCH

Sample Photographs

Borehole Name:	BH17-EBC-9	Mary River Expansion Study Stage 2
Location:	17 W 503548.47 7976371.396	
Completion Date:	October 29, 2017	Baffinland Iron Mines

DQ-15

BH17-EBC-9

DQ-16

27.4 | 27.7 | 28.0 | 28.3 | 28.7 | 29.0

BH17-EBC-9

29.0 | 29.3 | 29.6 | 29.9 | 30.2 | 30.5

DQ-17

BH17-EBC-9

30.5 | 30.8 | 31.1 | 31.4 | 31.7 | 32.0

BH17-EBC-9

32.0 | 32.3 | 32.6 | 32.9 | 33.2 | 33.5

BH17-EBC-9

33.5 | 33.8 | 34.1 | 34.4 | 34.7 | 35.1

DQ-18

BH17-EBC-9

35.1 | 35.4 | 35.7 | 36.0 | 36.3 | 36.6

Sample Photographs

Borehole Name:	BH17-EBC-9	Mary River Expansion Study Stage 2
Location:	17 W 503548.47 7976371.396	
Completion Date:	October 29, 2017	Baffinland Iron Mines

BH17-EBC-9

36.6 | 36.9 | 37.2 | 37.5 | 37.8 | 38.1

BH17-EBC-9

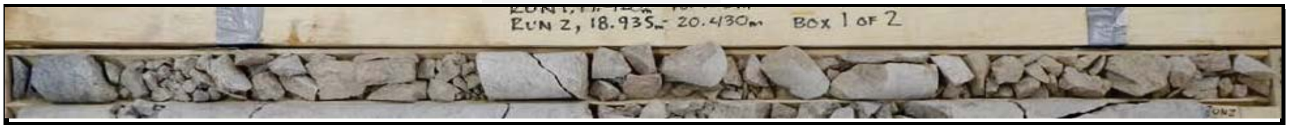
DQ-19

38.1 | 38.4 | 38.7 | 39.0 | 39.3 | 39.6

Sample Photographs

Borehole Name:	BH17-M008-R	Mary River Expansion Study Stage 2
Location:	17 W 503772 7974960	2017 Geotechnical Investigation
Completion Date:	September 18, 2017	Baffinland Iron Mines

BH17-M008-R



17.420 | 18.935

BH17-M008-R

18.935 | 20.430

BH17-M008-R

20.430

BH17-M008-R

21.990

Sample Photographs

Borehole Name:	BH17-RD-1	Mary River Expansion Study Stage 2
Location:	17 W 504095 7976552	2017 Geotechnical Investigation
Completion Date:	October 31, 2017	Baffinland Iron Mines

BH17-RD-1

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

BH17-RD-1

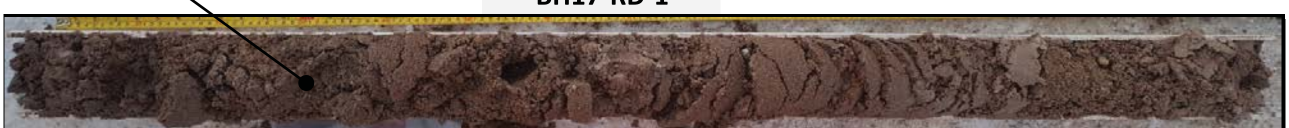
1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

BH17-RD-1

3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6

DS-1

BH17-RD-1



4.6 | 4.9 | 5.2 | 5.5 | 5.8 | 6.1

HATCH

Sample Photographs

Borehole Name:	BH17-RD-1A	Mary River Expansion Study Stage 2
Location:	17 W 504090 7976463	2017 Geotechnical Investigation
Completion Date:	October 31, 2017	Baffinland Iron Mines

BH17-RD-1A

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

BH17-RD-1A

1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

BH17-RD-1A

3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6

Sample Photographs

Borehole Name:	BH17-RD-1B	Mary River Expansion Study Stage 2
Location:	17 W 504100 7976358	2017 Geotechnical Investigation
Completion Date:	October 31, 2017	Baffinland Iron Mines

BH17-RD-1B

0 **Expanded/swelled due to of pulverized rockfill particles** 1.5

BH17-RD-1B

1.5 1.8 2.1 2.4 2.7 3.0

BH17-RD-1B

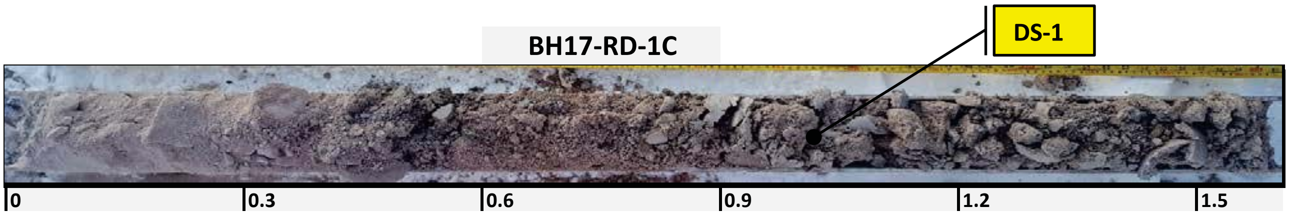
3.0 **Expanded/swelled due to of pulverized rockfill particles** 4.6

HATCH

Sample Photographs

Borehole Name:	BH17-RD-1C	Mary River Expansion Study Stage 2
Location:	17 W 504075 7976302	2017 Geotechnical Investigation
Completion Date:	October 31, 2017	Baffinland Iron Mines

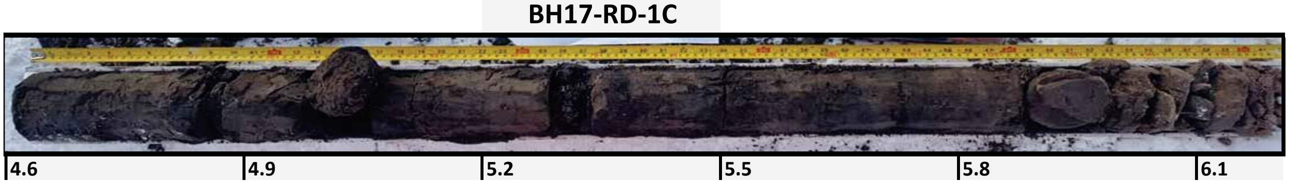
BH17-RD-1C



BH17-RD-1C

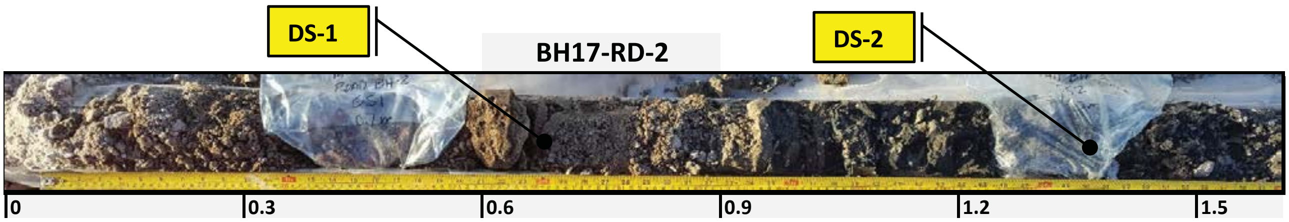
BH17-RD-1C

BH17-RD-1C



Sample Photographs

Borehole Name:	BH17-RD-2	Mary River Expansion Study Stage 2
Location:	17 W 503872 7976162	2017 Geotechnical Investigation
Completion Date:	October 6, 2017	Baffinland Iron Mines



HATCH

Sample Photographs

Borehole Name:	BH17-RD-3	Mary River Expansion Study Stage 2
Location:	17 W 503599 7975985	2017 Geotechnical Investigation
Completion Date:		Baffinland Iron Mines

BH17-RD-3

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

BH17-RD-3

1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

DS-1

BH17-RD-3

3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6

HATCH

Sample Photographs

Borehole Name:	BH17-RD-4	Mary River Expansion Study Stage 2
Location:	17 W 503594 7975136	2017 Geotechnical Investigation
Completion Date:	October 5, 2017	Baffinland Iron Mines

BH17-RD-4

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

BH17-RD-4

1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

BH17-RD-4

3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6

Sample Photographs

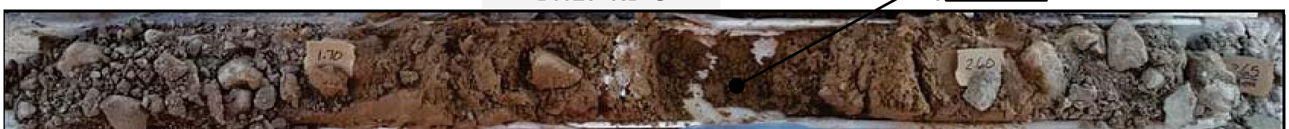
Borehole Name:	BH17-RD-5	Mary River Expansion Study Stage 2
Location:	17 W 503596 7974811	2017 Geotechnical Investigation
Completion Date:	October 5, 2017	Baffinland Iron Mines

BH17-RD-5

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

BH17-RD-5

DS-1



1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

HATCH

Sample Photographs

Borehole Name:	BH17-RD-6	Mary River Expansion Study Stage 2
Location:	17 W 503922 7974286	2017 Geotechnical Investigation
Completion Date:	October 5, 2017	Baffinland Iron Mines

BH17-RD-6

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

BH17-RD-6

1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

BH17-RD-6

3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6

BH17-RD-6

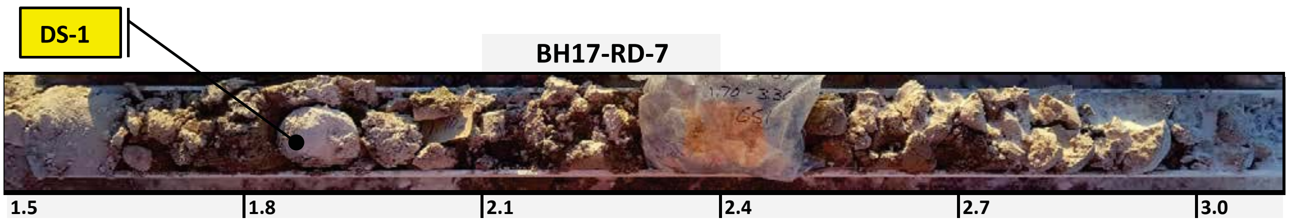
4.6 | 4.9 | 5.2 | 5.5 | 5.8 | 6.1

Sample Photographs

Borehole Name:	BH17-RD-7	Mary River Expansion Study Stage 2
Location:	17 W 503896 7974423	2017 Geotechnical Investigation
Completion Date:	October 5, 2017	Baffinland Iron Mines

BH17-RD-7

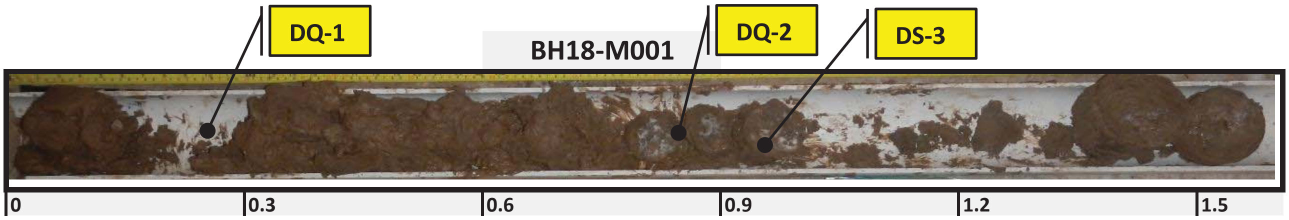
BH17-RD-7

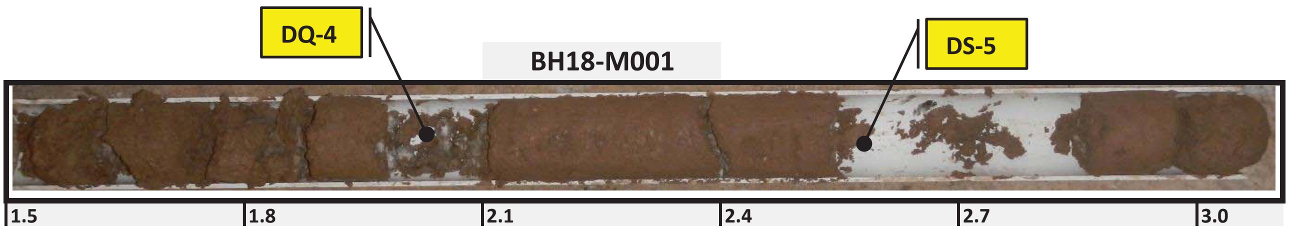


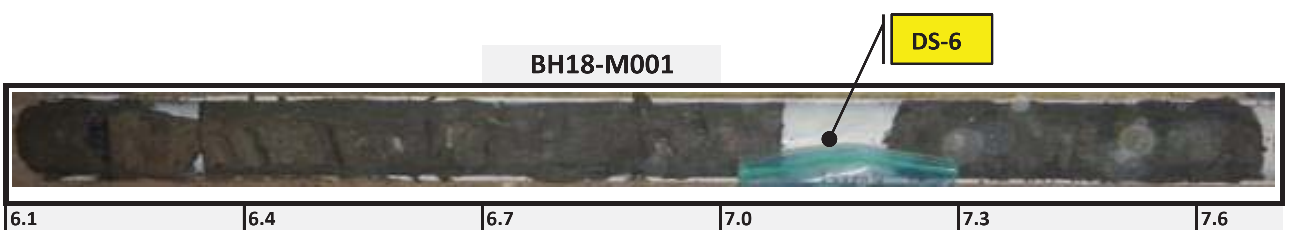
BH17-RD-7

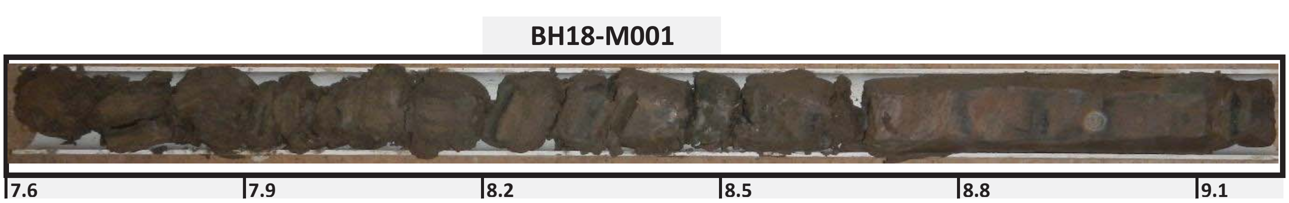
Sample Photographs

Borehole Name:	BH18-M001	Mary River Expansion Study Stage 2
Location:	17 W 503423 7974892	2018 Geotechnical Investigation
Completion Date:	March 5, 2018	Baffinland Iron Mines





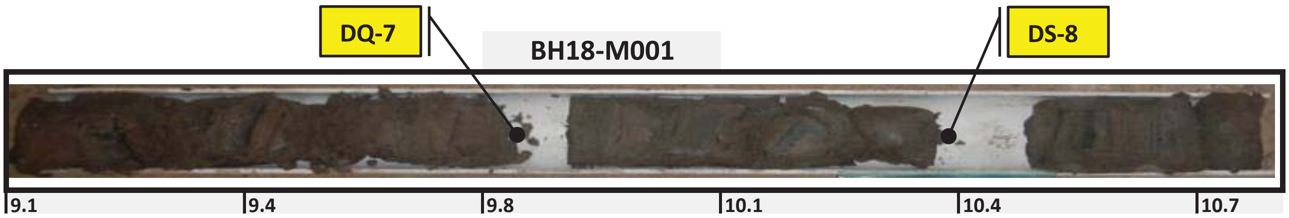


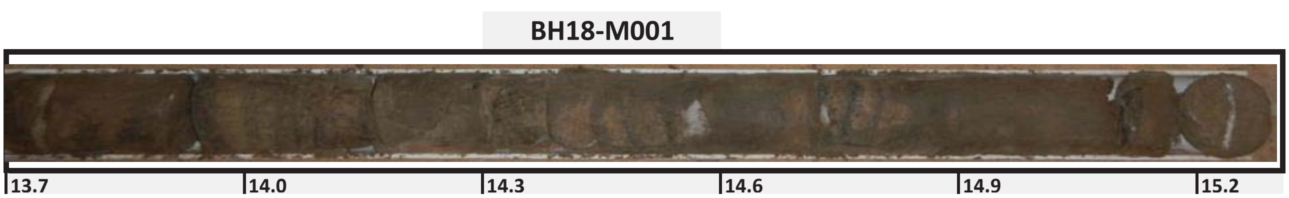


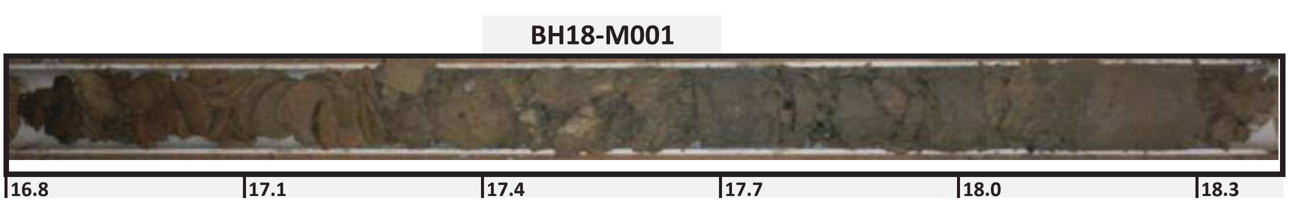
HATCH

Sample Photographs

Borehole Name:	BH18-M001	Mary River Expansion Study Stage 2
Location:	17 W 503423 7974892	
Completion Date:	March 5, 2018	Baffinland Iron Mines







Sample Photographs

Borehole Name:	BH18-M001	Mary River Expansion Study Stage 2
Location:	17 W 503423 7974892	
Completion Date:	March 5, 2018	Baffinland Iron Mines

BH18-M001

18.3 | 18.6 | 18.9 | 19.2 | 19.5 | 19.8

BH18-M001

19.8 | 20.1 | 20.4 | 20.7 | 21.0 | 21.3

BH18-M001

21.3 | 21.6 | 21.9 | 22.3 | 22.6 | 22.9

BH18-M001

22.9 | 23.2 | 23.5 | 23.8 | 24.1 | 24.4

BH18-M001

24.4 | 24.7 | 25.0 | 25.3 | 25.6 | 25.9

HATCH

Sample Photographs

Borehole Name:	BH18-M002	Mary River Expansion Study Stage 2
Location:	17 W 503328 7974867	2018 Geotechnical Investigation
Completion Date:	March 5, 2018	Baffinland Iron Mines

BH18-M002

DQ-1 DS-2

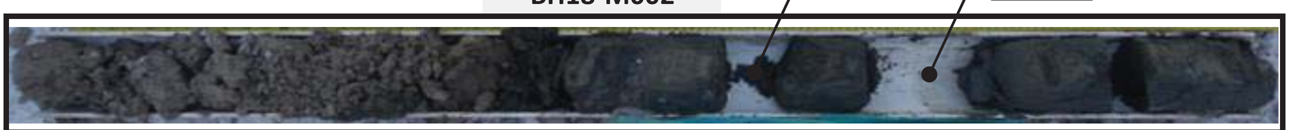
0 0.3 0.6 0.9 1.2 1.5

BH18-M002

1.5 1.8 2.1 2.4 2.7 3.0

BH18-M002

DQ-3 DS-4



3.0 3.4 3.7 4.0 4.3 4.6

BH18-M002

DQ-5

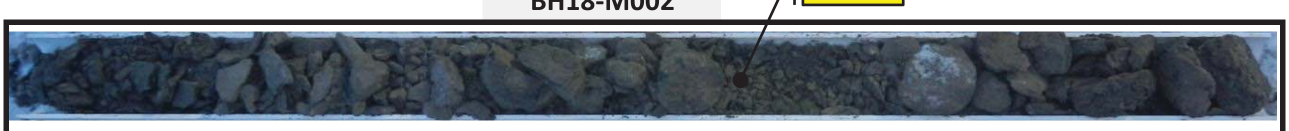
4.6 4.9 5.2 5.5 5.8 6.1

BH18-M002

6.1 6.4 6.7 7.0 7.3 7.6

BH18-M002

DS-6



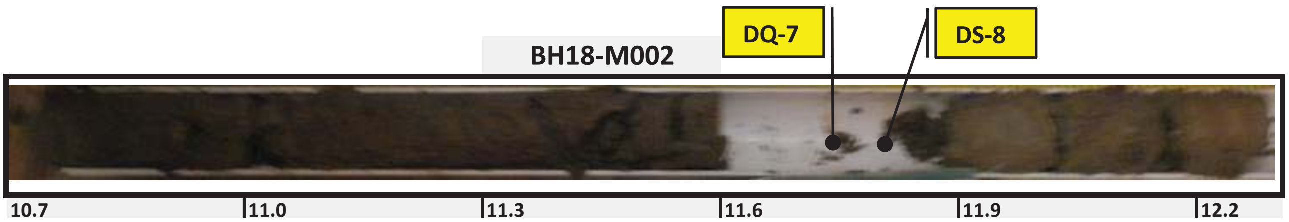
7.6 7.9 8.2 8.5 8.8 9.1

Sample Photographs

Borehole Name:	BH18-M002	Mary River Expansion Study Stage 2
Location:	17 W 503328 7974867	
Completion Date:	March 5, 2018	Baffinland Iron Mines

BH18-M002

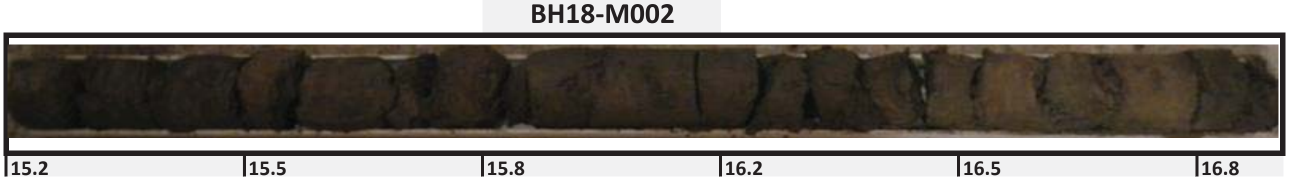
BH18-M002



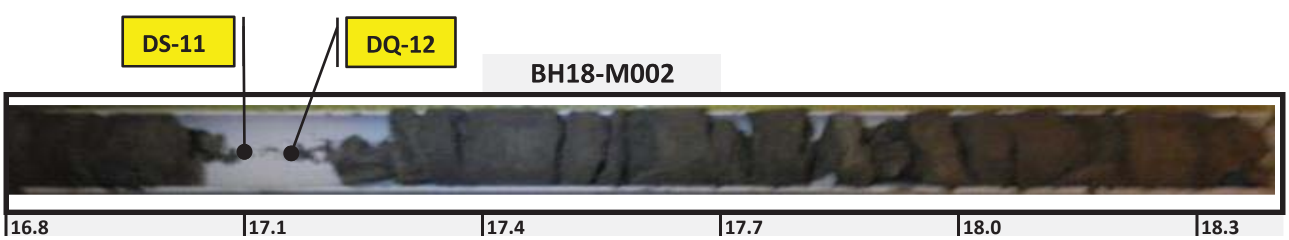
BH18-M002

BH18-M002

BH18-M002



BH18-M002



HATCH

Sample Photographs

Borehole Name:	BH18-M002	Mary River Expansion Study Stage 2
Location:	17 W 503328 7974867	
Completion Date:	March 5, 2018	Baffinland Iron Mines

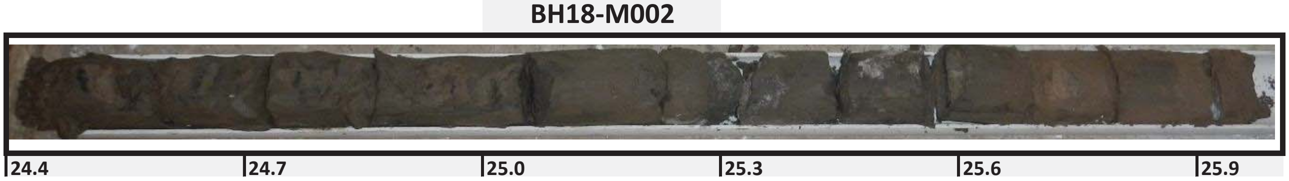
BH18-M002

BH18-M002

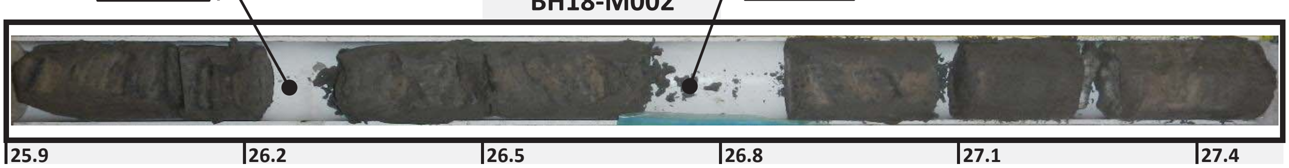
BH18-M002

BH18-M002

BH18-M002



BH18-M002



HATCH

Sample Photographs

Borehole Name:	BH18-M002	Mary River Expansion Study Stage 2
Location:	17 W 503328 7974867	
Completion Date:	March 5, 2018	Baffinland Iron Mines

BH18-M002

27.4 | 27.7 | 28.0 | 28.3 | 28.7 | 29.0

BH18-M002

29.0 | 29.3 | 29.6 | 29.9 | 30.2 | 30.5

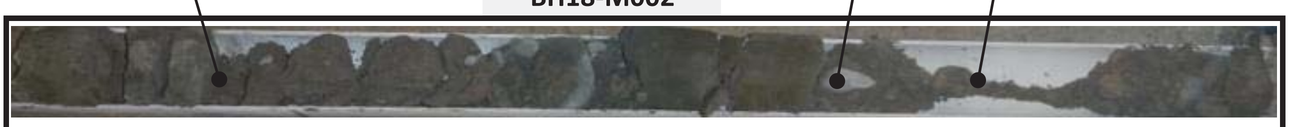
BH18-M002

30.5 | 30.8 | 31.1 | 31.4 | 31.7 | 32.0

BH18-M002

32.0 | 32.3 | 32.6 | 32.9 | 33.2 | 33.5

BH18-M002



33.5 | 33.8 | 34.1 | 34.4 | 34.7 | 35.1

BH18-M002

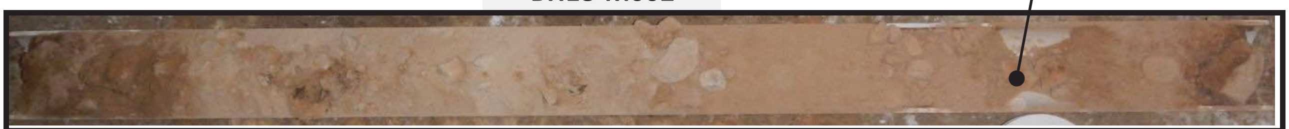
35.1 | 35.4 | 35.7 | 36.0 | 36.3 | 36.6

Sample Photographs

Borehole Name:	BH18-M002	Mary River Expansion Study Stage 2
Location:	17 W 503328 7974867	
Completion Date:	March 5, 2018	Baffinland Iron Mines

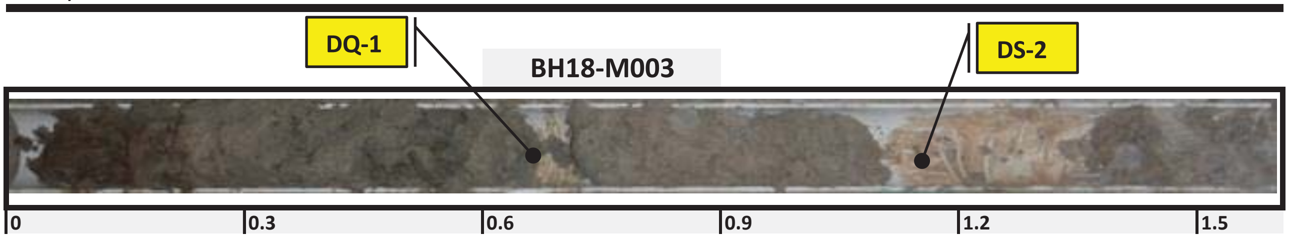
BH18-M002

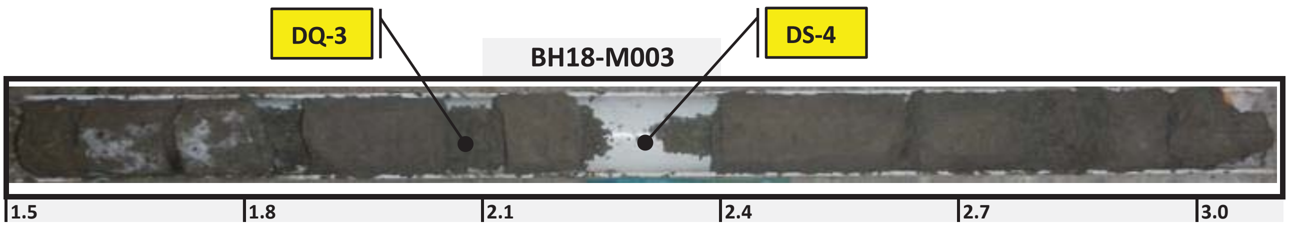
BH18-M002

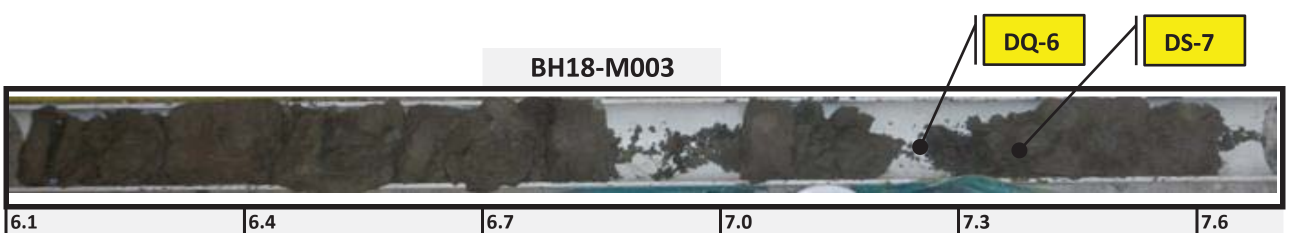


Sample Photographs

Borehole Name:	BH18-M003	Mary River Expansion Study Stage 2
Location:	17 W 503055 7974868	2018 Geotechnical Investigation
Completion Date:	March 6, 2018	Baffinland Iron Mines







HATCH

Sample Photographs

Borehole Name:	BH18-M003	Mary River Expansion Study Stage 2
Location:	17 W 503055 7974868	
Completion Date:	March 6, 2018	Baffinland Iron Mines

BH18-M003

9.1 | 9.4 | 9.8 | 10.1 | 10.4 | 10.7

BH18-M003

10.7 | 11.0 | 11.3 | 11.6 | 11.9 | 12.2

BH18-M003

12.2 | 12.5 | 12.8 | 13.1 | 13.4 | 13.7

BH18-M003

13.7 | 14.0 | 14.3 | 14.6 | 14.9 | 15.2

BH18-M003

15.2 | 15.5 | 15.8 | 16.2 | 16.5 | 16.8

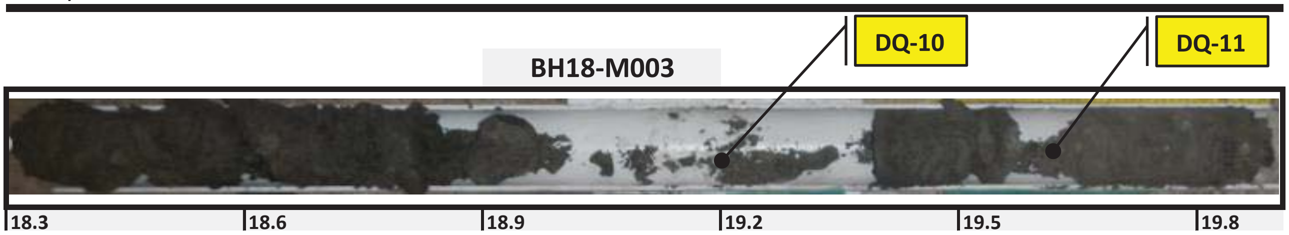
BH18-M003

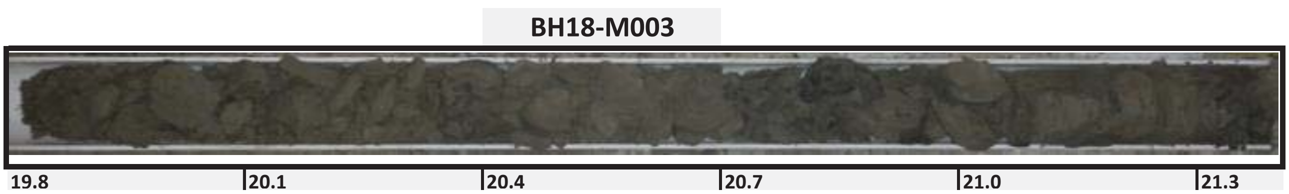
16.8 | 17.1 | 17.4 | 17.7 | 18.0 | 18.3

HATCH

Sample Photographs

Borehole Name:	BH18-M003	Mary River Expansion Study Stage 2
Location:	17 W 503055 7974868	
Completion Date:	March 6, 2018	Baffinland Iron Mines





Sample Photographs

Borehole Name:	BH18-M003	Mary River Expansion Study Stage 2
Location:	17 W 503055 7974868	
Completion Date:	March 6, 2018	Baffinland Iron Mines

DS-16 DQ-17

BH18-M003

27.4 27.7 28.0 28.3 28.7 29.0

BH18-M003

29.0 29.3 29.6 29.9 30.2 30.5

BH18-M003

30.5 30.8 31.1 31.4 31.7 32.0

DQ-18 DS-19

BH18-M003

32.0 32.3 32.6 32.9 33.2 33.5

BH18-M003

33.5 33.8 34.1 34.4 34.7 35.1

BH18-M003

35.1 35.4 35.7 36.0 36.3 36.6

Sample Photographs

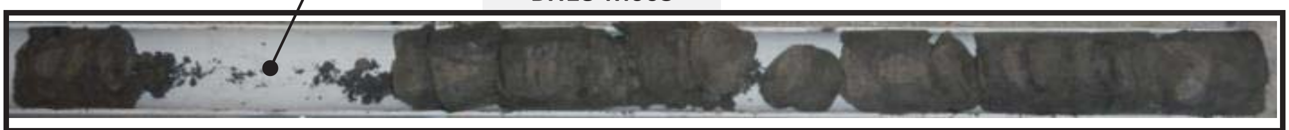
Borehole Name:	BH18-M003	Mary River Expansion Study Stage 2
Location:	17 W 503055 7974868	
Completion Date:	March 6, 2018	Baffinland Iron Mines

BH18-M003

36.6 | 36.9 | 37.2 | 37.5 | 37.8 | 38.1

DS-20

BH18-M003



38.1 | 38.4 | 38.7 | 39.0 | 39.3 | 39.6

BH18-M003

39.6 | 39.9 | 40.2 | 40.5 | 40.8 | 41.1

BH18-M003

41.1 | 41.5 | 41.8 | 42.1 | 42.4 | 42.7

DQ-23 DQ-22

BH18-M003

42.7 | 43.0 | 43.3 | 43.6 | 43.9 | 44.2

BH18-M003

44.2 | 44.5 | 44.8 | 45.1 | 45.4 | 45.7

HATCH

Sample Photographs

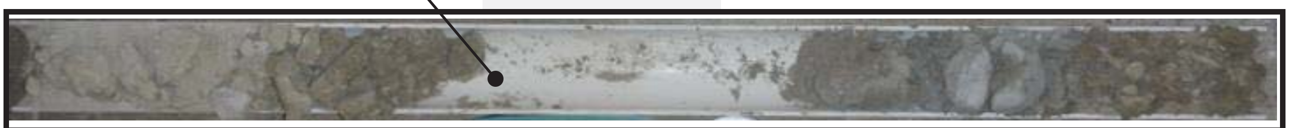
Borehole Name:	BH18-M003	Mary River Expansion Study Stage 2
Location:	17 W 503055 7974868	
Completion Date:	March 6, 2018	Baffinland Iron Mines

BH18-M003

45.7 | 46.0 | 46.3 | 46.6 | 46.9 | 47.2

DS-24

BH18-M003



47.2 | 47.5 | 47.9 | 48.2 | 48.5 | 48.8

BH18-M003

48.8 | 49.1 | 49.4 | 49.7 | 50.0 | 50.3

DS-26

BH18-M003

50.3 | 50.6 | 50.9 | 51.2 | 51.5 | 51.8

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	2018 Geotechnical Investigation
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5

DS-1 DQ-1

BH18-004

1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0

BH18-004

3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6

BH18-004

4.6 | 4.9 | 5.2 | 5.5 | 5.8 | 6.1

BH18-004

6.1 | 6.4 | 6.7 | 7.0 | 7.3 | 7.6

DQ-2

BH18-004

7.6 | 7.9 | 8.2 | 8.5 | 8.8 | 9.1

HATCH

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

9.1 | 9.4 | 9.8 | 10.1 | 10.4 | 10.7

BH18-004

10.7 | 11.0 | 11.3 | 11.6 | 11.9 | 12.2

BH18-004

12.2 | 12.5 | 12.8 | 13.1 | 13.4 | 13.7

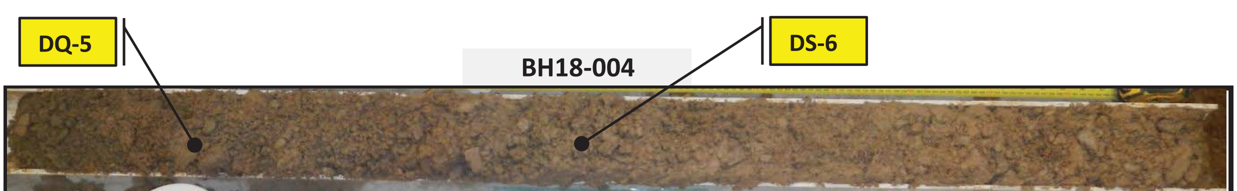
BH18-004

13.7 | 14.0 | 14.3 | 14.6 | 14.9 | 15.2

BH18-004

15.2 | 15.5 | 15.8 | 16.2 | 16.5 | 16.8

BH18-004



16.8 | 17.1 | 17.4 | 17.7 | 18.0 | 18.3

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

DQ-7

BH18-004

18.3 | 18.6 | 18.9 | 19.2 | 19.5 | 19.8

DQ-8

BH18-004

19.8 | 20.1 | 20.4 | 20.7 | 21.0 | 21.3

BH18-004

21.3 | 21.6 | 21.9 | 22.3 | 22.6 | 22.9

BH18-004

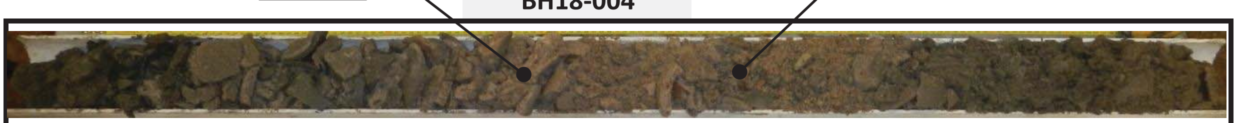
22.9 | 23.2 | 23.5 | 23.8 | 24.1 | 24.4

BH18-004

24.4 | 24.7 | 25.0 | 25.3 | 25.6 | 25.9

DQ-10 | DS-11

BH18-004



25.9 | 26.2 | 26.5 | 26.8 | 27.1 | 27.4

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

27.4 | 27.7 | 28.0 | 28.3 | 28.7 | 29.0

BH18-004

29.0 | 29.3 | 29.6 | 29.9 | 30.2 | 30.5

DQ-12

BH18-004

30.5 | 30.8 | 31.1 | 31.4 | 31.7 | 32.0

BH18-004

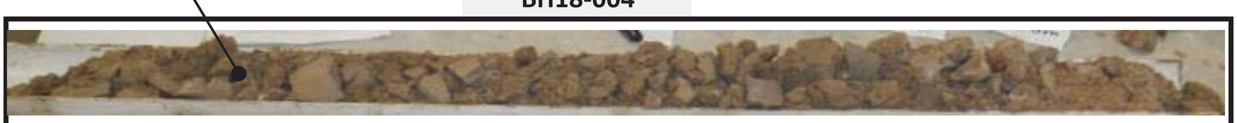
32.0 | 32.3 | 32.6 | 32.9 | 33.2 | 33.5

BH18-004

33.5 | 33.8 | 34.1 | 34.4 | 34.7 | 35.1

DQ-13

BH18-004



35.1 | 35.4 | 35.7 | 36.0 | 36.3 | 36.6

HATCH

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

36.6 | 36.9 | 37.2 | 37.5 | 37.8 | 38.1

BH18-004

38.1 | 38.4 | 38.7 | 39.0 | 39.3 | 39.6

DS-14

BH18-004

39.6 | 39.9 | 40.2 | 40.5 | 40.8 | 41.1

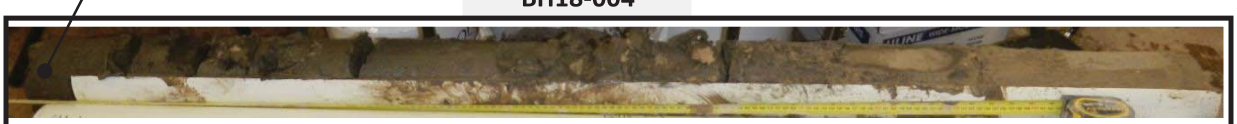
DQ-15

BH18-004

41.1 | 41.5 | 41.8 | 42.1 | 42.4 | 42.7

DS-17

BH18-004



42.7 | 43.0 | 43.3 | 43.6 | 43.9 | 44.2

BH18-004

44.2 | 44.5 | 44.8 | 45.1 | 45.4 | 45.7

HATCH

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

45.7 | 46.0 | 46.3 | 46.6 | 46.9 | 47.2

BH18-004

47.2 | 47.5 | 47.9 | 48.2 | 48.5 | 48.8

BH18-004

48.8 | 49.1 | 49.4 | 49.7 | 50.0 | 50.3

BH18-004

50.3 | 50.6 | 50.9 | 51.2 | 51.5 | 51.8

BH18-004

51.8 | 52.1 | 52.4 | 52.7 | 53.0 | 53.3

BH18-004

53.3 | 53.6 | 53.9 | 54.3 | 54.6 | 54.9

HATCH

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

54.9 | 55.2 | 55.5 | 55.8 | 56.1 | 56.4

BH18-004

56.4 | 56.7 | 57.0 | 57.3 | 57.6 | 57.9

BH18-004

Run not recovered

57.9 | 58.2 | 58.5 | 58.8 | 59.1 | 59.4

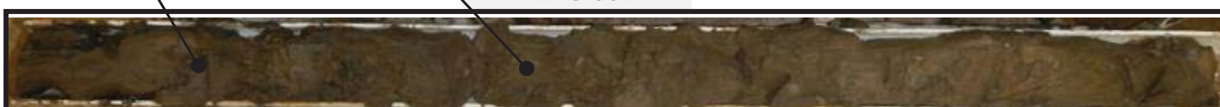
BH18-004

59.4 | 59.7 | 60.0 | 60.4 | 60.7 | 61.0

BH18-004

61.0 | 61.3 | 61.6 | 61.9 | 62.2 | 62.5

BH18-004



62.5 | 62.8 | 63.1 | 63.4 | 63.7 | 64.0

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

DQ-27

BH18-004

64.0 | 64.3 | 64.6 | 64.9 | 65.2 | 65.5

BH18-004

65.5 | 65.8 | 66.1 | 66.4 | 66.8 | 67.1

BH18-004

67.1 | 67.4 | 67.7 | 68.0 | 68.3 | 68.6

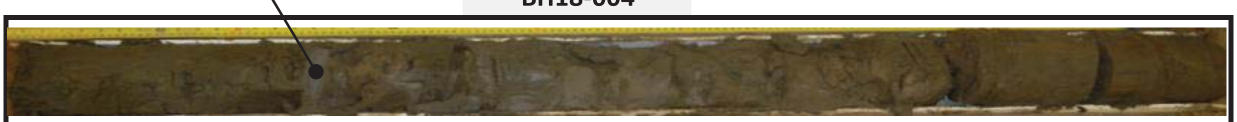
DQ-28

BH18-004

68.6 | 68.9 | 69.2 | 69.5 | 69.8 | 70.1

DS-29

BH18-004



70.1 | 70.4 | 70.7 | 71.0 | 71.3 | 71.6

DS-30

BH18-004

71.6 | 71.9 | 72.2 | 72.5 | 72.8 | 73.2

HATCH

Sample Photographs

Borehole Name:	BH18-004	Mary River Expansion Study Stage 2
Location:	17 W 563499 7976260	
Completion Date:	April 1, 2018	Baffinland Iron Mines

BH18-004

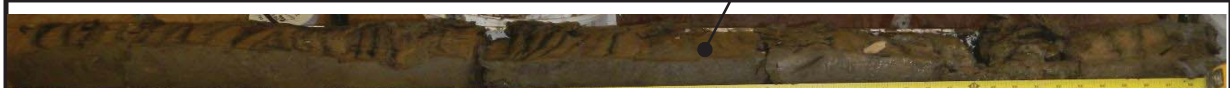
73.2 | 73.5 | 73.8 | 74.1 | 74.4 | 74.7

BH18-004

74.7 | 75.0 | 75.3 | 75.6 | 75.9 | 76.2

DS-32

BH18-004

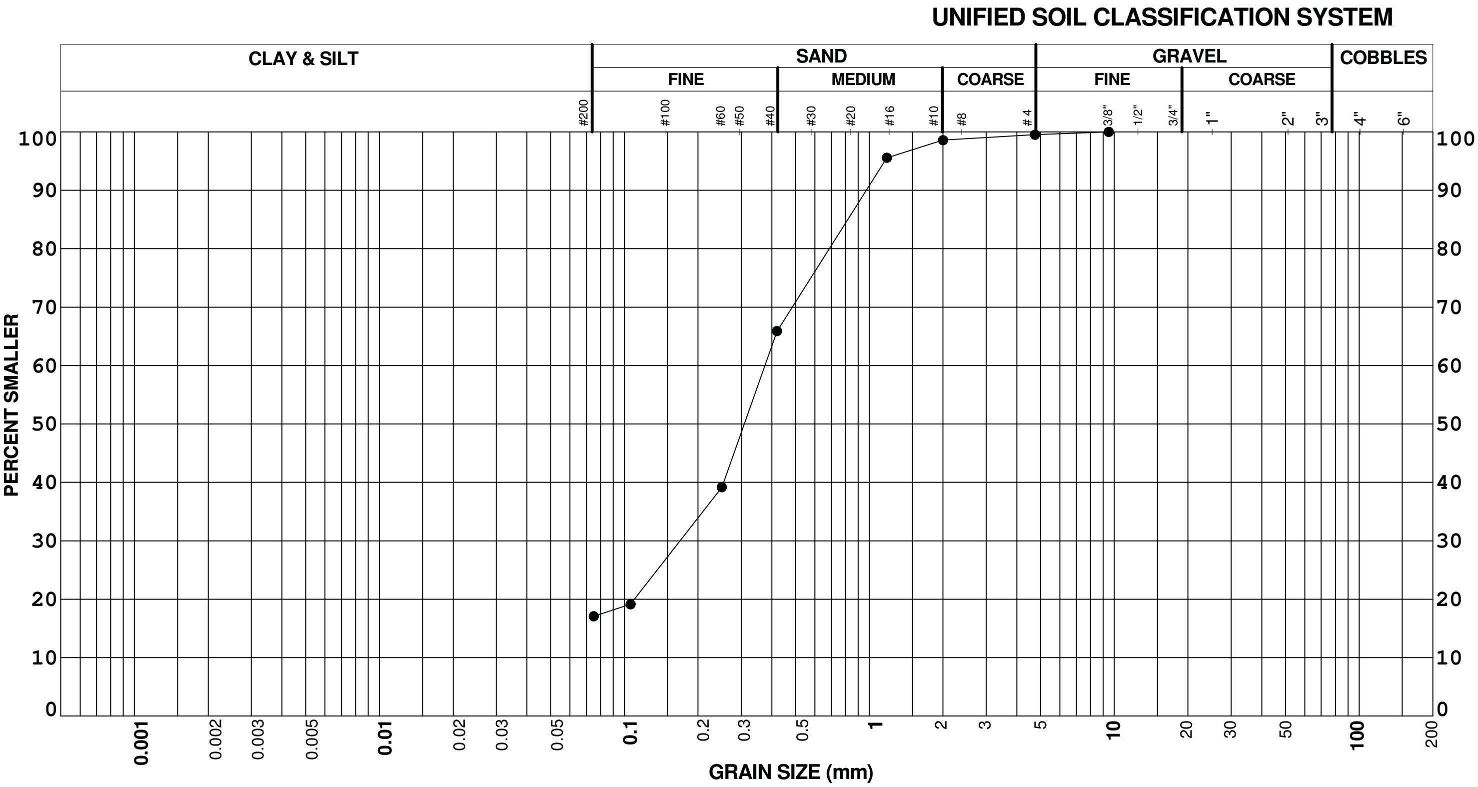


76.2 | 76.5 | 76.8 | 77.1 | 77.4 | 77.7

Appendix D

1

Laboratory Test Reports



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M001	BS4	5.90	0	82	17		

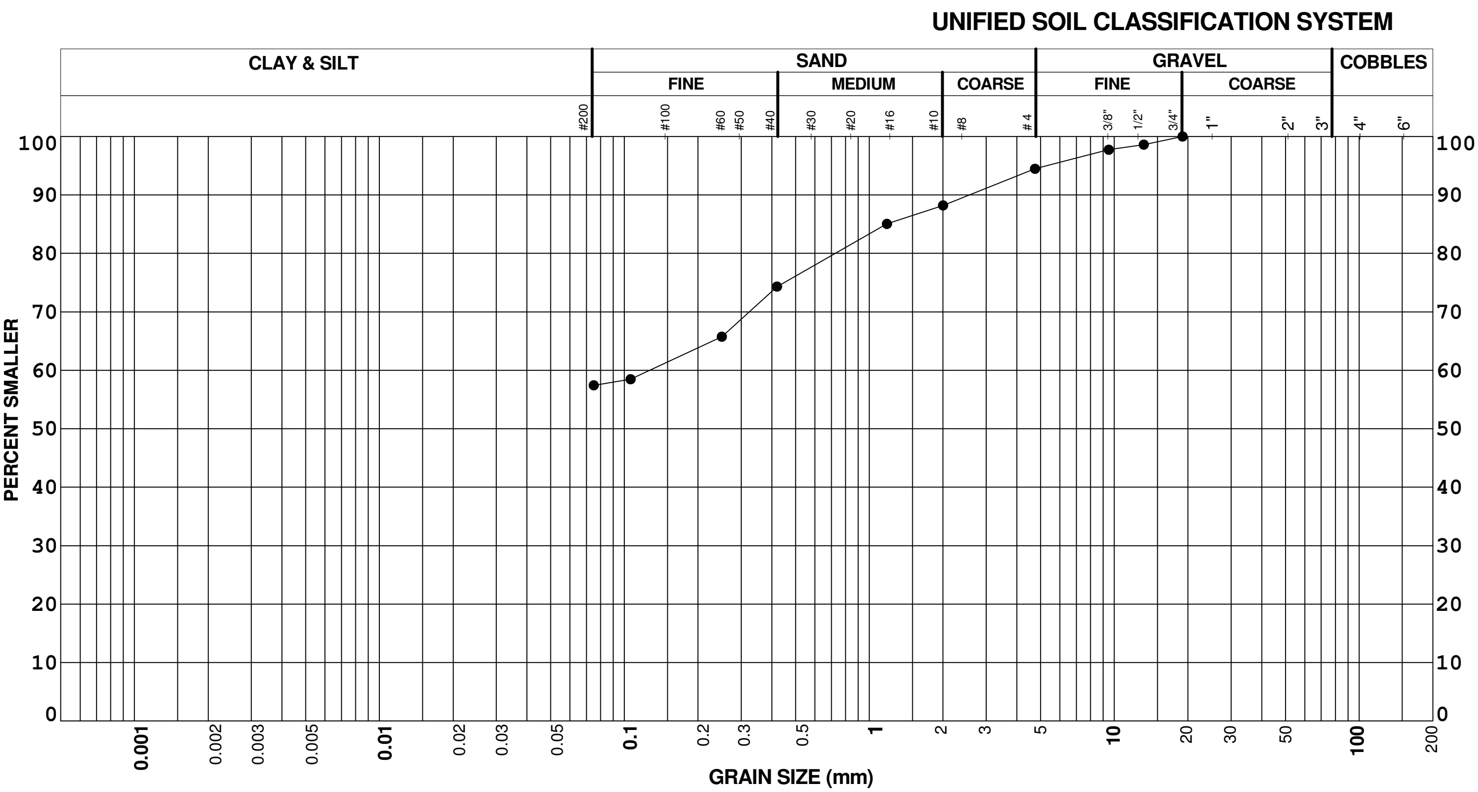
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M002	BS2	2.70	6	37	57		

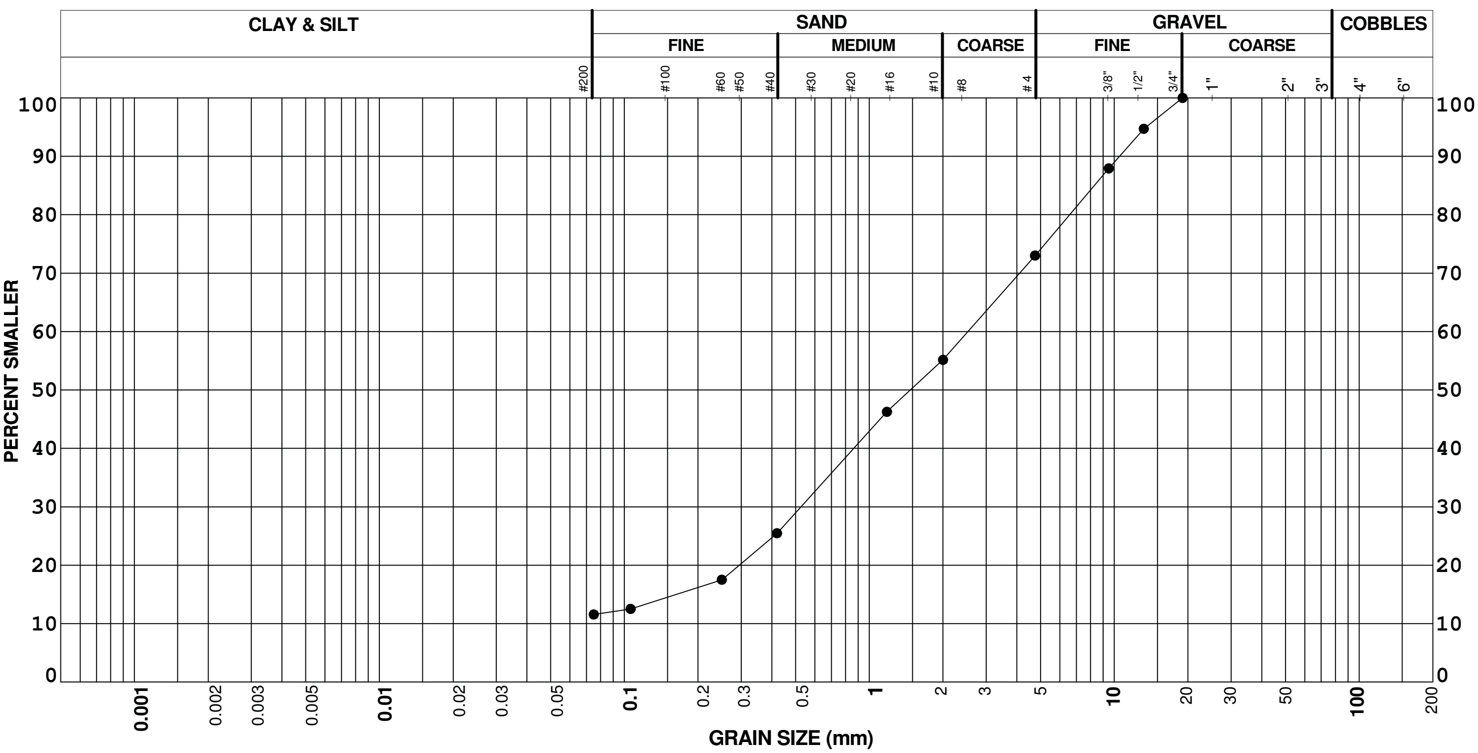
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

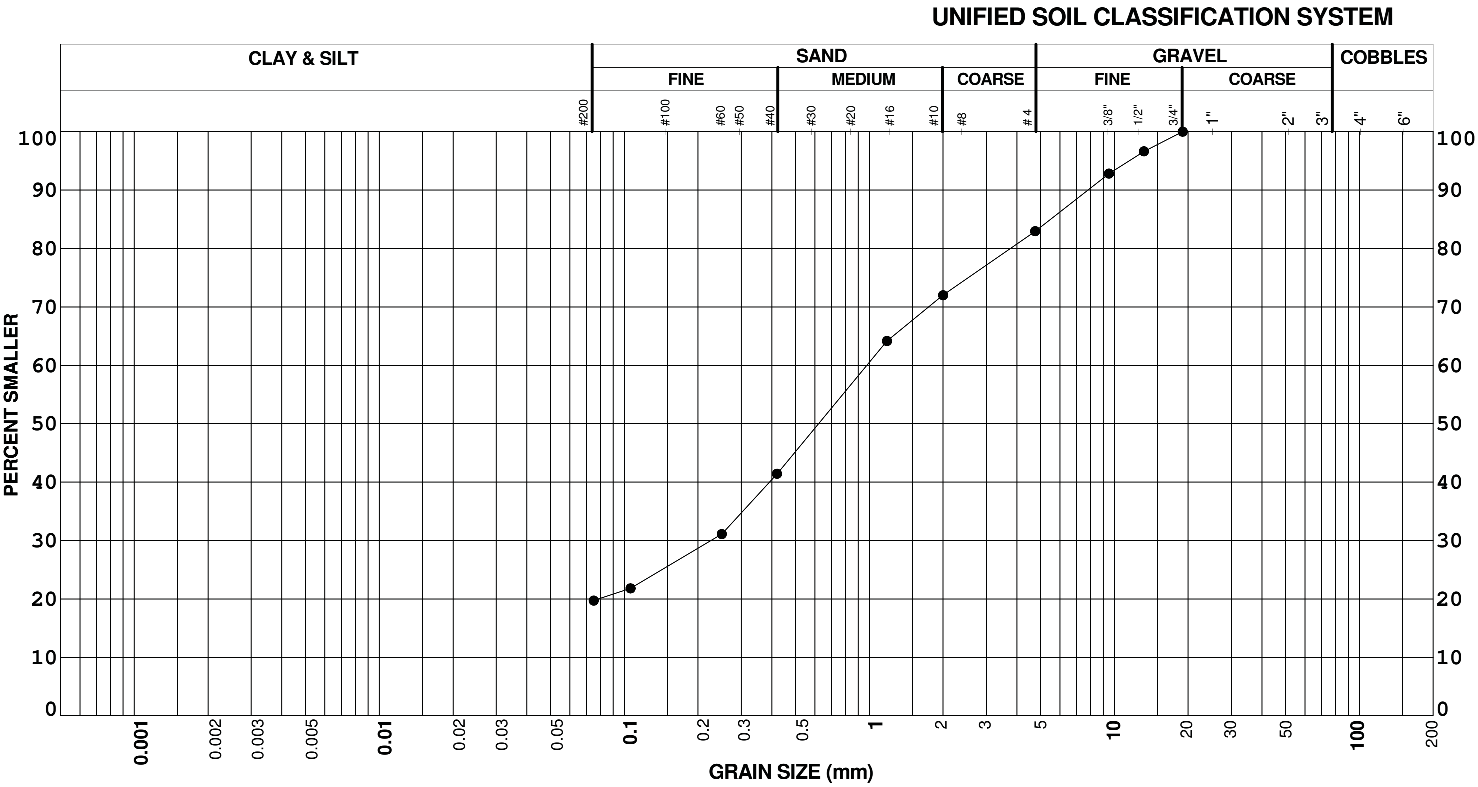
BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M002	BS3	4.00	27	61	12		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



REMARKS:

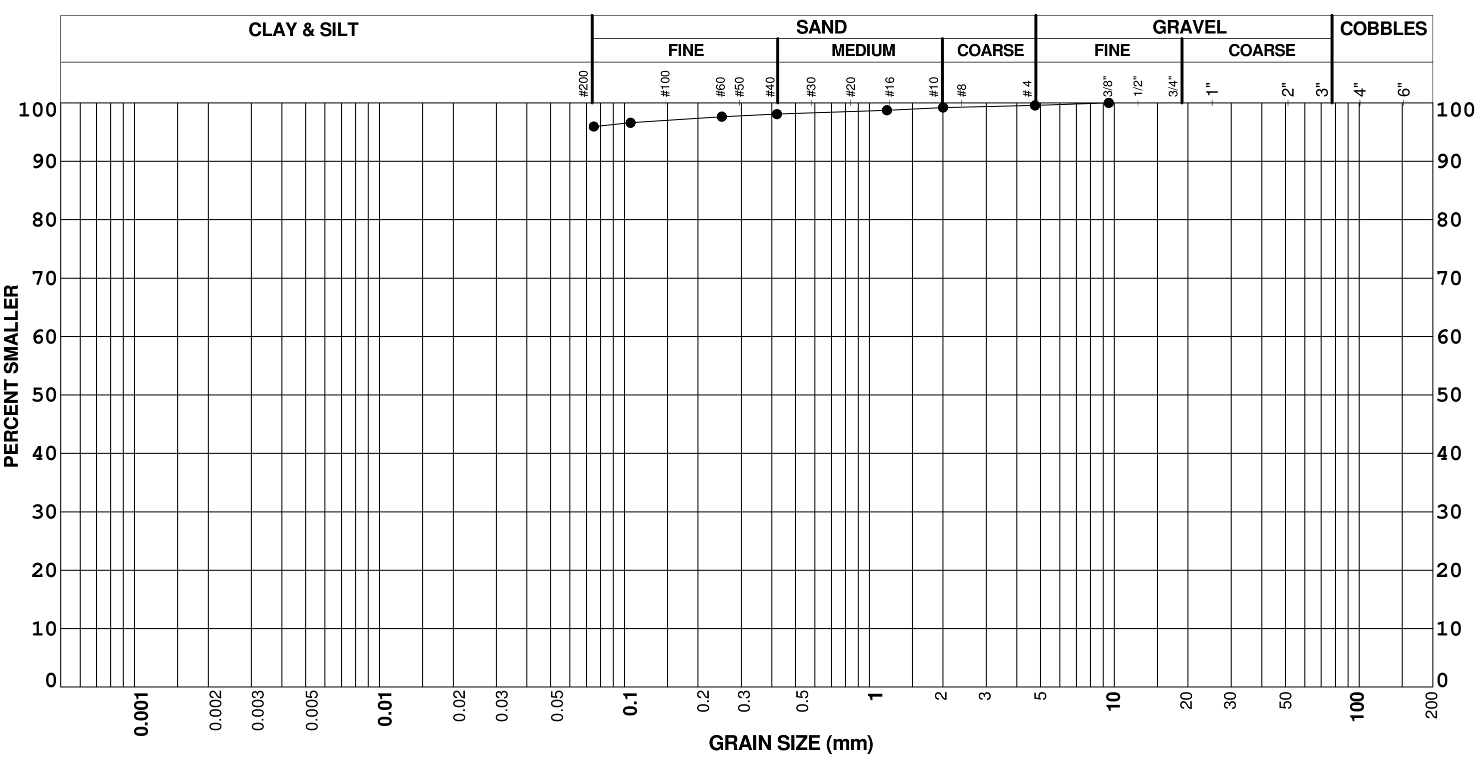
BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M003	BS1	1.20	17	63	20		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M003	BS2	2.70	0	4	96		

REMARKS:

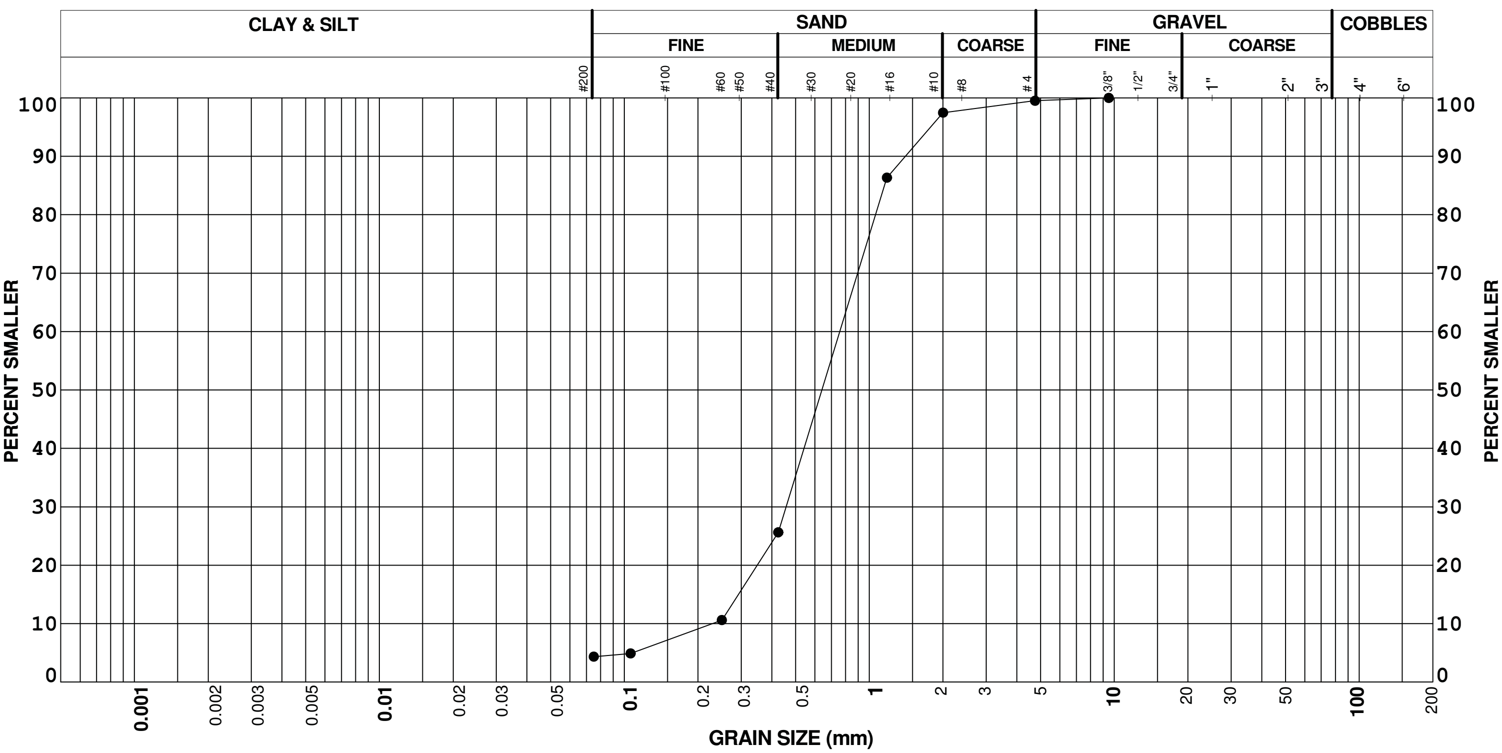
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M004	BS2	2.70	0	95	4		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

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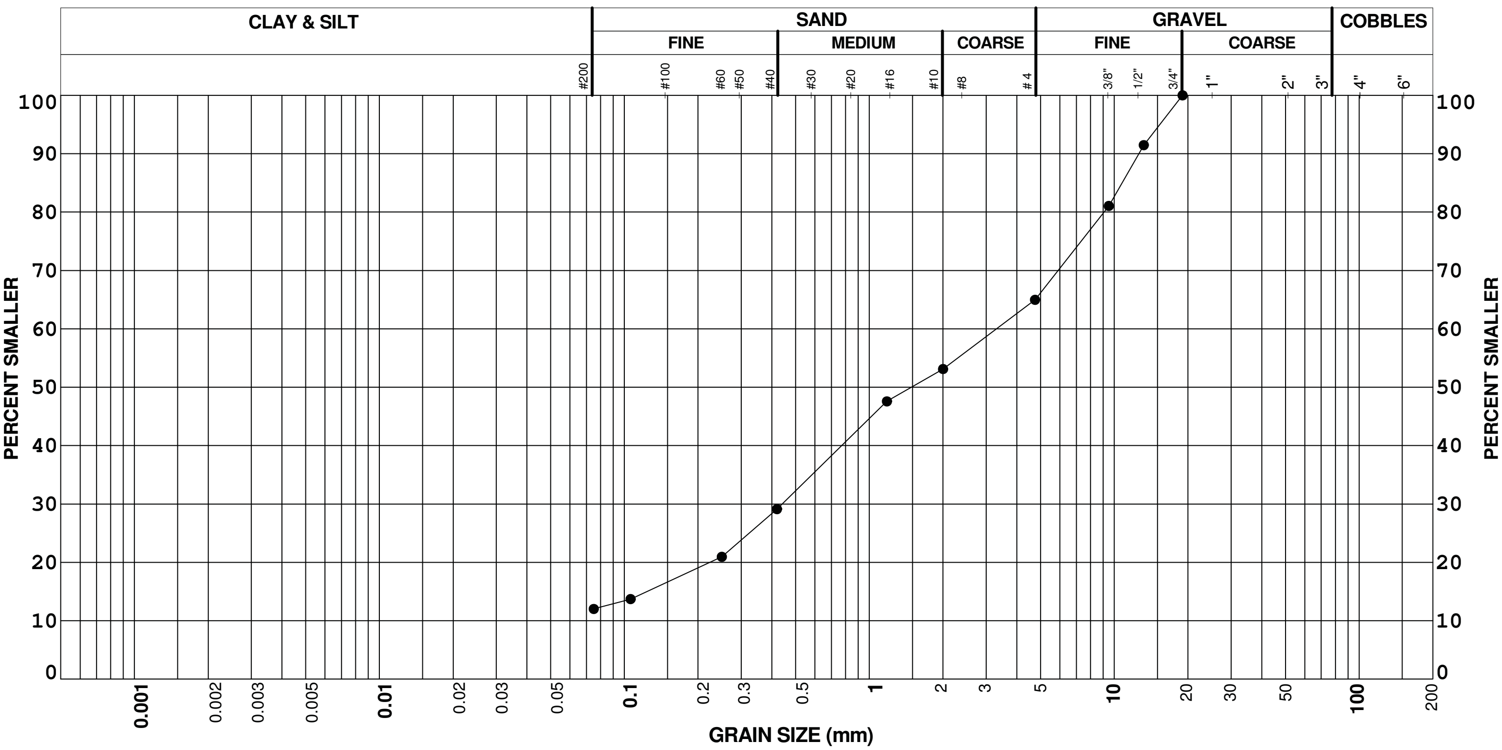
Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M005	BS2	2.70	35	53	12		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

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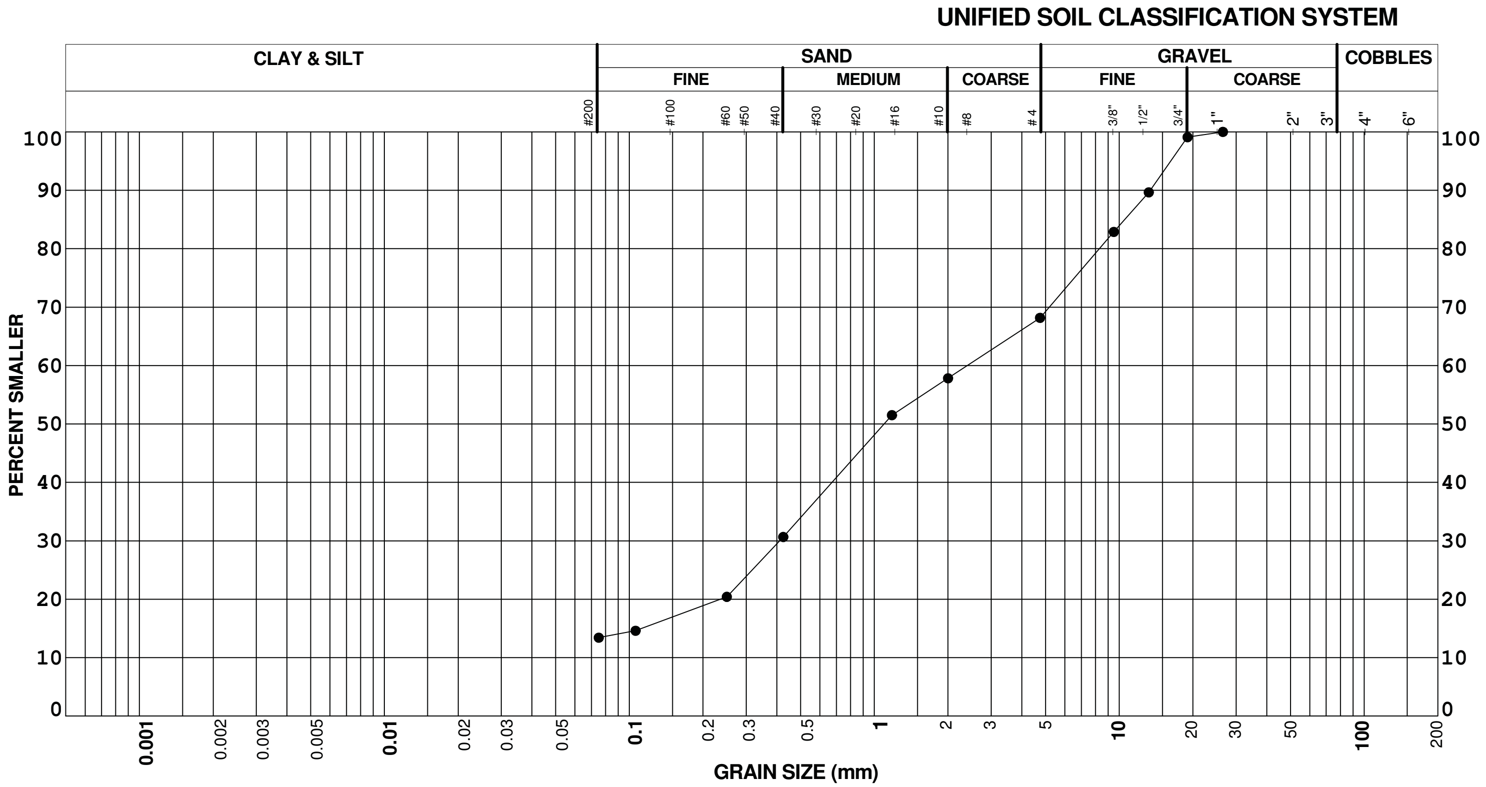
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M006	BS1	0.90	32	55	13		

REMARKS:

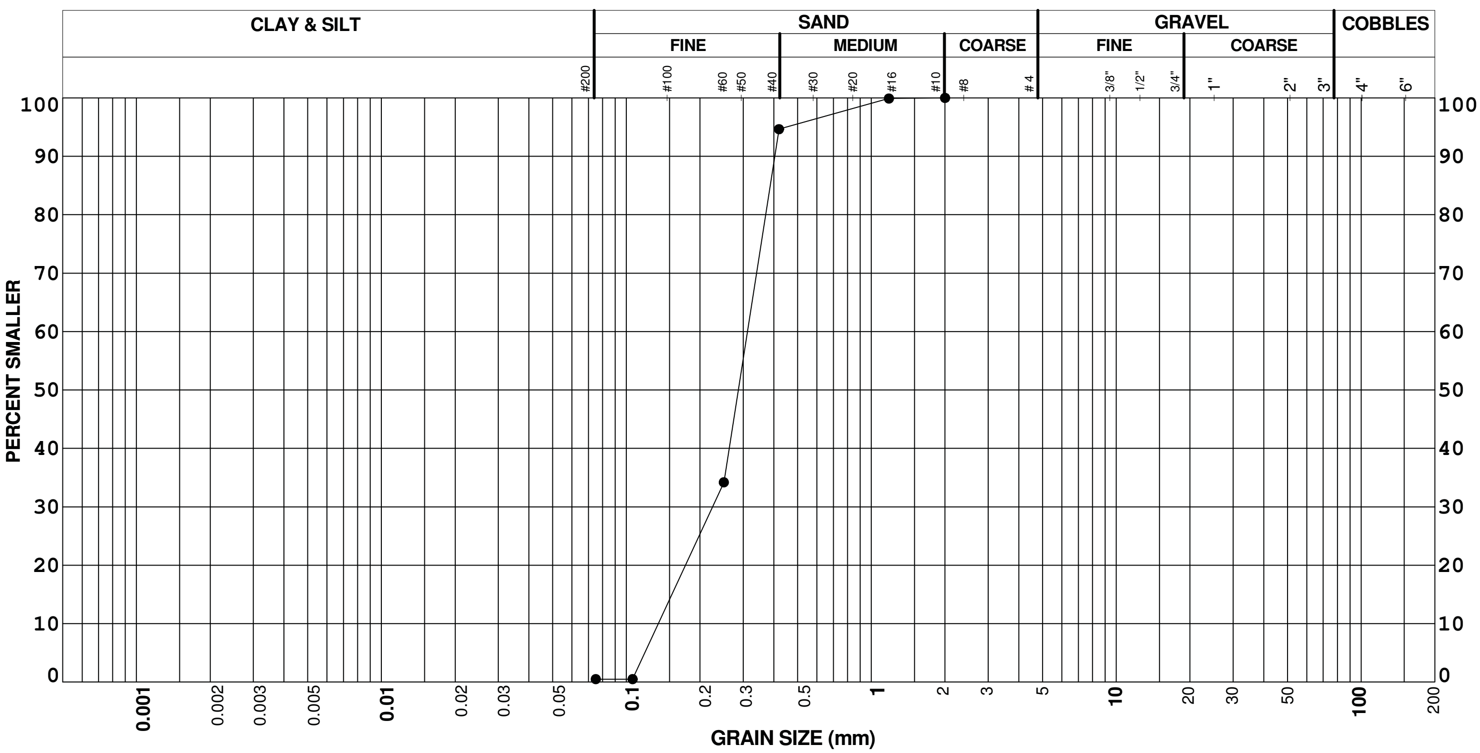
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH16-M007	BS3	3.05	0	100	0		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

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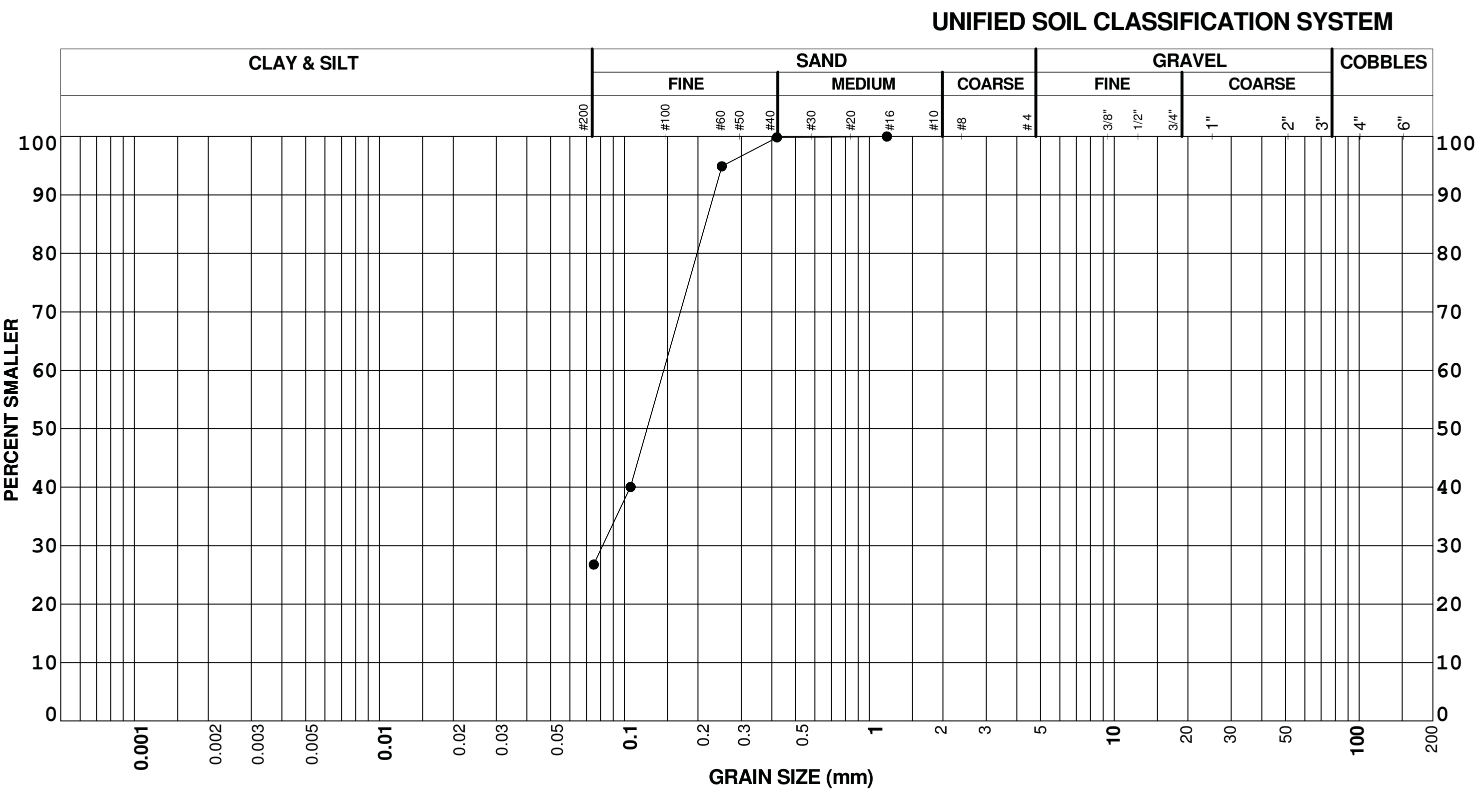
Project



REMARKS:

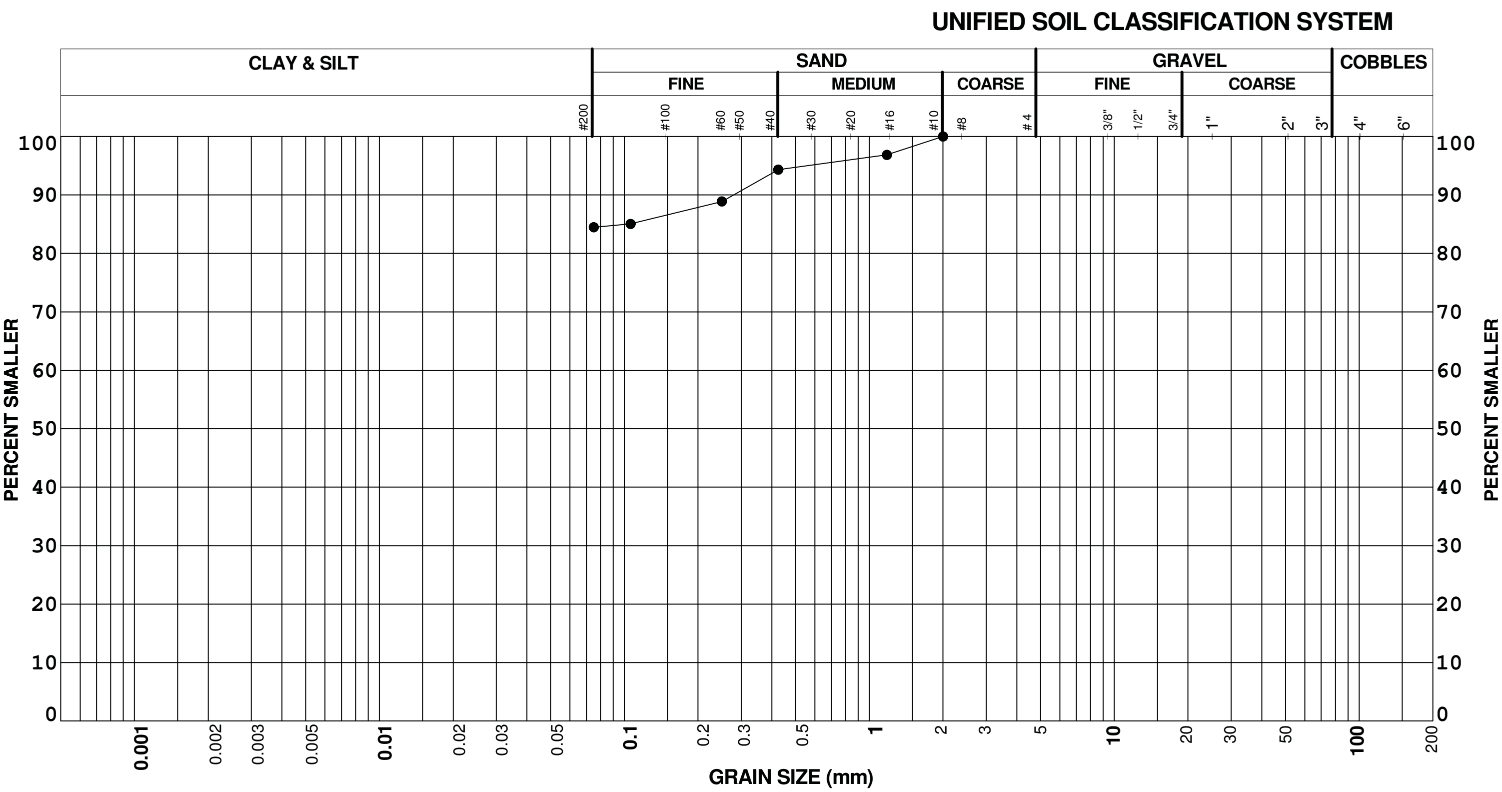
BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M008	BS3	3.05	0	73	27		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M010	BS1	0.90	0	16	84		

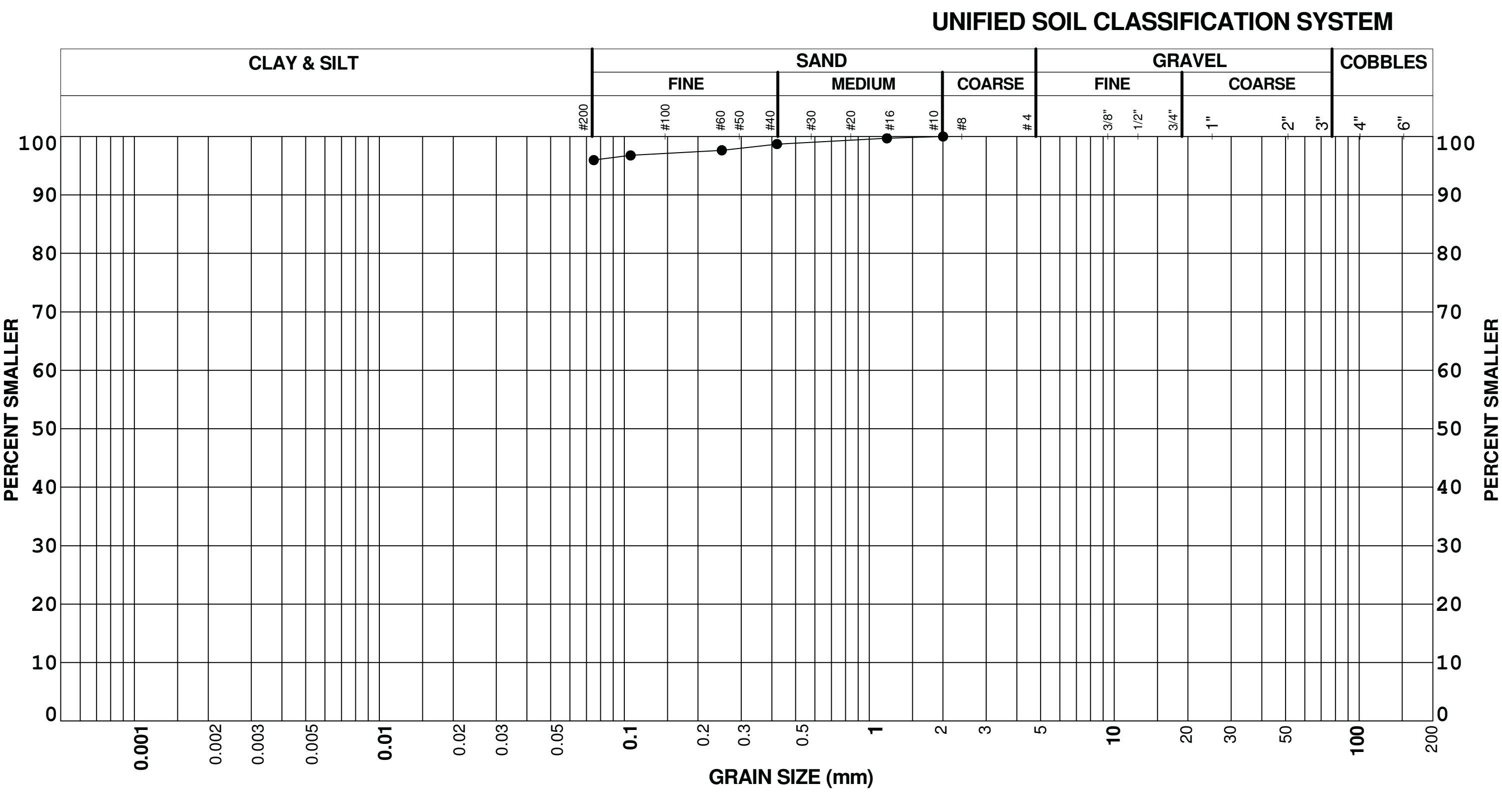
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M010	BS3	4.20	0	4	96		

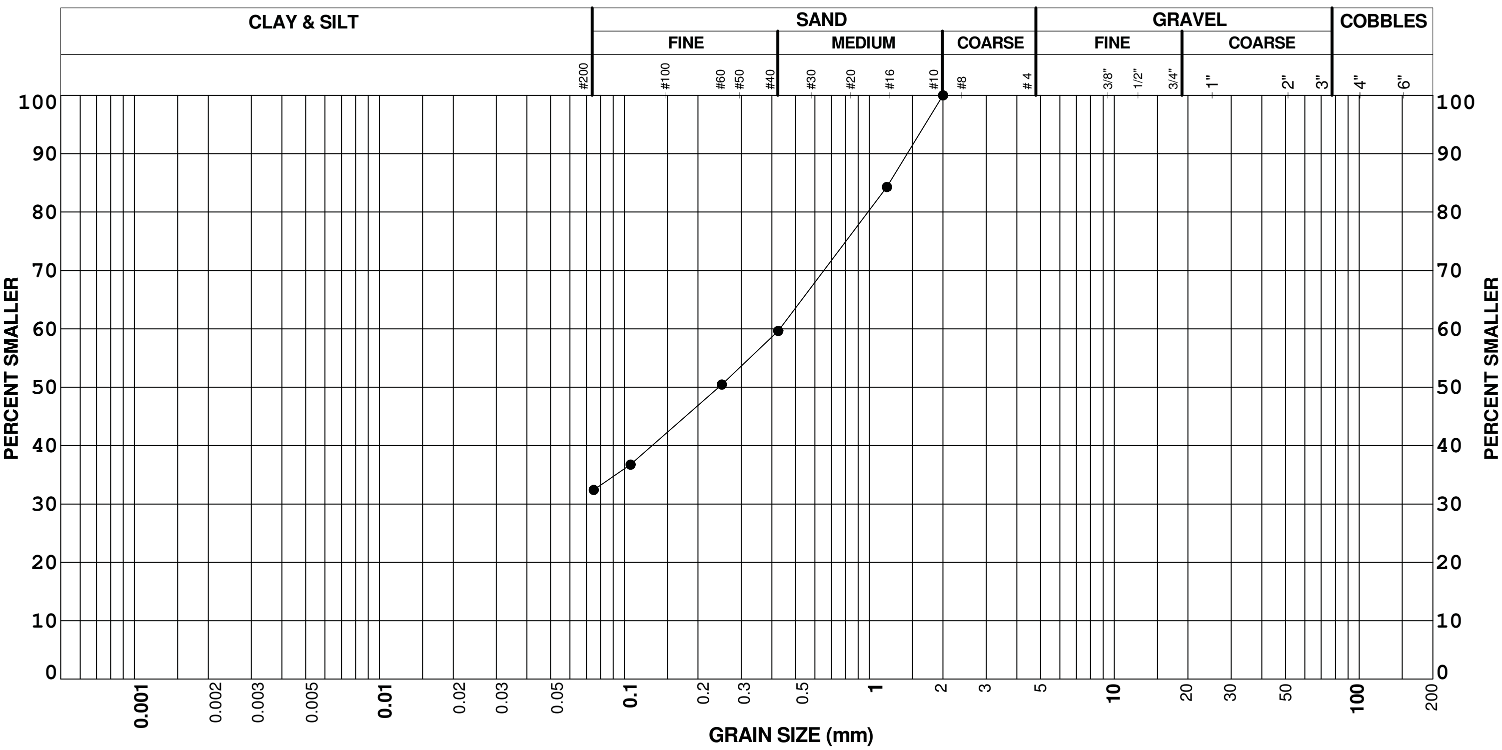
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH16-M011	BS1	1.20	0	68	32		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

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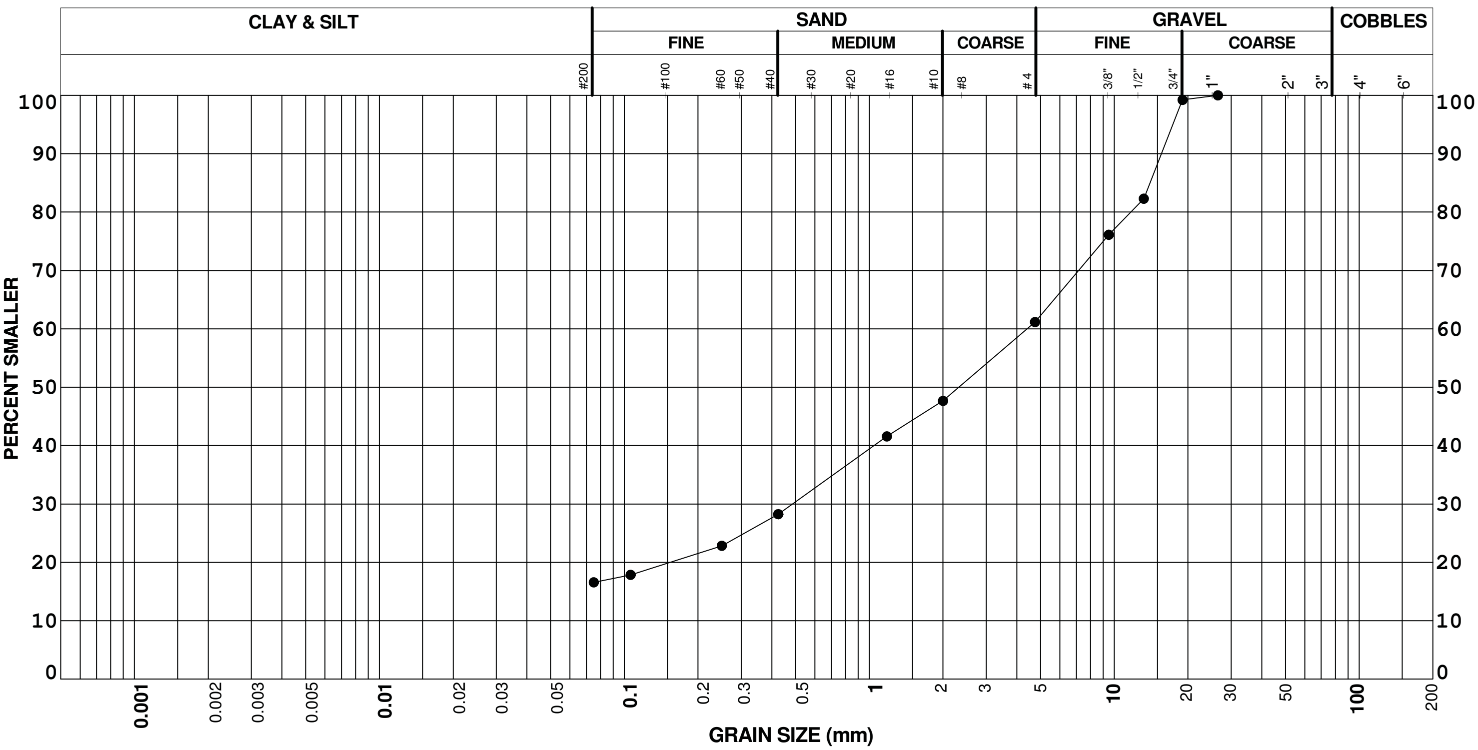
Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M012	BS1	0.90	39	45	17		

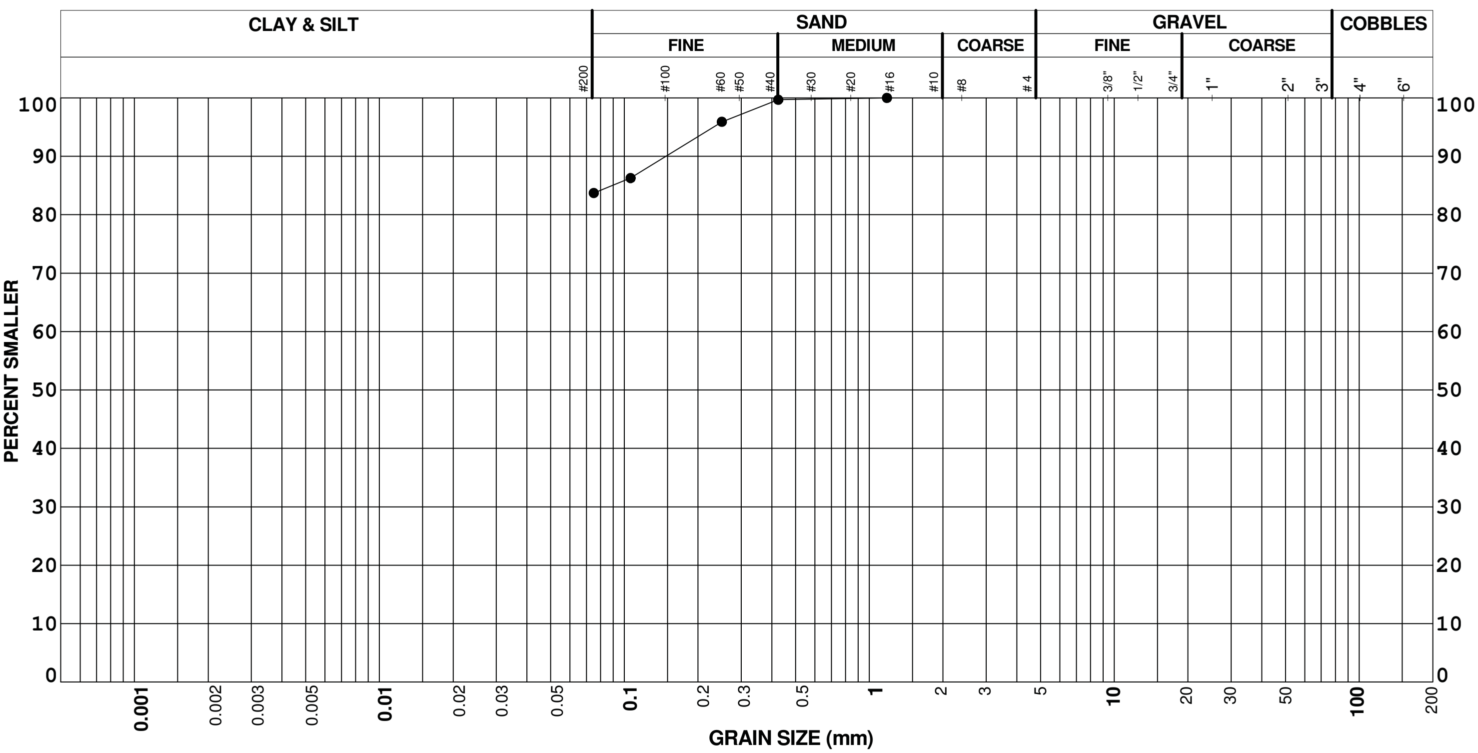
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M012	BS3	4.10	0	16	84		

REMARKS:

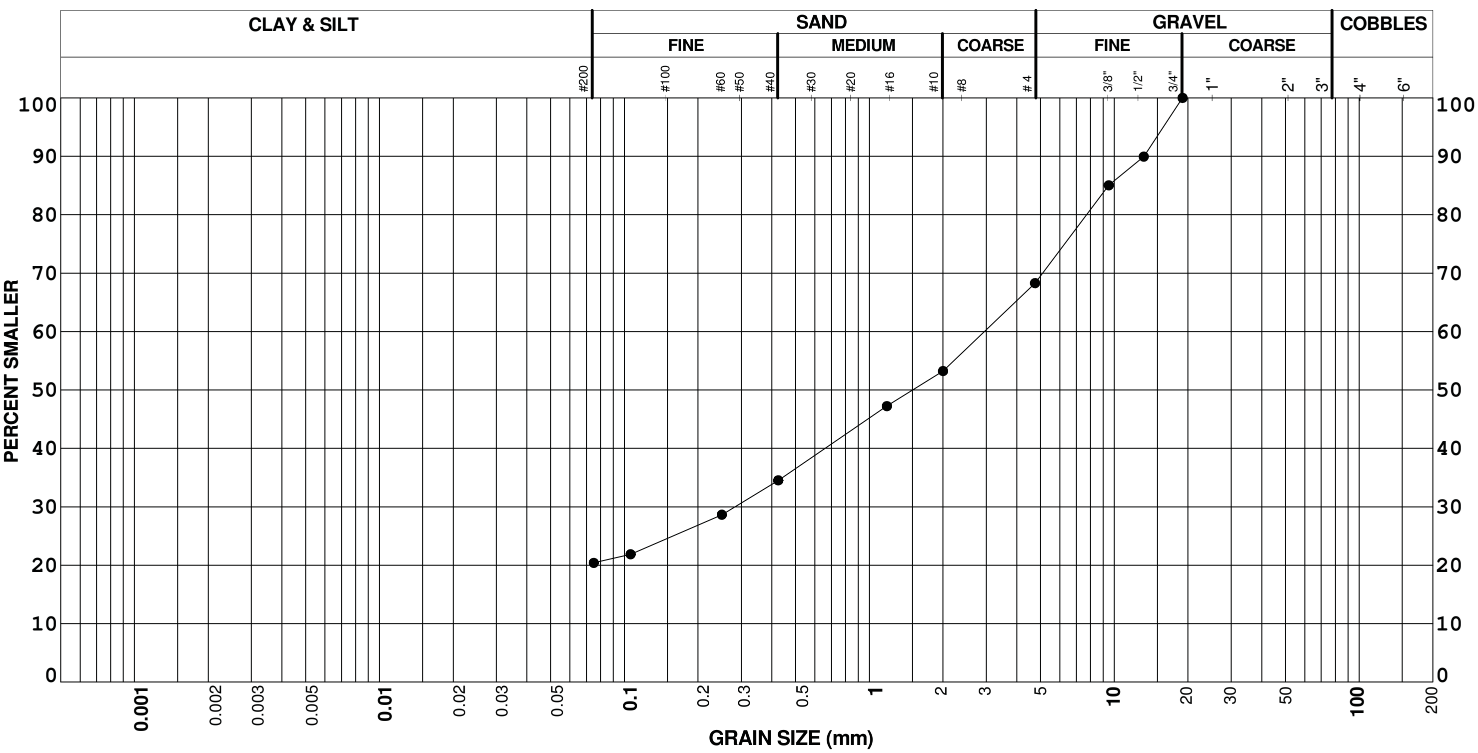
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M013	BS1	1.20	32	48	20		

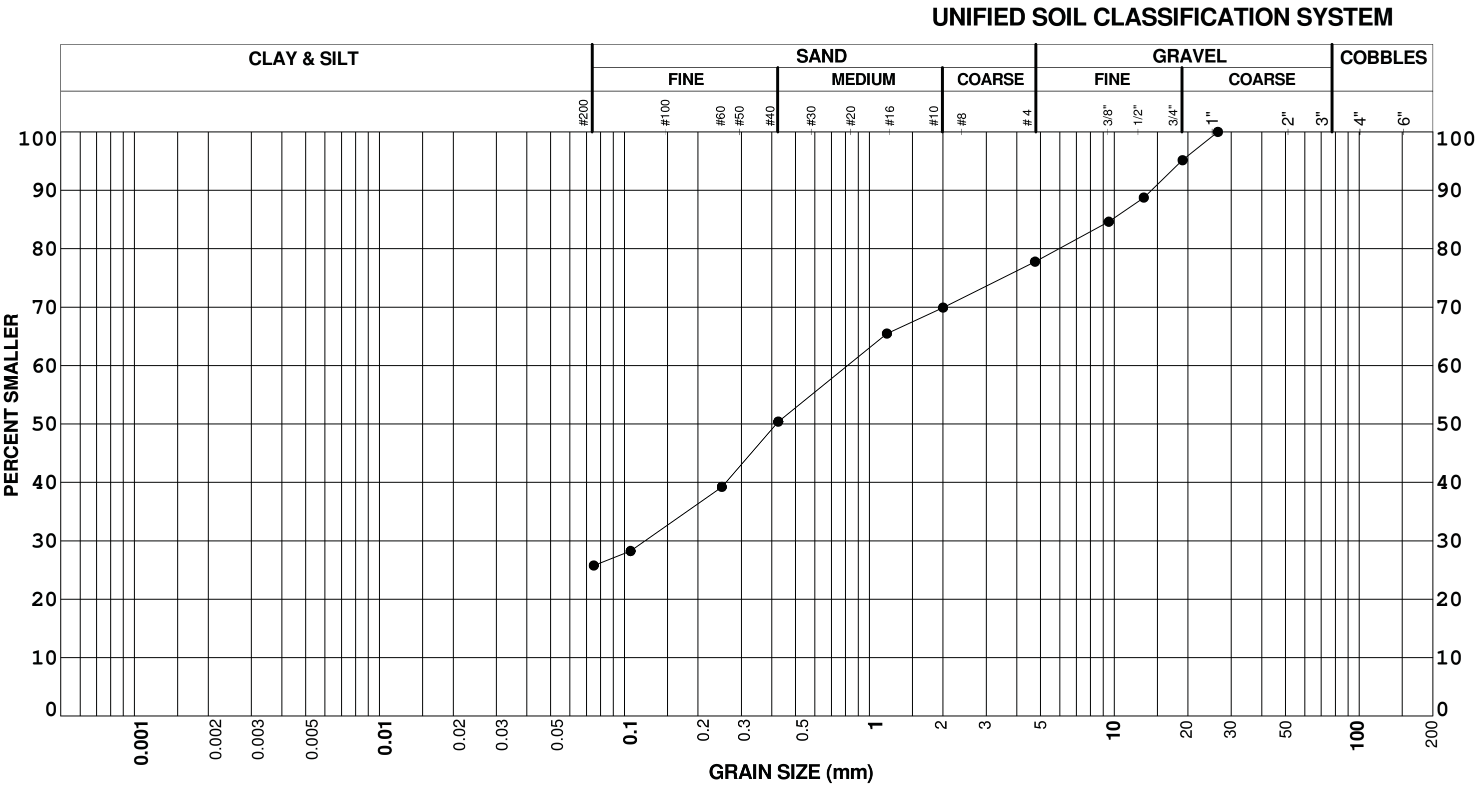
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M014	BS1	1.20	22	52	26		

REMARKS:

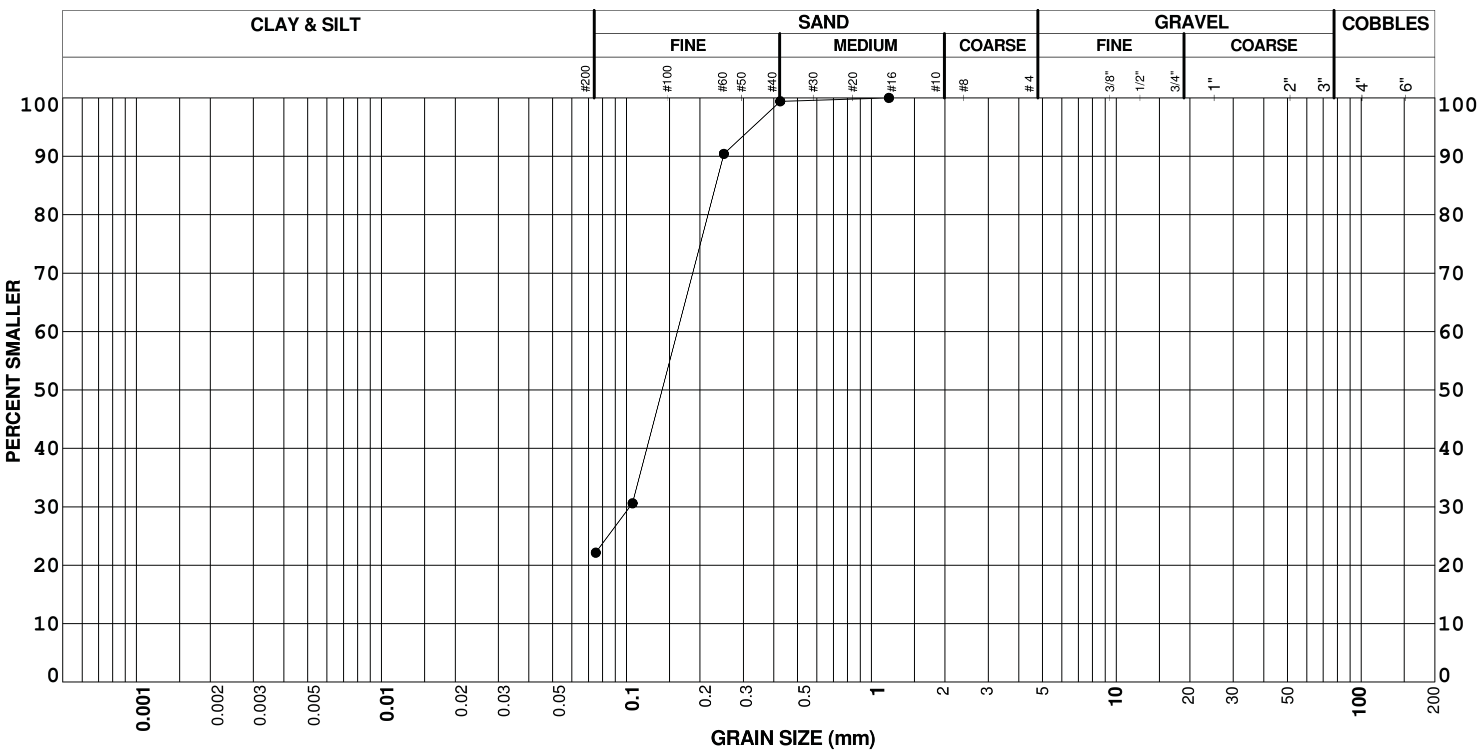
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M014	BS3	4.30	0	78	22		

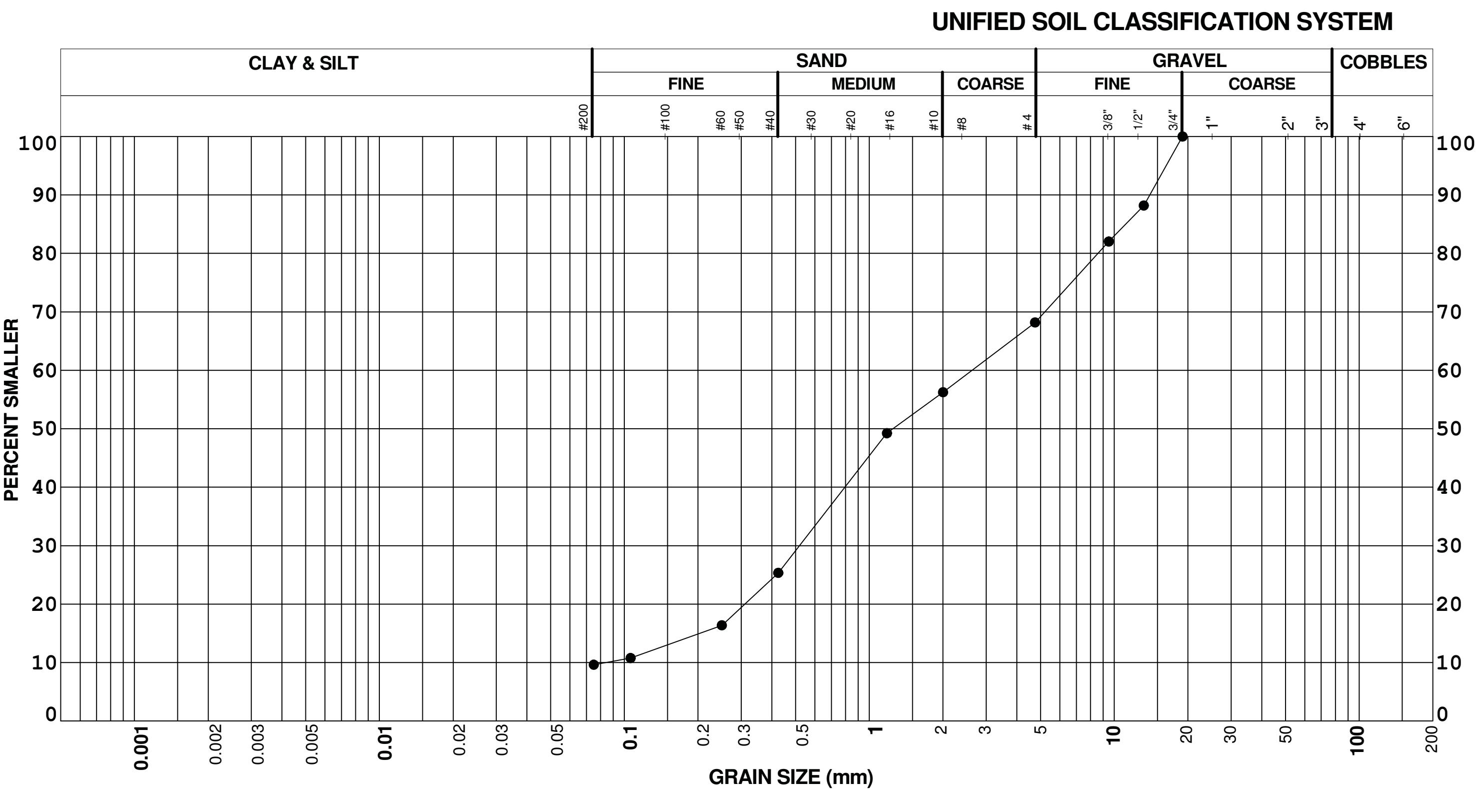
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M015	BS1	1.00	32	59	10		

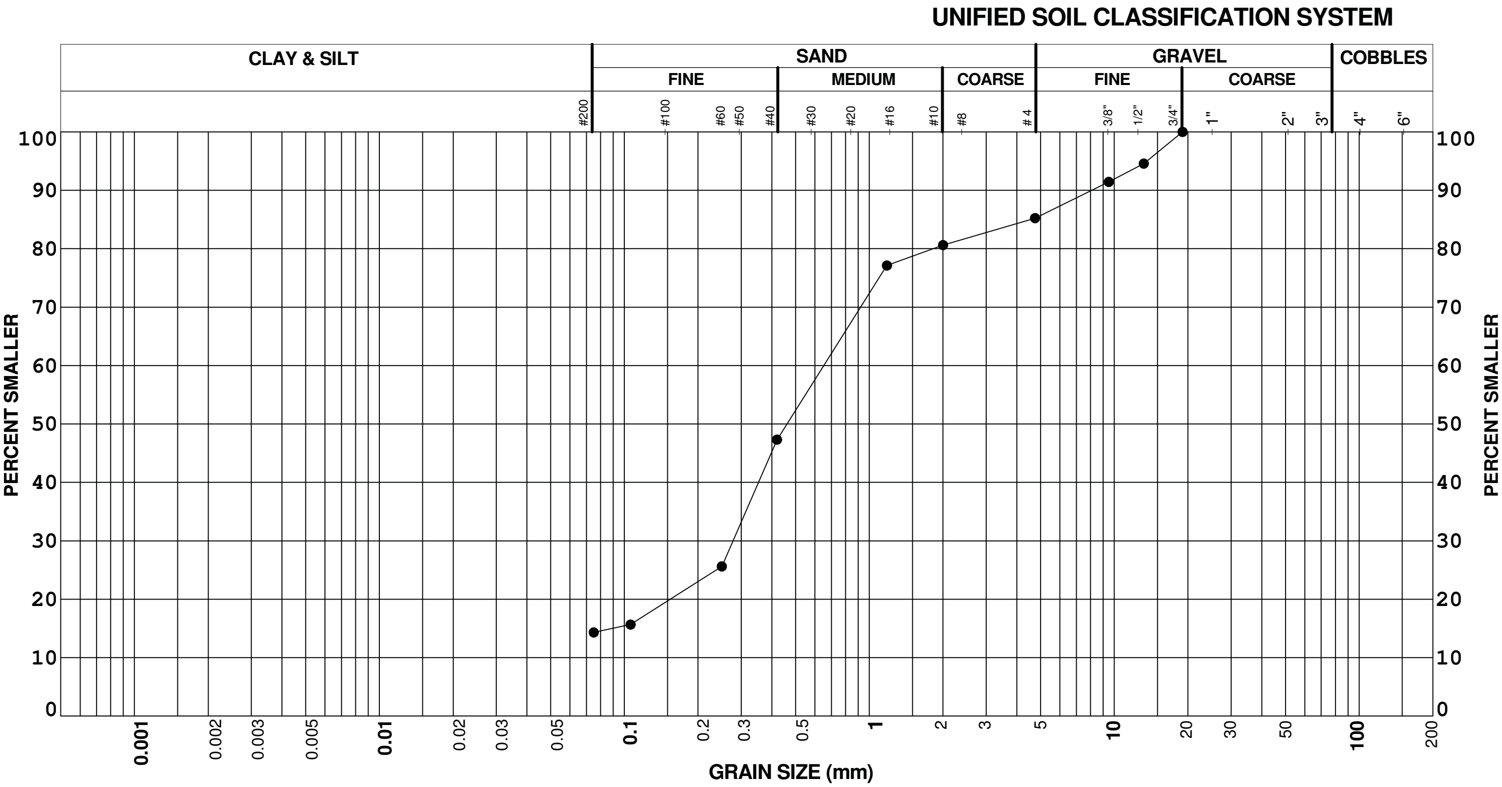
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



REMARKS:

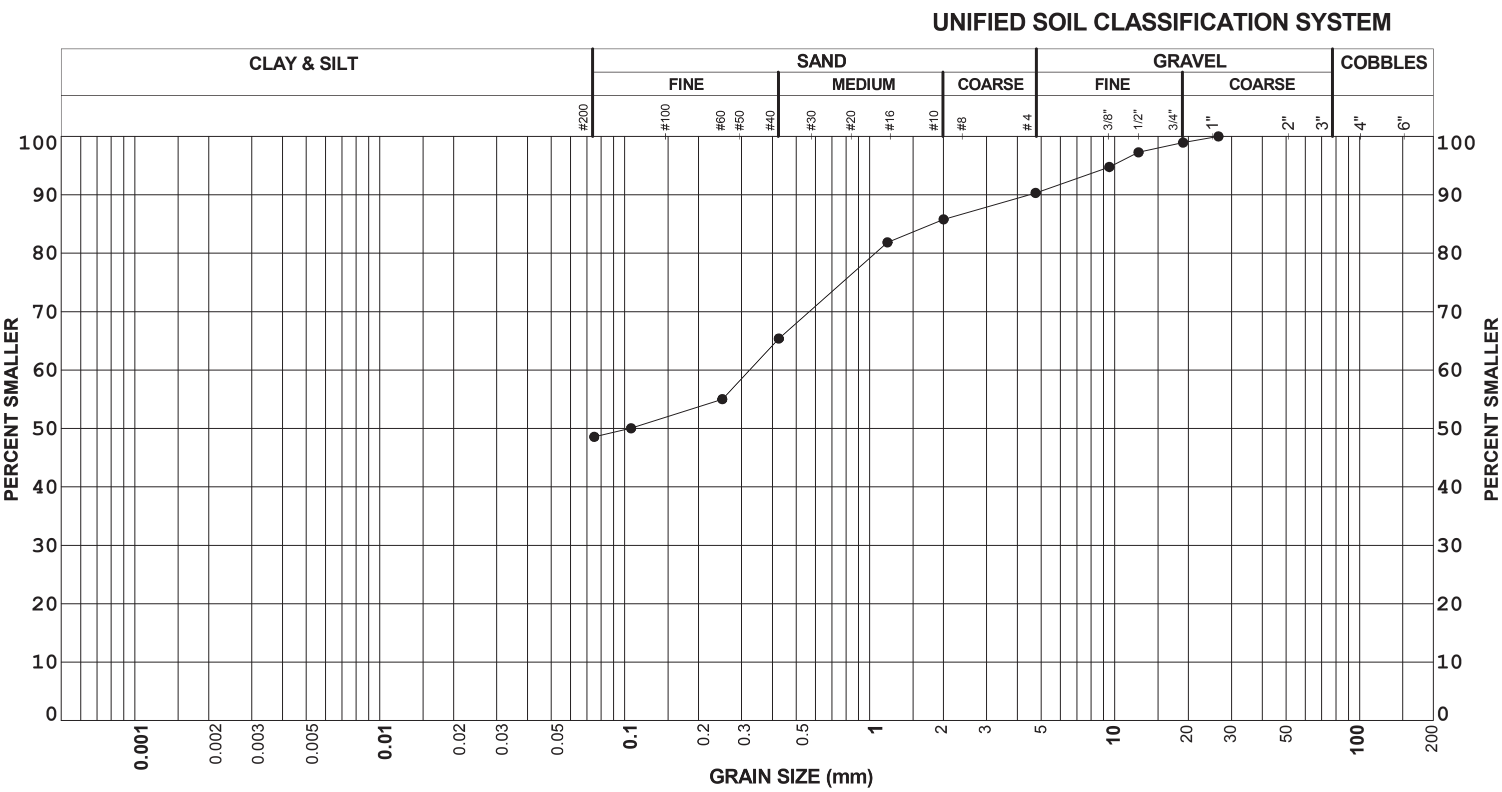
BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH16-M015	BS3	3.90	15	71	14		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-10	DS1	0.90	10	42	49		

REMARKS:

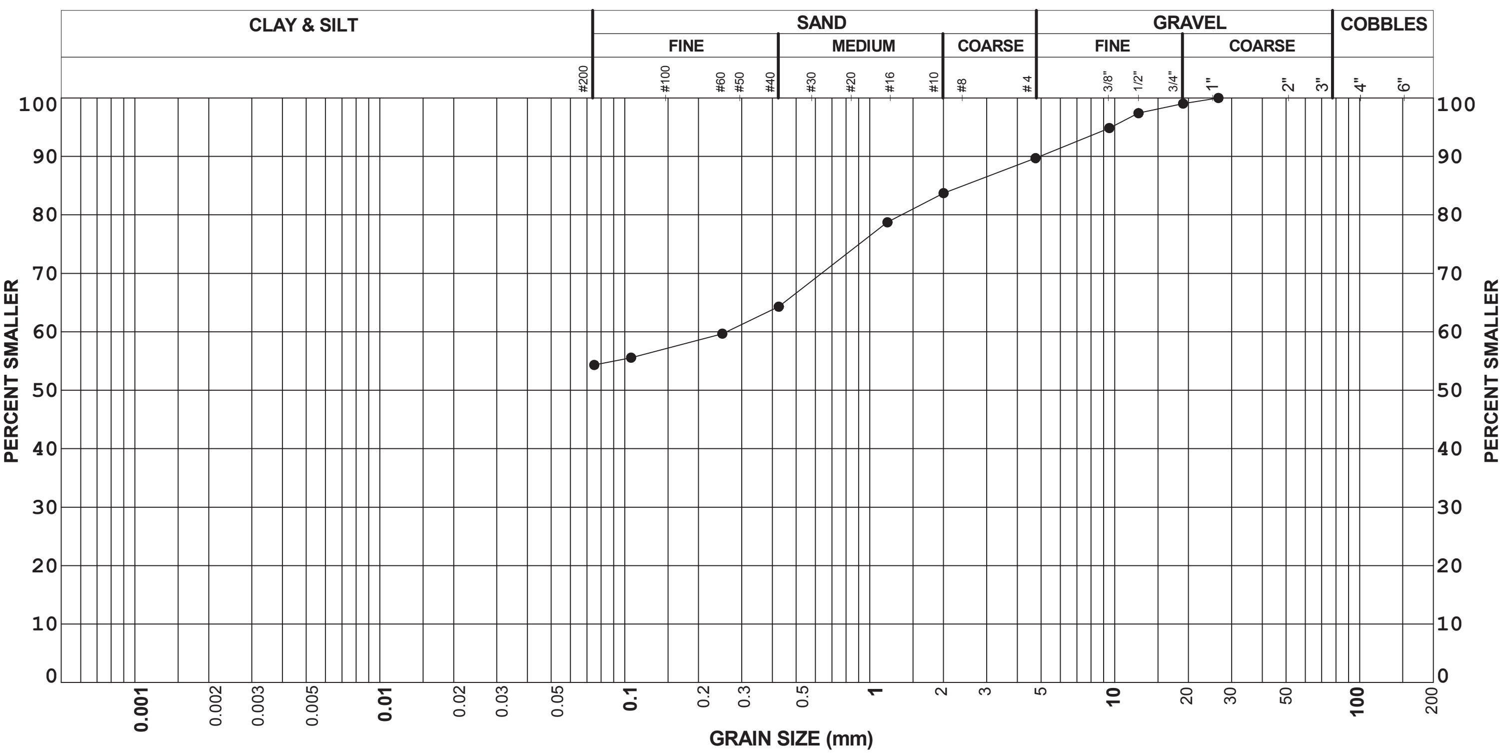
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-10	DS2	5.00	10	35	54		

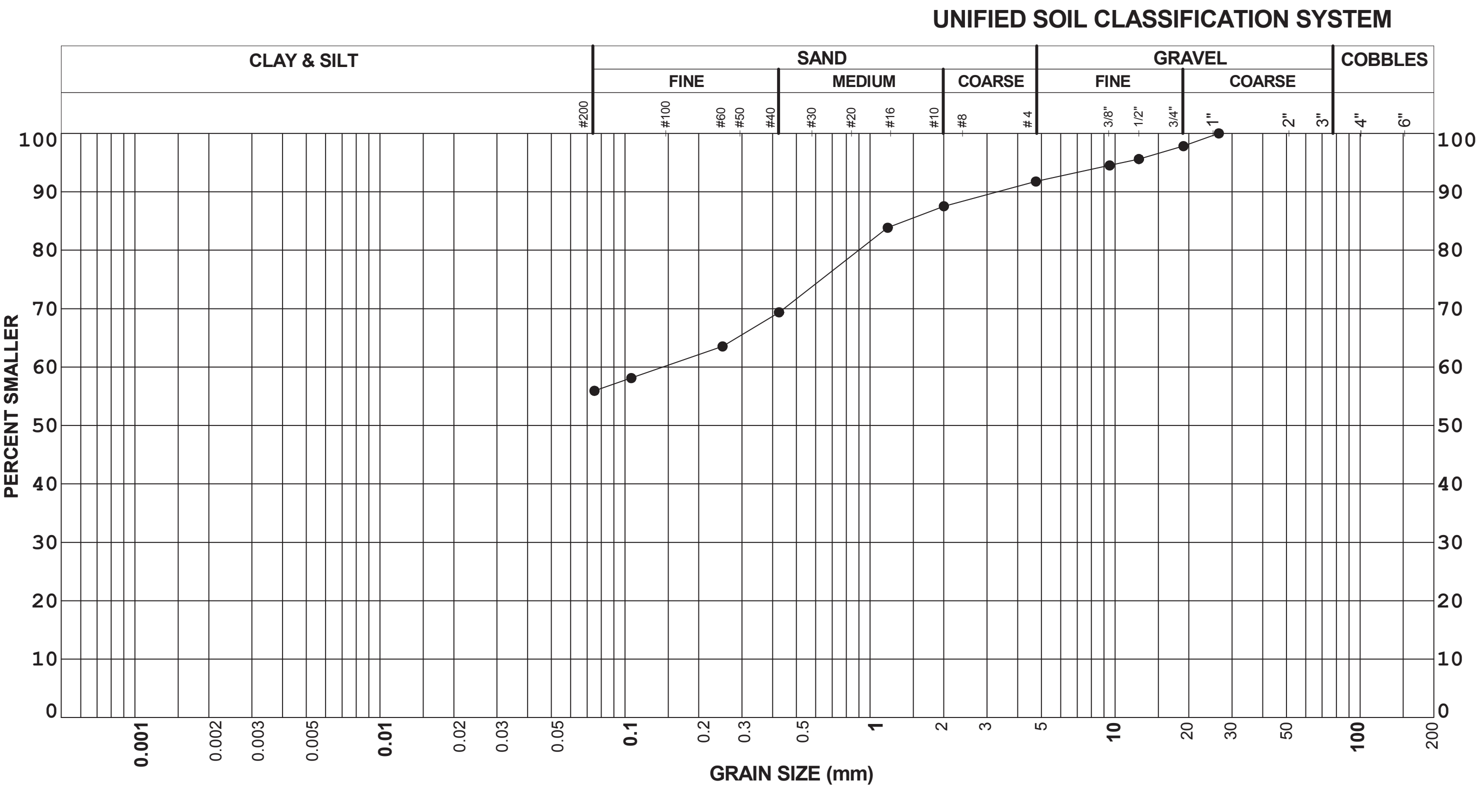
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-10	DS3	7.62	8	36	56		

REMARKS:

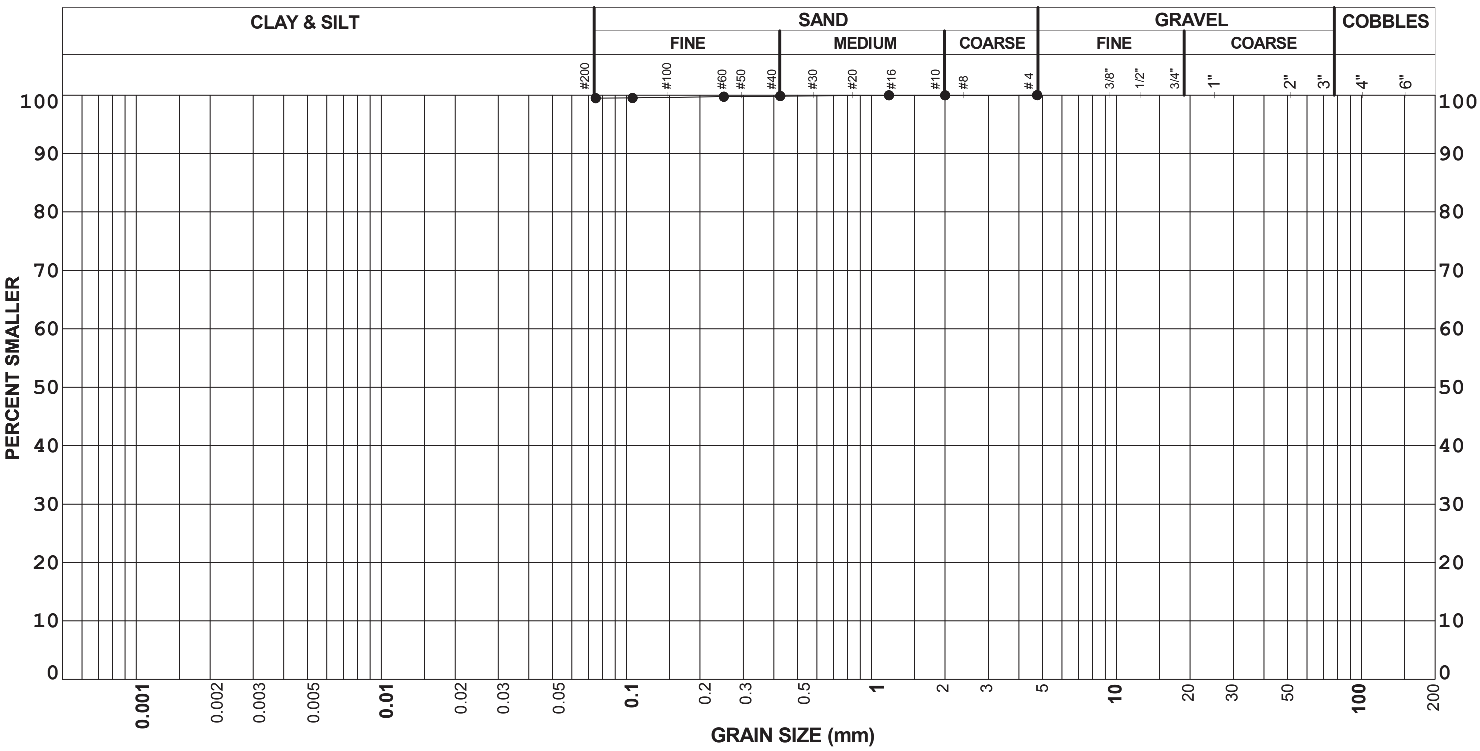
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-10	DS4	8.70	0	1	99		

REMARKS:

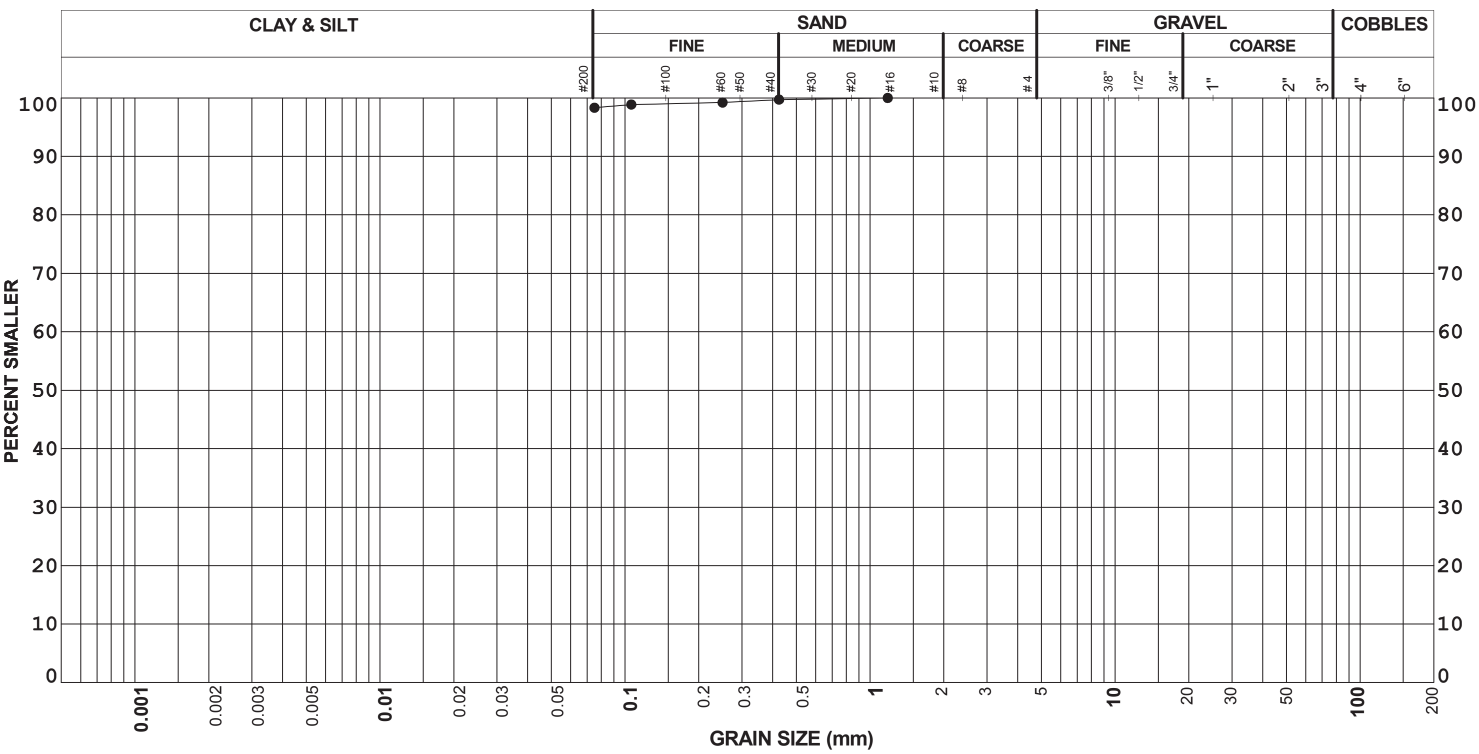
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-10	DS5	11.40	0	2	98		

REMARKS:

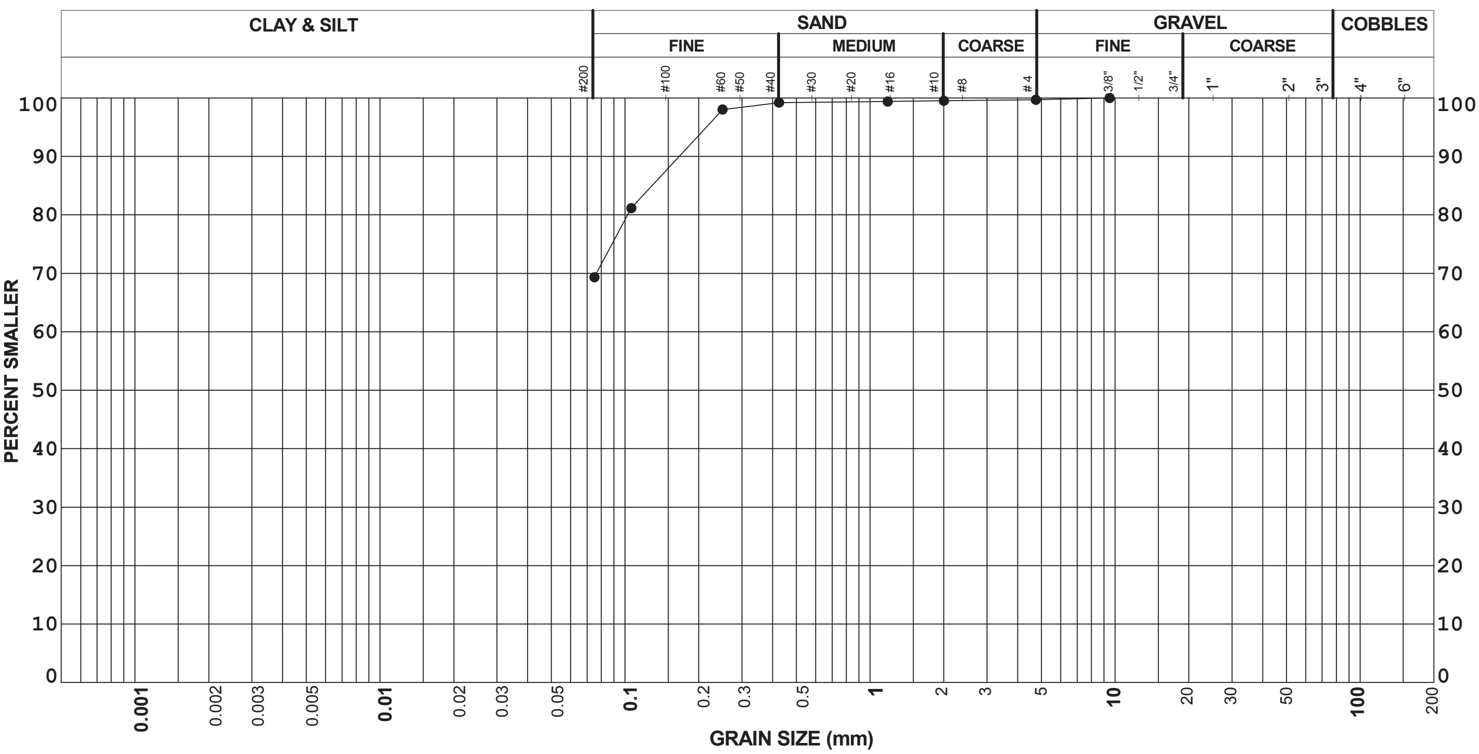
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-10	DS6	12.50	0	30	69		

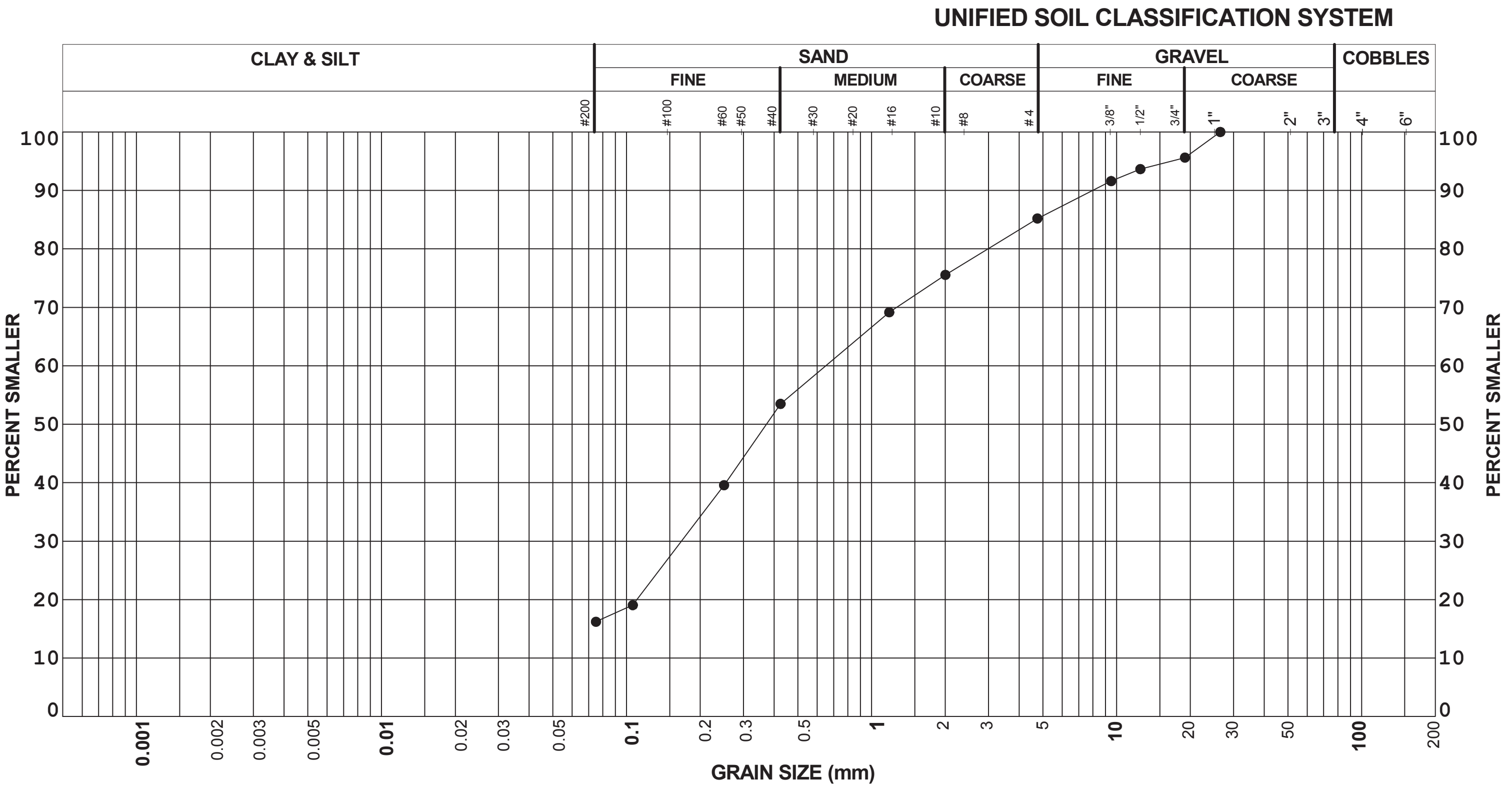
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-10	DS7	14.30	15	69	16		

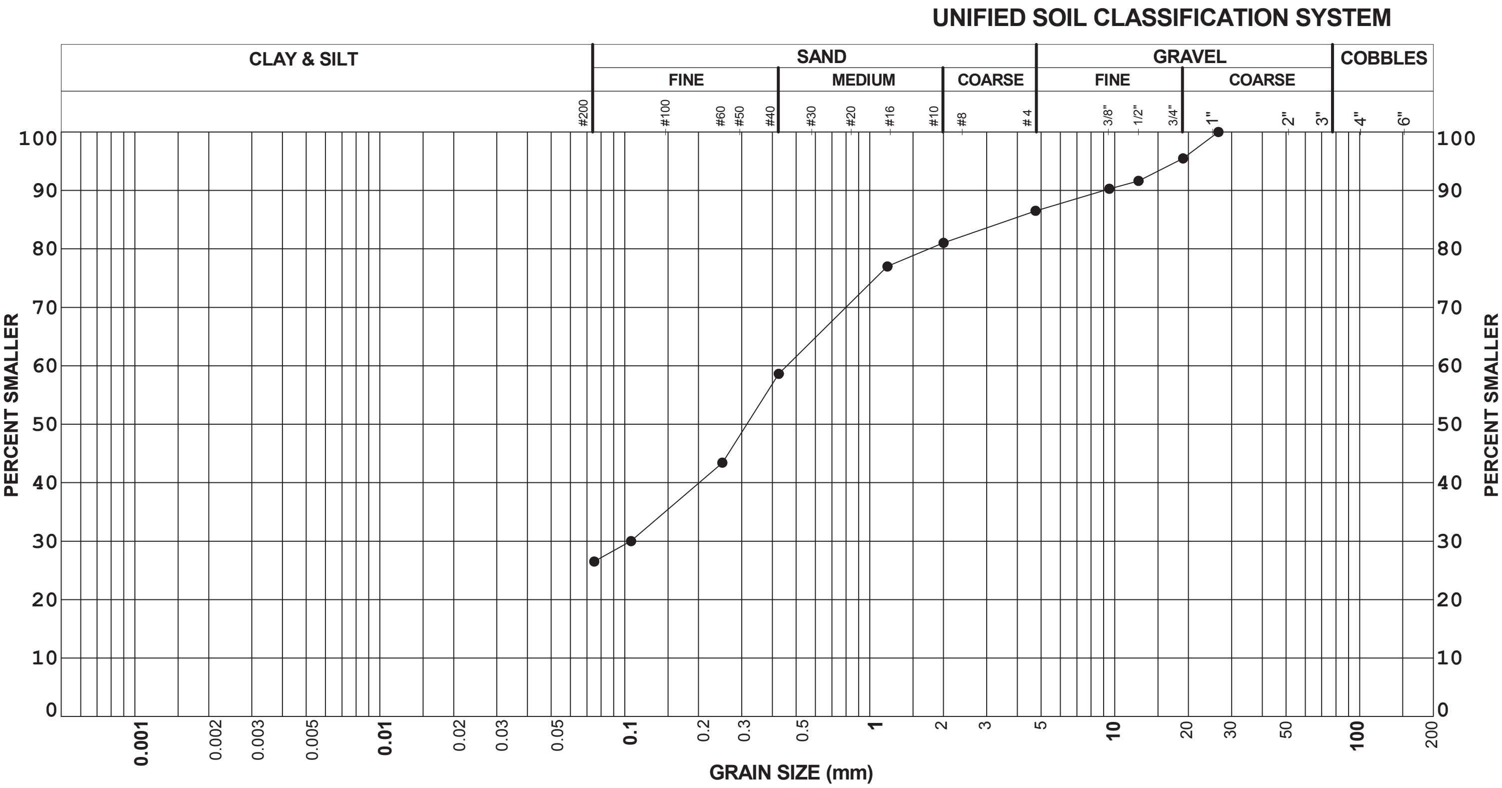
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-10	DS8	16.20	13	60	27		

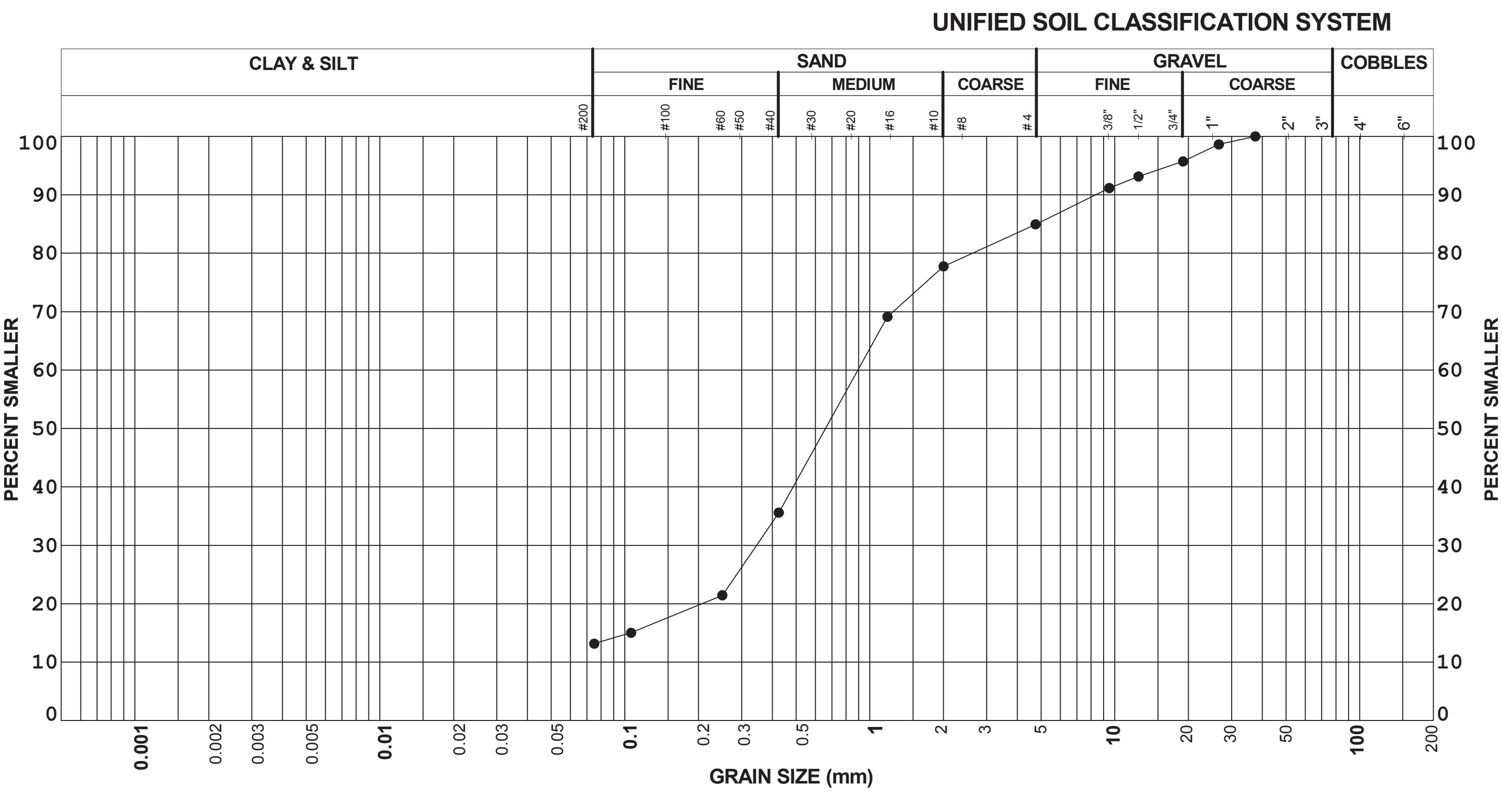
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS1	0.90	15	72	13		

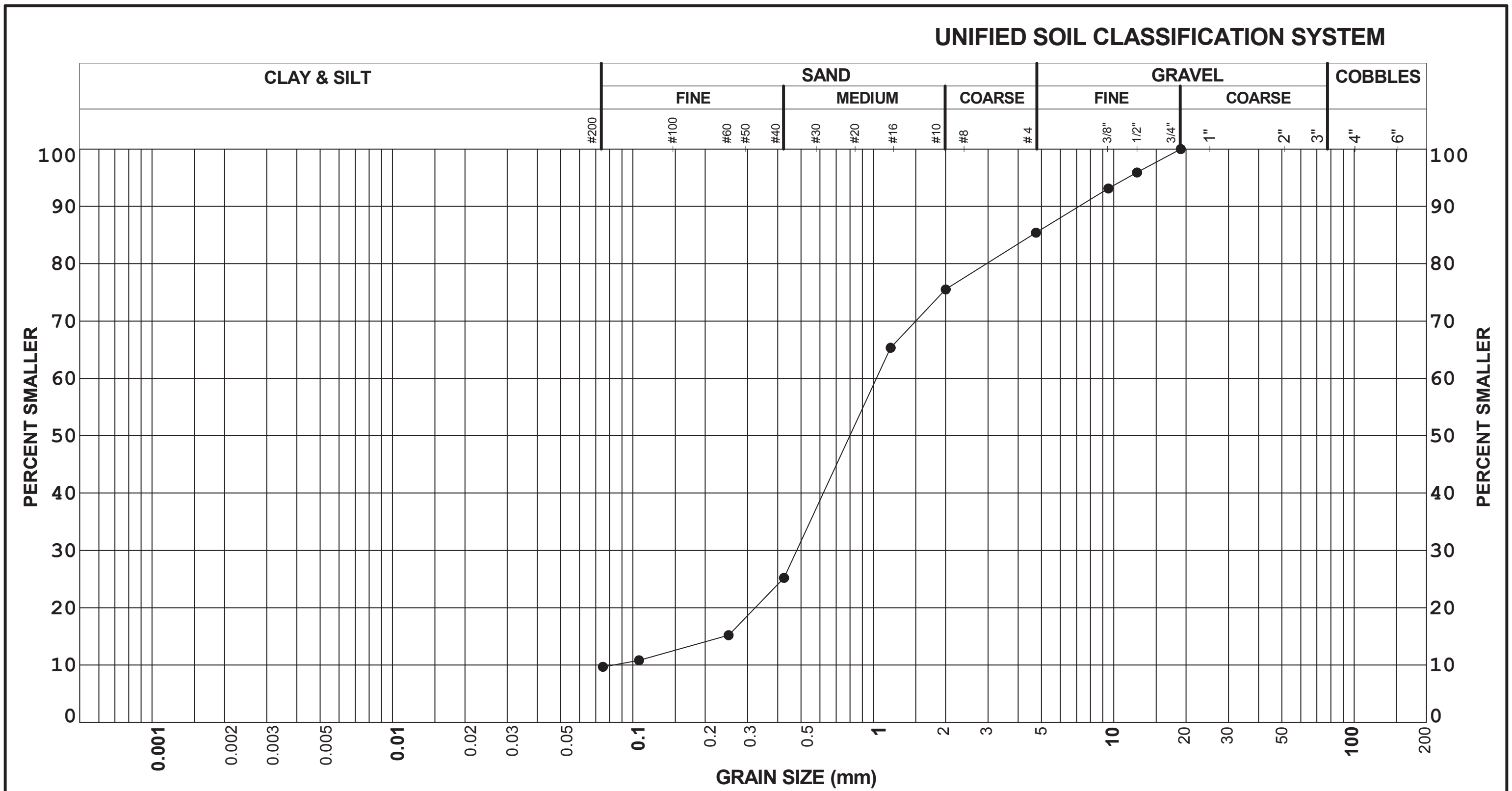
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-EBC-8	DS2	3.50	15	76	10		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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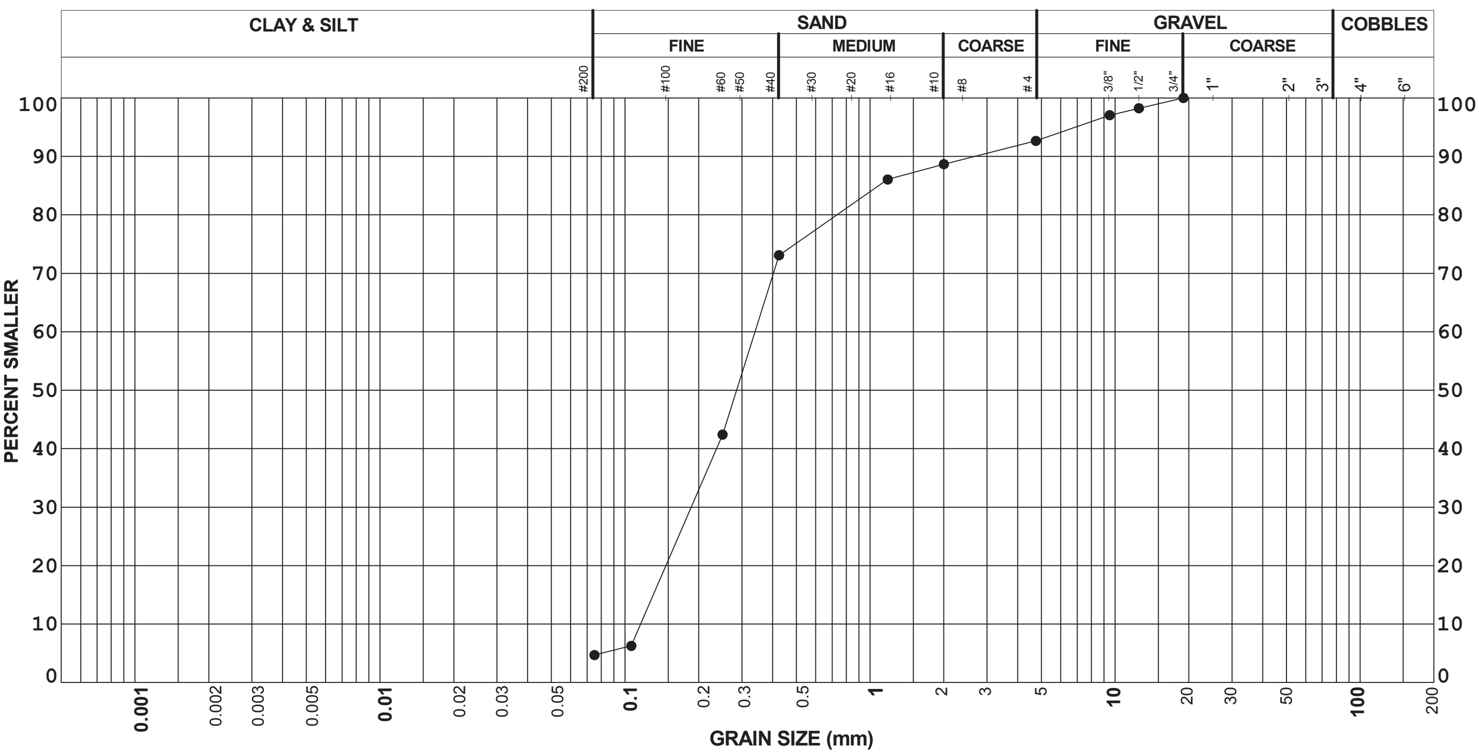
Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ3	5.00	7	88	5		

REMARKS:

GRAIN SIZE DISTRIBUTION

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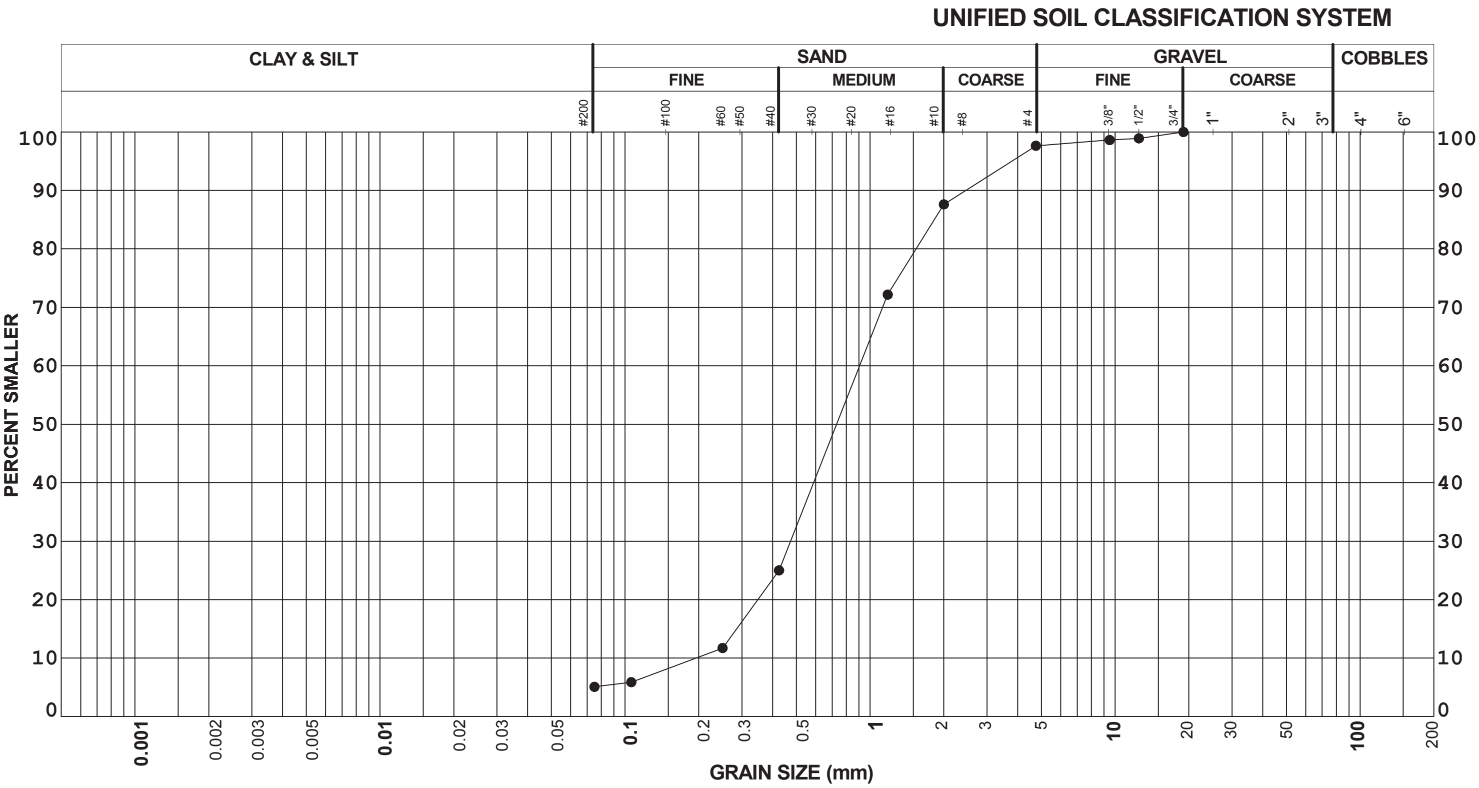

REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS4	6.30	2	93	5		

GRAIN SIZE DISTRIBUTION

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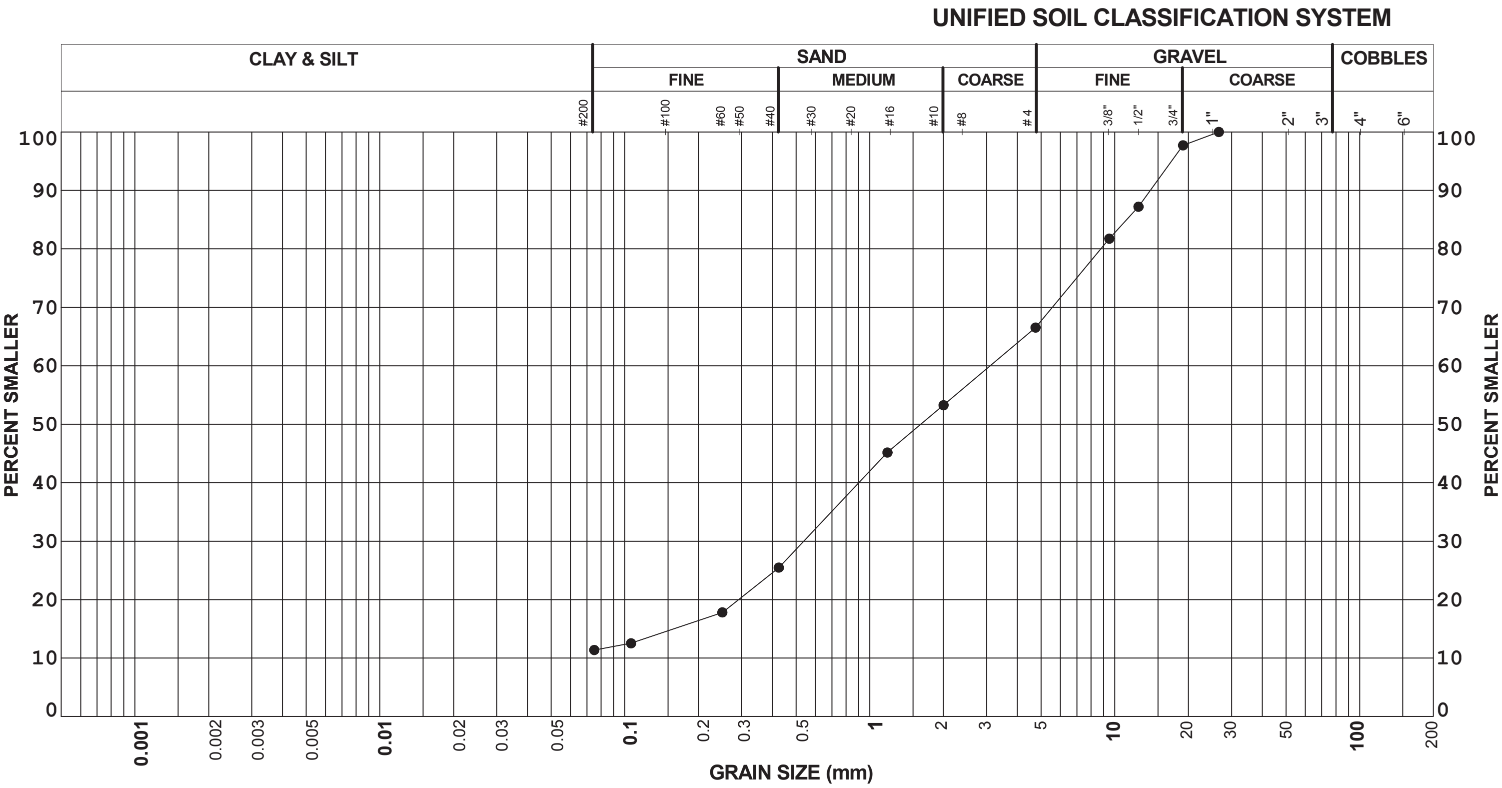

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS5	7.60	33	55	11		

REMARKS:

GRAIN SIZE DISTRIBUTION

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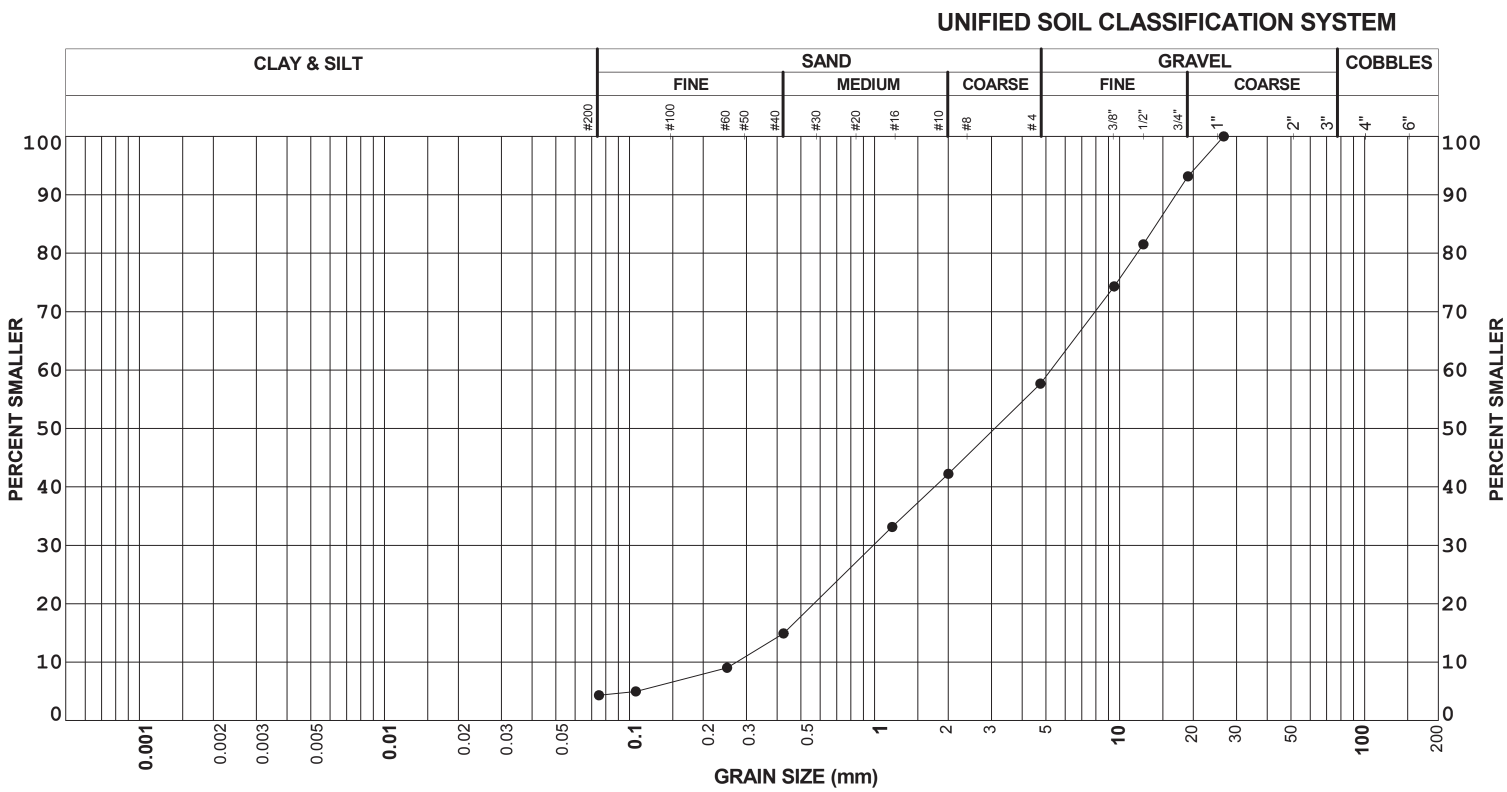
Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS6	9.30	42	53	4		

GRAIN SIZE DISTRIBUTION

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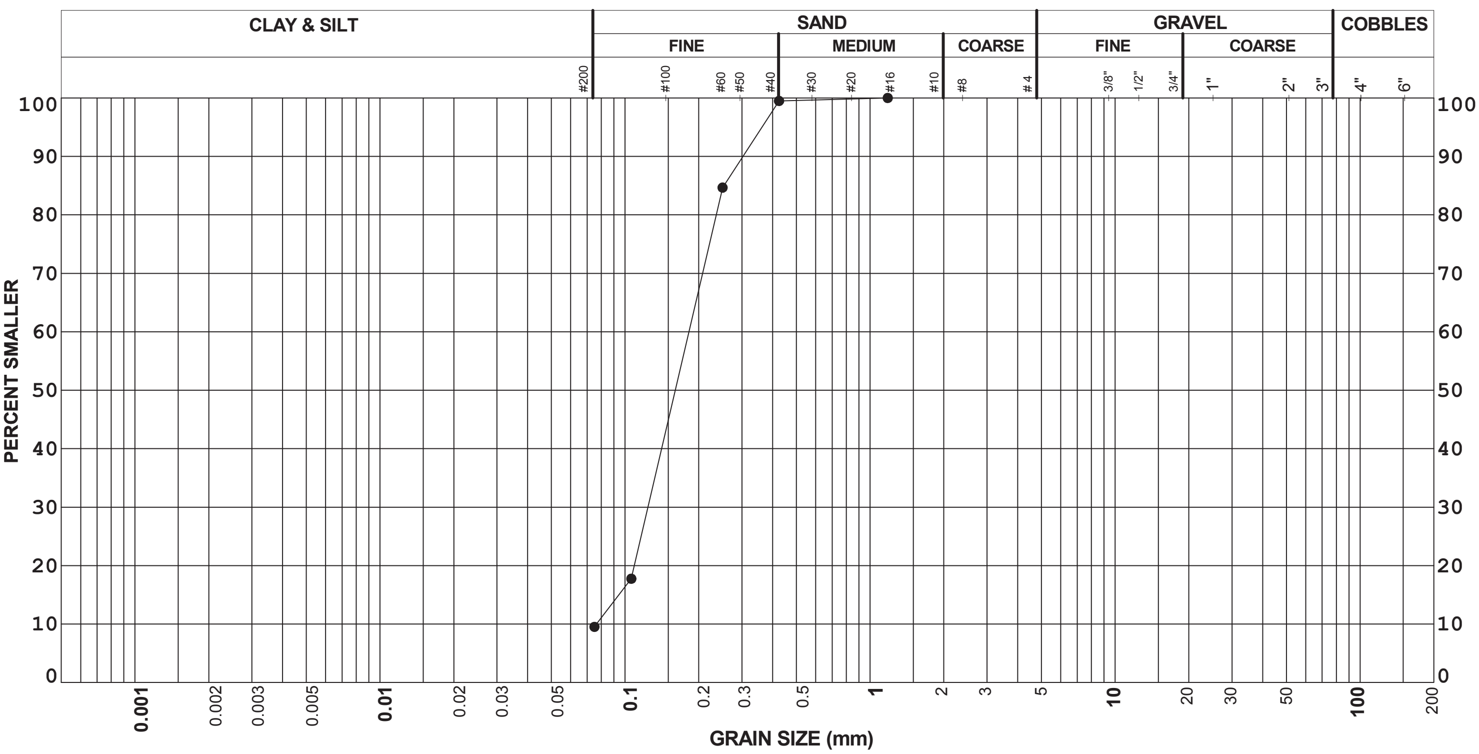
UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-EBC-8	DQ7	12.00	0	90	10		

GRAIN SIZE DISTRIBUTION

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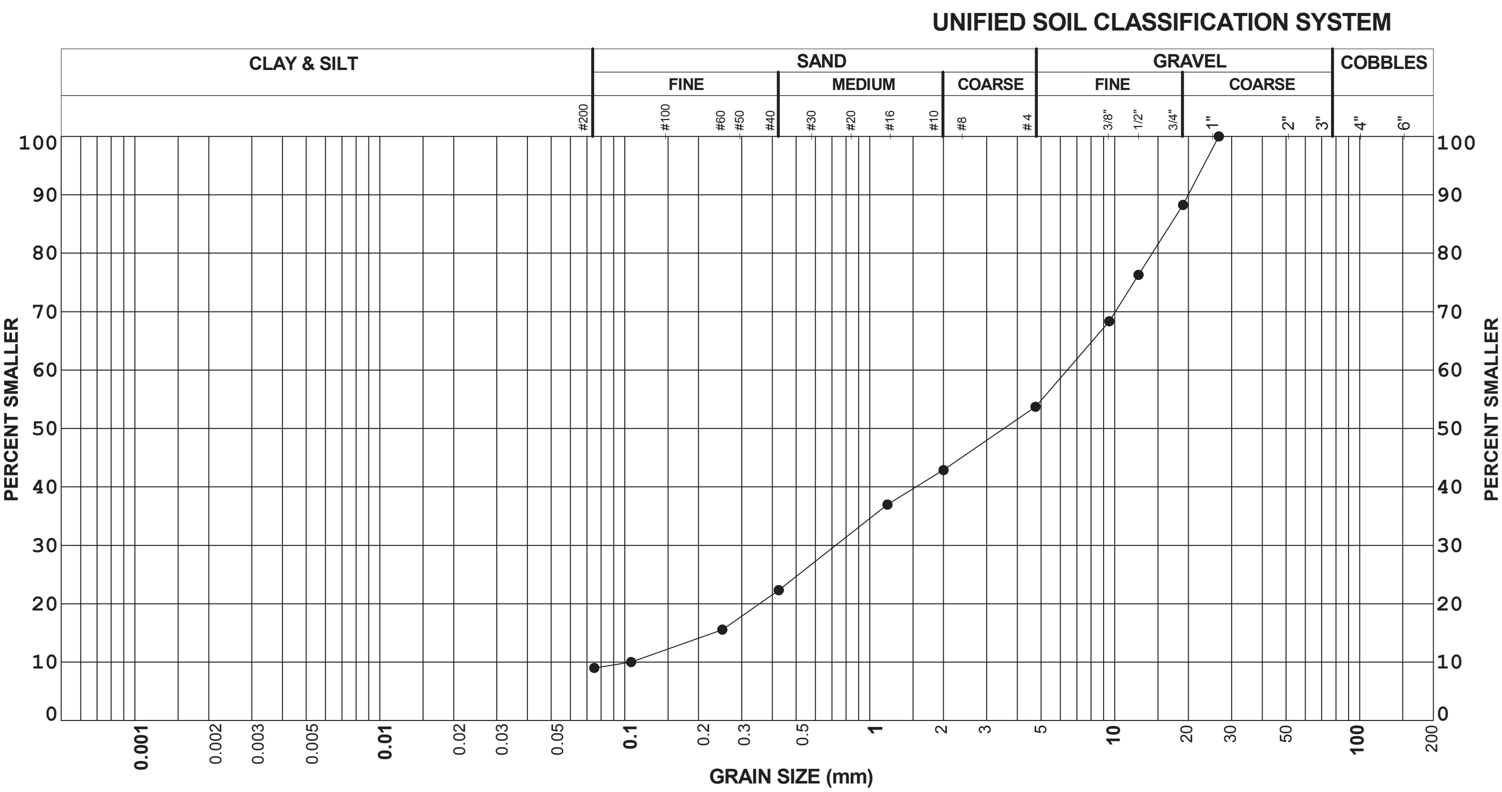

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS8	12.20	46	45	9		

REMARKS:

GRAIN SIZE DISTRIBUTION

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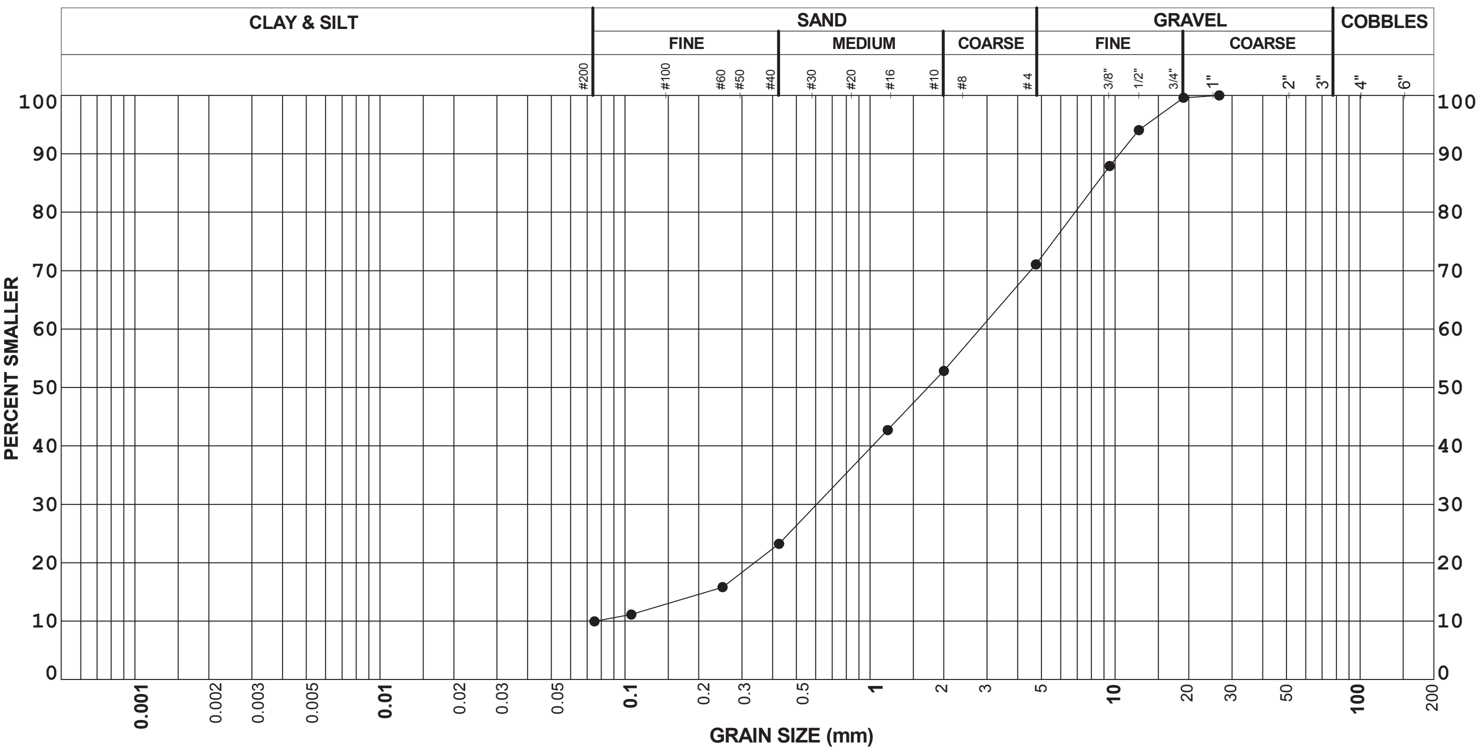
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS9	15.00	29	61	10		

REMARKS:

GRAIN SIZE DISTRIBUTION

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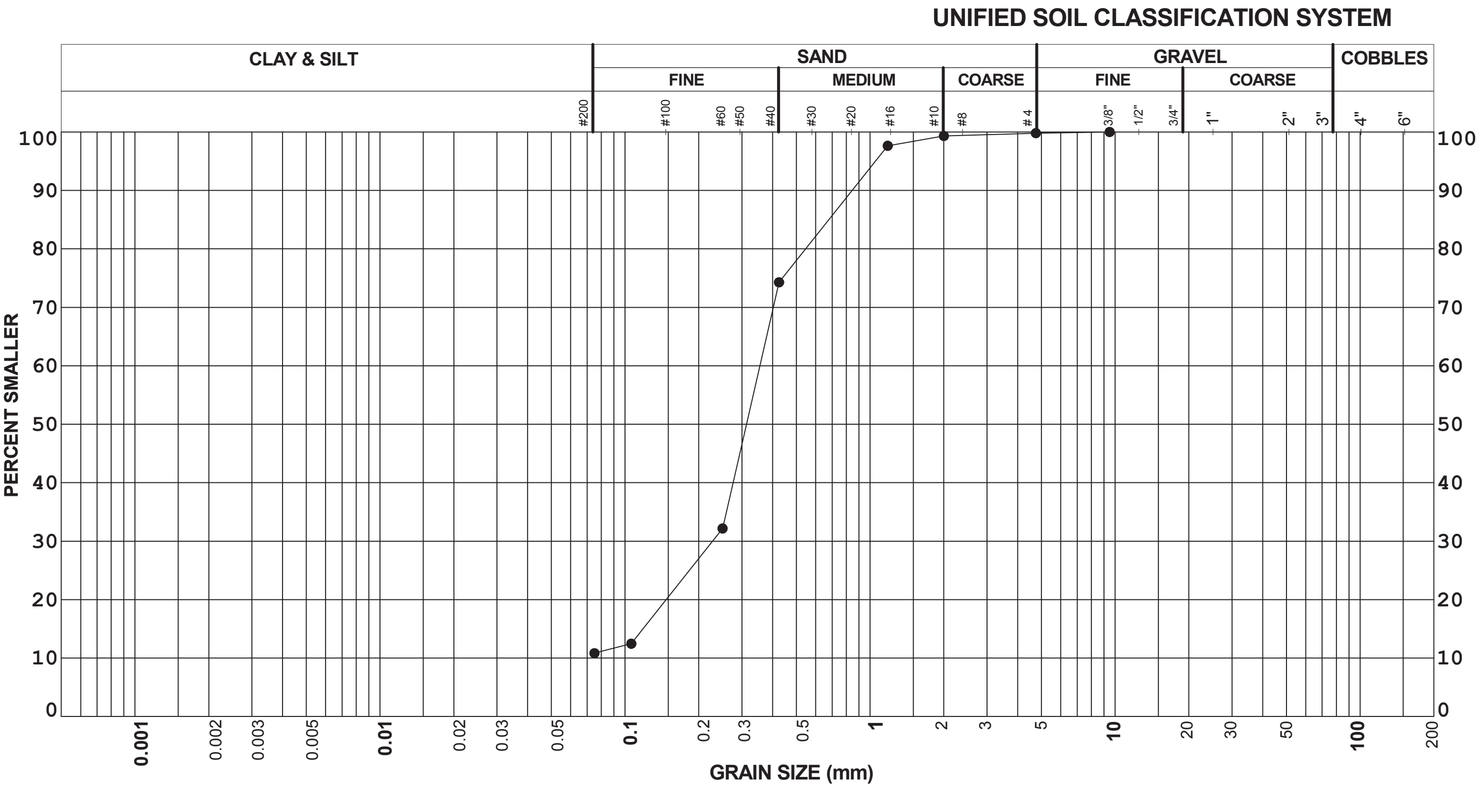
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS10	17.50	0	89	11		

REMARKS:

GRAIN SIZE DISTRIBUTION

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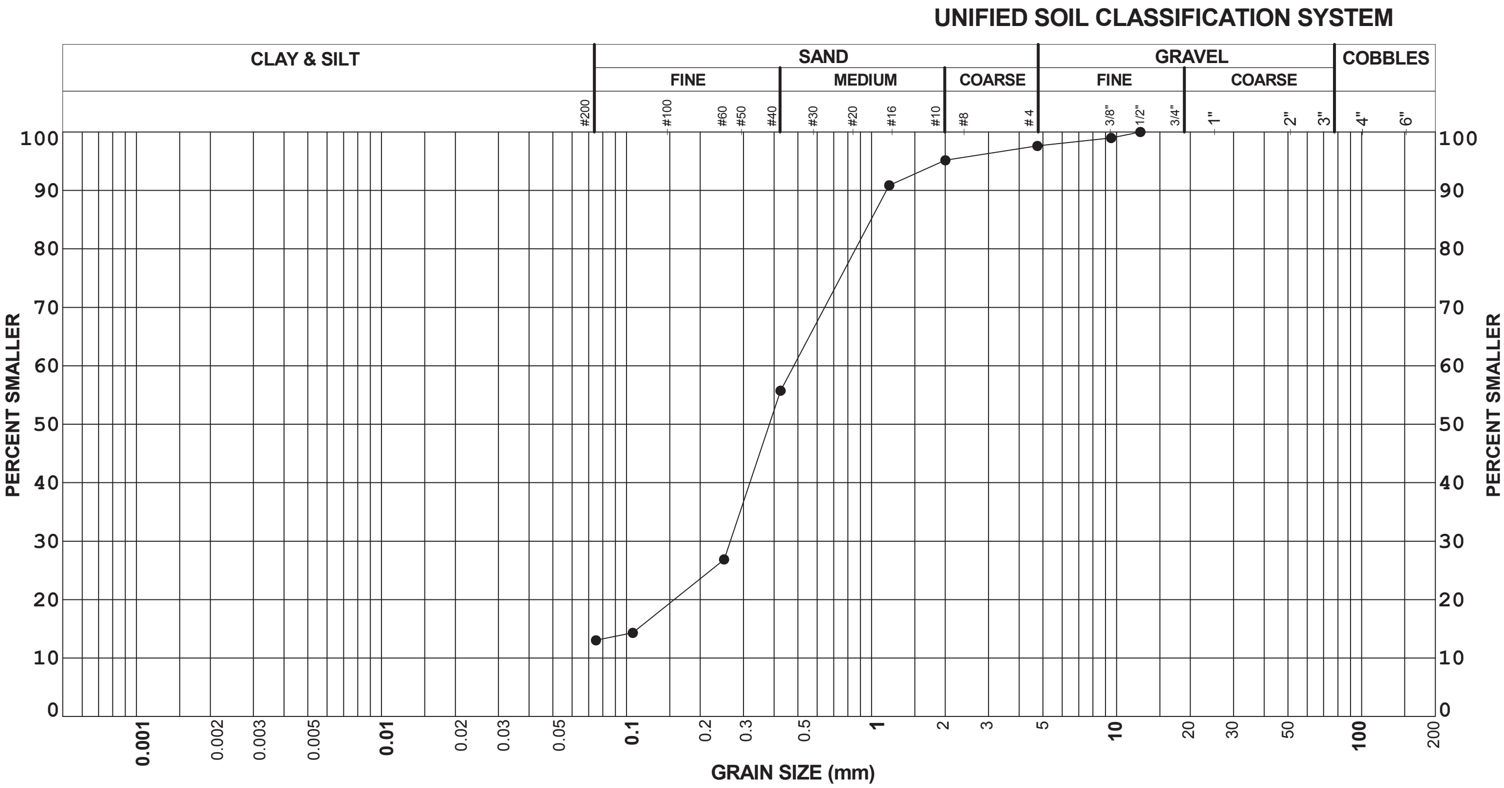

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ11	18.00	2	85	13		

REMARKS:

GRAIN SIZE DISTRIBUTION

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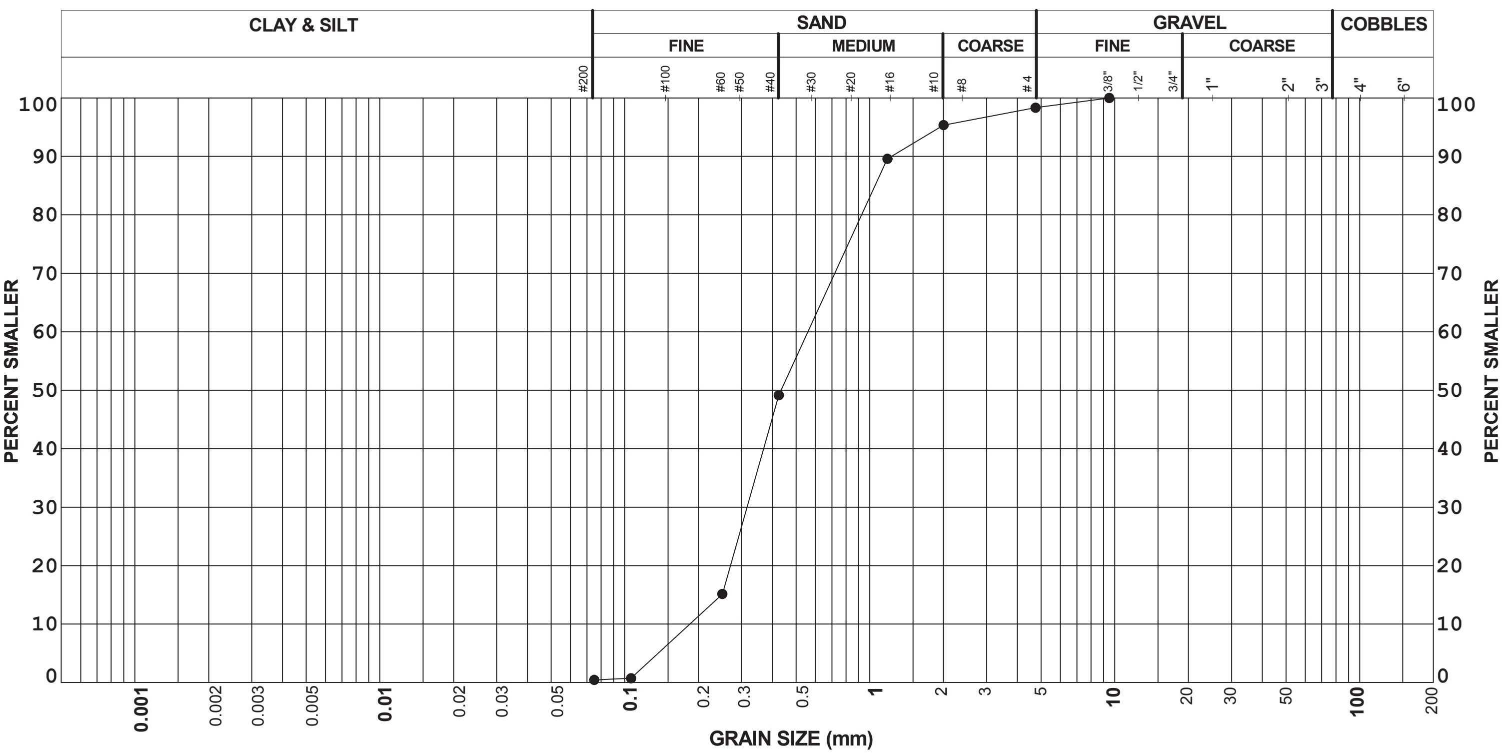
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ12	20.51	2	98	0		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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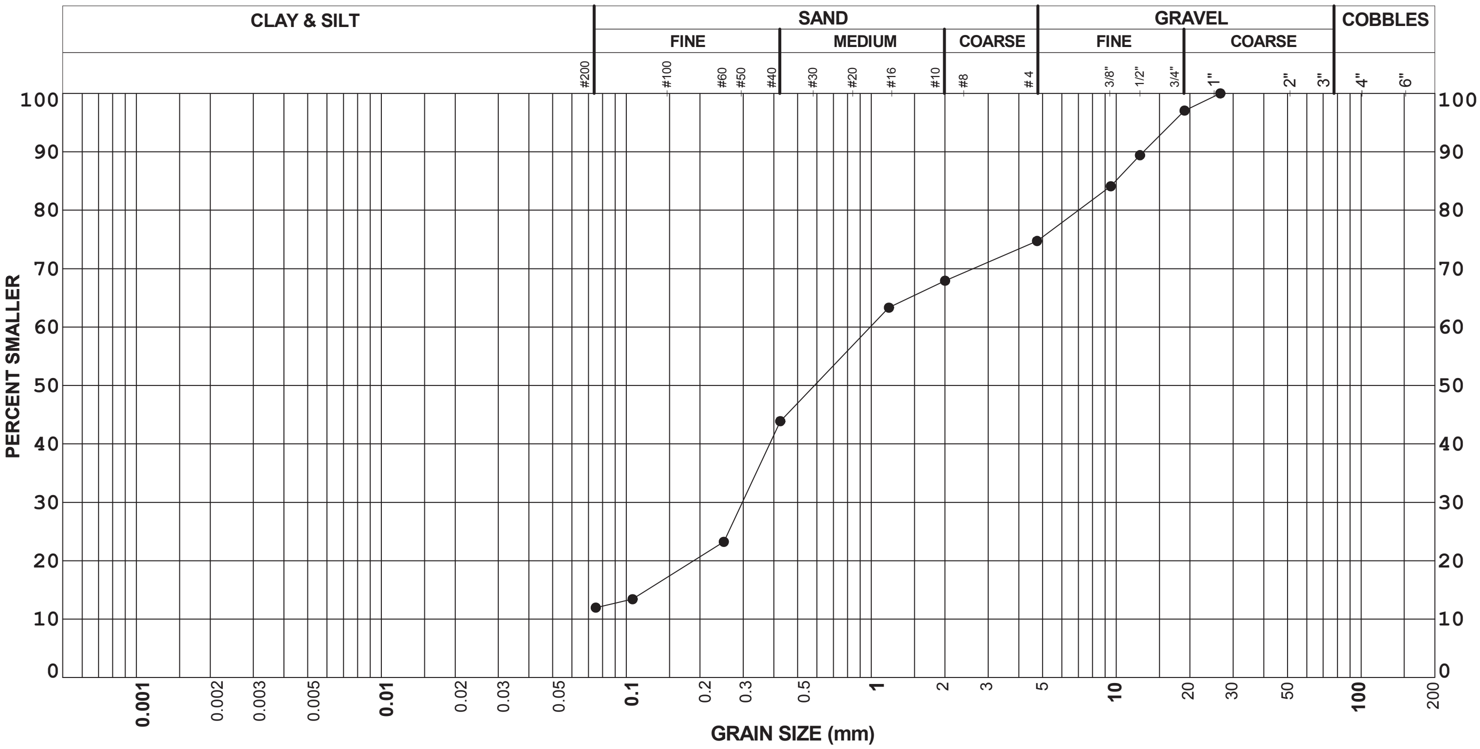
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS13	23.60	25	63	12		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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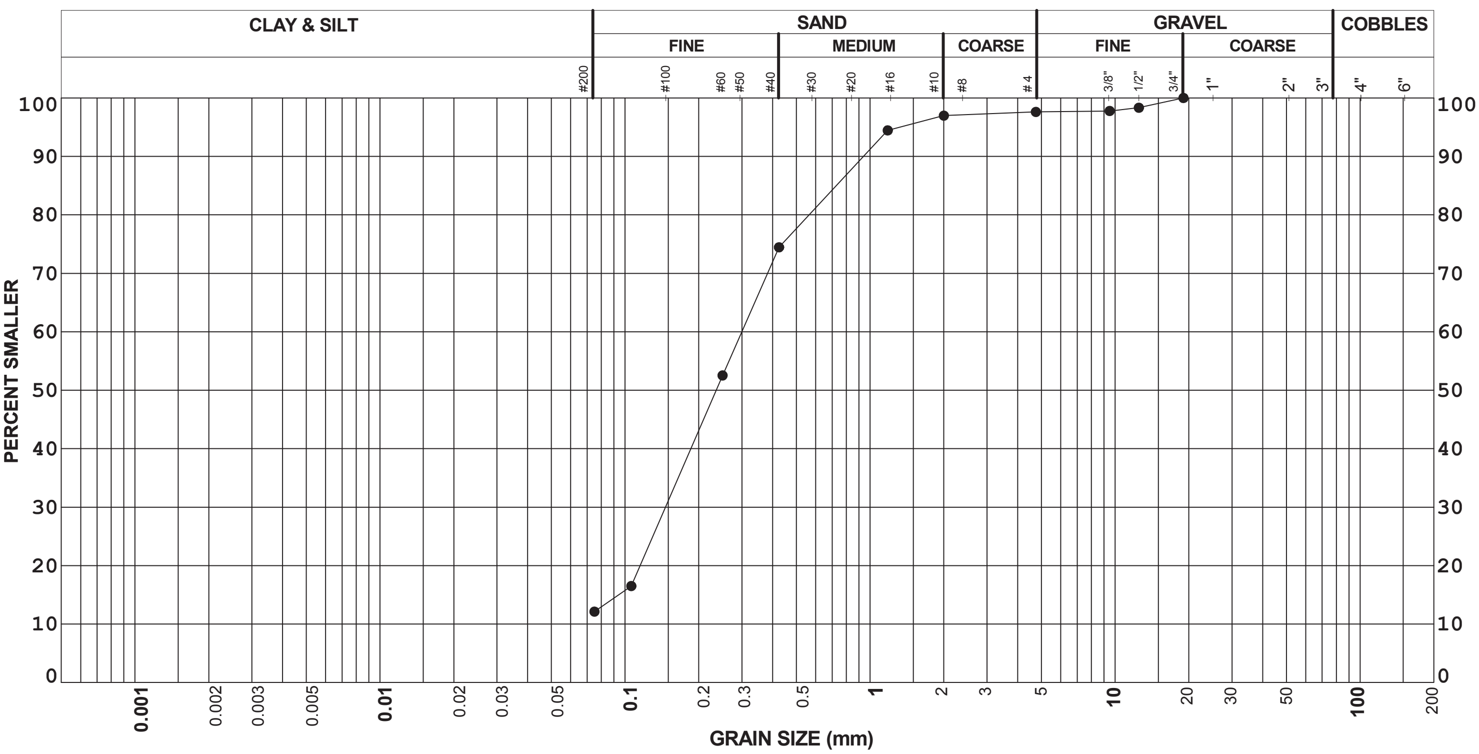
UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS14	26.60	2	86	12		

GRAIN SIZE DISTRIBUTION

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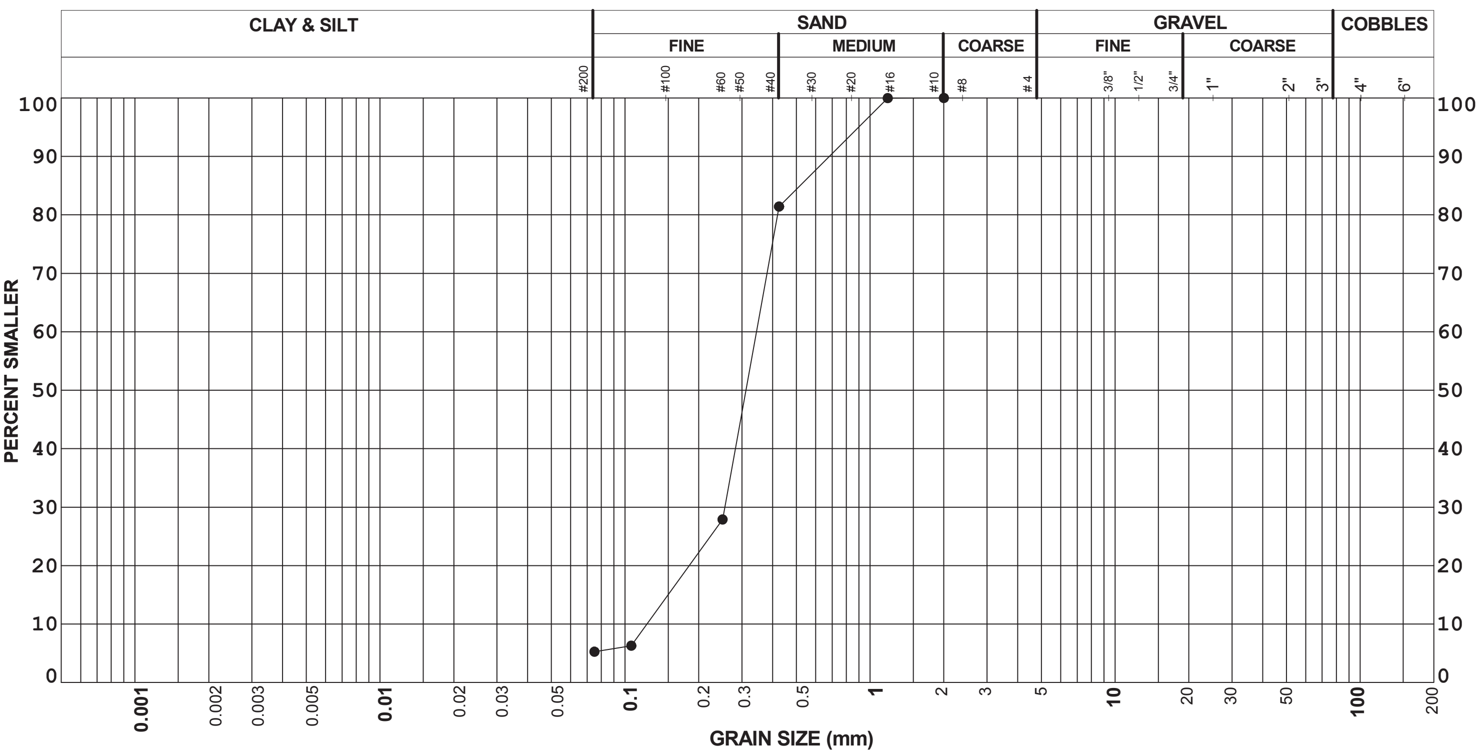
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ15	29.80	0	95	5		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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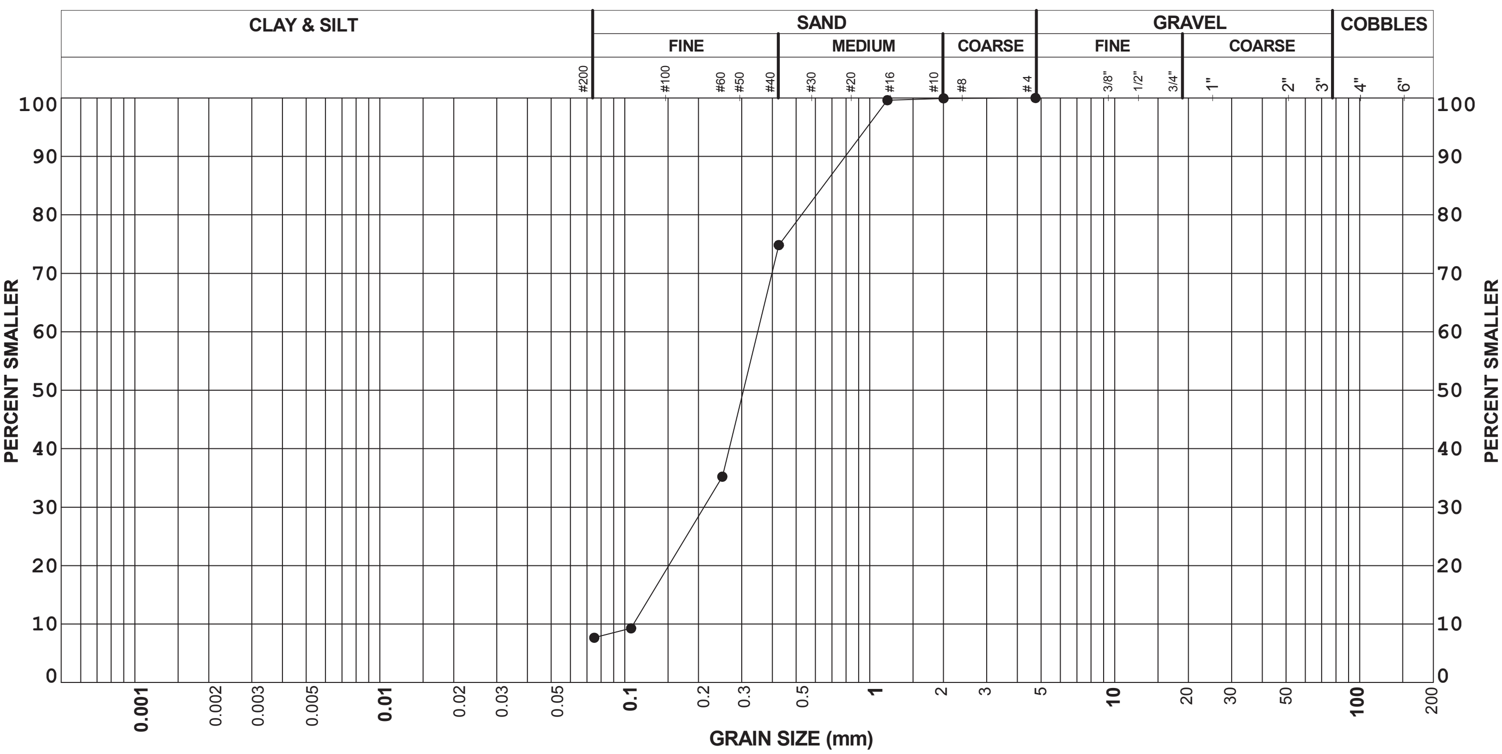
Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ16	32.90	0	92	8		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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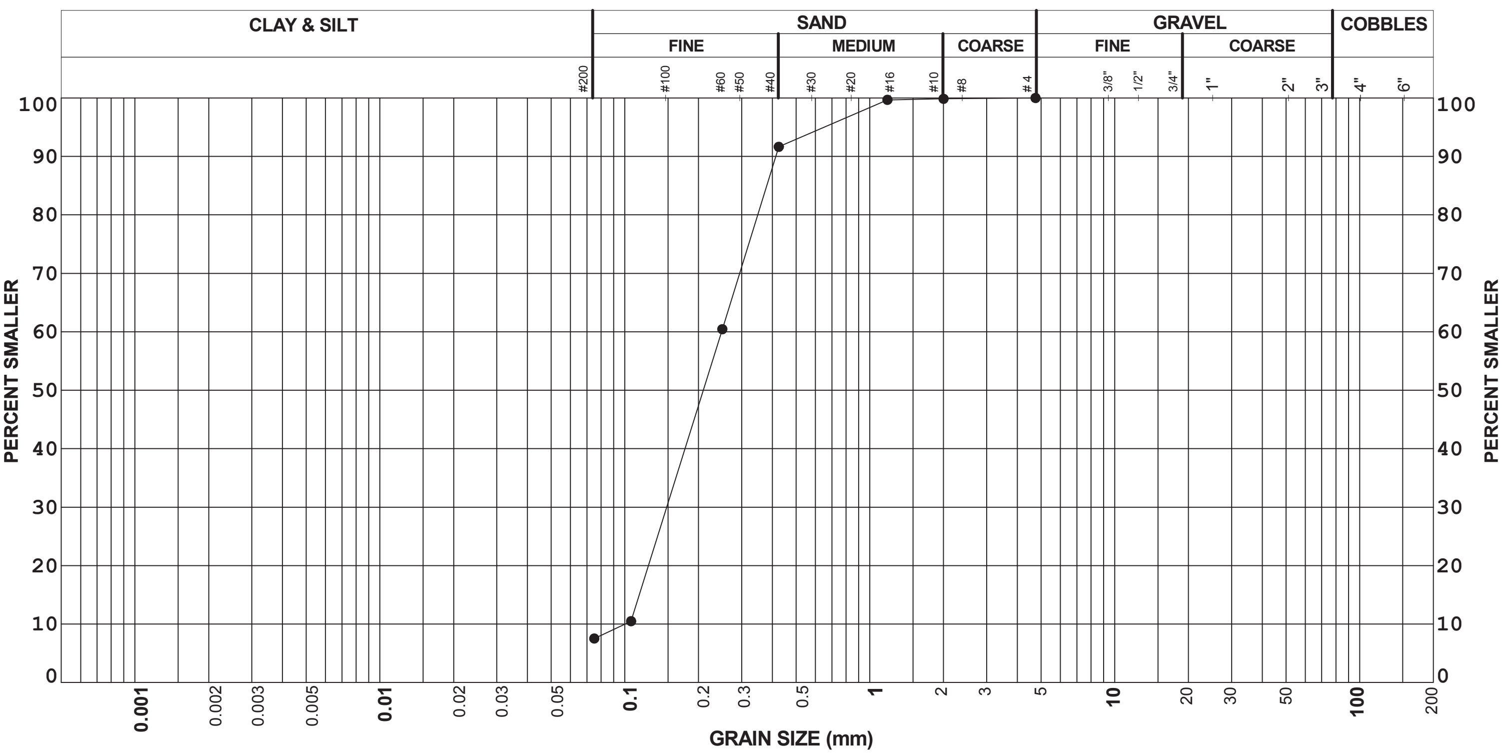
UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ17	37.40	0	92	8		

GRAIN SIZE DISTRIBUTION

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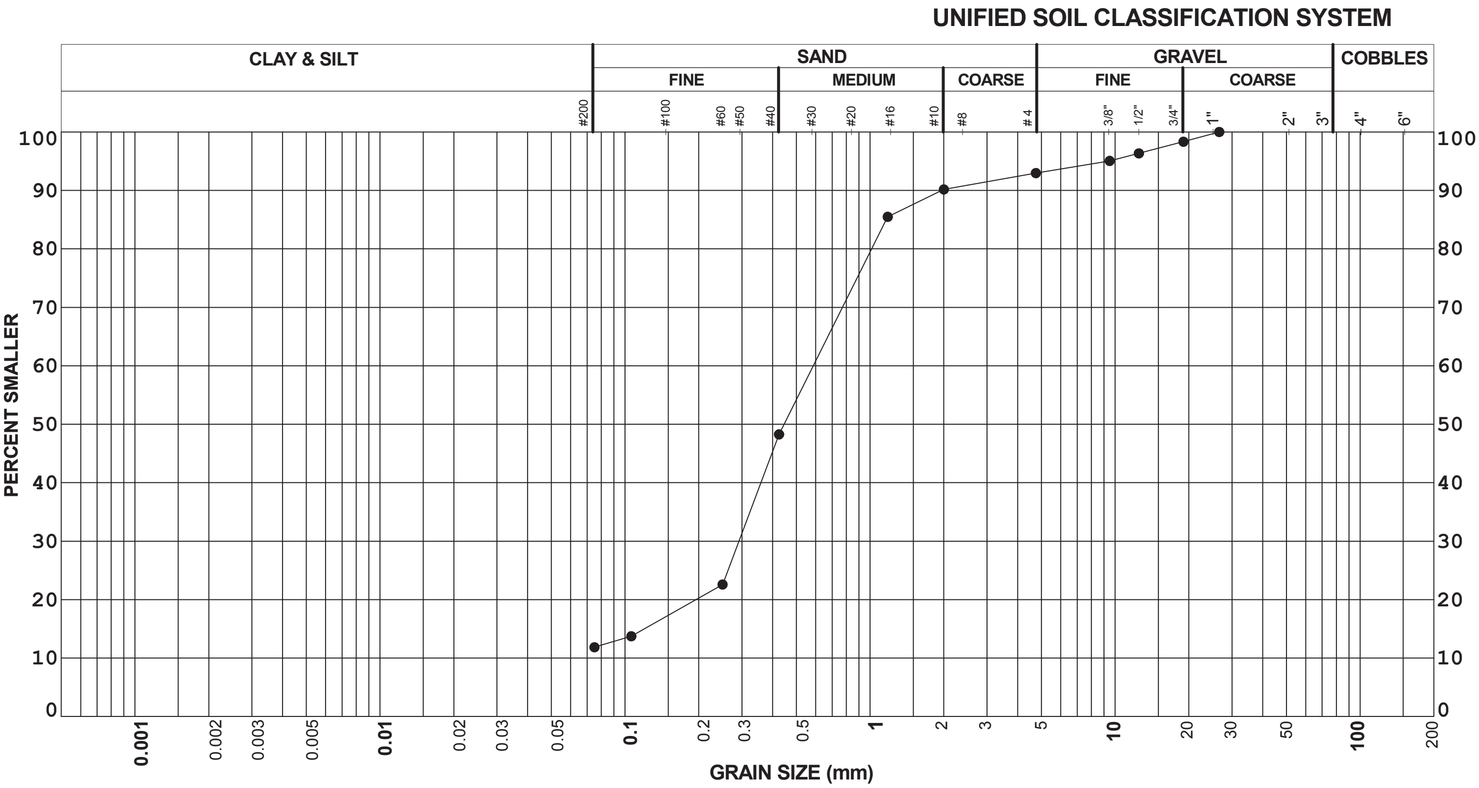

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DS18	39.30	7	81	12		

REMARKS:

GRAIN SIZE DISTRIBUTION

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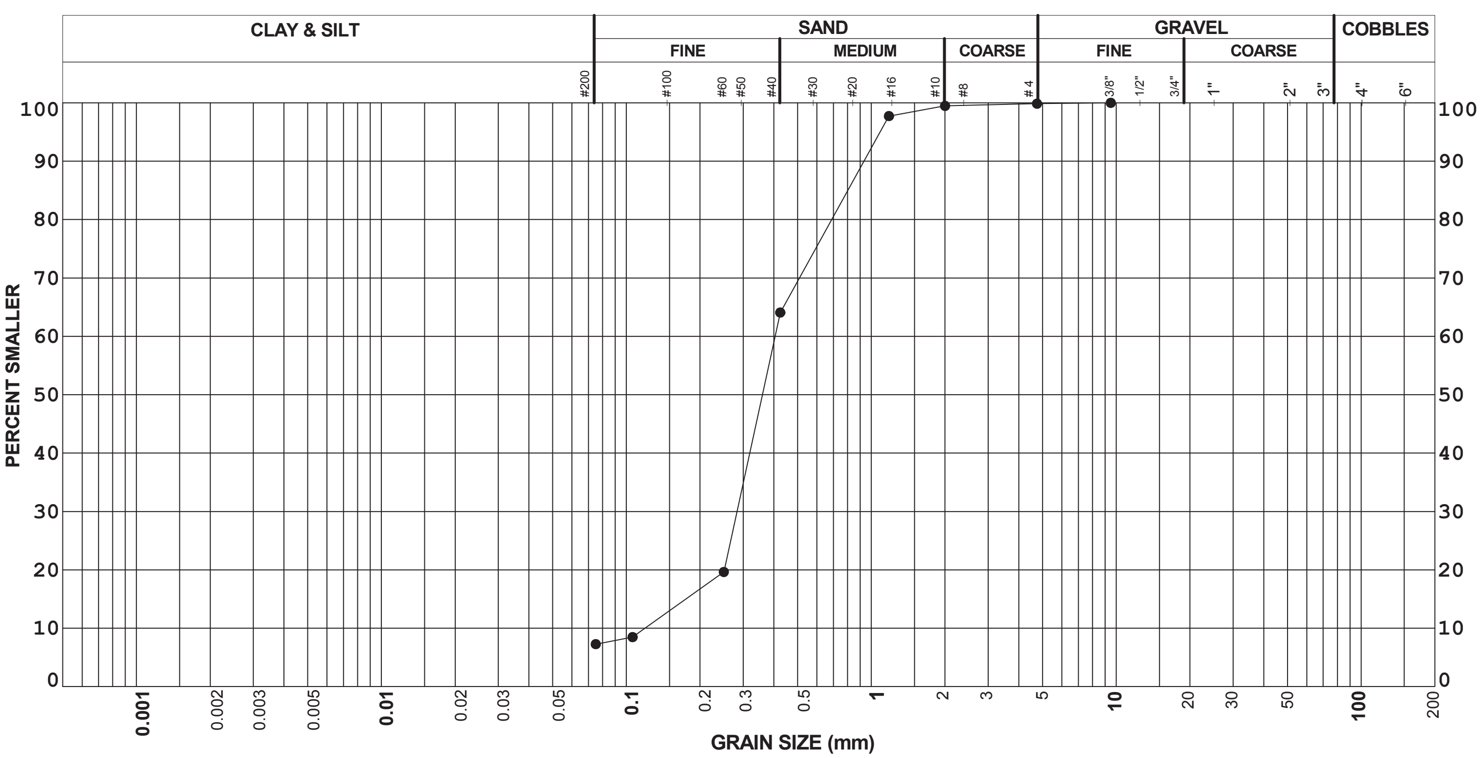
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-8	DQ19	39.40	0	93	7		

REMARKS:

GRAIN SIZE DISTRIBUTION

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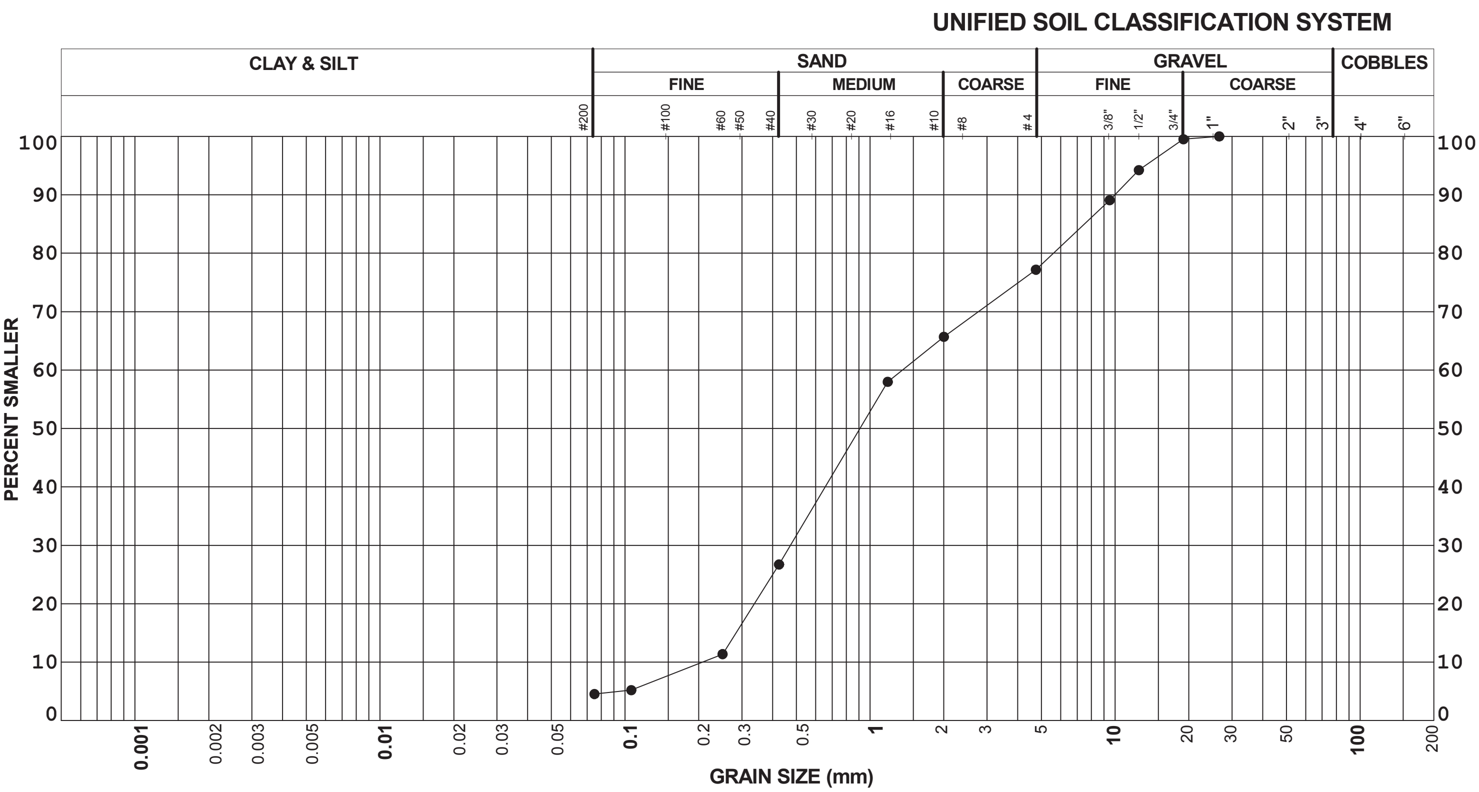
Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DS1	3.05	23	73	5		

GRAIN SIZE DISTRIBUTION

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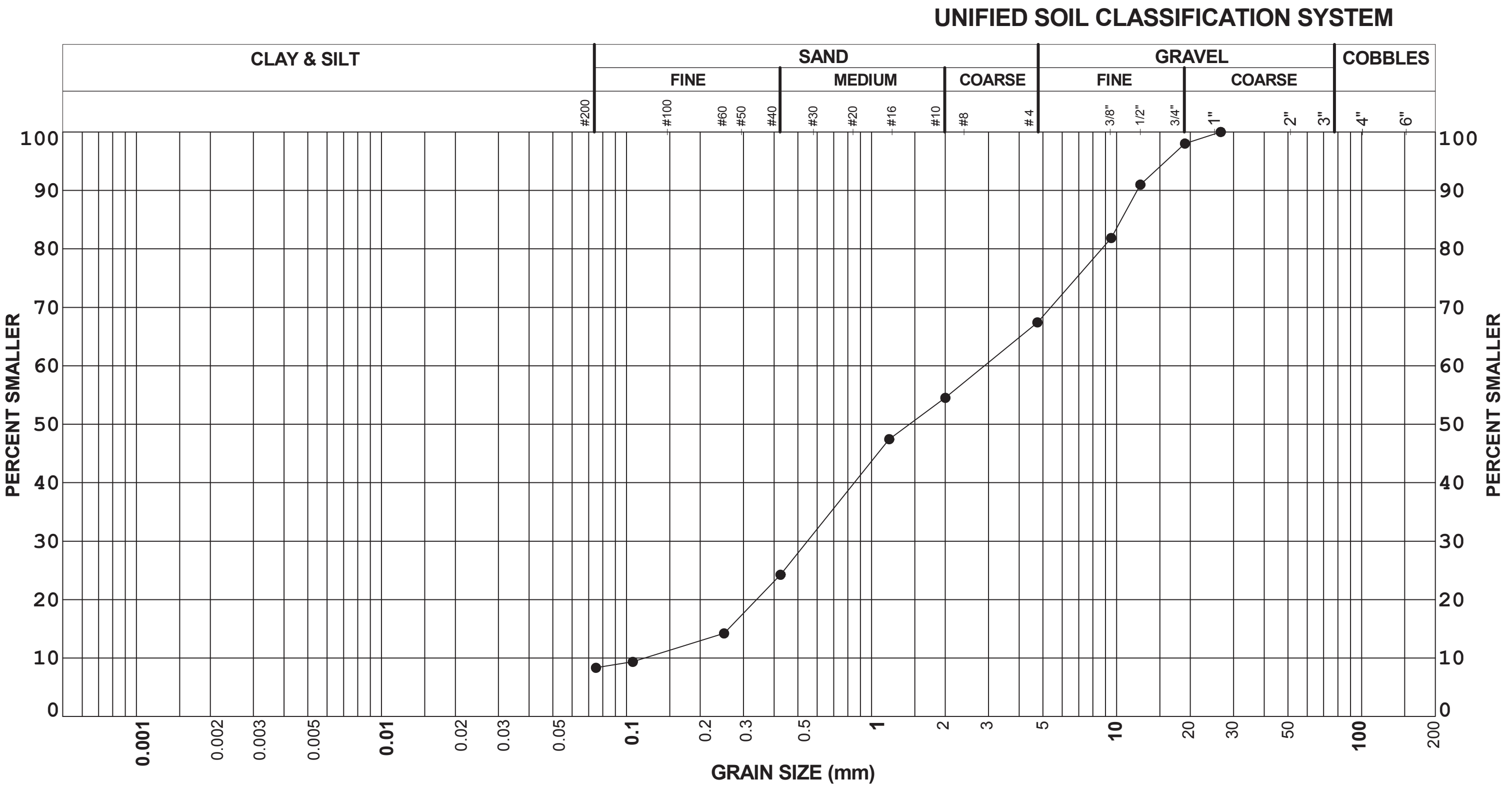

REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-EBC-9	DQ2	4.40	33	59	8		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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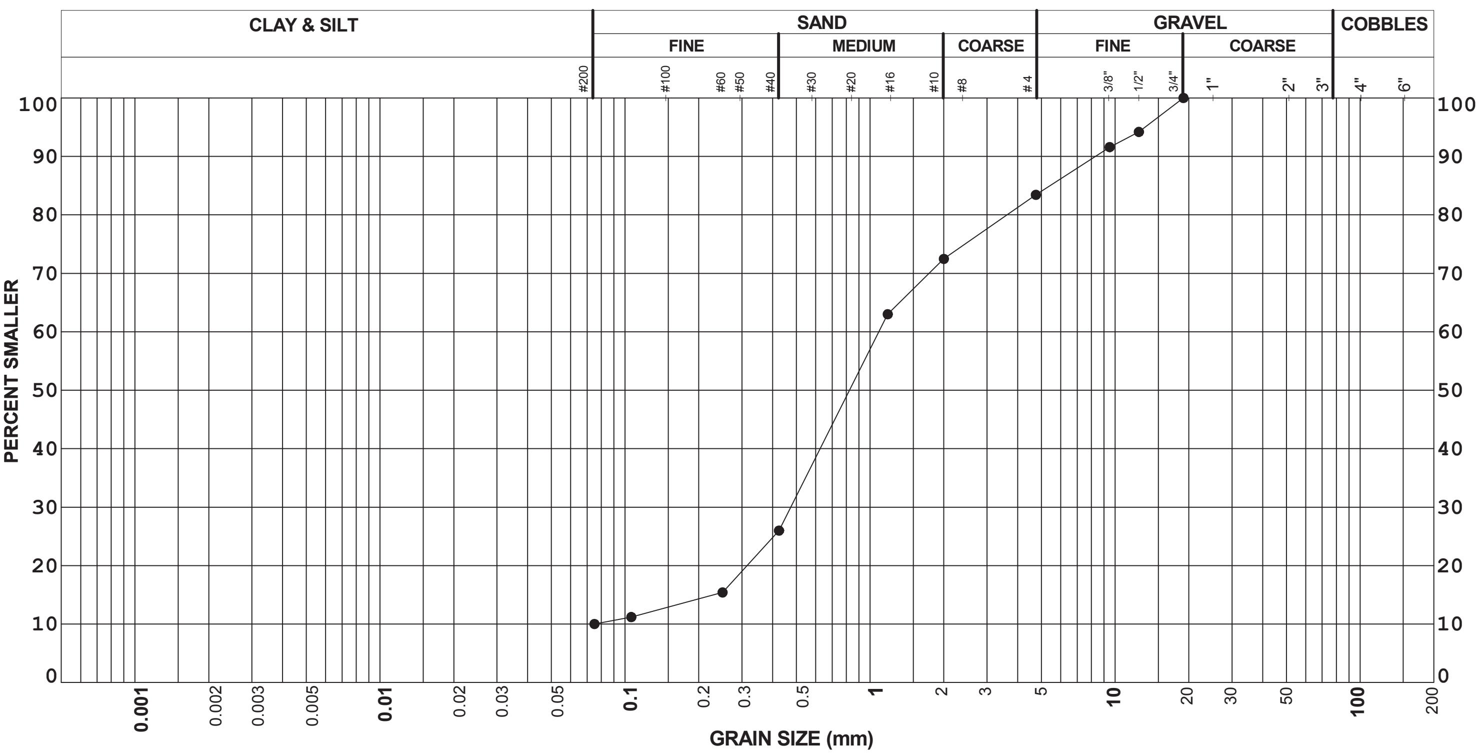
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DS3	6.00	17	73	10		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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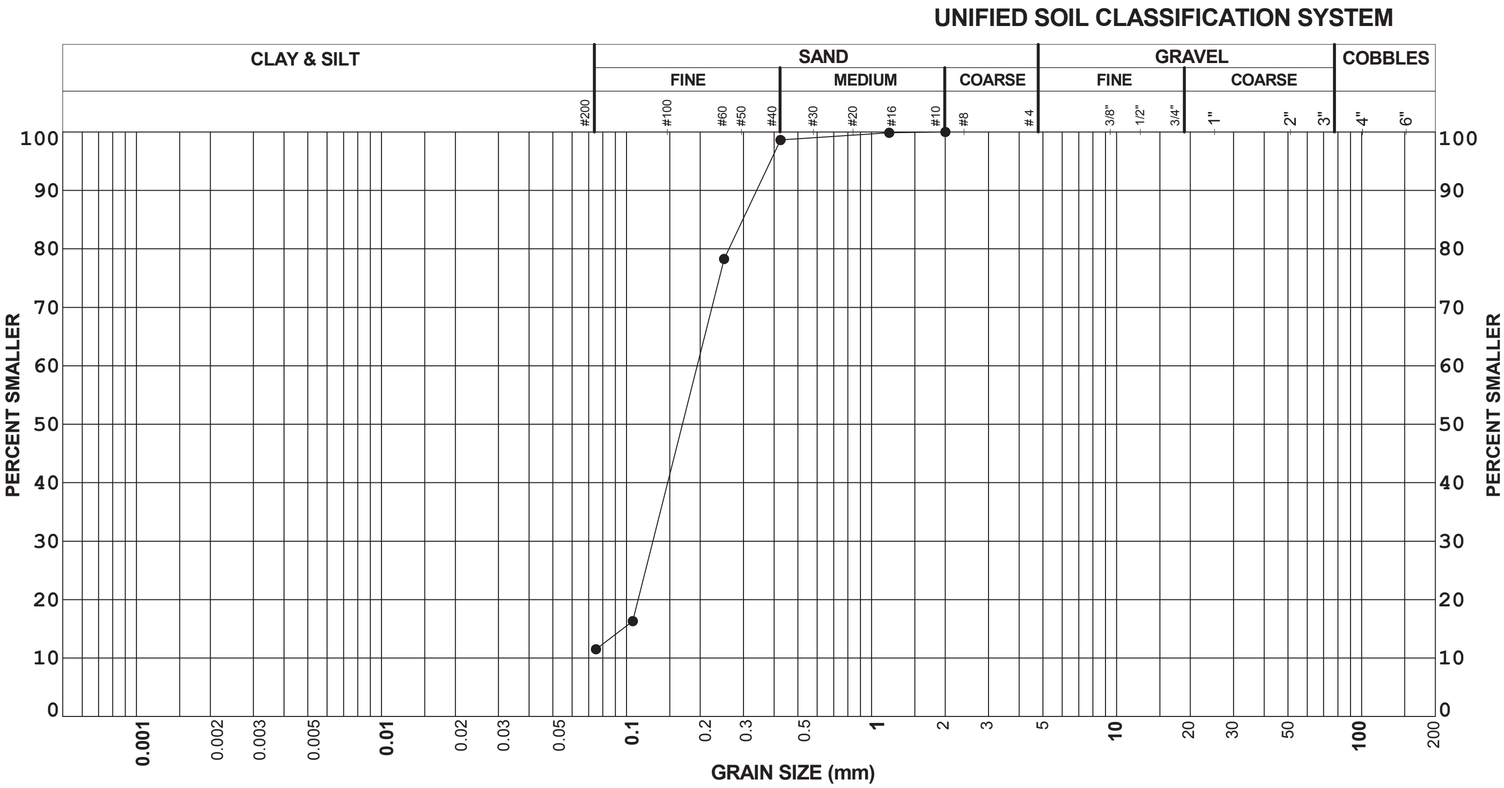
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ4	8.80	0	88	12		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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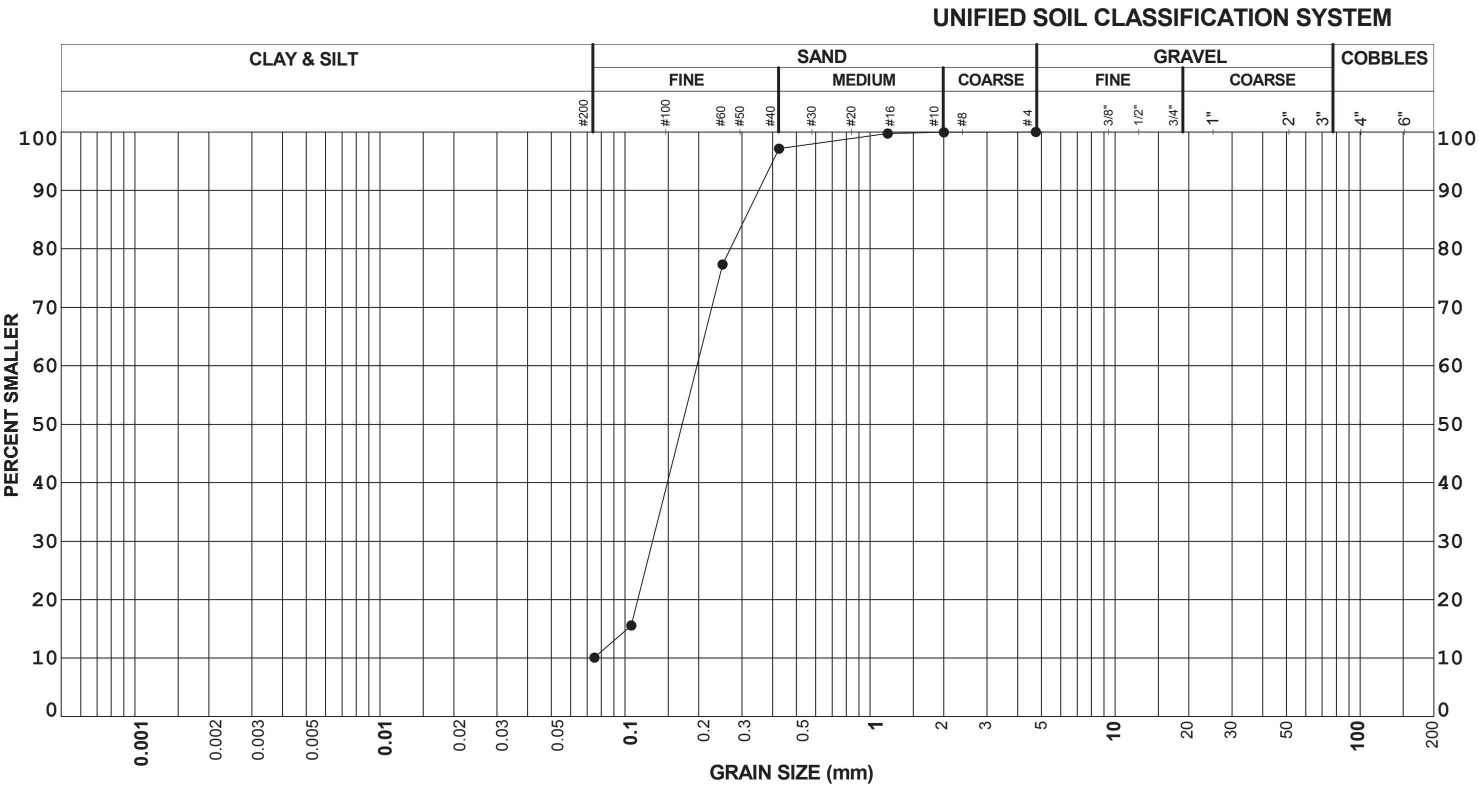
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ5	9.12	0	90	10		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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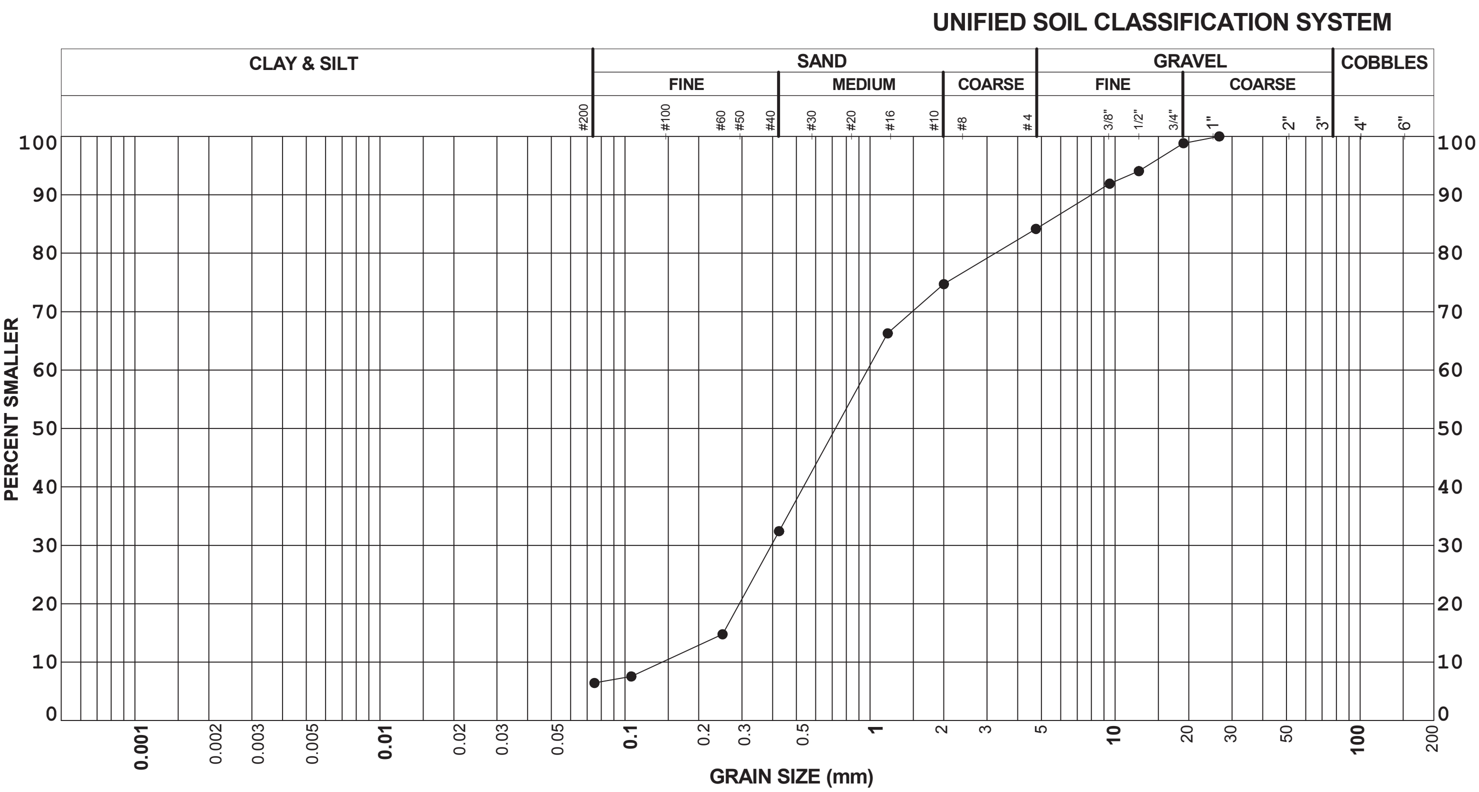
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DS6	11.00	16	78	6		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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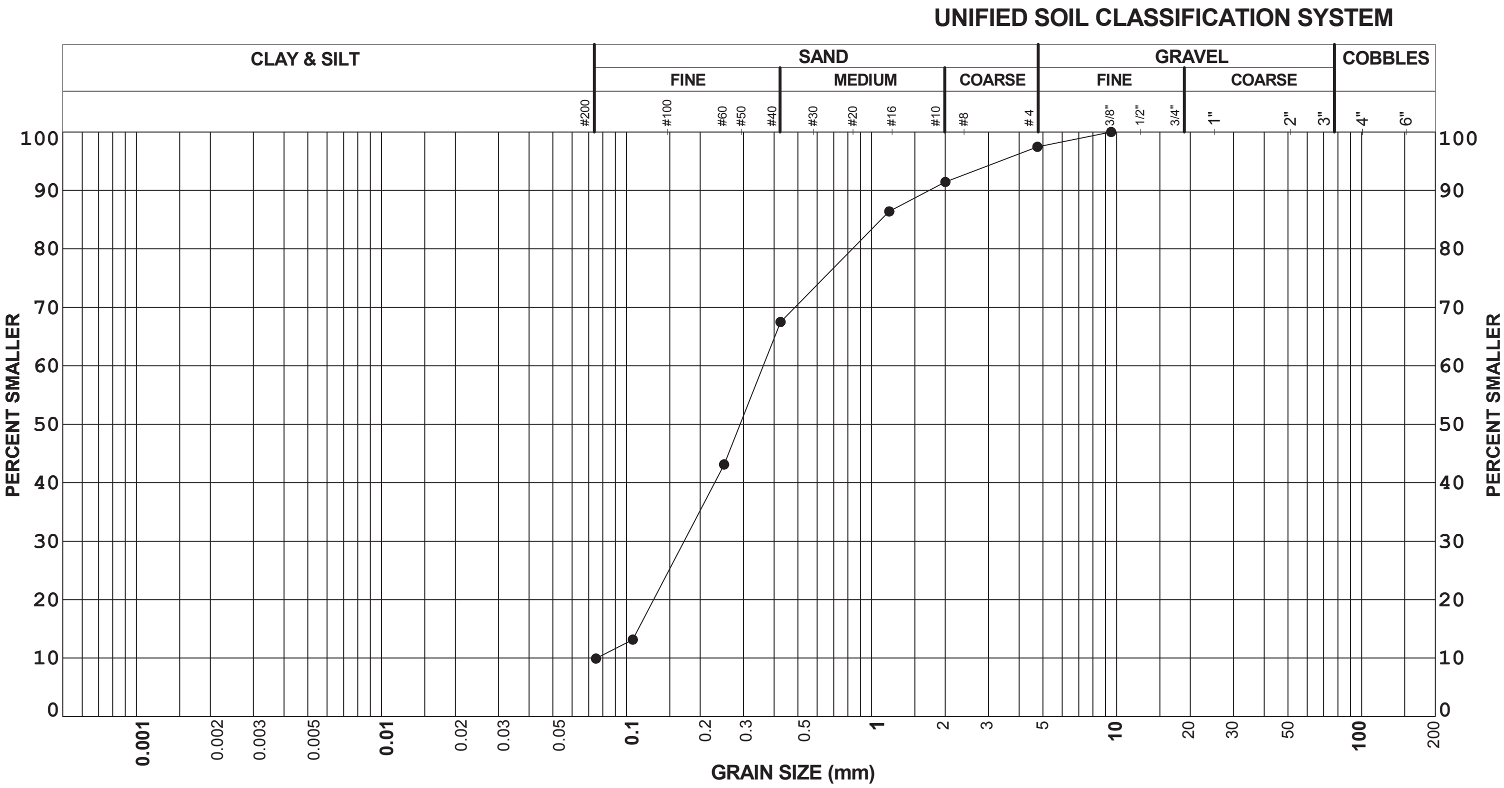
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ7	14.30	3	88	10		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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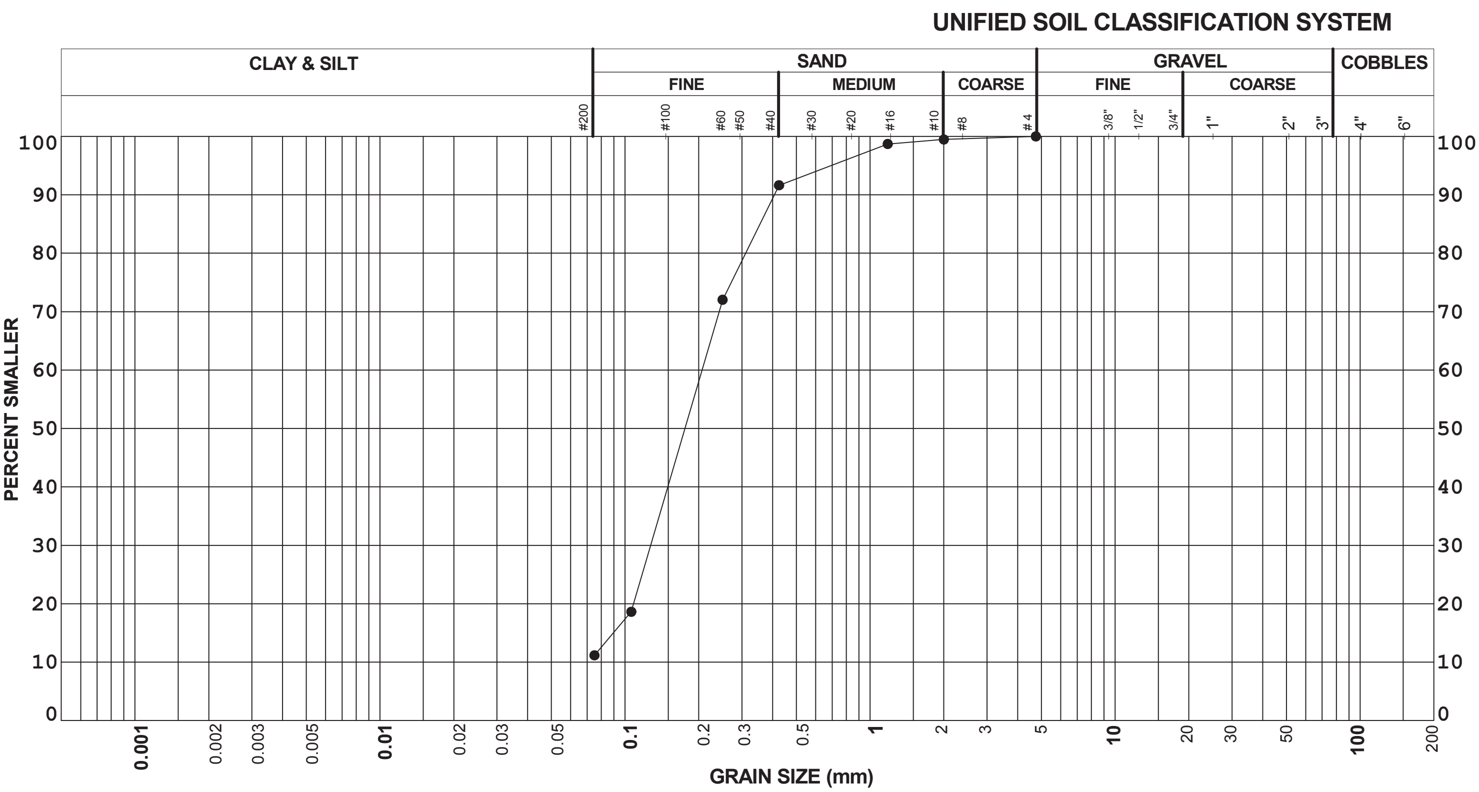
Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ9	17.25	0	89	11		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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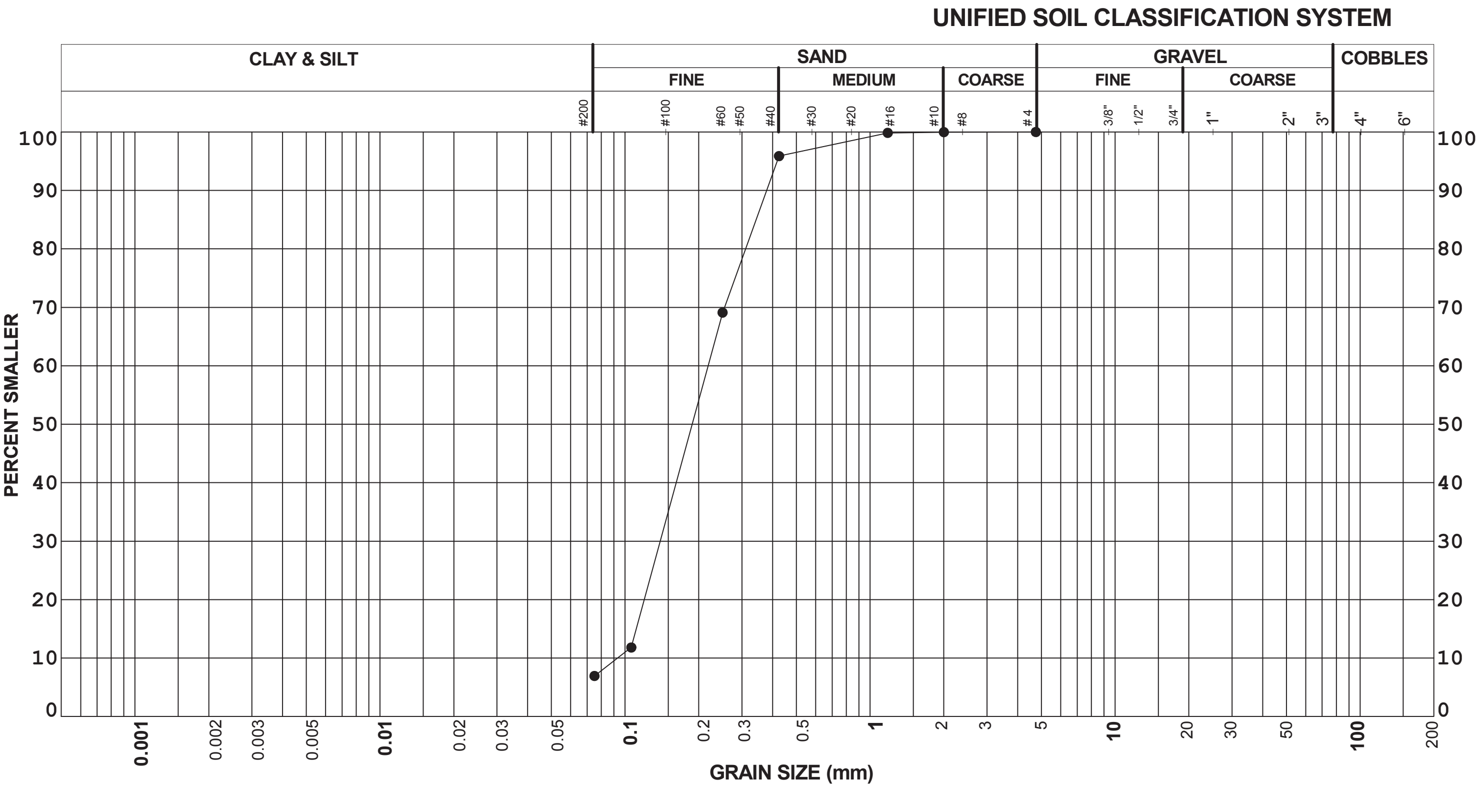
Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ10	18.00	0	93	7		

GRAIN SIZE DISTRIBUTION

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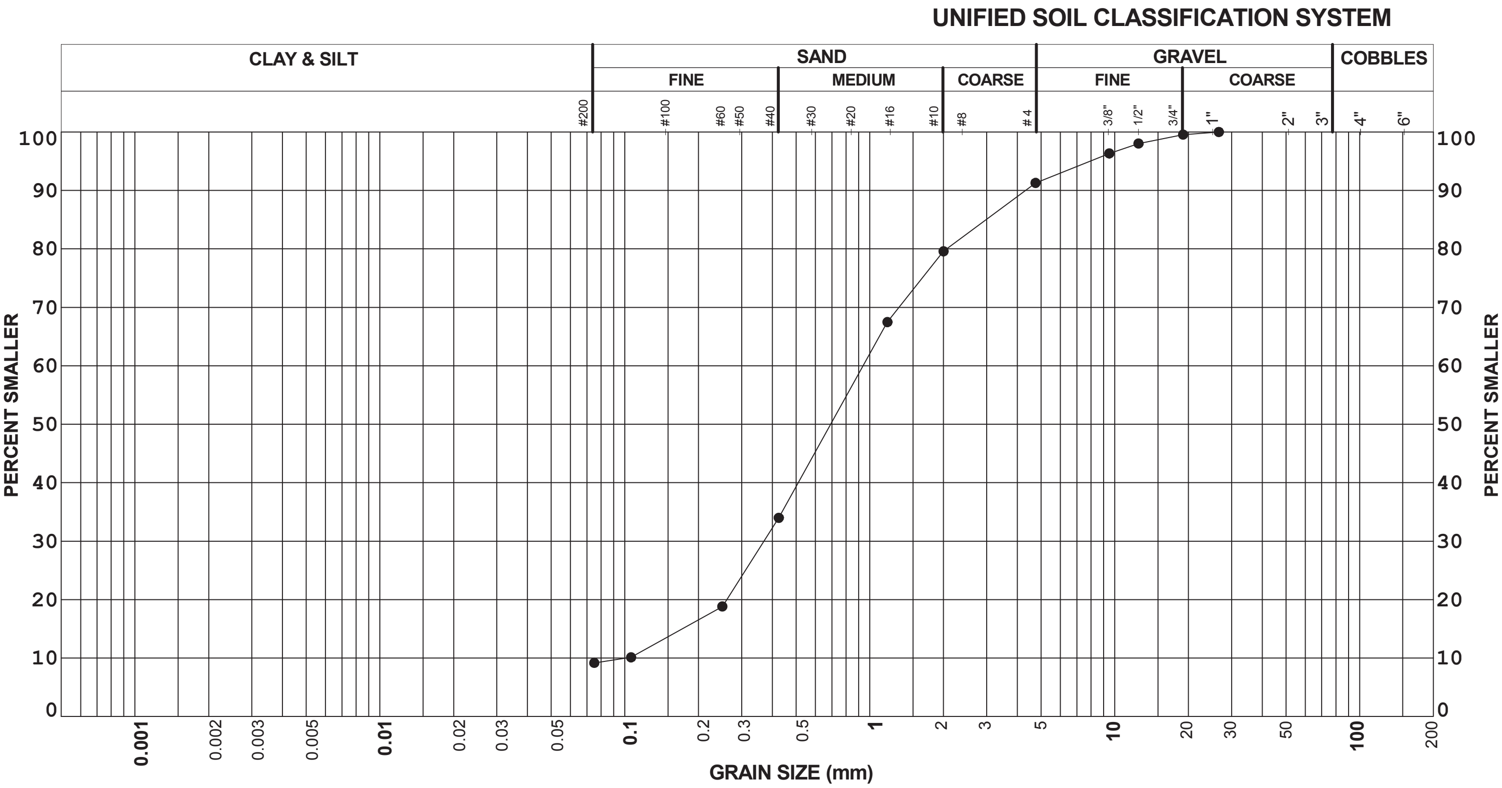
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DS11	19.76	9	82	9		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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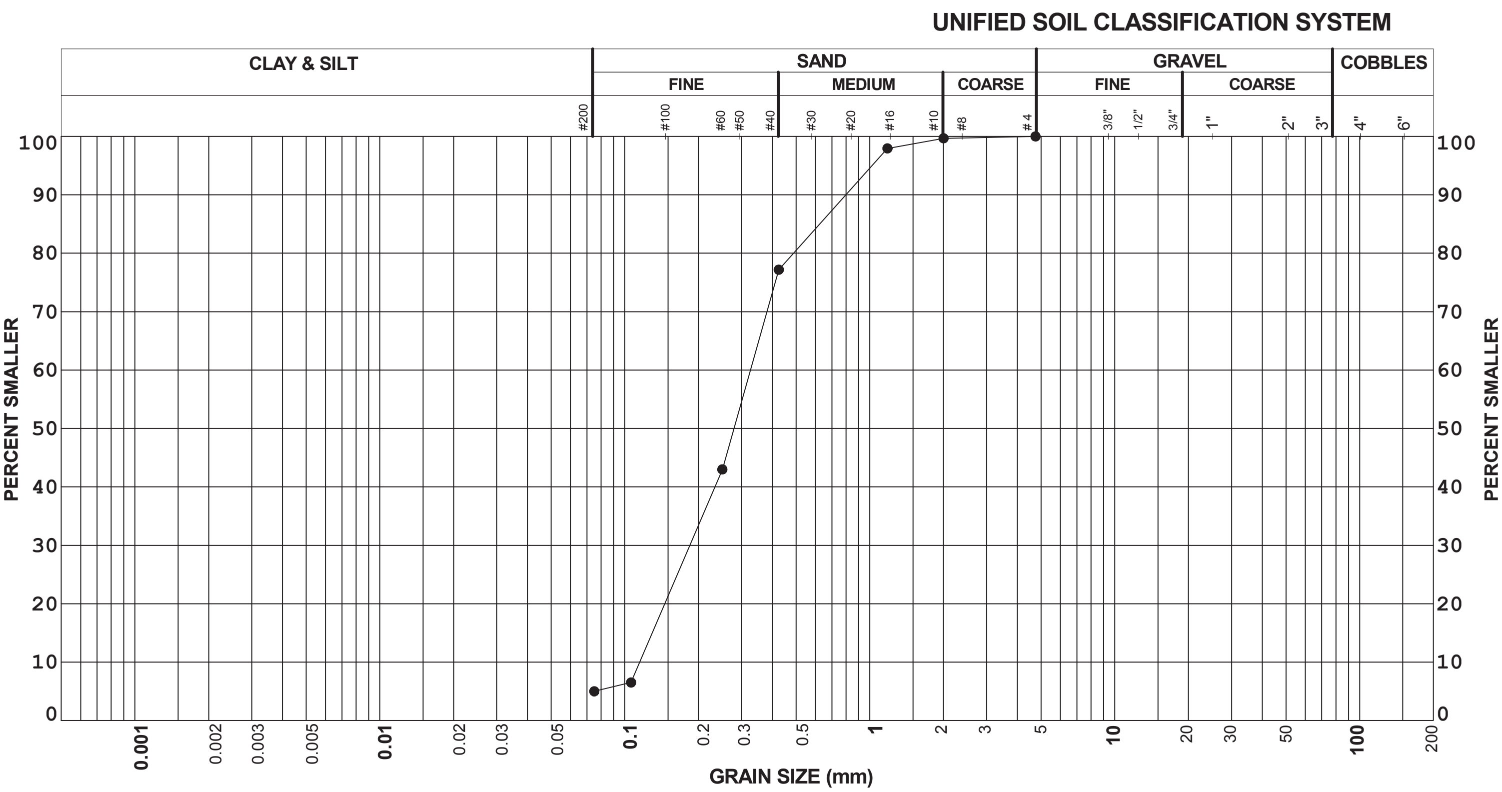
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ12	22.50	0	95	5		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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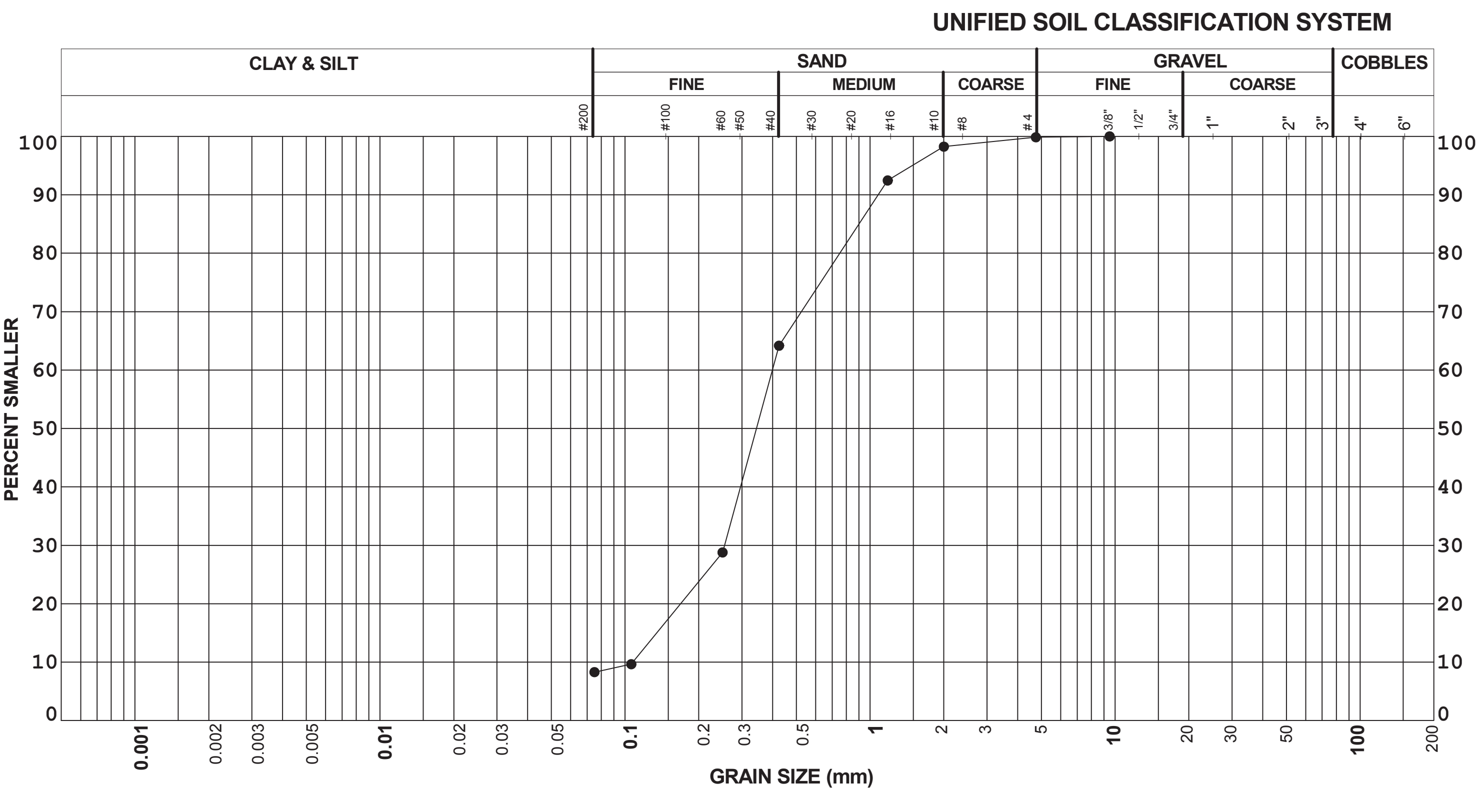
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ13	24.00	0	92	8		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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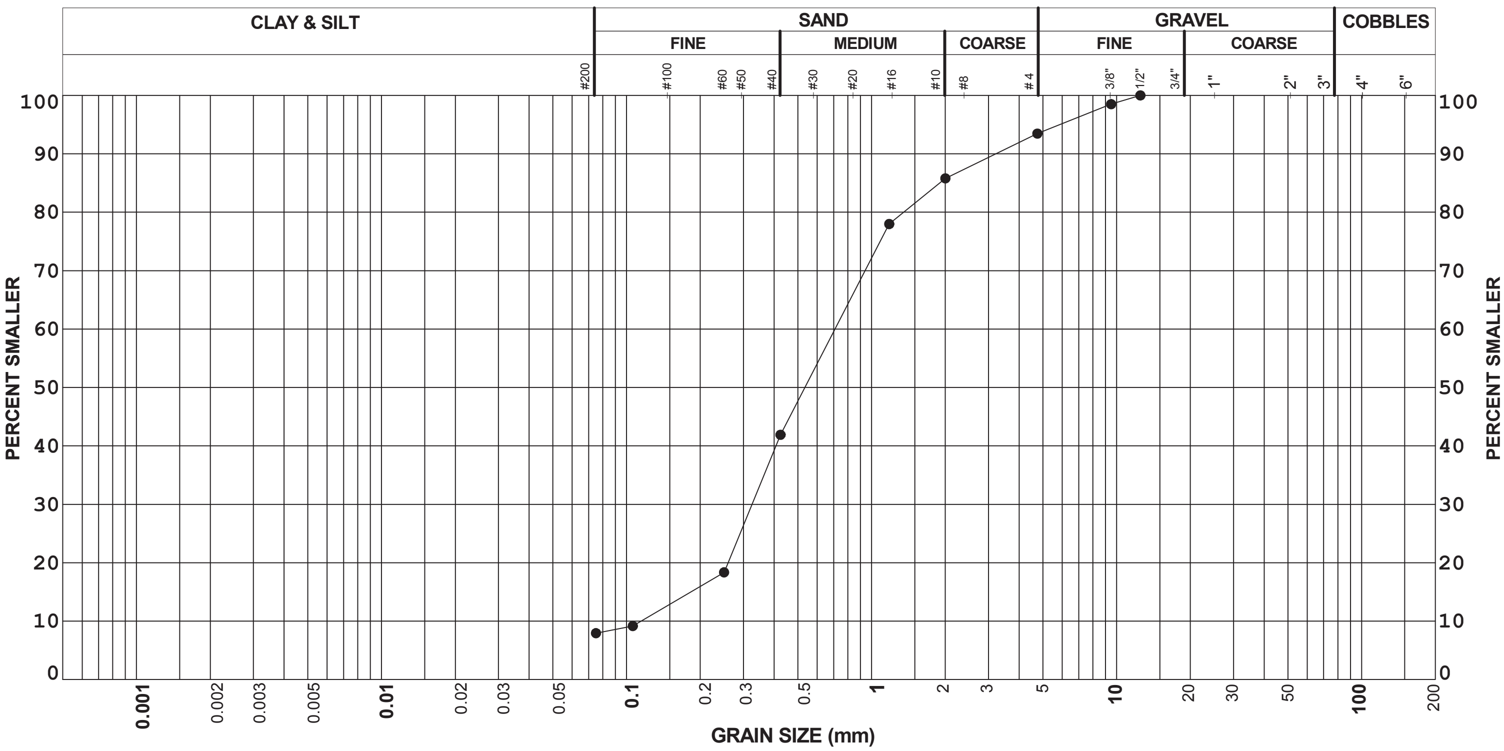
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ14	27.00	7	86	8		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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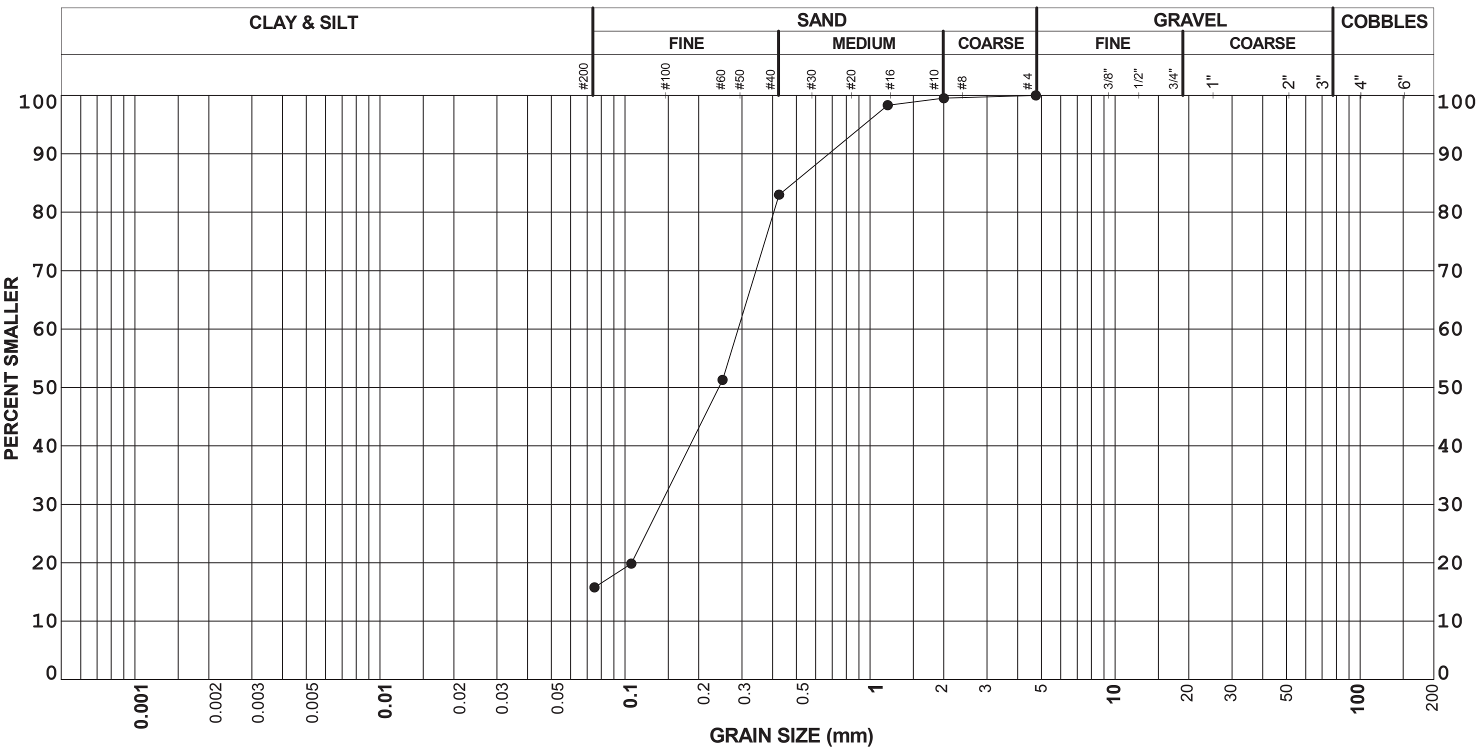
Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ15	27.40	0	84	16		

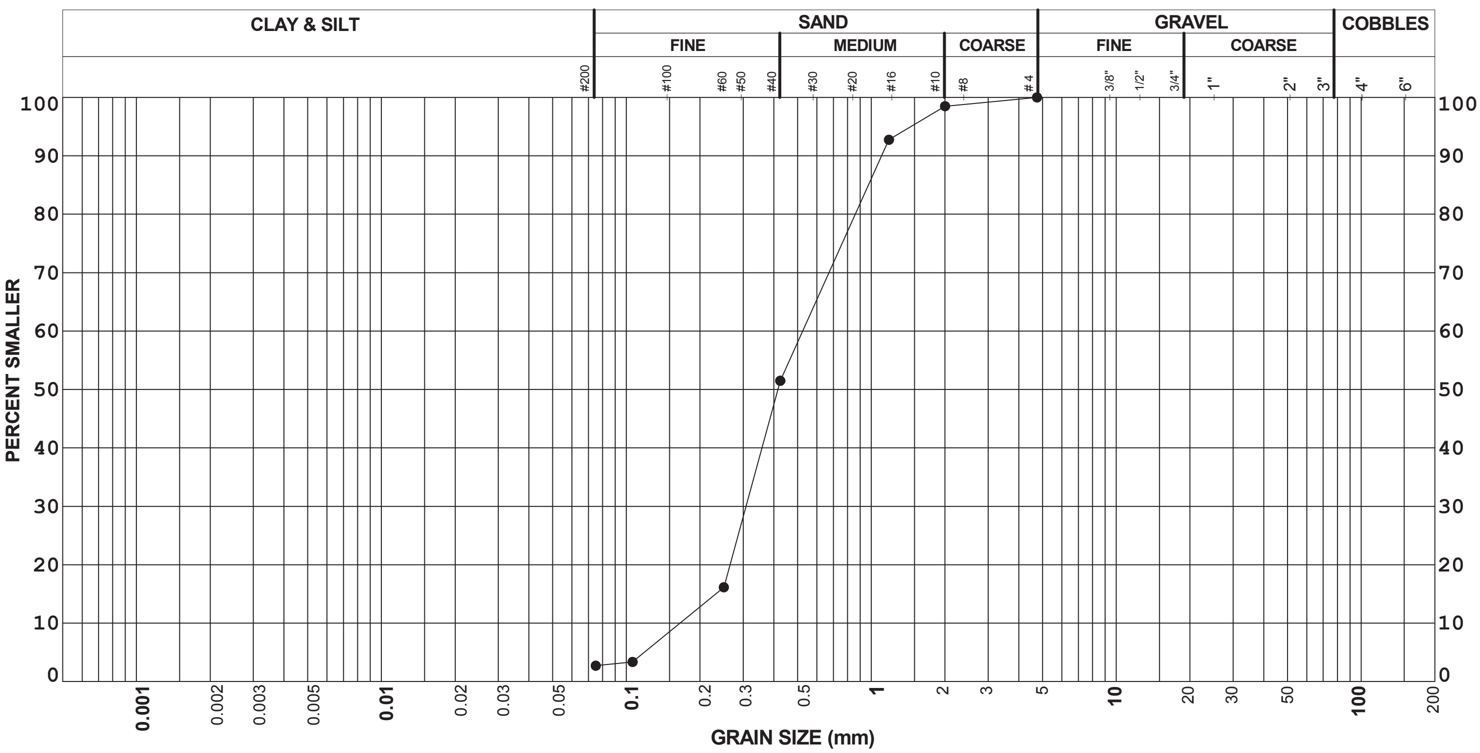
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ16	28.88	0	97	3		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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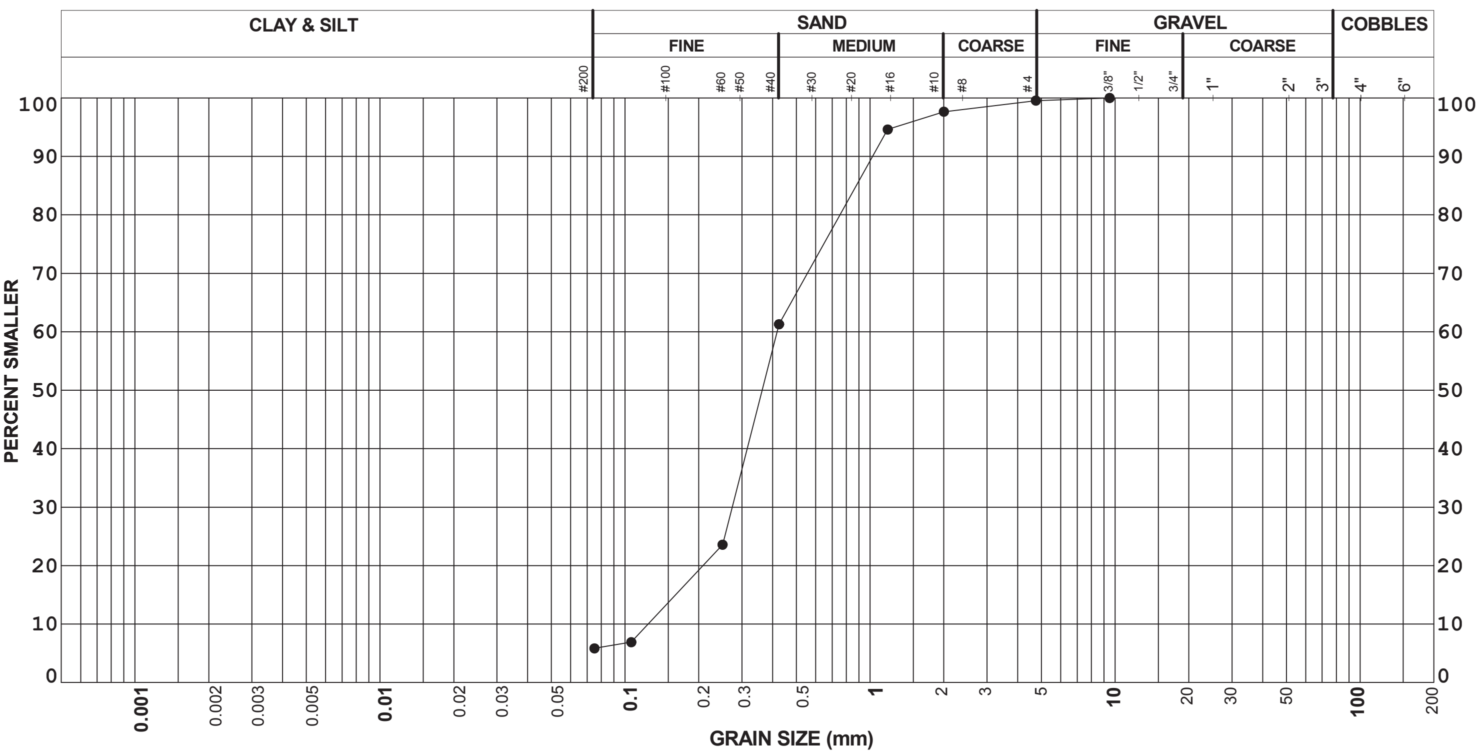
Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ17	31.50	0	94	6		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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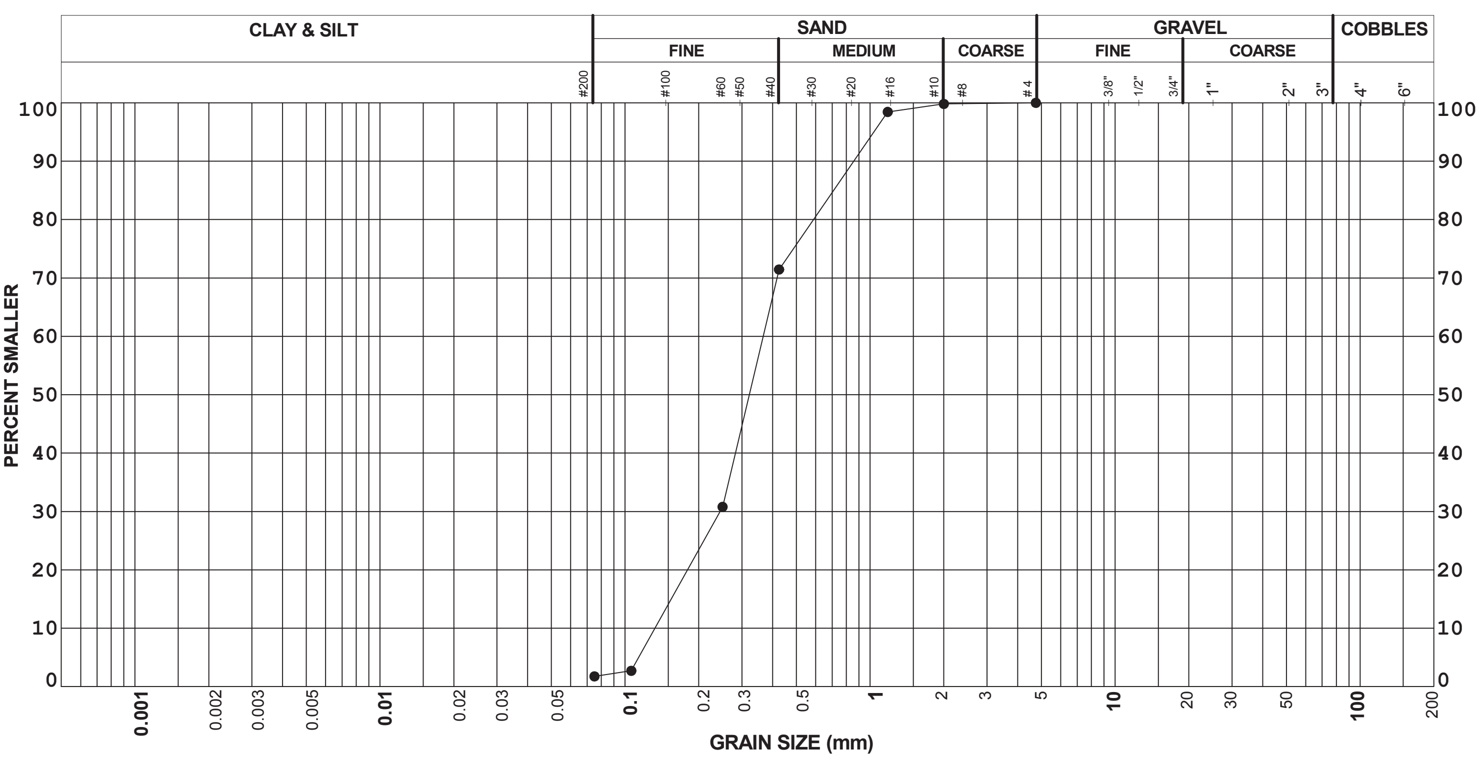
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-EBC-9	DQ19	39.00	0	98	2		

REMARKS:

GRAIN SIZE DISTRIBUTION

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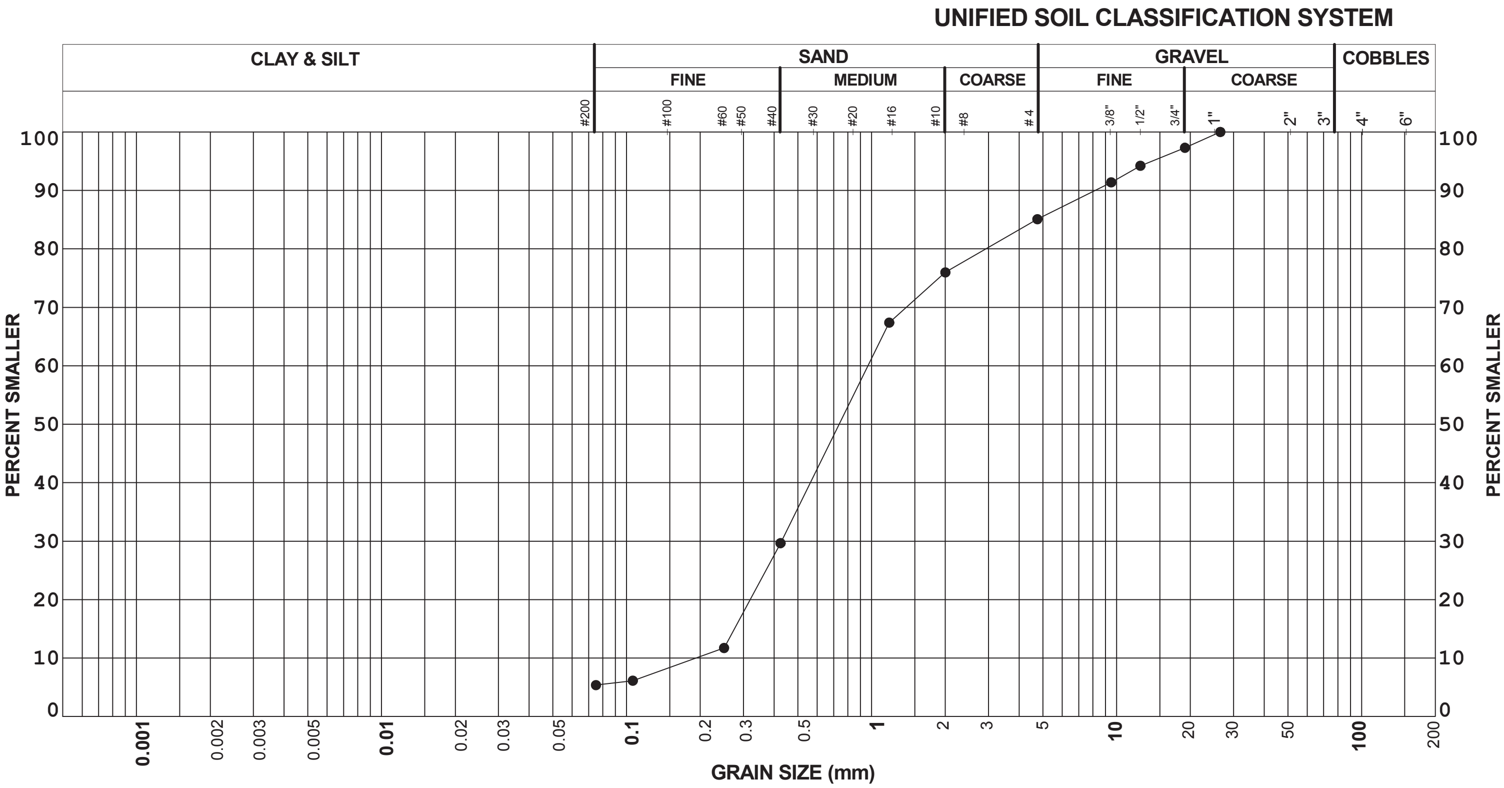
Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-1	DS1	5.00	15	80	5		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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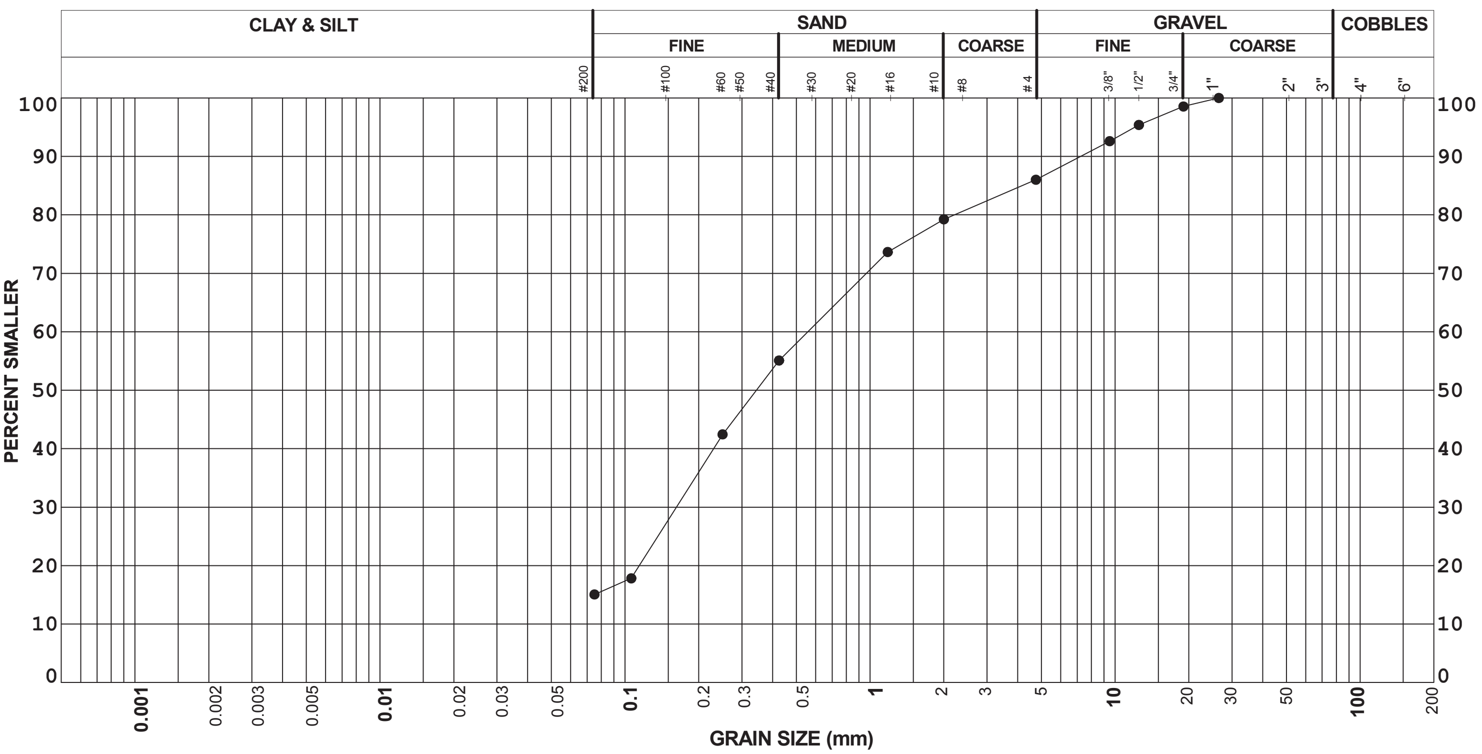
UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-1C	DS1	1.00	14	71	15		

GRAIN SIZE DISTRIBUTION

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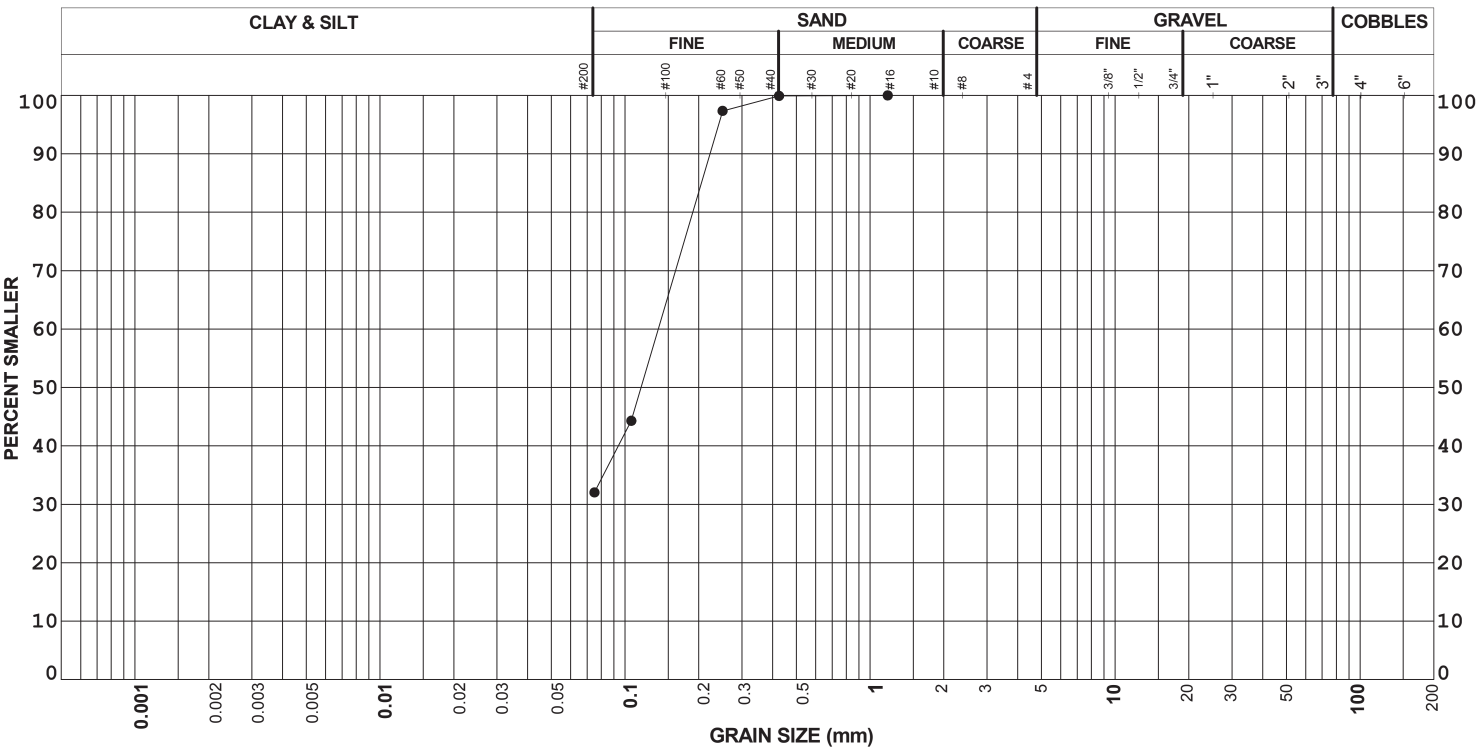
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-1C	DS2	2.00	0	68	32		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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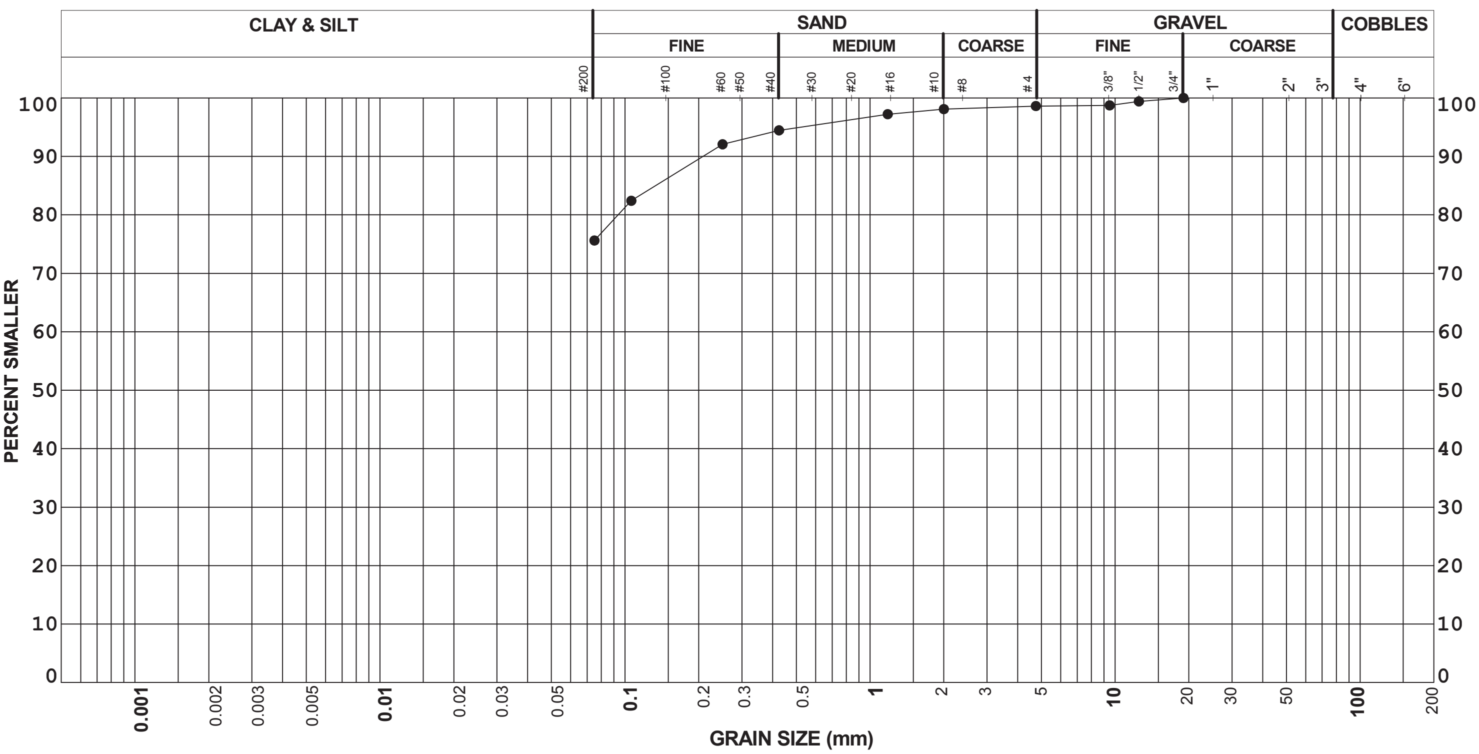
UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-1C	DS3	4.00	1	23	76		

REMARKS:

GRAIN SIZE DISTRIBUTION

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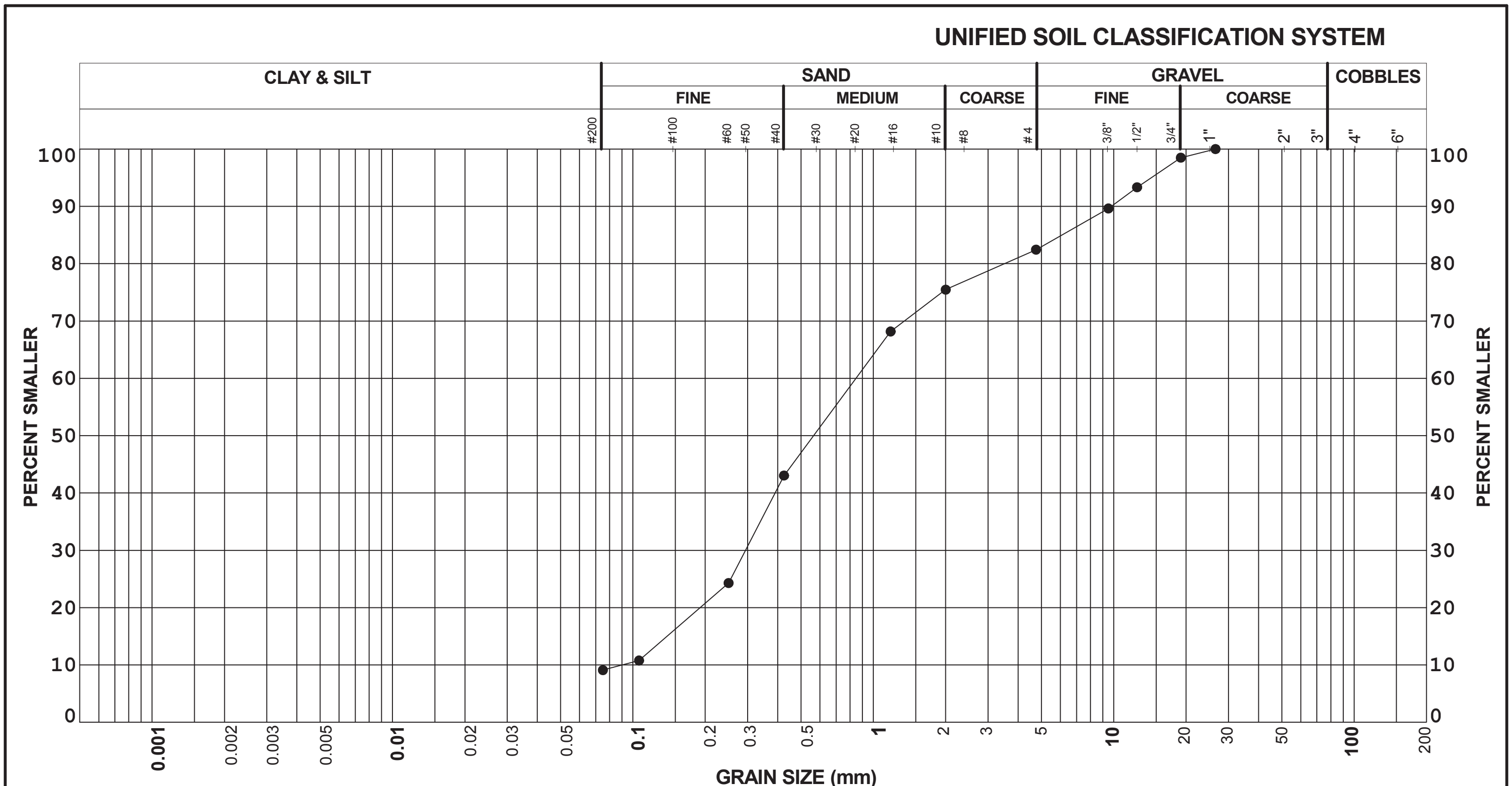
Project



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-RD-2	DS1	0.70	18	73	9		

GRAIN SIZE DISTRIBUTION

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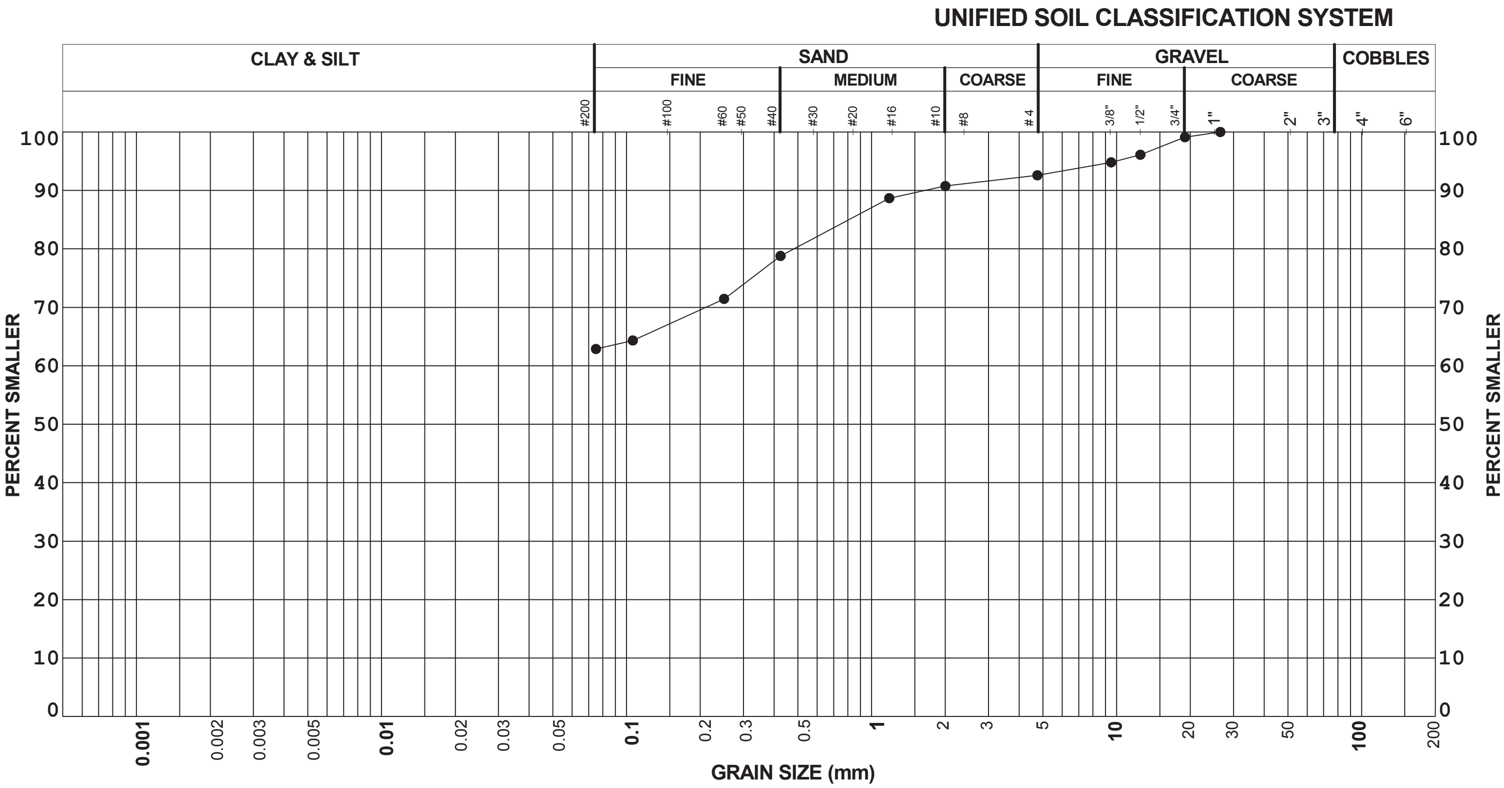

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-2	DS2	1.40	7	30	63		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

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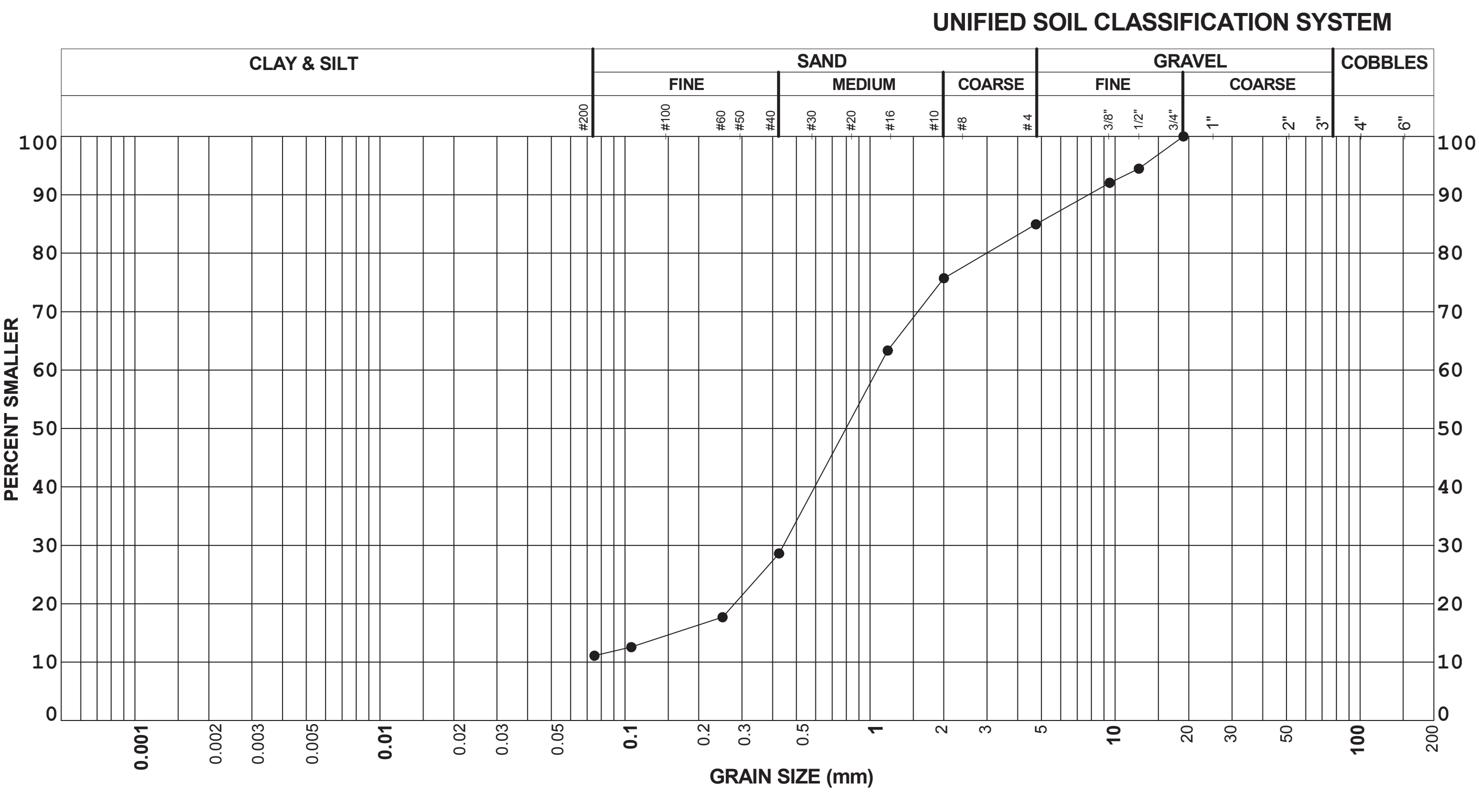
Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-2	DS3	2.20	15	74	11		

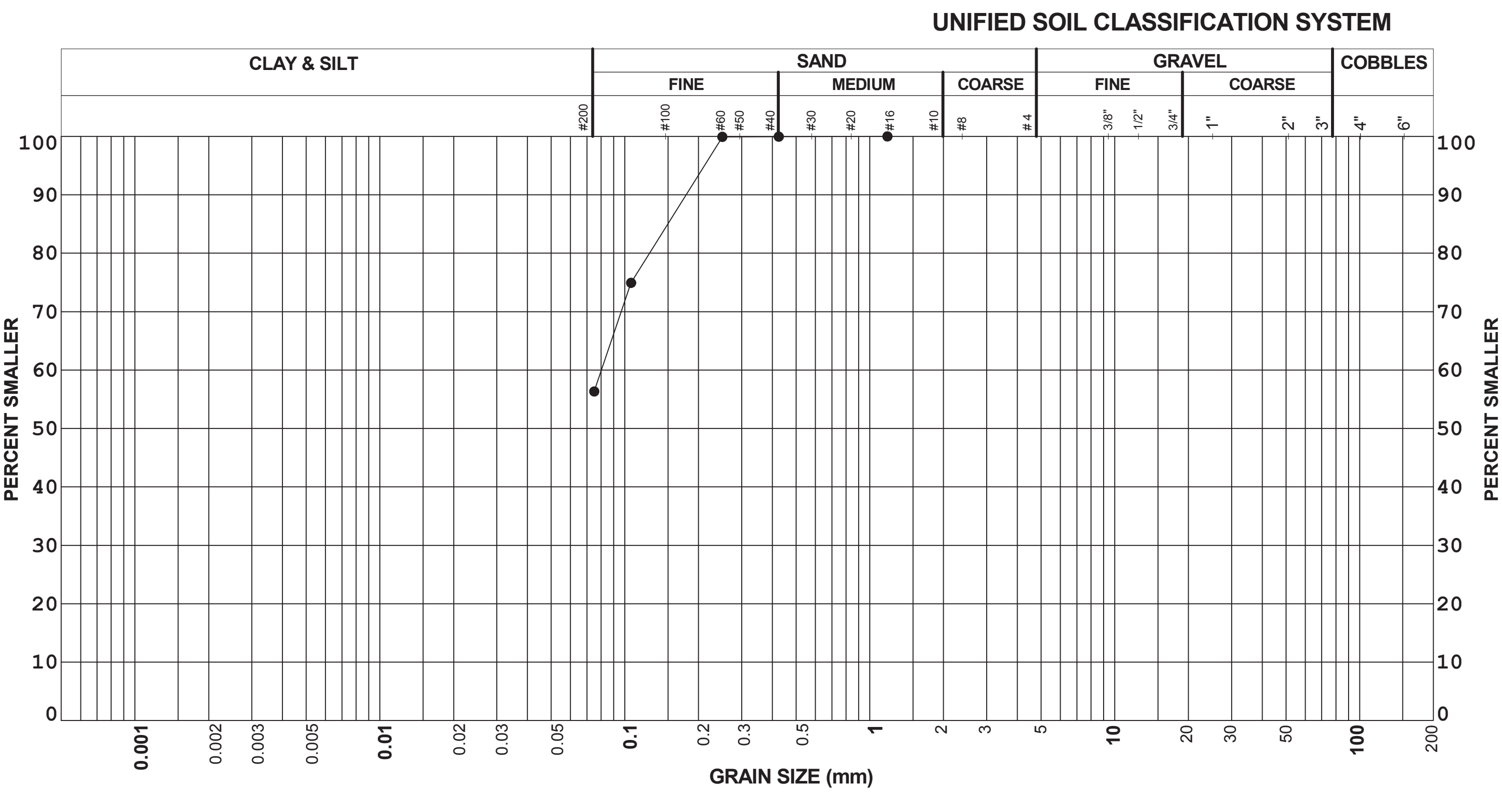
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-RD-2	DS4	4.00	0	44	56		

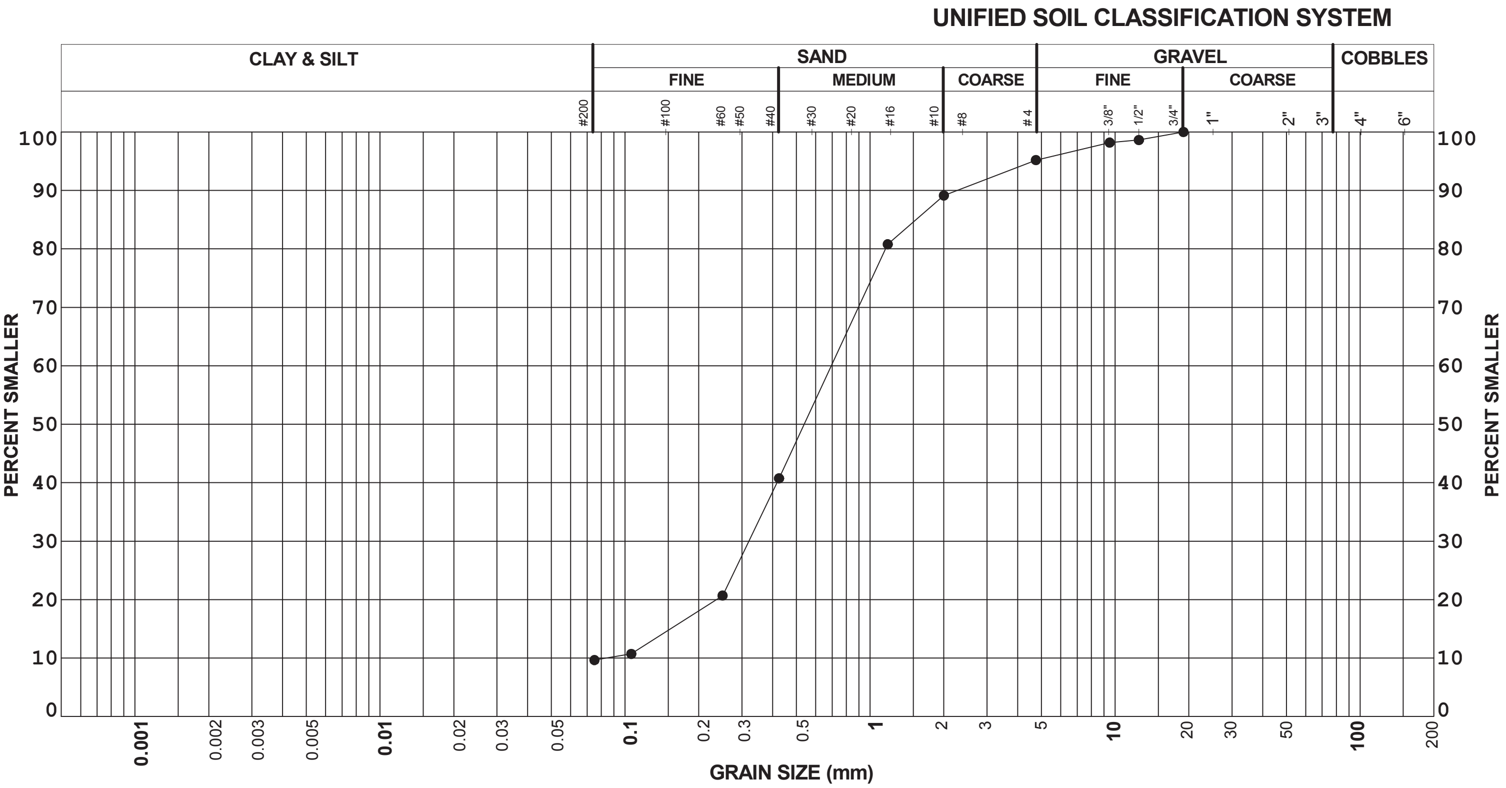
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project



REMARKS:

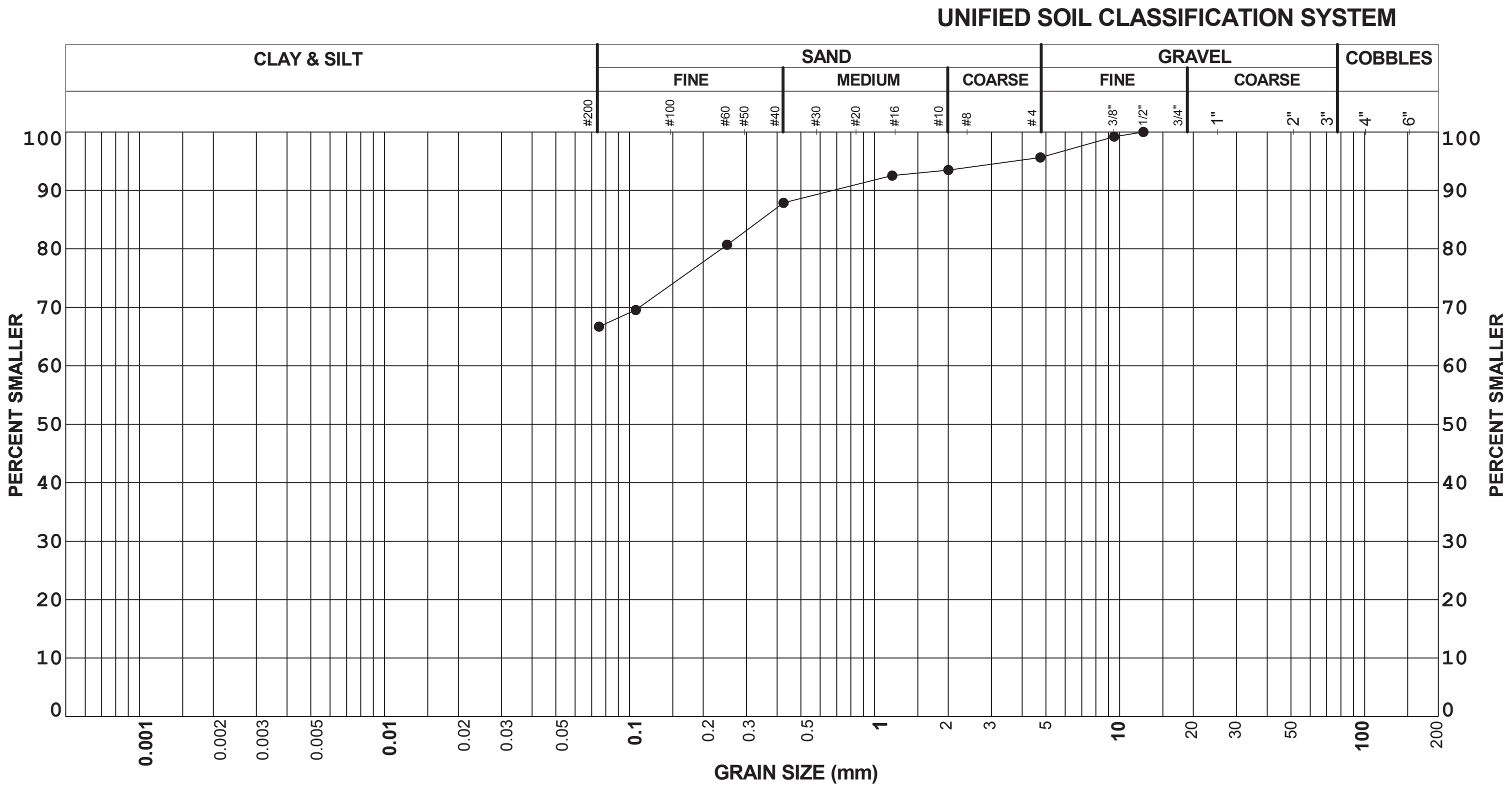
	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH17-RD-3	DS1	3.70	5	86	10		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-4	DQ1	2.20	4	29	67		

REMARKS:

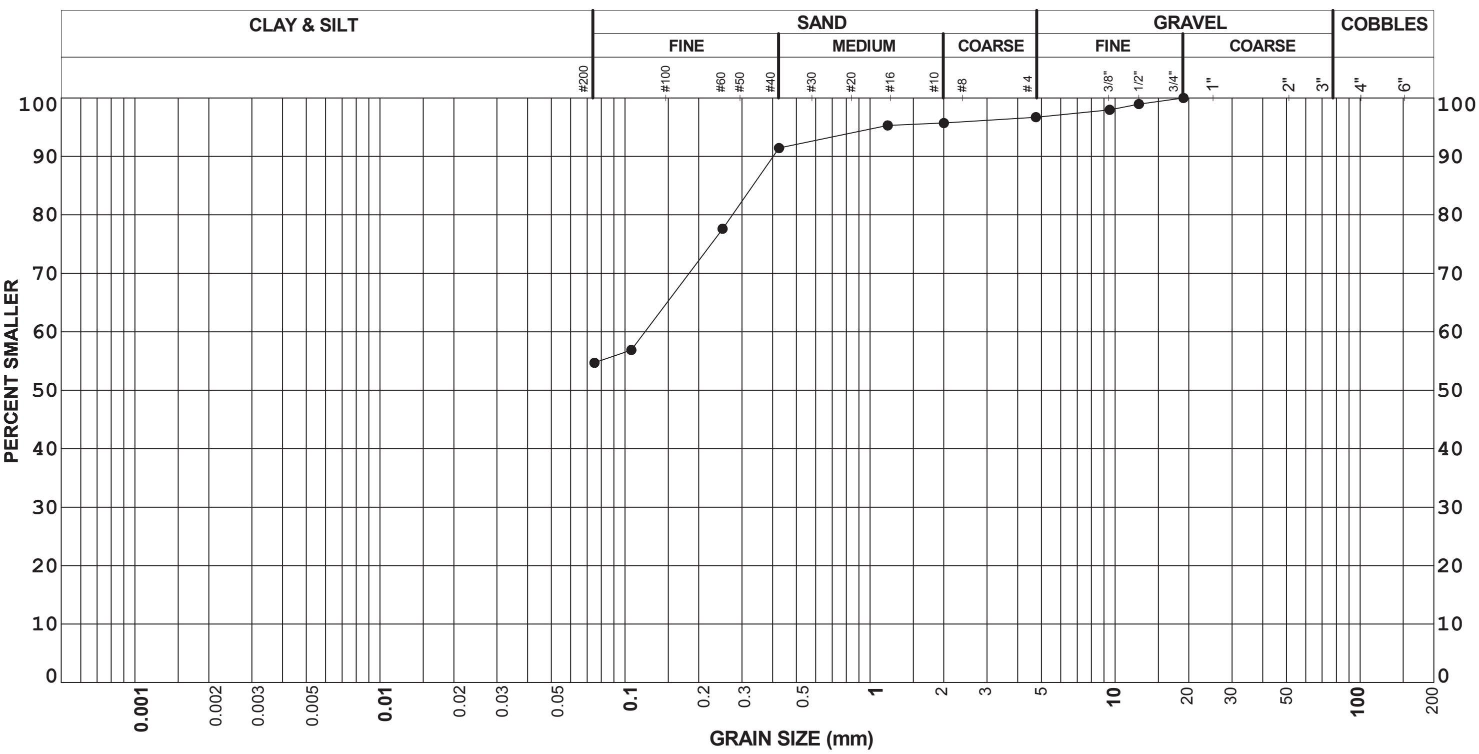
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

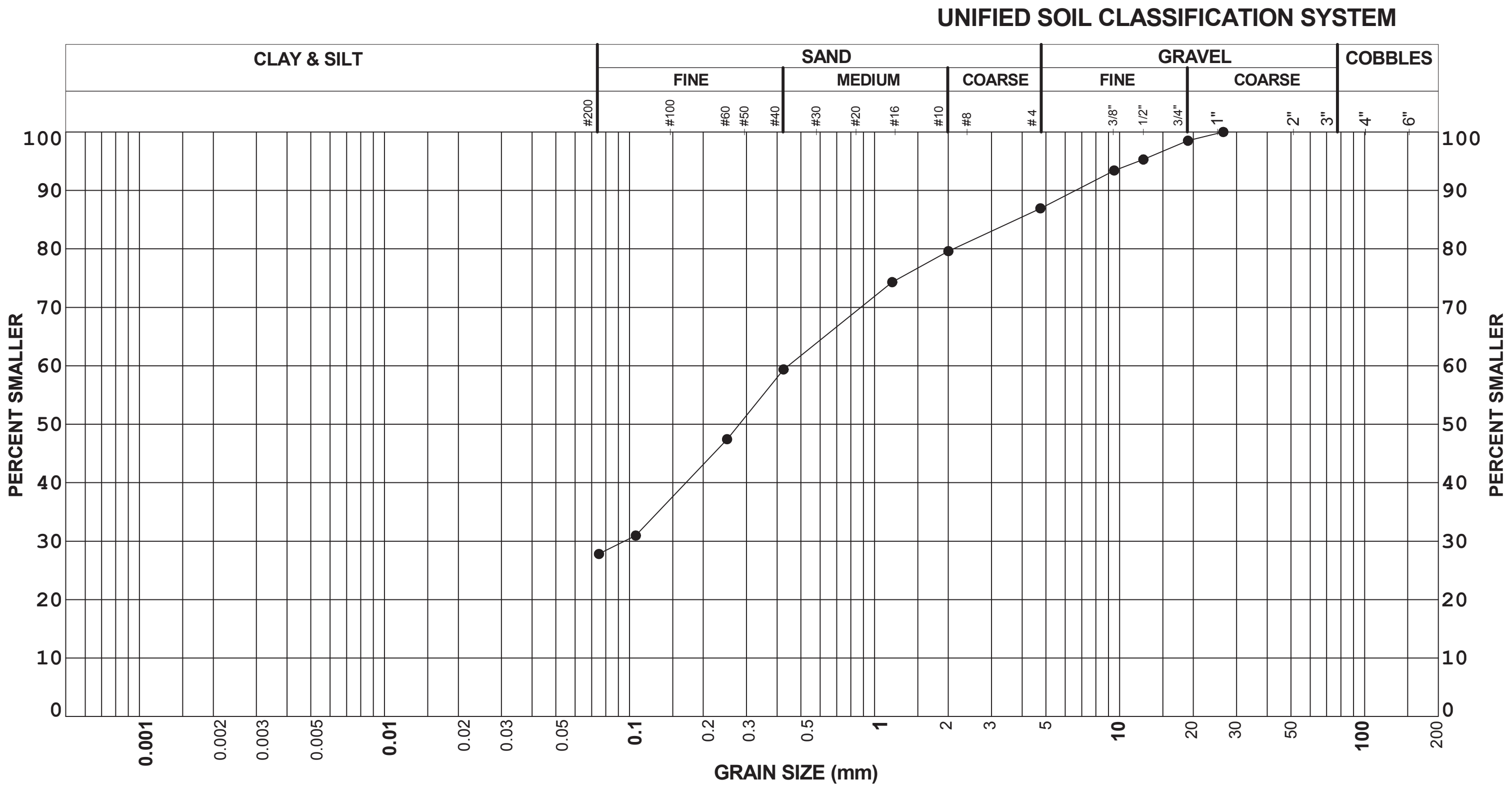
BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-5	DS1	2.40	3	42	55		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-7	DS1	1.90	13	59	28		

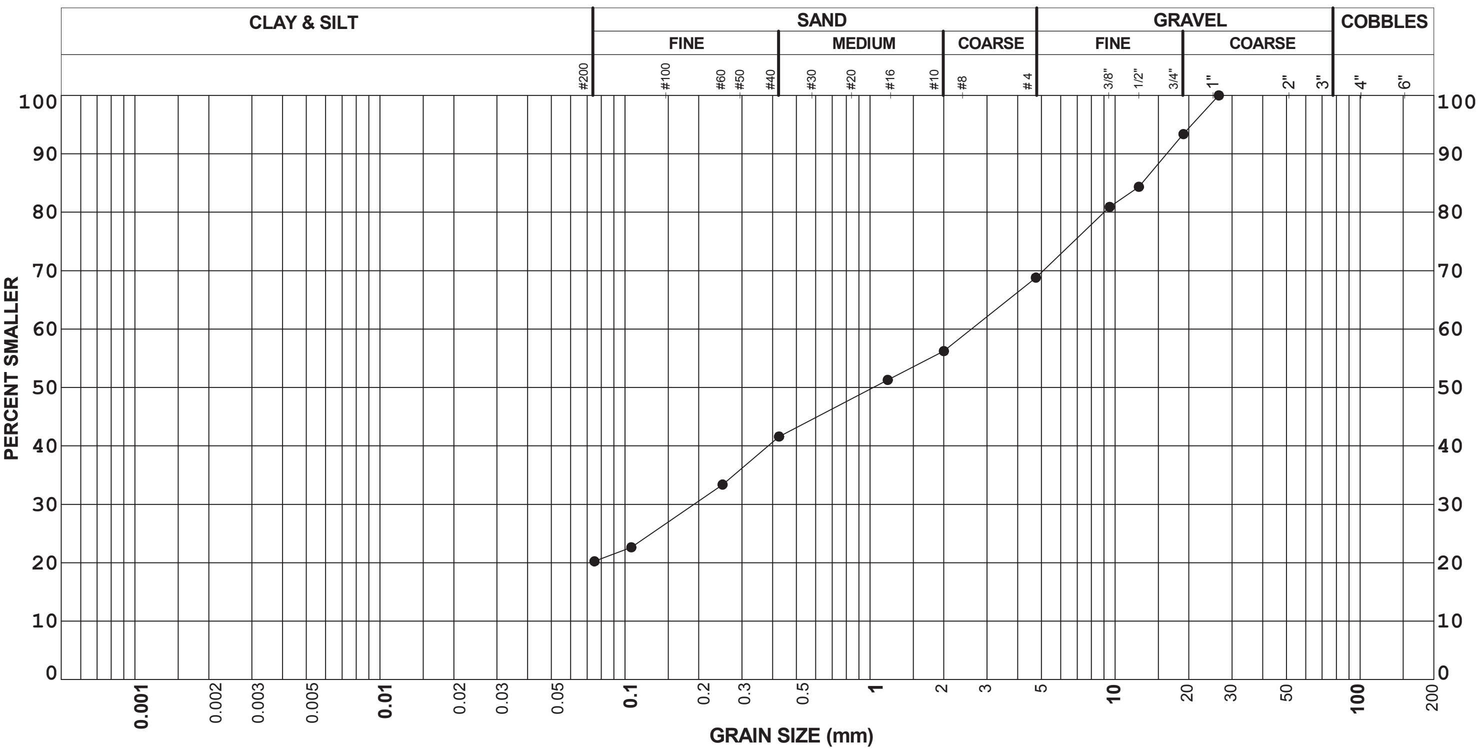
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH17-RD-7	DS2	3.40	31	49	20		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mines Corporation

HATCH

Project

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date: December 17, 2017

Project Number: H/353004

Project: **Mary River Expansion Project**

Baffinland Iron Mines
2275 Upper Middle Rd,
Oakville Ontario.

Attention: G. Qu

Sample	**As Listed Below**
Source	**BH17-10 Milne Port**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DS1	0.90	3.0	
DS2	5.00	13.0	
DS4	8.70	22.0	
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017

Name, Title, Date

Reviewed by: G. Qu

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date: December 17, 2017
Project Number: H/353004
Project: **Mary River Expansion Project**

Baffinland Iron Mines
2275 Upper Middle Rd,
Oakville Ontario.
Attention: G. Qu

Sample	**As Listed Below**
Source	**BH17-11 Milne Port**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DS2	5.50	1.0	
DS3	8.00	6.0	
DS6	15.00	7.0	
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017
Name, Title, Date

Reviewed by: G. Qu
Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	December 17, 2017	Baffinland Iron Mines
Project Number:	H/353004	2275 Upper Middle Rd, Oakville Ontario.
Project:	**Mary River Expansion Project**	**Attention:** Q. Qu

Sample	**As Listed Below**
Source	**BH17-12 Milne Port**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DS2	4.00	5.0	
DS3	5.00	27.0	
DS5	8.80	5.0	
DS6	13.60	6.0	
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017

Name, Title, Date

Reviewed by: G. Qu

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	December 17, 2017	Baffinland Iron Mines Corporation
Project Number:	H/353004	2275 Upper Middle Rd, Oakville Ontario.
Project:	**Mary River Expansion Project**	**Attention:** H.Ghiabi

Sample	**As Listed Below**
Source	**BH17-EBC-1**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ2	4.60	0.0	Ice Sample
DQ3	5.10	3.0	
DQ4	6.20	0.0	
DQ5	8.30	1.0	Ice Sample
DQ6	9.70	3.0	
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017

Name, Title, Date

Reviewed by: W. Hoyle, Feb.16, 2018

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer
ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	December 17, 2017	Baffinland Iron Mines Corporation	
Project Number:	H/353004	2275 Upper Middle Rd, Oakville Ontario.	
Project:	**Mary River Expansion Project**	**Attention:** H.Ghiabi	

Sample	**As Listed Below**
Source	**BH17-EBC-2**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ3	2.0	0.0	
DQ4	3.05	3.0	
DQ5	4.30	3.0	
DQ6	5.0	3.0	
BLANK	NA	0.0	Distilled Water
DQ7	5.8	6.0	
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017

Name, Title, Date

Reviewed by: W. Hoyle, Feb.16, 2018

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	December 17, 2017	Baffinland Iron Mines Corporation
Project Number:	H/353004	2275 Upper Middle Rd, Oakville Ontario.
Project:	**Mary River Expansion Project**	**Attention: G. Qu**

Sample	**As Listed Below**
Source	**BH17-EBC-8 - New Drive House, South End**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ3	5.00	3.0	
DQ7	12.00	14.0	
DQ9	15.00	13.0	
DQ11	18.00	22.0	
DQ12	20.51	9.0	
DQ13	23.70	8.0	
BLANK	NA	0.0	Distilled Water
DQ15	29.80	10.0	
DQ16	32.90	26.0	
DQ17	37.40	5.0	
DS18	39.30	22.0	
DQ19	39.40	14.0	
BLANK	NA	0.0	Distilled Water
Sea 1	0.0	28.0	Sea Water – Off Shore 700 m
Sea 2	0.0	26.0	Sea Water – Near Shore

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017
Name, Title, Date

Reviewed by: G. Qu, Dec.18,2017
Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer
ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	December 17, 2017	Baffinland Iron Mines Corporation
Project Number:	H/353004	2275 Upper Middle Rd, Oakville Ontario.
Project:	**Mary River Expansion Project**	**Attention: G. Qu**

Sample	**As Listed Below**
Source	**BH17-EBC- 9 - New Drive House, North End**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ2	4.40	8.0	
DQ4	8.80	13.0	
DQ7	14.30	12.0	
BLANK	NA	0.0	Distilled Water
DQ8	15.20	88.0	Soft/unfrozen zone
DQ10	18.0	11.0	
DQ12	22.5	10.0	
BLANK	NA	0.0	Distilled Water
DQ13	24.0	11.0	
DQ14	27.0	16.0	
DQ15	27.4	15.0	
BLANK	NA	0.0	Distilled Water
DQ17	31.5	5.0	
BLANK	NA	0.0	Distilled Water
Sea 1	0.0	28.0	Sea Water – Off Shore 700 m
Sea 2	0.0	26.0	Sea Water – Near Shore

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech., Dec. 17, 2017
Name, Title, Date

Reviewed by: G. Qu, Dec.18, 2017
Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Uniaxial Compressive Strength of Intact Rock Core Specimens - Method C:
ASTM D7012-10

HATCH
Geotechnical Laboratory

Date:	January 29. 2018	Baffinland Iron Mines Corporation
Project Number:	H/353004	2275 Upper Middle Road East, Oakville Ont.
Project:	**Mary River Expansion Project**	**Attention: G.Qu**

Sample	**Bedrock Core Sample from 19.22 m**
Source	**BH17-EBC-1**

Core Sample Data						
Length:	13.209	**cm**		**Weight:**	1098.5	**grams**
Diameter:	6.340	**cm**		**Density:**	2.63	**g/cm³**
Area:	31.570	**cm²**		**Maximum Load:**	518	**kN**
Volume:	417.006	**cm³**		**U.C.S.**	164.1	**Mpa**

Comments:

Reported by: R. Serluca, Lab Tech., January 20, 2018

Name, Title, Date

Reviewed by: G.Qu, Jan. 23, 2018

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Uniaxial Compressive Strength of Intact Rock Core Specimens - Method C:
ASTM D7012-10

HATCH
Geotechnical Laboratory

Date:	February 5. 2018	Baffinland Iron Mines Corporation
Project Number:	H/353004	2275 Upper Middle Road East, Oakville Ont.
Project:	**Mary River Expansion Project**	**Attention: G.Qu**

Sample	**Bedrock Core Sample from 17.90 m.**
Source	**BH17-EBC-2**

Core Sample Data

Length:	13.580	**cm**		**Weight:**	1133.5	**grams**
Diameter:	6.342	**cm**		**Density:**	2.64	**g/cm³**
Area:	31.580	**cm²**		**Maximum Load:**	510	**kN**
Volume:	428.99	**cm³**		**U.C.S.**	161.5	**Mpa**

Comments:

Reported by: R. Serluca, Lab Tech., February 5, 2018

Name, Title, Date

Reviewed by: G.Qu, Feb.6, 2018

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Uniaxial Compressive Strength of Intact Rock Core Specimens - Method C:
ASTM D7012-10

HATCH
Geotechnical Laboratory

Date: January 29. 2018
Project Number: H/353004
Project: **Mary River Expansion Project**

Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Oakville Ont.
Attention: G.Qu

Sample	**Bedrock Core Sample from 20.75 m**
Source	**BH17-M008-R**

Core Sample Data						
Length:	12.854	**cm**		**Weight:**	1043.0	**grams**
Diameter:	6.325	**cm**		**Density:**	2.58	**g/cm³**
Area:	31.421	**cm²**		**Maximum Load:**	182	**kN**
Volume:	403.881	**cm³**		**U.C.S.**	57.9	**Mpa**

Comments:

Reported by: R. Serluca, Lab Tech., January 20, 2018
Name, Title, Date

Reviewed by: G.Qu, Jan.23, 2018
Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Uniaxial Compressive Strength of Intact Rock Core Specimens - Method C:
ASTM D7012-10

HATCH
Geotechnical Laboratory

Date: January 29. 2018
Project Number: H/353004
Project: **Mary River Expansion Project**

Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Oakville Ont.
Attention: G.Qu

Sample	**Bedrock Core Sample from 21.05 m**
Source	**BH17-M008-R**

Core Sample Data						
Length:	15.008	**cm**		**Weight:**	1216.5	**grams**
Diameter:	6.327	**cm**		**Density:**	2.58	**g/cm³**
Area:	31.440	**cm²**		**Maximum Load:**	145	**kN**
Volume:	471.859	**cm³**		**U.C.S.**	46.1	**Mpa**

Comments:

Reported by: R. Serluca, Lab Tech., January 20, 2018
Name, Title, Date

Reviewed by: G. Qu, Jan. 23, 2018
Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Uniaxial Compressive Strength of Intact Rock Core Specimens - Method C:
ASTM D7012-10

HATCH
Geotechnical Laboratory

Date: January 29. 2018
Project Number: H/353004
Project: **Mary River Expansion Project**

Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Oakville Ont.
Attention: G. Qu

Sample	**Bedrock Core Sample from 21.42 m**
Source	**BH17-M008-R**

Core Sample Data

Length:	13.902	**cm**		**Weight:**	1127.3	**grams**
Diameter:	6.328	**cm**		**Density:**	2.58	**g/cm³**
Area:	31.450	**cm²**		**Maximum Load:**	298	**kN**
Volume:	437.224	**cm³**		**U.C.S.**	94.8	**Mpa**

Comments:

Reported by: R. Serluca, Lab Tech., January 20, 2018
Name, Title, Date

Reviewed by: Q. Qu, Jan.23, 2018
Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

15 February 2017
File: TB152049

Hatch Ltd.
4342 Queen St., Suite 500
Niagara Falls, ON
L2E 7J7 Canada

Attention: **Mr. Warren R. Hoyle, P.Geo.**

RE: **PHYSICAL TESTING OF BEDROCK CORE AND ROCK LUMPS**

1.0 INTRODUCTION

We are pleased to present the results of our Amec Foster Wheeler Hamilton laboratory testing conducted on rock lump samples provided by HATCH Limited (HATCH). It is understood the rock lump and bedrock core samples were sampled in January 2017 by a representative of Hatch. These samples were received in our laboratory on 26 January 2017.

2.0 METHODLOGY

A total of four pails of rock grab samples (4-8 inch) and bedrock cores were provided for physical durability testing. The aggregate was crushed using a laboratory crusher at Amec Foster Wheeler Hamilton Laboratory. The material was crushed to produce a 20mm coarse aggregate to be tested.

Testing of the 20mm crushed core samples was limited to:

Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	(CSA A23.2 - 29A)
Sieve Analysisof Coarse and Fine Aggregate	(CSA A23.2 - 2A)
Relative Density and Absorption of Coarse Aggregate	(CSA A23.2 - 12A)
Resistance of Unconfined Coarse Aggregate to Freezing and Thawing	(CSA A23.2 - 24A)

505 Woodward Avenue, Unit 1
Hamilton, Ontario L8H 6N6
Tel +1 905 312 0700
Fax +1 905 312 0771
amecfw.com

The results of testing are summarized in Table 1.

3.0 RESULTS

Table 1. Results of the Physical Testing Crushed Aggregate Sample

Test Required	Test Method	Laboratory Test Results			
		NF17-01	NF17-02	NF17-03	NF17-04
Relative Density (Specific Gravity)	CSA A23.2 - 12A	**2.662**	**2.655**	**2.618**	**2.995**
Absorption (%)	CSA A23.2 - 12A	**0.82**	**0.90**	**0.37**	**0.45**
Micro-Deval Abrasion (% loss)	CSA A23.2 - 29A	**10.5**	**11.0**	**4.5**	**7.9**
Unconfined Freeze-Thaw (% loss)	CSA A23.2 - 24A	**6.7**	**11.1**	**1.6**	**0.8**

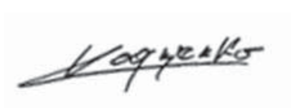
Presented in Enclosures 1 through 4 are the gradation results of the coarse portion of each sample.

Please contact us if you have any questions, or if we can be of further service evaluating aggregate sources.

Regards,

Amec Foster Wheeler Environment & Infrastructure
a Division of Amec Foster Wheeler Americas Limited

Reviewed by,



Ognjenko Lazic
Asphalt & Concrete
Laboratory Supervisor

Kristen Hand
Soils & Aggregate
Laboratory Supervisor

LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2 - 15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Job No.:	Client:	Sampled By:	Enclosure:
TB152049	Hatch Ltd.	Client	2

Name of Testing Laboratory:	Telephone No.:	Fax No.:
Amec Foster Wheeler Environment & Infrastructure	(905) 312 - 0700	(905) 312 - 0771

Sample Lab No.:	Sample Source:
S018-17	NF17-01

Sample Type:	Date Sampled:	Stockpile Quantity (t)
Crushed Core	January 2017	--

COARSE AGGREGATE

Nominal Max. Size (mm):	Aggregrate Inventory No.:	Gradation Results:	Meets Spec.: (Y/N)
20 mm	n/a	n/a	n/a

Limits for Deleterious Substances and Physical Properties of Aggregates

CSA Laboratory Test and Number	Acceptance Limits Maximum percentage by mass of total sample		Reference Material Results	Sample Results	Meets Spec. Y / N
Standard Requirements	**Concrete exposed to freezing & thawing**	**Other exposure conditions**			
Clay lumps - A23.2 - 3A †****	0.3 % maximum	0.5 % maximum	-	-	-
Low - density granular materials - A23.2 - 4A‡****	0.5 % maximum	1 % maximum	-	-	-
Material finer than 80 μm - A23.2 - 5A**	1% maximum[1]	1% maximum[1]	-	-	-
Absorption - A23.2 - 12A	-		0.37%	**0.82%**	-
Flat & elongated particles, Procedure A, 4:1 - A23.2-13A	20.0 % maximum	20.0 % maximum	-	-	-
Micro-Deval test - A23.2 - 29A	17 % maximum	21 % maximum	14.0%	**10.5%**	**Y**
Unconfined freeze-thaw test - A23.2 - 24A‡‡	6 % maximum	10 % maximum	9.5%	**6.7%**	**N/Y**
Abrasion loss - A23.2 - 16A and A23.2 - 17A§§	50 % maximum	50 % maximum	-	-	-
Petrographic examination of aggregate - A23.2 -15A	125 maximum	140 maximum	-	-	-
Alkali-Carbonate reactivity - A23.2 - 26A	chem. comp. must plot in non-exp. field		-	-	-
Accelerated mortar bar - A23.2 - 25A	maximum 0.150% at 14 days		-	-	-
Concrete prism - A23.2 - 14A	maximum 0.040% at one year		-	-	-
Alternative Requirements* **					
$MgSO_4$ soundness loss - A23.2 - 9A	12 % maximum	18 % maximum	-	-	-

Issued By: Kristen Hand (Print Name) — [signature] (Testing Laboratory Representative Signature) — 14 February 2017 (Date)

LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2-15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Enclosure: **2**

*Limits for deleterious substances not listed in this Table, such as coal, ochre (ironstone), shalestone, siltstone, or argillaceous limestone, shall be specified by the owner to encompass deleterious materials known to be present in a particular region. In the absence of such information, aggregate shall be accepted or rejected in accordance with clause 4.2.3.9

†Clay lumps are defined as fine-grained, consolidated, sedimentary materials of a hydrous aluminosilicate nature.

‡A liquid with a relative density of 2.0 is generally used to separate particles classified as coal or lignite. Liquids with relative densities higher or lower than 2.0 might be required to identify other deleterious low-density materials.

The amount of material of clay size shall be determined by performing a hydrometer analysis as per ASTM D 422 on a sample washed through an 80 μm sieve.

**In the case of crushed aggregate, if material finer than the 80 μm sieve consists of the dust of fracture, essentially free from clay or shale, the maximum shall be 2.0%

‡‡CSA A23.2-24A, a test for coarse aggregate, has good precision and shows fair correlation with the MgSO4 soundness test. For further information, see Rogers, Senior, & Boothe (1989)

§§The abrasion loss shall not be greater than 35% when the aggregate is used in concrete paving or for other concrete surfaces subjected to significant wear. This does not refer to air- cooled iron blast-furnace-slag coarse aggregate. The abrasion loss requirements for coarse aggregate shall be waived provided that the material meets the alternative requirements for Micro-deval detailed in this Table.

***The freeze-thaw requirements for coarse aggregate shall be waived provided that the material meets the laternative requirements for $MgSO_4$ soundness loss detailed in this Table.

****If the Coarse Aggregate when tested according to A23.2-15A does not show the presence of either clay lumps or low-density granular materials, the requirements for testing in accordance with 3A and 4A may be waived.

[1]This limit applies to the amount of material finer than 80μm as determined by washing only.

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SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

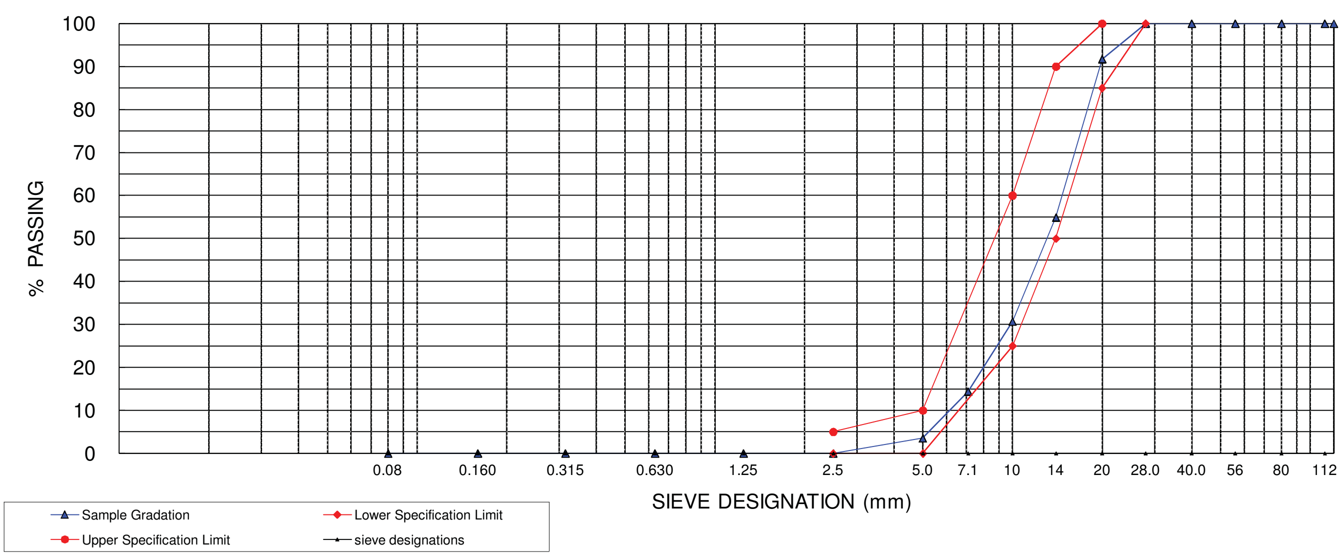
CSA A23.2-2A

Enclosure: 1
Date: 14 February 2017
Project No: TB152049

Client: Hatch
Sample Source: NF17-01
Sampled By: Client
Date Sampled: January 2017
Sample Type: Crushed Core
Specification: CSA A23.1-14, August 2014, Table 11, Group I, 20-5mm Concrete Stone Grading Requirements for Coarse Aggregate

Lab No: S018-17
Date Received: 26 January 2017
Date Tested: 6 February 2017
Lab Technician: KH

SIEVE SIZES (mm)	120	112	80	56	40.0	28.0	20	14	10	7.1	5	2.5	1.25	0.630	0.315	0.160	0.08
SPECIFICATIONS	-	-	-	-	-	100.0	85-100	50-90	25-60	-	0-10	0-5	-	-	-	-	-
% PASSING	100.0	100.0	100.0	100.0	100.0	100.0	91.7	54.9	30.7	14.4	3.5						
% RETAINING	0.0	0.0	0.0	0.0	0.0	0.0	8.3	45.1	69.3	85.6	96.5						



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TM-MAT-1005A-05

LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2 - 15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Job No.: TB152049	Client: Hatch Ltd	Sampled By: Client	Enclosure: 2
Name of Testing Laboratory: Amec Foster Wheeler Environment & Infrastructure		Telephone No.: (905) 312 - 0700	Fax No.: (905) 312 - 0771
Sample Lab No.: S019-17	Sample Source: NF17-02		
Sample Type: Crushed Core		Date Sampled: January 2017	Stockpile Quantity (t) --

COARSE AGGREGATE

Nominal Max. Size (mm):	Aggregrate Inventory No.:	Gradation Results:	Meets Spec.: (Y/N)
20 mm	n/a	n/a	n/a

Limits for Deleterious Substances and Physical Properties of Aggregates

CSA Laboratory Test and Number	Acceptance Limits – Maximum percentage by mass of total sample		Reference Material Results	Sample Results	Meets Spec. Y / N
Standard Requirements	**Concrete exposed to freezing & thawing**	**Other exposure conditions**			
Clay lumps - A23.2 - 3A †****	0.3 % maximum	0.5 % maximum	-	-	-
Low - density granular materials - A23.2 - 4A‡****	0.5 % maximum	1 % maximum	-	-	-
Material finer than 80 µm - A23.2 - 5A**	1% maximum[1]	1% maximum[1]	-	-	-
Absorption - A23.2 - 12A	-		0.37%	**0.90%**	-
Flat & elongated particles, Procedure A, 4:1 - A23.2-13A	20.0 % maximum	20.0 % maximum	-	-	-
Micro-Deval test - A23.2 - 29A	17 % maximum	21 % maximum	14.0%	**11.0%**	**Y**
Unconfined freeze-thaw test - A23.2 - 24A‡‡	6 % maximum	10 % maximum	9.5%	**11.1%**	**N**
Abrasion loss - A23.2 - 16A and A23.2 - 17A§§	50 % maximum	50 % maximum	-	-	-
Petrographic examination of aggregate - A23.2 -15A	125 maximum	140 maximum	-	-	-
Alkali-Carbonate reactivity - A23.2 - 26A	chem. comp. must plot in non-exp. field		-	-	-
Accelerated mortar bar - A23.2 - 25A	maximum 0.150% at 14 days		-	-	-
Concrete prism - A23.2 - 14A	maximum 0.040% at one year		-	-	-
Alternative Requirements* **					
$MgSO_4$ soundness loss - A23.2 - 9A	12 % maximum	18 % maximum			

Issued By: Kristen Hand — Print Name

[signature] — Testing Laboratory Representative Signature

14 February 2017 — Date

LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2-15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Enclosure: **2**

*Limits for deleterious substances not listed in this Table, such as coal, ochre (ironstone), shalestone, siltstone, or argillaceous limestone, shall be specified by the owner to encompass deleterious materials known to be present in a particular region. In the absence of such information, aggregate shall be accepted or rejected in accordance with clause 4.2.3.9

†Clay lumps are defined as fine-grained, consolidated, sedimentary materials of a hydrous aluminosilicate nature.

‡A liquid with a relative density of 2.0 is generally used to separate particles classified as coal or lignite. Liquids with relative densities higher or lower than 2.0 might be required to identify other deleterious low-density materials.

The amount of material of clay size shall be determined by performing a hydrometer analysis as per ASTM D 422 on a sample washed through an 80 µm sieve.

**In the case of crushed aggregate, if material finer than the 80 µm sieve consists of the dust of fracture, essentially free from clay or shale, the maximum shall be 2.0%

‡‡CSA A23.2-24A, a test for coarse aggregate, has good precision and shows fair correlation with the MgSO4 soundness test. For further information, see Rogers, Senior, & Boothe (1989)

§§The abrasion loss shall not be greater than 35% when the aggregate is used in concrete paving or for other concrete surfaces subjected to significant wear. This does not refer to air- cooled iron blast-furnace-slag coarse aggregate. The abrasion loss requirements for coarse aggregate shall be waived provided that the material meets the alternative requirements for Micro-deval detailed in this Table.

***The freeze-thaw requirements for coarse aggregate shall be waived provided that the material meets the laternative requirements for $MgSO_4$ soundness loss detailed in this Table.

****If the Coarse Aggregate when tested according to A23.2-15A does not show the presence of either clay lumps or low-density granular materials, the requirements for testing in accordance with 3A and 4A may be waived.

[1]This limit applies to the amount of material finer than 80µm as determined by washing only.

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SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

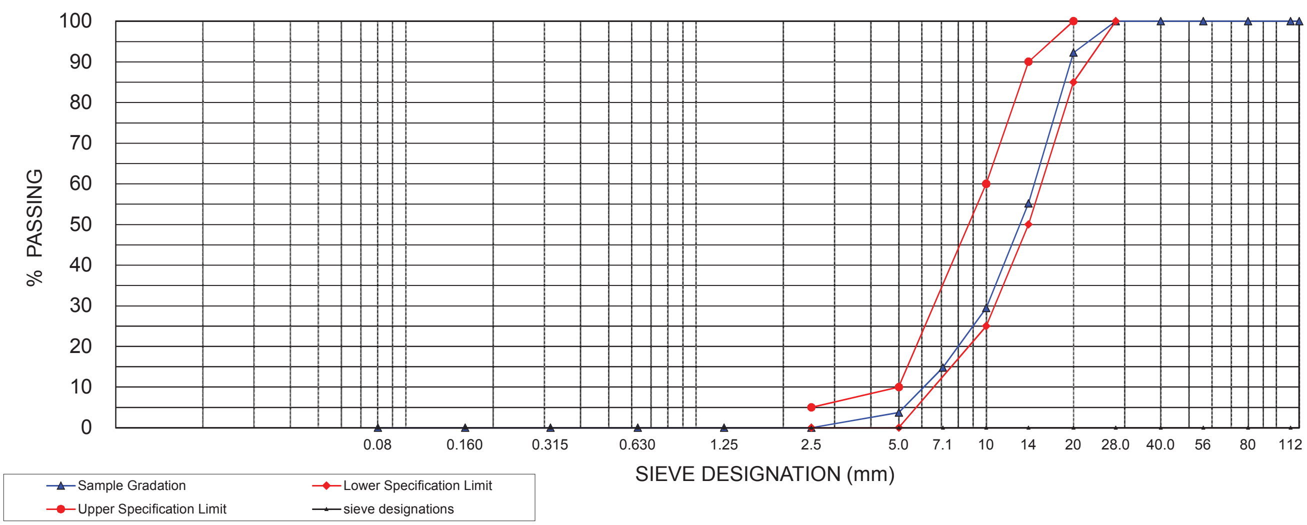
CSA A23.2-2A

Enclosure: 1
Date: 14 February 2017
Project No: TB152049

Client: Hatch Ltd
Sample Source: NF17-02
Sampled By: Client
Date Sampled: January 2017
Sample Type: Crushed Core
Specification: CSA A23.1-14, August 2014, Table 11, Group I, 20-5mm Concrete Stone
Grading Requirements for Coarse Aggregate

Lab No: S019-17
Date Received: 26 January 2017
Date Tested: 6 February 2017
Lab Technician: KH

SIEVE SIZES (mm)	120	112	80	56	40.0	28.0	20	14	10	7.1	5	2.5	1.25	0.630	0.315	0.160	0.08
SPECIFICATIONS	-	-	-	-	-	100.0	85-100	50-90	25-60	-	0-10	0-5	-	-	-	-	-
% PASSING	100.0	100.0	100.0	100.0	100.0	100.0	92.3	55.2	29.4	14.8	3.7						
% RETAINING	0.0	0.0	0.0	0.0	0.0	0.0	7.7	44.8	70.6	85.2	96.3						



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LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2 - 15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

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Job No.:	Client:	Sampled By:	Enclosure:
TB152049	Hatch Ltd.	Client	2

Name of Testing Laboratory:	Telephone No.:	Fax No.:
Amec Foster Wheeler Environment & Infrastructure	(905) 312 - 0700	(905) 312 - 0771

Sample Lab No.:	Sample Source:
S020-17	NF17-03

Sample Type:	Date Sampled:	Stockpile Quantity (t)
Crushed Core	Janaury 2017	--

COARSE AGGREGATE

Nominal Max. Size (mm):	Aggregrate Inventory No.:	Gradation Results:	Meets Spec.: (Y/N)
20 mm	n/a	n/a	n/a

Limits for Deleterious Substances and Physical Properties of Aggregates

CSA Laboratory Test and Number	Acceptance Limits Maximum percentage by mass of total sample		Reference Material Results	Sample Results	Meets Spec. Y / N
Standard Requirements	**Concrete exposed to freezing & thawing**	**Other exposure conditions**			
Clay lumps - A23.2 - 3A †****	0.3 % maximum	0.5 % maximum	-	-	-
Low - density granular materials - A23.2 - 4A‡****	0.5 % maximum	1 % maximum	-	-	-
Material finer than 80 µm - A23.2 - 5A**	1% maximum[1]	1% maximum[1]	-	-	-
Absorption - A23.2 - 12A	-		0.37%	**0.37%**	-
Flat & elongated particles, Procedure A, 4:1 - A23.2-13A	20.0 % maximum	20.0 % maximum	-	-	-
Micro-Deval test - A23.2 - 29A	17 % maximum	21 % maximum	14.0%	**4.5%**	Y
Unconfined freeze-thaw test - A23.2 - 24A‡‡	6 % maximum	10 % maximum	9.5%	**1.6%**	Y
Abrasion loss - A23.2 - 16A and A23.2 - 17A§§	50 % maximum	50 % maximum	-	-	-
Petrographic examination of aggregate - A23.2 -15A	125 maximum	140 maximum	-	-	-
Alkali-Carbonate reactivity - A23.2 - 26A	chem. comp. must plot in non-exp. field		-	-	-
Accelerated mortar bar - A23.2 - 25A	maximum 0.150% at 14 days		-	-	-
Concrete prism - A23.2 - 14A	maximum 0.040% at one year		-	-	-
Alternative Requirements* **					
$MgSO_4$ soundness loss - A23.2 - 9A	12 % maximum	18 % maximum			

Issued By: Kristen Hand (Print Name) — [signature] (Testing Laboratory Representative Signature) — 14 February 2017 (Date)

LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2-15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Enclosure: **2**

*Limits for deleterious substances not listed in this Table, such as coal, ochre (ironstone), shalestone, siltstone, or argillaceous limestone, shall be specified by the owner to encompass deleterious materials known to be present in a particular region. In the absence of such information, aggregate shall be accepted or rejected in accordance with clause 4.2.3.9

†Clay lumps are defined as fine-grained, consolidated, sedimentary materials of a hydrous aluminosilicate nature.

‡A liquid with a relative density of 2.0 is generally used to separate particles classified as coal or lignite. Liquids with relative densities higher or lower than 2.0 might be required to identify other deleterious low-density materials.

The amount of material of clay size shall be determined by performing a hydrometer analysis as per ASTM D 422 on a sample washed through an 80 µm sieve.

**In the case of crushed aggregate, if material finer than the 80 µm sieve consists of the dust of fracture, essentially free from clay or shale, the maximum shall be 2.0%

‡‡CSA A23.2-24A, a test for coarse aggregate, has good precision and shows fair correlation with the MgSO4 soundness test. For further information, see Rogers, Senior, & Boothe (1989)

§§The abrasion loss shall not be greater than 35% when the aggregate is used in concrete paving or for other concrete surfaces subjected to significant wear. This does not refer to air- cooled iron blast-furnace-slag coarse aggregate. The abrasion loss requirements for coarse aggregate shall be waived provided that the material meets the alternative requirements for Micro-deval detailed in this Table.

***The freeze-thaw requirements for coarse aggregate shall be waived provided that the material meets the laternative requirements for $MgSO_4$ soundness loss detailed in this Table.

****If the Coarse Aggregate when tested according to A23.2-15A does not show the presence of either clay lumps or low-density granular materials, the requirements for testing in accordance with 3A and 4A may be waived.

[1]This limit applies to the amount of material finer than 80µm as determined by washing only.

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

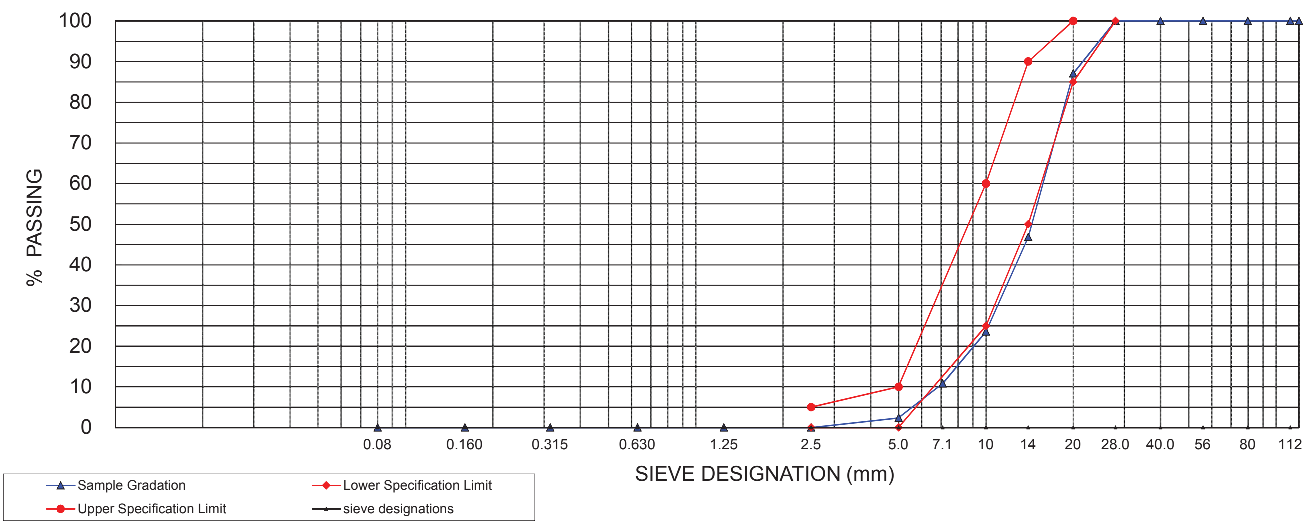
CSA A23.2-2A

Enclosure: 1
Date: 14 February 2017
Project No: TB152049

Client: Hatch Ltd.
Sample Source: NF17-03
Sampled By: Client
Date Sampled: January 2017
Sample Type: Crushed Core
Specification: CSA A23.1-14, August 2014, Table 11, Group I, 20-5mm Concrete Stone Grading Requirements for Coarse Aggregate

Lab No: S020-17
Date Received: 26 January 2017
Date Tested: 6 February 2017
Lab Technician: KH
Fineness Modulus: #DIV/0!

SIEVE SIZES (mm)	120	112	80	56	40.0	28.0	20	14	10	7.1	5	2.5	1.25	0.630	0.315	0.160	0.08
SPECIFICATIONS	-	-	-	-	-	100.0	85-100	50-90	25-60	-	0-10	0-5	-	-	-	-	-
% PASSING	100.0	100.0	100.0	100.0	100.0	100.0	87.1	46.8	23.6	10.8	2.4						
% RETAINING	0.0	0.0	0.0	0.0	0.0	0.0	12.9	53.2	76.4	89.2	97.6						



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LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2 - 15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Job No.:	Client:	Sampled By:	Enclosure:
TB152049	Hatch Ltd.	Client	**2**

Name of Testing Laboratory:	Telephone No.:	Fax No.:
Amec Foster Wheeler Environment & Infrastructure	(905) 312 - 0700	(905) 312 - 0771

Sample Lab No.:	Sample Source:
S021-17	NF17-04

Sample Type:	Date Sampled:	Stockpile Quantity (t)
Crushed Rock	January 2017	--

COARSE AGGREGATE

Nominal Max. Size (mm):	Aggregrate Inventory No.:	Gradation Results:	Meets Spec.: (Y/N)
20 mm	n/a	n/a	n/a

Limits for Deleterious Substances and Physical Properties of Aggregates

CSA Laboratory Test and Number	Acceptance Limits Maximum percentage by mass of total sample		Reference Material Results	Sample Results	Meets Spec. Y / N
Standard Requirements	**Concrete exposed to freezing & thawing**	**Other exposure conditions**			
Clay lumps - A23.2 - 3A †****	0.3 % maximum	0.5 % maximum	-	-	-
Low - density granular materials - A23.2 - 4A‡****	0.5 % maximum	1 % maximum	-	-	-
Material finer than 80 μm - A23.2 - 5A**	1% maximum[1]	1% maximum[1]	-	-	-
Absorption - A23.2 - 12A	-		0.37%	**0.45%**	-
Flat & elongated particles, Procedure A, 4:1 - A23.2-13A	20.0 % maximum	20.0 % maximum	-	-	-
Micro-Deval test - A23.2 - 29A	17 % maximum	21 % maximum	14.0%	**7.9%**	**Y**
Unconfined freeze-thaw test - A23.2 - 24A‡‡	6 % maximum	10 % maximum	9.5%	**0.8%**	**Y**
Abrasion loss - A23.2 - 16A and A23.2 - 17A§§	50 % maximum	50 % maximum	-	-	-
Petrographic examination of aggregate - A23.2 -15A	125 maximum	140 maximum	-	-	-
Alkali-Carbonate reactivity - A23.2 - 26A	chem. comp. must plot in non-exp. field		-	-	-
Accelerated mortar bar - A23.2 - 25A	maximum 0.150% at 14 days		-	-	-
Concrete prism - A23.2 - 14A	maximum 0.040% at one year		-	-	-
Alternative Requirements* **					
$MgSO_4$ soundness loss - A23.2 - 9A	12 % maximum	18 % maximum			

Issued By: Kristen Hand (Print Name) — [signature] (Testing Laboratory Representative Signature) — 14 February 2017 (Date)

LIMITS FOR DELETERIOUS SUBSTANCES AND PHYSICAL PROPERTIES OF AGGREGATE

CSA A23.1 - 14, Table 11 & 12 and A23.2-15A & 27A, Rev. August 2014

Clauses 4.2.3.2.2, 4.2.3.4.3, 4.2.3.5.1, 4.2.3.5.3.3, 4.2.3.5.3.4, 4.2.3.7 & 4.2.3.10.1

Enclosure: **2**

*Limits for deleterious substances not listed in this Table, such as coal, ochre (ironstone), shalestone, siltstone, or argillaceous limestone, shall be specified by the owner to encompass deleterious materials known to be present in a particular region. In the absence of such information, aggregate shall be accepted or rejected in accordance with clause 4.2.3.9

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‡‡CSA A23.2-24A, a test for coarse aggregate, has good precision and shows fair correlation with the MgSO4 soundness test. For further information, see Rogers, Senior, & Boothe (1989)

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***The freeze-thaw requirements for coarse aggregate shall be waived provided that the material meets the laternative requirements for $MgSO_4$ soundness loss detailed in this Table.

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[1]This limit applies to the amount of material finer than 80µm as determined by washing only.

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SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

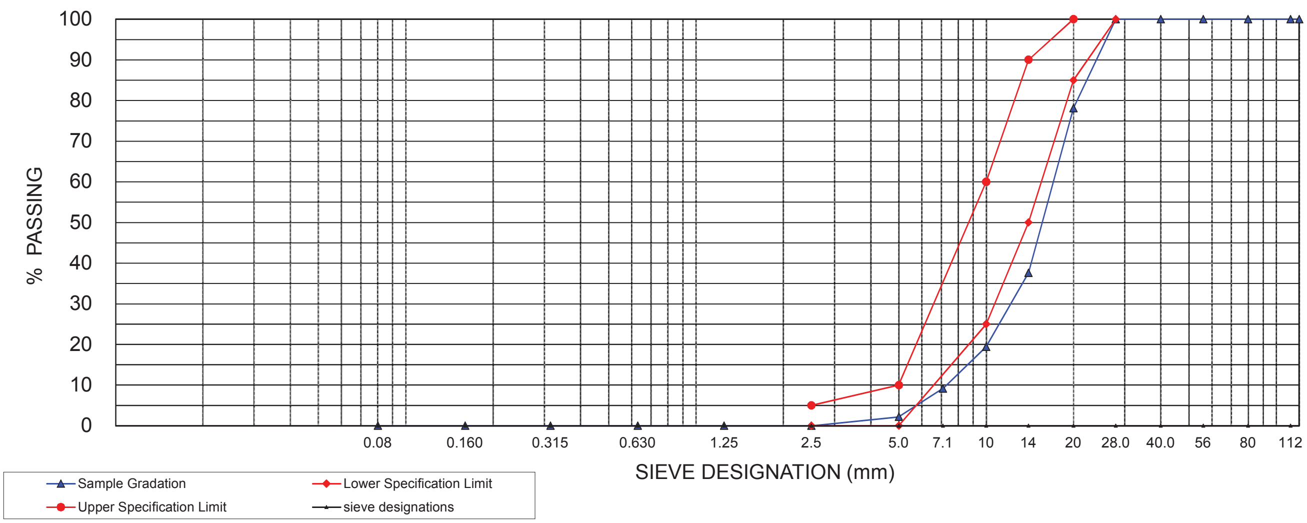
CSA A23.2-2A

Enclosure: 1
Date: 14 February 2017
Project No: TB152049

Client: Hatch Ltd.
Sample Source: NF17-04
Sampled By: Client
Date Sampled: January 2017
Sample Type: Crushed Rock
Specification: CSA A23.1-14, August 2014, Table 11, Group I, 20-5mm Concrete Stone
Grading Requirements for Coarse Aggregate

Lab No: S021-17
Date Received: 26 January 2017
Date Tested: 6 February 2017
Lab Technician: KH

SIEVE SIZES (mm)	120	112	80	56	40.0	28.0	20	14	10	7.1	5	2.5	1.25	0.630	0.315	0.160	0.08
SPECIFICATIONS	-	-	-	-	-	100.0	85-100	50-90	25-60	-	0-10	0-5	-	-	-	-	-
% PASSING	100.0	100.0	100.0	100.0	100.0	100.0	78.1	37.6	19.4	9.2	2.2						
% RETAINING	0.0	0.0	0.0	0.0	0.0	0.0	21.9	62.4	80.6	90.8	97.8						



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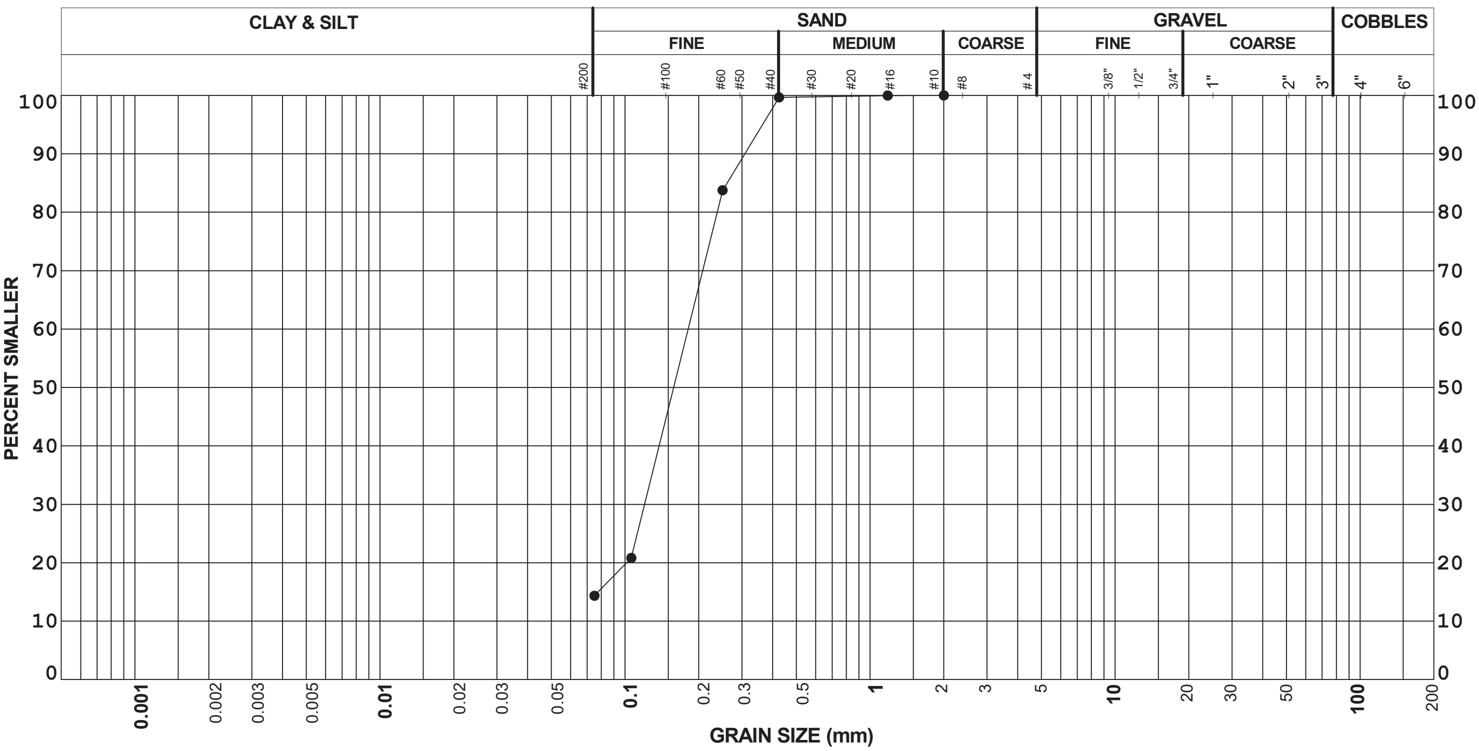
UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

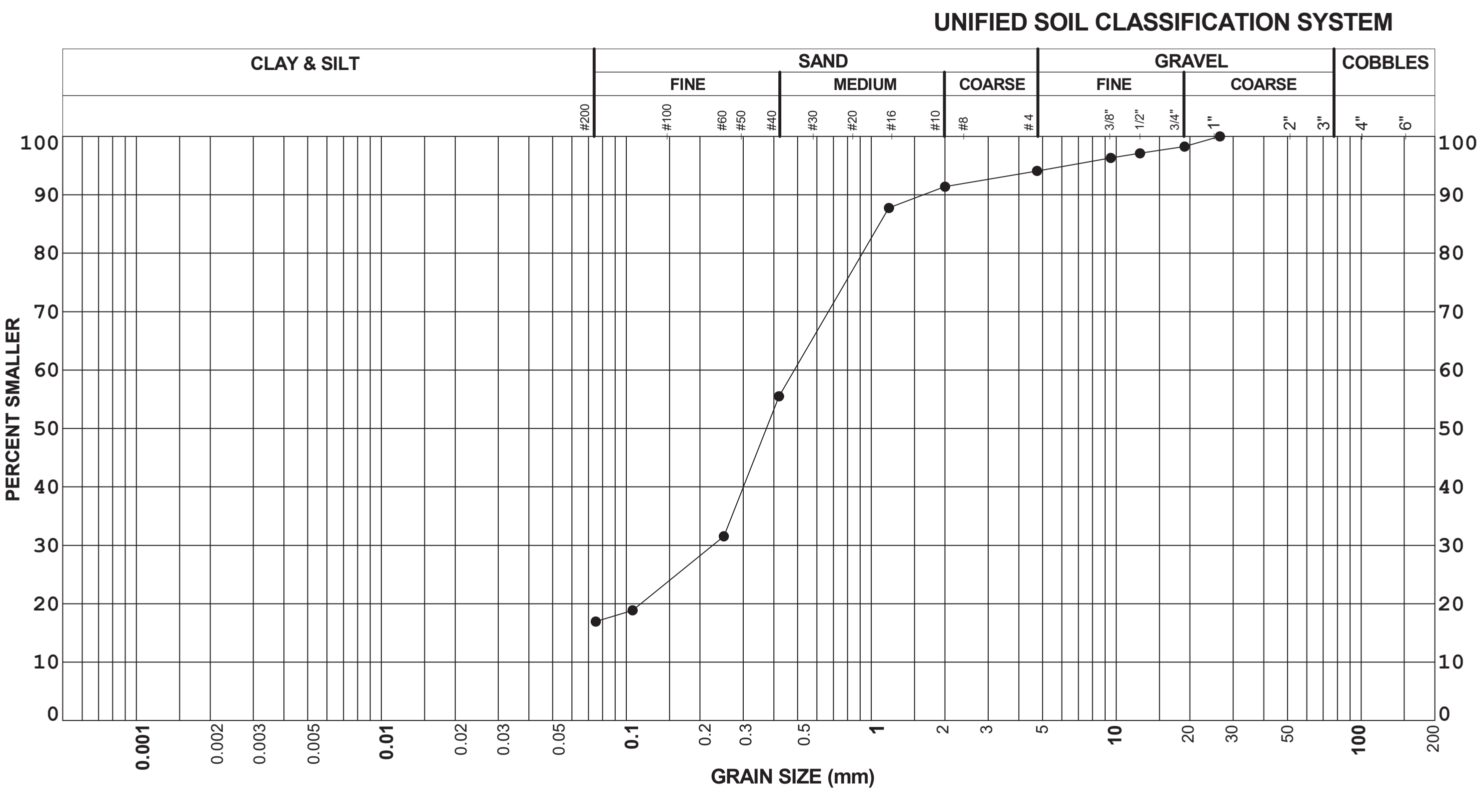
	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DS-1	2.40	0	86	14		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DQ-1	2.50	6	77	17		

REMARKS:

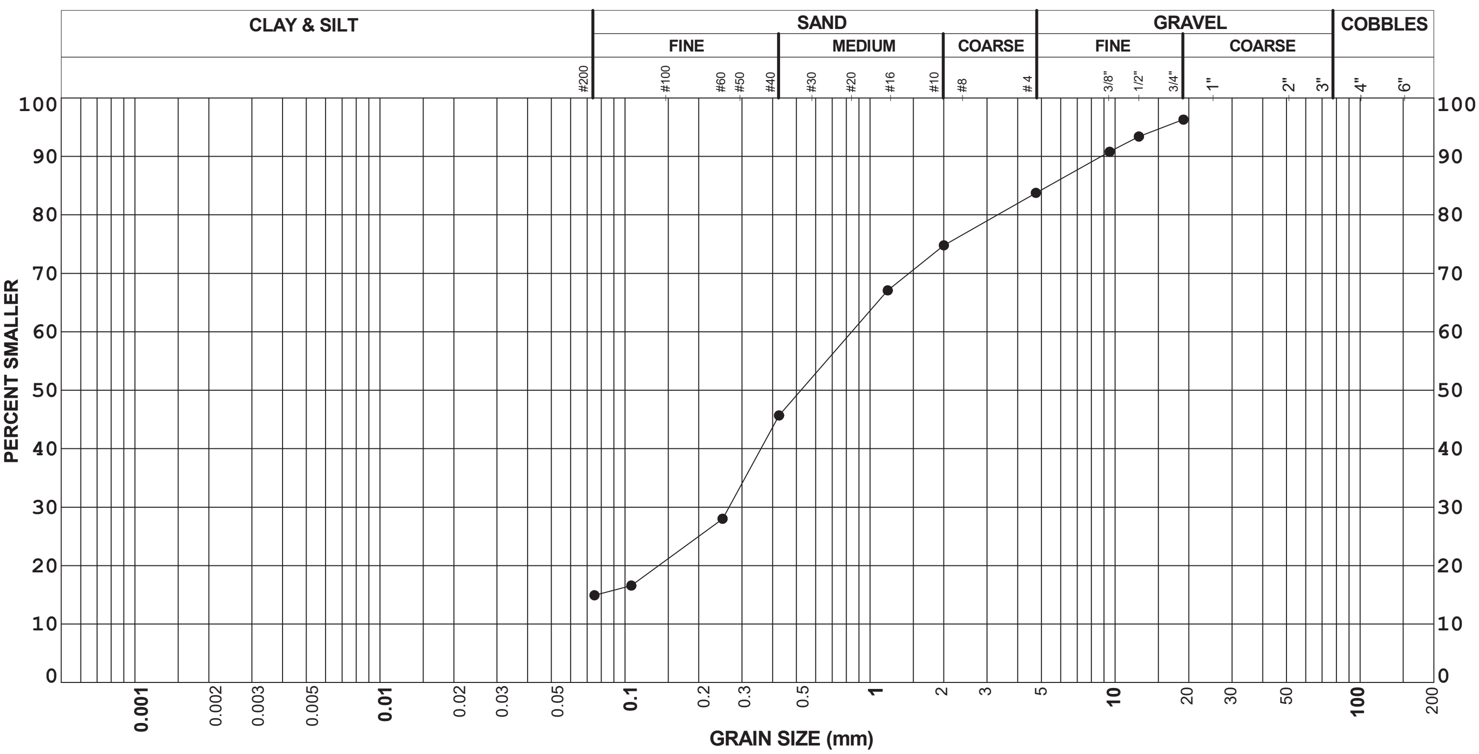
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DS-4	12.60	14	70	16		

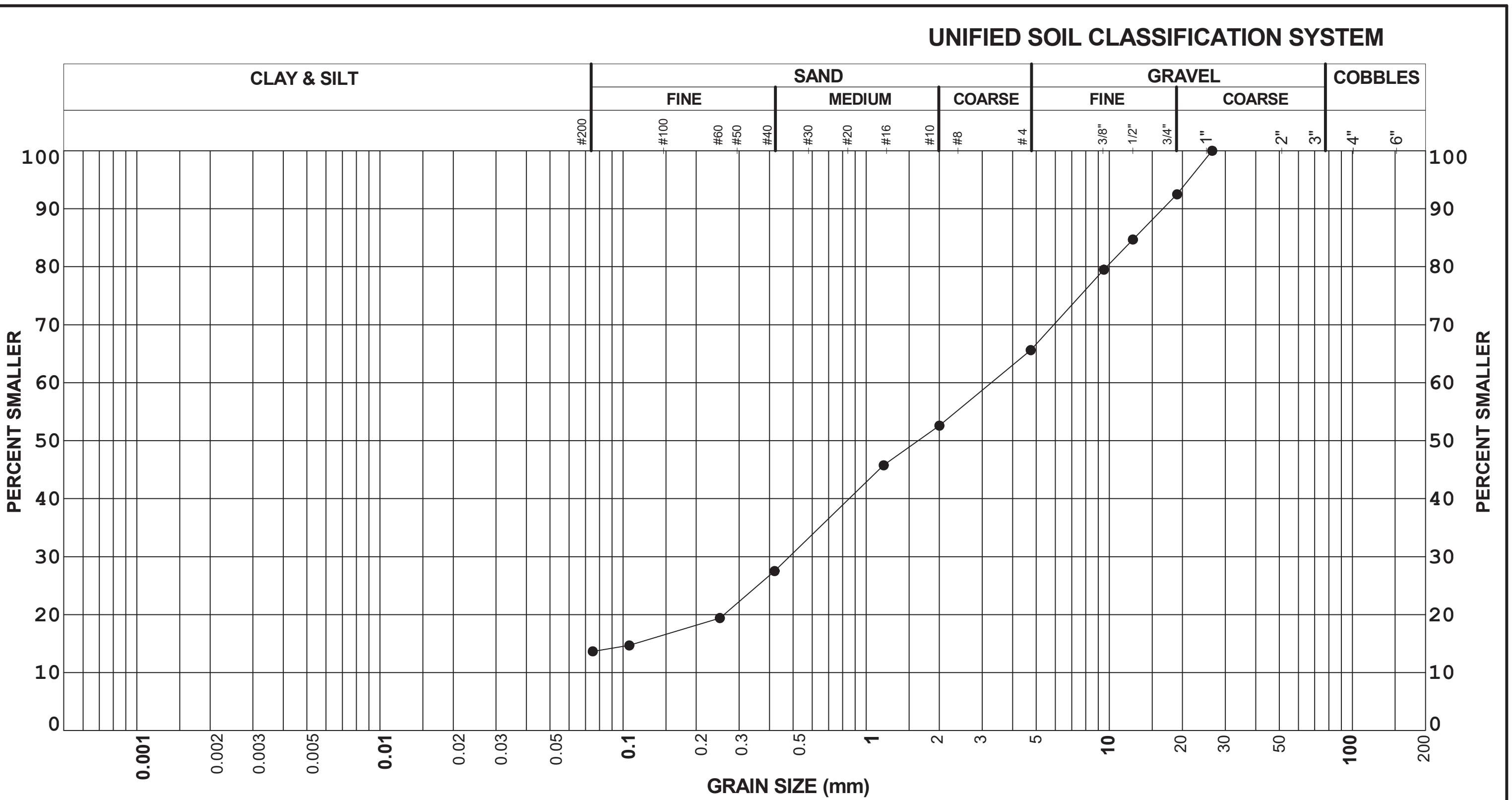
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DS-6	17.40	34	52	14		

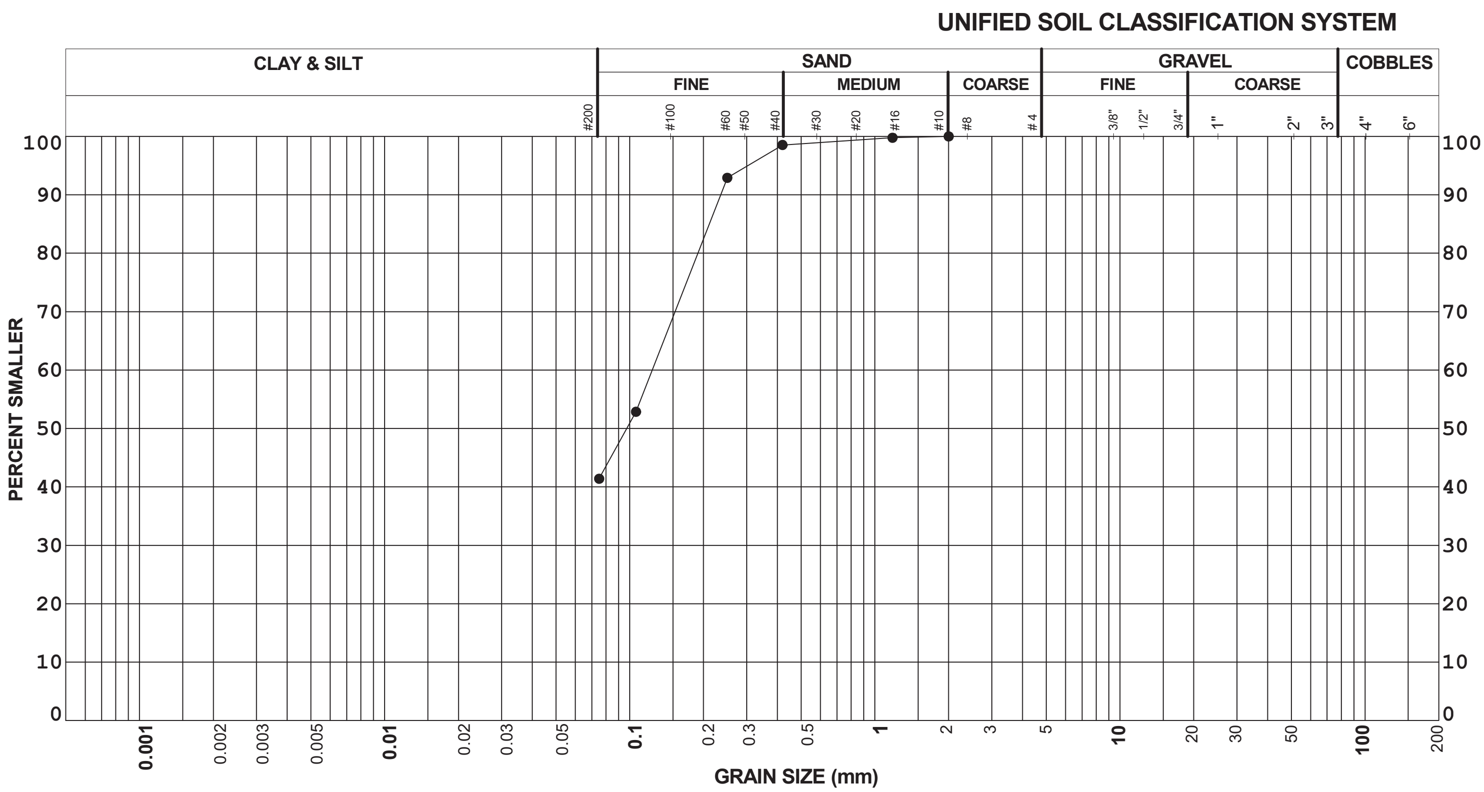
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DQ-8	21.00	0	59	41		

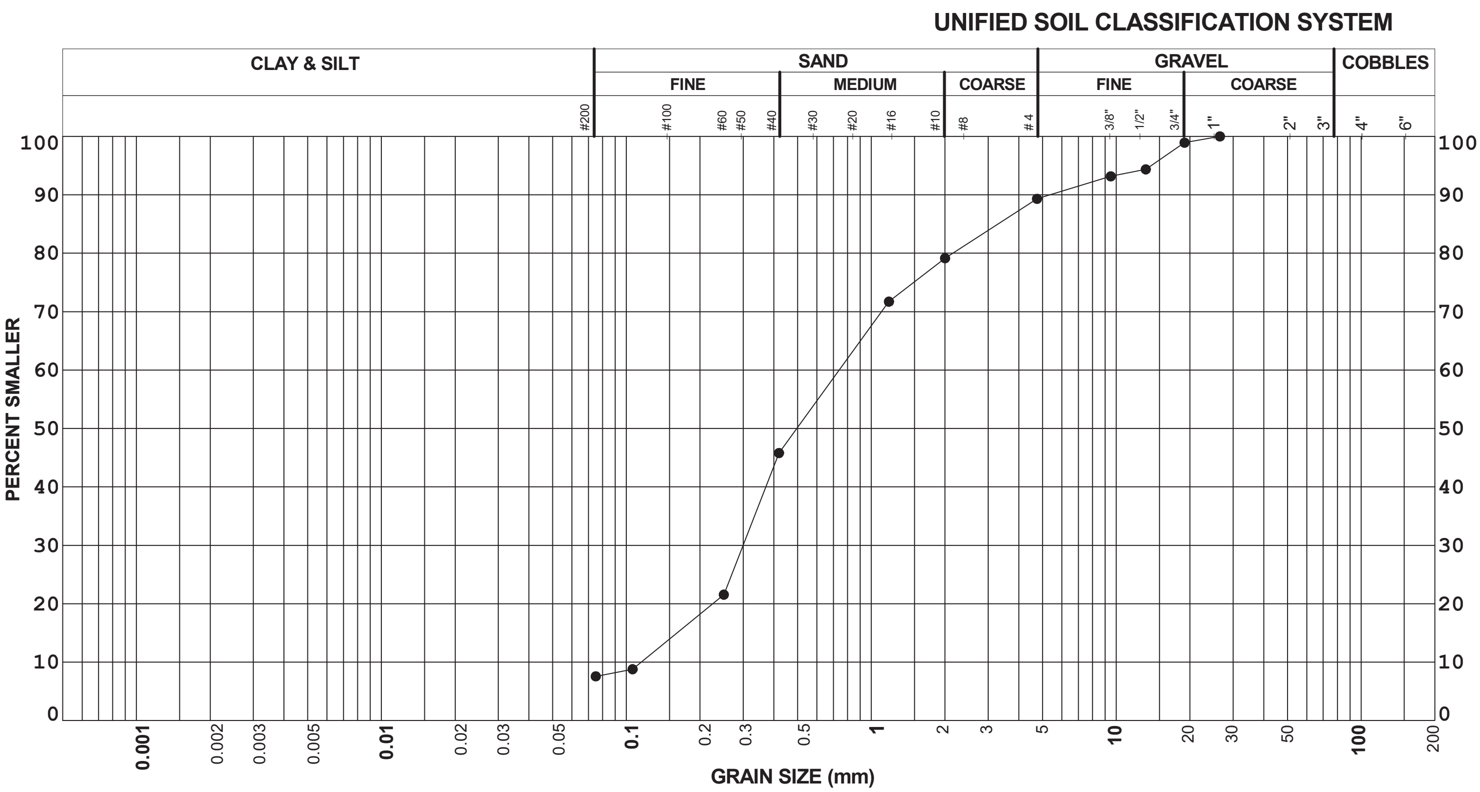
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DS-11	26.80	11	81	8		

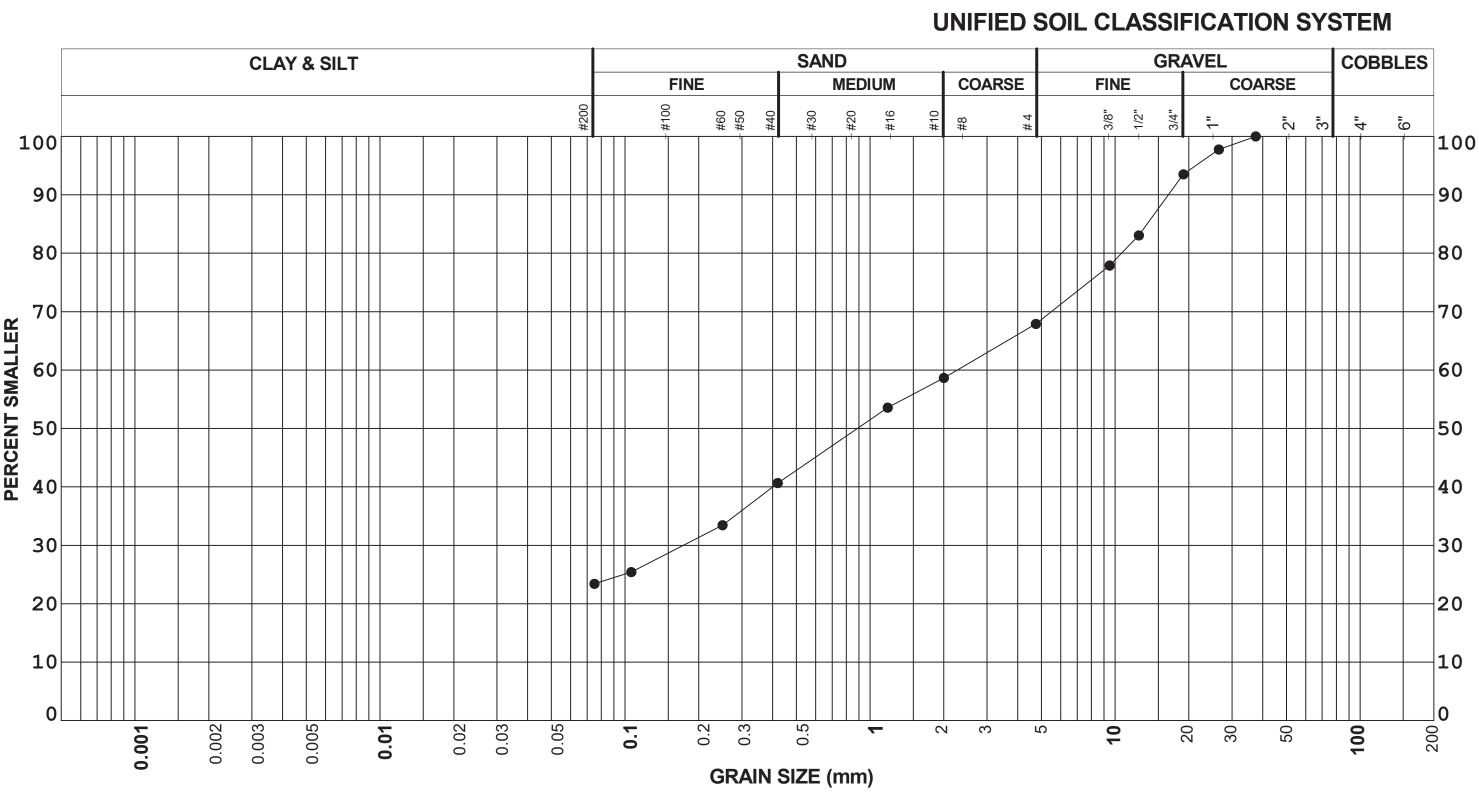
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DS-14	40.20	32	45	23		

REMARKS:

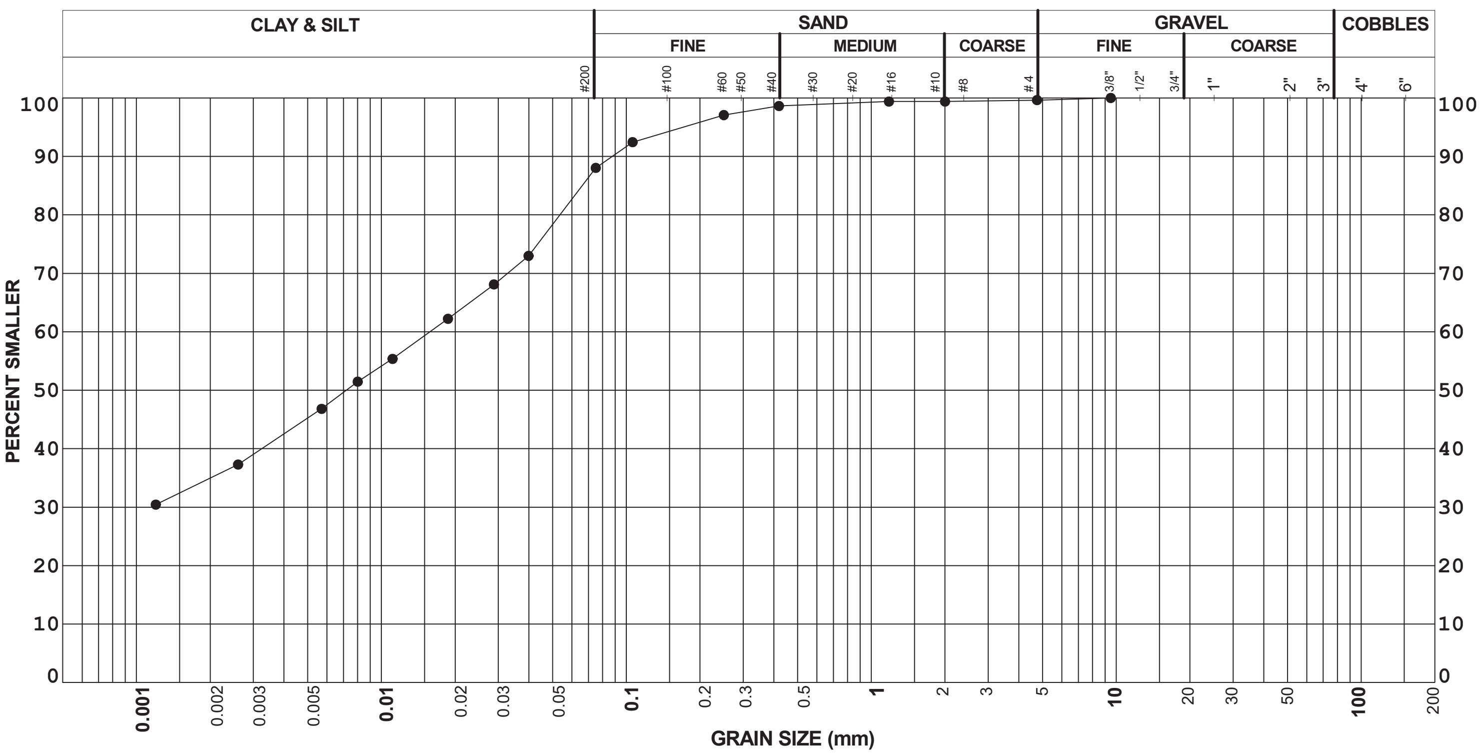
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DQ-16	42.70	0	12	88		

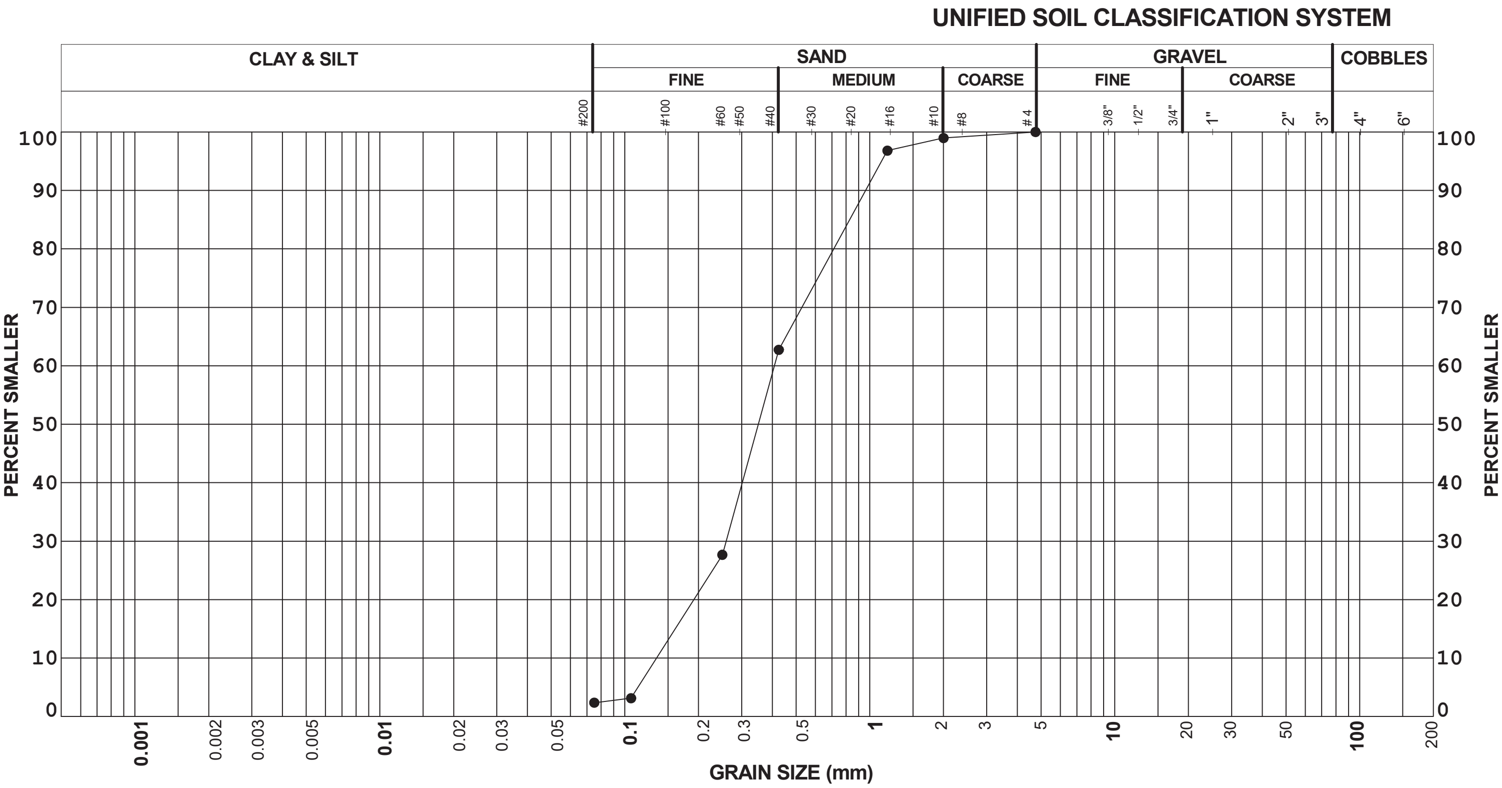
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DS-17	47.20	0	98	2		

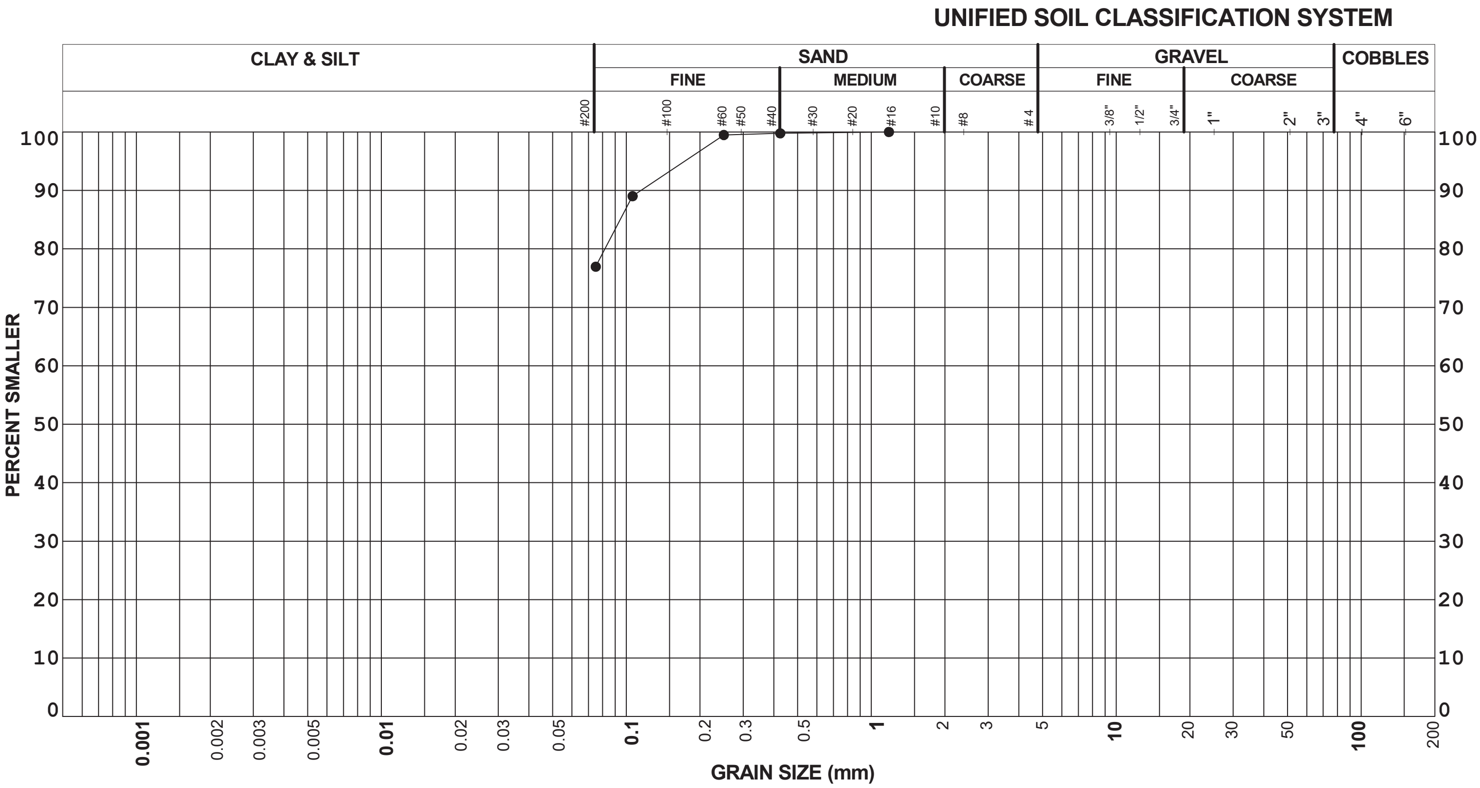
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DS-24	61.70	0	23	77		

REMARKS:

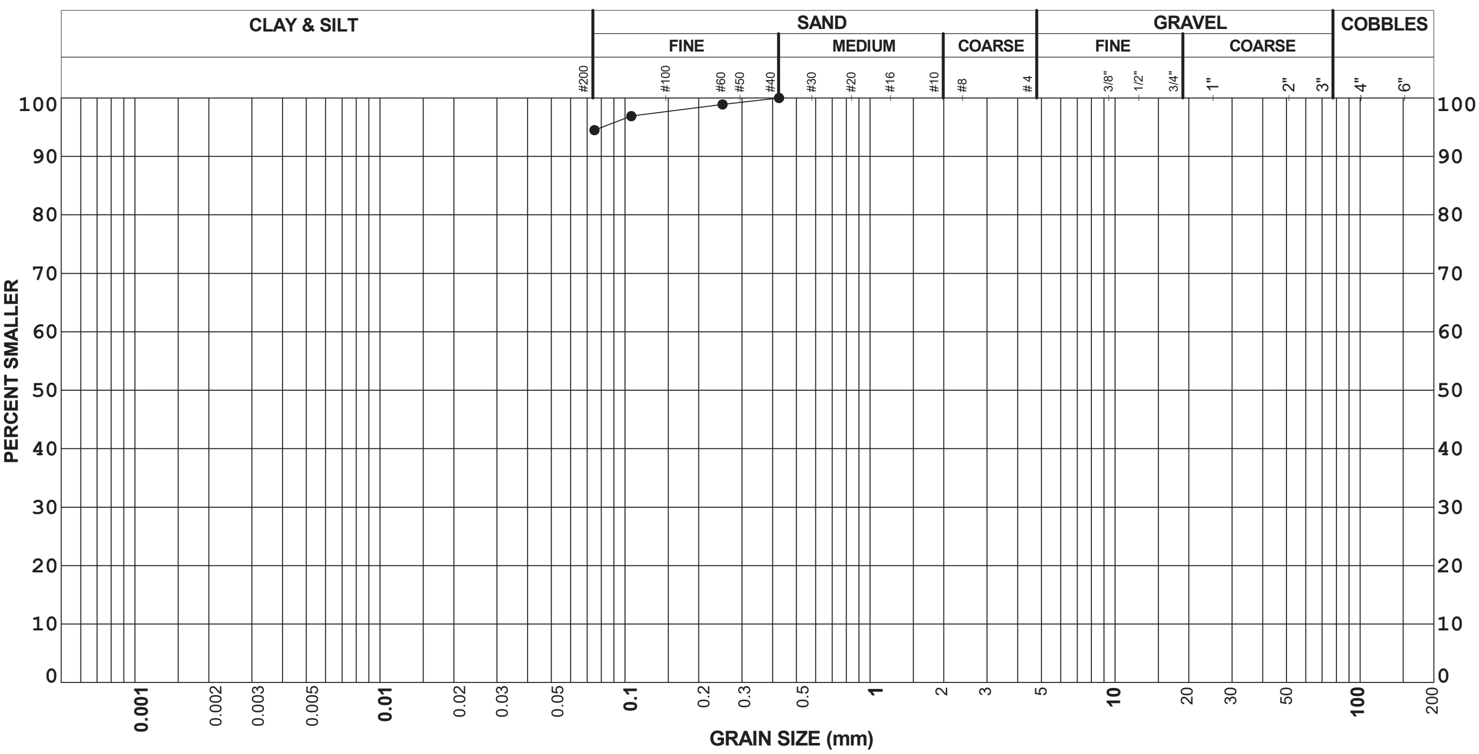
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DS-26	63.20	0	6	94		

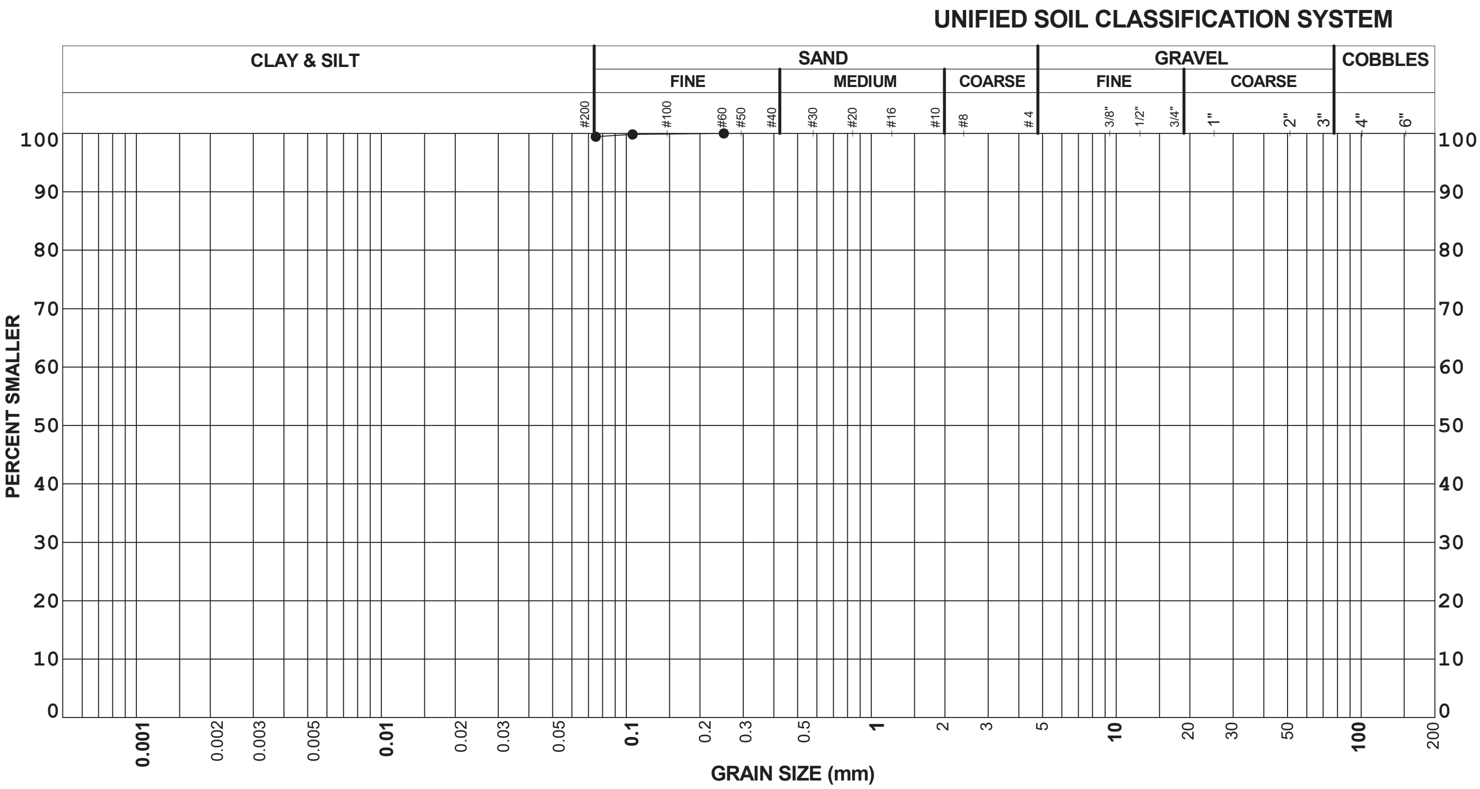
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DQ-28	68.90	0	1	99		

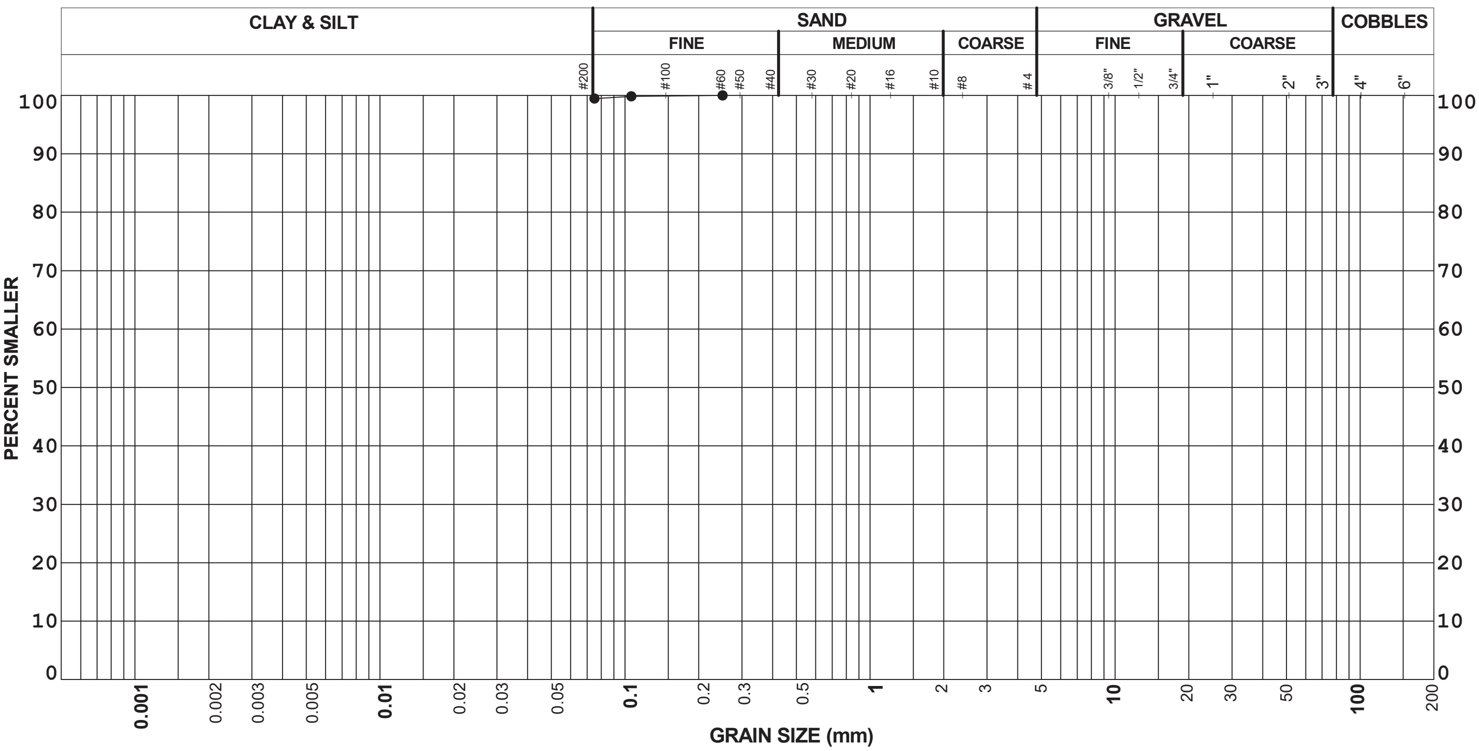
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-004	DS-29	70.50	0	1	99		

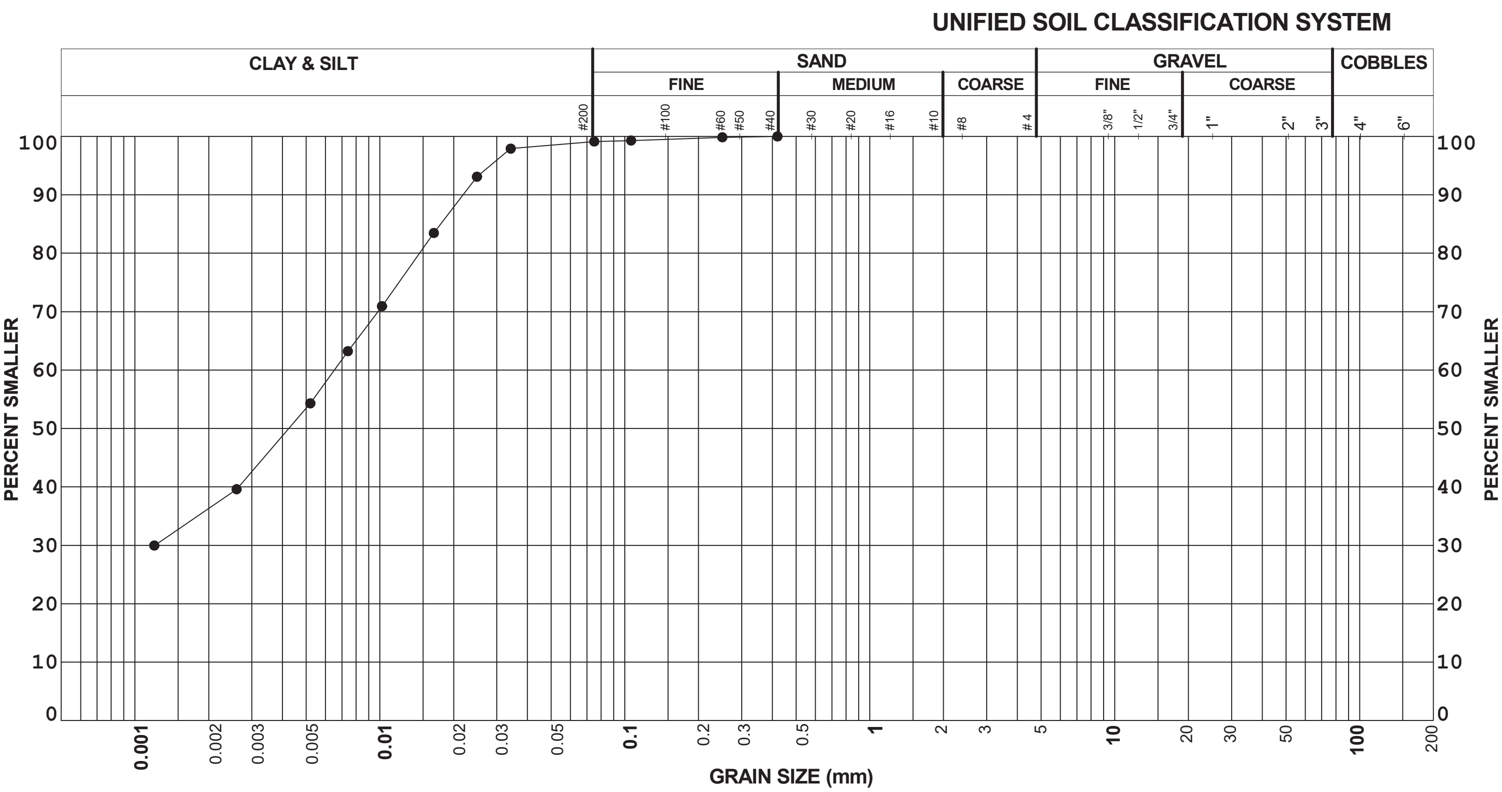
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



REMARKS:

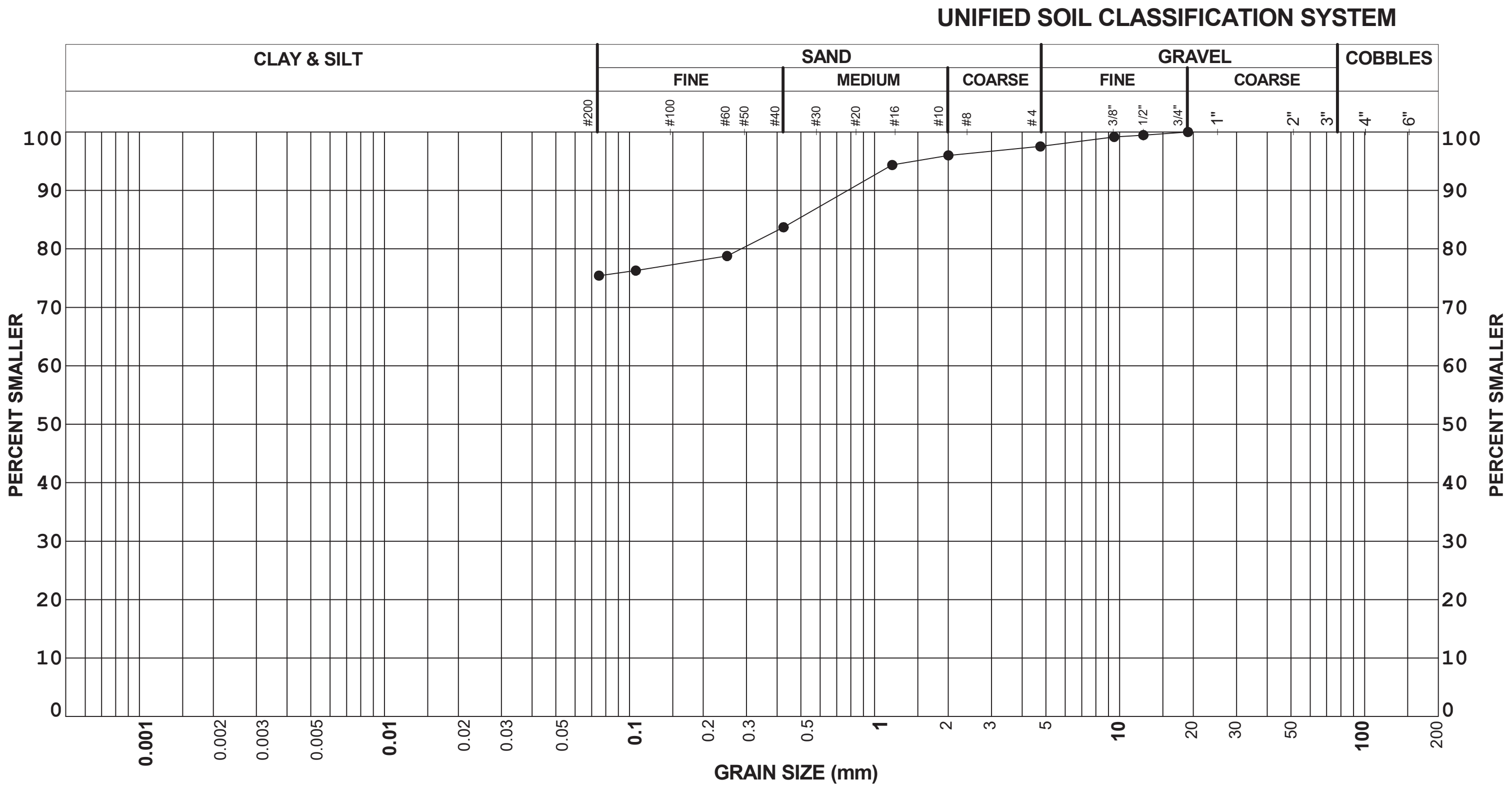
BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-004	DQ-30	72.00	0	1	99	33	14

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-3	0.90	2	23	75		

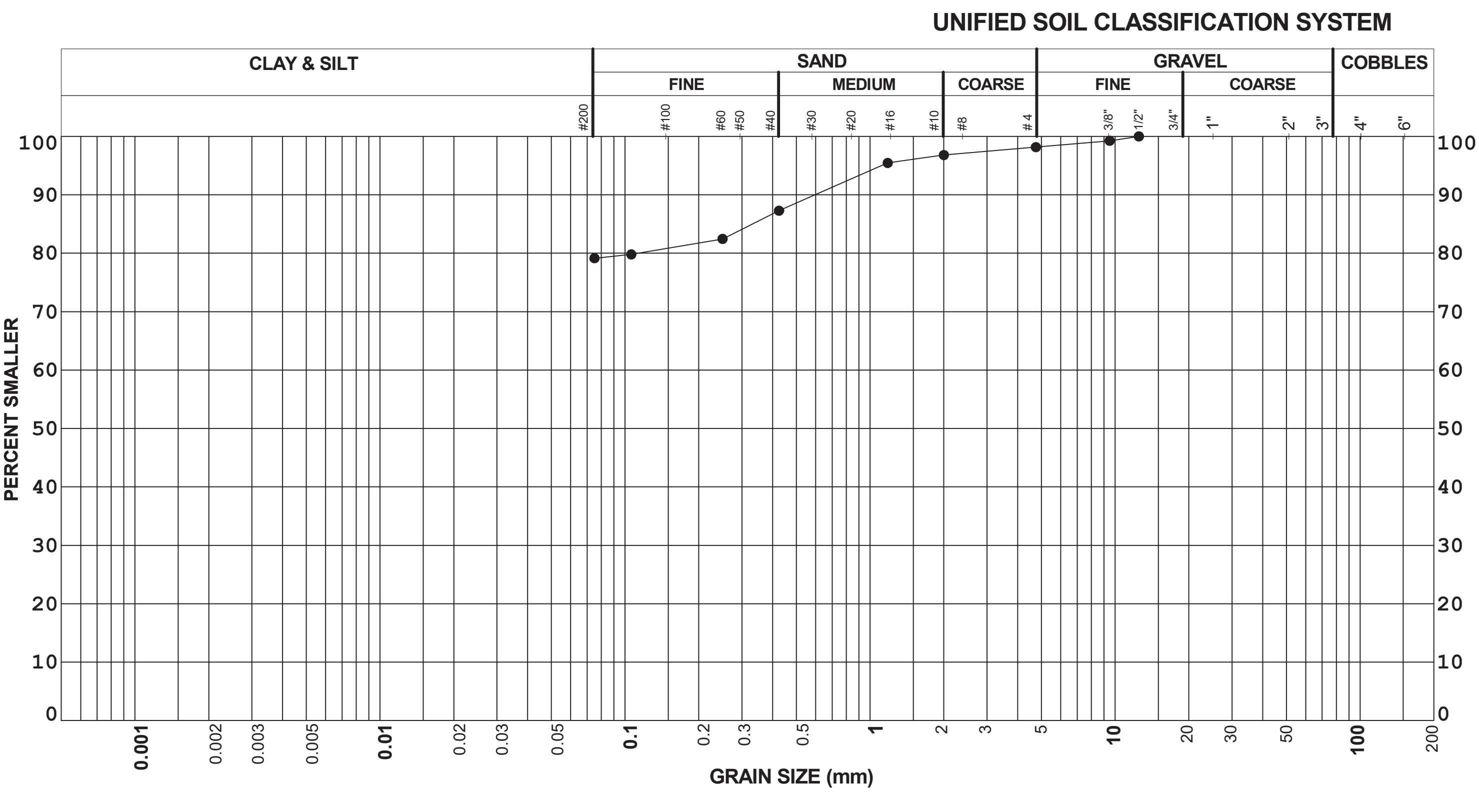
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



REMARKS:

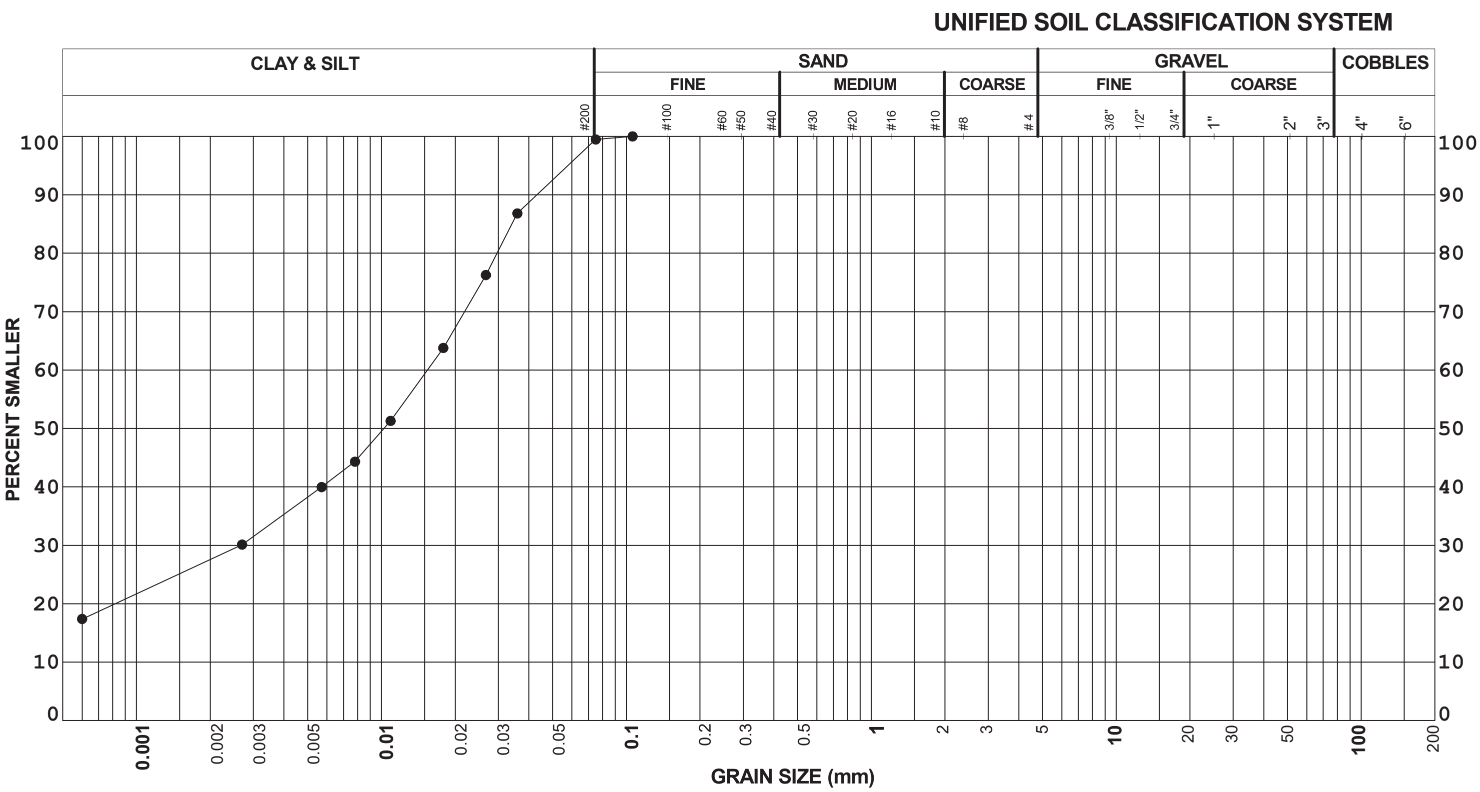
	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-M001	DS-5	2.40	2	19	79		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-6	7.00	0	1	99		

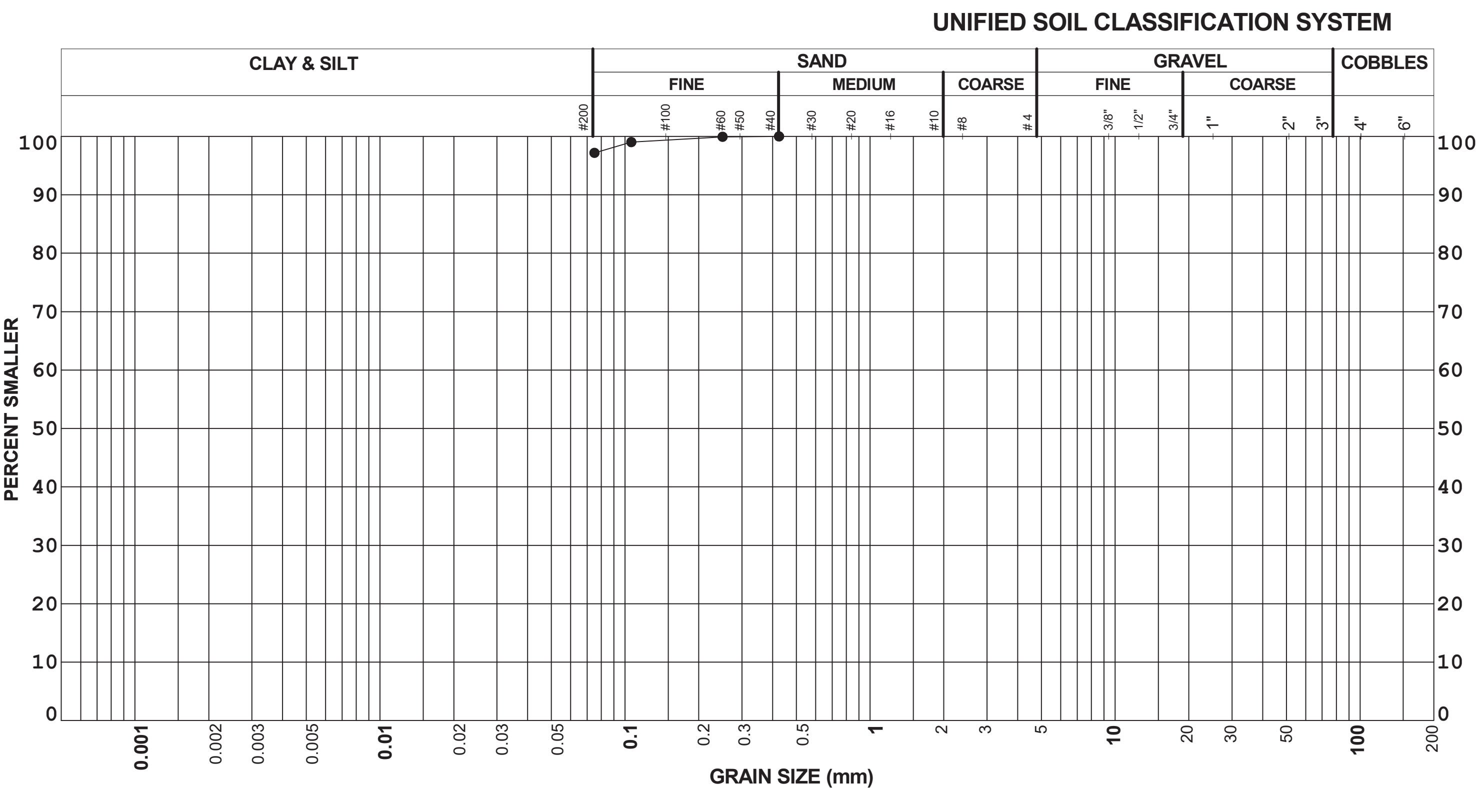
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-8	10.18	0	3	97		

REMARKS:

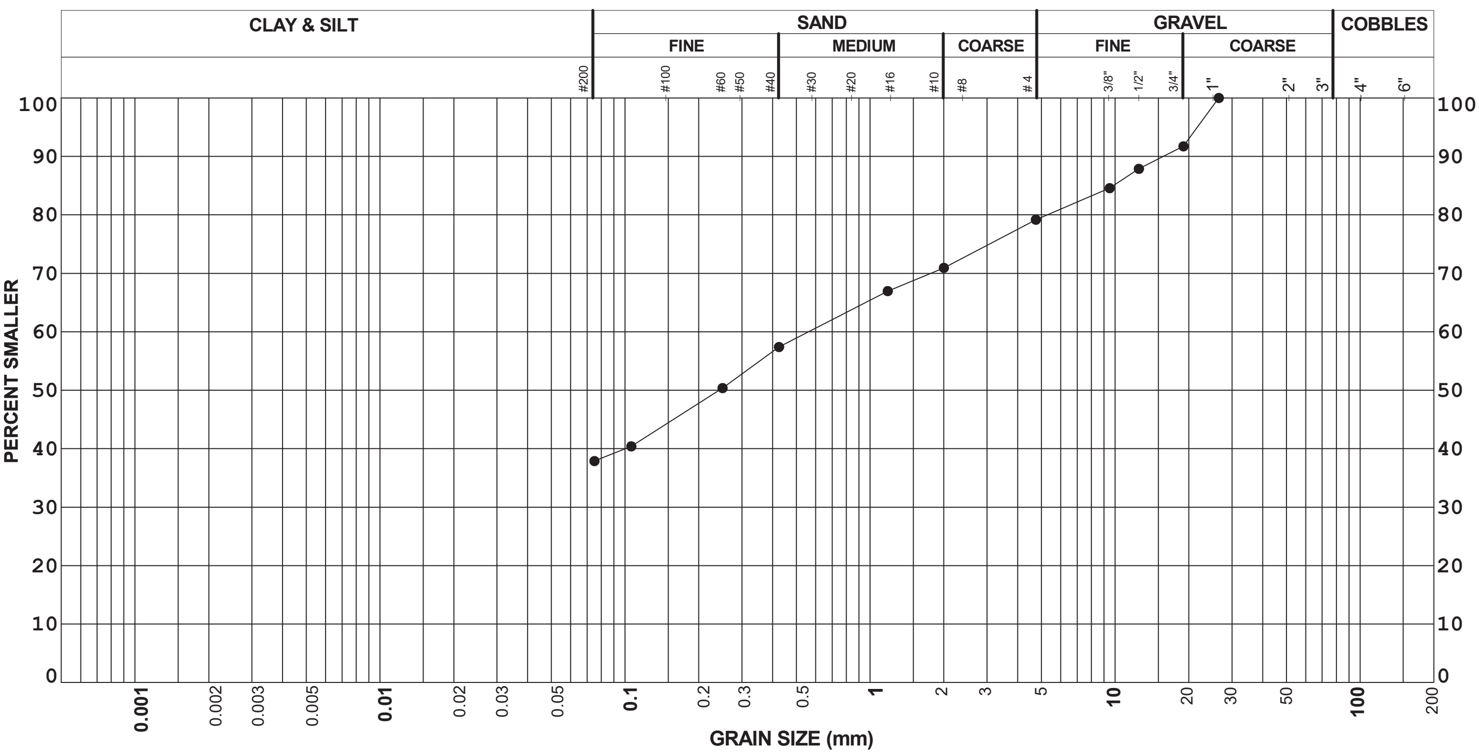
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-14	19.40	21	41	38		

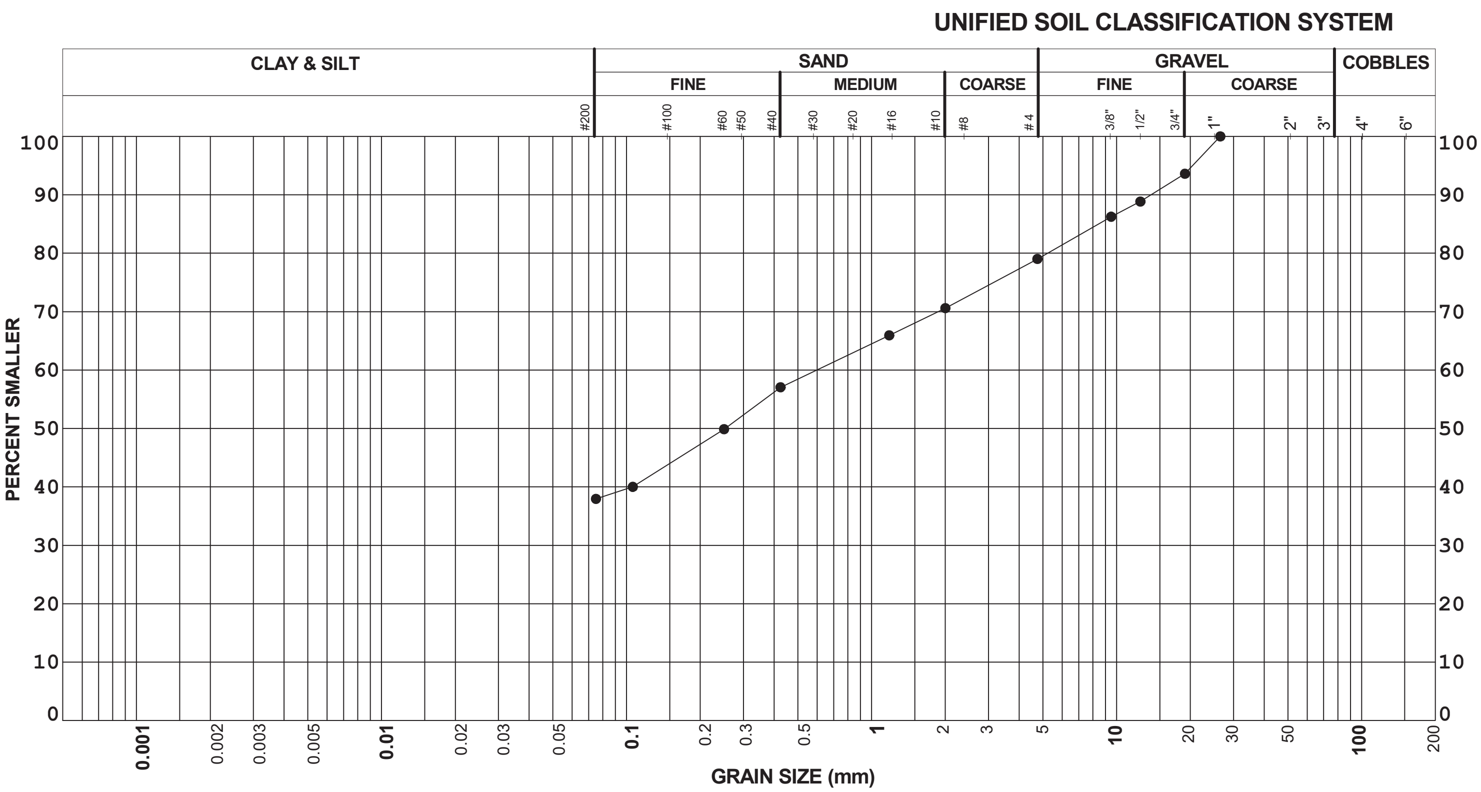
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-15	22.00	21	41	38		

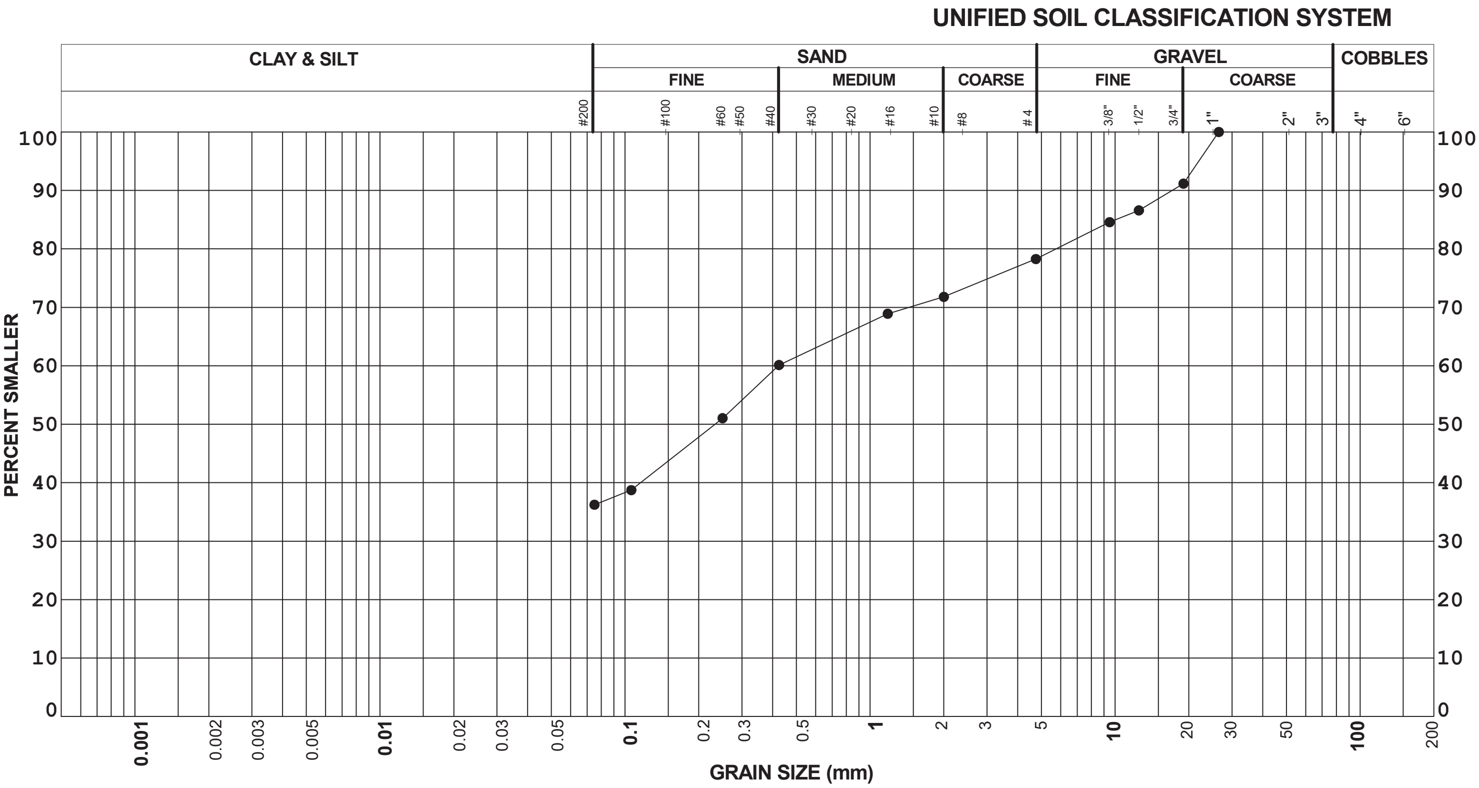
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-16	23.34	22	42	36		

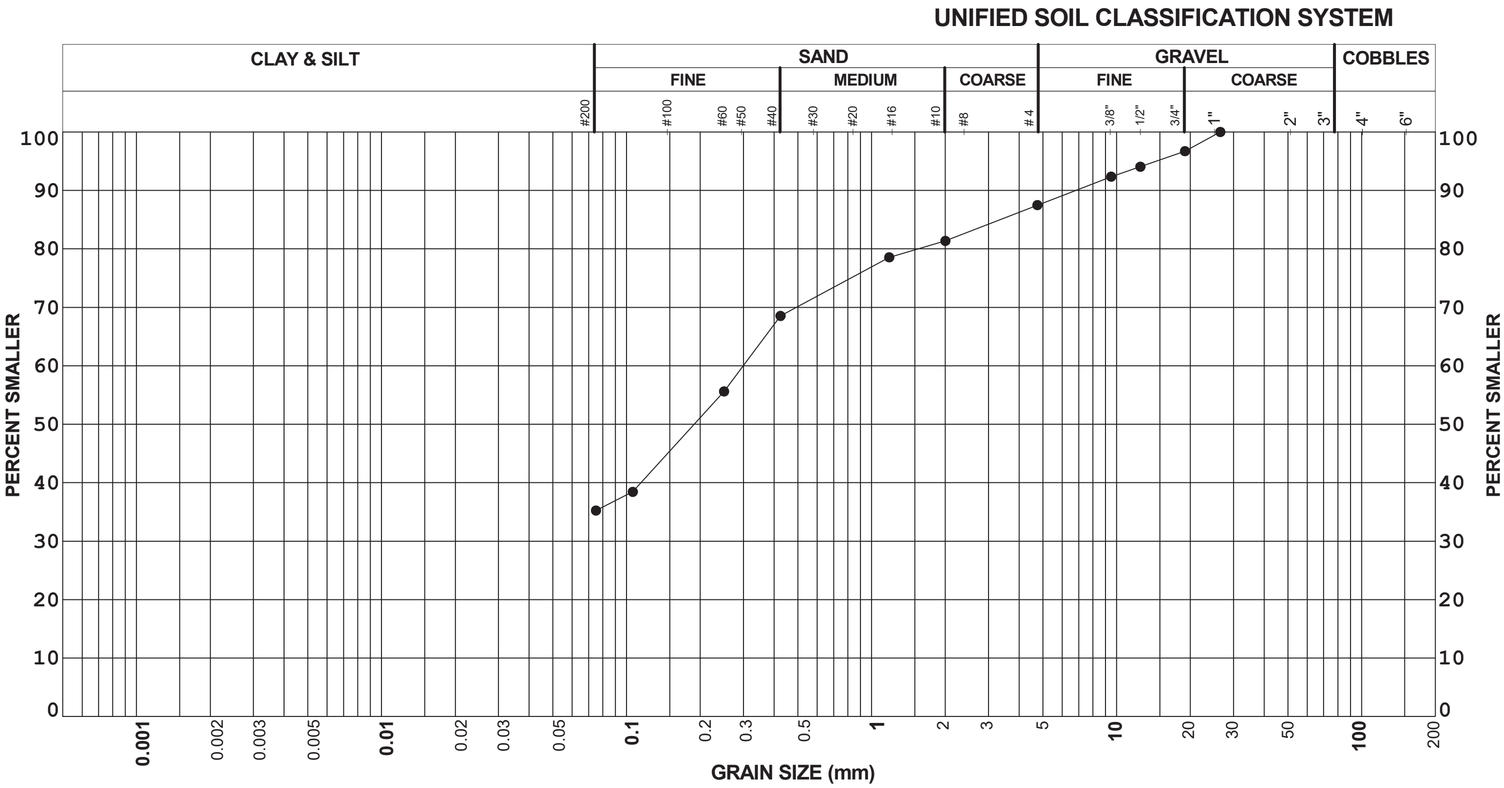
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M001	DS-17	25.35	13	52	35		

REMARKS:

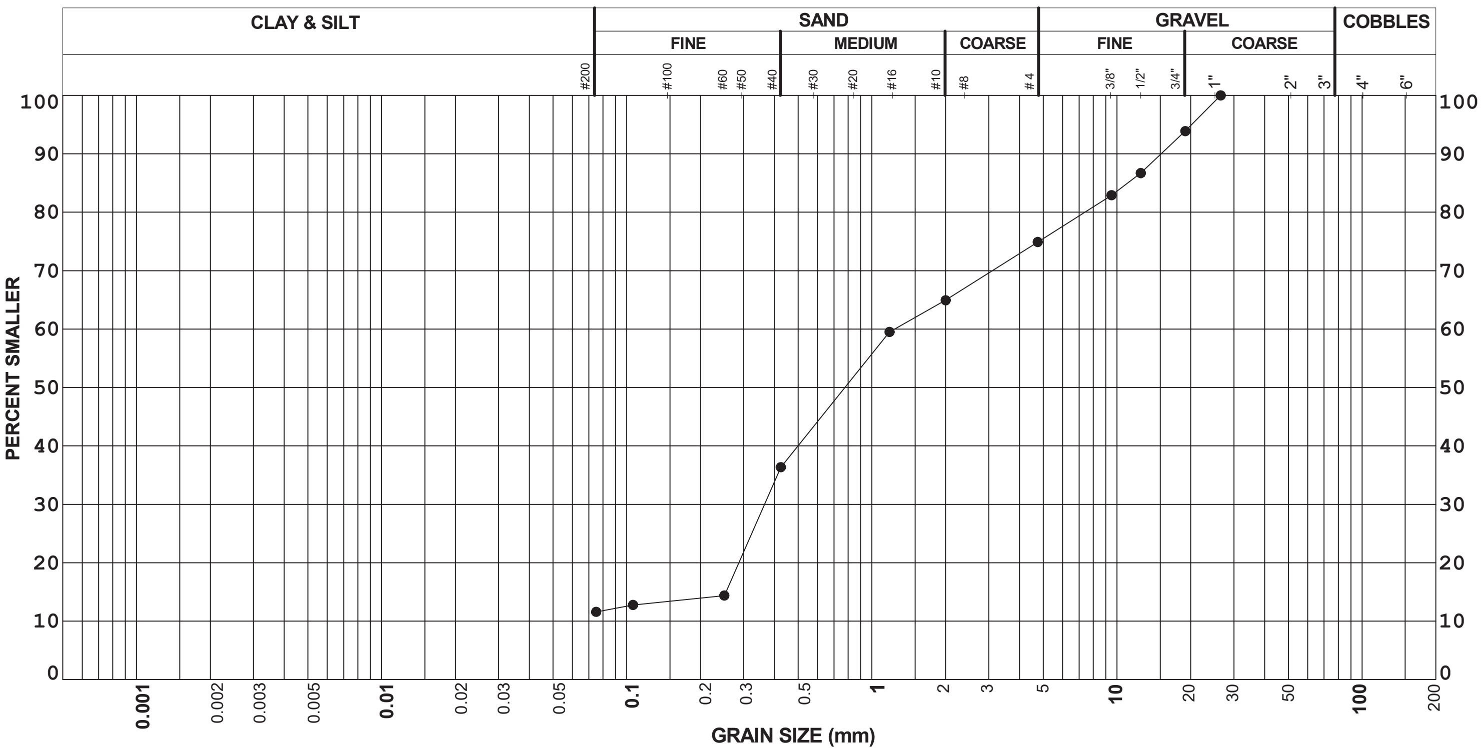
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DS-2	1.20	25	63	12		

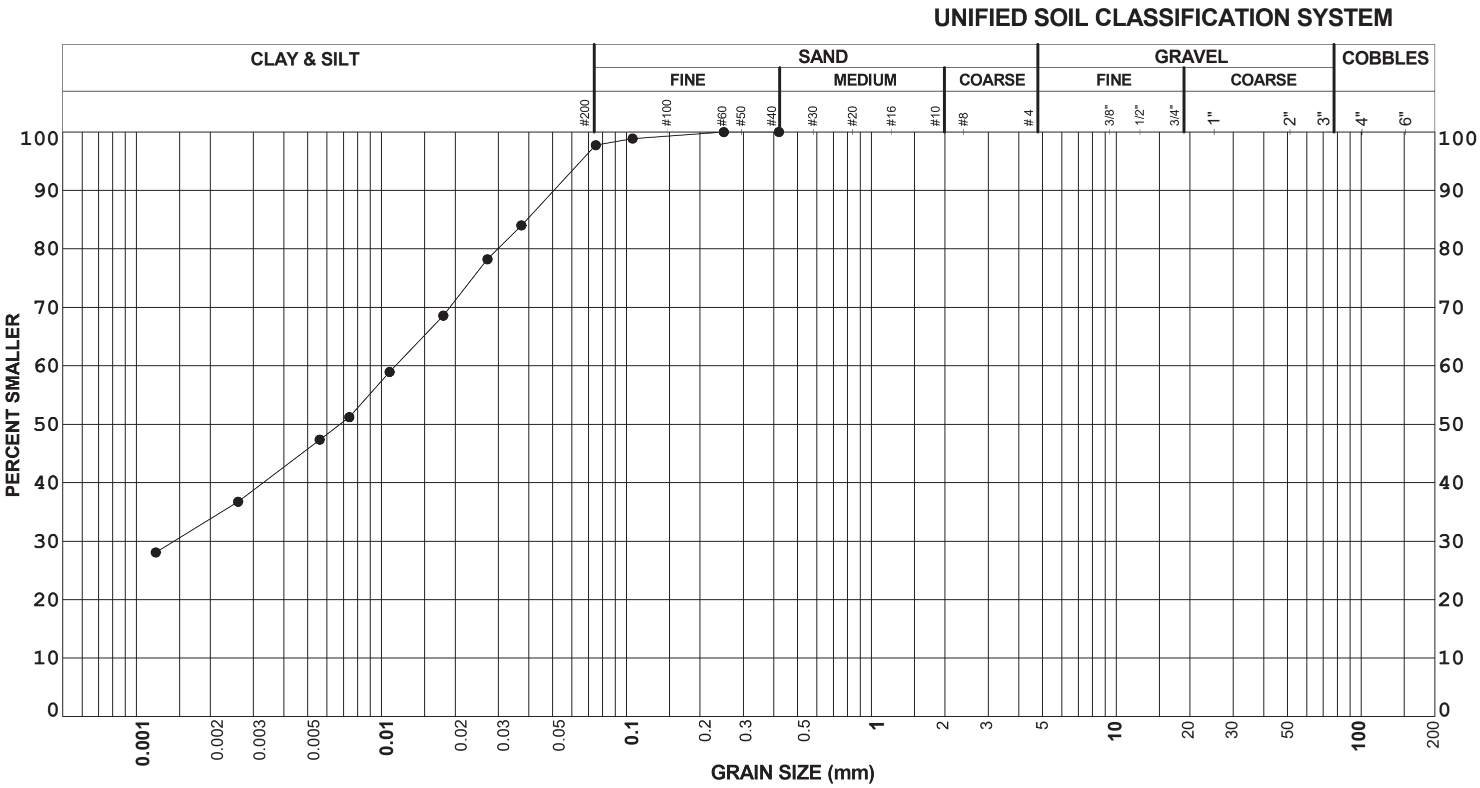
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DQ-3	3.85	0	2	98		

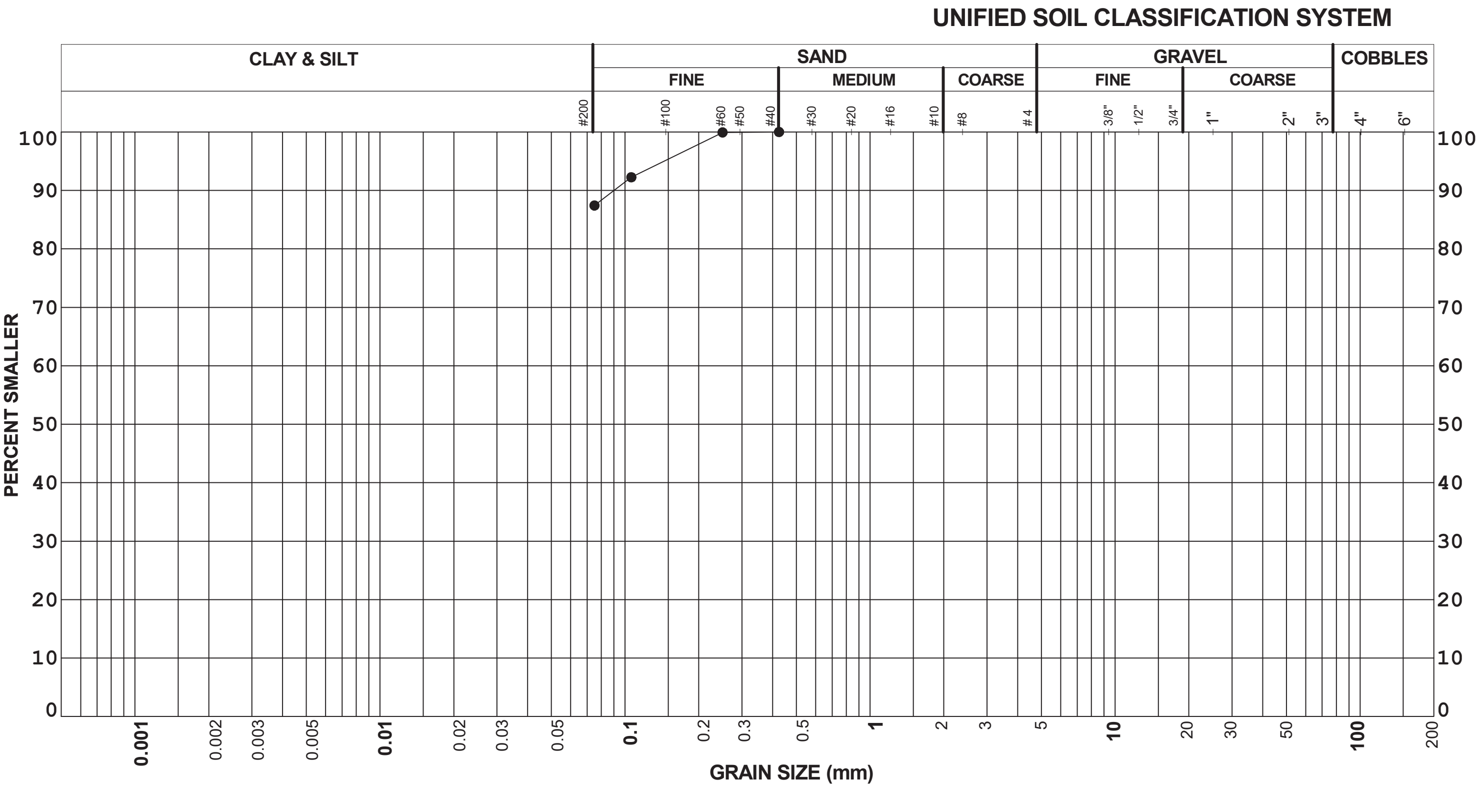
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DS-4	4.05	0	13	87		

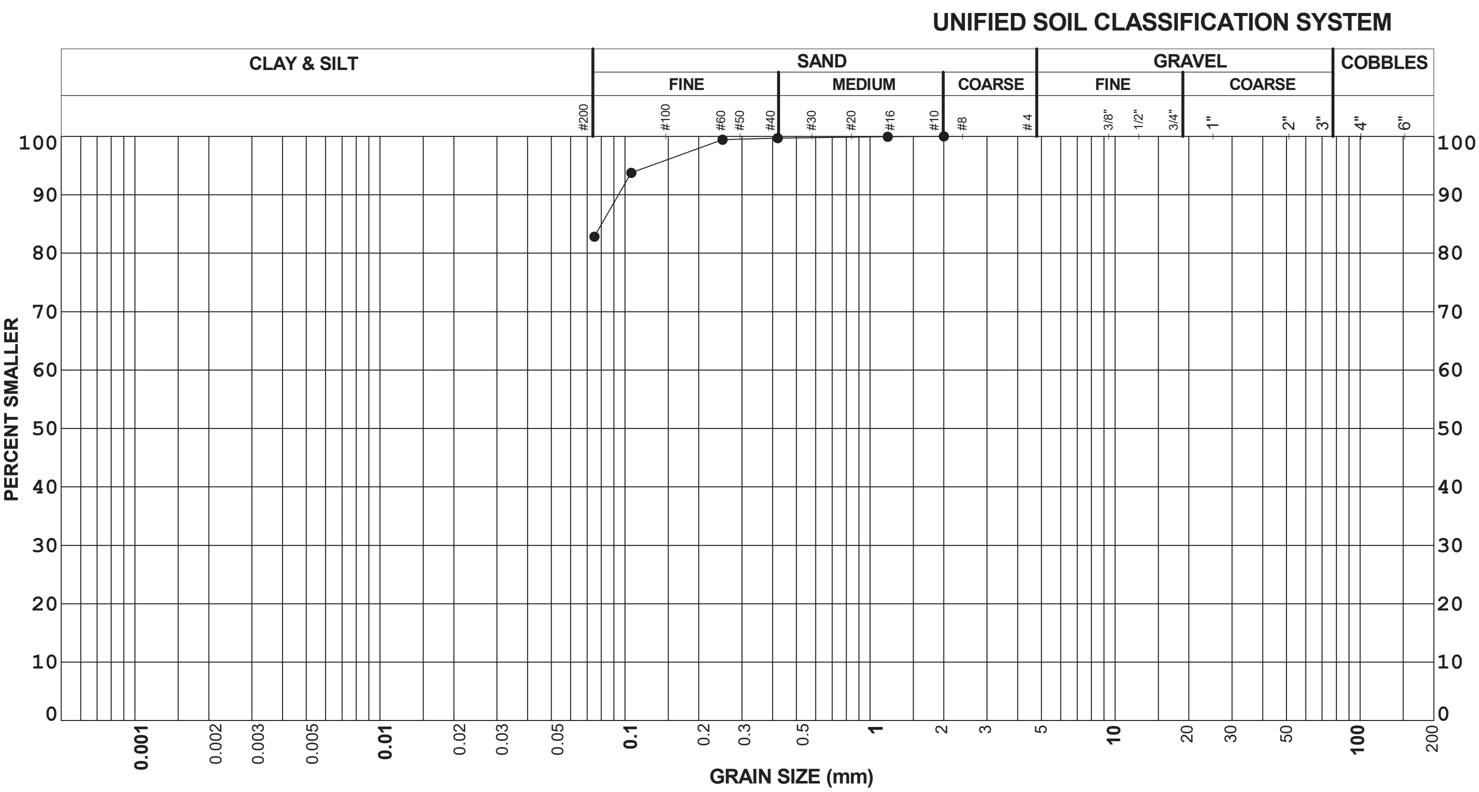
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DQ-5	5.60	0	17	83		

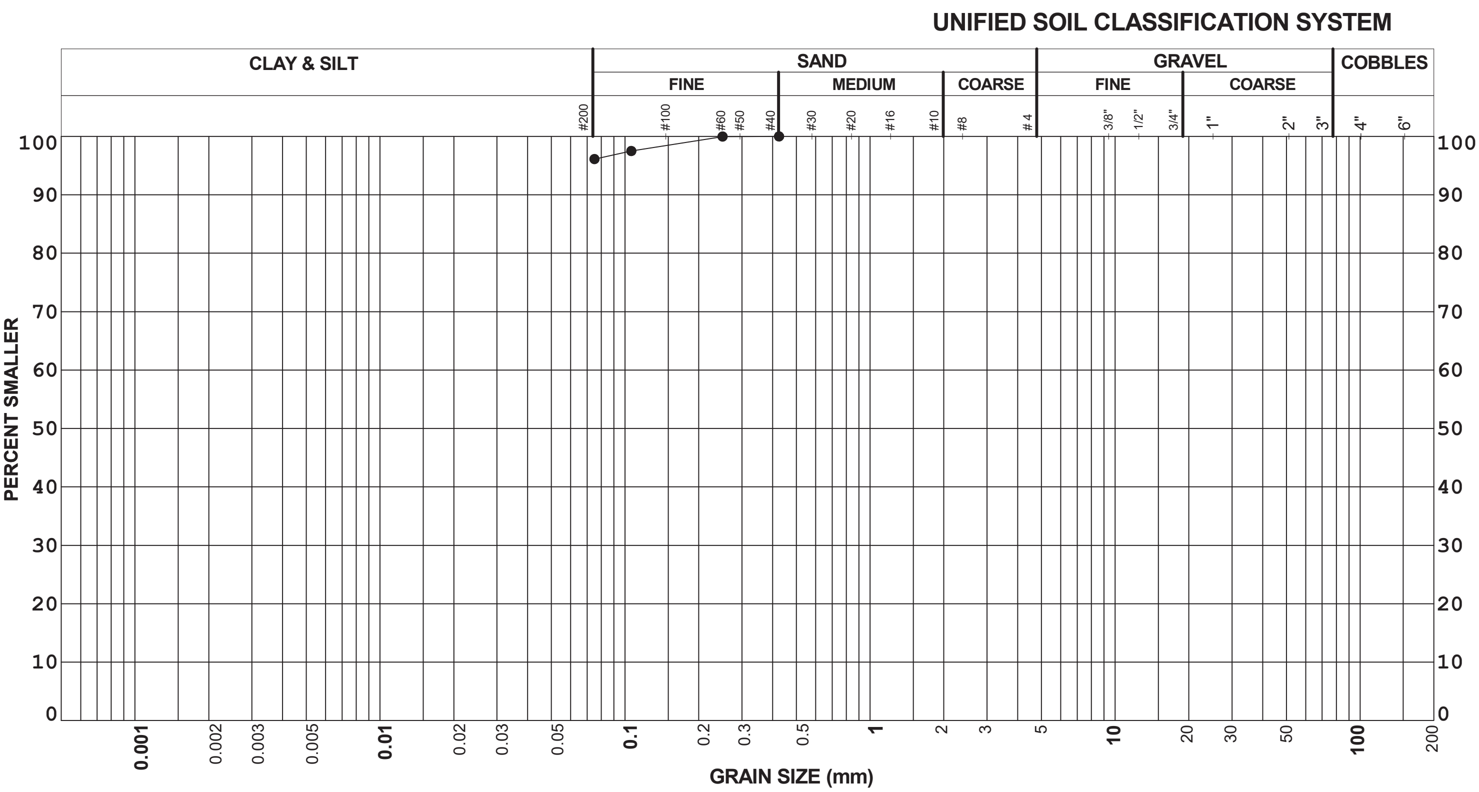
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DS-6	8.50	0	4	96		

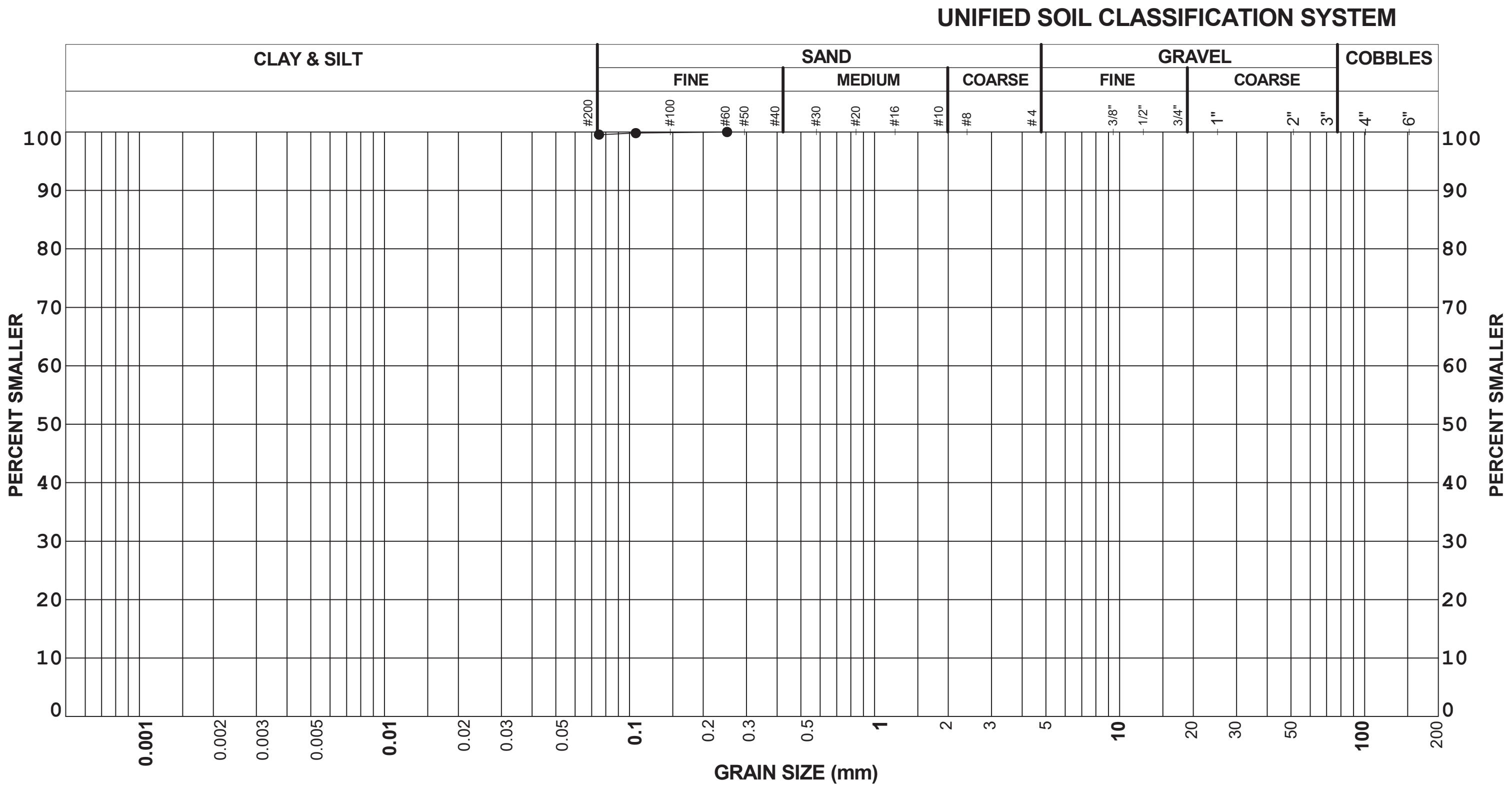
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DQ-7	11.50	0	0	100		

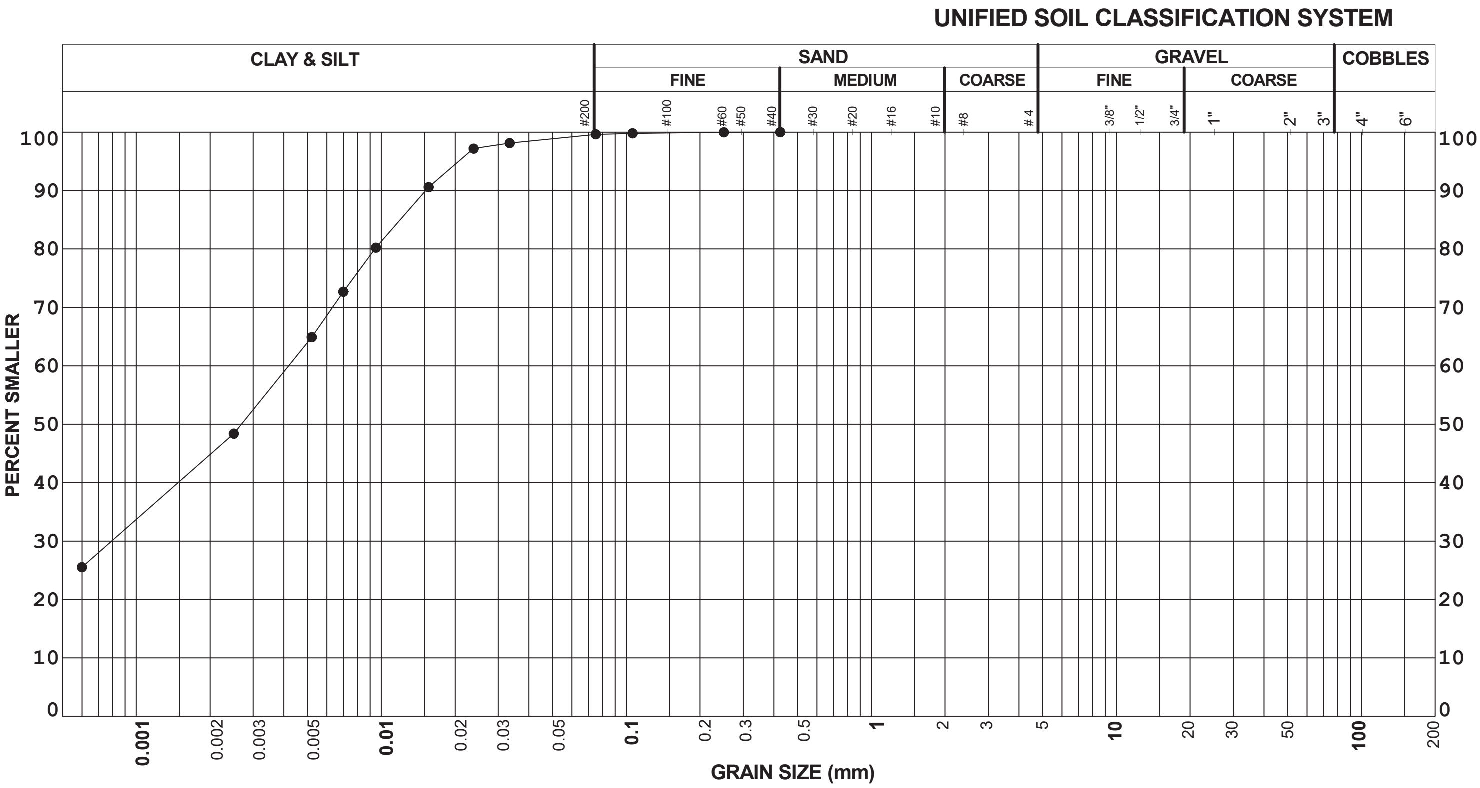
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DS-16	26.70	0	0	100	31	12

REMARKS:

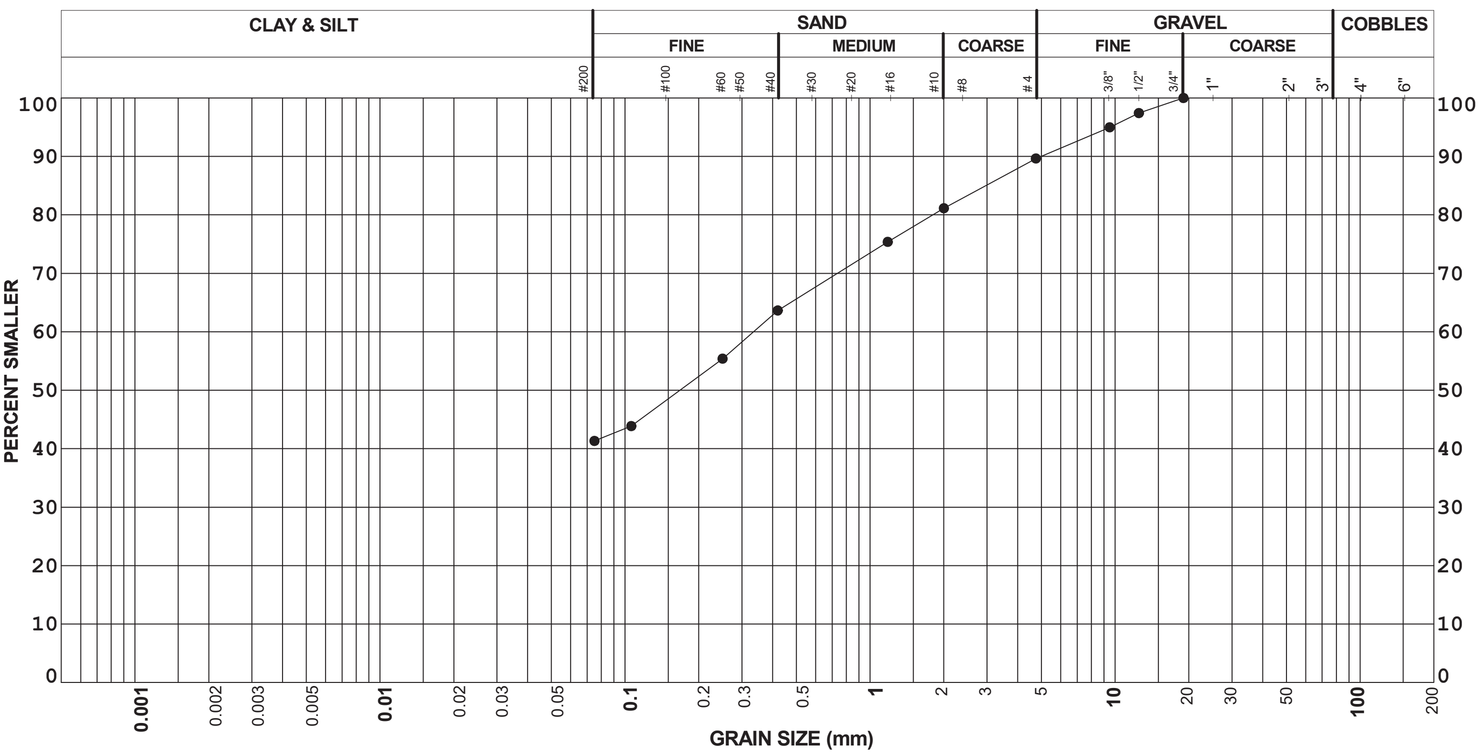
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M002	DQ-17	29.60	10	48	42		

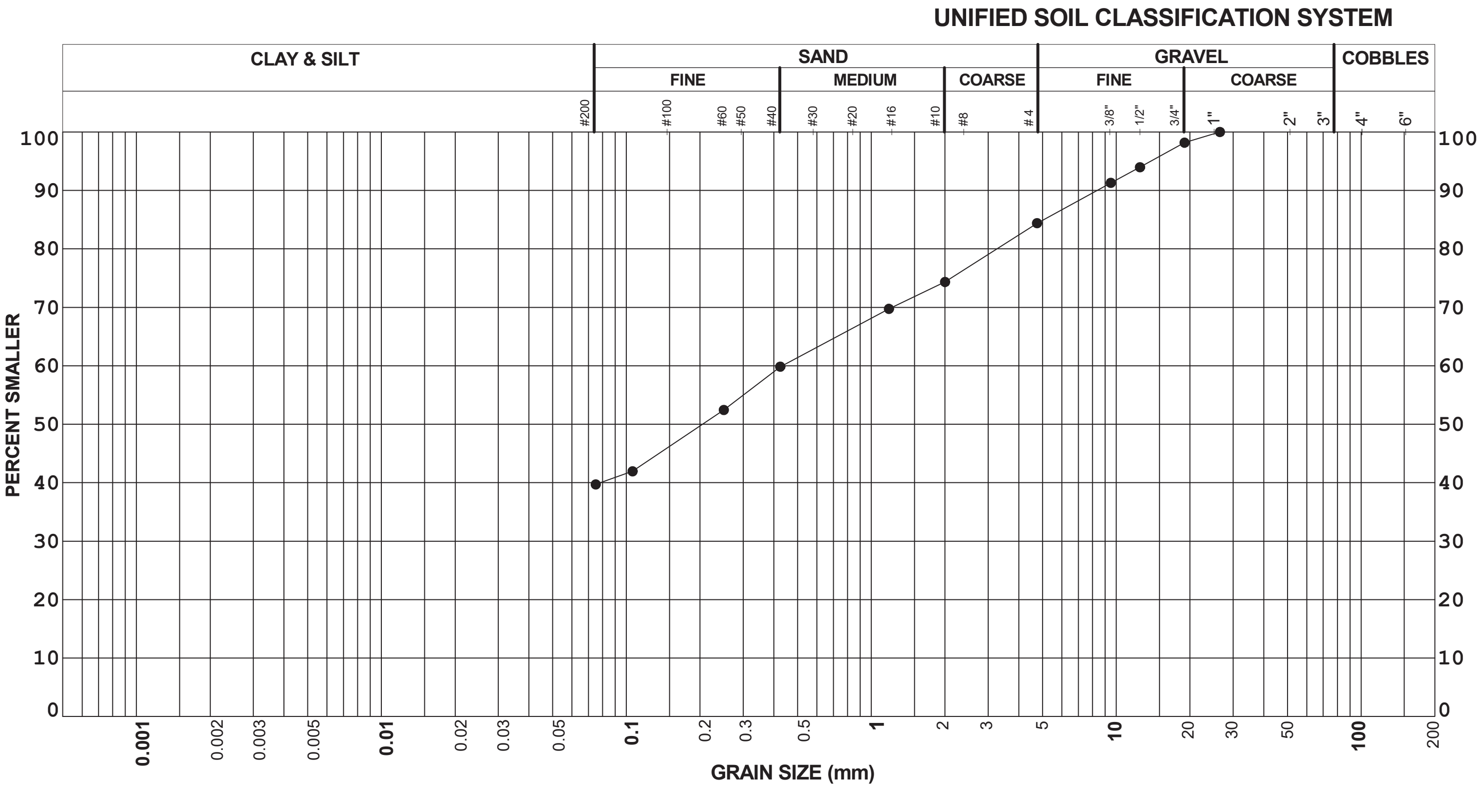
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-M002	DS-18	29.80	16	44	40		

REMARKS:

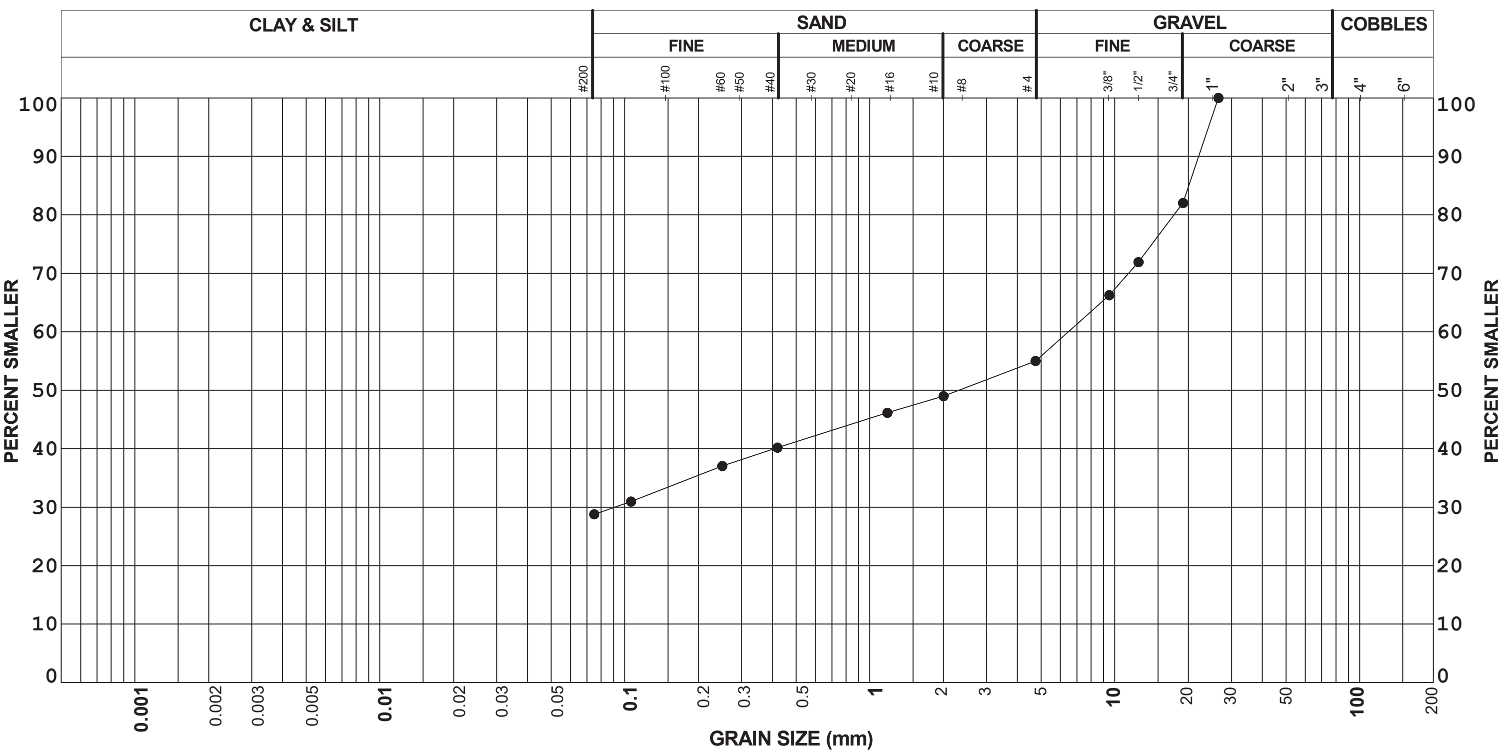
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

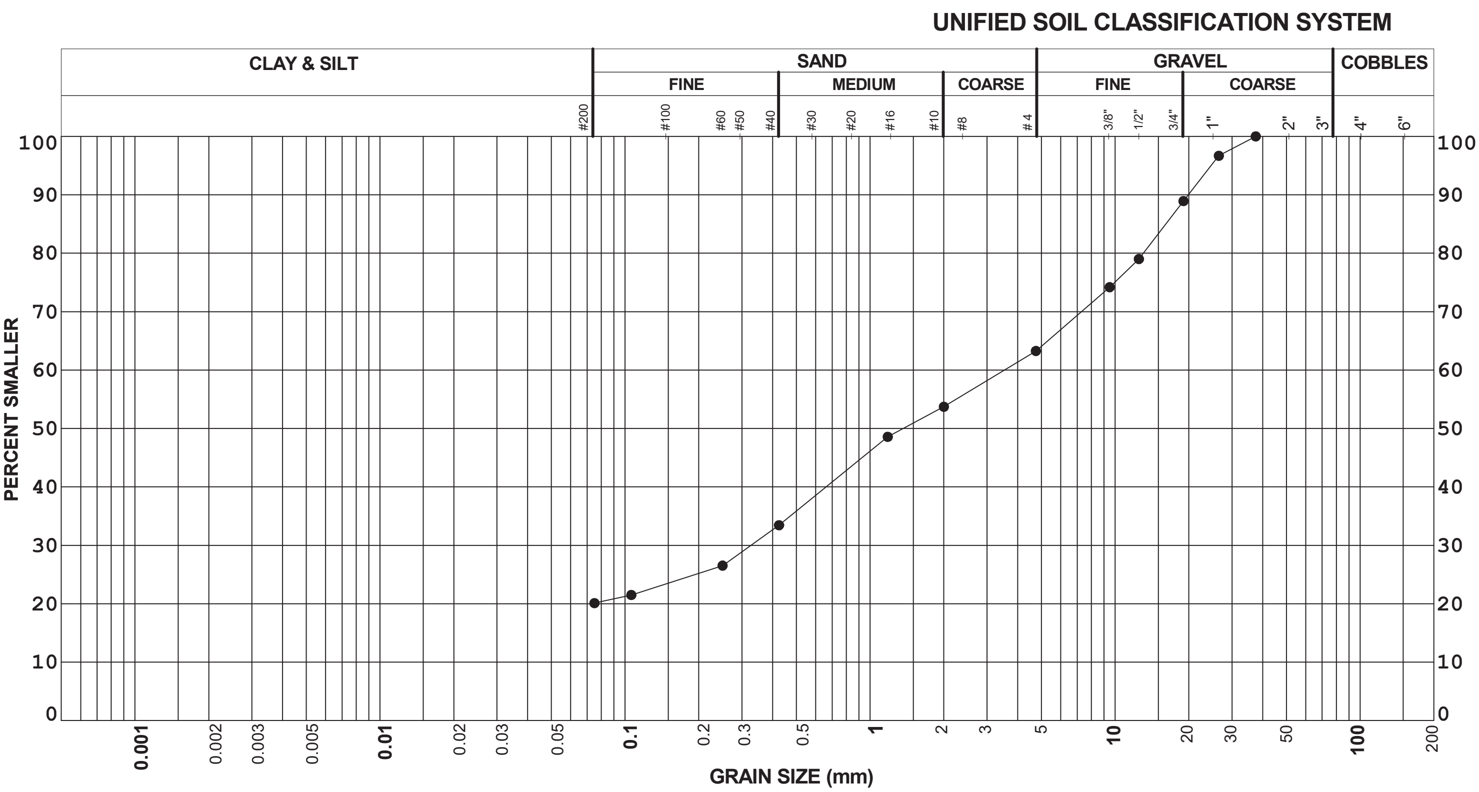
	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-M002	DQ-26	39.20	45	26	29		

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DS-2	1.00	37	43	20		

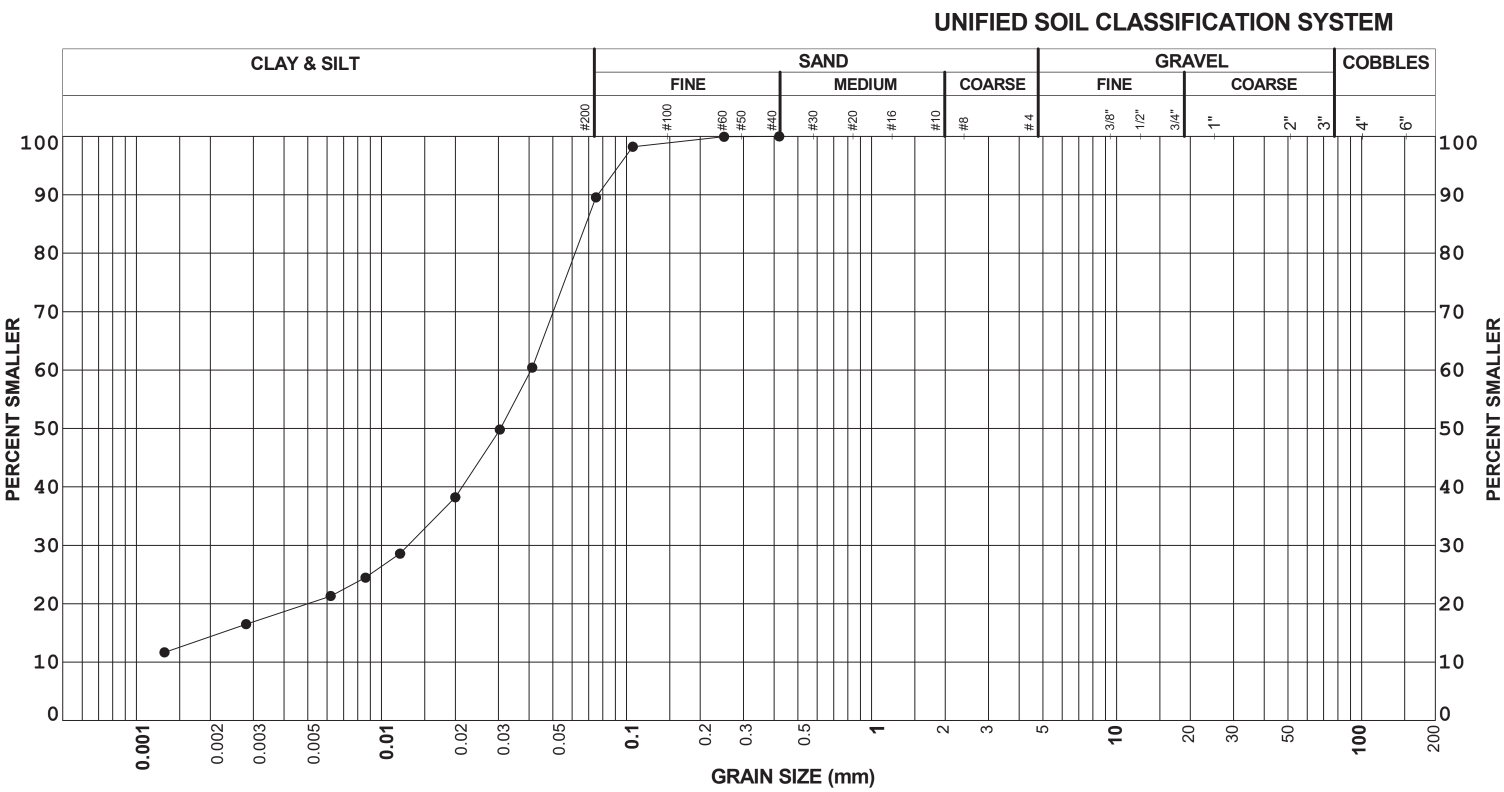
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DS-4	2.20	0	10	90		

REMARKS:

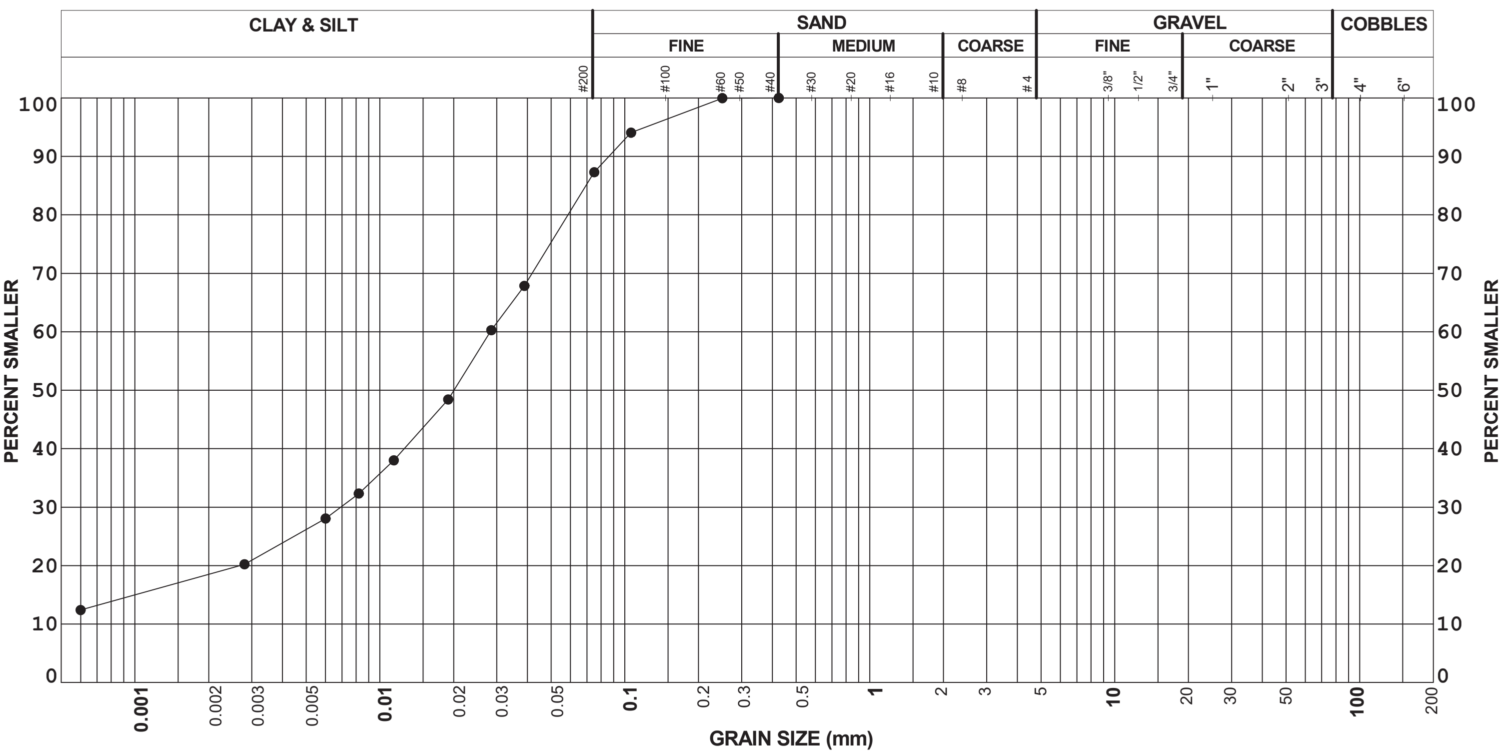
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-M003	DS-5	4.05	0	13	87		

REMARKS:

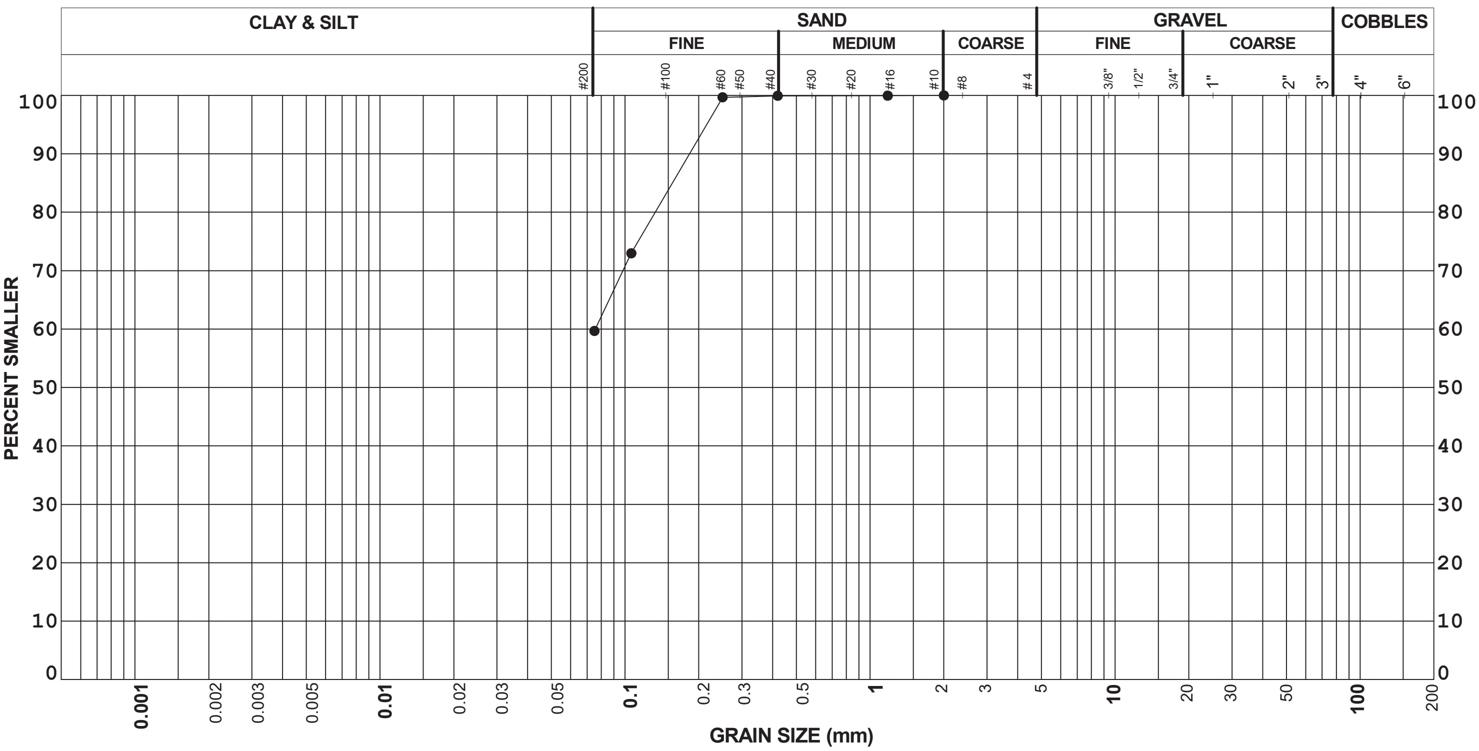
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-M003	DS-7	7.20	0	40	60		

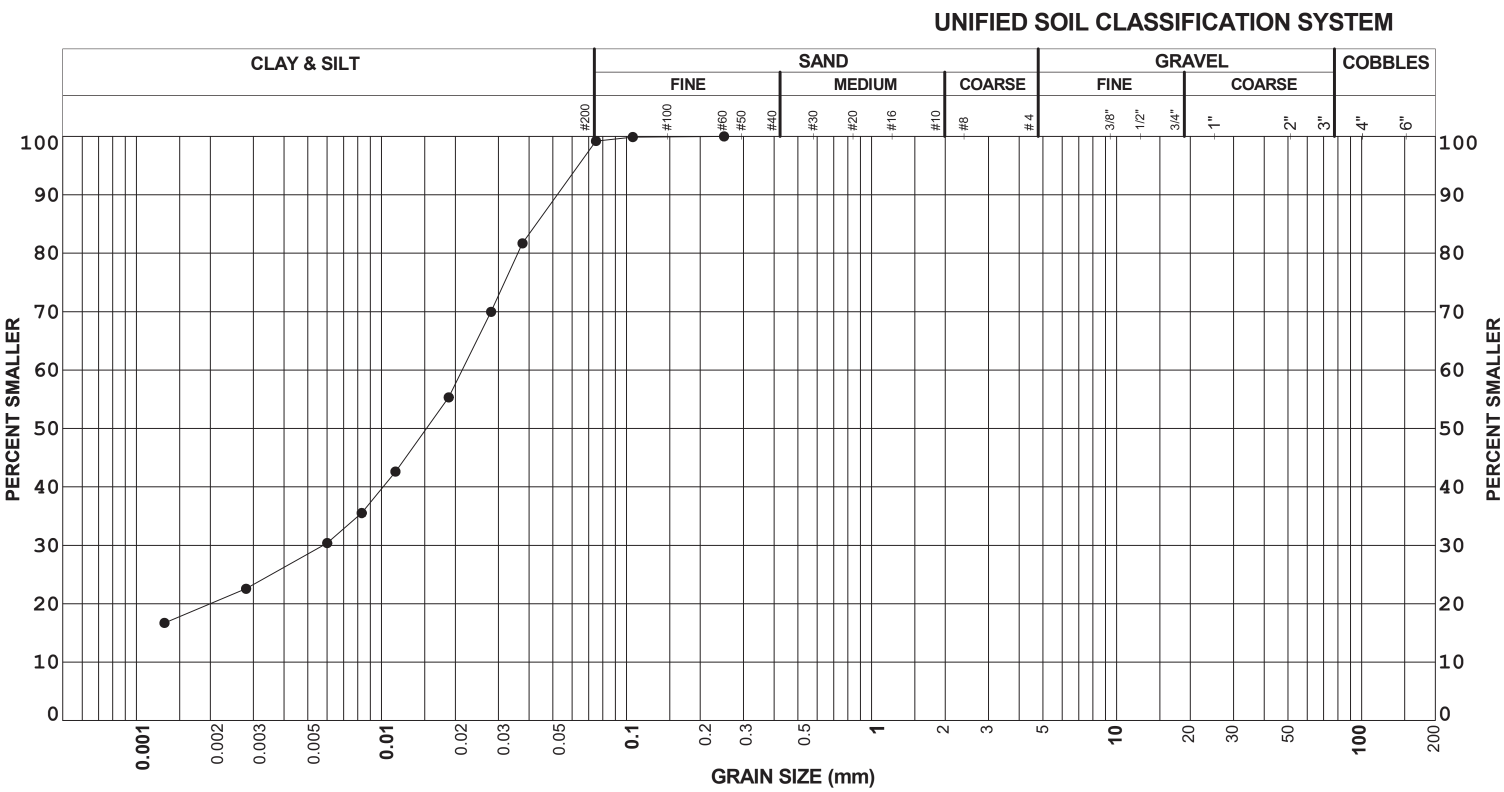
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DS-8	13.25	0	1	99		

REMARKS:

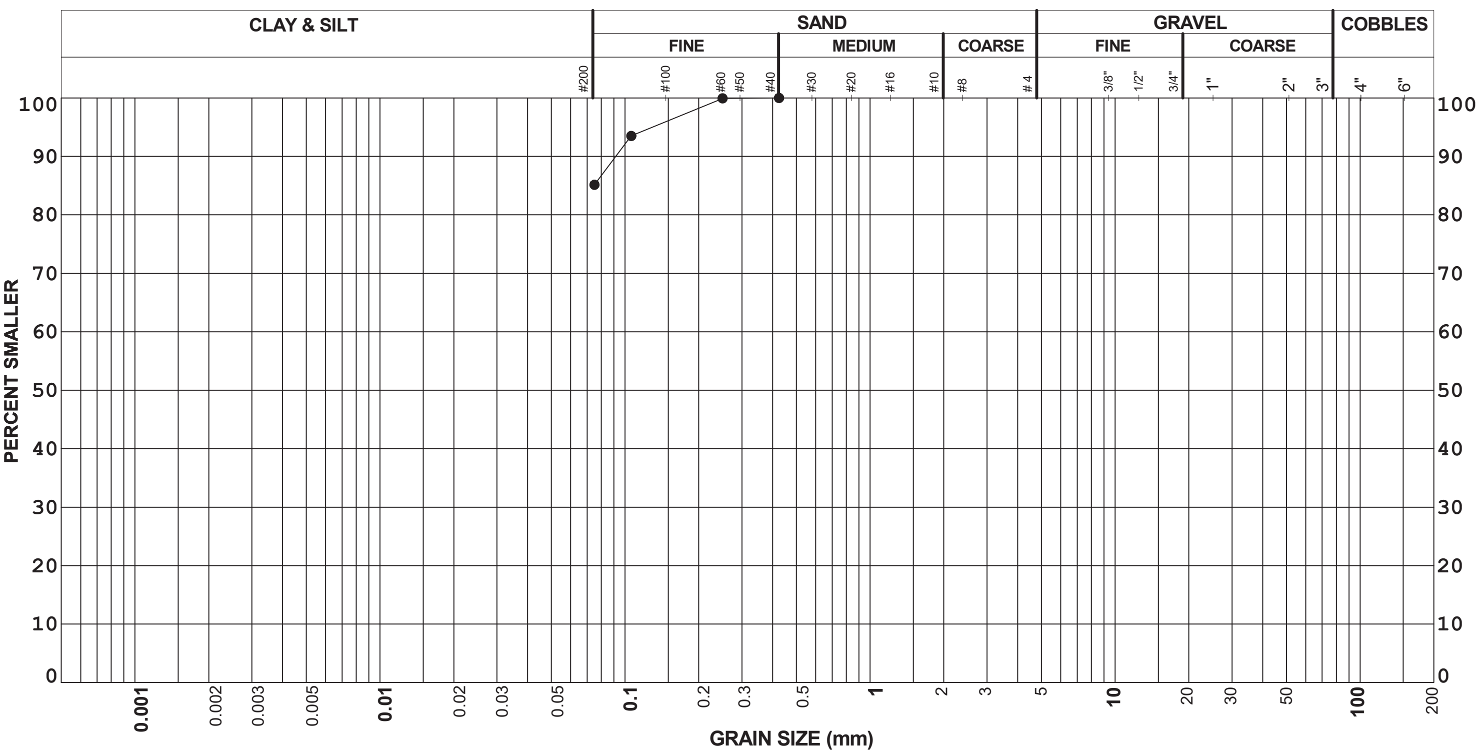
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS:

	BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
●	BH18-M003	DS-11	19.46	0	15	85		

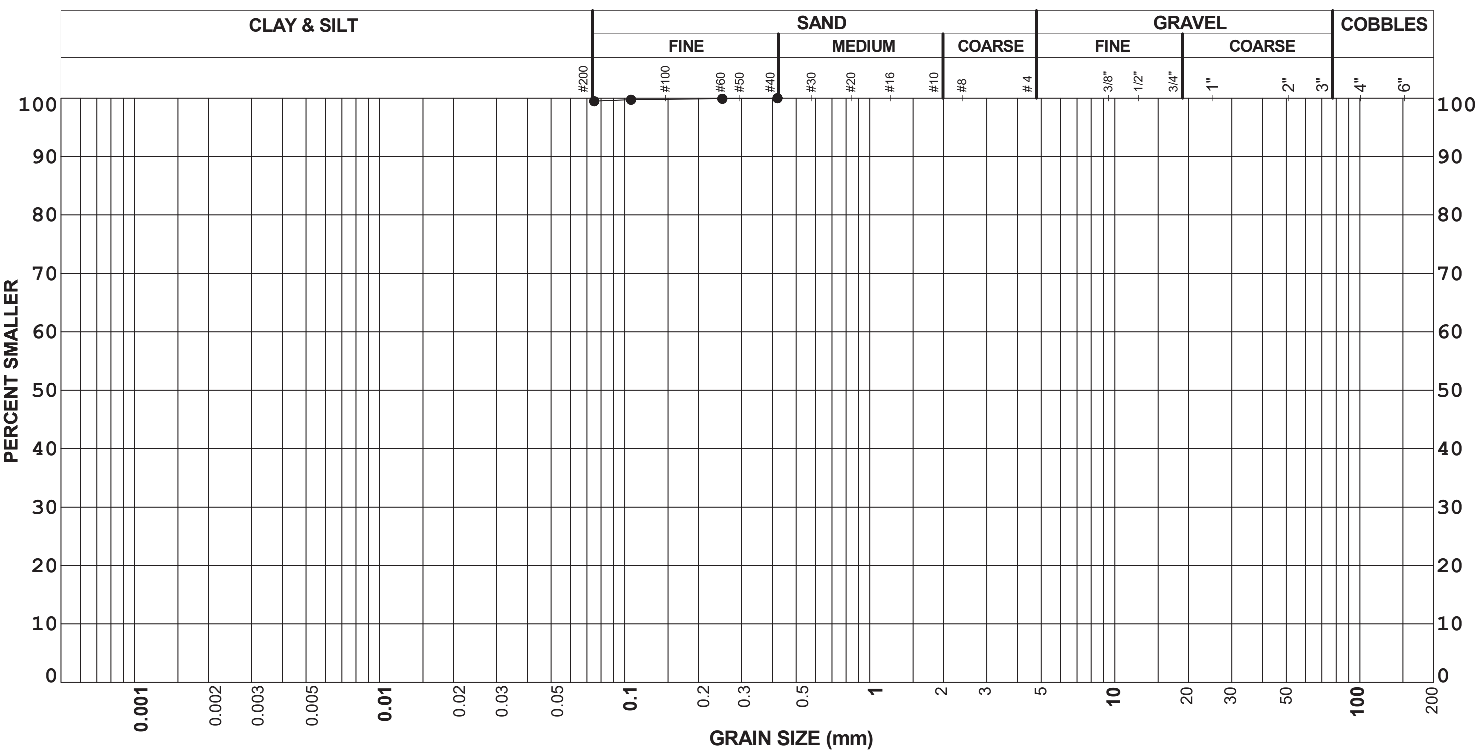
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DQ-13	24.02	0	1	99		

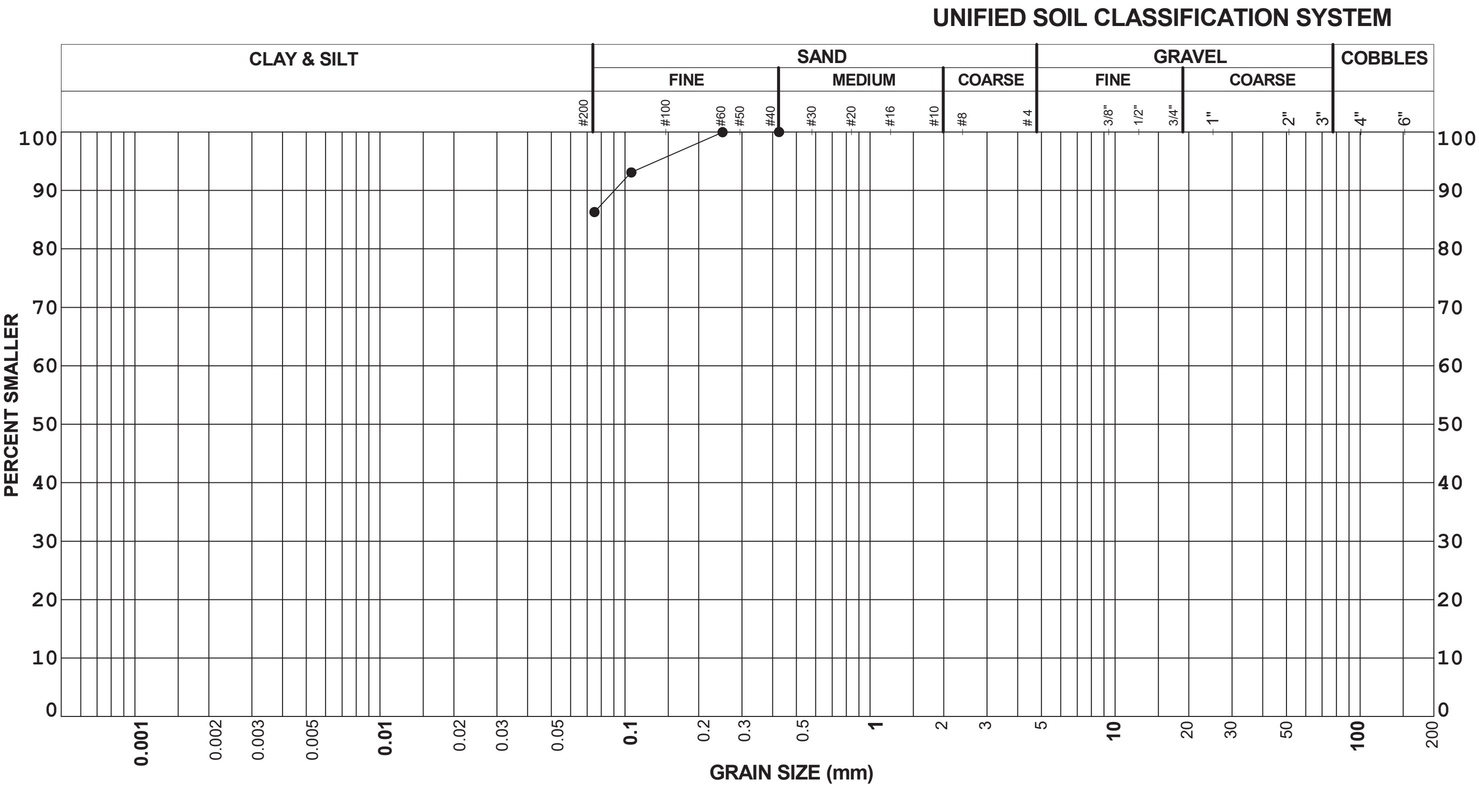
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DS-15	27.18	0	14	86		

REMARKS:

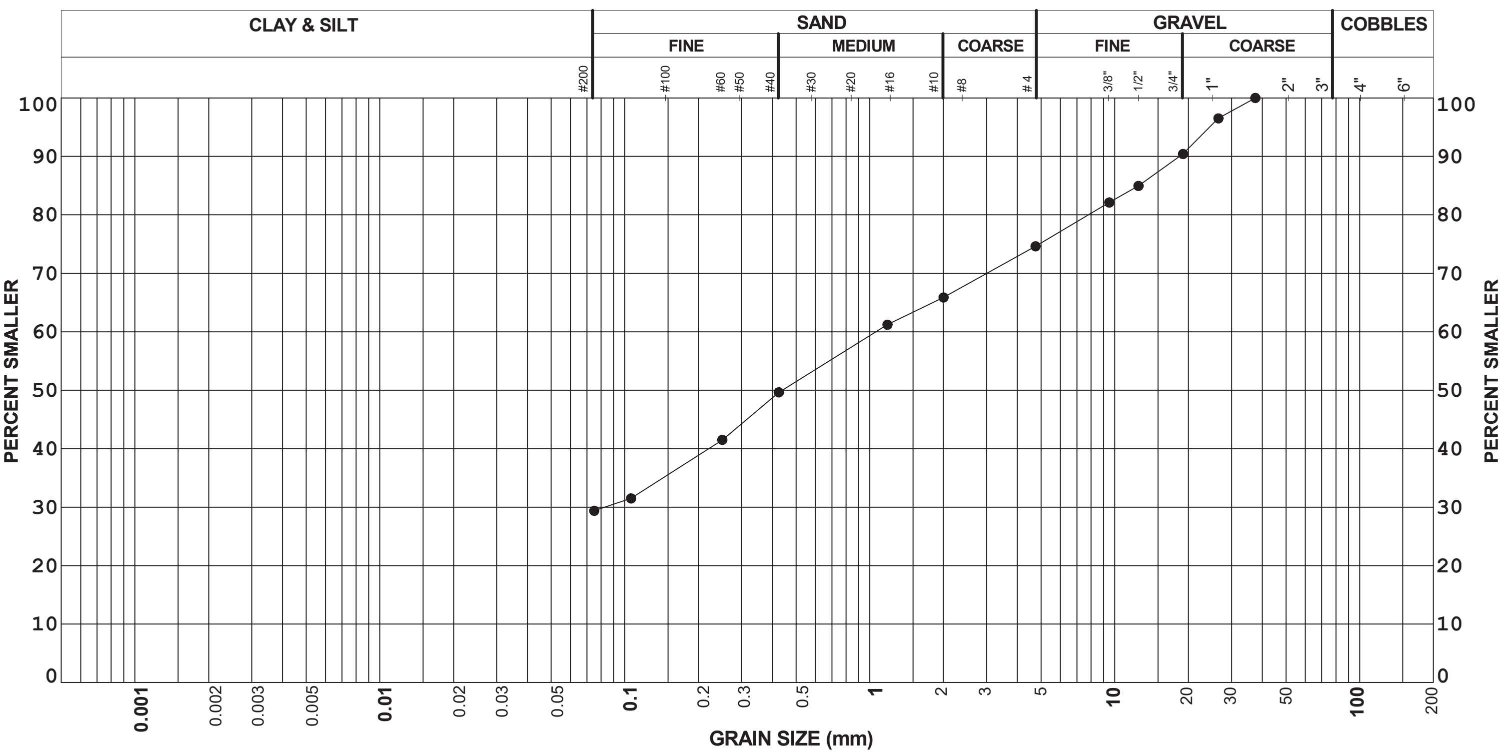
GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

UNIFIED SOIL CLASSIFICATION SYSTEM



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DS-24	47.70	25	45	30		

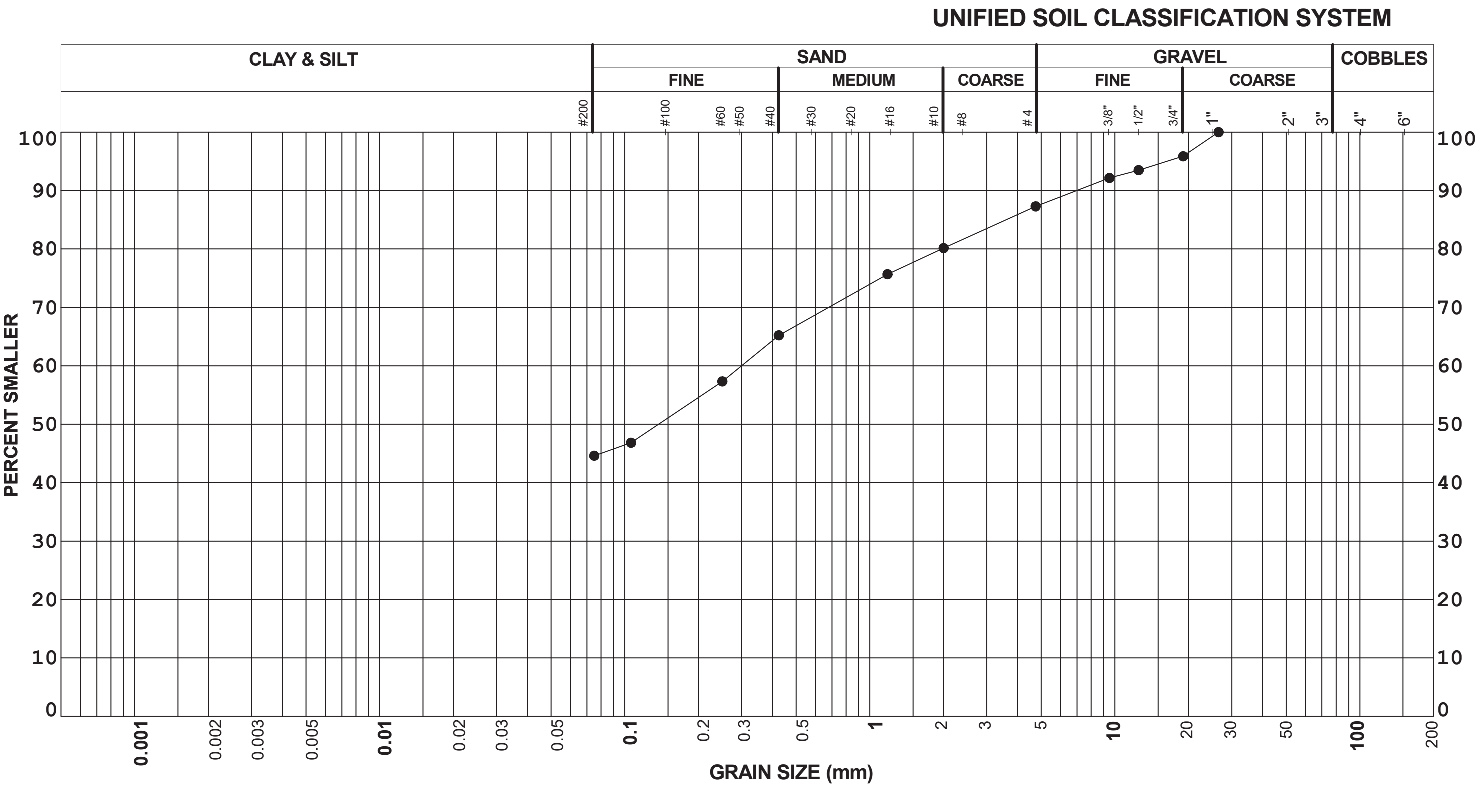
REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project



BOREHOLE	SAMPLE	DEPTH	GRAVEL (%)	SAND (%)	FINES (%)	LL (%)	PI (%)
● BH18-M003	DS-26	47.80	13	42	45		

REMARKS:

GRAIN SIZE DISTRIBUTION

Baffinland Iron Mine

HATCH

Project

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	June 10, 2018
Project Number:	H/353004
Project:	**Mary River Expansion Project**

Baffinland Iron Mines
2275 Upper Middle Rd,
Oakville Ontario.
Attention: H. Ghiabi

Sample	**As Listed Below**
Source	**BH18-004 Milne Port**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ1	0.20	1.0	
DQ2	8.20	8.0	
DQ3	13.4	10	
DQ5	17.1	10	
DQ7	18.48	10	
DQ8	21.0	34	
BLANK	NA	0.0	Distilled Water
DQ10	26.60	17	
DQ12	31.9	84	
DQ13	34.5	20	
DQ15	42.5	52	
DQ 17	48.8	31	
DQ18	56.8	10	
DQ20	55.8	73	
DQ23	62.8	>100	Beyond refractometer scale.
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: R. Serluca, Lab Tech. June 10, 2018

Name, Title, Date

Reviewed by: G. Qu, July 10, 2018

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer
ASTM D4542-15

HATCH
Geotechnical Laboratory

Date:	April 20, 2018	Baffinland Iron Mines
Project Number:	H/353004	2275 Upper Middle Rd, Oakville Ontario.
Project:	**Mary River Expansion Project**	**Attention:** G. Qu

Sample	As Listed Below
Source	**BH18-M003 Milne Port**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ1	0.20	4.0	
DQ3	0.70	10.0	
DQ6	2.00	25.0	
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: P. Snable, G.I.T. April 20, 2018

Name, Title, Date

Reviewed by: G. Qu, July 10, 2018.

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Pore Water Extraction and Determination of Soluble Salt Content of Soils by Refractometer

ASTM D4542-15

HATCH
Geotechnical Laboratory

Date: April 20, 2018

Project Number: H/353004

Project: **Mary River Expansion Project**

Baffinland Iron Mines
2275 Upper Middle Rd,
Oakville Ontario.

Attention: G. Qu

Sample	**As Listed Below**
Source	**BH18-M001 Milne Port**

Sample I.D	Depth (m)	Salinity Scale (ppt)	Notes
BLANK	NA	0.0	Distilled Water
DQ1	0.20	NA	Not enough moisture
DQ2	0.70	3.0	
DQ4	2.00	2.0	
DQ7	11.25	NA	Not enough moisture
DQ9	13.79	NA	Not enough moisture
BLANK	NA	0.0	Distilled Water

Comments: Tested with EXTECH Model RF20 Refractometer with automatic temperature compensation.

Reported by: P. Snable, G.I.T. April 20, 2018

Name, Title, Date

Reviewed by: G. Qu, July 10, 2018.

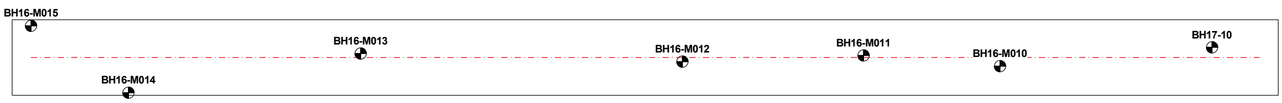
Name, Title, Date

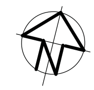
Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

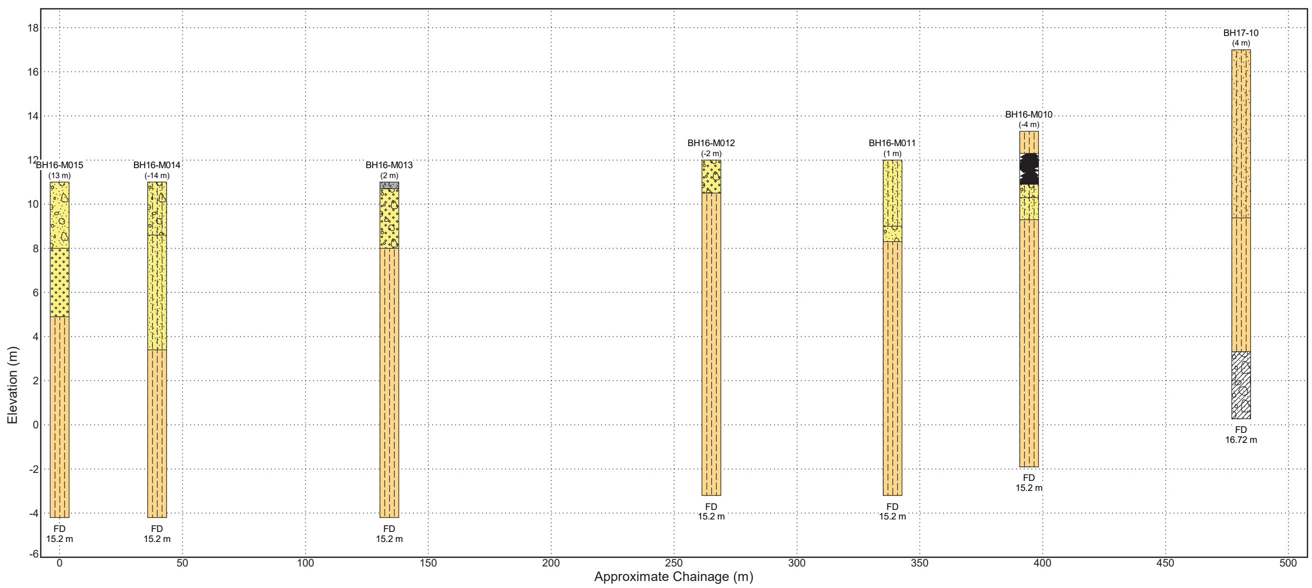
Appendix E

1

Fence Diagrams



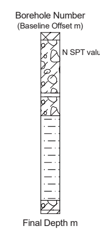




MAP KEY

- BH03 INVESTIGATION ON SECTION
- TP03 INVESTIGATION OFF SECTION
- SECTION LINES

POST LEGEND

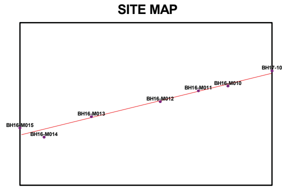


STRATAGRAPHIC BOUNDARIES

MATERIAL GRAPHICS

- SILT
- Well-graded Gravelly SAND
- Ice
- Topsoil
- Silty SAND with Gravel
- Well-graded SAND
- Silty SAND
- Sandy SILT
- Poorly-graded Gravelly SAND
- Glacial TILL

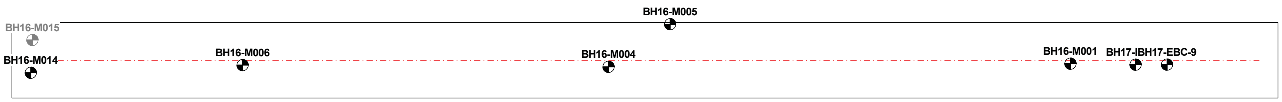
SITE MAP

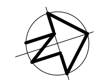


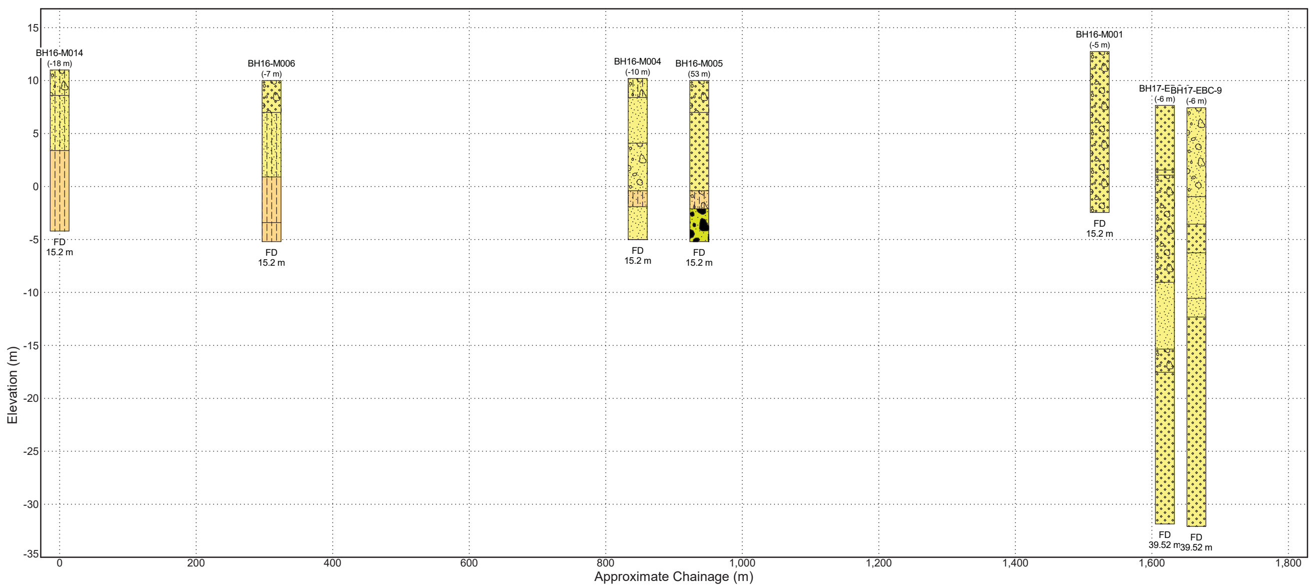
H 1:1538 — 0, 15, 30, 45, 60, 75m
V 1:171 — 0, 2, 4, 6, 8, 10m
Coord.System: UTM Zone 17 Height Datum: NAD83

HATCH

CLIENT Baffinland Iron Mines		PROJECT Mary River Expansion Study Stage 2	
DRAWN CL	DATE 5/25/2018	TITLE CONVEYER FENCE DIAGRAM CRUSHER SECTION	
CHECKED GQ	DATE 5/25/2018		
SCALE H 1:1538 V 1:171 VE=9X		PROJECT No H352034	FIGURE No E1







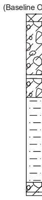
MAP KEY

BH03 INVESTIGATION ON SECTION

TP03 INVESTIGATION OFF SECTION

SECTION LINES

POST LEGEND

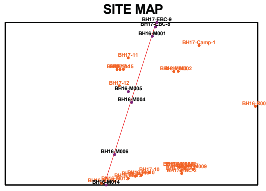


STRATAGRAPHIC BOUNDARIES

MATERIAL GRAPHICS

- Well-graded Gravelly SAND
- Well-graded SAND
- Silty SAND with Gravel
- Gravelly Sandy SILT
- Poorly-graded SAND
- Well-graded Sandy GRAVEL
- Poorly-graded Gravelly SAND
- Silty SAND
- Sandy SILT
- SILT

SITE MAP



H 1:5538

0 60 120 180 240 300m

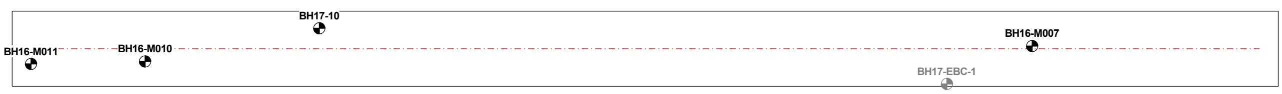
V 1:357

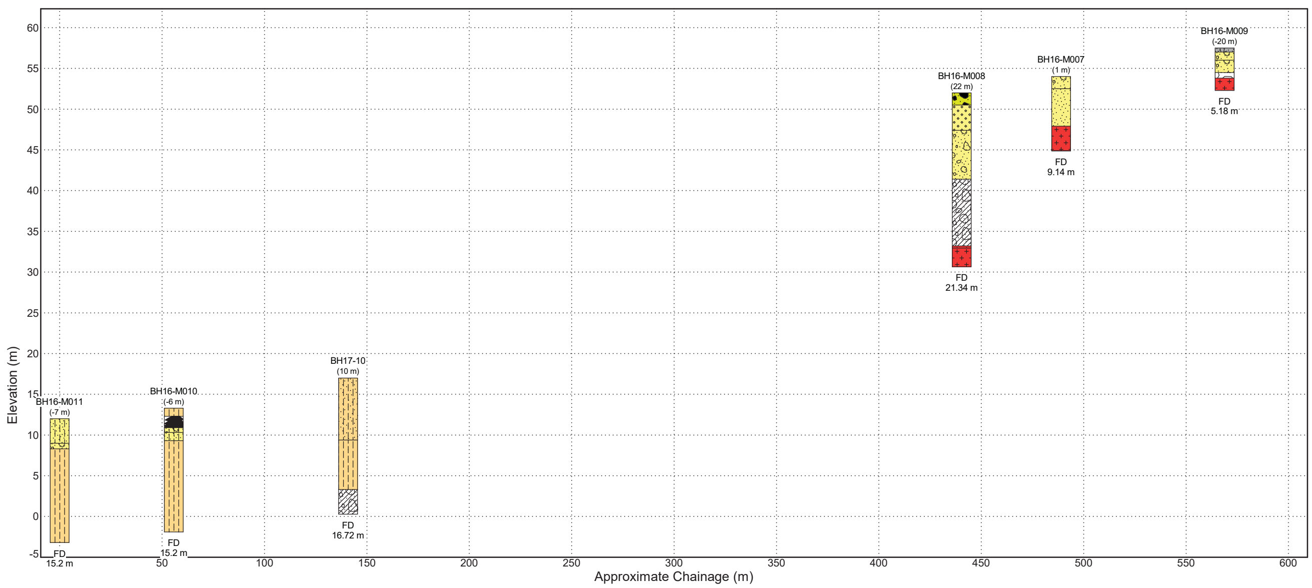
0 4 8 12 16 20m

Coord.System: UTM Zone 17 Height Datum: NAD83

HATCH

CLIENT Baffinland Iron Mines		PROJECT Mary River Expansion Study Stage 2	
DRAWN CL	DATE 5/25/2018	TITLE CONVEYER FENCE DIAGRAM STACKER RECLAIMER SECTION	
CHECKED GQ	DATE 5/25/2018		
SCALE H 1:5538 V 1:357 VE=16X		PROJECT No H352034	FIGURE No E2





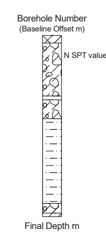
MAP KEY

BH03 INVESTIGATION ON SECTION

TP03 INVESTIGATION OFF SECTION

SECTION LINES

POST LEGEND

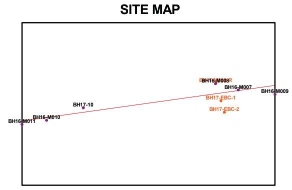


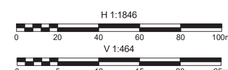
STRATAGRAPHIC BOUNDARIES

MATERIAL GRAPHICS

- Poorly-graded Gravelly SAND
- Poorly-graded SAND
- Granite, Diorite, Gabbro
- Well-graded Sandy GRAVEL
- Well-graded SAND
- Glacial TILL
- Topsoil
- BOULDERS
- SILT
- Ice
- Silty SAND with Gravel
- Silty SAND
- Sandy SILT

SITE MAP

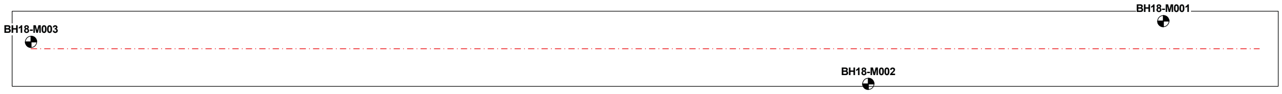


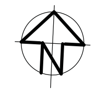


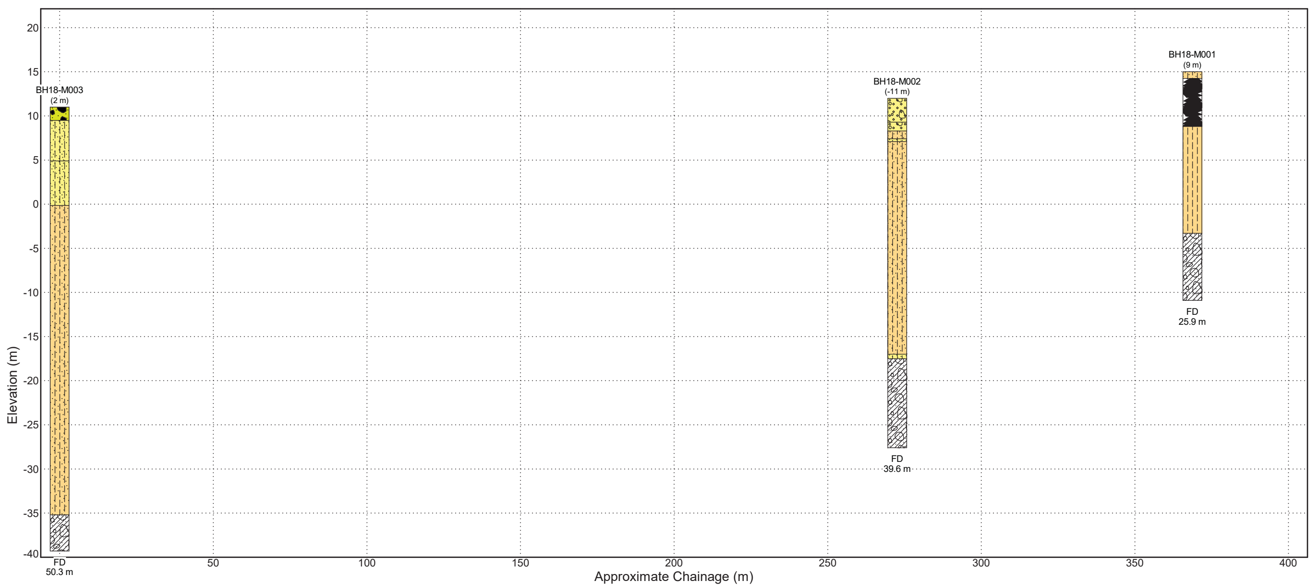
Coord.System: UTM Zone 17 Height Datum: NAD83

HATCH

CLIENT Baffinland Iron Mines		PROJECT Mary River Expansion Study Stage 2	
DRAWN CL	DATE 5/25/2018	TITLE CONVEYER FENCE DIAGRAM HILL SECTION	
CHECKED GQ	DATE 5/25/2018		
SCALE H 1:1846 V 1:464 VE=4X		PROJECT No H352034	FIGURE No E3







MAP KEY

- BH03 INVESTIGATION ON SECTION
- TP03 INVESTIGATION OFF SECTION
- SECTION LINES

POST LEGEND

Borehole Number (Baseline Offset m)

N SPT value

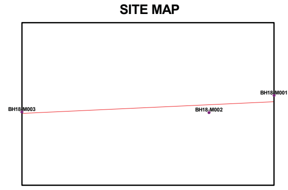
Final Depth m

STRATAGRAPHIC BOUNDARIES

MATERIAL GRAPHICS

- Sandy SILT
- Silty SAND
- Ice
- Well-graded Sandy GRAVEL
- SILT
- Glacial TILL
- Well-graded Gravelly SAND

SITE MAP



H 1:1231

0 10 20 30 40 50m

V 1:429

0 5 10 15 20 25m

Coord.System: "NAD83" Zone 17 Height Datum: NAD83

HATCH

CLIENT Baffinland Iron Mine		PROJECT Mary River Expansion Study	
DRAWN CL	DATE 8/15/2018	TITLE PORT SITE	
CHECKED MY	DATE 8/15/2018		
SCALE H 1:1231 V 1:429 VE=3X		PROJECT No H353004	FIGURE No I.4

Appendix F

1

Summary of Laboratory Results

Moisture Content and Gradation Test Results

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BS16-M001	BS-1	1.0				
	BS-2	2.5	18.0			
	BS-3	3.9	18.0			
	BS-4	5.9	19.0	0	82	17
	BS-5	7.0	16.0			
	BS-6	8.0	16.0			
	BS-7	9.9	16.0			
	BS-8	11.2	16.0			
	BS-9	12.4	18.0			
	BS-10	14.9	16.0			
BS16-M002	BS-1	1.3	100.0			
	BS-2	2.7	21.0	6	37	57
	BS-3	4.0	11.0	27	61	12
	BS-4	5.9				
	BS-5	7.2				
	BS-6	8.0	19.0			
	BS-7	10.0	14.0			
	BS-8	11.5	14.0			
	BS-9	13.0	16.0			
	BS-10	14.9	18.0			
BS16-M003	BS-1	1.2	18.0	17	63	20
	BS-2	2.7	33.0	0	4	96
	BS-3	4.6				
	BS-4	6.1				
	BS-5	7.3				
	BS-6	8.8				
	BS-7	10.3				
	BS-8	11.8				
	BS-9	13.4				
	BS-10	15.2				
BS16-M004	BS-1	1.0				
	BS-2	2.7		0	95	4
	BS-3	4.3				
	BS-4	5.8				
	BS-5	7.3	14.0			
	BS-6	8.8				
	BS-7	10.3				
	BS-8	11.8				
	BS-9	13.4				
	BS-10	14.9				

Moisture Content and Gradation Test Results

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BS16-M005	BS-1	1.2				
	BS-2	2.7	13.0	35	53	12
	BS-3	4.3				
	BS-4	5.8	20.0			
	BS-5	7.3				
	BS-6	8.8	16.0			
	BS-7	10.3				
	BS-8	11.8				
	BS-9	13.4				
	BS-10	14.9				
BS16-M006	BS-1	0.9		32	45	23
	BS-2	2.5				
	BS-3	4.4				
	BS-4	5.8				
	BS-5	7.3				
	BS-6	8.8				
	BS-7	10.3				
	BS-8	11.8				
	BS-9	13.4				
	BS-10	14.6				
BS16-M007	BS-1	0.6				
	BS-2	2.4	22.0			
	BS-3	3.6	19.0	0	100	0
BS16-M008	BS-1					
	BS-2	1.5				
	BS-3	3.1	18.0	0	73	27
	BS-4	4.6				
	BS-5	7.6	20.0			
	BS-6	9.1				
	BS-7	10.6	9.0			
	BS-8	12.5	12.0			
	BS-9	13.7				
	BS-10	15.5				
BS16-M009	BS-1	0.9				
	BS-2	2.1				
BS16-M010	BS-1	0.9		0	16	84
	BS-2	2.7				
	BS-3	4.2		0	4	96
	BS-4	5.5				
	BS-5	7.0				
	BS-6	8.5				
	BS-7	10.0				
	BS-8	11.5				
	BS-9	13.0				
	BS-10	14.7				

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BS16-M011	BS-1	1.2		0	68	32
	BS-2	2.5				
	BS-3	3.4				
	BS-4	5.5				
	BS-5	7.0				
	BS-6	8.5				
	BS-7	9.8				
	BS-8	11.6				
	BS-9	13.0				
	BS-10	14.7				
BS16-M012	BS-1	0.9		39	45	17
	BS-2	2.0				
	BS-3	4.1		0	16	84
	BS-4	5.6				
	BS-5	7.0				
	BS-6	8.6				
	BS-7	10.3				
	BS-8	11.6				
	BS-9	13.0				
	BS-10	14.9				
BS16-M013	BS-1	1.2		32	48	20
	BS-2	2.3				
	BS-3	4.0		5	33	61
	BS-4	5.1				
	BS-5	7.0				
	BS-6	8.5				
	BS-7	10.0				
	BS-8	11.5				
	BS-9	13.1				
	BS-10	14.6				
BS16-M014	BS-1	1.2		22	52	26
	BS-2	2.7				
	BS-3	4.3		0	78	22
	BS-4	6.1				
	BS-5	7.3				
	BS-6	8.8				
	BS-7	10.3				
	BS-8	11.8				
	BS-9	13.4				
	BS-10	14.9				
BS16-M015	BS-1	1.0		32	59	10
	BS-2	2.1				
	BS-3	3.9		15	71	14
	BS-4	5.5				
	BS-5	7.0				
	BS-6	8.2				
	BS-7	9.7				
	BS-8	11.5				
	BS-9	12.9				
	BS-10	14.8				

HATCH

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BH17-RD-1	DS-1	5.0	11.0	15	80	5
BH17-RD-1C	DS-1	1.0	10.2	14	71	15
	DS-2	2.0	24.5	0	68	32
	DS-3	4.0	21.3	1	23	76
BH17-RD-2	DS-1	0.7	8.9	18	73	9
	DS-2	1.4	21.8	7	30	63
	DS-3	2.2	11.7	15	74	11
	DS-4	4.0	22.7	0	44	56
BH17-RD-3	DS-1	3.7	11.8	5	86	10
BH17-RD-4	DS-1	2.2	71.6	4	29	67
BH17-RD-5	DS-1	2.4	16.8	3	42	55
BH17-RD-7	DS-1	1.7	6.8	13	59	28
	DS-2	3.3	5.1	31	49	20
BH17-CAMP-1	DS-1	0.8				
	DS-2	1.7				
	DS-3	4.0				
BH17-10	DS-1	0.9	25.9	10	42	48
	DS-2	5.0	19.0	10	35	55
	DS-3	7.6	9.2	8	36	56
	DS-4	8.7	37.2	0	1	99
	DS-5	11.4	21.1	0	2	98
	DS-6	12.5	18.4	0	30	70
	DS-7	14.3	7.5	15	69	16
	DS-8	16.2	7.6	13	60	27
BH17-11	DS-1	3.0	6.2			
	DS-2	5.5	29.4			
	DS-3	8.0	18.0			
	DS-4	9.0	18.0			
	DS-5	10.3	16.0			
	DS-6	15.0	18.7			
BH17-12	DS-1	1.5	12.8			
	DS-2	4.0	31.5			
	DS-3	5.0	27.1			
	DS-4	5.7	21.5			
	DS-5	8.8	23.6			
	DS-6	13.6	25.2			
BH17-13	DS-1	1.0				
	DS-2	2.4				
	DS-3	5.5				
BH17-14	DS-1	4.3				
BH17-EBC-1	DQ-1	3.2				
	DQ-2	4.6				
	DQ-3	5.1	21.3			
	DQ-4	6.2				
	DQ-5	8.3				
	DQ-6	9.7	25.3			
	DQ-7	11.2	9.4			
	DQ-8	12.5	8.1			
	DQ-9	13.4	9.4			
	DQ-10	14.0	4.2			

HATCH

Moisture Content and Gradation Test Results

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BH17-EBC-2	DQ-1	1.0	1.2			
	DQ-2	1.5	6.5			
	DQ-3	2.0	28.3			
	DQ-4	3.1	20.6			
	DQ-5	4.0	8.6			
	DQ-6	5.0	10.0			
	DQ-7	5.8	6.7			
	DQ-8	6.9	7.3			
	DQ-9	8.1	9.8			
BH17-EBC-8	DS-1	0.9	2.9	15	72	13
	DS-2	3.5	10.6	15	76	10
	DQ-3	5.0	21.0	7	88	5
	DS-4	6.3	15.4	2	93	5
	DS-5	7.6	10.1	33	55	11
	DS-6	9.3	8.3	42	53	4
	DQ-7	12.0	23.4			
	DS-8	12.2	5.6	46	45	9
	DS-9	15.0	9.0	29	61	10
	DS-10	17.5	16.6	0	89	11
	DQ-11	18.0	17.5	2	85	13
	DQ-12	20.5	19.5	2	98	0
	DS-13	23.6	10.5	25	63	12
	DQ-13B	23.7				
	DS-14	26.6	16.6	2	86	12
	DQ-15	29.8	23.1	0	95	5
	DQ-16	32.9	22.2	0	92	8
	DQ-17	37.4	21.5	0	92	8
	DS-18	39.3	13.1			
	DQ-19	39.4	18.8	0	93	7
BH17-EBC-9	DS-1	3.1	10.9	23	73	5
	DS-2	4.4	9.7	33	59	8
	DS-3	6.0	12.9	17	73	10
	DQ-4	8.8	23.3	0	88	12
	DQ-5	9.1	20.4	0	90	10
	DQ-6	11.0	11.5	16	78	6
	DQ-7	14.3	17.6	3	88	10
	DQ-8	15.2	13.1			
	DQ-9	17.3	20.9	0	89	11
	DQ-10	18.0	22.0	0	93	7
	DS-11	19.8	12.5	9	82	9
	DQ-12	22.5	21.1	0	95	5
	DQ-13	24.0	23.8	0	92	8
	DQ-14	27.0	18.5	7	86	8
	DQ-15	27.4	18.6	0	84	16
	DQ-16	28.9	25.7	0	97	3
	DQ-17	31.5	19.8	0	94	6
	DS-18	36.3				
	DQ-19	39.0	21.8	0	98	2

Soil Salinity Test Results

Borehole No.	Sample No.	Depth	Salinity Scale (ppt)
BH17-10	DS-1	0.9	3.0
	DS-2	5.0	13.0
	DS-4	8.7	22.0
BH17-11	DS-2	5.5	1.0
	DS-3	8.0	6.0
	DS-6	15.0	7.0
BH17-12	DS-2	4.0	5.0
	DS-3	5.0	27.0
	DS-5	8.8	5.0
	DS-6	13.6	6.0
BH17-EBC-1	DQ-2	4.6	0.0
	DQ-3	5.1	3.0
	DQ-4	6.2	0.0
	DQ-5	8.3	1.0
	DQ-6	9.7	3.0
BH17-EBC-2	DQ-3	2.0	0.0
	DQ-4	3.1	3.0
	DQ-5	4.3	3.0
	DQ-6	5.0	3.0
	DQ-7	5.8	6.0
BH17-EBC-8	DQ-3	5.0	3.0
	DQ-7	12.0	14.0
	DS-9	15.0	13.0
	DQ-11	18.0	22.0
	DQ-12	20.5	9.0
	DS-13	23.6	8.0
	DQ-15	29.8	10.0
	DQ-16	32.9	26.0
	DQ-17	37.4	5.0
	DS-18	39.3	22.0
	DQ-19	39.4	14.0
	Sea 1	0.0	28.0
	Sea 2	0.0	26.0
BH17-EBC-9	DS-2	4.4	8.0
	DQ-4	8.8	13.0
	DQ-7	14.3	12.0
	DQ-8	15.2	88.0
	DQ-10	18.0	11.0
	DQ-12	22.5	10.0
	DQ-13	24.0	11.0
	DQ-14	27.0	16.0
	DQ-15	27.4	15.0
	DQ-17	31.5	5.0
	Sea 1	0.0	28.0
	Sea 2	0.0	26.0

UCS and Point Load ASTM Test Results

HATCH

Borehole No.	Sample No.	U.C.S. (MPa)	Depth	Point Load ASTM(Mpa)
BH17-EBC-1	1	164.1	15.0	75.5
			16.0	182.5
			19.1	151.7
			19.2	
			19.4	
			19.8	119.6
			21.4	147.9
BH17-EBC-2	1	161.5	13.6	100.7
			14.0	157.4
			18.7	70.8
			17.8	
			18.7	133.8
			20.3	
BH17-M008-R	1	57.9	19.1	70.8
	2	46.1	19.4	47.2
	3	94.8	19.5	23.6
			20.3	94.4
			21.4	28.3
			21.9	100.7

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BH18-M001	DQ-1	0.2				
	DQ-2	0.7				
	DS-3	0.9	20	2	23	75
	DQ-4	2.0				
	DS-5	2.4	17	2	19	79
	DS-6	7.0	27	0	1	99
	DQ-7	9.7				
	DS-8	10.2	23	0	3	97
	DQ-9	12.3				
	DS-10	12.4				
	DS-12	16.5				
	DS-14	19.4	1	21	41	38
	DS-15	22.0	6	21	41	38
	DS-16	23.3	6	22	42	36
	DS-17	25.4	7	13	52	35
BH18-M002	DQ-1	1.1				
	DS-2	1.2	9	25	63	12
	DQ-3	3.8	20	0	2	98
	DS-4	4.0	20	0	13	87
	DQ-5	5.6	21	0	17	83
	DS-6	8.5	20	0	4	96
	DQ-7	11.5	25	0	0	100
	DS-8	11.6				
	DS-10	13.1				
	DQ-9	13.3				
	DS-11	17.0				
	DQ-12	17.1				
	DS-13	21.7				
	DQ-14	21.7				
	DQ-15	26.2				
	DS-16	26.7	23	0	0	100
	DQ-17	29.6	5	10	48	42
	DS-18	29.8	5	16	44	40
	DQ-19	32.0				
	DQ-23	33.7				
	DQ-22	34.5				
	DS-21	34.7				
	DS-24	36.3	2			
	DQ-25	36.6				
	DQ-26	39.2	3	45	26	29
BH18-M003	DQ-1	0.6				
	DS-2	1.0	8	37	43	20
	DQ-3	2.0				
	DS-4	2.2	27	0	10	90
	DS-5	4.0	21	0	13	87
	DQ-6	7.1				
	DS-7	7.2	24	0	40	60
	DS-8	13.3	22	0	1	99
	DQ-9	14.7				

Borehole No.	Sample No.	Depth	Moisture Content	Gravel (%)	Sand (%)	Fines (%)
BH18-M003	DQ-10	19.2				
	DS-11	19.5	21	0	15	85
	DS-12	23.5				
	DQ-13	24.0	25	0	1	99
	DQ-14	26.2				
	DS-15	27.2	20	0	14	86
	DS-16	27.7				
	DQ-17	28.7				
	DQ-18	32.2				
	DS-19	33.2				
	DS-20	38.4				
	DS-23	42.8				
	DQ-22	43.4				
	DS-24	47.7	6	25	45	30
	DS-26	50.9	7	13	42	45
	DQ-25	48.1				
BH18-004	DS-1	2.4	21	0	86	14
	DQ-1	2.5	14	6	77	17
	DQ-2	8.2				
	DS-4	12.6	9	14	70	16
	DQ-3	13.4				
	DQ-5	17.1				
	DS-6	17.4	7	34	52	14
	DQ-7	18.5				
	DQ-8	21.0	22	0	59	41
	DQ-10	26.6				
	DS-11	26.8	14	11	81	8
	DQ-12	31.9				
	DQ-13	35.4				
	DS-14	40.2	7	32	45	23
	DQ-15	42.5				
	DQ-16	42.7	20	0	12	88
	DS-17	47.2		0	98	2
	DQ-19	51.8				
	DQ-20	55.3				
	DQ-23	61.3				
	DS-24	61.7	18	0	23	77
	DQ-25	62.8				
	DS-26	63.2	18	0	6	94
	DQ-27	64.5				
	DQ-28	68.9	20	0	1	99
	DS-29	70.5		0	1	99
	DQ-30	72.0	20	0	1	99
	DQ-32	77.1				

Borehole No.	Sample No.	Depth	Salinity Scale (ppt)
BH18-004	DQ-1	0.2	1.0
	DQ-2	8.2	8.0
	DQ-3	13.4	10.0
	DQ-5	17.1	10.0
	DQ-7	18.5	10.0
	DQ-8	21.0	34.0
	DQ-10	26.6	17.0
	DQ-12	31.9	84.0
	DQ-13	24.5	20.0
	DQ-15	42.5	52.0
	DQ-17	48.8	31.0
	DQ-18	56.8	10.0
	DQ-20	55.8	73.0
	DQ-23	62.8	>100
BH18-M001	DQ-1	0.2	N/A
	DQ-2	0.7	3.0
	DQ-4	2.0	2.0
	DQ-7	11.3	N/A
	DQ-9	13.8	3.0
BH18-M003	DQ-1	0.2	4.0
	DQ-3	0.7	10.0
	DQ-6	2.0	25.0

Appendix G

Laboratory Certification

CCIL

Canadian Council of Independent Laboratories

CERTIFICATE OF CONFORMANCE

AGGREGATE LABORATORY CERTIFICATION

This is to certify that

Hatch Geotechnical Laboratory

Located at:

Niagara Falls ON

Has met the Standardization and Interlaboratory Testing Requirements of the CCIL/OSSGA AGGREGATE LABORATORY CERTIFICATION PROGRAM and has qualified under the following categories and test methods:

AGGREGATE QUALITY CONTROL LABORATORY (TYPE C)

LS-600/C-702; LS-601/C-117; LS-602/C-136; LS-607; LS-608; LS-621

AGGREGATE PHYSICAL PROPERTY LABORATORY (TYPE D)

LS-706/D698; LS-702/AASHTO T88; LS-703,704/D4318; LS-705/D854; LS-709/D2434

GIB MCINTEE, P. ENG.
CHAIRMAN, CERTIFICATION PROGRAM ADMINISTRATION COMMITTEE

May 1, 2018 - April 30, 2019
Date

GORDON H. LEAMAN, P. ENG.
PRESIDENT

CCIL

Canadian Council of Independent Laboratories

CERTIFICATE OF CONFORMANCE

AGGREGATE LABORATORY CERTIFICATION

This is to certify that

Hatch

Located at:

Niagara Falls ON

Has met the Standardization and Interlaboratory Testing Requirements of the CCIL/OSSGA AGGREGATE LABORATORY CERTIFICATION PROGRAM and has qualified under the following categories and test methods:

AGGREGATE QUALITY CONTROL LABORATORY (TYPE C)

LS-600/C-702; LS-601/C-117; LS-602/C-136; LS-607; LS-608; LS-621

AGGREGATE PHYSICAL PROPERTY LABORATORY (TYPE D)

LS-706/D698; LS-702/AASHTO T88; LS-703,704/D4318; LS-705/D854; LS-709/D2434

GIB MCINTEE, P. ENG.
CHAIRMAN, CERTIFICATION PROGRAM ADMINISTRATION COMMITTEE

May 1, 2017 - April 30, 2018
Date

GORDON H. LEAMAN, P. ENG.
PRESIDENT

Canadian Council of Independent Laboratories

CERTIFICATE OF CONFORMANCE

AGGREGATE LABORATORY CERTIFICATION

This is to certify that

Amec Foster Wheeler Environment & Infrastructure
A Division of Amec Foster Wheeler Americas Limited

Located at:

Hamilton ON

Has met the Standardization and Interlaboratory Testing Requirements of the CCIL/OSSGA AGGREGATE LABORATORY CERTIFICATION PROGRAM and has qualified under the following categories and test methods:

AGGREGATE QUALITY CONTROL LABORATORY (TYPE C)

LS-600/C-702; LS-601/C-117; LS-602/C-136; LS-607; LS-608; LS-621

AGGREGATE PHYSICAL PROPERTY LABORATORY (TYPE D)

LS-412/CSA A23.2-2C,-4C; LS-603/C131&535; LS-604/C127; LS-605/C128; LS-606/C88; LS-609/C294,5 (Petrographic Analysts : John Balinski, Martin Little, Amy McCulloch & Ivan Severenski); LS-610/C40; LS-613/D3042; LS-614/CSA A23.2-24A; LS-615/CSA A23.2-26A; LS-617; LS-618/D6928; LS-619/D7428; LS-620/CSA A23.2-25A; LS-623/D698; LS-709/D2434

Superpave Aggregate Consensus Properties

AASHTO T176/D2419; LS-629/AASHTO T304; ASTM D4791; ASTM D5821

GIB MCINTEE, P. ENG.
CHAIRMAN, CERTIFICATION PROGRAM ADMINISTRATION COMMITTEE

May 1, 2016 - April 30, 2017
Date

GORDON H. LEAMAN, P. ENG.
PRESIDENT

Appendix H

Geotechnical Investigation Safety Plan

1. Introduction

A geotechnical field investigation is underway to gather subsurface data for the 12 Mtpa mine expansion prefeasibility study, which includes an offshore (on ice) investigation for the proposed Ore Dock No. 2. This job hazard analysis (JHA) presents an assessment of the hazards and control measures to reduce the likelihood or consequence of the hazards in order to carry out the offshore investigation program. There are a total of 10 proposed boreholes for the dock area including 5 sonic boreholes and 5 Piezocone (CPTu) test holes.

Job Hazard Analysis Form

PROJECT/TASK: ZG003 Geotechnical Marine Drilling Milne Inlet		**Department: Projects Boart Longyear**							**JOB No.:ZG003**
SUPERVISOR: Emile Beauchamp		**LOCATION: Future Ore Dock Milne Inlet**							**DATE: March 12 ,2017**
JOB STEP Break the job into steps. Listing work which may be hazardous.	**HAZARDS** List the hazard or type of harm identified with each step.	**Inherent**			**CONTROL MEASURE** List the necessary control measures to be followed to eliminate/reduce the identified hazards.	**Residual**			**ACTION** Person who will ensure this happens
		Consequence	**Likelihood**	**Risk Ranking**		**Consequence**	**Likelihood**	**Risk Ranking**	
1. Pre-job JHA Review.	Missing critical items on the JHA that can lead to an incident	3	2	5	Conduct a pre-job JHA review with Safety and critical team members All workers will have the opportunity to identify changes needed Any changes will be added to this document	1	1	2	Marlon Coakley/Warren Hoyle
2. Workers to complete FLRA card in the field at location prior to starting work.	Additional hazards in the area that may not have been identified on the JHA and daily changes that may pose additional danger to the health and safety of workers, the environment and property	3	3	6	Look at immediate work area for hazards that may exist, not identified on the JHA. Have other workers in the group sign off on the FLHA	1	1	2	All workers
3. Load Weights – The number and types of vehicles and equipment and their maximum gross weights	Not knowing load calculations will run the risk of breaking through the ice.	5	3	8	All equipment and material shall have posted GVW or gross equipment weight or maximum pull back loads available for use with load-ice thickness tables and shall follow the Ice Safety Plan. Refer to Attachment B for minimum ice thickness required for the drilling operations and Attachment C for further guidelines regarding Ice Safety	4	2	6	Warren Hoyle

4. General Site	Ice Conditions – Slip falls Ice Conditions – Adequate load bearing capacity Inadequate lighting Interaction with a Polar Bear Cold Whiteout conditions Emergency Procedures	3	2	5	Construct a working platform for outside of drill shack to store drill steel and allow the use of salt Use of traction aids on work boots will be required for work on ice surfaces. Apply salt to drill shack decks Engineered Assessment of minimum ice thickness as referenced in Attachment B for ice thickness required for the drilling operations and Attachment C for further guidelines regarding Ice Safety Place delineators in the snow marking access from the drilling location to the shoreline Existing Baffinland procedure "Safely Working On Fresh And Salt Water Ice" shall be followed Polar Bear Monitor will be available at all times Employees will have appropriate PPE including clothing available for safely working in -40 C and windy conditions Worksite location is approximately 300 meters from the shoreline. No work will be conducted in whiteout conditions and a safety shelter will be available immediately adjacent to the work area Site emergency procedures will be provided and reviewed at site	2	1	3	All Crew

5. Working around water and sea ice	Water may appear to be completely frozen over, but not enough to support persons Falling in water Equipment breaking through ice Workers unaware of potential dangerous conditions	5 5 4 3	1 1 2 1	6 6 6 4	Ice thickness to be assessed before walking on ice as per BIM Policy. Initial ice profiling will be conducted with an ice auger Floatation suit will be used for the initial ice profiling using an ice auger. Survival Bag (sleeping bag) will be available to reduce the risk of hyperthermia Follow the BIM Working On Ice Procedure (BAF-PH1-320-PRO-005, Rev 0, March 1, 2016) All workers will be required to complete the Alberta Working Safely on Ice Procedure online training	2	1	3	Marlon Coakley/Warren Hoyle
6. Drill testing for ice thickness	Water may appear to be completely frozen over, but not enough to support persons. Large ice cracks or crevices Falling in water Strains/Sprains Slipping on ice Drilling ice with power auger Changes in ice conditions	3	4	7	Traction aids will be used for any ice work Ice thickness to be assessed before walking on ice Floatation suits will be worn by workers while ice auguring, the worker is to be tethered to a primary rescue worker at a distance of 30m Snow must be removed at the hole location so ice can be examined for quality as described in the Ice field guide. Hand shovelling may be necessary If crevices/ cracks greater than 50% of the ice thickness are present, repairs must be made if there is risk of falling through ice into deep water	2	2	4	Warren Hoyle / Marlon Coakley

					Ice thickness for a person to walk on must be a minimum 13 cm. **STOP** all work if this condition is not met and return to shore. Be aware when using power ice auger that auger bit could bind or jam, have secure footing and grip on auger The ice auger hole spacing will be 20 m along the centreline access and the grid established in the designated work area. Secondary test holes will be augured at 10 m spacing within 250 m of the shoreline, if required based on the variable ice thickness Complete daily inspections of ice surfaces and record on ice log inspection sheet				
7. Access from Land to Sea Ice Snow removal equipment, drill rig and access vehicles are to be used for borehole access	Long distances to walk Exposure to cold White Out conditions Risk of falling under sea ice along the shoreline	4	1	5	Proper warm winter wear to be used Sat phones and digital radio use. Rig mats to be used to bridge over the fractured ice transition area if the transition between sea ice and shoreline needs leveling Buddy system is important to verify presence of frost bite or other cold related concerns **Vehicle operators and passengers are not to wear seat belts when working on ice**	1	1	2	All workers

8. Refueling of equipment	Fuel spills Regulatory or social impacts Spills into water bodies	3	2	5	Use of duck ponds with any refueling Have sufficient spill cleanup supplies on hand to respond to potential spills Maximize space between refueling vehicle	3	1	4	All workers
9. Extreme weather exposure when working outdoors or driving to and from the Borehole Location	Stranded work crew in white out conditions Cold emergencies or cold injuries Mechanical equipment failure	4	2	6	BIM has a procedure that is designed for white out conditions – it would be announced on the radio An emergency shelter to be used when in the Marine Drilling areas Emergency Shelter: Heated wooden shack (7' 8" by 7' 8") set on platform with skis Crews to radio from Hatch leads Buddy system to watch out for fellow workers who may not realize they are developing frost bite Workers to dress in arctic gear and layered clothing Proper PPE required Equipment check list Review Tidal charts on a daily basis Workers to take warm up breaks to stay warm and alert At toolbox review weather forecast with crew and prepare accordingly	2	1	3	All workers

10. Chemical handling- No unusual chemicals other than equipment needs are anticipated to be used.	Spills, leaks Chemical splash Chemical exposure	2	2	4	All products to be stored in secondary containment MSDS to supplied to BIM for review MSDS books to be accessible at the work front MSDS training and WHMIS training completed before arriving to site PPE will be followed as per MSDS recommendations as will first aid and environmental responses Spills response training and supplies to be kept with the equipment	1	1	2	Boart Longyear
11. Waste management and Wildlife Encounters	Risk of wildlife encounters due to improper waste controls Regulatory non compliance	3	2	5	Crews will collect waste daily and transport it back to camp Crews will follow BIM waste management guidelines No placing or storing of food in the back of pickup trucks Secure all small tools and PPE as foxes may carry away small articles from the site	2	2	4	All workers
12. Ecological and Cultural sensitive areas	Risk of causing damage to archeological areas Destroying vegetation Sensitive wildlife and marine life areas Regulatory and reputation damage	3	3	6	Crews have been instructed that there will be **NO** entry to the area east of the sealift ramp Crews are not to build or alter any inukshuk's or other rock formations on the tundra Permits will be required for the work	2	2	4	All personnel

13. Assemble Drill on skid platform skid and construct four walls and roofs	General hazards associated with drill assembly Inadequate communication between Boart Longyear and Site Services / mobile equipment operators	2	2	4	FLRA to be complete by Boart Longyear supervisor prior to executing work Boart Longyear Drilling operations SOPs to be followed including Boart Longyear Procedure 4001	1	1	2	Warren Hoyle / Marlon Coakley
14. Auguring holes in ice for sonic drilling and CPT work	Large ice cracks or crevices Falling in water Strains/Sprains Slipping on ice Drilling ice with power auger Changes in ice conditions	3	3	6	Wear traction aids for any ice work PFDs to be worn by workers while ice auguring during the sonic drilling and CPT operations Snow must be removed at the hole location so ice can be examined for quality. Hand shovelling may be necessary Be aware when using power ice auger that auger bit could bind or jam, have secure footing and grip on auger Complete daily inspections of ice surfaces and record on ice log inspection sheet All holes must be marked using an orange spray paint Any hole in ice over 30 cm in diameter must have a physical barrier around the hole	3	2	5	
15. Working around rotating equipment	Entanglement injuries	3	2	5	All equipment guards to be in place and in good working condition No loose clothing or drawstrings that can get pulled into rotating equipment Long hair must be contained to prevent entanglement into rotating equipment	2	1	3	All workers

					If any maintenance is required then energy isolation procedures to be followed				
16. Isolation of energy sources	Potential energy release that causes injury	3	2	5	All crews will follow the BIM Zero Energy State (ZES) procedure Crews to be given the BIM ZES training on site and fully understand the BIM requirements	1	1	2	Boart Longyear Crews BIM H&S
17. Working on equipment	Slip and trip hazards around railings, stairs and uneven ground.	2	2	4	Rails are installed around deck and to be properly maintained in good condition Stairs to be used on equipment A head cage will be used to reduce chance of contact with the rotating head Estops to be in good working order and easily accessible FLRA to be completed daily to review hazards All crews will follow the BIM Zero Energy State (ZES) procedure	1	1	2	Boart Longyear crew
18. Ice monitoring during drilling activities	Excessive deflection in ice	4	3	7	Hatch geotechs crew will monitor ice conditions during drilling including cracks around the work area, monitor freeboard in drilled holes for signs of ice deflection	2	2	4	All crew

19. Spotter activities	Equipment could come in contact with Spotter	4	2	6	Spotter to maintain eye contact with driver Spotter to review FLRA Agreed hand signals to be used with drivers in conjunction with BIM spotter procedure Agreed hand signals will be documented on the FLRA Drivers to immediately stop if the Spotter is out of eye contact	1	1	2	Boart Longyear crew
20. Manual lifting	Pinch point, back injuries, muscle and joint sprains and strains	2	3	5	Work in pairs, FLRA reviews Work with a buddy on heavy or awkward lifts Use proper lifting techniques 100 pound pipes to be handled by two workers	1	1	2	All crew
21. Working with pressure systems	Pressurized water and hydraulic fluids are used on drill and support equipment	3	2	5	Pre operational inspection Follow all safe work procedures. ZES when maintenance is required.	1	1	2	Boart Longyear crew
22. Falling objects	Potential exists for falling of drill rod and casing falling from overhead	3	2	5	Rigging and slinging training required when working with suspended loads and overhead hazards Perform FLRA	1	1	2	Boart Longyear Hatch Geotec EHS techs
23. High noise and vibration areas on the rigs	Hearing damage	2	2	4	Hearing protection is required by use of ear plugs or muffs.	2	1	3	Boart Longyear Hatch Geotec EHS techs

24. Housekeeping	Potential exists for poor housekeeping causing slip/trips and other hazards	3	2	5	Daily site assessments and toolbox meetings by drillers and site supervisors BIM EHS techs to perform daily inspections	2	2	4	All Crew
25. Fatigue	Potential exists for crew fatigue	2	2	4	Fit for duty confirmation required for all employees, daily FLRA reviews Micro breaks to stretch Proper rest during off shift period	1	1	2	All Crew
26. Working at night or 24 hour darkness	Higher risk of injury due to poor visibility	3	3	6	Hi-vis work gear to be used Use of flashlight and headlamp Workers to stay within 10 meters (30 feet) of the worksites at any time Use of wobble lights and light tower Emergency shelter	1	1	2	All Crew
27. Hot work - welding	Fire risk Burn injuries Welders Flash	2	2	4	Hot work training Use of hot work permits and JHA for any Hot Work Fire Watch required Proper PPE Welding training required	1	1	2	Boart Longyear crew

28. Rescue Plan	Rough terrain Further injuries to casualty during transit. Snow storm, white out conditions. Darkness	3	3	6	The track unit will be used to pull the survival shack (survival shack is 7’ 8” x 7’ 8” square) on platform with skis. When an incident has occurred, the Geotechnical Engineer must call a Code 1. Provide first aid treatment to the injured person until MRT arrives on site MRT will be dispatched to the location. MRT will transport the casualty. Visibility (whiteout conditions) will hinder rescue time, rescuers will have to wait out the storm, or until the whiteout conditions have subsided.	2	2	4	Marlon Coakley/ Warren Hoyle
29. Cleanup and Demob	Unfrozen open holes Complacency	3	3	6	All drill holes must be filled in with water and snow upon completion of drilling operations A Hatch site representative will confirm safe conditions upon demob All debris must be removed from ice surface and disposed off site per waste management plan BIM safety and environment representatives to attend a post project closeout inspection to document the completion of the clean-up	2	2	4	Boart Longyear

Comments:

Baffinland

Baffinland Iron Mines Corporation - Mary River Project - ERP
Job Hazard Analysis Form

Score	CONSEQUENCE		
	People	Plant	Environment
5 – Very High/ Catastrophic	Multiple Fatalities.	Greater than $10 Million Loss	Catastrophe, destruction of sensitive environment, worldwide attention. Likely EPA prosecution. More than 30 days delay.
4 – High/ Major	Fatality or Permanent Disabilities.	$1 Million to $10 Million Loss	Disaster, high levels of media attention, high cost of clean-up. Offsite environmental harm; more than 10 days delay.
3 – Moderate	Major Injuries – Incapacitations or requiring time of work.	$100 Thousand to $1 Million Loss	Major spills, onsite release, substantial environmental nuisance, more than 1day delay. (Leads to additional resources call out i.e. SES).
2 – Low/ Minor	Significant Injuries – Medical Treatments, non-permanent injury.	$10 Thousand to $100 Thousand Loss	Significant spills. (Leads to a call out of Site Emergency Response Group).
1 – Very Low/ Insignificant	Minor Injuries – First Aid Treatments (cuts/bruises).	Less than $10 Thousand Loss	Low environmental impact. Minor Spills less than 80 Litres.

Score	LIKELIHOOD
5 – Almost Certain	The event is expected to occur in most circumstances. Likely to occur frequently - More than 1 per year.
4 – Likely/ Probable	The event will probably occur in most circumstances. Likely to occur several times – 1 per year.
3 – Moderate/ Occasional	The event should occur at some time. Likely to occur at some time – 1 per 5 years.
2 – Remote/ Unlikely	The event could occur at some time. Unlikely but possible. 1 per 10 years.
1 – Rare/ Very Unlikely	The event may occur only in exceptional circumstances. Assumed it may not be experienced. 1 per 100 years.

Job Hazard Analysis Attendees: Darryl Finlay, Marlon Coakley, Warren Hoyle, Usman Khan, Alex Boissonneault

	Name	Signature	Date
Written by:	Marlon Coakley	[signature]	Mar 20/2017
Reviewed by:	Warren Hoyle (Hatch)	[signature]	March 20, 2017
	Darryl Finlay (BIM Safety Coordinator)	[signature]	March 20, 2017

Risk Rating = Consequence + Likelihood

Consequence	Risk Rating				
5	6	7	8	9	10
4	5	6	7	8	9
3	4	5	6	7	8
2	3	4	5	6	7

Risk Rating - Definitions

Risk Rating	Definitions	*Action Required*
8 - 10	Intolerable	Task not to start till the risk is eliminated or reduced. Bring to the immediate attention of management. Formal assessment required. MUST reduce the risk as a matter of priority.
7	High	Bring to the immediate attention of management. Task not to start till the risk is eliminated or reduced. Further Assessment required. MUST reduce the risk as a matter of priority.
6	Significant Risk	Bring to the attention of supervision. Review risks and ensure that they are reduced to as low as reasonably practicable. To be dealt with as soon as possible, preferably before the task commences. Introduce some form of hardware to control risk.
5	Moderate Risk	Needs to be controlled but not necessarily immediately, an action plan to control the risk should be drawn up. Review effectiveness of controls. Ensure responsibilities for

								control are specified.
1	2	3	4	5	6	2-4	Low Risk	If practical reduce the risk. Ensure personnel are competent to do the task. Manage by routing procedure. Monitor for change
	1	2	3	4	5	**A JHA considers a variety of activities/tasks involved in a job scope and analyses the key hazards (sources of harm) and their consequences (types of harm) eg. Sources of harm – lifting a heavy pipe - manual handling. Types of harm – Back strain.**		
	Likelihood							

Main Points – On how to write a JHA.

1. Define the task – what is to be done.
2. Review previous JHA if any – have we done it before?
3. Identify the steps – what is to be done.
4. Identify the hazards of each step.
5. Identify who or what could be harmed.
6. Give the task a risk rating – Consequence + Frequency
7. Develop solutions to eliminate or control hazards in each step.
8. Review the risk rating after the control system has been implemented.
9. If risk rating unacceptable review the solutions till risk rating acceptable.
10. Agree who will implement the control system.
11. Document the JHA and discuss with the relevant personnel.

Hierarchy of Hazard Management – Control Measures

These steps outline what should be planned for when deciding what control measures are to be put in place. Whenever possible the highest step should be used first and then progress down the list.

1. Eliminate the hazard.
2. Substitution.
3. Reducing the frequency of a hazardous task.
4. Enclosing the hazard.
5. Additional procedures.
6. Additional supervision.
7. Additional training.
8. Instructions / information.
9. Some personal protective equipment.

Worker / Visitor review	Signature
Warren Hoyle	Warren Hoyle March 19/2017
Marlon Coakley	Marlon Coakley March 19/2017
Usman Khan	[signature]
Alex Boissonneault	[signature] March 19, 2017
Emile Beauchamp	[signature] March 19/2017
Samuel Flynn	[signature] March 19/2017
Ruben Gross	Ruben Gross MARCH 19/2017
Justin Gross	Justin Gross March 19/2017
Chris Entz	Chris Entz March 19/2017
Doug Roach	
Robbie Jordan	

Enclosed:

Attachment A – BIM Working on Ice Procedure
Attachment B – On Ice Platform for Geotechnical Drilling
Attachment C – Best Practice for Building and Working Safely on Ice Covers in Alberta
Attachment D – Ice Thickness Assessment
Attachment E – Ice Assessment Drawing

Attachment A – BIM Working on Ice Procedure

Baffinland Iron Mines Corporation

Working on Ice Procedure

BAF-PH1-320-PRO-0055

Rev 0

Prepared By: Shawn Parry
Department: Road Maintenance
Title: Manager
Date: February 9, 2017
Signature:

Approved By: Sylvain Proulx
Title: Chief Operating Officer
Date: February 9, 2017
Signature:

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TABLE OF CONTENTS

1 PURPOSE AND SCOPE 4

2 Definitions 4

2.1 Baffinland Classifications for Working on Ice 4

3 RESPONSIBILITIES 4

3.1 Chief Operating Officer or General Manager, Operations 4

3.2 Department Manager/Superintendent 4

3.3 Department Supervisor 4

3.4 Worker 5

3.5 Safety Superintendent or Coordinator 5

3.6 Mine Rescue Team Trainer or Delegate 5

4 PROTOCOL 6

4.1 Class A Job 6

4.2 Class B Job 7

4.3 Class C Job 7

5 Golds Ice Weight Bearing Capacity Formula 7

5.1 Working on Ice frozen to the bottom (River, Lake – etc.) 8

6 Working on Ice JHA and Work Planning Meeting 8

7 MEASURING AND RECORDING ICE THICKNESS 9

7.1 Test Hole Spacing 10

8 REFERENCES AND RECORDS 10

1 PURPOSE AND SCOPE

Baffinland Iron Mines Corporation is committed to taking the necessary steps to ensure that work performed on ice of lakes, rivers, streams or the ocean is conducted in a safe, efficient and environmentally compliant manner.

This procedure is not intended to provide instructions for large scale ice operations such as ice road construction and operation. For large scale ice operations, refer to "Best Practice for Building and Working Safely on Ice Covers in Alberta (Work Safe Alberta)".

2 DEFINITIONS

2.1 BAFFINLAND CLASSIFICATIONS FOR WORKING ON ICE

Class A Job – The ice is between 15 centimetres and 38 centimetres thick and the load weight, including people on the ice will be 4,536 kilograms or less.

Class B Job – The ice is more than 38 centimetres thick and the load weight, including people, is greater than 4,536 kilograms but less than 63,000 kilograms.

Class C Job – The job requirements cannot be met by either Class A or B guidelines.

See section 4, Protocols for a discussion of Class A, B and C requirements.

3 RESPONSIBILITIES

The following roles have specific accountabilities that must be met to ensure that any work on ice is conducted in a safe and environmentally responsible manner.

3.1 CHIEF OPERATING OFFICER OR GENERAL MANAGER, OPERATIONS

The Chief Operating Officer or General Manager, Operations must review and approve any Class C job for working on ice.

3.2 DEPARTMENT MANAGER/SUPERINTENDENT

The Department Manager and Superintendent are responsible to ensure their department supervisors are aware of and comply with this procedure. The manager and superintendent are also responsible to validate the terms and conditions of the JHA are implemented.

3.3 DEPARTMENT SUPERVISOR

The Supervisor is responsible for supervising the work/tasks in accordance with this procedure and the terms and conditions of the JHA. Specifically, the supervisor is responsible for:

- Notify the department manager and superintendent of the requirement to work on ice and send each a copy of the completed JHA.
- Ensure a geographically specific JHA is completed and implemented, prior to starting work.
- Notify the MRT Trainer and have them participate in the JHA.
- Ensuring that workers have reviewed and understand the JHA, prior to starting work.
- Supervise the work and act as the main point of contact for workers working on ice.

3.4 Worker

The worker, is responsible for the following:

- Review, sign and comply with the terms and conditions of the JHA.
- Promptly reporting to their supervisor, any safety concerns or incidents that occur while working on ice.

3.5 Safety Superintendent or Coordinator

The Safety Superintendent or Coordinator will facilitate the working on ice JHA process.

3.6 Mine Rescue Team Trainer or Delegate

The Mine Rescue Team Trainer or delegate is responsible to work with the supervisor to develop the rescue plan component of the JHA.

4 PROTOCOL

4.1 Class A Job

The following table provides requirements for performing work on ice under Class A conditions. The JHA must meet the following conditions;

Equipment Example	Weight (kilograms)	Minimum Ice Thickness (centimetres)	Ice Integrity
1 or 2 people and their tools and equipment	Up to 272	15	Solid ice that is free of cracks, water and slush
Snowmobile and rider	Up to 363	20	Solid ice that is free of cracks, water and slush
2 snowmobiles and riders	Up to 726	25	Solid ice that is free of cracks, water and slush
Pickup truck or other mobile equipment, cargo and driver/passengers	Up to 4536	38	Solid ice that is free of cracks, water and slush

4.2 Class B Job

The ice is greater than 38 centimetres thick and the load weight, including people, is greater than 4536 kilograms but less than 63, 000 kilograms.

Ice Thickness Calculation	Weight and Ice Thickness	Ice Integrity
The Golds formula found in Section 5 must be applied to calculate the safe ice thickness. The calculation, including safe ice thickness must be documented in or attached to the working on ice JHA.	The combined weight of the load, including equipment and people is greater than 4536 kilograms but less than 63, 000 kilograms and the ice is 38 centimetres thick or greater	Solid ice that is free of cracks, water and slush

4.3 Class C Job

The job requirements cannot be met by either Class A or B guidelines. The assistance of a professional engineer recognized as an authority on ice covers, must be consulted and their guidance documented in or attached to, the JHA.

5 Golds Ice Weight Bearing Capacity Formula

GOLD'S FORMULA

All guidelines currently in use in Canada are based on a technical paper published by Dr. Lorne Gold in 1971 entitled "Use of Ice Covers for Transportation". Gold's Formula is;

$P = A \times h^2$

Where:

- P is the allowable load in kilograms
- A is a parameter that depends on the strength of the ice
- h is the effective thickness of good quality ice (cm)

Gold suggested a range of A-values for lake ice that corresponds to a range of safe ice thicknesses for a given load or a range of acceptable loads for a given ice thickness. Baffinland has adopted Golds "Tolerable Risk" value for ice quality, therefore the A value in Golds formula will be four (4) when calculating ice thickness for a Baffinland Class B job.

Gold's formula **A** value of 4 is most commonly used for normal operations with moving vehicles. When equipment will be working in the same spot (stationary) for more than 2 hours, the value for **A** in Golds formula, must be reduced to two (2).

Two examples using the Golds Formula for a Class B job:

What is the weight capacity of good quality ice that is 60 cm thick?
Capacity (in Kgs) = A x h^2
Capacity (in Kgs) = 4 x (60x60)
Capacity (in Kgs) = 4 x 3600
Capacity = 14400 Kgs

The weight bearing capacity of good quality ice that is 60 cm thick is up to 14400 kilograms.

What is the weight bearing capacity of good quality ice that is 60 cm thick and the load will be stationary for 2 hours or more?
Capacity (in Kgs) = A x h^2
Capacity (in Kgs) = 2 x (60x60)
Capacity (in Kgs) = 2 x 3600
Capacity = 7200 Kgs

7, 200 kgs is the weight bearing capacity of good quality ice that is 60 cm thick and the load will be stationary for 2 hours or more.

5.1 Working on Ice frozen to the bottom (River, Lake – etc.)

When Ice thickness measurements determine the ice has frozen to the bottom in the area of travel and work, the ice may be considered as safe provided the ice quality is routinely monitored and remains solid and free of slush and water.

6 Working on Ice JHA and Work Planning Meeting

Working on ice may be divided into two parts;

1. initial measurement of ice thickness
2. working on the ice

Both parts require a JHA.

A work planning meeting must be held prior to any work on ice. This meeting will be based on review of the completed JHA. All individuals participating in the work must present and review their work instructions, roles and responsibilities. The following points will be covered in the JHA and will be covered as part of the topics of discussion during the "planning meeting":

- A description of the work to be done – with sufficient detail for individuals to understand their role
- Potential hazards associated with the work
- Personal safety equipment
- Specific safety procedures for working on ice
- Rescue procedures and necessary equipment
- Individual job tasks
- Communications and hand signals to be used
- Load (i.e. equipment, personnel) weight and distribution on ice during work
- Ice assessment – thickness and condition

JHA safety and emergency response considerations;

- Measuring ice thickness should always be a two person operation.
- Initial ice measurement must be done with a PFD and the lead tester on a tether to the second person who is a safe distance behind.
- Self-recovery is not the primary means of rescue, it's the second person and the tether.
- The MRT will provide a backup rescue plan.

7 MEASURING AND RECORDING ICE THICKNESS

The task of ice thickness measurements may be the subject of a separate JHA or may be included in the working on ice JHA.

Ice thickness is the primary measurement required to determine the safe working load that can be put on the ice (allowable load bearing capacity). Manual measurements are made by cutting a hole in the ice cover with an auger, a saw or an ice chisel and then directly measuring the ice thickness. Measurements are made in a prescribed spacing or pattern to provide sufficient coverage and verify the thickness of the ice cover.

It must be mentioned that in all cases of manual ice thickness measurements it is the absolute minimum thickness measured in all holes that must be used. Not an average or any other measurement.

It is imperative that a systematic procedure be implemented to document all ice thickness measurements. Measurement locations should be taken either with a Global Positioning System (GPS) receiver or marked with stakes, or other reliable system so that these locations can be tracked in future measurements or identified for repairs. This information is a key element in the monitoring control plan.

These records are vital to reconcile any ice failures that may occur. These records must be maintained in a log that is specific to recording ice thickness. See Appendix #1 - Ice Thickness Measurement Log

Suitable equipment and personal protective equipment (PPE) must be prescribed for the work. Initial testing should be conducted by at least two trained crew members travelling separately over the ice. The work could be carried out by travelling:

• On foot, by snowmobile or by amphibious vehicle.

• While testing, the crew should also be checking the ice for cracks and noting the snow load.

• If vehicles are used, two separate vehicles must be used at all times and must be separated at safe distance unless ice conditions are known.

7.1 Test Hole Spacing

Rivers

If GPR is used, test holes are only required for calibration and for mapping of thin areas. Recommend 30 meters between test holes along alternate edges. Look for thin areas caused by river current.

Lakes

If GPR is used, test holes are only required for calibration. If within 250 metres of shore: 30 meters between test holes along centre line. If more than 250 metres from shore: 250 metres between test holes along centre line

Note – these recommendations indicate normal test hole spacing. Good judgement based on field experience must be used when varying from these recommendations. In thin ice areas the suggested spacing should be reduced to determine their extent and severity.

8 REFERENCES AND RECORDS

- Baffinland Job Hazard Analysis Procedure BAF-PH1-810-PRO-0016r1
- Baffinland Iron Mines Corporation– Emergency Response Plan (BAF-PH1-830-P16-0007)
- Best Practice for Building and Working Safely on Ice Covers in Alberta (Work Safe Alberta)
- NWT Transportations Guide to Ice Road Construction

Appendix #1
Ice Thickness Measurement Log

Date:		Location:
Completed by:		Signature:
Weather Conditions, including temperature:		
Test Hole #	Ice Thickness	Notes on test hole – clear solid ice cracking, water – etc.
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Names of other participants		Signature of other participants

Attachment B – On Ice Platform for Geotechnical Drilling

On-Ice Platforms for Geotechnical Drilling at Steensby Island

2013-04-09	0	Approved for Use	V. Tatone	D. Wolek	S. Perry	D. Matthews
DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**	**APPROVED BY**

Table of Contents

1. Purpose **1**

2. Scope **1**

3. Roles and Responsibilities **1**

3.1 Construction Manager 1
3.2 Contractor's Line Managers 1
3.3 Site Health and Safety Manager 1
3.4 Supervisors 1
3.5 Employees 2

4. Definitions **2**

4.1 Solid Ice 2
4.2 Sea Ice 2
4.3 Rafted Ice or Raft Ice 2
4.4 Ice Platform 2
4.5 Rig Mat 2
4.6 Drill Rig 2

5. Procedure **3**

5.1 Specific Requirements for Ice Platforms 3

6. References **3**

List of Appendices

Appendix A

Illustrations

Appendix B

Consideration of Bearing Capacity of Ice for Geotechnical Drilling Program

1. Purpose

1.1 This Procedure identifies minimum safe work practices for the set-up and maintenance of on-ice platforms to be used to support geotechnical drill rigs for near shore work at Steensby Island.

NOTE: This Procedure does not replace safe work procedures for working on ice.

2. Scope

2.1 This Procedure applies to all locations where on-ice platforms are required for near shore work at Steensby Island.

3. Roles and Responsibilities

3.1 Construction Manager

3.1.1 The Construction Manager shall be accountable for ensuring full implementation and compliance with the requirements of this Procedure.

3.2 Contractor's Line Managers

3.2.1 Contractor's Line Managers shall have the following accountabilities:

- Conduct risk assessments for tasks associated with this Procedure and ensure the implementation of controls
- Ensure equipment is used and processes are applied in accordance with this Procedure

3.3 Site Health and Safety Manager

3.3.1 The Site Health and Safety Manager shall have the following accountabilities:

- Audit and monitor compliance with this Procedure
- Identify remedial corrective actions required to meet this Procedure

3.4 Supervisors

3.4.1 Supervisors shall have the following accountabilities:

- Ensure the application of this Procedure
- Responsibility for details of construction of the platforms
- Ensure that a JHA/FLRA is developed for tasks associated with this Procedure

- Ensure that employees review and sign the JHA/FLRA prior to task commencement
- Responsibility for removal of the ice platforms

3.5 Employees

3.5.1 All employees shall have the following accountabilities:

- Ensure they follow this Procedure
- Ensure that JHA/FLRA developed for tasks associated with this Procedure are followed

4. Definitions

4.1 Solid Ice

4.1.1 Stable sheet of solid ice, thickness adequate to safely support the operation. The solid ice may be subject to movement due to tides.

4.2 Sea Ice

4.2.1 Sea ice is any form of ice that is found at sea and has originated from the freezing of sea water.

4.3 Rafted Ice or Raft Ice

4.3.1 Ice in cakes or sheets overlapping or piled on one another. This is a body of near shore ice segments fused together and formed during fall freeze-up. The surface of suitable rafted ice should be reasonably flat and elevation at or near high tide. This rafted ice is a stable entity. Rafted ice that moves with the tides shall be regarded as unstable.

4.4 Ice Platform

4.4.1 A platform constructed on the rafted ice by flooding with salt water and including embedded rig mats.

4.5 Rig Mat

4.5.1 A portable platform used to support equipment used in construction and resource based activity including drill rigs.

4.6 Drill Rig

4.6.1 A track mounted drill rig used for geotechnical investigations.

5. Procedure

5.1 Specific Requirements for Ice Platforms

5.1.1 The rafted ice must be stable and fused to act as a homogeneous mass. Appropriate ice profiling and/or direct measurement of ice thickness is required.

5.1.2 Do not attempt to construct an ice platform in locations where sea ice is pushed up onto the rafted ice to a height exceeding 2 m.

5.1.3 The solid ice adjacent to the ice platform must be stable during tidal influence and capable of safely supporting the gravity loads imposed by the operation, including at the edge of the ice sheet. Appropriate ice profiling and/or direct measurement of ice thickness is required.

5.1.4 The zone of discontinuity between the solid and rafted ice must not be open water at any time and must be sufficiently narrow so that the rig mats will safely support the movement of equipment and personnel across this zone. No work is to be performed over this zone of discontinuity. Appropriate ice profiling and/or direct measurement of ice thickness is required.

5.1.5 The ice platform shall be constructed by alternate overlapping layers of rig mats and flooding with salt water until a suitable work space is created over the rafted ice. Profile the ice with an ice profiler or measure ice thickness using a mechanical ice auger prior to any flooding.

5.1.6 The rig mats shall be constructed of steel frames and timber cross beams. The rig mats shall be strong enough to bridge across the zone of discontinuity. Note that the attached sketch is conceptual only. The number of rig mats must be determined on site. It is anticipated that the number of available rig mats will not be more than six.

5.1.7 The rig mats shall be adequately connected by mechanical means to be determined at site.

5.1.8 The platform must be sufficiently long and wide to permit a clearance of at least two metres on each side of the equipment and supplies.

5.1.9 The platforms must be removed by means established by the supervisor.

6. References

Nunavut General Safety Regulations, R.R.N.W.T. 1990.

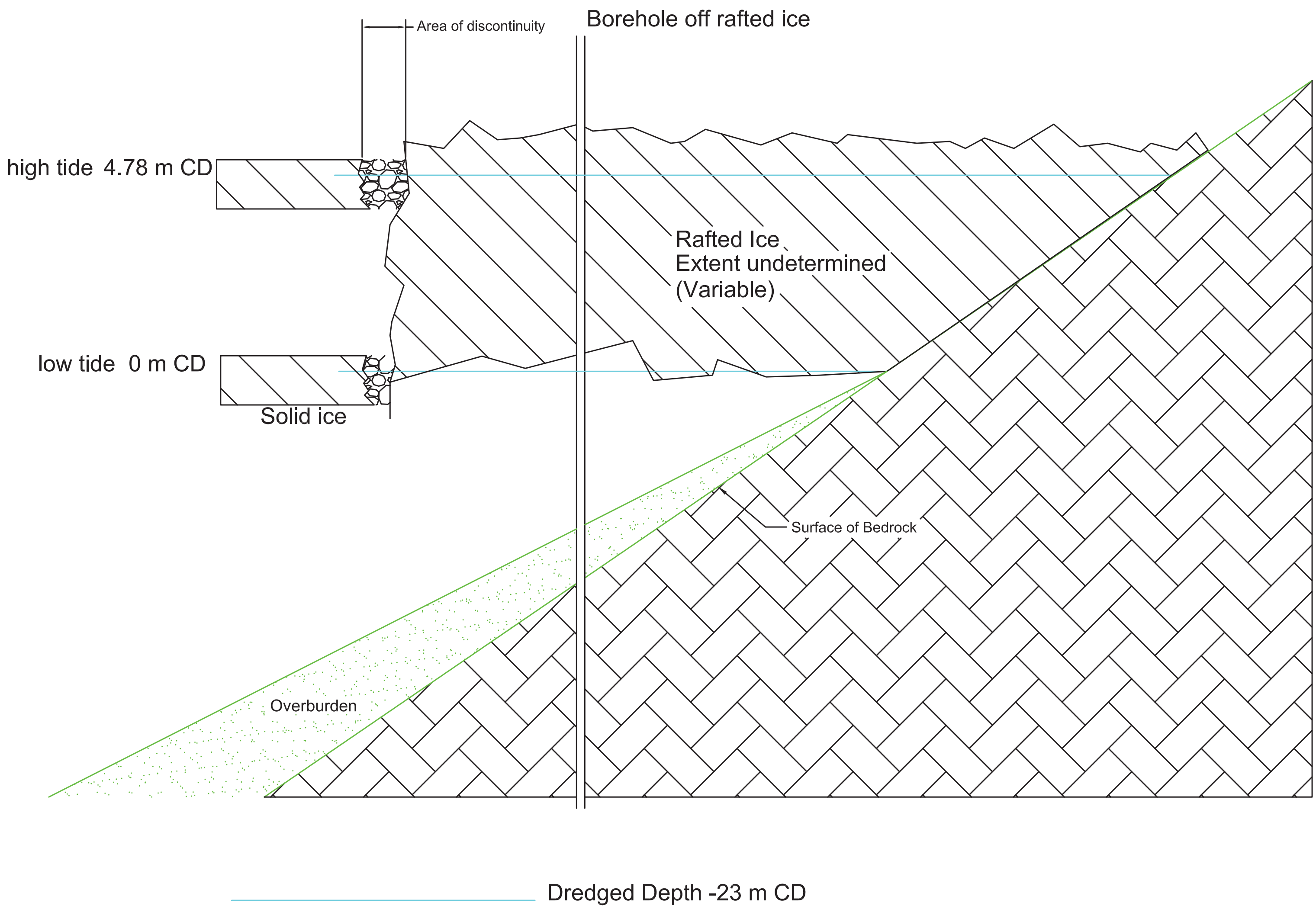
Nunavut Mine Health and Safety Regulations, R-125-95.

Safe Work Procedure – Working on Ice (HS-SWP-092).

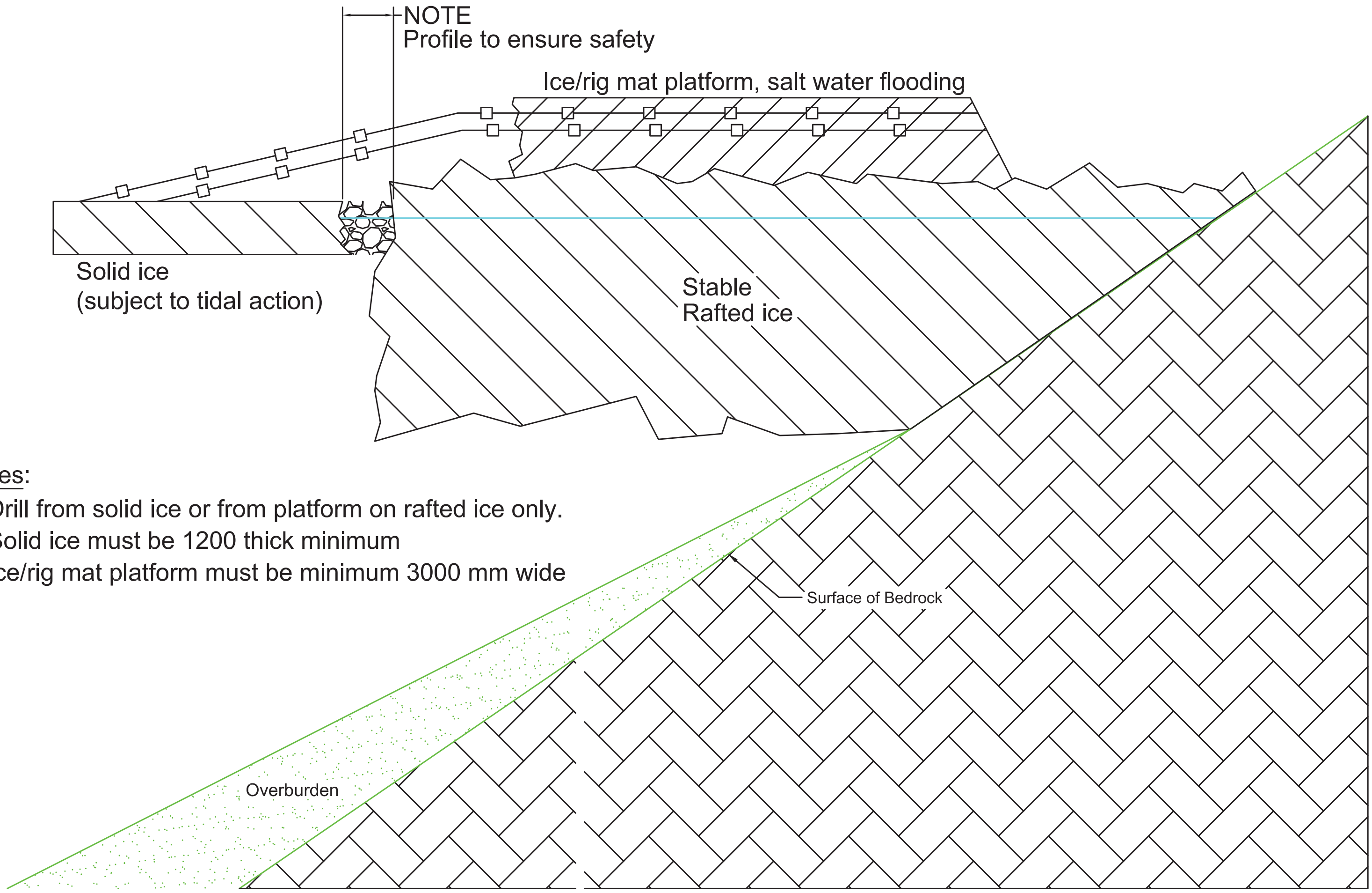
END OF SECTION

Appendix A

Illustrations



ORE DOCK
NEARSHORE CROSS SECTION



Notes:

1. Drill from solid ice or from platform on rafted ice only.
2. Solid ice must be 1200 thick minimum
3. Ice/rig mat platform must be minimum 3000 mm wide

ORE DOCK
ICE PLATFORM CONCEPT

Appendix B

Consideration of Bearing Capacity of Ice for Geotechnical Drilling Program

Project Memo

December 14, 2011

TO: K. Skebo FROM: B. Gill

cc: S. Hinchberger
R. MacCrimmon

Baffinland Iron Mines Corporation
Mary River Project

Consideration of Bearing Capacity of Ice for Geotechnical Drilling Program

1. Introduction

The purpose of this note is to consider the ice features that may affect the execution of a planned geotechnical drilling program in a safe and effective manner. The program will be conducted during April and May in the proposed mine and marine facilities areas of the Baffinland project on northern Baffin Island. This note addresses primarily the bearing capacity of the ice cover for supporting the drilling program vehicles and equipment.

1.1 Air Temperatures and Ice Thickness

The air temperatures over the period from 1971 to 2000 for Hall Beach to the southwest and Pond Inlet to the northeast for April and May are as follows:

Table 1-1: Air Temperatures

	Hall Beach		Pond Inlet	
	April	May	April	May
Daily Average	-20.4	-9.0	-22.1	-9.9
Daily Maximum	-15.2	-4.8	-17.7	-5.8
Daily Minimum	-25.6	-13.2	-26.5	-13.9

Thus it is seen that the air temperature is well below freezing for the period and ice will continue to grow. Ice thickness data for Hall Beach show that in most years, the thickness reaches to 2 m or greater by May. The minimum thickness for May over 50 years is approximately 1.5 m. This is a significant thickness that is capable of supporting very heavy loads.

1.2 The Bearing Capacity of Ice

The guidelines in Canada for determining safe working loads for operations on ice are based on work by Dr. L. Gold of the National Research Council (see for example, "A Field Guide to Ice Construction Safety" by NWT Department of Transportation, November, 2007 and "Best Practice for Building and Working Safely on Ice Covers in Alberta by Work Safe Alberta, Government of Alberta, October, 2009). Dr. Gold published his paper "Use of Ice Covers for Transportation" in 1971. His formula, which says that the safe working load is a function of the ice thickness squared, is $P = Ah^2$ where A is a parameter that is related to the ice strength and h is the ice thickness. The value of A may vary depending on the degree of risk one is willing to take and the offsetting precautionary and response measures that are implemented in a given case. For the current case in which the ice thickness is large, the ice is static, and the equipment loads are relatively modest in relation to the ice bearing capacity, one could assume a low risk factor, and the subsequent calculated minimum ice thickness for the planned equipment weight would be relatively high, but still well below the thickness in April and May. In the Alberta and NWT documents referred to above, the former document uses a range of values for 'A' from 3.5 to 7 and suggests hazard control measures appropriate to each level, whereas the latter document uses a single value of 4 for 'A'. Both of these documents are concerned with freshwater lake and river ice.

Using a value of 4 for 'A' and an ice thickness of 200 cm results in an allowable load of 160 tonnes or more than 12 times the weight of a Cat 950 loader. The ratio would be presumably even greater in the case of a drill rig. In the same manner, the minimum (freshwater) ice thickness that a stationary or slowly moving 950 loader weighing about 13,000 kg would require is 57 cm.

The allowable load in the case of sea ice would be less than that for an equivalent thickness of freshwater ice because of the lower strength (under the same temperature conditions) that results from brine inclusions in the sea ice. A reasonable understanding of this derating can be obtained by comparing the flexural strengths of the two types of ice. For a salinity of 8 ppt (parts per thousand) for arctic sea ice at an average ice temperature of -20 deg C, the resulting flexural strength is about 65 percent of the strength of freshwater ice at the same temperature. The minimum sea ice thickness for a 950 loader would then be about 70 cm. This is 35 percent of the expected ice thickness at the project site during the drilling period.

The rate of movement of the equipment is not expected to be a significant factor, unlike in the case of transport vehicles moving at speed on ice covers over relatively shallow water. The speeds in the present case will not be sufficient to cause any dynamic effects that could lead to a magnification in deflection of the ice cover. According to field studies reported in the above-referenced Alberta Government document, a vehicle would have to travel at 50 km/h over ice 1 m thick in 15 m of water to cause such effects.

1.3 Potential Hazard Control

As noted, the large ice thickness in relation to the minimums required to safely carry the loads and the static nature of the ice cover in the present case mean that this is a low-risk operation in terms of potential ice bearing problems. An appropriate hazard control procedure would entail prior ice measurements to confirm the anticipated thickness in the working areas, measurements thereafter if any uncertainties exist with respect to ice thickness, monitoring the ice quality (e.g. cracks, effects of warming, water on the ice, etc), and checking for deflection of the ice cover as time of equipment in one location increases (this can be done by observing the water level in boreholes).

An overall ice safety plan should be implemented, including orientation and instruction for employees and contractors and routine daily observations to ensure rules of working on an ice cover are followed.

BG:vl

Internal Memo

H352034

March 18, 2017

To: Warren Hoyle   From: Usman Khan

cc: Marlon Coakley
Alex Boissonneault
Sean Hinchberger
Tyler Bruce
Sven Heiner

Baffinland Iron Mines
Mary River Expansion Study Stage 2

Minimum Ice Thickness for Offshore Drilling at Milne Port 2017

1. Introduction

Hatch Ltd. (Hatch) was retained by Baffinland Iron Mines to conduct an offshore, on-ice, geotechnical drilling investigation at the Milne Port Site. This investigation is scheduled for the period of mid to late March 2017. In order to mitigate risk relating to ice breakthrough, the investigation team reviewed ice strength evaluation completed for a similar offshore investigation at the Steensby site in 2011.

2. Allowable Ice Loading

2.1 Moving Loads

The 2011 evaluation of ice thickness utilized Gold's formula to calculate the allowable weight for a variable ice thickness. Gold's formula is based on literature that utilizes data collected from ice breakthroughs and forms an empirical relationship to predict the allowable bearing capacity of ice.

$$P = Ah^2$$

P = Allowable load in kilograms

A = Constant which depends on the quality of the ice, the geometry of the load and the factor of safety appropriate

h = Effective thickness of the ice in centimeters

Further literature review suggests using a value of 4 as a conservative estimate for freshwater ice. Government of Alberta and Northwest territories both recommend using a factor of 4.

It is noted that a factor of 4 is used for freshwater ice and does not account for the reduction of flexural strength in sea ice due to the presence of brine. A reduction factor of 0.65 is applied per Hatch project memo entitled, “On-Ice Platforms for Geotechnical Drilling at Steensby Island” (Document # H349000-HS-SWP-165).

Table 2-1: Maximum Allowable Load On Sea Ice

Ice Thickness (cm)	Load (kg)	Load (lb)		Ice Thickness (cm)	Load (kg)	Load (lb)
5	60	150		105	28,660	63,200
10	260	580		110	31,460	69,360
15	580	1,290		115	34,380	75,810
20	1,040	2,300		120	37,440	82,550
25	1,620	3,590		125	40,620	89,570
30	2,340	5,160		130	43,940	96,880
35	3,180	7,030		135	47,380	104,470
40	4,160	9,180		140	50,960	112,350
45	5,260	11,610		145	54,660	120,520
50	6,500	14,340		150	58,500	128,980
55	7,860	17,340		155	62,460	137,720
60	9,360	20,640		160	66,560	146,740
65	10,980	24,220		165	70,780	156,060
70	12,740	28,090		170	75,140	165,660
75	14,620	32,250		175	79,620	175,550
80	16,640	36,690		180	84,240	185,720
85	18,780	41,420		185	88,980	196,180
90	21,060	46,430		190	93,860	206,930
95	23,460	51,740		195	98,860	217,970
100	26,000	57,330		200	104,000	229,290

2.2 Static Loads

Gold’s formula is adequate for calculating the allowable bearing capacity for moving loads on ice but it does not propose a relationship between allowable loads and ice thickness for static loads. To ensure ice safety for a static load operation, a literature review was completed. It was concluded that the deflection in ice must be monitored throughout the drilling operation and loading must be removed in case of excessive deflections. Ice cover should not exceed the freeboard elevation to ensure safety of the drilling crew.

3. Monitoring During Drilling Activities

A hole will be augured through ice within 5 m of the point of maximum load. The depth of water in the hole will be monitored throughout the duration of the drilling investigation at each borehole location. Drilling will be terminated if sea water is observed flowing through the top of the augured hole. Ref 3 provides further details regarding the bearing capacity of ice covers under static loads.

4. References

1. W, Gold. L. (n.d.). Field study on the load bearing capacity of ice covers. National Research Council Canada, 61(5), 3-7. Retrieved March 18, 2017, from http://nparc.cisti-icist.nrc-cnrc.gc.ca/eng/view/object/?id=e7d278d9-808a-4959-b9f7-27320d757afd
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UK:UK

Attachment(s)/Enclosure

Appendix I

Geophysical Assessment

GEOPHYSICS GPR INTERNATIONAL INC.

GEOPHYSICAL INVESTIGATION FOR BAFFINLAND RAILWAY, MARY RIVER PROJECT, NUNAVUT

PREPARED FOR:
Baffinland Iron Mines Corporation

Presented to:

HATCH

4342 Queen Street, Suite 500
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L2E 7J7

Project T17001B-Revision#004 **April 2018**

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January 2018 T-17001B

TABLE OF CONTENTS

1 INTRODUCTION.. 1

2 METHODOLOGY.. 3

2.1 Positioning, Topography and Units of Measurement..3
2.2 Ground Penetrating Radar (Georadar)..4

3 RESULTS.. 5

3.1 Subsurface Ice Mapping..5

4 CONCLUSIONS.. 8

Index of Figures

Figure 1: Overview map of the investigation area...2

Figure 2**:** Interpreted georadar image showing a typical ice...7

Index of Tables

Table 1: UTM coordinates of GPR survey lines...3

List of Appendices

APPENDIX A – Drawings GPR17 – MILNE INLET, GPR17 –KM19, GPR17 –KM20, GPR17 –KM39.6, GPR17 –KM49, GPR17 –KM82.2, GPR17 –KM97, GPR17 –KM100.1, GPR17 –KM109.

APPENDIX B – Georadar Fact Sheet

1 INTRODUCTION

Geophysics GPR International Inc. was requested by Hatch Ltd. to carry out a geophysical survey to aid in projection and planning of a proposed railway for the Mary River Project, Baffin Island, Nunavut.

The purpose of this investigation was to determine the extent of, as well as the thickness of subsurface ice.

The ground penetrating radar (georadar) method was applied to determine the presence of ice and calculate its thickness.

Data was collected from November 3rd to November 15, 2017.

The investigation included the following:

1) Georadar mapping of subsurface ice at nine sites approximately at Km 0, 19.4, 20.5, 39.5, 49.3, 82.2, 97.0, 100.1 and 109 along the proposed rail alignment. Further exploration with gridded georadar lines was conducted in regions both with and without the presence of ice.

Figure 1 presents an overview map of the investigation area with the locations of the respective sites.

The following report describes the various aspects of the survey including field techniques, survey design, interpretation techniques, and finally an interpretation in the form ice thickness maps.

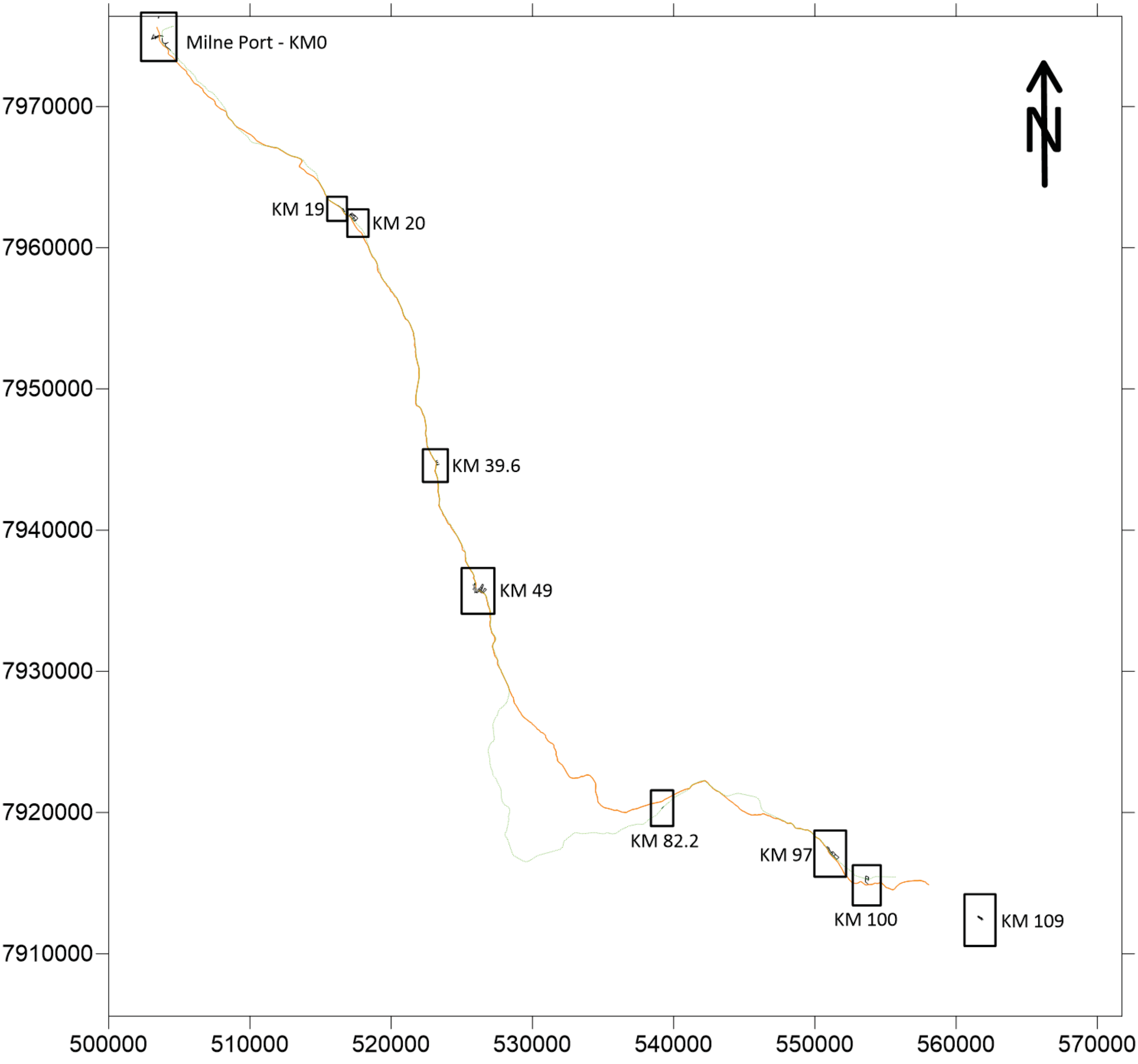

Figure 1: Overview map of the investigation area

2 METHODOLOGY

Georadar was used to determine the presence and thickness of ice.

2.1 Positioning, Topography and Units of Measurement

The emplacement of the survey areas was determined by the client.

The locations of the georadar survey lines for the purpose of subsurface ice mapping were oriented to align with the design of the proposed railway. Length and number of the lines were chosen based on in-field interpretation of georadar data. Positioning was controlled by the GPS device integrated into the georadar antenna. The UTM coordinates should be accurate to within +/- 2.0 m.

Table 1: UTM coordinates of GPR survey lines

Line No.	Start (0+00)		End (0+69)		Chainage (km)		Notes
	Easting	Northing	Easting	Northing	Start	End	
Line 0	502871.8	7976754.0	504000.0	7974502.0	0	2	Milne Port Area
Line 19.4	516252.0	7962974.0	516644.0	7962535.0	19.25	19.85	
Line 20.5	517047.0	7962251.0	517390.0	7961888.0	20.46	20.9	
Line 39.6	523146.0	7944888.0	523216.0	7944604.0	39.6	39.9	
Line 49.3	525992.0	7935880.0	526497.0	7935589.0	49.5	49.9	Rough Terrain
Line 82.2	539154.0	7920274.0	539291.0	7920419.0	82.2	82.4	
Line 97.0	551121.0	7917097.0	551250.0	7916944.0	97.0	97.6	Rough Terrain
Line 100.1	553584.0	7915318.0	553779.0	7915281.0	100.1	100.3	
Line 109.0	561530.0	7912604.0	561844.0	7912356.0	109.0	109.4	

The provided coordinates are NAD83/WGS84, UTM zone 17N.

The depth measurements are noted as depth from surface.

All geophysical measurements were collected in SI units.

In addition to Table 1, further georadar survey lines were created to further explore the given areas. These additional survey lines were generated in a grid-like fashion with the topography dictating the spacing of the lines.

2.2 Ground Penetrating Radar (Georadar)

Basic Theory

Georadar utilises radar technology to obtain a near-continuous profile of the subsurface. The basic principle is to emit an electromagnetic impulse into the ground at a predetermined frequency rate (typically 10 to 80 scans/second). This pulse will travel through the sub-surface and reflect off boundaries of differing dielectric constants (contrasts of EM impedances). The reflected pulse returns to the surface and is recorded by a receiver and displayed in real-time as a cross-sectional image. Only by moving the antennas along a profile directly over the targets can the locations and depths be determined. Examples of radar reflecting boundaries include air/water (water table); water/earth (bathymetry); earth/metal, PVC, or concrete (pipe locating); and differing earth materials (stratigraphic profiles, including bedrock profiles).

The depth of investigation is controlled by the frequency and power of the antenna limited by attenuation and diffraction of the radar signal. Lower frequency antennas provide greater depth penetration at the expense of resolution. The radar signal is attenuated by conductive ground materials (e.g. clays, dissolved salts etc.). The radar signal is diffracted by irregular shaped material (e.g. boulders, debris etc.) that prevents the clear return of the reflected pulse.

More information on the georadar operating principle can be found in Appendix B.

Survey Design

The georadar data were collected with a MALA Ground Explorer system and 160 MHz antenna. This antenna provides a favourable trade off between depth and resolution for ice detection. As well, this antenna has sufficient durability for the terrain and weather conditions for Baffin Island.

Positioning for the georadar survey was controlled by built-in GPS receiver.

Interpretation Method

Processing of the radar images involved basic horizontal normalization, elevation corrections and gain adjustments.

The vertical scale on all radar images is a two-way time scale representing the time taken for a radar pulse to transmit to a reflector and back to the receiver. In order to convert the time scale to a depth scale a signal velocity must be applied. The velocity with which the pulse travels through the given material is determined by the dielectric constant. This dielectric will vary with the type of material.

Calculating a velocity can be done in many ways but the most reliable method is with a test pit or borehole where the real rock contact can be exposed. Based on in-situ measurements or borehole data, the dielectric value can be approximated depending on the expect material type. An underestimate of the dielectric will result in an over estimate of the signal velocity and in turn an over estimate of the depths. For this site a dielectric of 4 (velocity of 15 cm/ns) was assumed based on the expected soil type and tables of relative dielectric values for commonly encountered materials. In this case the materials were mostly frozen granular/boulders with high ice content.

Interpretation of the data is based primarily on the qualitative analysis of three characteristics of radar reflections: continuity, amplitude and shape. The interpreter then identifies reflectors and textures within the radar records that represent subsurface contacts, objects or zones. The true nature of the interpreted features can only be assumed without corroborating evidence.

Ice bodies have a distinctive appearance on radar images. Granular host material appears as “noise” on the images, whereas uniform ice layer looks transparent with clearly defined top and bottom contacts and can be confidently identified. An example of a uniform ice lens is presented in Figure 2.

Non-uniform ice bodies (stratified or containing layers of soil) are more challenging for interpretation since structure irregularities create multiple reflections within the ice body. Often a borehole is needed to confirm the presence of ice. Other features such as increasing depth of investigation in the presence of thick ice layer may corroborate the interpretation.

In summary, ability of georadar is limited by the structure of the ice layer being surveyed and its composition. The identification of an ice layer may be impacted by irregularities inside the ice body, such as layering, fractures and soil inclusions. However, it is possible to create two categories of ice lenses, the obvious and less obvious that may need some ground truthing.

3 RESULTS

3.1 Subsurface Ice Mapping

Georadar data was collected at nine sites approximately at Km 0, 19.4, 20.5, 39.5, 49.3, 82.2, 97.0, 100.1 and 109 along the proposed rail alignment.

Locations of the survey lines and results of the georadar survey are presented in drawings GPR17 – MILNE INLET, GPR17 –KM19, GPR17 –KM20, GPR17 –KM39.6, GPR17 –KM49, GPR17 –KM82.2, GPR17 –KM97, GPR17 –KM100.1, GPR17 –KM109.

KM 0 - GPR17 – MILNE INLET

Multitude of survey lines conducted in the Milne Port area with no evidence of the presence of ice. Georadar penetration of the surface appeared shallow with poor signal attenuation, possibly due to material used for subsurface in port area. Total distance of 1.2km covered.

KM 19 - GPR17 –KM19

Two main survey lines conducted. No apparent ice presence in area. Area was not explored further due to time constraints. Total distance of 1.0km covered.

KM 20 - GPR17 –KM20

No apparent ice presence in area. Grid-like survey conducted to further explore region for ice; two further longitudinal lines, with three additional perpendicular cuts. Total distance of 2.9km covered.

KM 39.6 - GPR17 –KM39.6

No apparent ice presence in area. Latitudinal cuts conducted to further explore region for ice. No longitudinal lines due to topographic obstacle in area. Total distance of 1.5km covered.

KM 49 - GPR17 –KM49

Ice found in region, explored with additional lines where possible. Survey lines constrained due to topography and water in area. Total distance of 4.5km

KM 82.2 - GPR17 –KM82.2

No apparent ice presence in area. Due to distance from tote-road and time constraints no additional surveying was conducted in this area. Total distance of 200m covered.

KM 97 - GPR17 –KM97

No apparent ice presence in area. Area heavily constrained by topographic change. Additional survey lines done around topography to ensure safety maintained. Total distance of 2.2 km covered.

KM 100.1 - GPR17 –KM100.1

No apparent ice presence in area. Area constrained by water. Additional survey lines conducted in area. Total distance of 1.2km covered.

KM 109 - GPR17 –KM109

No apparent ice presence in area. Area constrained by topographic change. Additional survey lines conducted in area. Total distance of 1.2km covered.