123991

Appendix Q
Numerical Modeling of Breakup Ice Jams
Technical Memorandum
Lower Grasse River

Table of Contents

1.0 Introduction 1

1.1 2003 Grasse River Ice Jam 1

1.2 Overview of Computer Model 5

2.0 Model Calibration 6

2.1 Model Calibration Details and Results 10

2.1.1 March 27 Morning – Ice Stoppage at T3 10

2.1.2 March 27 Morning through March 27 Afternoon – Ice Stoppage at T6 11

2.1.3 March 27 Afternoon through March 28 Morning – Large Ice Jam at T16 12

2.1.4 March 29 Ice Jam Release 16

2.2 Effect of Ice Jam Roughness 19

3.0 Ice Jam Scenario Analysis 21

3.1 Effect of Location of Toe of Ice Jam 21

3.2 Effects of Upstream Discharge and Ice Supply 30

3.2.1 Changes in Sensitivity Case Scenarios Due to Revised USGS Flow Data….....40

3.3 Effect of Downstream Water Level 45

3.4 Effect of Extreme Discharge 48

4.0 Conclusions 50

5.0 References 50

List of Tables

2.1 Chronology of 2003 Ice Jam Event 9

3.1 100-Year Return Period Simulations 32

3.2 Revised Combinations of Breakup Discharge and Ice Thickness for Sensitivity Analysis Simulations 42

List of Figures

1.1 Air Temperature and Precipitation During March 2003 2

1.2 River Discharge During 2003 Spring Breakup Period 2

1.3 Downstream River Stage Above 46.4 m (IG85 Datum) 3

1.4 Lower Grasse River Ice Condition During March 2003 Breakup 4

1.5 Model Domain and Finite Element Mesh 6

2.1 Initial Steady State Longitudinal Profile Along the Centerline of the River 7

2.2 Centerline Used for Longitudinal Profile Plots 7

2.3 Water Discharge at Upstream Boundary During March 2003 Calibration Period 8

2.4 Ice Discharge at Upstream Boundary During March 2003 Calibration Period 8

2.5 Observed River Stage During 2003 Ice Jam Event 9

2.6 Ice Jam Model Results at 11:30 am – March 27 10

2.7 Predicted Current Velocity Under Ice Jam Near T3 at 11:30 am – March 27 11

2.8 Ice Jam Model Results at 4:30 pm – March 27 11

2.9 Predicted Current Velocity Under Ice Jam Near T6 at 4:30 pm – March 27 12

2.10 Ice Jam Model Results at 8:30 am – March 28 13

2.11 Ice Jam Profile at 8:30 am – March 28 13

2.12 Simulated Ice Jam Thickness Distribution at 8:30 am – March 28 14

2.13 Predicted Ice Jam Thickness in Vicinity of T16 at 8:30 am – March 28 14

2.14 Predicted Water Depth Under Ice Jam at 8:30 am – March 28 15

2.15 Predicted Current Velocity Under Ice Jam Near T16 at 8:30 am – March 28 15

2.16 Comparison of Predicted Ice Jam Profile at 8:30 am – March 28 to Tree Scar Data 16

2.17 Ice Jam Model Results 15 minutes after Ice Jam Release (12:45 am – March 29)… 17

2.18 Ice Jam Model Results 30 minutes after Ice Jam Release (1:00 am – March 29) 17

2.19 Ice Jam Model Results at 8:30 am – March 29 18

2.20 Ice Jam Model Results at 6:30 pm – March 29 18

2.21 Ice Jam Model Results at 4:30 am – March 30 19

2.22 Ice Jam Model Results at 8:30 am – March 28 with a Maximum Ice Manning's Coefficient of 0.1 20

2.23 Ice Jam Model Results at 8:30 am – March 28 with a Maximum Ice Manning's Coefficient of 0.15 20

3.1 Alternative Ice Jam Toe Locations – Plan View 21

3.2 Alternative Ice Jam Toe Locations – Section View 22

3.3 Model Results with Ice Jam Toe at T3 (8:30 am – March 28) 23

3.4 Predicted Current Velocity with Ice Jam Toe at T3 (8:30 am – March 28) 23

3.5 Model Results with Ice Jam Toe at T13 (8:30 am – March 28) 24

3.6 Predicted Current Velocity with Ice Jam Toe at T13 (8:30 am – March 28) 24

3.7 Model Results with Ice Jam Toe at T20 (8:30 am – March 28) 25

3.8 Predicted Current Velocity with Ice Jam Toe at T20 (8:30 am – March 28) 25

3.9 Model Results with Ice Jam Toe at T30 (12:30 pm – March 28) 26

3.10 Predicted Current Velocity with Ice Jam Toe at T30 (12:30 pm – March 28) 26

3.11 Model Results with Ice Jam Toe at T39 (12:30 pm – March 28) 27

3.12 Predicted Current Velocity with Ice Jam Toe at T39 (12:30 pm – March 28) 27

3.13 Model Results with Ice Jam Toe at T50 (12:30 pm – March 28) 28

3.14 Predicted Current Velocity with Ice Jam Toe at T50 (12:30 pm – March 28) 28

3.15 Model Results with Ice Jam Toe at T57 (8:30 am – March 29)..... 29

3.16 Predicted Current Velocity with Ice Jam Toe at T57 (8:30 am – March 29) 29

3.17 Computed Return Periods for Ice Cover Thickness and River Discharge at the Time of Ice Cover Breakup 31

3.18 Return Period for Combinations of Breakup Discharge and Ice Thickness 32

3.19 Case A: Q_{bk} = 10,617 cfs and h_i = 4 in. 34

3.20 Case B: Q_{bk} = 9,867 cfs and h_i = 10 in. 35

3.21 Case C: Q_{bk} = 9,072 cfs and h_i = 16 in. 36

3.22 Case D: Q_{bk} = 7,566 cfs and h_i = 22 in. 37

3.23 Case E: Q_{bk} = 5,630 cfs and h_i = 25.3 in. 38

3.24 Case F: Q_{bk} = 3,035 cfs and h_i = 28.7 in. 39

3.25 Revised Return Period Analysis for Combinations of Breakup Discharge and Ice Thickness. 41

3.26 Revised Case E: Q_{bk} = 6,724 cfs and h_i = 24 in. 44

3.27 Ice Jam with a Downstream Water Level Increase of 0.5 m 45

3.28 Ice Jam Profile Near T16 with a Downstream Water Level Increase of 0.5 m 46

3.29 Simulated Water Velocity Distribution Under Ice Jam with a Downstream Water Increase of 0.5 m 46

3.30 Ice Jam Profile with a Downstream Water Level Decrease of 0.5 m 47

3.31 Ice Jam Profile Near T16 with a Downstream Water Level Decrease of 0.5 m 47

3.32 Simulated Water Velocity Distribution Under Ice Jam with a Downstream Water Decrease of 0.5 m 48

3.33 Model Results with Jam at T-16 and a Breakup Discharge of 9,000 cfs (modeled peak of 13,682 cfs) 49

3.34 Predicted Water Velocity Under Ice Jam with a Breakup Discharge of 9,000 cfs (modeled peak of 13,682 cfs) 49

1.0 Introduction

The Grasse River is located in northern New York and flows through the Village of Massena before joining the St. Lawrence River. Upstream of the Village of Massena, the river has a relatively low slope and the ice cover forms as sheet ice. In Massena, the river passes through a rapids section and a partially-breached dam. In this reach, the river is typically ice-free during most of the winter. Downstream of Massena (referred to as the "lower Grasse River") the river is relatively deep as a result of dredging in the early 1900s to accommodate flows diverted from the St. Lawrence River through the Power Canal to produce hydroelectric power. The Power Canal is no longer used, but the deep channel remains. Sheet ice usually forms every winter in the lower Grasse River from the Power Canal to the St. Lawrence River. The lower Grasse River, about 11 kilometers (km) [6.8 miles] long, has a low water surface slope and the backwater from the St. Lawrence River impacts water levels. Water depth in the lower Grasse River varies from 4 meters (m) [13.1 feet (ft)] to 9 m [29.5 ft]. During spring 2003, an ice jam was observed in the lower Grasse River which caused bed scour in the vicinity of Alcoa's Capping Pilot Study area. In this report, results of a computer modeling study, performed using the DynaRICE model (Shen et al., 2000; and Shen and Liu, 2003), are presented to provide a better understanding of ice jam formation and associated flow conditions in the lower Grasse River.

1.1 2003 Grasse River Ice Jam

During the spring 2003 ice breakup in the Grasse River, an ice jam was observed within the lower Grasse River between transects T3 and T16. In late March, the flow in the Grasse River at Massena increased from about 28.3 cubic meters per second (cms) [1,000 cubic feet per second (cfs)] to a high flow of about 170 to 227 cms [6,000 to 8,000 cfs] due to spring runoff. This increased flow was also coincident with relatively warm air temperatures on March 28 and 29. Figure 1.1 shows daily average precipitation and air temperature during March 2003 at Massena. Daily flows for the Grasse River were estimated using stream gage records for the West Branch of the Oswegatchie River in Harrisville, New York. Grasse River discharge during March and April 2003 are presented on Figure 1.2. Figure 1.3 shows the water level relative to 46.4 m (IG85) [152.2 ft] in the St. Lawrence River at Cornwall, Ontario, Canada.

Figure 1.1 Air Temperature and Precipitation During March 2003

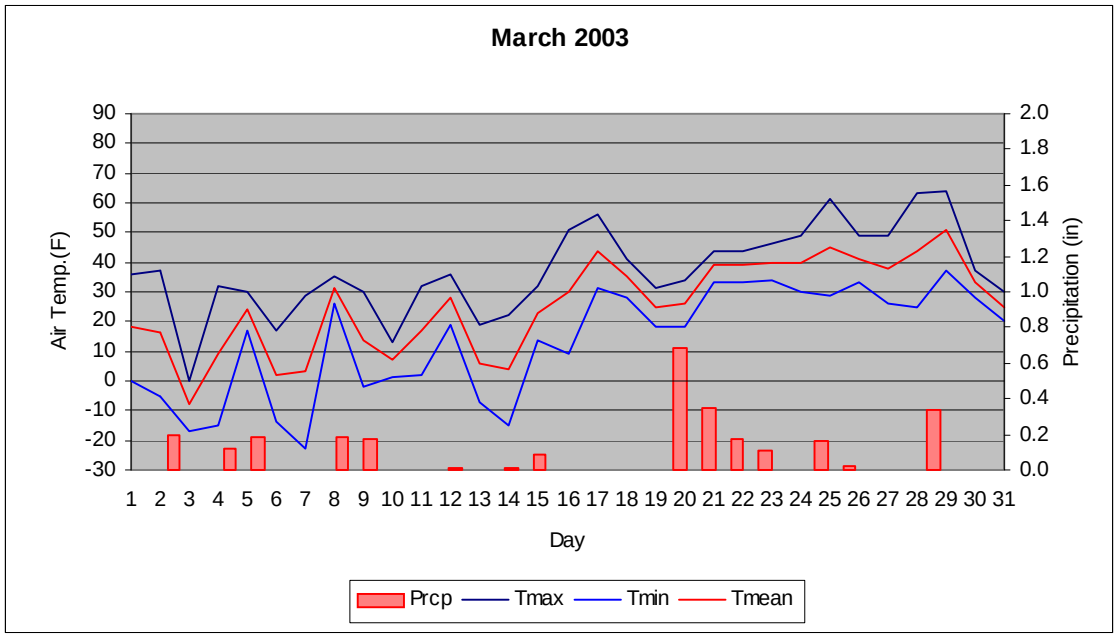


Figure 1.2 River Discharge During 2003 Spring Breakup Period

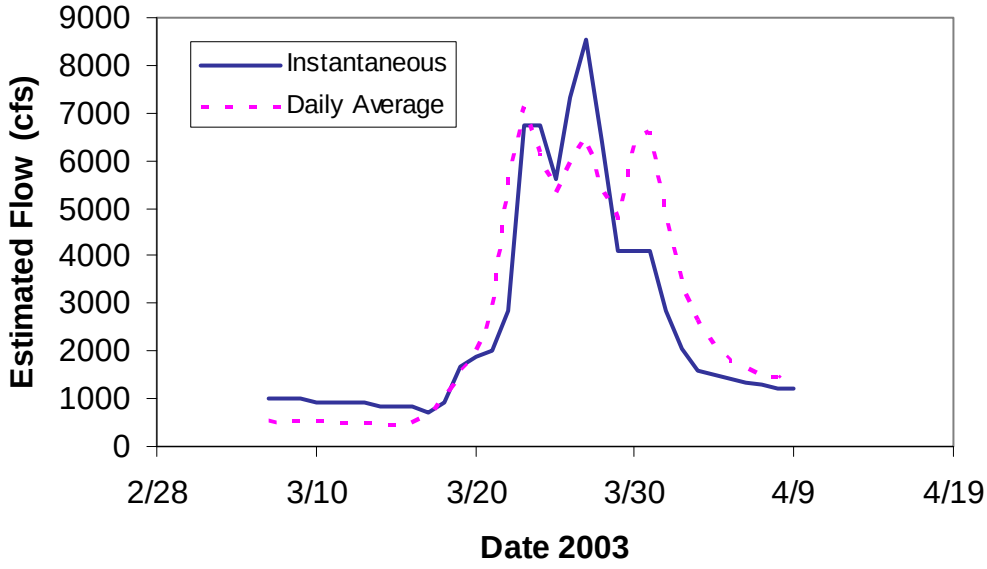
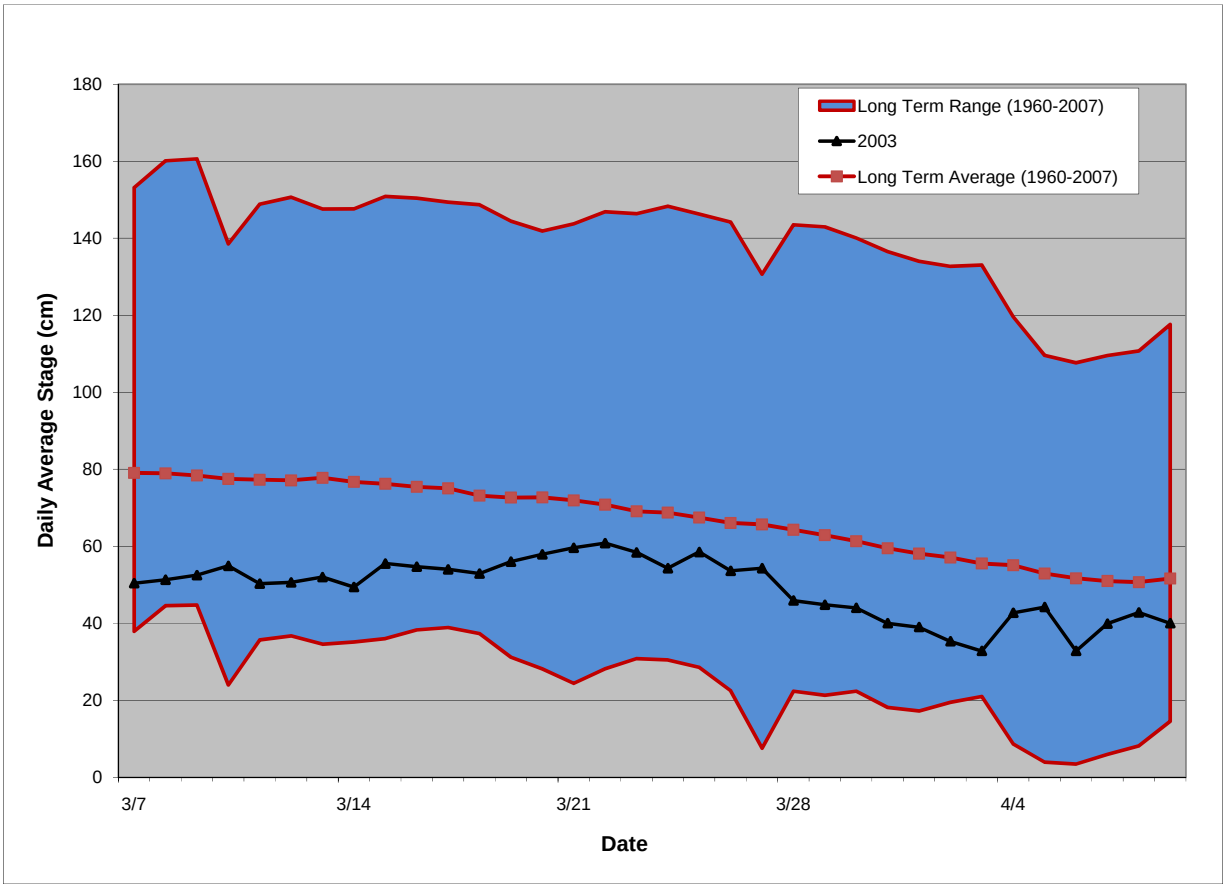


Figure 1.3 Downstream River Stage Above 46.4 m (Cornwall, Ontario-Station 14870-IG85 Datum)



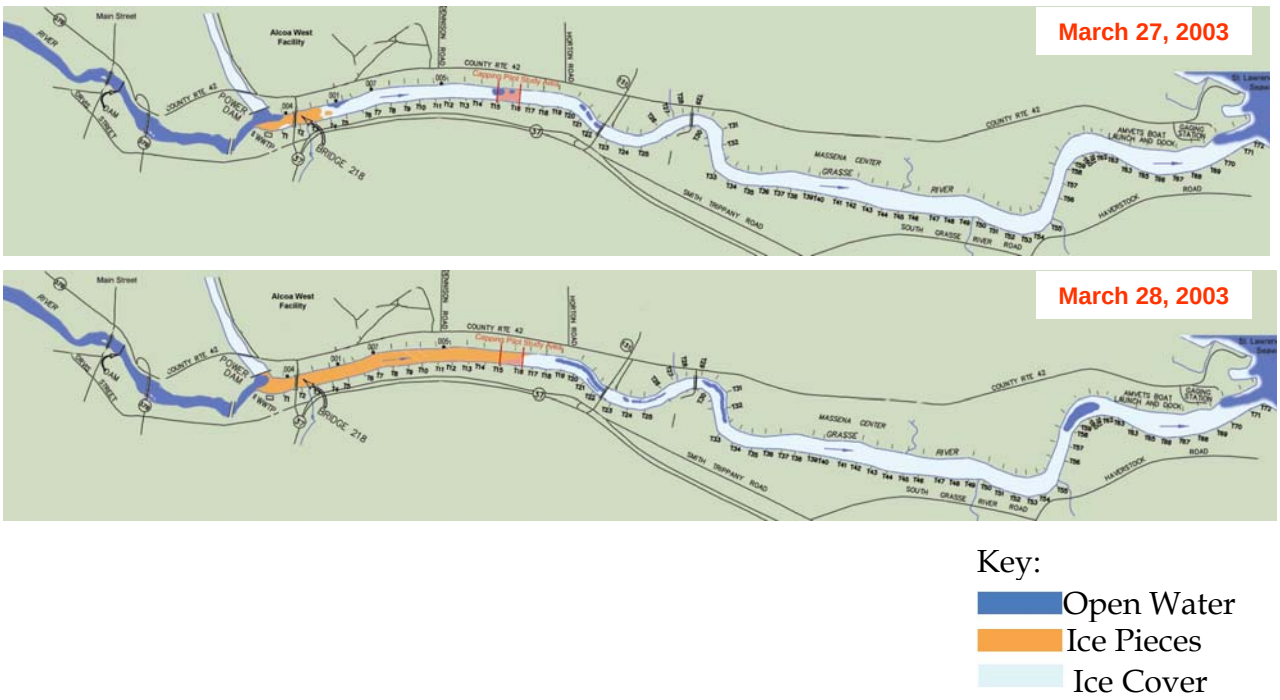
During the spring 2003 ice breakup, a high river flow raised the ice cover in the reaches upstream of Massena, freeing it from the river banks. An ice run occurred on March 28 when the ice cover upstream of Massena moved downstream; the upstream ice cover first fractured into large sheets and then progressively into smaller pieces as it passed over the rapids in Massena. This fractured ice was transported into the lower Grasse River where the intact ice cover was still in place. As the ice moved into the lower Grasse River, it encountered the intact ice cover, progressively broke up that ice and accumulated into an ice jam. One location where the toe of the ice jam, or downstream end of the ice accumulation, was positioned was approximately 2,439 m [8,000 ft] downstream of the Power Canal dam in the vicinity of an area of the river where a subaqueous capping pilot study had been undertaken in 2001. The river stage near Outfall 001 on March 28 was estimated to have increased approximately 2.7 m [8.9 ft] above the normal river stage due to the ice jam. Photographs taken on March 28 of the ice jam indicate that the ice freeboard was about 1.2 m [3.9 ft]. Breakup jams, such as this one, typically have the greatest ice thickness at the toe and diminish in thickness in the upstream direction, eventually attaining an equilibrium

thickness. The ice accumulation extended upstream nearly to the Power Canal. Figure 1.4 illustrates the position of the ice jam on March 27 and March 28. By the following day, March 29, the ice jam had broken up and all of the ice had cleared from the lower Grasse River, except for some remnant pieces along the banks. This clearing of ice was mainly due to the combined effects of the melting of the ice floes and the deterioration and melting of the downstream ice cover caused by warm temperatures and rain. In summary, the mechanisms that contributed to the 2003 ice jam in the lower Grasse River included:

- 2002-2003 winter conditions that caused relatively thick ice to be present in the Grasse River in spring 2003;
- a rapid increase in river flow rate that caused mechanical breakup of the ice cover upstream of Massena; and
- an intact ice cover was present in the lower Grasse River.

The combination of an intact ice cover on the lower Grasse River, a high river flow rate, and a large ice supply from upstream, resulted in a severe ice jam in 2003 in the lower Grasse River. The constriction of the flow area, particularly under the toe of the jam, caused elevated velocities under the jam, which contributed to scouring of the sediment bed in the vicinity of the toe of the ice jam.

Figure 1.4 Lower Grasse River Ice Condition During March 2003 Breakup



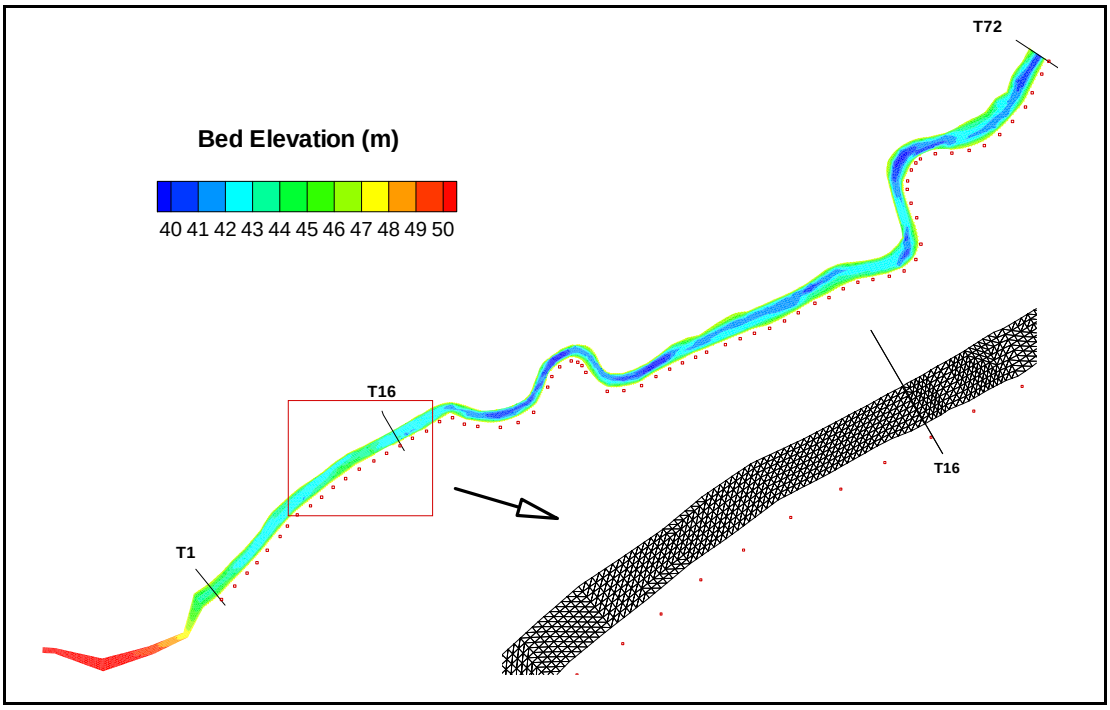
1.2 Overview of Computer Model

DynaRICE is a computer model that predicts the transport and jamming of surface ice in rivers. The model simulates the coupled dynamics of ice motion and water flow, including the flow through and under the ice rubble. The model does not consider thermal effects, such as the melting of ice mass. Therefore, ice jam simulations can be considered to produce conservative results. A complete description of DynaRICE is provided in Shen, et al., (2000) however, a brief overview of the model is given here. The ice dynamic equations in the model consider the significant external and internal forces, including water drag, gravity force, bank resistance, and internal resistance of ice. The internal ice resistance is governed by the material behavior of the ice and is described by viscous-plastic and elastic-plastic constitutive laws. The partial slip boundary condition for ice along solid boundaries is treated by the method of images. The effect of bed resistance on grounded ice is considered. A meshless Lagrangian discrete-parcel method (DPM) based on Smoothed Particle Hydrodynamics (SPH) is used to simulate the ice dynamics. This method uses Lagrangian parcels to represent the ice mass in the ice run and jam. The hydrodynamic sub-model in DynaRICE solves the two-dimensional, vertically-averaged, unsteady flow equations, including the flow through the ice mass. The Manning's resistance coefficient for the underside of the ice increases linearly with ice jam thickness; this parameter is adjusted during model calibration. DynaRICE has been extensively tested and validated using analytical solutions in idealized channels and field data for ice jams in natural rivers.

An important limitation of DynaRICE is that the model assumes that the sediment bed is non-moveable, which means that erosion and deposition processes under the ice jam are neglected. This limitation means that the model may under-predict the water depth at the toe of the ice jam and, hence, over-predict current velocities. In addition, the model may also over-predict the areas of ice jam grounding. Thus, the model should be considered to produce conservative results with respect to potential impacts on the sediment bed, e.g., scour and grounding.

The lower Grasse River model extends from the Main Street Bridge at the upstream boundary to the downstream end of the lower Grasse River at transect 72 (T72), as shown on Figure 1.5. A portion of the numerical mesh is also shown on Figure 1.5. The lower river is typically 122 m to 183 m [400 to 600 ft] wide with steep sideslopes. The river bathymetry is specified as depth below a water surface elevation of 47 m [154.2 ft] with respect to the IG85 datum. In all simulations, the river stage height is referenced to the IG85 datum.

Figure 1.5 Model Domain and Finite Element Mesh



2.0 Model Calibration

The lower Grasse River model was calibrated using data collected during the 2003 ice jam event. Initial conditions before ice jam formation are shown on Figure 2.1. The initial conditions shown on this figure represent a longitudinal profile along the centerline of the river channel (Figure 2.2). Subsequent figures that depict a longitudinal profile of model results are along this centerline. At the upstream boundary, the time-variable water discharge is specified as shown on Figure 1.2. The portion of the water discharge during the simulation period is shown on Figure 2.3. The ice supply at the upstream boundary is specified by a combination of ice floe thickness and concentration. For the 2003 ice jam, an ice floe thickness of 20 cm [7.9 inches (in)] was used at the upstream boundary based on the field observation. Ice floe concentration was initially estimated from field observations and then adjusted during model calibration. The resulting ice discharge specified at the upstream boundary is shown on Figure 2.4. The observed water level in the St. Lawrence at Cornwall, as shown on Figure 1.3, was used as the downstream boundary condition. Manning's coefficient for the sediment bed was set at 0.02. Manning's coefficient for the underside of the ice was adjusted during model calibration to match observed staging caused by the jam. This coefficient varies linearly with the jam thickness, from a minimum value of 0.03 to a maximum value of 0.13.

Figure 2.1 Initial Steady State Longitudinal Profile Along the Centerline of the River

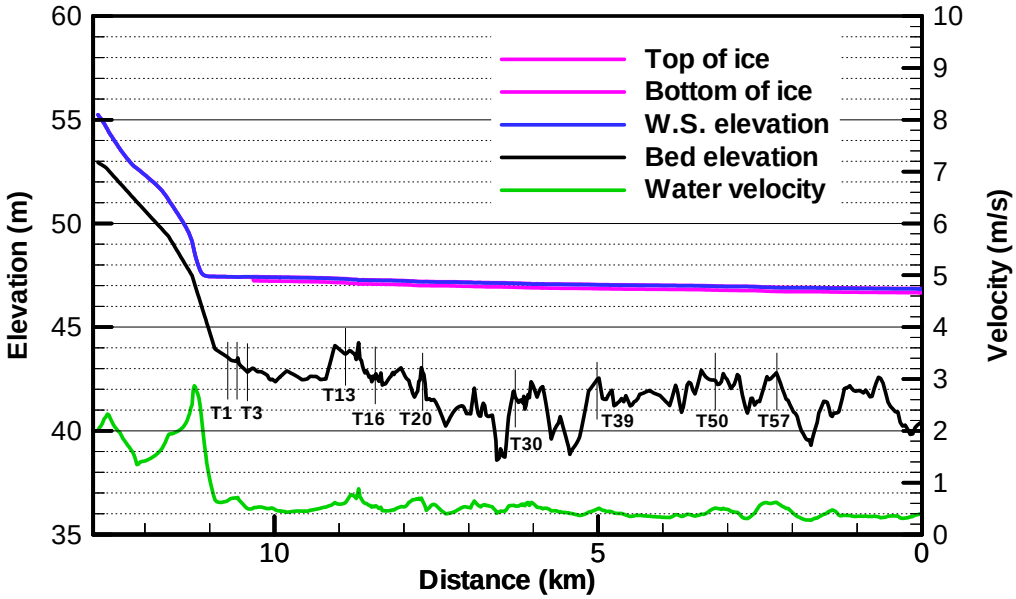


Figure 2.2 Centerline Used for Longitudinal Profile Plots

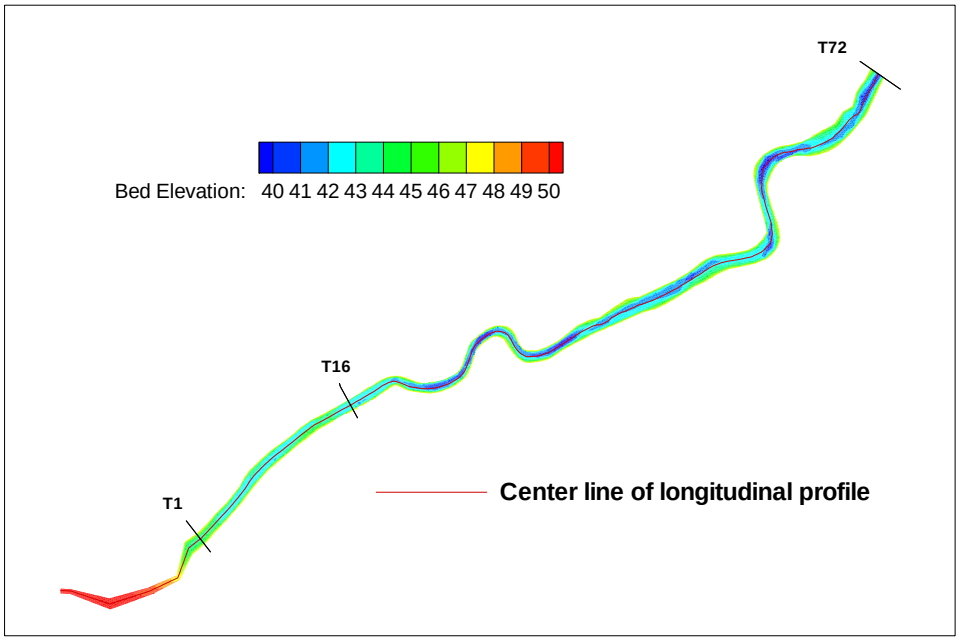


Figure 2.3 Water Discharge at Upstream Boundary During March 2003 Calibration Period

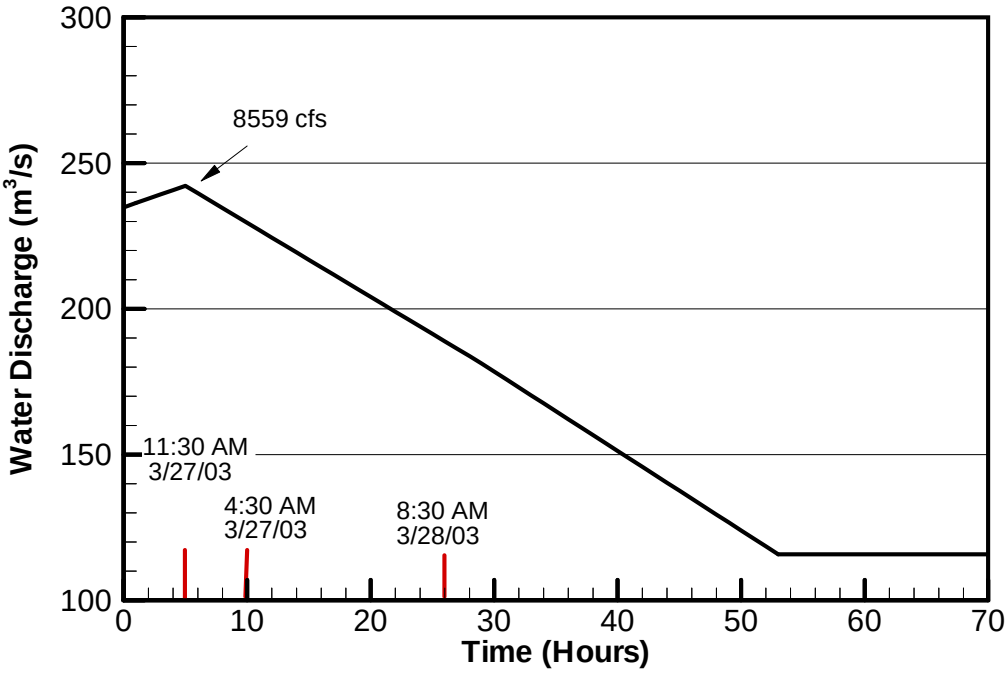
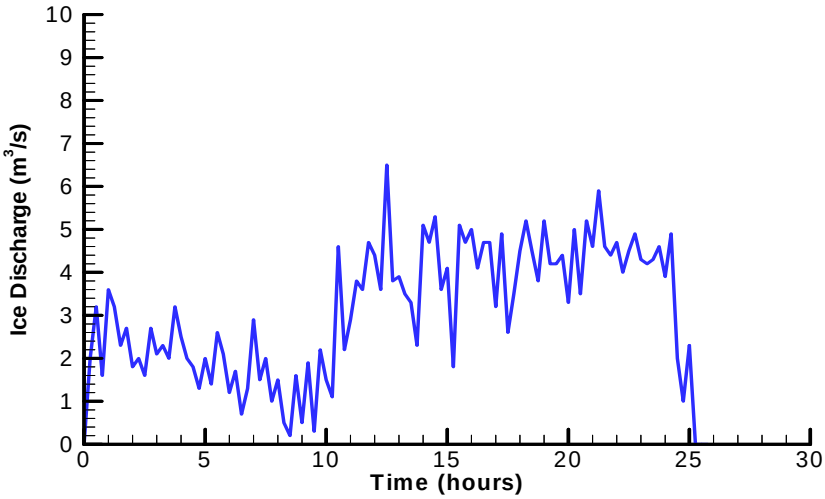


Figure 2.4 Ice Discharge at Upstream Boundary During March 2003 Calibration Period



The ice jam event that occurred during March 2003 was used to calibrate the model. A 70-hour simulation was conducted, starting at 6:30 am on March 27 and ending at 4:30 am on March 30. This time period was simulated using the model inputs discussed above. The model was calibrated through comparisons of model predictions to these observations and data: 1) water surface elevations at transect T1 and Outfall 001 (Figure 2.5); 2) ice jam length (Figure 1.4); and 3) tree scar survey data (see Appendix O to the main report)). As summarized in Table 2.1, which also shows the correspondence between the model time and

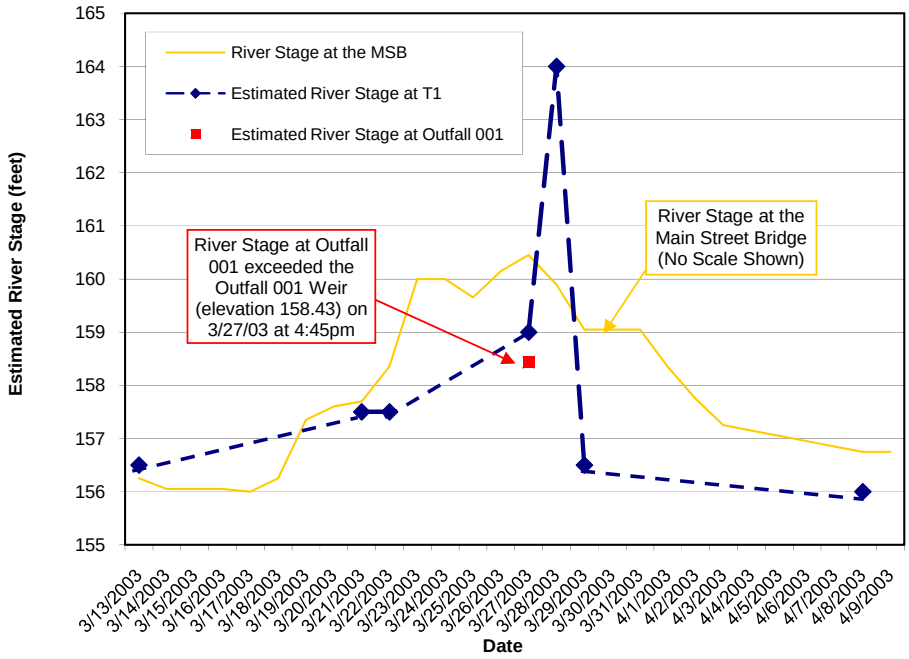
real time, the first ice jam was observed near T3 late in the morning of March 27. In the afternoon, the ice accumulation was observed to have passed Outfall 001. The jam was observed to have moved to T16 by 8:30 am on March 28. The ice jam broke up and all of the ice had cleared from the lower river by the morning of March 29. Since the ice cover strength was highly variable, changing with the weather conditions, and was not measured, no attempt was made to simulate the recession of the leading edge of the ice cover, which governs the location of the jam toe. Instead, the locations of the toe of the ice jam were specified in the model. The entire ice jamming and release process was simulated in the steps shown in Table 2.1.

Table 2.1 Chronology of 2003 Ice Jam Event

Model Time (hrs)	Real Time	Remarks
0	March 27, 6:30 AM	Ice run observed
5	March 27, 11:30 AM	A small jam observed near T3
10	March 27, 4:30 PM	Jam observed downstream of outfall 001, T6.5
26	March 28, 8:30 AM	Jam observed to have progressed to T16
42	March 29, 12:30 AM	Assumed ice jam release time
50	March 29, 8:30 AM	Observed no ice in the river
70	March 30, 4:30 AM	End of simulation

Figure 2.5 Observed River Stage During 2003 Ice Jam Event[1]

Note:
1. The estimated river stage elevations were recorded on the IG 1935 datum. Subtract 0.624 ft from the IG 1935 datum to convert to IG 85 datum.



2.1 Model Calibration Details and Results

This section describes the details of the calibration simulation.

2.1.1 March 27 Morning – Ice Stoppage at T3

This portion of the simulation was 5-hours long, from 6:30 to 11:30 am on March 27. During this period, the observed rubble ice accumulation extended from upstream of T1 to about midway between T3 and T4. An ice cover spanned the river downstream of the ice jam, from T3.5 to T72, with an assigned thickness of 0.2 m [0.7 ft]. The predicted water level at T1 compared well to the observed stage height of 48.3 m [158.5 ft] (see Figure 2.6). Predicted current velocities in the vicinity of the ice jam toe are presented on Figure 2.7.

Figure 2.6 Ice Jam Model Results at 11:30 am - March 27

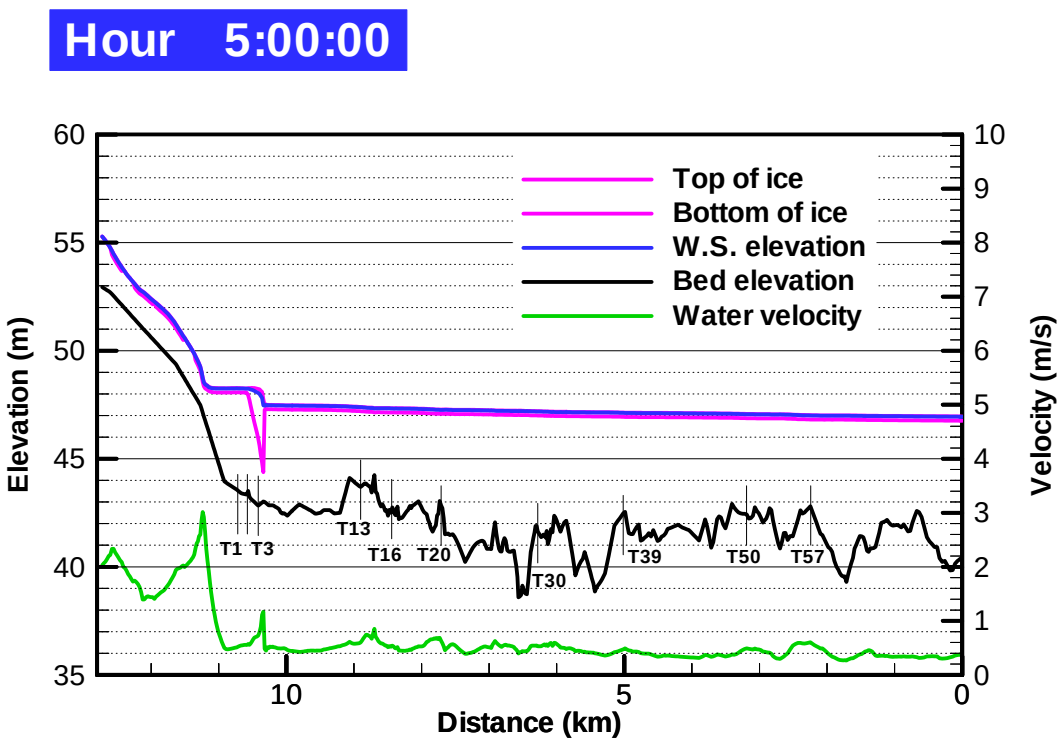
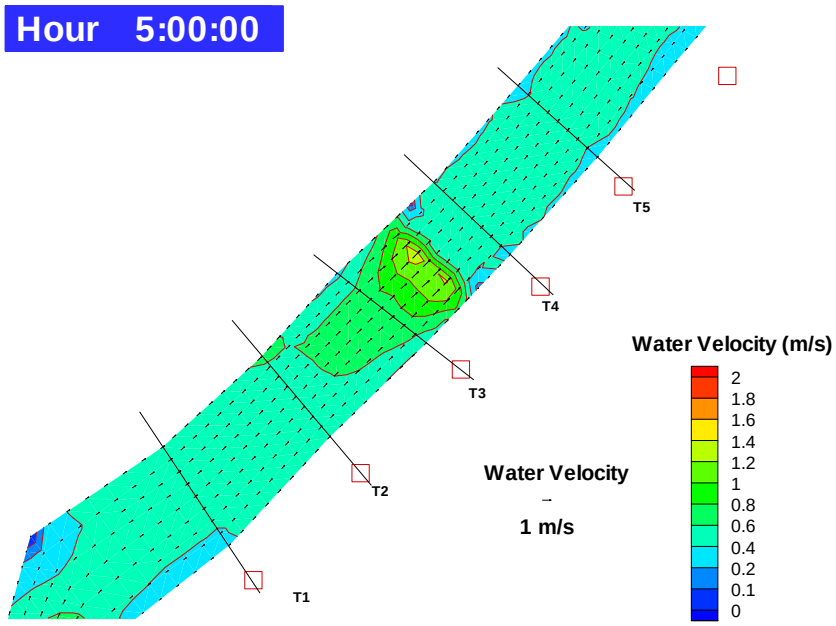


Figure 2.7 Predicted Current Velocity Under Ice Jam Near T3 at 11:30 am - March 27



2.1.2 March 27 Morning through March 27 Afternoon - Ice Stoppage at T6

The observed ice accumulation progressed to T6 between 11:30 am and 4:30 pm on March 27. During this 5-hour period of the simulation, the toe of the ice jam was specified at T6. The predicted water level at T1 agreed with the observed stage height of 48.3 m [158.5 ft] (Figure 2.8) near Outfall 001. Current velocities in the vicinity of T6 at 4:30 pm on March 27 are displayed on Figure 2.9.

Figure 2.8 Ice Jam Model Results at 4:30 pm - March 27

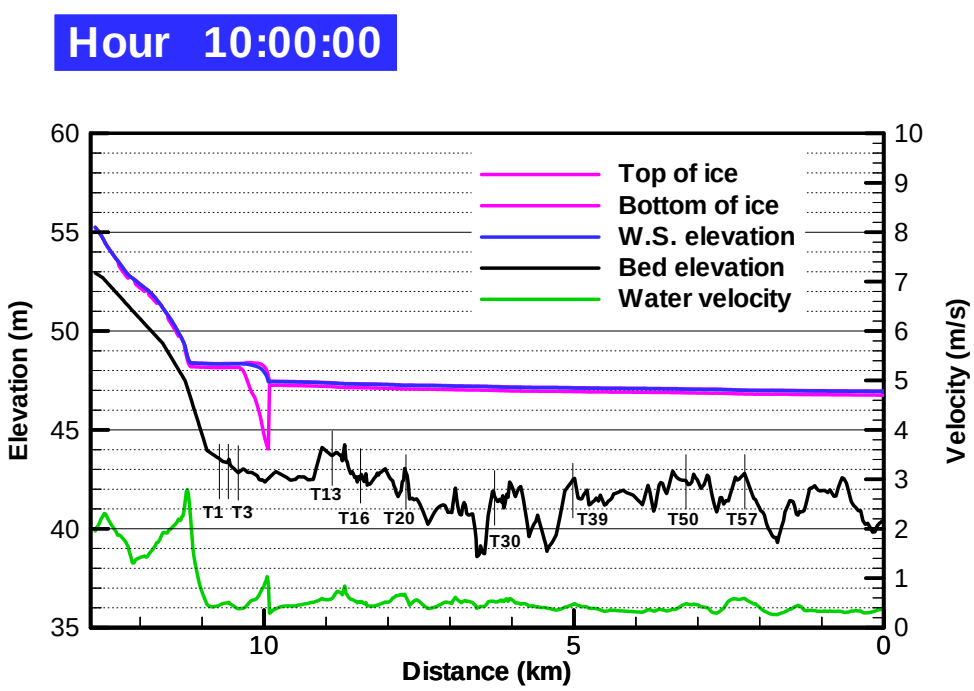
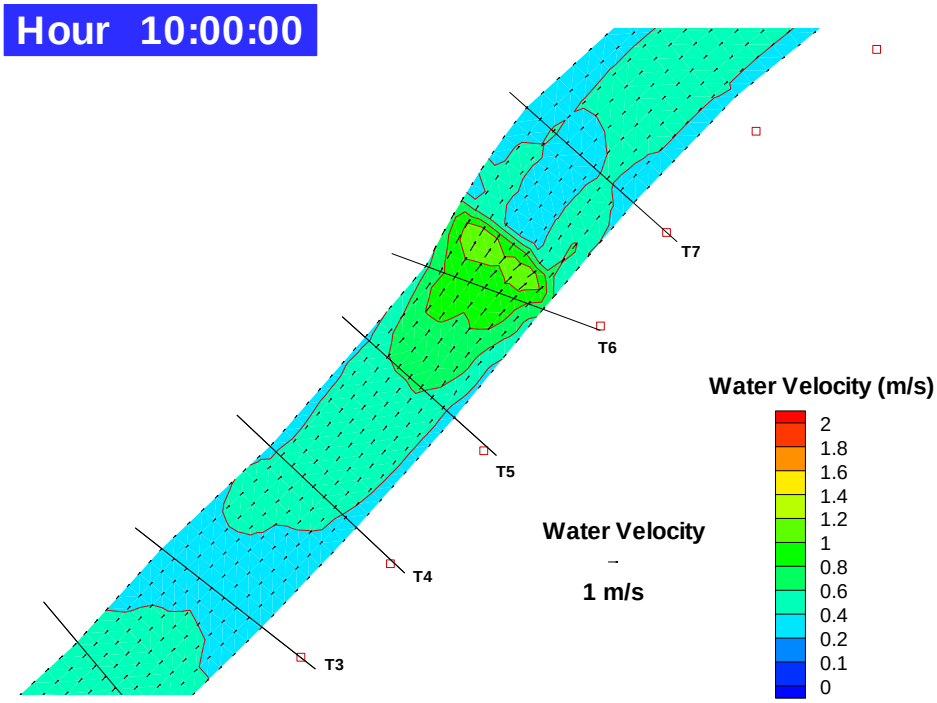


Figure 2.9 Predicted Current Velocity Under Ice Jam near T6 at 4:30 pm - March 27



2.1.3 March 27 Afternoon through March 28 Morning - Large Ice Jam at T16

The ice jam was observed to have progressed to T16 by 8:30 am on March 28. During the 16-hour period between 4:30 pm on March 27 and 8:30 am on March 28, the model simulated the accumulation of ice upstream of the specified jam toe location at T16. By 8:30 am on March 28, the model predicted that the ice jam had reached a state of equilibrium and was not increasing in size. At that time, the predicted stage height was 49.8 m [163.4 ft] at T1, which agreed with the observed stage height. The predicted upstream extent of the ice jam also agreed favorably with the observed extent of the jam.

The longitudinal distributions of predicted water level, ice thickness and current velocity at 8:30 am on March 28 are shown on Figure 2.10. The toe of the ice jam is about 4-5 m [13.1 ft to 16.4 ft] thick, with typical water depths under the ice of about 1 m [3.3 ft]. In the vicinity of the toe, the jam was predicted to be partially grounded at the toe (Figure 2.11). As discussed previously, some uncertainty exists in the capability of the model to accurately predict grounding due to the model assumption that the sediment bed is non-moveable. Current velocities under the toe generally ranged from 1 to 2 m/s [3.3 to 6.6 ft/s]. Spatial distributions of ice thickness are presented on Figures 2.12 and 2.13. The distribution of water depths under the ice in the vicinity of T16 are shown on Figure 2.14. Predicted current velocities near T16 are illustrated on Figure 2.15.

Figure 2.10 Ice Jam Model Results at 8:30 am - March 28

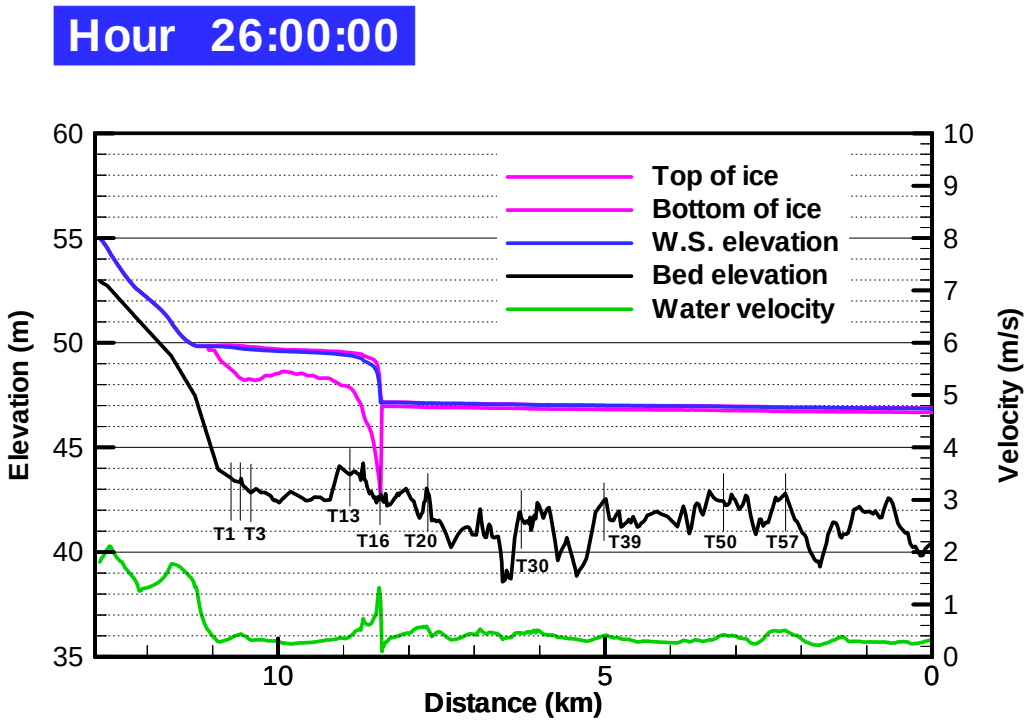


Figure 2.11 Ice Jam Profile at 8:30 am - March 28

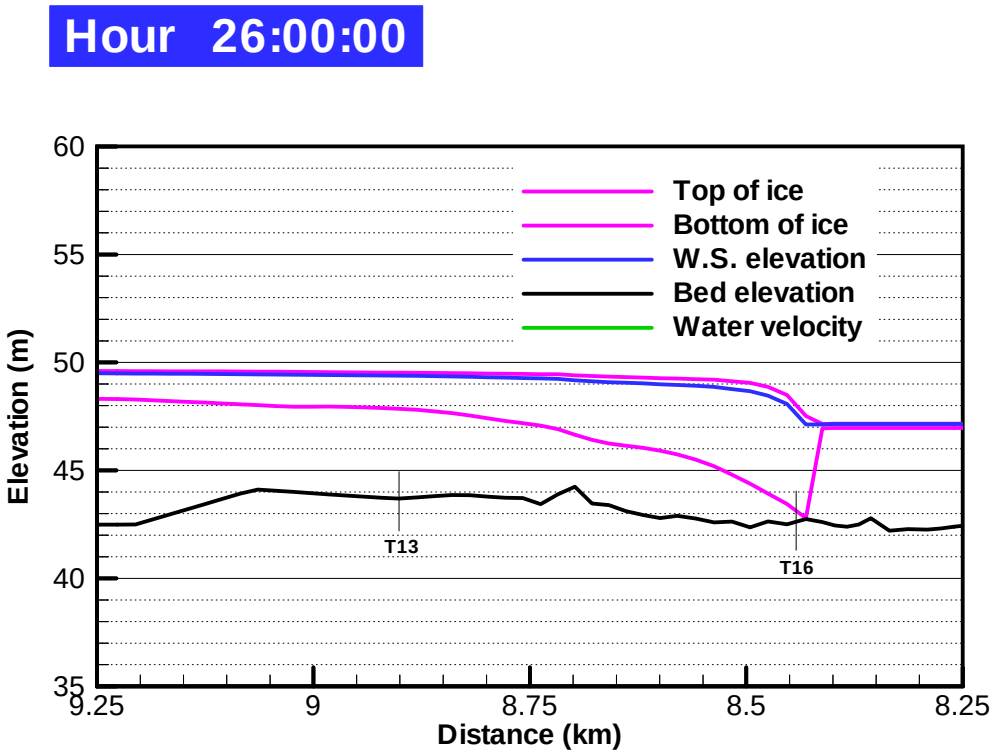


Figure 2.12 Simulated Ice Jam Thickness Distribution at 8:30 am - March 28

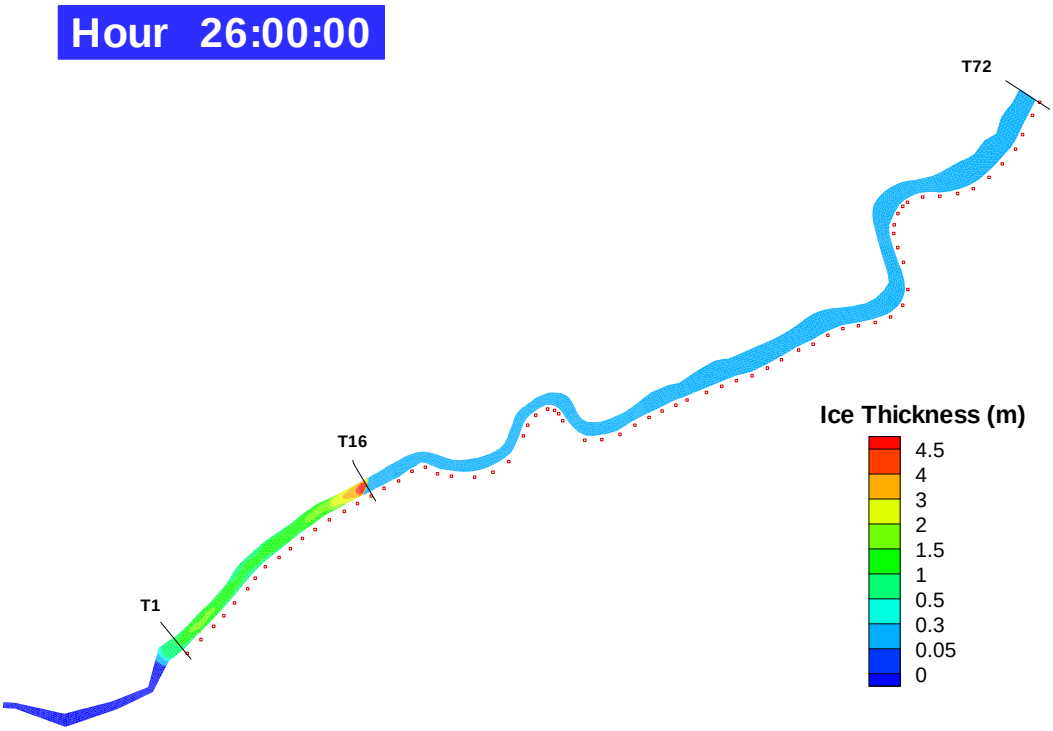


Figure 2.13 Predicted Ice Jam Thickness in Vicinity of T16 at 8:30 am - March 28

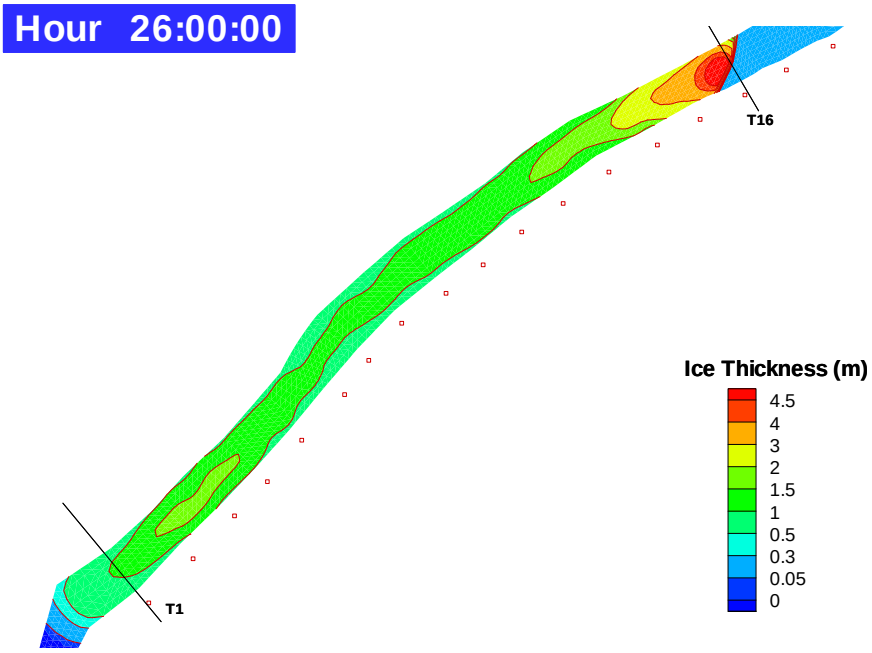


Figure 2.14 Predicted Water Depth Under Ice Jam at 8:30 am - March 28

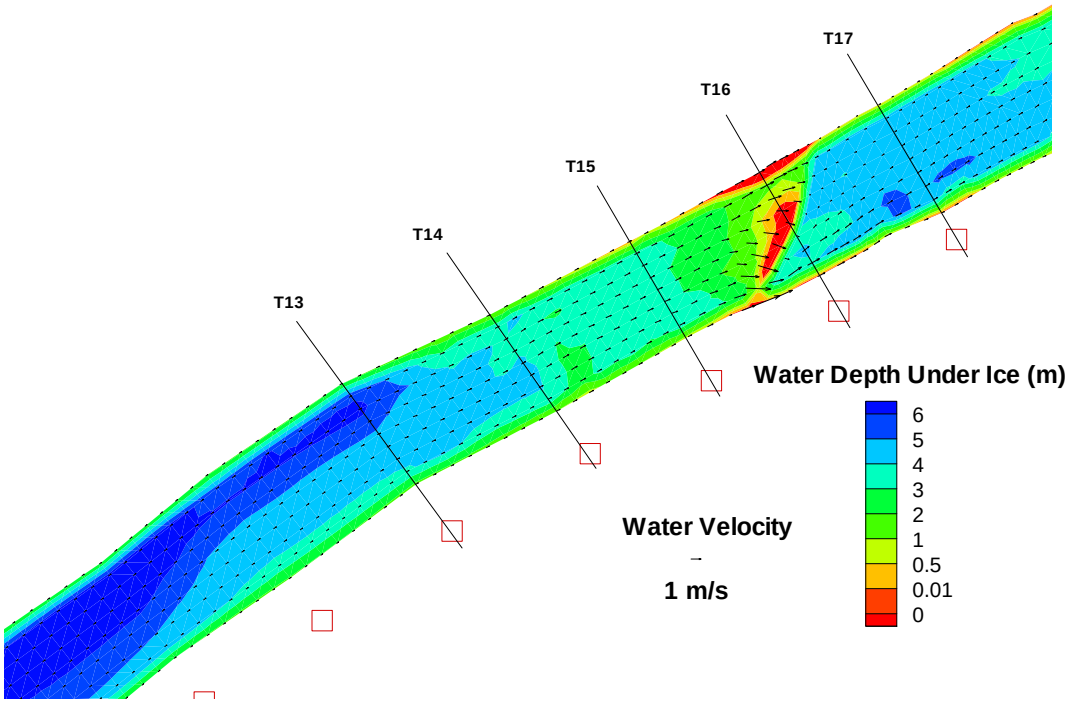
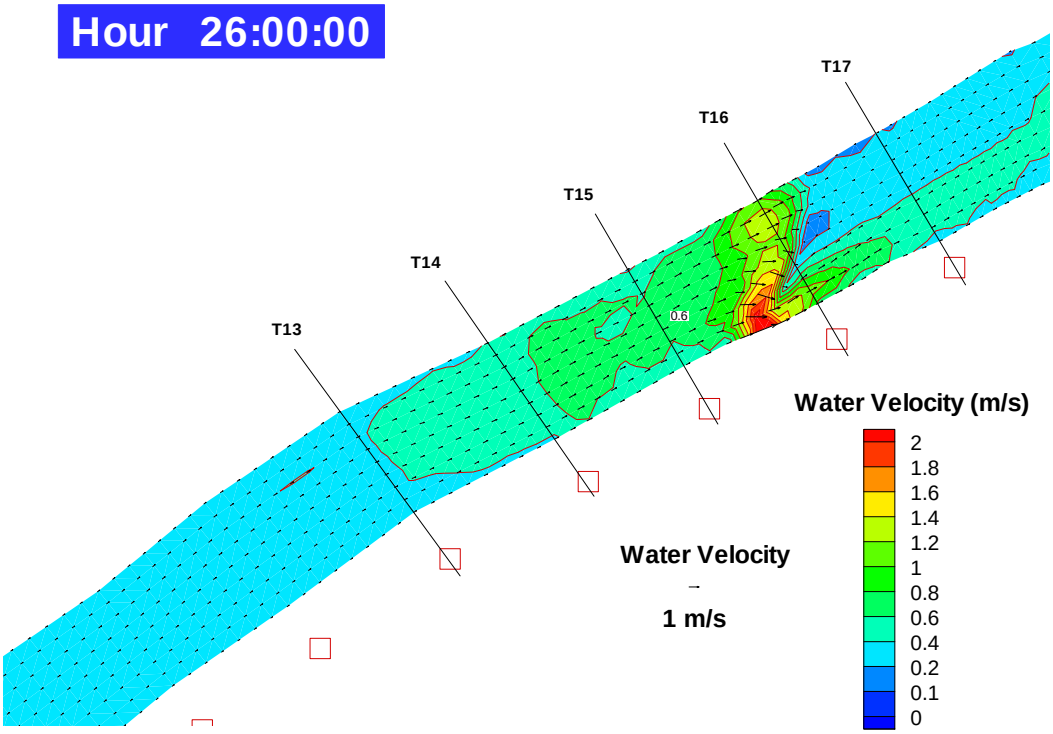
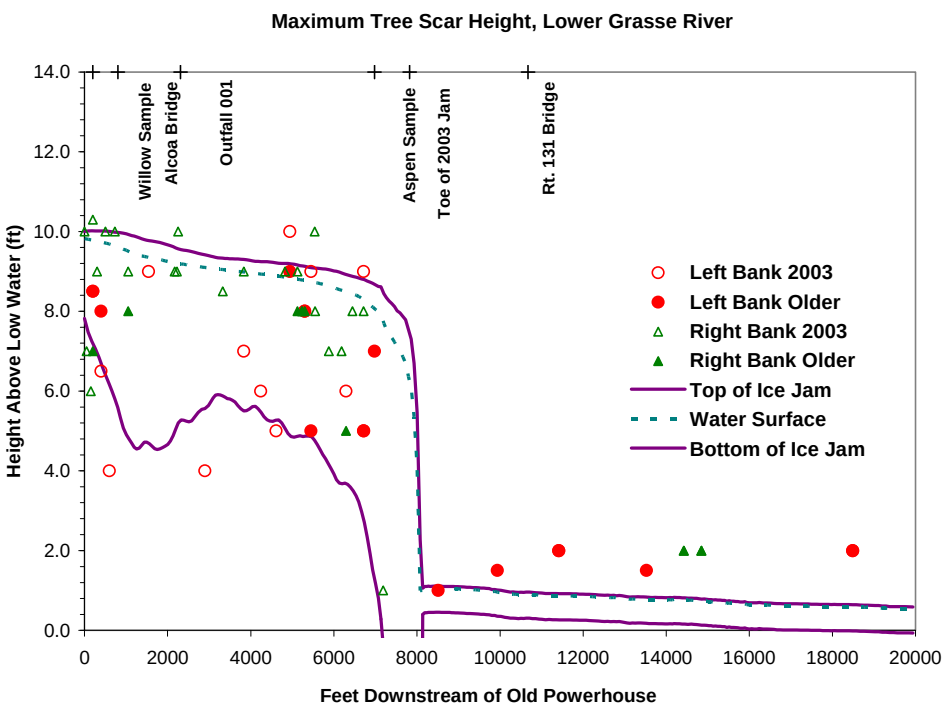


Figure 2.15 Predicted Current Velocity Under Ice Jam Near T16 at 8:30 am – March 28



Another useful comparison of model predictions to site-specific data involves tree scar data. A survey of tree scar height was conducted along the lower Grasse River during summer 2003 (see Appendix O to the main report). Tree scars can be used to estimate the height of the top of the ice jam during past ice jam events. The spatial distribution of tree scar heights in the lower Grasse River is shown on Figure 2.16. This figure also displays the predicted height of the top of the ice jam at 8:30 am on March 28. Good agreement between predicted ice jam stage and tree scar heights is noted, providing additional confidence in the predictive capability of the model.

Figure 2.16 Comparison of Predicted Ice Jam Profile at 8:30 am – March 28 to Tree Scar Data



2.1.4 March 29 Ice Jam Release

The ice jam at T16 released sometime between 8:30 am on March 28 and 8:30 am on March 29. For purposes of the calibration simulation, it was assumed that the ice jam release occurred at 12:30 am on March 29. The reduction in ice mass due to melting was not considered in the simulation. Model results at five different times after the jam release are shown on Figures 2.17 through 2.21. The sudden ice jam release formed a surge of water, with a peak velocity of about 2 m/s [6.6 ft/s], during the initial 15 minutes after 12:30 am (Figure 2.18). By 1:00 am, peak current velocity had dropped to about 1 m/s [3.3 ft/s] as the surge dissipated; the surge due to the ice jam release reached the downstream boundary, i.e., confluence with the St. Lawrence River, within 30 minutes. The model predicted that the ice rubble would not be cleared out of the river by the end of the simulation, i.e., 4:30 am on March 30 (Figure 2.21). These results are not consistent with the observed behavior on the

river, where the ice jam moved out much faster. This inconsistency is caused by neglecting ice melting in the model.

Figure 2.17 Ice Jam Model Results 15 minutes after Ice Jam Release (12:45 am - March 29)

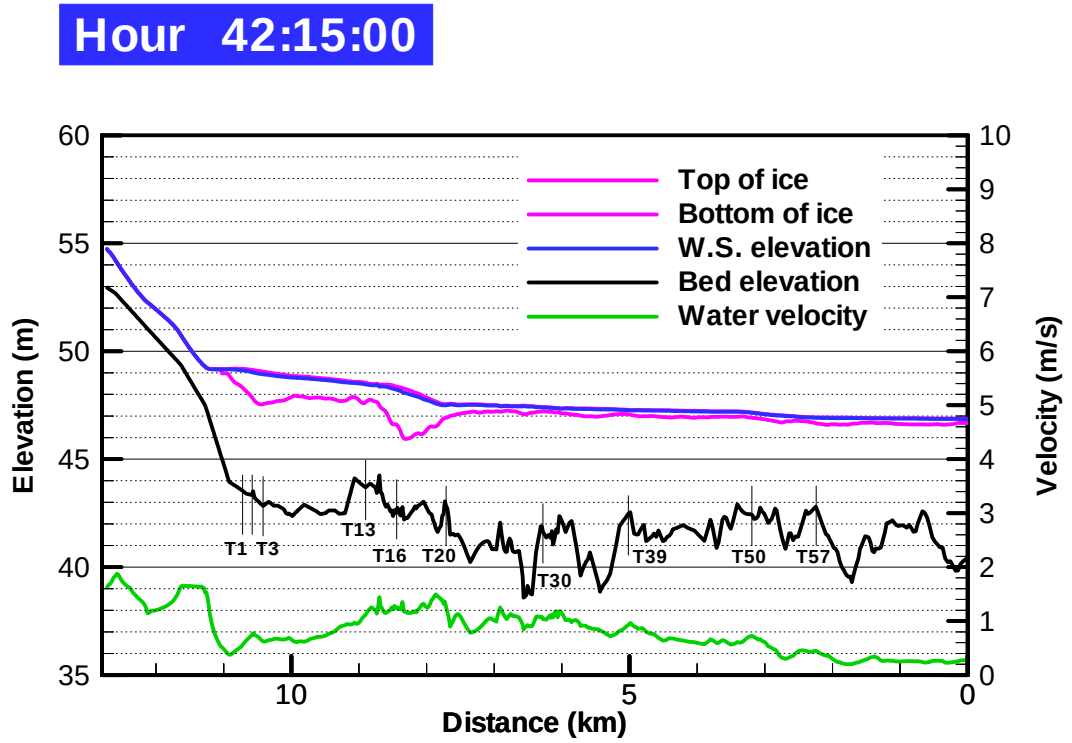


Figure 2.18 Ice Jam Model Results 30 minutes after Ice Jam Release (1:00 am - March 29)

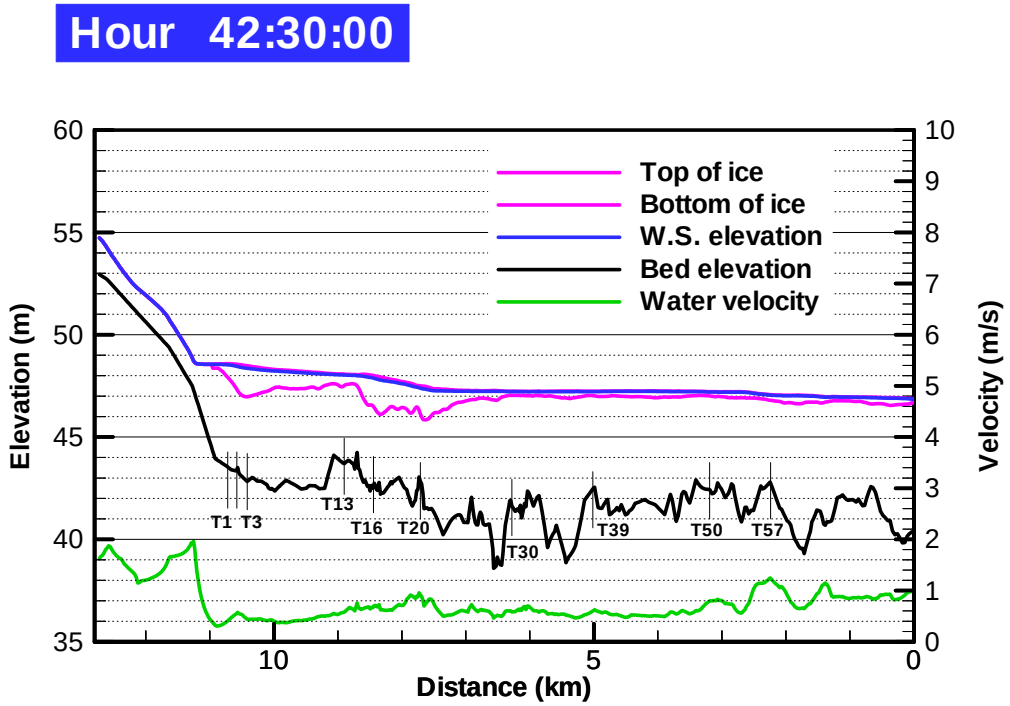


Figure 2.19 Ice Jam Model Results at 8:30 am – March 29

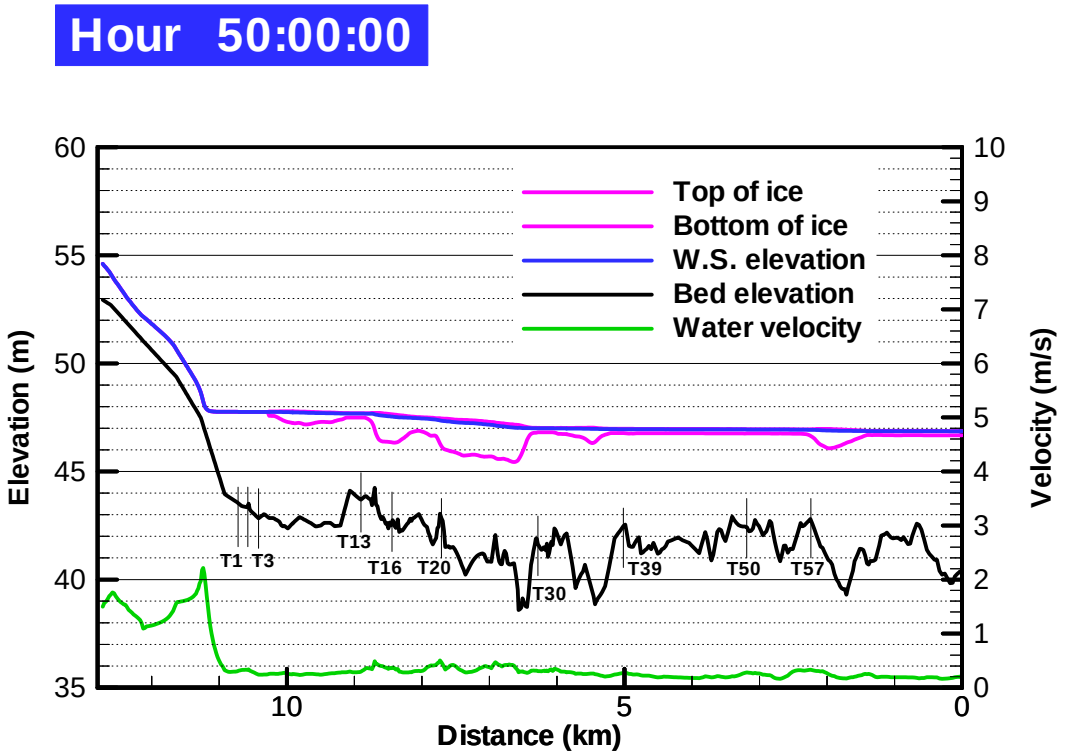


Figure 2.20 Ice Jam Model Results at 6:30 pm – March 29

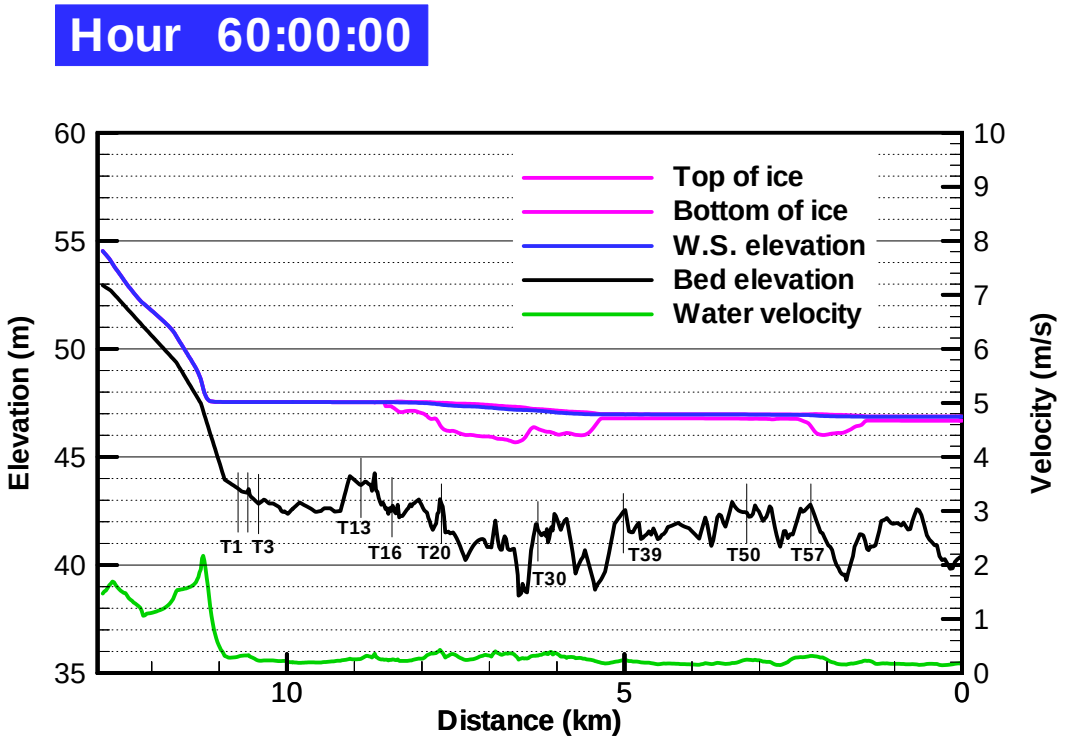
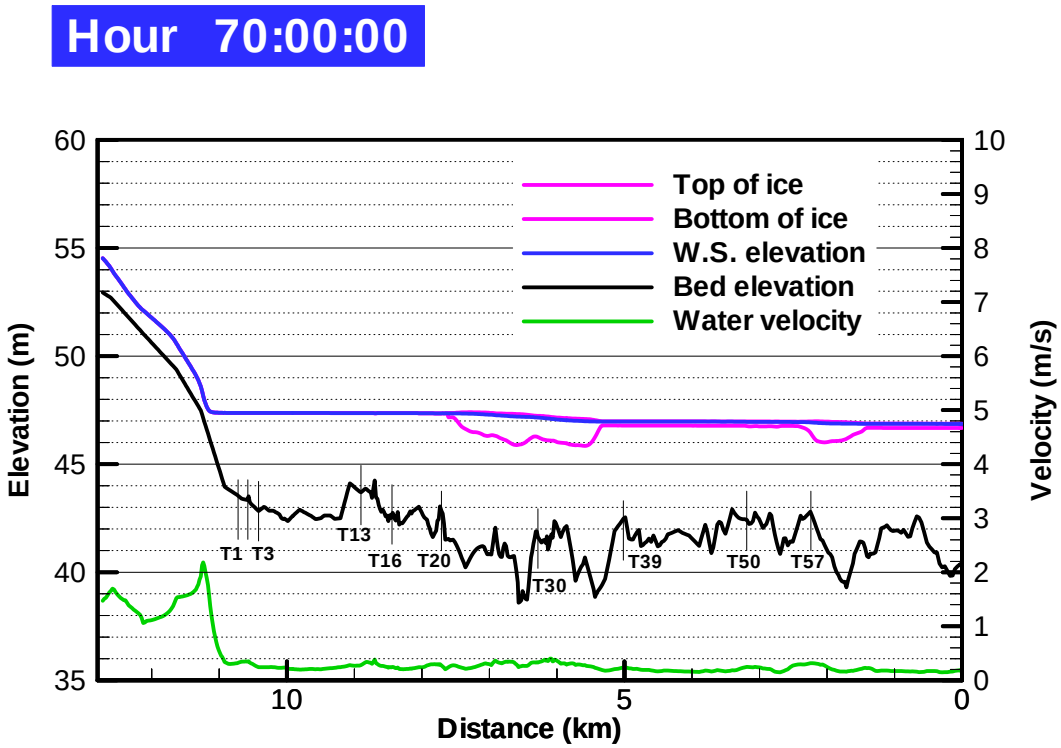


Figure 2.21 Ice Jam Model Results at 4:30 am – March 30



2.2 Effect of Ice Jam Roughness

The primary parameter used to calibrate the model was the Manning's coefficient of the underside of the ice jam, which represents the effective roughness of the ice. For breakup ice jams in a given river, the ice Manning's coefficient should not vary significantly. However, simulations were conducted to investigate the sensitivity of model predictions to this parameter. Optimum model calibration was achieved using a value of 0.13 as the maximum Manning's coefficient for the underside of the ice jam. Using this parameter value, the simulated and observed maximum water levels at T1 agreed, i.e., stage height of 49.8 m [163.4 ft]. Sensitivity simulations were conducted using maximum ice Manning's coefficients of 0.10 and 0.15. Both the jam thickness and stage height increase with an increase in the ice Manning's coefficient. Predicted maximum stage height at T1 was 49.4 m [162.1 ft] using a Manning's coefficient of 0.10, which is a decrease of 0.4 m [1.3 ft] compared to the calibration results (Figure 2.22). Predicted current velocity under the jam toe is about the same as that of the calibration case. For the upper limit of Manning's coefficient value of 0.15, the stage height at T1 was predicted to be 50.3 m [165.0 ft], an increase of 0.5 m [1.6 ft] from the calibration simulation (Figure 2.23). The predicted current velocity was 0.2 m/s [0.7 ft/s] greater than the calibration case.

Figure 2.22 Ice Jam Model Results at 8:30 am – March 28 with a Maximum Ice Manning's Coefficient of 0.1

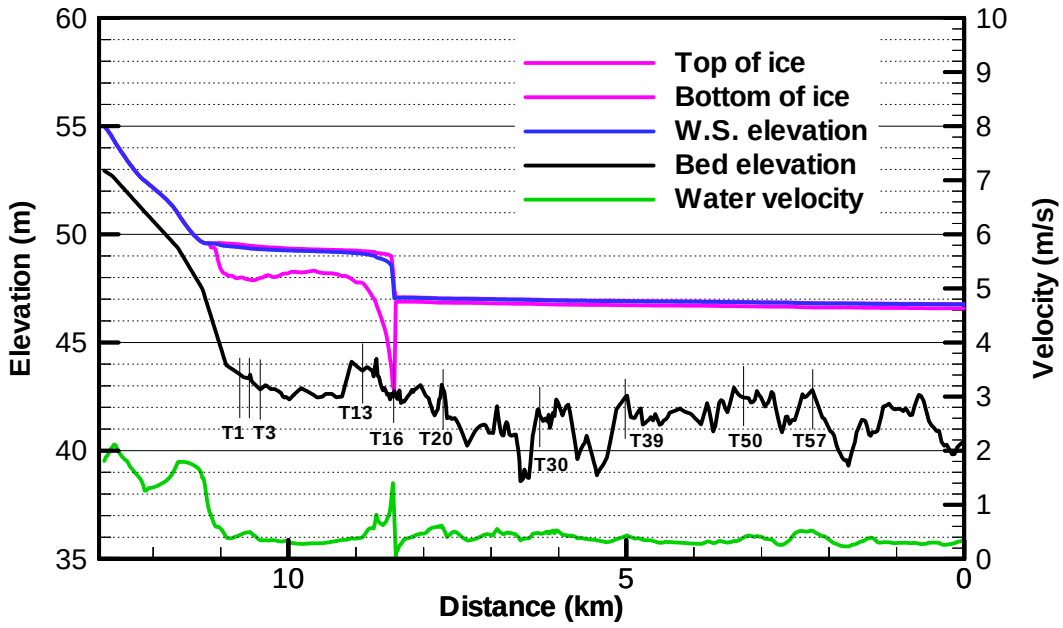
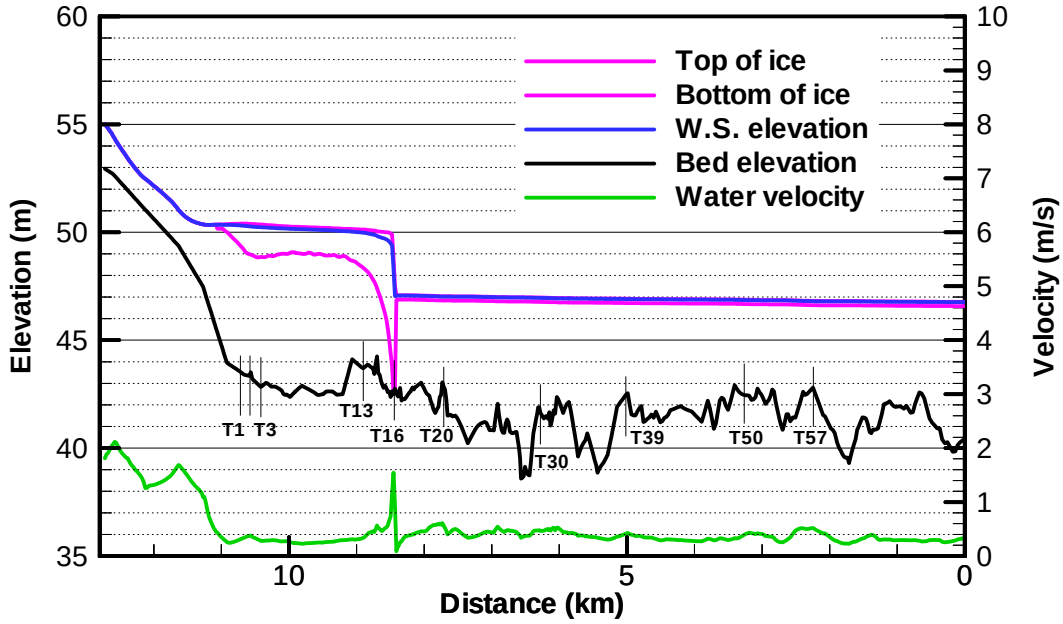


Figure 2.23 Ice Jam Model Results at 8:30 am – March 28 with a Maximum Ice Manning's Coefficient of 0.15



3.0 Ice Jam Scenario Analysis

The ice jam model was calibrated to match the observed stage height at T1 during the March 2003 event. The 2003 ice jam simulation utilized the river discharge hydrograph shown in Figure 1.2. The breakup ice thickness was based on a degree-day simulation through the winter of 2002-2003 (see Appendix N to the main report). The locations of the ice jam toe were specified based on field observations, but uncertainty exists concerning the timing of toe movement between these locations.

A variety of combinations of ice jam toe location, flood hydrograph, and ice thickness could possibly occur during other years. Thus, various simulations were conducted to investigate the impacts of different scenarios for toe location, flow rate, ice thickness, and downstream water level. However, it is noted that evidence from the Tree Scar Survey (Appendix O to the main report) showed that the 2003 ice jam produced the highest observed tree scars, suggesting that the 2003 ice jam event was the most severe ice jam in the lower Grasse River, at least as recorded by trees up to 40 years old.

3.1 Effect of Location of Toe of Ice Jam

Seven alternative locations that were suspected to be potential areas where ice jams might form under favorable conditions were selected along the lower Grasse River. The seven locations are: T3, T13, T20, T30, T39, T50 and T57 (see Figures 3.1 and 3.2). These locations are generally at the shallower locations or at a river bend, where a jam is more likely to form. Model simulations were conducted with the ice jam toe specified at these alternative locations, but using the flood hydrograph and ice supply associated with the 2003 event. In the shallower locations, it is expected that a jam would be thicker than at deeper locations. It is noted that the tree scar study indicated that elevated water levels from ice jams were not observed downstream of T16.

Figure 3.1 Alternative Ice Jam Toe Locations – Plan View

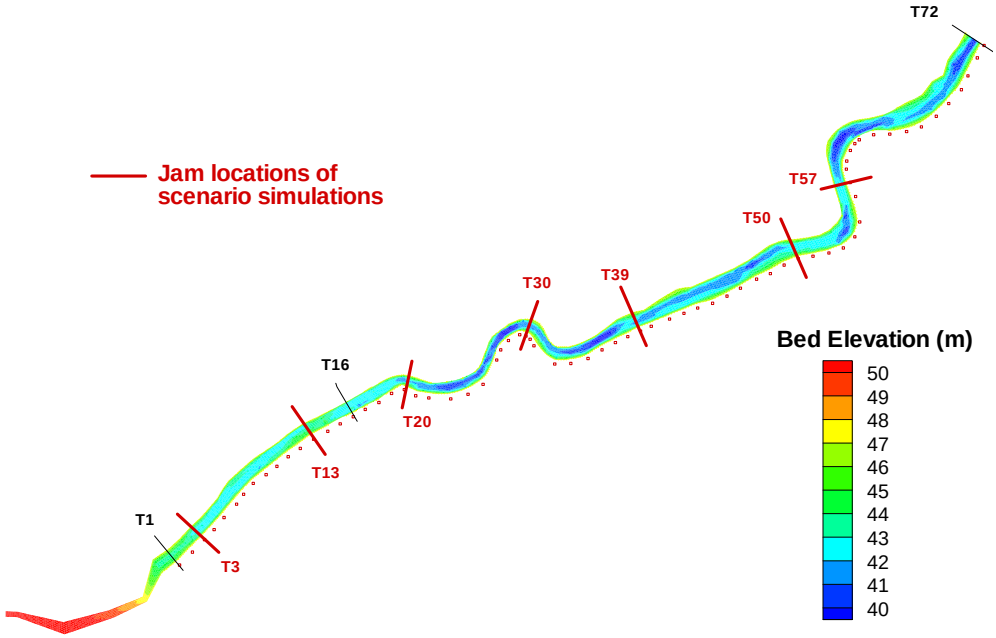
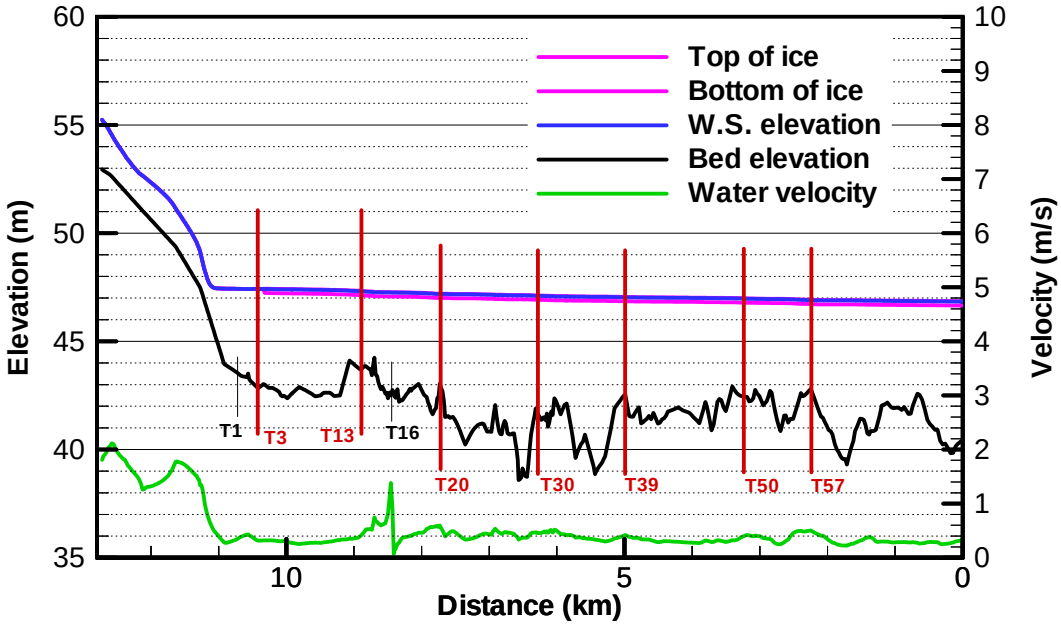


Figure 3.2 Alternative Ice Jam Toe Locations – Section View



For the fixed ice jam locations, the T3 location is constrained to accumulate breakup ice in a steeper reach of the river (Figure 3.3). For the T13 location, the water depth is shallower than at T16 (Figure 3.5). In both cases, higher water surface slopes and larger gravity forces resulted in shorter and thicker ice jam formations. The current velocities underneath the jam toe, as shown on Figures 3.4 and 3.6, are about 10 percent higher than that shown on Figure 2.15 for the 2003 calibration simulation when the jam was at T16. The model predicted a thick ice jam toe and some partial grounding when the jam toe was fixed at T3 and T13. As noted in Section 1.2, the DynaRICE model assumes that the sediment bed is non-moveable, i.e., no erosion or deposition, which means that the model may over-predict the extent of partial grounding of the ice jam; grounding may not be predicted if the sediment bed movement is accounted for in the model. No evidence of partial grounding, such as those observed in Lake Erie (Grass, 1984), was found in the bathymetry data collected after the 2003 ice jam event.

For a fixed ice jam at T20, the model results are similar to the 2003 calibration simulation except that the jam toe thickness (about 4 m [13.1 ft]) is less than that of the calibration simulation. The predicted maximum current velocity beneath the jam is about 1.8 m/s [5.9 ft/s] and the jam is partially grounded (Figures 3.7 and 3.8).

For a fixed ice jam at T30, the ice jam is predicted to be thinner (about 3 m [9.8 ft]) than the 2003 calibration simulation (Figure 3.9). In addition, under-ice current velocities are lower and the maximum velocity is about 1.0 m/s [3.3 ft/s] (Figure 3.10).

For a fixed ice jam at T39, the maximum jam toe thickness is 2.8 m [9.2 ft] (Figure 3.11). The model results indicate that maximum current velocity beneath the jam toe at T39 is 0.8 m/s [2.6 ft/s], which is lower than the 2003 calibration results (Figure 3.12). Model predictions with the toe at T50 are similar to the results with the toe at T39 (Figures 3.13 and 3.14). With the toe at T57, the jam toe thickness is about 4 m [13.1 ft] and the maximum current velocity beneath the jam is 1.4 m/s [4.6 ft/s] (Figures 3.15 and 3.16).

Figure 3.3 Model Results with Ice Jam Toe at T3 (8:30 am – March 28)

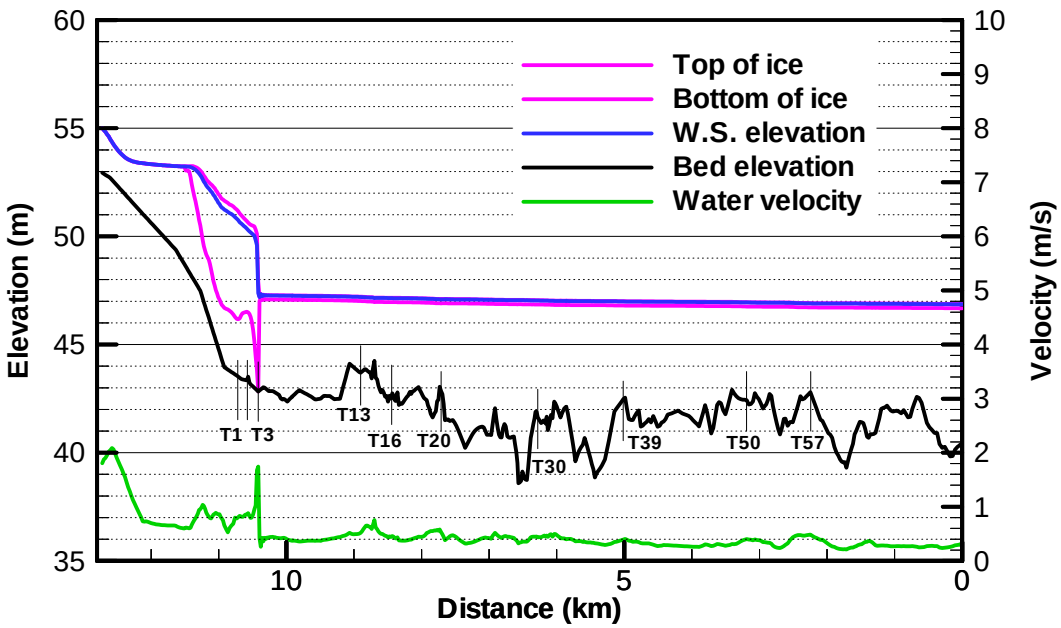


Figure 3.4 Predicted Current Velocity with Ice Jam Toe at T3 (8:30 am - March 28)

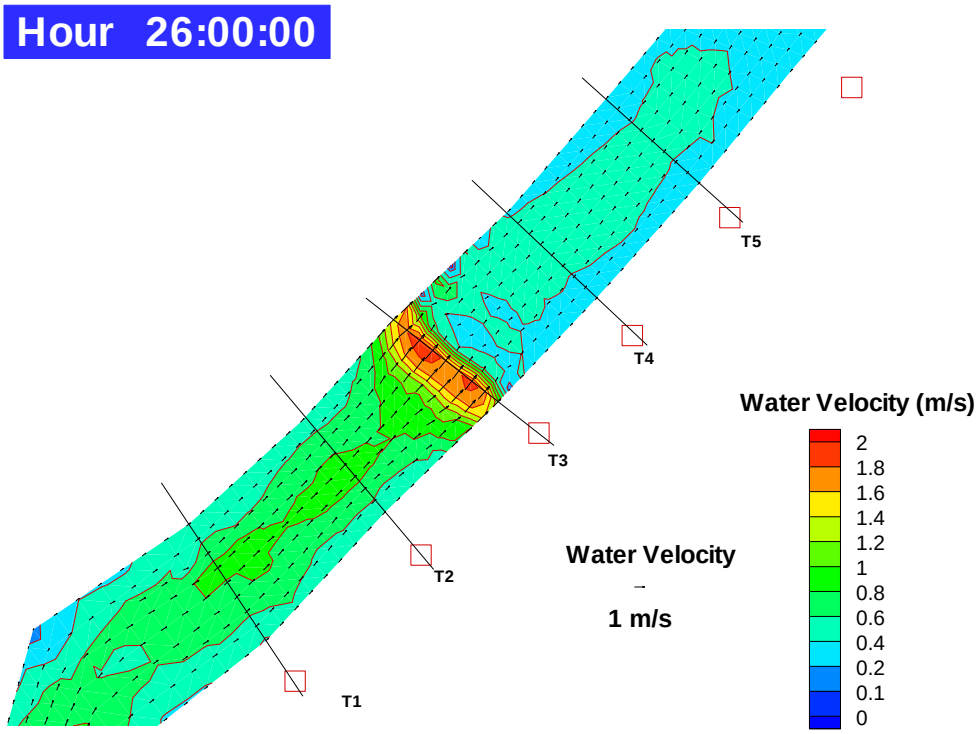


Figure 3.5 Model Results with Ice Jam Toe at T13 (8:30 am – March 28)

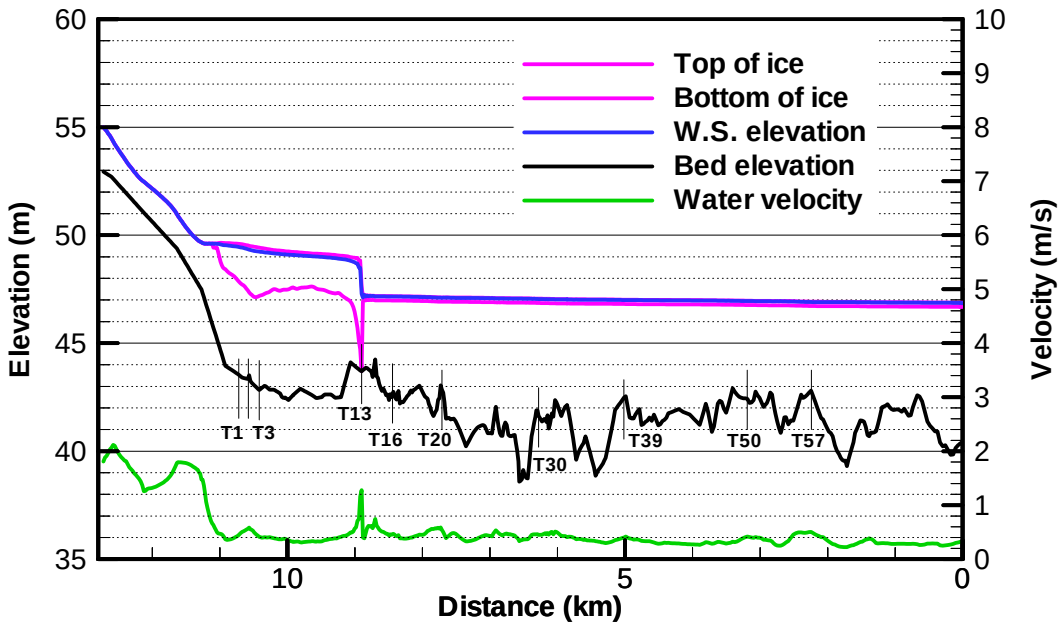


Figure 3.6 Predicted Current Velocity with Ice Jam Toe at T13 (8:30 am – March 28)

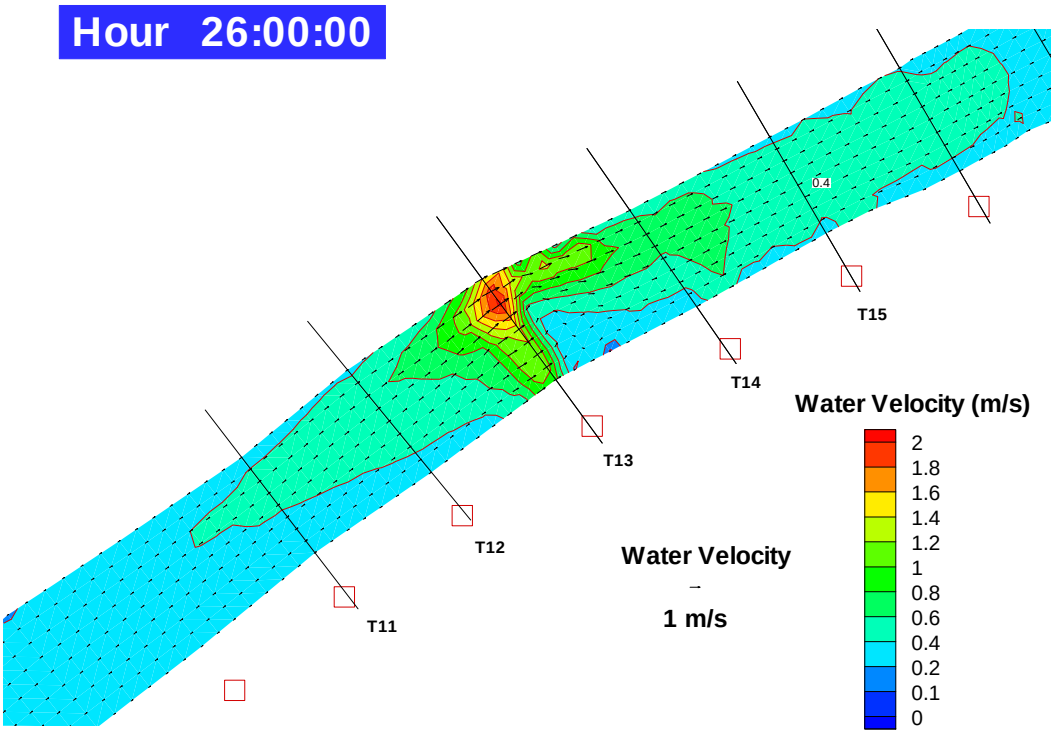


Figure 3.7 Model Results with Ice Jam Toe at T20 (8:30 am – March 28)

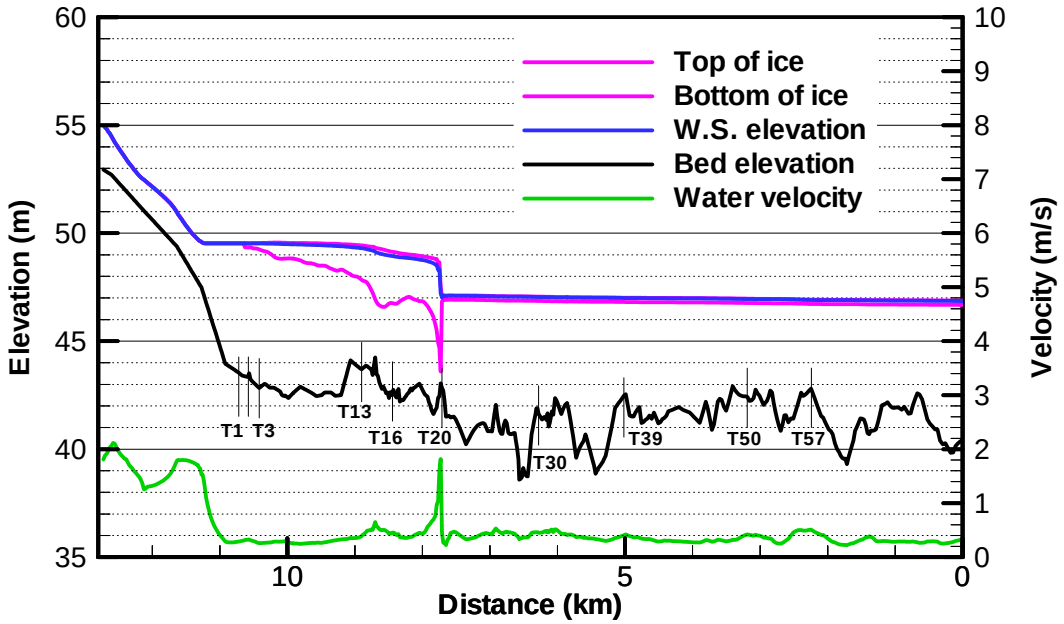


Figure 3.8 Predicted Current Velocity with Ice Jam Toe at T20 (8:30 am – March 28)

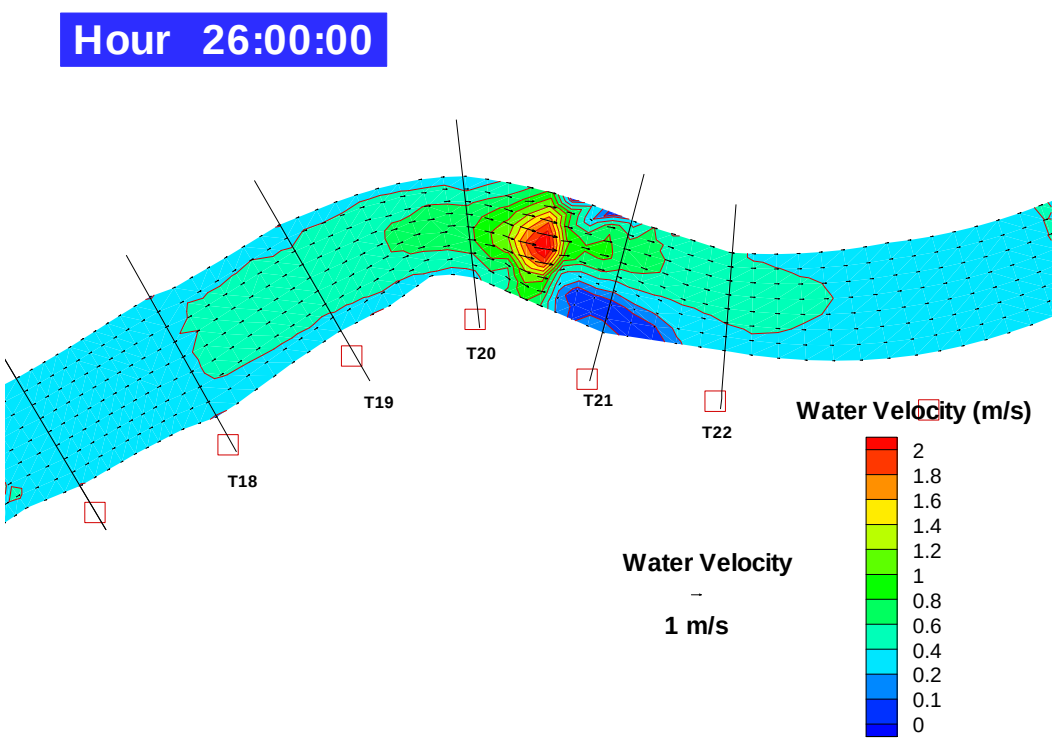


Figure 3.9 Model Results with Ice Jam Toe at T30 (12:30 pm – March 28)

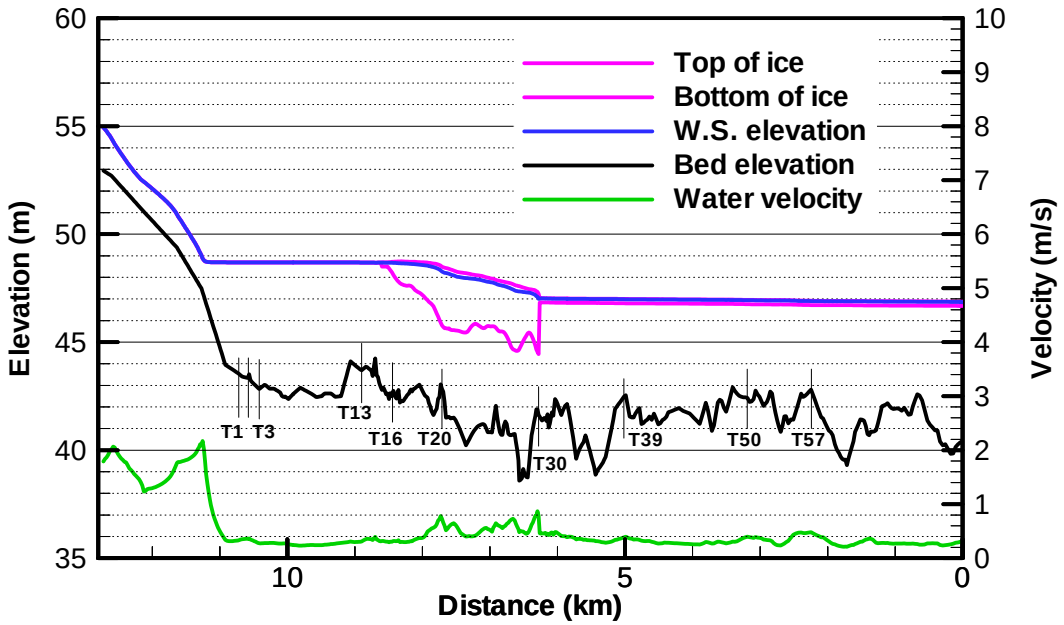


Figure 3.10 Predicted Current Velocity with Ice Jam Toe at T30 (12:30 pm – March 28)

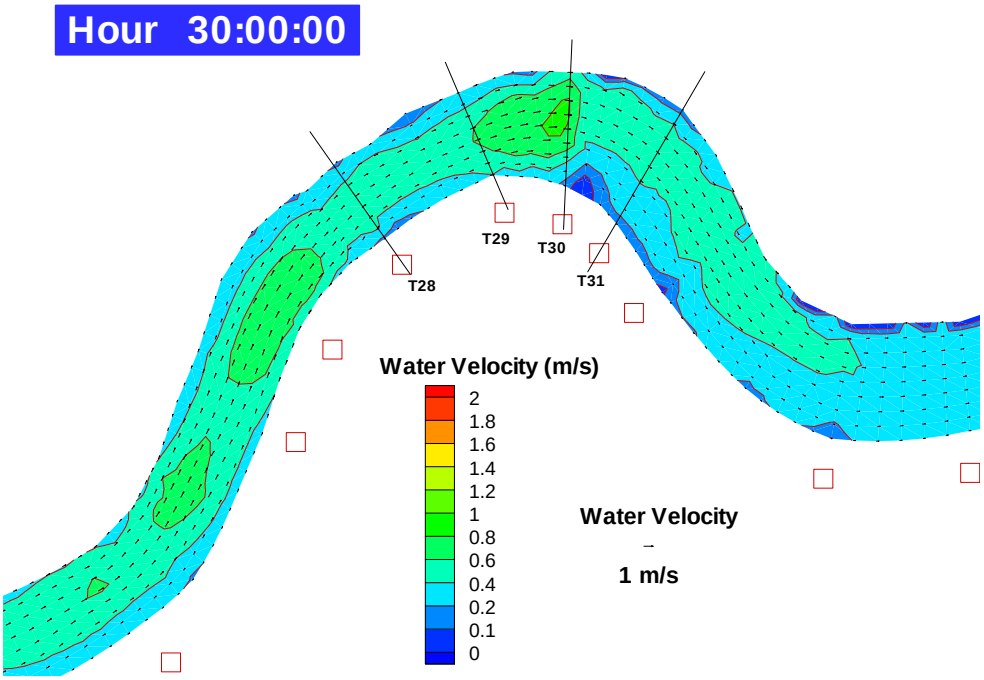


Figure 3.11 Model Results with Ice Jam Toe at T39 (12:30 pm – March 28)

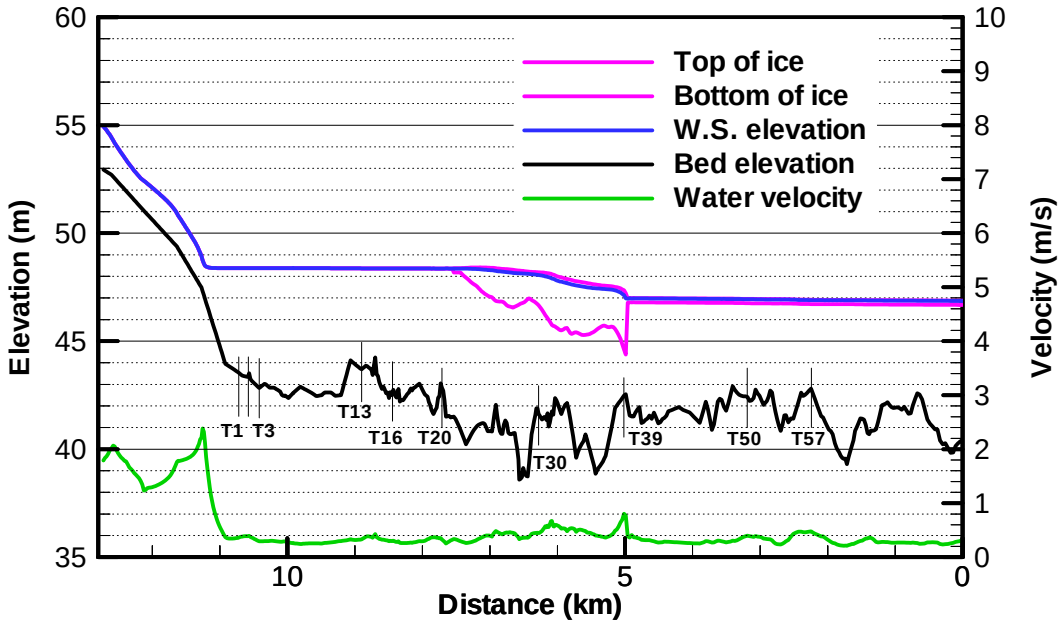


Figure 3.12 Predicted Current Velocity with Ice Jam Toe at T39 (12:30 pm – March 28)

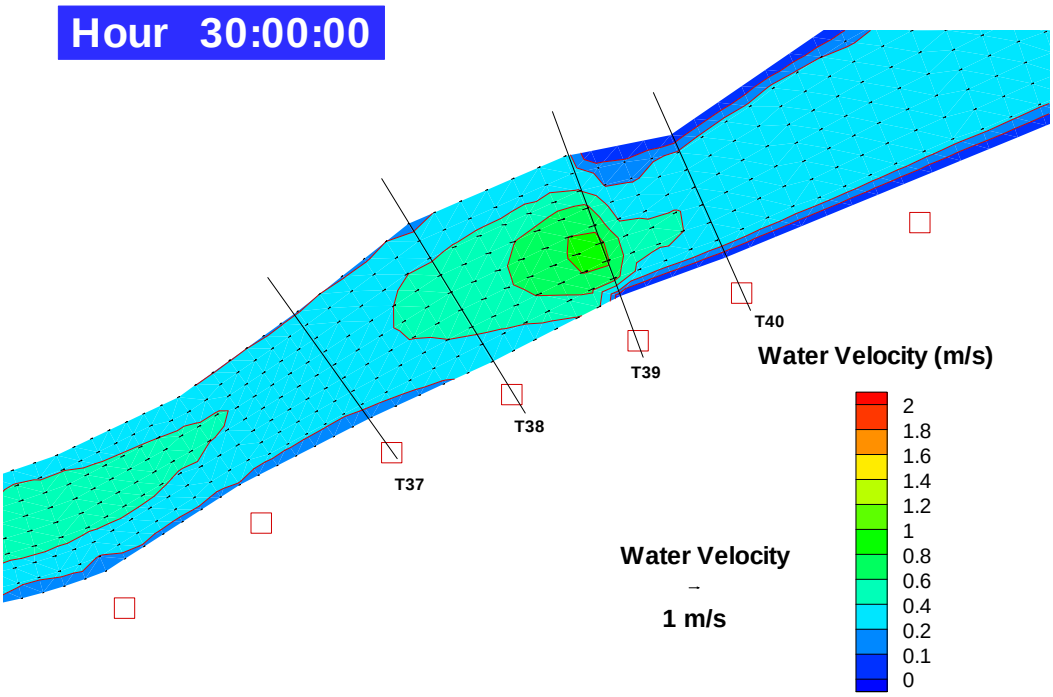


Figure 3.13 Model Results with Ice Jam Toe at T50 (12:30 pm – March 28)

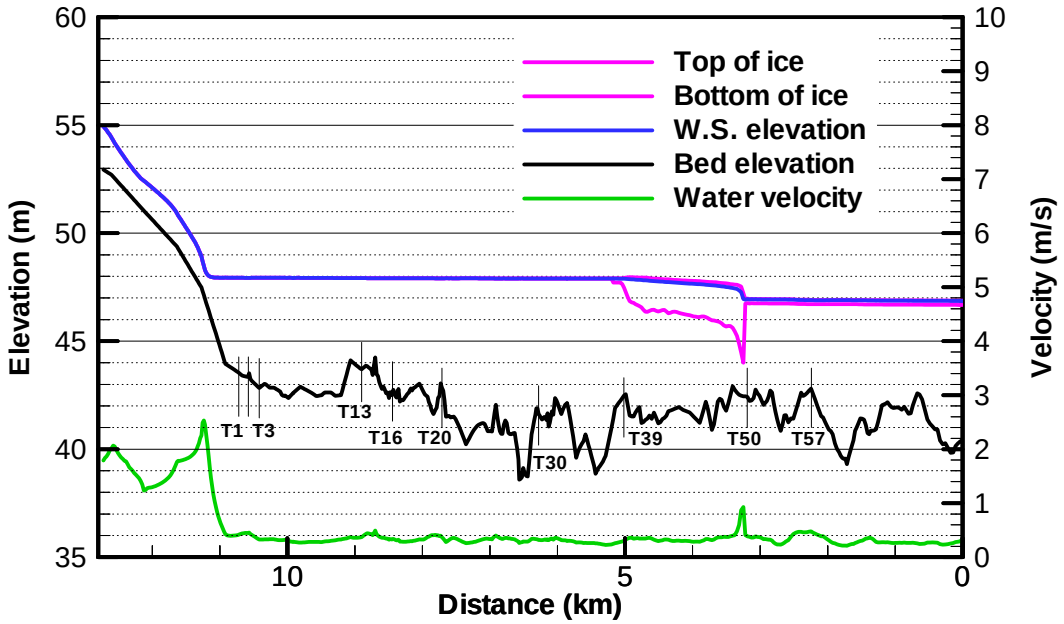


Figure 3.14 Predicted Current Velocity with Ice Jam Toe at T50 (12:30 pm – March 28)

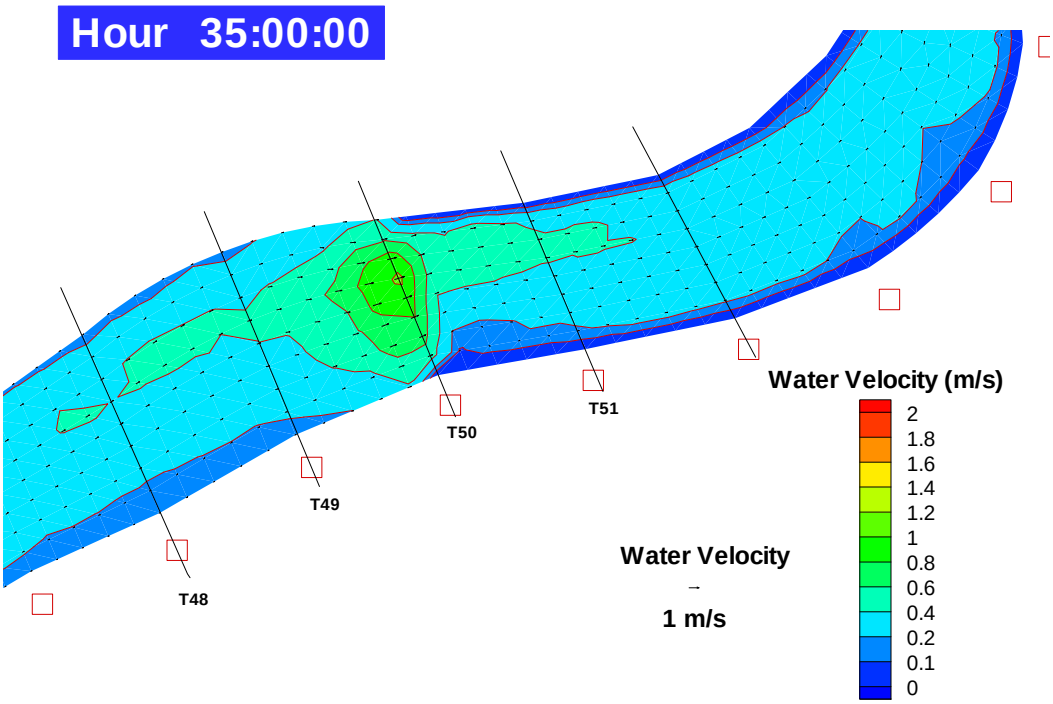


Figure 3.15 Model Results with Ice Jam Toe at T57 (8:30 am – March 29)

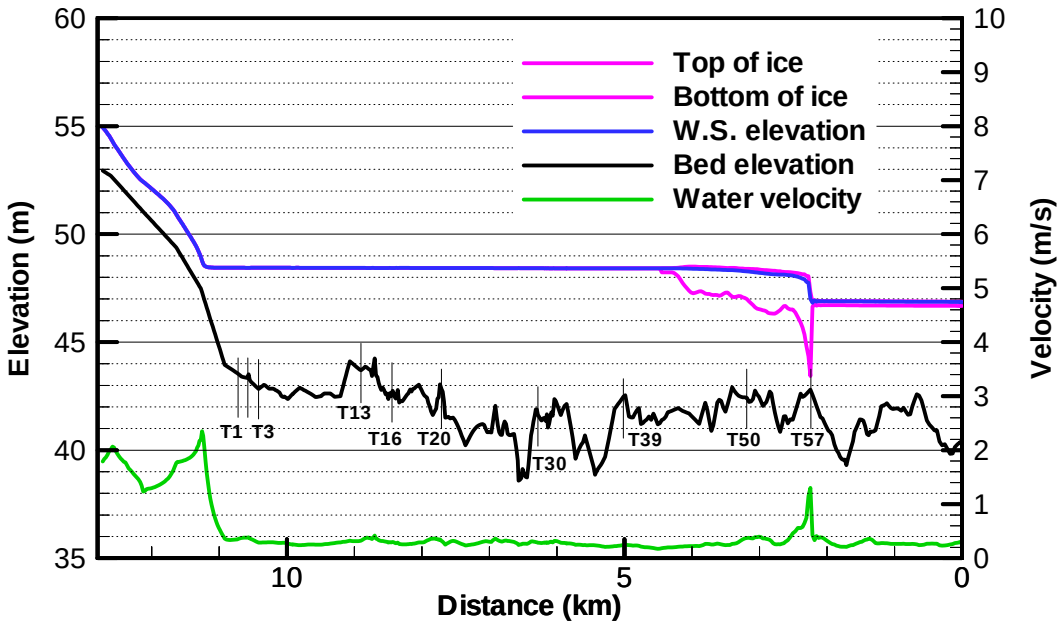
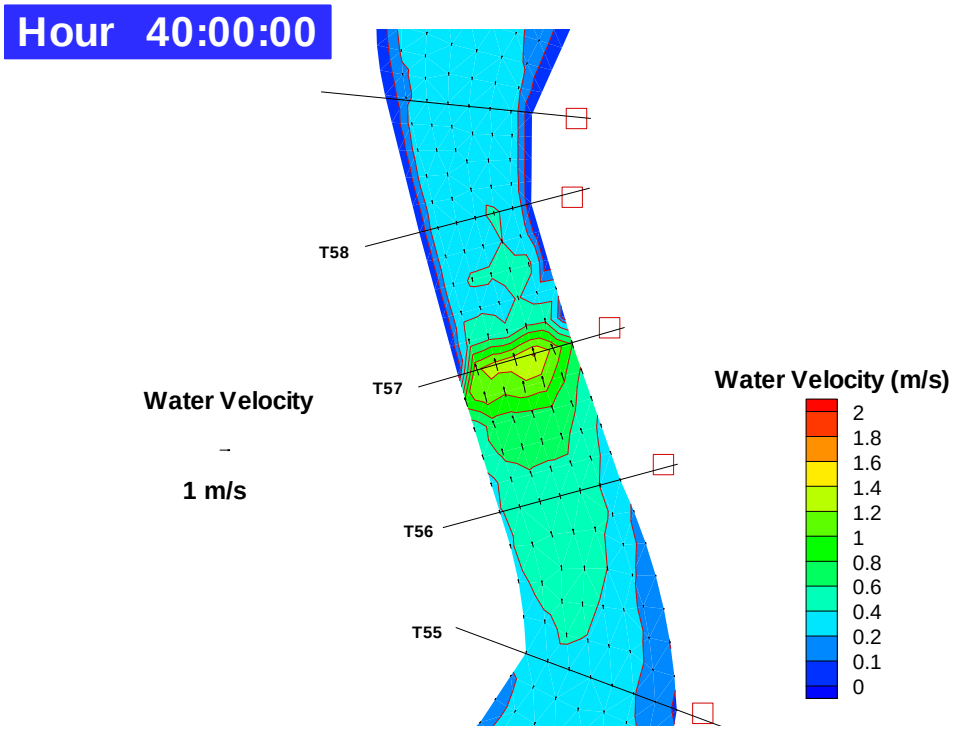


Figure 3.16 Predicted Current Velocity with Ice Jam Toe at T57 (8:30 am – March 29)



3.2 Effects of Upstream Discharge and Ice Supply

The river discharge and ice cover thickness (and, therefore, ice supply) at the time of ice breakup can affect the size and geometry of an ice jam. The breakup discharge and ice thickness are independent of each other, but a probability analysis can be performed to determine a 100-year return period for combinations of these variables. The results of the probability analysis, and sensitivity analysis DynaRICE simulations with different combinations of breakup discharge and ice cover thickness are discussed below.

A statistical analysis was performed to determine the combinations of river discharge and ice cover thickness at the time of breakup that have a one percent chance of occurring in any given year (i.e., 100-year return frequency), based on the historic river flow information and ice thickness estimates. The 100-year return frequency was used as an indicator of the potential magnitude of ice jam events. Since not all ice jams result in sediment scour, the 100-year return frequency described herein cannot be used as a direct predictor of the potential magnitude of sediment scour during any of these events; other information (e.g., tree scar analysis) must be considered when ranking the severity of a particular event.

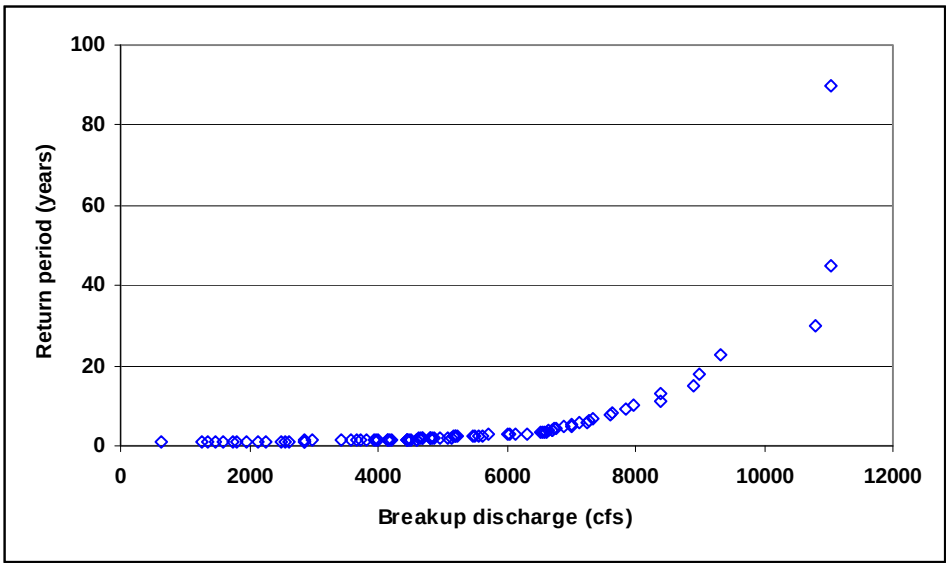
Using the 81-year record of river flow information and ice cover thickness estimates (from the hindcasting analysis; see Appendix N to the main report), the probability and return period of river discharge (Q) and ice cover thickness (h) at the time of ice breakup were computed individually using the Weibull formula:

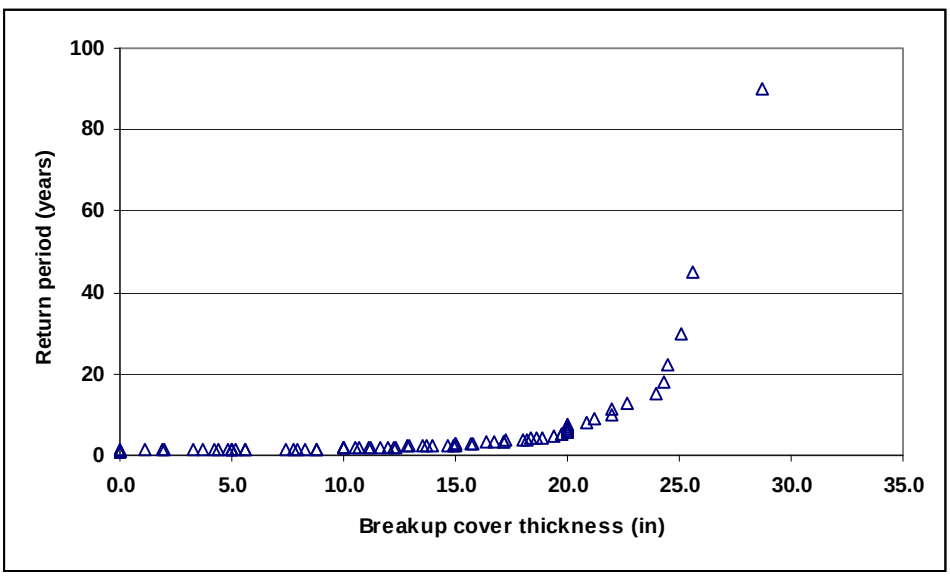
$$\frac{1}{T} = P = \frac{m}{n+1} \qquad (1)$$

where m is the rank of descending values, with the largest equal to 1;
n = number of events;
P = exceedence probability; and
T = return period.

Return periods for river discharge and ice cover thickness at the time of breakup are presented on Figure 3.17.

Figure 3.17 Computed Return Periods for Ice Cover Thickness and River Discharge at the Time of Ice Cover Breakup.

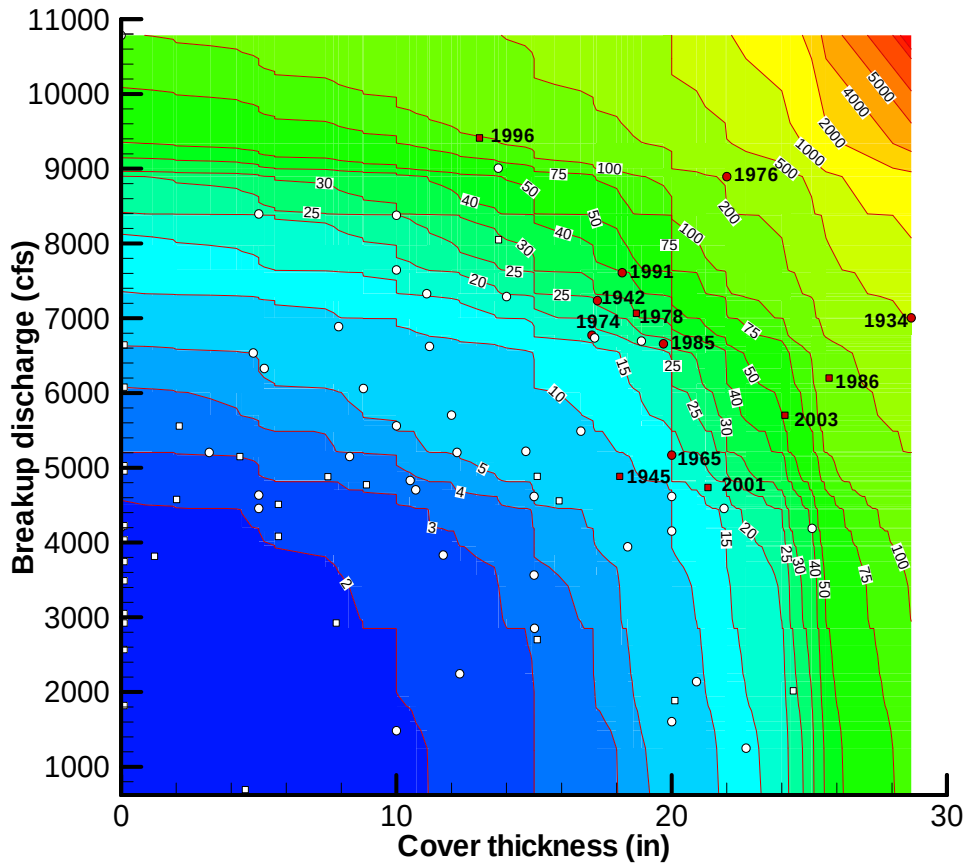




Since the two parameters are independent (i.e., not related to each other), a combined probability analysis was performed, where the probability of each breakup jam event was calculated as $P(Q \subset h) = P(Q) \times P(h)$ and the return period as $T = 1/P(Q \subset h)$.

Results of this combined probability analysis are shown on Figure 3.18. Symbols indicating observed and possible historical ice jams for a specific year, based on the hindcasting analysis (Appendix N to the main report), are also presented on this figure. The results presented on Figure 3.18 were used to determine combinations of discharge and ice supply having an estimated 100-year return period (i.e., a one percent chance of occurring in any year).

Figure 3.18 Return Period for Combinations of Breakup Discharge and Ice Thickness.



Six combinations were selected for use in the sensitivity analysis of the DynaRICE model; these scenarios are listed in Table 3.1. The breakup discharge and cover thickness for the 2003 case are shown for comparison. Subsequent to the modeling of these scenarios, provisional discharge data provided by the USGS were finalized, which required revisions to both Figure 3.18 and Table 3.1 (see Section 3.2.1 for discussion).

Table 3.1 100-Year Return Period Simulations.

Case	Breakup Discharge Q_{bk} (cfs)	Modeled Peak Discharge (cfs)	Cover Thickness h_i (inches)
2003	5,630	8,559	28.75
Q-Ice-A	10,617	16,140	4
Q-Ice-B	9,876	15,014	10
Q-Ice-C	9,072	13,792	16
Q-Ice-D	7,566	11,502	22
Q-Ice E	5,630	8,559	25.3
Q-Ice-F	3,035	4,614	28.7

For each simulation, the location of the jam toe was set at T16 (i.e., same location as the 2003 event). The flood hydrograph was specified by proportionally adjusting the 2003 event hydrograph using:

$$Q(t)^{100} = Q(t)^{03} \times \frac{Q_{bk}^{100}}{Q_{bk}^{03}} \qquad (2)$$

where: $Q(t)^{100}$ and $Q(t)^{03}$ are time-dependent discharges at the upstream boundary for the 100-year and 2003 events, respectively; and Q_{bk}^{100} and Q_{bk}^{03} are the breakup discharges given in Table 3.1. The peak discharge modeled during the simulation, based on equation (2), is also shown in Table 3.1.

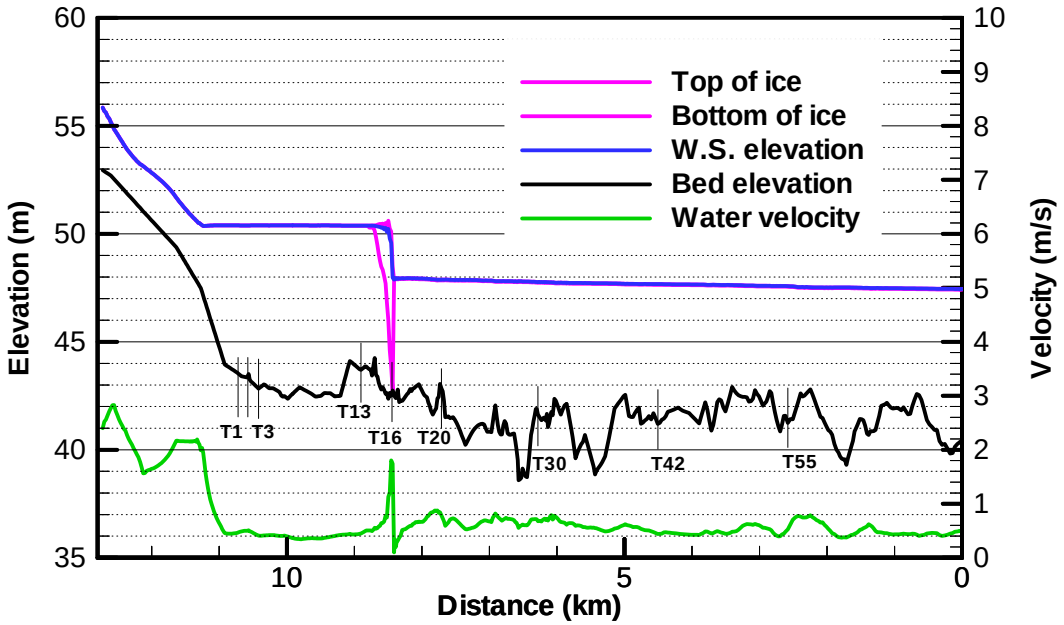
Similarly, the ice supply was specified using the breakup ice thickness ratio as follows:

$$V_{ice}^{100} = V_{ice}^{03} \times \frac{h_i^{100}}{h_i^{03}} \qquad (3)$$

where: V_{ice}^{100} and V_{ice}^{03} are the ice supplies for the 100-year and 2003 events, respectively; and h_i^{100} and h_i^{03} are the breakup ice thicknesses for the 100-year and 2003 events, respectively, given in Table 3.1. Note that the 2003 ice supply volume (V_{ice}^{03}) was based on an ice floe thickness of about 20 centimeters [8 in], as observed in the field. The ice floe thickness represents the thickness of ice pieces entrained within the jam, and should not be confused with the ice cover thickness at the time of breakup, which occurred several days prior to jam formation. The floe thickness accounts for the melting that occurred as the breakup period and the jam progressed. The water level (i.e., stage height) at the downstream boundary of the model was set at 47.36 m [155.38 ft] for all simulations.

The results of the six sensitivity cases A through F are presented in Figures 3.19 through 3.24, respectively. A profile of the ice jam in each case is shown at the time of full jam formation, hour 26 in the simulation.

Figure 3.19 Case A: Q_{bk}=10,617 cfs and h_i= 4 in.



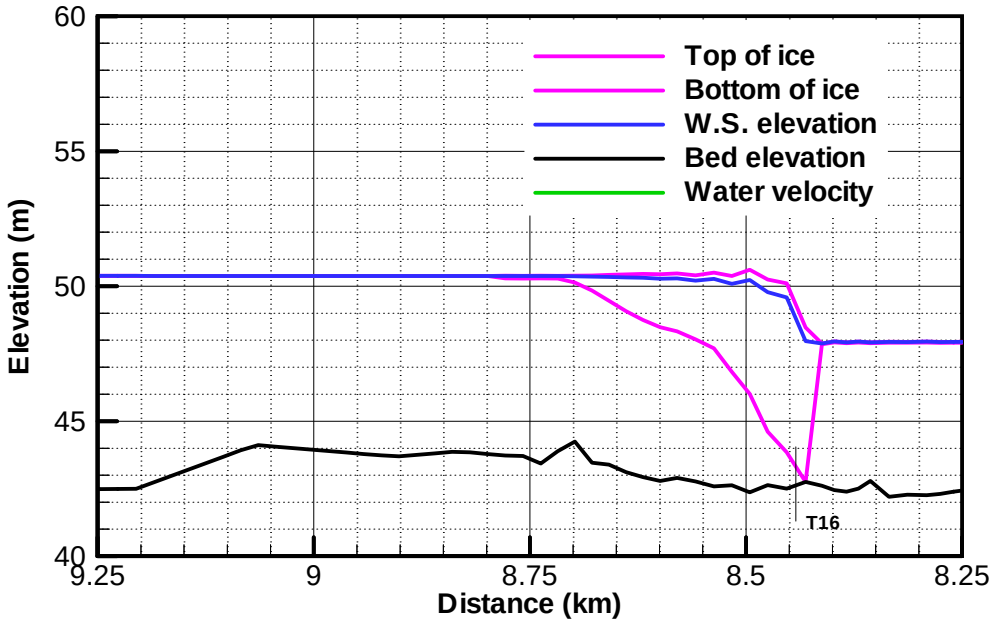
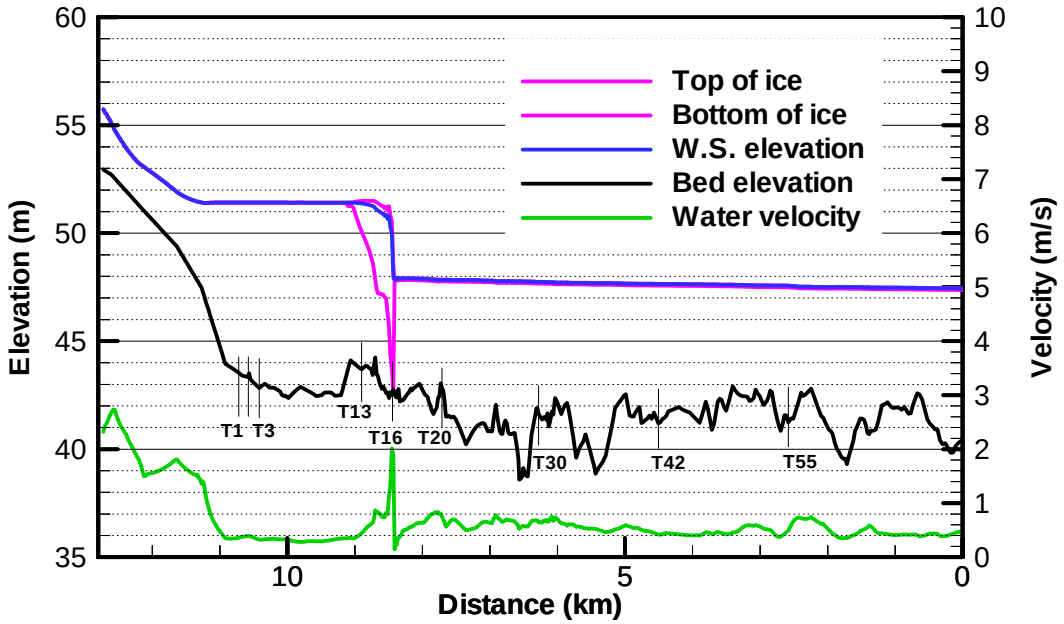


Figure 3.20 Case B: Q_{bk}=9,867 cfs and h_i= 10 in.



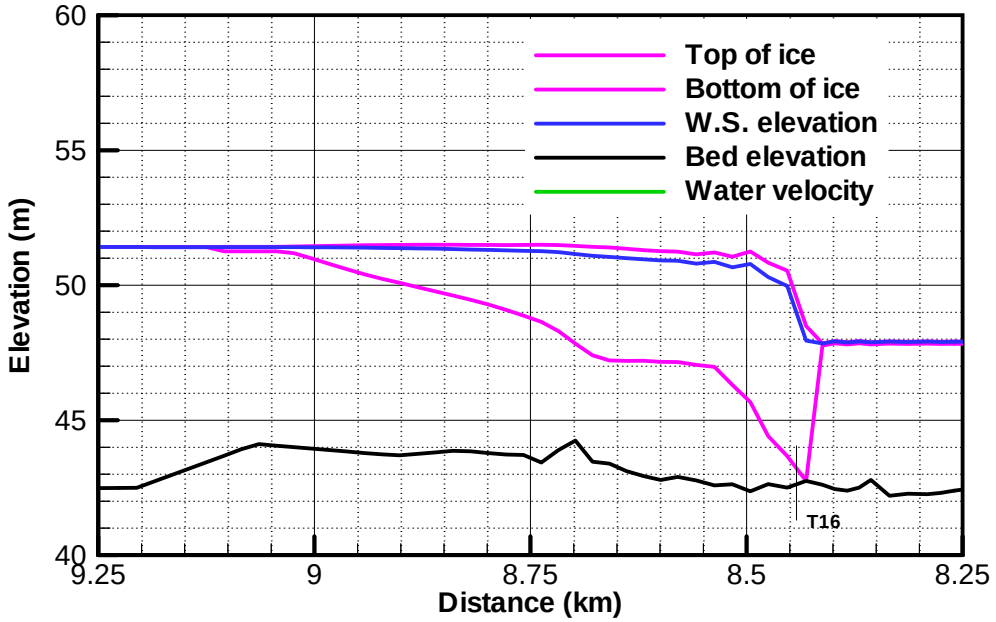
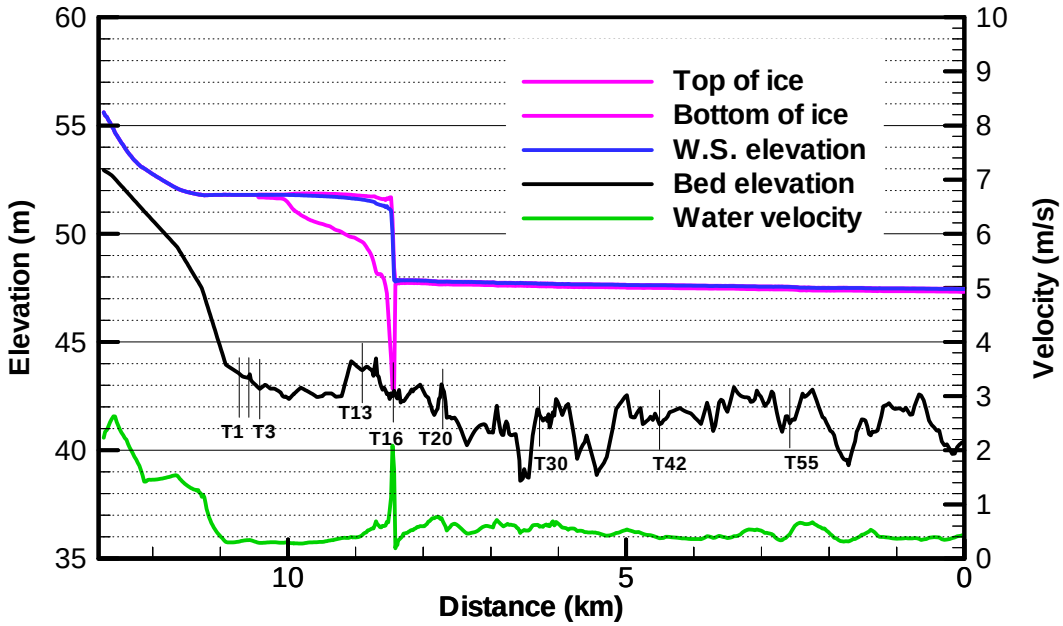


Figure 3.21 Case C: Q_{bk}=9,072 cfs and h_i= 16 in.



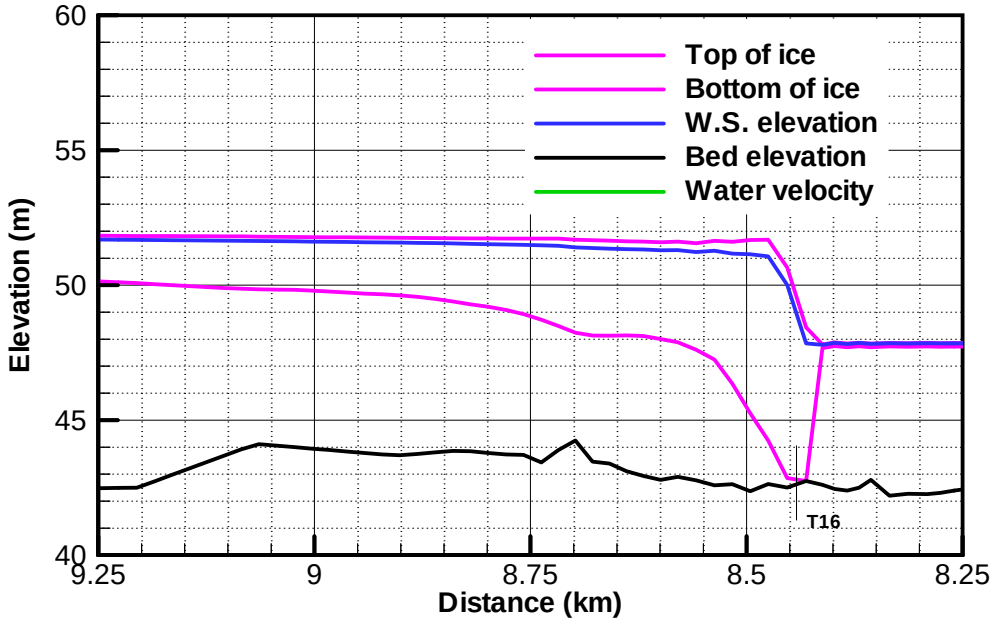
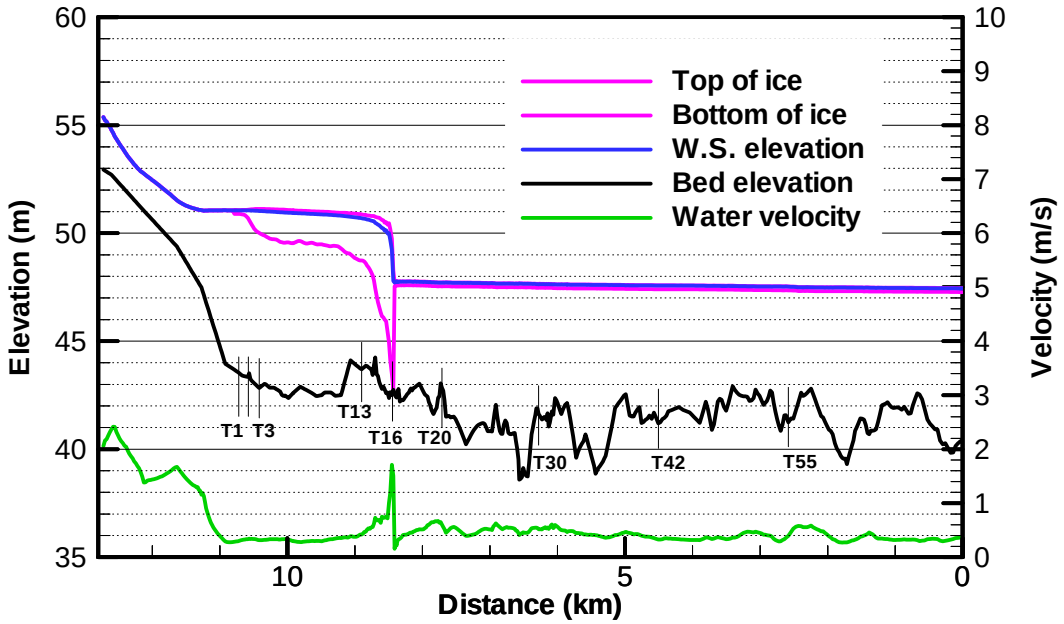


Figure 3.22 Case D: Q_{bk}=7,566 cfs and h_i= 22 in.



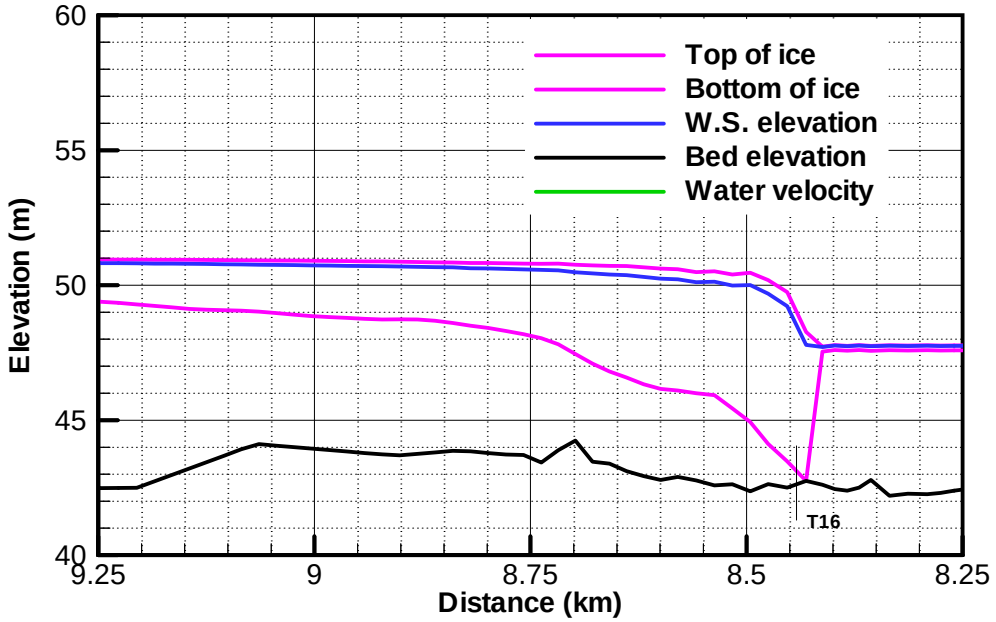
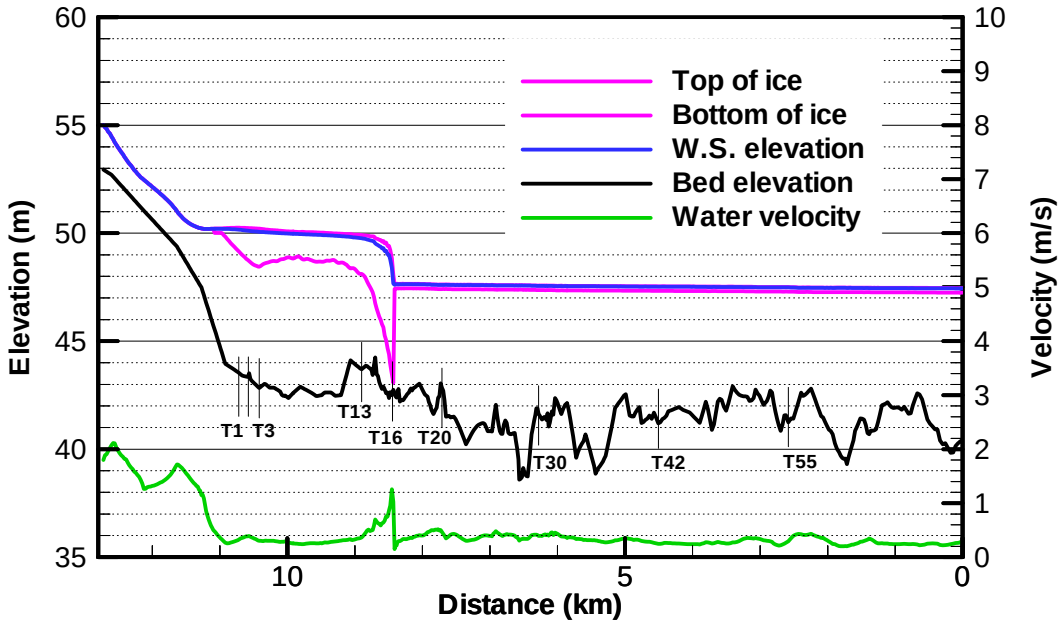


Figure 3.23 Case E: Q_{bk}=5,630 cfs and h_i= 25.3 in.



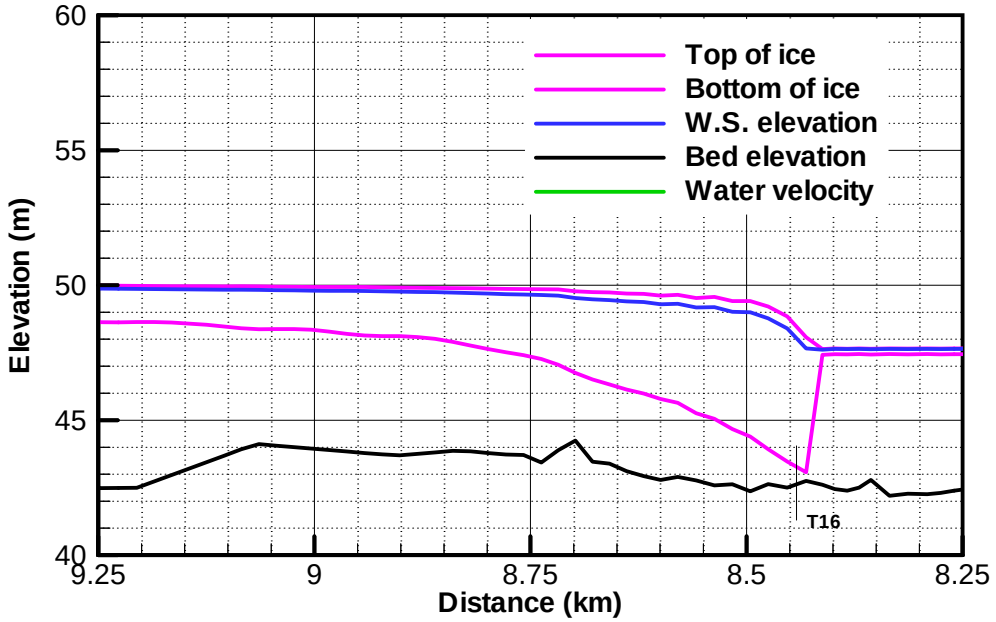
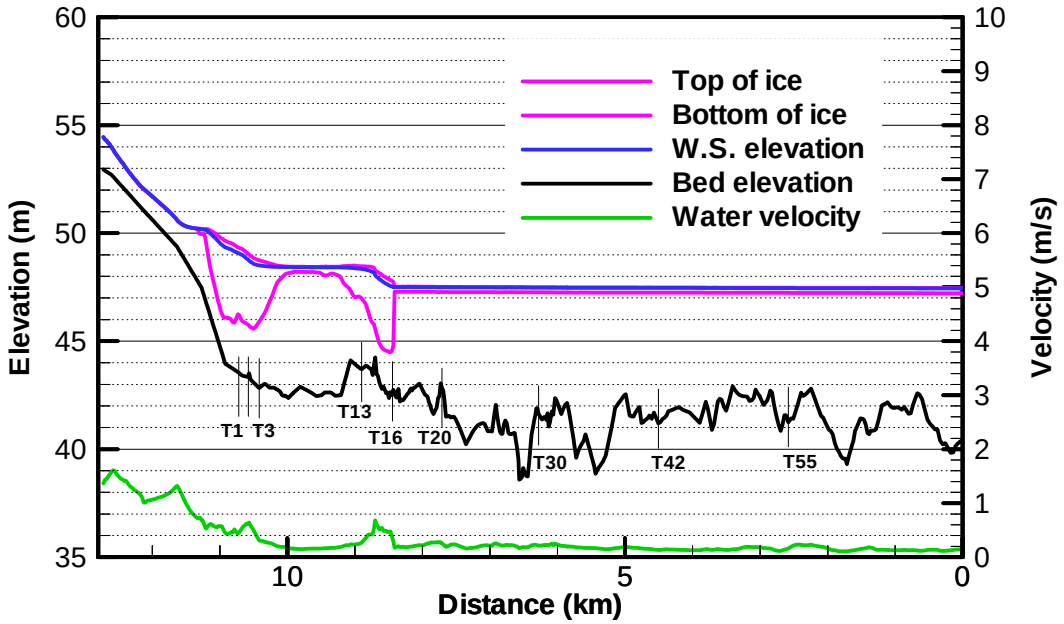
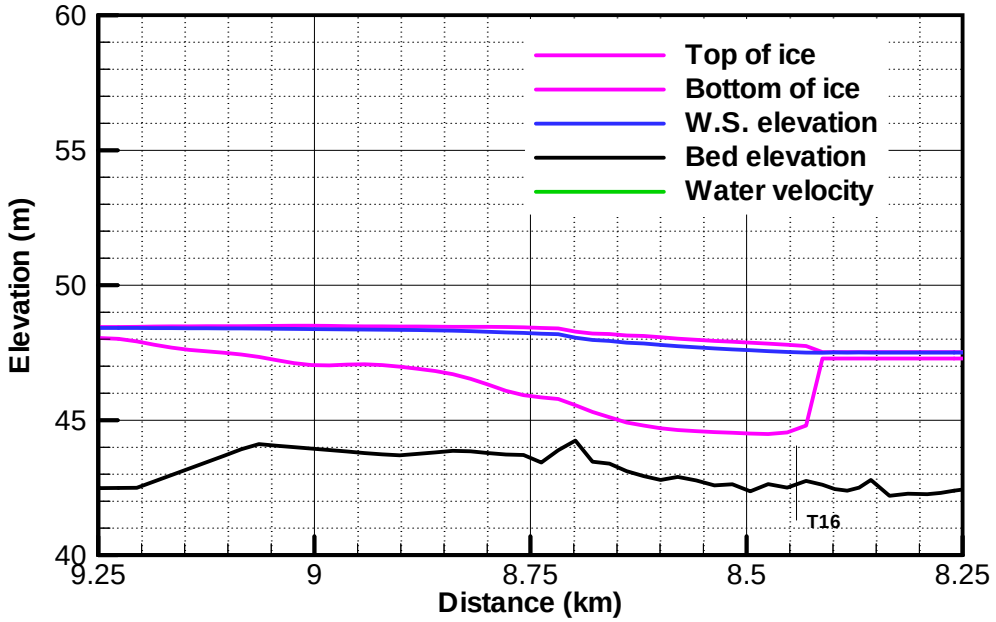


Figure 3.24 Case F: Q_{bk}=3,035 cfs and h_i= 28.7 in.





The results in Figures 3.19 through 3.24 show that among discharge and ice supply, the discharge is the more important factor with regard to the thickness of the ice jam toe. Reducing ice supply will not reduce toe thickness, but the ice jam length and stage height are reduced. The results of this sensitivity analysis are discussed further in *Evaluation of Bottom Shear Stress Underneath Ice Jams in the Lower Grasse River* (Appendix V to the main report).

For the evaluation of potential ice control measures, the 2003 event -- which is the most severe event on record -- was considered the design event for this evaluation. In addition, the six "more severe" events with recurrence intervals of one in 100 years (i.e., sensitivity cases A through E) were examined to reflect the inherent year-to-year variations in ice supply volume and river discharge. Together, these seven cases were used to evaluate the performance of potential ice control measures under a range of extreme conditions.

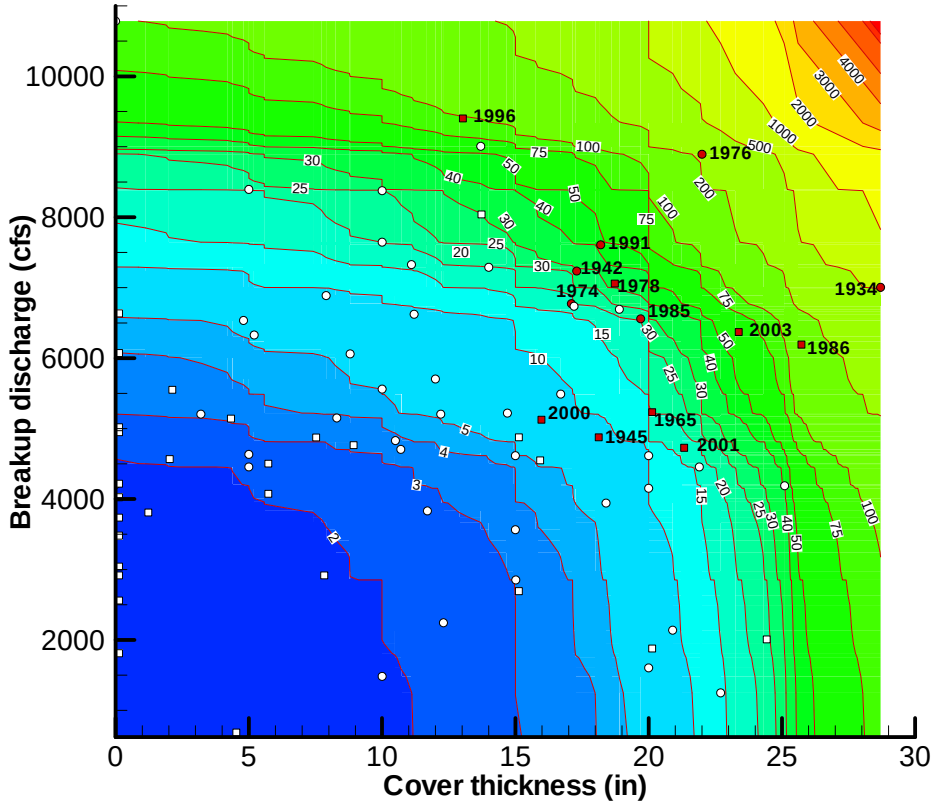
3.2.1.Changes in Sensitivity Case Scenarios Due to Revised USGS Flow Data

In 2006 Alcoa became aware that provisional flow data collected from the West Branch of the Oswegatachie River (used to estimate flow in the Grasse River at Massena) had been finalized by USGS for water years 2000 through 2003 (October 1, 1999 through September 30, 2003). Alcoa's ice expert group re-evaluated the spring breakup hydrographs for the winters of 2000 through 2003, in order to determine what effect, if any, the changes in flow data would have on the 100-year return frequency breakup discharge and ice thickness combinations used in the DynaRICE model sensitivity analyses. The results of the re-evaluation were presented in *Revised Parameters for DynaRICE 100-Year Return Period Sensitivity Analysis Simulations – Technical Memorandum* (Alcoa, December 2006), which is incorporated by reference for the summary discussion below.

Most of the changes in USGS flow data (nearly 85%) were relatively small (i.e., less than 100 cfs). The more significant changes generally occurred during winter/spring months, when the Oswegatchie River gage was either offline or likely producing readings affected by ice conditions on the river. Flow records immediately preceding and following the estimated breakup dates for 2000 through 2003 were reviewed more closely to assess possible implications to the hindcasting analysis and consequently the combined probability plot for breakup discharge and ice cover thickness at time of breakup (Figure 3.18). A significant change in flow of almost 1,000 cfs for the dates of March 22 and 23, 2003 resulted in the redesignation of the 2003 breakup date as March 23 (formerly March 22), which changed both the breakup discharge (5,630 cfs to 6,303 cfs) and ice cover thickness at the time of breakup (24 inches to 23.25 inches). Each of these values factors significantly into equations (2) and (3) shown above.

Using the revisions to the flow record and the revised breakup discharge for 2003, the combined probability plot (Figure 3-18) was updated as shown in Figure 3.25.

Figure 3.25 Revised Return Period Analysis for Combinations of Breakup Discharge and Ice Thickness.



The revised combinations of breakup discharge and ice cover thickness for the 100-year return period sensitivity analysis are shown in Table 3.2, along with the modeled peak discharges derived from equation (2).

The change in USGS flow data resulted in relatively minor changes in the probability plot (Figure 3.25) and consequently the breakup discharges associated with the 100-year return period line, as shown in Table 3.2. The most significant change occurs with the modeled peak discharges for each sensitivity case, as derived from equation (2). For all but one case (Case E), the modeled peak discharge decreases. Therefore, the DynaRICE simulation results shown in Figures 3.19 through 3.24 (with the exception of Case E) already represent a more conservative representation of the ice jam conditions in each case. Therefore, revised simulations for Cases A, B, C, D and F with the toe of the jam at T16 (the 2003 location) were not performed. For Case E, the DynaRICE simulation was rerun with the revised proportioned hydrograph. The results are shown in Figure 3.26, at hour 26 in the simulation. By comparison with Figure 3.23, it can be seen that the increased hydrograph with an additional 572 cfs in the modeled peak discharge, and the modest change in ice supply represented by a 1.3 inch reduction in cover thickness at breakup, do not result in an appreciable difference in under-ice velocity. Only slight differences in jam configuration are noticeable. The resulting backwater elevation immediately upstream of the jam appears to be approximately 0.5 m [1.64 ft] less in the revised Case E.

Table 3.2 Revised Combinations of Breakup Discharge and Ice Thickness for Sensitivity Analysis Simulations.

Case	Original			Revised		
	Breakup Discharge Q_{bk} (cfs)	Modeled Peak Discharge (cfs)	Cover Thickness h_i (inches)	Breakup Discharge Q_{bk} (cfs)	Modeled Peak Discharge (cfs)	Cover Thickness h_i (inches)
2003	5,630	8,559	28.75[1]	6,303	8,559	23.25
Q-Ice-A	10,617	16,140	4	10,608	14,405	4
Q-Ice-B	9,876	15,014	10	9,936	13,492	10
Q-Ice-C	9,072	13,792	16	9,139	12,410	16
Q-Ice-D	7,566	11,502	22	7,372	10,011	22
Q-Ice-E	5,630	8,559	25.3	6,724	9,131	24
Q-Ice-F	3,035	4,614	28.7	3,289	4,466	28.7

The calibration of the DynaRICE model to the 2003 ice jam event, as discussed in Section 2.1 is not affected by the finalization of USGS flow records and redesignation of the 2003 breakup date as March 23 (from March 22). Model simulations of the 2003 case use the site-specific hydrograph based on the instantaneous tapedown measurements from the Main Street bridge collected during the 2003 breakup. The ice supply is based on the ice floe thickness and estimated concentrations determined from field conditions, and is independent of the h_i variable (ice cover thickness at time of breakup) used in the 100-year return period cases. Similarly, modeling of the 2003 "design event" with a stand alone ice control structure at T6.75 is unaffected by the change in breakup date.

The revised USGS flow records and subsequent changes in the sensitivity analysis scenarios (Table 3.2) affected several aspects of the ice management studies for the Grasse River, and all have been addressed accordingly as described below:

- *Hindcasting Analysis* – Changes in USGS flow records resulted in only modest changes to the records used in this analysis. The hindcast analysis was revised to reflect these new flow records and is presented in Appendix N to the main report. The updated analysis did not change the predicted occurrence of prior ice jams.

- *Performance Evaluation for Pier-Type Ice Control Structure at Transect T6.75* – Ice retention capability and projected backwater effects were evaluated using DynaRICE modeling and the revised sensitivity case simulations shown in Table 3.2. These sensitivity analysis were considered along with the 2003 design event conditions to evaluate the performance of the T6.75 ice control structure under a range of extreme conditions (Alcoa, October 2007).

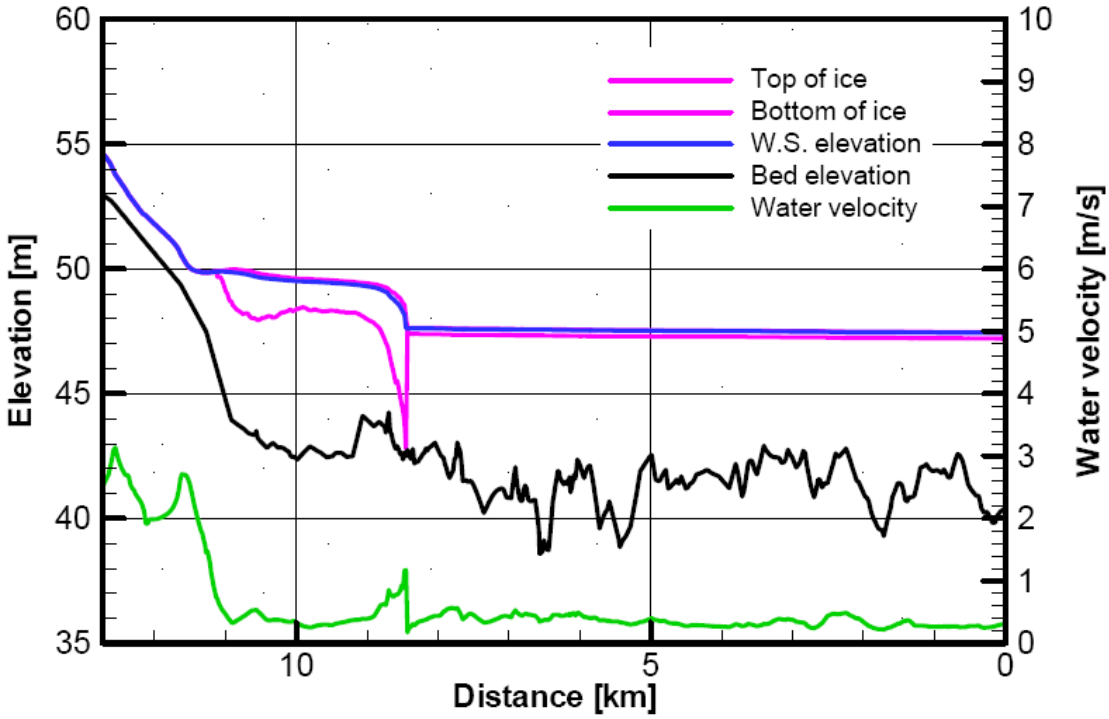
[1] This value was incorrectly shown as 24 inches in the original table presented in the April 2004 *Draft CCLGR Addendum*. Review of ice thickness measurement data indicated that the 24-inch value originally reported corresponds to an observed ice thickness made by CDM on 3/12/03 (not 3/22/03); no field observation of ice thickness was made on 3/22/03. Therefore, this ice cover thickness value is the hindcast-predicted ice thickness estimate for 3/22/03.

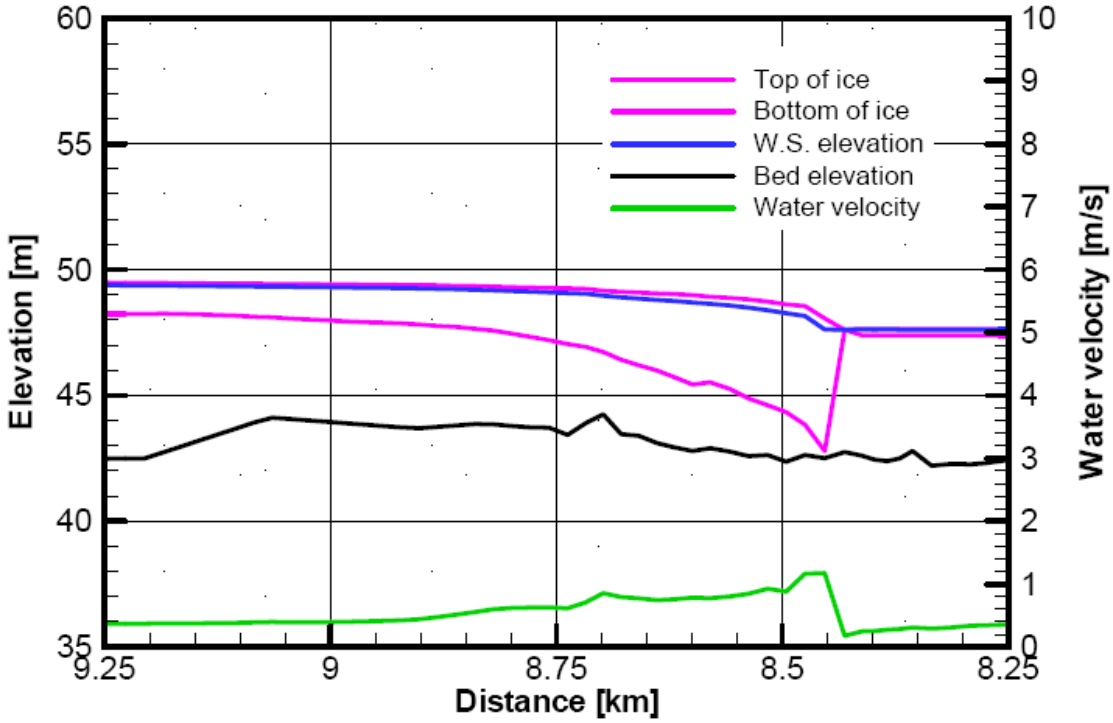
- *Physical Modeling for Ice Control Structure at Transect T6.75* – The revised sensitivity analysis scenarios shown in Table 3.2 served as the basis for the conditions tested in the physical modeling study of the T6.75 ice control structure. Design parameters such as pier spacing, pier height and pier placement were determined for an extreme set of ice supply and river discharge conditions.

- *Ice Control Evaluation for Grasse River Hydoelectric Dam* – The revised sensitivity case scenarios shown in Table 3.2 were used in numerical and physical modeling studies to evaluate ice retention capability and projected backwater effects for a hydroelectric dam project proposed for the Grasse River by the Massena Electric Department (QEA, June 2008).

- *Analysis of Bottom Shear Stress for Armored Cap Design* – DynaRICE modeling and turbulence modeling of the sensitivity analysis scenarios were performed to aid in the design of an armored cap to withstand the forces underneath an ice jam during extreme (i.e., 1-in-100 year) events. With the exception of Case E, the revised modeled peak flows for each of the sensitivity cases decreased as a result of the changes in USGS flow records (in comparison to the original sensitivity cases). As a result, Case E was re-run; results are presented in Appendix V of the main report.

Figure 3.26 Revised Case E: Q_{bk}=6,724 cfs and h_i= 24 in.





3.3 Effect of Downstream Water Level

Simulations were conducted to: examine the effect of the water surface elevation at the downstream boundary. Two cases with variations of the downstream water level by +0.5 and –0.5 m [+1.6 and -1.6 ft] from the baseline case of the 2003 event were simulated. All other conditions were kept the same. The simulated ice jam profile with the downstream water level increased by 0.5 m [1.6 ft] is shown on Figures 3.27 and 3.28. Figure 3.29 shows the velocity distribution near the jam toe for this case. These results show that the downstream water level increase will not cause significant change in the simulated ice jam profile. The current velocity is reduced, but the change is insignificant. The highest water level at T1 is the same as that in the 2003 calibration simulation. For the case with a decreased downstream water level, the predicted jam profile shows slightly more grounding than the 2003 calibration simulation (Figures 3.30 and 3.31). The highest water level at T1 is also the same as the 2003 calibration simulation. The maximum current velocity is about 1.6 m/s [5.3 ft/s] (Figure 3.32), which is comparable to that of the 2003 calibration simulation.

Figure 3.27 Ice Jam Profile with a Downstream Water Level Increase of 0.5 m

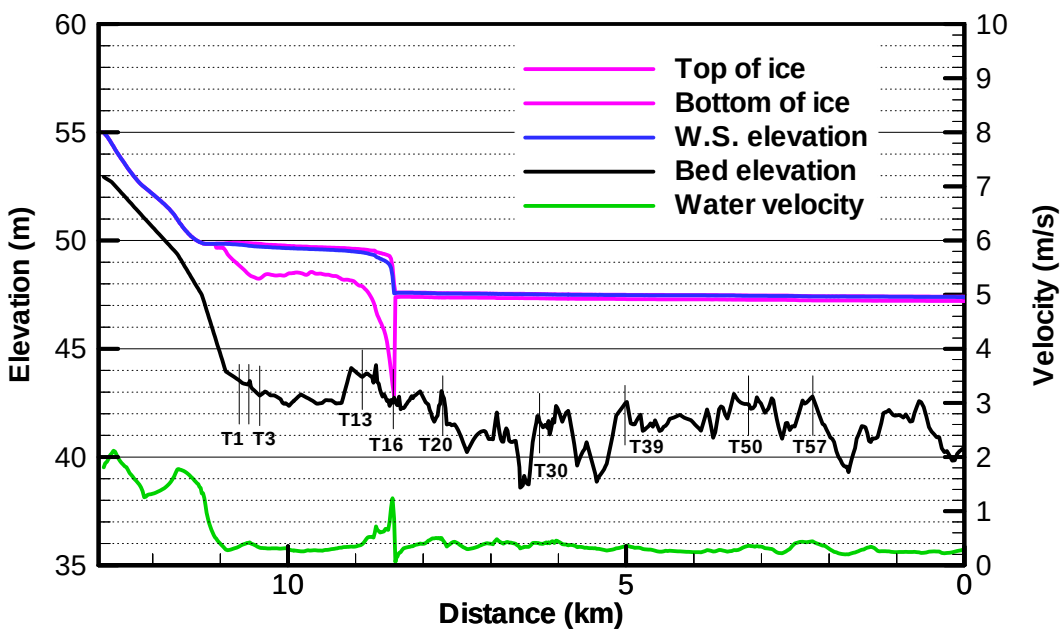


Figure 3.28 Ice Jam Profile Near T16 with a Downstream Water Level Increase of 0.5 m

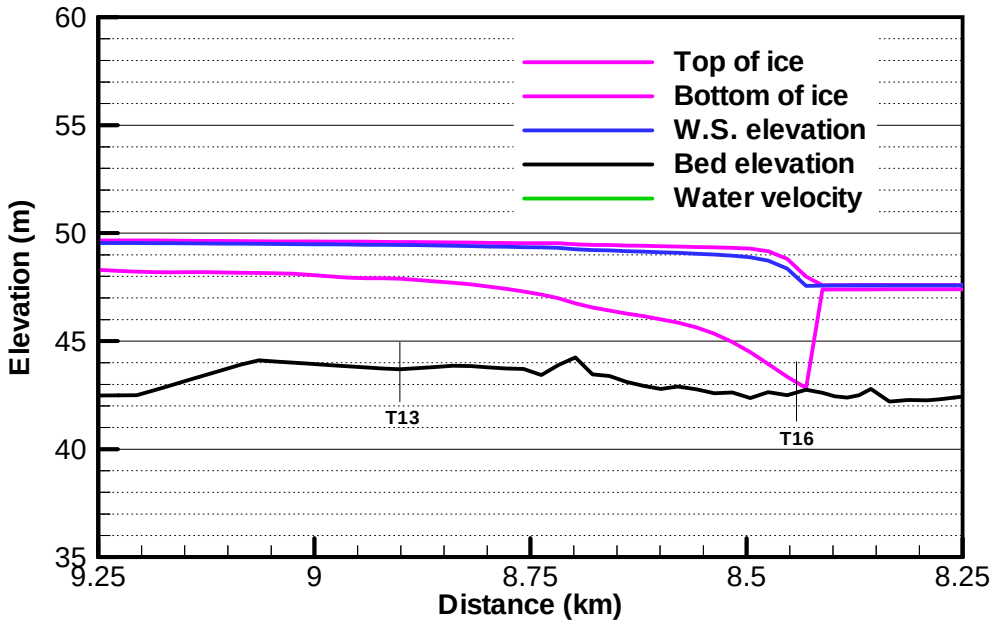


Figure 3.29 Simulated Water Velocity Distribution Under Ice Jam with a Downstream Water Increase of 0.5 m

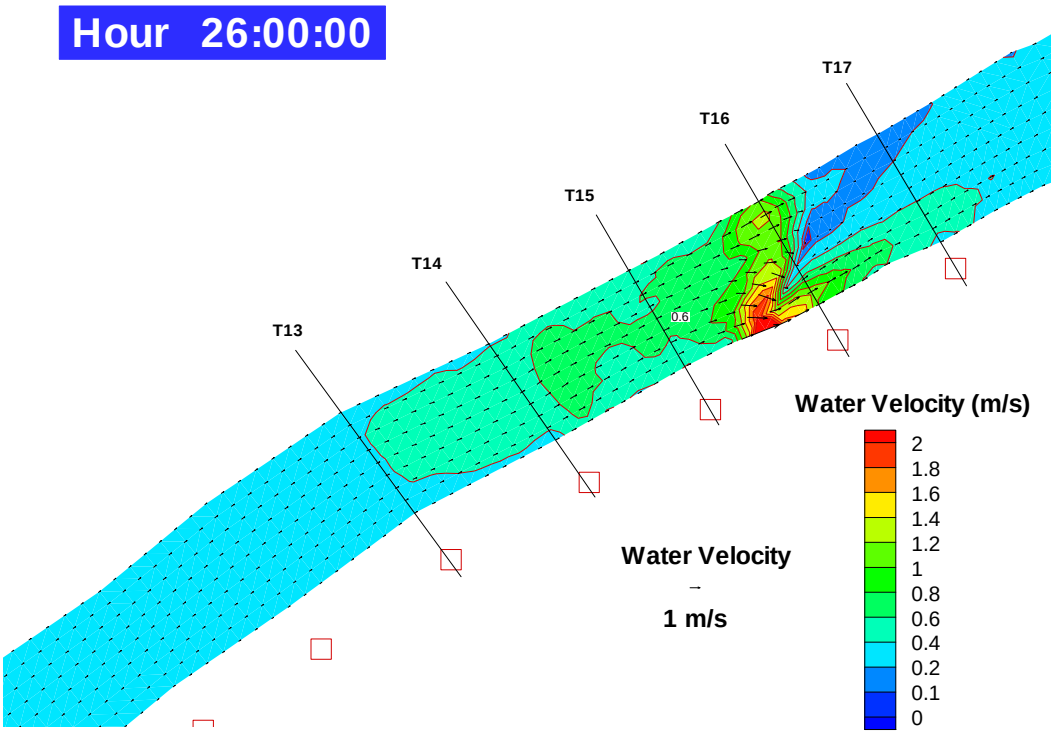


Figure 3.30 Ice Jam Profile with a Downstream Water Level Decrease of 0.5 m

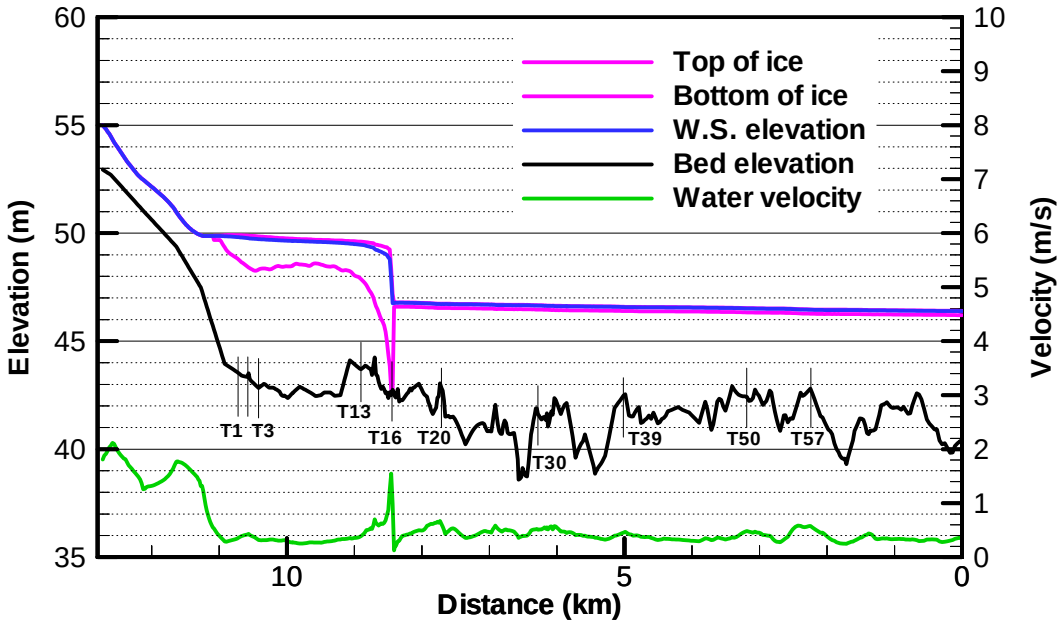


Figure 3.31 Ice Jam Profile Near T16 with a Downstream Water Level Decrease of 0.5 m

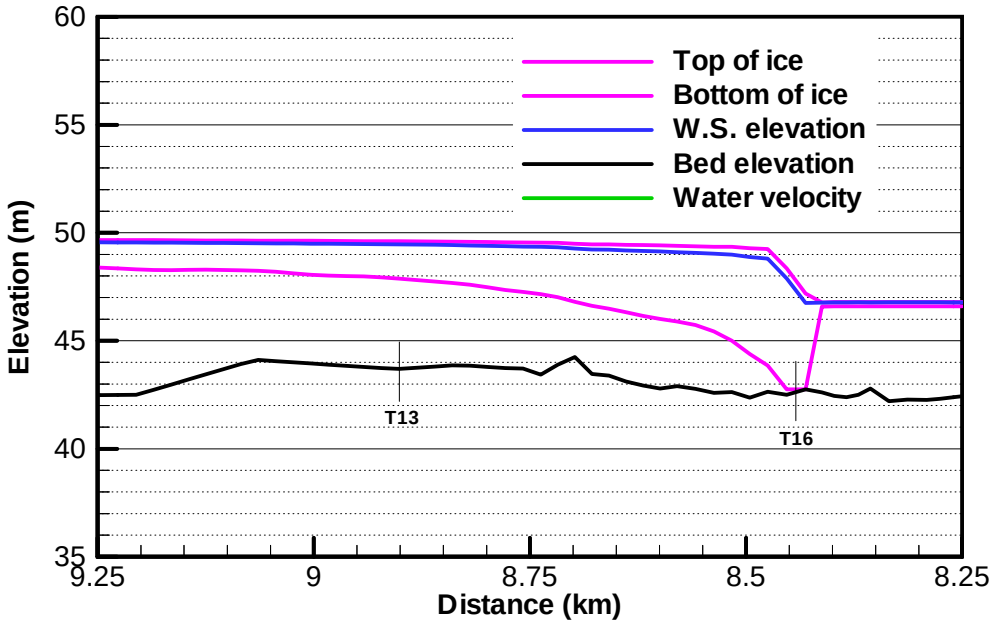
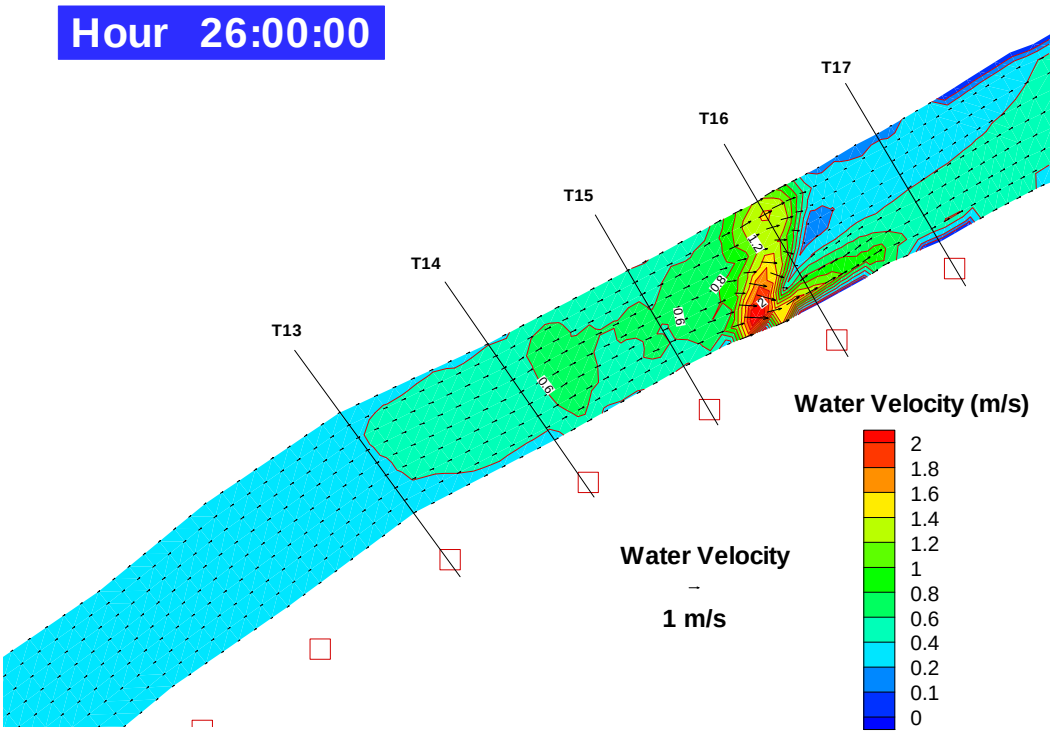


Figure 3.32 Simulated Water Velocity Distribution Under Ice Jam with a Downstream Water Decrease of 0.5 m



3.4 Effects of Extreme Discharge

A simulation was conducted with high discharge to investigate the potential impacts of an extreme event. An analysis of historical data showed that the probable maximum breakup water discharge is about 9,000 cfs. Based on this result, a simulation was conducted using a flood hydrograph that was proportionally increased from the 2003 event hydrograph (see Figure 1.2) to a peak discharge of 13,682 cfs. The ice supply of 2003 event was used. Since the jam thickness has already reached an equilibrium condition, increasing ice supply only makes the jam longer and does not increase thickness of the toe. Model results for this extreme event are shown on Figures 3.33 and 3.34.

Figure 3.33 Model results with jam at T-16 and a breakup discharge of 9,000 cfs (modeled peak of 13,682 cfs).

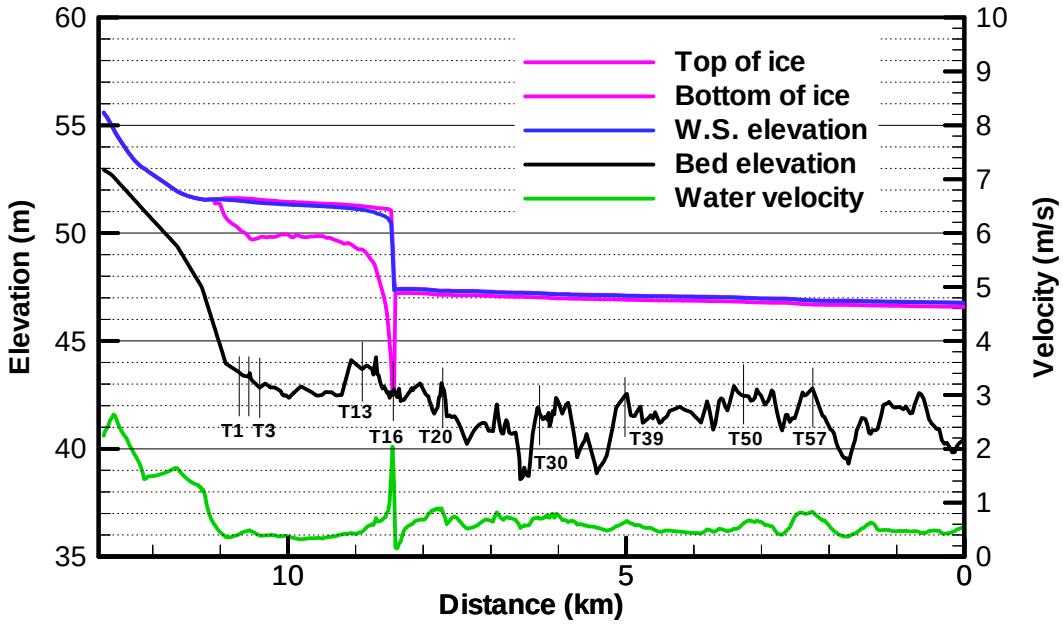
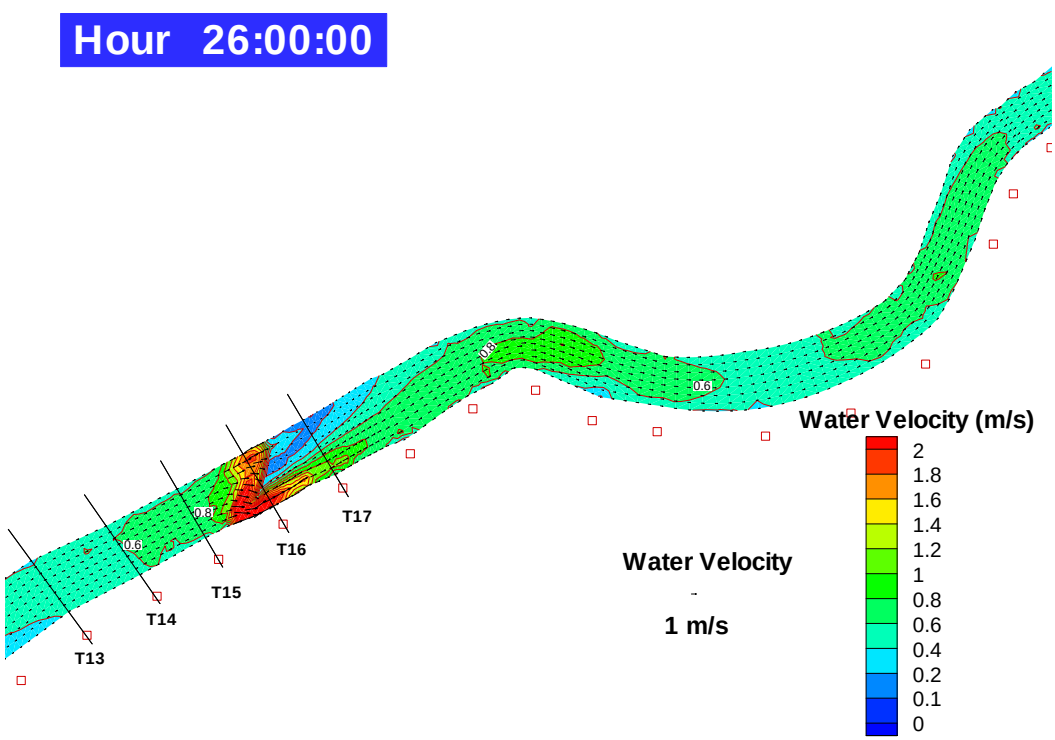


Figure 3.34 Predicted water velocity under ice jam with a breakup discharge of 9,000 cfs (modeled peak of 13,682 cfs).



4.0 Conclusions

This report presents a numerical model study of breakup ice jam formation and associated flow conditions in the lower Grasse River. The study provides information on ice jam evolution that cannot be determined from field observations. The model was calibrated using observed stage height and jam area data for the 2003 ice jam event. Additional validation of the model was accomplished using tree scar data. The ice jam event of 2003 was caused by high water discharge at the time of the breakup ice run, together with a large ice supply and intact ice cover on the lower Grasse River. The model results indicate that the jam was partially grounded. The prediction of partial grounding, however, should be viewed as a conservative estimate because, as noted in Section 1.2, the assumption of a rigid bed (i.e., no erosion or deposition) will make it possible for the model to over-predict areas of grounding, as well as potentially over-predict current velocity magnitude. The release of the jam increases the flow velocity over a short period of time due to the release of water mass stored upstream of the jam toe.

A sensitivity analysis was performed to evaluate changes in model predictions resulting from changes in several model input parameters. The sensitivity analysis involves varying specific input parameters over a likely range of values and determining the impacts on model results. The parameters tested included: river discharge; ice supply volume from upstream sources; location of ice jam formation; downstream water level; and underside roughness (i.e., Manning's coefficient) of the ice cover and jam. The input parameters that have the largest impact on ice jam related scour are the ice supply volume and discharge. Discharge is the dominating factor for ice jam toe thickness, while ice supply is the dominating factor on the ice jam length and backwater stage. Large ice supply will lengthen the jam and increase the stage effect, but will generally not affect toe thickness once the ice volume exceeds that needed for the jam to reach its equilibrium thickness.

For the evaluation of potential ice control measures, the 2003 event -- which is the most severe event on record -- was considered the design event for this evaluation. In addition, six events with recurrence intervals of one in 100 years (i.e., sensitivity cases A through E) were examined to reflect the inherent year-to-year variations in ice supply volume and river discharge. Together, these seven cases were used to evaluate the performance of potential ice control measures under a range of extreme conditions.

5.0 References

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QUALITY ASSURANCE/QUALITY CONTROL REVIEW OF THE 2003/2004 GRASSE RIVER DATA

1.0 INTRODUCTION

This appendix describes the quality control evaluation conducted for the sediment, water, and resident fish data collected from the lower Grasse River in 2003 and 2004. Guidelines set forth in the *Phase I Sediment Sampling Plan for the Capping Pilot Study Area and Immediate Vicinity* (Alcoa, June 2003), *Phase II Grasse River Sampling Work Plan* (Alcoa, November 2003), *Supplemental Sediment Sampling Upstream of Transect T20 Work Plan* (Alcoa, January 2004), *2003 Monitoring Work Plan* (Alcoa, April 2003), and *2004 Monitoring Work Plan* (Alcoa, April 2004) were supplemented, where appropriate, with those discussed in the Quality Assurance Project Plan (QAPP) developed for the Grasse River project (Blasland, Bouck & Lee, Inc. [BBL], September 1993). These guidelines were established to assess whether field, laboratory, and data management activities were performed in a manner that is appropriate for accomplishing the project objectives.

The procedures and metrics used in the quality assurance/quality control (QA/QC) evaluation are presented in Section 2.0, while the results of the data evaluation are discussed in Section 3.0.

2.0 QA/QC PROCEDURES

The QA/QC procedures used to evaluate the data collected during 2003/2004 consisted of several steps, including:

- review of the field chain-of-custody (COC) forms and data received from the laboratory for completeness;

- automation of data compilation, when possible, to minimize errors within the database; and

- review of the QA/QC data to assure that results of the quality control analyses are within the control limits developed for the project.

Upon receipt of the data, the field COC forms were reviewed and compared to the data received from the laboratory to ensure that sample identifications listed on the COC forms matched those reported in the data packages. This process was used to check that results were reported for all field and QA/QC samples (such as matrix spike [MS] and matrix spike duplicates [MSD]).

Following this review, the data were compiled and entered into an Excel database. Most data from the laboratory were received electronically and appended to the existing database using tools available in Excel. Some of the QA/QC data were entered by hand from electronic copies of laboratory data summary packages.

After the data were incorporated into the project database, several metrics (as outlined in the QAPP) were evaluated to determine the quality of the sediment, water column, and resident fish data. Data metrics used in this evaluation included:

- overall data completeness;
- method detection limits (MDL);
- number of QA/QC samples collected and analyzed;
- blank analysis;
- MS and MSD analyses; and
- field duplicate analysis.

Data were deemed acceptable if the following criteria were satisfied:

- Overall data completeness equaled or exceeded 90 percent (%). Overall data completeness was computed by dividing the number of valid data obtained by the total number of data planned for collection and analyses.

- MDLs from the QAPP for total polychlorinated biphenyls (PCBs) quantified on an Aroclor basis in sediment, water, and biota samples were about 0.08 milligrams per kilogram (mg/kg), 65 nanograms per liter (ng/L), and 0.05 mg/kg, respectively. MDLs for total PCB congeners were not specified. The MDL for total suspended solids (TSS) in water was 1.0 milligram per liter (mg/L). A MDL for the analysis of total organic carbon (TOC) in sediment via the United States Environmental Protection Agency (USEPA) Lloyd Kahn method was not specified in the QAPP. The MDL reported by Northeast Analytical, Inc. (NEA) for this method was approximately 81 mg/kg.

- For sediment samples, a minimum of one blind duplicate and one MS/MSD pair were collected for every twenty field samples. Rinse blanks were collected at least once per week when field crews were using non-disposable equipment.

- For the routine water column samples, a minimum of one equipment rinse blank was collected before and after sampling. In addition, at least one duplicate sample and one MS/MSD pair were collected each round.

- For resident fish samples, a minimum of one MS/MSD pair was to be prepared by the laboratory for every twenty submitted field samples.

- PCB levels in laboratory, equipment (rinse), and method blanks were near or below the detection limit.

- Percent recoveries for MS/MSD samples analyzed for total PCBs were between 70 and 130% (to evaluate accuracy). Criteria for percent recoveries

for MS/MSD samples analyzed for lead-210 or cesium-137 were not established.

- The relative percent difference between MS and MSD samples analyzed for total PCBs were less than 35% (to evaluate precision). Criteria for relative percent differences between MS/MSD samples analyzed for lead-210 or cesium-137 were not specified.

- The relative percent difference between the field sample and its duplicate analyzed for TOC was less than 35%. Criteria for relative percent differences between field samples and their duplicates analyzed for total PCBs, lead-210, cesium-137, grain size, or TSS were not prescribed in the QAPP.

Data that did not comply with the guidelines outlined above are documented in Section 3.0.

3.0 RESULTS OF QA/QC ANALYSES

This section presents the results of the QA/QC analyses performed on the 2003/2004 data. A discussion of the sediment, water column, and resident fish data is provided below.

3.1 Sediment

The results of the QA/QC evaluation of the sediment data are provided below. Individual data that did not comply with the method guidelines and project requirements are listed in **Table 1**. Sediment results are separated by the following analysis types: PCBs, TOC, lead-210, cesium-137, and grain size.

3.1.1 PCBs (Congener)

Completeness. Sediment samples collected during Phase I field activities were analyzed for PCB congeners. Samples were collected at 66 (90%) of the planned 73 grab and core sample locations; samples could not be obtained at the other seven locations due to a lack of recoverable sediment in the target areas. No samples were lost during shipment or analysis.

Method detection limit. Since a MDL was not prescribed for PCB congeners, the MDL for Aroclors was used for comparison. The MDL for total PCB congeners was computed for each sample by multiplying the MDL reported for individual congeners by 221[1]. The computed MDLs for the 28 total PCB samples with reported concentrations below the MDL ranged from 0.06 to 0.14 mg/kg. Fifteen of these samples were analyzed using methods having detection limits that were at or below 0.08 mg/kg. Detection limits for the 13 samples[2] greater than 0.08 mg/kg were low, ranging between 0.09 and 0.14 mg/kg.

Number of QA/QC samples. Twenty-two field duplicates and 23 MS/MSD samples were collected and analyzed for PCBs as part of the Phase I field activities, which exceeded the requirements of 18 field duplicates and 18 MS/MSD pairs. Twenty-nine laboratory blanks and 29 laboratory spikes were also analyzed. No rinse blanks were collected because disposable sampling equipment was used during the survey.

Blanks. All laboratory blanks were below the MDL. No other blanks were analyzed.

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[1] The MDL for IUPAC numbers 1, 2, and 3 are five times higher than for other congeners; therefore, the MDL on a total PCB basis for all 209 congeners is equal to (206*MDL)+(3*5*MDL), or 221*MDL.

[2] The reported sediment detection limits are adjusted from the base PQL (0.05 mg/kg) by the sample dry weight and final dilution factors. Several samples had high percent moisture values and were subsequently diluted to bring the PCB concentration within the calibration range of the instrument.

Matrix spike and matrix spike duplicates. Six of the 23 MS samples and four of the 23 MSD samples had percent recoveries outside of the prescribed limits of 70 to 130%. Percent recoveries below the lower limit ranged from 35 to 60%. Percent recoveries above the upper limit ranged from 131 to 316% (see **Table 1**). The percent recoveries for one MS/MSD pair (1B1-11 [0 to 3 inches]) were not available because the field sample contained a high PCB concentration that required the spiked samples to be diluted for proper PCB quantification. Precision was lost in the quantification of the diluted spike since its concentration was much lower than the actual sample concentration. The relative percent differences between six of the 23 pairs of MS/MSD were greater than 35%; they ranged from 41 to 146% (see **Table 1**).

MS and/or MSD samples whose percent recoveries were below 70% or above 130% and their parent sample are qualified as estimated ("J") in the data table sediment_bz. Although the recoveries for the MS/MSD samples fall outside the requirement, results from their parent samples are still useable since other laboratory controls (such as surrogate spikes and laboratory control spikes) indicate that the inability to recover these matrix spikes accurately is likely associated with the sample matrix.

Field duplicates. The relative percent differences between the 22 field samples and corresponding duplicates ranged from 37 to 110%. A criterion for relative percent difference between samples and their duplicates analyzed for total PCBs was not prescribed for this project.

3.1.2 PCBs (Aroclor)

Completeness. Sediment samples collected during the 2003 Phase II, January 2004, and 2004 Focused Studies field activities were analyzed for PCBs on an Aroclor basis. Samples were collected at 179 (81%) of the planned 222 grab and core locations during the 2003 Phase II and January 2004 activities. Samples

could not be obtained at 43 locations due to a lack of recoverable sediment in the target areas. The inability to meet the completeness criteria of 90% does not affect the usability of data that were collected because the field conditions were not controllable. Bank samples were collected at all 24 planned transects. No sediment samples were lost during shipment or analysis.

Samples were collected at 100% of the 30 planned core locations during the 2004 Focused Studies activities.

Method detection limit. Seventy-five of the 2003 Phase II and January 2004 sediment samples had PCB levels that were reported below the detection limit. Forty-nine of these samples were analyzed at a detection limit at or below 0.08 mg/kg. Detection limits for the 26 samples[3] that did not conform to the prescribed detection limit were low, ranging between 0.09 and 0.12 mg/kg, and, therefore, do no warrant exclusion from the database. It should be noted that samples were reported as non-detect by the laboratory if their concentrations were less than the practical quantitation limit (PQL).

One hundred five of the 2004 Focused Studies sediment samples had PCB levels that were reported below the detection limit. Sixty-five of these samples were analyzed at a detection limit at or below 0.08 mg/kg. Detection limits[3] for the 40 samples that did not conform to the prescribed detection limit were low, ranging between 0.080 and 0.154 mg/kg, and, therefore, do no warrant exclusion from the database. It should be noted that samples were reported as non-detect by the laboratory if their concentrations were less than the PQL.

Number of QA/QC samples. During the 2003 Phase II sampling activities, 30 field duplicates and 30 MS/MSD pairs were required for PCB analysis and 30 field

[3] The reported sediment detection limits are adjusted from the base PQL (0.05 mg/kg) by the sample dry weight and final dilution factors. Several samples had high percent moisture values and were subsequently diluted to bring the PCB concentration within the calibration range of the instrument.

duplicates for TOC analysis. The number of QA/QC samples collected, analyzed, and reported by the laboratory did not meet these requirements; 26 field duplicates, 27 MS, and 26 MSD were analyzed for PCBs and 26 field duplicates were analyzed for TOC. Since the method used for PCB analysis states that duplicate samples with detectable organics may be appropriate in place of MSD samples, a sufficient number of MSD samples was analyzed according to the standard operating procedure (NEA, April 2002). Therefore, the omission of three MS and four MSD samples does not affect the usability of the data.

During the January 2004 sampling activities, 10 field duplicates and 10 MS/MSD pairs for PCB analysis and 10 field duplicates for TOC analysis were required. The number of QA/QC samples analyzed met or exceeded these requirements.

Two rinse blanks were collected during bank sediment sampling. In addition, 74 method blanks and 74 laboratory control spikes were analyzed for PCBs.

During the 2004 Focused Studies sampling activities, 21 field duplicates and 21 MS/MSD pairs were required for PCB analysis. The number of QA/QC samples collected, analyzed, and reported by the laboratory exceeded these requirements; 26 field duplicates, 26 MS, and 25 MSD were analyzed for PCBs. The MSD for location NST10-S was not reported due to insufficient material after re-extraction.

Blanks. Seventy-four of the 75 2003 Phase II and January 2004 sediment method blanks contained non-detectable levels of PCBs. The total PCB concentration in the one sample above the detection limit was 0.36 mg/kg. The two rinse blanks collected during the sampling program did not contain detectable levels of PCBs or TOC.

All of the 35 Focused Studies sediment method blanks contained non-detectable levels of PCBs.

Matrix spike and matrix spike duplicates. Percent recoveries for seven of the 38 MS and four of the 37 MSD samples collected as part of 2003 Phase II and January 2004 activities were outside of the prescribed limits (see **Table 1**). Percent recoveries below the lower limit (i.e., 70%) ranged from 39 to 67%; percent recoveries above the upper limit (i.e., 130%) ranged from 132 to 181%. Six pairs of MS/MSD samples had greater than 35% relative percent difference (see **Table 1**). The relative percent differences of these pairs ranged from 41 to 95%.

Percent recoveries for four of the 25 MS and one of the 25 MSD samples collected as part of the 2004 Focused Studies were outside of the prescribed limits (see **Table 1**). Percent recoveries below the lower limit (i.e., 70%) ranged from 27% to 67%; the percent recovery above the upper limit (i.e., 130%) was 138%. Three pairs of MS/MSD samples had greater than 35% relative percent difference (see **Table 1**). The relative percent differences of these ranged from 63% to 118%

MS and/or MSD samples whose percent recoveries were below 70% or above 130% and their parent sample are qualified as estimated ("J") in the data table sediment_aro. Although the recoveries for the MS/MSD samples fall outside the requirement, results from their parent samples are still useable since other laboratory controls (such as surrogate spikes and laboratory control spikes) indicate that the inability to recover these matrix spikes accurately is likely associated with the sample matrix.

Field duplicates. The relative percent differences between the 36 field samples and corresponding duplicates collected as part of the 2003 Phase II and January 2004 activities ranged from 36 to 200%. A criterion for relative percent difference between samples and their duplicates analyzed for total PCBs was not prescribed for this project.

The relative percent differences between the 26 field samples and corresponding duplicates collected as part of the 2004 Focused Studies ranged from 4% to 200%. A criterion for relative percent difference between samples and their duplicates analyzed for total PCBs was not prescribed for this project.

3.1.3 Total Organic Carbon

Completeness. In addition to analysis for total PCBs, sediment samples collected during the 2003 Phase I, 2003 Phase II, January 2004, and 2004 Focused Studies field activities were analyzed for TOC. No samples were lost during shipment or analysis. A total of 1,617 field samples were analyzed for TOC.

Method detection limit. The detection limit for the eight 2003 Phase II and January 2004 samples with TOC results reported as non-detect ranged from 330 to 634 mg/kg, exceeding the MDL for TOC of 81 mg/kg for the USEPA Lloyd Kahn method. It should be noted that samples were reported as non-detect by the laboratory if their concentrations were less than the PQL.

All TOC samples collected as part of the Focused Studies were reported above the PQL.

Number of QA/QC samples. The collection and analysis of 24, 30, and 10 field duplicates for TOC were required during the 2003 Phase I, 2003 Phase II, and January 2004 field activities, respectively. Twenty-nine, 26, and 10 field duplicates were collected for each survey, respectively.

The collection and analysis of 26 Focused Studies field duplicates for TOC exceeded the requirement of 21 duplicates.

Blanks. This criterion is not applicable.

Matrix spike and matrix spike duplicates. This criterion is not applicable.

Field duplicates. Thirty-eight of 65 field duplicates collected as part of 2003 Phase II and January 2004 activities had relative percent differences within prescribed limits. The relative percent difference between the 27 field samples and corresponding duplicates not meeting this requirement ranged from 38 to 197% (see **Table 1**).

Twenty of 26 field duplicates collected as part of the 2004 Focused Studies had relative percent differences within prescribed limits. The relative percent difference between the six field samples and corresponding duplicates not meeting this requirement ranged from 38% to 122% (see **Table 1**). Given the inherent variability (historic range of non-detect to over 300,000 mg/kg) in TOC levels in the Grasse River and the small amount (i.e., milligrams) of sediment used for TOC analysis, difficulty reproducing TOC results is expected and, thus, does not warrant exclusion of these data.

3.1.4 Lead-210

Completeness. As planned, segments from three cores were collected and analyzed for lead-210 during the 2003 Phase I field activities. No sediment samples were lost during shipment or analysis.

Method detection limit. The detection limit for lead-210 ranged from 0.13 to 0.37 picoCurie per gram [pCi/g] dry weight. No detection limit for lead-210 was prescribed for this project.

Number of QA/QC samples. The number of QA/QC samples collected met the requirements of three duplicates and three MS/MSD pairs. No rinse blanks were collected during sediment sampling since disposable equipment was used during

the survey. In addition, three soil spikes and three water blanks were analyzed for lead-210.

Blanks. Lead-210 levels in all three water blanks were below the detection limit.

Matrix spike and matrix spike duplicates. Percent recoveries for MS/MSD samples analyzed for lead-210 ranged from 94 to 113%. Criteria for percent recoveries for MS/MSD samples were not prescribed for this project.

Field duplicates. The relative percent difference between the three pairs of samples and their duplicates ranged from 8 to 26%. A criterion for relative percent difference between samples and their duplicates analyzed for lead-210 was not specified in the QAPP.

3.1.5 Cesium-137

Completeness. As planned, segments from five cores were collected and analyzed for cesium-137 during the 2003 Phase II sampling. No sediment samples were lost during shipment or analysis.

Method detection limit. The detection limit for cesium-137 ranged from 0.02 to 0.06 pCi/g dry weight. No detection limit for cesium-137 was prescribed for this project.

Number of QA/QC samples. The appropriate numbers (five field duplicates and five MS/MSD pairs) of QA/QC samples were collected and analyzed. No rinse blanks were collected during sediment sampling because disposable equipment was used. In addition, three laboratory control samples were analyzed.

Blanks. This criterion is not applicable.

Matrix spike and matrix spike duplicates. Percent recoveries for MS/MSD samples analyzed for cesium-137 ranged from 91 to 106%. Criteria for percent recoveries for MS/MSD samples were not established in the QAPP.

Field duplicates. The relative percent difference between the five pairs of samples and their duplicates ranged from 3 to 9%. A criterion for relative percent difference between samples and their duplicates analyzed for cesium-137 was not specified in the QAPP.

3.1.6 Grain Size

Completeness. During the 2003 Phase I, 2003 Phase II, and January 2004 field activities, sediment samples were collected from 265 locations and analyzed for grain size. No samples were lost during shipment or analysis. Results were not able to be obtained for 19 samples for several reasons: 11 contained only wood chips (segments from T7-M, T22-S, T26-N, T28-M, T29-S, and T30-S); one sample did not have enough material for sieve analysis (NST31-S, 3 to 12 inches); one sample did not contain enough material for sieve and hydrometer analyses (T29-S, 3 to 6 inches); and six were reported has having insufficient sample size or debris (segments from T6.5-S2, T7.5-S2, T9-N2, and T19-S2). Sediments could not be collected at 51 additional locations due to lack of recoverable sediment.

During the 2004 Focused Studies field activities, sediment samples were collected from 20 locations and analyzed for grain size. No samples were lost during shipment or analysis.

Method detection limit. This criterion is not applicable.

Number of QA/QC samples. During the 2003 Phase II/January 2004 and 2004 Focused activities, ten and eight field duplicate samples, respectively, were collected and analyzed for grain size, which met the requirement.

Blanks. This criterion is not applicable.

Matrix spike and matrix spike duplicates. This criterion is not applicable.

Field duplicates. A criterion for relative percent difference between grain size results for samples and their duplicates was not specified in the QAPP.

3.2 Water Column

QA/QC samples were inadvertently not collected during the monitoring of TSS during the spring high flow/ice breakup (one duplicate TSS sample per 20 field samples during a mobilization or a minimum of one per mobilization). This subsection reports the assessment of QA/QC data collected during the routine water monitoring program.

Completeness. Samples (one bottle for PCB analysis and one bottle for TSS analysis at each sampling transect) were collected as planned for all seven transects during the 13 rounds of routine monitoring in 2003 and the 15 rounds of routine monitoring in 2004. The samples collected at WCMSB during Round 1 (2003) were inadvertently not analyzed for PCBs or TSS. During Round 3 (2003) at WCT11 (0.8 times total water column depth), the sample bottle designated for PCB analysis was broken during transport to the laboratory and, therefore, was not analyzed.

Method detection limit. Since a MDL was not prescribed for PCB congeners, the MDL for Aroclors was used for comparison. The lower bound estimate of the nominal MDL for routine monitoring water samples was about 27.8 ng/L for total PCBs (Alcoa, April 2002), below the QAPP requirement of 65 ng/L.

The MDL for TSS met the requirement of 1.0 mg/L.

Number of QA/QC samples. The number of 2003 field duplicates and MS/MSD samples exceeded the requirement of six each. The number of rinse blanks met the requirement of 26. Additional QA/QC samples for PCBs included 12 laboratory blanks and 13 laboratory control spikes. The requirement of one field duplicate per month for TSS analysis was fulfilled.

The number of 2004 field duplicates met the requirement of one per round (15). The number of MS/MSD pairs met the requirement one per round with the exception of Round 1 when there was insufficient sample volume for MSD analysis. The number of rinse blanks met the requirement of 30. Additional QA/QC samples for PCBs included 15 laboratory blanks and 15 laboratory control spikes. The requirement of one field duplicate per month for TSS analysis was fulfilled

Blanks. All 2003 blank concentrations were below the nominal detection limit. Reported PCB levels in rinse blanks ranged from 0.0 to 4.5 ng/L. Laboratory blank concentrations ranged from 0.0 to 0.7 ng/L.

All 2004 blank concentrations were near or below the nominal detection limit. Reported PCB levels in rinse blanks ranged from 0.0 to 11.1 ng/L, with one exception at 29.1 ng/L. Laboratory blank concentrations ranged from 0.0 to 3.1 ng/L, with one exception at 14.5 ng/L.

Matrix spike and matrix spike duplicates. All 2003 13 MS/MSD pairs were within prescribed percent recoveries and relative percent differences.

In 2004, one of the 14 MS/MSD pairs was not within the prescribed relative percent differences; it had a RPD of 44.1% (see **Table 1**). The percent recovery for the same MSD was not within the acceptable limits; it had 52% recovery (see **Table 1**).

Field duplicates. In 2003, the relative percent difference between the five pairs of samples and their duplicates analyzed for total PCBs and for TSS ranged from 4 to 156% and 0 to 46%, respectively. In 2004, the relative percent difference between the fifteen pairs of samples and their duplicates analyzed for total PCBs and for TSS ranged from 3% to 182% and 0% to 71%, respectively. Criteria for the relative percent differences between samples and their duplicates analyzed for total PCBs and for TSS were not defined in the QAPP.

3.3 Resident Fish

Completeness. Due to the scarcity of target fish encountered during 2003 sample collection, fewer samples were collected than planned (96 of 156 or 62%). The following provides a summary of incomplete samples sets by species:

- smallmouth bass: 36 of 73 (49%);
- brown bullhead: 48 of 59 (81%); and
- adult spottail shiner: 0 of 12 (0%)

No samples were lost during shipment or analysis. The inability to meet the completeness criteria of 90% does not affect the usability of data that were collected because the field conditions were not controllable.

Also, in 2004, fewer samples were collected than planned (141 of 156 or 90%) due to the scarcity of target fish encountered during sample collection. The following provides a summary of incomplete samples sets by species:

- smallmouth bass: 73 of 73 (100%);
- brown bullhead: 59 of 59 (100%);
- adult spottail shiner: 0 of 12 (0%); and
- YOY spottail shiner: 9 of 12 (75%).

No samples were lost during shipment or analysis.

Method detection limit. The detection limits for total PCBs in 2003 and 2004 field samples were about 0.05 mg/kg wet weight, as specified in the QAPP. It should be noted that samples were reported as non-detect by the laboratory if their concentrations were less than the PQL.

Number of QA/QC samples. Five MS/MSD pairs were required in 2003, results for four pairs were reported by the laboratory. Since MS/MSD samples were selected and prepared from portions of field samples by the laboratory personnel as deemed necessary, the omission of one QA/QC pair does not affect the usability of the data. In addition, seven method blanks and seven laboratory control spikes were included for analysis.

In 2004, seven MS/MSD pairs were required; only five pairs were extracted, analyzed, and reported by the laboratory. In addition, nine method blanks and nine laboratory control spikes were included for analysis.

Blanks. All 2003 and 2004 method blanks contained non-detectable PCB levels.

Matrix spike and matrix spike duplicates. All MS/MSD sample pairs had relative percent differences within prescribed limits. Two of the 2004 MS percent recoveries fell outside the prescribed limits at 136% and 138% (see **Table 1**).

Field duplicates. The collection of field duplicates was not performed as part of the resident fish sampling program.

4.0 SUMMARY

In general, the quality of the data for sediment, water column, and resident fish samples collected during 2003/2004 met the guidelines established for the project. On the infrequent occasions when guidelines were not met, the affected samples are

identified in the database as appropriate. As a result of the QA/QC evaluation, all data that were collected were deemed appropriate for use in performing qualitative and quantitative evaluations required to satisfy the project objectives.

5.0 REFERENCES

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GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

Table 1
2003-2004 Routine Monitoring and Focused Studies Data
Individual Samples Not Meeting QA/QC Guidelines

Media	Analyte	Sampling Program	Sample Date	Location (depth)	Field Sample	Field Duplicate	% Recovery		Relative % Difference		Reason for Non-Compliance
							MS	MSD	Field Duplicate	MS/MSD	
Sediment	PCB (Congener)	Phase I	6/19/03	1B1-11 (0-3")	---	---	***N/A*** [9]	***N/A*** [9]	---	---	MS and MSD not available
			6/19/03	PC4-23 (0-3")	---	---	75.1	***131.0***	---	***54.2***	MSD falls outside %R limit; falls outside MS/MSD % RPD limit
			6/24/03	1A-17 (56-62")	---	---	***34.6***	***221.0***	---	***145.9***	MS and MSD fall outside %R limit; falls outside MS/MSD % RPD limit
			6/24/03	NST18-N (12-18")	---	---	***59.6***	104.0	---	***54.3***	MS falls outside %R limit; falls outside MS/MSD % RPD limit
			6/24/03	NST18-S (12-18")	---	---	***210.0***	107.0	---	***65.0***	MS falls outside %R limit; falls outside MS/MSD % RPD limit
			6/25/03	T20-M (49-50cm)	---	---	***52.1***	***49.7***	---	4.7	MS and MSD fall outside %R limit
			7/1/03	T18-M (39-40cm)	---	---	***209.0***	***316.0***	---	***40.8***	MS and MSD fall outside %R limit; falls outside MS/MSD % RPD limit
			7/1/03	T19-M (49-50cm)	---	---	***45.1***	78.2	---	***53.7***	MS falls outside %R limit; falls outside MS/MSD % RPD limit
	PCB (Aroclor)	Phase II	10/9/03	NST41-S (12-24")	---	---	110.0	***N/A***	---	---	MSD not available
			10/10/03	T37-SSS (24-36")	---	---	***133.0***	***140.0***	---	5.1	MS and MSD fall outside %R limit
			10/14/03	T7-M (9-10cm)	---	---	76.5	123.0	---	***46.6***	Falls outside MS/MSD %RPD limit
			10/14/03	T7-M (109-110cm)	---	---	***181.0***	119.0	---	***41.3***	MS falls outside %R limit; falls outside MS/MSD % RPD limit
			10/14/03	T7-M (134-135cm)	---	---	106.0	***38.6***	---	***93.2***	MSD falls outside %R limit; falls outside MS/MSD % RPD limit
			10/28/03	T24-N (4-5cm)	---	---	***65.7***	71.3	---	8.1	MS falls outside %R limit
			10/28/03	T28-M (59-60cm)	---	---	***51.7***	***143.0***	---	***93.8***	MS and MSD fall outside %R limit; falls outside MS/MSD % RPD limit
			10/29/03	T68-M (39-40cm)	---	---	***133.0***	129.0	---	3.1	MS falls outside %R limit
			11/5/03	T46-N (0-3")	---	---	124.0	***132.0***	---	6.3	MSD falls outside %R limit
			11/11/03	T35-N (39-40cm)	---	---	***38.8***	109.0	---	***95.0***	MS falls outside %R limit; falls outside MS/MSD % RPD limit
		January 2004	1/21/04	T6.5-S2 (54-60")	---	---	***66.5***	115.0	---	***53.4***	MS falls outside %R limit; falls outside MS/MSD % RPD limit
		Focused	5/27/04	T37-NB (6-12in)	---	---	***49.30***	94.60	---	***63.00***	MS falls outside %R limit; MS/MSD fall outside %RPD limit
			9/13/04	NST10-N (54-55cm)	---	---	***66.80***	78.80	---	16.50	MS falls outside %R limit
			9/13/04	NST10-S (9-10cm)	---	---	117.00	***N/A***	---	***N/A***	No MSD reported by the lab due to insufficient material after re-extraction
			9/14/04	NST54-S (19-20cm)	---	---	***35.60***	***138.00***	---	***118.00***	MS and MSD fall outside %R limit; MS/MSD fall outside %RPD limit
			9/15/04	NST26-S (14-15cm)	---	---	***27.30***	87.70	---	***105.00***	MS falls outside %R limit; MS/MSD fall outside %RPD limit
	TOC	Phase I	6/19/03	1A-35 (0-3")	2770	8110	---	---	***98.2***	---	Field duplicate falls outside %RPD limit
			6/19/03	PC4-11 (0-3")	6160	2980	---	---	***69.6***	---	Field duplicate falls outside %RPD limit
			6/23/03	PC4-SS (6-12")	429 10	8240	---	---	***180.2***	---	Field duplicate falls outside %RPD limit
			6/24/03	1A-17 (36-48")	3600	5400	---	---	***40.0***	---	Field duplicate falls outside %RPD limit
			6/24/03	PC2-SS (6-12")	490 10	3700	---	---	***153.2***	---	Field duplicate falls outside %RPD limit
			6/24/03	NST18-S (6-12")	3600	7800	---	---	***73.7***	---	Field duplicate falls outside %RPD limit
			6/25/03	T20-M (44-45cm)	34000	20000	---	---	***51.9***	---	Field duplicate falls outside %RPD limit
			6/26/03	T18-N (14-15cm)	4300	2400	---	---	***56.7***	---	Field duplicate falls outside %RPD limit
			6/26/03	T18-N (24-25cm)	20000	43000	---	---	***73.0***	---	Field duplicate falls outside %RPD limit
			6/26/03	T19-N (2-3cm)	22000	15000	---	---	***37.8***	---	Field duplicate falls outside %RPD limit
			6/30/03	T17-N (2-3cm)	36000	19000	---	---	***61.8***	---	Field duplicate falls outside %RPD limit
			6/30/03	T17-M (19-20cm)	350 10	40000	---	---	***196.5***	---	Field duplicate falls outside %RPD limit
			6/30/03	T17-N (24-25cm)	17000	11000	---	---	***42.9***	---	Field duplicate falls outside %RPD limit
			6/30/03	T17-M (34-35cm)	37000	7500	---	---	***132.6***	---	Field duplicate falls outside %RPD limit
			6/30/03	T17-M (39-40cm)	26000	16000	---	---	***47.6***	---	Field duplicate falls outside %RPD limit
			7/1/03	T18-M (29-30cm)	3400	28000	---	---	***156.7***	---	Field duplicate falls outside %RPD limit
			7/1/03	T18-M (44-45cm)	39000	170000	---	---	***125.4***	---	Field duplicate falls outside %RPD limit
			7/1/03	T19-M (44-45cm)	42000	27000	---	---	***43.5***	---	Field duplicate falls outside %RPD limit
			7/1/03	T20-N (3-4cm)	16000	27000	---	---	***51.2***	---	Field duplicate falls outside %RPD limit
			7/1/03	T21-S (9-10cm)	20000	47000	---	---	***80.6***	---	Field duplicate falls outside %RPD limit

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

Table 1
2003-2004 Routine Monitoring and Focused Studies Data
Individual Samples Not Meeting QA/QC Guidelines

Media	Analyte	Sampling Program	Sample Date	Location (depth)	Field Sample	Field Duplicate	% Recovery		Relative % Difference		Reason for Non-Compliance
							MS	MSD	Field Duplicate	MS/MSD	
Sediment (continued)	TOC	Phase II	9/24/03	T9-N (0-3")	3600	2200	---	---	***48.3***	---	Field duplicate falls outside %RPD limit
			9/25/03	T13-N (0-3")	1200	2500	---	---	***70.3***	---	Field duplicate falls outside %RPD limit
			10/6/03	T5-N (12-24")	4100	1300	---	---	***103.7***	---	Field duplicate falls outside %RPD limit
			10/14/03	T7-M (7-8cm)	7900	5200	---	---	***41.2***	---	Field duplicate falls outside %RPD limit
			10/22/03	T10-M (24-25cm)	7100	11000	---	---	***43.1***	---	Field duplicate falls outside %RPD limit
			11/10/03	T55-M (14-15cm)	7900	840	---	---	***161.6***	---	Field duplicate falls outside %RPD limit
		January 2004	1/20/04	T8-N2 (3-12")	7000	17000	---	---	***83.3***	---	Field duplicate falls outside %RPD limit
		Focused	9/13/04	NST10-N (0-1cm)	14000	3400	---	---	***121.84***	---	Field duplicate falls outside %RPD limit
			9/14/04	NST26-N (14-15cm)	6100	21000	---	---	***109.96***	---	Field duplicate falls outside %RPD limit
			9/14/04	NST54-N (6-7cm)	23000	14000	---	---	***48.65***	---	Field duplicate falls outside %RPD limit
			9/14/04	NST54-N (34-35cm)	3000	1600	---	---	***60.87***	---	Field duplicate falls outside %RPD limit
			9/15/04	NST48-N (9-10cm)	14000	8200	---	---	***52.25***	---	Field duplicate falls outside %RPD limit
			9/15/04	NST26-S (14-15cm)	1700	2500	---	---	***38.10***	---	Field duplicate falls outside %RPD limit
Water	PCB (Congener)	SRS	4/5/04	WC-T11(0.2)	---	---	94.4	***N/A***	---	***N/A***	No MSD reported by the lab
			9/20/04	WC-007(0.2)	16.80	---	81.60	***52.10***	---	***44.10***	MSD falls outside %R limit, MS/MSD falls outside %RPD
Resident Fish	PCB (Aroclor)	TMS	9/1/04	Lower/ Sm Mouth Bass	0.79	---	***136.00***	127.00	---	5.40	MS falls outside %R limits
			9/2/04	Back/ Sm Mouth Bass	-0.05[10]	---	***138.00***	124.00	---	7.10	MS falls outside %R limits

Notes:
1. Units:
   Sediment: PCB (mg/kg dry); TOC (mg/kg)
   Water: PCB (ng/L)
   Fish: PCB (mg/kg wet)
2. MS - matrix spike; MSD - matrix spike duplicate; %R - Percent Recovery; PCB - polychlorinated biphenyl, TOC - total organic carbon, cm - centimeters, mm - millimeters, in - inches, TSS - total suspended solids
3. Criteria listed in QAPP (BBL, September 1993): MS/MSD %R should be between 70 and 130%, %RPD should be less than 35%, Surrogate %R should be between 60 and 150%.
4. Bold and italicized numbers indicate where samples did not meet criteria.
5. %RPD of MS/MSD sample based on percent recoveries.
6. %RPD of field duplicate sample based on sample concentrations.
7. %RPD = |(A-B)| / ((A+B)/2) * 100
8. --- Not applicable; N/A not available.
9. MS and MSD percent recoveries not available. Because the actual sample contained a high PCB concentration, the spiked sample needed to be diluted for proper PCB quantification. Precision was lost in the quantification of the diluted spike since its concentration was much lower than the actual sample concentration.
10. Result is listed at negative of the detection limit; where applicable, the %RPD is computed using the detection limit.

2004 Monitoring Work Plan

Grasse River Study Area
Massena, NY

Alcoa Inc.
Massena, New York

April 2004

Table of Contents

Section 1. Introduction.....1-1

Section 2. Continuation of 2003 Phase II Field Activities.....2-1

2.1 Introduction.....2-1
2.2 Collection of Upstream River and Floodplain Cross Sections.....2-1
2.2.1 Objective.....2-1
2.2.2 Survey Locations and Protocol.....2-1

Section 3. 2004 SRS Program.....3-1

3.1 Introduction.....3-1
3.2 Routine Water Column Monitoring.....3-1
3.2.1 Objective.....3-1
3.2.2 Sampling Locations.....3-1
3.2.3 Protocol.....3-2
3.2.4 Analyses.....3-2
3.2.5 QA/QC Samples.....3-2
3.3 Resident Fish Monitoring.....3-2
3.3.1 Objective.....3-2
3.3.2 Sampling Locations.....3-2
3.3.3 Protocol.....3-3
3.3.4 Analyses.....3-3
3.3.5 QA/QC Samples.....3-3

Section 4. 2004 Focused Studies.....4-1

4.1 Introduction.....4-1
4.2 Sediment Core Collection.....4-1
4.2.1 Objective.....4-1
4.2.2 Sampling Locations.....4-1
4.2.3 Protocol.....4-2
4.2.4 Analyses.....4-2
4.2.5 QA/QC Samples.....4-2
4.3 Sediment Probing.....4-2
4.3.1 Objective.....4-2
4.3.2 Probing Locations.....4-3
4.3.3 Protocol.....4-3
4.4 TSS Monitoring During Spring High Flow/Ice Breakup.....4-3
4.4.1 Objective.....4-3
4.4.2 Sampling Locations.....4-3
4.4.3 Protocol.....4-4
4.4.4 Analyses.....4-4
4.4.5 QA/QC Samples.....4-4

References

Figures

Figure 1-1	Grasse River Study Area – Location Map
Figure 1-2	Grasse River 2004 Monitoring Program Schedule
Figure 2-1 through 2-2	Upstream Cross Section Locations
Figure 3-1	2004 SRS Program - Water Column Monitoring Locations
Figure 3-2	2004 SRS Program - Resident Fish Monitoring Locations
Figure 4-1 through 4-7	2004 Focused Studies Sediment Core Collection and Probing Locations
Figure 4-8	2004 Focused Studies TSS Sample Locations

Appendices

Appendix A	Water Column Sampling and Flow Measurement Procedures
Appendix B	Field Sample Packing, Handling, and Shipping Procedures
Appendix C	Resident Fish Sampling Procedures
Appendix D	Sediment Sampling Procedures

1. Introduction

This document describes the field sampling activities that Alcoa Inc. (Alcoa) will perform in 2004 within the Grasse River Study Area (Study Area) located in Massena, New York (NY). These field activities include: sampling and monitoring to complete the activities prescribed in the 2003 *Phase II Grasse River Sampling Work Plan* (Alcoa, November 2003); routine annual monitoring, including the Supplemental Remedial Studies (SRS) and the river ice monitoring programs; and additional focused studies intended to evaluate specific lower river characteristics.

The Study Area is located along the northern boundary of NY State in the town and village of Massena, and encompasses approximately 8.5 miles of the Grasse River. The Study Area stretch of the river extends from Massena (just downstream of the Route 37 Bridge) to the St. Lawrence River confluence (Figure 1-1). The Study Area also includes Robinson Creek (which discharges to the St. Lawrence River) and the Massena Power Canal (which extends from the Massena Intake Dam located on the St. Lawrence River to the former Massena Power Dam). Monitoring and sampling activities will be performed throughout the Study Area (except Robinson Creek). It should be noted that a portion of the continuation of the 2003 Phase II field activities and river ice monitoring activities will be conducted upstream of the Study Area boundary.

The field sampling activities that Alcoa will conduct during the 2004 field sampling season are outlined below.

- Continuation of the 2003 Phase II Field Activities
    - Collection of upstream river and floodplain cross section information

- 2004 SRS Program
    - Routine water column monitoring
    - Resident fish trend monitoring

- 2004 Focused Studies
    - Sediment sampling
    - Sediment probing
    - Total suspended solids (TSS) monitoring

Also, for the purposes of completeness, it should be noted that two additional programs have already been completed within the Study Area in 2004: supplemental sediment sampling upstream of sediment probing Transect 20 (T20); and monitoring of river ice formation and breakup. The activities associated with these programs are summarized below. Details regarding each program were provided in *Sediment Sampling Upstream of Transect T20* (Alcoa, January 2004) and *2003/2004 Grasse River Ice Monitoring Work Plan* (Alcoa, December 2003), respectively, and will therefore not be discussed further in this document.

- Sediment Sampling Upstream of T20
    - This program was conducted in January 2004 and consisted of the collection of 20 sediment cores from two fine sediment deposits located upstream of T20. Core samples were submitted for polychlorinated biphenyl (PCB), total organic carbon (TOC), bulk density, percent moisture, percent solids and grain size analyses. Details regarding the specific collection locations and sampling methodology are described in the aforementioned work plan.

2004 River Ice Monitoring

- This program was initiated in January 2004 and completed in March 2004 and consisted of several tasks including:
  - Monitoring/recording of climatological conditions;
  - River stage monitoring;
  - Monitoring of river ice cover extent, type, and thickness during the formation and mid-winter periods;
  - River ice cover and thickness monitoring during ice breakup; and
  - Documentation of 2003/2004 river ice conditions.
- Results of the river ice monitoring will be documented in a report following the spring 2004 ice melt/breakup in the river.

The objectives, sampling locations, protocol, analyses, and quality assurance/quality control (QA/QC) measures associated with the continuation of 2003 Phase II Field Activities, 2004 SRS Program, and 2004 Focused Studies are described in Sections 2 through 4, respectively. An overview of the schedule for the 2004 monitoring activities is presented on Figure 1-2; details on the timing of specific activities are provided throughout each section.

As results become available for each program, Alcoa will present this information to the Agencies (collectively the United States Environmental Protection Agency [USEPA], New York State Department of Environmental Conservation [NYSDEC], and the St. Regis Mohawk Tribe [SRMT]) at one or more technical meetings. An annual summary report documenting the sampling results will be submitted to the Agencies in early 2005.

2. Continuation of 2003 Phase II Field Activities

2.1 Introduction

The 2003 Phase II Field Activities were performed from September to December 2003. The activities conducted as part of the 2003 Phase II Field Activities are described in the *Phase II Grasse River Sampling Work Plan* (Alcoa, November 2003) and included installation of a United States Geological Survey (USGS) gaging station, collection of upstream river and floodplain cross sections, underwater survey/bathymetry work, sediment sample collection, sampling of bank soils, and additional tree scar survey work. All activities specified under this work plan were completed prior to demobilizing in December 2003, except for collection of the upstream river and floodplain cross sections. It was intended that the cross section information be gathered in 2003, however, due to the onset of winter weather conditions, this information was not collected in 2003 and will instead be performed in 2004 as described below.

2.2 Collection of Upstream River and Floodplain Cross Sections

The collection of the upstream river and floodplain cross section information was originally described in the *Phase II Grasse River Sampling Work Plan* (Alcoa, November 2003), and is provided herein for purposes of convenience. River and floodplain cross sections will be generated using survey data to be collected in the upstream portion of the Grasse River between Louisville and Massena.

2.2.1 Objective

River and floodplain cross section information will be obtained upstream of the Study Area to provide river geometry data needed to support the design of an ice control structure in this part of the river.

2.2.2 Survey Locations and Protocol

A total of 13 transects extending from just downstream of Louisville Road to just downstream of NY State Route 37 will be surveyed to develop the cross sectional profiles for these locations (see Figures 2-1 and 2-2). Prior to performing work in the floodplain portions of each transect, access agreements must be secured with each property owner. If access is not granted along a particular transect, the cross section information will not be obtained in the floodplain portion of that transect. Collection of the cross section information will be performed in the spring, once river conditions permit safe work conditions, and access agreements have been obtained.

Elevation data, water depth, and sediment depth information (where applicable) will be collected in the river and floodplain extending to an elevation of approximately 210 feet mean sea level (MSL). The spacing of survey points along each transect will vary. Where the topography is more variable, survey information will be recorded at approximately 10-foot spacing; where the topography is less variable (e.g., floodplain areas), survey points will be spaced further apart (e.g., 50- to 100-foot intervals). Locations along each transect will be surveyed using the differential global positioning system (DGPS).

3. 2004 SRS Program

3.1 Introduction

The SRS Program was initiated by Alcoa in 1995 to obtain site-specific information through continued field sampling of PCBs and other parameters (e.g., river velocity, water temperature, conductivity, dissolved oxygen [DO], pH, turbidity, and suspended solids) in the Study Area. The components of the 2004 SRS Program include:

- Routine water column monitoring; and
- Resident fish trend monitoring.

Details regarding each monitoring component are provided below.

3.2 Routine Water Column Monitoring

3.2.1 Objective

Routine water column monitoring will be performed biweekly, once river conditions safely permit (i.e., following ice breakup in early April), through October 2004. Data obtained from routine water column sampling will be used to continue monitoring PCB concentrations in the water column and documenting variations associated with location, season, flow, temperature, biological activity, and other variables.

3.2.2 Sampling Locations

Water column samples will be collected biweekly from seven locations: Main Street Bridge in Massena (WCMSB); sediment probing Transect T11 (WCT11); water column transect (WC) 007; Route 131 Bridge (WC131); WC011; WC012; and WC013. All water column sampling locations are provided on Figure 3-1. Samples will be collected from mid channel at each location. At WCMSB, one sample will be collected at 0.5 times the total water column depth (due to shallow water conditions); at all other sample locations (i.e., WCT11, WC007, WC131, WC011, WC012, and WC013), one sample will be collected from each location at 0.2 and 0.8 times the total water column depth.

During water column sampling activities, specific conductivity and water temperature measurements will be obtained every 2 feet in the water column at mid channel to document the presence of stratification. Water temperature, DO, specific conductivity, pH, and turbidity (i.e., water quality parameters) also will be obtained at each water column sampling depth as described above.

Sampling and collection of water quality parameters at WCT11, WC007, WC131, WC011, WC012, and WC013 will occur via boat. Samples at WCMSB will be collected from the bridge, and water quality parameters will be collected from the bridge during lower flow conditions and from shore just downstream of the bridge during higher flow conditions.

Note that velocity profiling will be performed biweekly at WC001 (if conditions permit) to estimate river flow (Figure 2-1) until such time that the USGS gage installed at Chase Mills yields information sufficient for flow determination by the USGS. Once these flow data are available, velocity profiling at WC001 will be discontinued.

3.2.3 Protocol

The water column sampling and velocity profiling procedures are outlined in Appendix A.

3.2.4 Analyses

Water column samples will be submitted to Northeast Analytical, Inc. (NEA) in Schenectady, New York (NY) for analysis of PCB congener (unfiltered) and TSS. All samples will be handled, packaged and shipped according to the protocol described in Appendix B. All other water column parameters will be measured real time and recorded in the field. All analyses performed by NEA will be consistent with the analytical methods described in the Supplemental Remedial Studies Program: 2001 Monitoring Work Plan (Alcoa, March 2001).

3.2.5 QA/QC Samples

QA/QC samples will include an equipment rinse blank before and after each sampling round to be analyzed for PCB congener. In addition, one duplicate sample and one matrix spike/matrix spike duplicate (MS/MSD) sample will be collected and analyzed for PCB congener, and one duplicate will be collected and analyzed for TSS every round.

3.3 Resident Fish Monitoring

3.3.1 Objective

The Grasse River resident fish monitoring program in 2004 will consist of the collection of fall adult fish to continue observation of annual trends in fish PCB concentrations, as well as young-of-year (YOY) spottail shiner sample collection and analysis to serve as an indicator of short-term PCB exposure.

3.3.2 Sampling Locations

The 2004 resident fish collection efforts will be conducted in the September timeframe. Note that this year's sampling event will occur slightly earlier than previous years in an attempt to avoid cooler temperatures. The program will include the collection of 17 adult (≥25 centimeters [cm]) smallmouth bass (*Micropterus dolomieui*) and 18 adult (≥25 cm) brown bullhead (*Ameiurus nebulosus*) from the Upper, Middle, and Lower Stretches of the river. Five adult smallmouth bass and five adult brown bullhead will be collected from the Background Stretch. In addition, 17 adult smallmouth bass will be collected from the Power Canal. Sample collection locations are shown on Figure 3-2. Coordinates will be recorded for all adult smallmouth bass and

brown bullhead samples using a boat-mounted global positioning system (GPS) unit (note the GPS unit has a horizontal accuracy of +/- 15 feet).

Further, as part of the fall resident fish trend monitoring program, monitoring of adult spottail shiner (*Notropis hudsonius*) samples will be conducted. This monitoring will include collection of three whole-body composite samples, consisting of a minimum of 15 adult spottail shiners from each of four locations (i.e., total of 12 samples) within the Study Area: near Outfall 001; near the Unnamed Tributary; at the Mouth of the river; and within the Background Stretch (locations provided on Figure 3-2).

The YOY spottail shiner monitoring program will consist of the collection of three whole-body composite samples (each sample containing a minimum of 15 individual spottail shiners [≤6.5 cm]) from each of the four sampling locations identified for collection of adult spottail shiners.

Note that previous sampling efforts have shown that adequate sample size in each reach/location targeted is dependent on actual species availability and, as a result, the targeted numbers of fish/samples may not be achieved for all species at all reaches/locations.

3.3.3 Protocol

The resident fish sampling protocol is outlined in Appendix C. As required, a License to Collect or Possess will be obtained from the NYSDEC prior to commencement of this program.

3.3.4 Analyses

All resident fish samples will be sent to NEA in Schenectady, NY for analysis of PCBs (Aroclor) and lipid content. Both adult and YOY spottail shiner samples will be submitted as whole-body composite samples. Smallmouth bass samples will be prepared by the laboratory as skin-on, scales-off fillets, and brown bullhead samples will be prepared by the laboratory as skin-off fillets. A subset of these samples will subsequently be selected for PCB congener analyses. All samples will be handled, packaged and shipped according to the protocol described in Appendix B. All analyses performed by NEA will be consistent with the analytical methods described in the Supplemental Remedial Studies Program: 2001 Monitoring Work Plan (Alcoa, March 2001).

3.3.5 QA/QC Samples

QA/QC samples will consist of one MS/MSD sample per 20 samples collected. QA/QC samples will be prepared by the laboratory from submitted fish samples.

4. 2004 Focused Studies

4.1 Introduction

Alcoa will perform a series of focused sampling and monitoring activities in the lower river in 2004 to provide additional information to supplement the database developed from the 2003 river characterization studies. Specifically, the focused studies include:

- Collection of additional sediment cores from areas of the river where additional characterization was determined to be necessary based on the results of the 2003 sampling program;
- Conducting sediment probing in select areas of the lower river; and
- Water column monitoring during spring high flow event and/or ice breakup.

Additional river characterization activities were planned in the event that a significant ice jam event occurred in the lower river in the spring of 2004. As no ice jamming was observed in the lower river during the spring 2004 breakup, these activities have not been included in the plan.

The following sections provide additional details on the components of the 2004 Focused Studies.

4.2 Sediment Core Collection

4.2.1 Objective

Sediment cores will be collected from four locations in the lower river where the core data collected during the 2003 Phase II sampling activities exhibited unusual physical and/or chemical profiles. These sediment cores will be used to further investigate sediment stability in these areas of the river.

4.2.2 Sampling Locations

Sediment cores will be collected in spring 2004 near four 2003 sediment core collection locations: T35N; T37N; T46M; and T71N. At each of these locations, one high resolution core will be collected from within a 10-foot radius of the original location sampled in 2003 (center location). A medium resolution core will also be collected at the center location to obtain adequate sample volume for grain size analyses. In addition, four equally spaced medium resolution cores will be collected around the center high resolution core location (similar to the 2000/2001 sampling) along a circle with an 80-foot radius (perimeter locations). The approximate sediment core collection locations are provided on Figures 4-4, 4-5, and 4-7. A total of four high resolution cores (including four co-located medium resolution cores) and 16 medium resolution cores will be collected.

4.2.3 Protocol

The location of each sediment core will be determined and recorded using DGPS. Sediment cores will be collected using Lexan® tubing with a check valve push core apparatus in accordance with the collection protocol described in Appendix D. Core samples will be advanced through the sediment to refusal.

The recovered cores will be segmented according to their resolution. High resolution cores will be segmented into one centimeter (cm) sections; the top eight cm and every fifth interval (i.e., 9 to 10 cm, 14 to 15 cm, etc.) thereafter will be submitted for laboratory analyses. The remaining sections will be archived. Medium resolution cores will be segmented 0 to 3 inches (in), 3 to 6 in, and every 6 in thereafter.

Each core will be split longitudinally and observed for physical characterization (e.g., color, texture, grain size) with observations recorded. These characteristics will include general soil type (sand, silt, clay and organic matter/other matter), as determined using the Unified Soil Classification System (USCS) and approximate grain size category (fine, medium, coarse). Photographs will be obtained of each core/grab sample intact and during sectioning. Core segments will be homogenized prior to placement in sample jars.

At each sample collection location, total water depth, total sediment depth probed, and total sediment recovered will also be measured and recorded in the field log book. All samples will be handled, packaged and shipped according to the protocol described in Appendix B.

4.2.4 Analyses

All high resolution and medium resolution perimeter core sections will be submitted to Northeast Analytical (NEA) in Schenectady, NY for PCBs (Aroclor), TOC, bulk density, percent moisture, and percent solids analyses. Samples for grain size analysis will be submitted to the Camp Dresser & McKee (CDM) Soils Laboratory in Cambridge, Massachusetts. High resolution core sections that require archiving will be sent to the Alcoa Technical Center in Alcoa Center, Pennsylvania (PA) for proper storage.

4.2.5 QA/QC Samples

QA/QC samples will include one blind duplicate sample and one MS/MSD sample per 20 samples collected. The blind duplicate samples will be analyzed for PCBs (Aroclor), TOC, and grain size. The MS/MSD samples will be analyzed for PCBs (Aroclor). If necessary, rinse blank samples will be collected before and after sampling performed with non-disposable equipment and submitted for PCBs (Aroclor) analysis.

4.3 Sediment Probing

4.3.1 Objective

Sediment probing will be performed in select areas of the lower river to confirm sediment depths in coarse sediment areas. Sediment areas have been classified by Ocean Surveys, Inc. (OSI) during the 2003 side scan sonar surveys performed in the lower river (OSI, August 2003; OSI, November 2003).

4.3.2 Probing Locations

Physical probing generally will be performed in five to 10 locations within several major coarse (Type I) sediment areas. The major coarse sediment areas targeted for probing activities include:

- T11 to T14.5;
- T20.5 to T28;
- T29 to T36;
- T37.5 to T38.5;
- T39 to T41.5;
- T48 to T54; and
- T55 to T59.5.

The proposed probing locations are shown on Figures 4-1 through 4-7.

4.3.3 Protocol

Each probing location will be determined and recorded using DGPS. Probing activities will be performed by pushing (using reasonable human force) a 5/8-in outside diameter steel pipe vertically through the water column into the sediment. The total depth the rod penetrates through each different sediment type (e.g., silt, sand, etc.) is recorded until refusal at rock or hard bottom. General physical characterization also will also be performed at select locations determined in the field by pulling cores for visual observation to confirm the sediment types (e.g., fine or coarse materials). A confirmatory core is generally pulled when the sediment type or thickness varies from those probing locations measured previously.

At each location, the water surface elevation, water depth, sediment depth, physical characterization and other observations (e.g., presence of cobbles/boulders, debris, bedrock [to the extent possible], etc.) will be recorded in the field notes as appropriate.

4.4 TSS Monitoring During Spring High Flow/Ice Breakup

4.4.1 Objective

Collection of suspended solids information during a spring high flow event and/or ice breakup (late March) will provide quantitative information on the amount of solids that enter the lower Grasse River from upstream during elevated flows or as a result of ice breakup.

4.4.2 Sampling Locations

Water column samples will be collected from the WCMSB and the Alcoa Bridge (WCAB) (see Figure 4-8) as conditions safely permit.

4.4.3 Protocol

The hydrograph resulting from the USGS gage at Chase Mills will be monitored to determine sampling initiation and frequency. The TSS monitoring program will be conducted during the rising and falling limbs of the hydrograph to the extent possible. It is likely that multiple mobilizations will be necessary to capture the desired conditions. Each mobilization and associated samples collected (and analyzed) will be noted in the field book. Water column samples will be collected at approximately 0.5 times the total water column depth at each location hourly during the rising limb and once every two hours on the falling limb (as conditions allow). It is likely that sample locations (and potentially depths) will be modified in the field to accommodate actual conditions encountered. Any deviations will be noted in the field book. Samples at WCMSB and WCAB will be collected from the bridge using a Wildco horizontal water sampler.

4.4.4 Analyses

Water column samples will be hand delivered to the Alcoa Chem Lab in Massena, NY for TSS analysis.

4.4.5 QA/QC Samples

QA/QC samples will include one duplicate TSS analysis per 20 samples collected during a mobilization, or a minimum of one per mobilization.

References

Alcoa Inc. (Alcoa). *2003/2004 Grasse River Ice Monitoring Work Plan*. December 2003.

Alcoa. *Phase II Grasse River Sampling Work Plan*. November 2003.

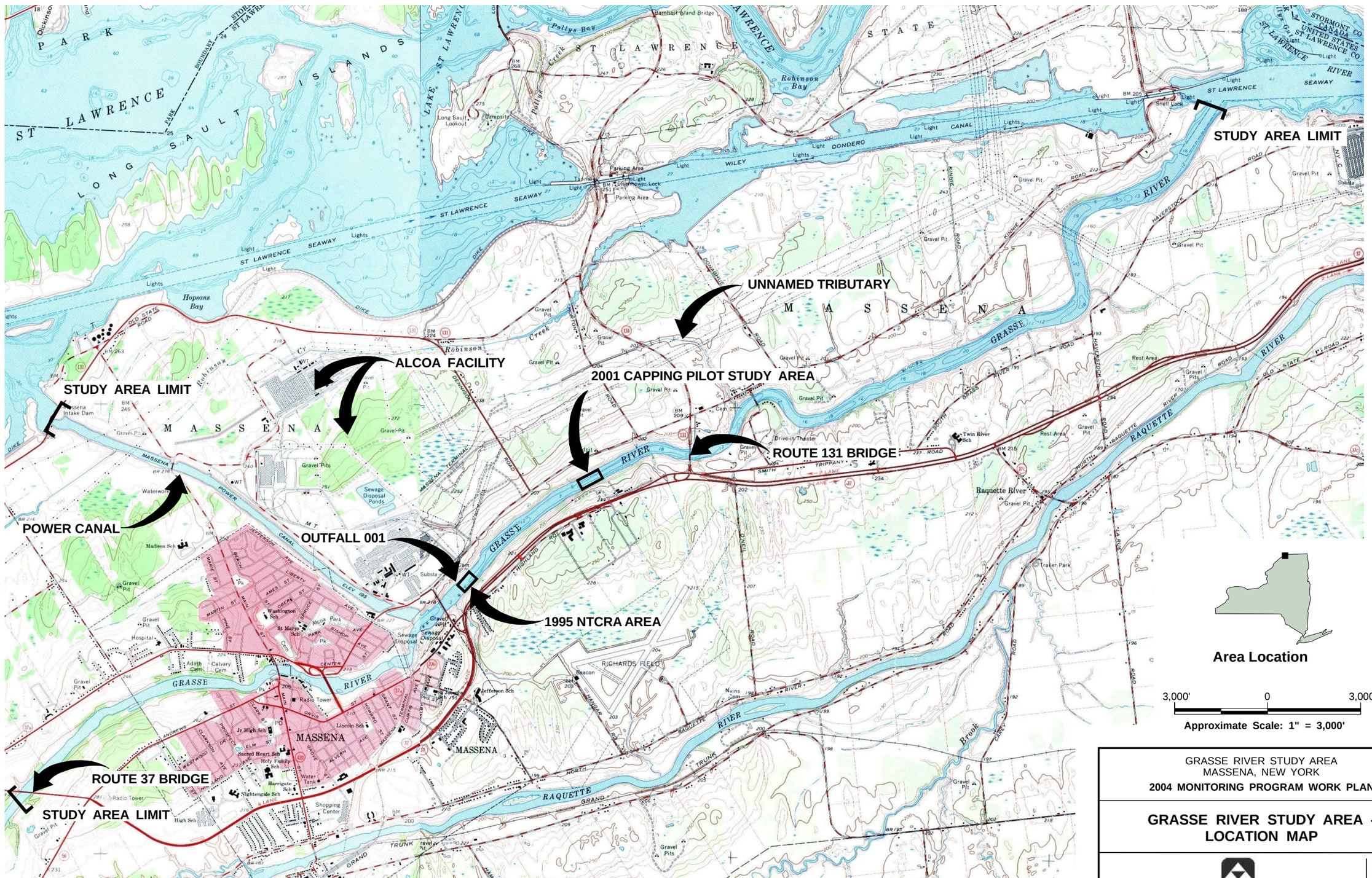
Alcoa. *Sediment Sampling Upstream of Transect T20*. January 2004.

Alcoa. *Supplemental Remedial Studies Program: 2001 Monitoring Work Plan*. March 2001.

Ocean Surveys, Inc. (OSI). *Final Report. Remote Sensing Survey Grasse River Investigation T1 to T38*. August 2003.

OSI. *Final Report. Remote Sensing Survey Grasse River Investigation T38 to T72*. November 2003.

Figures



GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

GRASSE RIVER STUDY AREA - LOCATION MAP

ALCOA

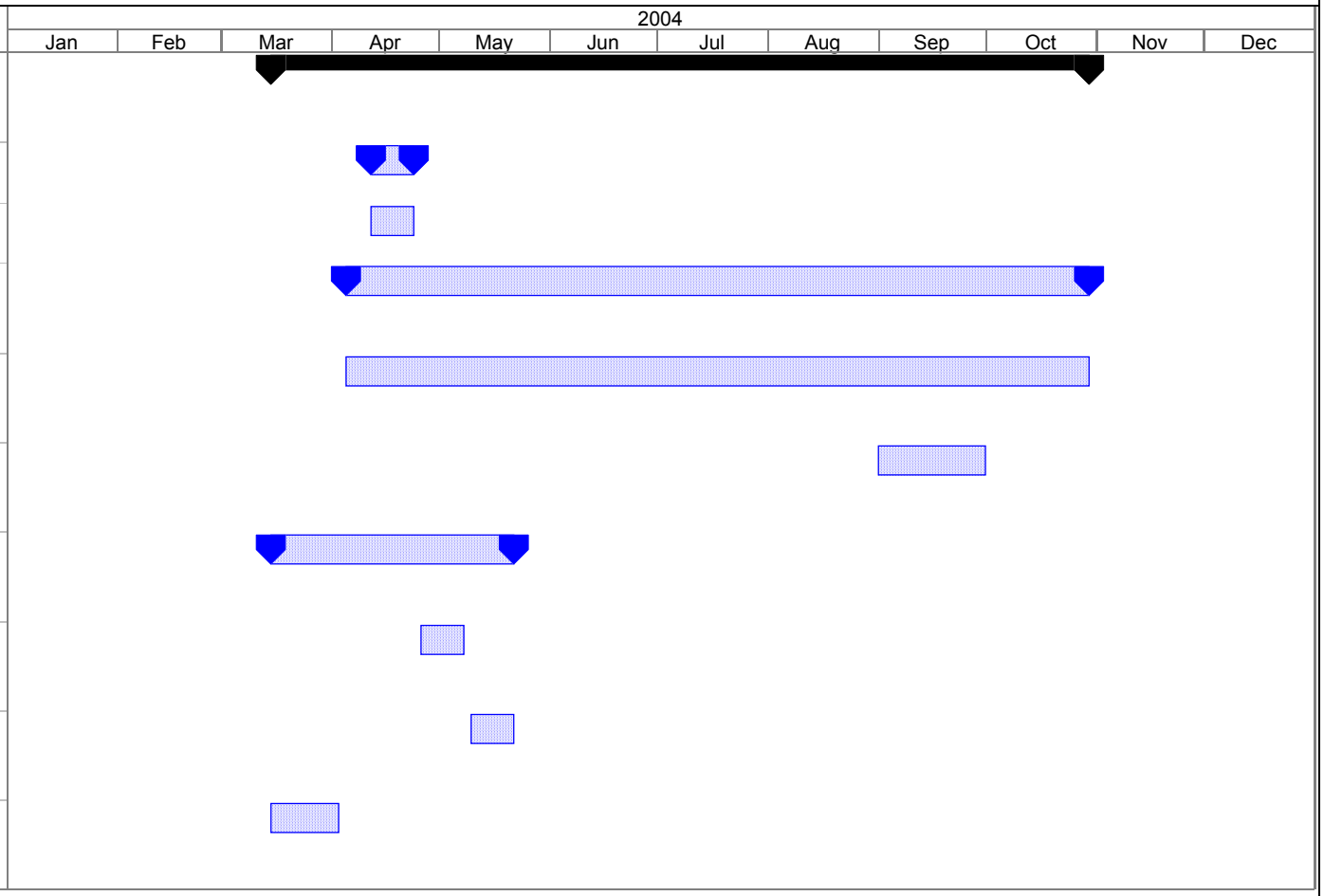
FIGURE 1-1

03/15/04 SYR-D54-DJH LBR MRC KFS
10464002/10464n01.cdr

REFERENCE: MASSENA, NEW YORK-ONTARIO USGS QUAD. 1964 RAQUETTE RIVER, NEW YORK-ONTARIO USGS QUAD. 1964

Figure 1-2
Grasse River 2004 Monitoring Program Schedule

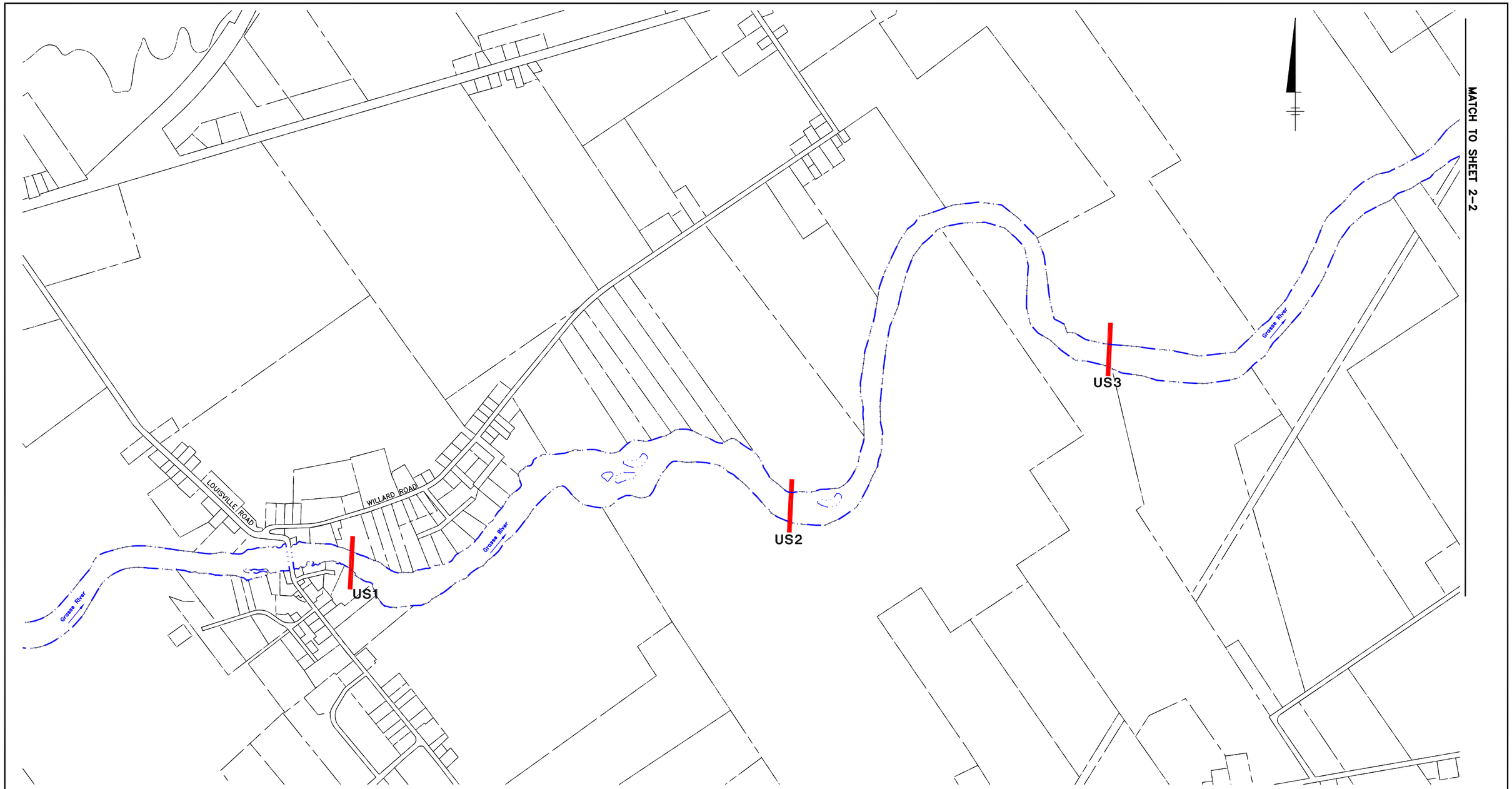
ID	Task Name
1	**2004 Monitoring Program**
2	**Continuation of 2003 Phase II Field Activities**
3	Upstream River and Floodplain Cross Sections
4	**2004 SRS Program**
5	Routine Water Column and Flow Measurements
6	Resident Fish Trend Monitoring
7	**2004 Focused Studies**
8	Sediment Core Collection
9	Sediment Probing
10	TSS Monitoring During Spring High Flow/Ice Breakup



Project: Fig1-2_2004sched
Date: Tue 4/13/04

Task Summary

Notes:
1. Schedule provides approximate timeframes for implementation of monitoring activities.
2. Routine water column sampling and flow measurements will be performed biweekly following ice breakup (early April) through October.



LEGEND:

US1 — APPROXIMATE UPSTREAM CROSS-SECTION LOCATION

NOTES:

1. BASEMAP INFORMATION OBTAINED FROM A FIGURE BY CAMP DRESSER & MCKEE ENTITLED "ALCOA, INC. – MASSENA OPERATIONS – WEST PLANT" DATED AUGUST 1, 2003.

2. PROPERTY INFORMATION OBTAINED FROM ST. LAWRENCE COUNTY REAL PROPERTY DATA FOR 2000.

0 500' 1000'
GRAPHIC SCALE

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

UPSTREAM CROSS SECTION LOCATIONS

ALCOA

FIGURE
2-1

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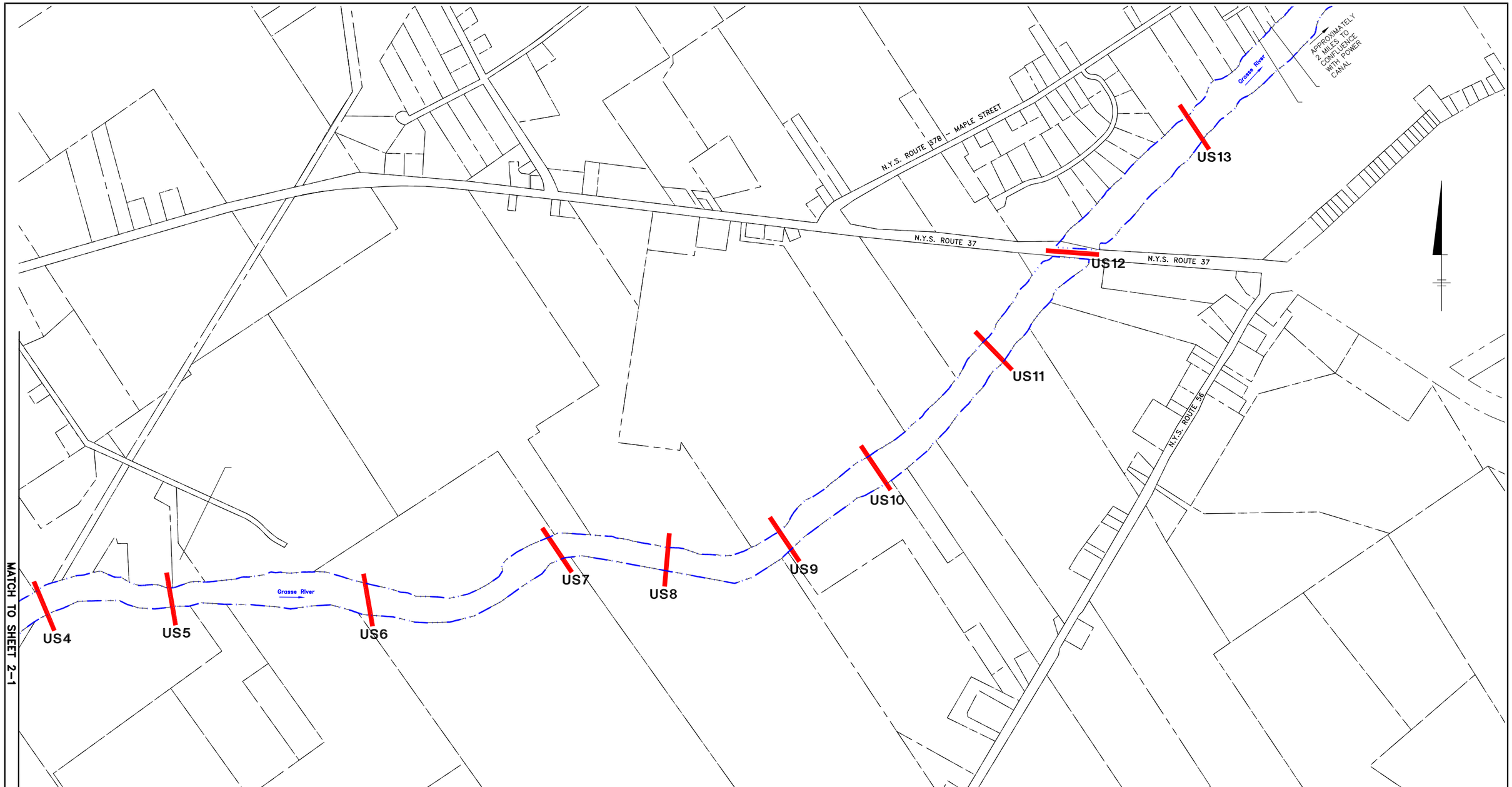

LEGEND:

US4 — APPROXIMATE UPSTREAM CROSS-SECTION LOCATION

NOTES:

1. BASEMAP INFORMATION OBTAINED FROM A FIGURE BY CAMP DRESSER & MCKEE ENTITLED "ALCOA, INC. – MASSENA OPERATIONS – WEST PLANT" DATED AUGUST 1, 2003.

2. PROPERTY INFORMATION OBTAINED FROM ST. LAWRENCE COUNTY REAL PROPERTY DATA FOR 2000.

0 500' 1000'
GRAPHIC SCALE

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

UPSTREAM CROSS SECTION LOCATIONS

ALCOA

FIGURE
2-2

X: 10485X02.DWG, 10485X02.TIF
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03/15/04 SYR-85-DMJ
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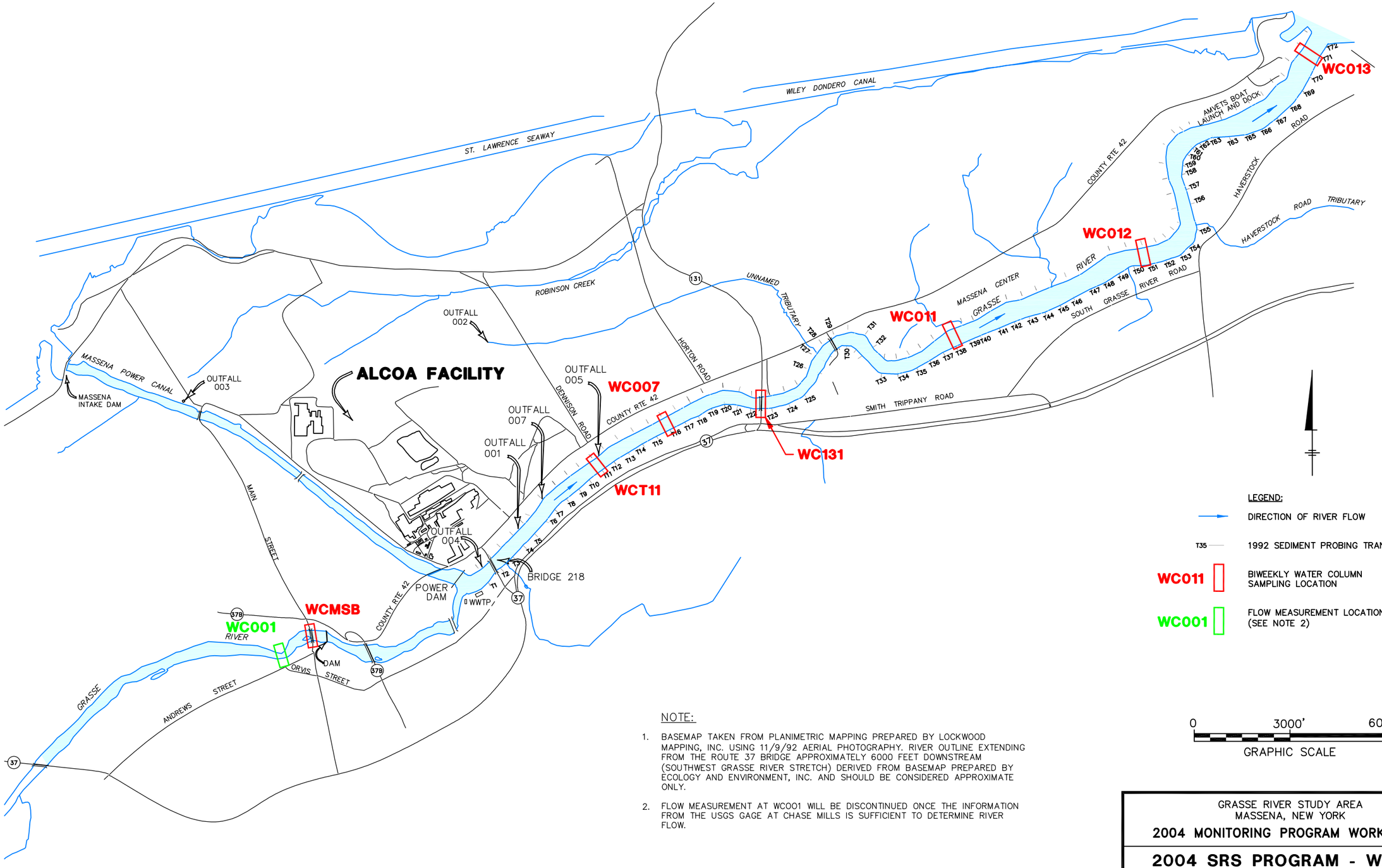

NOTE:

1. BASEMAP TAKEN FROM PLANIMETRIC MAPPING PREPARED BY LOCKWOOD MAPPING, INC. USING 11/9/92 AERIAL PHOTOGRAPHY. RIVER OUTLINE EXTENDING FROM THE ROUTE 37 BRIDGE APPROXIMATELY 6000 FEET DOWNSTREAM (SOUTHWEST GRASSE RIVER STRETCH) DERIVED FROM BASEMAP PREPARED BY ECOLOGY AND ENVIRONMENT, INC. AND SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. FLOW MEASUREMENT AT WC001 WILL BE DISCONTINUED ONCE THE INFORMATION FROM THE USGS GAGE AT CHASE MILLS IS SUFFICIENT TO DETERMINE RIVER FLOW.

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

2004 MONITORING PROGRAM WORK PLAN

2004 SRS PROGRAM - WATER COLUMN MONITORING LOCATIONS

ALCOA

FIGURE **3-1**

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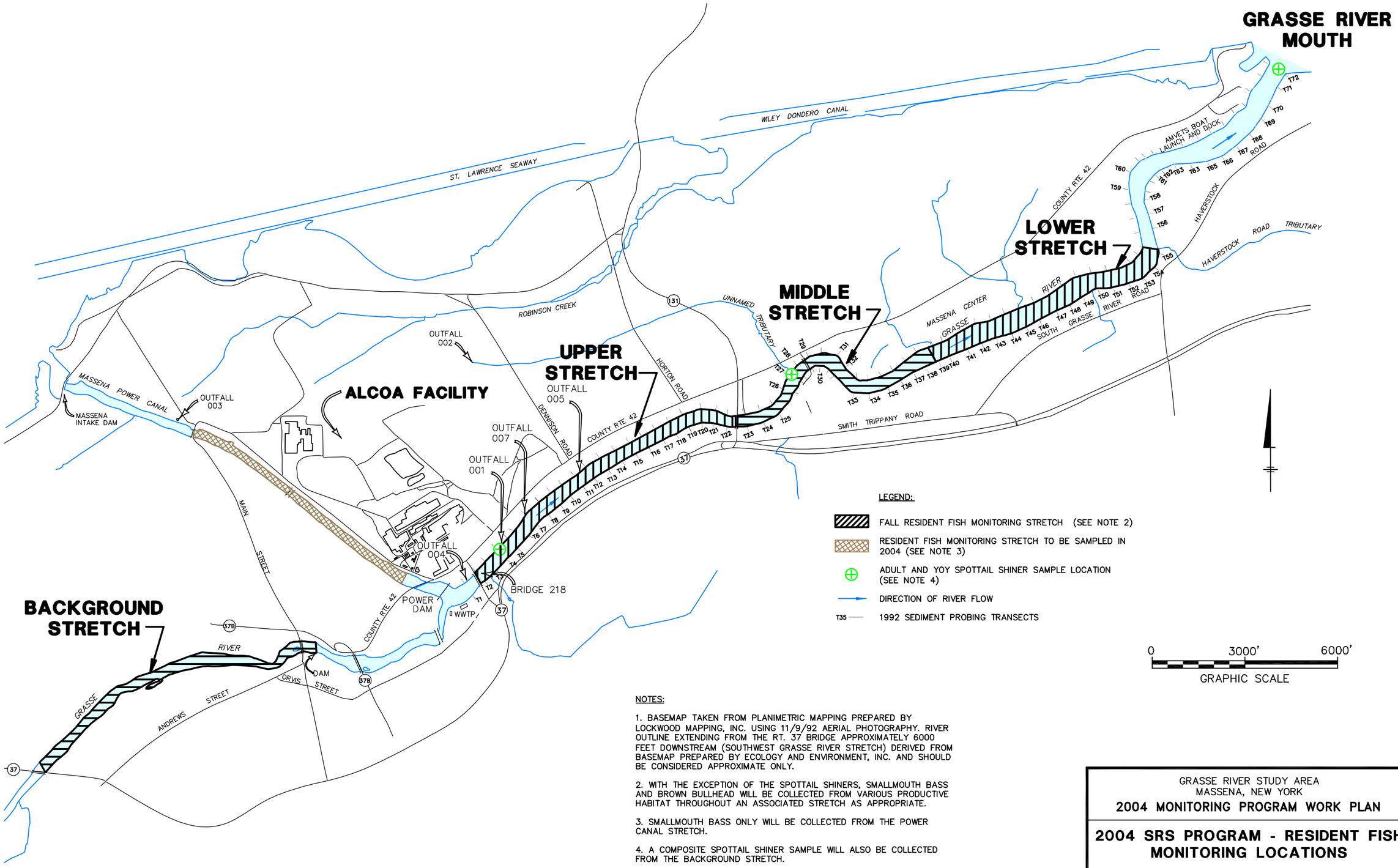


NOTES:

1. BASEMAP TAKEN FROM PLANIMETRIC MAPPING PREPARED BY LOCKWOOD MAPPING, INC. USING 11/9/92 AERIAL PHOTOGRAPHY. RIVER OUTLINE EXTENDING FROM THE RT. 37 BRIDGE APPROXIMATELY 6000 FEET DOWNSTREAM (SOUTHWEST GRASSE RIVER STRETCH) DERIVED FROM BASEMAP PREPARED BY ECOLOGY AND ENVIRONMENT, INC. AND SHOULD BE CONSIDERED APPROXIMATE ONLY.

2. WITH THE EXCEPTION OF THE SPOTTAIL SHINERS, SMALLMOUTH BASS AND BROWN BULLHEAD WILL BE COLLECTED FROM VARIOUS PRODUCTIVE HABITAT THROUGHOUT AN ASSOCIATED STRETCH AS APPROPRIATE.

3. SMALLMOUTH BASS ONLY WILL BE COLLECTED FROM THE POWER CANAL STRETCH.

4. A COMPOSITE SPOTTAIL SHINER SAMPLE WILL ALSO BE COLLECTED FROM THE BACKGROUND STRETCH.

X: 10485X01.DWG, 10485X01.TIF
L: ON=*, OFF=REF
P: PAGESET/SYR-BL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485B04.DWG

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

2004 MONITORING PROGRAM WORK PLAN

2004 SRS PROGRAM - RESIDENT FISH MONITORING LOCATIONS

ALCOA

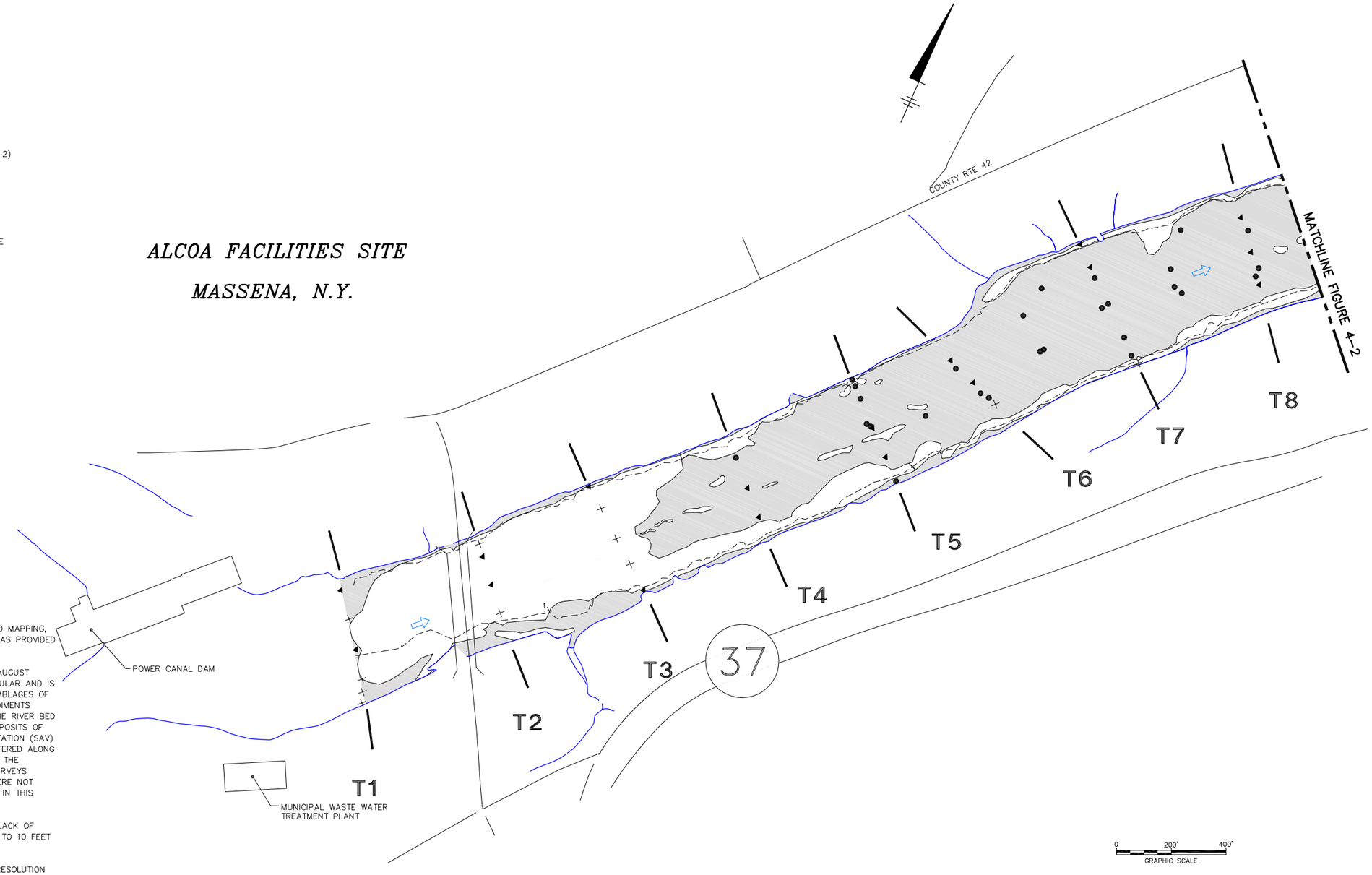
FIGURE **3-2**

LEGEND:

- T35 — 1992 SEDIMENT PROBING TRANSECT
- RIVER BOUNDARY
- NEAR SHORE AREA
- TYPE II SEDIMENT (FINE – SEE NOTE 2)
- TYPE I SEDIMENT (COARSE – SEE NOTE 2)
- SUBMERGED AQUATIC VEGETATION (SEE NOTE 2)
- 2003 SURFACE SEDIMENT SAMPLE LOCATION
- 2003/2004 SEDIMENT CORE LOCATION
- 2003 SAMPLE LOCATION – NO SEDIMENT RECOVERED (SEE NOTE 3)
- 2004 APPROXIMATE MEDIUM RESOLUTION CORE LOCATION
- 2004 APPROXIMATE HIGH RESOLUTION CORE LOCATION (SEE NOTE 4)
- 2004 APPROXIMATE PROBING LOCATION
- DIRECTION OF RIVER FLOW

ALCOA FACILITIES SITE

MASSENA, N.Y.



NOTES:

1. BASEMAP TAKEN FROM PLANIMETRIC MAPPING PREPARED BY LOCKWOOD MAPPING, INC. USING 11/9/92 AERIAL PHOTOGRAPHY. EXTENT OF NEAR SHORE AREAS PROVIDED BY QUANTITATIVE ENVIRONMENTAL ANALYSIS, LLC (QEA).

2. BOTTOM TYPE DEFINITIONS REPORTED BY OCEAN SURVEYS, INC. (OSI, AUGUST 2003). TYPE I SEDIMENT INDICATES THAT THE RIVER BED APPEARS IRREGULAR AND IS PRINCIPALLY REPRESENTED BY POSSIBLE ROCK OUTCROPS AND/OR ASSEMBLAGES OF BOULDERS/COBBLES WHICH MAY BE OVERLAIN BY A THIN VENEER OF SEDIMENTS COMPOSED OF SANDS AND GRAVEL. TYPE II SEDIMENT INDICATES THAT THE RIVER BED APPEARS FLAT/SMOOTH AND IS PRINCIPALLY COMPOSED OF SEDIMENT DEPOSITS OF CLAY, SAND AND GRAVEL. THE PRESENCE OF SUBMERGED AQUATIC VEGETATION (SAV) IS INDICATED ONLY BETWEEN T38 AND T72 AS VEGETATION WAS ENCOUNTERED ALONG BOTH BANKS OF THE RIVER DURING THE TIME OF SURVEY THAT BLOCKED THE PROPAGATION OF THE ACOUSTIC SIGNALS (OSI, NOVEMBER 2003). THE SURVEYS CONDUCTED BETWEEN T1 AND T38 DURING OTHER TIMES OF THE YEAR WERE NOT IMPACTED BY THE PRESENCE OF SAV, AND AS SUCH SAV IS NOT SHOWN IN THIS STRETCH OF RIVER.

3. SEVERAL TARGETED LOCATIONS WERE NOT SAMPLED IN 2003 DUE TO LACK OF RECOVERABLE SEDIMENT IN THE IMMEDIATE AREA (i.e., APPROXIMATELY 3 TO 10 FEET AROUND THE SAMPLE LOCATION).

4. AT EACH HIGH RESOLUTION CORE LOCATION, A CO-LOCATED MEDIUM RESOLUTION CORE WILL BE COLLECTED FOR GRAIN SIZE ANALYSIS.

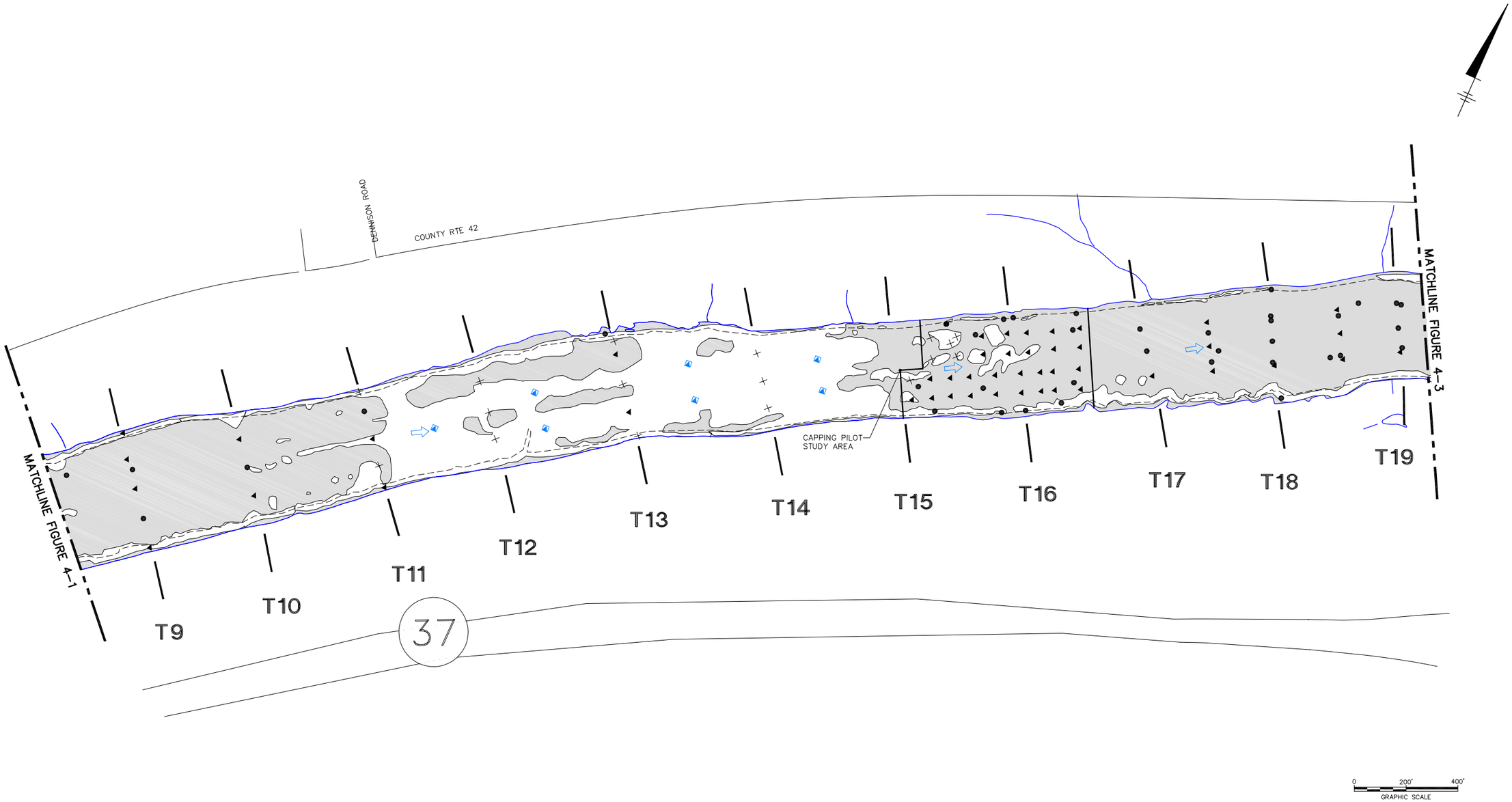
GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE **4-1**

X: 1085X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*, SS-DATA, SP-DATA
P: PAGESET/SYR-DL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485C01.DWG



SEE FIGURE 4-1 FOR NOTES AND LEGEND INFORMATION

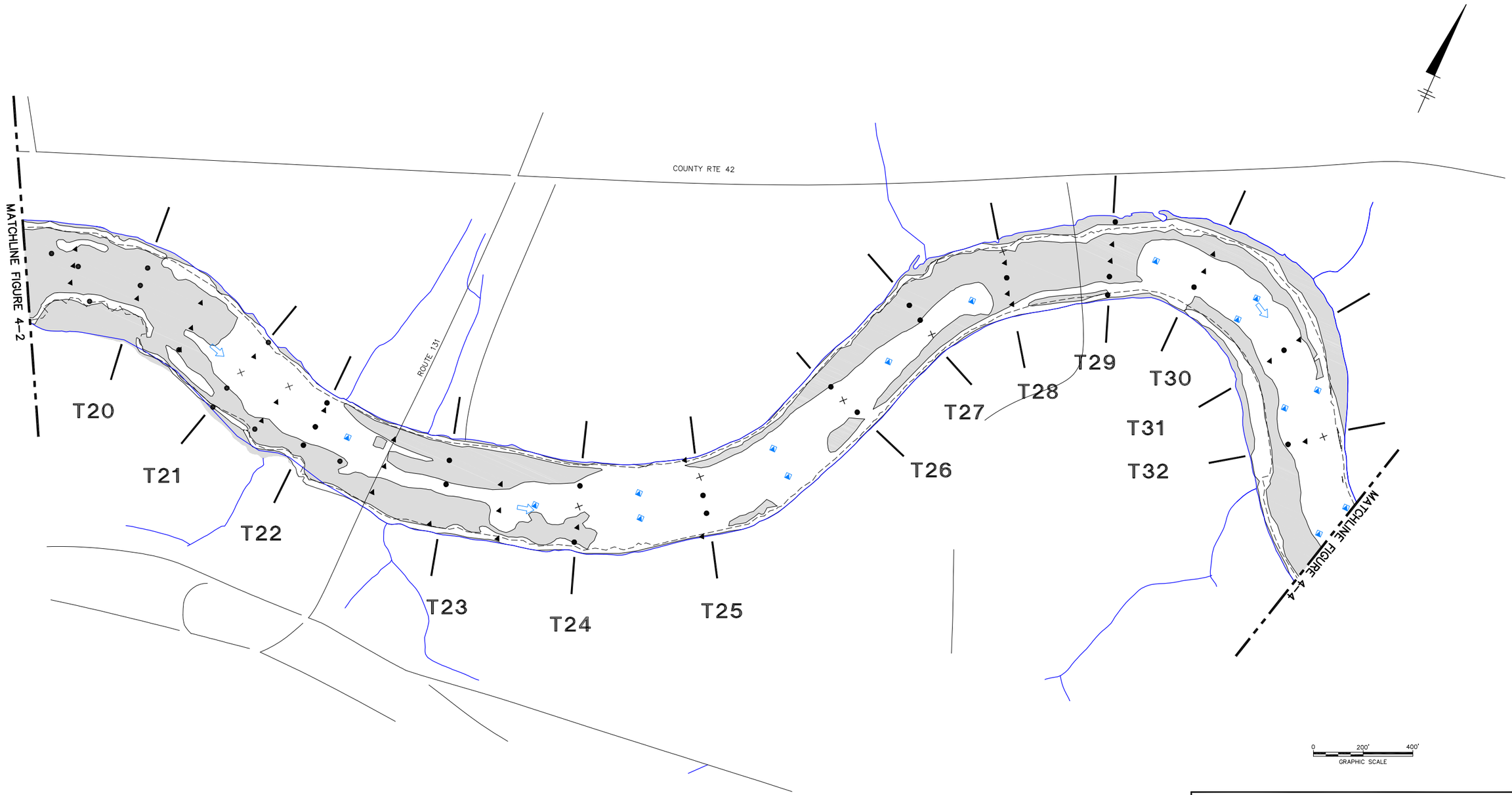
GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE
4-2

X: 10485X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*, |FLOWARROW
P: PAGESET/SYR-DL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485C02.DWG



SEE FIGURE 4-1 FOR NOTES AND LEGEND INFORMATION

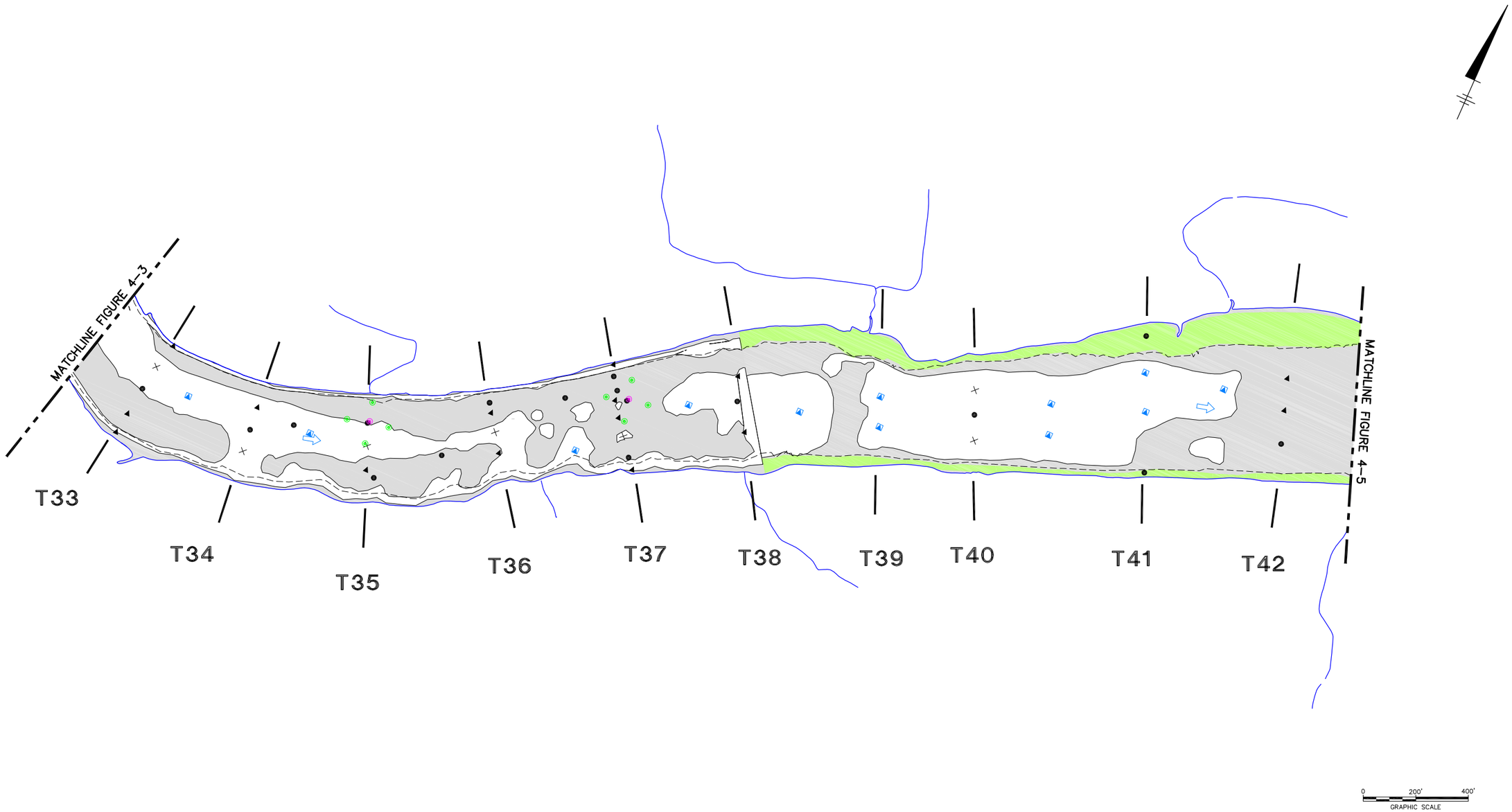
GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE
4-3

X: 10485X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*
P: PAGESET/SYR-DL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485C04.DWG



SEE FIGURE 4-1 FOR NOTES AND LEGEND INFORMATION

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE
4-4

X: 10485X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*
P: PAGESET/SYR-DL
4/12/04 SYR-85-DMJ GMS
10485003/MARCH1504/10485C05.DWG

SEE FIGURE 4-1 FOR NOTES AND LEGEND INFORMATION

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE
4-5

X: 10485X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*
P: PAGESET/SYR-DL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485C06.DWG

SEE FIGURE 4-1 FOR NOTES AND LEGEND INFORMATION

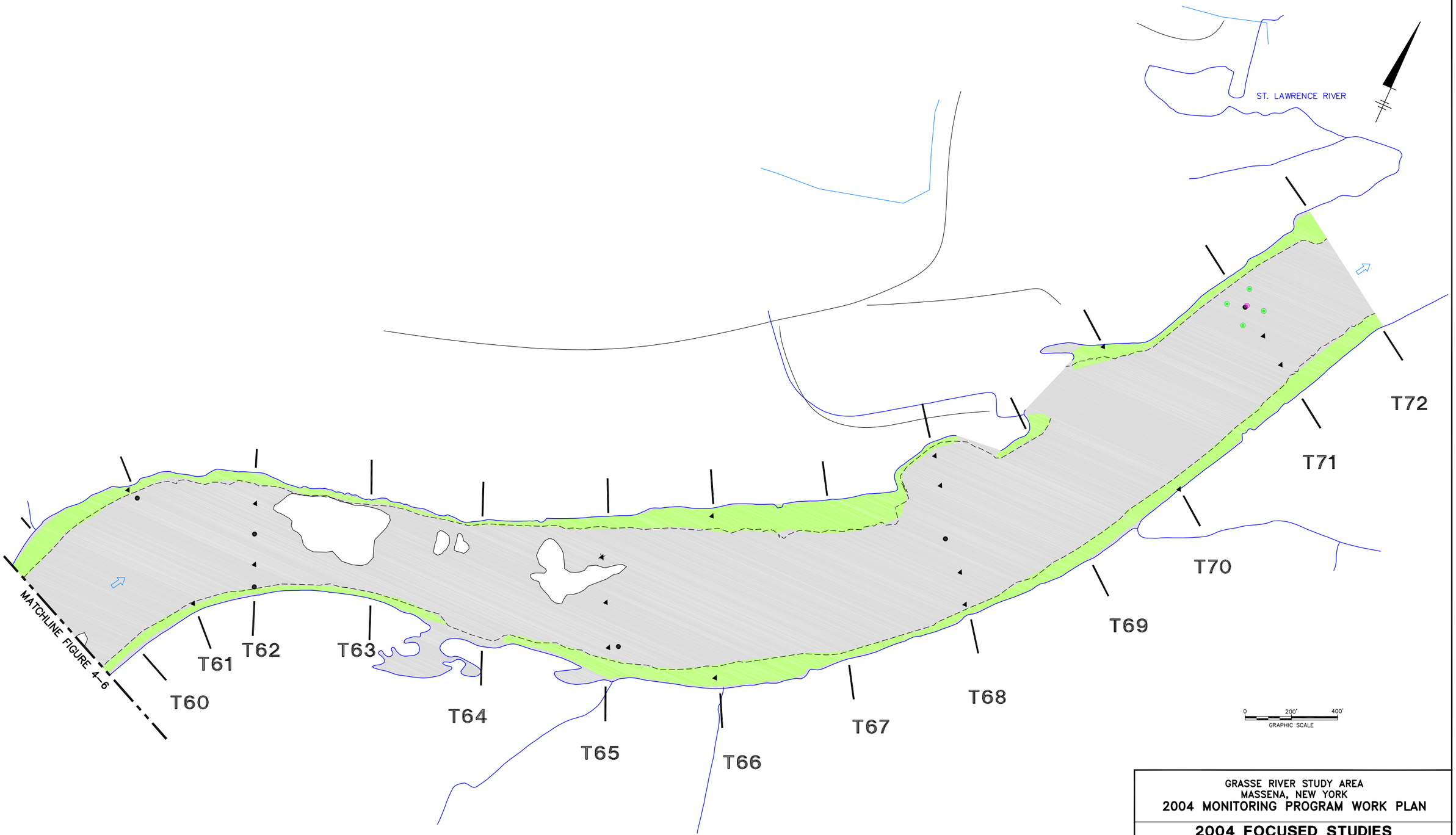
X: 10485X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*
P: PAGESET/SYR-DL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485C07.DWG

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE
4-6



SEE FIGURE 4-1 FOR NOTES AND LEGEND INFORMATION

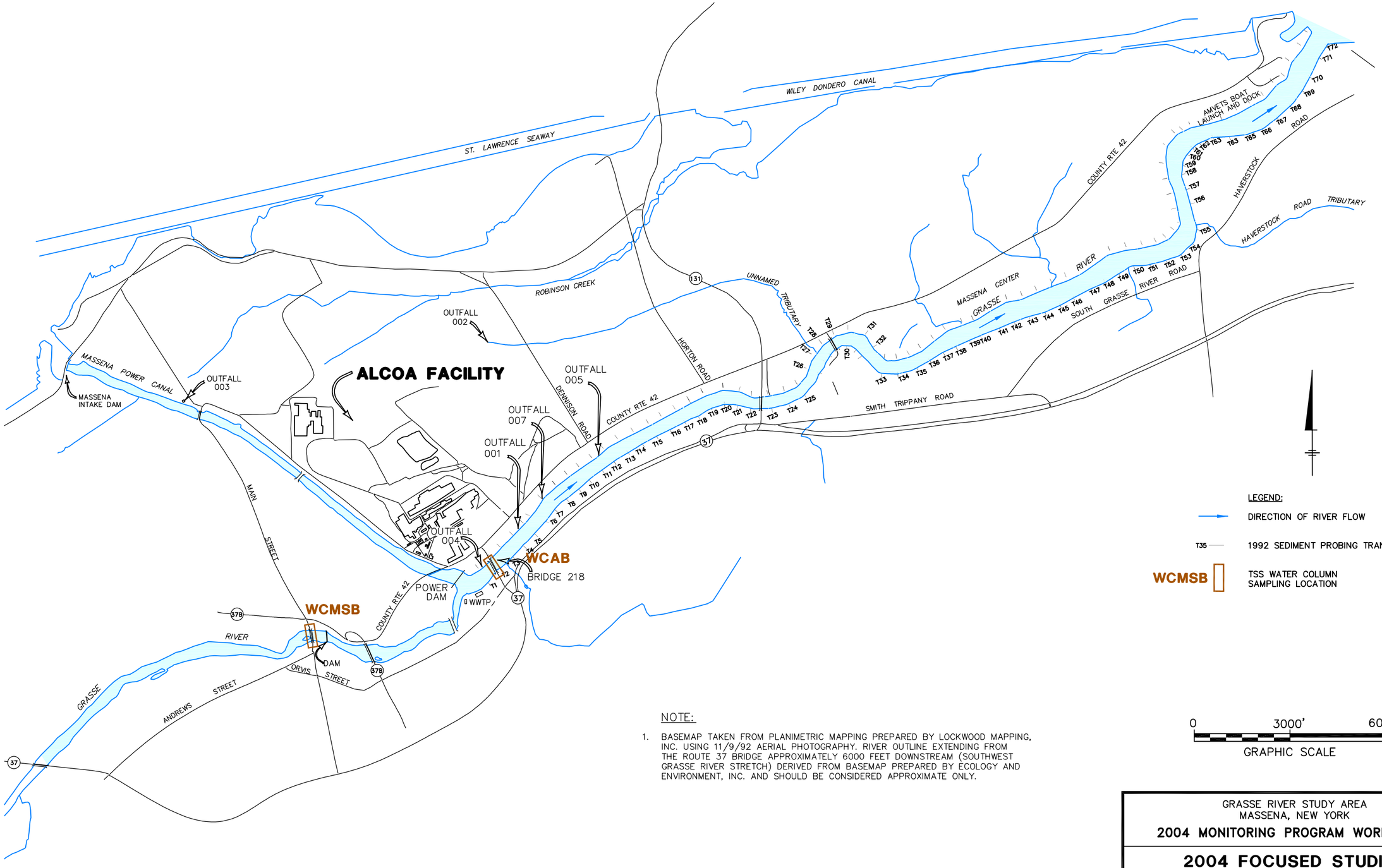
X: 10485X03.DWG, X04.DWG, 10485X03.TIF
L: ON=*, OFF=*REF*
P: PAGESET/SYR-DL
4/13/04 SYR-85-DMJ GMS
10485001/MARCH1504/10485C08.DWG

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK
2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES PROBING AND SEDIMENT CORE LOCATIONS

ALCOA

FIGURE
4-7



NOTE:

1. BASEMAP TAKEN FROM PLANIMETRIC MAPPING PREPARED BY LOCKWOOD MAPPING, INC. USING 11/9/92 AERIAL PHOTOGRAPHY. RIVER OUTLINE EXTENDING FROM THE ROUTE 37 BRIDGE APPROXIMATELY 6000 FEET DOWNSTREAM (SOUTHWEST GRASSE RIVER STRETCH) DERIVED FROM BASEMAP PREPARED BY ECOLOGY AND ENVIRONMENT, INC. AND SHOULD BE CONSIDERED APPROXIMATE ONLY.

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

2004 MONITORING PROGRAM WORK PLAN

2004 FOCUSED STUDIES TSS SAMPLE LOCATIONS

ALCOA

FIGURE **4-8**

X: 10485X01.DWG, 10485X01.TIF
L: ON=*, OFF=REF
P: PAGESET/PLT-BL
3/18/04 SYR-85-DMJ
10485001/MARCH1504/10485B05.DWG

Appendices

Appendix A

Water Column Sampling and Flow Measurement Procedures

Appendix A

Water Column Sampling and Flow Measurement Procedures

This protocol sets forth the field procedures for the collection of water column samples (via boat and bridge), and velocity measurements in the Grasse River.

Water Column Sampling Procedures via Boat

The general procedures to be followed when obtaining water column samples via boat are outlined below.

Materials
The following materials will be available, as required, during water column sampling:

- Health and safety equipment (as required by the Health and Safety Plan [BBL, 2004]);
- Cleaning equipment;
- Boat and motor;
- Surveyor's rod;
- Depth sounder;
- Combination water quality meter;
- Duct tape;
- Field notebook;
- 200-foot measuring tape;
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice;
- Appropriate water sampler (i.e., Wildco Kemmerer stainless steel bottle sampler [Kemmerer]); and
- Appropriate sample containers and forms.

Water Column Sampling Procedures
Water column samples will be collected from a boat using a stainless steel Kemmerer water sampler. Samples will be collected mid channel at specified river locations at depths of 0.2 and 0.8 times the total water column depth (or other appropriate depth as specified in the Work Plan). The procedures for collection of water column samples are provided below.

1. Identify sampling location in field notebook along with other appropriate information.

2. Don health and safety equipment (as required by the Health and Safety Plan).

3. Clean the sampling equipment prior to initial use, between sampling at each transect, and at the completion of sampling as follows: distilled water rinse; acetone rinse; hexane triple rinse; and distilled water triple rinse.

4. Prepare one rinse-blank sample prior to and after sampling activities, by pouring de-ionized water supplied by the Alcoa Massena Operations ChemLab through the cleaned Kemmerer and filling the sample containers as described in steps 8 and 9.

5. Measure the total depth of the water column using a surveyor’s rod to the nearest 0.1 foot.

6. Lower the water sampler to 0.8 times the total water column depth and release triggers.

7. Raise the water sampler from the water column with minimal disturbance.

8. Remove the covers from the appropriate laboratory supplied containers and slightly tilt the mouth of the container below the sampling device.

9. Empty the sampler slowly, allowing the sample stream to flow gently down the side of the sample container (with minimal entry turbulence).

10. Repeat steps 6-9 for collection of sample at 0.2 times the total water column depth.

11. Repeat steps 5-10 at the other river locations.

12. At each station, collect in-situ measurements of conductivity and temperature at 2-foot intervals throughout the water column, and temperature, pH, turbidity, conductivity, and DO at 0.2 and 0.8 times the total water column depth. Record results on the appropriate form and/or field notebook.

13. Secure all sample jar caps tightly.

14. Label all sample containers.

15. Place filled sample containers on ice in a cooler.

16. Collect field duplicate and MS/MSD samples during each sampling event. Field duplicates and MS/MSD samples will be prepared by filling additional sets of sample containers with water collected at the same time and depth. One additional set of sample containers will be filled for field duplicates and two sets of containers will be filled for MS/MSD samples.

17. Follow procedures for preservation of samples and packing, handling, and shipping with associated chain-of-custody procedures for samples as described in Appendix B.

18. Record required information on the appropriate forms and/or field notebook.

Water Column Sampling Procedures via Bridge

The general procedures to be followed when obtaining water column samples via bridge are outlined below. It is anticipated that the only water column sampling to be performed from a bridge would be at WCMSB, therefore this procedure has been written to reflect sampling at that location. Should sampling be required at another bridge location, sample depths may need to be adjusted.

Materials

The following materials will be available, as required, during water column sampling:

- Health and safety equipment [as required by the Health and Safety Plan (BBL, 2004)];
- Cleaning equipment;
- Surveyor's rod;
- Measuring tape and appropriate weight;

- Combination water quality meter;
- Field notebook;
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice;
- Appropriate water sampler (i.e., Wildco Kemmerer stainless steel bottle sampler); and
- Appropriate sample containers and forms.

Water Column Sampling Procedures

Water column samples will be collected from a bridge using a stainless steel Kemmerer water sampler or by discrete grab collection.

1. Schedule sampling activities to occur during off-peak traffic hours (i.e., between 10:00 AM and 11:00 AM or between 2:00 PM and 3:00 PM), preferably during low wind conditions.

2. Don and/or ensure proper use of health and safety equipment/precautions (as required by the Health and Safety Plan).

3. Clean the sampling equipment prior to initial use, between collection of each sample, and at the completion of sampling as follows: distilled water rinse; acetone rinse; hexane triple rinse; and distilled water triple rinse.

4. Prepare one rinse-blank sample prior to and after sampling activities, by pouring distilled water through the cleaned Kemmerer and filling the sample containers as described in steps 10 and 11.

5. Conduct all sampling from the bridge at approximately the middle of the river.

6. Observe the presence/absence of boating traffic on the river in the vicinity of sampling activities. Proceed with sampling if there are no obstructions (e.g., boats passing under the bridge).

7. Measure the total depth of the water column at the middle of the river by extending the surveyor's rod or weighted tape measure into the water until it reaches the river bottom.

8. Attached laboratory supplied container to the surveyor’s rod at 0.5 times the total water column depth and lower rod to the river bottom.

9. Raise the surveyor’s rod and sample container from the water column with minimal disturbance.

10. Repeat steps 8 and 9 for collection of additional water column sample (if required).

11. In-situ measurements of conductivity and temperature will be obtained at 2-foot intervals throughout the water column, and temperature, pH, turbidity, conductivity, and DO will be collected at 0.5 times the total water column depth at WC001 during surface water flow measurement due to shallow fast flowing water at WCMSB. Results will be recorded on the appropriate form and/or field notebook. Once velocity profiling is no longer necessary due to the United States Geological Survey (USGS) gage, in-situ water quality parameters will be collected either from the bridge or, during high flow conditions, from shore just downstream of the bridge.

12. Secure all sample jar caps tightly.

13. Label all sample containers.

14. Place filled sample containers on ice in a cooler.

15. Collect field duplicate and MS/MSD samples during each sampling event. Field duplicates and MS/MSD samples will be prepared by filling additional sets of sample containers with water collected at the same time and depth. One additional set of sample containers will be filled for field duplicates and two sets of containers will be filled for MS/MSD samples.

16. Follow procedures outlined in Appendix B for preservation of samples and packing, handling, and shipping with associated chain-of-custody procedures for samples.

17. Record required information on the appropriate forms and/or field notebook.

Surface Water Flow Measurement Procedures

The following procedures will be used to determine the velocity profile at the river cross-section at WC001.

Materials

The following materials will be available, as required, during the flow measurement:

- Health and Safety equipment [as required by the Health and Safety Plan (BBL, 2004)];
- Boat with oars;
- Anchor;
- Surveyor’s rod;
- Rope;
- Electromagnetic or ADV velocity meter; and
- Field notebook.

1. Don personal protective equipment (as required in the Health and Safety Plan);

2. Extend rope across the river;

3. Measure the width of the river, then divide and mark into equally spaced measurement locations. For rivers/streams greater than 100 feet in width, the spacing should be 20 feet.

4. Calibrate velocity meter as per manufacturer's specifications.

5. Lower the surveyor's rod and measure and record the water depth to the nearest 0.1 foot at each measurement location.

6. Velocities will be determined using the two-point method. Attach the velocity meter probe to the surveyor's rod, measure and record the velocity in feet per second at depths equaling 0.2 and 0.8 times the total river depth at each measurement location. Average the two velocity measurements to obtain the average velocity for that vertical section.

7. Record all measurements in field notebook.

Calculate the river flow rate by multiplying the average velocity reading times the cross-sectional area of the 5-foot (or 10- or 20-foot) increment. The total flow rate is the sum of the velocity times the area for each increment.

$$Q_T = V_1 A_1 + V_2 A_2 + ...+ V_n A_n$$

Where: Q_T = Total flow in cubic feet per second
V_{1-n} = Average velocity for a vertical section (feet per second)
A_{1-n} = Cross-sectional area of each increment (square feet)

References:

Blasland, Bouck & Lee, Inc. (BBL). Health and Safety Plan for Field Activities at the Grasse River Study Area. 2004.

Appendix B

Field Sample Packing, Handling, and Shipping Procedures

Appendix B

Field Sample Handling, Packing, and Shipping Procedures

This protocol sets forth the field procedures for sample handling, packing, and shipping for all samples (i.e., water column, fish, and sediment) collected from the Grasse River.

Handling

1. Fill in sample label (Attachment B1) with:
   a. Sample type (e.g., surface water);
   b. Project number and site name;
   c. Sample identification code and other sample identification information, if applicable;
   d. Analysis required;
   e. Date;
   f. Time sampled;
   g. Sampler initials and affiliation;
   h. Sample type (composite or discrete);
   i. Tissue preparation procedure (biota; e.g. fillets, whole body), if applicable; and
   j. Preservative added, if applicable.

2. Cover the label with clear packing tape to secure it onto the container.

3. Check the caps on the sample containers to ensure that they are tightly sealed.

4. Wrap the sample container cap with clear packing tape to prevent it from becoming loose.

5. Initiate chain-of-custody (Attachment B2) by designated sampling personnel responsible for sample custody (after sampling or prior to sample packing). Note: If the designated sampling person relinquishes the samples to other sampling or field personnel for packing or other purposes, the samplers will complete the chain-of-custody prior to this transfer. The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer.

Packing

1. Using packing tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport (if applicable).

2. Place each container or package in individual polyethylene bags (Ziploc®-type) and seal.

3. Place one to two inches of cushioning material at the bottom of the cooler.

4. Place the sealed sample containers and package upright in the cooler.

5. Package ice in double lined Ziploc®-type plastic bags and place loosely in the cooler. Do not pack ice so tightly that it may prevent addition of sufficient cushioning material.

6. Fill the remaining space in the cooler with cushioning material.

7. Place the completed chain-of-custody forms (Attachment B2) in a large Ziploc®-type bag and tape the forms to the inside of the cooler lid.

8. Close the lid of the cooler and fasten with packing tape.

9. Wrap strapping tape around both ends of the cooler at least twice.

10. Mark the cooler on the outside with the following information: shipping address, return address, "Fragile" labels (Attachment B3) on the top and on one side, and arrows indicating "This Side Up" (Attachment B3) on two adjacent sides.

11. Place a signed custody seal label (Attachment B4) over front right and back left of the cooler lid and cover with clear plastic tape.

Shipping

1. All samples will be hand delivered or delivered by an express carrier within 48 hours or less from the date of sample collection.

2. The following chain-of-custody procedures will apply to sample shipping:
   a. Relinquish the sample containers to the laboratory via express carrier. The signed and dated forms should be included in the cooler. The express carrier is not required to sign the chain-of-custody forms. The sampler should retain the express carrier receipt or bill of lading.
   b. When the samples are received by the laboratory, the laboratory personnel shall complete the chain-of-custody forms by recording receipt of samples, measure and record the internal temperature of the shipping container, and then check the sample identification numbers on the containers to the chain-of-custody forms.

ATTACHMENT B1
SAMPLE LABEL

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

PROJECT #	
SAMPLE I.D.	DATE
SAMPLE TYPE ☐ Soil/Sediment ☐ Water	COLLECTION MODE ☐ Composite ☐ Grab	TIME
ANALYSIS	
SAMPLER(S)	PRESERVATIVE

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists
6723 Towpath Road, P.O. Box 66
Syracuse, New York 13214-0066
TEL: (315) 446-9120

ATTACHMENT B2

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
SAMPLERS: *(Signature)*	

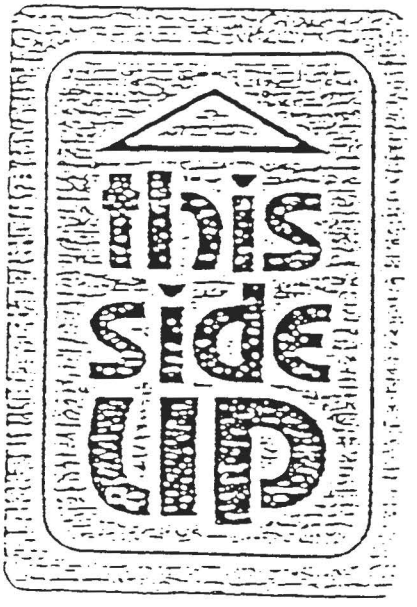
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	Number of Containers							REMARKS

Relinquished by: *(Signature)*	DATE	TIME	Received by: *(Signature)*	Relinquished by: *(Signature)*	DATE	TIME	Relinquished by: *(Signature)*
Relinquished by: *(Signature)*	DATE	TIME	Received by: *(Signature)*	Relinquished by: *(Signature)*	DATE	TIME	Relinquished by: *(Signature)*
Relinquished by: *(Signature)*	DATE	TIME	Received for Laboratory by: *(Signature)*	DATE	TIME	Remarks:	

10/23/95
5951188L CDR

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ATTACHMENT B3
PACKING LABELS



ATTACHMENT B4
CUSTODY SEAL LABEL

CUSTODY SEAL

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

6723 Towpath Road, Box 66,
Syracuse, N.Y. 13214-0066
TEL (315) 446-9120

SEALED BY

_____

DATE _____ TIME _____

Appendix C

Resident Fish Sampling Procedures

Appendix C

Resident Fish Sampling Procedures

This protocol sets forth the field procedures for fish collection, species identification, length and weight measurements, and sample processing. All field operations will be conducted by trained field biologists. The following procedures apply to all target fish species retained for chemical analysis.

Materials
The following materials will be available for use, as required, during fish collection activities:

- Health and Safety equipment (as required by the Health and Safety Plan [BBL, 2004]);
- Fish collection equipment (see Attachment C1 and C2);
- Live well;
- Holding container with ice;
- Fish measuring board;
- Suspended-weight or top-loading spring balance;
- Top-loading electronic balance;
- Mesh bags, trays, or other containers suitable for holding fish to be weighed;
- Appropriate packaging materials and forms;
- Transport container (cooler) with ice; and
- Field notebook.

Procedures
The general procedures that will be followed during fish collection are provided below.

1. Identify sampling location and target fish species for collection.

2. Select collection method(s) based on the sampling location. In general, electrofishing (either by boat or streamside unit), netting, and/or angling will be used for fish sample collection. Details regarding the materials, set-up, and procedures for each collection method are provided in Attachments C1 and C2. (Note: The crew leader has the discretion to stop any collections due to weather, sampling conditions, safety considerations, or equipment malfunctions.)

3. Don health and safety equipment according to the collection procedure selected.

4. Collect the selected number of each target species specified for the sampling location, to the extent feasible.

5. When fish are collected, record the following in the field notebook:
   - Sampling location (general and specific);
   - Date and time of sampling;
   - Crew;
   - Sampling method; and
   - General notes on habitat type and fish species observed.

6. Retain target fish species for chemical analysis. Release non-target fish species. For adult smallmouth bass and brown bullhead sampling, fish should be $\geq$25 cm in size. For YOY sampling, the estimated

maximum total length of YOY spottail shiners at the time of sampling is 6.5 cm (Scott and Crossman, 1973 and Becker, 1983).

7. Record GPS coordinates of all smallmouth bass and brown bullhead sample collection locations.

8. Place retained fish in a live well or in a holding container with ice.

9. Continue coverage of the area. If no additional fish are collected, move to a different area within the same sampling location.

10. Repeat steps 4 through 8 until selected quantities for each target fish species for the sampling location are obtained or the entire area of the sampling location has been covered. At the crew leader's discretion, use an alternate technique per those described above in step 2 to obtain the selected quantities of target species (if possible).

11. Identification of retained specimens will be conducted by examining each fish externally or with the aid of optical equipment (when necessary) for diagnostic characteristics as described in any of the following references:
    - Hubbs, C.L. & K.F. Lagler, 1958. Fishes of the Great Lakes Region. University of Michigan Press, Ann Arbor, MI. 213p.
    - Smith, C.L. 1985. The Inland Fishes of New York State. NYSDEC, Albany, NY. 522p.
    - Werner, R.G. 1980. Freshwater Fishes of New York State, Syracuse University Press, Syracuse, NY. 186p.

12. Record common names (of standard and unambiguous usage) in the field notebook.

13. For sample preparation, place the fish on the measuring board and measure total fish length. Total length is defined as the distance from the anterior extent of the head to the tip of the longest caudal fin lobe when compressed.

14. Record length to the nearest 0.1 cm in the field notebook. For composite samples, the maximum and minimum length for individuals comprising the sample will be recorded.

15. Calibrate the balances prior to weighing fish from each sample location (balances will be calibrated following manufacturer specifications and procedures.)

16. Zero the balance prior to weighing each fish.

17. Weigh individual fish singularly using one of the following methods:
    a. If using a top-loading balance weigh either directly or in a tared container;
    b. If using a suspended-weight balance weigh either directly or in a mesh bag or other suitable container.

    The minimum mass requirements for the YOY spottail shiner analytical program are 10 grams per sample.

18. Record the total fish weight to the nearest gram in the field notebook. For composite samples, the number of individuals in each composite will also be recorded in the field notebook.

19. Examine each fish for the occurrence and nature of any external anomalies (e.g., general physical condition), including absence or erosion of fins; deformation of any structure; cuts, scars or areas of

regenerated scales; presence of apparent lesions or diseases; and the occurrence of other abnormalities. Record observations in the field notebook.

20. Prepare the samples for shipment to the laboratory. Wrap whole fish and whole fish composite samples in aluminum foil and then freezer paper. Samples will be wrapped with a label containing the appropriate sample information.

21. Select the fish tissue sample preparation procedure (i.e., skin-on fillets, skin-off fillets, remaining carcass, whole-body, whole-body composite) and chemical analysis that the laboratory will follow. Record this information for each fish tissue sample in the field notebook and on the chain-of-custody form. Laboratory preparation of fillet and remaining carcass fish tissue samples will be completed per the guidance below:
    a. NYSDEC Standard Fillet (skin-on, scales-off fillet)
       This consists of the entire fillet and overlying skin. Standard skin-on, scales-off fillets will be prepared for all individual game fish samples (except bullhead and catfish) exceeding 6 inches in length.
    b. NYSDEC Standard Skinned Fillet (skin-off fillet)
       This consists of the entire fillet with the skin and scales (if any) removed. Standard skin-off fillets will be prepared for all individual bullhead samples exceeding 6 inches in length.
    c. Remaining Carcass
       Carcass samples consist of all remaining offal from preparation of NYSDEC Standard and Standard Skinned Fillets. Carcass samples, if included in the analytical program, will be prepared only in conjunction with fillet samples.

22. Prepare samples for shipment to the laboratory following the appropriate packing and shipping with chain-of-custody procedures presented in Appendix B.

References:

Becker, George C. Fishes of Wisconsin. The University of Wisconsin Press, Madison, WI. 1983 (p 540 – 544).

Blasland, Bouck & Lee, Inc. (BBL). Health and Safety Plan for Field Activities at the Grasse River Study Area. 2004.

Scott, W.B. and Crossman, E.J. Freshwater Fishes of Canada Fisheries. Research Board of Canada, Ottawa. 1973.

Attachment C1

Boat-Mounted Electrofishing

This protocol sets forth the proper procedures for performing boat-mounted electrofishing.

Equipment
The following equipment will be available, at a minimum:

- Electrofishing boat;
- Electrodes;
- Gasoline powered generator;
- Control equipment to regulate voltage and current to the electrodes;
- Wiring to provide safe transmission of current under operating conditions;
- Switching, including a switch that keeps the circuit open unless actively and continuously closed (i.e., a "dead-man's" switch);
- Fish collecting equipment such as dip nets with handles of non-conductive material; and
- Safety equipment including life preservers, footwear with non-conductive soles, and non-conducting gloves.

Setup and Checkout
The field crew will set up and test electrofishing equipment in accordance with the procedures specified in the operating manual for the unit(s) employed at the site.

Operation

A. Field Crew
   1. Crew leader will be responsible for:
      - Control of the boat; and
      - Operation of the control equipment and generator.
   2. Field crew member (operator) will be responsible for:
      - Control of the dead-man's switch; and
      - Capturing the fish.

B. Operation
   1. Apply current to the water by closure of the dead-man's switch while the generator and control equipment are operative.
   2. Collect fish in dip nets when seen.

Safety Considerations

A. Sampling will be temporarily halted when any persons, pets, or livestock are observed in the water or on the shore within approximately 40 feet of the electrofishing unit.

B. Sampling will also be halted when any other boats are observed within 150 feet of the electrofishing boat.

Attachment C2

Other Fish Sampling Techniques

This protocol sets forth the proper procedures for performing fish sampling through angling, dip netting, gill netting, and minnow traps.

Equipment

A. Angling
   1. Rod and reel
   2. Bait or artificial lures
   3. Landing net

B. Dip Netting
   1. Dip net (a bag formed of netting, which is attached to a single handle). The bag usually contains a rigid frame around the opening of the bag to hold it open.

C. Gill Netting
   1. Gill Net (a rectangular net similar to a seine net of specific mesh size to capture the target species).

D. Minnow Traps
   1. Minnow traps
   2. Bait

Operation

A. Angling

In the event angling is used, the field crew will adhere to the relevant regulations defined by the general fishing licenses/laws and/or collecting permit. Angling involves the use of bait or artificial lures. The nature of the gear, the bait or lures, the method of use, the time of sampling, and the length of sampling time will depend on the collecting conditions and the target groups.

B. Dip Netting
   1. Note the dimensions of the bag of the net, the mesh of the netting, the length of the handle, and the precise mode of operation in the field notebook.
   2. Scoop fish in net from shallow water, while wading, or operating from a boat, or hold net in place while fish are chased into the net.
   3. Use nets in conjunction with other techniques (e.g., to collect fish stunned by electrofishing).

C. Gill Netting
   1. Note the dimensions of the net, the mesh of the netting and the specific location of operation.
   2. Extend the net perpendicular to the anticipated movement of fish and leave set for a period of time.
   3. Retrieve the net and remove captured fish.

D. Minnow Traps
   1. Note the location of the trap in the field notebook.
   2. Secure the trap by rope to a stationary object on the streambank or a float.
   3. Bait trap.
   4. Place trap underwater for a period of time.
   5. Retrieve trap and remove captured biota.

Appendix D

Sediment Sampling Procedures

Appendix D

Sediment Sampling Procedures

This protocol sets forth the field procedures for the collection of sediment via Lexan® tubing and grab samples using a hand-held dredge from the Grasse River.

Materials
The following materials will be available, as required, during sediment sampling:

- Health and safety equipment (as required by the Health and Safety Plan [BBL, 2004]);
- Cleaning equipment;
- Disposable aluminum pans;
- Disposable spatulas;
- Appropriate sample containers and forms;
- Coolers with ice;
- Field notebook;
- Anchor;
- Boat and motor;
- Rope;
- Survey's rod;
- Duct tape;
- Lexan® tubing with end caps;
- Push rod;
- Hacksaw;
- Steel core driver;
- Vacuum pump;
- Piston sampler/check valve push core device; and
- Six-foot rule.

Sampling Procedures
The following procedures will be used to collect sediment samples.

1. Don health and safety equipment (as required in the Health and Safety Plan).

2. Clean reusable sampling equipment as follows: non-phosphate detergent and distilled water wash; distilled water rinse; rinse equipment with solvent (hexane); distilled water rinse; allow to air dry and wrap in aluminum foil.

3. Use DGPS surveying techniques to locate the proposed sample location and position the boat with anchors.

4. Identify the proposed sample location in the field notebook along with other appropriate information collected during sediment sampling activities.

5. Measure the total depth of the water using a surveyor’s rod to the nearest 0.1 foot.

6. At each sample location, lower a section of Lexan® tube until it just reaches the top of the sediment. (Sections of Lexan® tube may need to be spliced together or the Lexan® tube may be attached to a check valve core device).

7. Push the Lexan® tube with a straight vertical entry into the sediment so as to secure a reliably representative core sample. Measure the depth of sediment.

8. Drive the tube until refusal using a steel core drive and measure the additional distance. (This procedure is performed to obtain a "plug" at the bottom of the core and prevent the loose sediment from escaping.)

9. Place a vacuum pump on the top end of the Lexan® tube and create a vacuum to prevent the sediment from escaping (note this is not needed if using a check valve core device).

10. Slowly pull the tube from the sediment, twisting it slightly as it is removed (if necessary).

11. Before the tube is fully removed from the water, place a cap on the bottom end of the tube while it is still submerged.

12. Keeping the tube upright, wipe the bottom end dry and seal the end with duct tape and label. Measure the length of sediment recovered and evaluate the integrity of the core. If additional cores are necessary to obtain a sufficient sample, repeat the coring procedure at the location adjacent to the previous one sampled.

13. While keeping the core upright, use a hacksaw to make a horizontal cut in the tube approximately one inch above the sediment.

14. Re-cap the cut end of the tube, seal the cap with duct tape, and mark this end as "top".

15. Wipe the tube dry.

16. If sample sectioning is required, slice tube open or push sediment from the tube and slice according to appropriate segmenting scheme.

17. Homogenize samples in a disposable aluminum pan.

18. Place homogenized sample in appropriate sample containers and cap.

19. Label all sample containers.

20. Place filled sample containers on ice in a cooler.

21. Follow procedures for packing, handling, and shipping with associated chain-of-custody procedures of samples as set forth in Appendix B.

22. Record required information on the appropriate forms and/or field notebook.

23. Field duplicate and MS/MSD samples will be obtained for every 20 sediment samples collected.

As an alternative sampling method, steps 6 through 15 may be replaced with steps a through g, as follows:

a. At each sample location, drop open dredge from side of boat making sure that the end of the rope is maintained at all times.

b. Once the dredge has been allowed to settle into the bottom sediment, a hard pull on the rope will close the sediment inside the dredge.

c. Retrieve the dredge into the boat.

d. Open the dredge to allow the sediment to empty onto a stainless steel tray or bowl.

e. Multiple casts will be made and composited at each location until sufficient sample volume is obtained.

f. Observe the sample and record descriptions in the field notebook.

g. If chemical laboratory analyses are being performed, rinse blanks will be obtained by pouring de-ionized water supplied by the Alcoa Massena Operation ChemLab through a cleaned stainless steel dredge onto a cleaned stainless steel tray. From the tray, the appropriate sample containers will be filled. Rinse blanks should be collected at the start and finish of sampling activities.

References:

Blasland, Bouck & Lee, Inc. (BBL). Health and Safety Plan for Field Activities at the Grasse River Study Area. 2004.

CDM Geotechnical Laboratory

AASHTO R18

Memorandum

To: *Kelly Clawson*

From: *Kurt Sjoblom, Ph.D.*

Date: *July 15, 2004*

Subject: *Geotechnical Laboratory Testing Results*
ALCOA-Grain Size Analysis 2003-2004
Massena, NY
1902-41247-HYD

Enclosed is the ***final*** laboratory report for testing of the sample(s) received on June 1, 2004.

It should be noted that the test specimen(s) used for this report was/were believed to be representative of the material produced under the designation herein stated. However, these results are indicative of only the specimens that were actually tested. The testing herein is based upon accepted industry practice as well as the test method listed. The **CDM Geotechnical Engineering Laboratory** neither accepts responsibility for nor makes claim to the final use and purpose of the material.

The test data and all associated project information shall be held in confidence and disclosed to other parties only with the authorization of the Client or Client Officer.

It is the laboratory policy to keep any remaining tested materials for 2 weeks after issue of this report. Materials untested will not be archived. Should the need arise for longer storage time, please advise the laboratory in writing.

If you have any questions concerning testing results and or procedures please feel free to contact the laboratory at 617-452-6801.

The tests were performed in accordance with the following standard(s):

- Standard Test Method for Particle-Size Analysis of Soils (ASTM D422);
- Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (ASTM D2216).

Please contact me if you have any questions regarding the test results.

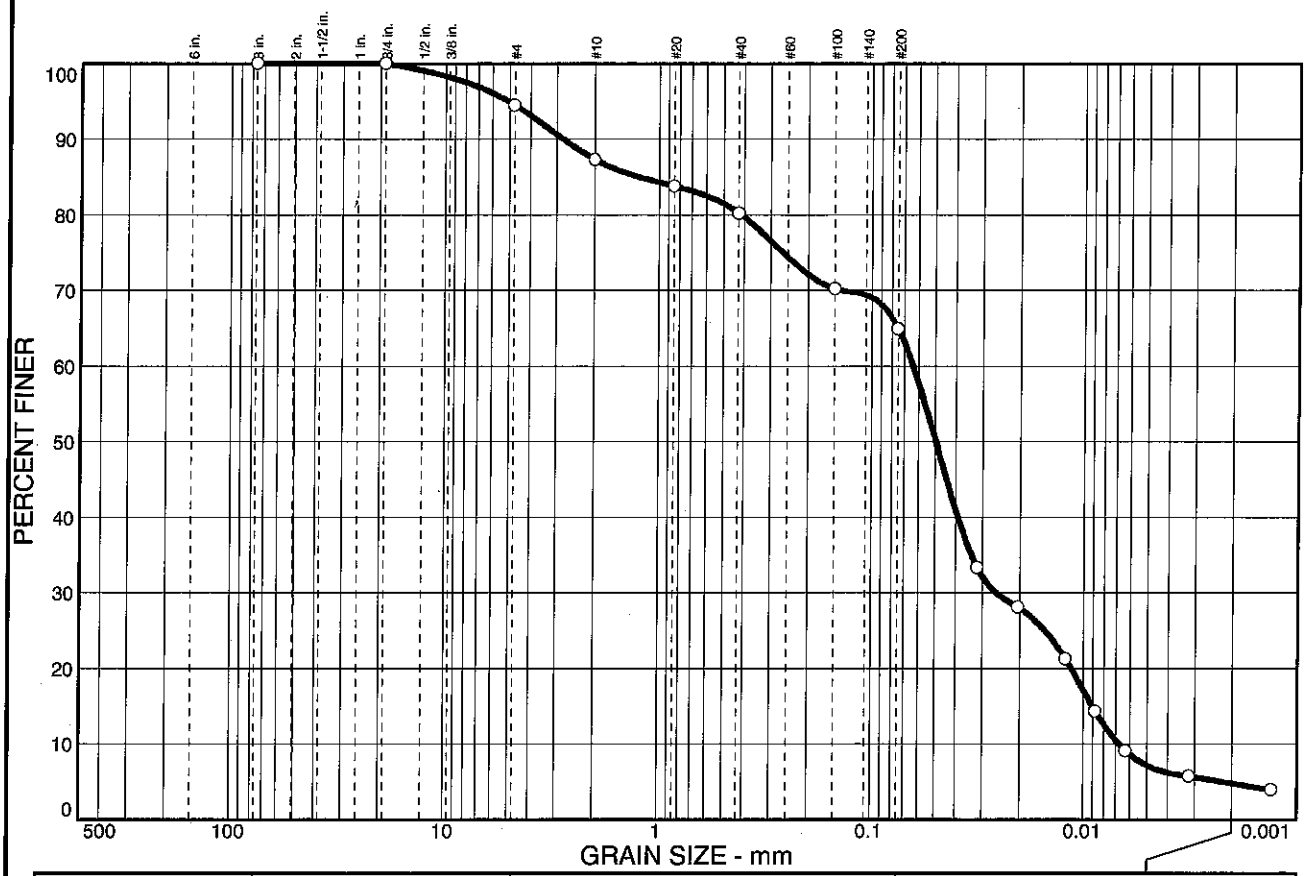
Thank you.

Digital Signature

δ Kurt J. Sjoblom

Digitally signed by Kurt J. Sjoblom
DN: CN = Kurt J. Sjoblom, C = US, O = CDM, OU = GTSLAB
Reason: I attest to the accuracy and integrity of this document
Date: 2004.07.20 11:10:35 -04'00'

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	5.5	7.2	7.1	15.3	60.1	4.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	94.5		
#10	87.3		
#20	83.8		
#40	80.2		
#100	70.2		
#200	64.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 1.24 D_{60}= 0.0639 D_{50}= 0.0499
D_{30}= 0.0259 D_{15}= 0.0091 D_{10}= 0.0068
C_u= 9.42 C_c= 1.54

Classification

USCS= ML AASHTO= --

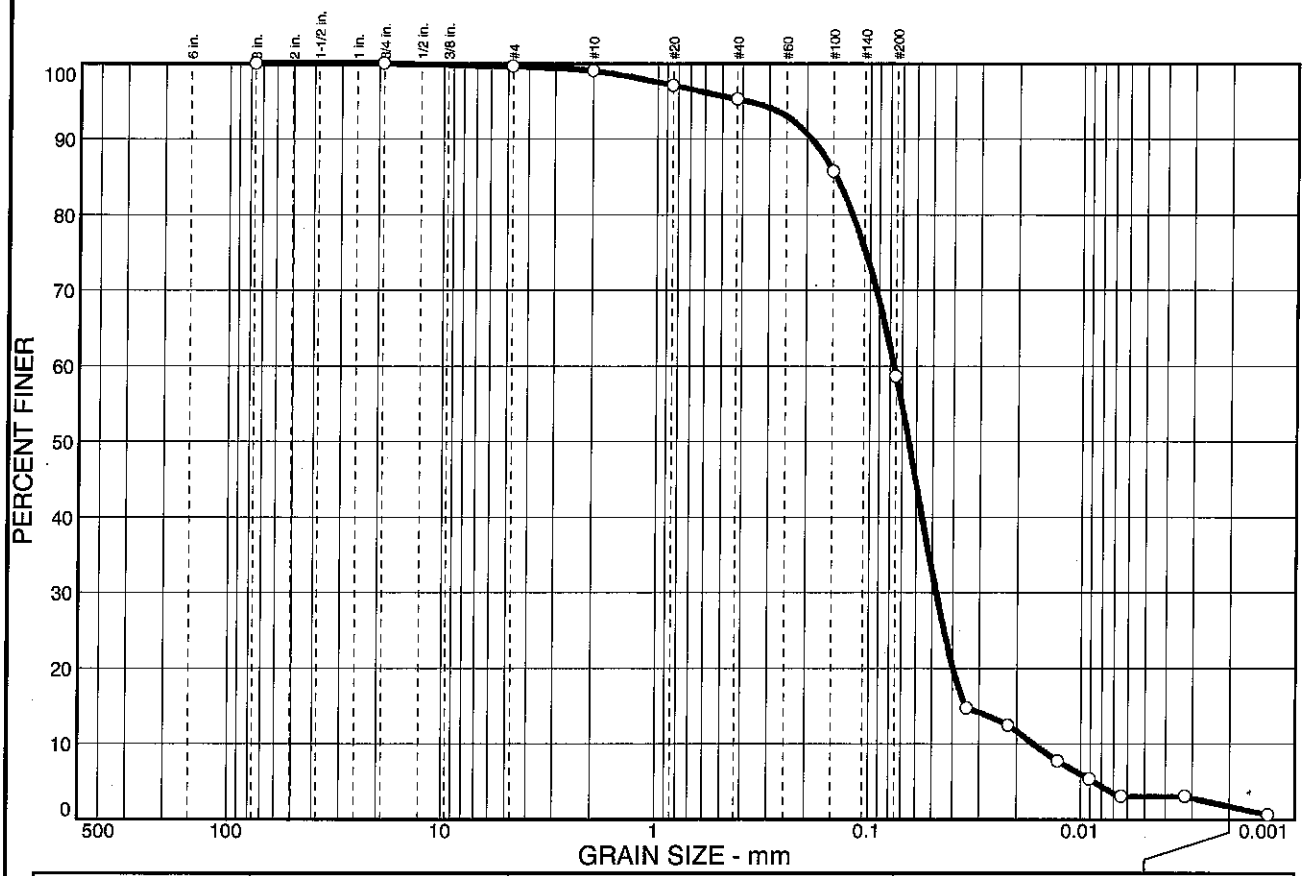
Remarks

As received moisture content = 171.0%
Soil classification and description based
on Visual-Manaul Procedure (ASTM-D2488)

Sample No.: SED-DUP28-28 **Source of Sample:** **Date:** 5/27/04
Location: DUP28 **Elev./Depth:**

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	0.6	3.7	36.7	56.9	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.6		
#10	99.0		
#20	97.1		
#40	95.3		
#100	85.7		
#200	58.6		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.146 D_{60}= 0.0768 D_{50}= 0.0654
D_{30}= 0.0482 D_{15}= 0.0348 D_{10}= 0.0167
C_u= 4.60 C_c= 1.81

Classification

USCS= ML AASHTO= --

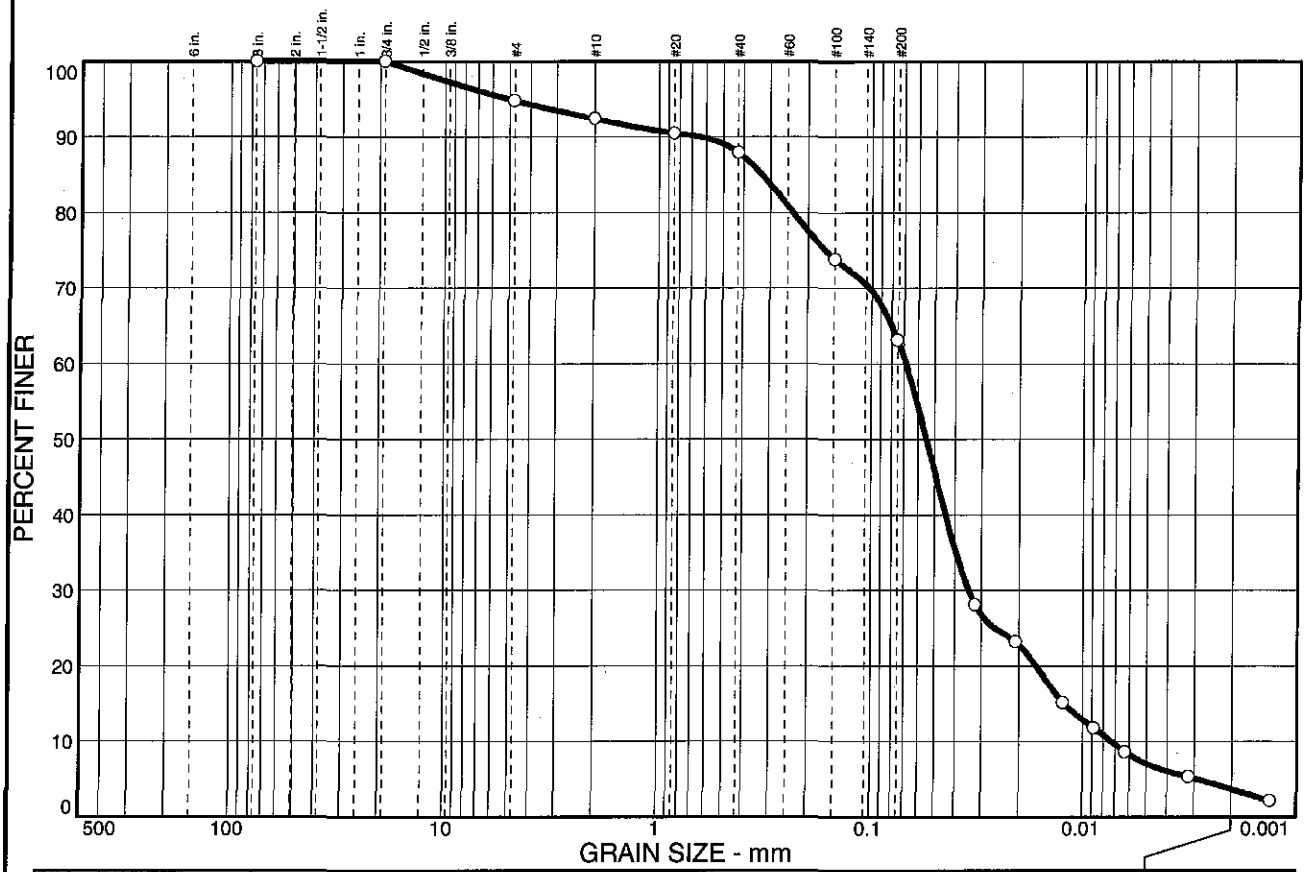
Remarks

As received moisture content = 221.2%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP30-30 **Source of Sample:** **Date:** 5/27/04
Location: DUP30 **Elev./Depth:**

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	5.2	2.4	4.5	24.8	59.4	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	94.8		
#10	92.4		
#20	90.5		
#40	87.9		
#100	73.8		
#200	63.1		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.330 D_{60}= 0.0688 D_{50}= 0.0549
D_{30}= 0.0345 D_{15}= 0.0122 D_{10}= 0.0073
C_u= 9.38 C_c= 2.36

Classification

USCS= ML AASHTO= --

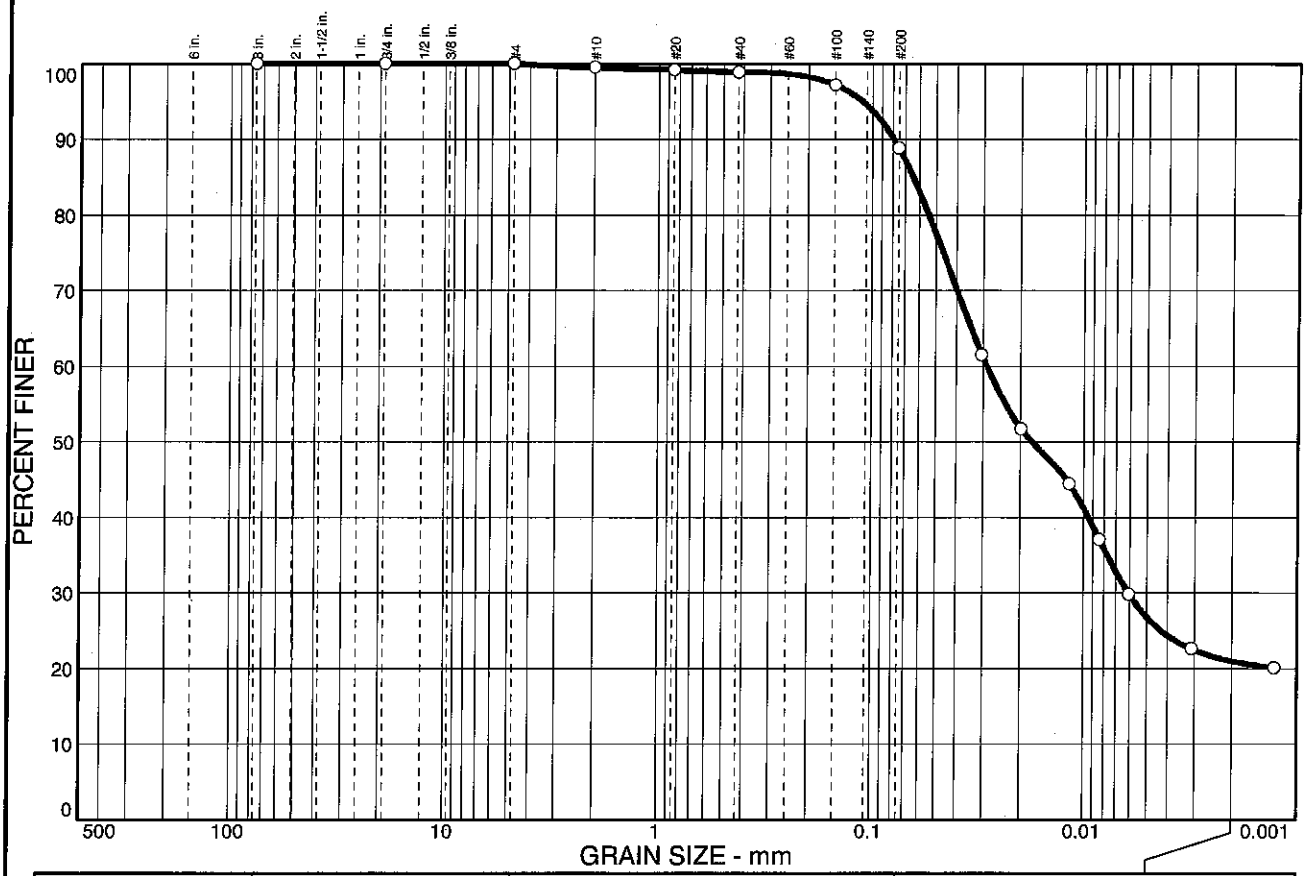
Remarks

As received moisture content = 230.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-3036 **Source of Sample:** **Date:** 5/27/04
Location: T37NC **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.5	0.6	10.1	67.8	21.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.5		
#20	99.2		
#40	98.9		
#100	97.2		
#200	88.8		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0644 D_{60}= 0.0288 D_{50}= 0.0176
D_{30}= 0.0061 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

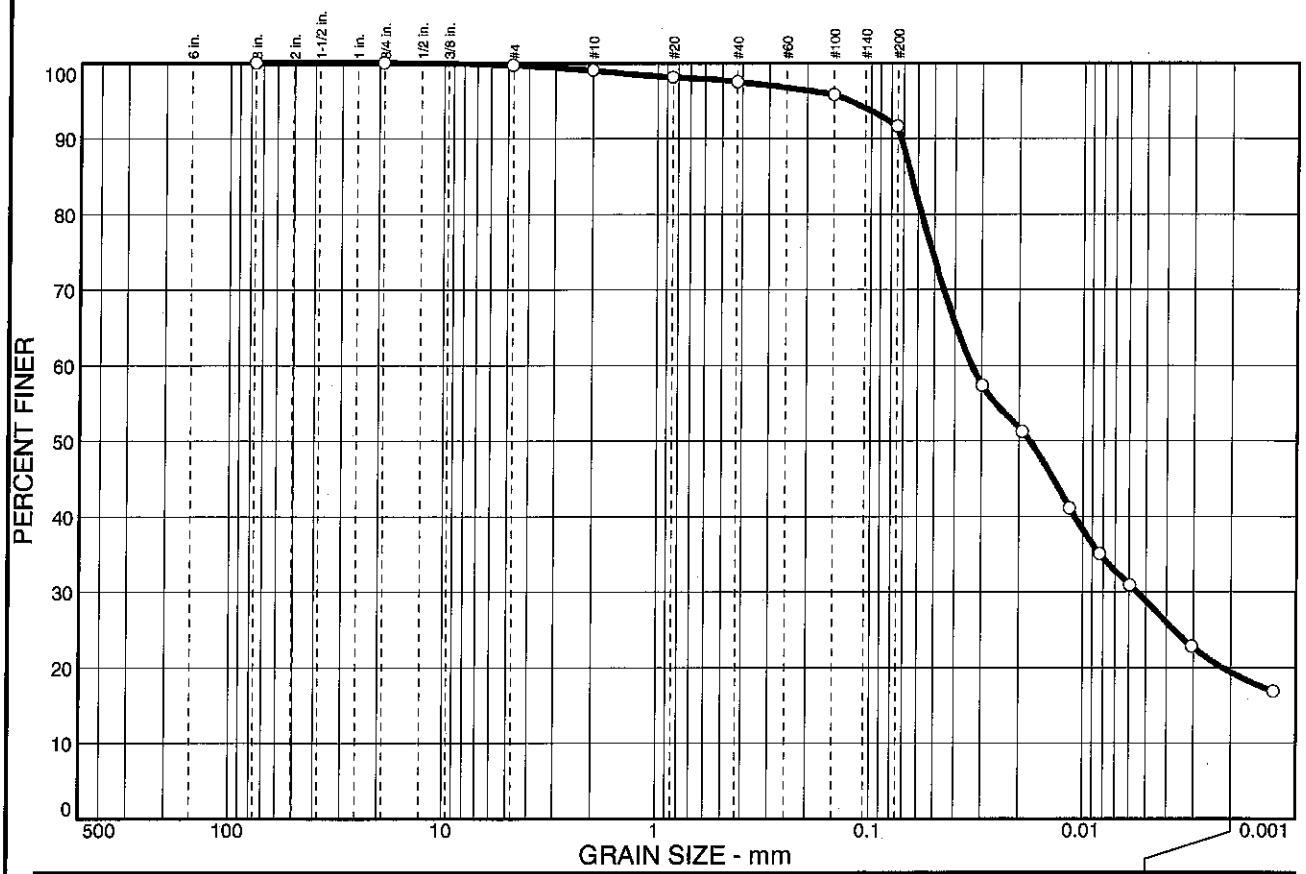
Remarks

As received moisture content = 221.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-ND-0612 **Source of Sample:** **Date:** 5/27/04
Location: T37ND **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.7	1.5	5.9	72.3	19.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.0		
#20	98.1		
#40	97.5		
#100	95.8		
#200	91.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0647 D_{60}= 0.0334 D_{50}= 0.0178
D_{30}= 0.0055 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

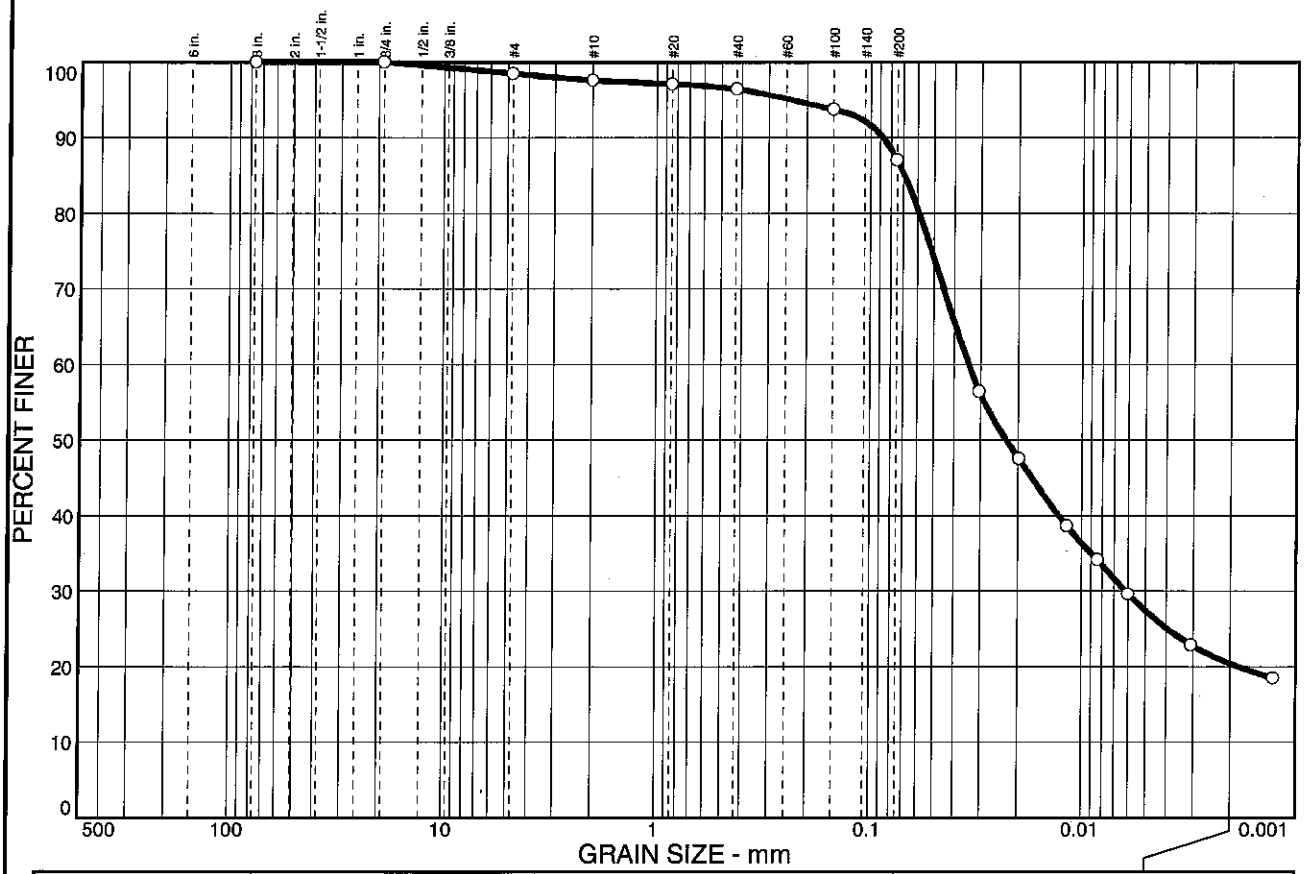
Remarks

As received moisture content = 168.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-ND-1218 **Source of Sample:** **Date:** 5/27/04
Location: T37ND **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.5	0.9	1.2	9.4	66.6	20.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.5		
#10	97.6		
#20	97.1		
#40	96.4		
#100	93.7		
#200	87.0		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0694 D_{60}= 0.0342 D_{50}= 0.0228
D_{30}= 0.0062 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

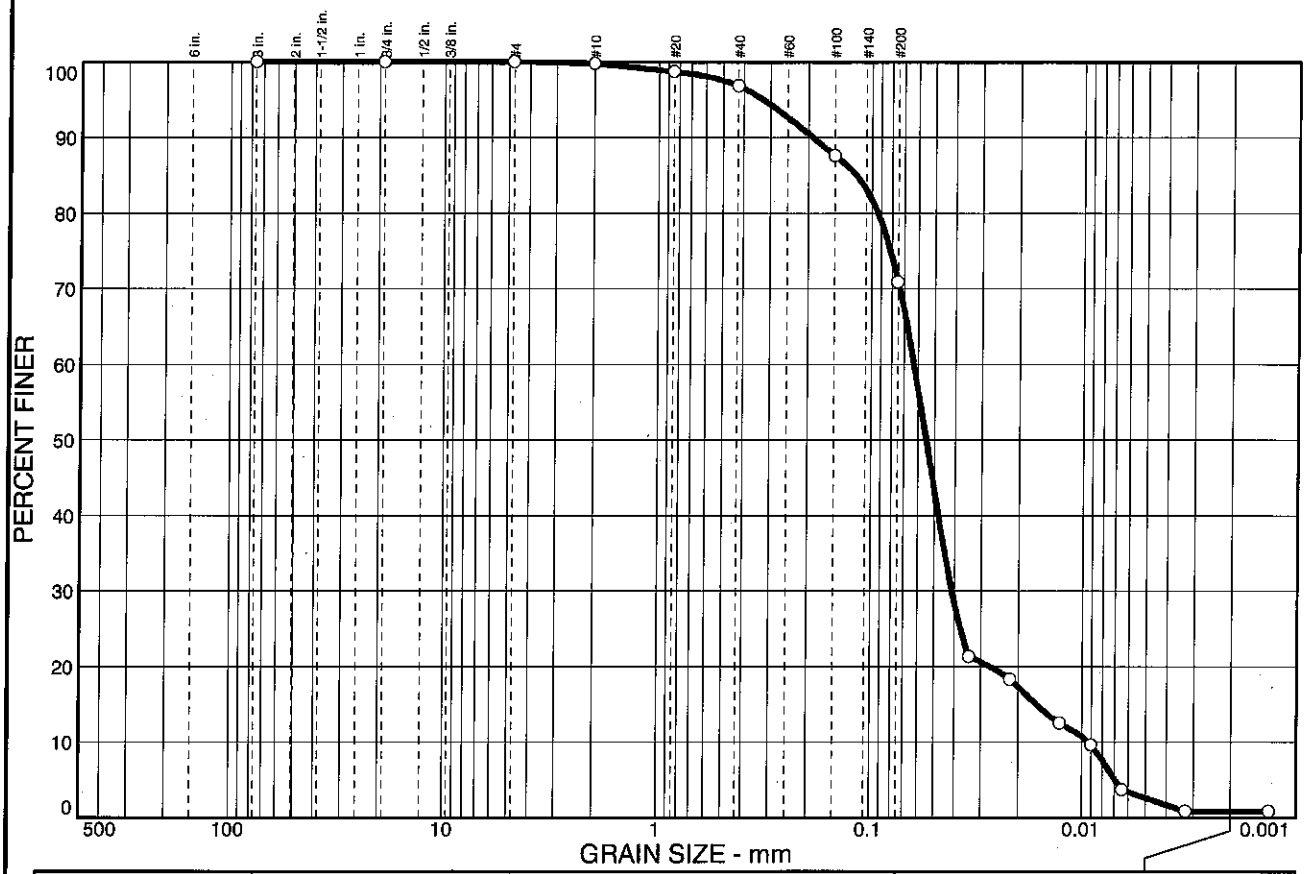
Remarks

As received moisture content = 203.6%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-ND-1826 **Source of Sample:** **Date:** 5/27/04
Location: T37ND **Elev./Depth:** 18-26

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	3.0	25.9	70.1	0.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	98.7		
#40	96.8		
#100	87.6		
#200	70.9		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.119 D_{60}= 0.0631 D_{50}= 0.0550
D_{30}= 0.0413 D_{15}= 0.0164 D_{10}= 0.0093
C_u= 6.78 C_c= 2.91

Classification

USCS= ML AASHTO= --

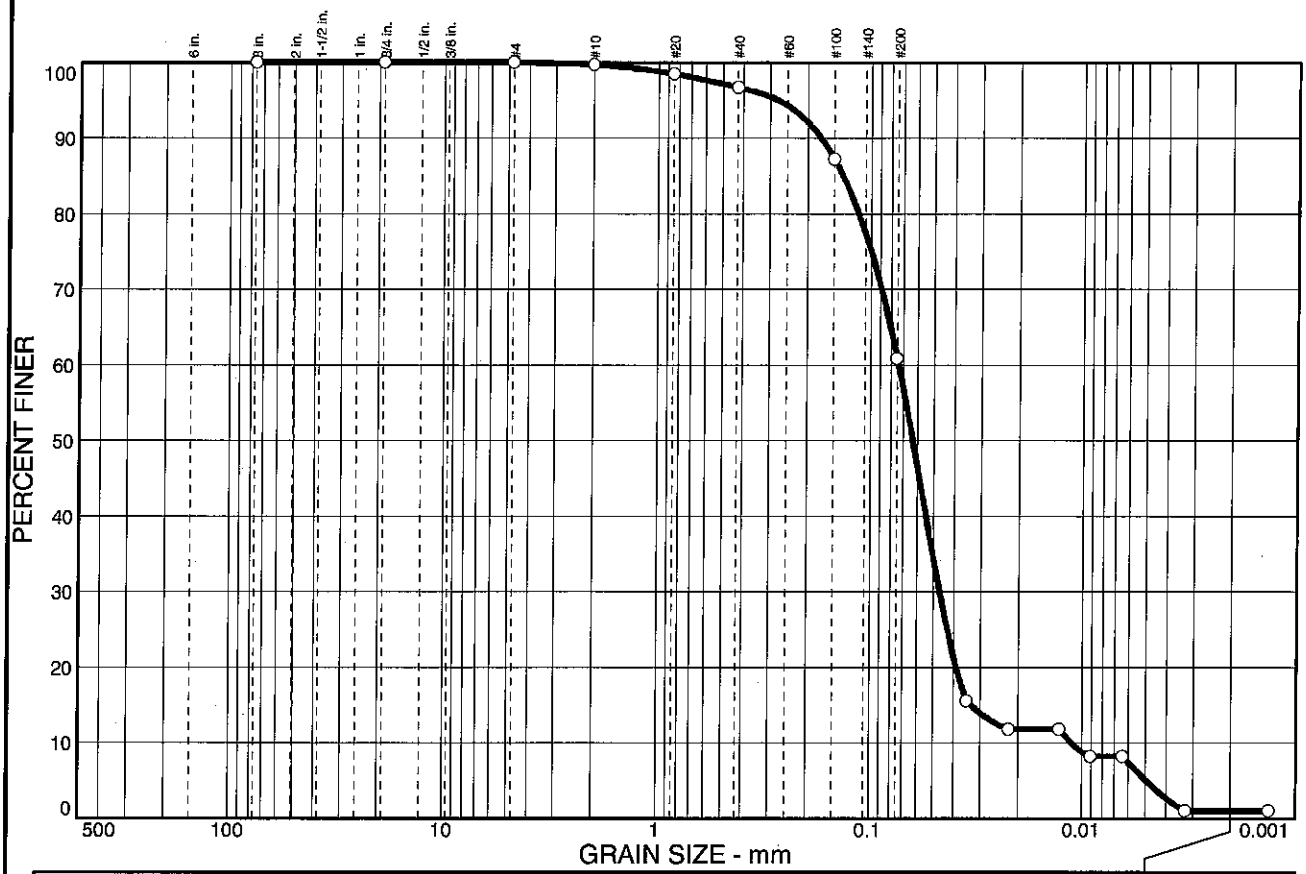
Remarks

As received moisture content = 301.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NE-0003 **Source of Sample:** **Date:** 5/27/04
Location: T37NE **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.3	3.0	35.9	59.8	1.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.7		
#20	98.5		
#40	96.7		
#100	87.2		
#200	60.8		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.136 D_{60}= 0.0740 D_{50}= 0.0633
D_{30}= 0.0469 D_{15}= 0.0333 D_{10}= 0.0112
C_u= 6.63 C_c= 2.67

Classification

USCS= ML AASHTO= --

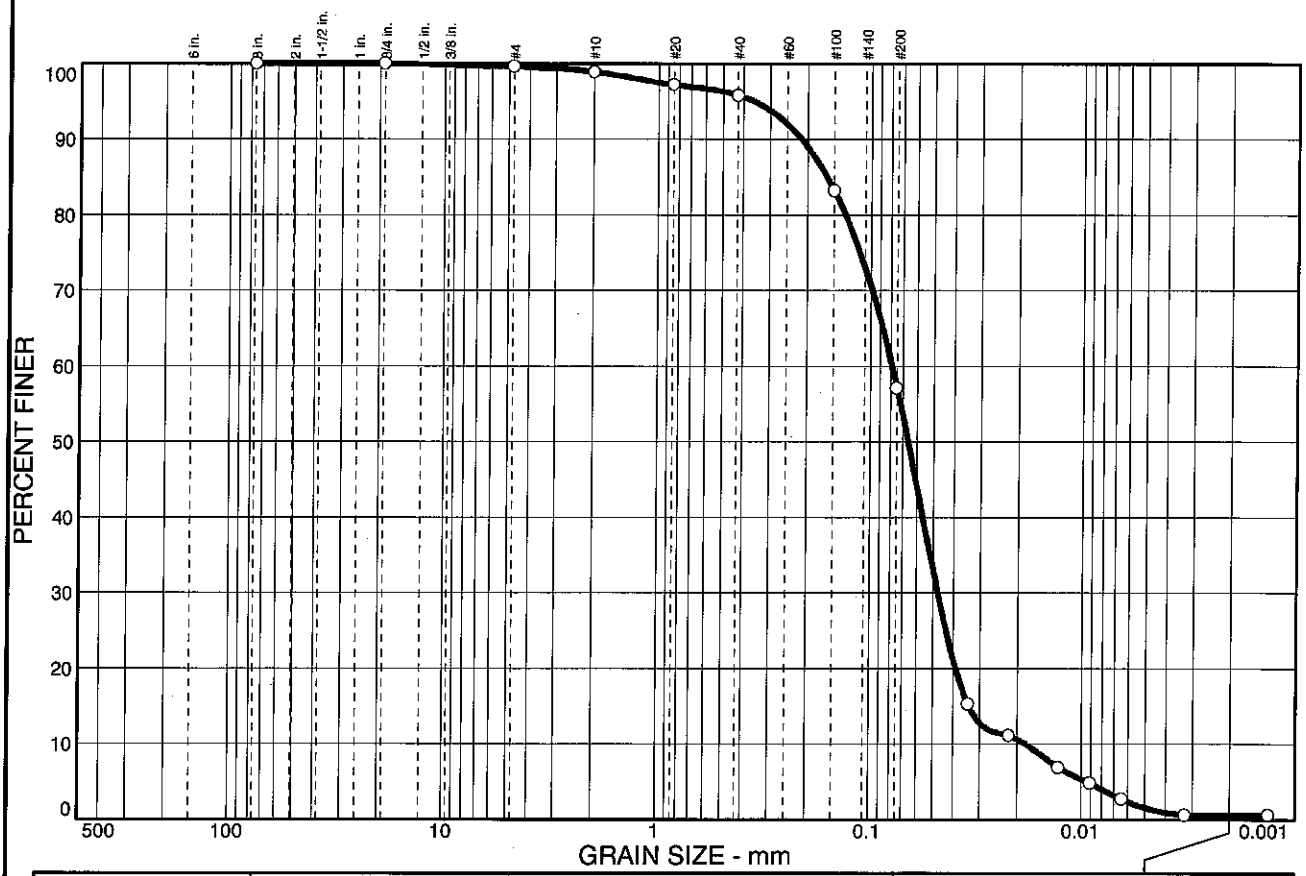
Remarks

As received moisture content = 178.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NE-0306 **Source of Sample:** **Date:** 5/27/04
Location: T37NE **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	0.7	3.1	38.7	56.5	0.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.6		
#10	98.9		
#20	97.2		
#40	95.8		
#100	83.2		
#200	57.1		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.162 D_{60}= 0.0792 D_{50}= 0.0663
D_{30}= 0.0477 D_{15}= 0.0338 D_{10}= 0.0183
C_u= 4.33 C_c= 1.57

Classification

USCS= ML AASHTO= --

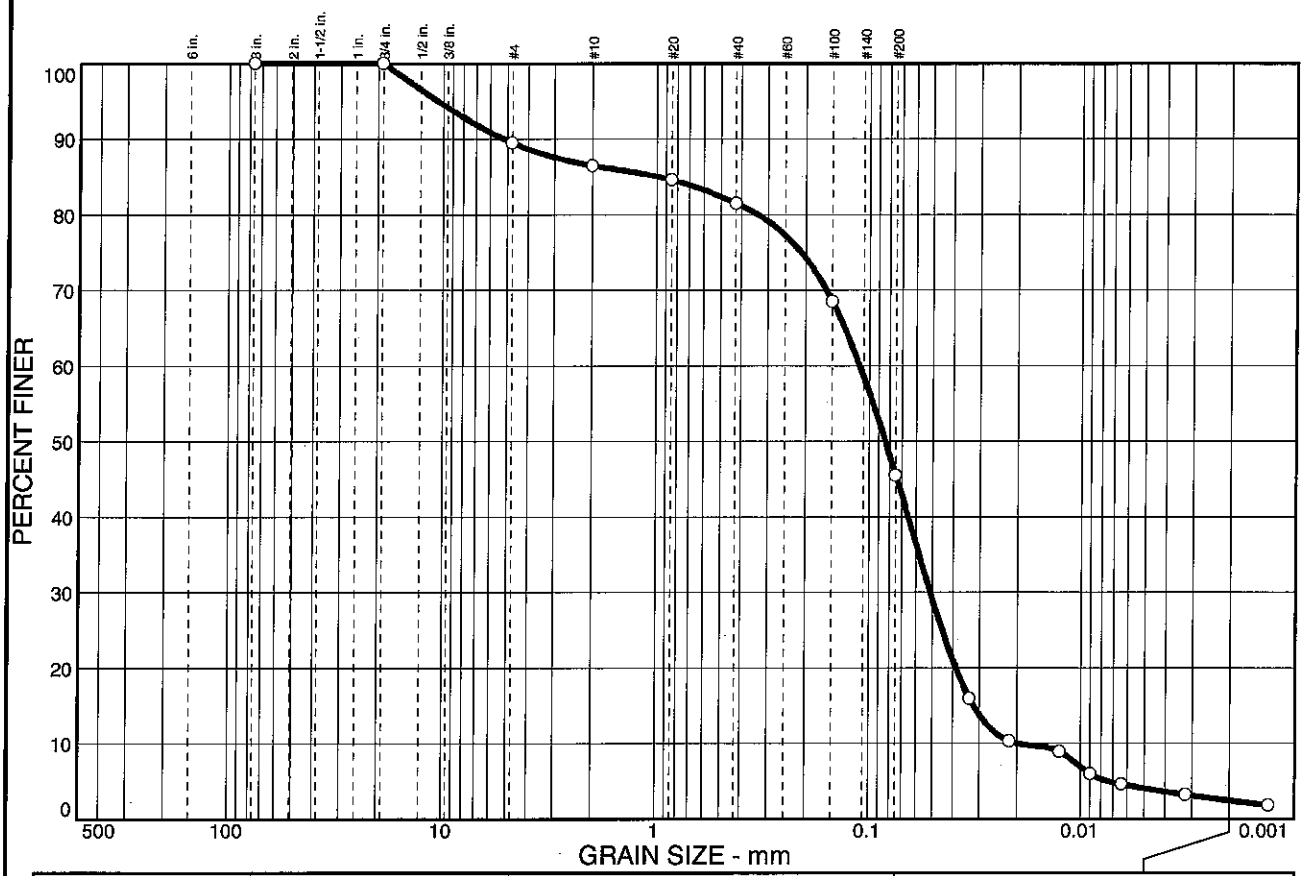
Remarks

As received moisture content = 195.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NE-0612 **Source of Sample:** **Date:** 5/27/04
Location: T37NE **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	10.5	3.0	5.0	36.0	43.1	2.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	89.5		
#10	86.5		
#20	84.6		
#40	81.5		
#100	68.5		
#200	45.5		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.978 D_{60}= 0.111 D_{50}= 0.0841
D_{30}= 0.0514 D_{15}= 0.0320 D_{10}= 0.0199
C_u= 5.61 C_c= 1.19

Classification

USCS= SM AASHTO= --

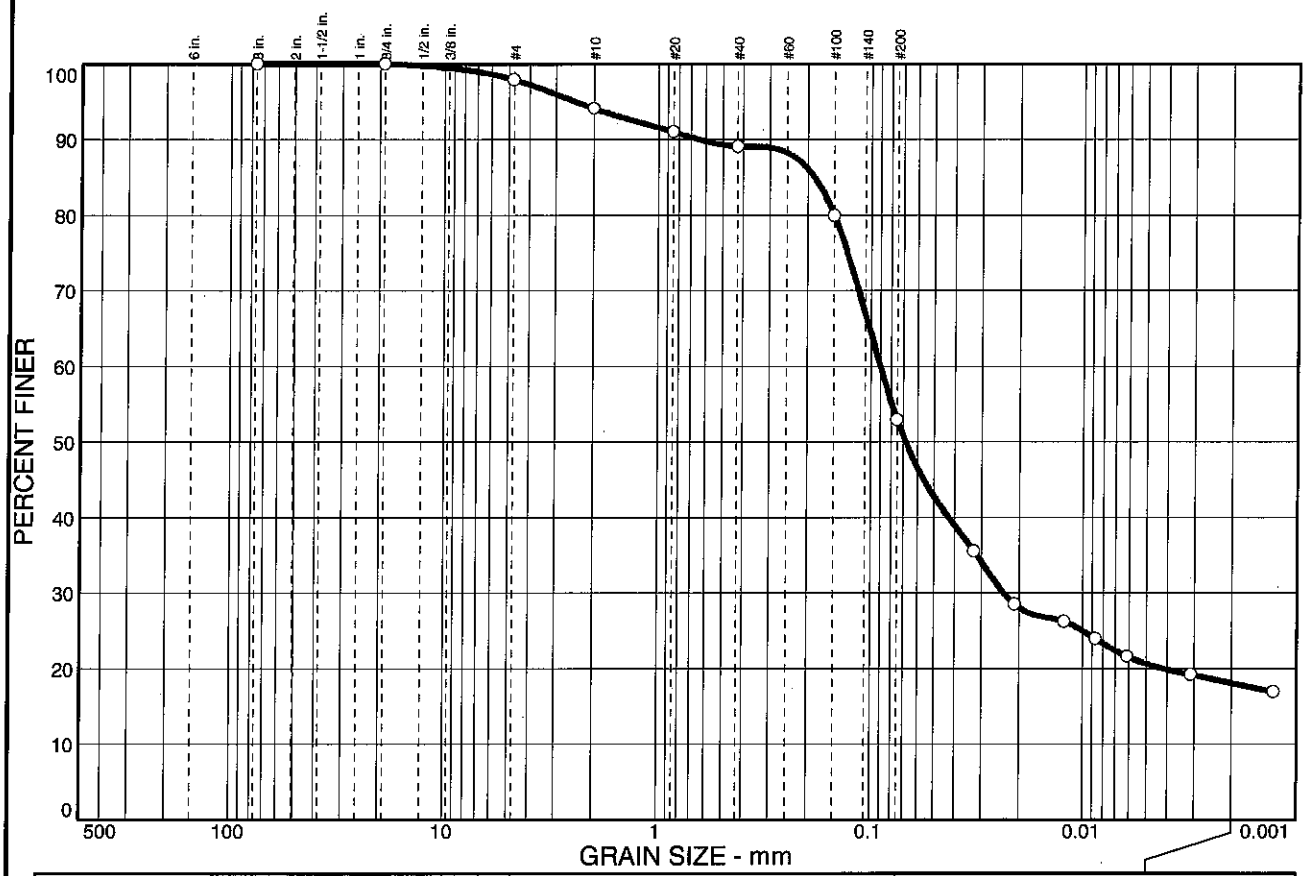
Remarks

As received moisture content = 115.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NE-1218 **Source of Sample:** **Date:** 5/27/04
Location: T37NE **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	2.1	3.8	5.0	36.2	34.8	18.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	97.9		
#10	94.1		
#20	91.0		
#40	89.1		
#100	79.9		
#200	52.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.186 D_{60}= 0.0904 D_{50}= 0.0684
D_{30}= 0.0236 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

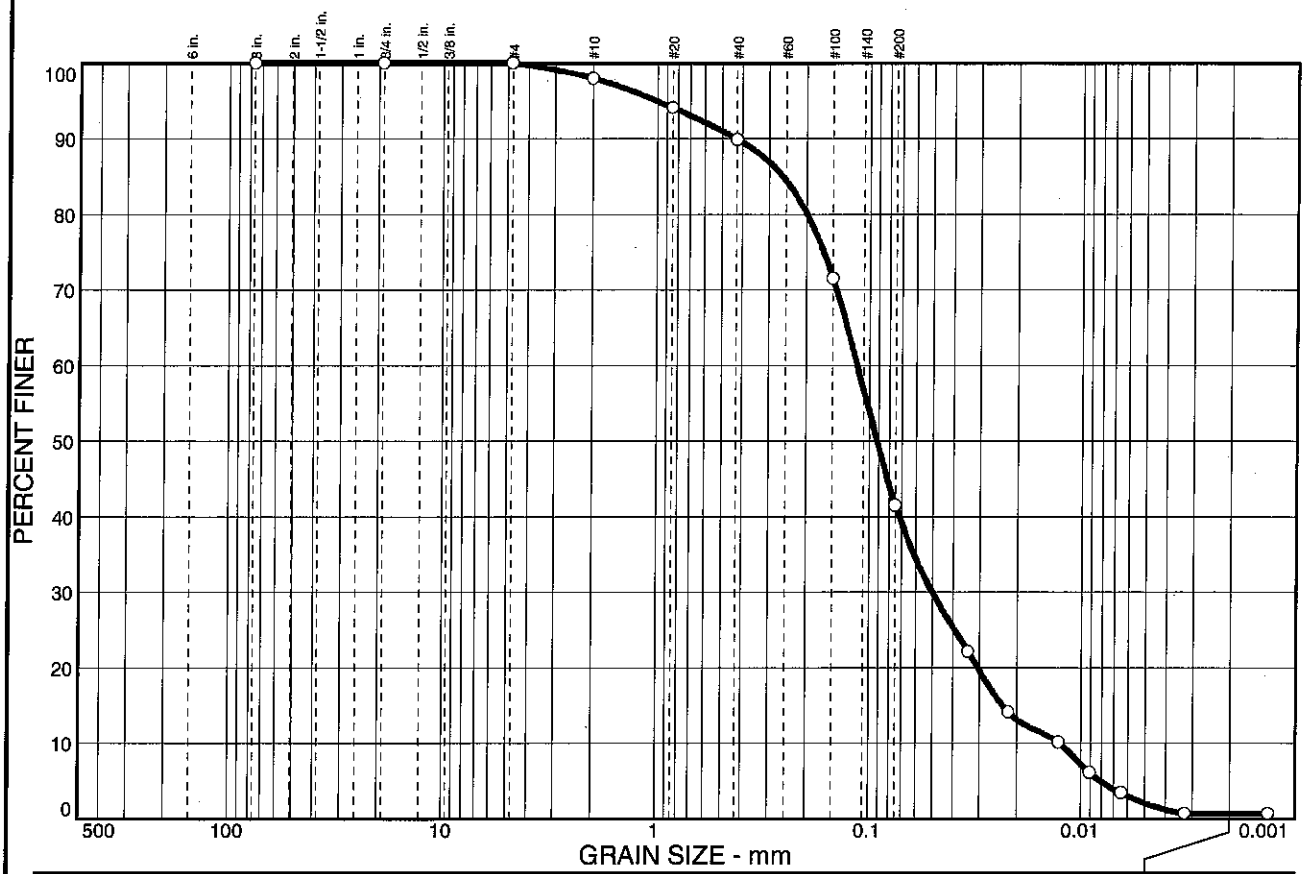
Remarks

As received moisture content = 227.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NG-0003 **Source of Sample:** **Date:** 5/27/04
Location: T37NG **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	2.0	8.1	48.4	40.8	0.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	98.0		
#20	94.1		
#40	89.9		
#100	71.5		
#200	41.5		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.259 D_{60}= 0.114 D_{50}= 0.0920
D_{30}= 0.0503 D_{15}= 0.0234 D_{10}= 0.0126
C_u= 9.08 C_c= 1.75

Classification

USCS= SM AASHTO= --

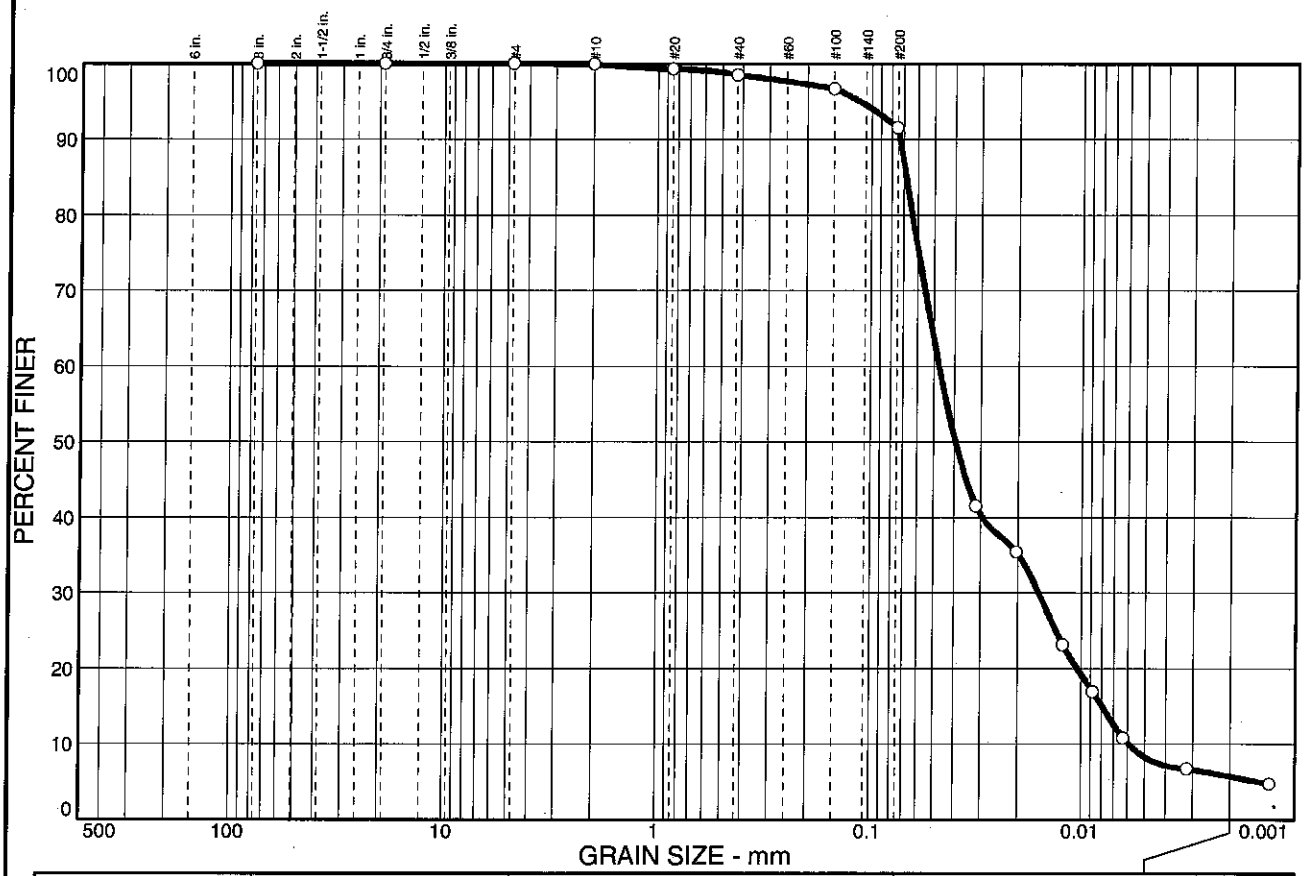
Remarks

As received moisture content = 171.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NG-0306 **Source of Sample:** **Date:** 5/27/04
Location: T37NG **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.4	7.0	85.8	5.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.3		
#40	98.5		
#100	96.7		
#200	91.5		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0686 D_{60}= 0.0475 D_{50}= 0.0396
D_{30}= 0.0159 D_{15}= 0.0080 D_{10}= 0.0060
C_u= 7.97 C_c= 0.90

Classification

USCS= ML AASHTO= --

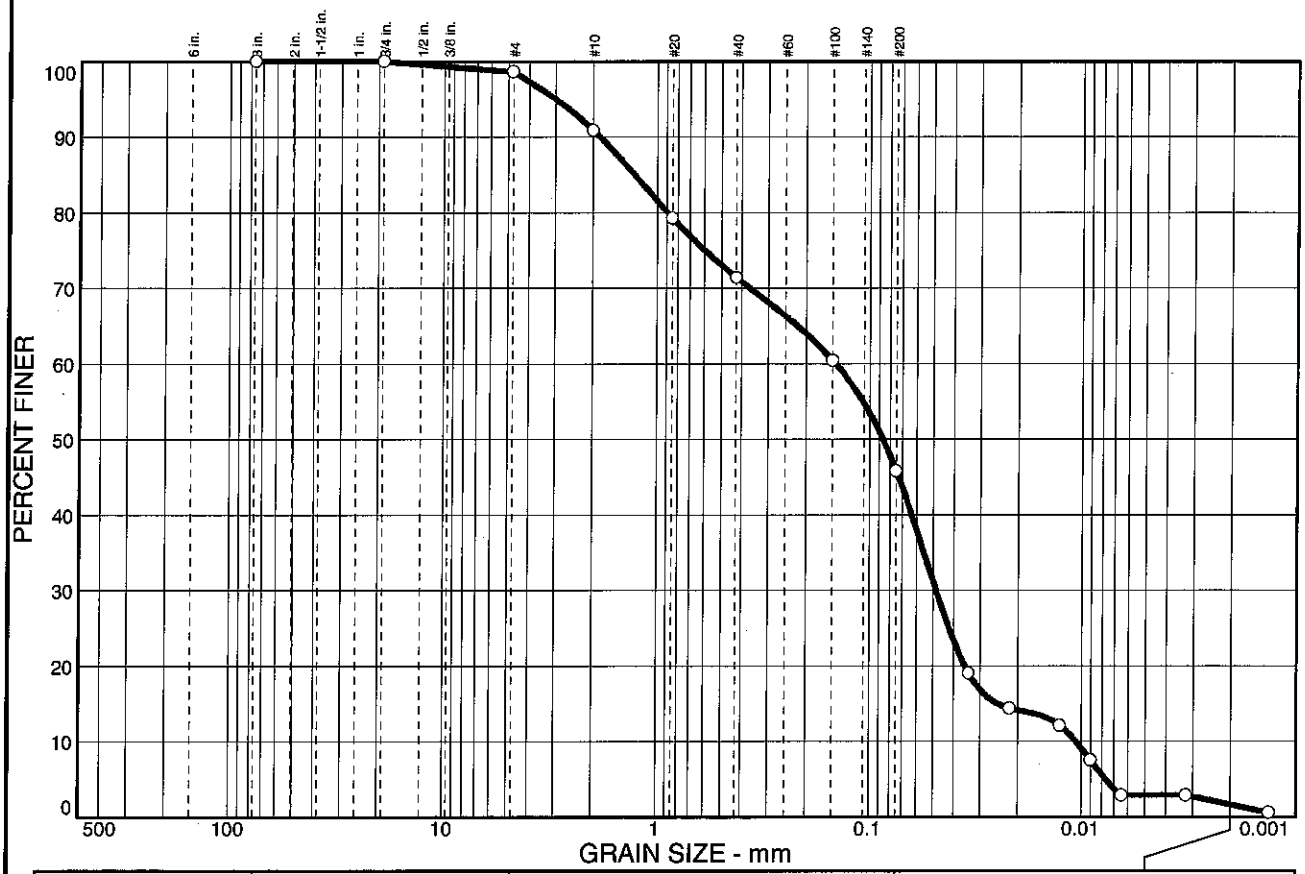
Remarks

As received moisture content = 207.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NG-1218 **Source of Sample:** **Date:** 5/27/04
Location: T37NG **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.4	7.7	19.5	25.6	44.1	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.6		
#10	90.9		
#20	79.3		
#40	71.4		
#100	60.4		
#200	45.8		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 1.28 D_{60}= 0.146 D_{50}= 0.0867
D_{30}= 0.0487 D_{15}= 0.0248 D_{10}= 0.0106
C_u= 13.72 C_c= 1.53

Classification

USCS= SM AASHTO= --

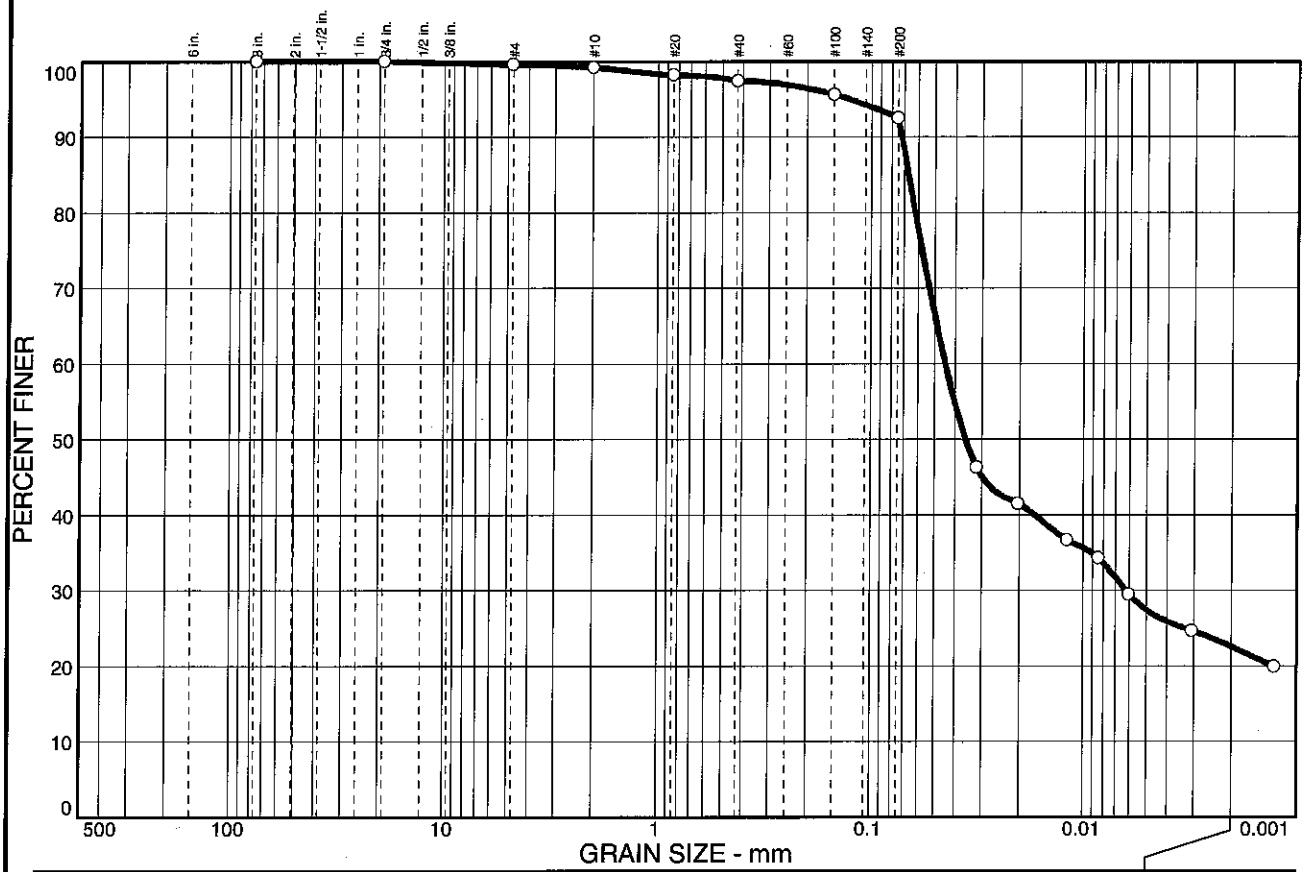
Remarks

As received moisture content = 206.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NG-1827 **Source of Sample:** **Date:** 5/27/04
Location: T37NG **Elev./Depth:** 18-27

CDM Jessberger Geotechnical Engineering Laboratory	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	0.4	1.8	4.9	69.9	22.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.6		
#10	99.2		
#20	98.2		
#40	97.4		
#100	95.6		
#200	92.5		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0671 D_{60}= 0.0448 D_{50}= 0.0358
D_{30}= 0.0063 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

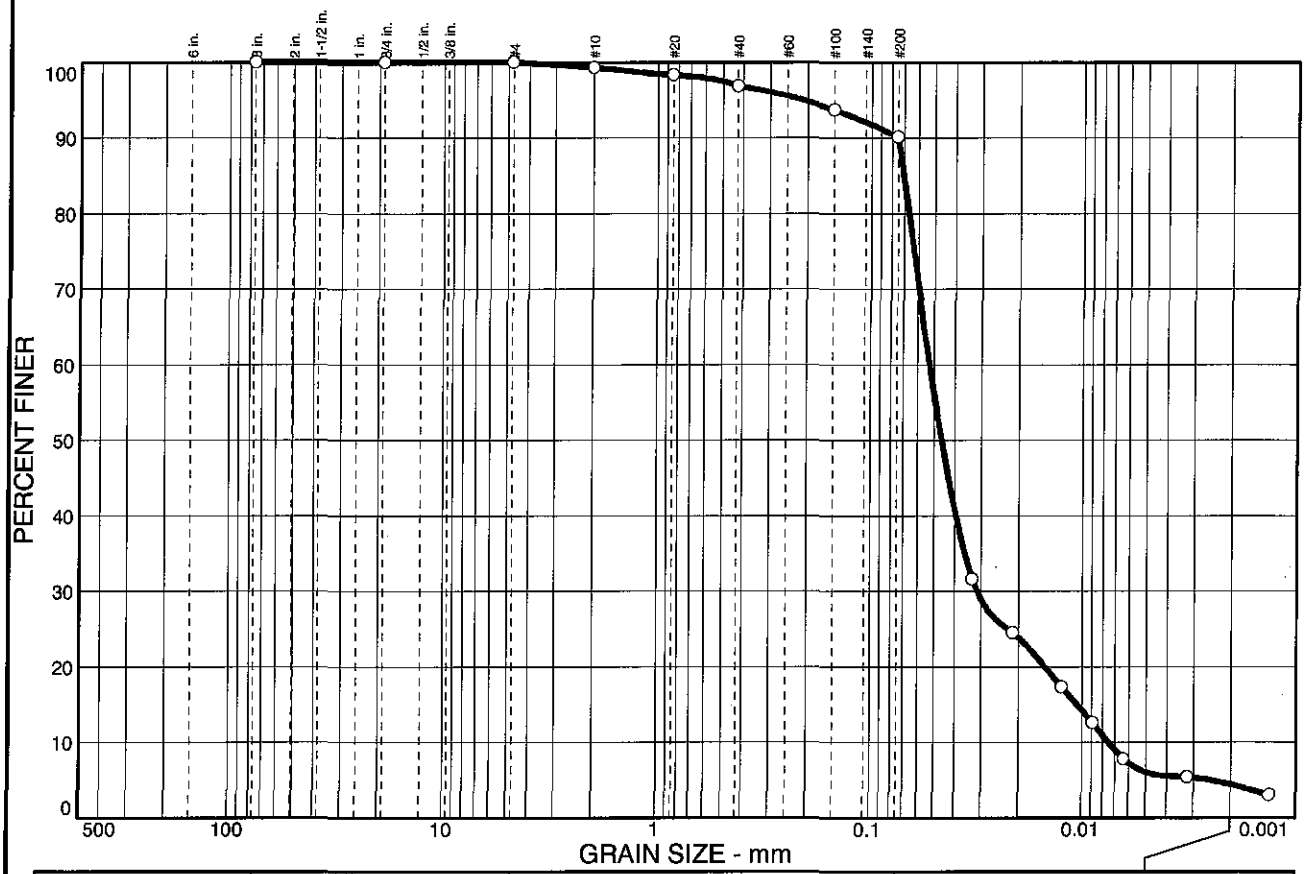
Remarks

As received moisture content = 223.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NE-0003 **Source of Sample:** **Date:** 5/25/04
Location: T71NE **Elev./Depth:** 00-03

CDM Jessberger Geotechnical Engineering Laboratory	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.7	2.5	6.7	85.7	4.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.3		
#20	98.3		
#40	96.8		
#100	93.7		
#200	90.1		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0708 D_{60}= 0.0529 D_{50}= 0.0463
D_{30}= 0.0313 D_{15}= 0.0106 D_{10}= 0.0075
C_u= 7.02 C_c= 2.46

Classification

USCS= ML AASHTO= --

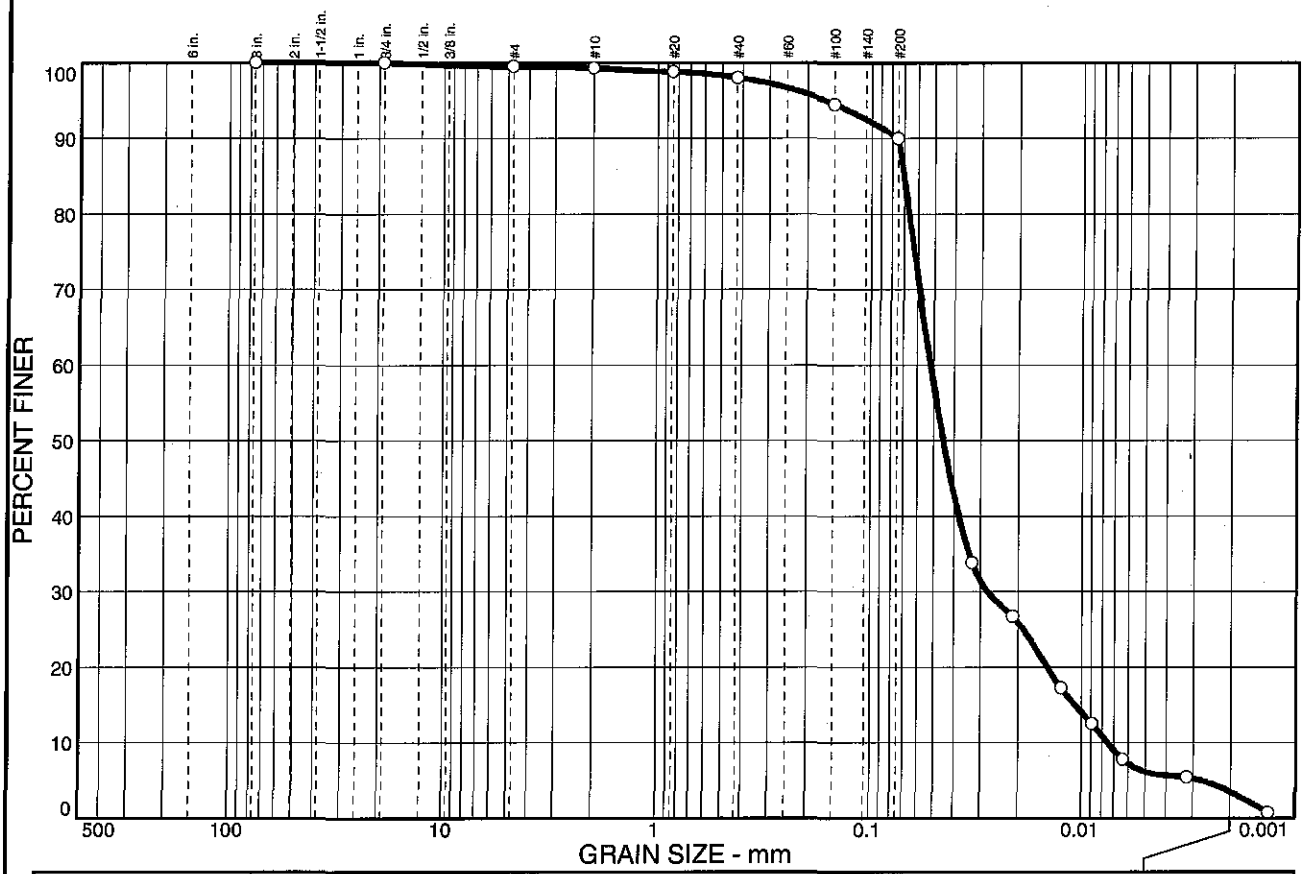
Remarks

As received moisture content = 211.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NE-0306 **Source of Sample:** **Date:** 5/25/04
Location: T71NE **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.5	0.2	1.3	8.0	86.6	3.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.5		
#10	99.3		
#20	98.8		
#40	98.0		
#100	94.5		
#200	90.0		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0707 D_{60}= 0.0520 D_{50}= 0.0452
D_{30}= 0.0278 D_{15}= 0.0108 D_{10}= 0.0075
C_u= 6.89 C_c= 1.97

Classification

USCS= ML AASHTO= --

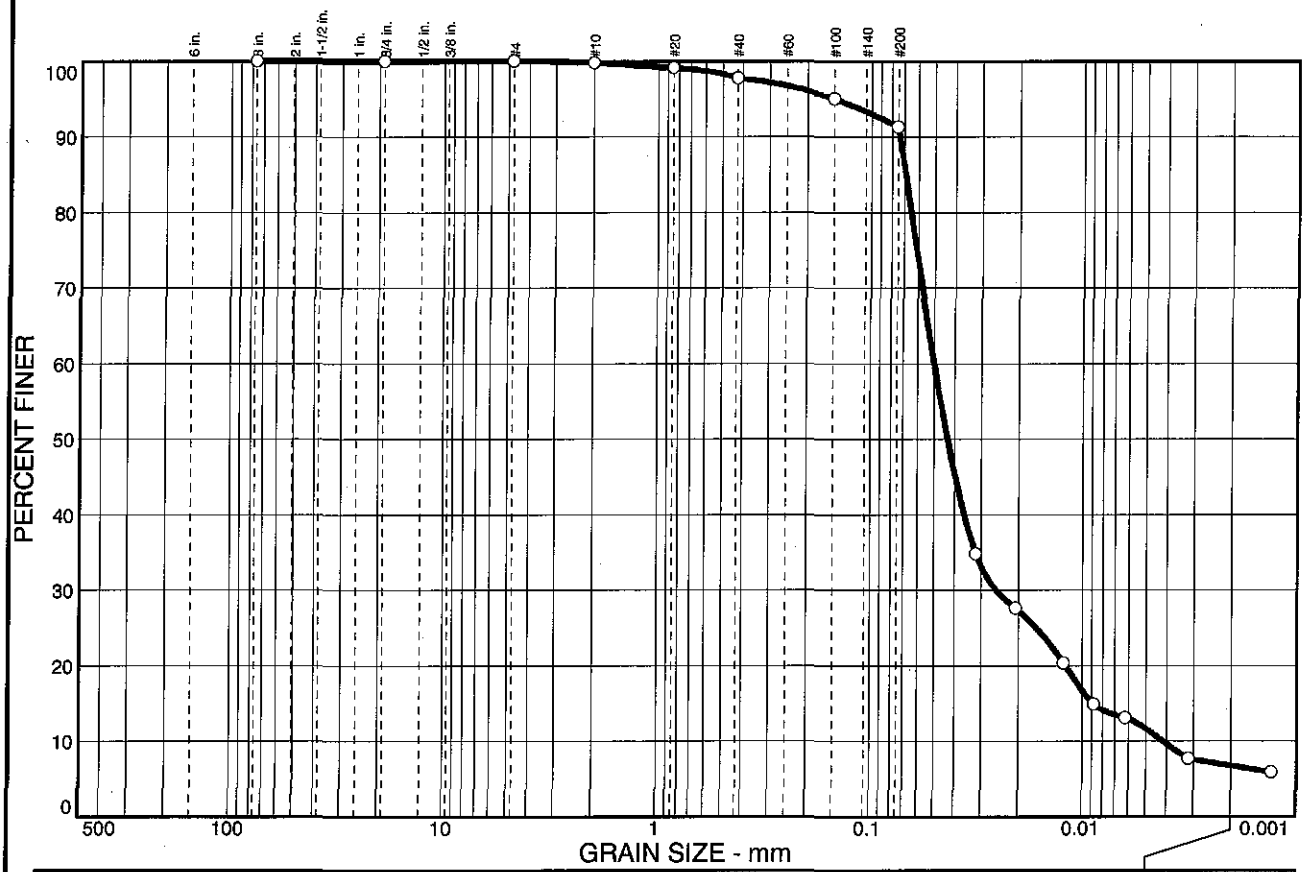
Remarks

As received moisture content = 200.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NE-0612 **Source of Sample:** **Date:** 5/25/04
Location: T71NE **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	2.1	6.4	84.5	6.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	99.1		
#40	97.7		
#100	95.0		
#200	91.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0694 D_{60}= 0.0503 D_{50}= 0.0434
D_{30}= 0.0256 D_{15}= 0.0089 D_{10}= 0.0042
C_u= 12.07 C_c= 3.12

Classification

USCS= ML AASHTO= --

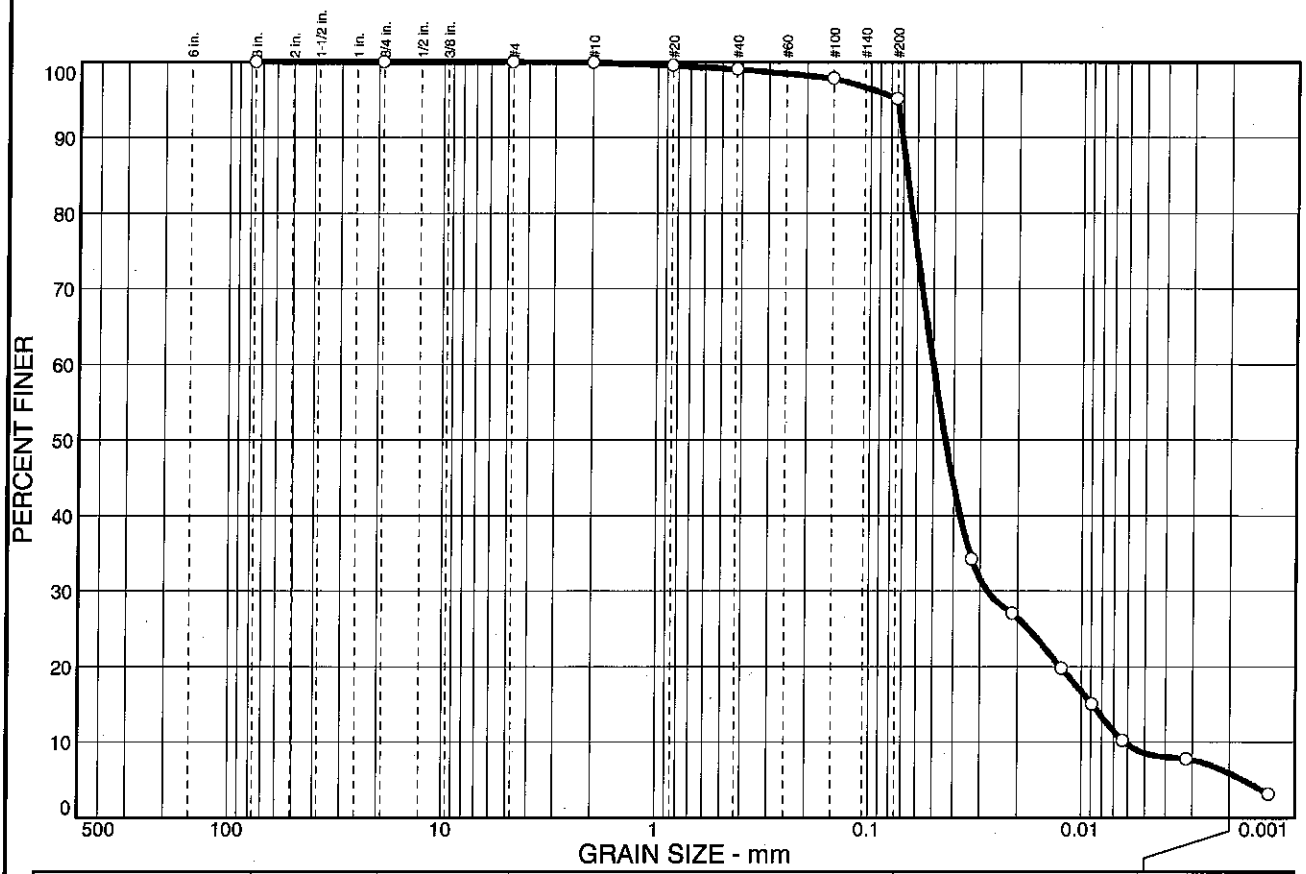
Remarks

As received moisture content = 177.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NE-1218 **Source of Sample:** **Date:** 5/25/04
Location: T71NE **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.9	3.9	89.2	5.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.5		
#40	99.0		
#100	97.8		
#200	95.1		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0672 D_{60}= 0.0504 D_{50}= 0.0440
D_{30}= 0.0277 D_{15}= 0.0089 D_{10}= 0.0062
C_u= 8.09 C_c= 2.45

Classification

USCS= ML AASHTO= --

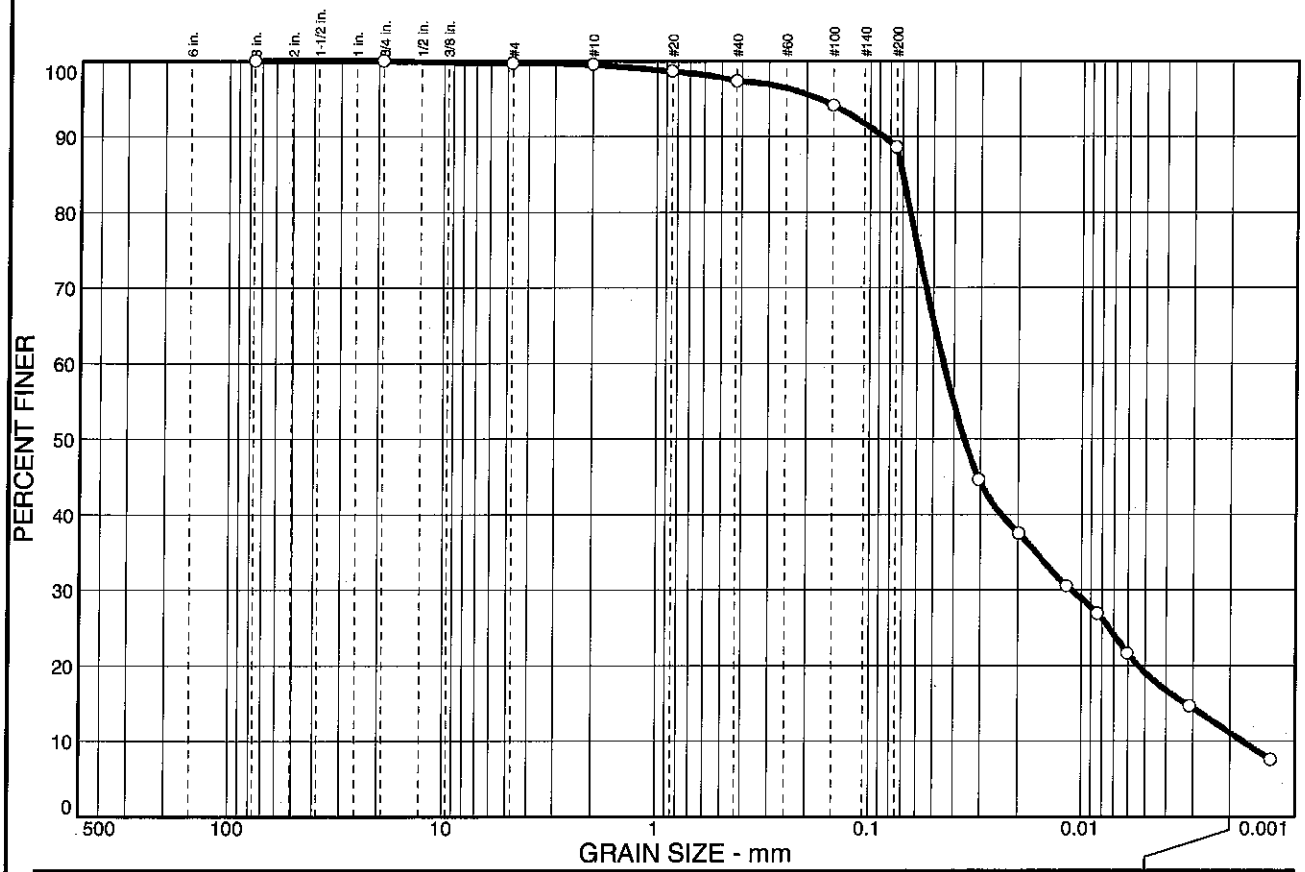
Remarks

As received moisture content = 180.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NE-1824 **Source of Sample:** **Date:** 5/25/04
Location: T71NE **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.2	2.2	8.7	77.5	11.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.5		
#20	98.6		
#40	97.3		
#100	94.1		
#200	88.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0705 D_{60}= 0.0450 D_{50}= 0.0359
D_{30}= 0.0112 D_{15}= 0.0033 D_{10}= 0.0018
C_u= 25.61 C_c= 1.58

Classification

USCS= ML AASHTO= --

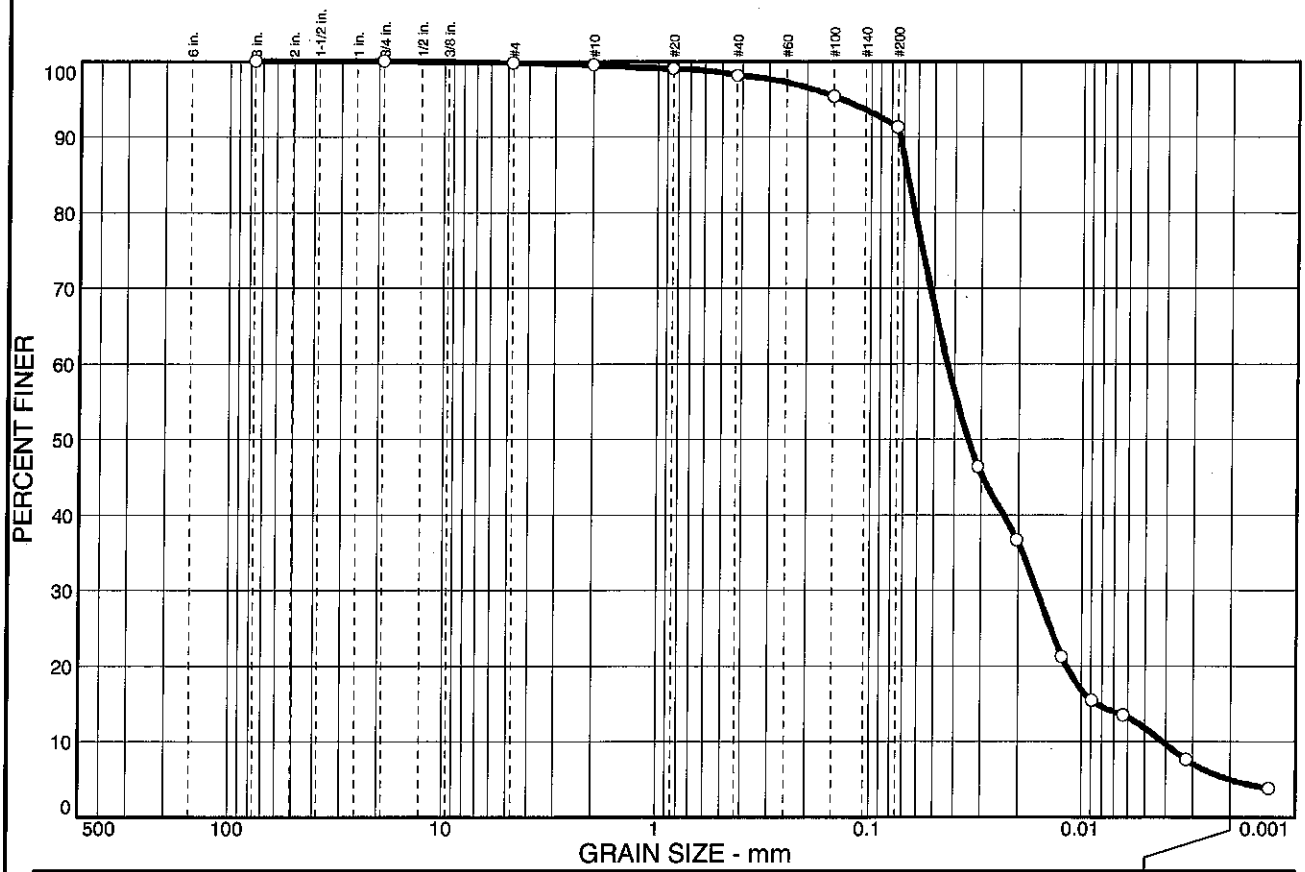
Remarks

As received moisture content = 140.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NE-2430 **Source of Sample:** **Date:** 5/25/04
Location: T71NE **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.3	1.4	6.8	86.4	4.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.5		
#20	99.0		
#40	98.1		
#100	95.4		
#200	91.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0676 D_{60}= 0.0435 D_{50}= 0.0345
D_{30}= 0.0163 D_{15}= 0.0085 D_{10}= 0.0042
C_u= 10.45 C_c= 1.47

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 171.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP08 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: DUP08 **Elev./Depth:**

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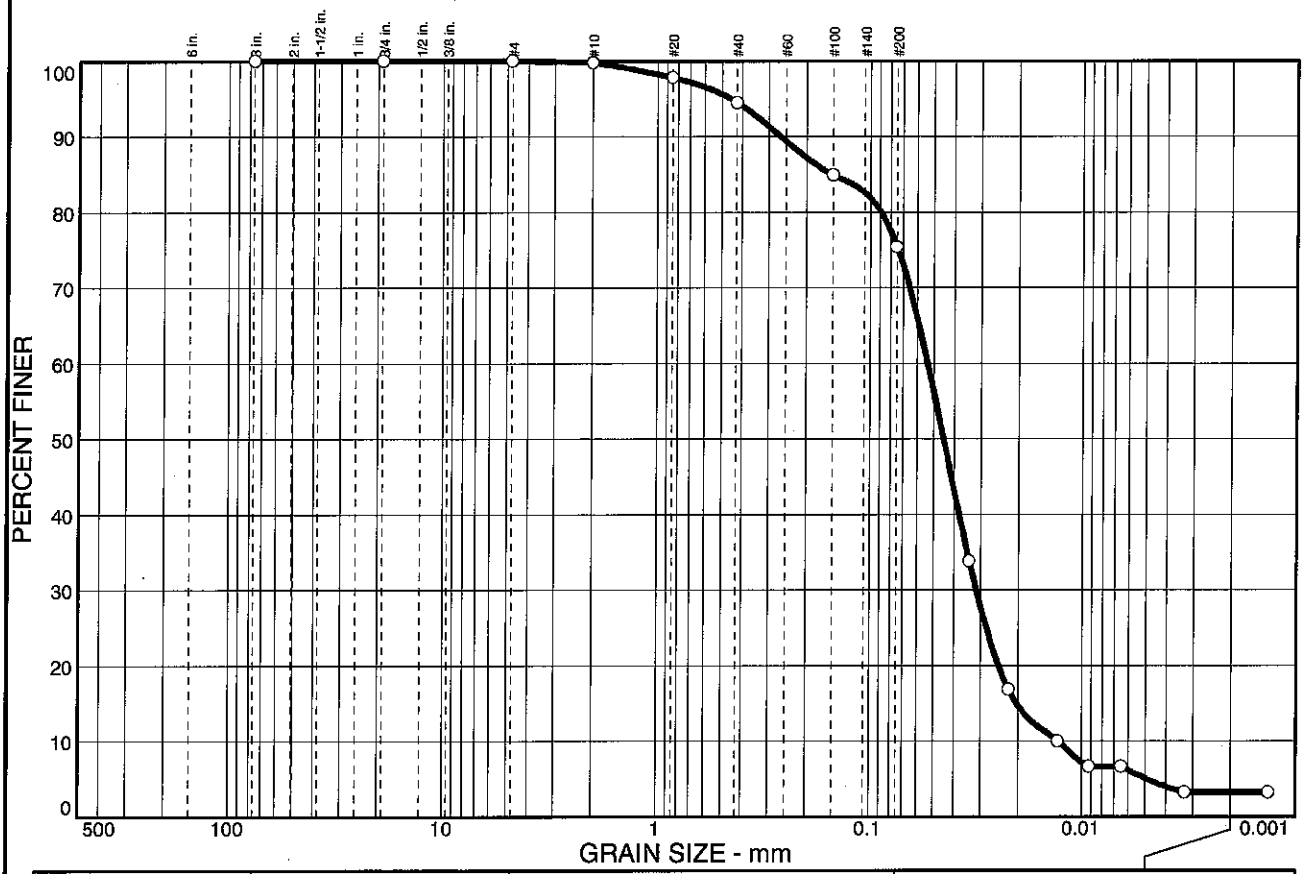
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	5.3	19.1	72.2	3.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	97.8		
#40	94.5		
#100	84.9		
#200	75.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.152 D_{60}= 0.0538 D_{50}= 0.0452
D_{30}= 0.0315 D_{15}= 0.0204 D_{10}= 0.0129
C_u= 4.16 C_c= 1.43

Classification

USCS= ML AASHTO= --

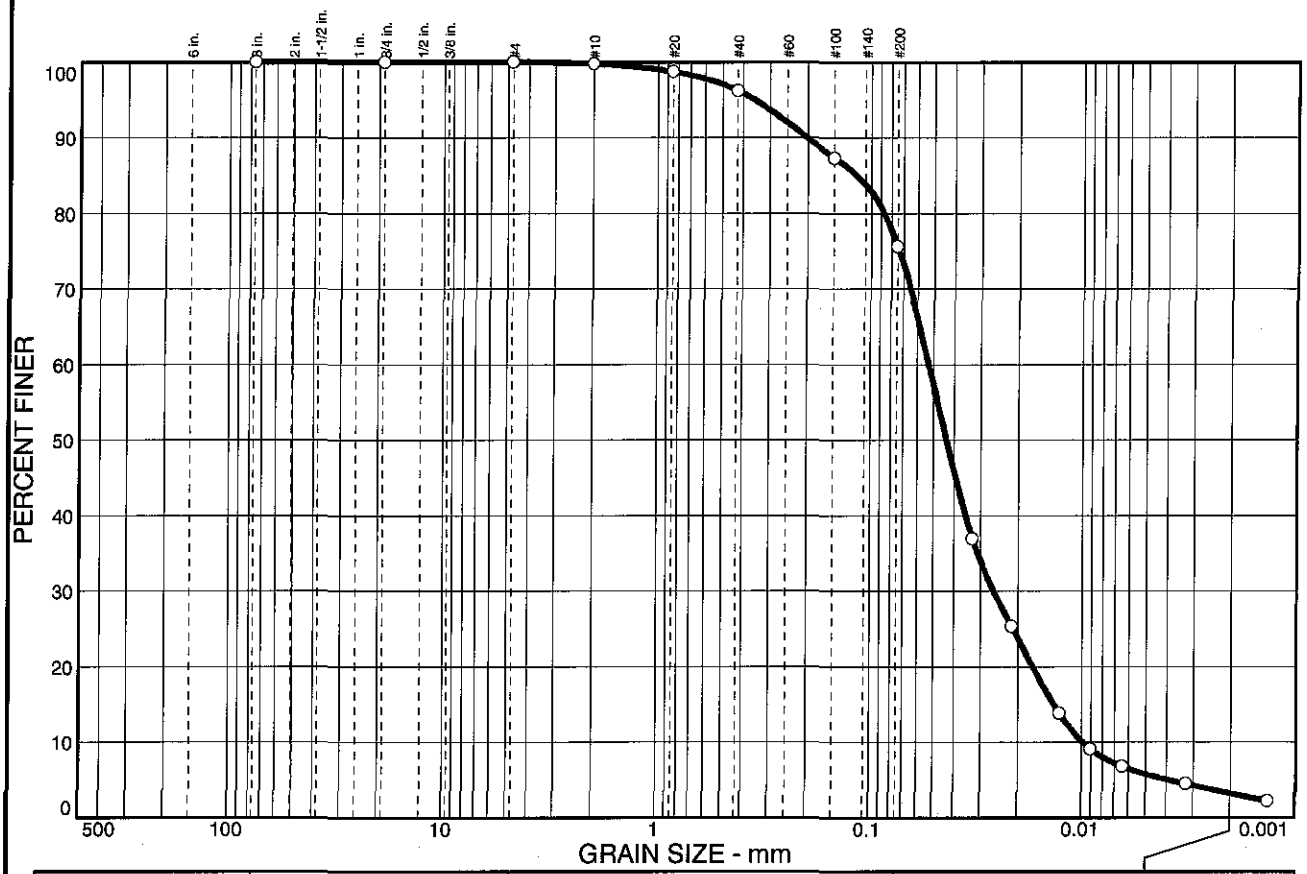
Remarks

As received moisture content = 210.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-0003 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	3.6	20.6	72.4	3.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	98.7		
#40	96.2		
#100	87.3		
#200	75.6		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.117 D_{60}= 0.0530 D_{50}= 0.0437
D_{30}= 0.0261 D_{15}= 0.0135 D_{10}= 0.0099
C_u= 5.37 C_c= 1.30

Classification

USCS= ML AASHTO= --

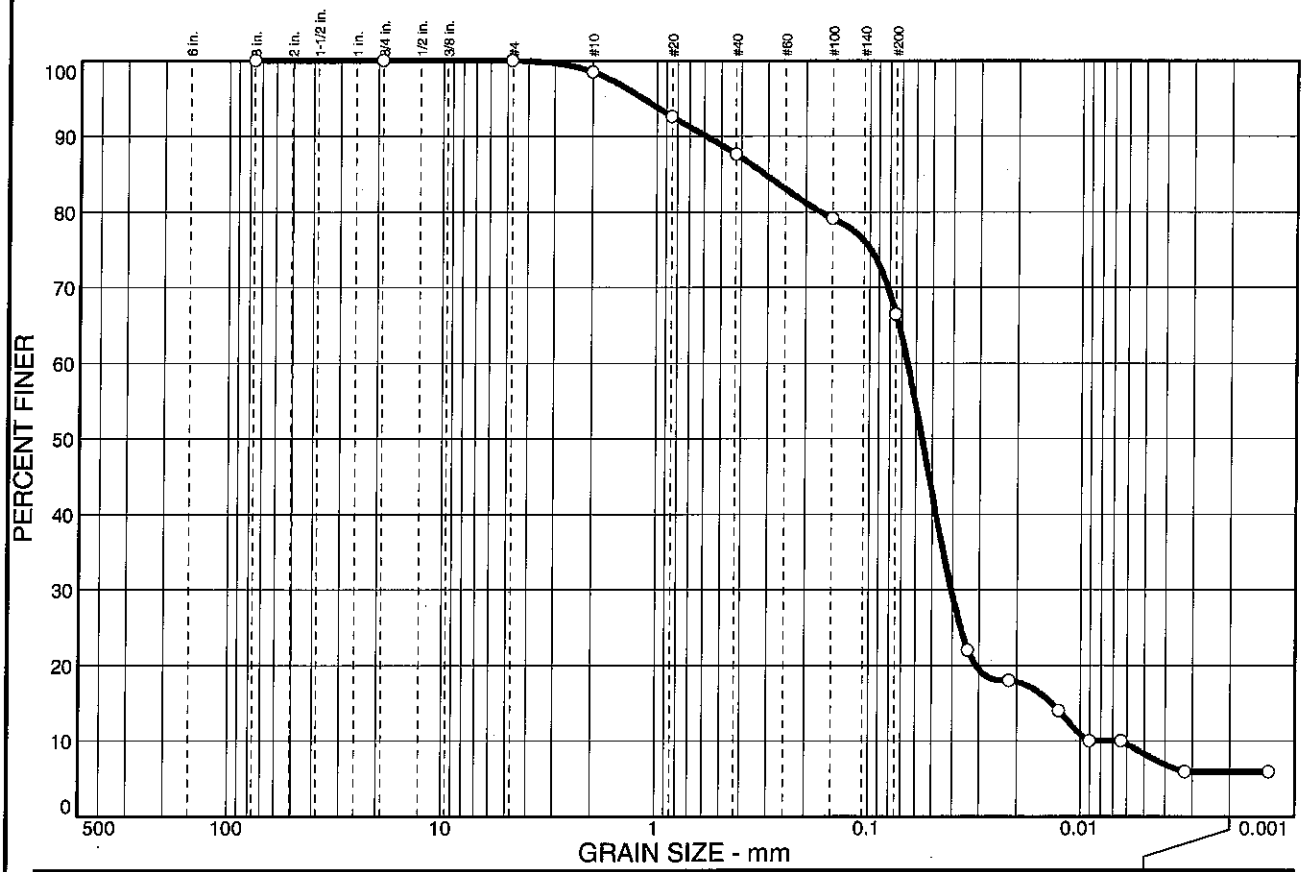
Remarks

As received moisture content = 193.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-0306 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	1.5	10.9	21.1	60.6	5.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	98.5		
#20	92.6		
#40	87.6		
#100	79.1		
#200	66.5		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.312 D_{60}= 0.0661 D_{50}= 0.0562
D_{30}= 0.0407 D_{15}= 0.0137 D_{10}= 0.0064
C_u= 10.35 C_c= 3.93

Classification

USCS= ML AASHTO= --

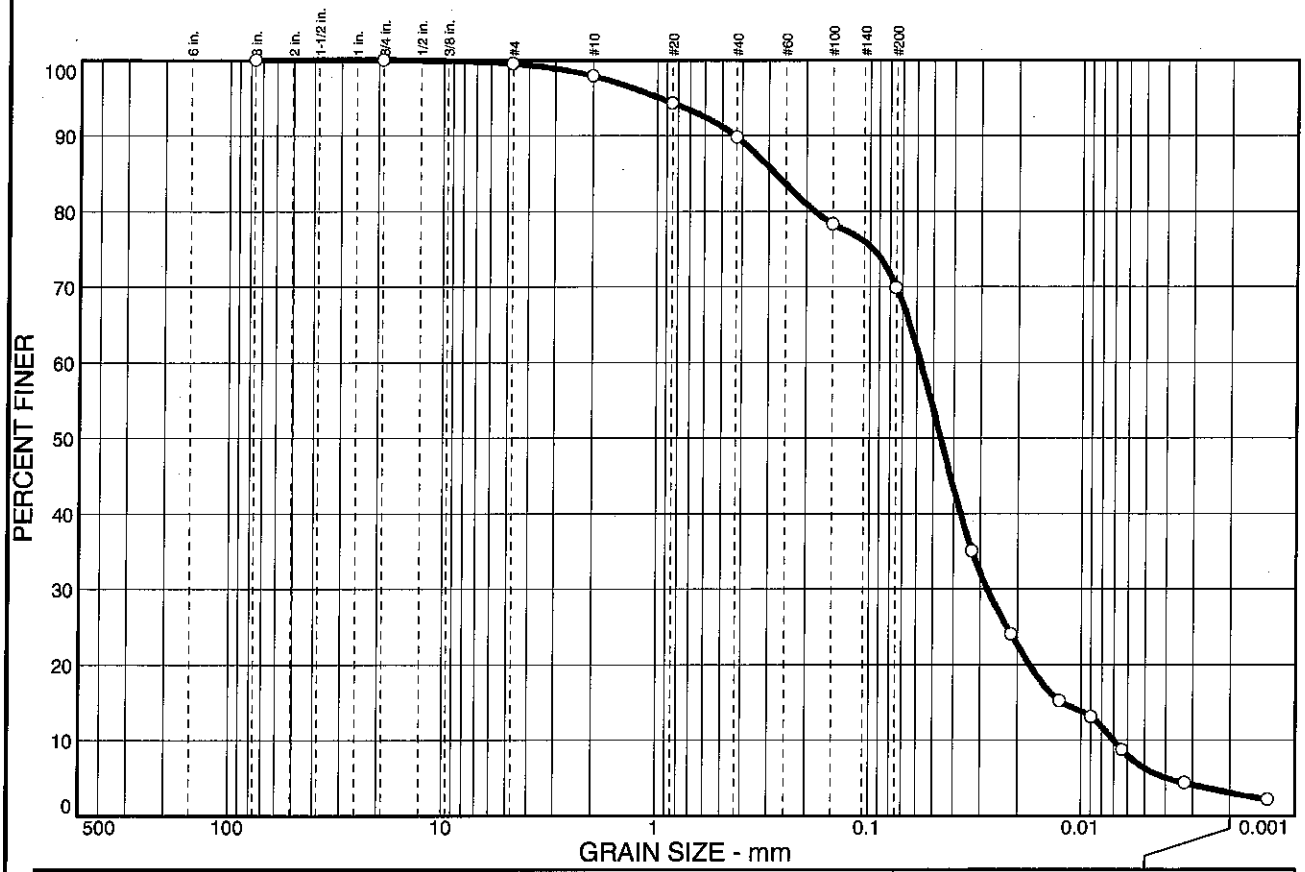
Remarks

As received moisture content = 173.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-0612 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T46MD **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.5	1.6	8.1	19.9	66.9	3.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.5		
#10	97.9		
#20	94.3		
#40	89.8		
#100	78.3		
#200	69.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.280 D_{60}= 0.0576 D_{50}= 0.0464
D_{30}= 0.0278 D_{15}= 0.0123 D_{10}= 0.0071
C_u= 8.15 C_c= 1.90

Classification

USCS= ML AASHTO= --

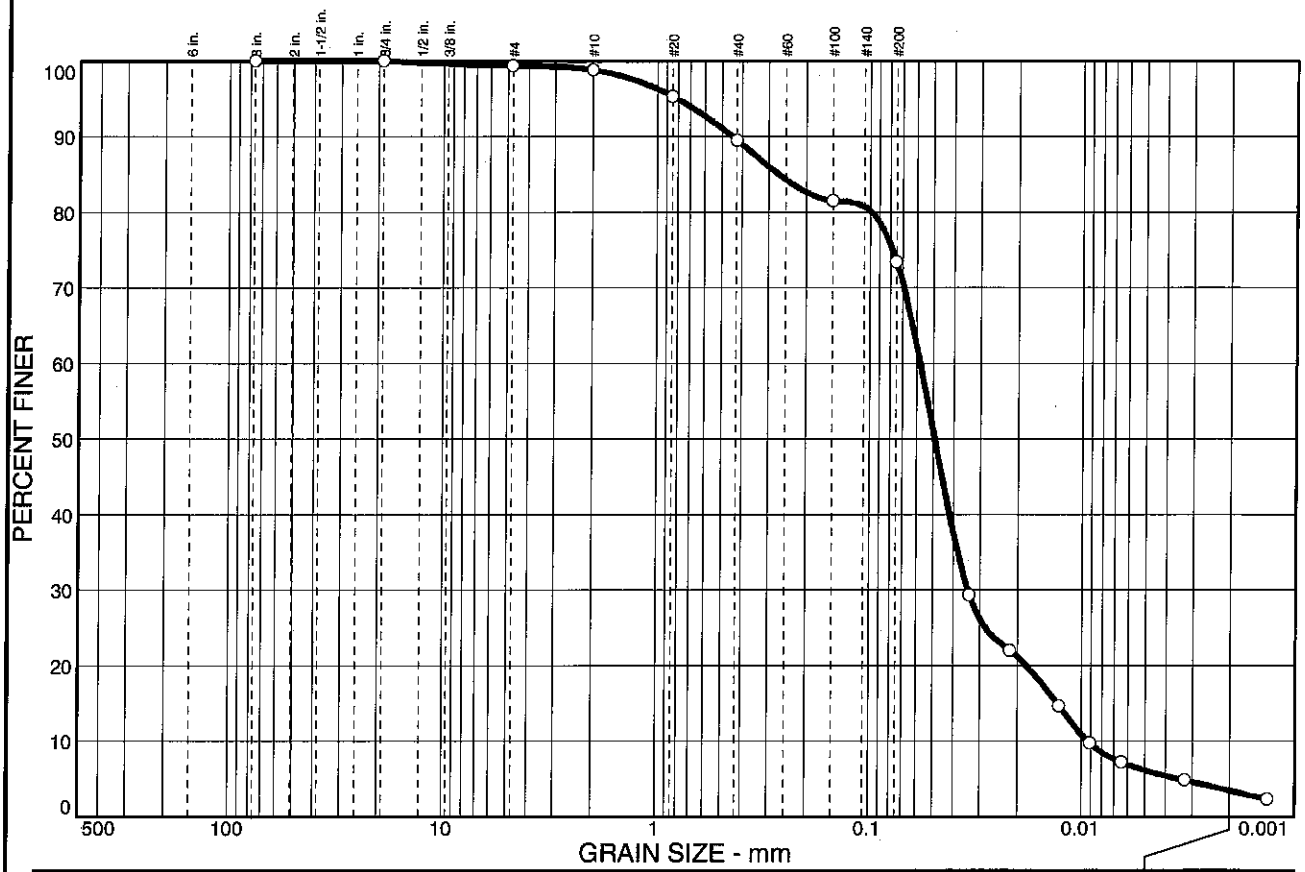
Remarks

As received moisture content = 195.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-1218 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.6	0.6	9.3	16.1	70.0	3.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.4		
#10	98.8		
#20	95.3		
#40	89.5		
#100	81.5		
#200	73.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.270 D_{60}= 0.0579 D_{50}= 0.0494
D_{30}= 0.0342 D_{15}= 0.0130 D_{10}= 0.0093
C_u= 6.21 C_c= 2.17

Classification

USCS= ML AASHTO= --

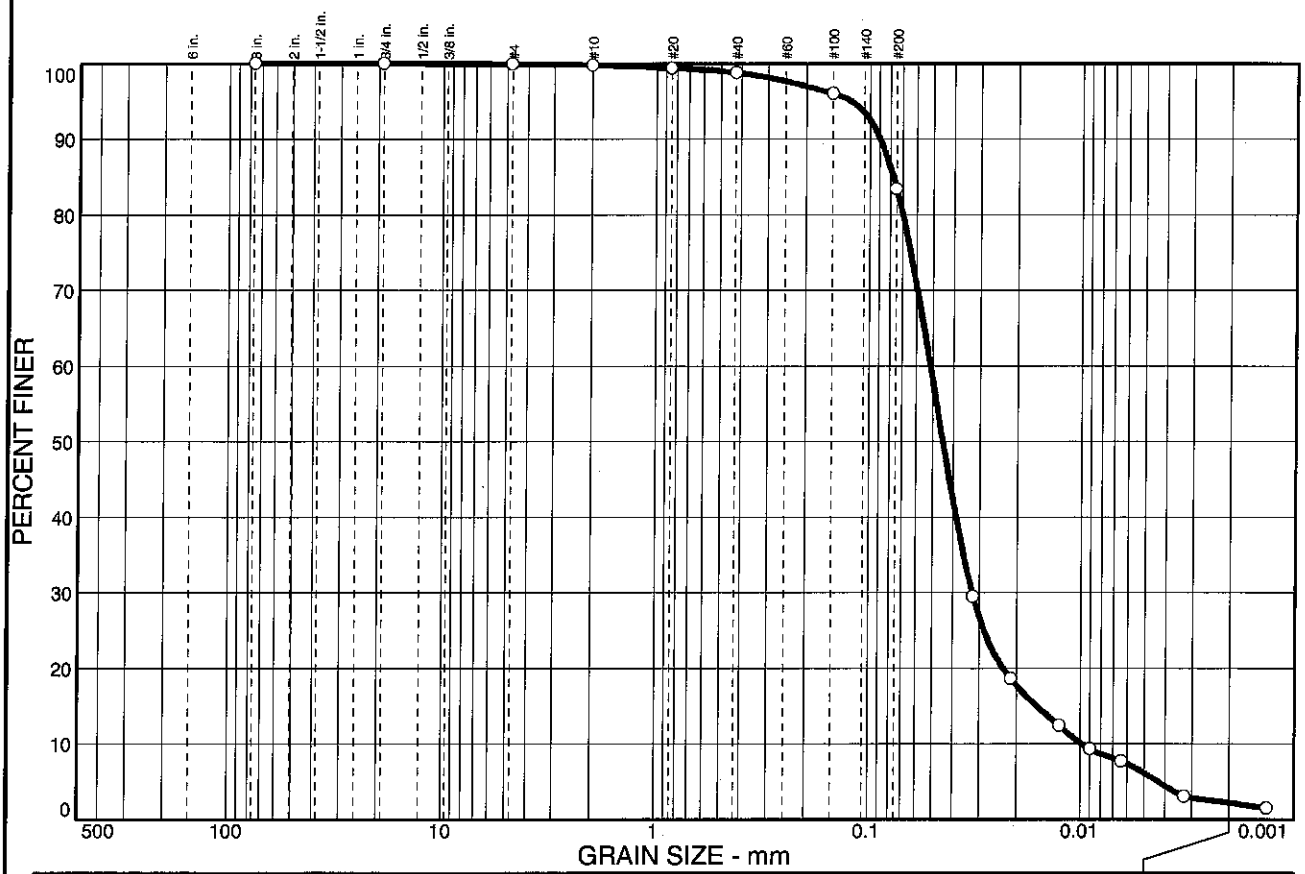
Remarks

As received moisture content = 200.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-1824 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.1	1.0	15.4	81.2	2.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.8		
#20	99.4		
#40	98.8		
#100	96.0		
#200	83.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0777 D_{60}= 0.0517 D_{50}= 0.0450
D_{30}= 0.0324 D_{15}= 0.0160 D_{10}= 0.0098
C_u= 5.25 C_c= 2.07

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 137.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-2430 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 24-30

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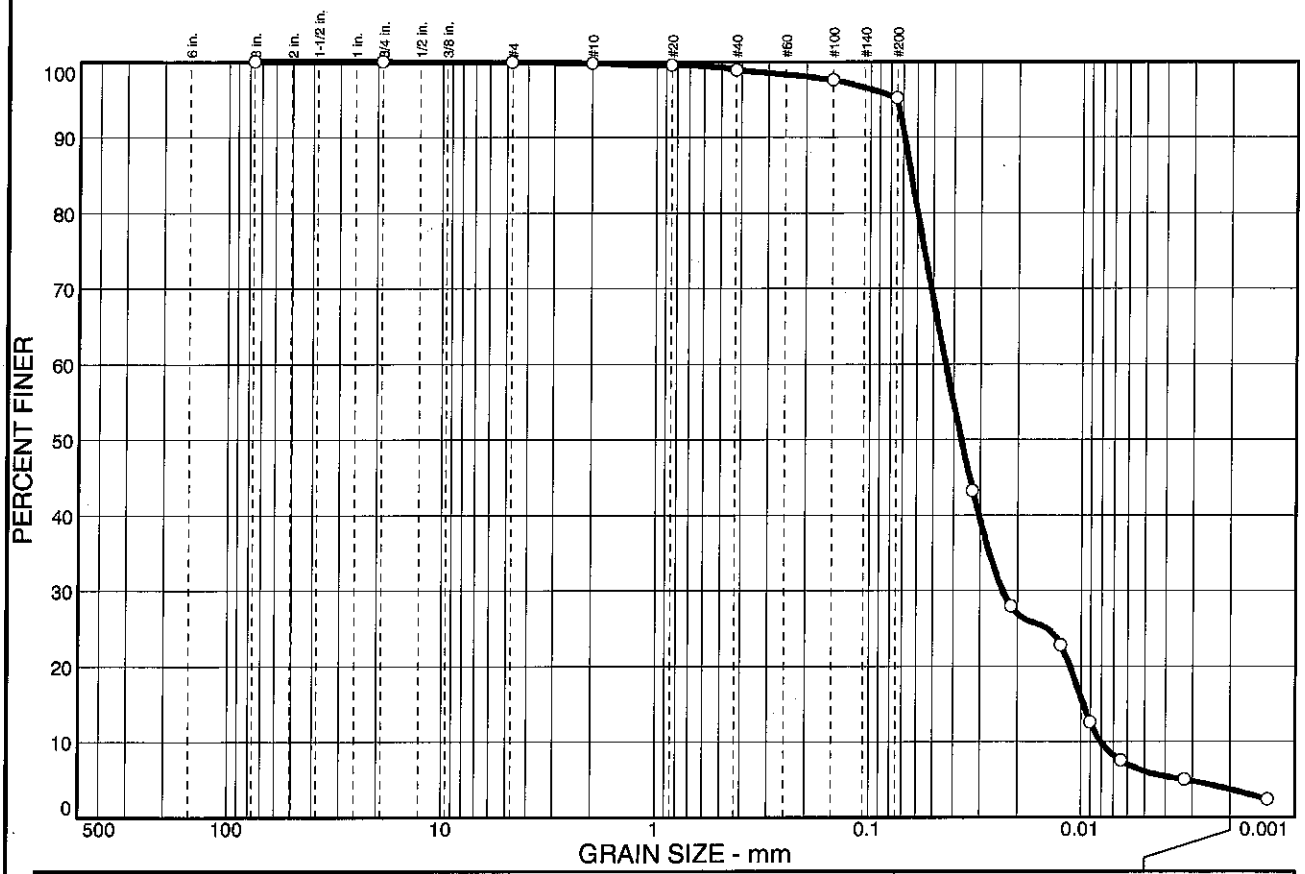
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.1	0.9	3.7	91.5	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.8		
#20	99.5		
#40	98.9		
#100	97.6		
#200	95.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0645 D_{60}= 0.0439 D_{50}= 0.0370
D_{30}= 0.0234 D_{15}= 0.0098 D_{10}= 0.0080
C_u= 5.46 C_c= 1.56

Classification

USCS= ML AASHTO= --

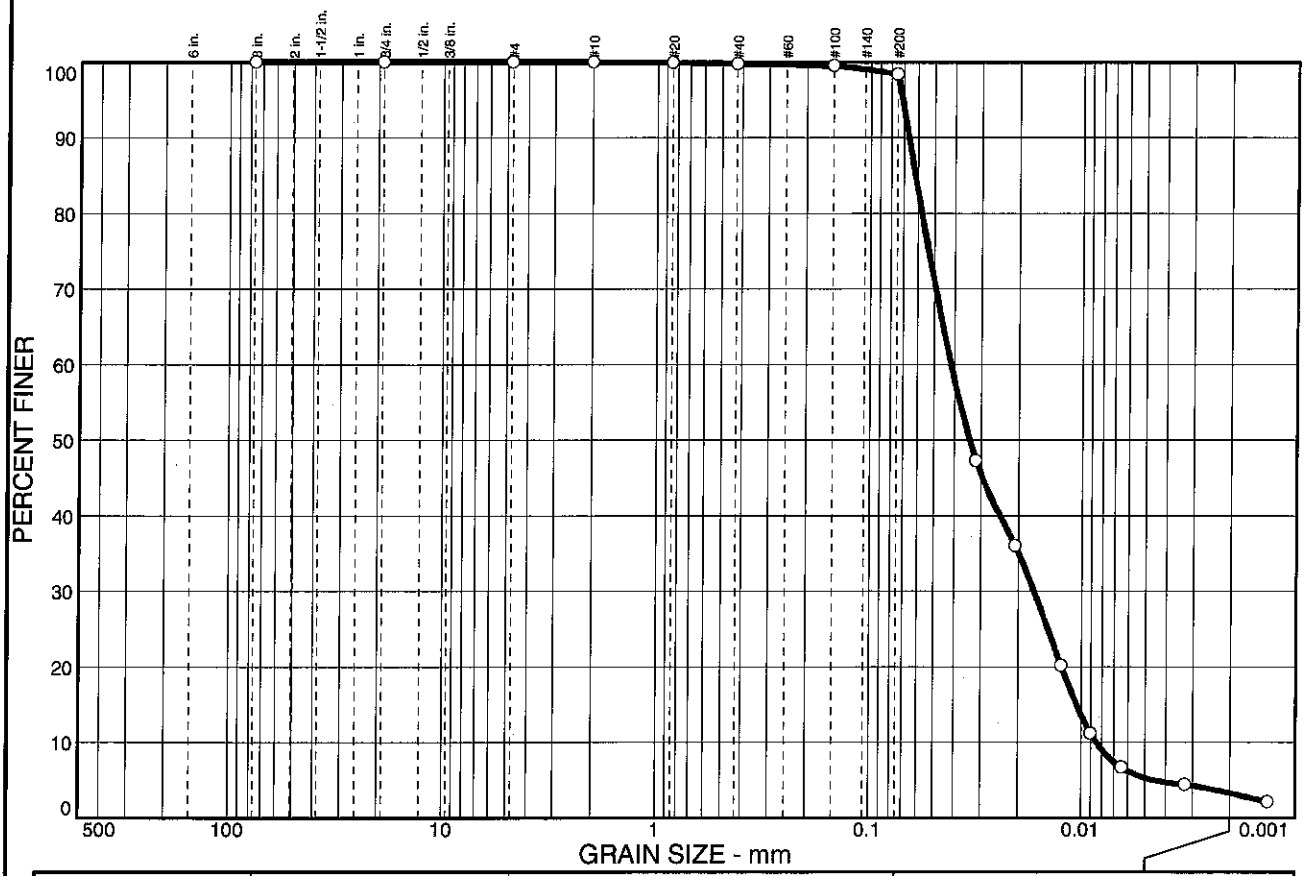
Remarks

As received moisture content = 195.8%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-3036 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.2	1.4	95.1	3.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.8		
#100	99.5		
#200	98.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0620 D_{60}= 0.0418 D_{50}= 0.0340
D_{30}= 0.0169 D_{15}= 0.0105 D_{10}= 0.0085
C_u= 4.92 C_c= 0.80

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 189.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-3642 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 36-42

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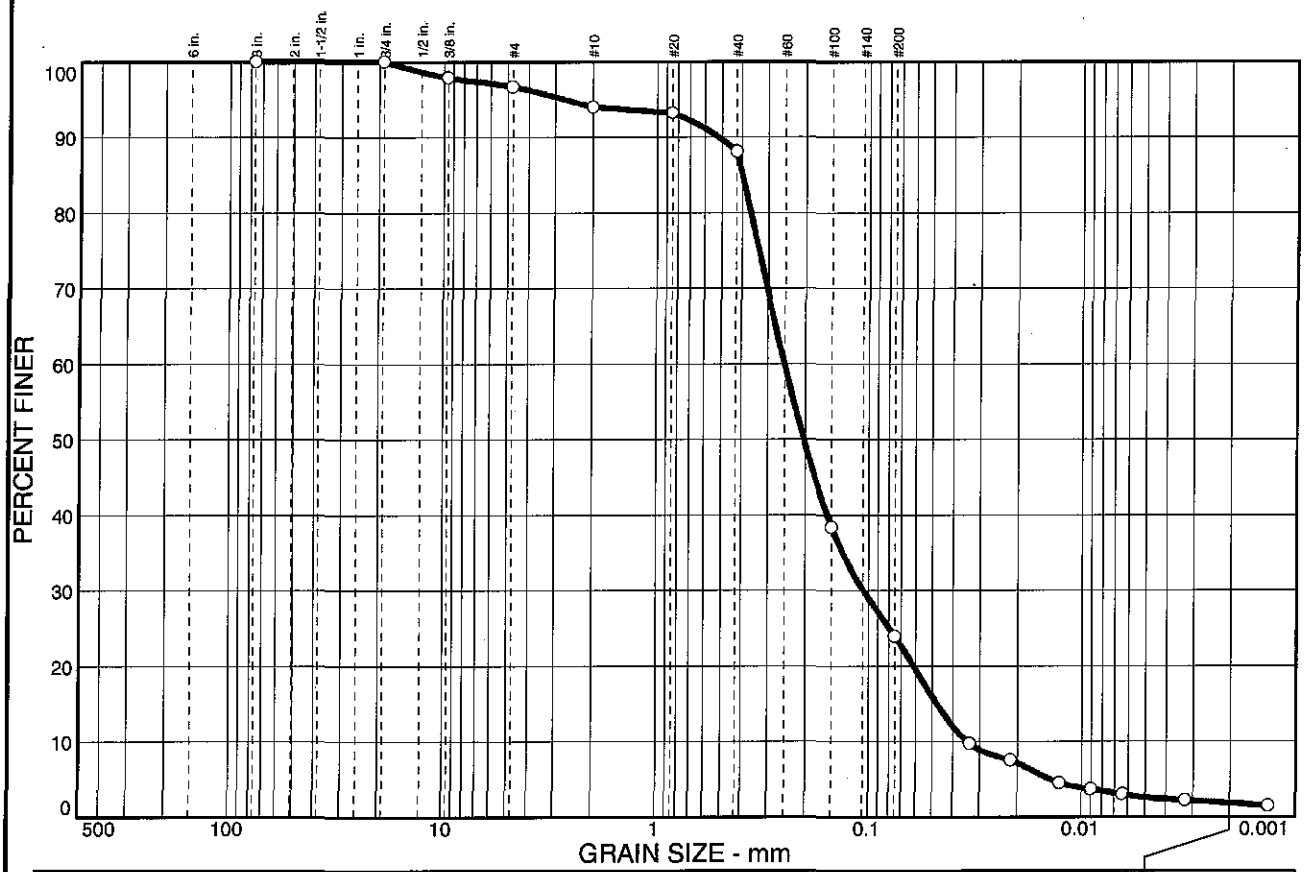
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	3.3	2.7	5.9	64.2	22.1	1.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
3/8 in.	97.9		
#4	96.7		
#10	94.0		
#20	93.2		
#40	88.1		
#100	38.4		
#200	23.9		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.401 D_{60}= 0.251 D_{50}= 0.203
D_{30}= 0.106 D_{15}= 0.0478 D_{10}= 0.0344
C_u= 7.30 C_c= 1.30

Classification

USCS= SM AASHTO= --

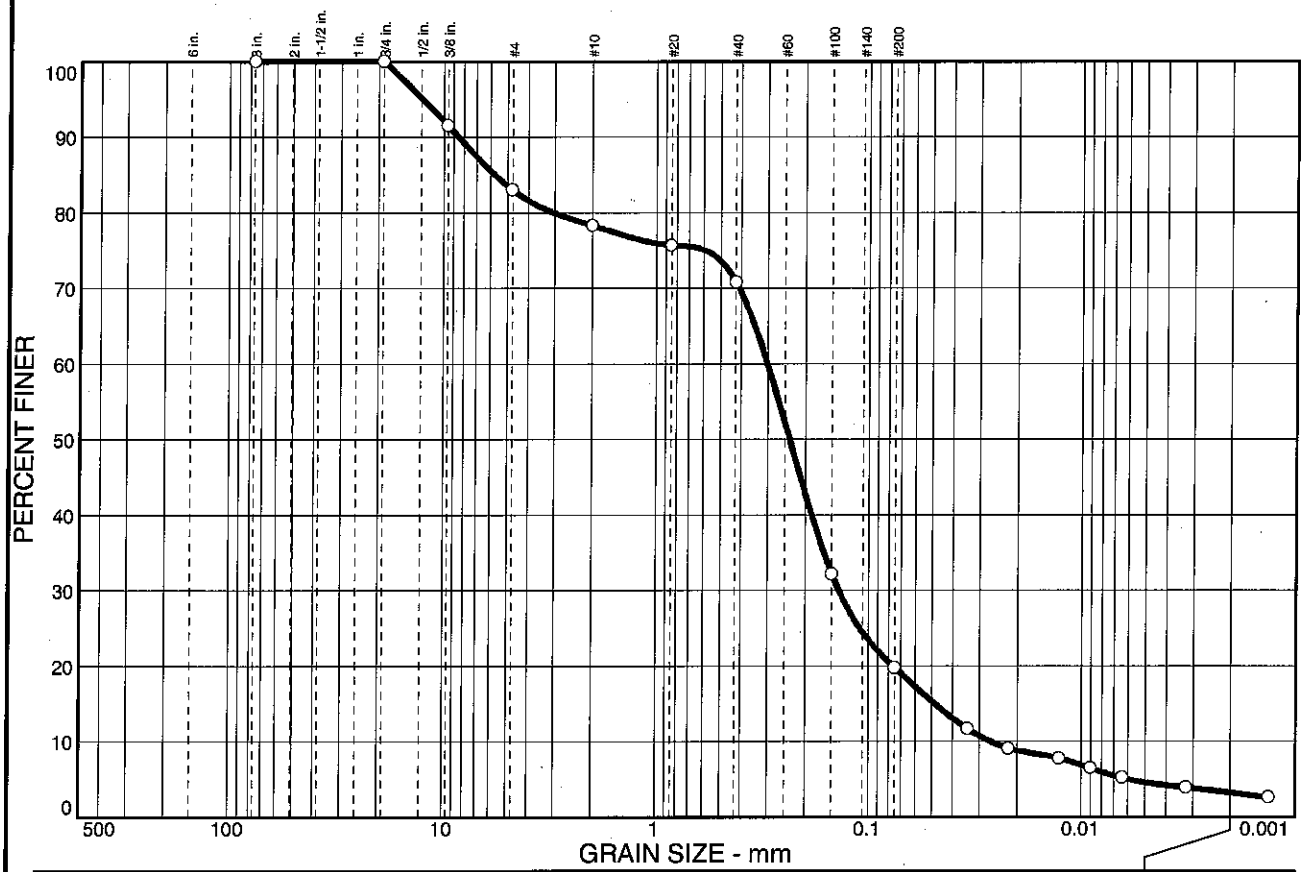
Remarks

As received moisture content = 35.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-4248 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 42-48

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	17.0	4.7	7.5	51.0	16.6	3.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
3/8 in.	91.5		
#4	83.0		
#10	78.3		
#20	75.7		
#40	70.8		
#100	32.2		
#200	19.8		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 5.74 D_{60}= 0.303 D_{50}= 0.238
D_{30}= 0.139 D_{15}= 0.0488 D_{10}= 0.0266
C_u= 11.37 C_c= 2.39

Classification

USCS= SM AASHTO= --

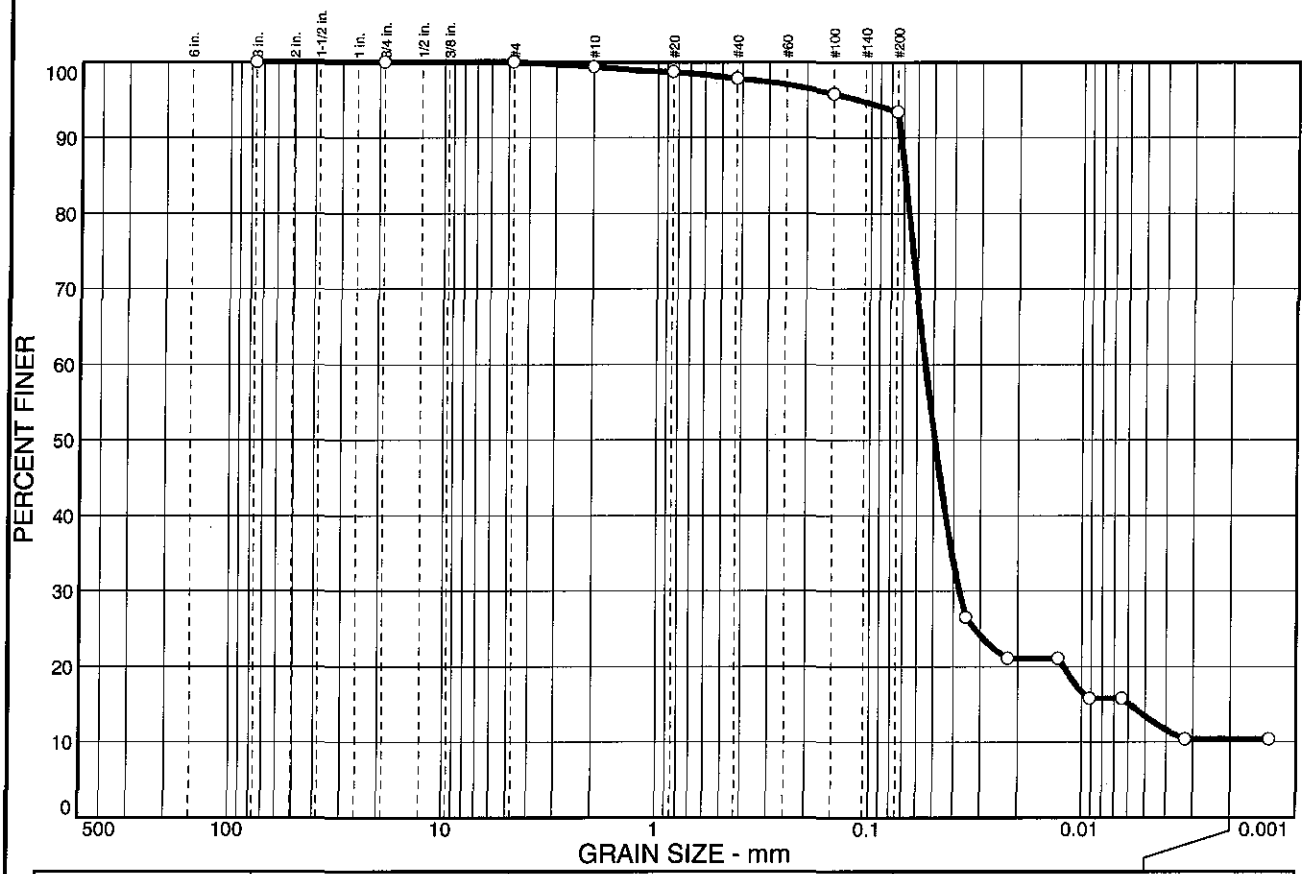
Remarks

As received moisture content = 22.3%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MD-4851 **Source of Sample:** 7/5 **Date:** 5/26/04
Location: T46MD **Elev./Depth:** 48-51

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.6	1.6	4.4	83.0	10.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.4		
#20	98.7		
#40	97.8		
#100	95.8		
#200	93.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0695 D_{60}= 0.0549 D_{50}= 0.0494
D_{30}= 0.0377 D_{15}= 0.0059 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

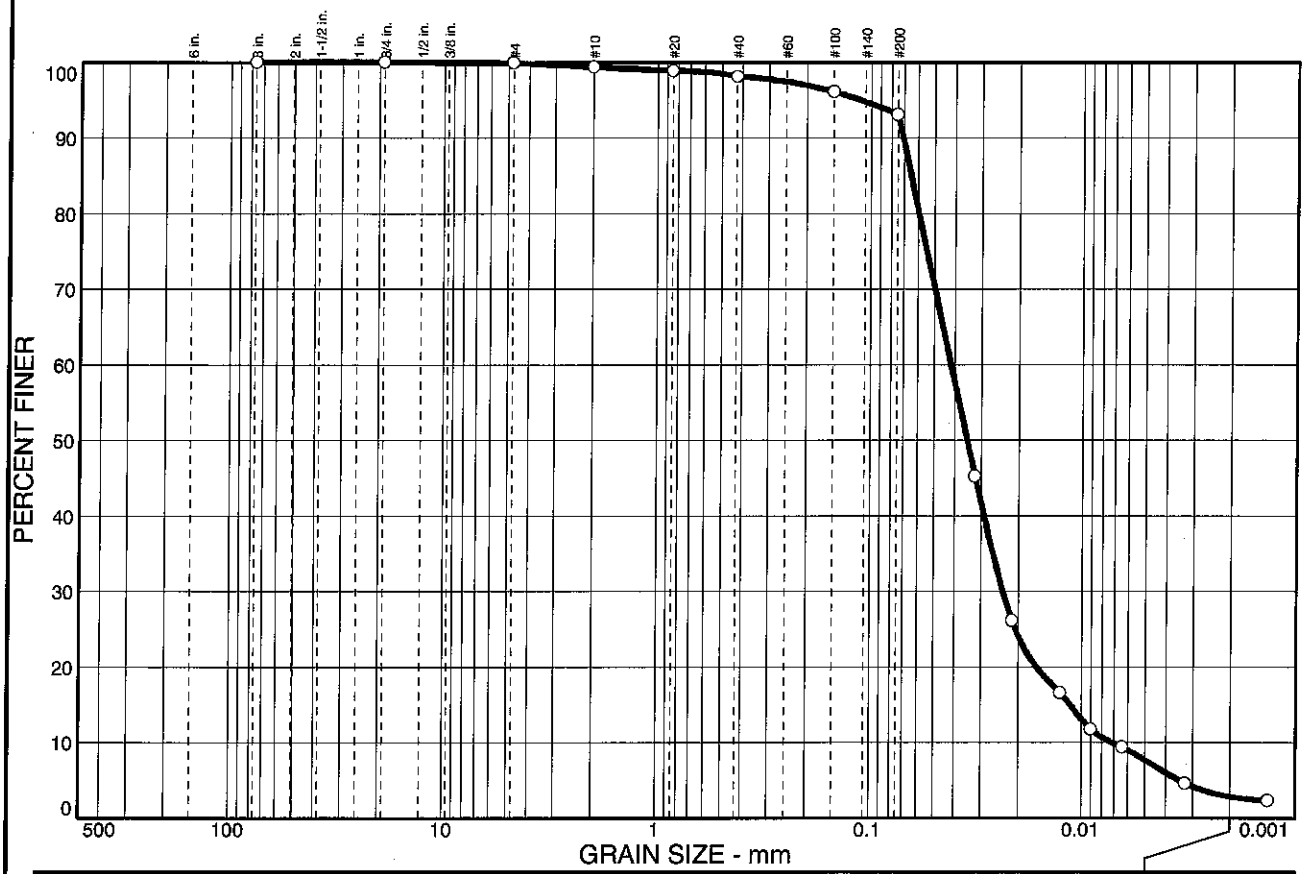
Remarks

As received moisture content = 229.4%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-0003 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.5	1.3	5.0	90.3	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.4		
#20	98.9		
#40	98.1		
#100	96.1		
#200	93.1		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0650 D_{60}= 0.0419 D_{50}= 0.0350
D_{30}= 0.0237 D_{15}= 0.0113 D_{10}= 0.0071
C_u= 5.86 C_c= 1.87

Classification

USCS= ML AASHTO= --

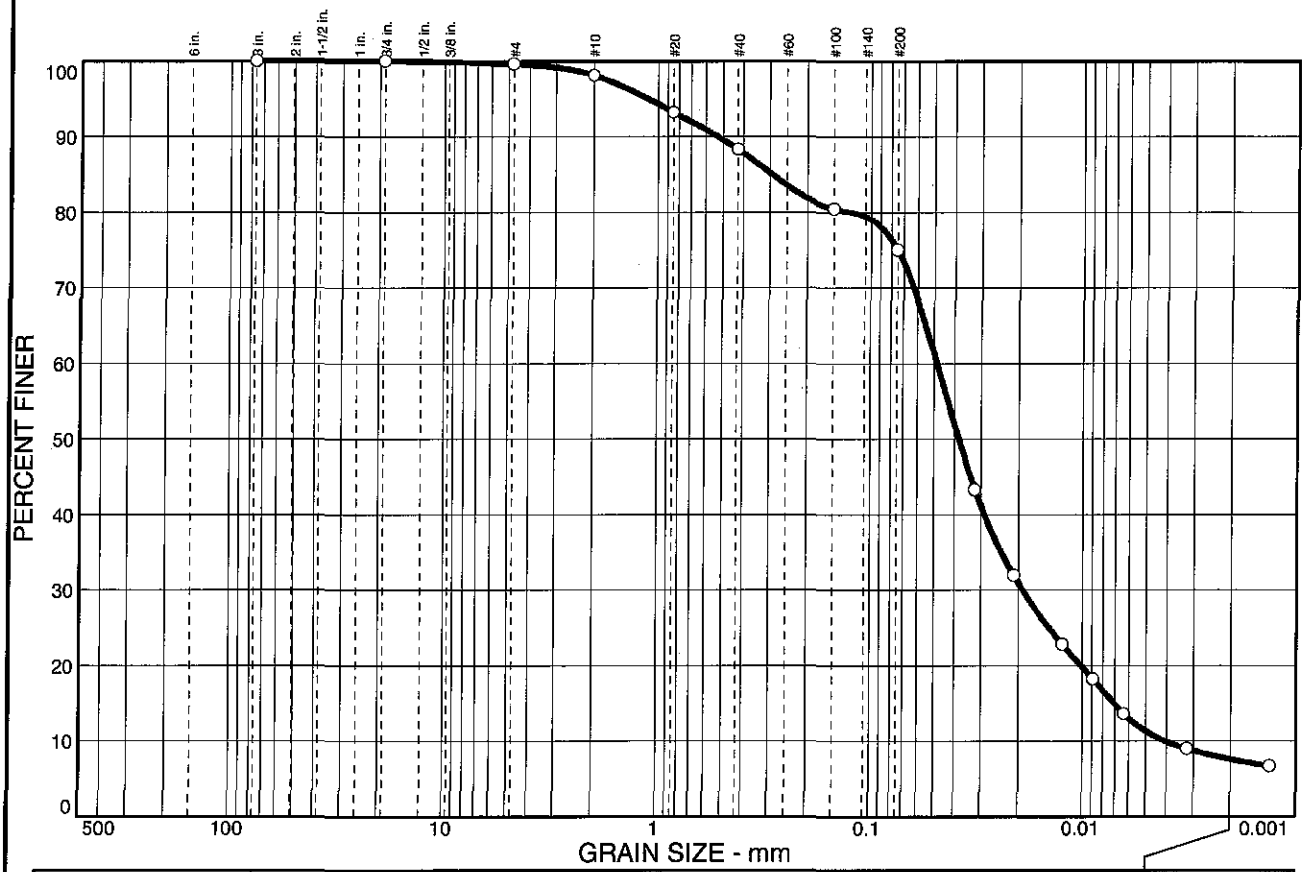
Remarks

As received moisture content = 175.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-0306 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	1.5	9.8	13.3	67.4	7.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.6		
#10	98.1		
#20	93.2		
#40	88.3		
#100	80.4		
#200	75.0		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.294 D_{60}= 0.0486 D_{50}= 0.0383
D_{30}= 0.0191 D_{15}= 0.0071 D_{10}= 0.0041
C_u= 11.96 C_c= 1.85

Classification

USCS= ML AASHTO= --

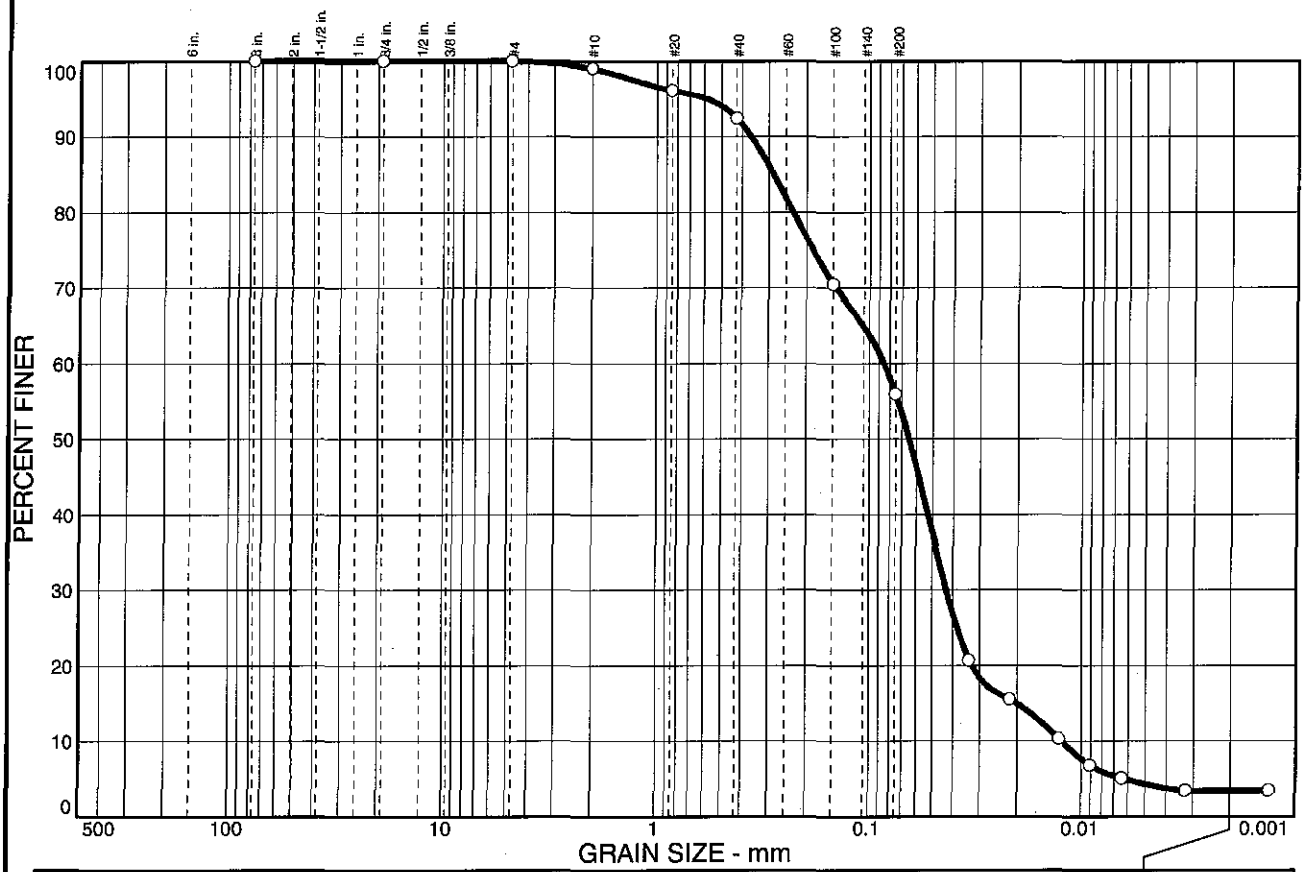
Remarks

As received moisture content = 191.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-0612 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	1.0	6.6	36.5	52.5	3.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.0		
#20	96.1		
#40	92.4		
#100	70.5		
#200	55.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.286 D_{60}= 0.0853 D_{50}= 0.0650
D_{30}= 0.0432 D_{15}= 0.0202 D_{10}= 0.0124
C_u= 6.89 C_c= 1.76

Classification

USCS= ML AASHTO= --

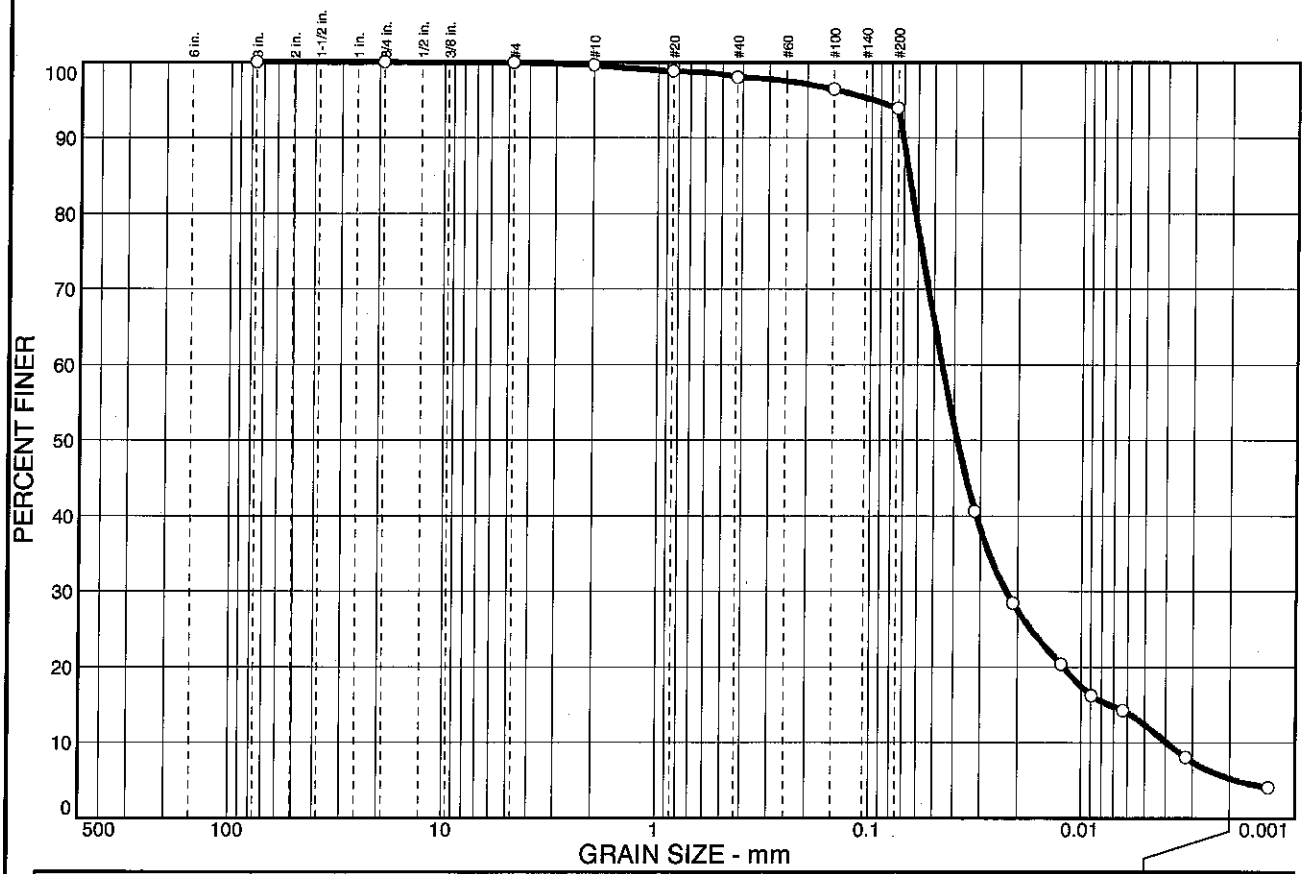
Remarks

As received moisture content = 90.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-3036 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.3	1.6	4.1	88.7	5.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.6		
#20	98.8		
#40	98.0		
#100	96.4		
#200	93.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

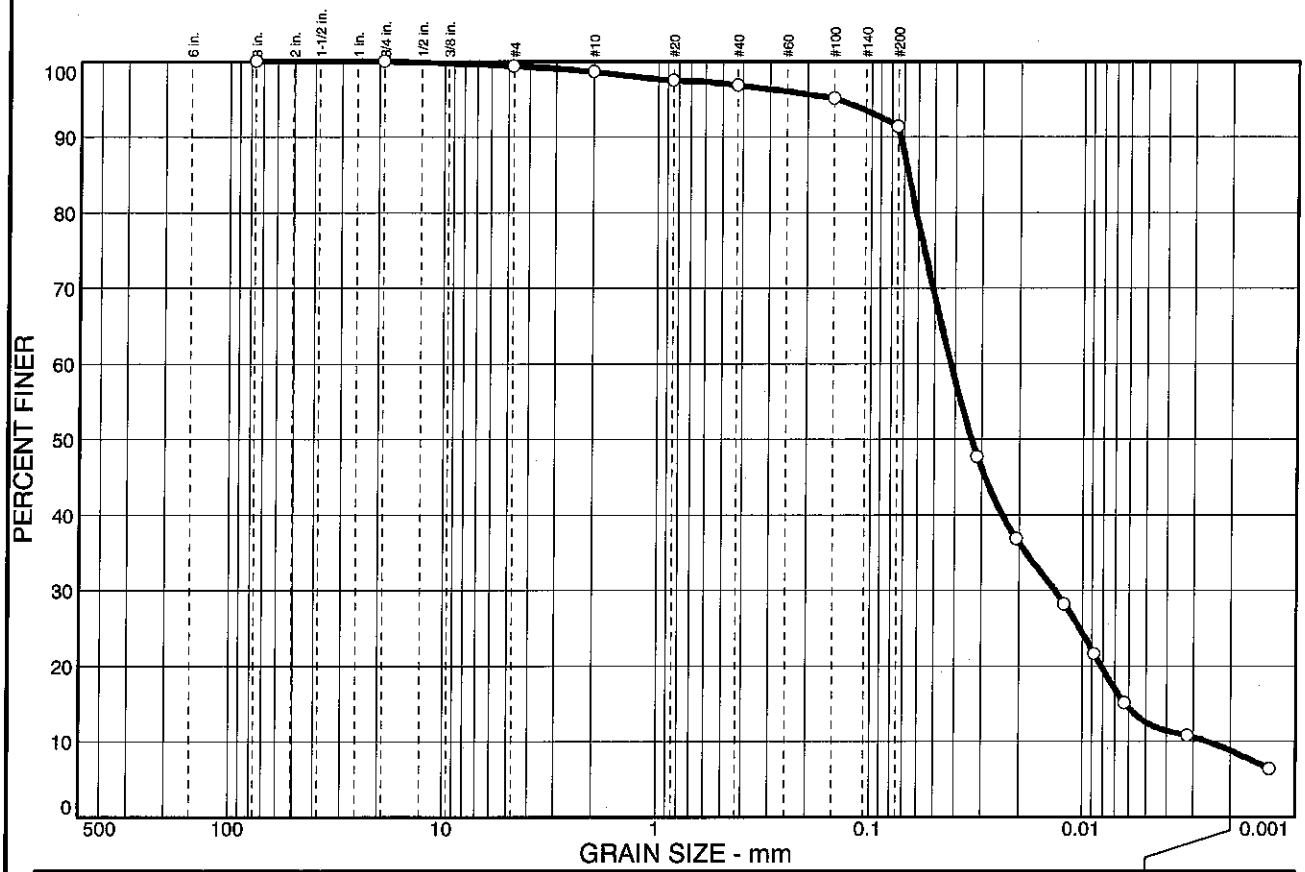
Remarks

As received moisture content = 166.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-0306 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.6	0.8	1.8	5.4	82.6	8.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.4		
#10	98.6		
#20	97.5		
#40	96.8		
#100	95.1		
#200	91.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0670 D_{60}= 0.0421 D_{50}= 0.0335
D_{30}= 0.0136 D_{15}= 0.0063 D_{10}= 0.0026
C_u= 16.42 C_c= 1.70

Classification

USCS= ML AASHTO= --

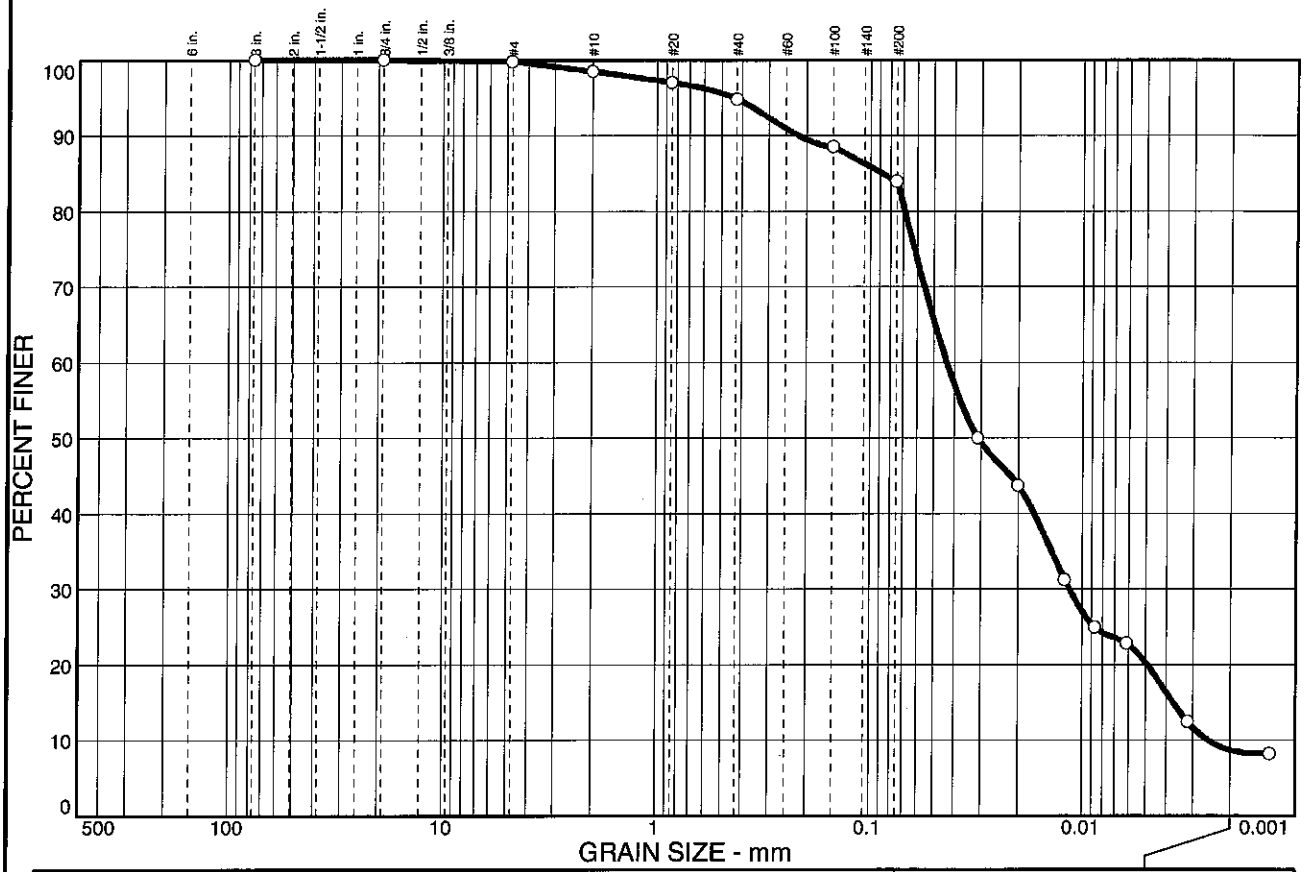
Remarks

As received moisture content = 185.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-0612 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	1.3	3.7	10.9	75.2	8.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	98.5		
#20	97.0		
#40	94.8		
#100	88.5		
#200	83.9		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0881 D_{60}= 0.0436 D_{50}= 0.0310
D_{30}= 0.0115 D_{15}= 0.0037 D_{10}= 0.0026
C_u= 17.11 C_c= 1.18

Classification

USCS= ML AASHTO= --

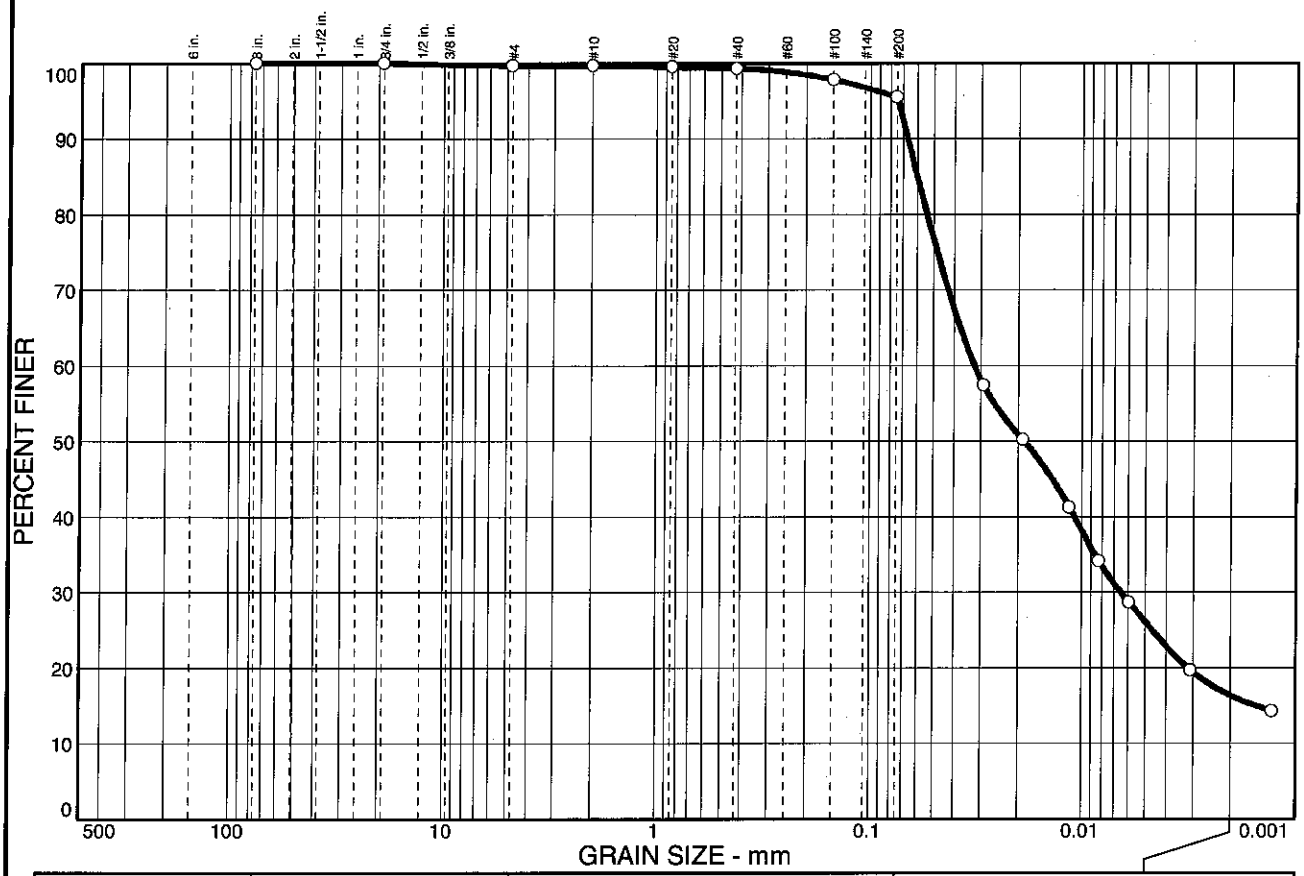
Remarks

As received moisture content = 158.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-1824 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.0	0.4	3.8	79.2	16.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.7		
#20	99.5		
#40	99.3		
#100	97.8		
#200	95.5		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0602 D_{60}= 0.0322 D_{50}= 0.0188
D_{30}= 0.0065 D_{15}= 0.0015 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

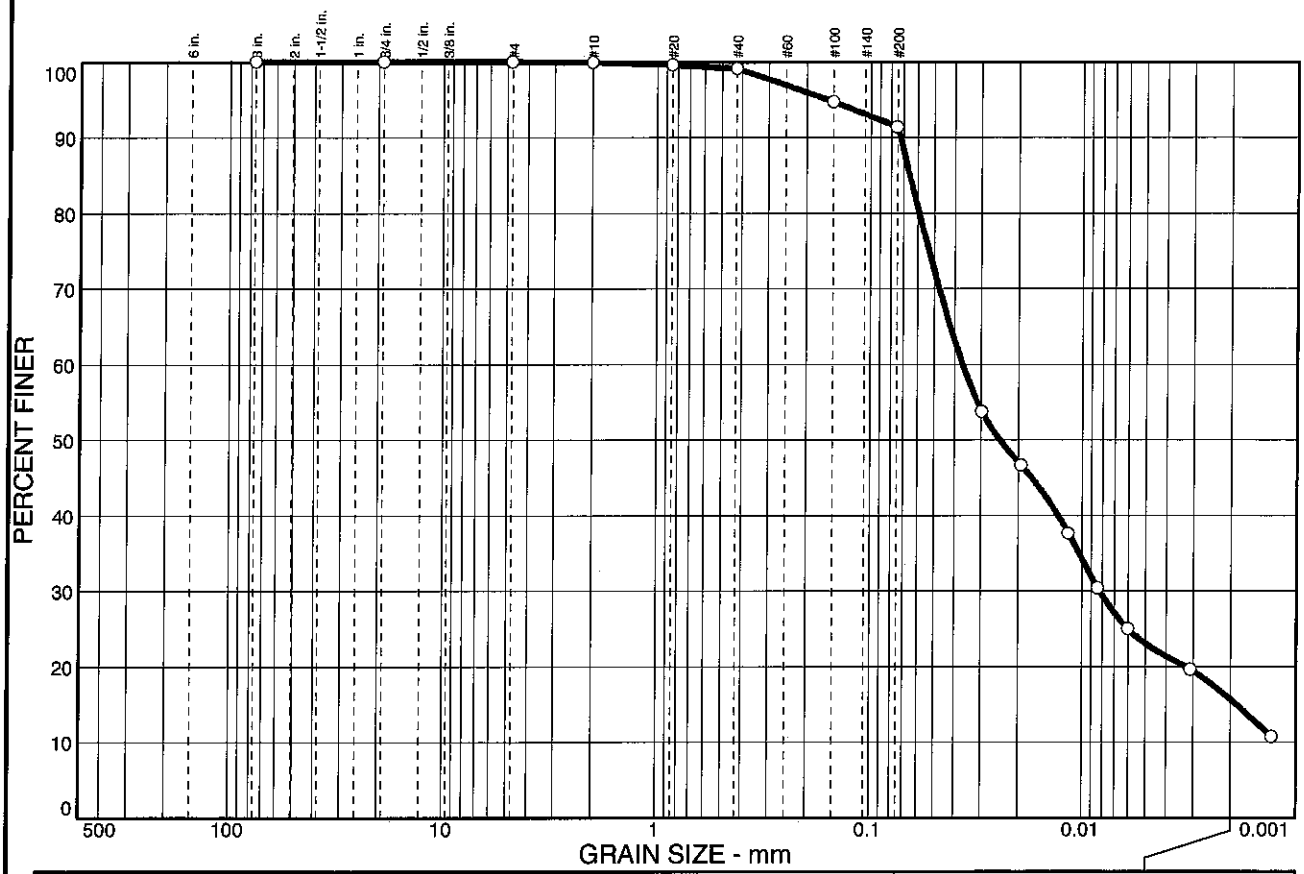
Remarks

As received moisture content = 141.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-2430 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.8	7.7	75.8	15.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.1		
#100	94.7		
#200	91.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0658 D_{60}= 0.0368 D_{50}= 0.0245
D_{30}= 0.0082 D_{15}= 0.0019 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

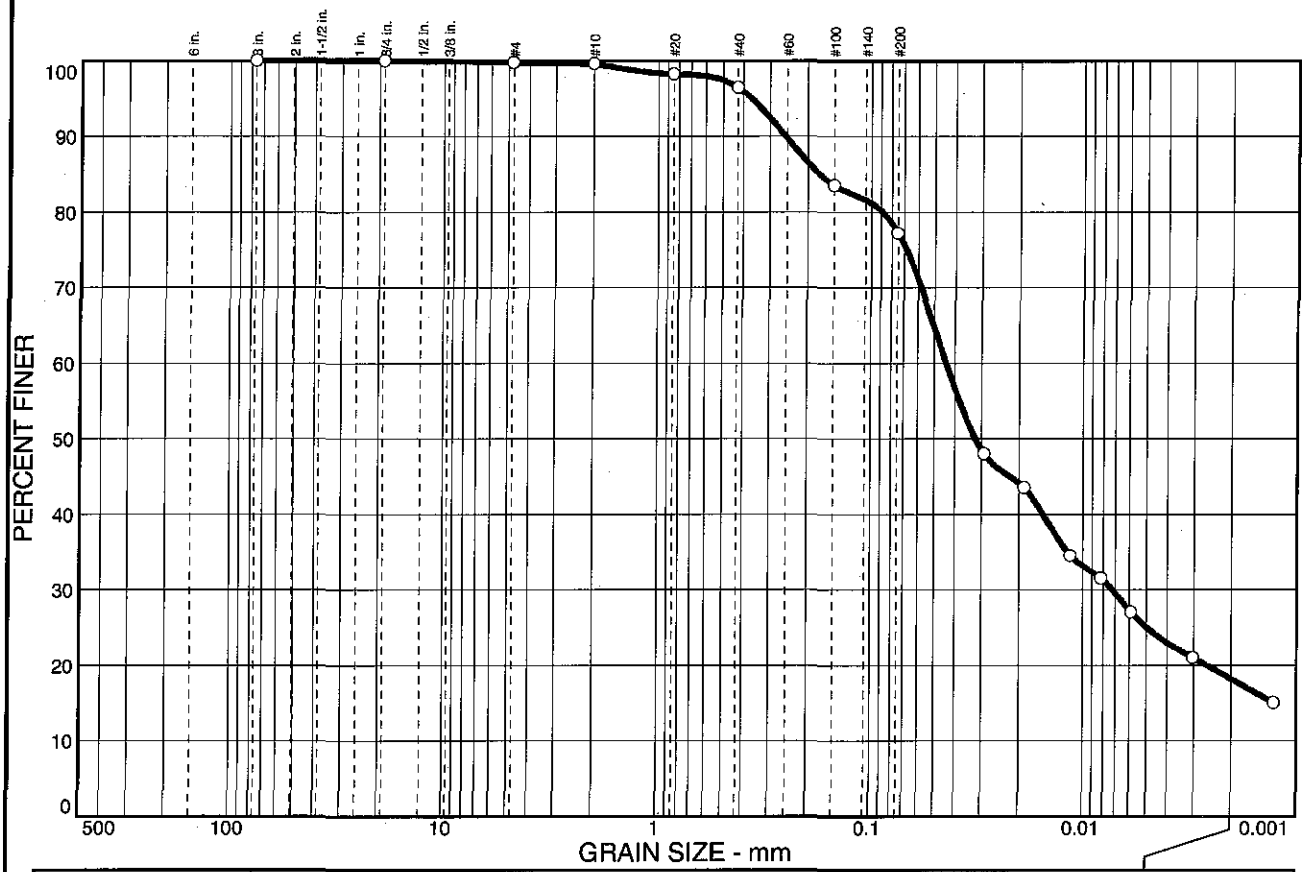
Remarks

As received moisture content = 131.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-3036 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.2	3.2	19.2	59.0	18.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.6		
#20	98.2		
#40	96.4		
#100	83.5		
#200	77.2		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.176 D_{60}= 0.0441 D_{50}= 0.0321
D_{30}= 0.0072 D_{15}= 0.0013 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 97.7%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-3642 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 36-42

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.4	3.4	7.9	57.7	30.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.5		
#20	98.0		
#40	96.1		
#100	90.6		
#200	88.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0672 D_{60}= 0.0142 D_{50}= 0.0080
D_{30}= 0.0019 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

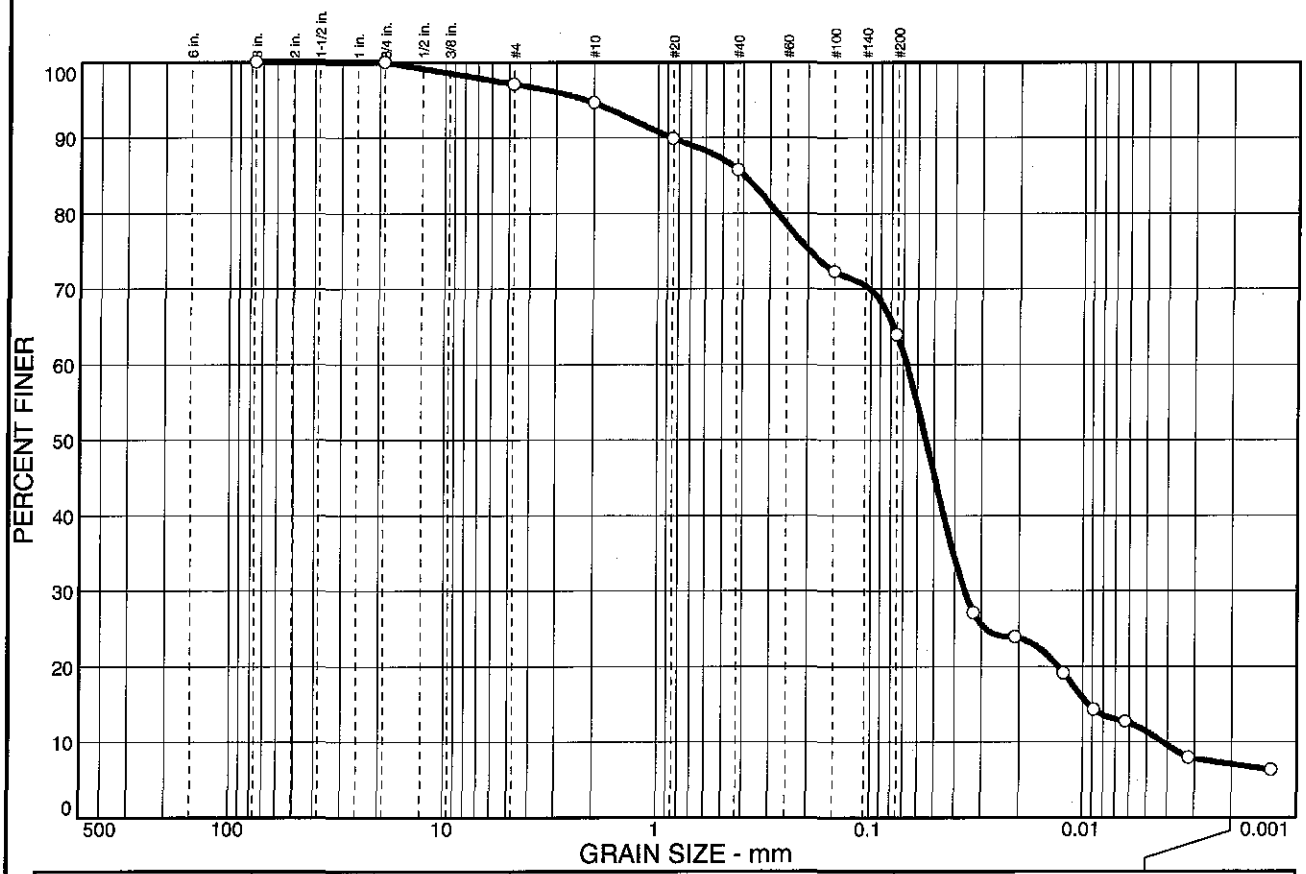
Remarks

As received moisture content = 94.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-4248 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 42-48

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	2.9	2.5	8.9	21.8	56.8	7.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	97.1		
#10	94.6		
#20	89.9		
#40	85.7		
#100	72.3		
#200	63.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.399 D_{60}= 0.0676 D_{50}= 0.0548
D_{30}= 0.0359 D_{15}= 0.0094 D_{10}= 0.0042
C_u= 16.02 C_c= 4.52

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 131.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-0003 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 00-03

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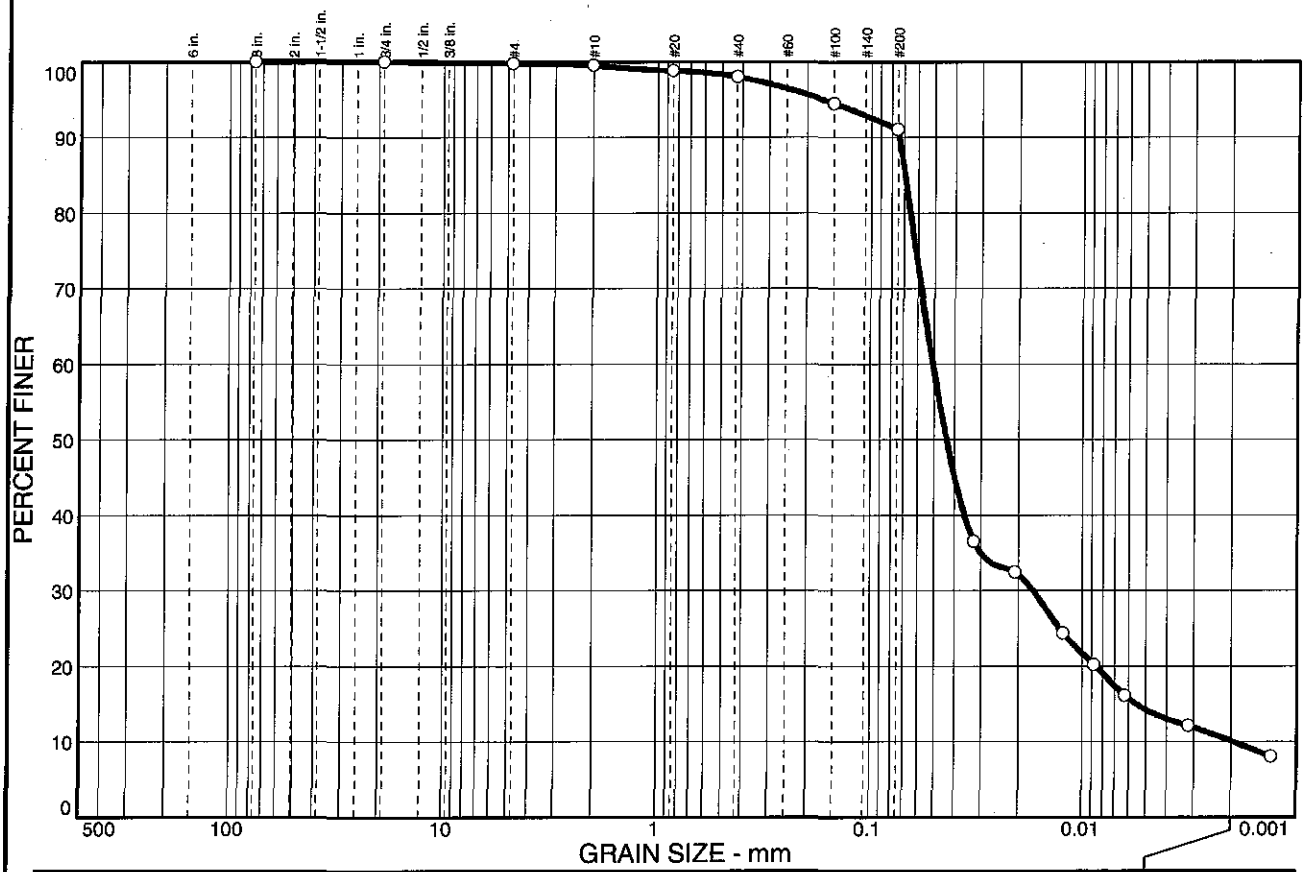
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.3	1.5	7.0	80.9	10.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.5		
#20	98.8		
#40	98.0		
#100	94.5		
#200	91.0		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0698 D_{60}= 0.0509 D_{50}= 0.0438
D_{30}= 0.0171 D_{15}= 0.0056 D_{10}= 0.0020
C_u= 25.84 C_c= 2.91

Classification

USCS= ML AASHTO= --

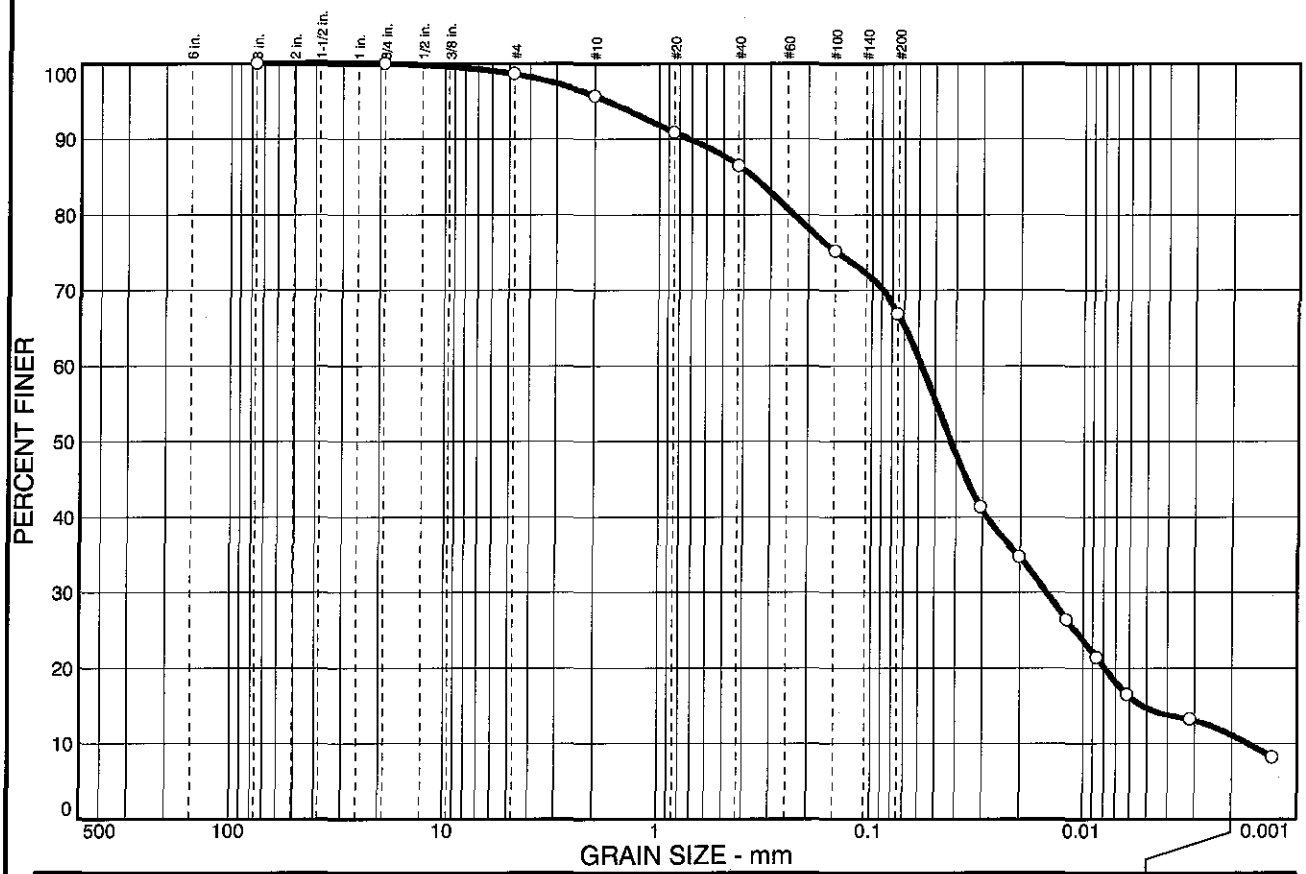
Remarks

As received moisture content = 150.2%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-0306 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.4	2.9	9.2	19.6	55.8	11.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.6		
#10	95.7		
#20	90.9		
#40	86.5		
#100	75.2		
#200	66.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.363 D_{60}= 0.0580 D_{50}= 0.0423
D_{30}= 0.0149 D_{15}= 0.0053 D_{10}= 0.0017
C_u= 34.27 C_c= 2.26

Classification

USCS= ML AASHTO= --

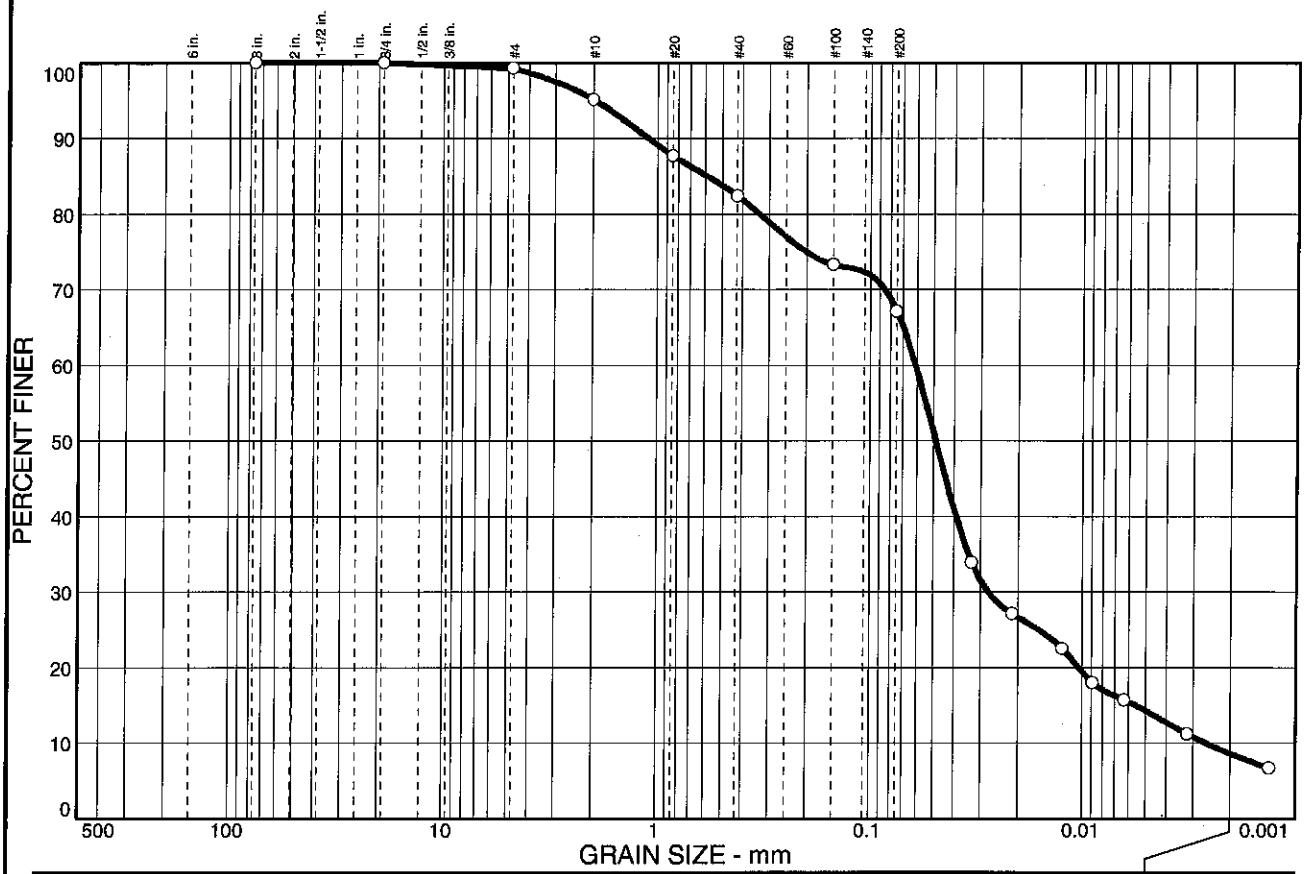
Remarks

As received moisture content = 120.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-0612 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.7	4.2	12.7	15.3	58.5	8.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.3		
#10	95.1		
#20	87.7		
#40	82.4		
#100	73.3		
#200	67.1		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.589 D_{60}= 0.0613 D_{50}= 0.0490
D_{30}= 0.0276 D_{15}= 0.0056 D_{10}= 0.0026
C_u= 23.44 C_c= 4.76

Classification

USCS= ML AASHTO= --

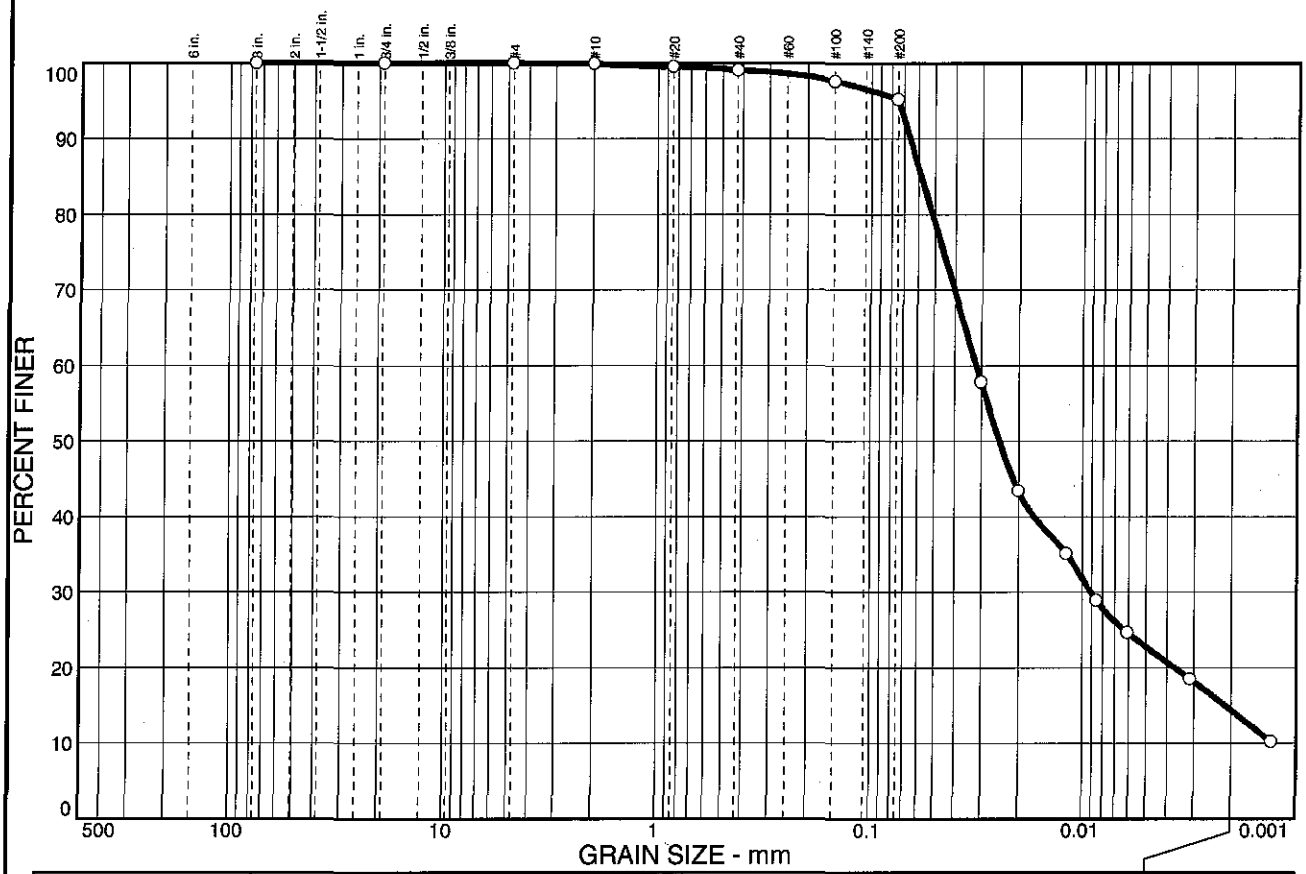
Remarks

As received moisture content = 130.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-1218 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.9	3.8	80.9	14.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.5		
#40	99.0		
#100	97.6		
#200	95.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0584 D_{60}= 0.0318 D_{50}= 0.0247
D_{30}= 0.0091 D_{15}= 0.0021 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

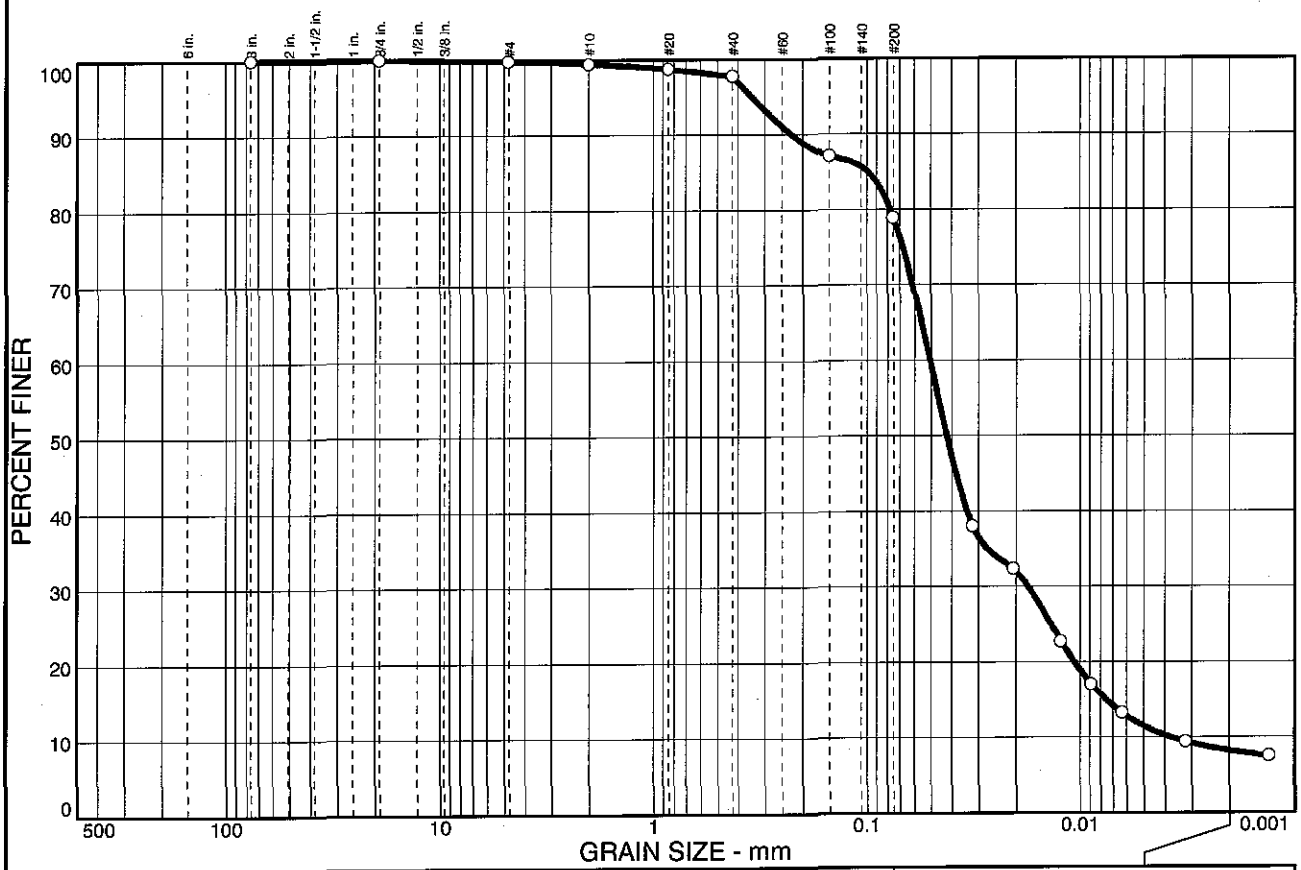
Remarks

As received moisture content = 122.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-1824 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.4	1.7	18.8	70.7	8.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.4		
#20	98.7		
#40	97.7		
#100	87.1		
#200	78.9		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0989 D_{60}= 0.0509 D_{50}= 0.0425
D_{30}= 0.0176 D_{15}= 0.0076 D_{10}= 0.0038
C_u= 13.54 C_c= 1.61

Classification

USCS= ML AASHTO= --

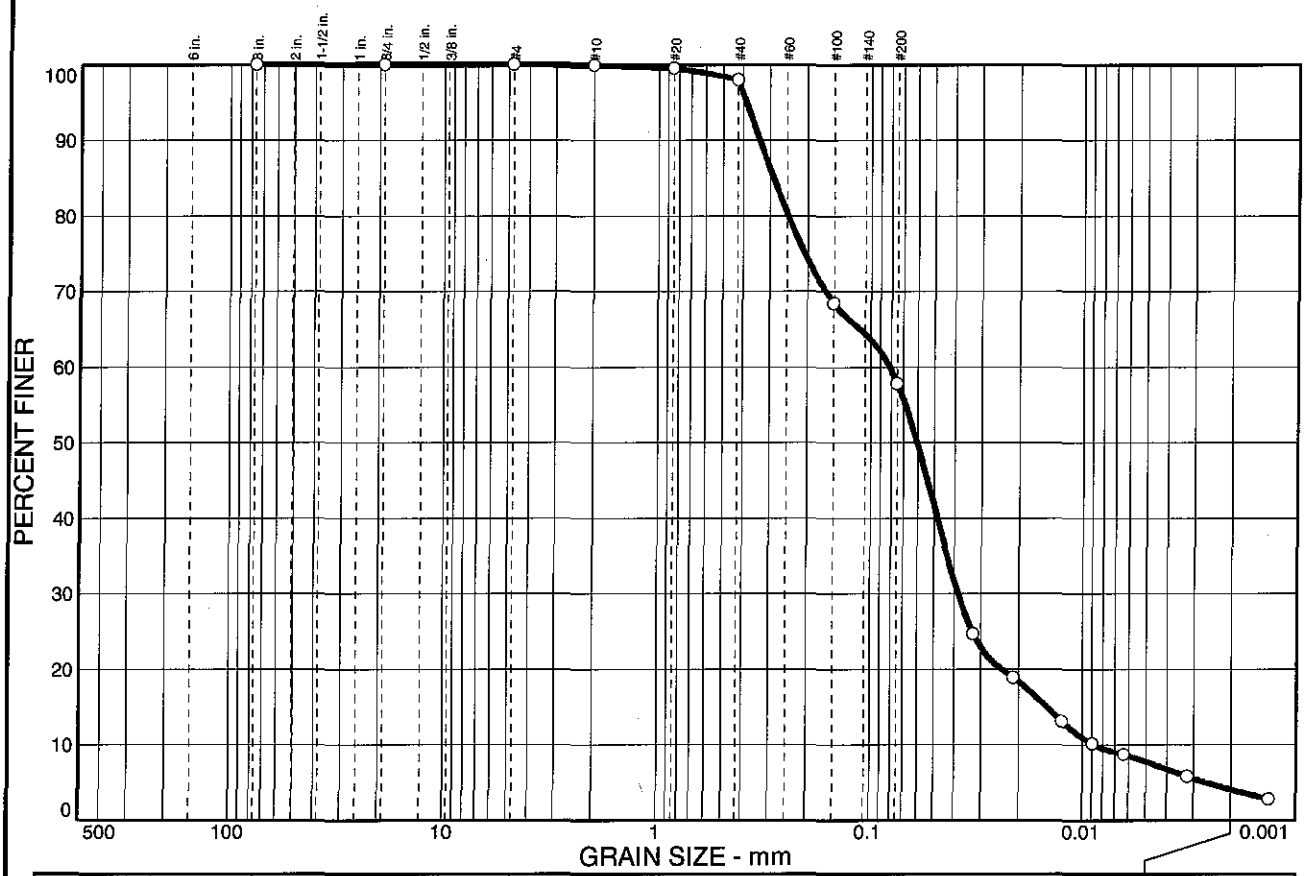
Remarks

As received moisture content = 113.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-2430 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.9	40.2	53.7	4.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.5		
#40	98.0		
#100	68.4		
#200	57.8		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.290 D_{60}= 0.0815 D_{50}= 0.0606
D_{30}= 0.0384 D_{15}= 0.0147 D_{10}= 0.0088
C_u= 9.28 C_c= 2.06

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 78.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-3036 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	1.6	42.3	51.7	4.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	100.0		
#20	99.6		
#40	98.4		
#100	67.6		
#200	56.1		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.280 D_{60}= 0.102 D_{50}= 0.0439
D_{30}= 0.0275 D_{15}= 0.0205 D_{10}= 0.0092
C_u= 11.07 C_c= 0.80

Classification

USCS= ML AASHTO= --

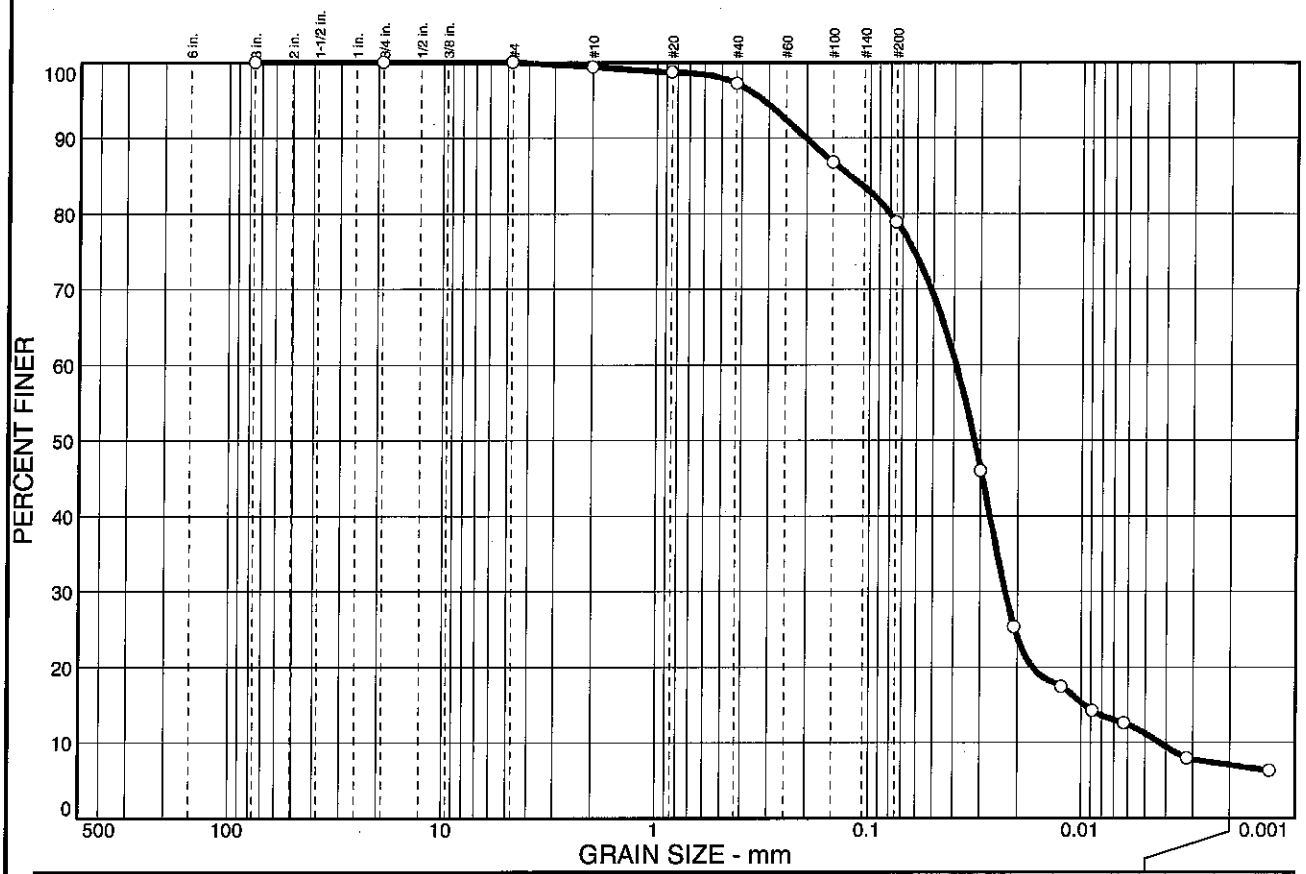
Remarks

As received moisture content = 74.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-ND-3639 **Source of Sample:** 7/5 **Date:** 5/25/04
Location: T71ND **Elev./Depth:** 36-39

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.6	2.2	18.3	71.8	7.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.4		
#20	98.7		
#40	97.2		
#100	86.8		
#200	78.9		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.124 D_{60}= 0.0393 D_{50}= 0.0320
D_{30}= 0.0229 D_{15}= 0.0096 D_{10}= 0.0043
C_u= 9.17 C_c= 3.11

Classification

USCS= ML AASHTO= --

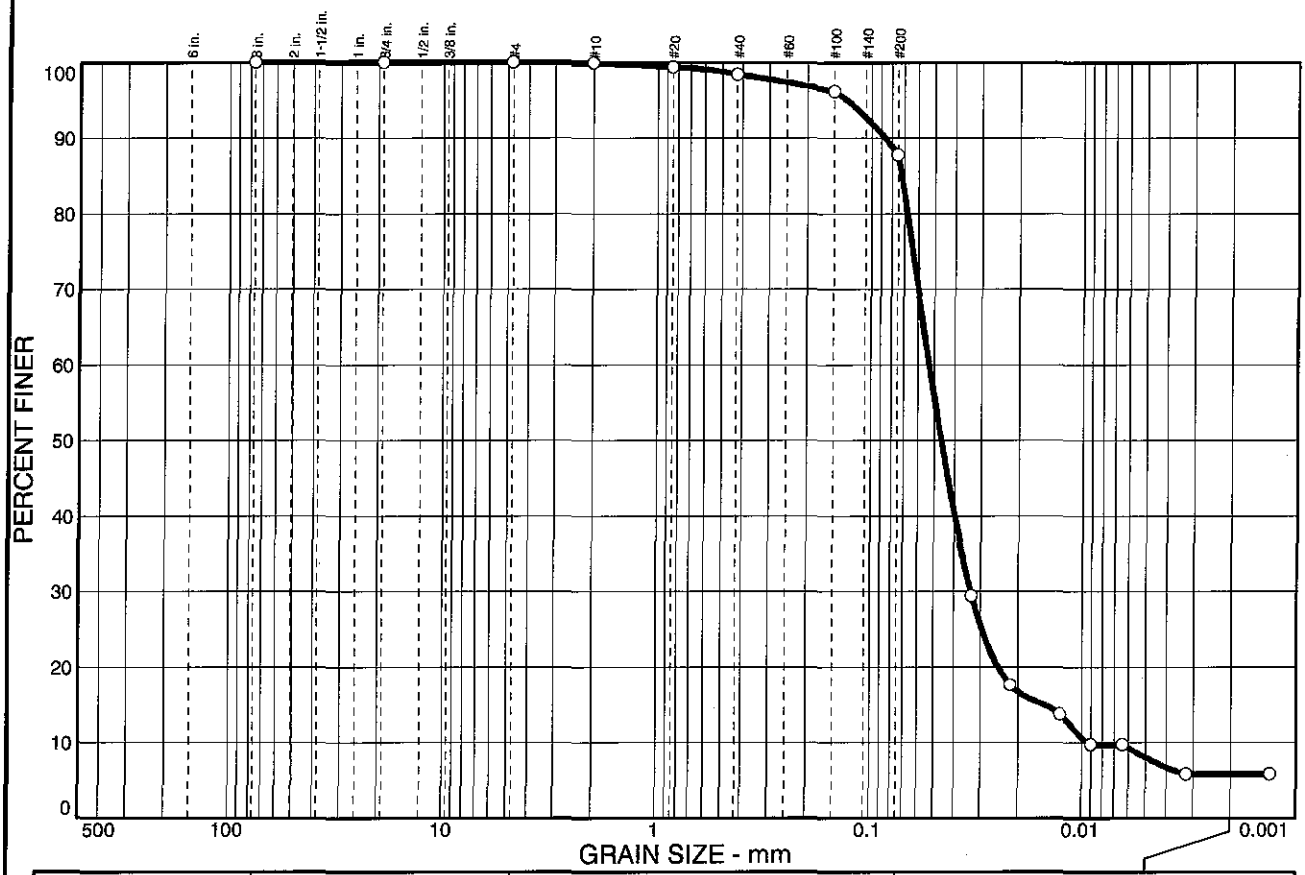
Remarks

As received moisture content = 128.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP10 **Source of Sample:** 6/28 **Date:** 5/25/04
Location: DUP10 **Elev./Depth:**

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.5	10.6	82.0	5.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.4		
#40	98.4		
#100	96.2		
#200	87.8		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0725 D_{60}= 0.0531 D_{50}= 0.0465
D_{30}= 0.0334 D_{15}= 0.0150 D_{10}= 0.0094
C_u= 5.66 C_c= 2.23

Classification

USCS= ML AASHTO= --

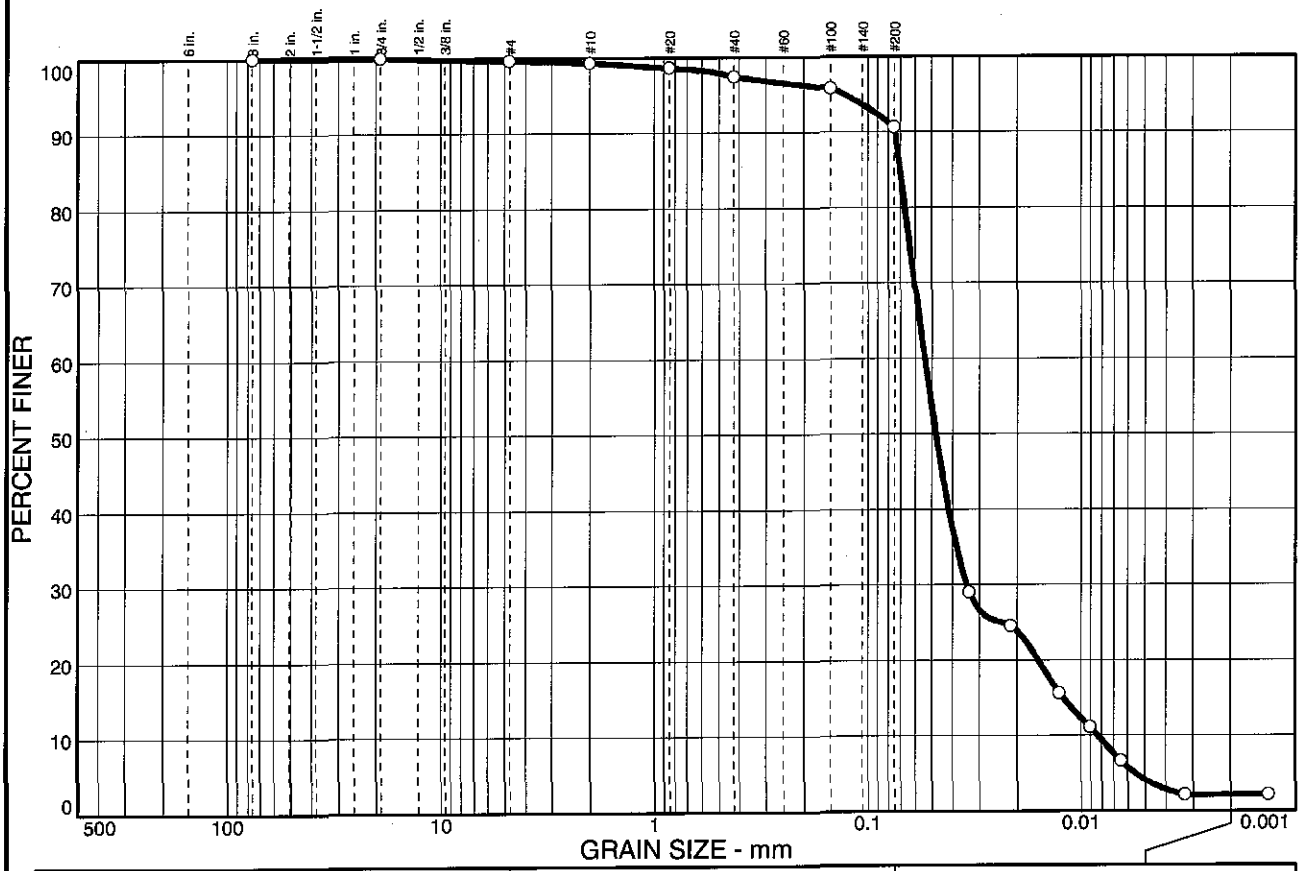
Remarks

As received moisture content = 181.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP23 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: DUP23 **Elev./Depth:**

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	0.3	1.9	6.8	88.5	2.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.6		
#10	99.3		
#20	98.6		
#40	97.4		
#100	95.8		
#200	90.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0708 D_{60}= 0.0543 D_{50}= 0.0482
D_{30}= 0.0344 D_{15}= 0.0122 D_{10}= 0.0083
C_u= 6.52 C_c= 2.62

Classification

USCS= ML AASHTO= --

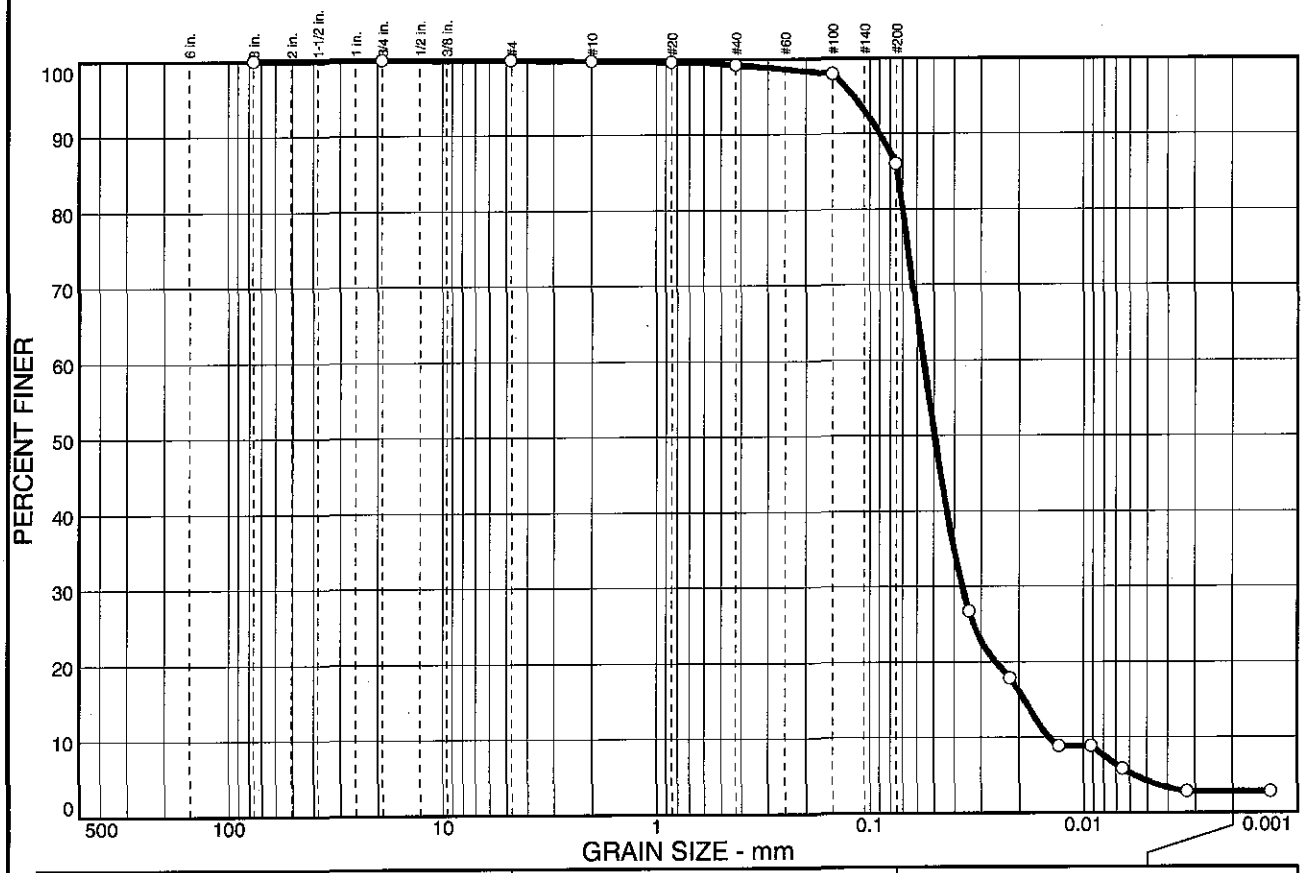
Remarks

As received moisture content = 203.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP24 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: DUP24 **Elev./Depth:**

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.1	0.6	13.2	83.2	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.8		
#20	99.6		
#40	99.2		
#100	97.9		
#200	86.0		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0742 D_{60}= 0.0562 D_{50}= 0.0498
D_{30}= 0.0368 D_{15}= 0.0189 D_{10}= 0.0145
C_u= 3.87 C_c= 1.67

Classification

USCS= ML AASHTO= --

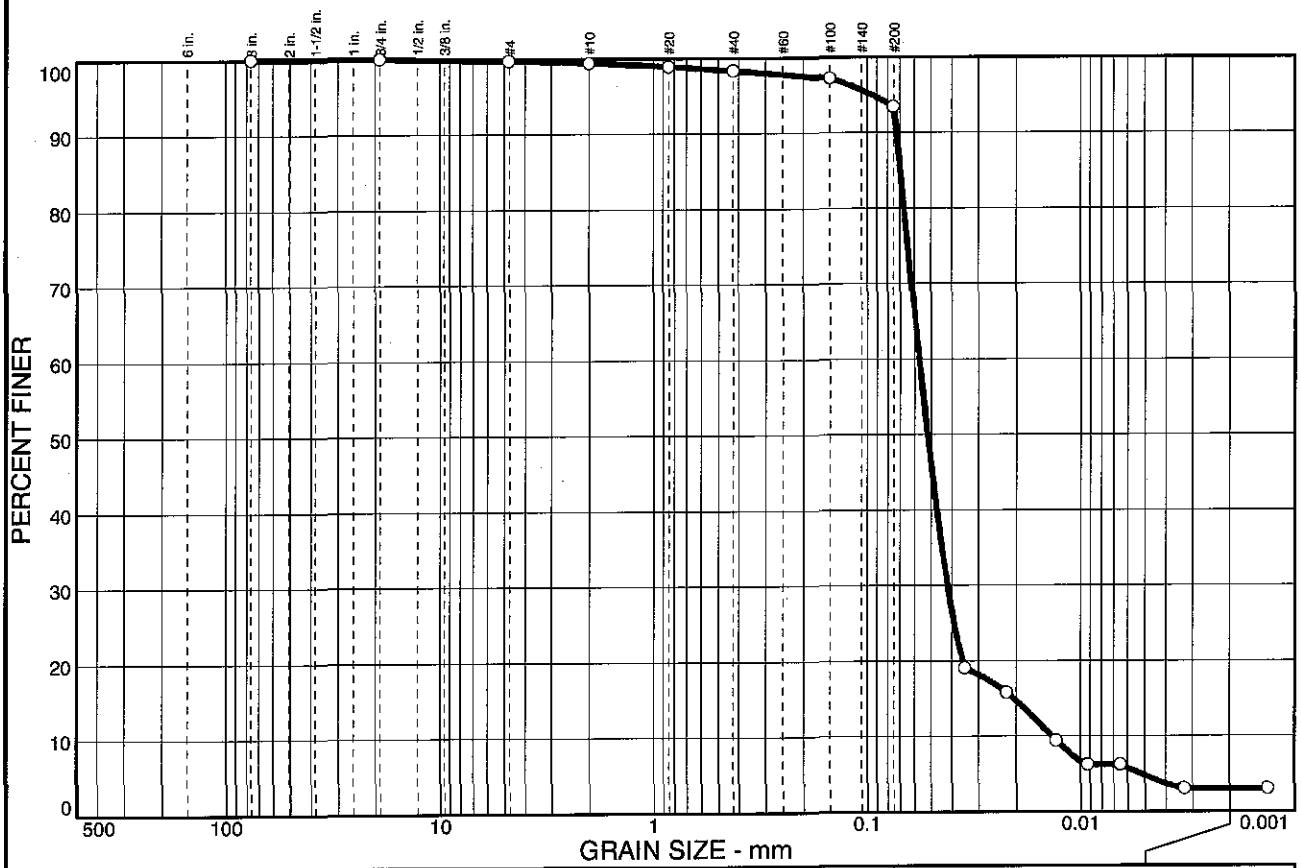
Remarks

As received moisture content = 293.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-0003 **Source of Sample:** 6/28 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.3	1.1	4.9	90.4	3.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.4		
#20	98.9		
#40	98.3		
#100	97.2		
#200	93.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0702 D_{60}= 0.0571 D_{50}= 0.0522
D_{30}= 0.0421 D_{15}= 0.0205 D_{10}= 0.0136
C_u= 4.21 C_c= 2.29

Classification

USCS= ML AASHTO= --

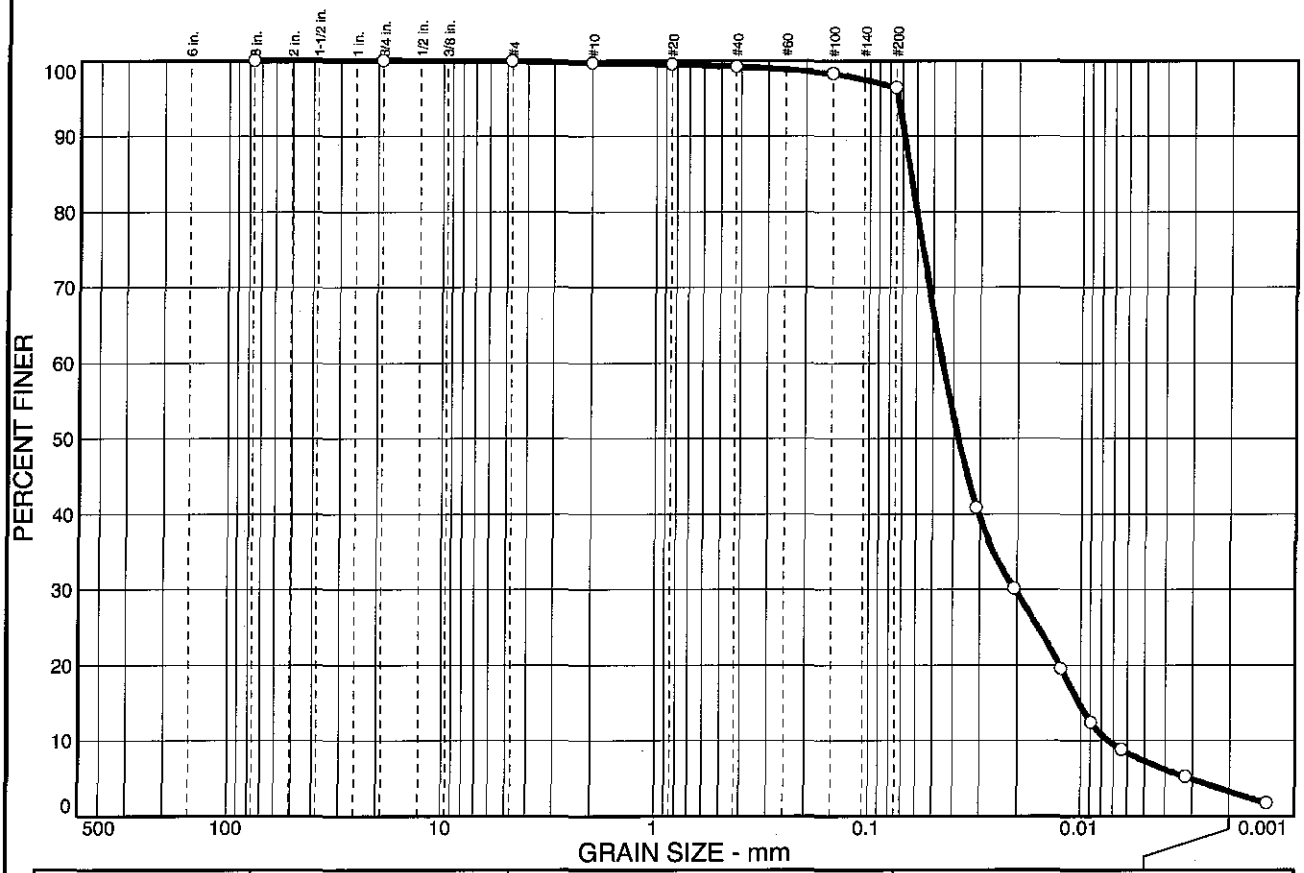
Remarks

As received moisture content = 325.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-0003 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	0.5	2.8	93.1	3.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.5		
#40	99.2		
#100	98.3		
#200	96.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0645 D_{60}= 0.0452 D_{50}= 0.0381
D_{30}= 0.0205 D_{15}= 0.0102 D_{10}= 0.0074
C_u= 6.09 C_c= 1.25

Classification

USCS= ML AASHTO= --

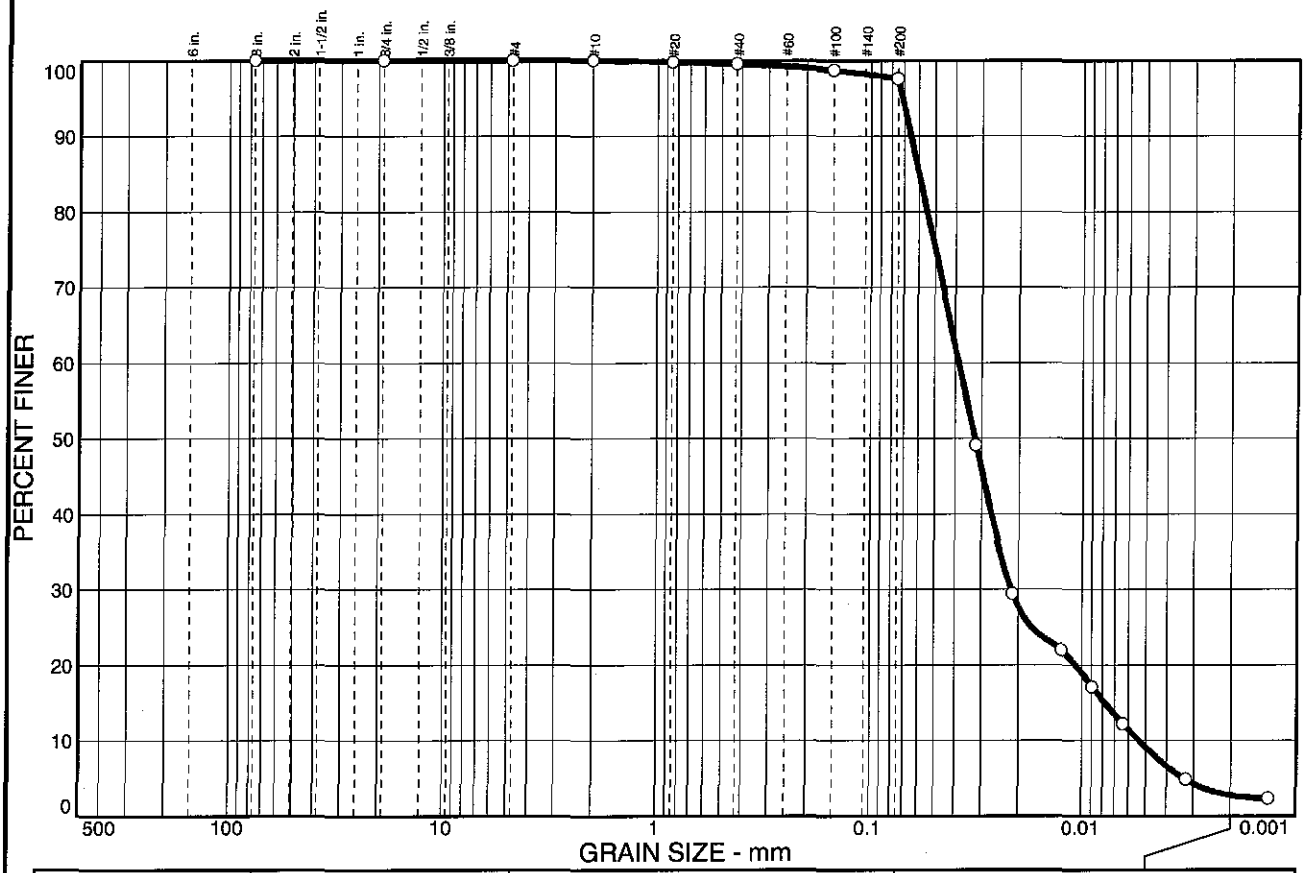
Remarks

As received moisture content = 165.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-4854 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 45-54

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.5	1.9	94.9	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	100.0		
#20	99.8		
#40	99.5		
#100	98.7		
#200	97.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0600 D_{60}= 0.0386 D_{50}= 0.0324
D_{30}= 0.0216 D_{15}= 0.0078 D_{10}= 0.0054
C_u= 7.15 C_c= 2.24

Classification

USCS= ML AASHTO= --

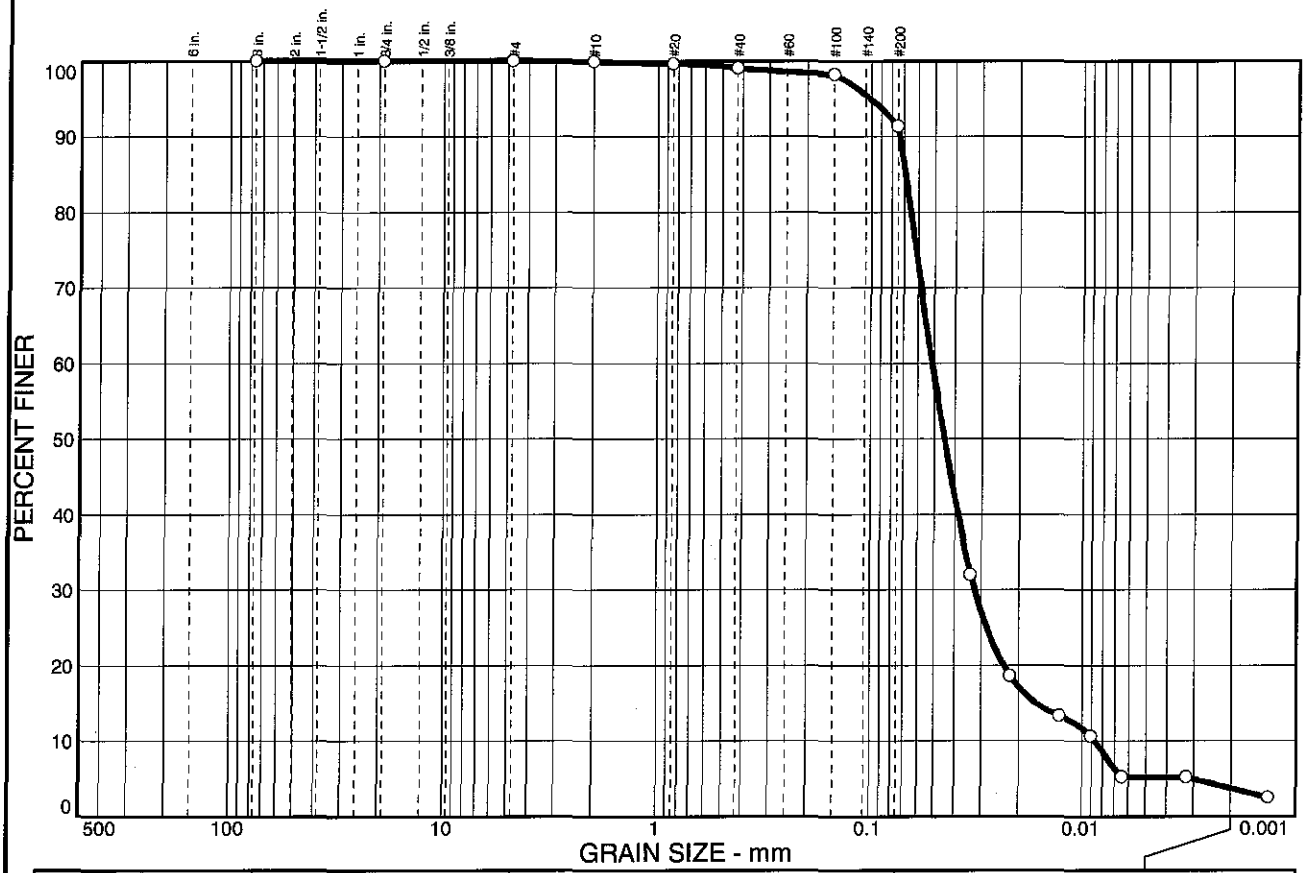
Remarks

As received moisture content = 219.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-3642 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 36-42

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.9	7.6	87.7	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.0		
#100	98.2		
#200	91.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0695 D_{60}= 0.0514 D_{50}= 0.0450
D_{30}= 0.0322 D_{15}= 0.0165 D_{10}= 0.0087
C_u= 5.90 C_c= 2.31

Classification

USCS= ML AASHTO= --

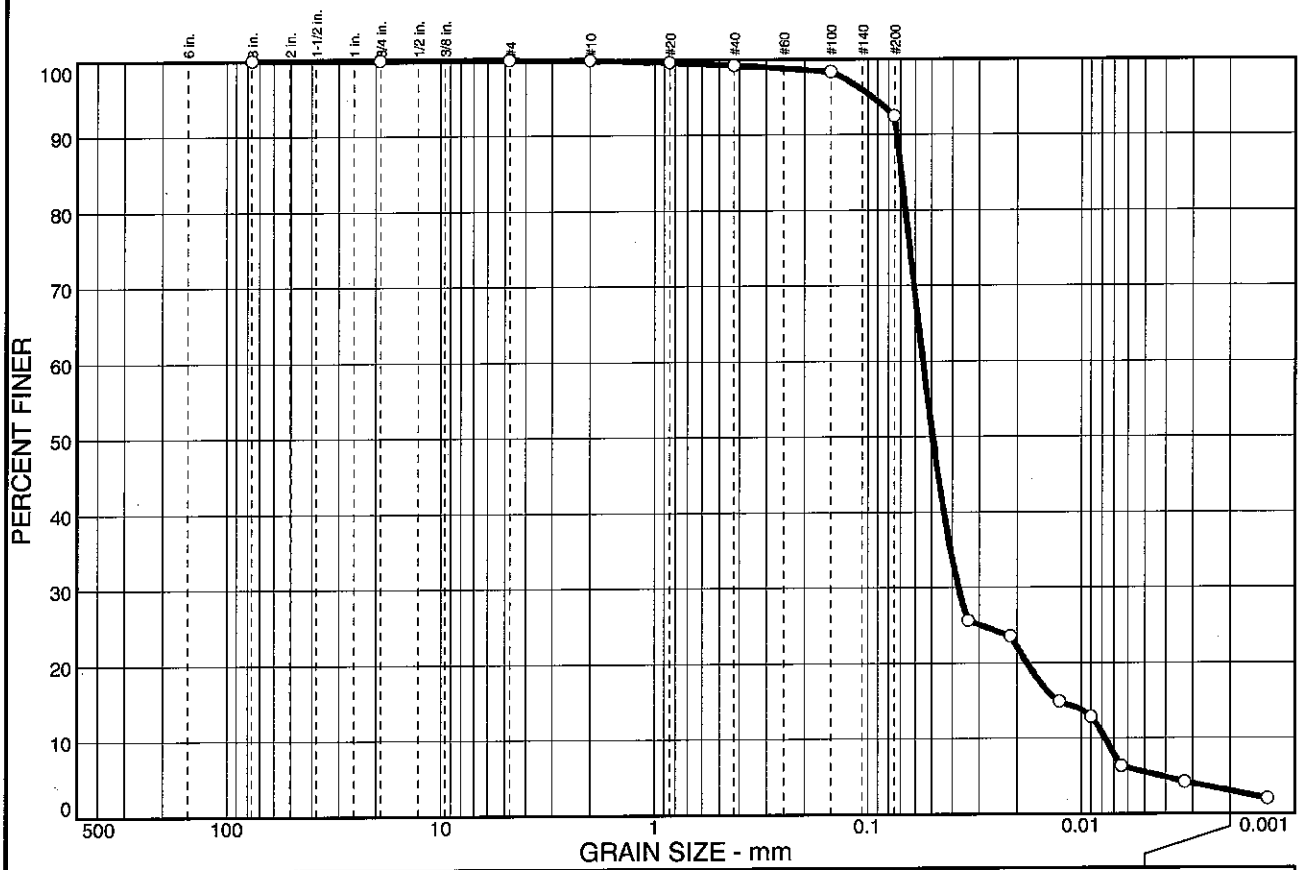
Remarks

As received moisture content = 219.8%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-0003 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.7	6.8	89.4	3.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.2		
#100	98.3		
#200	92.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0701 D_{60}= 0.0552 D_{50}= 0.0497
D_{30}= 0.0376 D_{15}= 0.0128 D_{10}= 0.0077
C_u= 7.15 C_c= 3.31

Classification

USCS= ML AASHTO= --

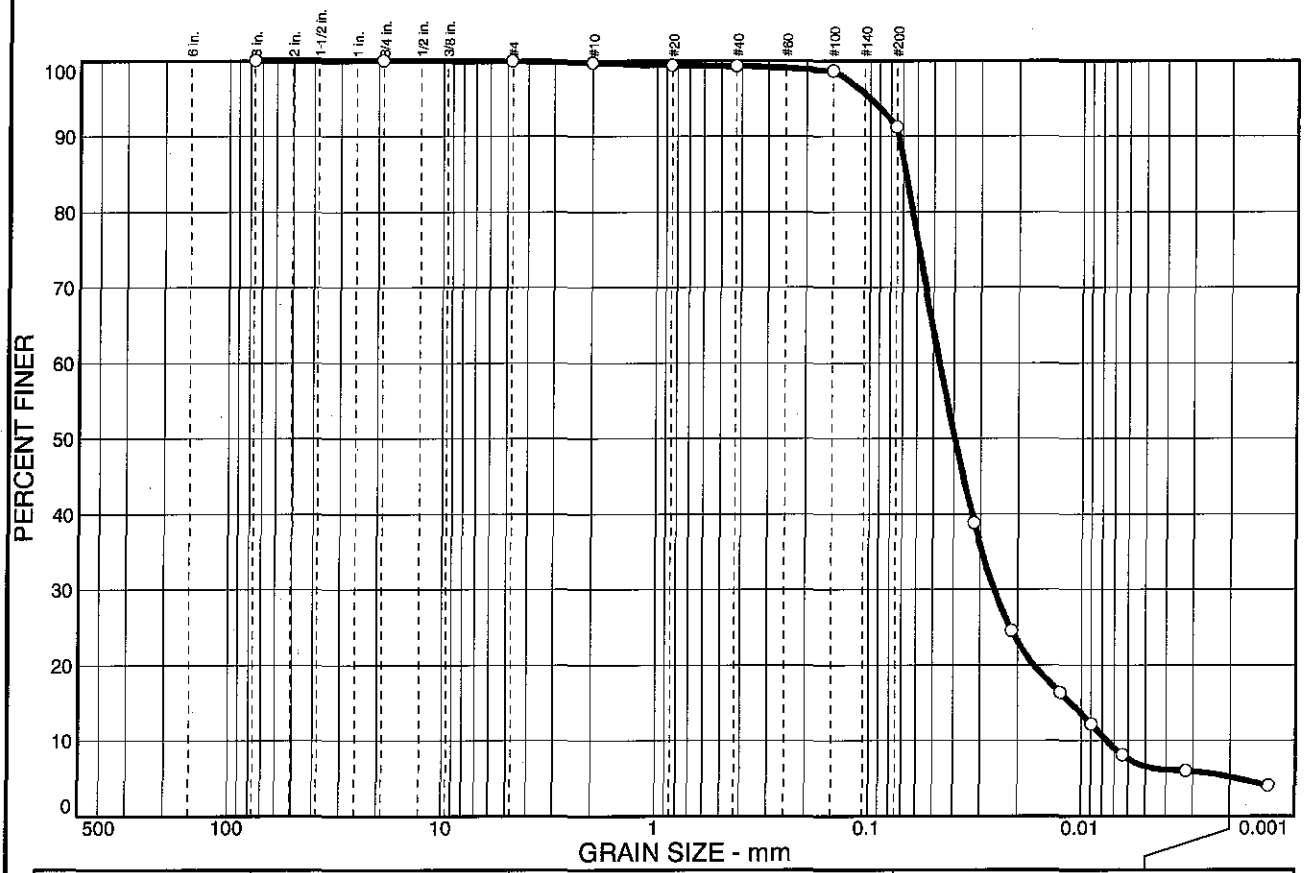
Remarks

As received moisture content = 202.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-0306 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	0.4	8.1	86.0	5.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.4		
#40	99.3		
#100	98.6		
#200	91.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0684 D_{60}= 0.0470 D_{50}= 0.0398
D_{30}= 0.0257 D_{15}= 0.0112 D_{10}= 0.0076
C_u= 6.18 C_c= 1.85

Classification

USCS= ML AASHTO= --

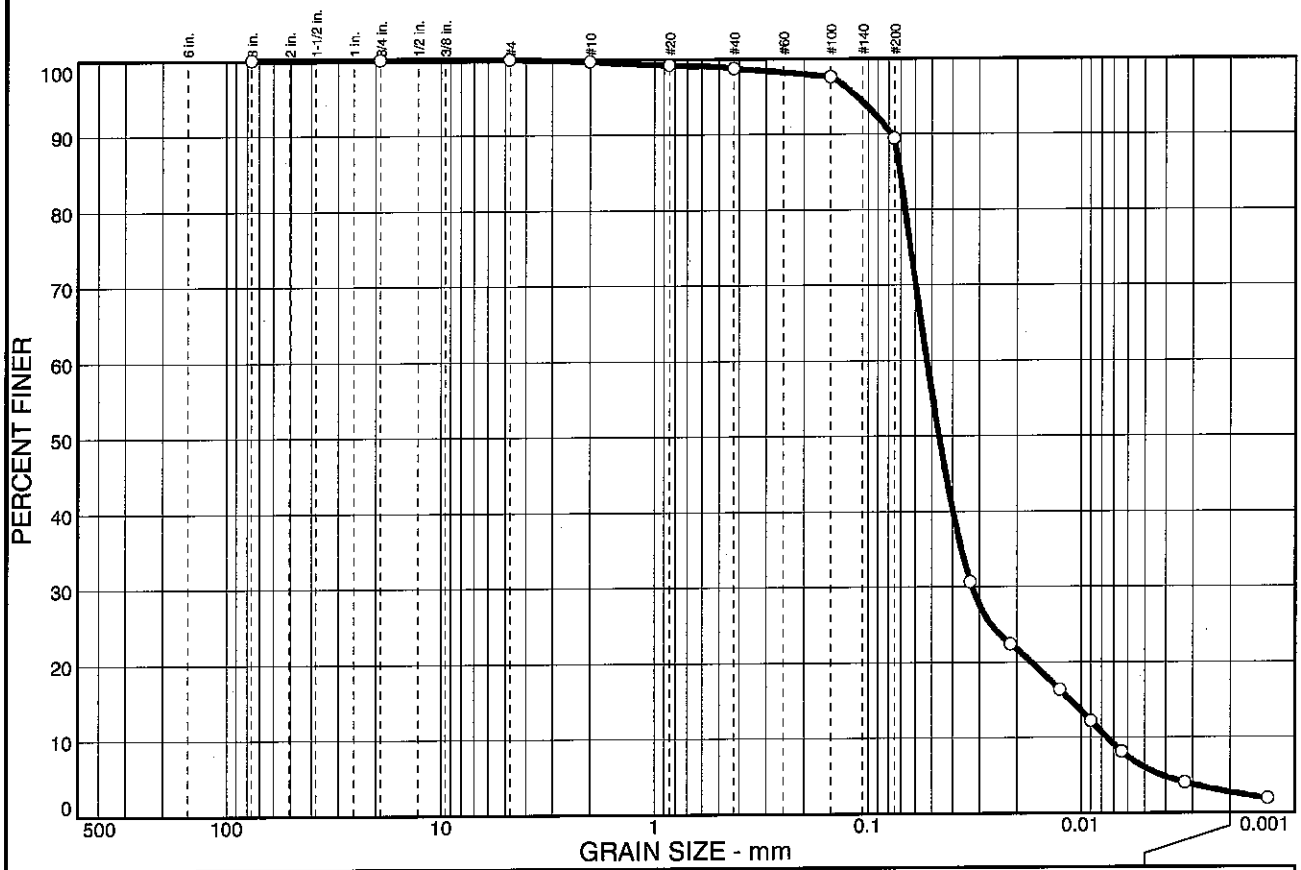
Remarks

As received moisture content = 178.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-0612 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.3	1.0	9.3	86.7	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.7		
#20	99.2		
#40	98.7		
#100	97.6		
#200	89.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0713 D_{60}= 0.0530 D_{50}= 0.0465
D_{30}= 0.0324 D_{15}= 0.0113 D_{10}= 0.0076
C_u= 7.01 C_c= 2.62

Classification

USCS= ML AASHTO= --

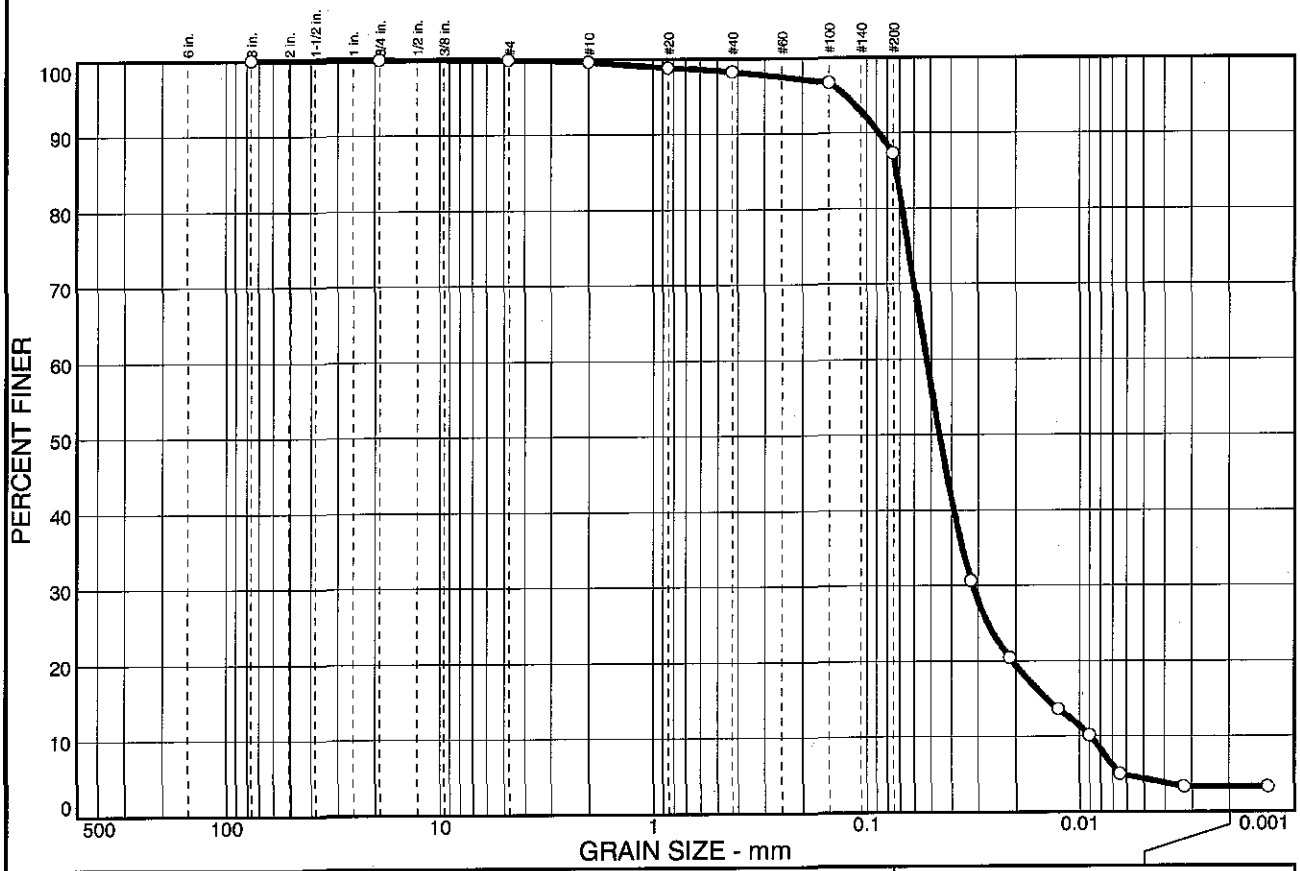
Remarks

As received moisture content = 174.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-1218 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.3	1.4	10.9	84.0	3.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.6		
#20	98.8		
#40	98.2		
#100	96.7		
#200	87.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0728 D_{60}= 0.0528 D_{50}= 0.0459
D_{30}= 0.0318 D_{15}= 0.0143 D_{10}= 0.0089
C_u= 5.92 C_c= 2.15

Classification

USCS= ML AASHTO= --

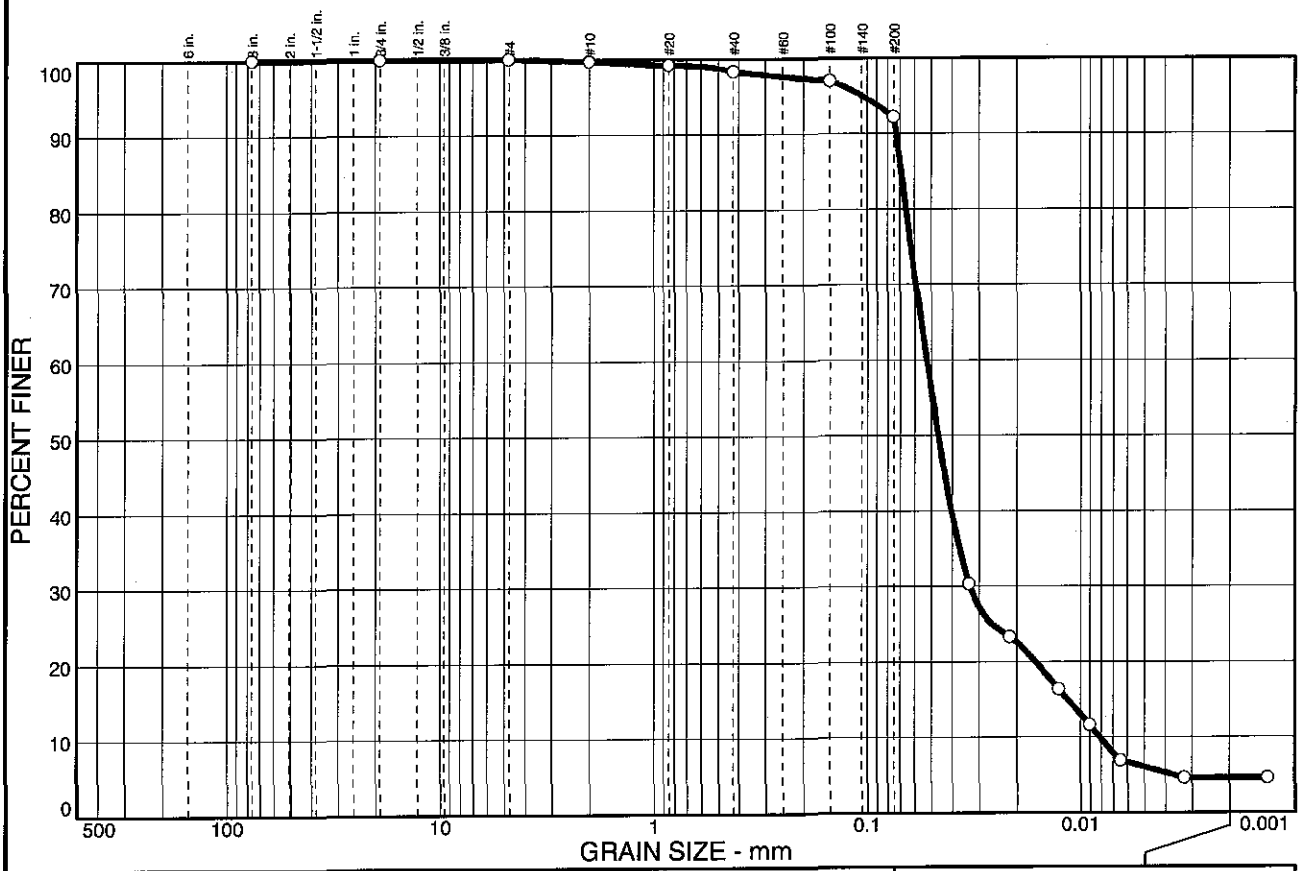
Remarks

As received moisture content 165.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-1824 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.3	1.4	6.1	87.6	4.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.7		
#20	99.2		
#40	98.3		
#100	97.0		
#200	92.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0695 D_{60}= 0.0529 D_{50}= 0.0468
D_{30}= 0.0331 D_{15}= 0.0115 D_{10}= 0.0081
C_u= 6.52 C_c= 2.55

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 201.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-2430 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.4	1.1	5.3	90.3	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.4		
#20	98.9		
#40	98.3		
#100	97.1		
#200	93.0		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0685 D_{60}= 0.0510 D_{50}= 0.0445
D_{30}= 0.0297 D_{15}= 0.0103 D_{10}= 0.0076
C_u= 6.70 C_c= 2.28

Classification

USCS= ML AASHTO= --

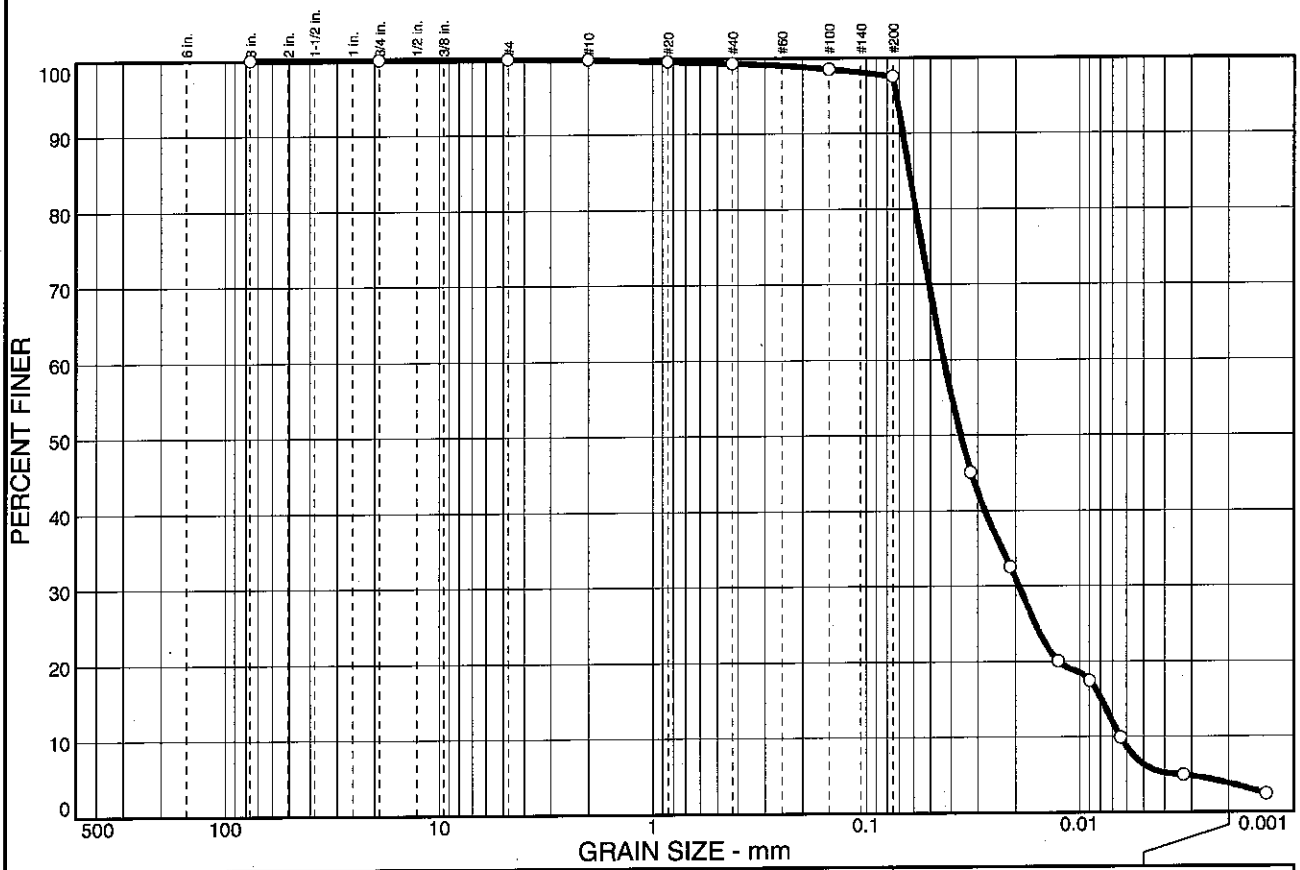
Remarks

As received moisture content = 193.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-3036 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.6	1.8	93.7	3.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.3		
#100	98.5		
#200	97.5		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0632 D_{60}= 0.0435 D_{50}= 0.0361
D_{30}= 0.0193 D_{15}= 0.0079 D_{10}= 0.0065
C_u= 6.74 C_c= 1.33

Classification

USCS= ML AASHTO= --

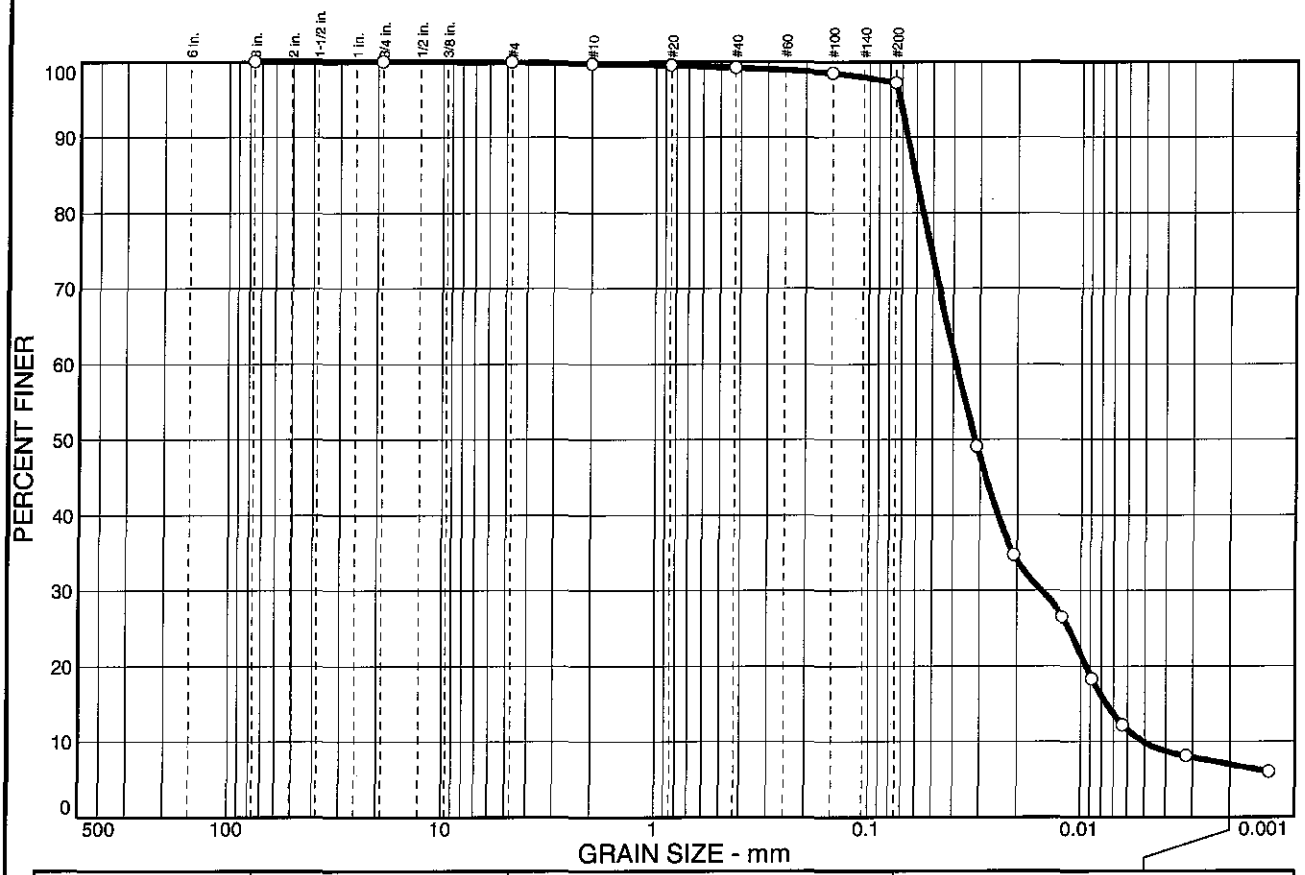
Remarks

As received moisture content = 221.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-3642 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 36-42

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	0.5	2.0	90.2	7.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.5		
#40	99.2		
#100	98.5		
#200	97.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0610 D_{60}= 0.0389 D_{50}= 0.0316
D_{30}= 0.0153 D_{15}= 0.0076 D_{10}= 0.0051
C_u= 7.63 C_c= 1.18

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 183.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-ME-4245 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46ME **Elev./Depth:** 42-45

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	0.8	5.6	85.1	8.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.6		
#40	98.9		
#100	97.7		
#200	93.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0698 D_{60}= 0.0559 D_{50}= 0.0507
D_{30}= 0.0400 D_{15}= 0.0143 D_{10}= 0.0037
C_u= 14.93 C_c= 7.65

Classification

USCS= ML AASHTO= --

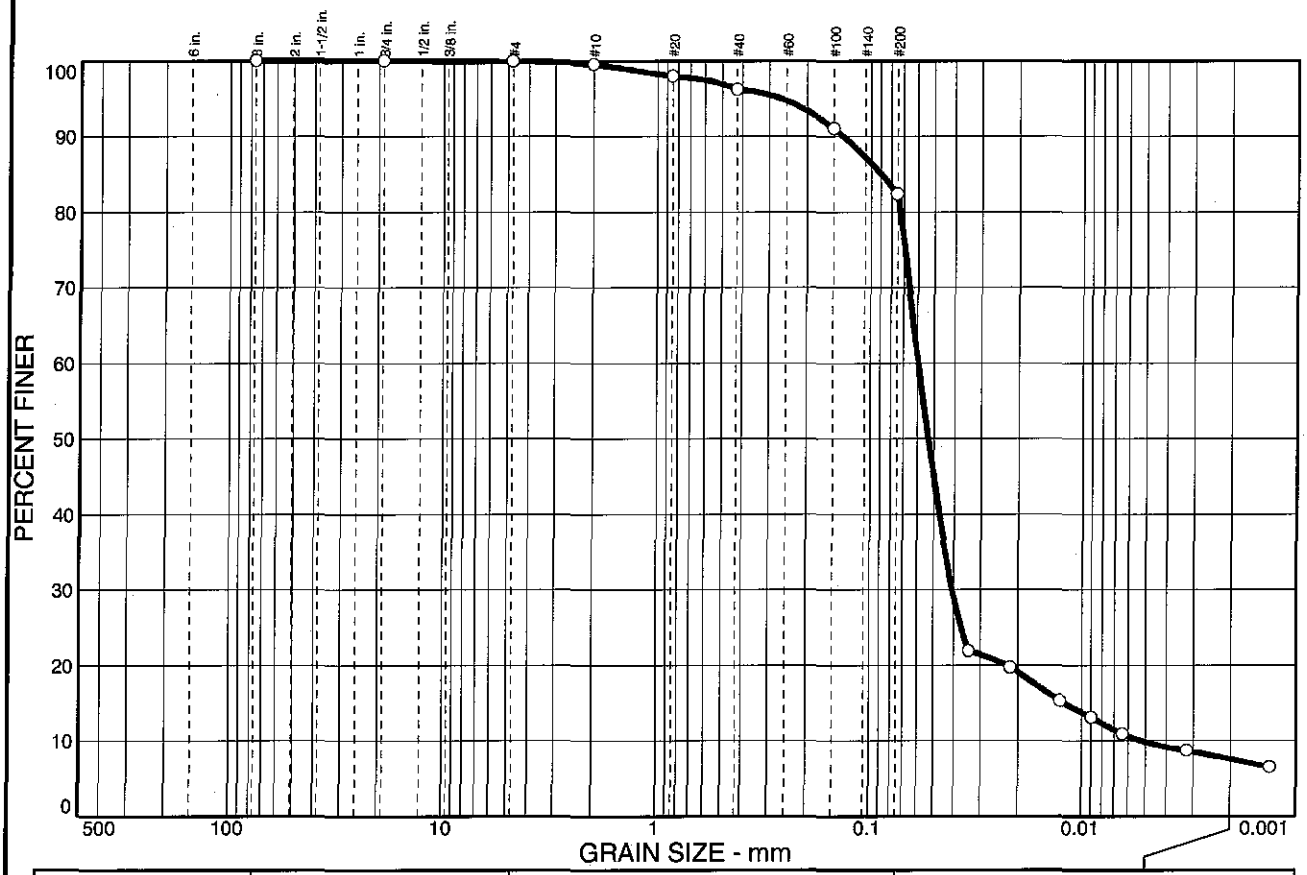
Remarks

As received moisture content = 206.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-0003 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.4	3.3	13.8	74.8	7.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.5		
#20	98.0		
#40	96.2		
#100	91.0		
#200	82.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0896 D_{60}= 0.0596 D_{50}= 0.0534
D_{30}= 0.0408 D_{15}= 0.0121 D_{10}= 0.0053
C_u= 11.35 C_c= 5.33

Classification

USCS= ML AASHTO= --

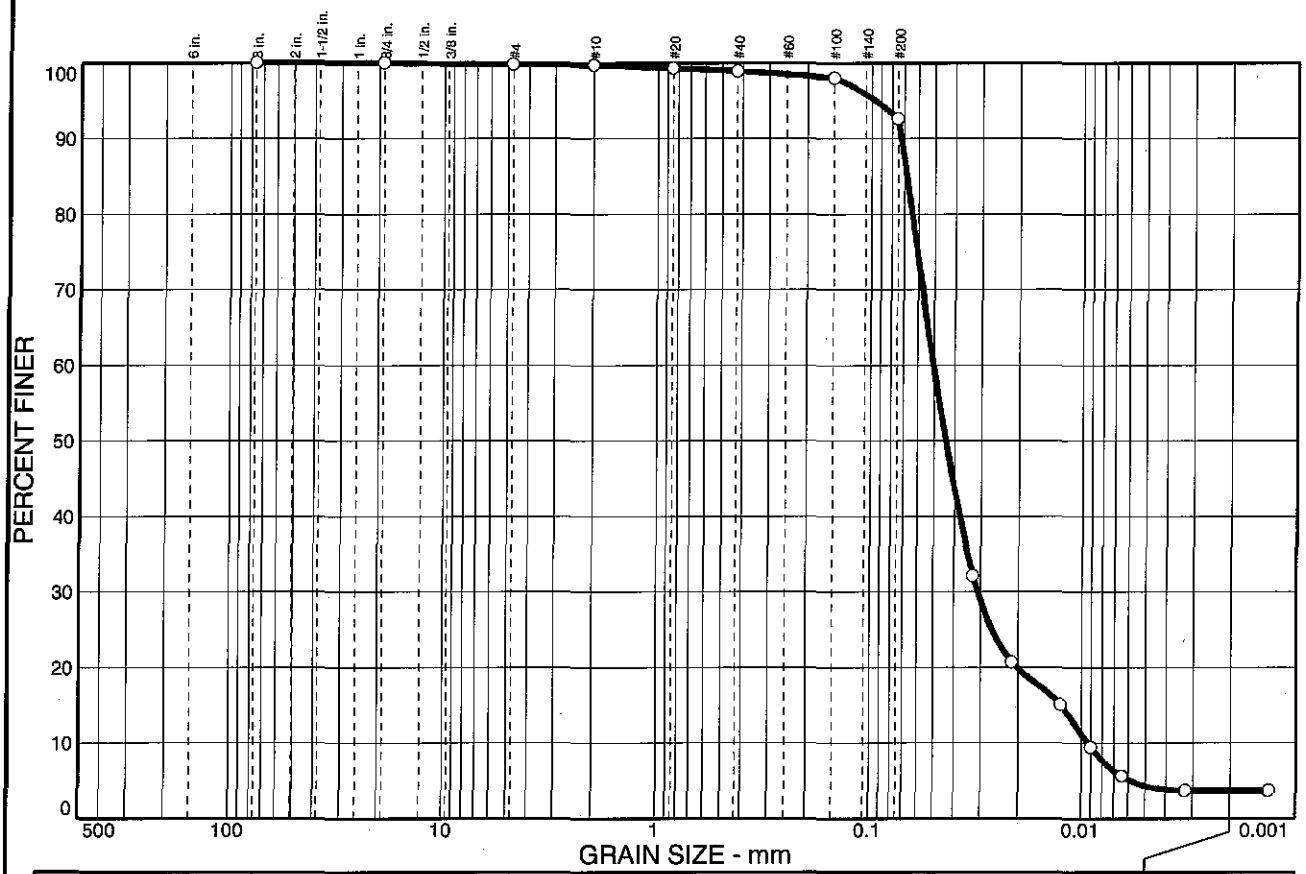
Remarks

As received moisture content = 196.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-0306 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.1	0.8	6.3	88.9	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.7		
#20	99.3		
#40	98.9		
#100	98.0		
#200	92.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0686 D_{60}= 0.0506 D_{50}= 0.0442
D_{30}= 0.0309 D_{15}= 0.0126 D_{10}= 0.0094
C_u= 5.40 C_c= 2.02

Classification

USCS= ML AASHTO= --

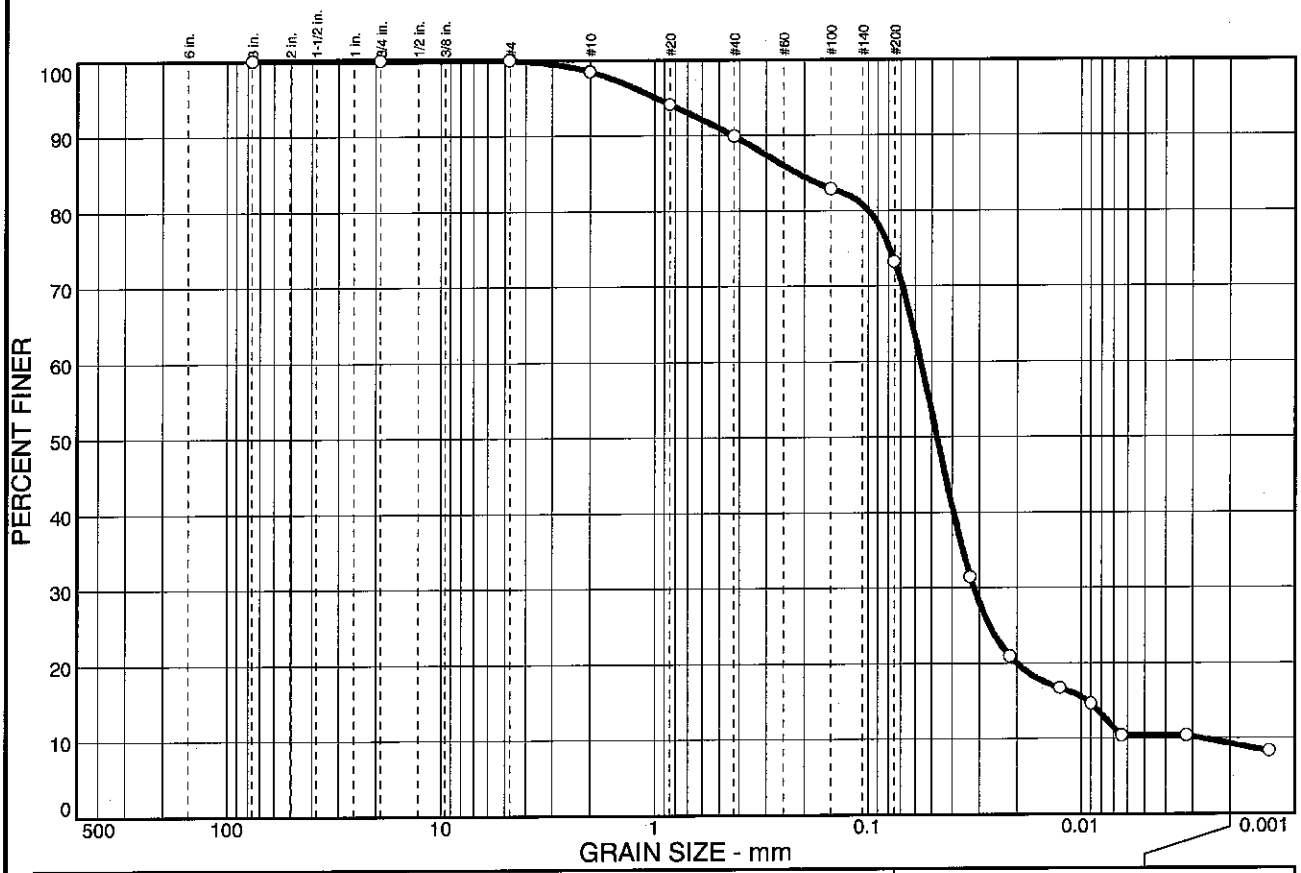
Remarks

As received moisture content = 183.3%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-0612 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	1.5	8.6	16.7	63.9	9.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	98.5		
#20	94.1		
#40	89.9		
#100	82.9		
#200	73.2		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.216 D_{60}= 0.0566 D_{50}= 0.0474
D_{30}= 0.0318 D_{15}= 0.0093 D_{10}= 0.0027
C_u= 21.00 C_c= 6.61

Classification

USCS= ML AASHTO= --

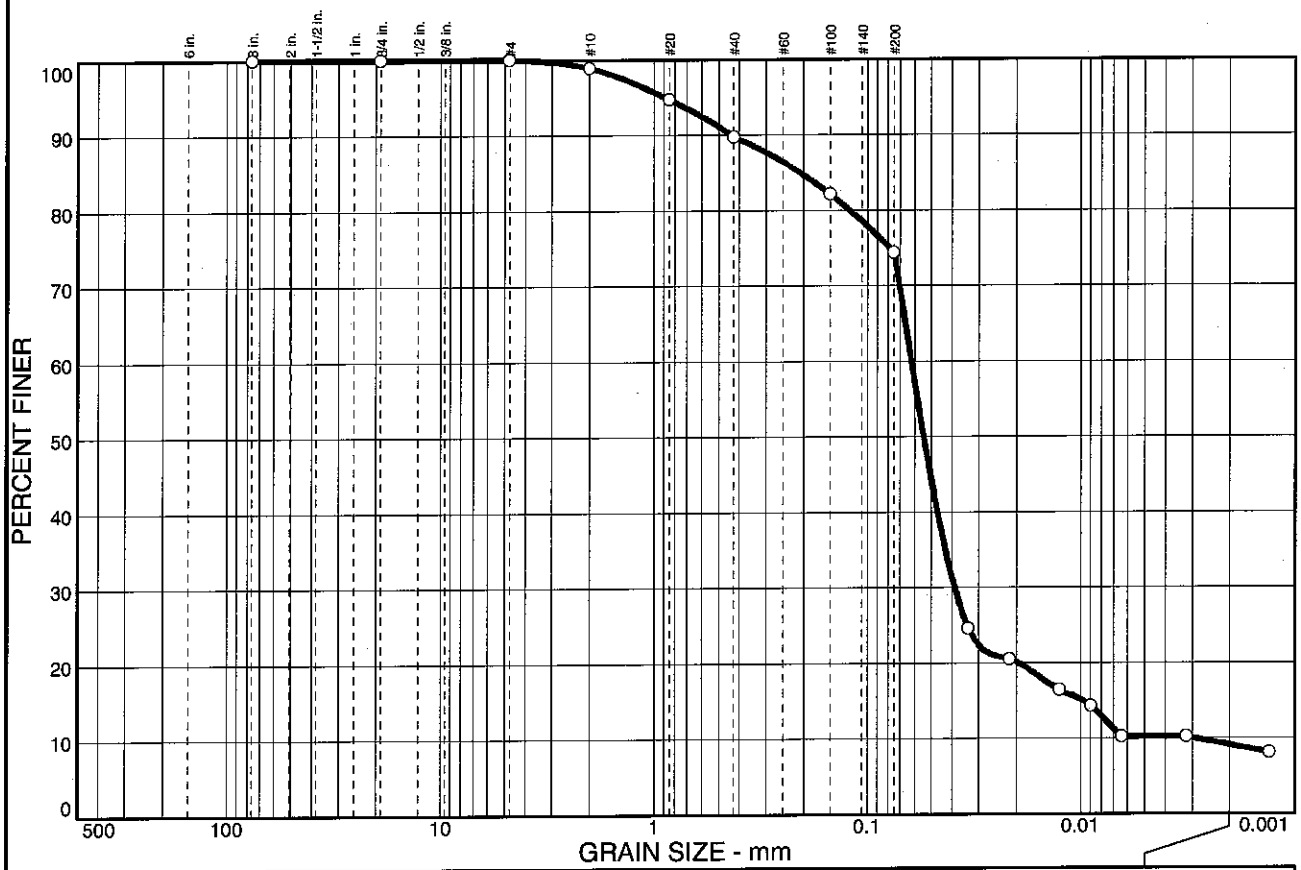
Remarks

As received moisture content = 190.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-1218 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	1.1	9.2	15.3	65.3	9.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	98.9		
#20	94.7		
#40	89.7		
#100	82.1		
#200	74.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.208 D_{60}= 0.0624 D_{50}= 0.0545
D_{30}= 0.0390 D_{15}= 0.0097 D_{10}= 0.0029
C_u= 21.26 C_c= 8.31

Classification

USCS= ML AASHTO= --

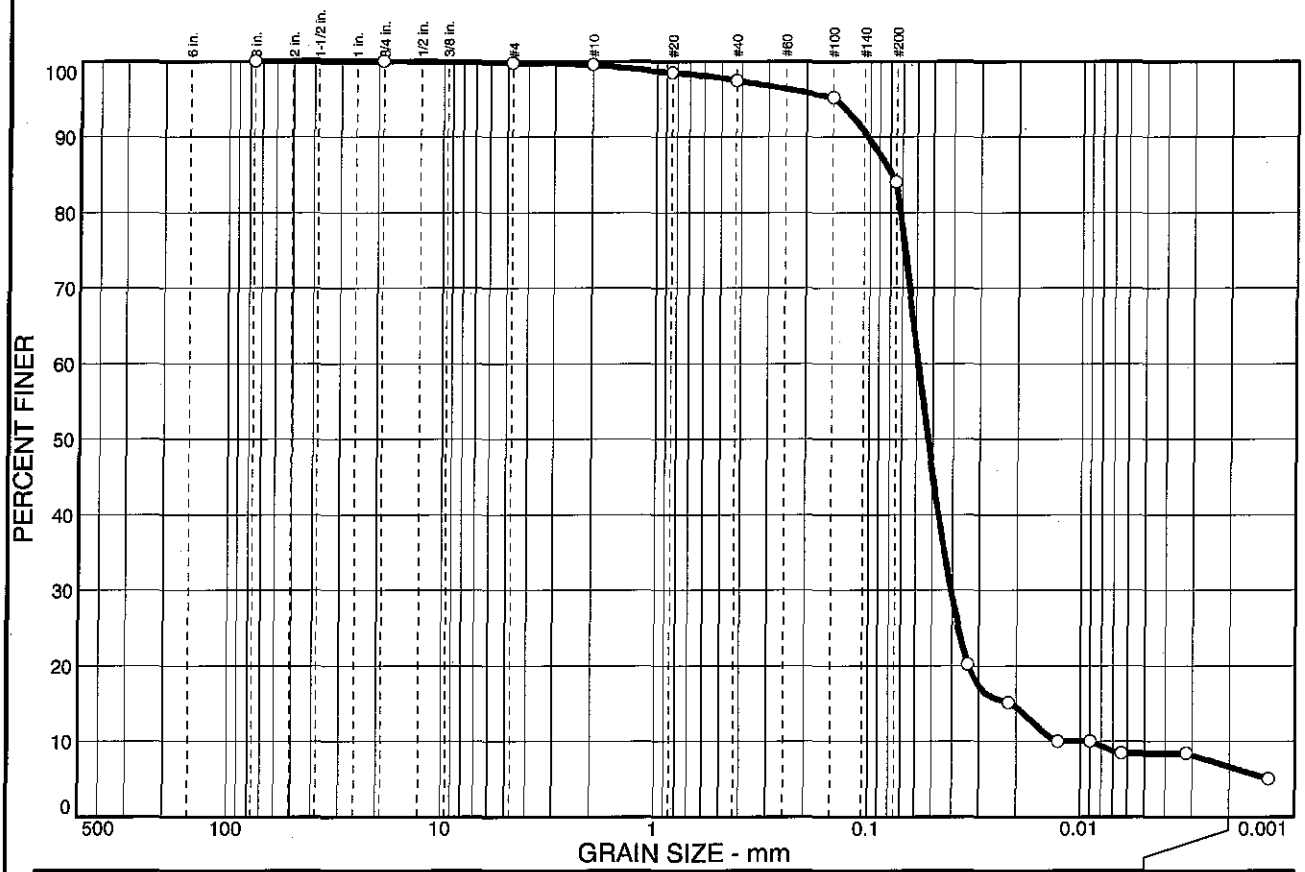
Remarks

As received moisture content = 187.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-1824 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.3	2.1	13.4	77.4	6.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.5		
#20	98.5		
#40	97.4		
#100	95.2		
#200	84.0		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0786 D_{60}= 0.0588 D_{50}= 0.0528
D_{30}= 0.0409 D_{15}= 0.0213 D_{10}= 0.0090
C_u= 6.54 C_c= 3.16

Classification

USCS= ML AASHTO= --

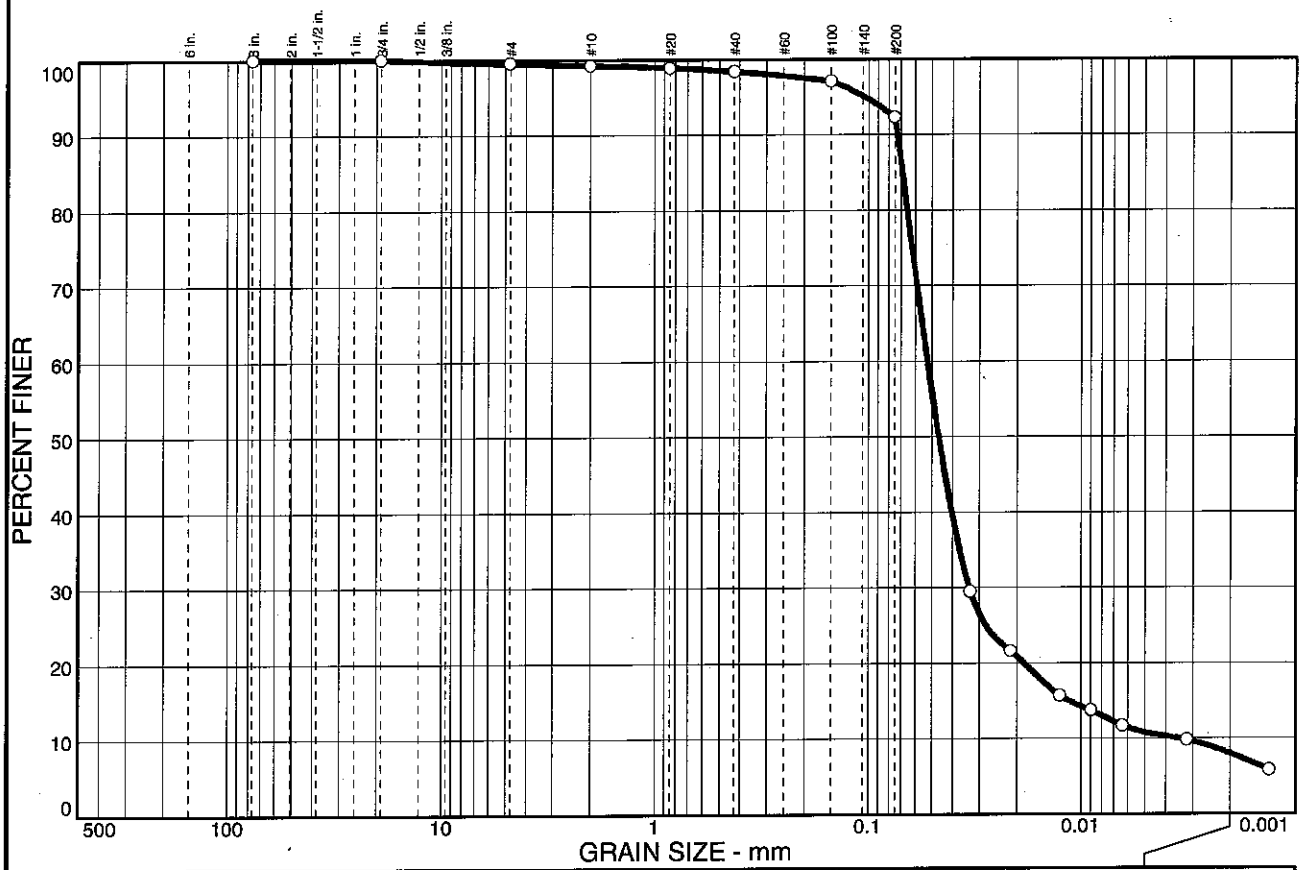
Remarks

As received moisture content = 158.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-3036 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.5	0.3	0.8	6.1	84.3	8.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.5		
#10	99.2		
#20	98.9		
#40	98.4		
#100	97.1		
#200	92.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0694 D_{60}= 0.0527 D_{50}= 0.0466
D_{30}= 0.0334 D_{15}= 0.0114 D_{10}= 0.0035
C_u= 15.24 C_c= 6.11

Classification

USCS= ML AASHTO= --

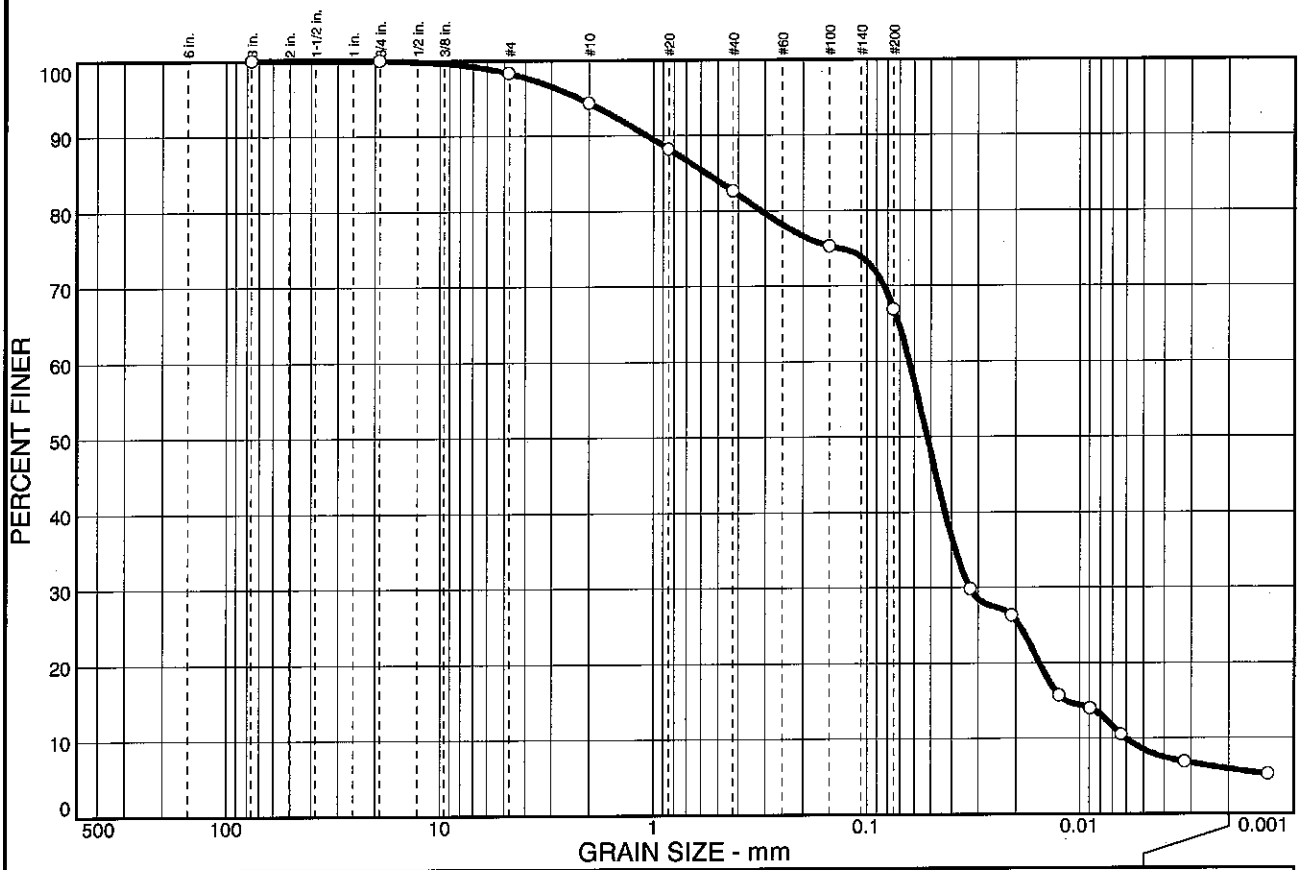
Remarks

As received moisture content = 184.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-3642 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 36-42

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.7	4.0	11.7	15.7	61.0	5.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.3		
#10	94.3		
#20	88.2		
#40	82.6		
#100	75.3		
#200	66.9		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.567 D_{60}= 0.0636 D_{50}= 0.0523
D_{30}= 0.0328 D_{15}= 0.0116 D_{10}= 0.0060
C_u= 10.51 C_c= 2.80

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 154.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-4248 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 42-48

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.1	0.7	3.3	92.7	3.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.8		
#20	99.6		
#40	99.1		
#100	98.2		
#200	95.8		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0643 D_{60}= 0.0435 D_{50}= 0.0352
D_{30}= 0.0162 D_{15}= 0.0072 D_{10}= 0.0051
C_u= 8.48 C_c= 1.17

Classification

USCS= ML AASHTO= --

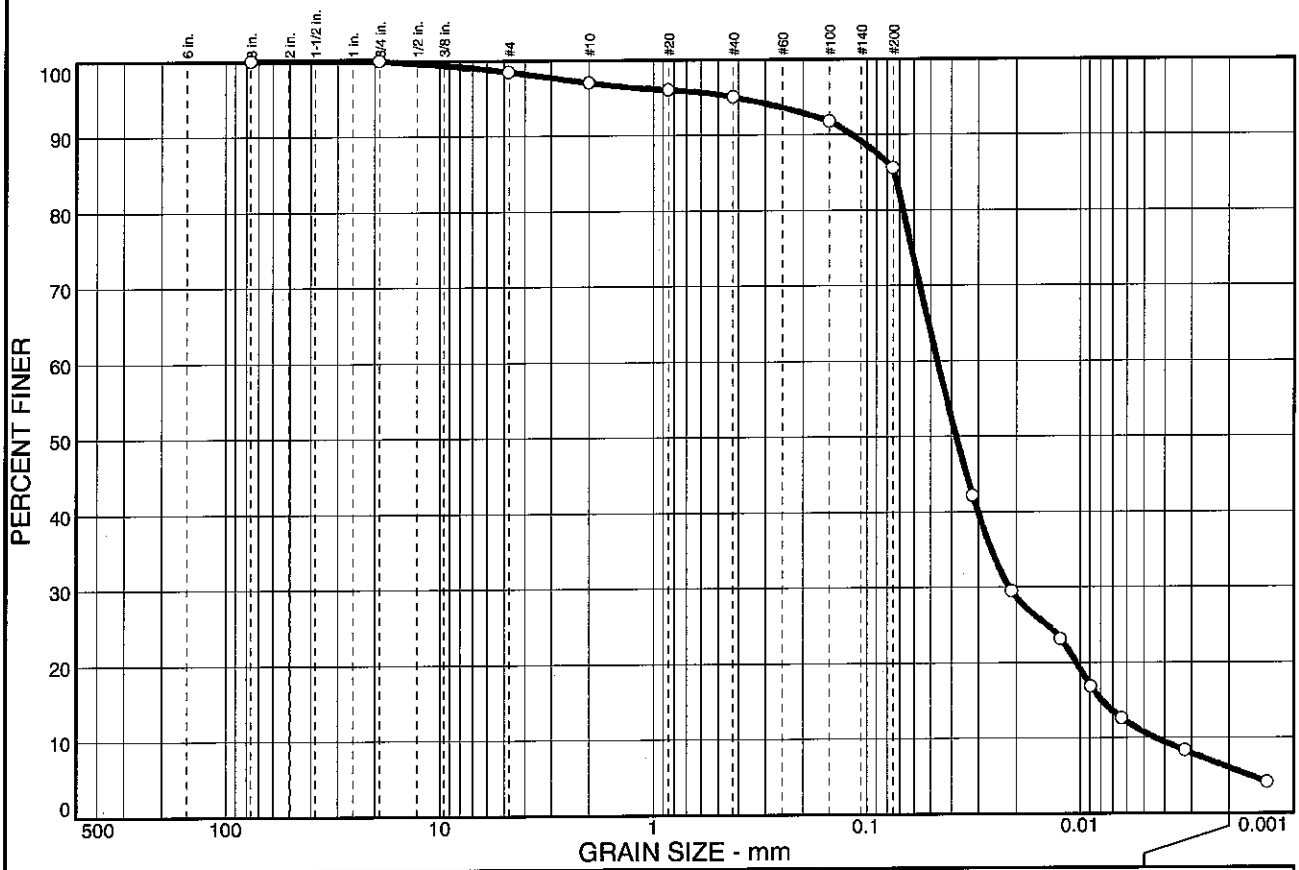
Remarks

As received moisture content = 176.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-4854 **Source of Sample:** 6/28 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 48-54

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.5	1.5	2.0	9.4	79.6	6.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.5		
#10	97.0		
#20	96.0		
#40	95.0		
#100	91.8		
#200	85.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0742 D_{60}= 0.0468 D_{50}= 0.0382
D_{30}= 0.0215 D_{15}= 0.0079 D_{10}= 0.0044
C_u= 10.53 C_c= 2.23

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 167.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-1218 **Source of Sample:** 6/28 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.7	1.8	6.8	14.5	67.2	9.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.3		
#10	97.5		
#20	94.6		
#40	90.7		
#100	82.0		
#200	76.2		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.221 D_{60}= 0.0383 D_{50}= 0.0259
D_{30}= 0.0126 D_{15}= 0.0043 D_{10}= 0.0023
C_u= 16.57 C_c= 1.79

Classification

USCS= ML AASHTO= --

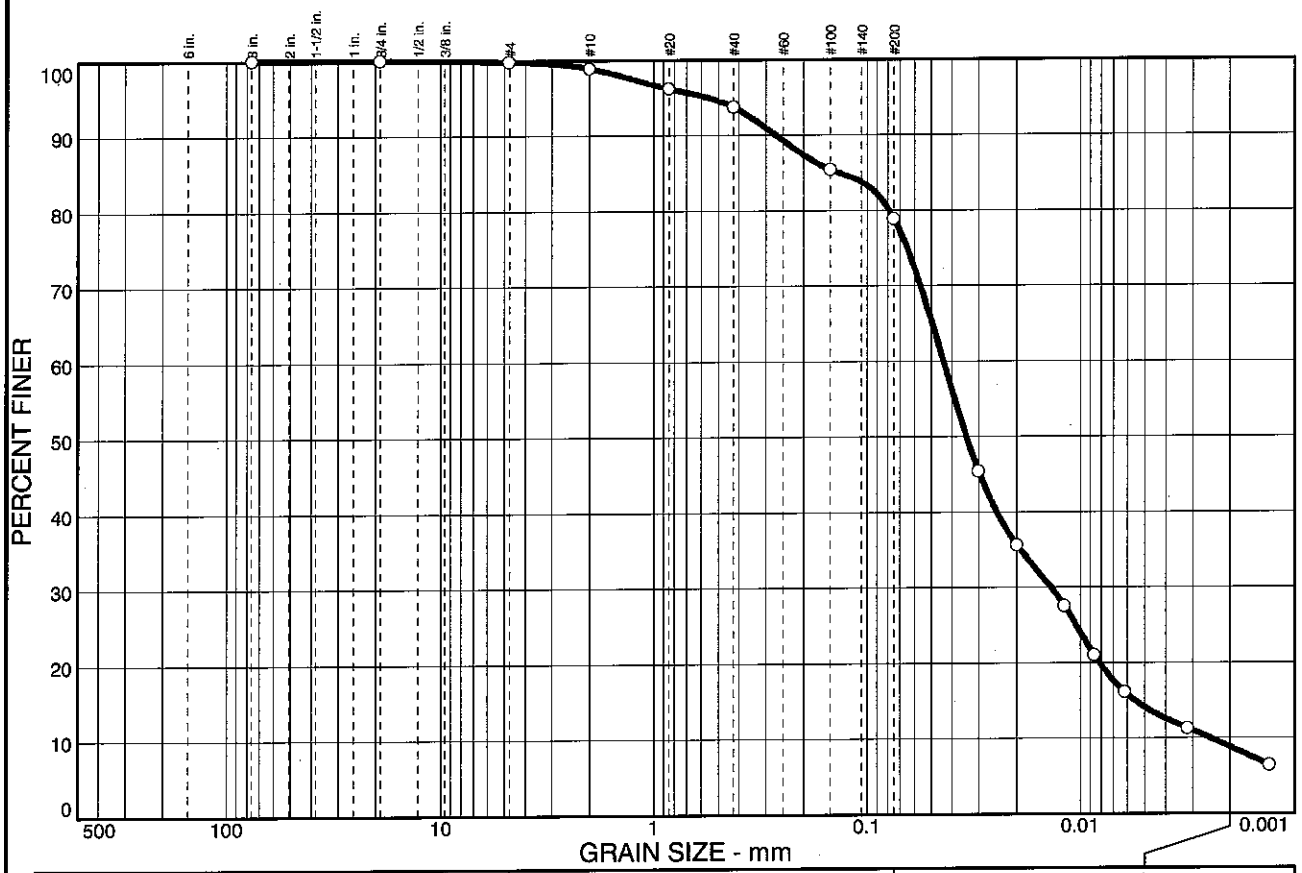
Remarks

As received moisture content = 172.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-1824 **Source of Sample:** 6/28 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.9	5.2	14.8	70.1	8.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	98.9		
#20	96.2		
#40	93.7		
#100	85.4		
#200	78.9		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.137 D_{60}= 0.0440 D_{50}= 0.0343
D_{30}= 0.0138 D_{15}= 0.0056 D_{10}= 0.0025
C_u= 17.79 C_c= 1.74

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 129.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NB-2430 **Source of Sample:** 6/28 **Date:** 5/25/04
Location: T71NB **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.7	0.4	1.6	3.4	89.0	4.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.3		
#10	98.9		
#20	98.0		
#40	97.3		
#100	96.0		
#200	93.9		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0681 D_{60}= 0.0512 D_{50}= 0.0448
D_{30}= 0.0272 D_{15}= 0.0096 D_{10}= 0.0061
C_u= 8.44 C_c= 2.38

Classification

USCS= ML AASHTO= --

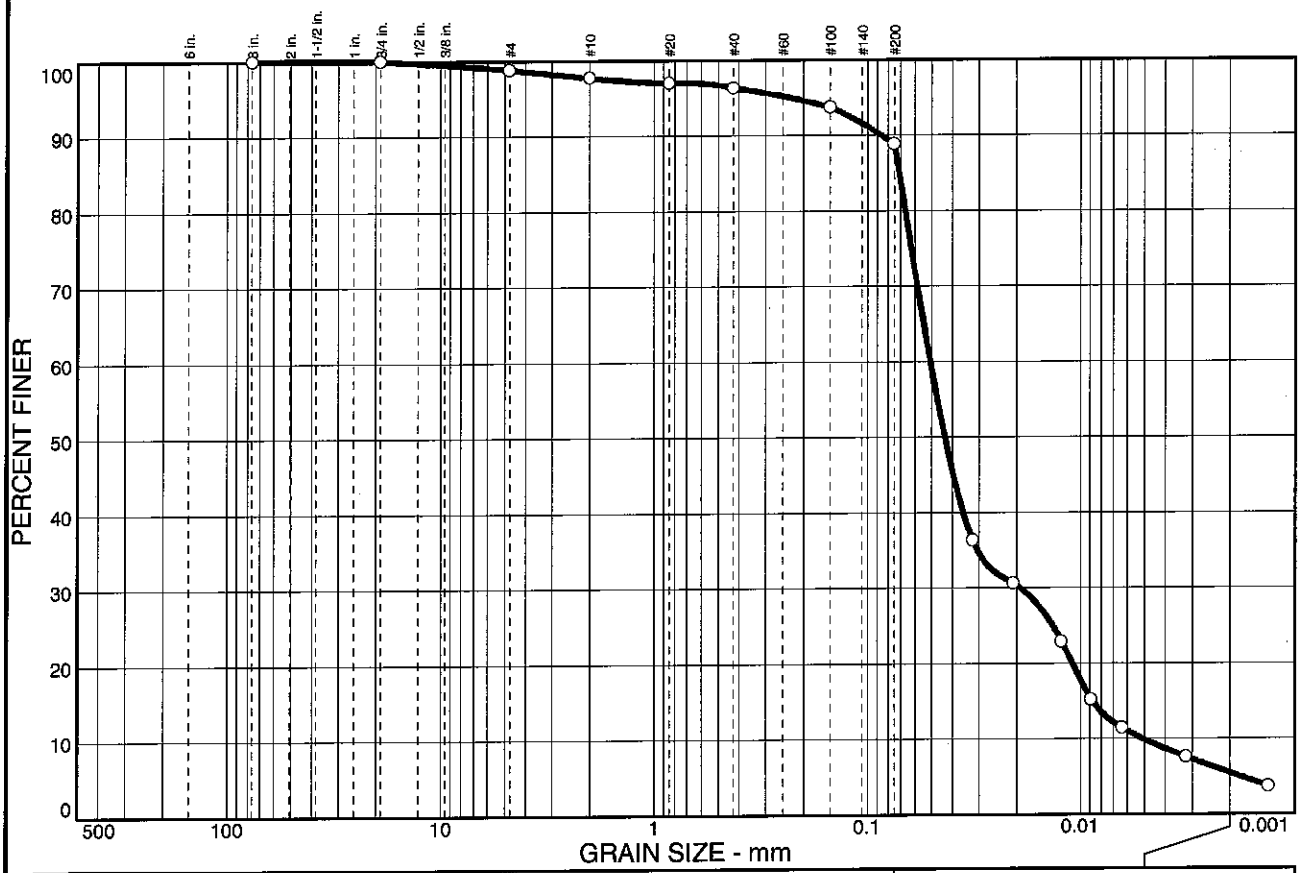
Remarks

As received moisture content = 223.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-0003 **Source of Sample:** 6/28 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.2	1.1	1.4	7.5	83.3	5.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.8		
#10	97.7		
#20	97.0		
#40	96.3		
#100	93.7		
#200	88.8		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0714 D_{60}= 0.0510 D_{50}= 0.0436
D_{30}= 0.0193 D_{15}= 0.0088 D_{10}= 0.0051
C_u= 9.97 C_c= 1.42

Classification

USCS= ML AASHTO= --

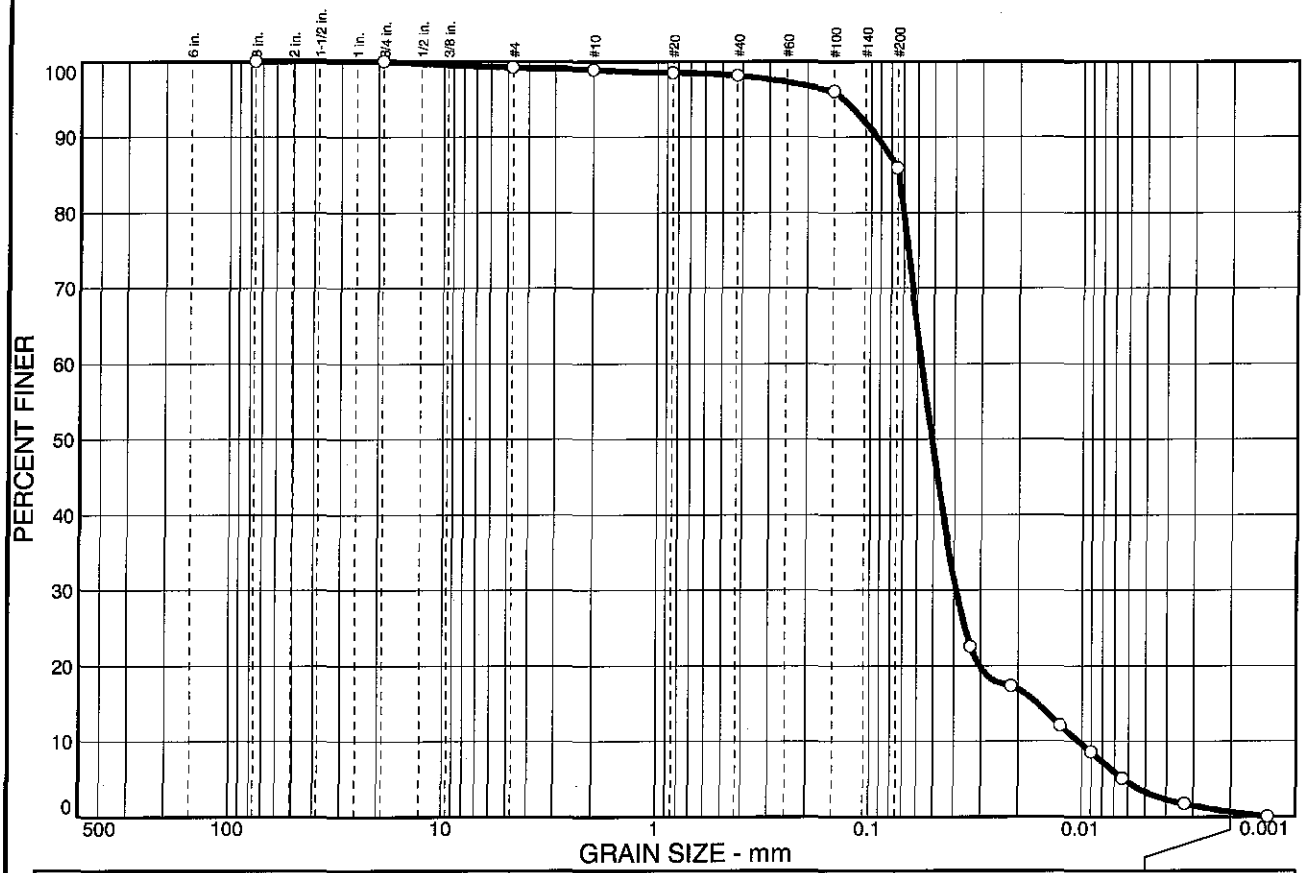
Remarks

As received moisture content = 163.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-0003 **Source of Sample:** 6/28 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.8	0.3	0.8	12.2	85.2	0.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.2		
#10	98.9		
#20	98.5		
#40	98.1		
#100	96.0		
#200	85.9		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0743 D_{60}= 0.0574 D_{50}= 0.0513
D_{30}= 0.0392 D_{15}= 0.0163 D_{10}= 0.0103
C_u= 5.55 C_c= 2.58

Classification

USCS= ML AASHTO= --

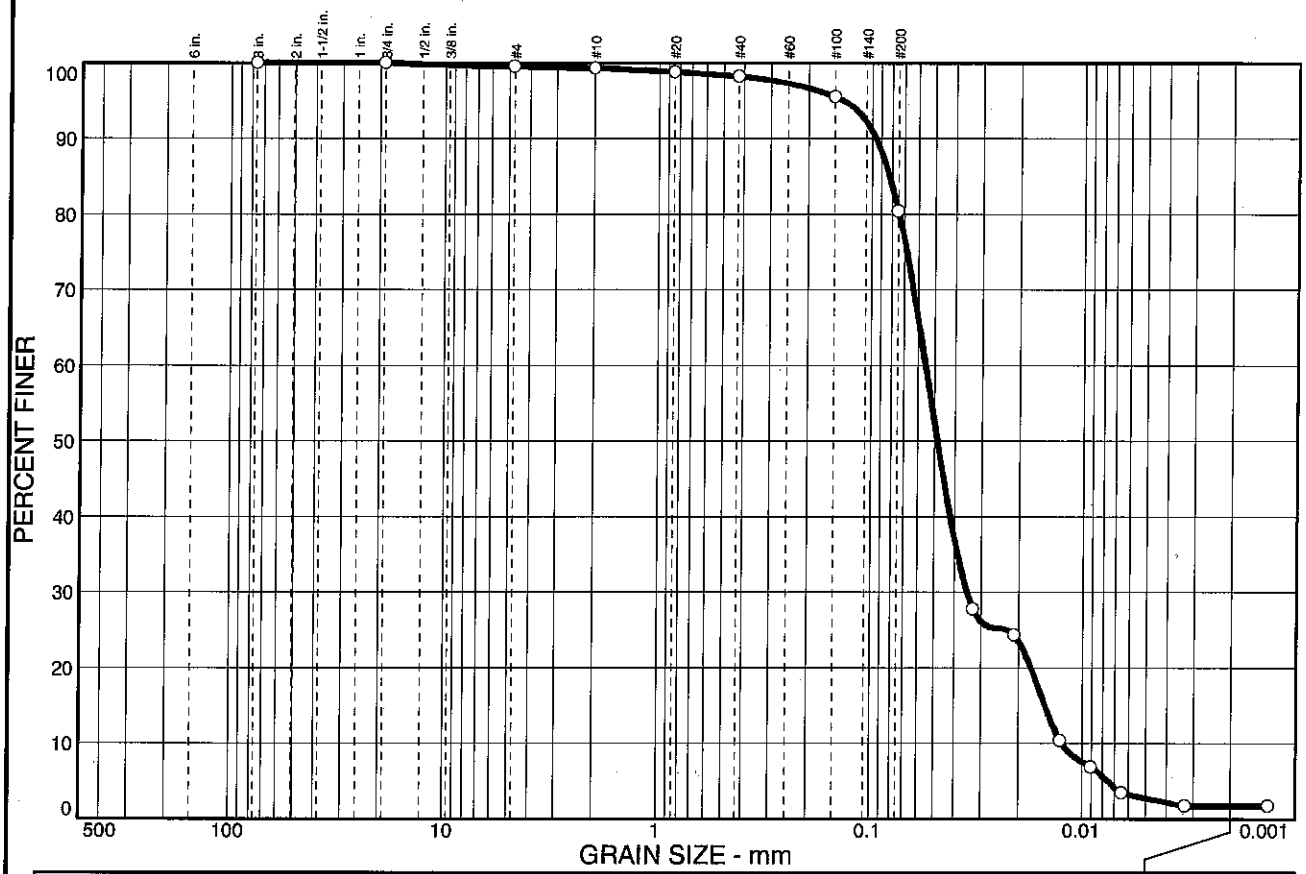
Remarks

As received moisture content = 150.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-0612 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T37NB **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.5	0.2	1.1	17.8	78.7	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.5		
#10	99.3		
#20	98.8		
#40	98.2		
#100	95.5		
#200	80.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0826 D_{60}= 0.0555 D_{50}= 0.0487
D_{30}= 0.0350 D_{15}= 0.0150 D_{10}= 0.0124
C_u= 4.46 C_c= 1.77

Classification

USCS= ML AASHTO= --

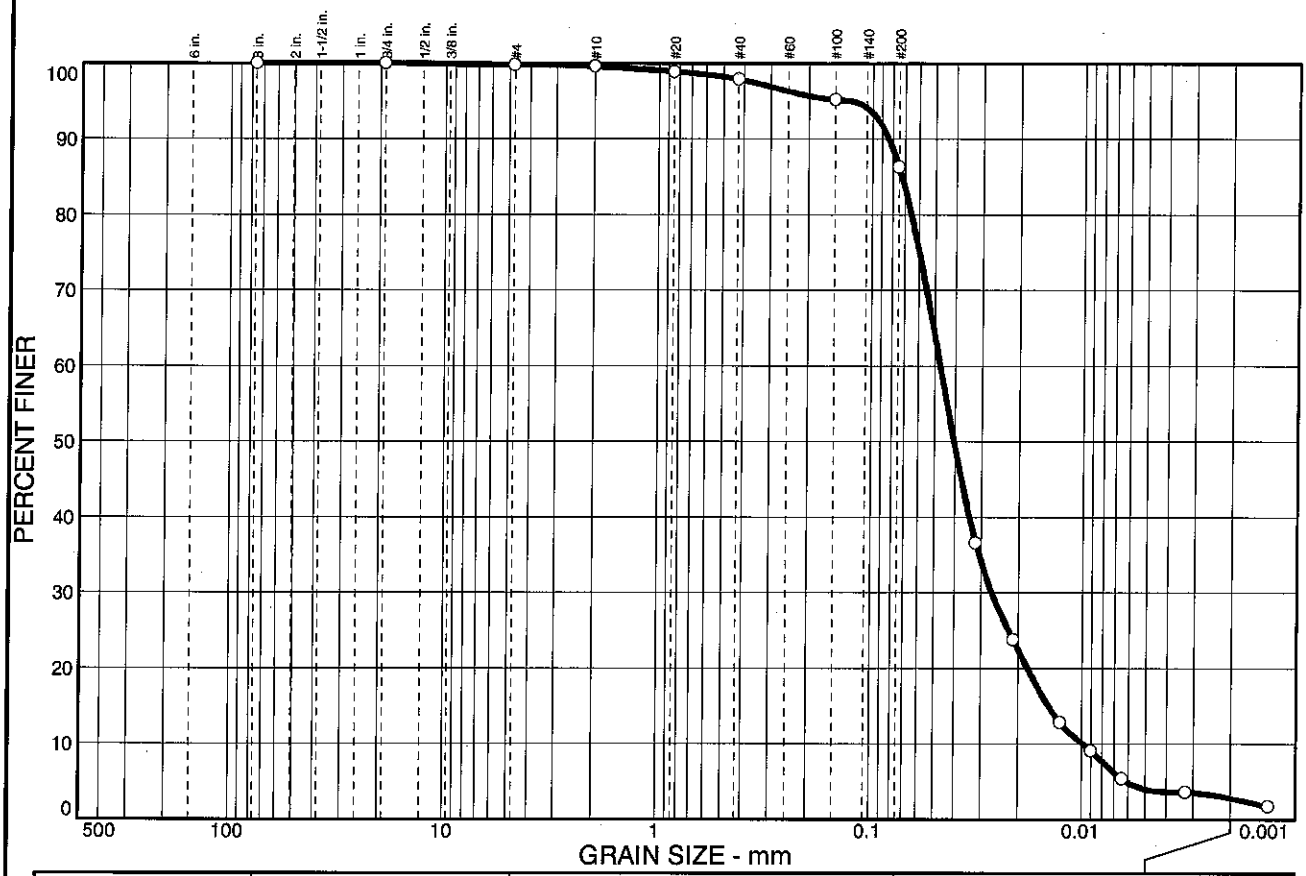
Remarks

As received moisture content = 139.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-4248 **Source of Sample:** 6/21 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 42-48

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.2	1.7	11.6	83.5	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.6		
#20	98.9		
#40	97.9		
#100	95.2		
#200	86.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0727 D_{60}= 0.0474 D_{50}= 0.0406
D_{30}= 0.0267 D_{15}= 0.0144 D_{10}= 0.0099
C_u= 4.80 C_c= 1.52

Classification

USCS= ML AASHTO= --

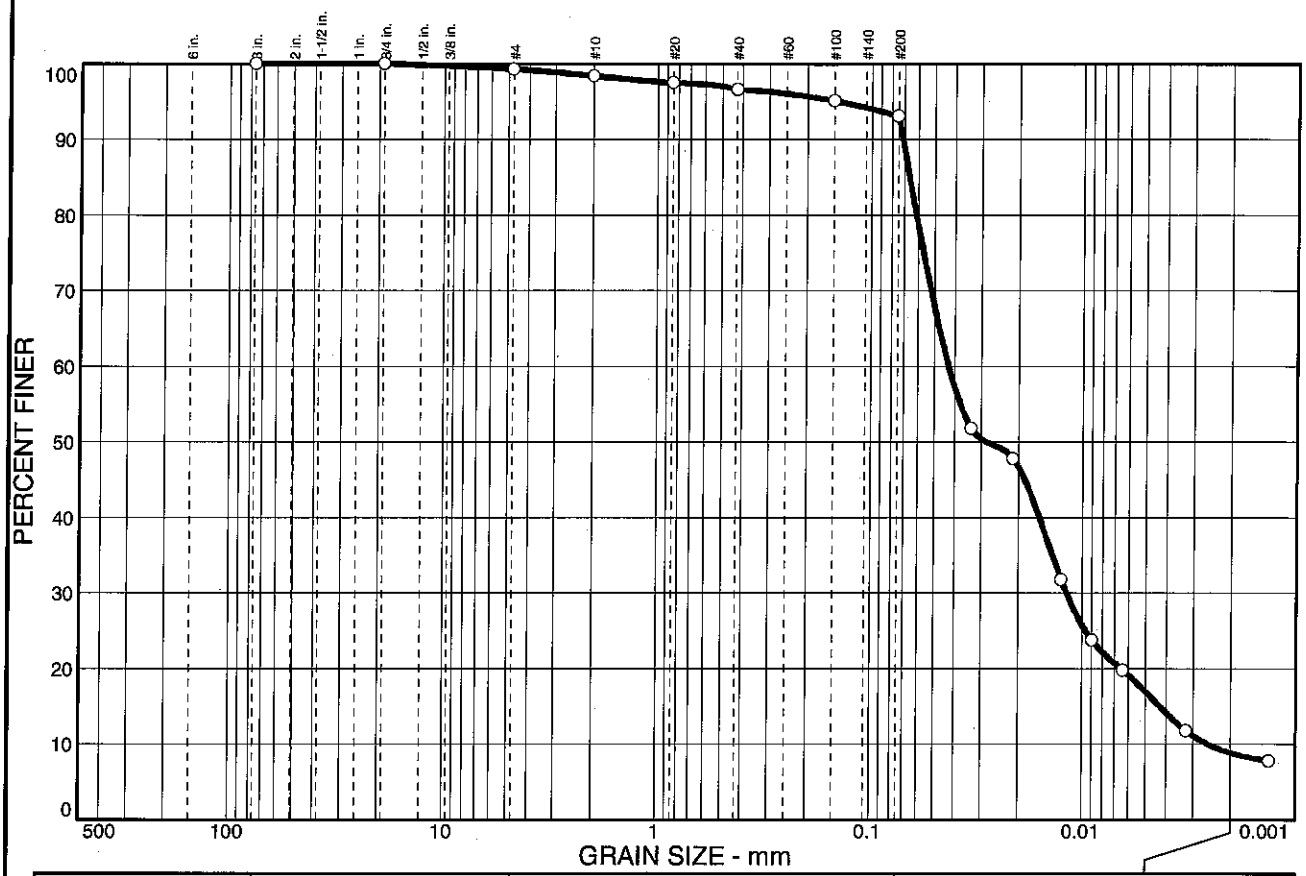
Remarks

As received moisture content = 140.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-6067 **Source of Sample:** 6/21 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 60-67

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.7	0.9	1.8	3.5	84.3	8.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.3		
#10	98.4		
#20	97.5		
#40	96.6		
#100	95.1		
#200	93.1		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0664 D_{60}= 0.0430 D_{50}= 0.0286
D_{30}= 0.0118 D_{15}= 0.0043 D_{10}= 0.0026
C_u= 16.83 C_c= 1.28

Classification

USCS= ML AASHTO= --

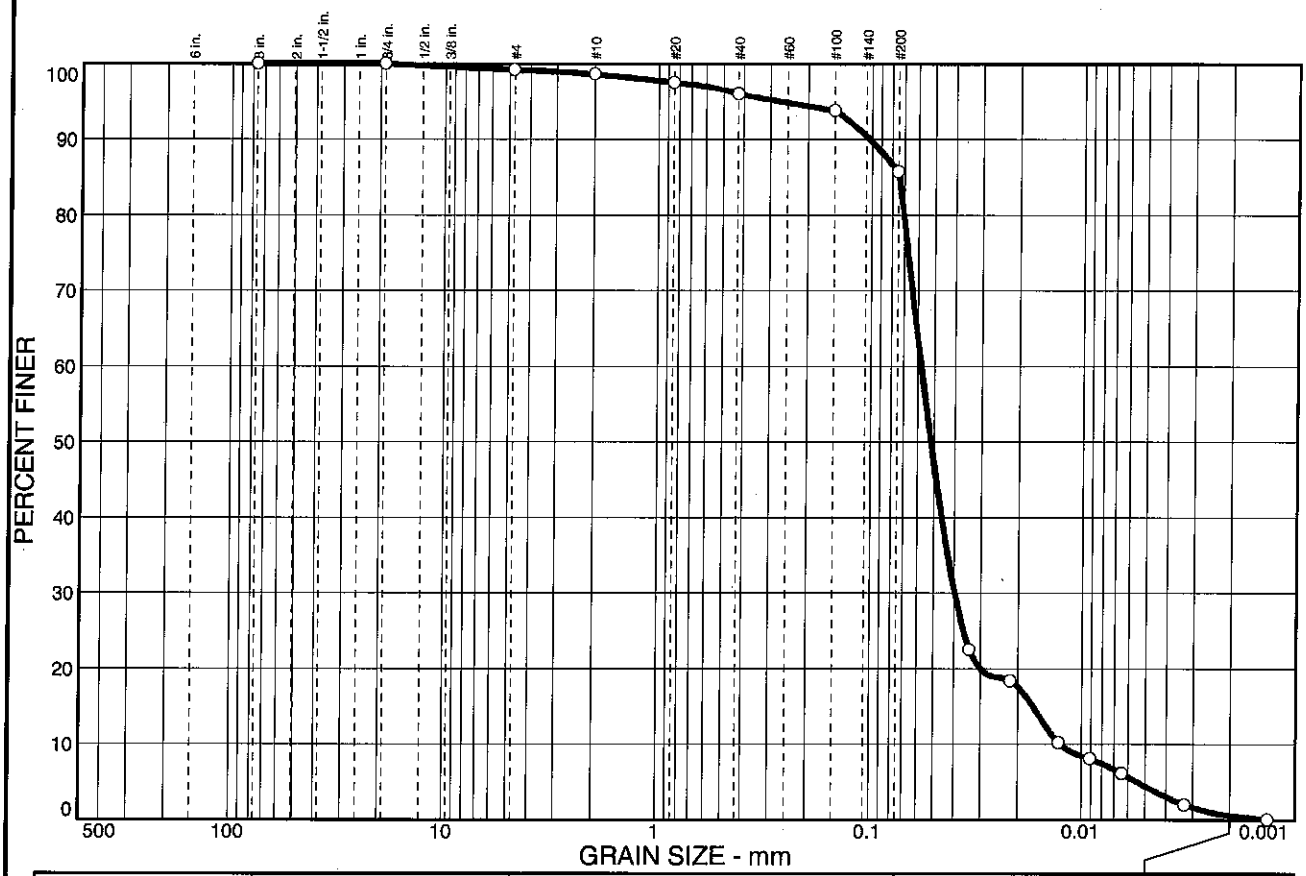
Remarks

As received moisture content = 362.0%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-0003 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T37NC **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.8	0.6	2.6	10.3	85.1	0.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.2		
#10	98.6		
#20	97.5		
#40	96.0		
#100	93.8		
#200	85.7		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0745 D_{60}= 0.0580 D_{50}= 0.0520
D_{30}= 0.0398 D_{15}= 0.0169 D_{10}= 0.0126
C_u= 4.62 C_c= 2.18

Classification

USCS= ML AASHTO= --

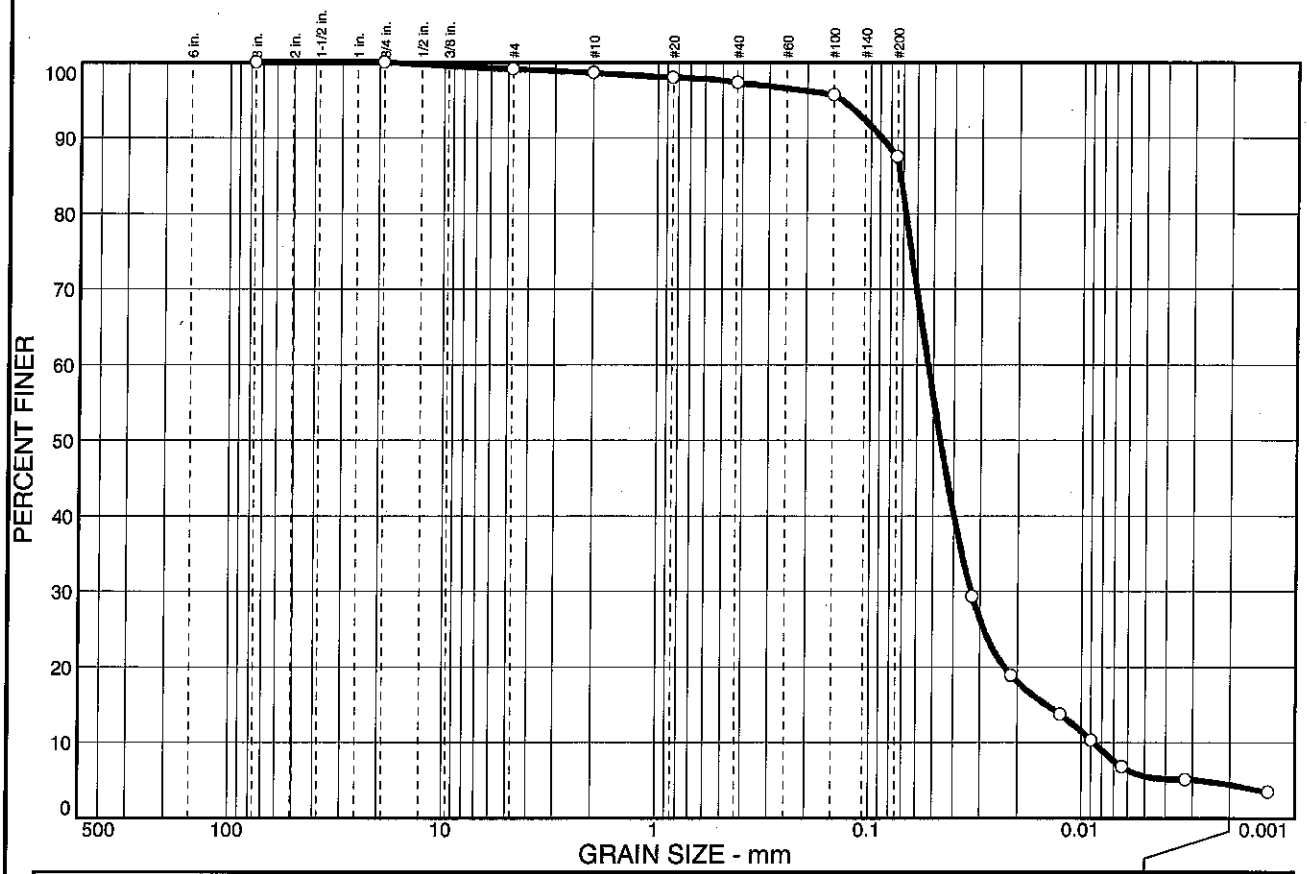
Remarks

As received moisture content = 199.8%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-0306 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.9	0.5	1.3	9.8	83.1	4.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.1		
#10	98.6		
#20	98.0		
#40	97.3		
#100	95.7		
#200	87.5		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0727 D_{60}= 0.0533 D_{50}= 0.0466
D_{30}= 0.0331 D_{15}= 0.0146 D_{10}= 0.0087
C_u= 6.09 C_c= 2.35

Classification

USCS= ML AASHTO= --

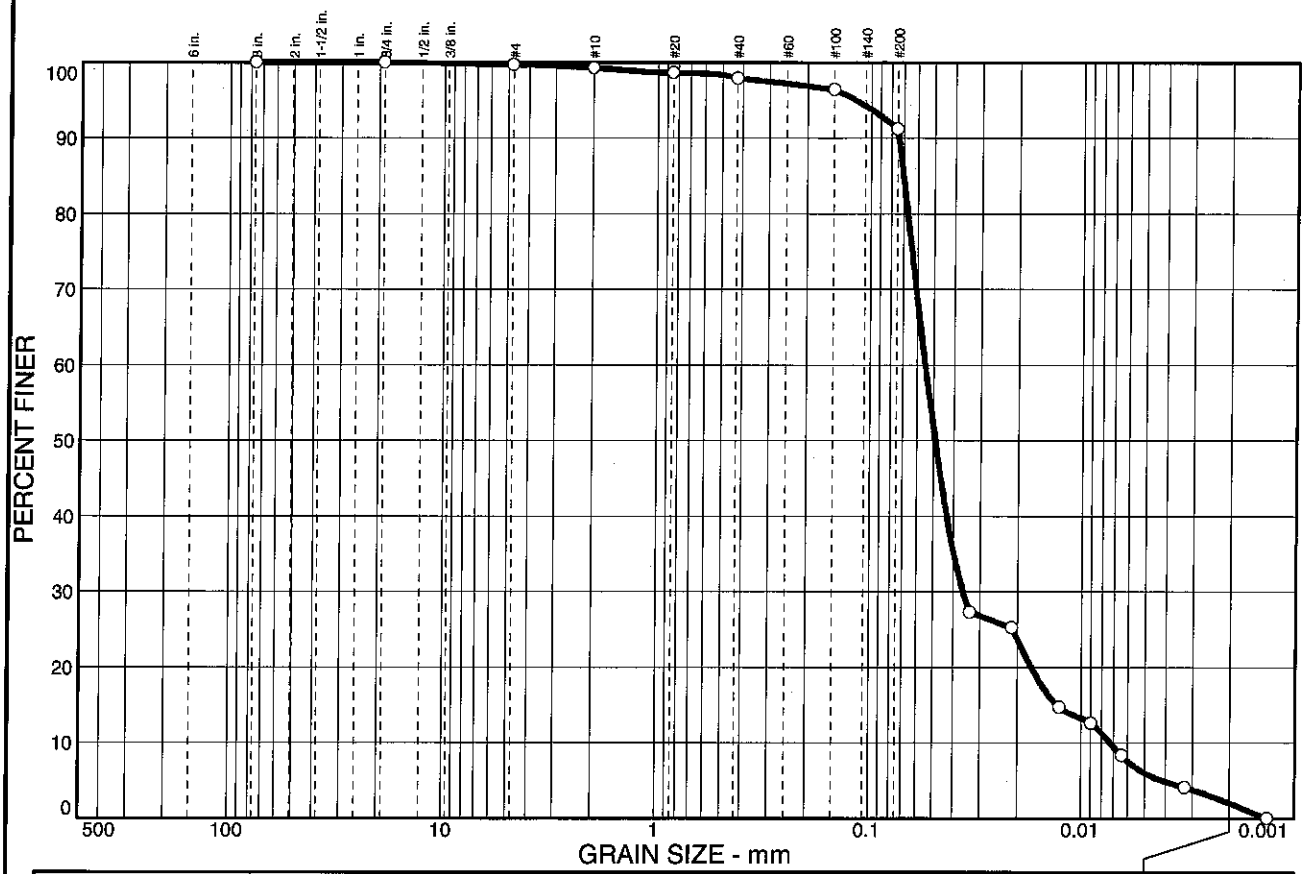
Remarks

As received moisture content = 136.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-0612 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.4	1.4	6.7	89.2	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.3		
#20	98.6		
#40	97.9		
#100	96.4		
#200	91.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0707 D_{60}= 0.0551 D_{50}= 0.0493
D_{30}= 0.0362 D_{15}= 0.0130 D_{10}= 0.0073
C_u= 7.57 C_c= 3.26

Classification

USCS= ML AASHTO= --

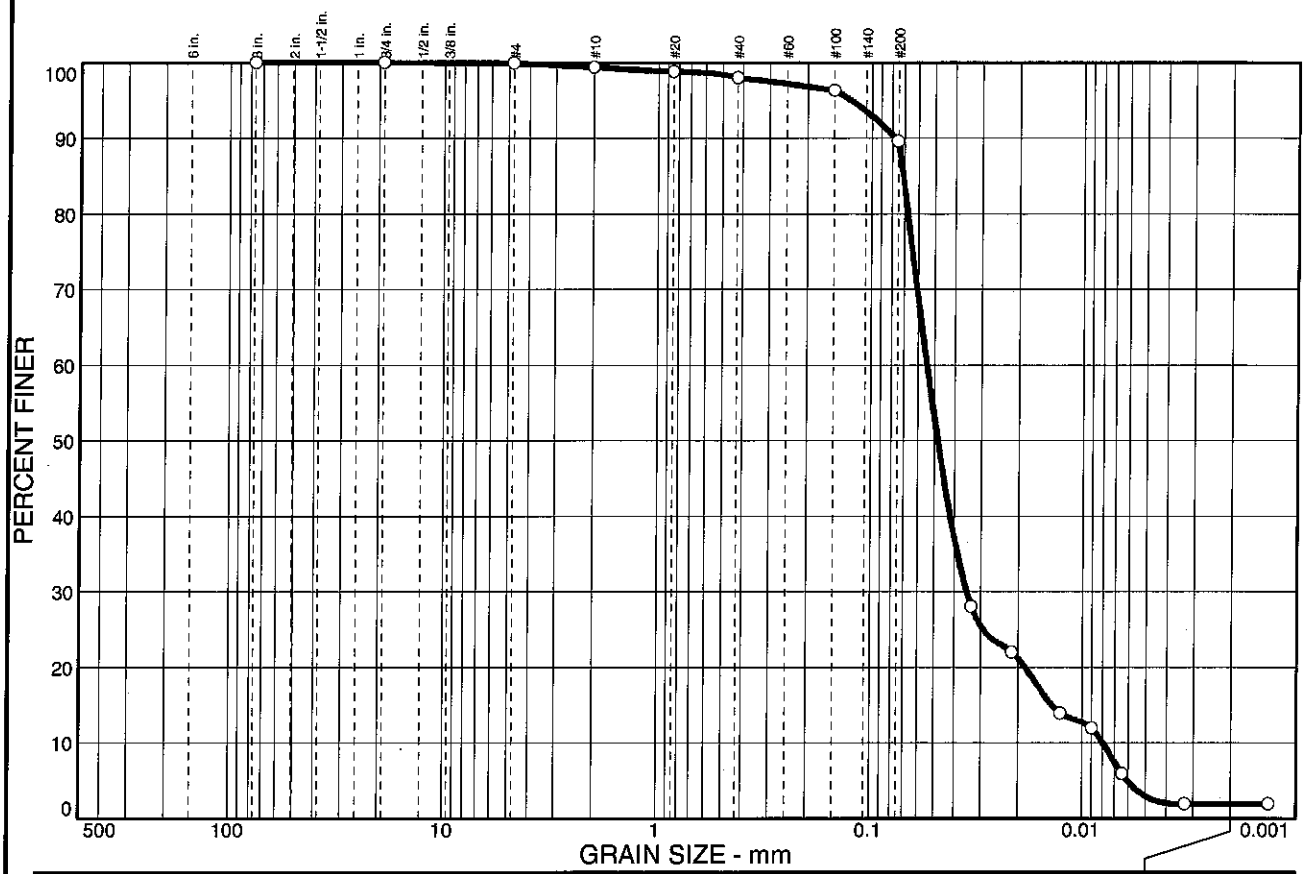
Remarks

As received moisture content = 190.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-1218 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.5	1.4	8.4	87.7	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.4		
#20	98.8		
#40	98.0		
#100	96.3		
#200	89.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0715 D_{60}= 0.0545 D_{50}= 0.0484
D_{30}= 0.0350 D_{15}= 0.0139 D_{10}= 0.0080
C_u= 6.85 C_c= 2.82

Classification

USCS= ML AASHTO= --

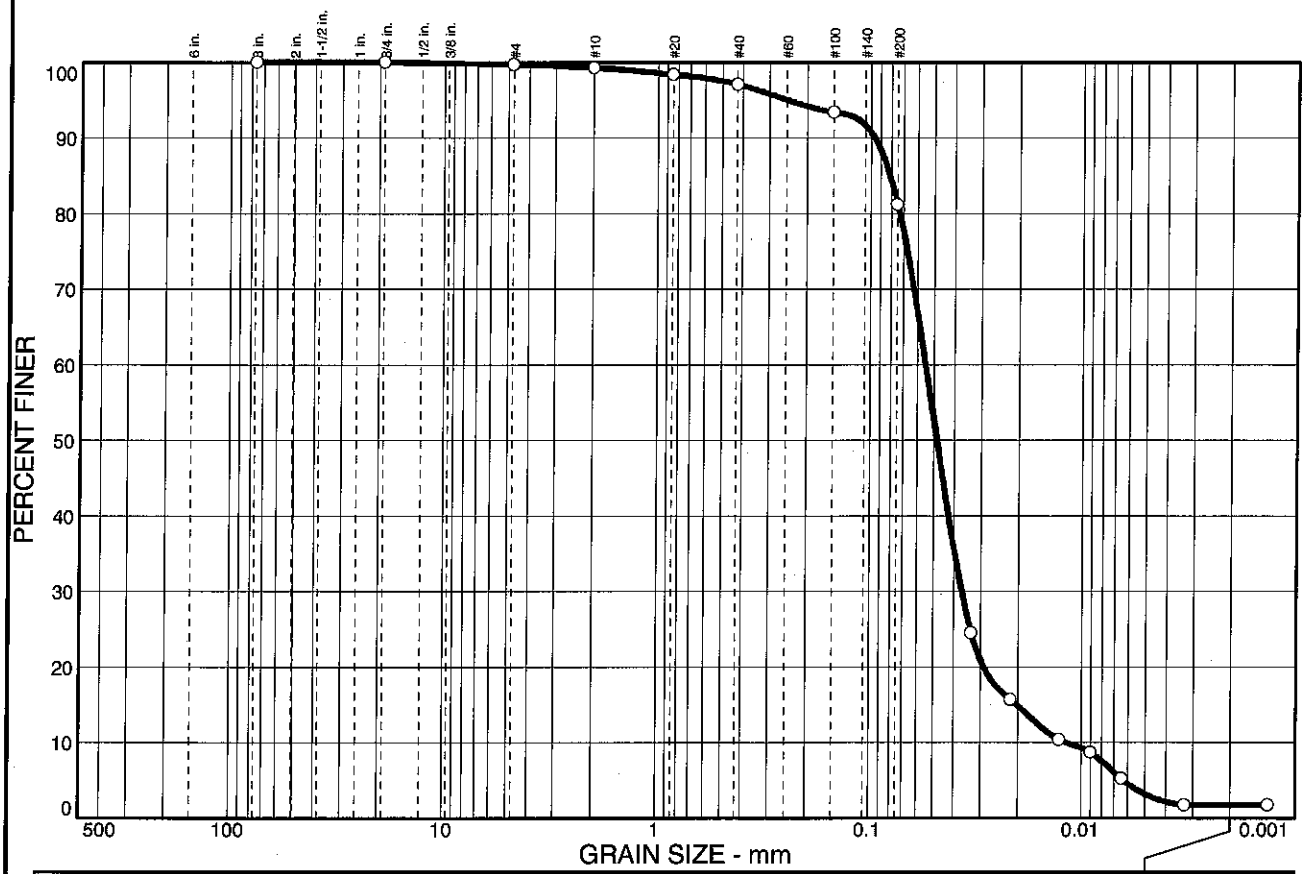
Remarks

As received moisture content = 174.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-1824 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.4	2.2	15.9	79.5	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.3		
#20	98.4		
#40	97.1		
#100	93.4		
#200	81.2		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0815 D_{60}= 0.0551 D_{50}= 0.0486
D_{30}= 0.0368 D_{15}= 0.0202 D_{10}= 0.0118
C_u= 4.68 C_c= 2.10

Classification

USCS= ML AASHTO= --

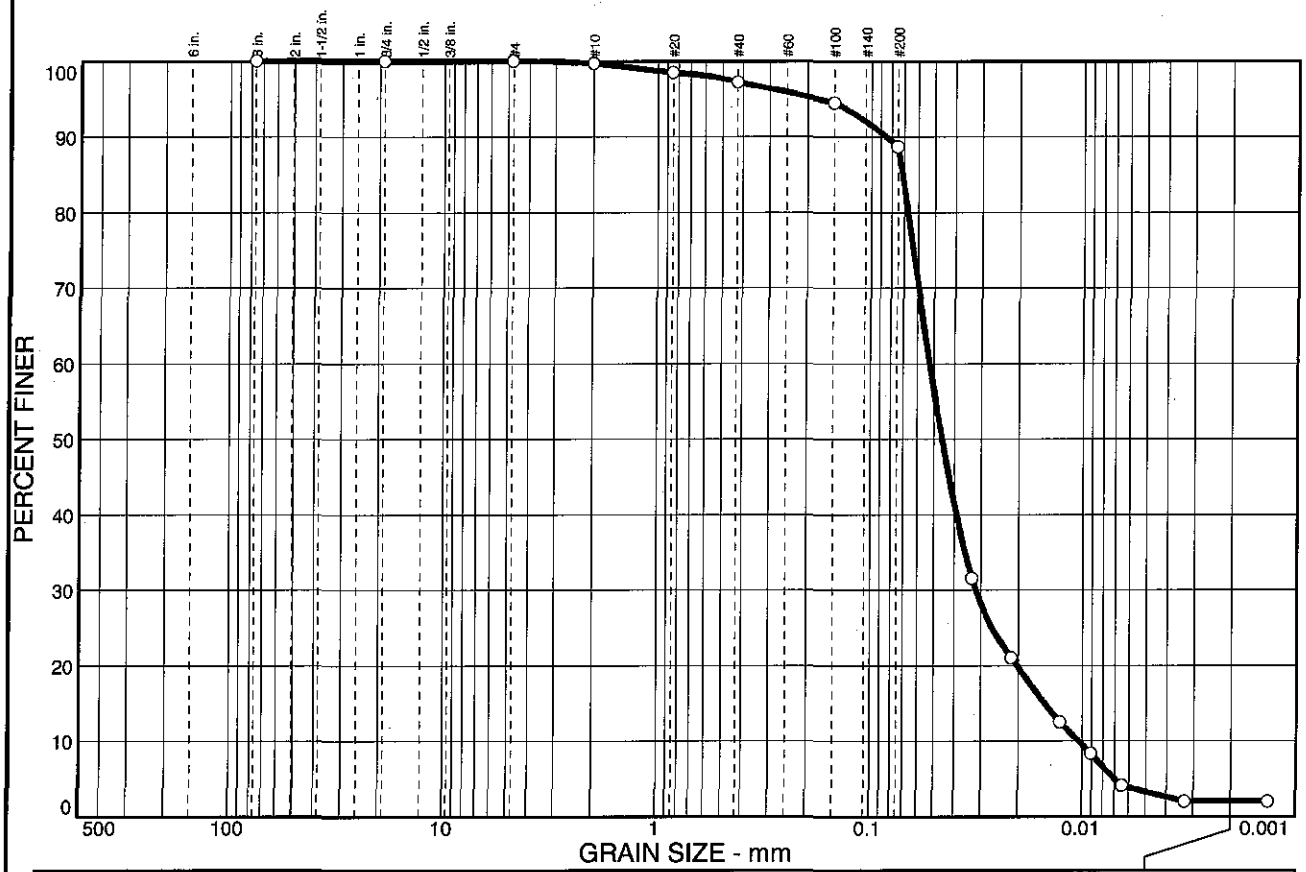
Remarks

As received moisture content = 155.8%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-2430 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.3	2.5	8.5	86.7	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.7		
#20	98.5		
#40	97.2		
#100	94.5		
#200	88.7		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0717 D_{60}= 0.0526 D_{50}= 0.0459
D_{30}= 0.0317 D_{15}= 0.0150 D_{10}= 0.0104
C_u= 5.05 C_c= 1.83

Classification

USCS= ML AASHTO= --

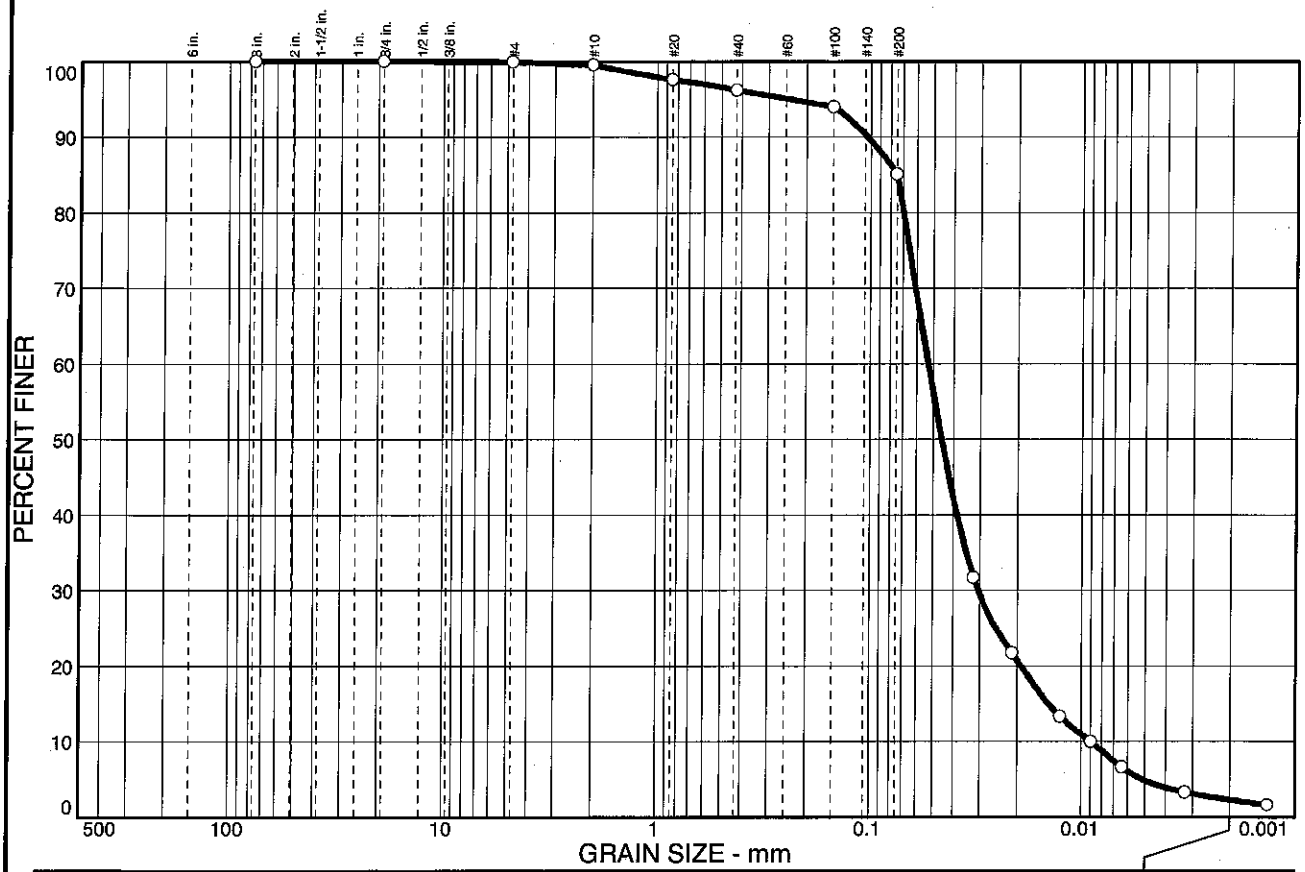
Remarks

As received moisture content = 181.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-3036 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.4	3.3	11.1	82.8	2.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.5		
#20	97.6		
#40	96.2		
#100	94.0		
#200	85.1		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0749 D_{60}= 0.0531 D_{50}= 0.0457
D_{30}= 0.0306 D_{15}= 0.0142 D_{10}= 0.0090
C_u= 5.91 C_c= 1.96

Classification

USCS= ML AASHTO= --

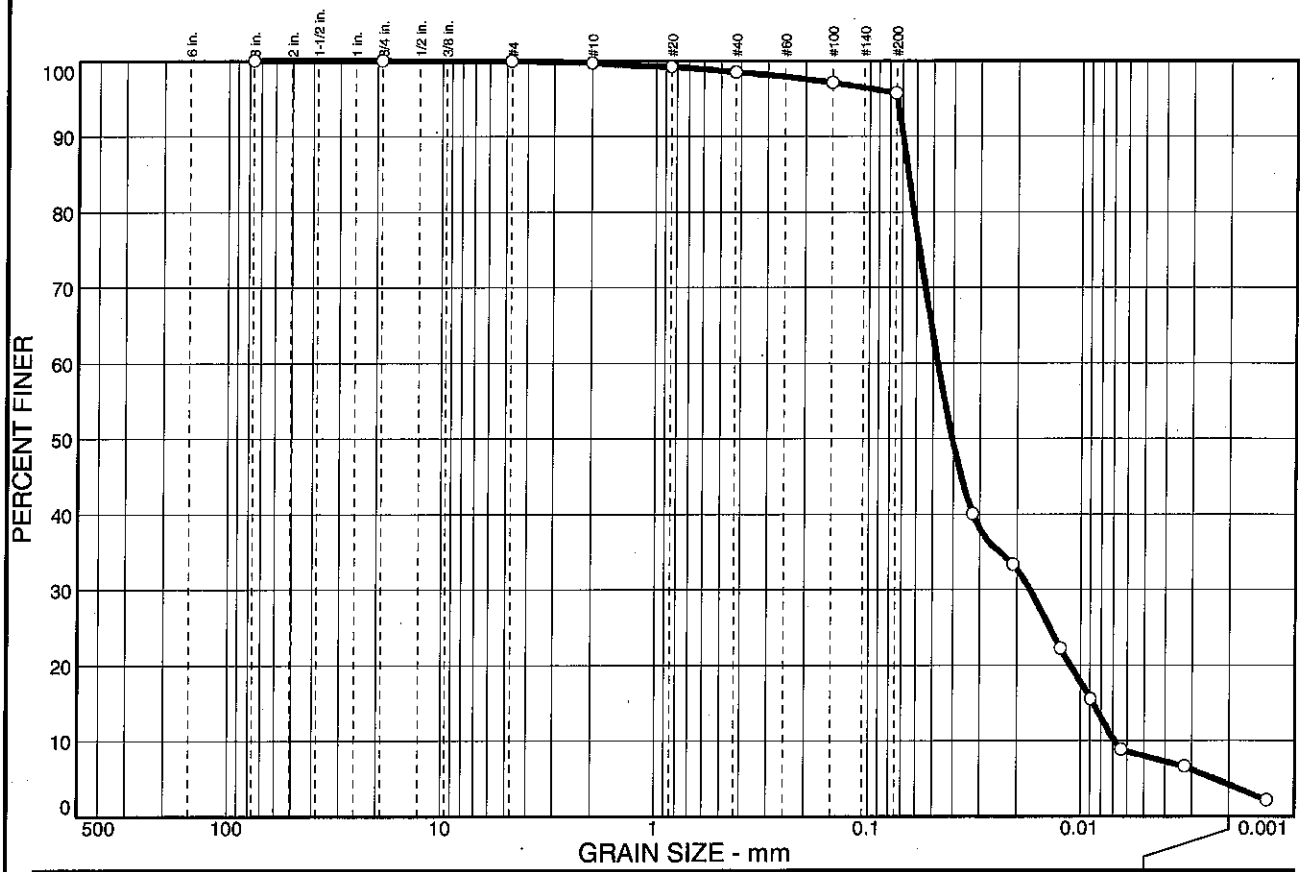
Remarks

As received moisture content = 163.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-3642 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 36-42

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	1.2	2.8	91.5	4.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.2		
#40	98.5		
#100	97.1		
#200	95.7		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0660 D_{60}= 0.0477 D_{50}= 0.0407
D_{30}= 0.0174 D_{15}= 0.0087 D_{10}= 0.0069
C_u= 6.92 C_c= 0.92

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 208.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-4248 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 42-48

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	5.2	1.6	2.6	7.2	51.2	32.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	94.8		
#10	93.2		
#20	92.1		
#40	90.6		
#100	86.2		
#200	83.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.112 D_{60}= 0.0343 D_{50}= 0.0132
D_{30}= 0.0016 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

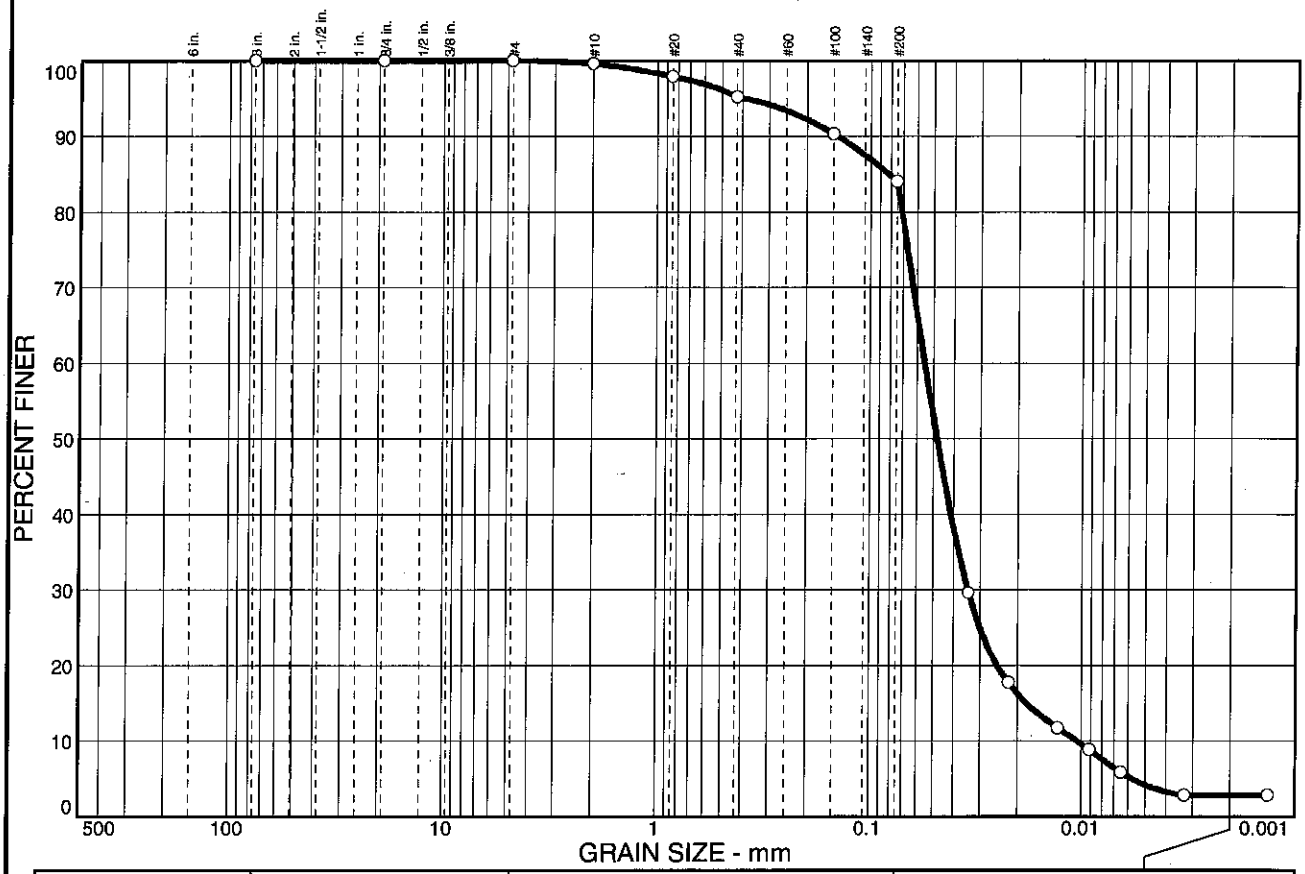
Remarks

As received moisture content = 116.6%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MB-5457 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MB **Elev./Depth:** 54-57

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.4	4.4	11.2	81.2	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.6		
#20	97.9		
#40	95.2		
#100	90.3		
#200	84.0		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0824 D_{60}= 0.0554 D_{50}= 0.0483
D_{30}= 0.0343 D_{15}= 0.0181 D_{10}= 0.0105
C_u= 5.28 C_c= 2.03

Classification

USCS= ML AASHTO= --

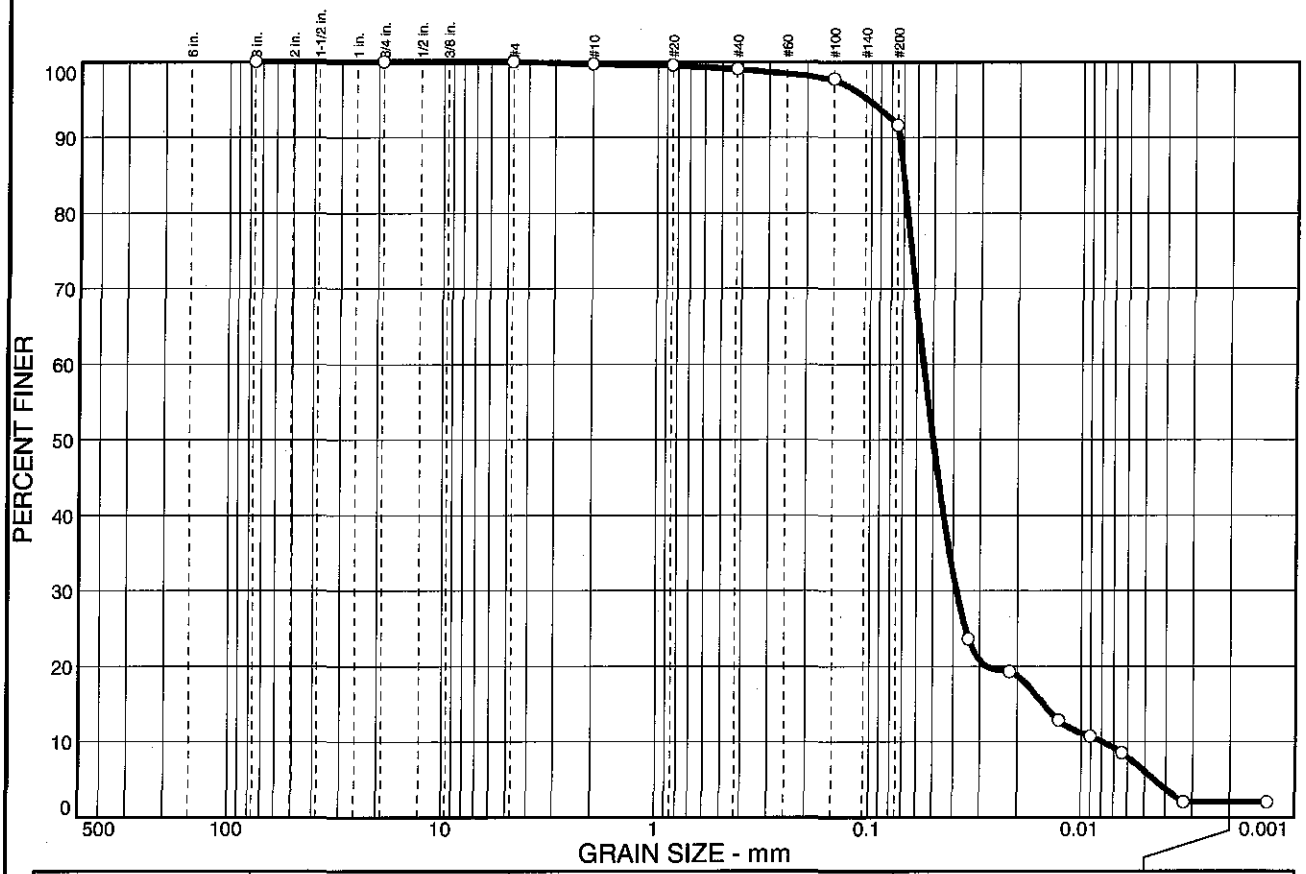
Remarks

As received moisture content = 289.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-0003 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.3	0.7	7.4	89.6	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.7		
#20	99.5		
#40	99.0		
#100	97.7		
#200	91.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0706 D_{60}= 0.0558 D_{50}= 0.0503
D_{30}= 0.0387 D_{15}= 0.0150 D_{10}= 0.0079
C_u= 7.05 C_c= 3.40

Classification

USCS= ML AASHTO= --

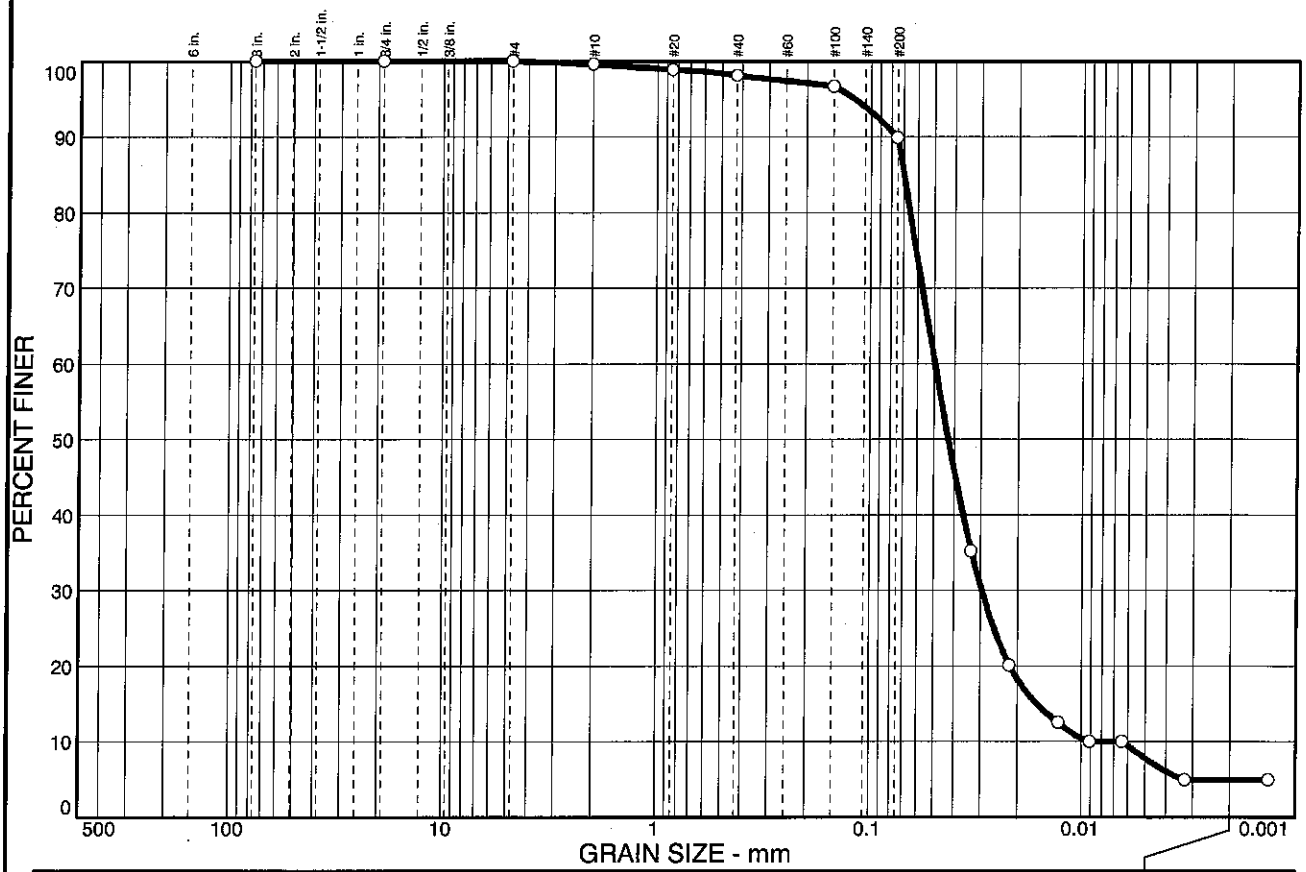
Remarks

As received moisture content = 194.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-0612 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.4	1.5	8.2	85.0	4.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.6		
#20	98.9		
#40	98.1		
#100	96.7		
#200	89.9		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0702 D_{60}= 0.0498 D_{50}= 0.0429
D_{30}= 0.0296 D_{15}= 0.0162 D_{10}= 0.0064
C_u= 7.76 C_c= 2.73

Classification

USCS= ML AASHTO= --

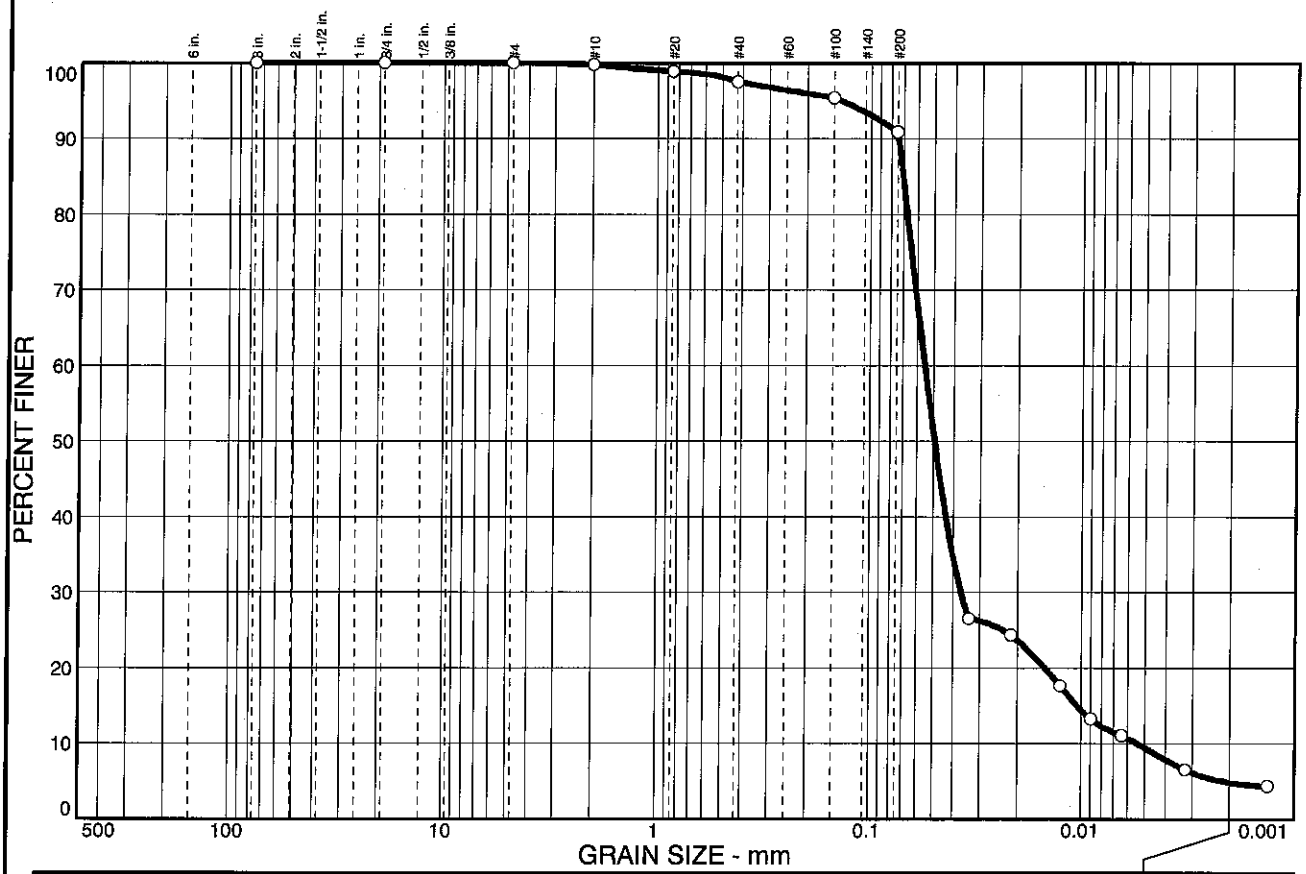
Remarks

As received moisture content = 179.8%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-1218 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	2.3	6.6	86.1	4.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	98.9		
#40	97.5		
#100	95.4		
#200	90.9		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0709 D_{60}= 0.0554 D_{50}= 0.0496
D_{30}= 0.0369 D_{15}= 0.0105 D_{10}= 0.0054
C_u= 10.17 C_c= 4.51

Classification

USCS= ML AASHTO= --

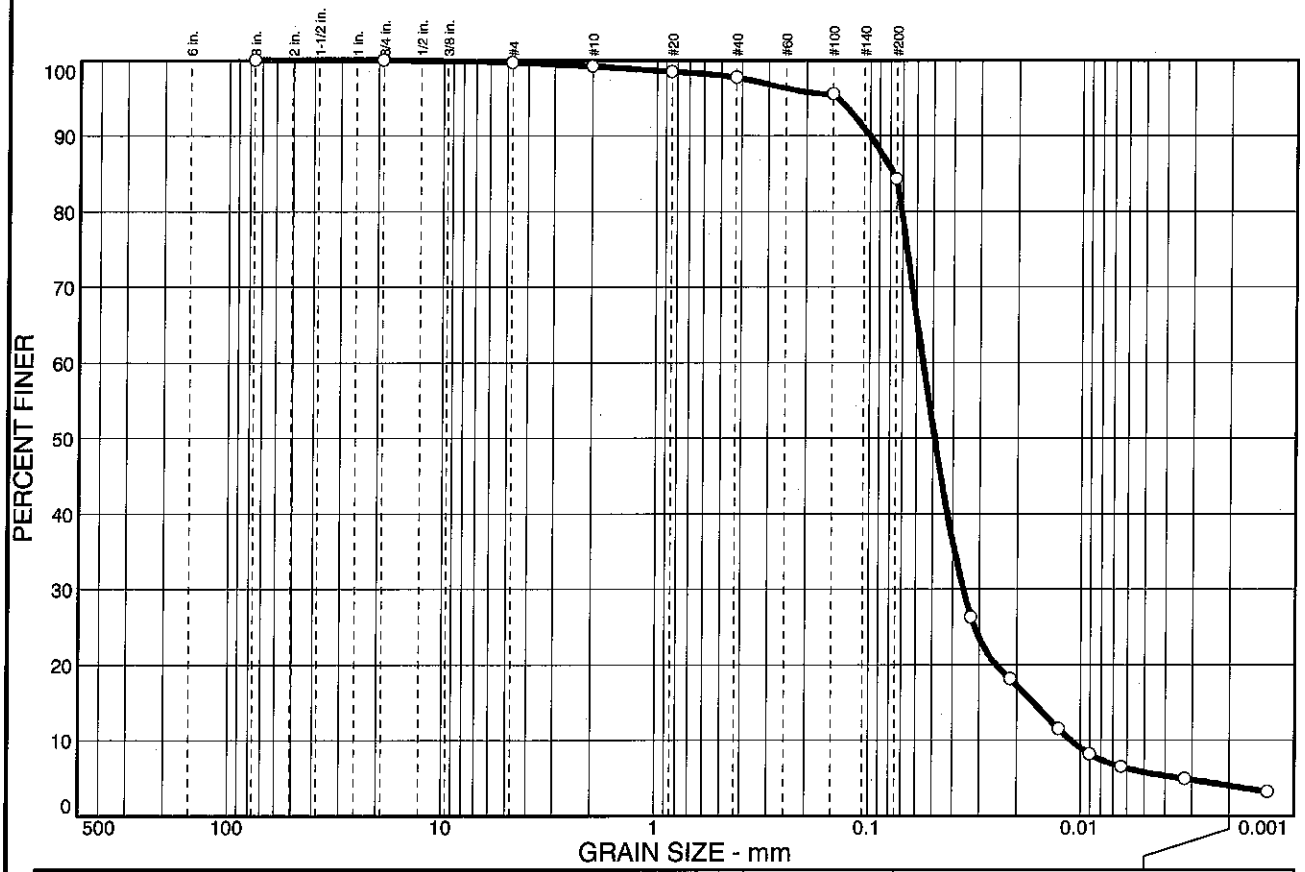
Remarks

As received moisture content = 195.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-1824 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.3	0.5	1.5	13.4	80.3	4.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.7		
#10	99.2		
#20	98.5		
#40	97.7		
#100	95.5		
#200	84.3		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0775 D_{60}= 0.0560 D_{50}= 0.0492
D_{30}= 0.0357 D_{15}= 0.0167 D_{10}= 0.0110
C_u= 5.07 C_c= 2.07

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 152.2%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-2430 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 24-30

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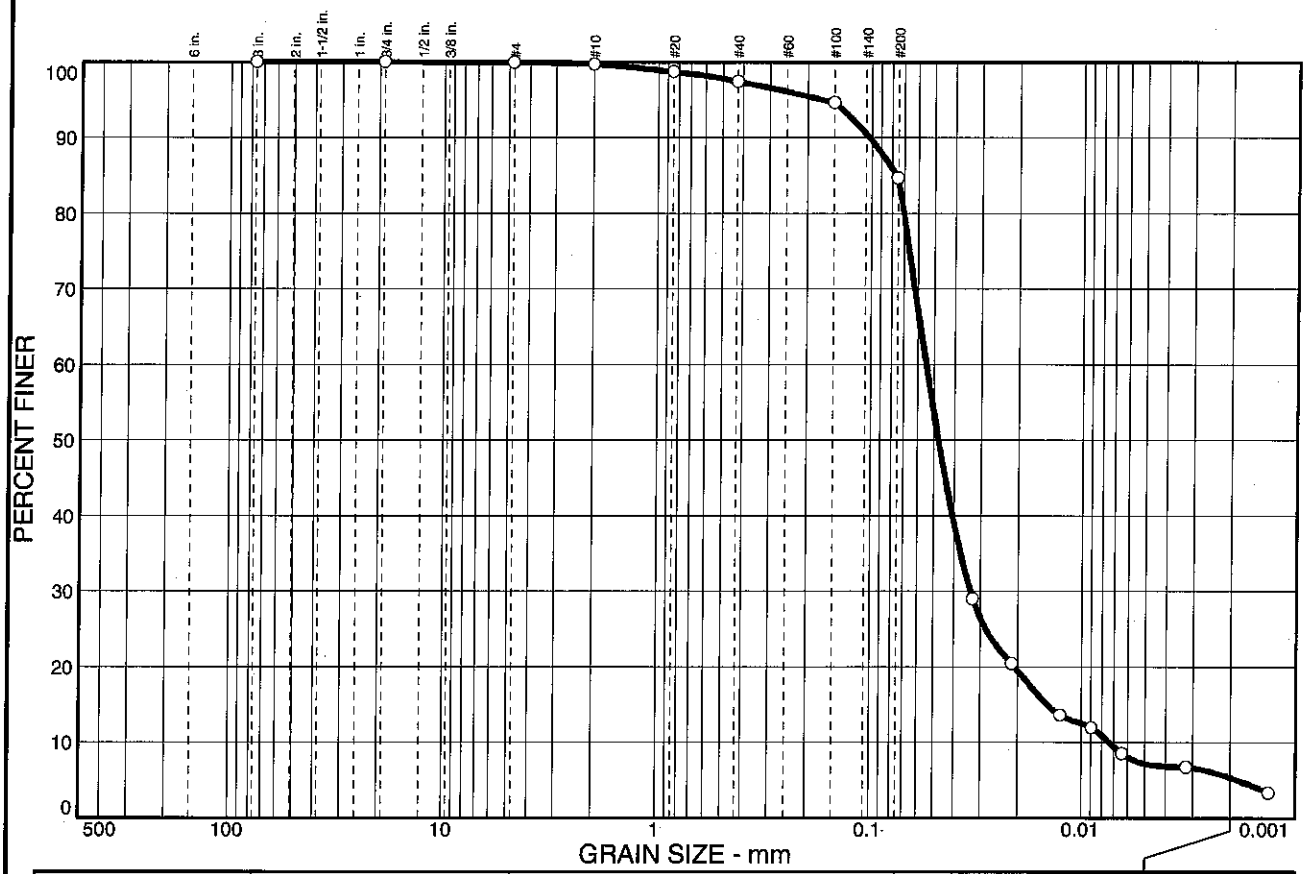
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	2.3	12.7	79.4	5.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	98.7		
#40	97.4		
#100	94.6		
#200	84.7		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0762 D_{60}= 0.0548 D_{50}= 0.0478
D_{30}= 0.0334 D_{15}= 0.0145 D_{10}= 0.0074
C_u= 7.43 C_c= 2.76

Classification

USCS= ML AASHTO= --

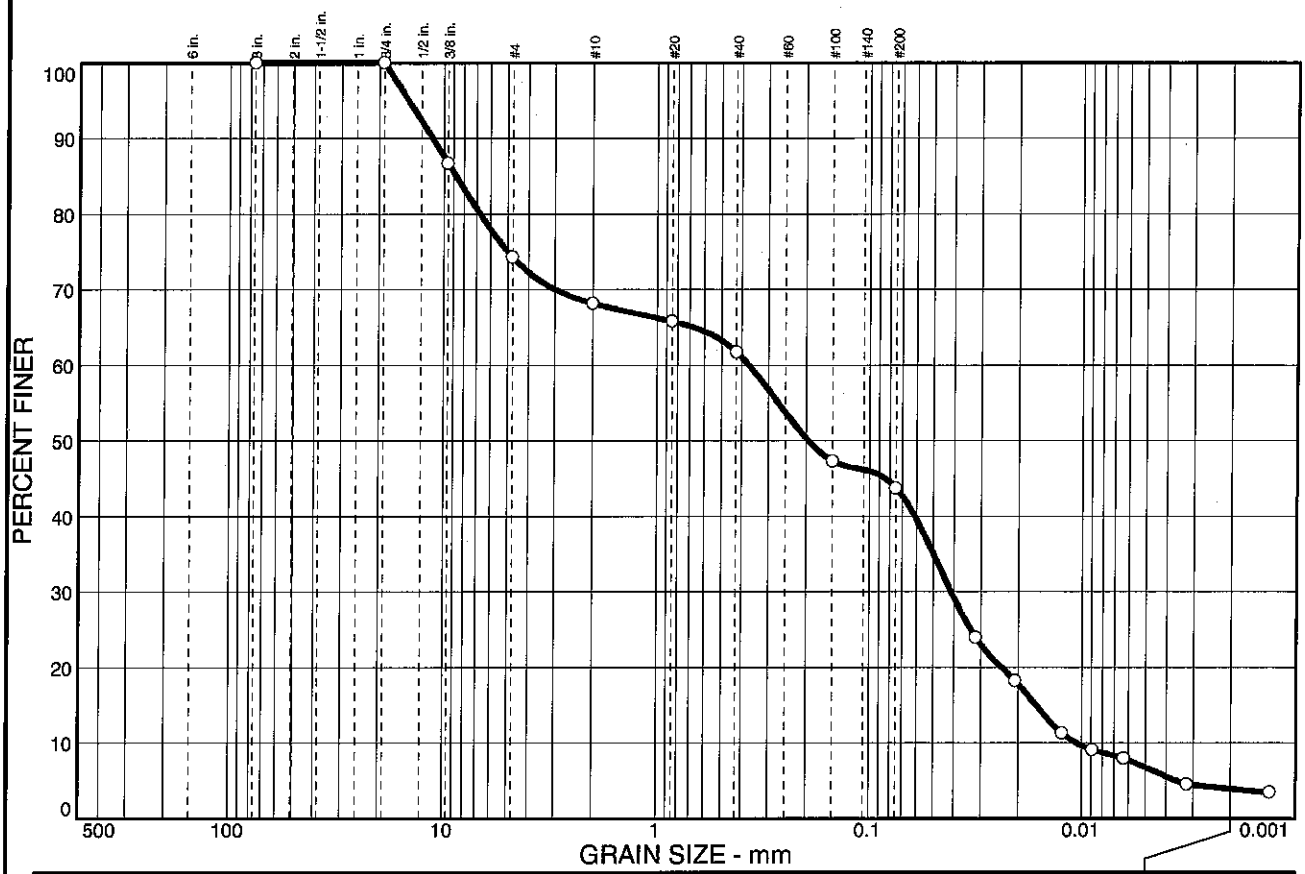
Remarks

As received moisture content = 161.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-3036 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	25.7	6.1	6.5	18.0	39.8	3.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
3/8 in.	86.7		
#4	74.3		
#10	68.2		
#20	65.8		
#40	61.7		
#100	47.3		
#200	43.7		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 8.74 D_{60}= 0.372 D_{50}= 0.195
D_{30}= 0.0414 D_{15}= 0.0165 D_{10}= 0.0106
C_u= 35.14 C_c= 0.44

Classification

USCS= SM AASHTO= --

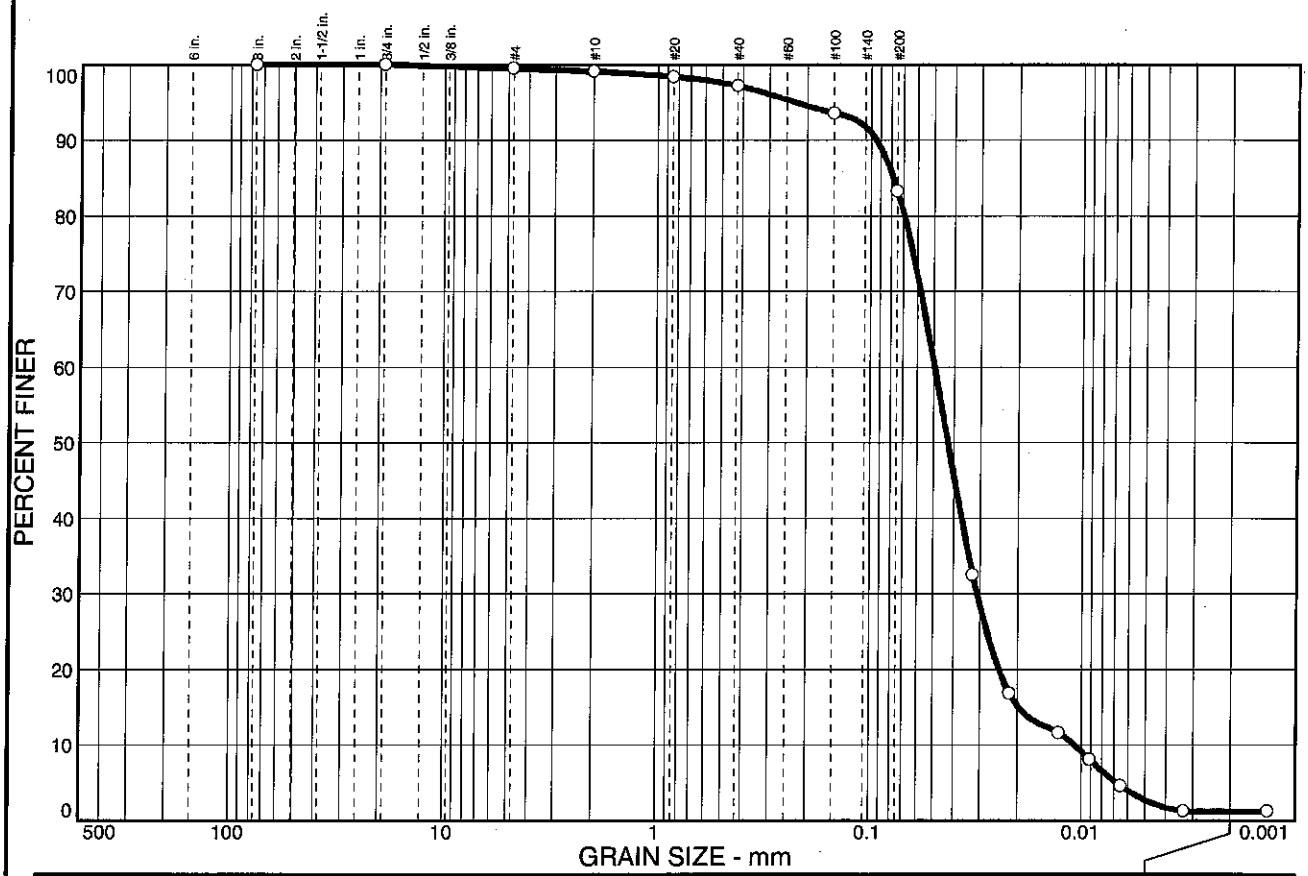
Remarks

As received moisture content = 87.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-4247 **Source of Sample:** 6/21 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 42-47

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.5	0.4	1.9	13.9	82.1	1.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.5		
#10	99.1		
#20	98.4		
#40	97.2		
#100	93.6		
#200	83.3		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0785 D_{60}= 0.0498 D_{50}= 0.0429
D_{30}= 0.0310 D_{15}= 0.0198 D_{10}= 0.0108
C_u= 4.62 C_c= 1.79

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 141.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP26-26 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: DUP26 **Elev./Depth:** 26

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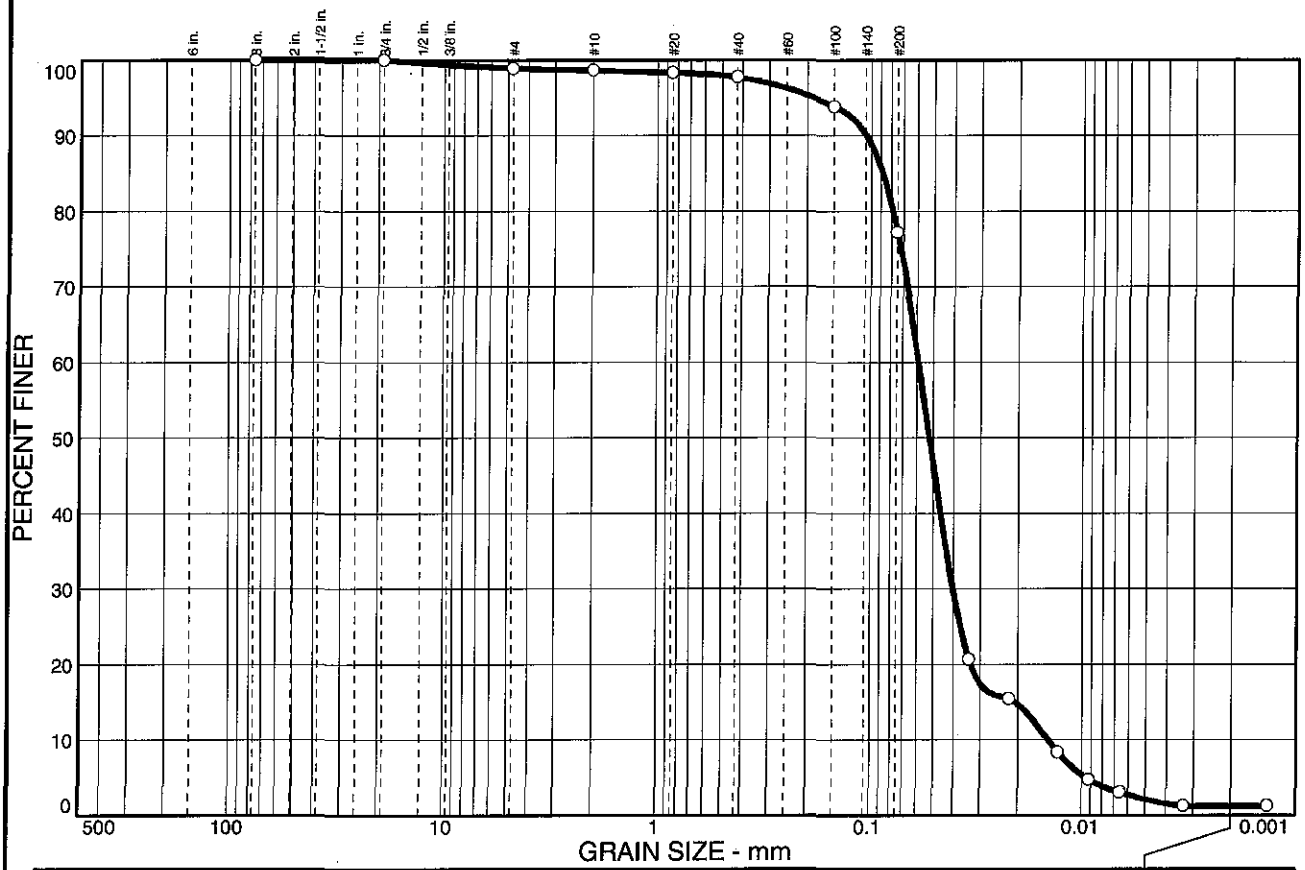
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.1	0.3	0.9	20.5	76.0	1.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.9		
#10	98.6		
#20	98.3		
#40	97.7		
#100	93.8		
#200	77.2		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0884 D_{60}= 0.0591 D_{50}= 0.0524
D_{30}= 0.0405 D_{15}= 0.0207 D_{10}= 0.0144
C_u= 4.09 C_c= 1.92

Classification

USCS= ML AASHTO= --

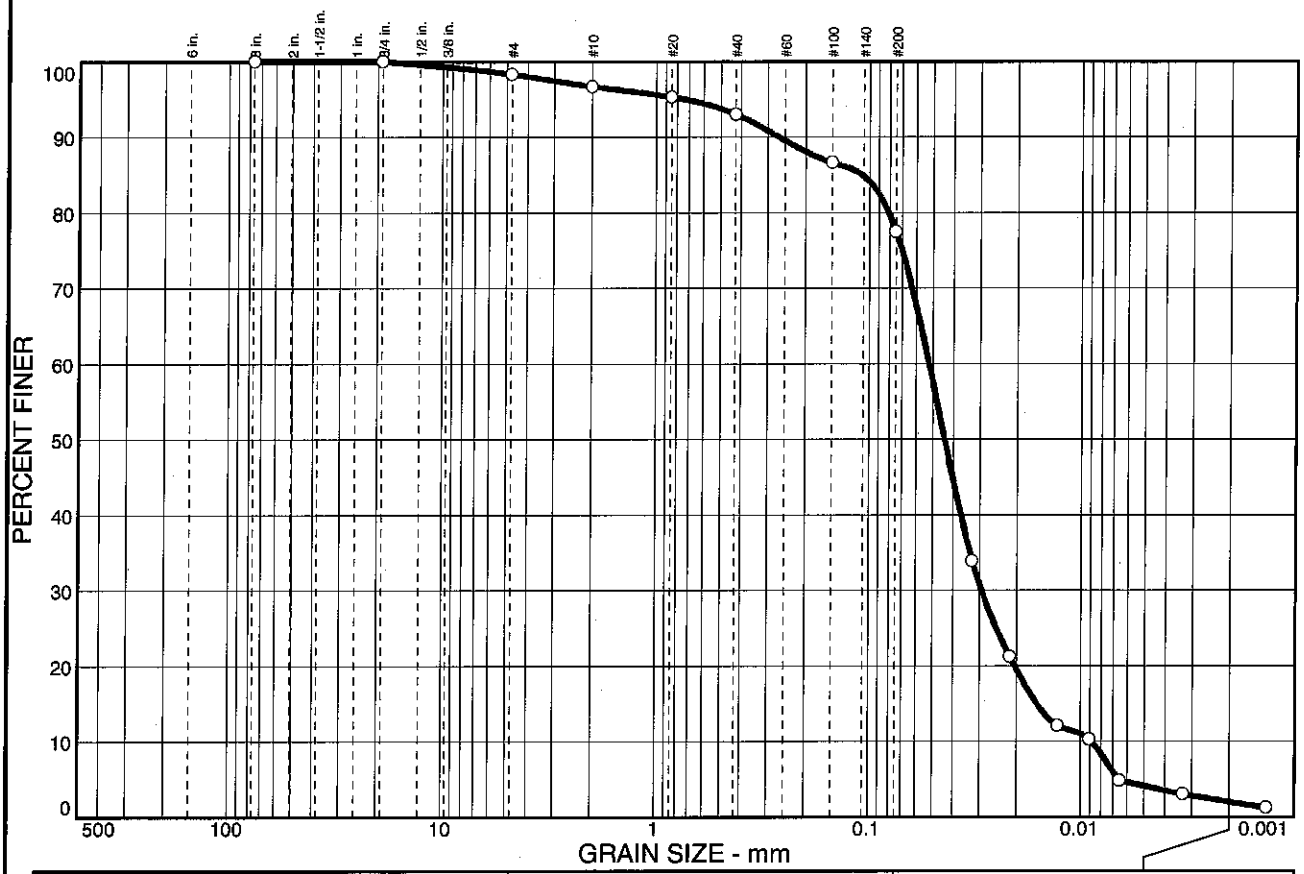
Remarks

As received moisture content = 140.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-0306 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.7	1.6	3.7	15.5	75.5	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.3		
#10	96.7		
#20	95.3		
#40	93.0		
#100	86.6		
#200	77.5		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.108 D_{60}= 0.0524 D_{50}= 0.0442
D_{30}= 0.0294 D_{15}= 0.0161 D_{10}= 0.0089
C_u= 5.91 C_c= 1.86

Classification

USCS= ML AASHTO= --

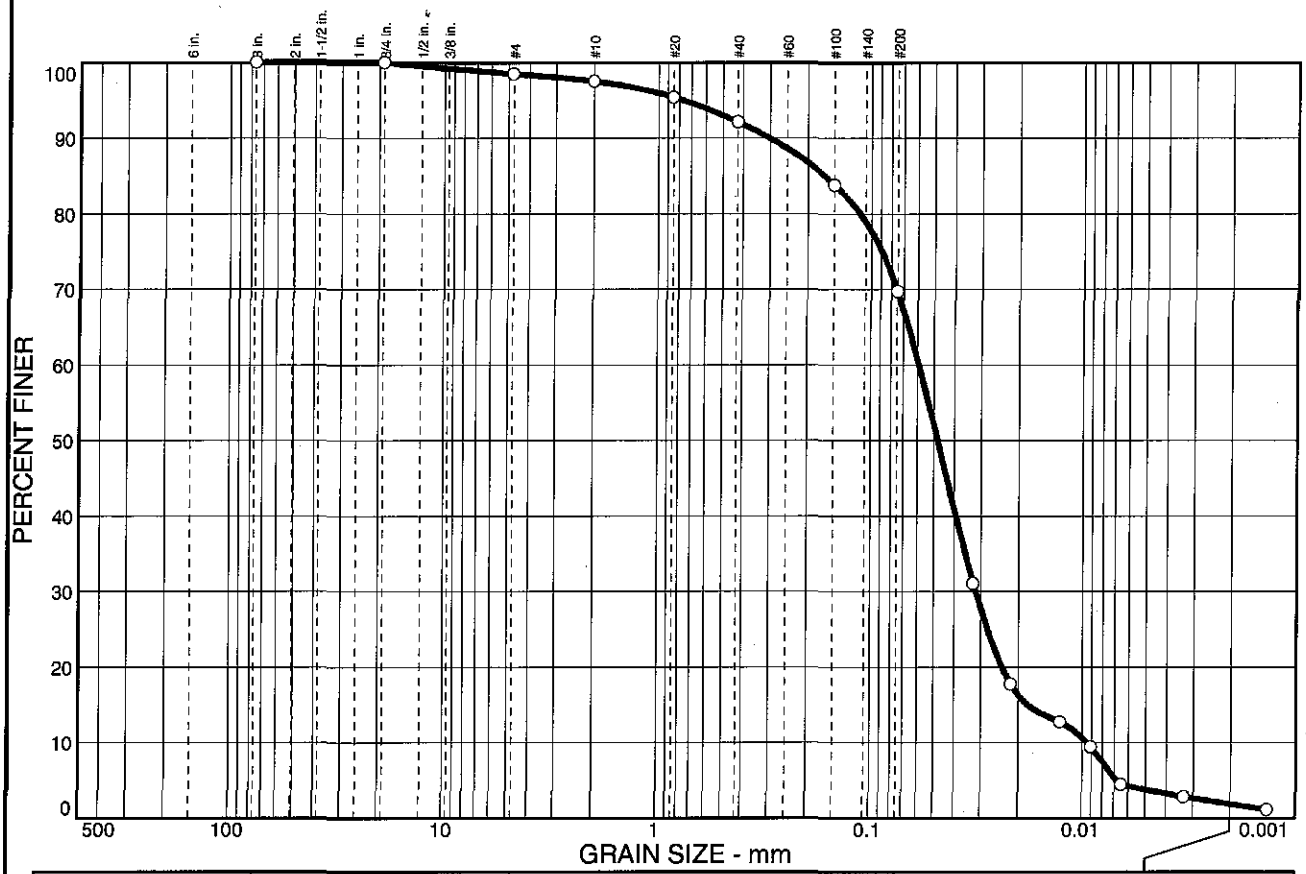
Remarks

As received moisture content = 167.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-1218 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.5	1.0	5.4	22.4	67.8	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.5		
#10	97.5		
#20	95.4		
#40	92.1		
#100	83.8		
#200	69.7		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.167 D_{60}= 0.0593 D_{50}= 0.0482
D_{30}= 0.0317 D_{15}= 0.0180 D_{10}= 0.0095
C_u= 6.24 C_c= 1.79

Classification

USCS= ML AASHTO= --

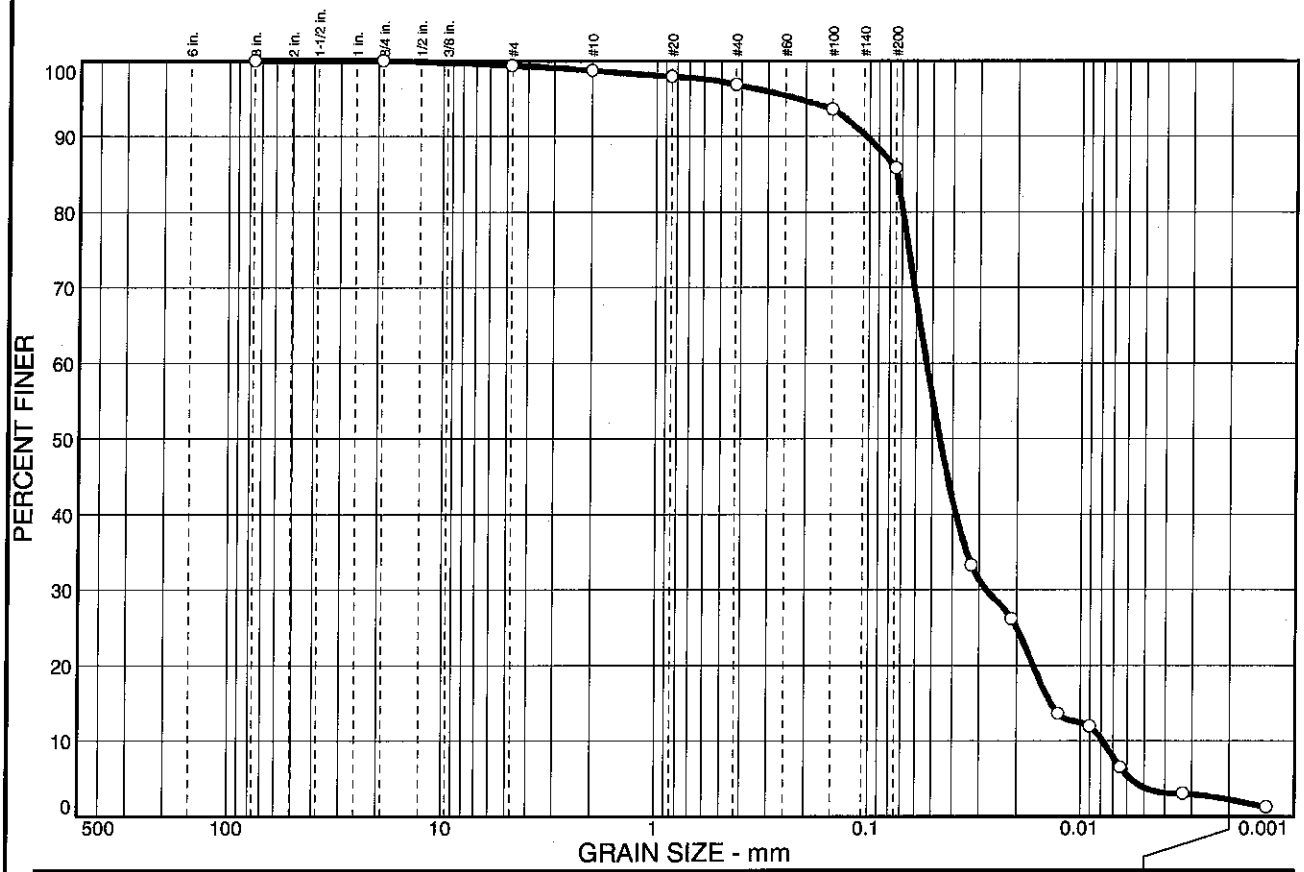
Remarks

As received moisture content = 154.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-1824 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.6	0.7	1.9	11.0	83.6	2.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.4		
#10	98.7		
#20	97.9		
#40	96.8		
#100	93.6		
#200	85.8		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0742 D_{60}= 0.0535 D_{50}= 0.0462
D_{30}= 0.0278 D_{15}= 0.0138 D_{10}= 0.0079
C_u= 6.79 C_c= 1.83

Classification

USCS= ML AASHTO= --

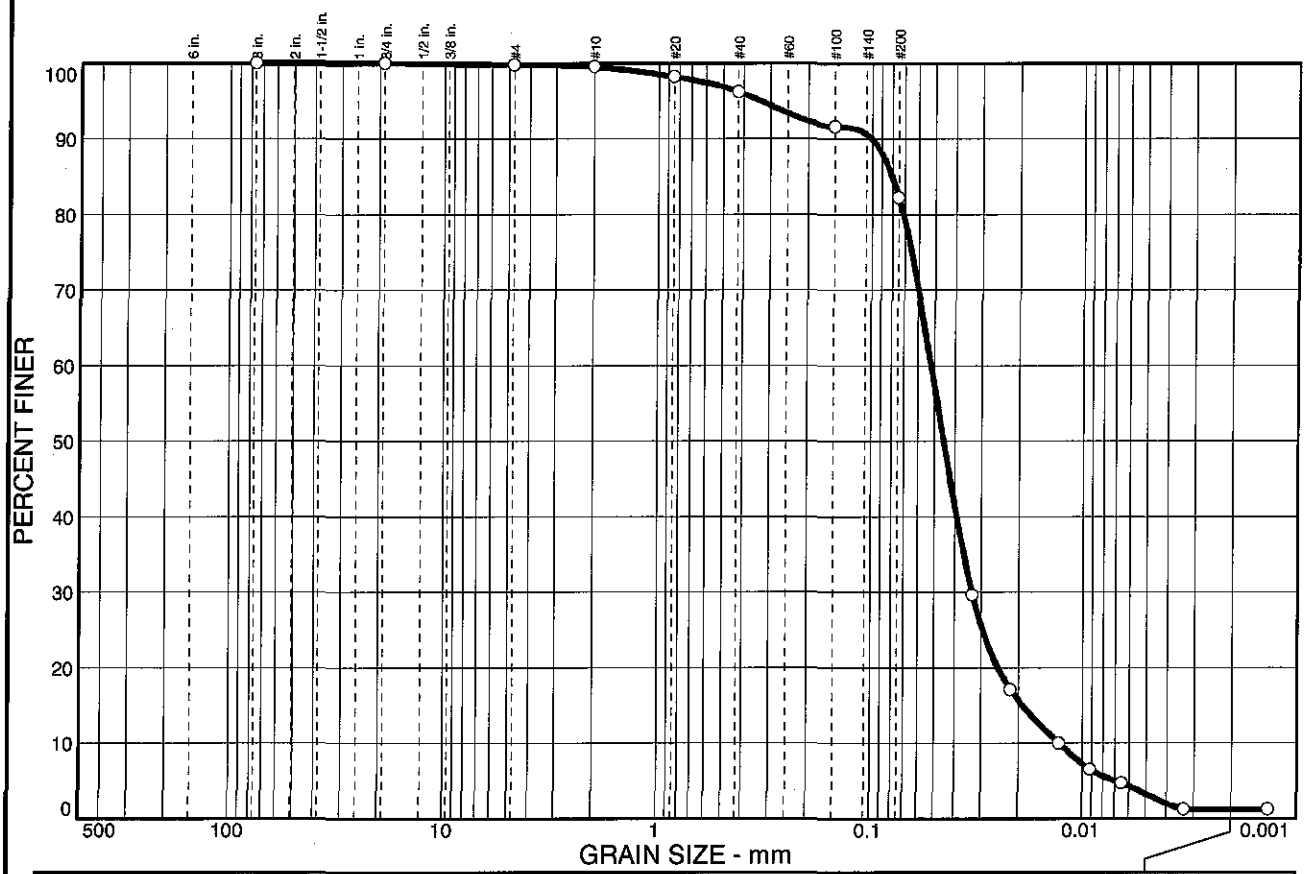
Remarks

As received moisture content = 156.5%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-2430 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.3	3.3	14.0	81.0	1.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.5		
#20	98.2		
#40	96.2		
#100	91.6		
#200	82.2		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0806 D_{60}= 0.0522 D_{50}= 0.0454
D_{30}= 0.0332 D_{15}= 0.0191 D_{10}= 0.0129
C_u= 4.06 C_c= 1.64

Classification

USCS= ML AASHTO= --

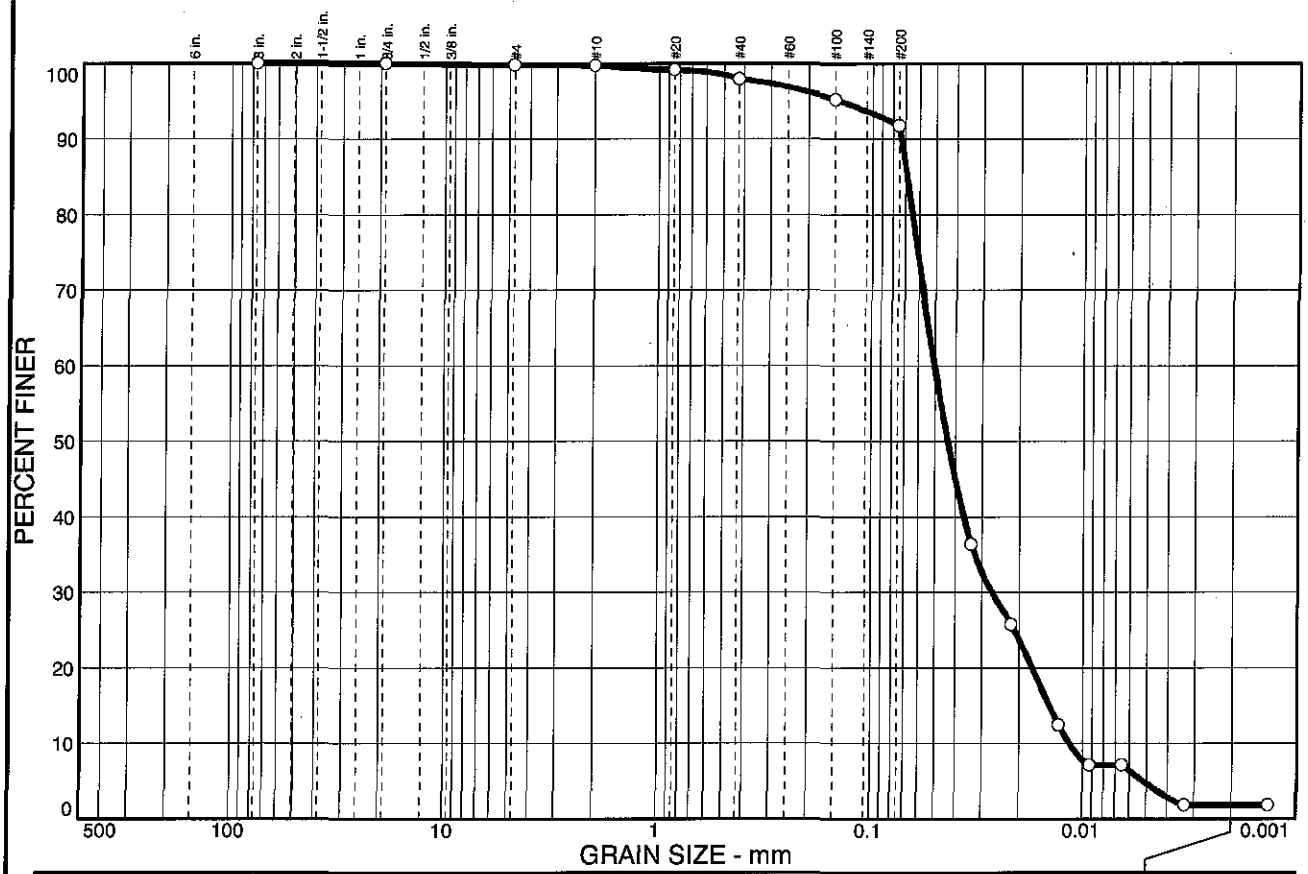
Remarks

As received moisture content = 146.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-3036 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 30-36

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.1	1.8	6.1	90.0	1.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.7		
#20	99.1		
#40	97.9		
#100	95.2		
#200	91.8		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0691 D_{60}= 0.0505 D_{50}= 0.0437
D_{30}= 0.0269 D_{15}= 0.0144 D_{10}= 0.0116
C_u= 4.37 C_c= 1.24

Classification

USCS= ML AASHTO= --

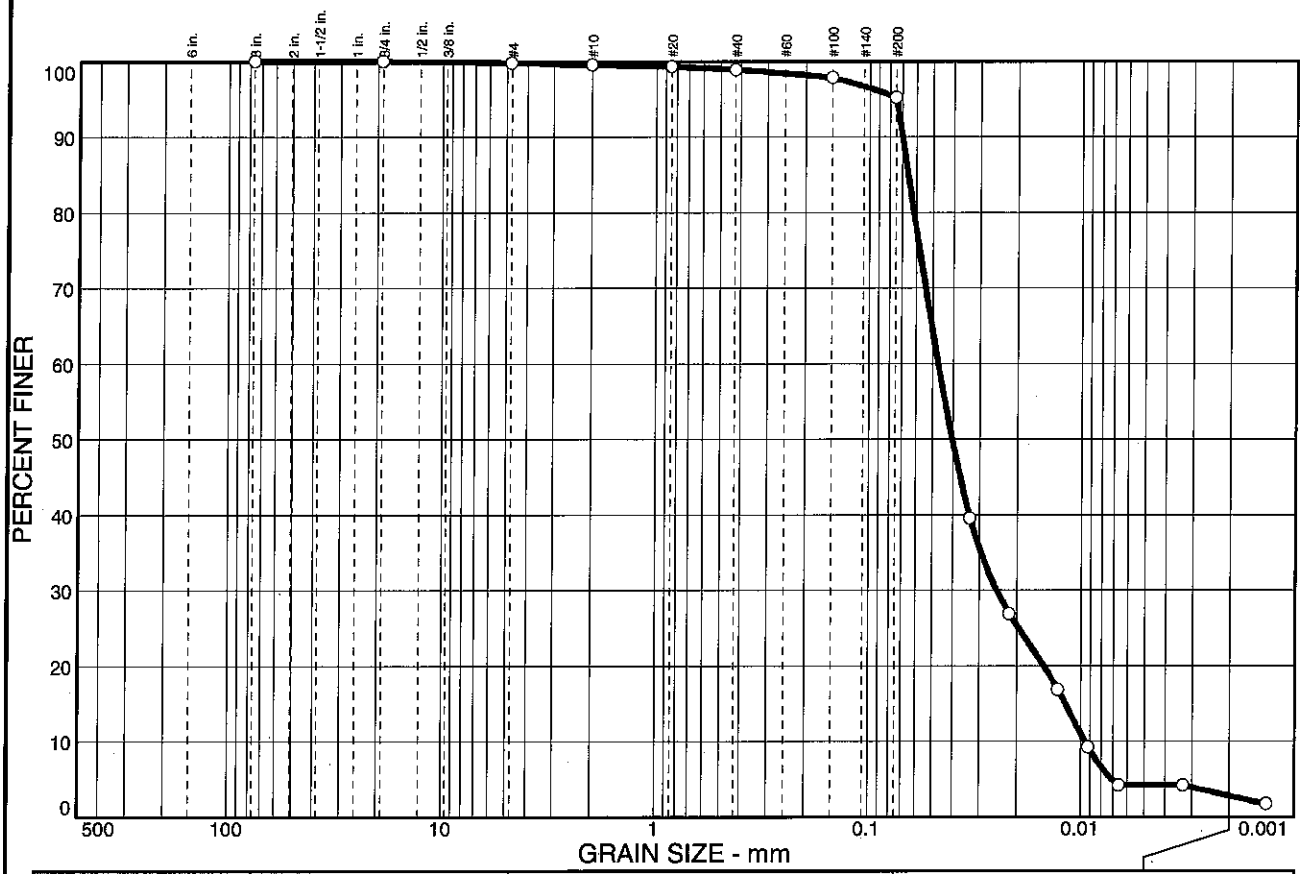
Remarks

As received moisture content = 187.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-3642 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 36-42

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.3	0.6	3.7	92.4	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.5		
#20	99.3		
#40	98.9		
#100	97.8		
#200	95.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0660 D_{60}= 0.0473 D_{50}= 0.0405
D_{30}= 0.0249 D_{15}= 0.0118 D_{10}= 0.0095
C_u= 4.96 C_c= 1.37

Classification

USCS= ML AASHTO= --

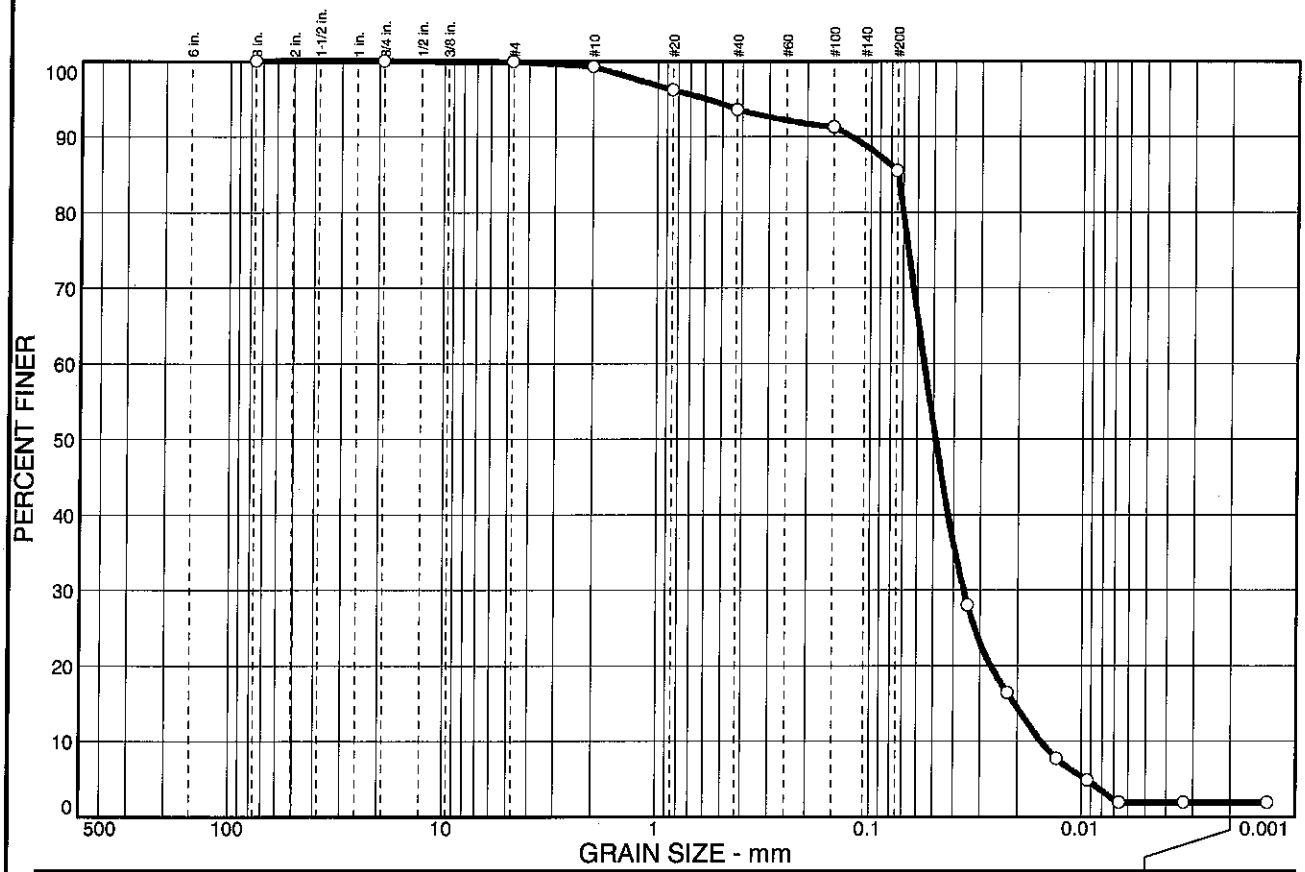
Remarks

As received moisture content = 191.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-4854 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 48-54

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.6	5.7	8.1	83.6	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.3		
#20	96.2		
#40	93.6		
#100	91.3		
#200	85.5		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0746 D_{60}= 0.0558 D_{50}= 0.0492
D_{30}= 0.0359 D_{15}= 0.0206 D_{10}= 0.0155
C_u= 3.60 C_c= 1.49

Classification

USCS= ML AASHTO= --

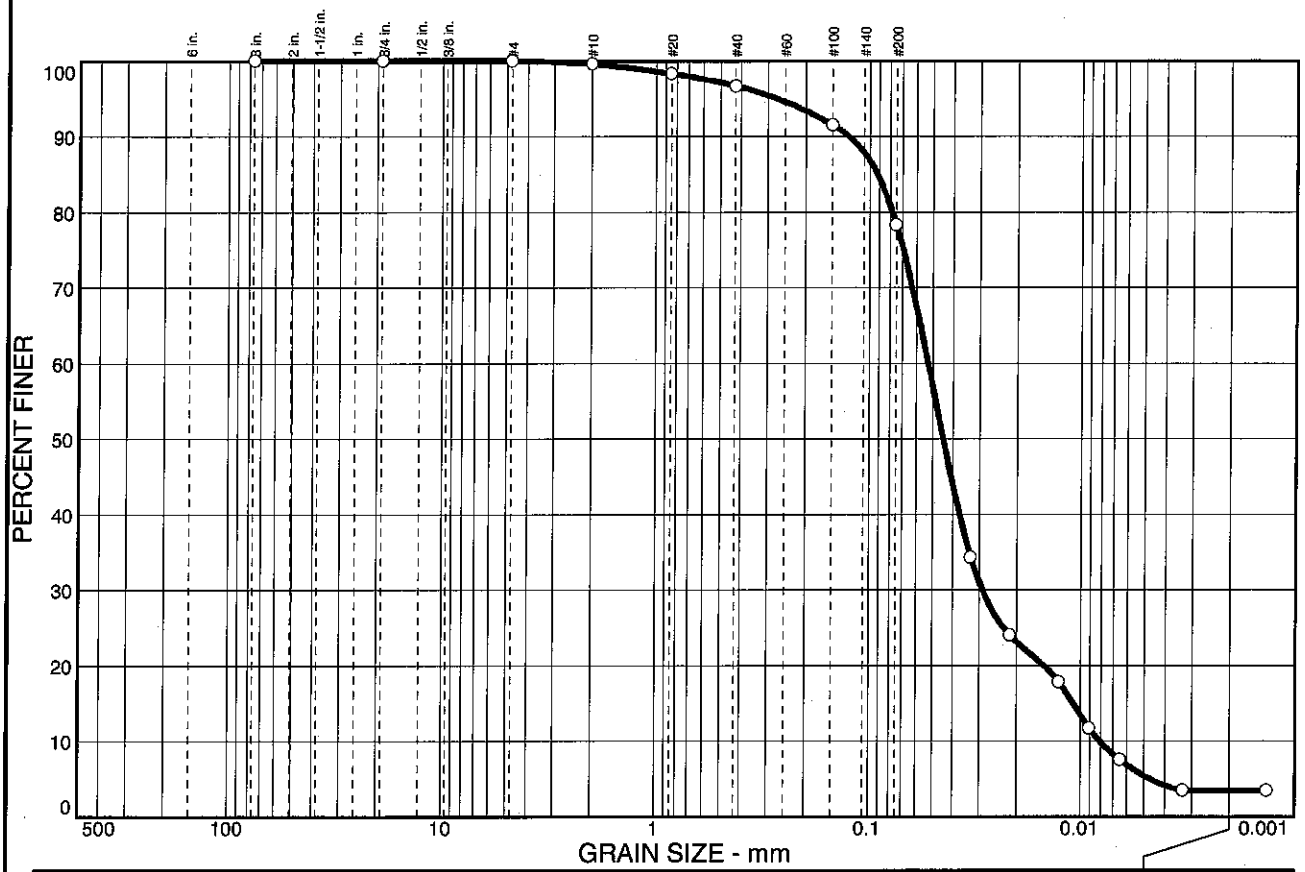
Remarks

As received moisture content = 210.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NB-5460 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NB **Elev./Depth:** 54-60

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.4	2.9	18.4	74.9	3.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.6		
#20	98.3		
#40	96.7		
#100	91.5		
#200	78.3		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0923 D_{60}= 0.0530 D_{50}= 0.0448
D_{30}= 0.0290 D_{15}= 0.0108 D_{10}= 0.0081
C_u= 6.52 C_c= 1.96

Classification

USCS= ML AASHTO= --

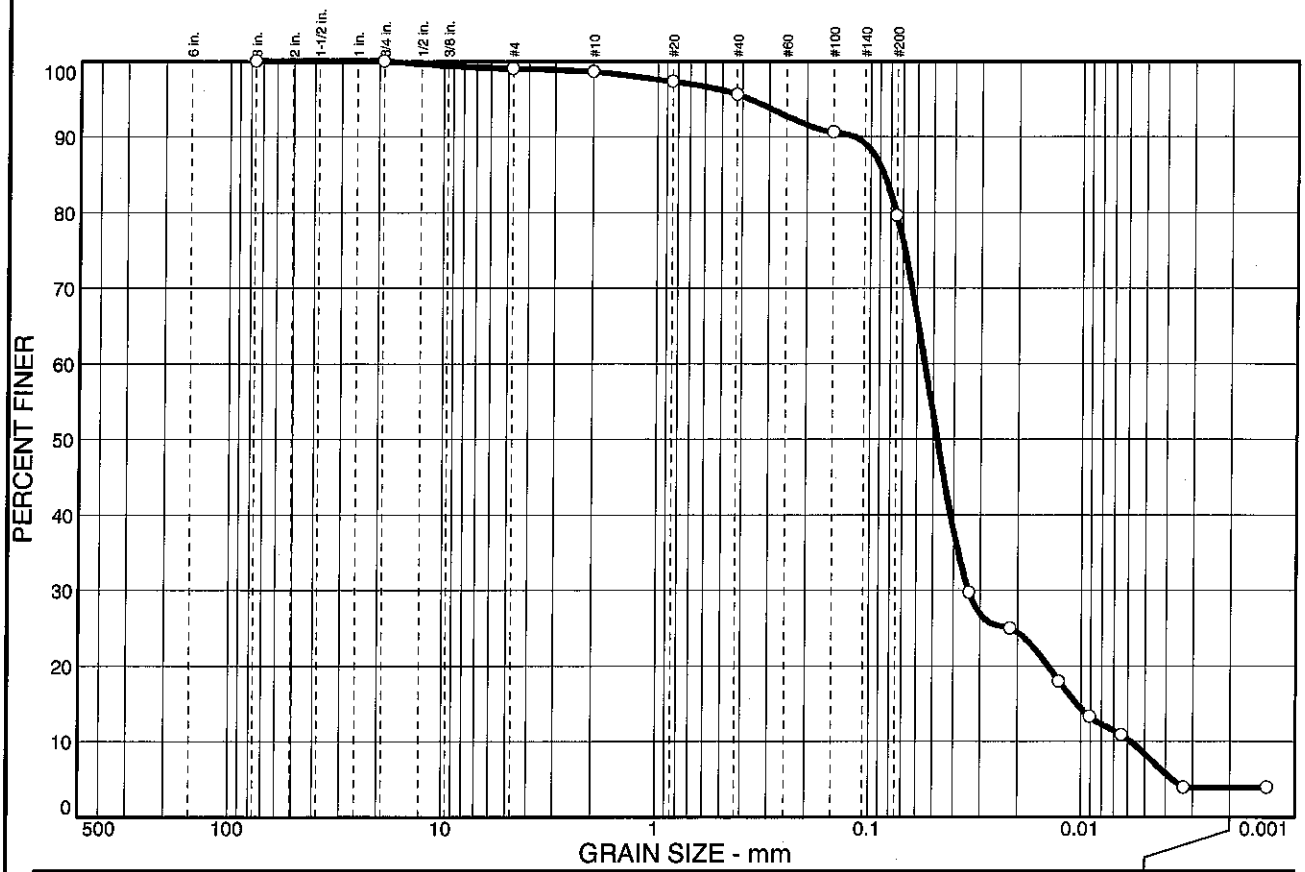
Remarks

As received moisture content = 201.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-0306 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NC **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.0	0.4	3.0	16.0	75.7	3.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.0		
#10	98.6		
#20	97.3		
#40	95.6		
#100	90.6		
#200	79.6		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0863 D_{60}= 0.0552 D_{50}= 0.0481
D_{30}= 0.0341 D_{15}= 0.0105 D_{10}= 0.0058
C_u= 9.45 C_c= 3.60

Classification

USCS= ML AASHTO= --

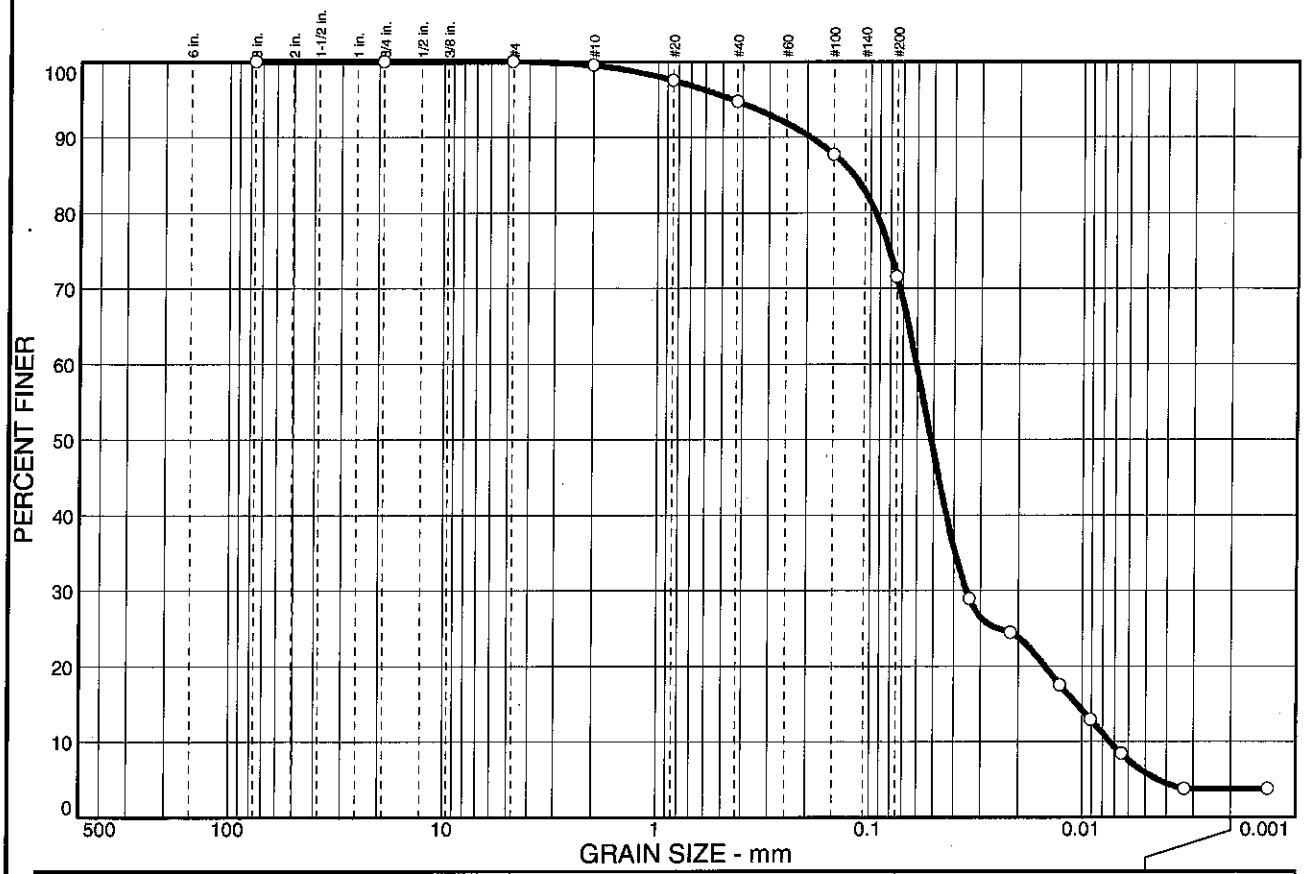
Remarks

As received moisture content = 214.5%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-0612 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NC **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.5	4.8	23.2	67.7	3.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.5		
#20	97.5		
#40	94.7		
#100	87.7		
#200	71.5		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.120 D_{60}= 0.0608 D_{50}= 0.0517
D_{30}= 0.0350 D_{15}= 0.0106 D_{10}= 0.0074
C_u= 8.24 C_c= 2.73

Classification

USCS= ML AASHTO= --

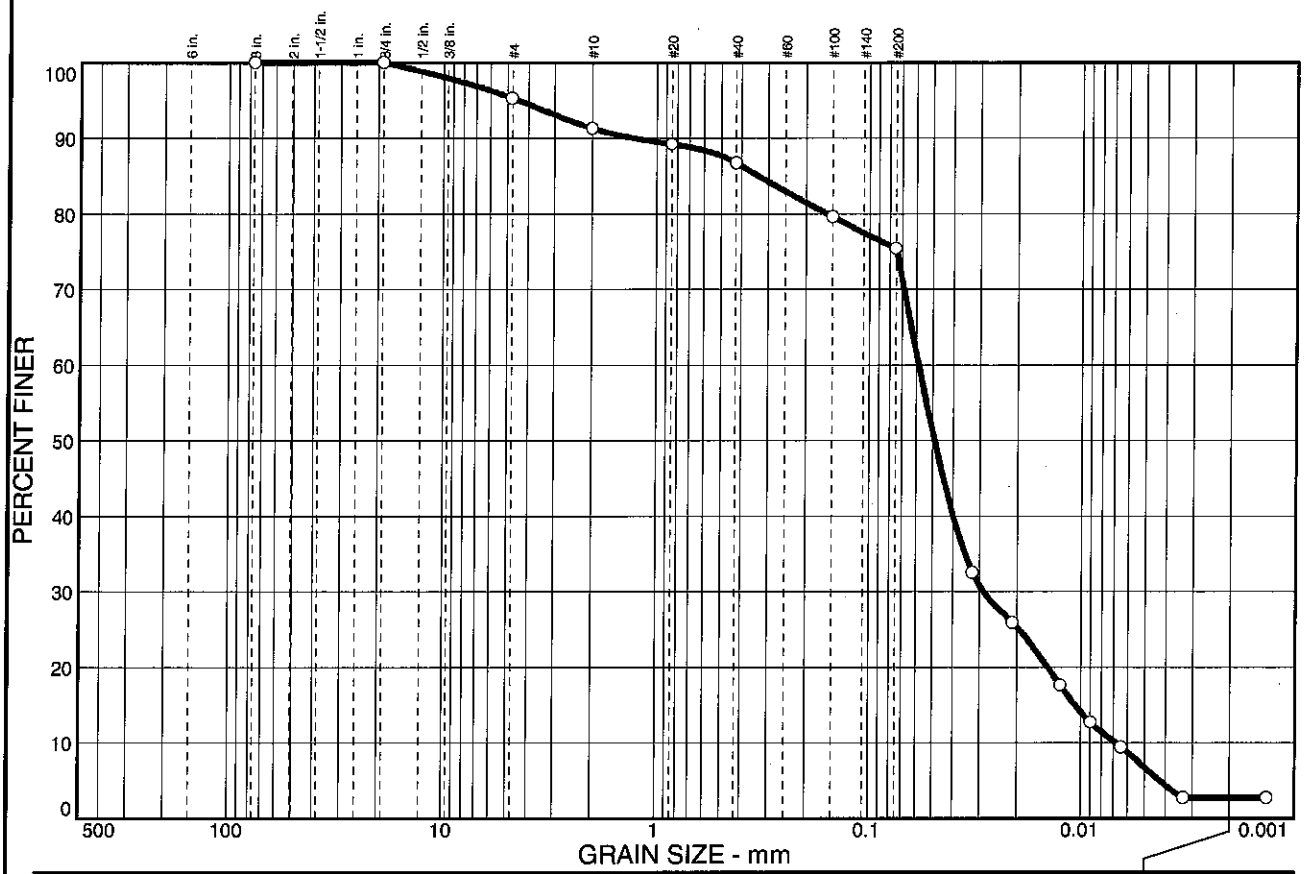
Remarks

As received moisture content = 202.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-1218 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NC **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	4.7	4.0	4.6	11.3	72.7	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	95.3		
#10	91.3		
#20	89.2		
#40	86.7		
#100	79.6		
#200	75.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.335 D_{60}= 0.0586 D_{50}= 0.0492
D_{30}= 0.0287 D_{15}= 0.0106 D_{10}= 0.0068
C_u= 8.55 C_c= 2.06

Classification

USCS= ML AASHTO= --

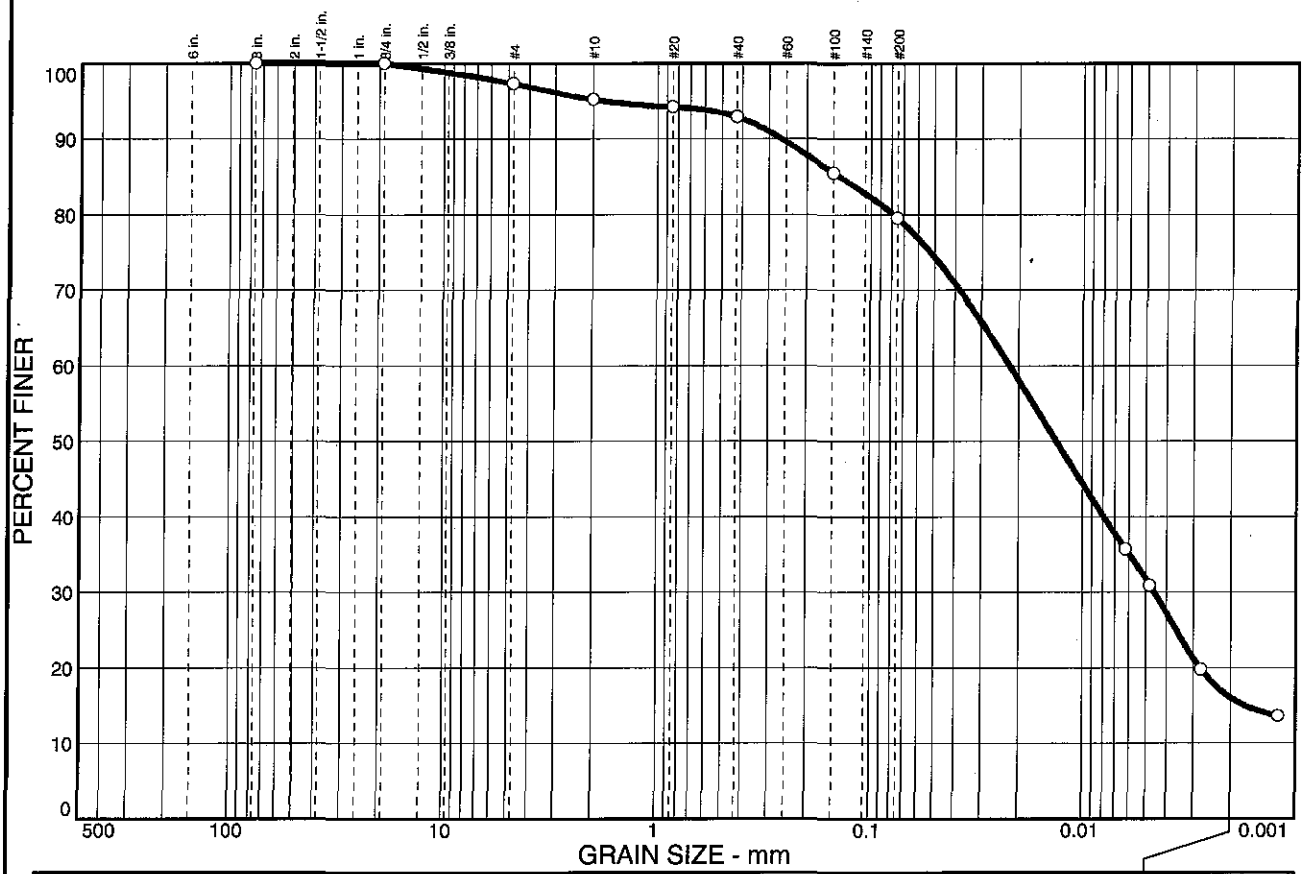
Remarks

As received moisture content = 167.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-1824 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NC **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	2.7	2.1	2.3	13.4	63.5	16.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	97.3		
#10	95.2		
#20	94.2		
#40	92.9		
#100	85.5		
#200	79.5		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.141 D_{60}= 0.0221 D_{50}= 0.0133
D_{30}= 0.0046 D_{15}= 0.0017 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

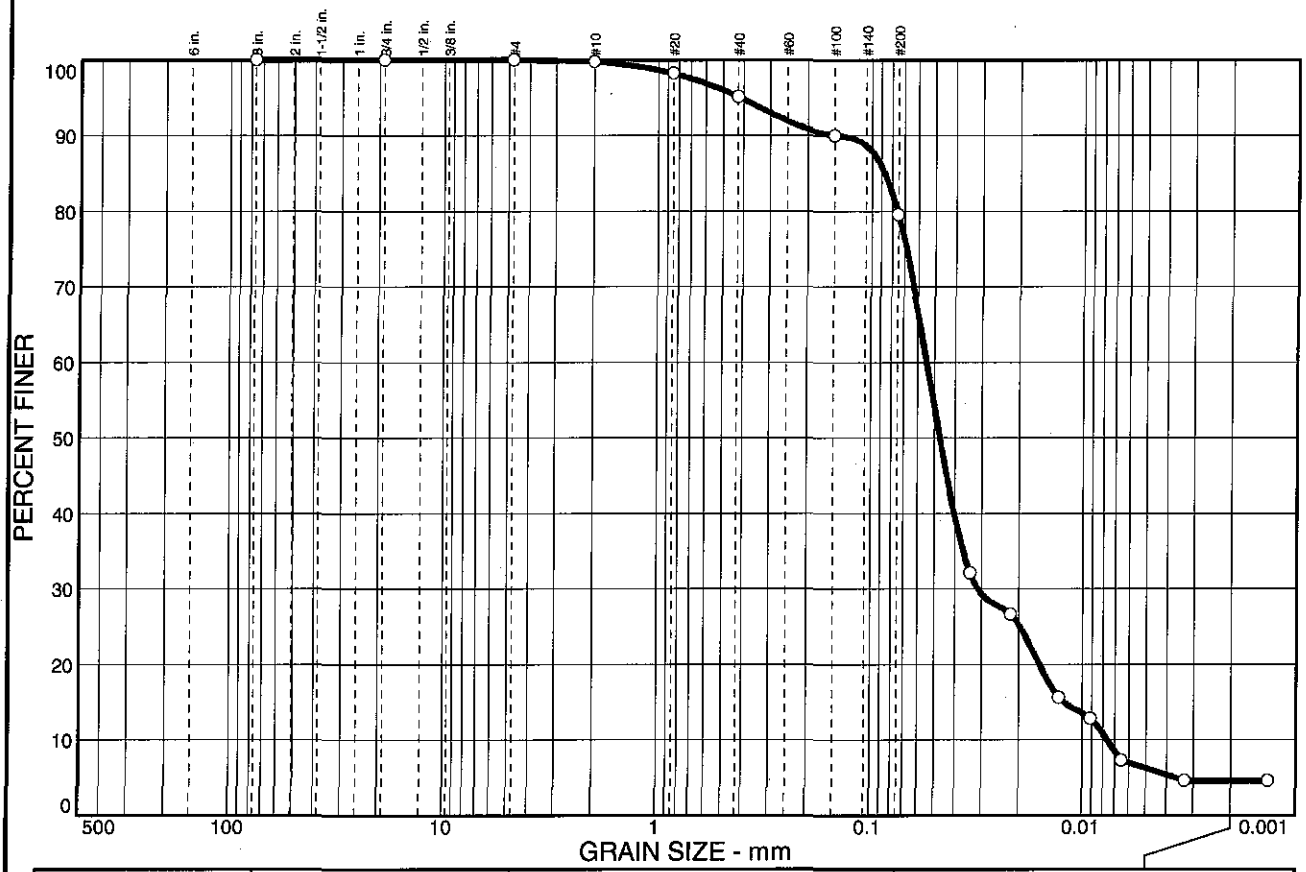
Remarks

As received moisture content = 37.1%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NC-2430 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NC **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	4.7	15.6	74.9	4.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	98.2		
#40	95.1		
#100	90.0		
#200	79.5		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0872 D_{60}= 0.0547 D_{50}= 0.0474
D_{30}= 0.0313 D_{15}= 0.0122 D_{10}= 0.0076
C_u= 7.15 C_c= 2.34

Classification

USCS= ML AASHTO= --

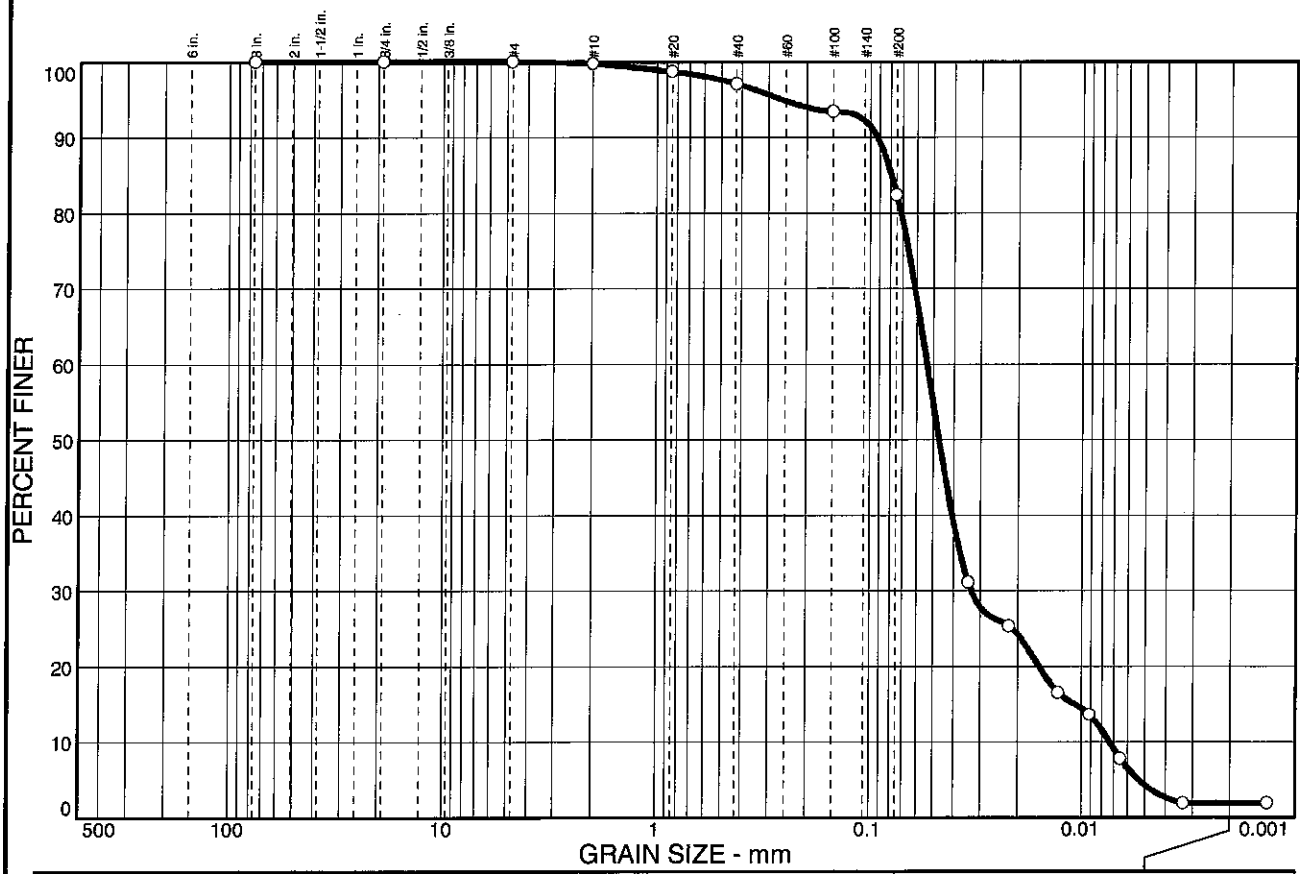
Remarks

As received moisture content = 275.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-ND-0003 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37ND **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	2.7	14.7	80.5	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	98.7		
#40	97.1		
#100	93.4		
#200	82.4		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0794 D_{60}= 0.0538 D_{50}= 0.0472
D_{30}= 0.0331 D_{15}= 0.0107 D_{10}= 0.0074
C_u= 7.30 C_c= 2.76

Classification

USCS= ML AASHTO= --

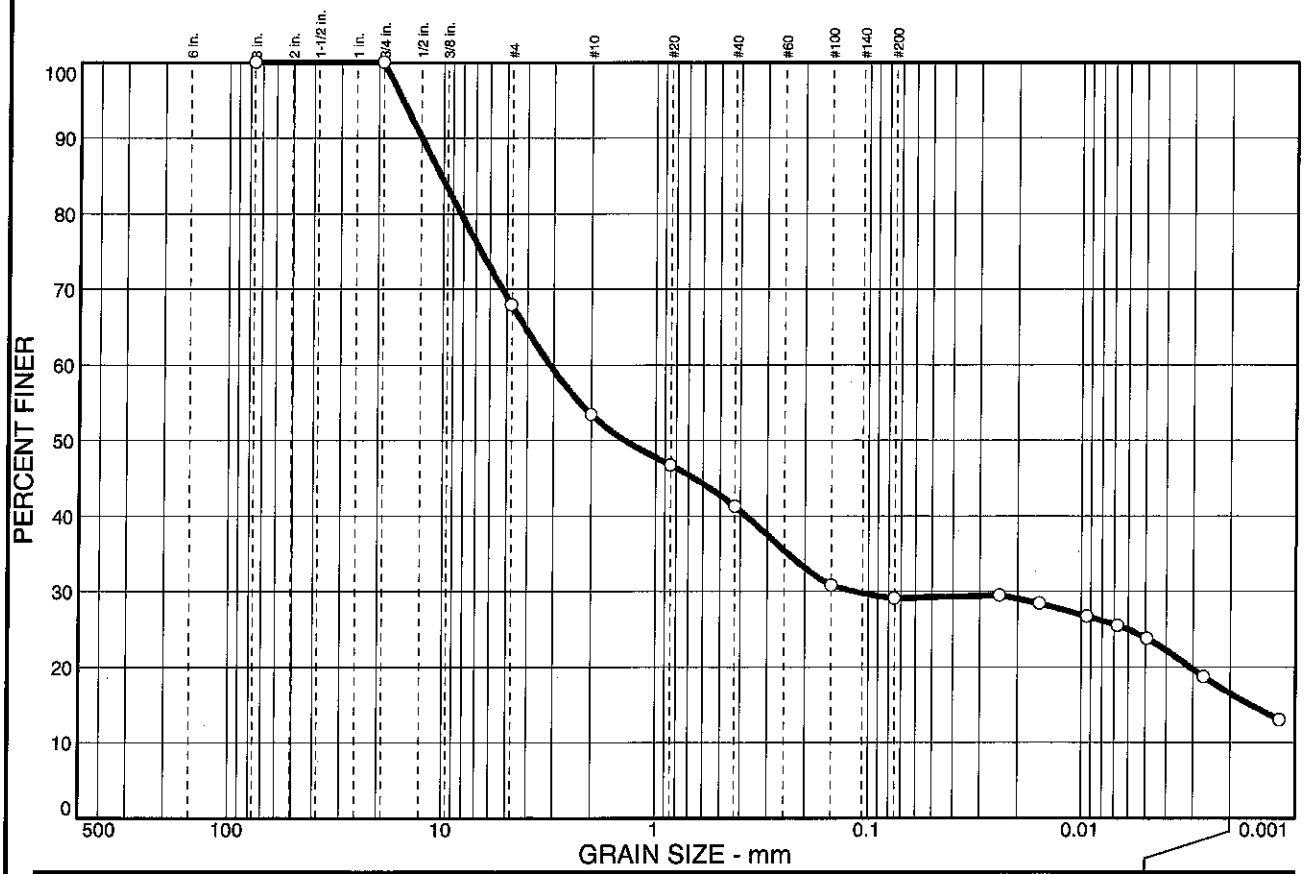
Remarks

As received moisture content = 246.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-ND-0306 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37ND **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	32.1	14.5	12.2	12.1	12.6	16.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	67.9		
#10	53.4		
#20	46.7		
#40	41.2		
#100	30.8		
#200	29.1		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 10.2 D_{60}= 3.14 D_{50}= 1.40
D_{30}= 0.116 D_{15}= 0.0016 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= --

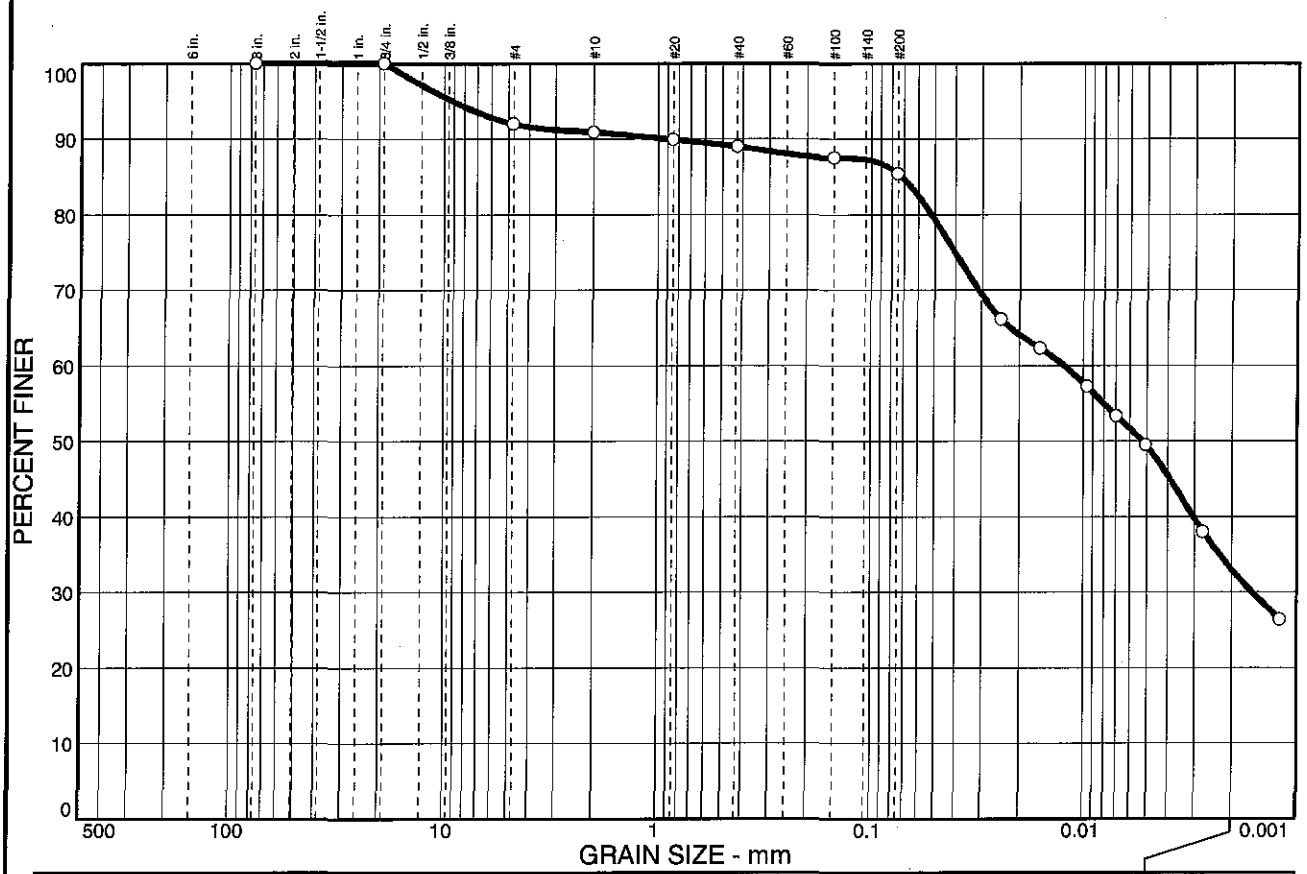
Remarks

As received moisture content = 21.9%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NE-18-24 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NE **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	8.0	1.1	1.9	3.6	52.5	32.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	92.0		
#10	90.9		
#20	89.9		
#40	89.0		
#100	87.5		
#200	85.4		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0723 D_{60}= 0.0123 D_{50}= 0.0053
D_{30}= 0.0016 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

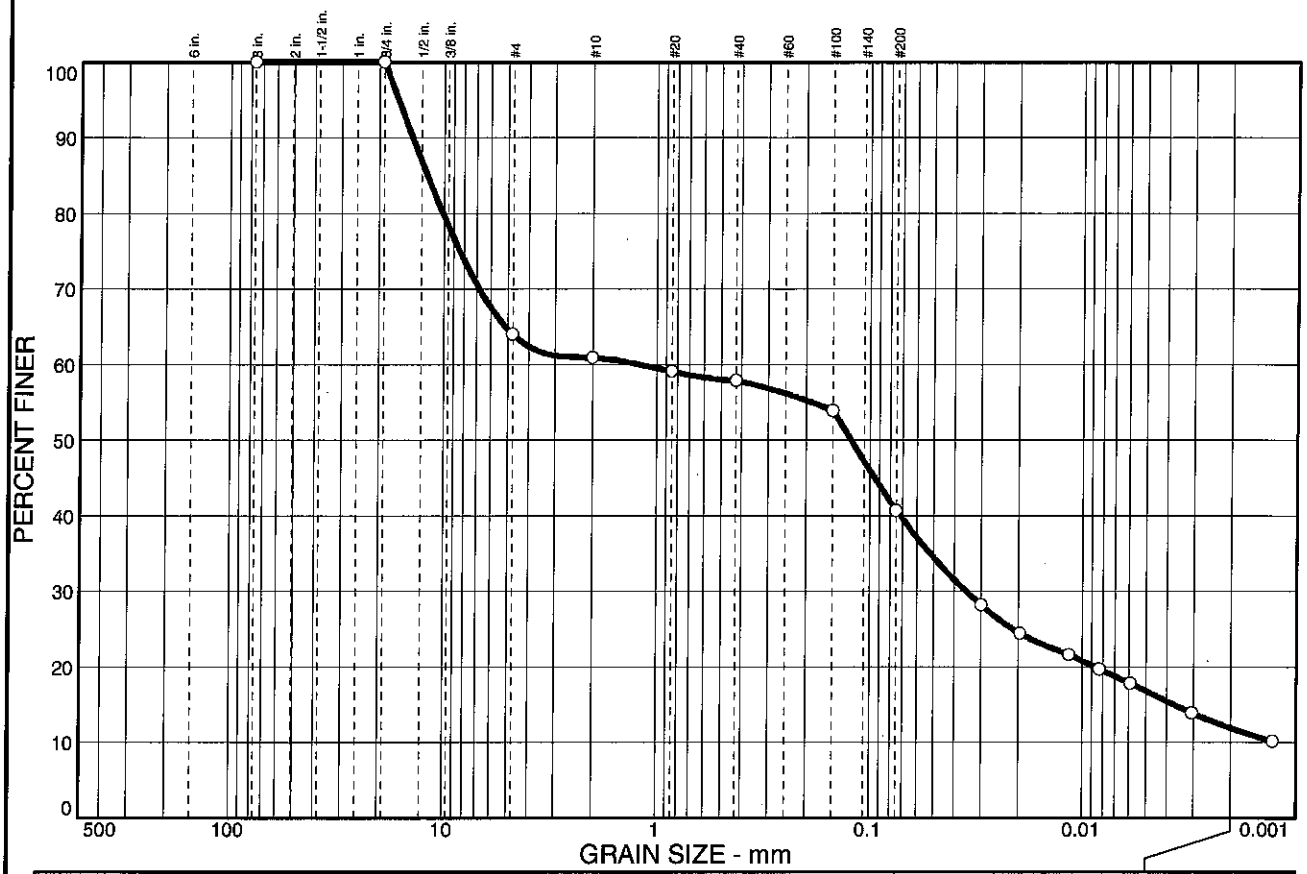
Remarks

As received moisture content = 92.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NE-2428 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NE **Elev./Depth:** 24-28

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	36.0	3.1	3.0	17.2	28.8	11.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	64.0		
#10	60.9		
#20	59.1		
#40	57.9		
#100	53.9		
#200	40.7		

* (no specification provided)

Soil Description

Silty gravel with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 12.0 D_{60}= 1.20 D_{50}= 0.123
D_{30}= 0.0353 D_{15}= 0.0037 D_{10}=
C_u= C_c=

Classification

USCS= GM AASHTO= --

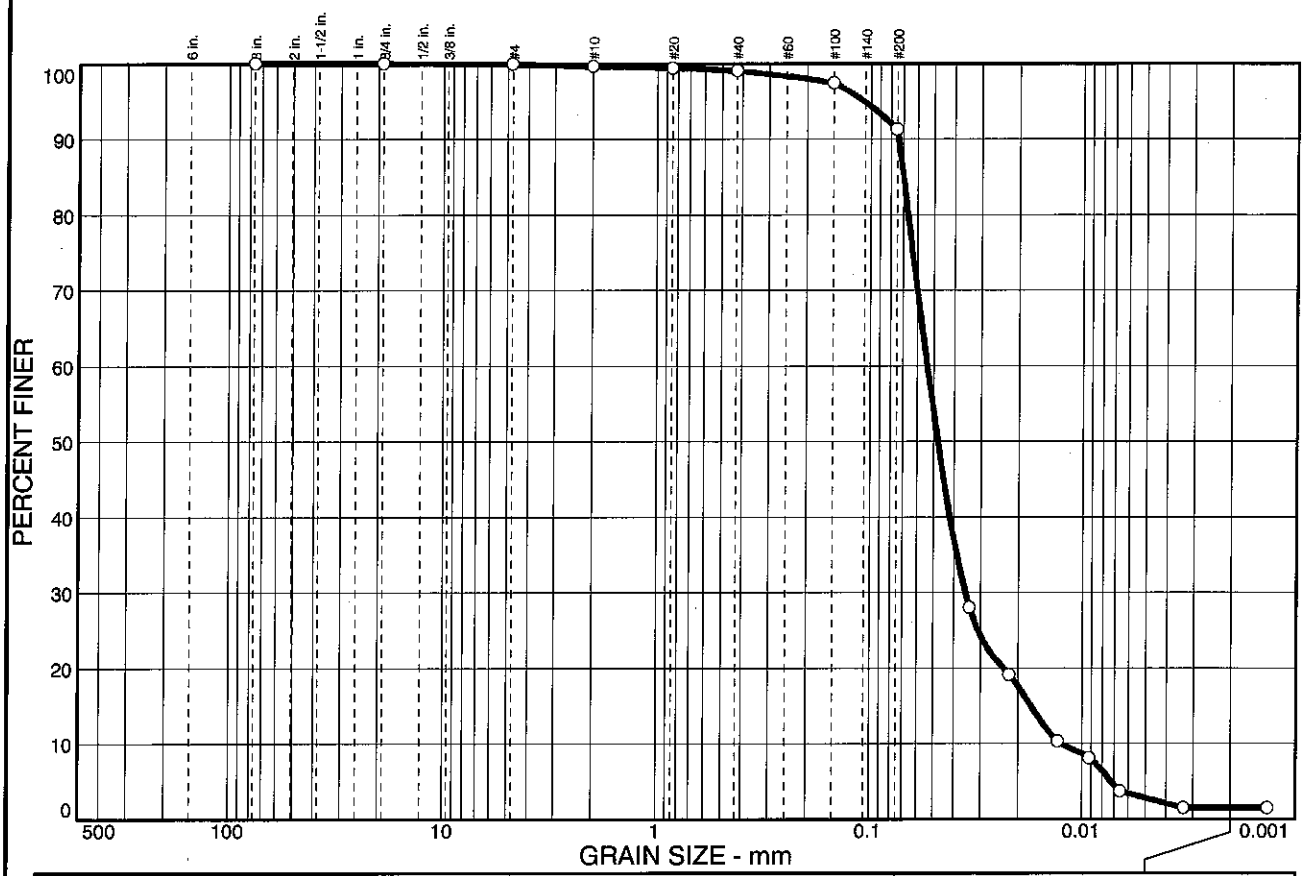
Remarks

As received moisture content = 62.8%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T37-NG-0612 **Source of Sample:** 6/14 **Date:** 5/27/04
Location: T37NG **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.3	0.6	7.7	89.8	1.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.6		
#20	99.4		
#40	99.0		
#100	97.4		
#200	91.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0703 D_{60}= 0.0540 D_{50}= 0.0480
D_{30}= 0.0354 D_{15}= 0.0174 D_{10}= 0.0125
C_u= 4.32 C_c= 1.85

Classification

USCS= ML AASHTO= --

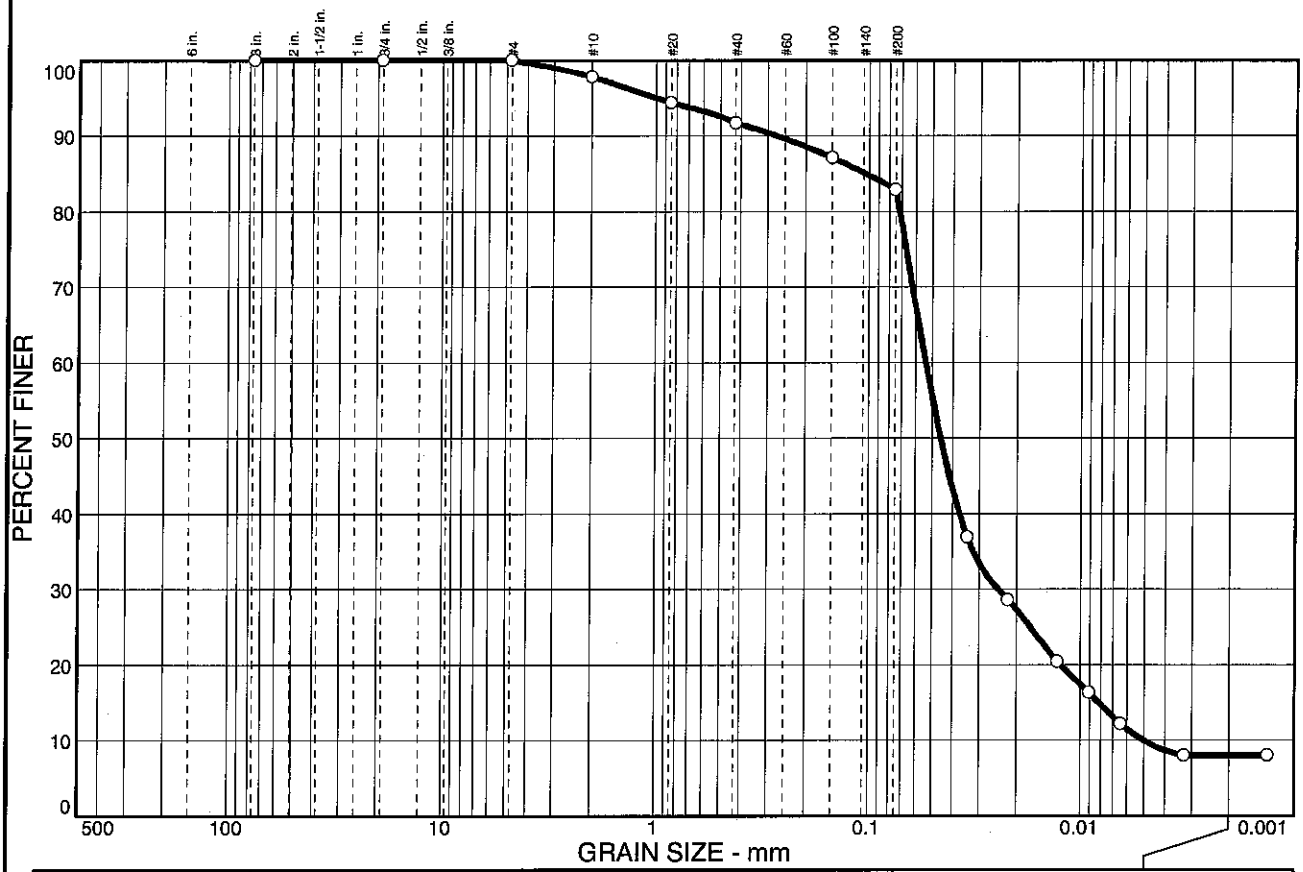
Remarks

As received moisture content = 208.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MC-0306 **Source of Sample:** 6/14 **Date:** 5/26/04
Location: T46MC **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	2.2	6.1	8.8	74.9	8.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	97.8		
#20	94.4		
#40	91.7		
#100	87.1		
#200	82.9		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.104 D_{60}= 0.0539 D_{50}= 0.0457
D_{30}= 0.0243 D_{15}= 0.0082 D_{10}= 0.0050
C_u= 10.70 C_c= 2.18

Classification

USCS= ML AASHTO= --

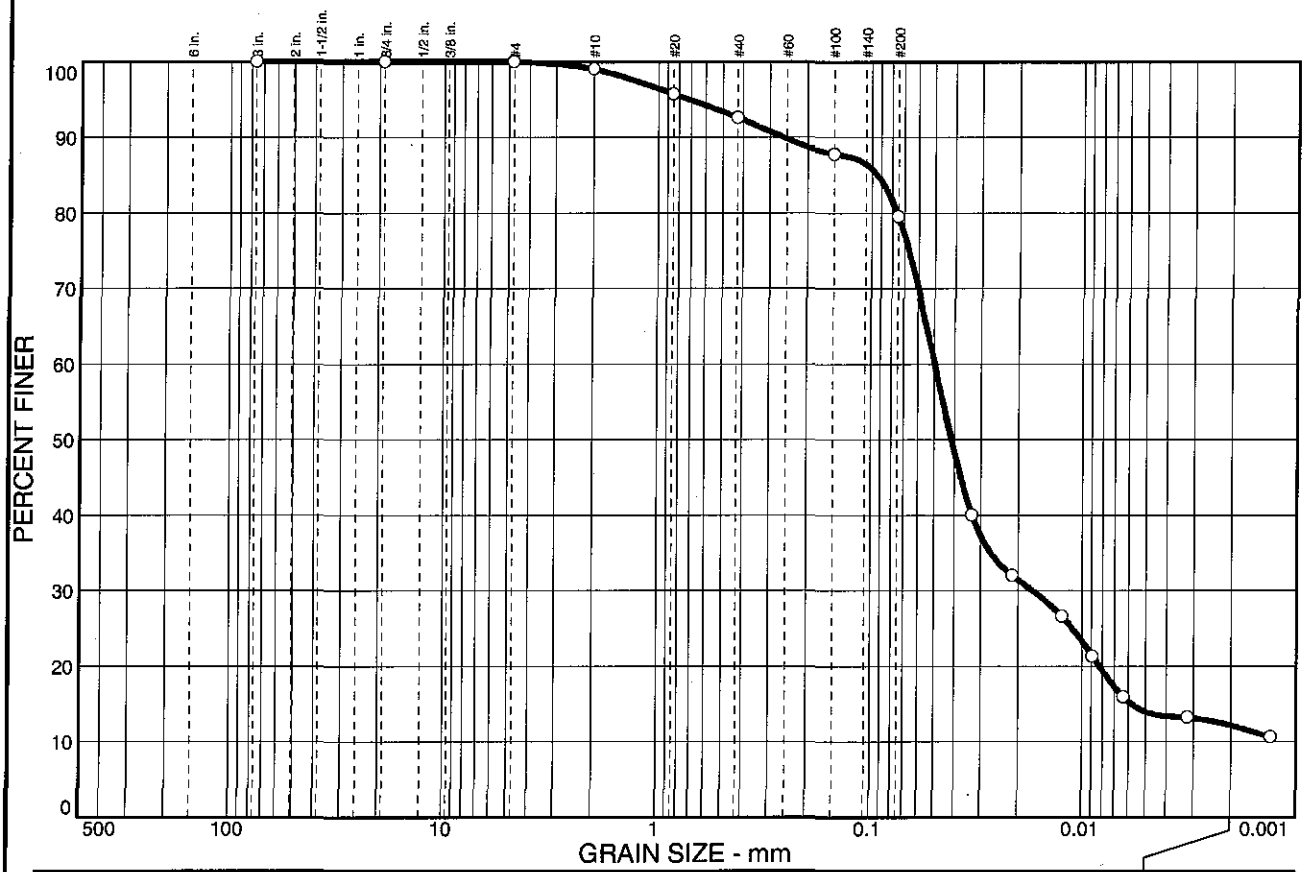
Remarks

As received moisture content = 408.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NC-0003 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NC **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	1.0	6.4	13.1	67.3	12.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.0		
#20	95.7		
#40	92.6		
#100	87.8		
#200	79.5		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0941 D_{60}= 0.0500 D_{50}= 0.0415
D_{30}= 0.0171 D_{15}= 0.0058 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 288.0%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-ND-0003 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35ND **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	2.4	4.2	3.0	3.7	67.0	19.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	97.6		
#10	93.4		
#20	92.3		
#40	90.4		
#100	87.3		
#200	86.7		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0722 D_{60}= 0.0391 D_{50}= 0.0274
D_{30}= 0.0040 D_{15}= 0.0013 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

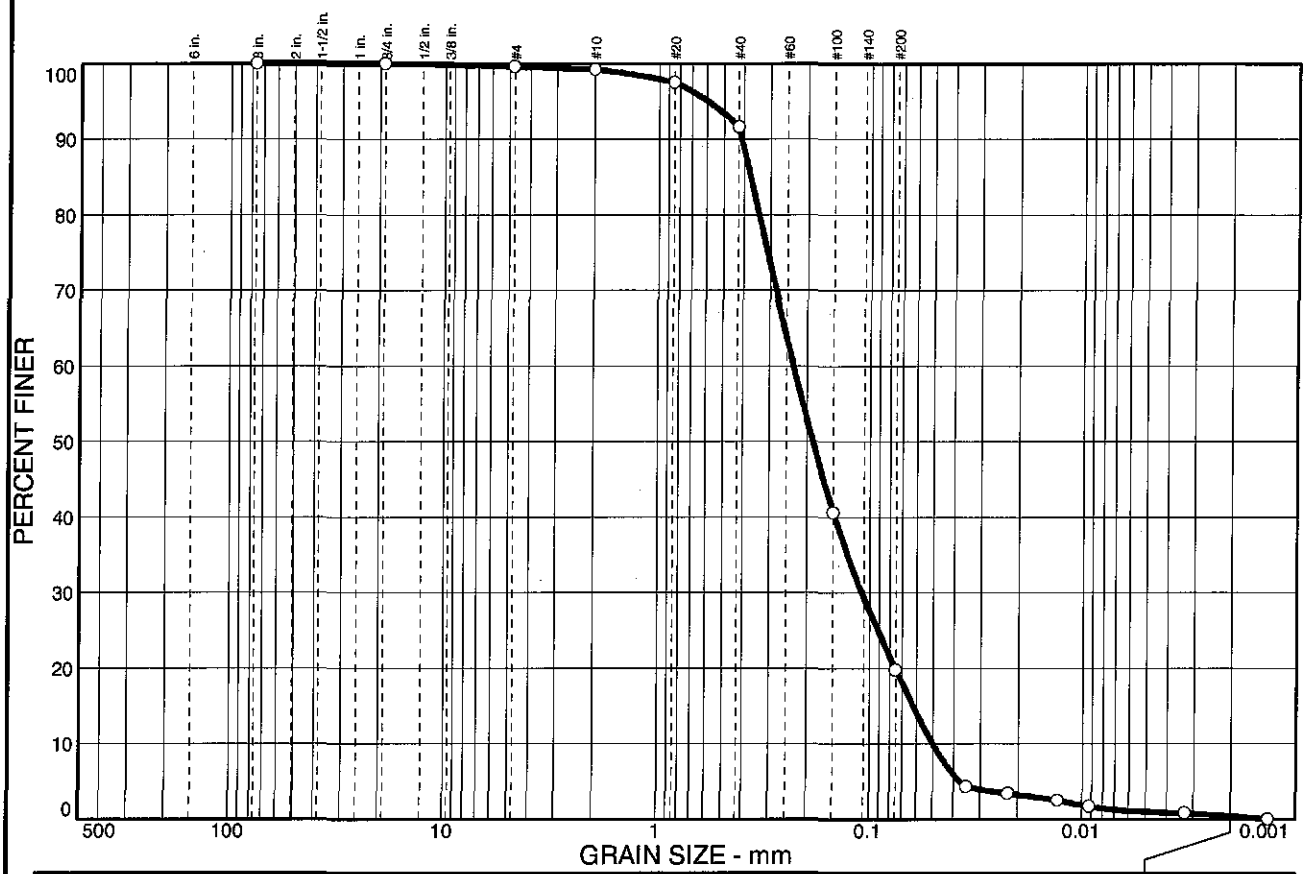
Remarks

As received moisture content = 73.6%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NE-1215 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NE **Elev./Depth:** 12-15

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	0.4	7.6	71.8	19.4	0.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.6		
#10	99.2		
#20	97.5		
#40	91.6		
#100	40.6		
#200	19.8		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.375 D_{60}= 0.232 D_{50}= 0.188
D_{30}= 0.109 D_{15}= 0.0623 D_{10}= 0.0504
C_u= 4.60 C_c= 1.02

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 34.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-DUP34 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: DUP34 **Elev./Depth:**

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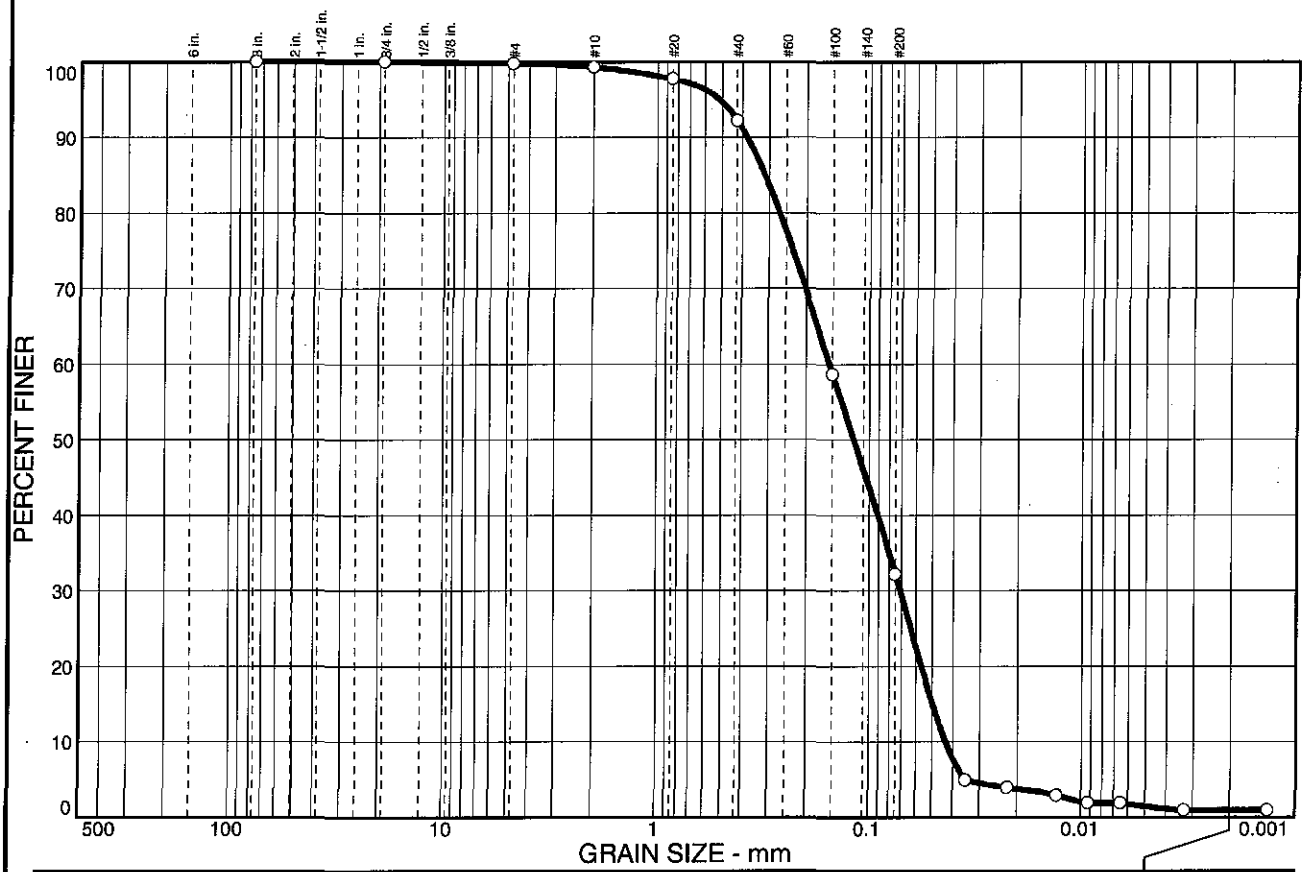
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.5	7.1	60.0	31.3	0.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.3		
#20	97.7		
#40	92.2		
#100	58.6		
#200	32.2		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.315 D_{60}= 0.156 D_{50}= 0.119
D_{30}= 0.0712 D_{15}= 0.0500 D_{10}= 0.0434
C_u= 3.59 C_c= 0.75

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 55.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-0003 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 00-03

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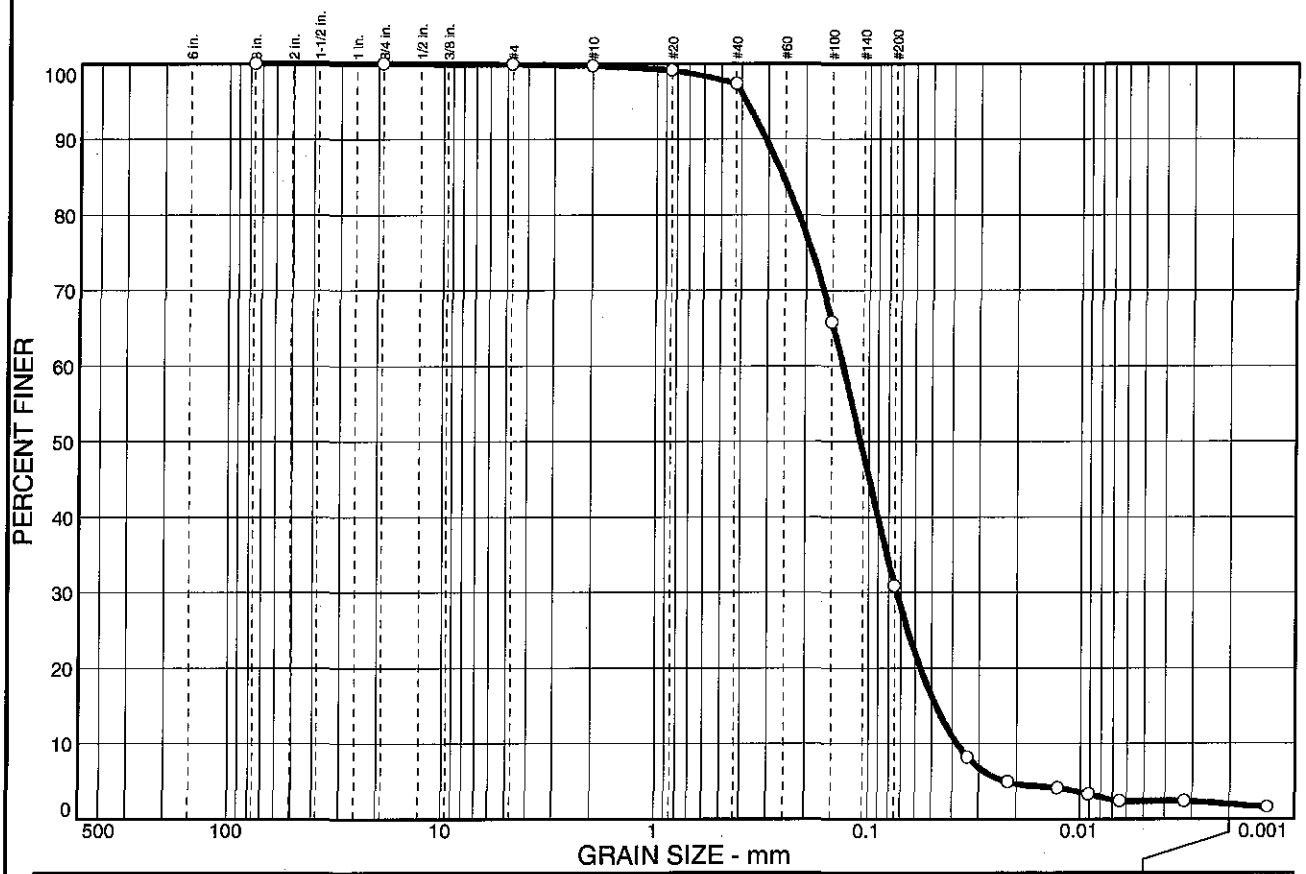
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.2	2.4	66.4	28.9	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.1		
#40	97.3		
#100	65.8		
#200	30.9		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.256 D_{60}= 0.133 D_{50}= 0.110
D_{30}= 0.0735 D_{15}= 0.0479 D_{10}= 0.0381
C_u= 3.48 C_c= 1.07

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 48.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-0306 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 03-06

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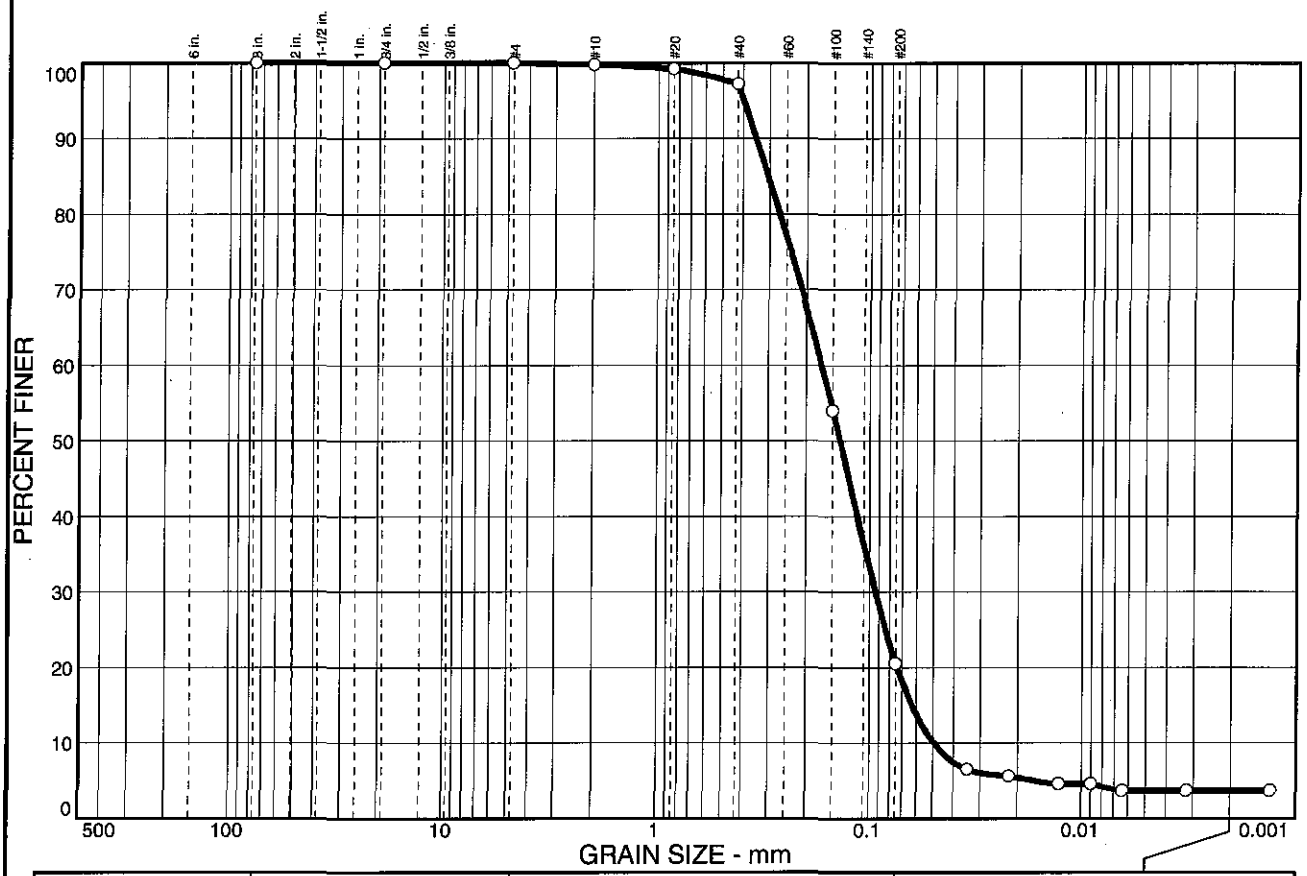
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	2.6	76.7	16.8	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	99.2		
#40	97.2		
#100	54.0		
#200	20.5		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.306 D_{60}= 0.170 D_{50}= 0.139
D_{30}= 0.0937 D_{15}= 0.0630 D_{10}= 0.0497
C_u= 3.41 C_c= 1.04

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 40.0%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-0612 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 06-12

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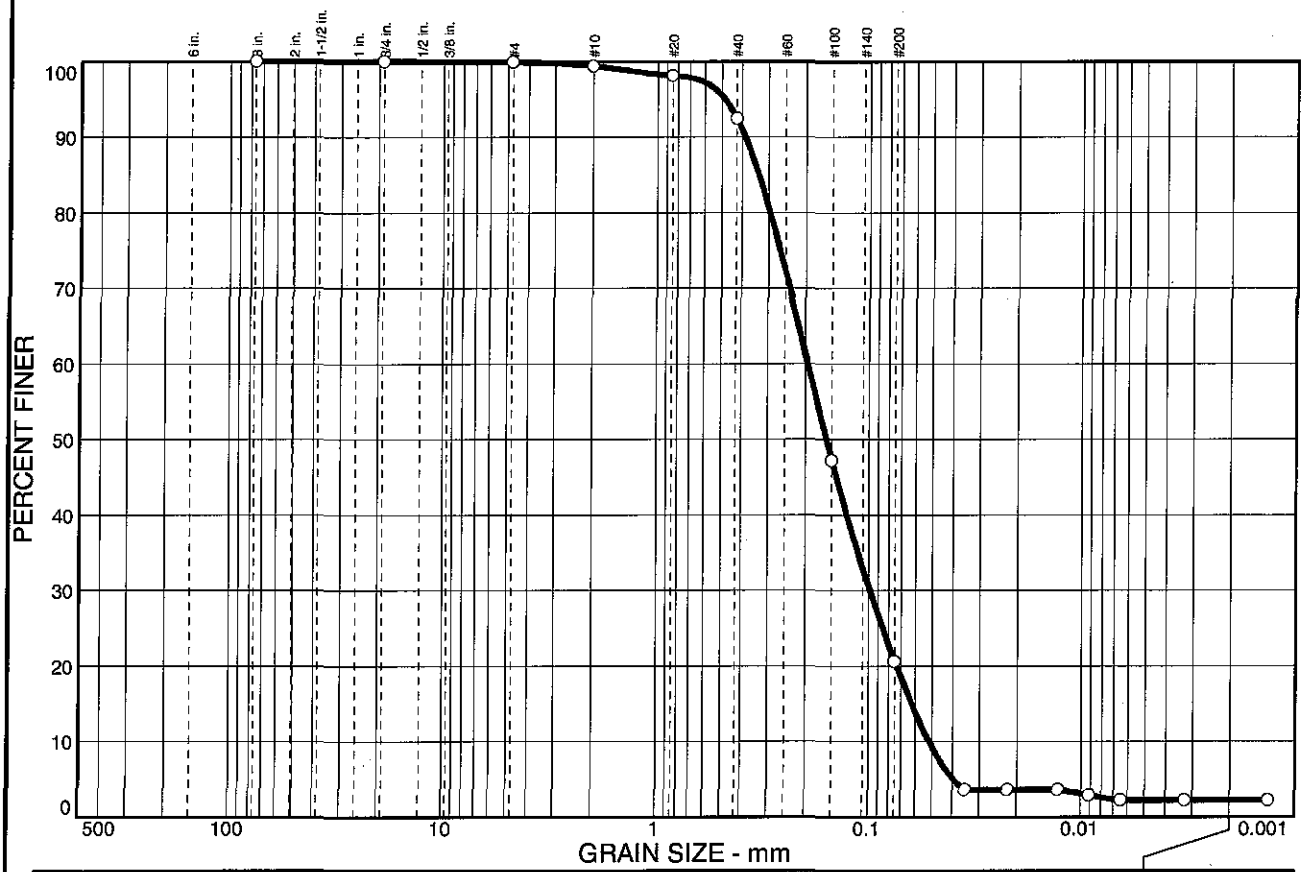
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.5	7.0	71.8	18.4	2.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.4		
#20	98.1		
#40	92.4		
#100	47.2		
#200	20.6		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.335 D_{60}= 0.195 D_{50}= 0.159
D_{30}= 0.0986 D_{15}= 0.0625 D_{10}= 0.0519
C_u= 3.76 C_c= 0.96

Classification

USCS= SM AASHTO= --

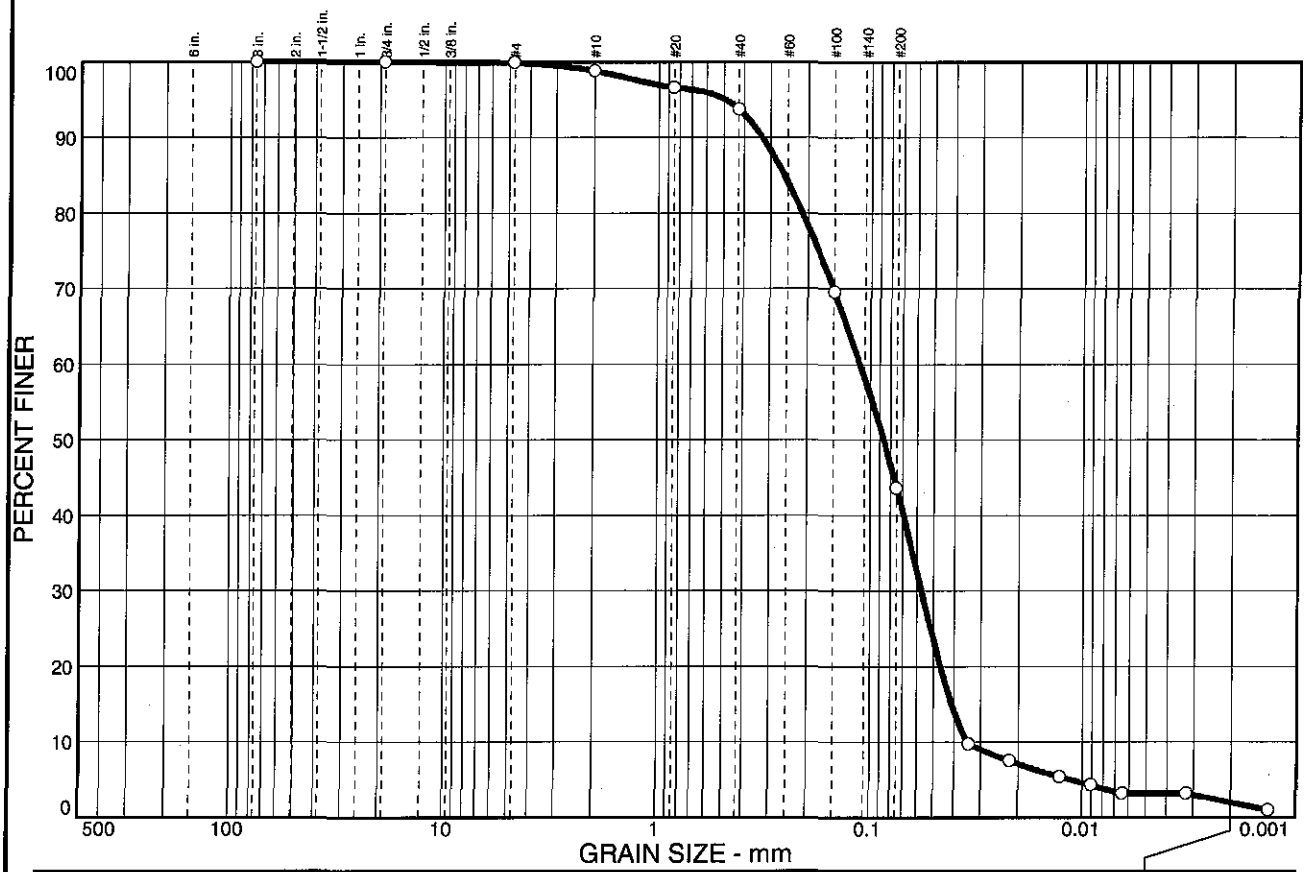
Remarks

As received moisture content = 35.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-1218 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	1.1	5.1	50.1	41.6	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	98.8		
#20	96.6		
#40	93.7		
#100	69.6		
#200	43.6		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.260 D_{60}= 0.112 D_{50}= 0.0865
D_{30}= 0.0572 D_{15}= 0.0412 D_{10}= 0.0347
C_u= 3.23 C_c= 0.84

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 74.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-1824 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 18-24

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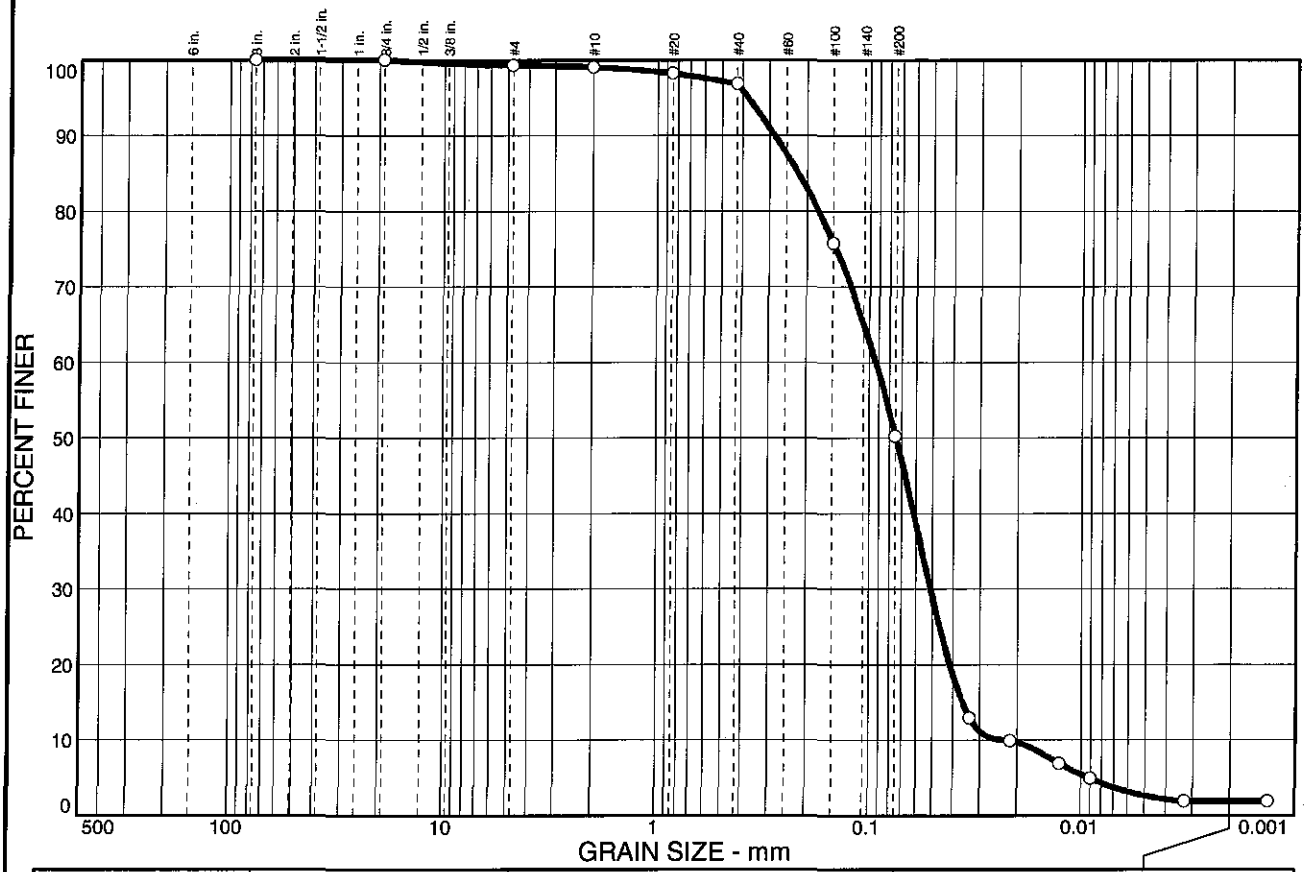
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.7	0.3	2.2	46.6	48.3	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.3		
#10	99.0		
#20	98.2		
#40	96.8		
#100	75.8		
#200	50.2		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.220 D_{60}= 0.0933 D_{50}= 0.0747
D_{30}= 0.0513 D_{15}= 0.0362 D_{10}= 0.0231
C_u= 4.05 C_c= 1.22

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 67.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-2430 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 24-30

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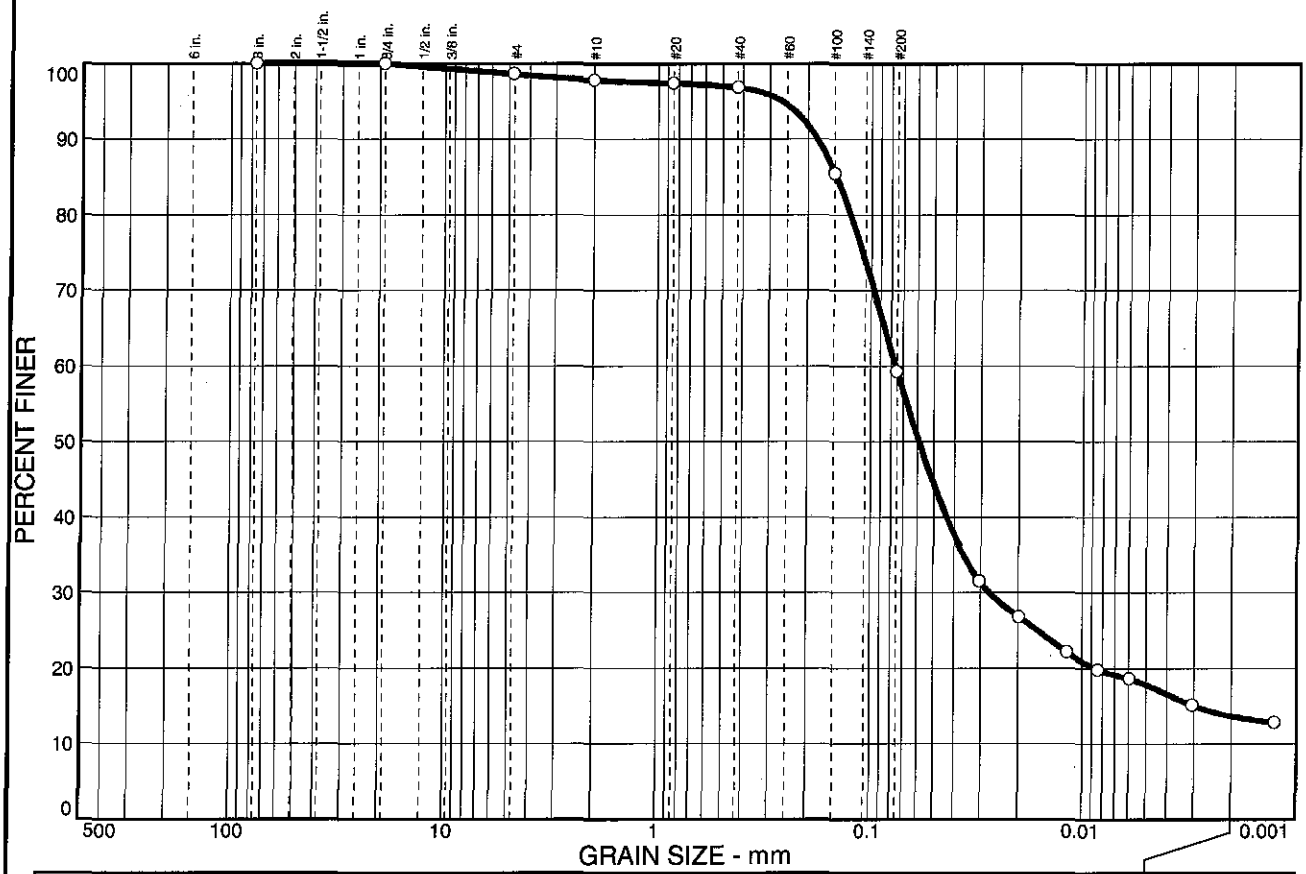
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.4	0.8	1.0	37.5	45.6	13.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.6		
#10	97.8		
#20	97.4		
#40	96.8		
#100	85.5		
#200	59.3		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.147 D_{60}= 0.0763 D_{50}= 0.0590
D_{30}= 0.0274 D_{15}= 0.0030 D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 77.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-3036 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 30-36

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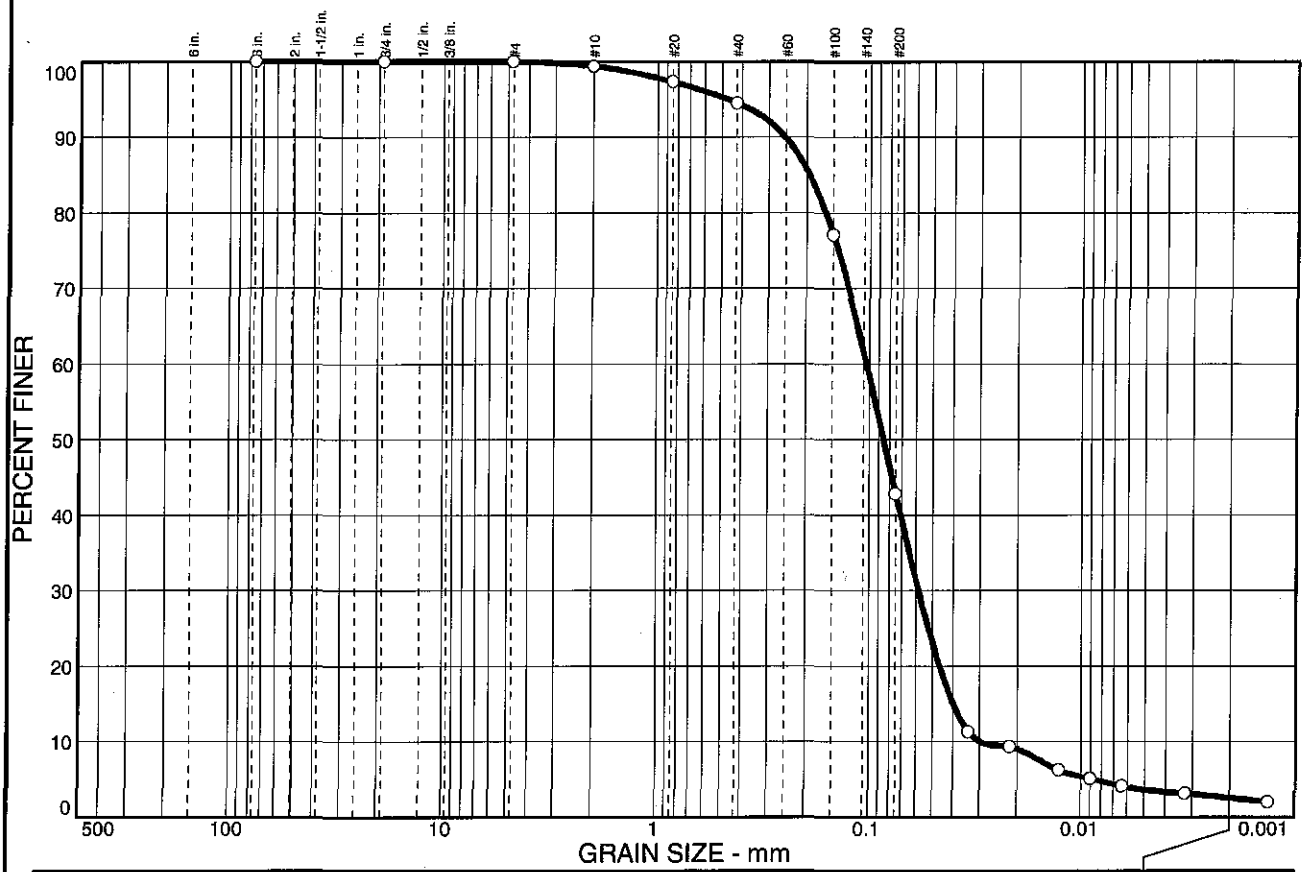
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.6	4.9	51.7	40.3	2.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.4		
#20	97.3		
#40	94.5		
#100	77.1		
#200	42.8		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.194 D_{60}= 0.103 D_{50}= 0.0857
D_{30}= 0.0585 D_{15}= 0.0400 D_{10}= 0.0298
C_u= 3.46 C_c= 1.11

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 71.3%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NB-3642 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NB **Elev./Depth:** 36-42

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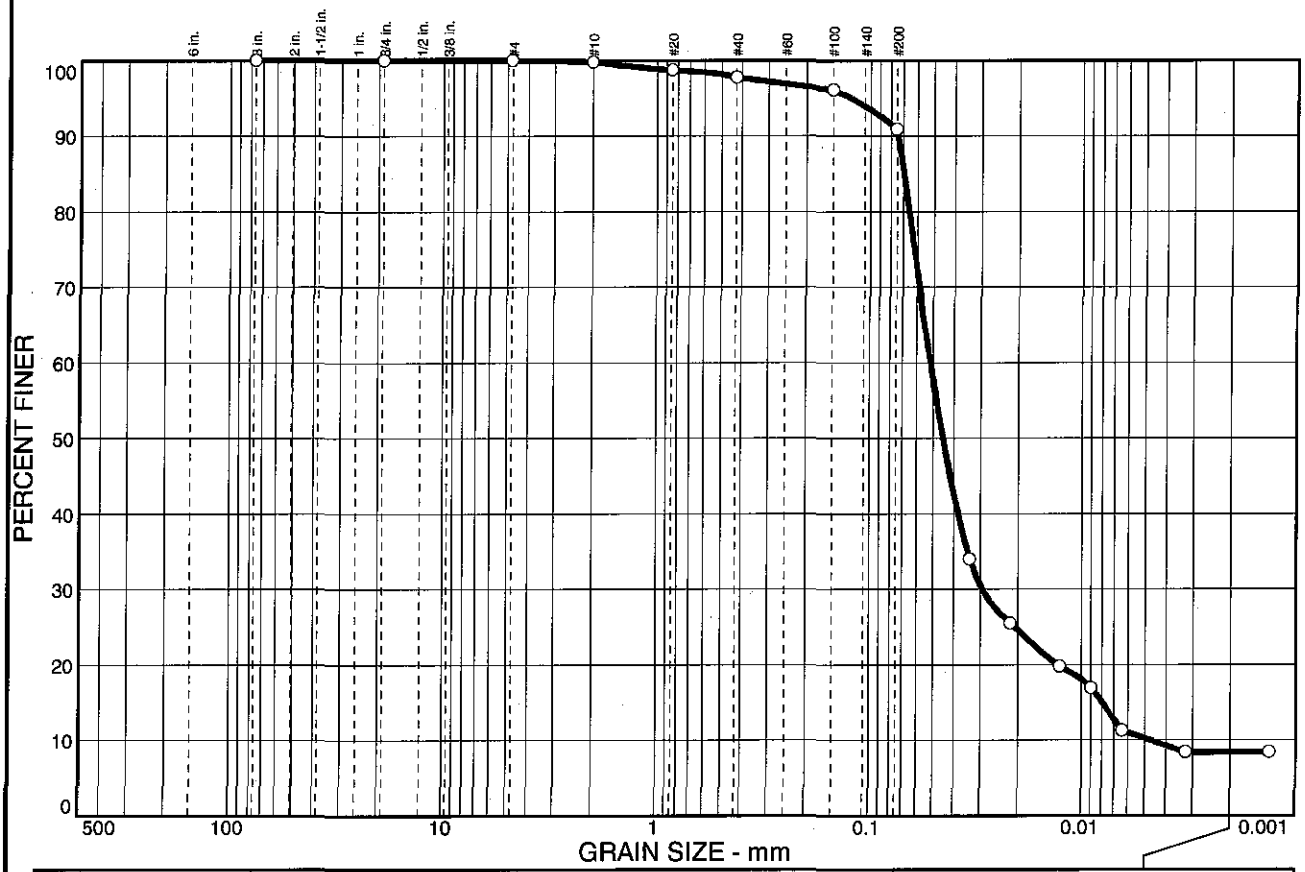
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	2.1	6.8	82.5	8.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	98.7		
#40	97.7		
#100	96.1		
#200	90.9		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0700 D_{60}= 0.0518 D_{50}= 0.0452
D_{30}= 0.0294 D_{15}= 0.0080 D_{10}= 0.0047
C_u= 10.98 C_c= 3.53

Classification

USCS= ML AASHTO= --

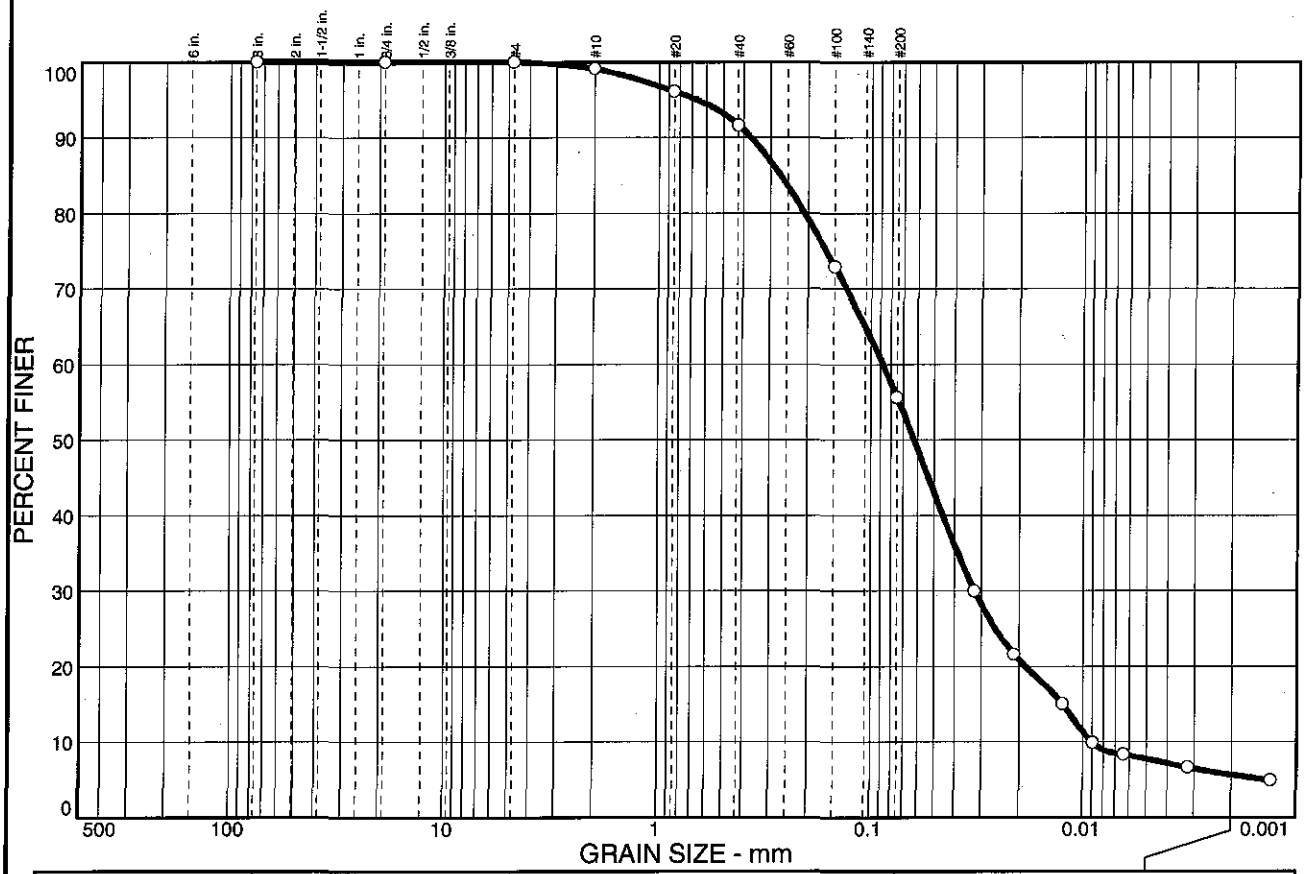
Remarks

As received moisture content = 278.8%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NC-0306 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NC **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.9	7.5	36.0	50.0	5.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.1		
#20	96.1		
#40	91.6		
#100	72.9		
#200	55.6		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.271 D_{60}= 0.0877 D_{50}= 0.0625
D_{30}= 0.0323 D_{15}= 0.0125 D_{10}= 0.0091
C_u= 9.68 C_c= 1.31

Classification

USCS= ML AASHTO= --

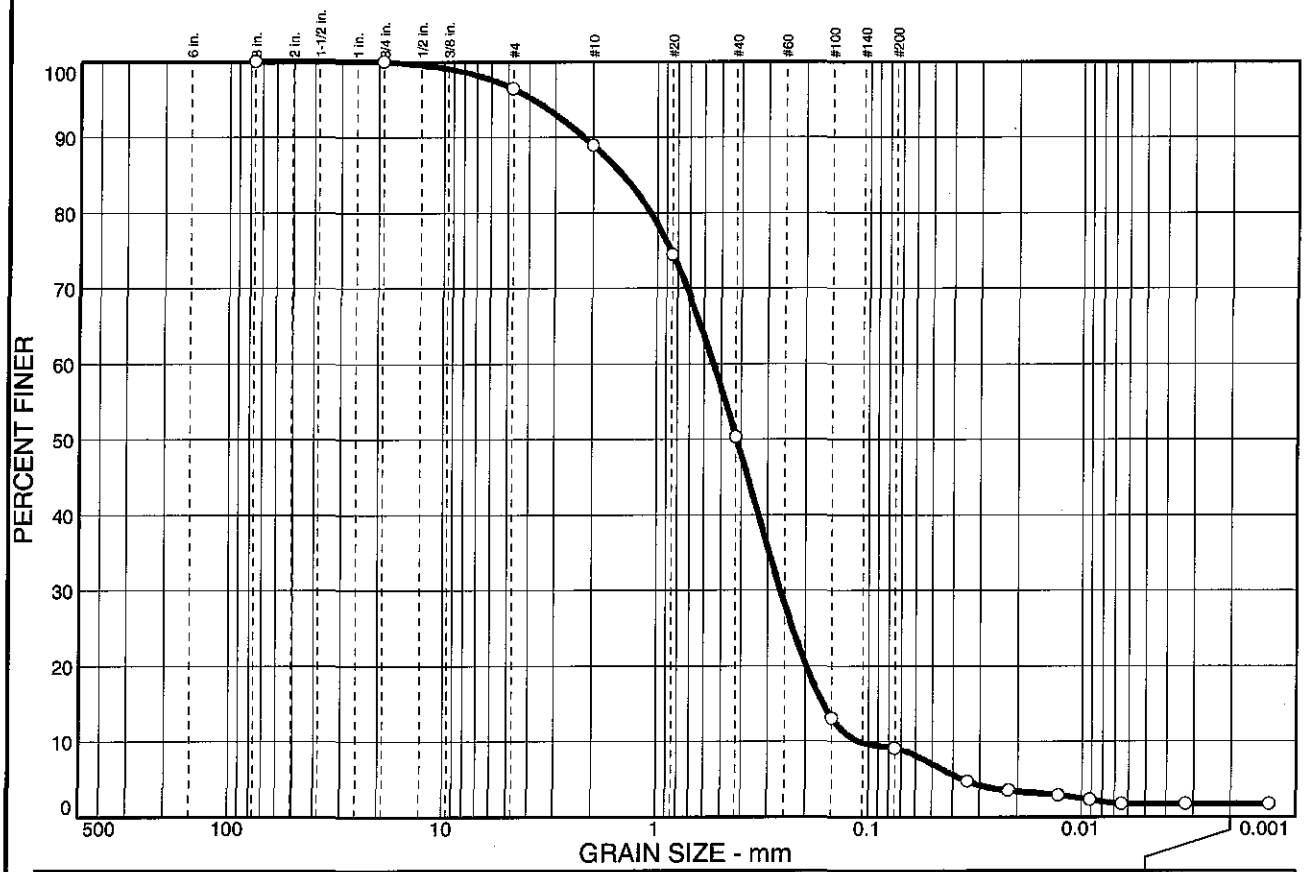
Remarks

As received moisture content = 162.7%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NC-0612 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NC **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	3.6	7.5	38.6	41.2	7.4	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	96.4		
#10	88.9		
#20	74.5		
#40	50.3		
#100	13.1		
#200	9.1		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 1.46 D_{60}= 0.543 D_{50}= 0.422
D_{30}= 0.262 D_{15}= 0.165 D_{10}= 0.111
C_u= 4.91 C_c= 1.14

Classification

USCS= SP-SM AASHTO= --

Remarks

As received moisture content = 23.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NC-1216 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NC **Elev./Depth:** 12-16

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PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	22.6	0.6	3.6	6.4	59.1	7.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	77.4		
#10	76.8		
#20	75.1		
#40	73.2		
#100	69.9		
#200	66.8		

* (no specification provided)

Soil Description

Gravelly silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 8.97 D_{60}= 0.0638 D_{50}= 0.0502
D_{30}= 0.0290 D_{15}= 0.0087 D_{10}= 0.0053
C_u= 12.10 C_c= 2.49

Classification

USCS= ML AASHTO= --

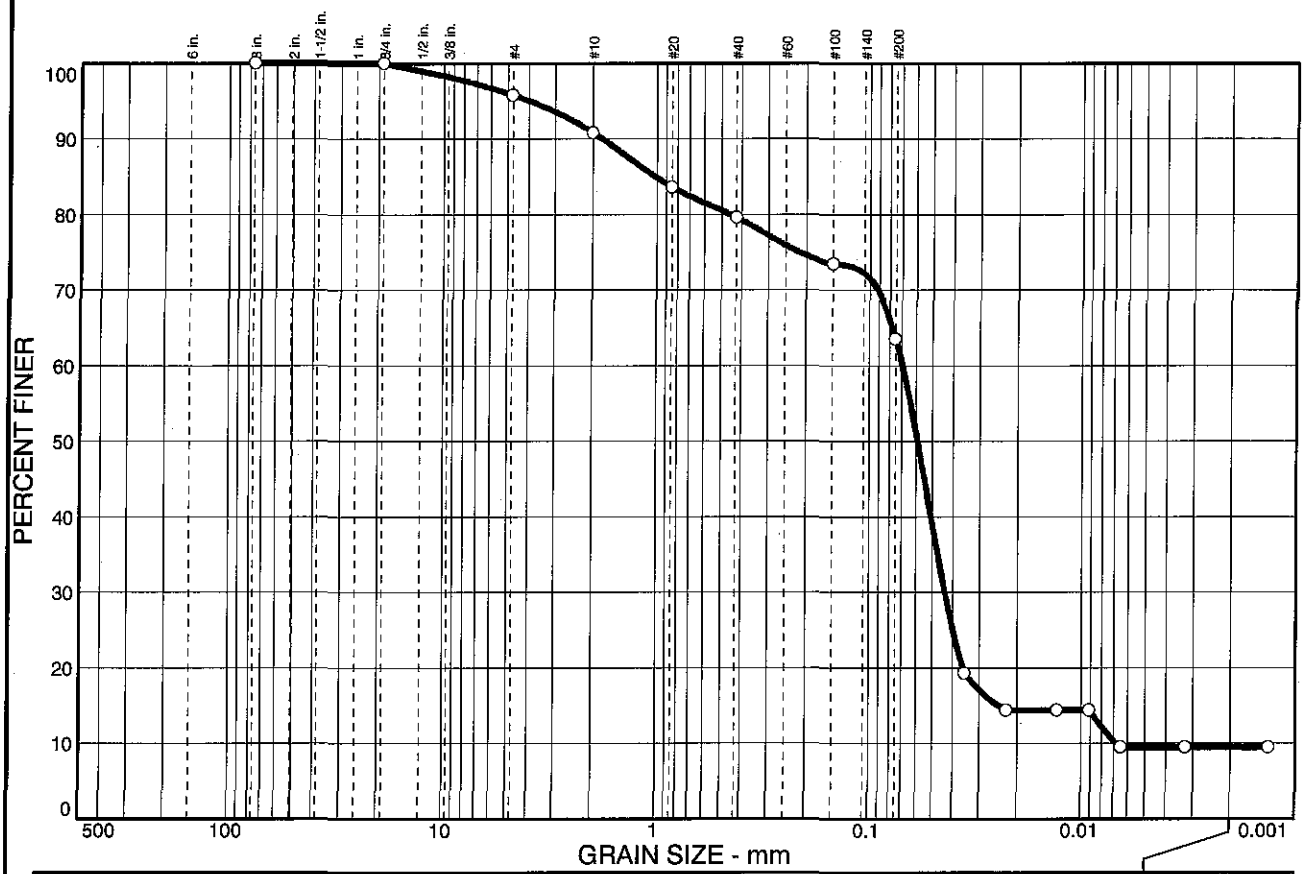
Remarks

As received moisture content = 201.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-ND-0304 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35ND **Elev./Depth:** 03-04

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	4.2	5.0	11.2	16.1	54.0	9.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	95.8		
#10	90.8		
#20	83.6		
#40	79.6		
#100	73.5		
#200	63.5		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 1.02 D_{60}= 0.0698 D_{50}= 0.0592
D_{30}= 0.0437 D_{15}= 0.0244 D_{10}= 0.0068
C_u= 10.24 C_c= 4.02

Classification

USCS= ML AASHTO= --

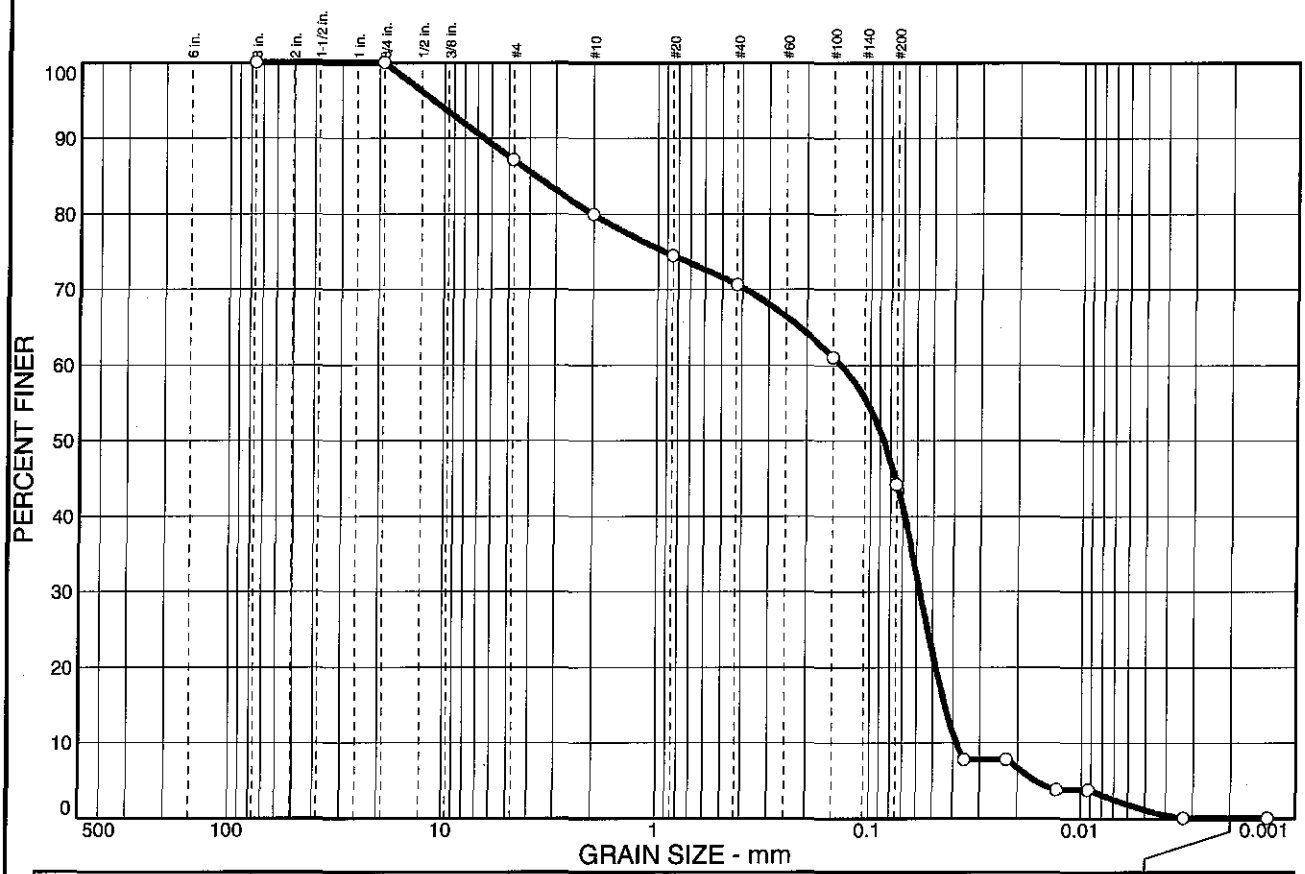
Remarks

As received moisture content = 348.3%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NE-0003 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NE **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	12.9	7.2	9.3	26.4	44.2	0.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	87.1		
#10	79.9		
#20	74.5		
#40	70.6		
#100	61.0		
#200	44.2		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 3.75 D_{60}= 0.138 D_{50}= 0.0867
D_{30}= 0.0578 D_{15}= 0.0439 D_{10}= 0.0387
C_u= 3.58 C_c= 0.62

Classification

USCS= SM AASHTO= --

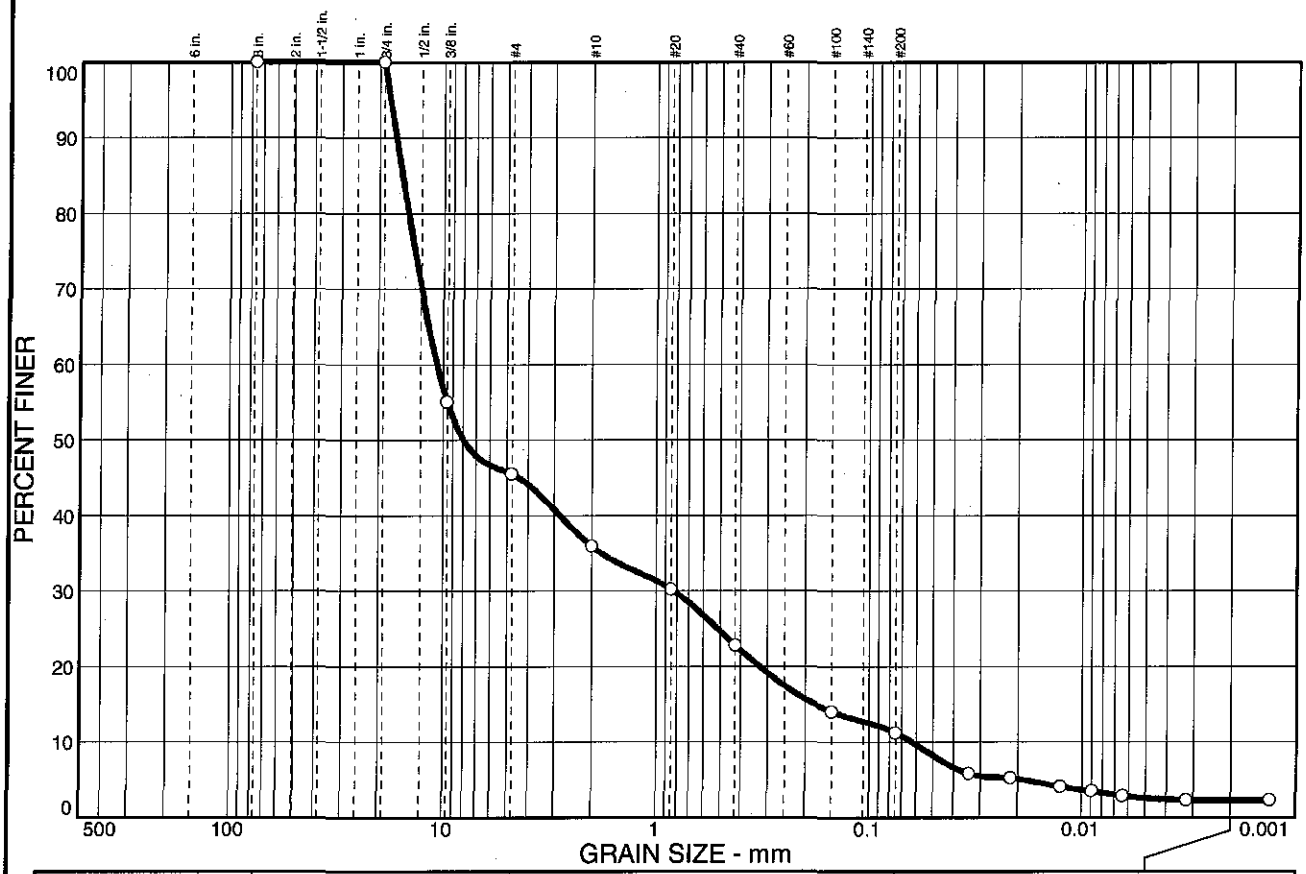
Remarks

As received moisture content = 190.6%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NE-0306 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NE **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	54.5	9.6	13.1	11.6	8.9	2.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
3/8 in.	55.0		
#4	45.5		
#10	35.9		
#20	30.2		
#40	22.8		
#100	14.0		
#200	11.2		

* (no specification provided)

Soil Description

Well-graded gravel with silt and sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 15.7 D_{60}= 10.7 D_{50}= 8.00
D_{30}= 0.829 D_{15}= 0.180 D_{10}= 0.0629
C_u= 169.52 C_c= 1.02

Classification

USCS= GW-GM AASHTO= --

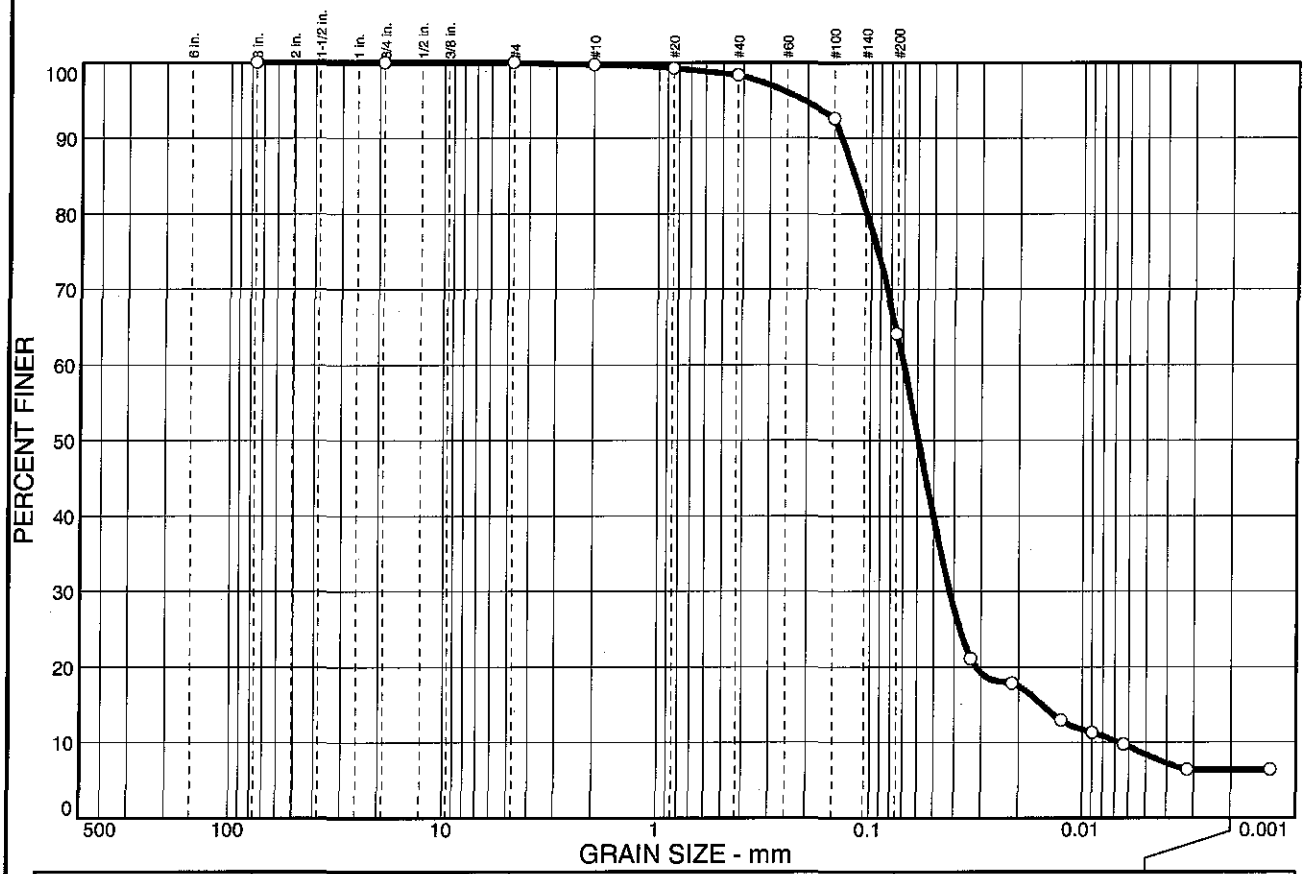
Remarks

As received moisture content = 28.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NE-0612 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NE **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.3	1.4	34.2	57.7	6.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.7		
#20	99.2		
#40	98.3		
#100	92.6		
#200	64.1		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.120 D_{60}= 0.0698 D_{50}= 0.0593
D_{30}= 0.0422 D_{15}= 0.0155 D_{10}= 0.0067
C_u= 10.39 C_c= 3.79

Classification

USCS= ML AASHTO= --

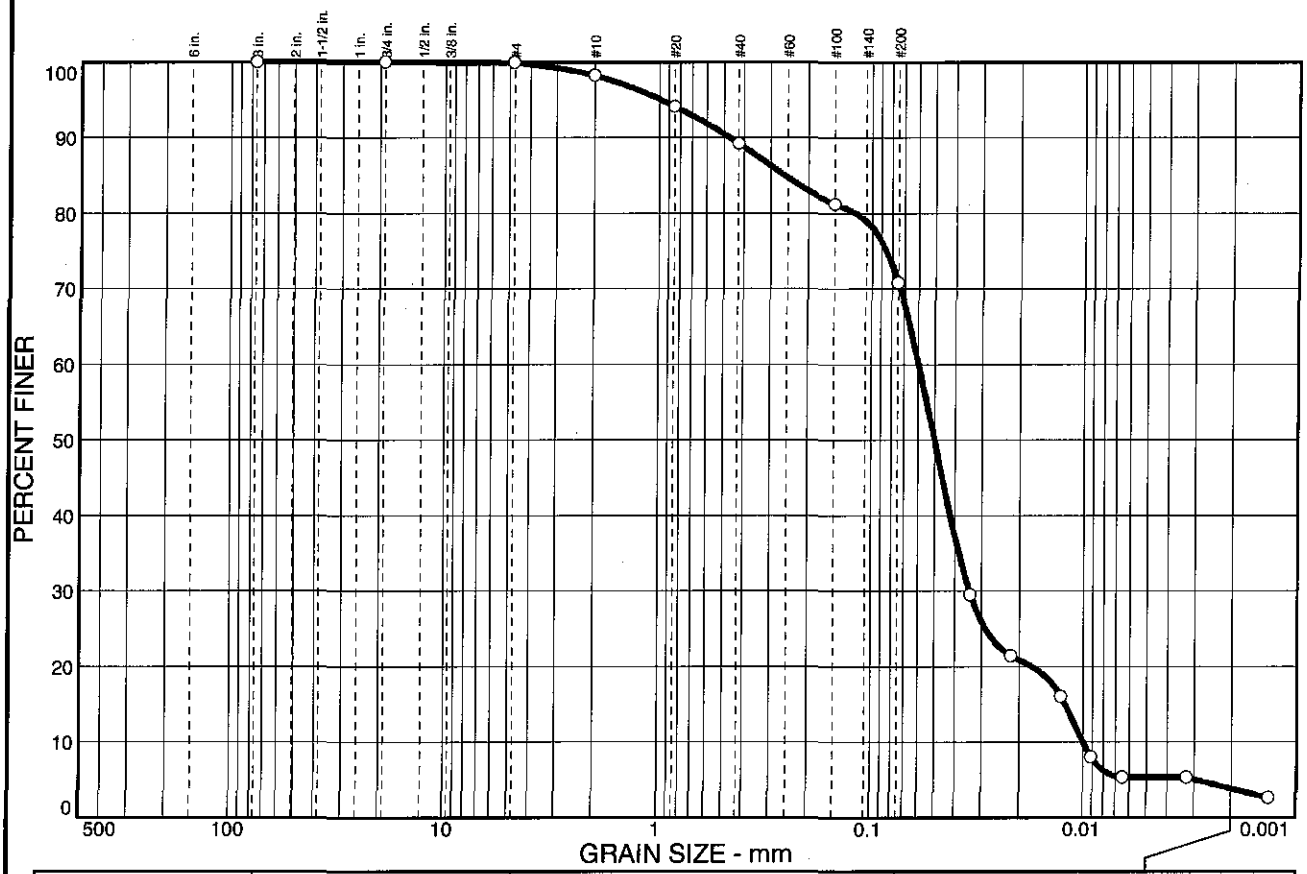
Remarks

As received moisture content = 160.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NG-0003 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NG **Elev./Depth:** 00-03

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	1.7	9.0	18.4	67.0	3.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	98.2		
#20	94.1		
#40	89.2		
#100	81.2		
#200	70.8		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.259 D_{60}= 0.0599 D_{50}= 0.0504
D_{30}= 0.0342 D_{15}= 0.0122 D_{10}= 0.0100
C_u= 5.98 C_c= 1.96

Classification

USCS= ML AASHTO= --

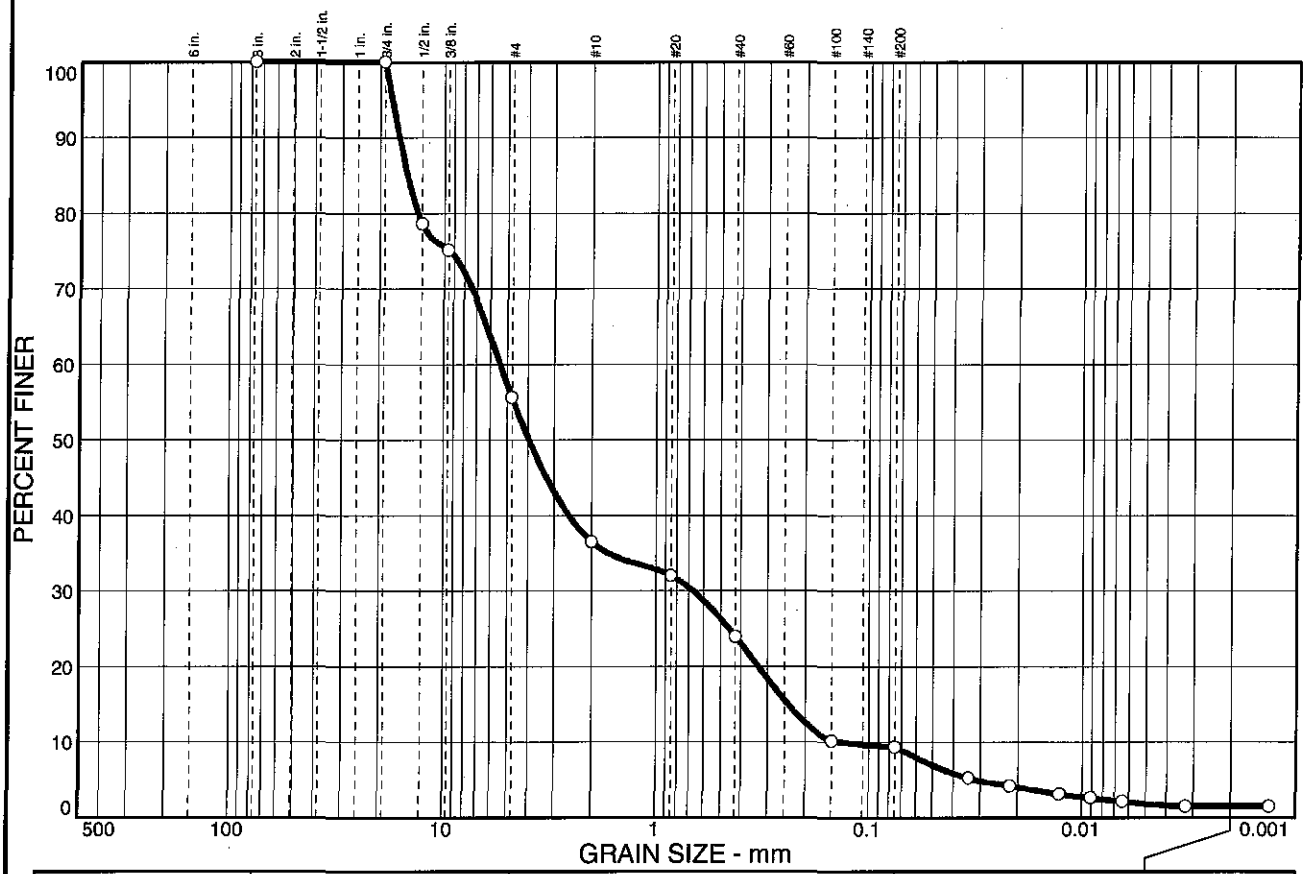
Remarks

As received moisture content = 239.1%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NG-0306 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NG **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	44.4	19.1	12.6	14.6	7.8	1.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
1/2 in.	78.6		
3/8 in.	75.1		
#4	55.6		
#10	36.5		
#20	32.0		
#40	23.9		
#100	10.1		
#200	9.3		

* (no specification provided)

Soil Description

Poorly graded sand with silt and gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 14.9 D_{60}= 5.41 D_{50}= 3.95
D_{30}= 0.673 D_{15}= 0.241 D_{10}= 0.138
C_u= 39.35 C_c= 0.61

Classification

USCS= SP-SM AASHTO= --

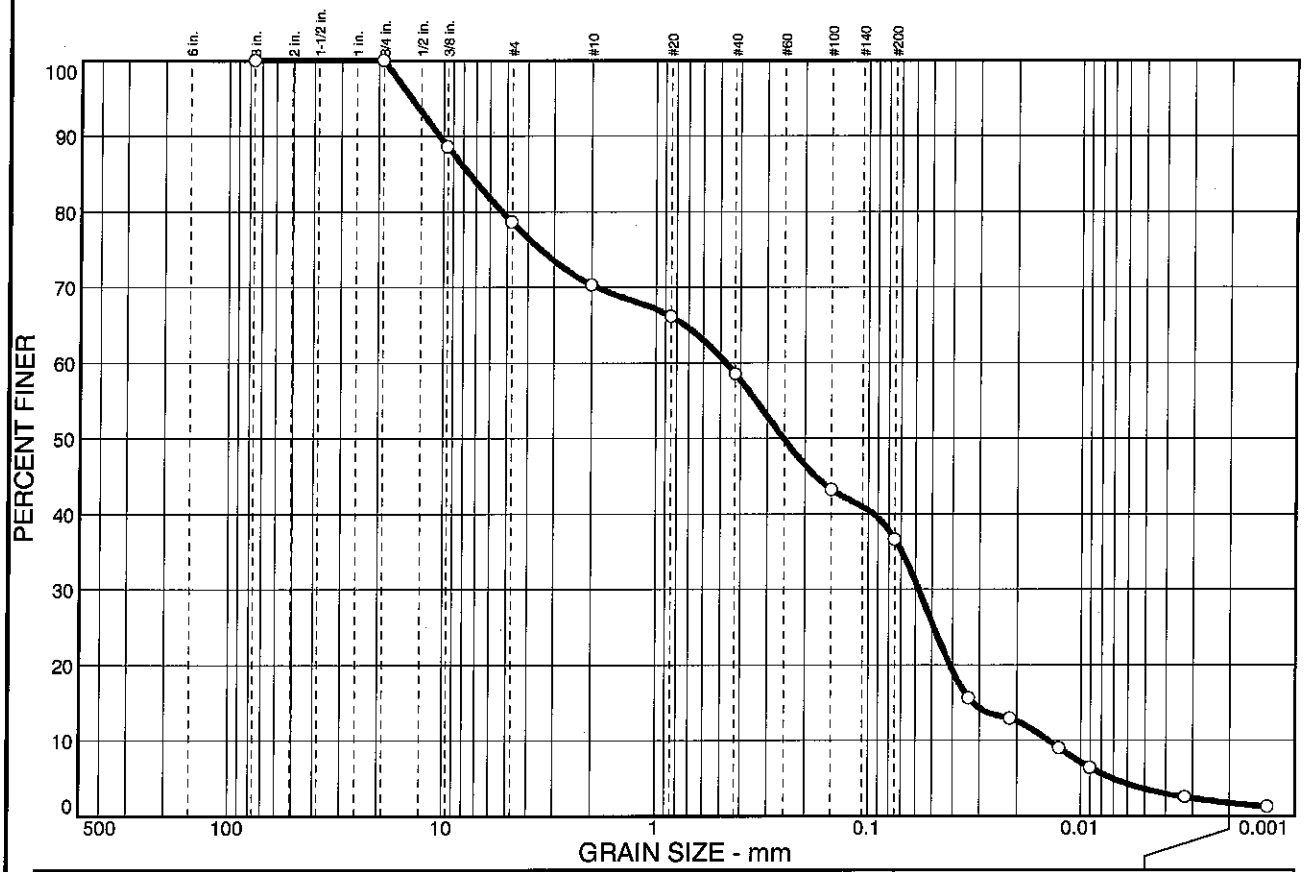
Remarks

As received moisture content = 19.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NG-0612 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NG **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	21.4	8.3	11.8	21.9	34.9	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
3/8 in.	88.6		
#4	78.6		
#10	70.3		
#20	66.1		
#40	58.5		
#100	43.2		
#200	36.6		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 7.53 D_{60}= 0.472 D_{50}= 0.253
D_{30}= 0.0580 D_{15}= 0.0321 D_{10}= 0.0142
C_u= 33.29 C_c= 0.50

Classification

USCS= SM AASHTO= --

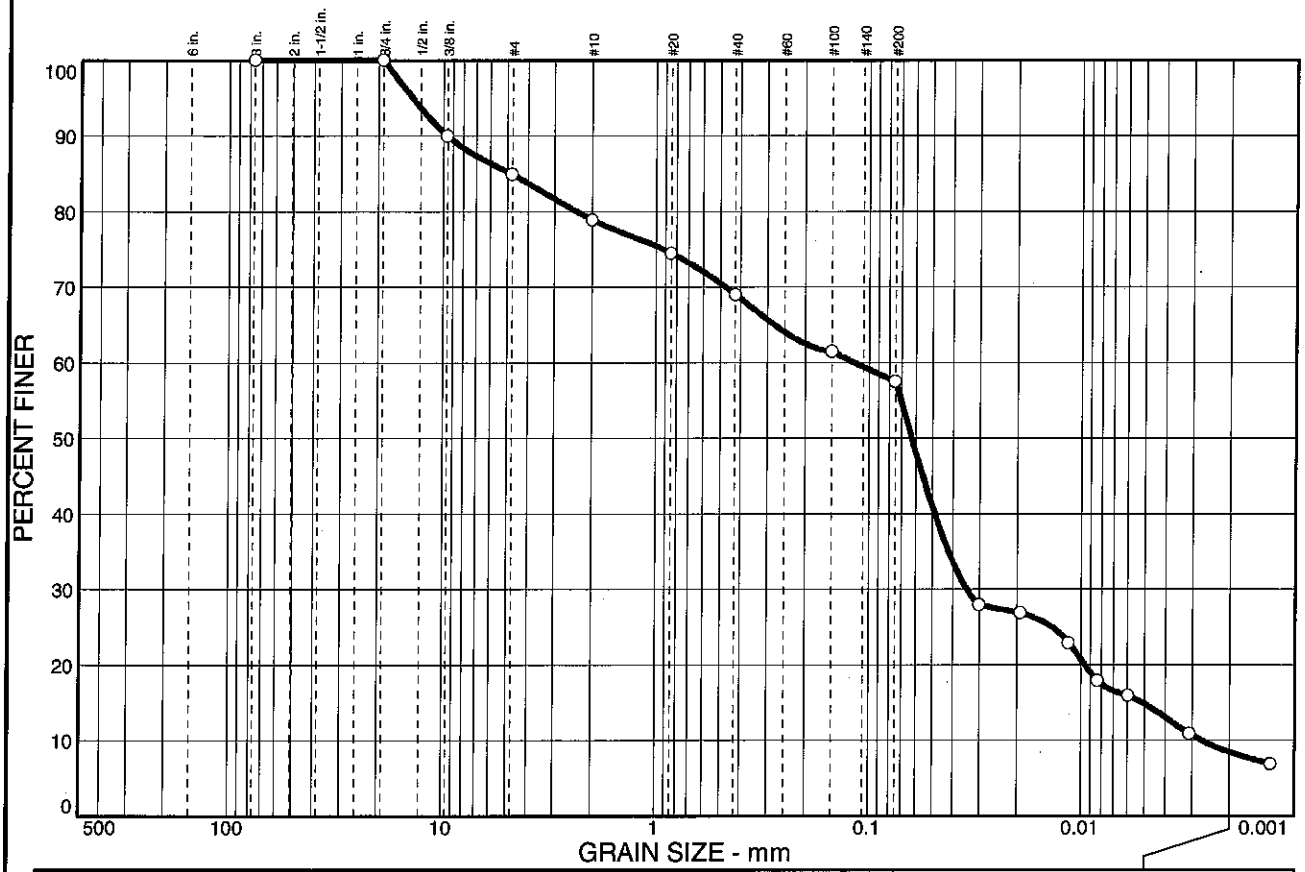
Remarks

As received moisture content = 116.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NG-1218 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NG **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	15.1	6.0	9.9	11.5	49.0	8.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
3/8 in.	90.0		
#4	84.9		
#10	78.9		
#20	74.5		
#40	69.0		
#100	61.5		
#200	57.5		

* (no specification provided)

Soil Description

Sandy silt with gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 4.82 D_{60}= 0.117 D_{50}= 0.0630
D_{30}= 0.0345 D_{15}= 0.0051 D_{10}= 0.0027
C_u= 43.49 C_c= 3.75

Classification

USCS= ML AASHTO= --

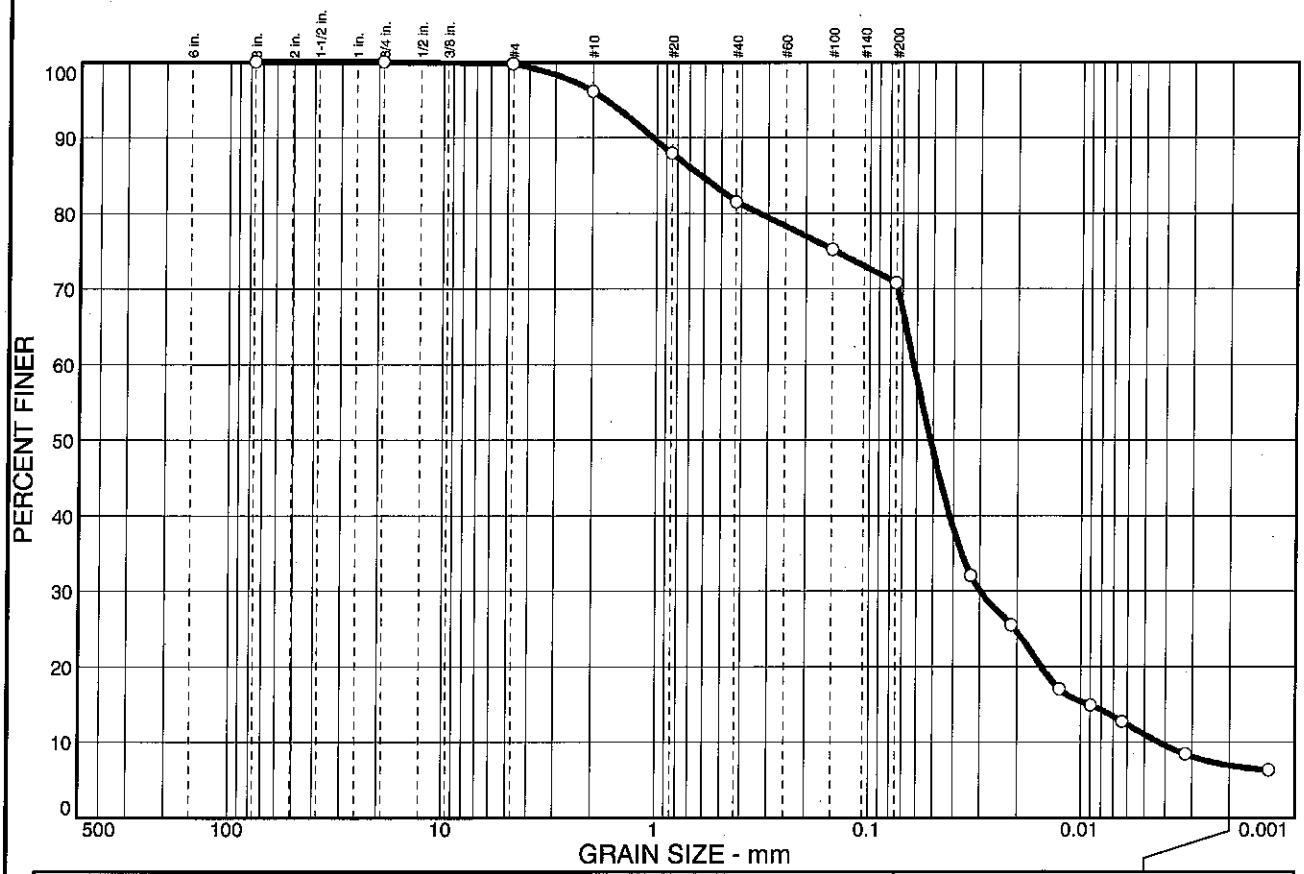
Remarks

As received moisture content = 47.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T35-NG-1822 **Source of Sample:** 7/12 **Date:** 6/1/04
Location: T35NG **Elev./Depth:** 18-22

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	3.7	14.6	10.7	63.9	6.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	96.1		
#20	87.9		
#40	81.5		
#100	75.2		
#200	70.8		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.624 D_{60}= 0.0622 D_{50}= 0.0518
D_{30}= 0.0299 D_{15}= 0.0091 D_{10}= 0.0043
C_u= 14.50 C_c= 3.35

Classification

USCS= ML AASHTO= --

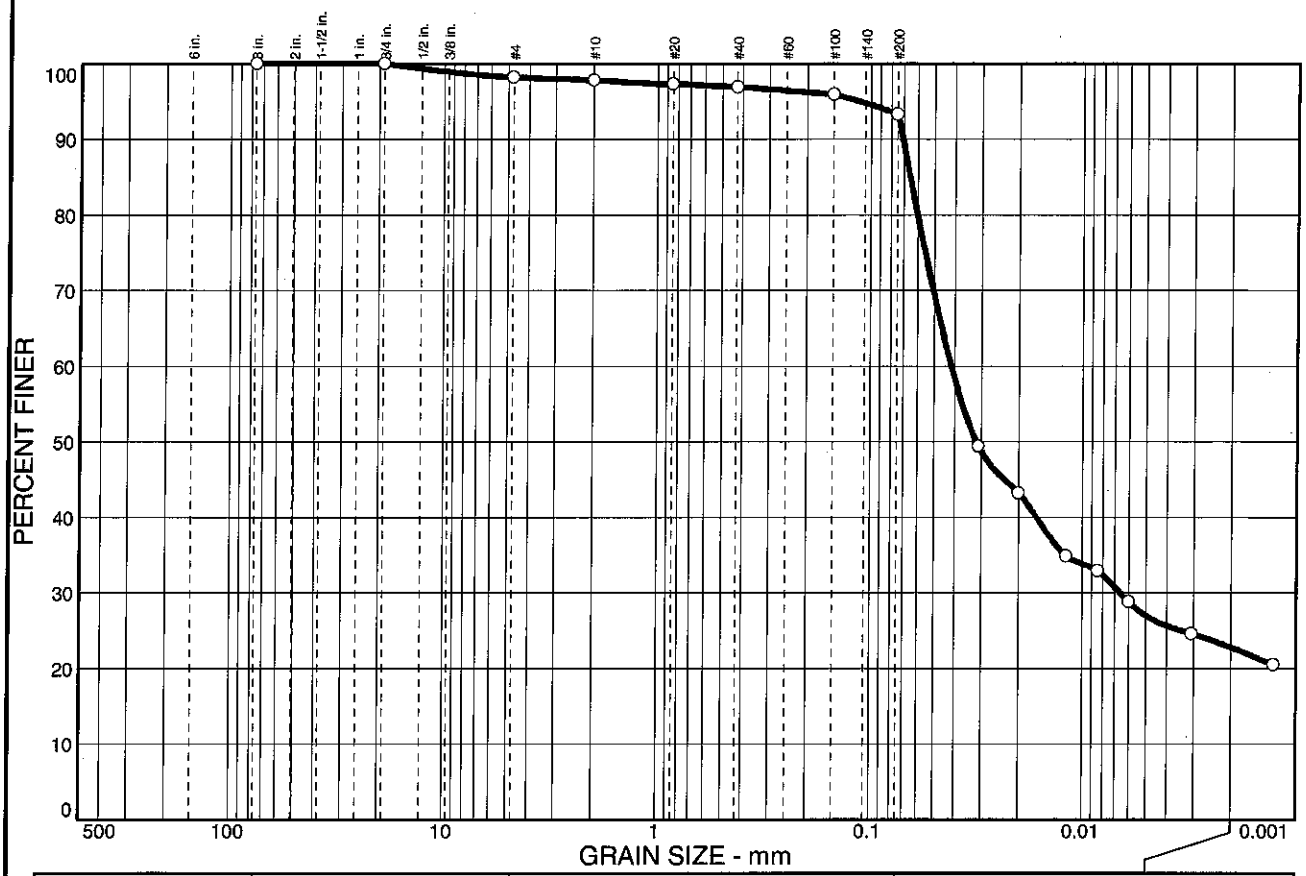
Remarks

As received moisture content = 196.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-2430 **Source of Sample:** 7/12 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 24-30

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.8	0.4	0.9	3.6	70.5	22.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.2		
#10	97.8		
#20	97.3		
#40	96.9		
#100	95.9		
#200	93.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0656 D_{60}= 0.0417 D_{50}= 0.0317
D_{30}= 0.0066 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 180.7%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T46-MG-5460 **Source of Sample:** 7/12 **Date:** 5/26/04
Location: T46MG **Elev./Depth:** 54-60

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT

% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	1.9	7.9	80.8	9.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	99.0		
#40	97.9		
#100	93.5		
#200	90.0		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0705 D_{60}= 0.0506 D_{50}= 0.0432
D_{30}= 0.0153 D_{15}= 0.0049 D_{10}= 0.0026
C_u= 19.42 C_c= 1.79

Classification

USCS= ML AASHTO= --

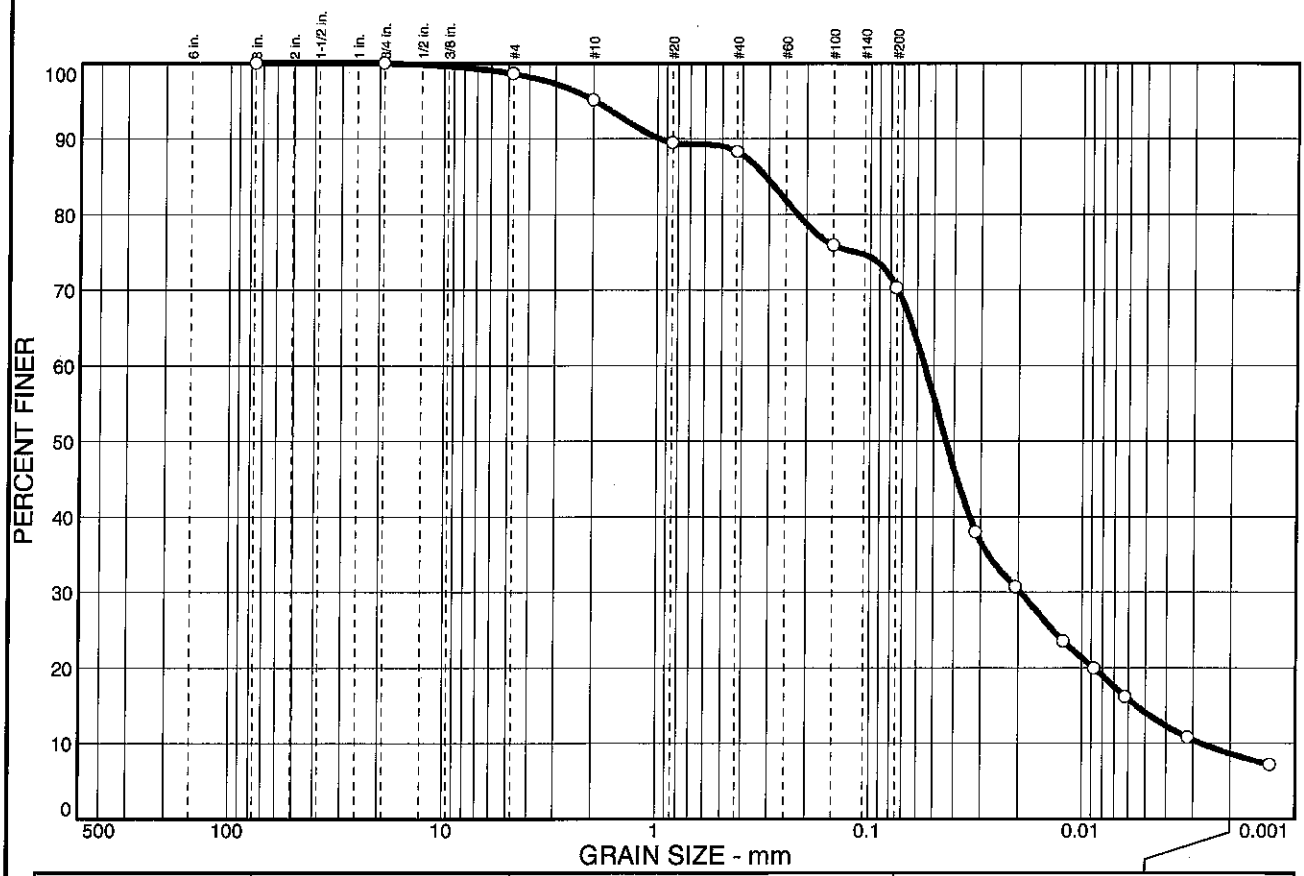
Remarks

As received moisture content = 174.9%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NC-1218 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NC **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.4	3.5	6.8	18.0	61.7	8.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.6		
#10	95.1		
#20	89.5		
#40	88.3		
#100	75.9		
#200	70.3		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.312 D_{60}= 0.0554 D_{50}= 0.0439
D_{30}= 0.0195 D_{15}= 0.0055 D_{10}= 0.0027
C_u= 20.27 C_c= 2.51

Classification

USCS= ML AASHTO= --

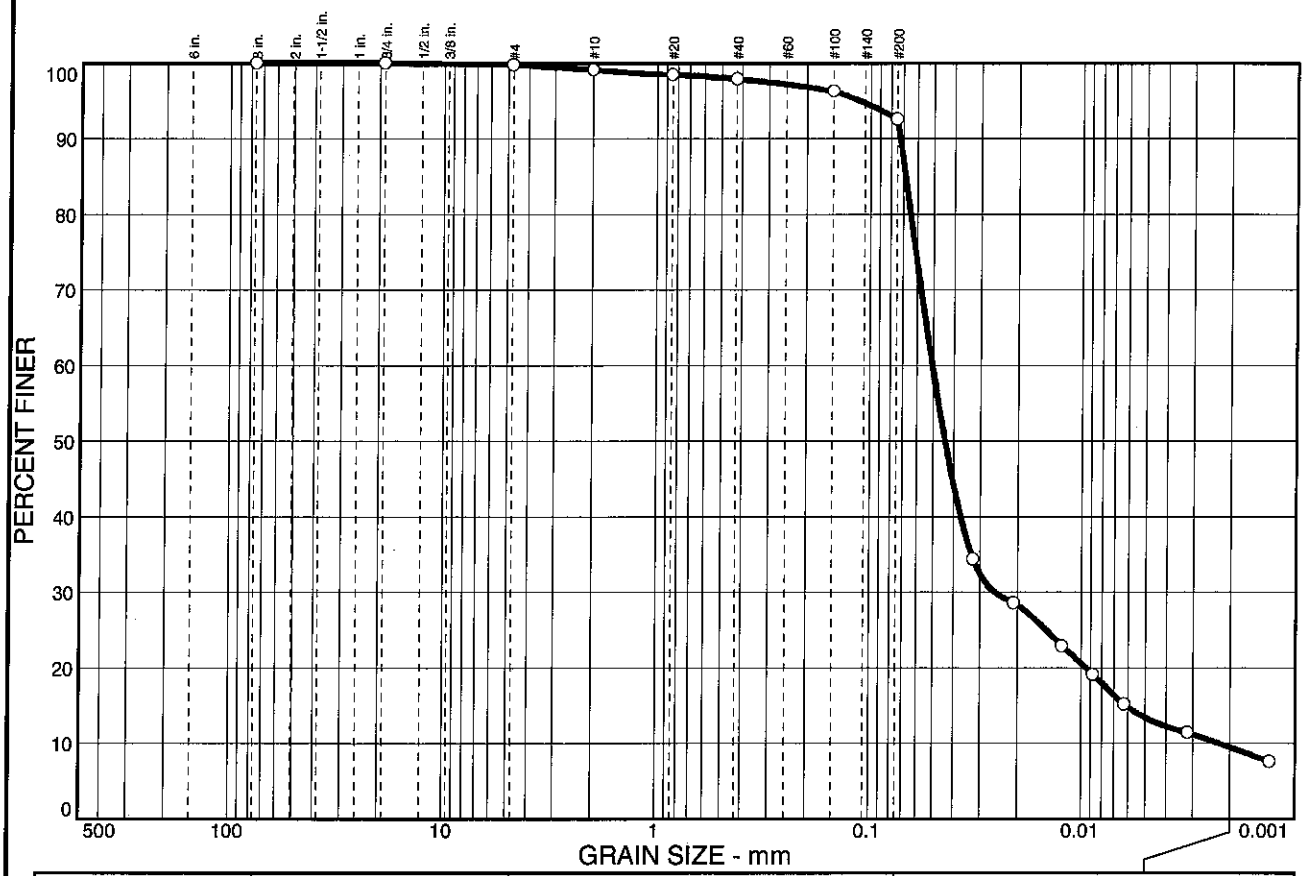
Remarks

As received moisture content = 175.0%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-0306 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 03-06

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.7	1.2	5.3	83.1	9.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.8		
#10	99.1		
#20	98.5		
#40	97.9		
#100	96.3		
#200	92.6		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0687 D_{60}= 0.0508 D_{50}= 0.0441
D_{30}= 0.0255 D_{15}= 0.0061 D_{10}= 0.0022
C_u= 22.65 C_c= 5.72

Classification

USCS= ML AASHTO= --

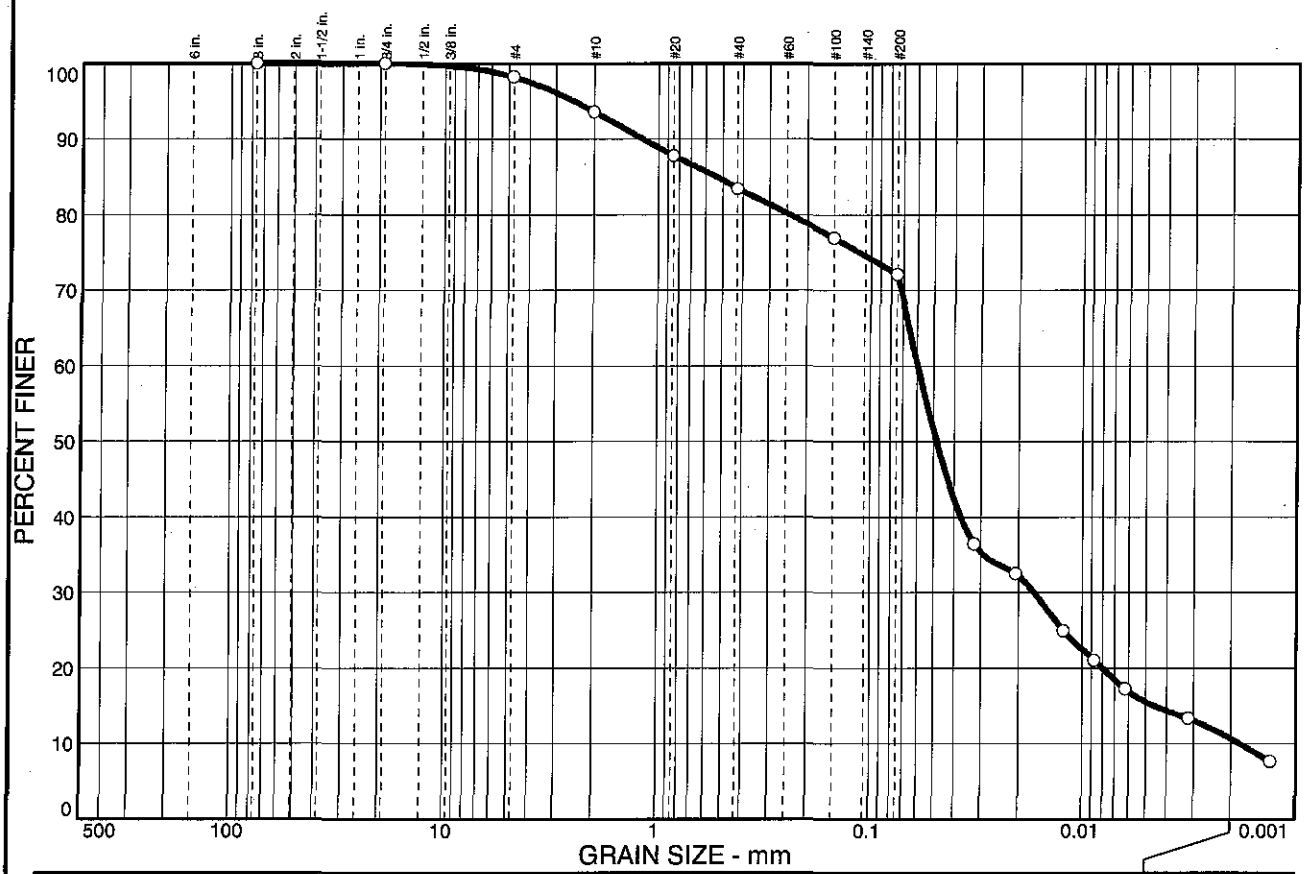
Remarks

As received moisture content = 165.1%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-0612 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 06-12

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.8	4.6	10.2	11.3	61.5	10.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.2		
#10	93.6		
#20	87.8		
#40	83.4		
#100	76.9		
#200	72.1		

* (no specification provided)

Soil Description

Silt with sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.535 D_{60}= 0.0597 D_{50}= 0.0486
D_{30}= 0.0169 D_{15}= 0.0046 D_{10}= 0.0018
C_u= 32.67 C_c= 2.60

Classification

USCS= ML AASHTO= --

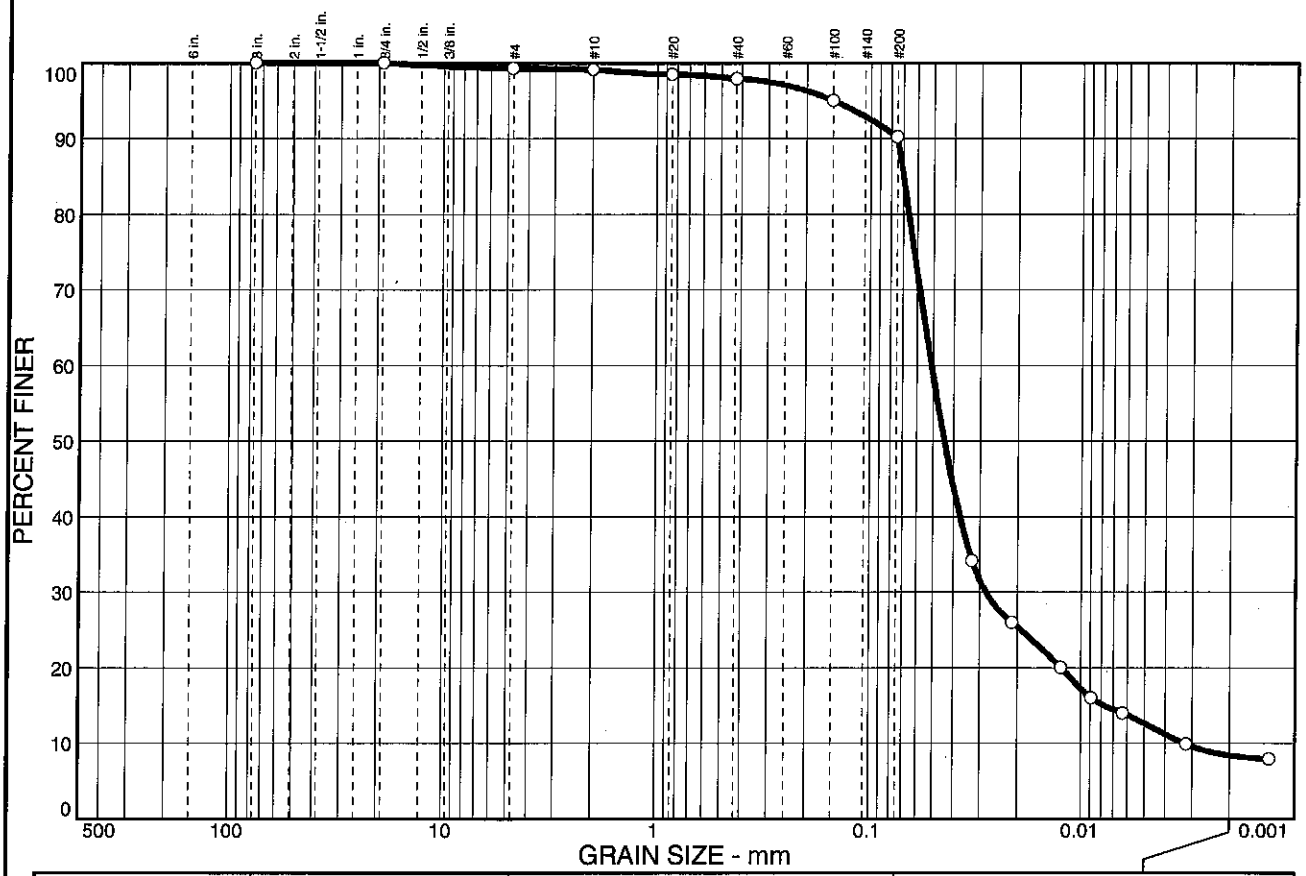
Remarks

As received moisture content = 150.0%
Soil classification and description based
on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-1218 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 12-18

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.7	0.2	1.2	7.7	81.8	8.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.3		
#10	99.1		
#20	98.5		
#40	97.9		
#100	95.0		
#200	90.2		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0704 D_{60}= 0.0513 D_{50}= 0.0444
D_{30}= 0.0281 D_{15}= 0.0077 D_{10}= 0.0033
C_u= 15.74 C_c= 4.72

Classification

USCS= ML AASHTO= --

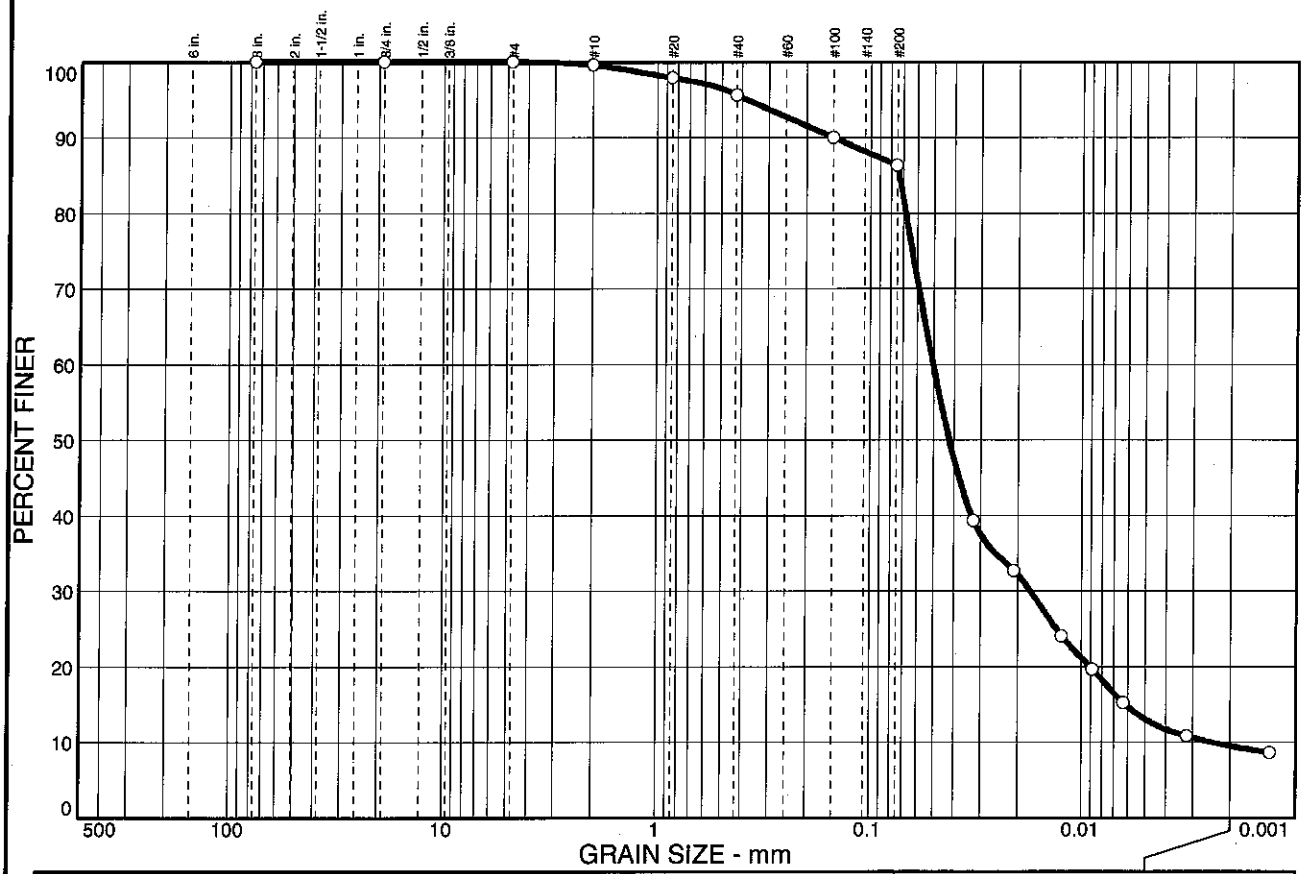
Remarks

As received moisture content = 140.5%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-1824 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 18-24

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.4	4.0	9.3	76.8	9.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.6		
#20	97.9		
#40	95.6		
#100	90.0		
#200	86.3		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.0736 D_{60}= 0.0506 D_{50}= 0.0423
D_{30}= 0.0174 D_{15}= 0.0062 D_{10}= 0.0025
C_u= 20.64 C_c= 2.45

Classification

USCS= ML AASHTO= --

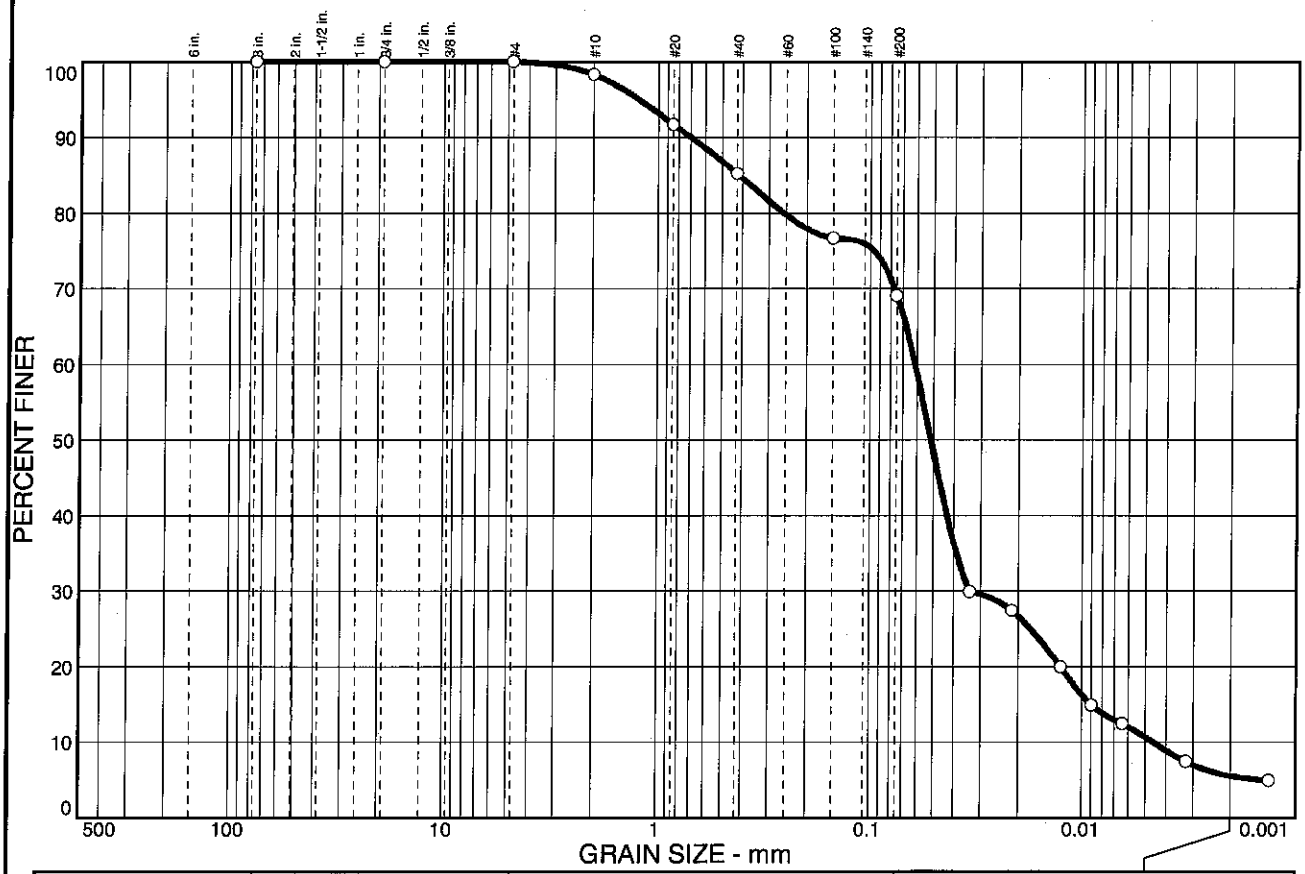
Remarks

As received moisture content = 147.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-2431 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 24-31

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	1.7	13.1	16.1	63.6	5.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	98.3		
#20	91.7		
#40	85.2		
#100	76.7		
#200	69.1		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.417 D_{60}= 0.0617 D_{50}= 0.0517
D_{30}= 0.0337 D_{15}= 0.0091 D_{10}= 0.0046
C_u= 13.36 C_c= 3.99

Classification

USCS= ML AASHTO= --

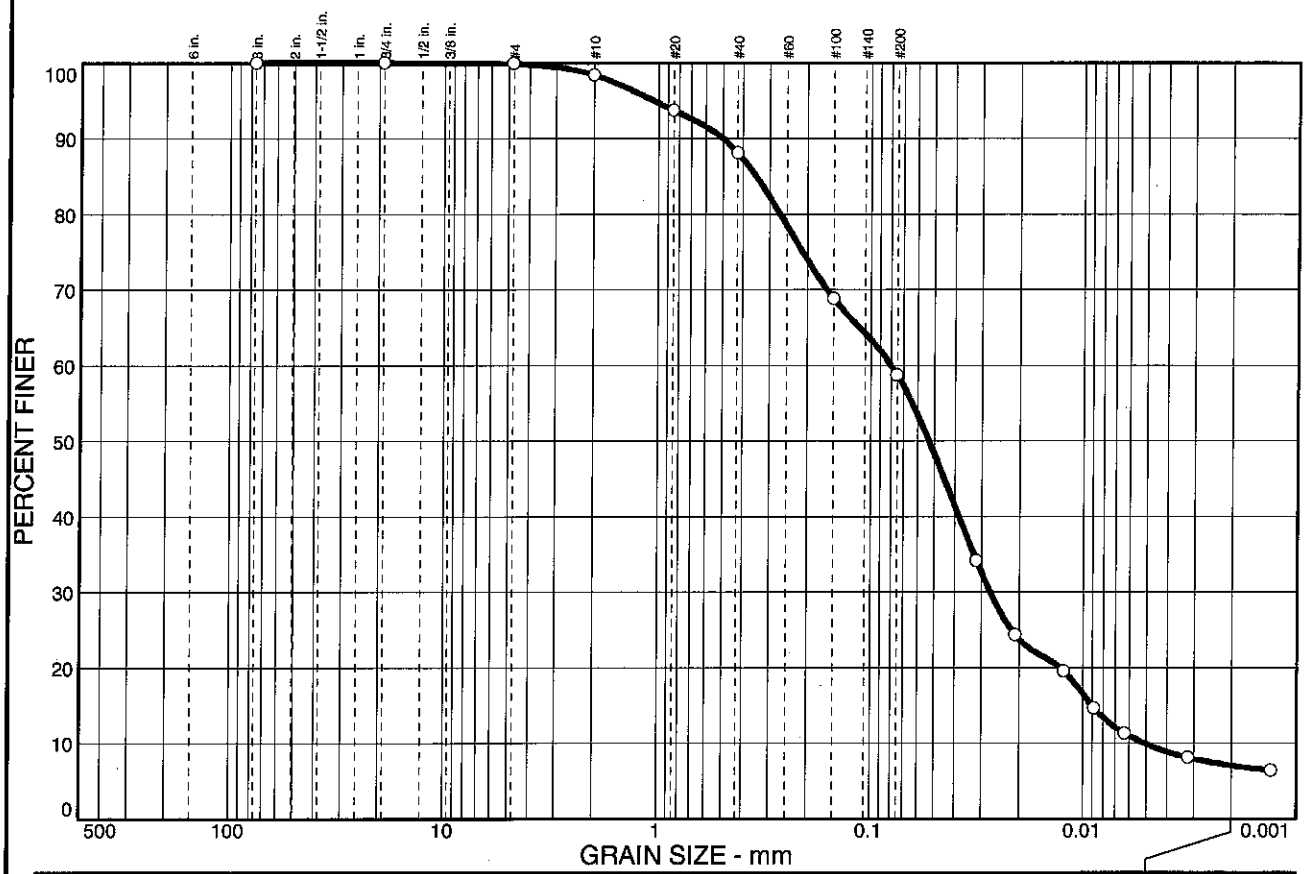
Remarks

As received moisture content = 155.4%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-3133 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 31-33

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	1.5	10.3	29.4	51.7	7.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	98.4		
#20	93.7		
#40	88.1		
#100	68.8		
#200	58.7		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.349 D_{60}= 0.0802 D_{50}= 0.0532
D_{30}= 0.0273 D_{15}= 0.0091 D_{10}= 0.0051
C_u= 15.65 C_c= 1.82

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 107.2%
Soil classification and description based on Visual-Manual Procedure (ASTM-D2488)

Sample No.: SED-T71-NG-3339 **Source of Sample:** 7/12 **Date:** 5/25/04
Location: T71NG **Elev./Depth:** 33-39

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** ALCOA **Project:** Secure Landfill Cell 3 **Project No:** 01902-41247 **Plate**

Sediment Core Graphic Logs

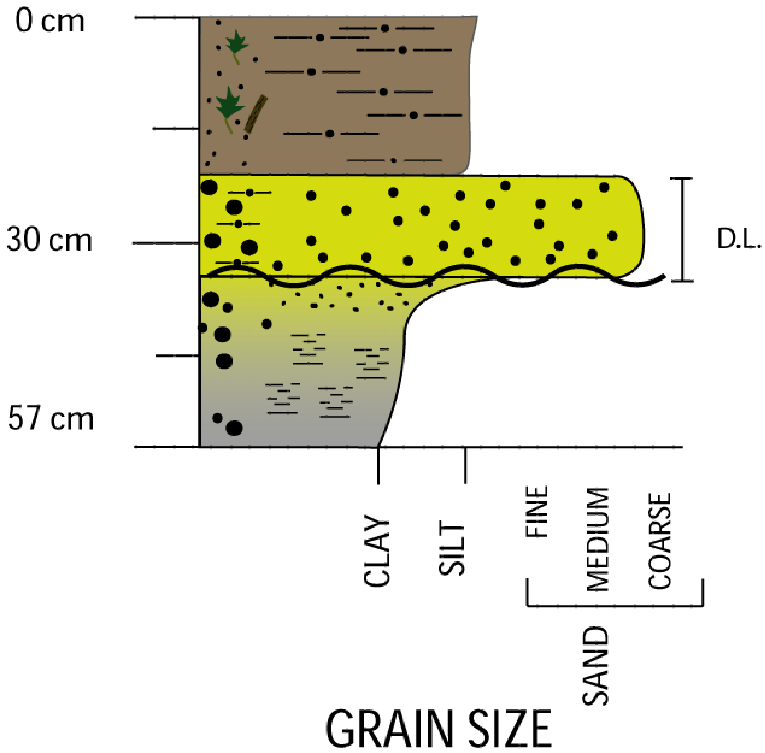
2004 Focused Program

This appendix contains graphic logs of each sediment core collected during the 2004 Focused Sediment Sampling Program. These logs were developed by Dr. Rudy Slingerland of Penn State University using color photographs and grain size information.

CORE: T35NA

GRASSE RIVER

MASSENA, NY



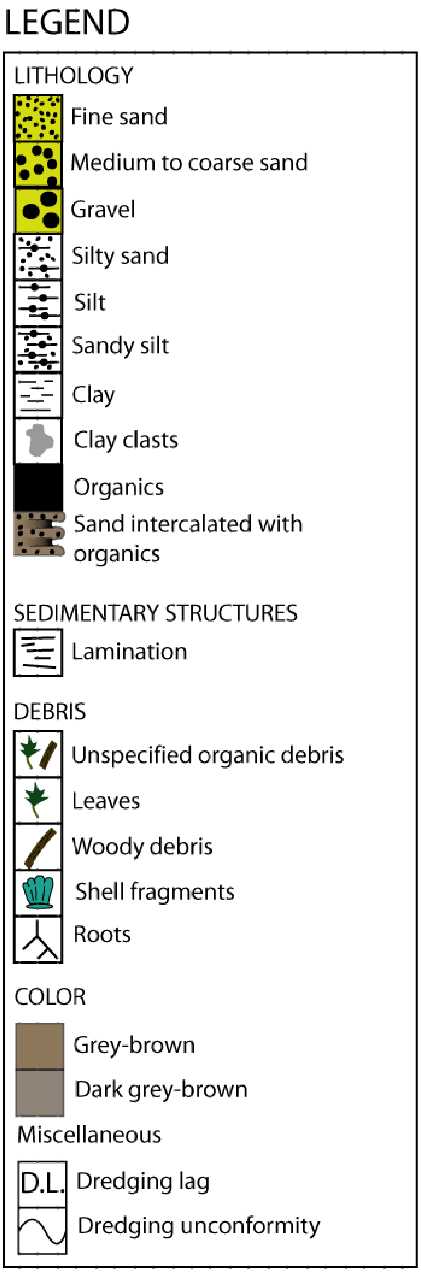


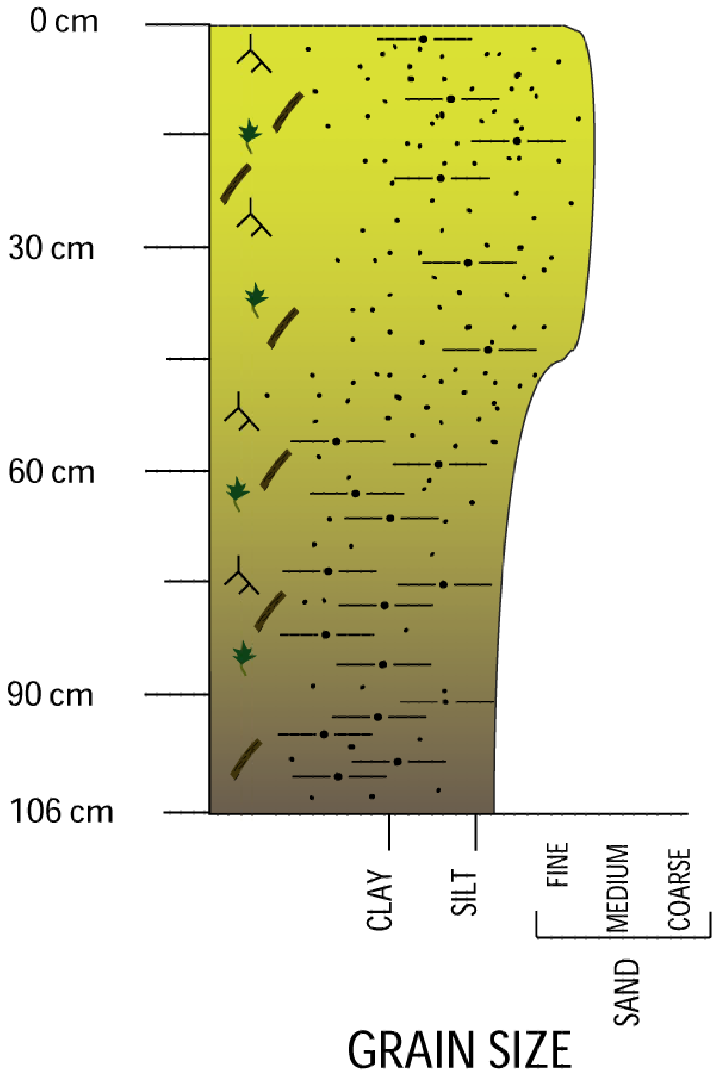
Figure U-1. Graphic Log for Core T35NA

PREPARED BY SLINGERLAND/EDMONDS from BBL data and core photos (9/10/04)

CORE: T35NB

GRASSE RIVER

MASSENA, NY



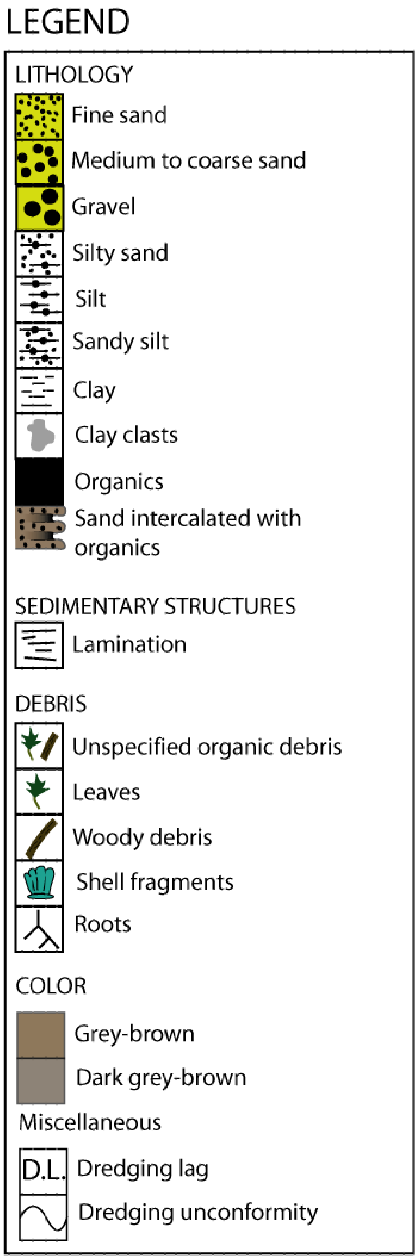


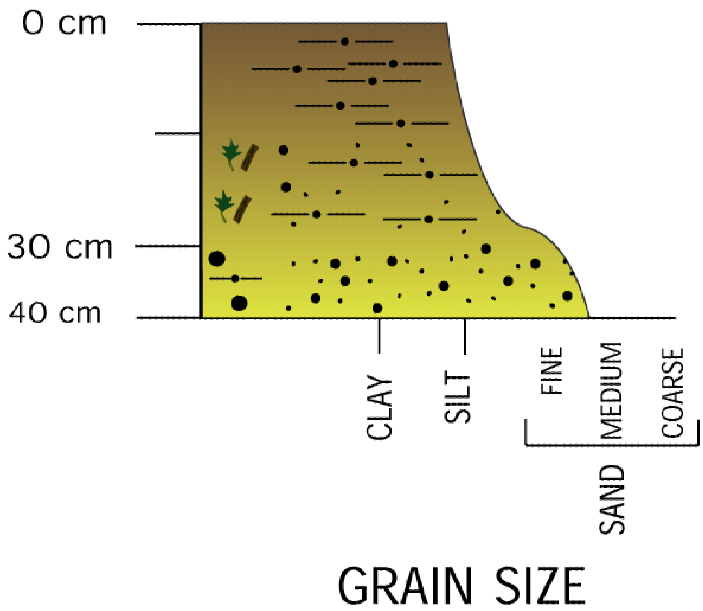
Figure U-2. Graphic Log for Core T35NB

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T35NC

GRASSE RIVER

MASSENA, NY



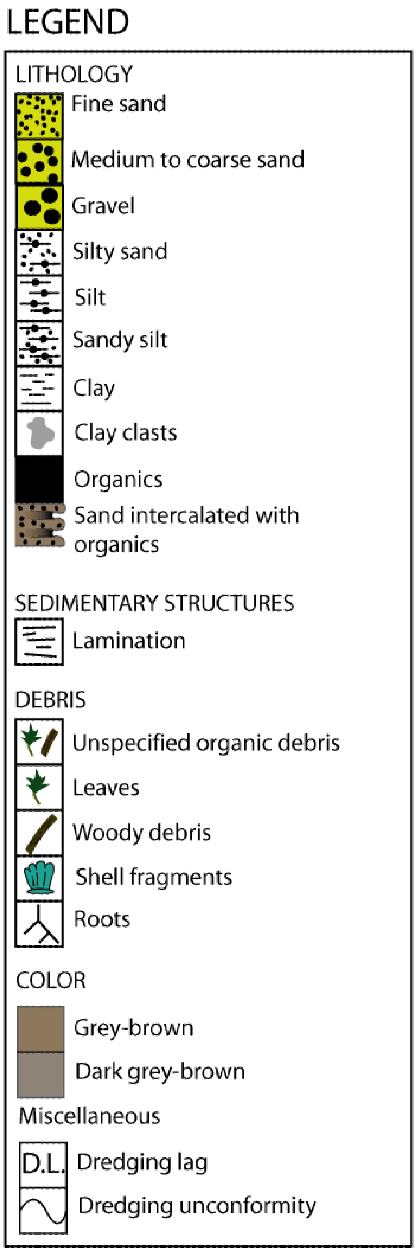


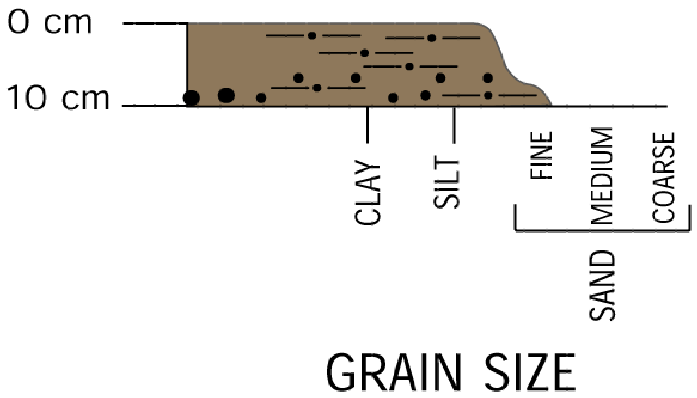
Figure U-3. Graphic Log for Core T35NC

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T35ND

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

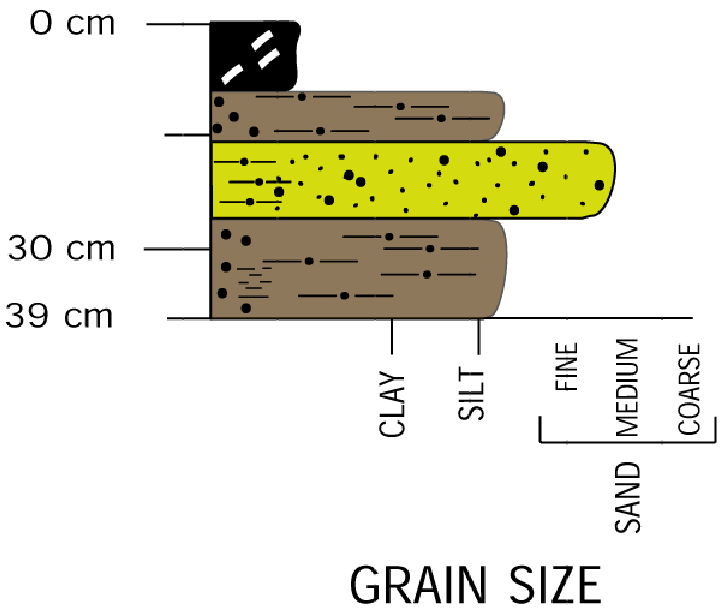
Figure U-4. Graphic Log for Core T35ND

PREPARED BY SLINGERLAND/EDMONDS fromBBL
data and core photos (9/10/04)

CORE: T35NE

GRASSE RIVER

MASSENA, NY



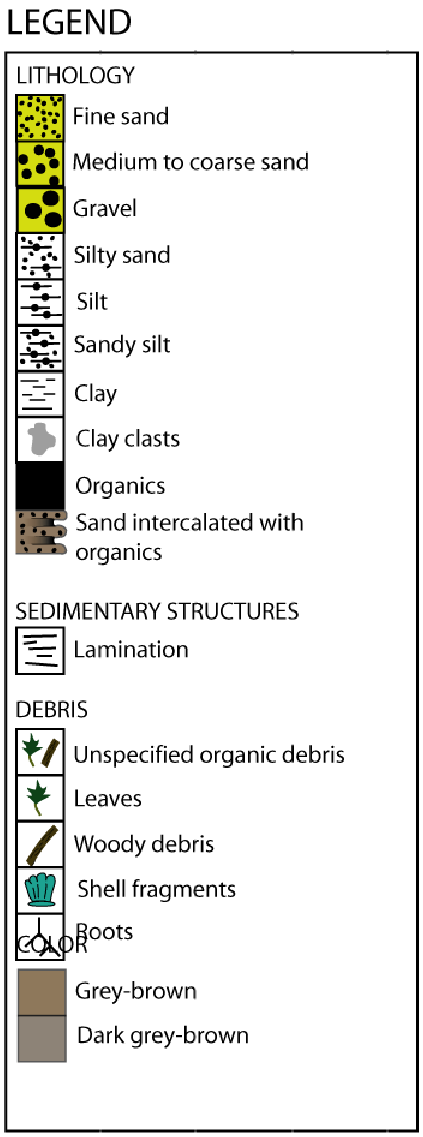


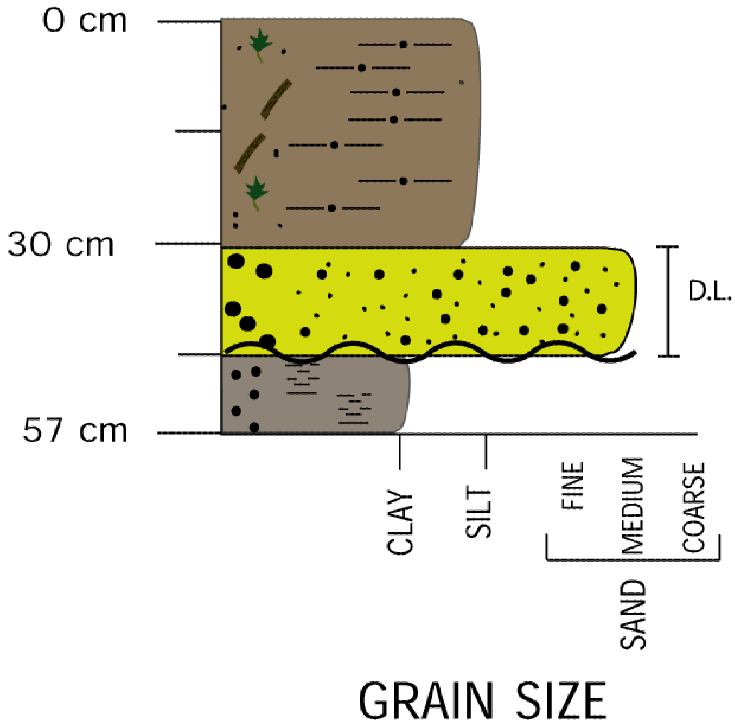
Figure U-5. Graphic Log for Core T35NE

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T35NG

GRASSE RIVER

MASSENA, NY



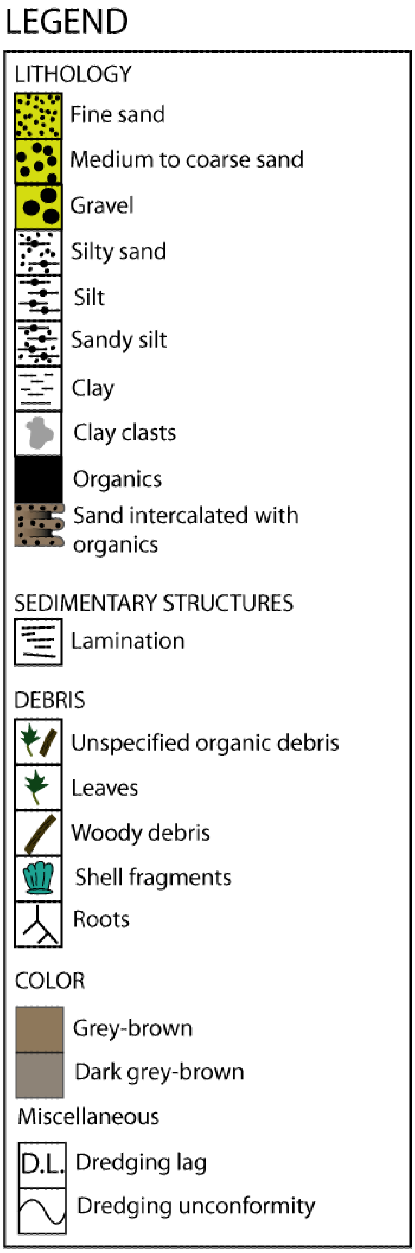


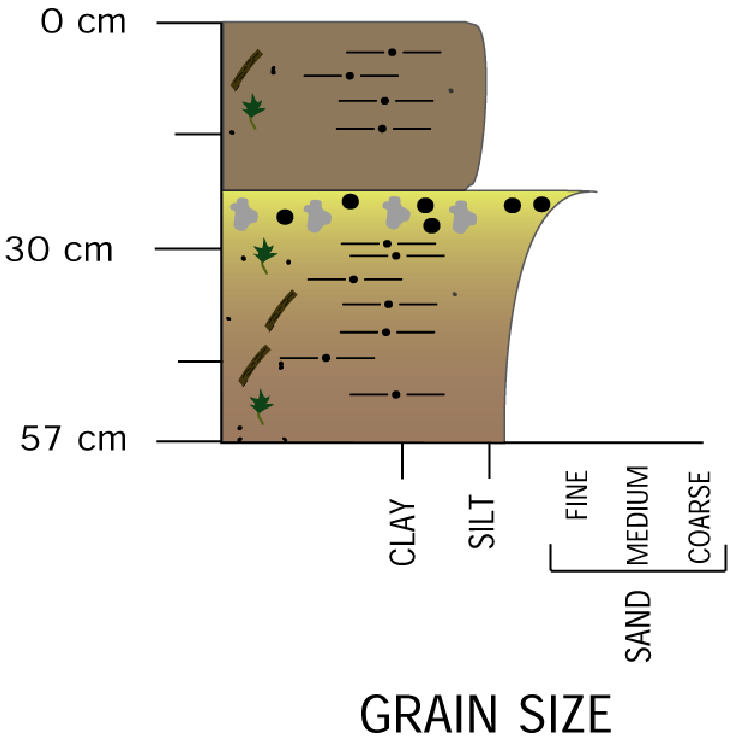
Figure U-6. Graphic Log for Core T35NG

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T37NA

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

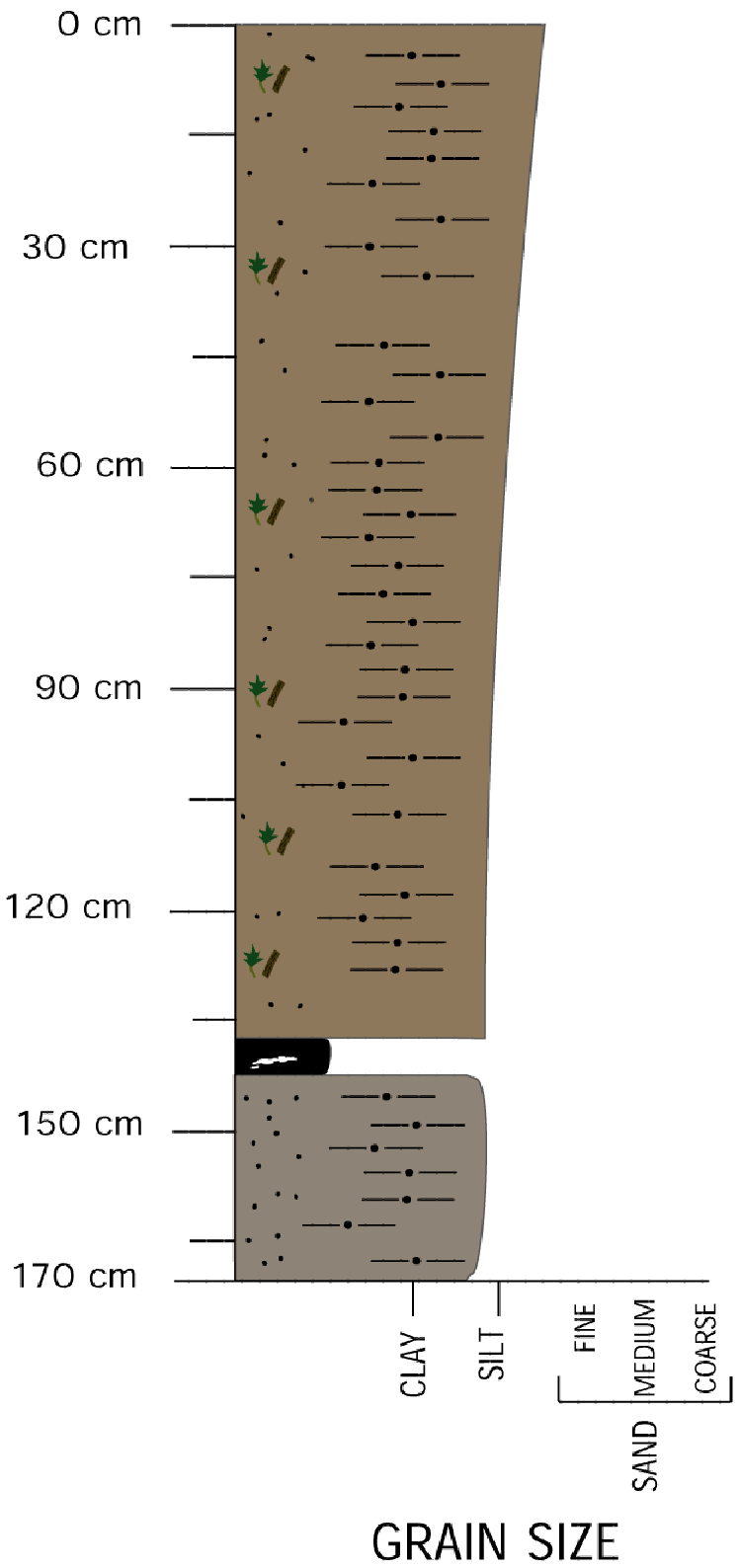
Figure U-7. Graphic Log for Core T37NA

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T37NB

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

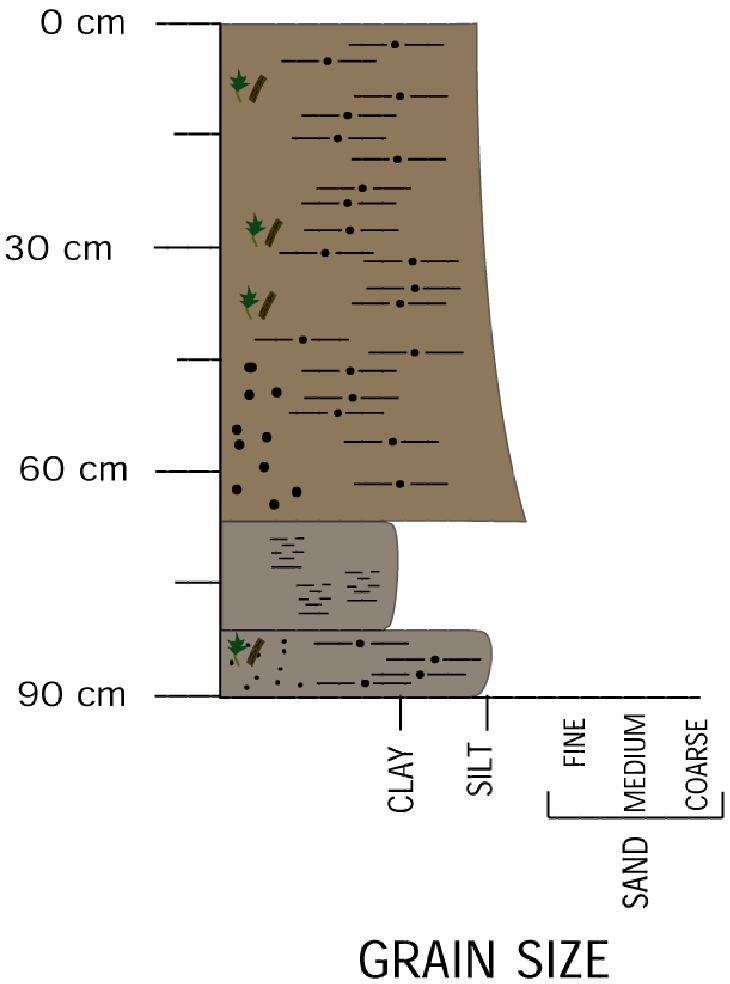
Figure U-8. Graphic Log for Core T37NB

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (12/6/03)

CORE: T37NC

GRASSE RIVER

MASSENA, NY



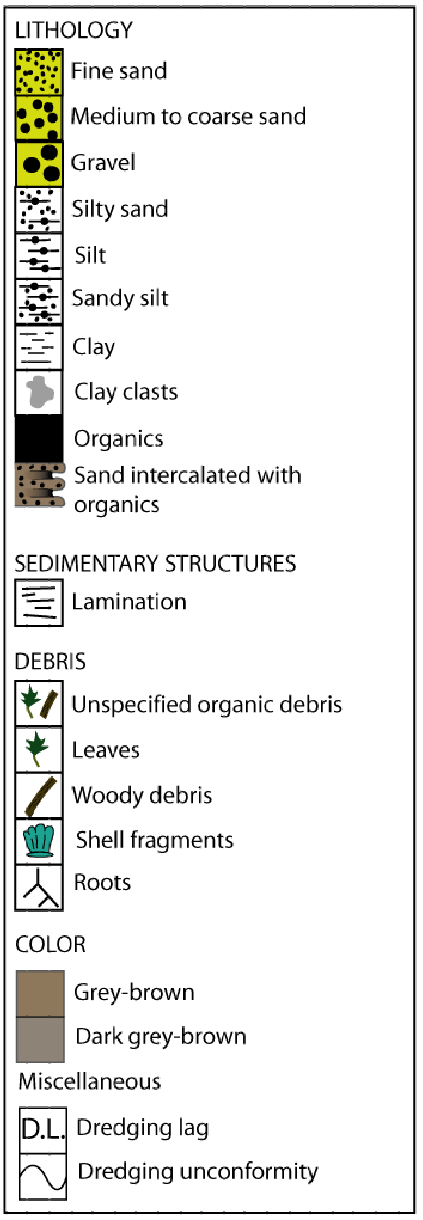


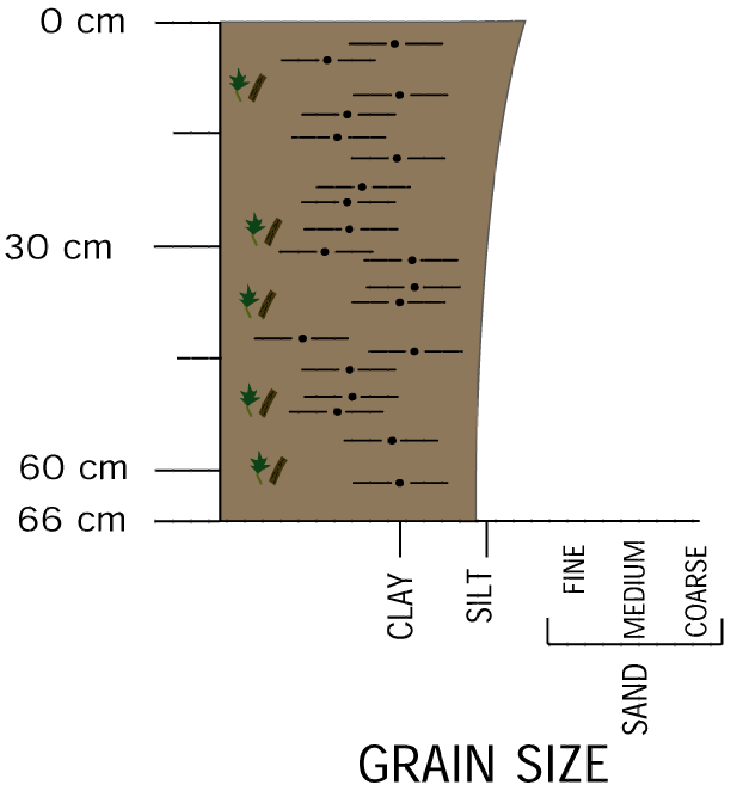
Figure U-9. Graphic Log for Core T37NC

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T37ND

GRASSE RIVER

MASSENA, NY



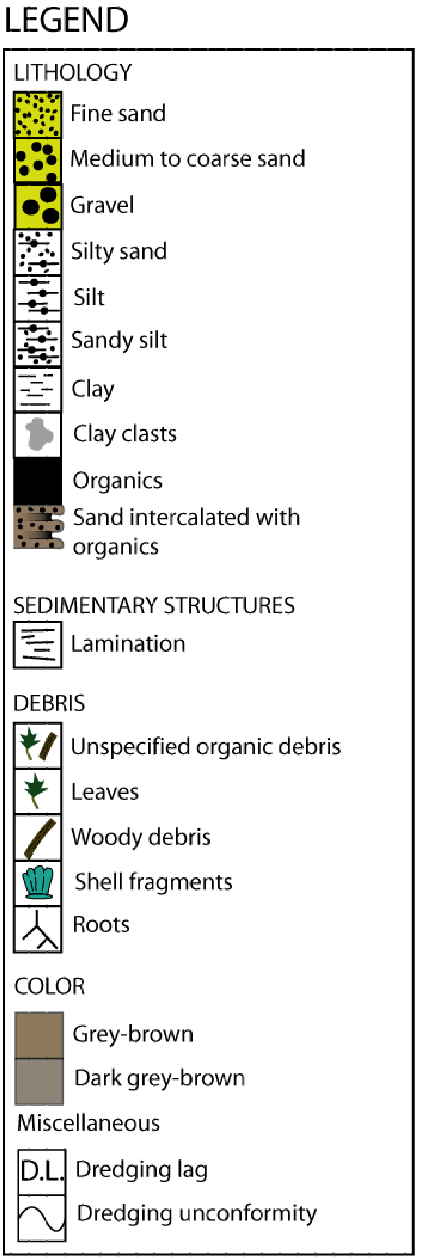


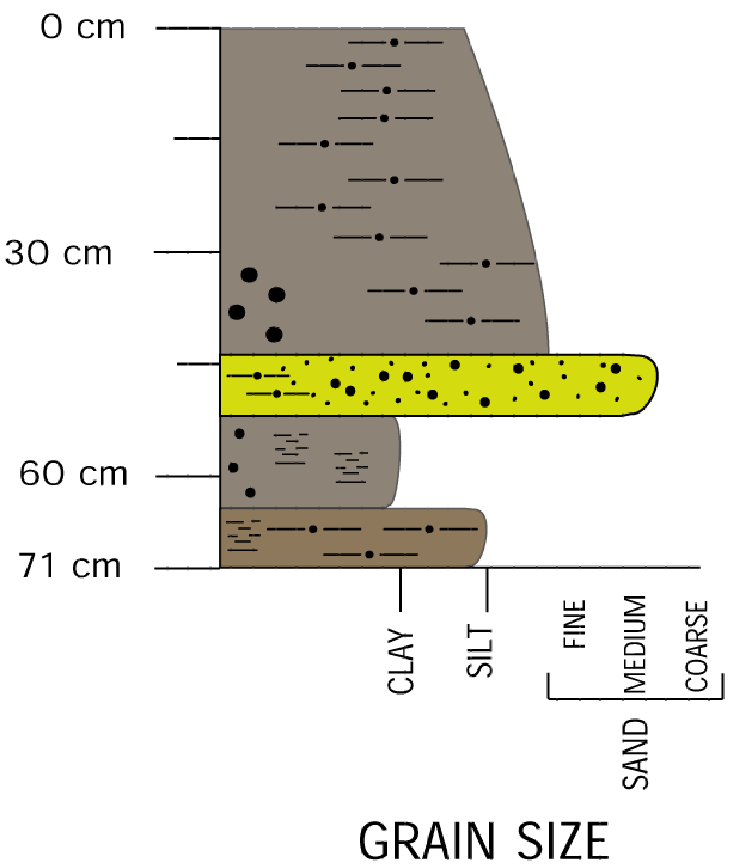
Figure U-10. Graphic Log for Core T37ND

PREPARED BY SLINGERLAND/EDMONDS fromBBL
data and core photos (9/10/04)

CORE: T37NE

GRASSE RIVER

MASSENA, NY



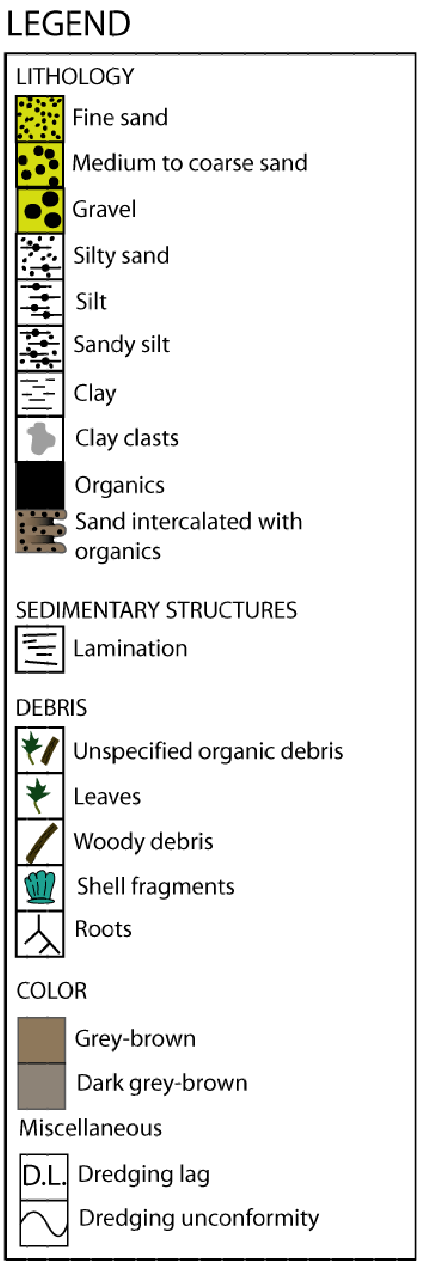


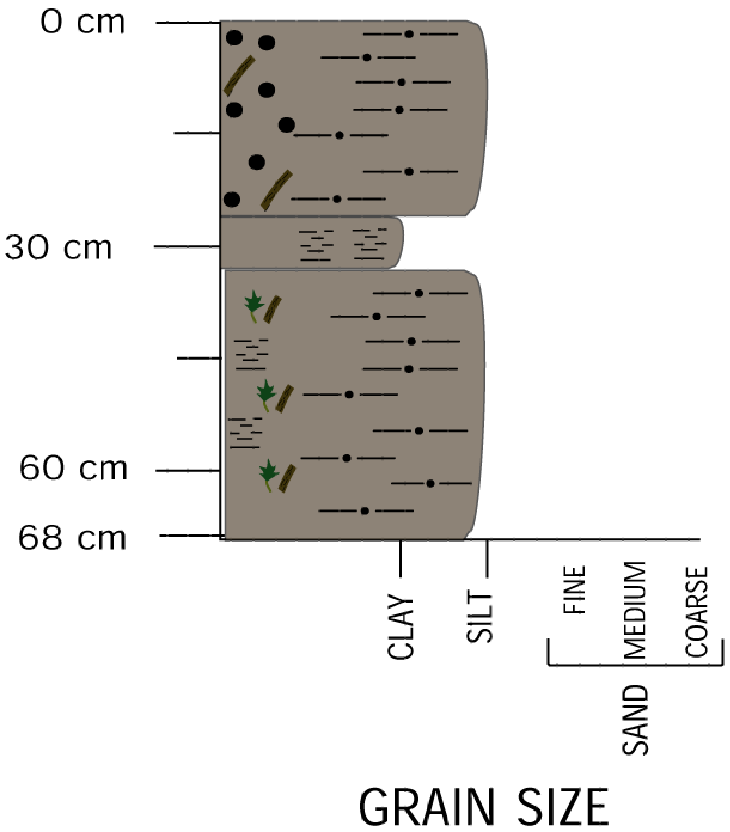
Figure U-11. Graphic Log for Core T37NE

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T37NG

GRASSE RIVER

MASSENA, NY



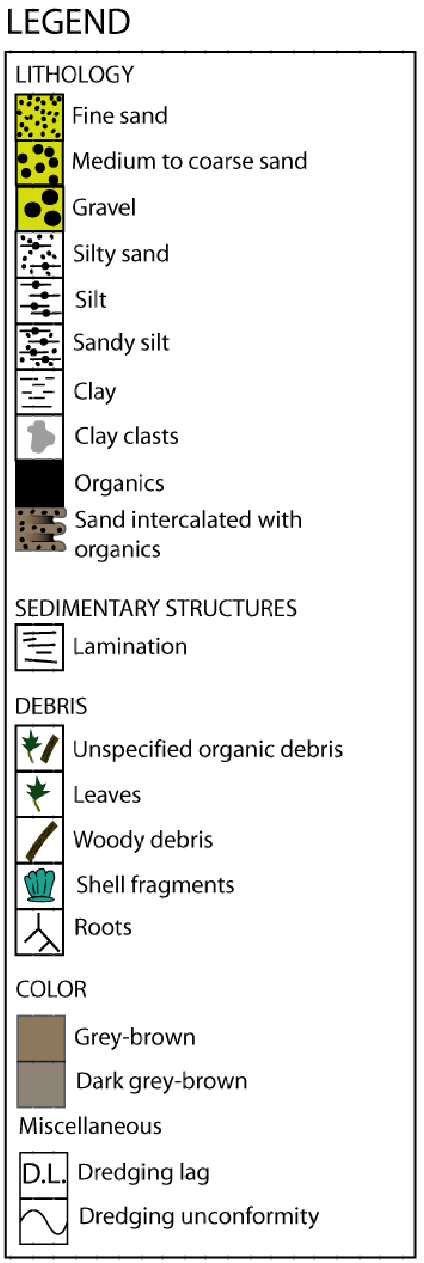


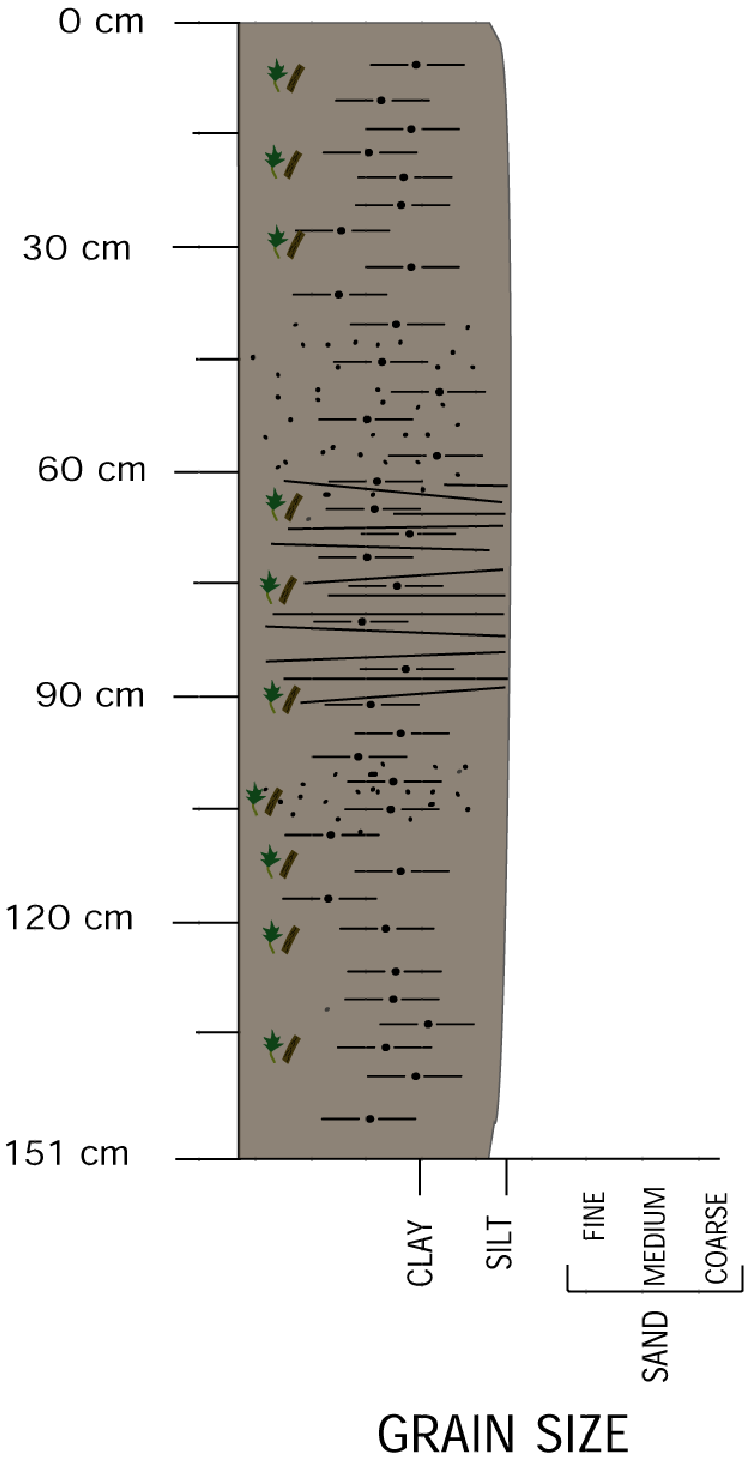
Figure U-12. Graphic Log for Core T37NG

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/10/04)

CORE: T46MA

GRASSE RIVER

MASSENA, NY



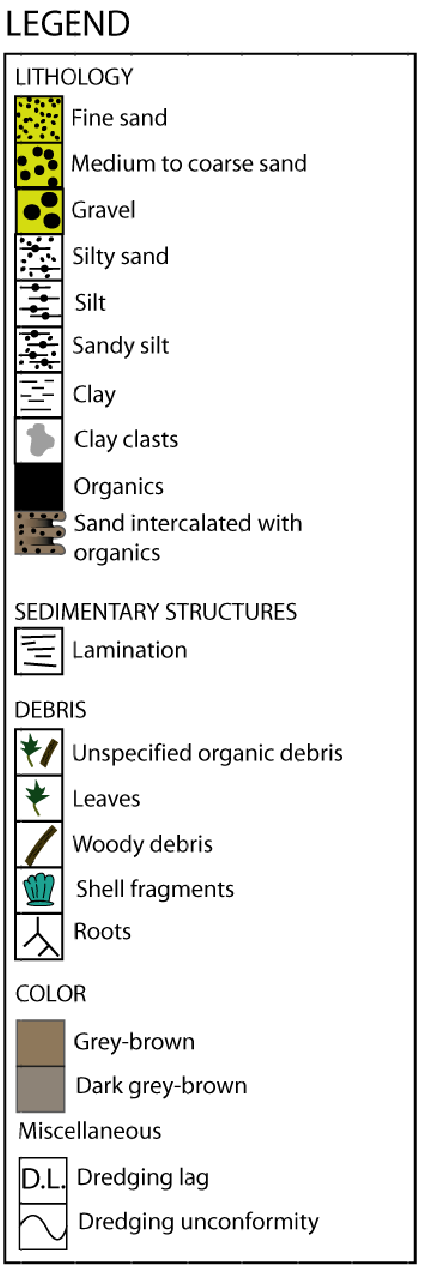


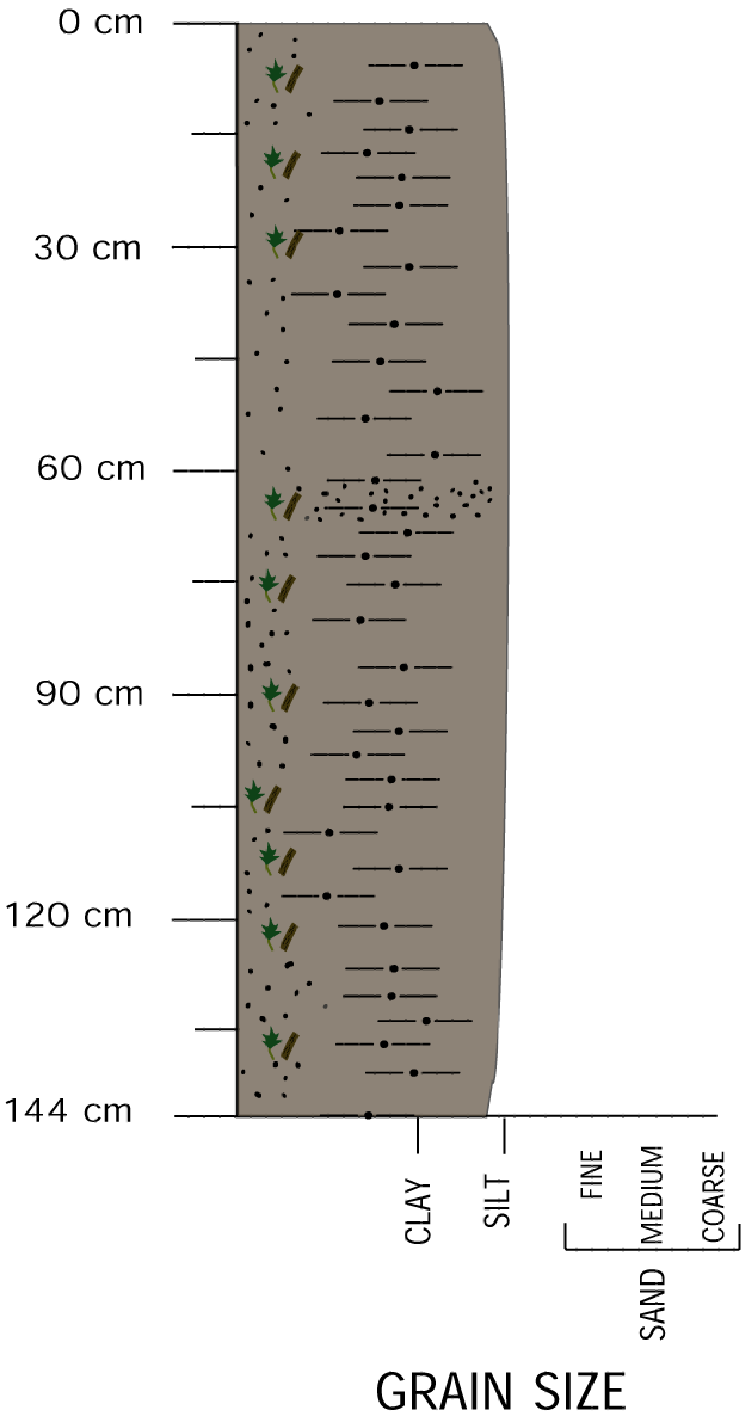
Figure U-13. Graphic Log for Core T46MA

PREPARED BY SLINGERLAND/EDMONDS fromBBL
data and core photos (9/11/04)

CORE: T46MB

GRASSE RIVER

MASSENA, NY



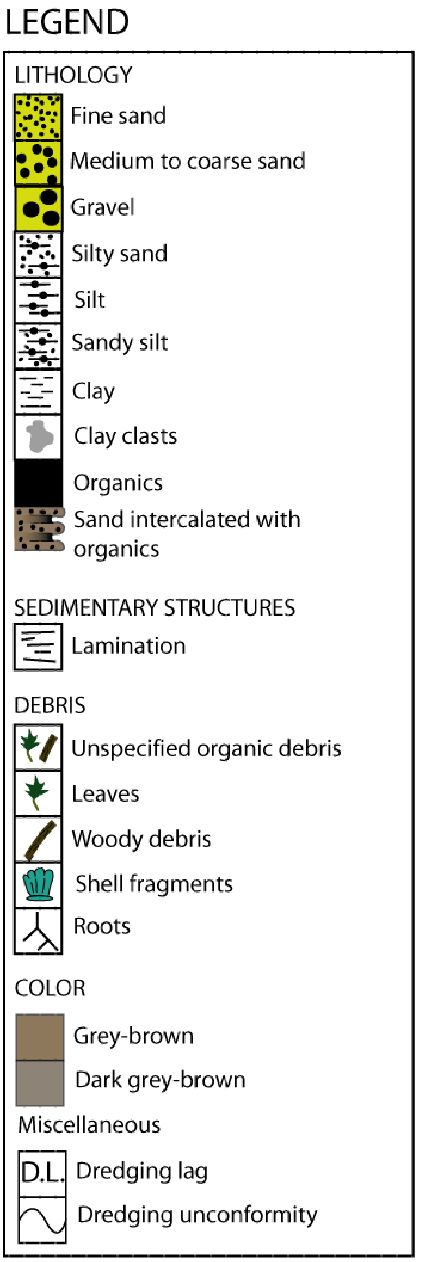


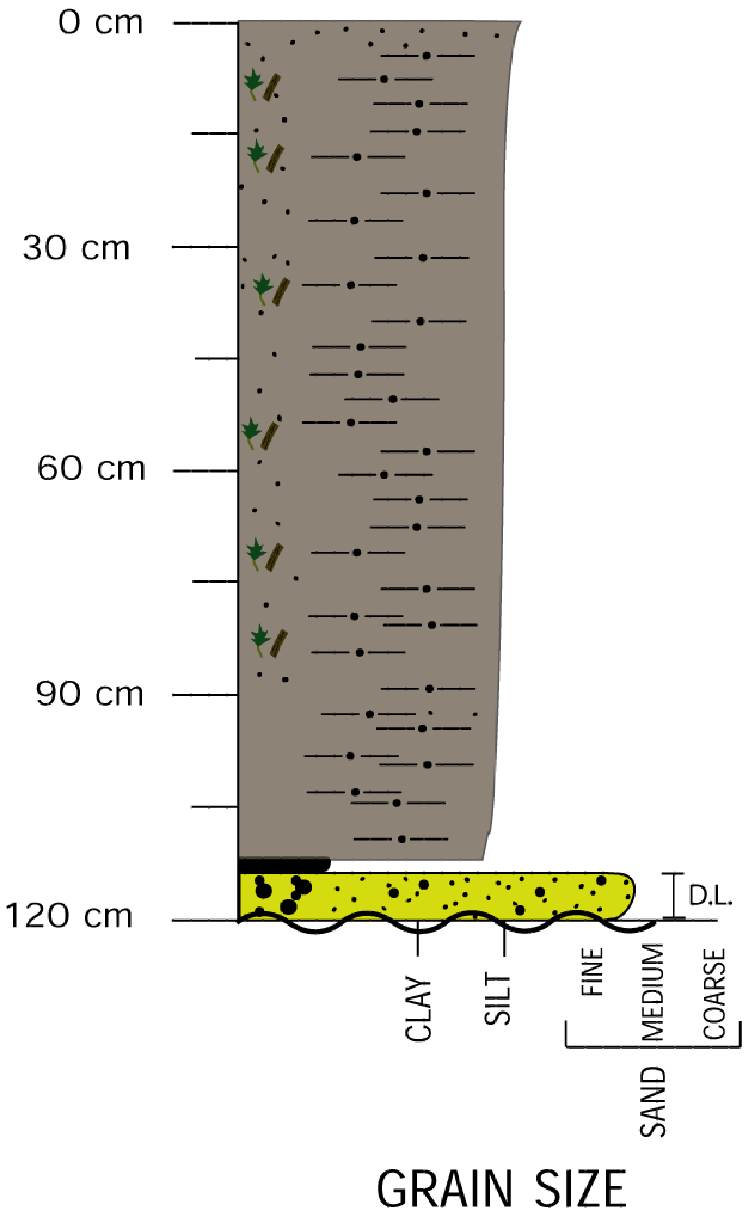
Figure U-14. Graphic Log for Core T46MB

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T46MC

GRASSE RIVER

MASSENA, NY



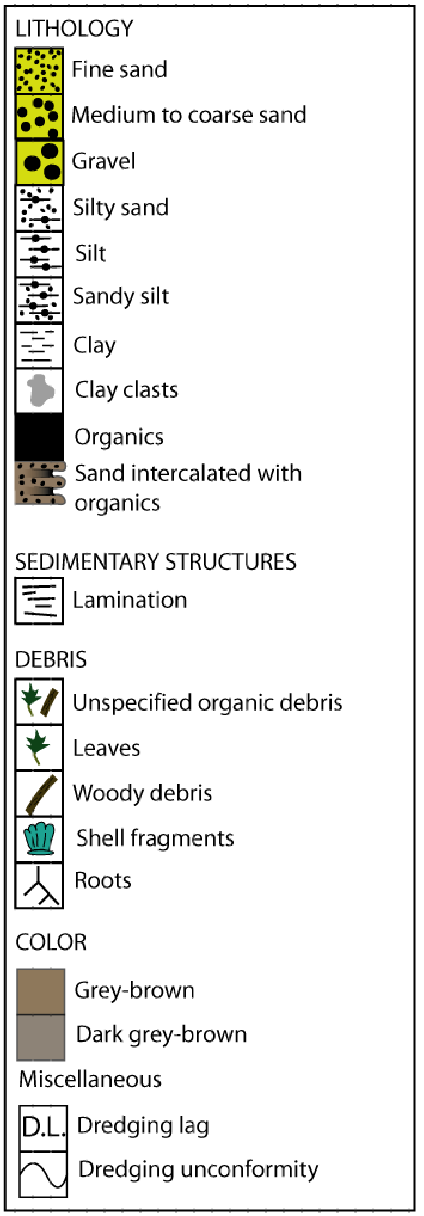


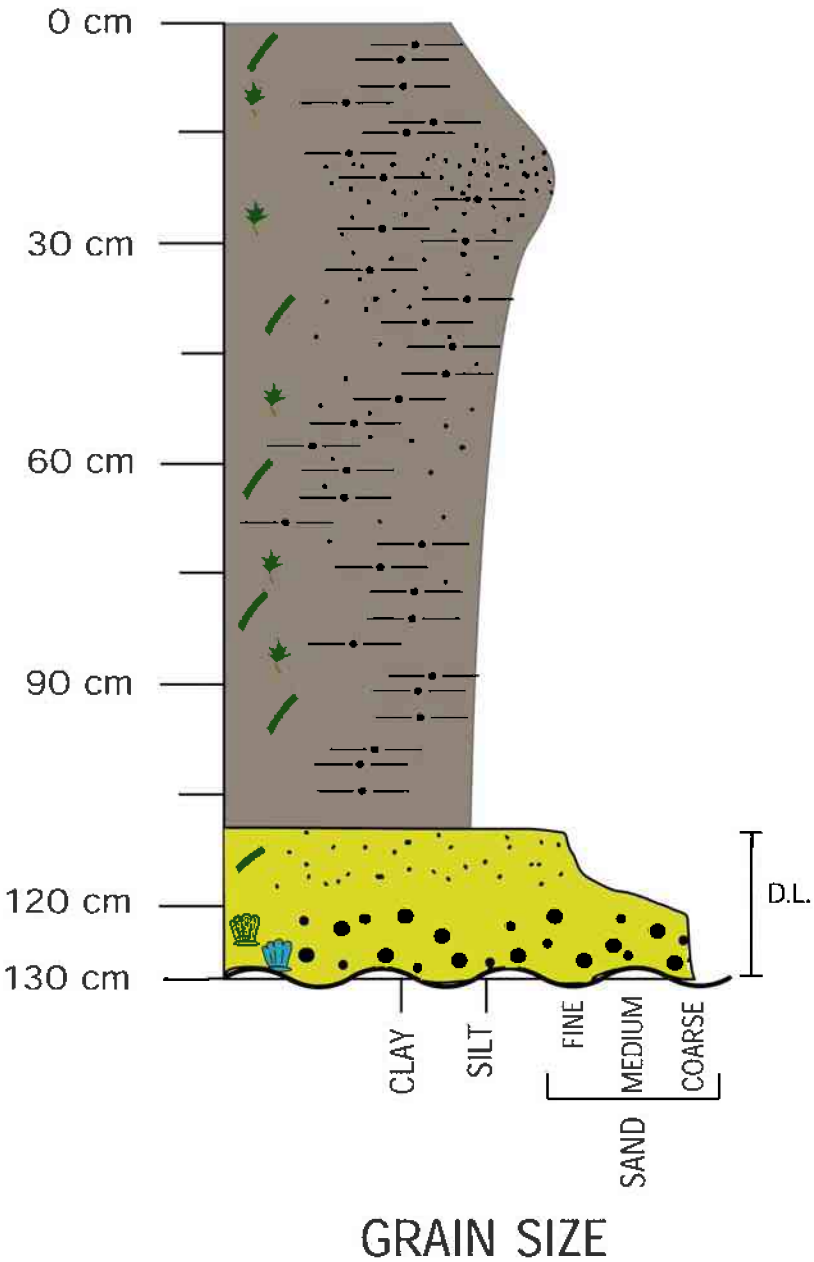
Figure U-15. Graphic Log for Core T46MC

PREPARED BY SLINGERLAND/EDMONDS fromBBL
data and core photos (9/11/04)

CORE: T46MD

GRASSE RIVER

MASSENA, NY



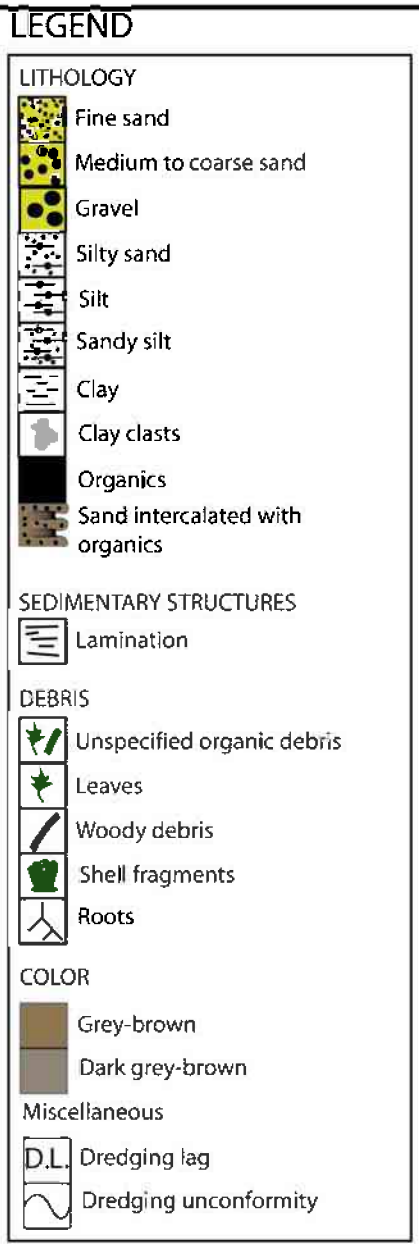


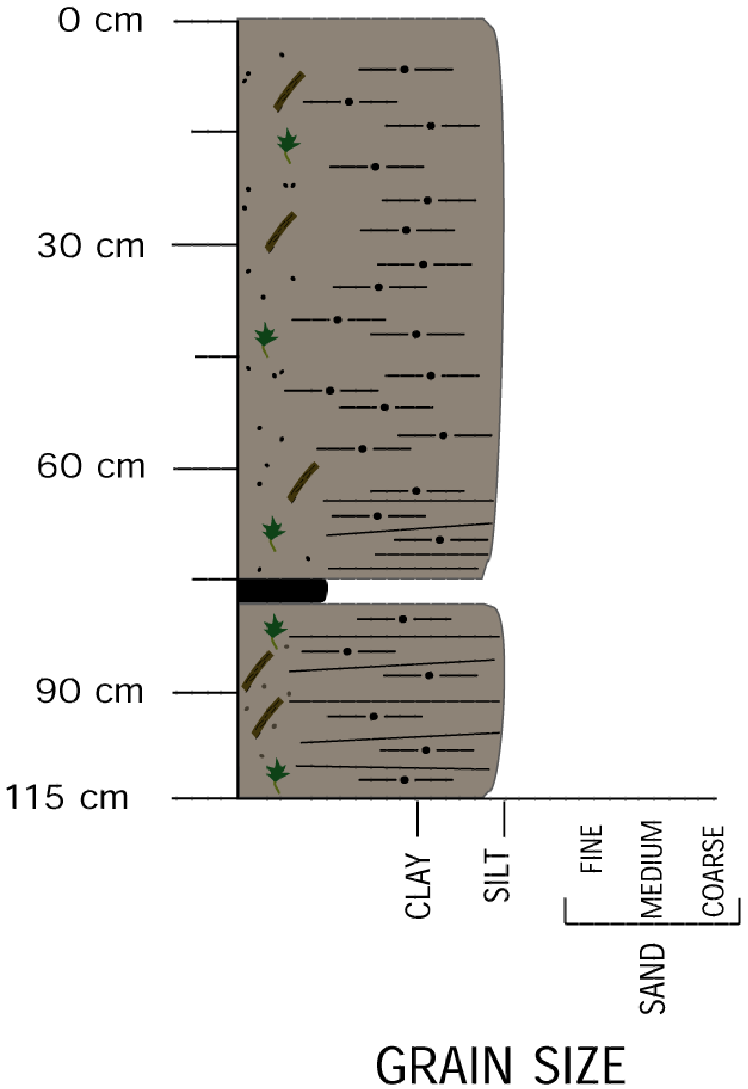
Figure U-16. Graphic Log for Core T46MD

PREPARED BY SLINGERLAND/EDMONDS fromBBL
data and core photos (9/11/04)

CORE: T46ME

GRASSE RIVER

MASSENA, NY



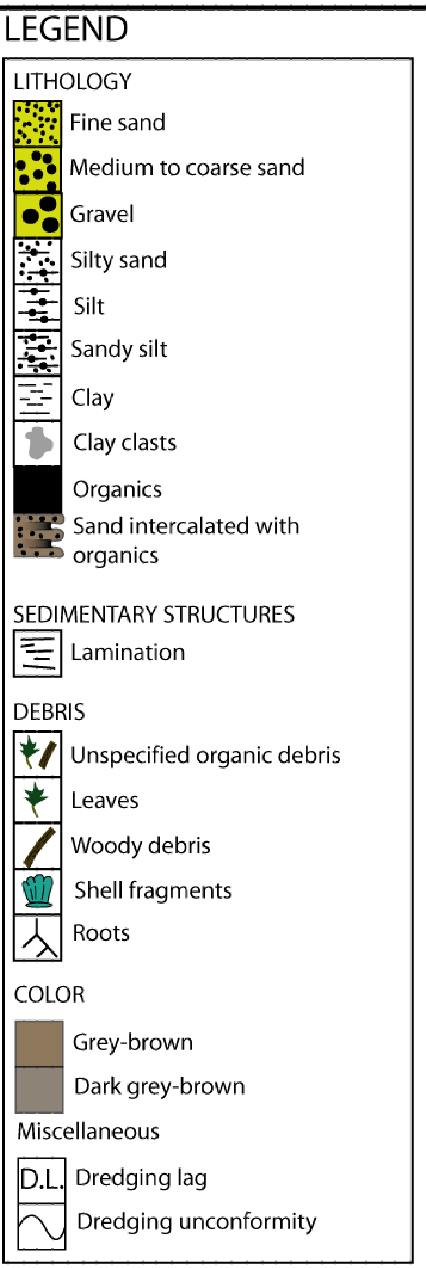


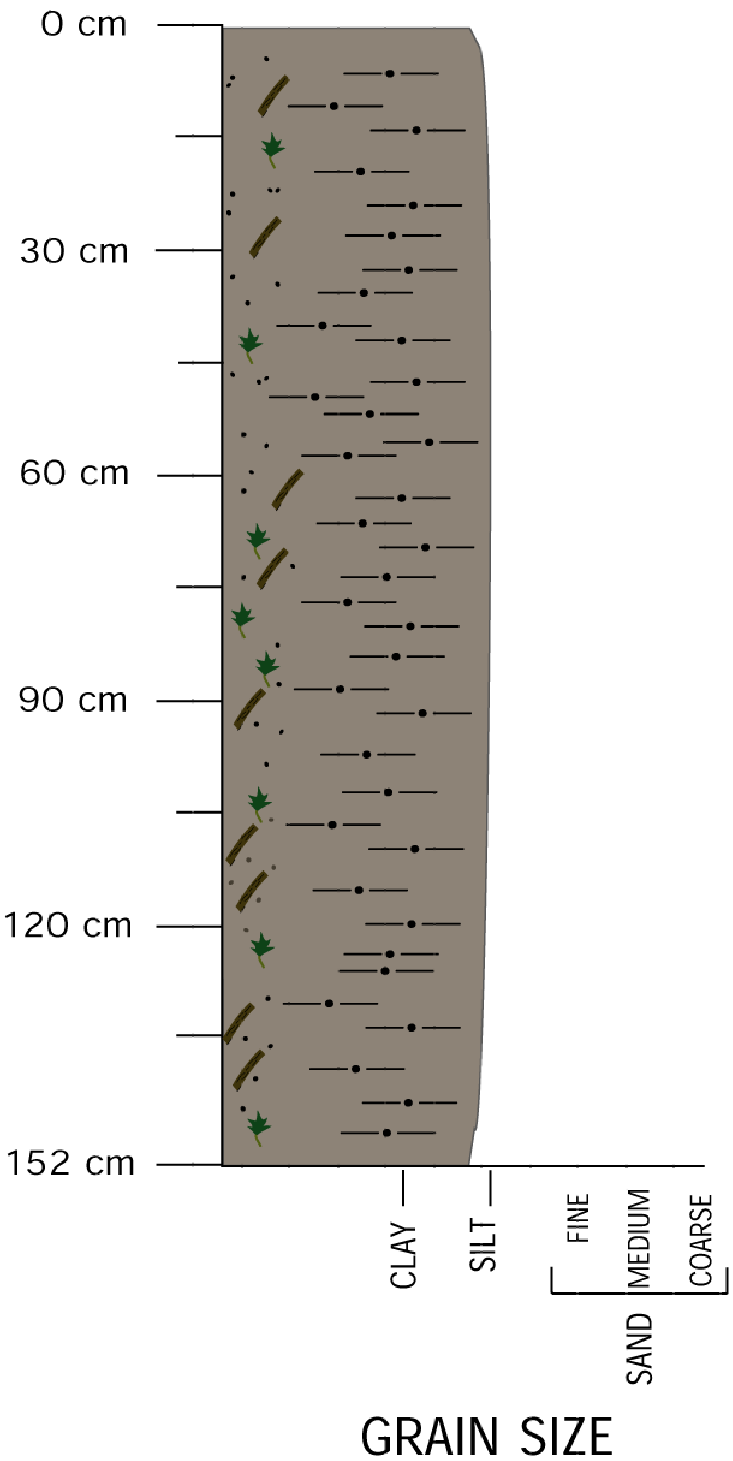
Figure U-17. Graphic Log for Core T46ME

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T46MG

GRASSE RIVER

MASSENA, NY



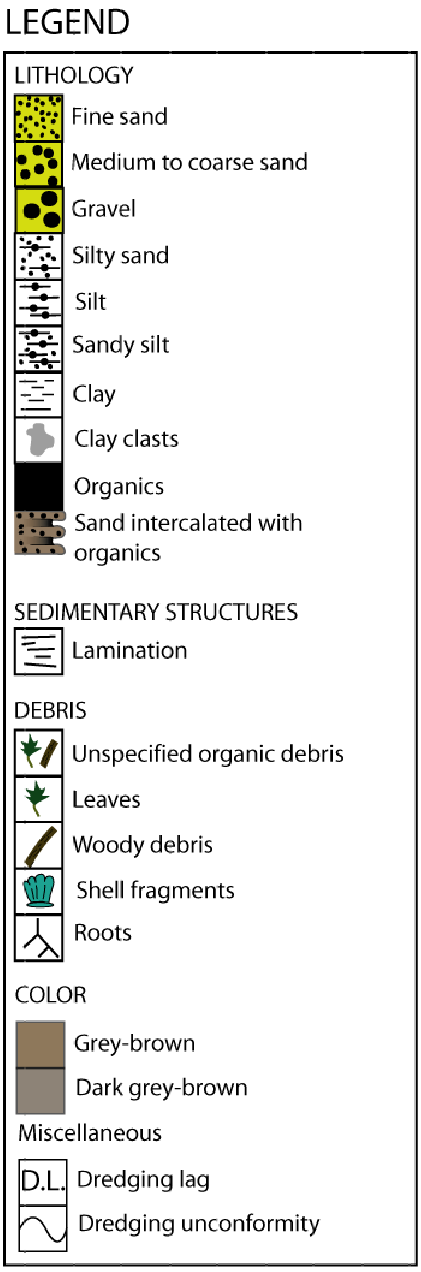


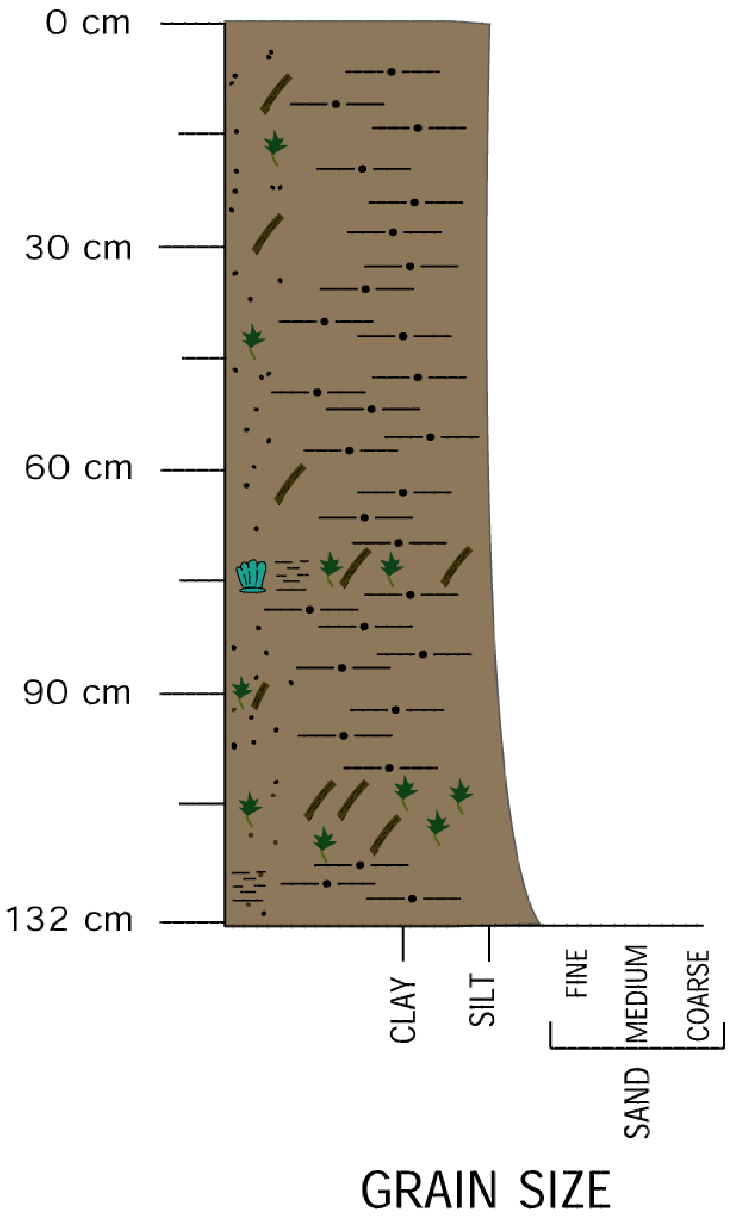
Figure U-18. Graphic Log for Core T46MG

PREPARED BY SLINGERLAND/EDMONDS fromBBL
data and core photos (9/11/04)

CORE: T71NA

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

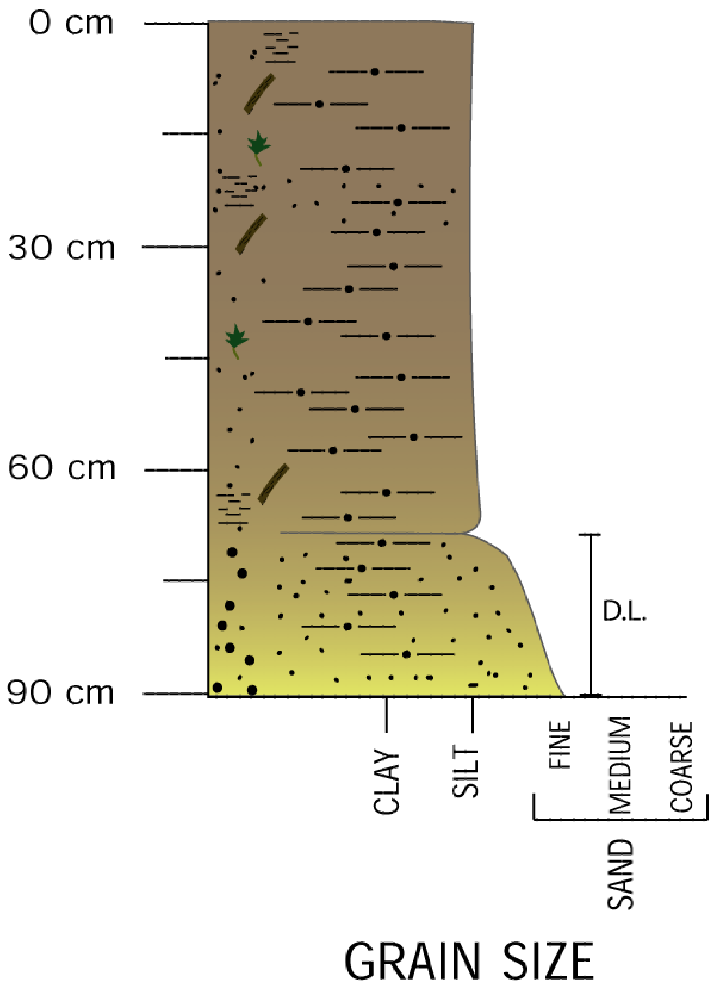
Figure U-19. Graphic Log for Core T71NA

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T71NB

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

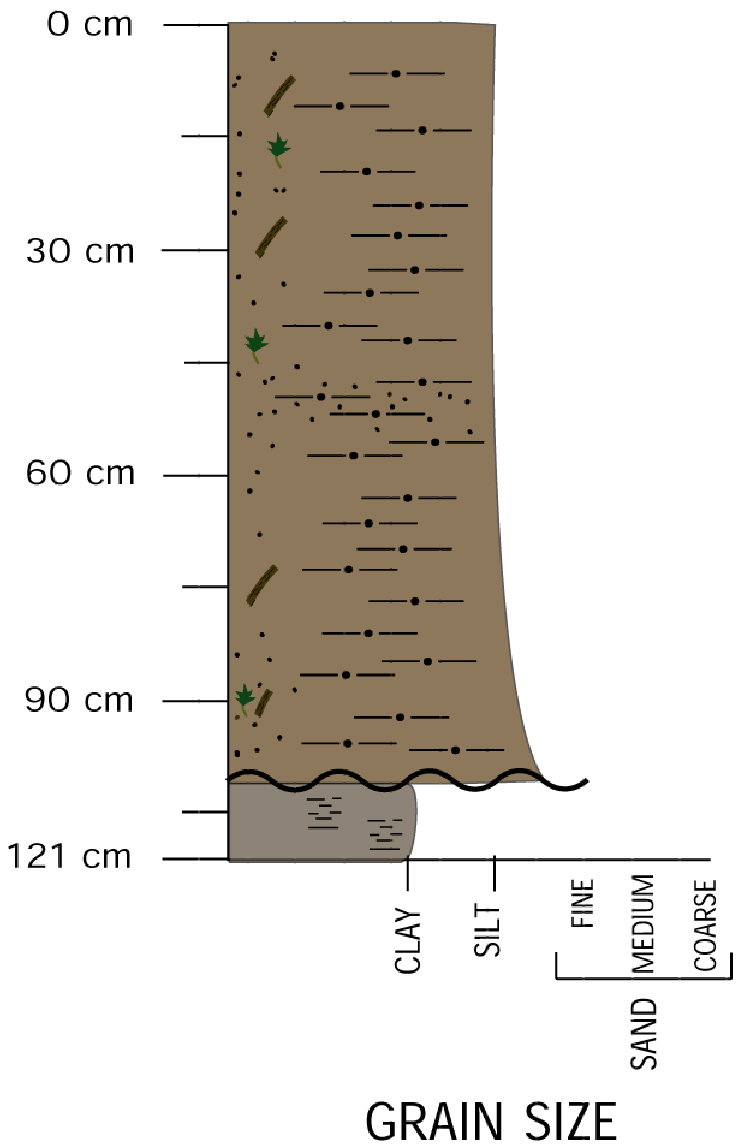
Figure U-20. Graphic Log for Core T71NB

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T71NC

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

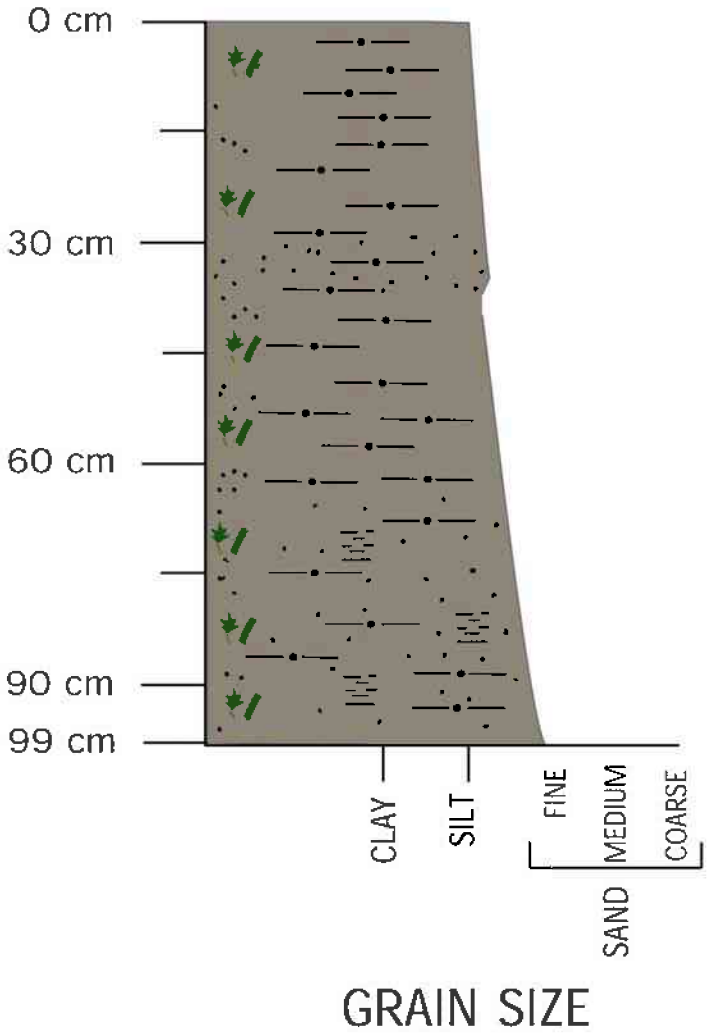
Figure U-21. Graphic Log for Core T71NC

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T71ND

GRASSE RIVER

MASSENA, NY



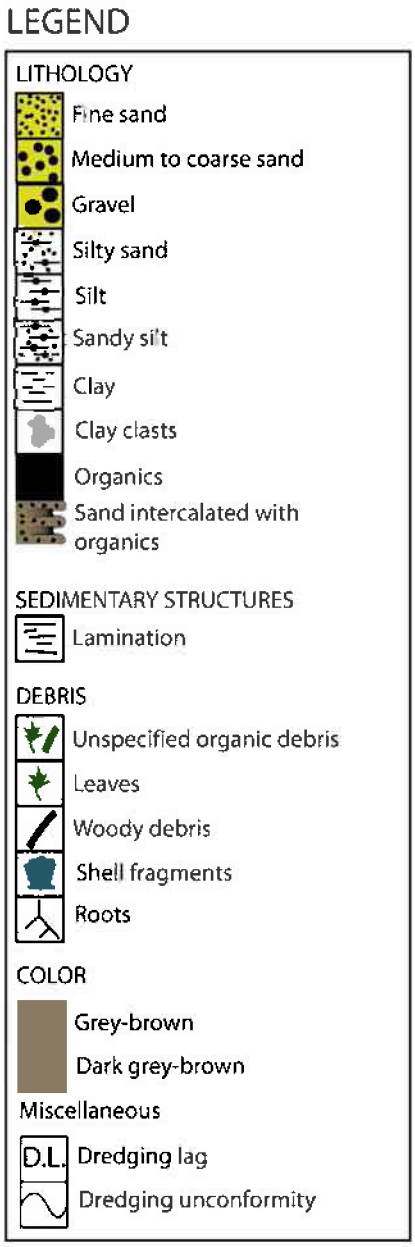


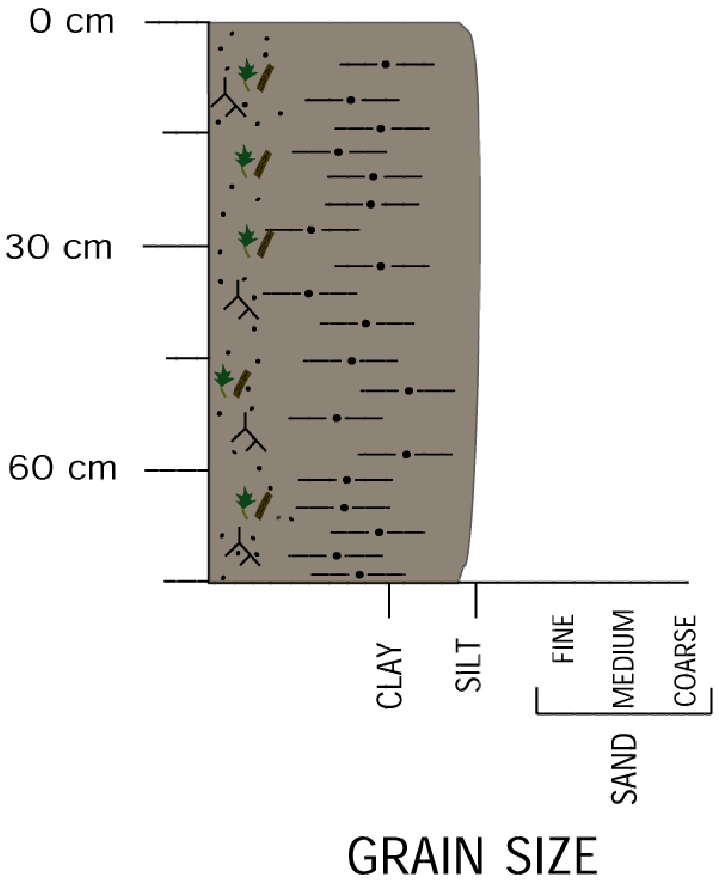
Figure U-22. Graphic Log for Core T71ND

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T71NE

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

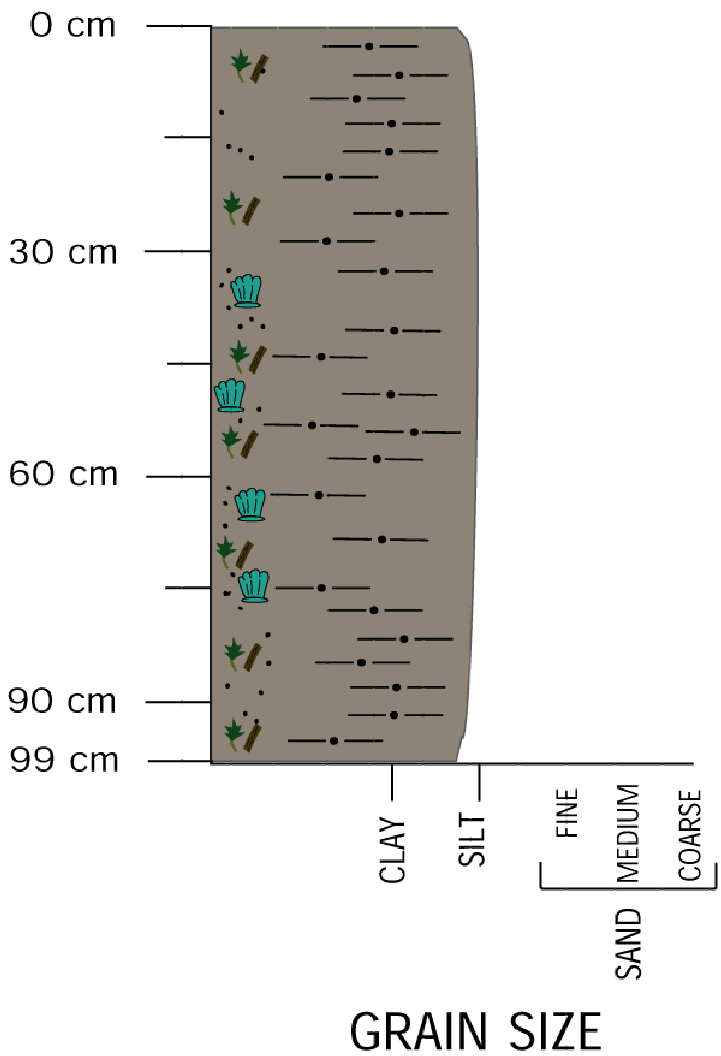
Figure U-23. Graphic Log for Core T71NE

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

CORE: T71NG

GRASSE RIVER

MASSENA, NY



LEGEND

LITHOLOGY

- Fine sand
- Medium to coarse sand
- Gravel
- Silty sand
- Silt
- Sandy silt
- Clay
- Clay clasts
- Organics
- Sand intercalated with organics

SEDIMENTARY STRUCTURES

- Lamination

DEBRIS

- Unspecified organic debris
- Leaves
- Woody debris
- Shell fragments
- Roots

COLOR

- Grey-brown
- Dark grey-brown

Miscellaneous

- D.L. Dredging lag
- Dredging unconformity

Figure U-24. Graphic Log for Core T71NG

PREPARED BY SLINGERLAND/EDMONDS fromBBL data and core photos (9/11/04)

Evaluation of Bottom Shear Stress Underneath Ice Jams in the Lower Grasse River

Alcoa Inc.
Massena, New York

April 2009

Table of Contents

SECTION 1 INTRODUCTION **1-1**

SECTION 2 OVERVIEW OF STUDY METHODOLOGY **2-1**

SECTION 3 EVALUATION OF DYNARICE ICE JAM MODEL RESULTS **3-3**
3.1 POTENTIAL IMPACTS OF 2003 ICE JAM EVENT 3-3
3.2 COMPARATIVE ANALYSIS OF ICE JAM SCENARIOS 3-5
3.2.1 Ice Jam Location Scenarios 3-6
3.2.2 Discharge-Ice Supply Scenarios 3-6
3.2.3 Extreme Discharge Scenario at T16 3-6
3.2.4 Downstream Boundary Scenario 3-7
3.2.5 Summary 3-7

SECTION 4 ESTIMATION OF EFFECTIVE BED STRESS **4-1**
4.1 SHEAR STRESS DUE TO MEAN CURRENT VELOCITY 4-1
4.2 EFFECTIVE BED STRESS 4-2

SECTION 5 TURBULENT FLOW MODELING **5-1**
5.1 UTILITY OF A RANS MODEL 5-1
5.2 GENERAL DESCRIPTION OF RANS MODEL 5-2
5.3 APPLICATION OF RANS MODEL 5-2

SECTION 6 RANS MODEL SIMULATION OF 2003 ICE JAM EVENT **6-1**
6.1 DEVELOPMENT OF MODEL INPUTS 6-1
6.2 EFFECTS OF RANDOM ICE JAM THICKNESS PROFILE 6-4
6.3 SIMULATION OF T16-2003 EVENT 6-5

SECTION 7 EFFECTIVE BED STRESS DURING 2003 EVENT **7-1**
7.1 METHOD FOR CALCULATING EFFECTIVE BED STRESS 7-1
7.2 RESULTS FOR T16-2003 EVENT 7-4
7.3 COMPARATIVE ANALYSIS OF ICE JAM SCENARIOS 7-5

SECTION 8 CONCLUSIONS **8-1**

SECTION 9 REFERENCES **9-1**

List of Tables

Table 3-1. Description of ice jam event scenarios.

Table 3-2. Average velocity, water depth, and ice jam thickness for ice jam scenarios.

Table 3-3. Scour-related results from DynaRICE modeling.

Table 7-1. Revised combinations of breakup discharge and ice thickness.

List of Figures

Figure 2-1. Methodology used to estimate effective bed stresses under the toe of an ice jam.

Figure 3-1. Comparison of DynaRICE results for the 2003 ice jam event at T3.5, T6.5 and T16: average velocity, water depth and ice jam thickness.

Figure 3-2. Comparison of DynaRICE results for the 2003 ice jam event at T3.5, T6.5 and T16: 0.6 m/s (2 ft/s) contour interval analysis.

Figure 3-3. Comparison of location scenarios to T16-2003 event: average velocity, water depth and ice jam thickness.

Figure 3-4. Comparison of location scenarios to T16-2003 event: 0.6 m/s (2 ft/s) contour interval analysis.

Figure 3-5. Comparison of discharge-ice supply scenarios to T16-2003 event: average velocity, water depth and ice jam thickness.

Figure 3-6. Comparison of discharge-ice supply scenarios to T16-2003 event: 0.6 m/s (2 ft/s) contour interval analysis.

Figure 3-7. Comparison of extreme discharge and downstream stage height scenarios to T16-2003 event: average velocity, water depth and ice jam thickness.

Figure 3-8. Comparison of extreme discharge and downstream stage height scenarios to T16-2003 event: 0.6 m/s (2 ft/s) contour interval analysis.

Figure 6-1. Relationship between standard deviation of ice jam thickness and average ice jam thickness.

Figure 6-2. Spatial variation of ice jam thickness, mean current velocity, and bottom shear stress for 15-m long section of random ice profile.
Figure 6-3. Frequency distribution of normalized mean current velocity for T16-2003 event.
Figure 6-4. Frequency distribution of normalized mean shear stress for T16-2003 event.
Figure 6-5. Numerical grid for STORM/CFD2000 simulation along 12-m long section of ice profile.
Figure 6-6. Predicted current velocities during T16-2003 event for 12-m long section of ice profile. This section is located approximately 110-120 m from the upstream boundary of the model domain (see Figure 6-9).
Figure 6-7. Predicted current velocities during T16-2003 event for 12-m long section of ice profile. This section is located approximately 280-290 m from the upstream boundary of the model domain (see Figure 6-11).
Figure 6-8. Predicted TKE during T16-2003 event: 0 - 75 m section.
Figure 6-9. Predicted TKE during T16-2003 event: 75 - 150 m section.
Figure 6-10. Predicted TKE during T16-2003 event: 150 - 225 m section.
Figure 6-11. Predicted TKE during T16-2003 event: 225 - 300 m section.

Figure 7-1. Configuration of water tunnel used in experiments conducted by Fredsoe et al. (2003).
Figure 7-2. Frequency distributions of bed stress during T16-2003 event for five ice profiles.
Figure 7-3. Frequency distributions of bed stress during T16-2003 event for combined ice profiles.
Figure 7-4. Frequency distribution of effective velocity during T16-2003 event.
Figure 7-5. Comparison of frequency distributions of effective bed stress for location scenarios to T16-2003 event: Loc-1, Loc-2, Loc-3 and Loc-4.
Figure 7-6. Comparison of frequency distributions of effective bed stress for location scenarios to T16-2003 event: Loc-5, Loc-6 and Loc-7.
Figure 7-7. Comparison of frequency distributions of effective bed stress for discharge-ice supply scenarios to T16-2003 event.
Figure 7-8. Comparison of bottom shear stress distributions for the original and revised Q-Ice-E scenarios.

Figure 7-9. Comparison of frequency distributions of effective bed stress to T16-2003 event: extreme discharge, stage-1 and stage-2 scenarios.

Figure 7-10. Cumulative frequency distribution of ratio of TKE component to effective bed stress.

Figure 7-11. Correlation between effective bed stress and Froude number.

SECTION 1
INTRODUCTION

The ice jam that occurred in the lower Grasse River in spring 2003 caused sediment bed scour in select portions of the river between T1 and T19. Alcoa Inc. (Alcoa) conducted a comprehensive investigation to understand the impacts of ice jam-related scour events on the fate and transport of PCBs in the lower Grasse River (see main report). One component of this investigation was computer model simulations of the 2003 ice jam event, which were performed to improve the understanding of the operative mechanism(s) that contributed to the observed scour. This modeling effort was undertaken by researchers at Clarkson University and involved the application of the numerical model DynaRICE, which simulates the complex relationships between river flow and ice cover dynamics. Specifically, DynaRICE was used to predict the transport and jamming of surface ice in the lower Grasse River during the 2003 event (see Appendix Q to the main report). Results of this modeling effort suggest that increased velocities underneath the toe of the ice jam alone, although elevated relative to ice-free conditions, were too low to cause substantive scour of river sediments and the cap material (i.e., 1:1 sand/topsoil cap mixture) placed in the river as part of the 2001 Capping Pilot Study (Alcoa, 2002) and that other operative mechanisms (e.g., turbulence generated by the rough underside of the ice jam) contributed to the scour observed in 2003 (see main report).

As part of the study described herein, additional modeling was conducted to simulate the two components of effective bed stress: 1) shear stress due to mean current velocity; and 2) stress resulting from the turbulence generated by the rough surface on the underside of the ice jam. For this effort, a Reynolds-averaged Navier-Stokes (RANS) model was applied, in conjunction with results from the DynaRICE model, and used to develop: 1) an understanding of the hydrodynamic processes generating turbulent forces on the sediment bed; and 2) a method for quantifying the forces acting on the sediment bed underneath the toe of the ice jam. This information is useful for designing an armored cap, which is being evaluated as a potential remedial technology for the river.

This memorandum presents the results of the DynaRICE and turbulence (RANS) modeling studies. Specifically, Section 2 presents an overview of study objectives and the methodology used to achieve these goals. Section 3 presents an evaluation of the DynaRICE model results for the 2003 ice jam event, as well as an assessment of the sensitivity of the model predictions to changes in various model inputs. Section 4 discusses the general approach used to estimate the effective bed stress caused by the increased velocities and turbulence generated underneath the toe of an ice jam. Development of the turbulence model and its application to the 2003 ice jam event are discussed in Sections 5 and 6, respectively, while the use of the model to support the design of an armored cap is presented in Section 7. Finally, conclusions drawn from the modeling studies are presented in Section 8.

SECTION 2
OVERVIEW OF STUDY METHODOLOGY

The primary objective of this study was to develop a rational method for estimating effective bed stress underneath the toe of an ice jam for a range of ice and flow conditions. Results of the modeling analyses were used in the design process for an armored cap, which is being evaluated as a potential remedial technology for the lower Grasse River.

The methodology used to calculate effective bed stress under an ice jam is somewhat complex, since it involves using two computer models and a relatively complicated analysis of the model results. Detailed descriptions of the application of the models (i.e., DynaRICE and a RANS model), along with the analyses of model results, are provided in the following sections of this report. An overview of study methodology is presented here so as to provide a comprehensive picture of the various components of the analyses and how the individual components fit together.

Two spatial scales are relevant for simulating turbulent flow under an ice jam. Large spatial scale parameters include mean current velocity under the ice jam (i.e., mean component of a turbulent flow), average water depth under the ice, and average ice jam thickness; "large scale" corresponds to horizontal spatial scales of approximately 20 meters (m) (66 feet [ft]) or larger. The DynaRICE model is used to simulate large-scale processes associated with flow under an ice jam; this information was averaged over space (to account for variations in the vicinity of the toe of the ice jam) and time (for the peak flow condition). Turbulence is generated by the rough underside of the ice; "small-scale" variations in ice jam thickness create the rough surface that generates turbulence and the spatial scale of these variations is about 1 m (3 ft). A RANS model (i.e., STORM/CFD2000, see Section 5) is used to simulate turbulent flow due to small-scale effects of the ice jam. Thus, both models are needed to properly simulate flow under the ice jam at the two spatial scales of importance.

Calculating effective bed stress underneath the ice jam, which depends on the mean current velocity and near-bed turbulence due to the rough underside of the ice, is accomplished for a particular ice jam event (e.g., the 2003 event) as follows:

- Use DynaRICE to predict the large-scale flow parameters: mean current velocity under the jam, water depth under the ice, and average ice jam thickness.

- Large-scale information from DynaRICE is used to develop model inputs for the STORM/CFD2000 model. The critical model input for STORM/CFD2000 is specification of the geometry for the rough underside of the ice jam, which has small-scale horizontal variations in ice jam thickness (and, hence, water depth under the jam) of approximately 1 m (3 ft). A random spatial profile of ice jam thickness is generated to represent the small-scale variability of ice jam thickness over the length of the ice jam toe such that the large-scale average ice jam thickness corresponds to the value predicted by DynaRICE. In addition, mean current velocity simulated by DynaRICE is used to specify the inlet velocity at the upstream boundary of the numerical grid for STORM/CFD2000.

- For a given flow condition and random ice profile, the turbulence model (STORM/CFD2000) is used to simulate current velocity and near-bed turbulence (represented as turbulent kinetic energy [TKE]) underneath the jam on small spatial scales (about 1 m). These two variables, predicted by STORM/CFD2000, are used to calculate effective bed stress along the length of the ice jam toe, which is about 300 m (980 ft) long.

- Effective bed stress is composed of two components: 1) shear stress due to current velocity; and 2) a fraction of the near-bed TKE, both of which are predicted by STORM/CFD2000). The amount of the near-bed TKE that contributes to effective bed stress is determined from experimental data collected in a water tunnel (Fredsoe et al. 2003).

The process described above is illustrated in Figure 2-1.

SECTION 3
EVALUATION OF DYNARICE ICE JAM MODEL RESULTS

The DynaRICE model is a state-of-the-art ice jam model that is capable of simulating the transport and jamming of ice in rivers. This model was applied to the Grasse River by Professor Hung Tao Shen and Dr. Lianwu Liu at Clarkson University. A complete description of model development, calibration and application is provided in Appendix Q to the main report.

The primary goal of this section is to gain some insight into the causes of spatial variability in bed scour during the 2003 event by analyzing DynaRICE results, which is addressed in the next sub-section. Uncertainty in various inputs to DynaRICE (e.g., flow rate, location of the ice jam toe) affects the predictions of the model, which introduces uncertainty into conclusions that may be derived from an analysis of the 2003 event results. The potential impact of uncertainty in model inputs was addressed through a comparative analysis of the 2003 event to a range of ice jam scenarios.

3.1 POTENTIAL IMPACTS OF 2003 ICE JAM EVENT

During the 2003 ice jam event, the toe of the ice jam formed at three locations in the lower Grasse River: 1) T3.5; 2) T6.5; and 3) T16. The extent and depth of bed scour in the vicinity of each toe location was variable, with the largest amount of scour occurring near T16. Differences in bed scour at the three jam toe locations are caused by a number of factors, including: erosion properties of bed sediment (e.g., grain size, porosity, cohesion, etc.); total bed shear stress under the jam; and duration that the toe was at a particular location. Sufficient information and data, especially duration of the jam toe at a particular location and configuration of the underside of the ice jam, are not available during the 2003 ice jam event to conduct a supportable evaluation of bed scour using the DynaRICE model. Therefore, the present analysis of DynaRICE results is limited to hydrodynamic effects (e.g., current velocity) and does not consider an analysis of sediment transport (i.e., bed scour) under an ice jam.

Three primary variables predicted by the DynaRICE model were evaluated: depth-averaged current velocity beneath an ice jam (*U*); water depth under the toe of the ice jam (*h*); and ice jam thickness (T_{ice}). Average values of these parameters in the vicinity of the toe of the ice jam at T3.5, T6.5 and T16 during the 2003 event are compared in Figure 3-1 (numeric values are presented in Table 3-2). These results indicate that average values of *U* and *h* are within about 15 percent (%) at the three locations, even though average ice jam thickness is about 40% to 60% greater at T16 than the two upstream transects. Thus, reasons for spatial variability in bed scour during the 2003 event cannot be directly inferred from these model results.

A better understanding of potential impacts of an ice jam on bed scour in the lower Grasse River may be developed through additional analysis of the DynaRICE simulations. Three parameters related to bed scour were developed from the model predictions: 1) surface area underneath the toe of the ice jam with velocities greater than 0.6 m/s (2 feet per second [ft/s]) (i.e., area within the 0.6 m/s contour interval); 2) average velocity within the 0.6 m/s contour interval; and 3) maximum velocity within the 0.6 m/s contour interval. The 0.6 m/s criterion is used as a threshold because it represents a current velocity above which significant bed scour may be expected based on past studies (Graf, 1971; United States Army Corps of Engineers [USACE], 1991). For convenience, these parameters will be referred to as the 0.6-mps parameters (e.g., 0.6-mps average velocity).

The 0.6-mps parameters at T3.5, T6.5 and T16 during the 2003 event are compared in Figure 3-2 (see Table 3-3 for numerical values). The 0.6-mps average velocity is approximately equal at each location. The 0.6-mps area, however, is about 50% greater at T16 than at T3.5 and T6.5. In addition, the 0.6-mps maximum velocity at T16 is 37% and 64% greater than the predicted maximum values at T3.5 and T6.5, respectively. These results are consistent with the observation of increased scour at T16. Thus, the 0.6-mps parameters appear to be useful measures for comparing the potential impacts of different ice jam scenarios.

3.2 COMPARATIVE ANALYSIS OF ICE JAM SCENARIOS

A range of scenario simulations were conducted to investigate the impacts of different input parameters on model results (see Appendix Q to the main report). Four general types of scenarios were simulated: 1) 2003 event with the toe of the ice jam specified at seven different locations (locations selected to represent a range of low bathymetric conditions in the river); 2) six events with estimated 100-year return frequencies (based on combinations of flow rate and ice jam thickness; hereafter referred to as discharge-ice supply scenarios); 3) an extreme discharge event (flow rate set equal to approximately two times the flow observed during the 2003 event) at T16; and 4) variation in downstream boundary condition (i.e., stage height; see Table 3-1). The 100-year simulations identified above (item #2) represent estimated return frequencies for combinations of river discharge and ice thickness at the time of ice breakup and, as such, are indicators of the potential magnitude of ice jam events; they are not direct predictors of the potential magnitude of sediment scour. Since not all ice jams result in sediment scour, other information (e.g., tree scar analysis) must be considered when ranking the severity of a particular event. The 100-year simulations presented herein were performed to understand the range of shear stresses that could be experienced by the river bed under different low probability ice jam events. Note that the combination of river discharge and ice thickness assumed in the extreme discharge event simulation (item #3) represents an event with a lower probability of occurrence relative to the 100-year scenarios (see Appendix Q to the main report).

The potential impacts of these scenarios were evaluated through comparisons to the results at T16 during the 2003 event; these comparisons were performed to estimate the severity of the simulated event relative to the 2003 event. This comparison is necessary for determining the validity of using the 2003 event results for remedial alternative design purposes (e.g., design of an armored cap). Numerical comparisons of model results for all scenario simulations are presented in Tables 3-2 and 3-3. For convenience, results at T16 during the 2003 event are referred to as the T16-2003 value.

3.2.1 Ice Jam Location Scenarios

For the seven location scenarios, U and T_{ice} are less than the T16-2003 values at all locations except at Loc-1 (T3) (see Figure 3-3 and Table 3-2). Similarly, predicted 0.6-mps areas are approximately equal to or less than the T16-2003 area at all locations except at Loc-1, where the 0.6-mps area is approximately two times larger than the T16-2003 area (Figure 3-4 and Table 3-3). The 0.6-mps average velocities at the seven locations are within 15% of the T16-2003 value. For the three upstream transects (T3, T13, and T20), the 0.6-mps maximum velocity is greater than the T16-2003 value, with the largest difference being 27%. The 0.6-mps maximum velocities at the four transects downstream of T20 are 22% to 53% less than the T16-2003 value. See Figure 3-4 for graphical comparisons of these scenario results.

3.2.2 Discharge-Ice Supply Scenarios

Average current velocities predicted for the discharge-ice supply scenarios (i.e., Q-Ice-A through Q-Ice-F) are similar in magnitude to the T16-2003 value, except for the Q-Ice-F scenario, which is significantly lower, presumably due to the relatively low flow rate during that event (Figure 3-5 and Table 3-2). Average water depth tends to decrease with decreasing flow rate (and increasing ice supply thickness) during the discharge-ice supply events. The Q-Ice-A and Q-Ice-B scenarios yield 0.6-mps areas that are 66% and 107% larger than the T16-2003 area (Figure 3-6 and Table 3-3). The 0.6-mps average and maximum velocities for scenarios Q-Ice-A, Q-Ice-B, Q-Ice-C and Q-Ice-D are greater than the T16-2003 values, while the Q-Ice-E values are approximately the same as T16-2003 values.

3.2.3 Extreme Discharge Scenario at T16

The extreme discharge simulation produced average U, h, and T_{ice} values that are 24%, 55% and 19% greater, respectively, than the T16-2003 values (Figure 3-7 and Table 3-2). The 0.6-mps area during the extreme event at T16 is about twice as large as the T16-2003 area (Figure 3-8 and Table 3-3). The extreme discharge and T16-2003 events are predicted to have

equal 0.6-mps average velocities, whereas the maximum velocity during the extreme event is 39% higher for the extreme discharge scenario.

3.2.4 Downstream Boundary Scenario

For this scenario, the T16-2003 event simulation was repeated with the stage height at the downstream boundary increased and decreased by 0.5 m (1.6 ft) with respect to the original value. It was found that adjusting the stage height at the downstream boundary of the model has minimal impact on simulation results. Comparisons of the two stage height scenarios to the T16-2003 event on Figures 3-7 and 3-8 show that this boundary condition has a minor effect on ice jam parameters that may affect bed scour.

3.2.5 Summary

The results presented in this section indicate that variations in location of the toe of the ice jam, flow rate and ice supply thickness affect the large-scale characteristics of an ice jam. The DynaRICE model predictions do not, however, include the effects of small-scale, random variations in ice jam thickness nor are the effects of turbulence explicitly incorporated into the model. As will be shown in the following sections of this report, the effects of small-scale random variations in ice jam thickness and turbulence generated under the ice jam are important. Thus, a reliable evaluation of the relative severity of the 2003 event can only be accomplished by analyzing the turbulent flow under the toe of an ice jam, in conjunction with accounting for small-scale variations in jam thickness.

Table 3-1. Description of ice jam event scenarios.

Scenario Designation	Report Section(1)	Description
T3.5-2003	2.1	2003 ice jam event, results at T3.5
T6.5-2003	2.1	2003 ice jam event, results at T6.5
T16-2003	2.1	2003 ice jam event, results at T16
Loc-1	3.1	Location scenario: T3
Loc-2	3.1	Location scenario: T13
Loc-3	3.1	Location scenario: T20
Loc-4	3.1	Location scenario: T30
Loc-5	3.1	Location scenario: T39
Loc-6	3.1	Location scenario: T50
Loc-7	3.1	Location scenario: T57
Q-Ice-A	3.2	Discharge-ice supply scenario: Q_{bk} = 10,617 cfs, h_i = 4 in(2)
Q-Ice-B	3.2	Discharge-ice supply scenario: Q_{bk} = 9,876 cfs, h_i = 10 in
Q-Ice-C	3.2	Discharge-ice supply scenario: Q_{bk} = 9,072 cfs, h_i = 16 in
Q-Ice-D	3.2	Discharge-ice supply scenario: Q_{bk} = 7,566 cfs, h_i = 22 in
Q-Ice-E	3.2	Discharge-ice supply scenario: Q_{bk} = 5,630 cfs, h_i = 25 in
Q-Ice-F	3.2	Discharge-ice supply scenario: Q_{bk} = 3,035 cfs, h_i = 29 in
Extreme flow	3.4	Extreme flow event: Q = 13,682 cfs
Stage-1	3.3	Downstream stage height: + 0.5 m
Stage-2	3.3	Downstream stage height: - 0.5 m

(1) Section number in Appendix Q to the main report that describes each scenario simulation.

(2) h_i is thickness of the upstream ice supply (ice cover thickness at the time of breakup).

Table 3-2. Average velocity, water depth, and ice jam thickness for ice jam scenarios.

Simulation Designation	Mean Current Velocity, *U* (m/s [ft/s])	Average Water Depth, *h* (m [ft])	Average Ice Jam Thickness, T_{ice} (m [ft])
T3.5-2003	0.67 [2.2]	1.8 [5.9]	1.8 [6.0]
T6.5-2003	0.67 [2.2]	2.0 [6.4]	2.1 [7.0]
T16-2003	0.76 [2.5]	1.8 [5.8]	3.0 [9.8]
Loc-1	0.76 [2.5]	1.3 [4.4]	3.9 [12.7]
Loc-2	0.58 [1.9]	2.0 [6.4]	2.3 [7.4]
Loc-3	0.61 [2.0]	2.0 [6.4]	2.4 [7.8]
Loc-4	0.46 [1.5]	2.2 [7.2]	1.9 [6.3]
Loc-5	0.40 [1.3]	1.8 [6.0]	1.9 [6.2]
Loc-6	0.40 [1.3]	1.6 [5.3]	2.0 [6.6]
Loc-7	0.58 [1.9]	1.5 [4.8]	2.3 [7.6]
Q-Ice-A	0.82 [2.7]	3.7 [12.2]	2.1 [6.9]
Q-Ice-B	0.91 [3.0]	2.7 [8.7]	3.8 [12.4]
Q-Ice-C	0.82 [2.7]	3.1 [10.2]	3.7 [12.2]
Q-Ice-D	0.79 [2.6]	2.3 [7.4]	3.6 [11.9]
Q-Ice-E	0.70 [2.3]	1.8 [5.8]	3.2 [10.6]
Q-Ice-F	0.46 [1.5]	1.3 [4.3]	2.6 [8.4]
Extreme discharge	0.94 [3.1]	2.7 [9.0]	3.6 [11.7]
Stage-1	0.70 [2.3]	1.8 [5.8]	3.0 [9.9]
Stage-2	0.67 [2.2]	1.7 [5.7]	3.0 [9.9]

Table 3-3. Scour-related results from DynaRICE modeling.

Simulation Designation	Area Within 0.6-mps Contour (hectares [acres])	Average Velocity Within 0.6-mps Contour (m/s [ft/s])	Maximum Velocity Within 0.6-mps Contour (m/s [ft/s])
T3.5-2003	1.9 [4.6]	0.79 [2.6]	1.3 [4.3]
T6.5-2003	2.0 [4.9]	0.85 [2.8]	1.1 [3.6]
T16-2003	3.0 [7.3]	0.82 [2.7]	1.8 [5.9]
Loc-1	5.8 [14.4]	0.94 [3.1]	1.9 [6.2]
Loc-2	2.8 [6.8]	0.91 [3.0]	2.1 [6.9]
Loc-3	1.9 [4.7]	0.94 [3.1]	2.3 [7.5]
Loc-4	3.2 [8.0]	0.73 [2.4]	0.88 [2.9]
Loc-5	1.6 [3.9]	0.76 [2.5]	0.85 [2.8]
Loc-6	0.81 [2.0]	0.79 [2.6]	1.1 [3.6]
Loc-7	1.3 [3.1]	0.94 [3.1]	1.4 [4.6]
Q-Ice-A	4.9 [12.1]	1.1 [3.5]	2.9 [9.5]
Q-Ice-B	2.1 [15.1]	0.98 [3.2]	2.9 [9.5]
Q-Ice-C	3.1 [7.7]	1.0 [3.3]	2.9 [9.5]
Q-Ice-D	3.5 [8.7]	0.88 [2.9]	2.1 [7.0]
Q-Ice-E	2.9 [7.1]	0.82 [2.7]	1.6 [5.2]
Q-Ice-F	0.57 [1.4]	0.64 [2.1]	0.70 [2.3]
Extreme discharge	6.1 [15.0]	0.82 [2.7]	2.5 [8.2]
Stage-1	2.6 [6.4]	0.79 [2.6]	1.8 [5.9]
Stage-2	2.6 [6.4]	0.85 [2.8]	1.9 [6.1]

SECTION 4
ESTIMATION OF EFFECTIVE BED STRESS

As discussed in Section 2, the primary goal of this study is to develop a method for estimating bottom shear stress under an ice jam. This section presents the theoretical basis for calculating effective bed stress, which is composed of two components: 1) shear stress due to mean current velocity; and 2) stress due to a portion of the near-bed turbulent energy (TKE).

4.1 SHEAR STRESS DUE TO MEAN CURRENT VELOCITY

An approach for calculating bottom shear stress, which is a measure of the turbulent force impacting the sediment bed, underneath an ice jam was developed by Beltaos (2001). This method is used to calculate bottom shear stress (τ_m) due to the mean current velocity using:

$$\tau_m = 0.125\, \rho\, f\, U^2 \tag{4-1}$$

where U is the mean current velocity (i.e., mean component of a turbulent flow); f is the bottom friction factor; and ρ is the density of water. The bottom friction factor (f) depends on: effective bed roughness (d_{bed}); effective roughness of the underside of the ice jam (d_{ice}); water depth under the ice jam (h); and ice jam thickness (T_{ice}), and is calculated as follows (Beltaos, 2001):

$$f = 0.14\, (d_{bed}/d_o)^{1/2}\, [\, 1 + (d_{bed}/d_{ice})^{1/2}\,]^2\, (T_{ice} / h) \tag{4-2}$$

where the composite effective roughness (d_o) is given by:

$$d_o = [\, 0.5\, (\, d_{bed}^{1/2} + d_{ice}^{1/2}\,)\,]^2 \tag{4-3}$$

The effective roughness of the underside of the ice jam is estimated using (Beltaos, 2001):

$$d_{ice} = 0.4\ T_{ice} \tag{4-4}$$

As discussed in Section 3, DynaRICE was used to predict conditions in the vicinity of T16 during the 2003 event. Results from that model simulation indicate that average conditions near the ice jam toe at T16 were: T_{ice} = 3.0 m (9.8 feet [ft]); h = 1.8 m (5.9 ft); and U = 0.76 meters per second (m/s; 2.5 ft/s). Using these parameter values in the Beltaos approach, and assuming d_{bed} = 2 millimeters (mm), yields a friction factor (f) of 0.021 and a bottom shear stress of 1.5 Pascals (Pa). Using erosion potential parameters developed from Grasse River data (Alcoa, 2001), a shear stress of 1.5 Pa will erode less than 0.01 m of cohesive sediment in the river. Thus, this shear stress value is not high enough to have caused the large scour depths (up to about 1 m) observed in the vicinity of T16. Note that the lower Grasse River hydrodynamic model used an effective bed roughness of 1.2 mm (Alcoa, 2001), which yields a friction factor of 0.016 and a bottom shear stress of 1.1 Pa; the bed roughness used in the Grasse River model was determined through model calibration. Thus, assuming an effective bed roughness of 2 mm in these calculations produces conservative results.

4.2 EFFECTIVE BED STRESS

Beltaos (2001) developed the formulations presented in Section 4.1 based on a longitudinal force balance on flow between the sediment bed and an ice jam. This longitudinal force balance does not account for turbulent energy impacting the bed in the vertical plane. Thus, turbulent forces acting on the sediment bed during the 2003 event as a result of turbulence generated by the rough underside of the ice jam are not accounted for explicitly in the Beltaos approach and, hence, likely account for the underestimation of bottom shear stress. A more appropriate quantity to consider in this analysis is effective bed stress, which represents the sum of all turbulent forces acting on the sediment bed. It is assumed in this study that turbulence generated along the underside of the ice jam is advected toward the sediment bed, where this turbulent energy (referred to as turbulent kinetic energy or TKE) combines with bottom shear

stress due to currents and increases the total turbulent force experienced by the bed. This situation is analogous to turbulence generated by breaking waves at the water surface being advected downward through the water column and increasing the turbulent forces on the sediment bed (Fredsoe et al., 2003).

Based on the assumption that turbulence generated under the ice jam is advected to the bed where it increases the bottom shear stress, the effective bed stress (τ_{eff}) is formulated such that it is composed of two components (Fredsoe et al., 2003): 1) shear stress due to mean current velocity (τ_m); and 2) a portion of the TKE in the near-bed layer (see Section 7 for a discussion of the near-bed layer). This approach is formulated as:

$$\tau_{eff} = \tau_m + \alpha \, TKE_{nb} \tag{4-5}$$

where TKE_{nb} is total kinetic energy in the near-bed layer (units of L^2/T^2, e.g., m^2/s^2) and α is a proportionality constant (units of M/L^3, e.g., kg/m^3). A method for estimating the value of α is presented in Section 7.

Calculation of effective bed stress thus requires determining near-bed TKE under the toe of the ice jam. A method for predicting TKE in this type of flow involves the use of a RANS model (Pope, 2000). In this study, a RANS model called STORM/CFD2000, developed by Adaptive Research Inc. (Alhambra, California), is used to simulate turbulent flow under the ice jam and to provide estimates of near-bed TKE.

The overall approach for estimating effective bed stress under the toe of an ice jam is to first predict large-scale ice jam parameters (e.g., U, h, and T_{ice}) using DynaRICE. This information is then used to develop inputs for STORM/CFD2000, which simulates local-scale turbulent flow underneath the toe of the ice jam. Finally, results of the DynaRICE and STORM/CFD2000 models are combined to calculate effective bed stress using Equation 4-5.

Initially, it was envisioned that STORM/CFD2000 would be used to calculate both components of effective bed stress in Equation 4-5. However, a review of the specification of boundary conditions in STORM/CFD2000 indicated that this approach is problematic because a smooth boundary is assumed in the model. This assumption produces significant under-prediction of bed shear stress due to mean current velocity (τ_m). Thus, the approach described above, where DynaRICE results are used to estimate the local mean current velocity that is used to calculate τ_m, yields more conservative and realistic results.

SECTION 5
TURBULENT FLOW MODELING

Determining the effective bed stress under an ice jam toe requires estimation of near-bed TKE levels, as discussed in Section 4. Calculating near-bed TKE is accomplished through simulation of turbulent flow underneath an ice jam. This type of modeling requires use of a RANS hydrodynamic model. This section discusses: 1) the need for a RANS model; 2) general description of the RANS model applied in this study; and 3) how the RANS model was used.

5.1 UTILITY OF A RANS MODEL

Generally, flow underneath the toe of an ice jam is highly turbulent[1], with a significant amount of turbulence generated by the rough underside of the ice. The existence of substantial turbulence under an ice jam is evident in experiments conducted by USACE researchers at the Cold Regions Research and Engineering Laboratory (CRREL), where flume tests were conducted to investigate bed scour underneath an ice jam (Hains and Zabilansky, 2004). Results of those experiments indicate that bed scour occurs underneath a laboratory ice jam when the mean current velocity is less than the critical velocity for initiation of scour, indicating that TKE generated by the rough ice surface contributes to the effective bed stress.

The Beltaos (2001) approach attempts to incorporate the effects of this ice roughness on bottom roughness (see Equations 4-2 to 4-4). This approach, however, does not explicitly account for turbulence effects. Thus, the contribution of turbulence generated by the rough ice needs to be explicitly incorporated into the calculation of effective bed stress.

Determining the amount of turbulence generated in the flow underneath an ice jam is accomplished by application of a RANS model (Pope, 2000). This type of hydrodynamic model solves the conservation of mass and momentum equations, but includes the effects of turbulence

[1] For a current velocity (U) of 0.76 m/s and water depth under the ice jam (h) of 1.8 m, the Reynolds number ($R_e = U\,h\,/\,v$) is 855,000, where the kinematic viscosity of water (v) at 4°C is 1.6 x 10^{-6} m^2/s.

through incorporation of a turbulence closure sub-model. A widely-used turbulence closure model is the k-ε model, which consists of transport equations for turbulent kinetic energy (TKE or k in the nomenclature) and dissipation rate of TKE (ε).

5.2 GENERAL DESCRIPTION OF RANS MODEL

The RANS model used in this study is STORM/CFD2000. The general characteristics of the model are: time-dependent; three-dimensional; k-ε turbulence closure sub-model; and boundary-fitted numerical grid. A full description of the theoretical structure of STORM/CFD2000 is provided in Adaptive Research (2002). A validation study was conducted to evaluate the reliability of STORM/CFD2000 (Adaptive Research, 2000). Three validation tests were used to compare model results to known analytical and test-case problems: 1) radiative heat transfer in a triangular oven; 2) one-dimensional heat transfer; and 3) free convection in a square cavity. In addition, two validation tests involved comparisons to published experimental data: 1) free convection, conjugate and radiative heat transfer within a nuclear storage facility; and 2) turbulent circular jet. These validation tests, combined with application of STORM/CFD2000 to a number of other complex flow problems, indicate that this model is capable of simulating turbulent flow underneath an ice jam.

5.3 APPLICATION OF RANS MODEL

A primary objective of this study is to calculate effective bed stress in the vicinity of the toe of an ice jam. Calculating effective bed stress requires a combination of the model results produced by DynaRICE and STORM/CFD2000. The large-scale features of flow under an ice jam (i.e., U, h, and T_{ice}) are simulated using DynaRICE. These large-scale parameters are then used as inputs to STORM/CFD2000, which simulates turbulent flow underneath the ice jam and incorporates the effects of small-scale variations in ice jam thickness under the jam. In this context, “large-scale” refers to spatial scales on the order of grid cells in DynaRICE, which is approximately 20 m (66 ft). “Small-scale” variations correspond to spatial scales of

approximately 1 m (3 ft); modeling of turbulent flow under an ice jam using STORM/CFD2000 is conducted using grid spacing corresponding to these small-scale variations.

Effective bed stress (τ_{eff}) is calculated in two steps. First, shear stress due to mean current velocity (τ_m) is calculated using mean current velocity (U) information from DynaRICE. Second, near-bed TKE predicted by STORM/CFD2000 (i.e., TKE is predicted by the k-ε turbulence closure sub-model) is used to estimate the contribution of ice-generated turbulence to the effective bed stress. These two components are summed to provide an estimate of τ_{eff} underneath the toe of an ice jam.

SECTION 6
RANS MODEL SIMULATION OF 2003 ICE JAM EVENT

Simulation of turbulent flow underneath the ice jam toe during the 2003 event requires specification of various model inputs, including: geometry of the ice jam (i.e., spatially variable ice jam thickness) and incoming flow rate at the upstream boundary of the model domain. The development of model inputs is presented in Section 6.1, with the focus of that discussion being on a procedure to generate a random ice jam thickness profile to represent the rough underside of the ice jam. The effects of a random ice jam thickness profile on water depth and current velocity, which are found to be significant, are discussed in Section 6.2. Finally, results from the RANS (i.e., STORM/CFD2000) simulation of the 2003 event are presented in Section 6.3.

6.1 DEVELOPMENT OF MODEL INPUTS

Results from the DynaRICE simulation of the 2003 ice jam event indicate that the jam toe extended along an approximate 300-m stretch of the lower Grasse River in the vicinity of T16. As discussed in Section 3, large-scale average values for this region of the ice jam are: U_{ave} = 0.76 m/s (2.5 ft/s); h_{ave} = 1.77 m (5.8 ft); T_{ice} = 3.0 m (9.8 ft). These large-scale parameter values form the basis of inputs to STORM/CFD2000 for the 2003 ice jam simulation.

Estimating the distribution of effective bed stress under the 2003 ice jam at T16 was accomplished by using STORM/CFD2000 to simulate flow in a two-dimensional plane, which represents the longitudinal axis along the river (x-axis) and vertical axis in the water column (y-axis), under the ice jam. While it is possible to simulate three-dimensional flow under the jam by accounting for lateral variations in ice jam thickness and water depth, this added complexity would not significantly improve model accuracy or provide a better estimate of the distribution of τ_{eff} under the ice jam.

As previously discussed, DynaRICE predicts average ice jam thickness on the scale of the numerical grid for that model, which is approximately 20 m (66 ft). In an ice jam, local ice

jam thickness (T_{loc}) is a combination of the large-scale average thickness (T_{ice}) and a randomly varying component (T_{ran}). The random variations in ice jam thickness occur on relatively small horizontal scales on the order of 1 m (3 ft). The small-scale, random variations in ice jam thickness are important because these features of the jam are a primary factor in generating turbulence.

Since DynaRICE predicts large-scale ice jam geometry (i.e., T_{ice}), a method is needed to approximate small-scale, random variations in ice thickness under the jam. Fortunately, data exist for these small-scale thickness variations (Beltaos, 2001). Measurements of ice jam profiles were made on the Restigouche, Saint John, and Matapedia Rivers in Canada. Generally, these data show that the random fluctuations in ice thickness under a jam are normally distributed about a mean value (Beltaos, 2001). In addition, the standard deviation of ice jam thickness (s_{ice}) was determined from data collected during 20 sampling events on the three rivers (see Table 2 in Beltaos, 2001). The following correlation (Figure 6-1) was developed between s_{ice} and ice jam thickness (T_{ice}):

$$s_{ice} = 0.306\, T_{ice} + 0.043 \text{ for } T_{ice} \leq 3 \text{ m}$$

$$= 0.96 \text{ for } T_{ice} > 3 \text{ m} \qquad (6\text{-}1)$$

where s_{ice} and T_{ice} have units of meters. As a first-order approximation, the assumption was made that s_{ice} is constant for T_{ice} greater than 3 m (i.e., equal to the linear regression value for T_{ice} = 3 m) because only two data points exist for ice jam thickness greater than 3 m; this approximation is reasonable because minimal data make it difficult to develop a more complex relationship between T_{ice} and s_{ice} for T_{ice} > 3 m. The R^2-value for the correlation is 0.80.

For the 2003 event, a random ice jam thickness profile was generated as follows. Within the 300-m length of the 2003 ice jam toe at T16, DynaRICE predicted longitudinal variation in the laterally-averaged value of T_{ice}, with this parameter ranging between 2.69 and 3.45 m (8.8 and 11.3 ft) in the 300-m span of the jam toe. Note that the overall average of T_{ice} in this region

is 3.0 m (9.8 ft). Variations in laterally-averaged T_{ice}, however, cause relatively small variations in s_{ice}, which range from 0.87 to 0.96 m (2.9 to 3.1 ft). These spatial variations in T_{ice} and s_{ice} were incorporated into the 300-m longitudinal profile of the T16-2003 ice jam. This profile was generated on a longitudinal grid with a horizontal spacing of 1.5 m (4.9 ft). The local ice jam thickness at each grid point was determined using:

$$T_{loc} = T_{ice} + \lambda\, s_{ice} \tag{6-2}$$

where λ is a normally-distributed random number with mean of zero and standard deviation of one. Note that the random component of thickness is referred to as T_{ran} (= $\lambda\, s_{ice}$).

To prevent T_{ran} from becoming unrealistically large (i.e., causing the laterally-averaged ice jam thickness to approach the bed), the maximum value of T_{ran} was set at 1.34 m, which corresponds to values of 4.34 m (14.2 ft) and 0.43 m (1.4 ft) for local ice jam thickness and water depth under the jam toe, respectively. For this maximum value of T_{ran}, the local mean current velocity is 2.8 m/s (8.2 ft/s) during the 2003 event. Typically, for current velocities greater than about 2 m/s (6.6 ft/s), ice will be eroded from the underside of an ice jam; critical velocities for ice erosion range from 1.2 to 2.4 m/s (3.9 to 7.9 ft/s) (USACE, 1999). Thus, setting a maximum value of T_{ran} is a reasonable assumption because an ice jam may start to erode before this ice jam thickness occurs. In addition, this restriction on T_{ran} was applied to no more than one grid point (out of a total of 200 grid points) in each of the five random profiles used to evaluate the 2003 event, indicating that this assumption has minimal effect on simulation results. A 15-m section of the random ice profile is shown on the top panel of Figure 6-2. Note that the average values of T_{ice} and h (i.e., 3.00 and 1.77 m, respectively) are preserved in the 300-m random profile.

6.2 EFFECTS OF RANDOM ICE JAM THICKNESS PROFILE

For average ice jam thickness and water depth conditions, the mean current velocity is 0.76 m/s (2.5 ft/s) for the T16-2003 jam. Variations in mean current velocity under the ice jam due to random ice jam thickness (or water depth) fluctuations are estimated using a conservation of mass approach. The local water depth (h_{loc}) is given by:

$$h_{loc} = h_{ave} - T_{ran} \tag{6-3}$$

where h_{ave} is average water depth. The local mean current velocity (U_{loc}) is

$$U_{loc} = (h_{ave}/h_{loc})\ U_{ave} \tag{6-4}$$

Variations in U_{loc} for a 15-m section of the random ice jam profile are shown on the middle panel of Figure 6-2. For this particular section, changes in current velocity relative to U_{ave} range from minor to moderate due to the geometry of this portion of the profile. Larger variations in U_{loc} occur in regions where h_{loc} is significantly different from h_{ave}. This result is reflected in the frequency distribution of mean current velocity under the ice jam presented in Figure 6-3, where U_{loc} is normalized with respect to U_{ave}. Random variations in ice jam thickness (and, hence, water depth under the jam) cause the mean current velocity to be increased by up to a factor of four relative to the average velocity; approximately 10% of the area under the jam experiences mean current velocities that are more than two times greater than U_{ave}.

Bottom shear stress due to mean current velocity (τ_m) under the random ice profile is estimated using Equation 4-1. The resulting variability in τ_m is shown on Figures 6-2 and 6-4. The frequency distribution of normalized shear stress (Figure 6-4) shows that the maximum shear stress is approximately 15 times greater than the median shear stress (2.1 Pa), with about 25% of the area exposed to shear stresses greater than 4 Pa.

These results demonstrate that including random variations in ice jam thickness in the analysis significantly increases local values of mean current velocity and associated bottom shear stress. Thus, the simplified analysis of bottom shear stress discussed in Section 4 produces an underestimated value for two reasons: 1) use of average ice jam thickness instead of accounting for local, random variations; and 2) neglect of TKE effects. Inclusion of near-bed turbulent energy into the effective bed stress requires application of STORM/CFD2000.

6.3 SIMULATION OF T16-2003 EVENT

Flow underneath the ice jam is simulated using STORM/CFD2000, with the model simulating two-dimensional hydrodynamics in the longitudinal and vertical planes. The model effectively simulates flow in a conduit, with the ice jam and sediment bed forming the upper and lower walls, respectively, of the conduit. The numerical grid for the T16-2003 event is 300-m long and uses 400 longitudinal grid cells with a size of 0.75 m (2.5 ft). The water column between the sediment bed and the ice jam varies in depth due to the random variations in ice jam thickness; the sediment bed is assumed to be flat. A boundary-fitted grid, with 20 layers in the vertical, is used to discretize the water column. Numerical experiments were conducted during initial development of the model to evaluate the effect of grid resolution on model predictions. The results of these numerical experiments demonstrated that increasing grid resolution, compared to the numerical grid described above (i.e., 20 layers in the vertical), had minimal effect on model results (i.e., prediction of TKE_{nb} values, which are used to calculate effective bed stress). A portion of the numerical grid is shown on Figure 6-5.

Current velocity at the upstream (inlet) boundary of the model is set at 0.76 m/s (2.5 ft/s), which corresponds to the average current velocity for the T16-2003 event. With this inlet velocity, the steady-state velocity distribution under the ice jam was predicted. Examples of velocity distributions at two 12-m long sections of the jam are presented on Figures 6-6 and 6-7; these velocity distributions are at two locations (i.e., about 110-120 and 280-290 m from the upstream boundary of the model domain) along the same ice profile. The ability of the model to

simulate complicated flow patterns due to the complex geometry under the ice jam is illustrated in these figures.

Prediction of TKE under the jam is the primary reason for applying STORM/CFD2000 to this problem. The model explicitly simulates the production, dissipation and transport of TKE through use of a k-ε turbulence closure submodel. The predicted spatial distribution of TKE, which has units of square meters per square seconds (m^2/s^2), for steady-state conditions during the T16-2003 event is shown on Figures 6-8 through 6-11 (each figure presents a 75-m long portion of the ice jam). These figures show that TKE is generated at certain locations, transported, and eventually dissipated. The primary areas of TKE generation occur immediately downstream of contractions under the ice jam. The geometry of the channel upstream and downstream of a contraction affects the level of TKE; significantly different levels of TKE can result at two locations with similar water depths at the contraction point due to geometry differences. Presumably, the random nature of the ice jam thickness and water depth contributes to the differences in predicted TKE.

SECTION 7
EFFECTIVE BED STRESS DURING 2003 EVENT

The primary goal of this study (i.e., to calculate effective bed stress) is realized in this section by using RANS model results in Equation 4-5. Prior to applying this formulation, the proportionality constant (α) for the TKE component of effective bed stress must be determined. A method for estimating α from experimental data is presented in Section 7.1, along with other details related to processing of RANS model output. Presentation and discussion of results for the 2003 event and a comparative analysis to various ice jam scenarios are provided in Sections 7.2 and 7.3, respectively.

7.1 METHOD FOR CALCULATING EFFECTIVE BED STRESS

As indicated in Equation 4-5, effective bed stress is the sum of two components due to: 1) mean current velocity; and 2) near-bed TKE. The TKE component of bed shear stress is proportional to the near-bed TKE, where the proportionality constant is denoted as α. The value of α must be estimated from experimental data; it cannot be determined from theoretical analysis.

A recent experimental investigation of externally-generated turbulence on bed shear stress was conducted by Fredsoe et al. (2003). The objective of that study was to simulate the turbulence in the wave boundary layer under broken waves in the swash zone (i.e., zone on a beach where waves are breaking). This was accomplished by conducting experiments in a U-shaped, oscillating water tunnel, where water was pumped back and forth through the test section with a frequency of 9.72 seconds to represent wave-generated turbulence (Fredsoe et al., 2003). In the test section, perforated obstructions were attached to the roof of the water tunnel; the obstructions generated turbulence that was advected to the tunnel bed (see Figure 7-1).

Measurements of maximum bed shear stress were made for three conditions in the water tunnel: 1) undisturbed (i.e., no obstructions); 2) low-porosity obstructions; and 3) high-porosity

obstructions. To ensure dynamic similarity between different experimental conditions, the Reynolds number (*Re*) needs to be equivalent, where:

$$Re = U_{om}\, a / \nu \tag{7-1}$$

and U_{om} is the maximum velocity in the outer flow region, a is the amplitude of outer-flow motion, and ν is the kinematic viscosity of water. For $Re = 1.7 \times 10^6$, the maximum shear stresses for the undisturbed, low-porosity and high-porosity cases are 2.2, 4.0, and 4.1 Pa, respectively (Fredsoe et al., 2003). Thus, the externally-generated turbulence increases bottom shear stress by a factor of two for these experimental conditions. In addition, these results indicate that the porosity of the obstructions, which varied by a factor of 64 between the low- and high-porosity cases, has minimal impact on bottom shear stress.

The results of the Fredsoe et al. (2003) experiments are used to estimate the value of α as follows. Flow in the water tunnel, with and without obstructions, was simulated using STORM/CFD2000. Geometry information for the water tunnel is provided in Fredsoe et al. (2003); this information was used to construct two numerical grids to simulate flow in the water tunnel, one without obstructions (undisturbed case) and the other with obstructions. The small-scale flow within the obstructions could not be simulated using STORM/CFD2000 so, as a first-order approximation, the obstructions were treated as solid boundaries in the model. This approximation is valid because the experimental results indicate that the porosity of the obstructions has minimal impact on bottom shear stress.

Experimental conditions in the water tunnel for $Re = 1.7 \times 10^6$ correspond to $U_{om} = 1.10$ m/s (3.6 ft/s). Two simulations were conducted with U_{om} set at 1.10 m/s (3.6 ft/s): 1) no obstructions; and 2) with obstructions. For case 1 (no obstructions), it is assumed that negligible TKE is generated by the flow, so:

$$\tau_{eff,1} = \tau_{m,1} \tag{7-2}$$

where $\tau_{eff,1}$ is effective bed stress for case 1 and $\tau_{m,1}$ is shear stress due to mean current velocity. For case 2 (with obstructions), the effective bed stress is:

$$\tau_{eff,2} = \tau_{m,1} + \alpha\, TKE_2 \tag{7-3}$$

where TKE_2 is the near-bed TKE. The results of Fredsoe et al. (2003) indicate that for these experimental conditions:

$$\tau_{eff,1} / \tau_{eff,2} = 2.2 / 4.05 = 0.54 \tag{7-4}$$

where effective bed stress for case 2 ($\tau_{eff,2}$) is assumed to be the average value of the low-porosity and high-porosity obstruction tests. Thus, combining Equations 7-3 and 7-4 yields:

$$\alpha = 0.85\ \tau_{m,1} / TKE_2 \tag{7-5}$$

where $\tau_{m,1}$ is determined from case 1 simulation results. Near-bed TKE for case 2 (TKE_2) is estimated by assuming that the average TKE in the bottom boundary layer is representative of TKE_2. The bottom boundary layer thickness (δ) was determined to be 1.8 mm for the no-obstructions, low-porosity and high-porosity cases (Fredsoe et al., 2003). For the case 2 simulation, the model predicted TKE at the bed surface (Y_1 = 0) and at the first grid point above the bed, located at Y_2 = 5.5 mm. A valid approximation for estimating TKE between Y_1 and Y_2 is that TKE varies linearly between these two points. Thus, the average TKE in the bottom boundary layer corresponds to TKE at 0.9 mm above the bed, so that:

$$TKE_2 = 0.84\ TKE_2(Y_1) + 0.16\ TKE_2(Y_2) \tag{7-6}$$

where $TKE_2(Y_1)$ and $TKE_2(Y_2)$ are predicted values of TKE for case 2 at 0 and 5.5 mm above the bed, respectively. This procedure yielded a value of 0.33 kg/m^3 for α.

Near-bed TKE must be estimated for calculation of effective bed stress under the ice jam. Similar to the situation for the water tunnel simulation discussed above, TKE is predicted at the bed surface (Y_1 = 0) and at the first grid point above the bed (Y_2). For the water tunnel simulation, the bottom boundary layer thickness is clearly an appropriate averaging height for near-bed TKE. An appropriate averaging height is not apparent for the ice jam simulations. Thus, it is assumed that the best estimate of near-bed TKE (TKE_{nb}) for modeling flow under the ice jam is the average of TKE at Y_1 and Y_2, or:

$$TKE_{nb} = 0.5\ (TKE(Y_1) + TKE(Y_2)) \tag{7-7}$$

This approximation is used in all of the simulations discussed below.

7.2 RESULTS FOR T16-2003 EVENT

Predicted current velocities and near-bed TKE are used to calculate τ_{eff} and τ_m underneath the 300-m long ice jam toe during the T16-2003 event (Figure 7-2). The median value of the mean shear stress (τ_m) is about 2.1 Pa; τ_m ranges from approximately 0.4 to 20 Pa. The impact of near-bed TKE on τ_{eff} is significant, with the median value for τ_{eff} (about 8 Pa) being about four times larger than the median value of τ_m; τ_{eff} ranges from approximately 1 to 90 Pa.

The potential impact of the ice jam thickness profile, which is not unique due to its random nature, on model predictions was investigated by generating four additional random profiles. The T16-2003 simulation was repeated using each of these four profiles. The frequency distributions of τ_{eff} and τ_m for all five ice profiles are shown on Figure 7-2. These results show that the predicted bed stress distribution is not dependent on the ice profile,

provided that each random profile is created using the same average and standard deviation for ice jam thickness.

Improved estimates of the distributions of τ_{eff} and τ_m are achieved by combining the results of all five T16-2003 simulations (Figure 7-3). Both distributions are approximately log-normally distributed. The median value of τ_{eff} is 7.5 Pa, with a range of 0.6 to about 90 Pa.

Incorporation of the STORM/CFD2000 results into the armored cap design process requires not only the total shear stress under the jam toe (i.e., Shields method), but also requires conversion of the predicted effective bed stress to an effective velocity (U_{eff}) for use in an alternate design methodology (i.e., Isbash equation). As a first-order approximation, assume that the median of the mean shear stress (2.1 Pa) is related to the average velocity (0.76 m/s), which results in a bottom friction factor (f) of 0.0291. Assuming that the friction factor is approximately constant, Equation 4-1 is rearranged such that:

$$U_{eff} = (8\ \tau_{eff} / \rho f)^{1/2} \qquad (7\text{-}8)$$

where f is set equal to 0.0291.

The effective bed stresses (τ_{eff}) for the T16-2003 event were converted to effective velocities; the frequency distribution of U_{eff} is shown on Figure 7-4. Similar to the τ_{eff} distribution, the effective velocities are log-normally distributed. The median value of U_{eff} is 1.5 m/s (4.9 ft/s), with a range of 0.43 to 5.2 m/s (1.4 to 17 ft/s).

7.3 COMPARATIVE ANALYSIS OF ICE JAM SCENARIOS

An important consideration in the armor design process is whether or not the T16-2003 simulation represents an ice jam event with sufficiently low frequency that it can be confidently specified as the design event. This issue is addressed by simulating flow under an ice jam with

STORM/CFD2000 for the various scenarios listed in Table 3-1 and comparing those results to the T16-2003 simulation.

The seven-location scenario results are compared to the T16-2003 event on Figures 7-5 and 7-6. The frequency distributions of τ_{eff} on these figures show that none of the alternative locations of the ice jam toe produce turbulent bed forces that exceed levels occurring during the T16-2003 event.

Results of the discharge-ice supply scenarios are compared to the T16-2003 event on Figure 7-7. While the Q-Ice-E scenario is comparable to the T16-2003 event, none of the discharge-ice supply scenario shear stress distributions exceed the impacts of the design event. Subsequent to the development of the discharge-ice supply scenarios, which were based on a provisional flow record, the U.S. Geological Survey revised the provisional flows for the West Branch of the Oswegatchie River (used to estimate flow in the Grasse River), including the 2003 breakup discharge that was used to scale each of the discharge-ice supply scenarios (Alcoa, 2006). As a result, the return period analysis for combinations of breakup discharge and ice thickness was revised and a new set of discharge-ice supply scenarios was developed (see Table 7-1). With the exception of Q-Ice-E, the revised model peak flows for each of the sensitivity analysis cases are lower relative to those presented in Table 3-1 (and presented in Figure 7-7). Therefore, DynaRICE and STORM/CFD2000 were re-run for the revised discharge-ice supply combination for Q-Ice-E. The results of the STORM/CFD2000 simulation for the revised and original Q-Ice-E scenarios are compared in Figure 7-8. This comparison demonstrates that the distribution of shear stresses predicted using the revised discharge and ice supply combination for Q-Ice-E are lower than those for the original scenario.

Similar to the discharge-ice supply scenarios, the extreme discharge event does not produce ice jam conditions that generate bed forces greater than those generated during the T16-2003 event (Figure 7-9). Varying stage height at the downstream boundary has minimal impact on bed shear stress under the ice jam (Figure 7-9).

Table 7-1. Revised combinations of breakup discharge and ice thickness.

Scenario	Original Analysis			Revised Analysis		
	Breakup Discharge Q_{bk} (cfs)	Modeled Peak Discharge (cfs)	Cover Thickness h_i (cfs)	Breakup Discharge Q_{bk} (cfs)	Modeled Peak Discharge (cfs)	Cover Thickness h_i (cfs)
2003	5,630	8,559	28.75	6,303	8,559	23.25
Q-Ice-A	10,617	16,140	4	10,608	14,405	4
Q-Ice-B	9,876	15,014	10	9,936	13,492	10
Q-Ice-C	9,072	13,792	16	9,139	12,410	16
Q-Ice-D	7,566	11,502	22	7,372	10,011	22
Q-Ice-E	5,630	8,559	25.3	6,724	9,131	24
Q-Ice-F	3,035	4,614	28.7	3,289	4,466	28.7

This comparative analysis indicates that bed shear stress underneath the toe of an ice jam is generated through a complex combination of hydrodynamic processes. Increased flow rate does not necessarily translate to higher bed stress; ice jam thickness and water depth under the jam toe appear to adjust to increasing flow rate such that bed stress may not increase. For example, flow rate during the extreme discharge scenario was about 5,000 to 6,000 cfs greater than the peak flow during the T16-2003 event. Effective bed stress during the T16-2003 event, however, was greater than the extreme discharge case for about 40% of the area under the toe of the jam; maximum bed stresses during the extreme discharge and T16-2003 events are approximately 20 and 90 Pa, respectively (Figure 7-9). These differences in effective bed stress are likely due to differences in ice jam thickness and water depth for the two cases; average water depth and ice jam thickness are greater for the extreme discharge case (see Figure 3-7).

The above results indicate that effective bed stresses under the jam toe during the T16-2003 event represent extreme conditions that are not exceeded by other rare ice jam events, for which a wide range of conditions were investigated. The results of this analysis, which are primarily based on model simulations, are partially supported by two data-based analyses. The 2003 ice jam produced the highest observed tree scars observed along the lower Grasse River, suggesting this was the most severe event recorded by trees over the past 40 years (see Appendix O to the main report). In addition, the stratigraphic analysis suggested that the 2003 event was one of the most severe events that occurred in the lower river, due to the thickness and longitudinal extent of the observed event beds (see Appendix P to the main report).

Additional analysis of effective bed stress during the T16-2003 event was conducted to develop an improved understanding of why effective bed stress during this event was greater than during other design scenarios. While it is difficult to determine precisely the causes for the relatively high bed stresses predicted for the T16-2003 event, an evaluation of the relative magnitudes of the mean velocity and TKE components of effective bed stress suggest that the TKE component during the T16-2003 event is relatively high, compared to other design scenarios. This characteristic may be caused by a unique combination of flow, water depth and ice jam thickness during the T16-2003 event that produced conditions which tended to maximize the TKE component of effective bed stress.

For the T16-2003 event, the relative contributions of the mean and TKE components of effective bed stress were analyzed at 15 different locations under the ice jam. These 15 locations were randomly chosen because of the random nature of the ice jam thickness profile. A cumulative frequency distribution of the ratio of the TKE stress component to the effective bed stress for the 15 locations during the T16-2003 event is shown on Figure 7-10. For water depths (h) greater than 1.5 m, which occurred at 12 of the 15 locations, the TKE shear stress component corresponds to about 60% to 80% of the effective bed stress. This result means that the TKE component is approximately 1.5 to 4 times greater in magnitude than the mean velocity component of effective bed stress for water depths greater than 1.5 m. For water depths less than 1.5 m, the TKE component corresponds to about 50% to 55% of the effective bed stress. This result indicates that the mean velocity and TKE components represent approximately equal portions of the effective bed stress for water depths less than 1.5 m.

The investigation of the relative contributions of the mean velocity and TKE components lead to an interesting, and unexpected, discovery of a relationship between effective bed stress and the Froude number for flow underneath an ice jam. The Froude number (Fr) is a dimensionless ratio between the mean current velocity and water depth under the ice jam:

$$Fr = U_{loc}/(gh_{loc})^{1/2} \qquad (7\text{-}9)$$

where U_{loc} is the local mean current velocity, h_{loc} is local water depth, and g is acceleration due to gravity. The relationship between effective bed stress and Froude number for the 12 locations with water depth greater than 1.5 m is shown on Figure 7-11. These results show a strong correlation (R = 0.98) between effective bed stress and Froude number (based on local values of mean current velocity and water depth), which is given by:

$$\tau_{eff} = 61.5\ Fr\ -3.8 \qquad (7\text{-}10)$$

where effective bed stress (τ_{eff}) has units of Pa (N/m^2). This correlation is very useful because it can be used to estimate, with relatively high confidence, the effective bed stress under an ice jam based on two local parameters (U_{loc} and h_{loc}) which can be determined without conducting a STORM/CFD2000 simulation. Equation 7-11 over-predicts effective bed shear stress for water depths less than 1.5 m, hence, it produces conservative estimates for that range of depths.

SECTION 8
CONCLUSIONS

Design of an armored cap, which is being evaluated as a potential remedial technology for the lower Grasse River, requires quantitative estimates of hydrodynamic forces impacting the sediment bed underneath the toe of an ice jam. The modeling approach used in this study, which combines results of the DynaRICE and STORM/CFD2000 models, provides a method for estimating the effective bed stress, due to mean current velocity and ice jam generated turbulence, under a jam toe. While uncertainty exists in the modeling results, the approach utilized is consistent with the current state of the science for providing the information needed for armored cap design purposes. As discussed in Section 7, the predictions generated from the modeling efforts were compared with available field data generated during the 2003 ice scour investigation, and the results were consistent with both the observations of the tree scar study and the analysis of the stratigraphic coring information.

In addition to producing results that are used in the armored cap design process, several insights concerning turbulent flow under an ice jam were developed from the modeling study. First, determining the potential impact of an ice jam scenario on bed shear stress cannot be achieved using an approach that only considers macro-scale conditions such as flow rate, ice supply thickness, or jam toe location. Similarly, large-scale ice jam parameters, as predicted by DynaRICE, such as average velocity, water depth or ice jam thickness cannot solely be used to evaluate the relative severity of a particular scenario.

Second, the scenario comparisons in Section 7 are interesting because the DynaRICE scenario results discussed in Section 3 suggest that specific ice jam scenarios may produce higher current velocities than the T16-2003 event. The turbulence modeling demonstrates, however, that the DynaRICE results cannot be used in isolation. Therefore, neglecting the effects of the random ice profile and ice-generated turbulence on bottom shear stress may lead to inaccurate conclusions about the relative severity of the T16-2003 event, as well as the potential impacts of a particular ice jam scenario.

Finally, the comparative analysis presented in Section 7 indicates that the T16-2003 event produced bed stresses that correspond to extreme conditions. A range of ice jam conditions (e.g., six discharge-ice supply events and an extreme discharge case) were simulated and none of these rare events generated bed shear stress distributions that exceeded the T16-2003 distribution. Thus, these results indicate that the T16-2003 event can be used as the design event when considering an armored cap for various lower Grasse River remedial alternatives.

SECTION 9
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FIGURES

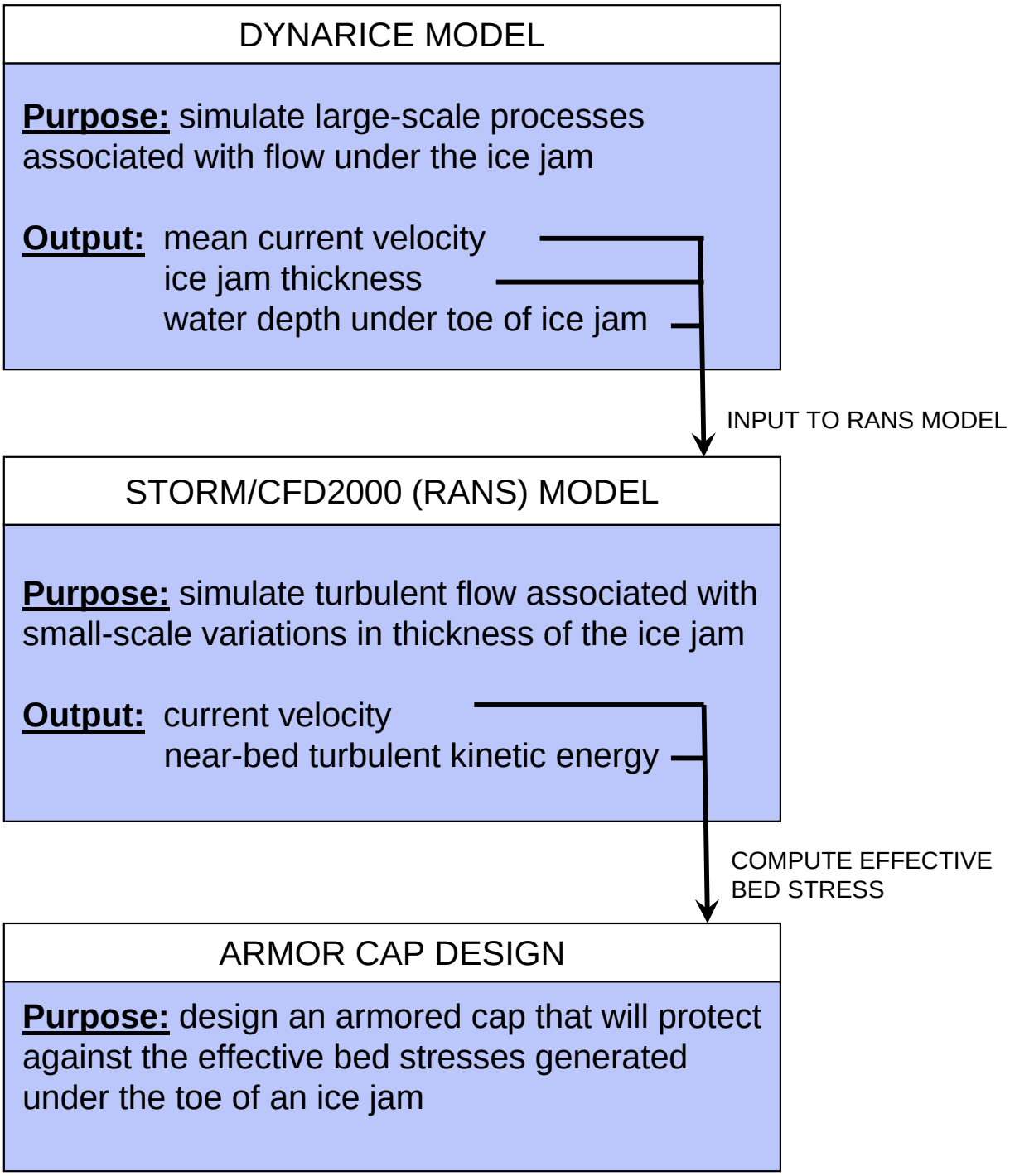

Figure 2-1. Methodology used to estimate effective bed stresses under the toe of an ice jam.

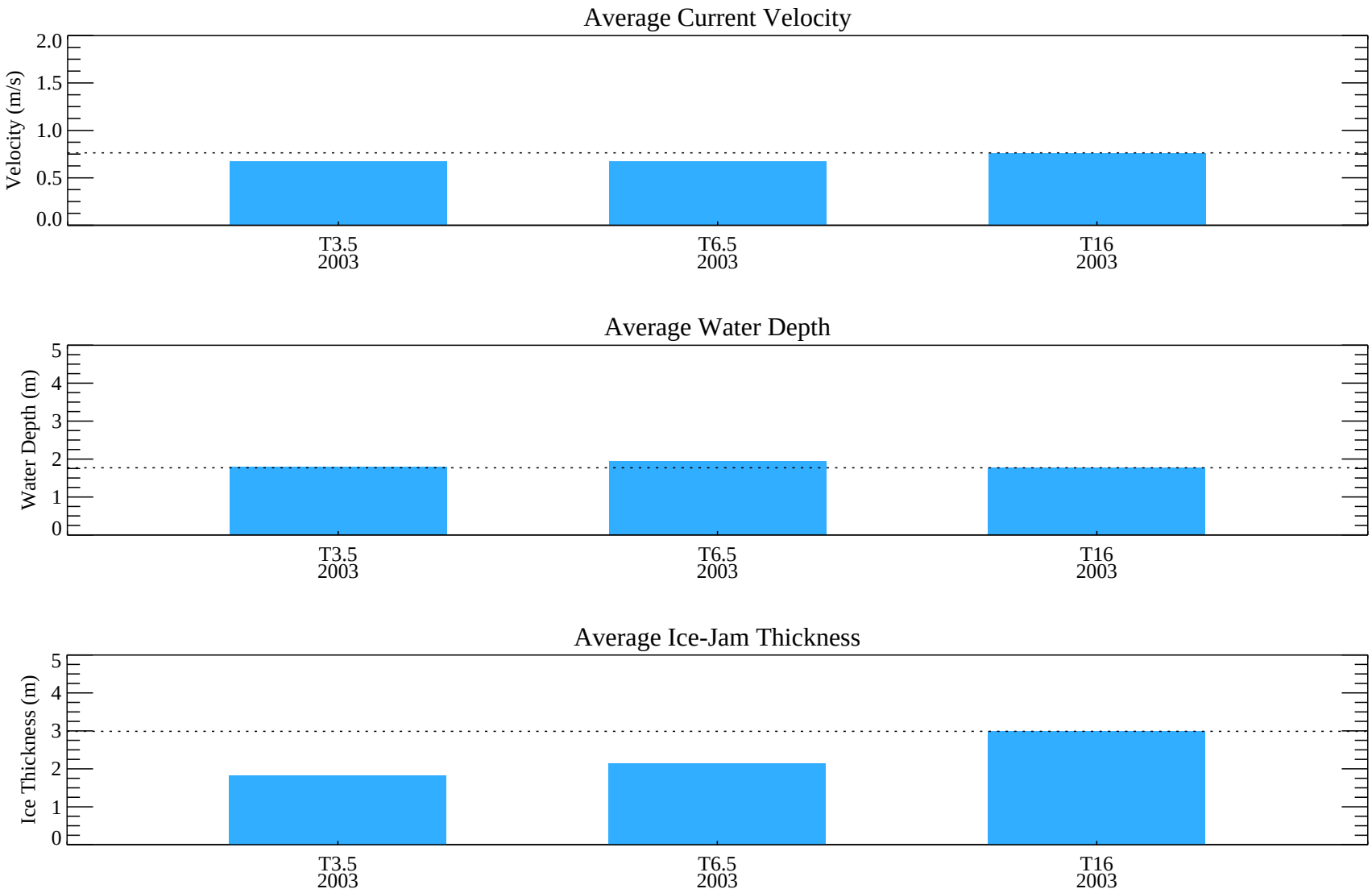

Figure 3-1. Comparison of DynaRice results for the 2003 ice jam event at T3.5, T6.5 and T16: average velocity, water depth and ice jam thickness. Dashed lines represent model results for simulation of the ice jam at T16.

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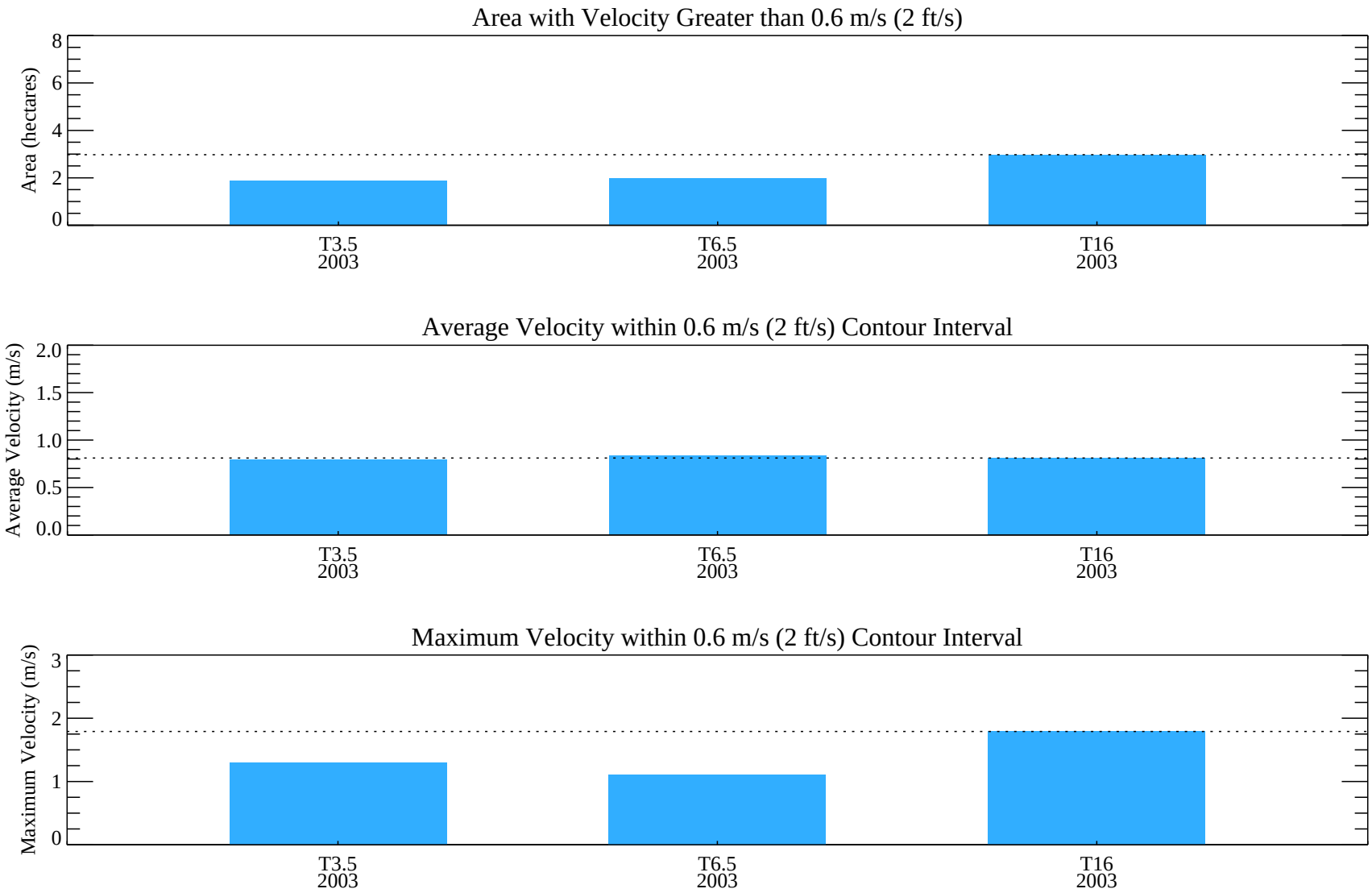

Figure 3-2. Comparison of DynaRice results for 2003 ice jam event at T3.5, T6.5 and T16: 0.6 m/s (2 ft/s) contour interval analysis. Dashed lines represent model results for simulation of the ice jam at T16.

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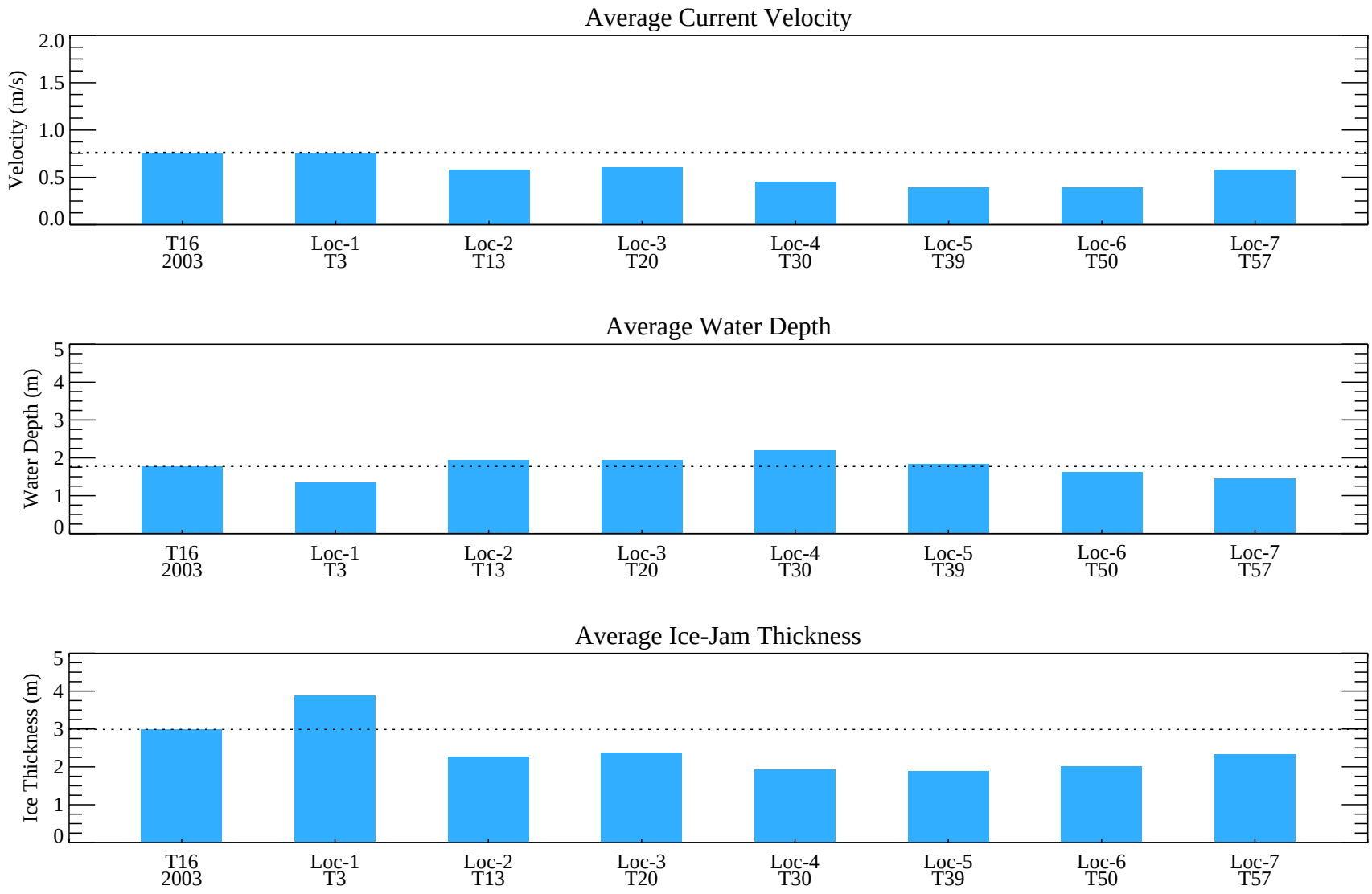

Figure 3-3. Comparison of location scenarios to T16-2003 event: average velocity, water depth and ice jam thickness. Dashed lines represent model results for simulation of the ice jam at T16.

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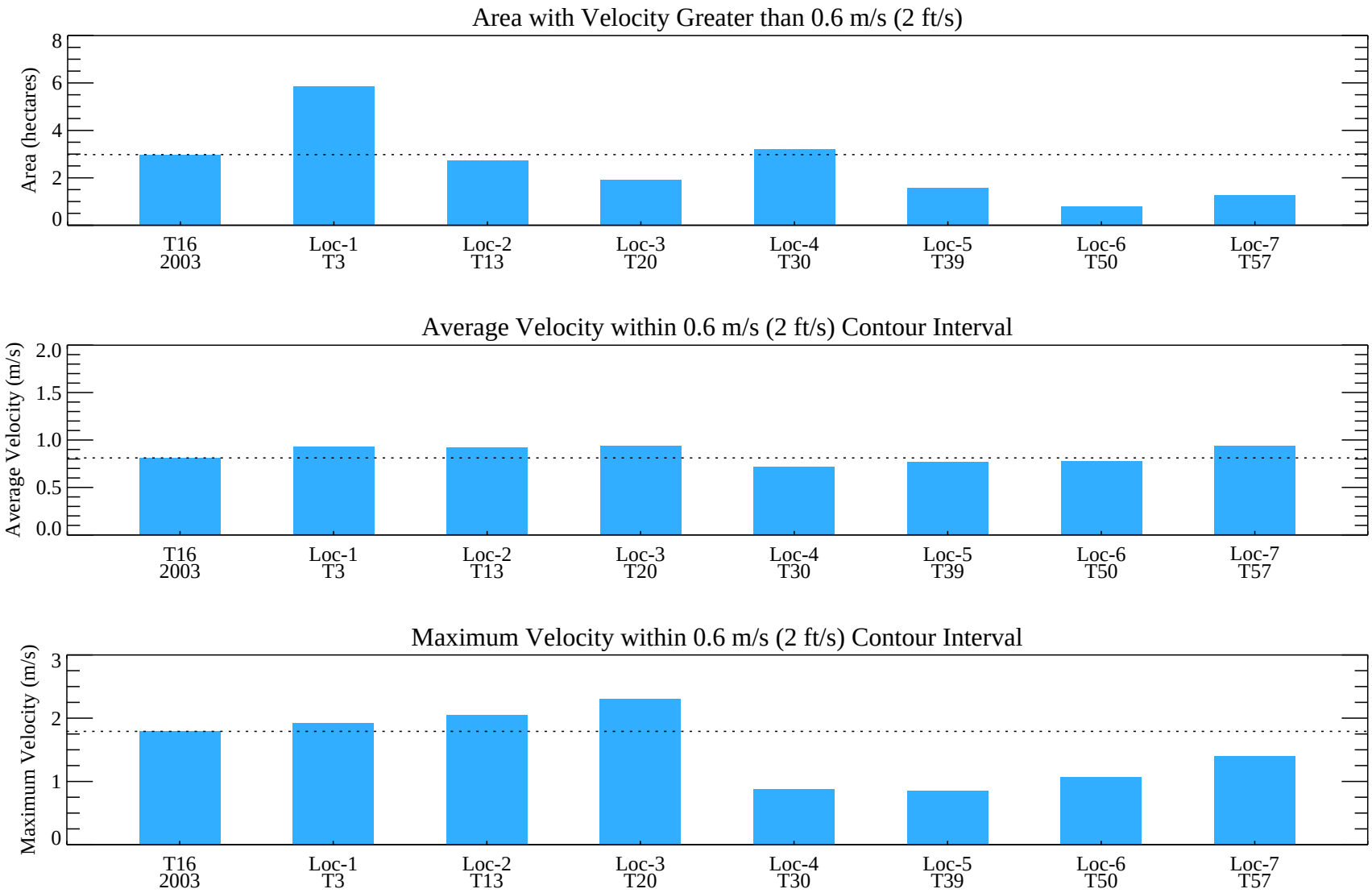

Figure 3-4. Comparison of location scenarios to T16-2003 event: 0.6 m/s (2 ft/s) contour interval analysis. Dashed lines represent model results for simulation of the ice jam at T16.

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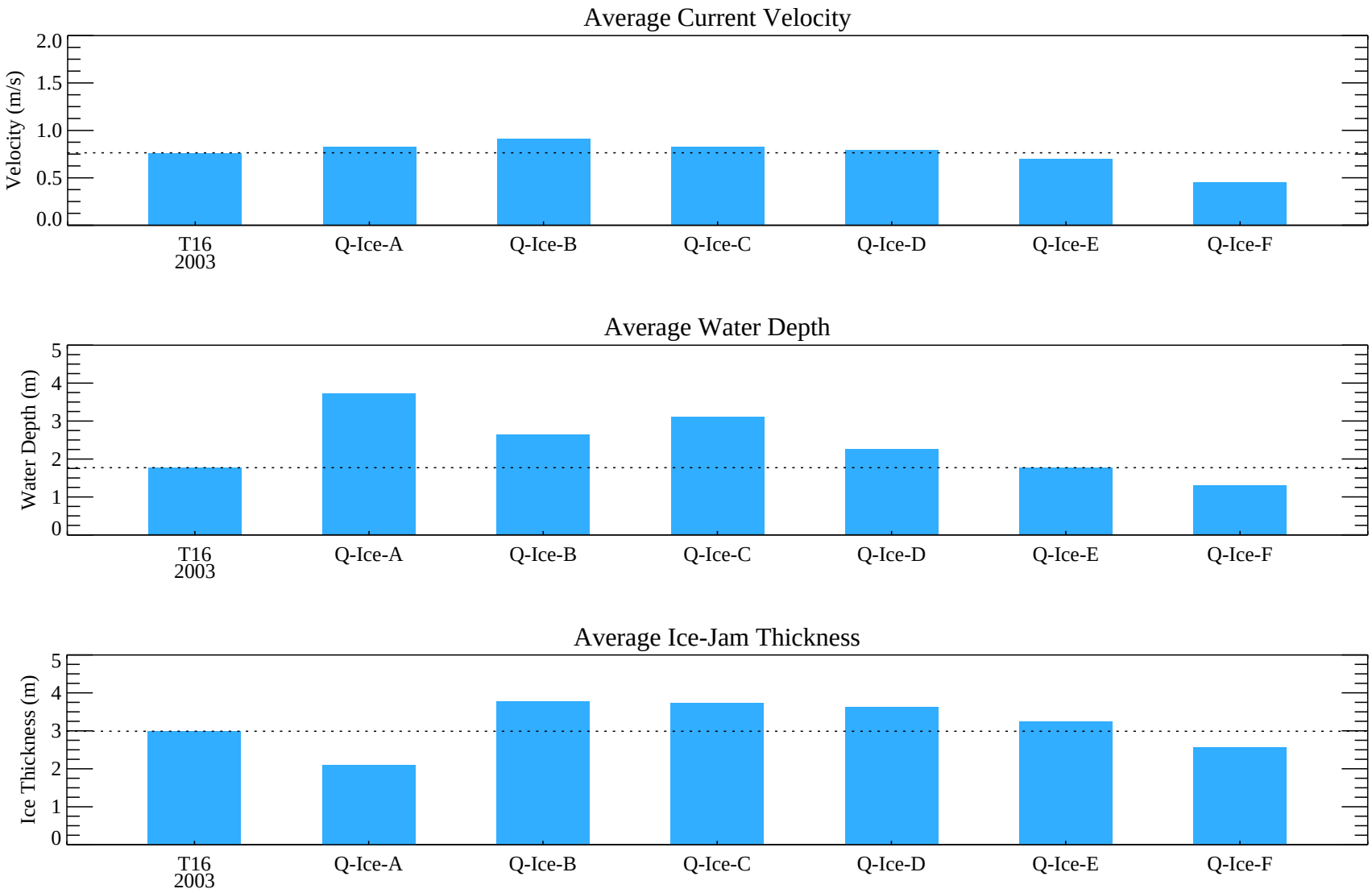

Figure 3-5. Comparison of discharge-ice-supply scenarios to T16-2003 event: average velocity, water depth and ice jam thickness. Dashed lines represent model results for simulation of the ice jam at T16.

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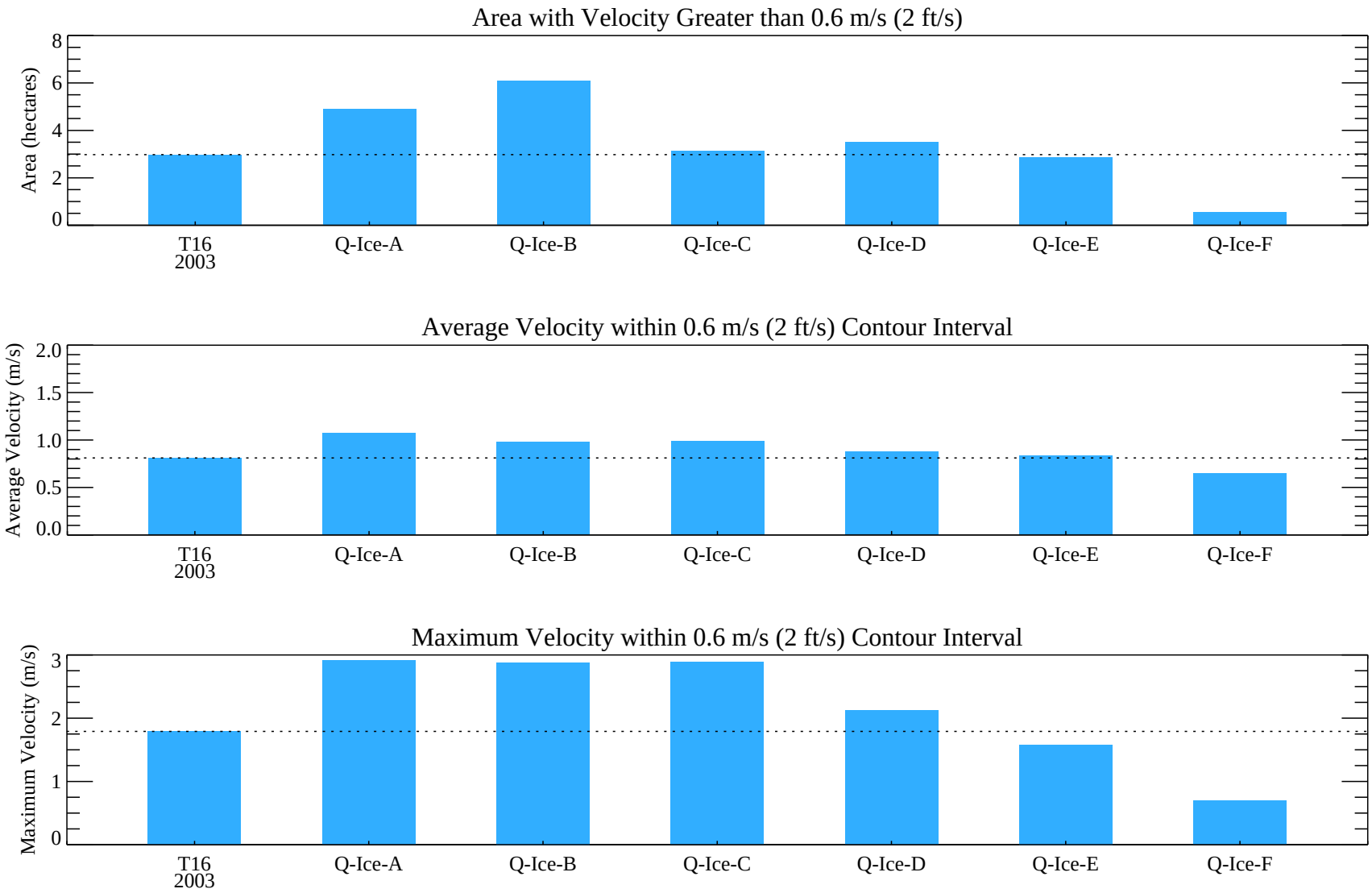

Figure 3-6. Comparison of discharge-ice supply scenarios to T16-2003 event: 0.6 m/s (2 ft/s) contour interval analysis. Dashed lines represent model results for simulation of the ice jam at T16.

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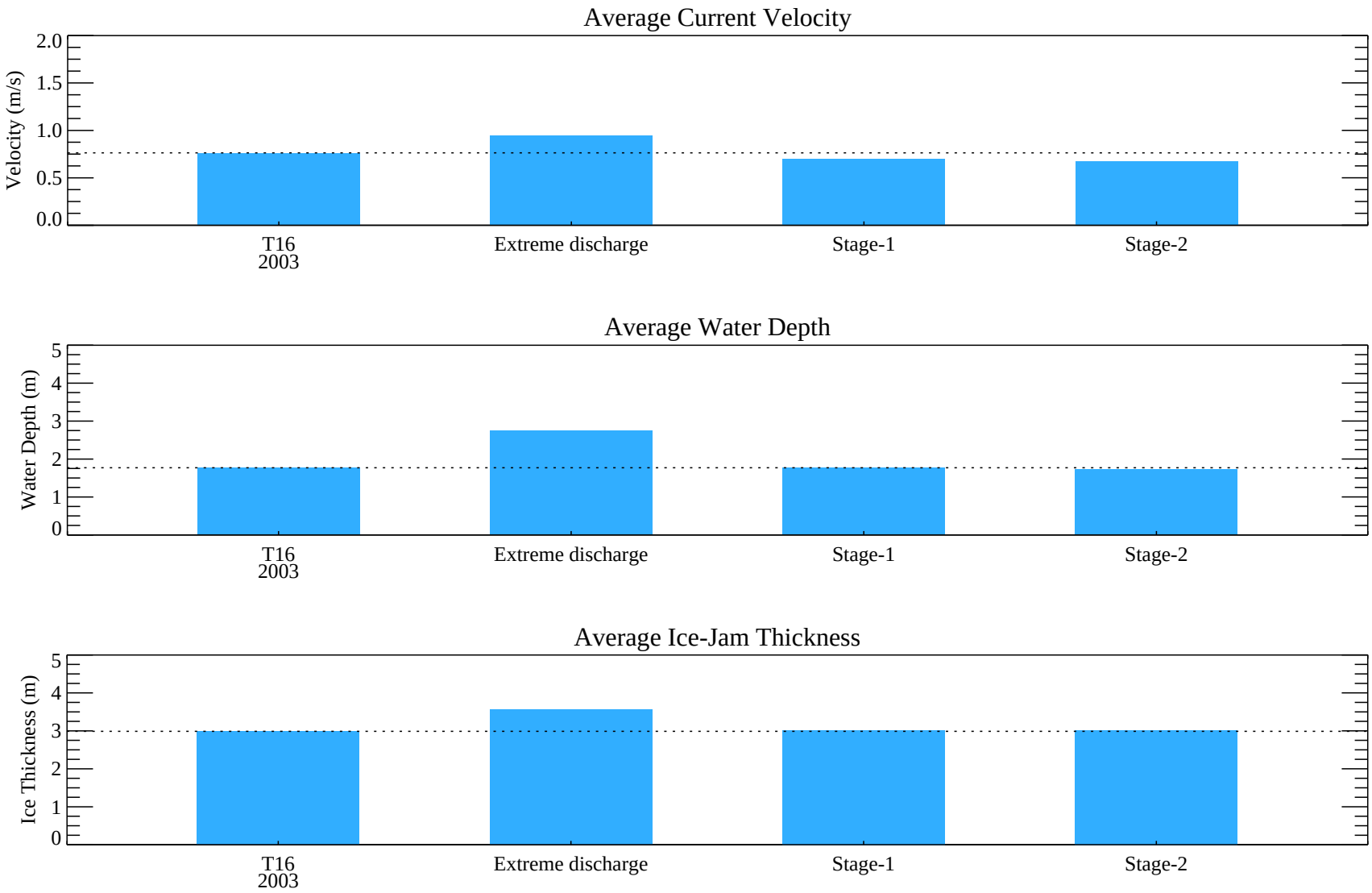

Figure 3-7. Comparison of extreme discharge and downstream stage height scenarios to T16-2003 event: average velocity, water depth and ice jam thickness. Dashed lines represent model results for simulation of the ice jam at T16.

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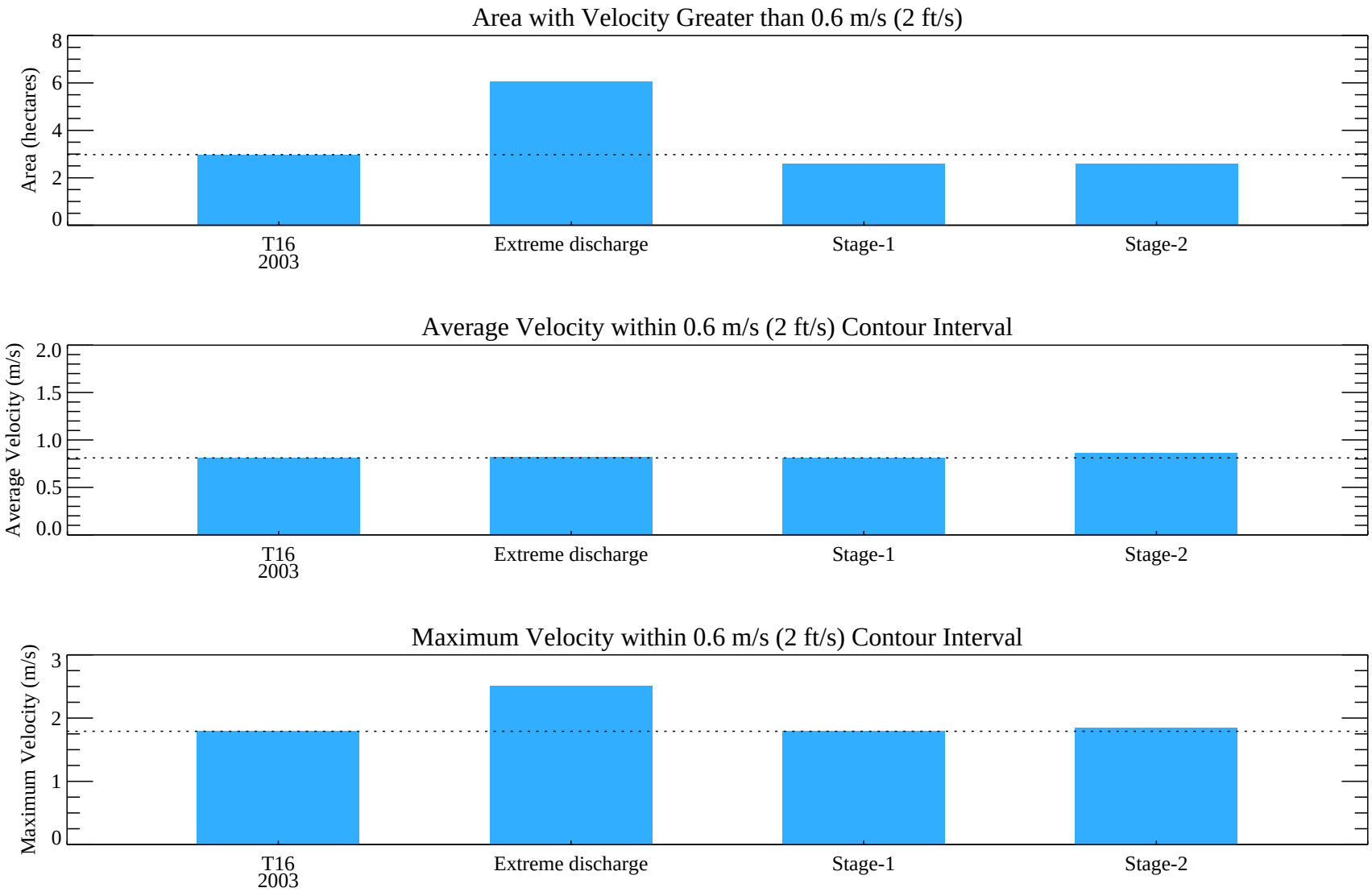

Figure 3-8. Comparison of extreme discharge and downstream stage height scenarios to T16-2003 event: 0.6 m/s (2 ft/s) contour interval analysis. Dashed lines represent model results for simulation of the ice jam at T16.

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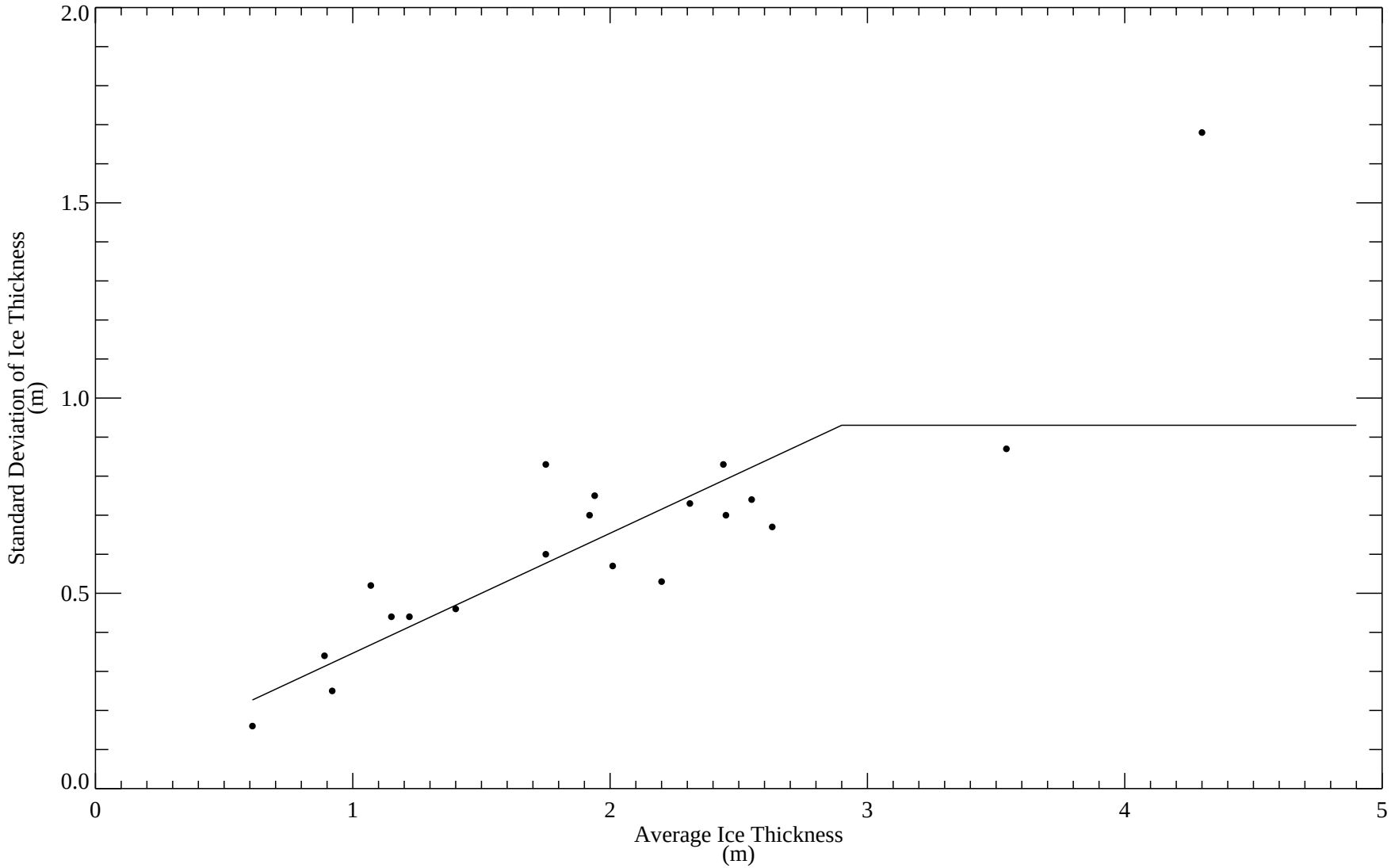

Figure 6-1. Relationship between standard deviation of ice jam thickness and average ice jam thickness. Data from Beltaos (2001). Solid line represents Equation (6-1).

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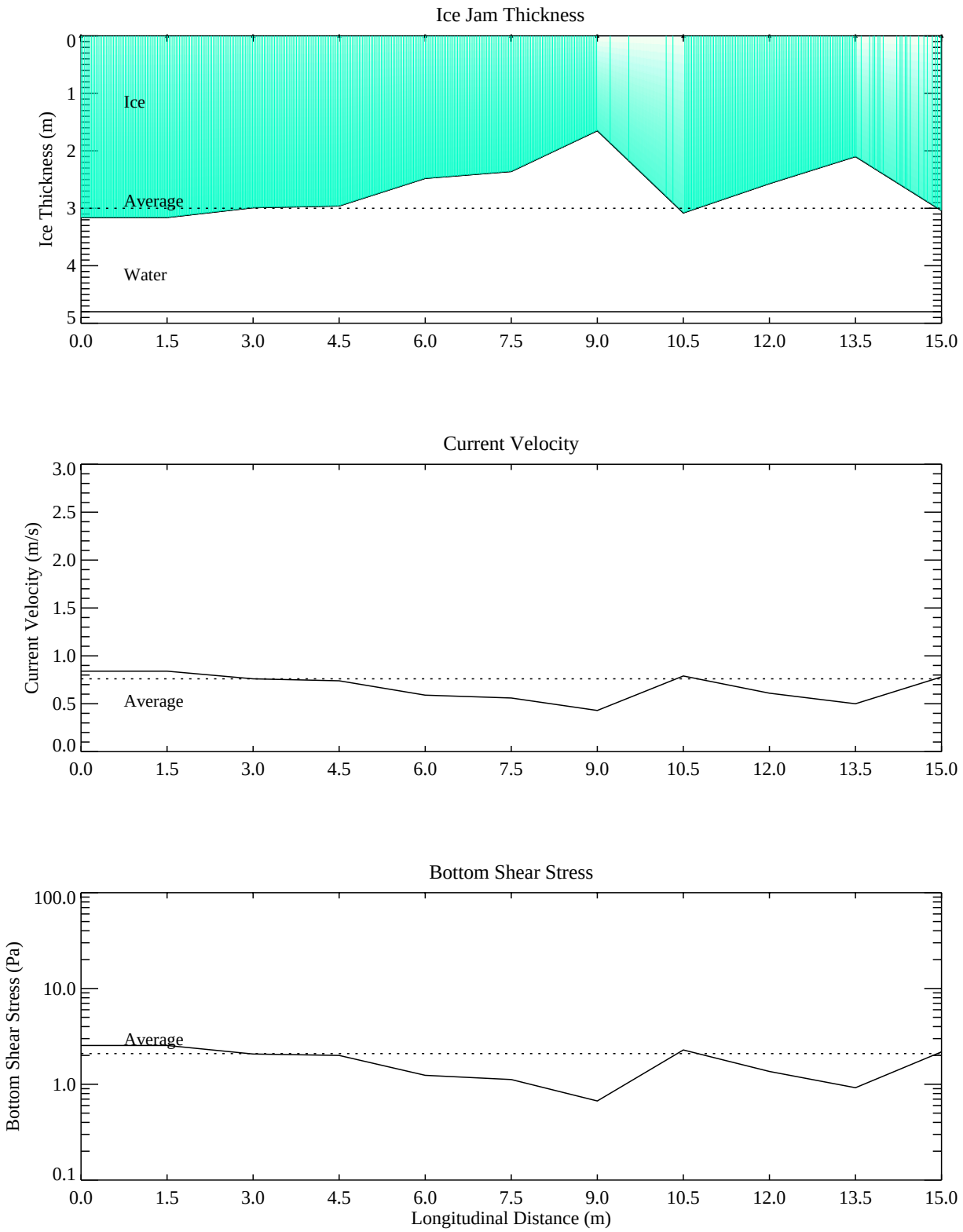

Figure 6-2. Spatial variation of ice jam thickness, mean current velocity, and bottom shear stress for 15-m long section of random ice profile.

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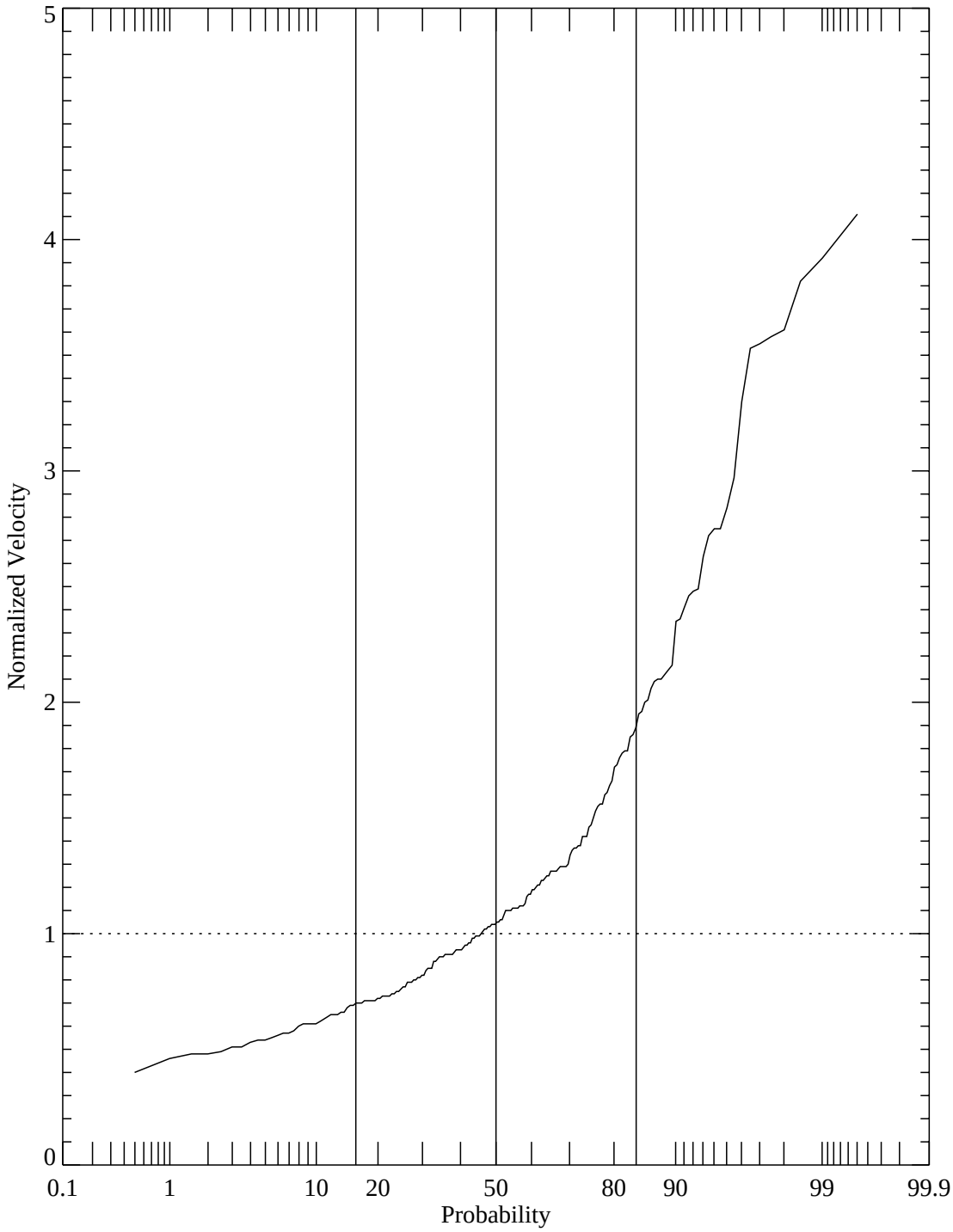

Figure 6-3. Frequency distribution of normalized mean current velocity for T16-2003 event. Velocity is normalized with respect to average value of 0.76 m/s (2.5 ft/s).

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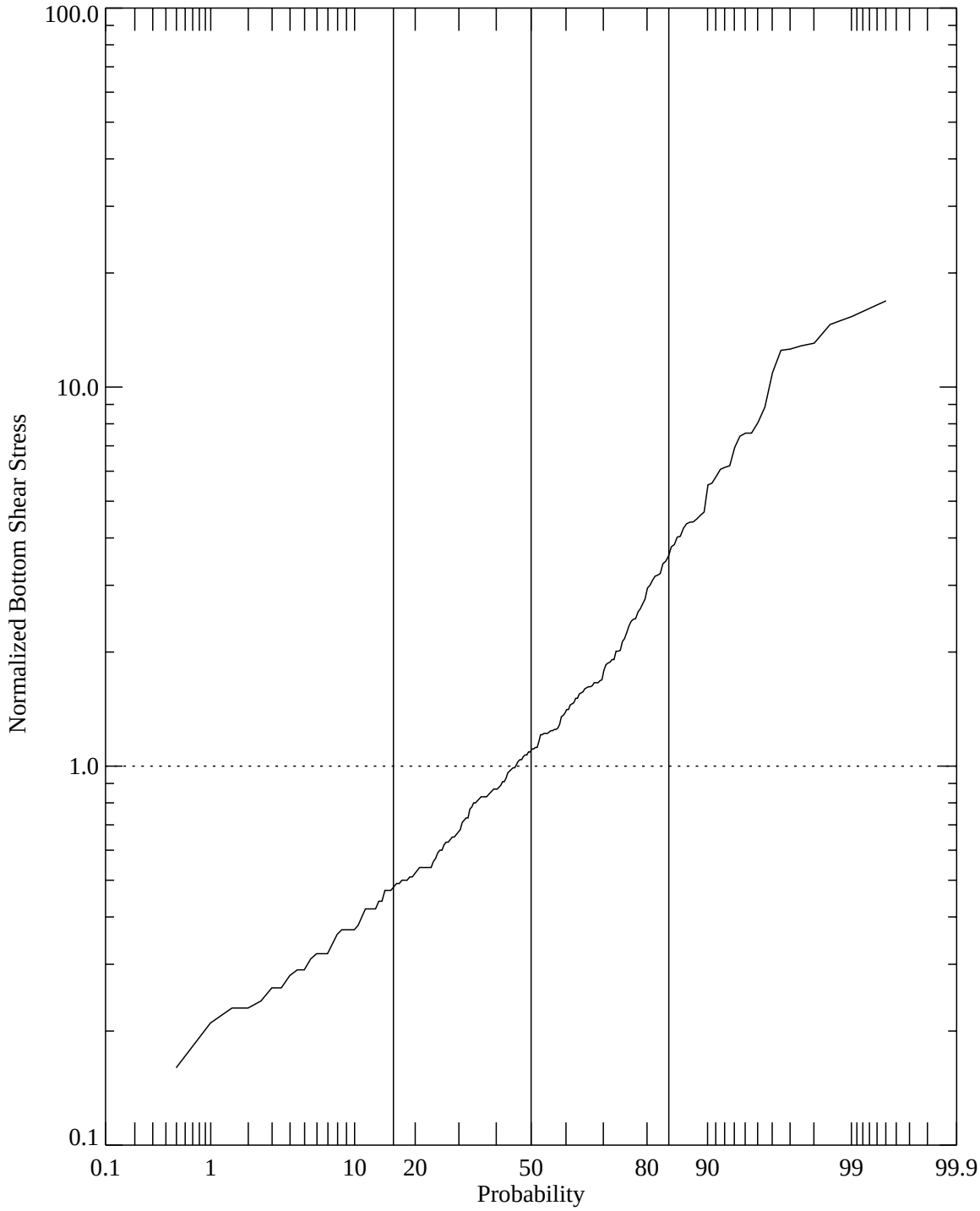

Figure 6-4. Frequency distribution of normalized mean shear stress for T16-2003 event. Mean shear stress normalized with respect to median value of 2.1 Pa.

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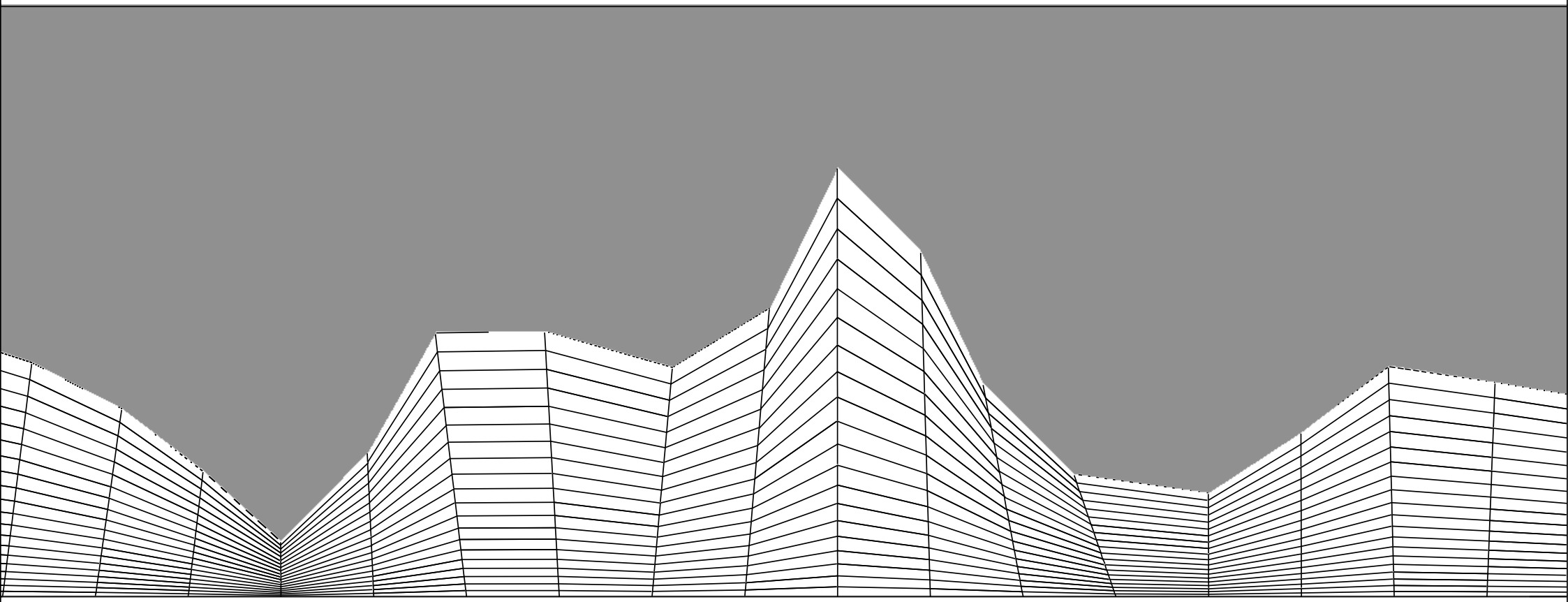

Figure 6-5. Numerical grid for CFD2000 simulation along 12-m long section of ice profile.

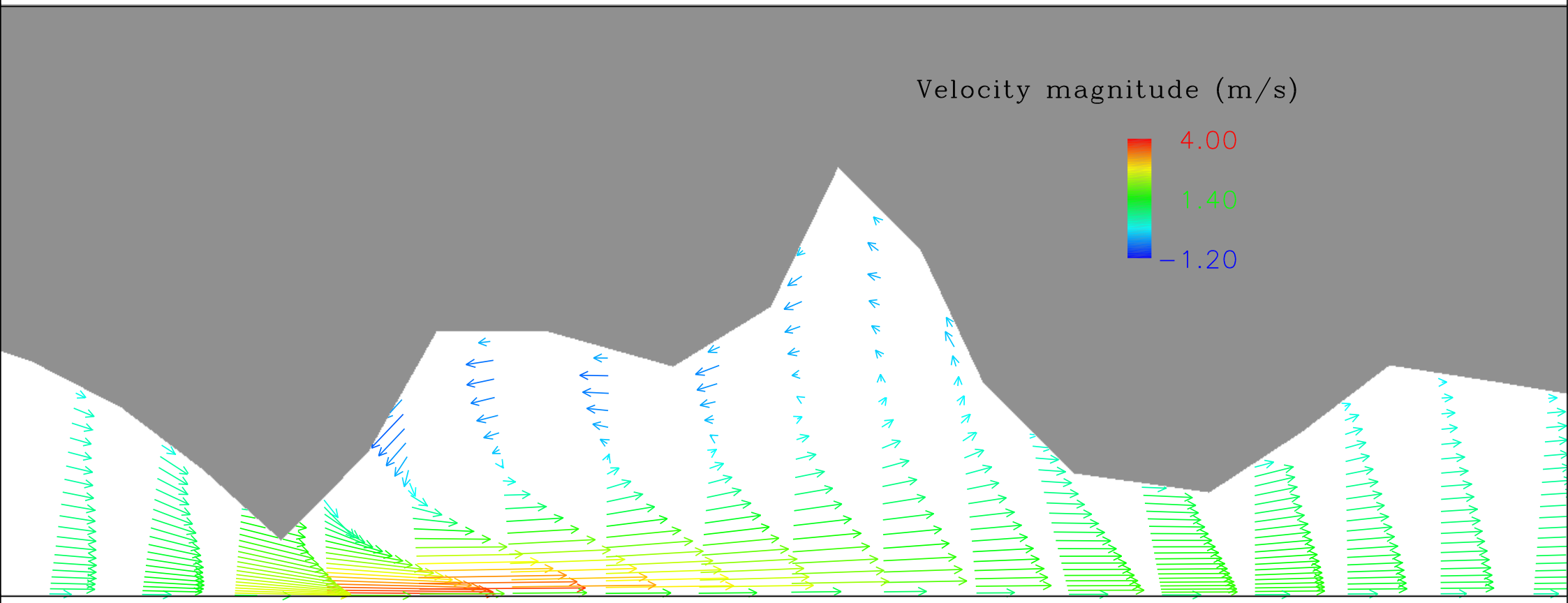

Figure 6−6. Predicted current velocities during T16−2003 event for 12−m long section of ice profile. This section is located approximately 110−120 m from the upstream boundary of the model domain (see Figure 6−9).

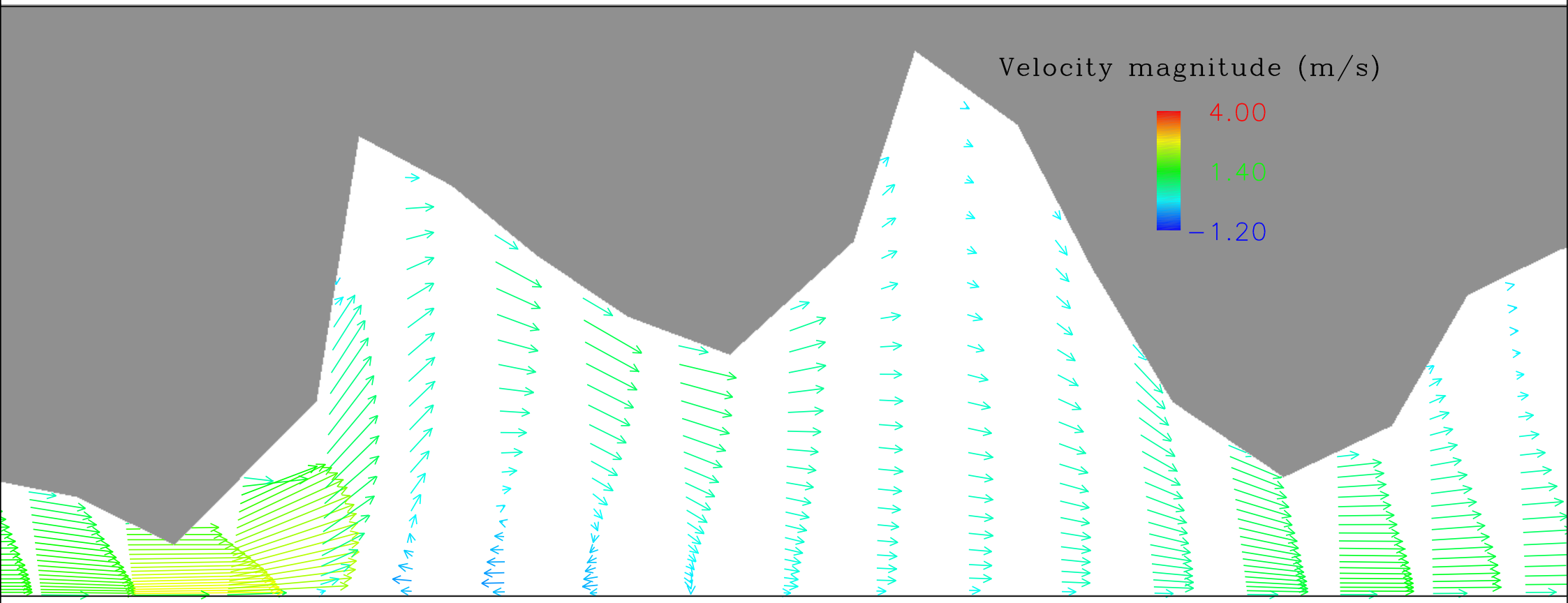

Figure 6−7. Predicted current velocities during T16−2003 event for 12−m long section of ice profile. This section is located approximately 280−290 m from the upstream boundary of the model domain (see Figure 6−11).

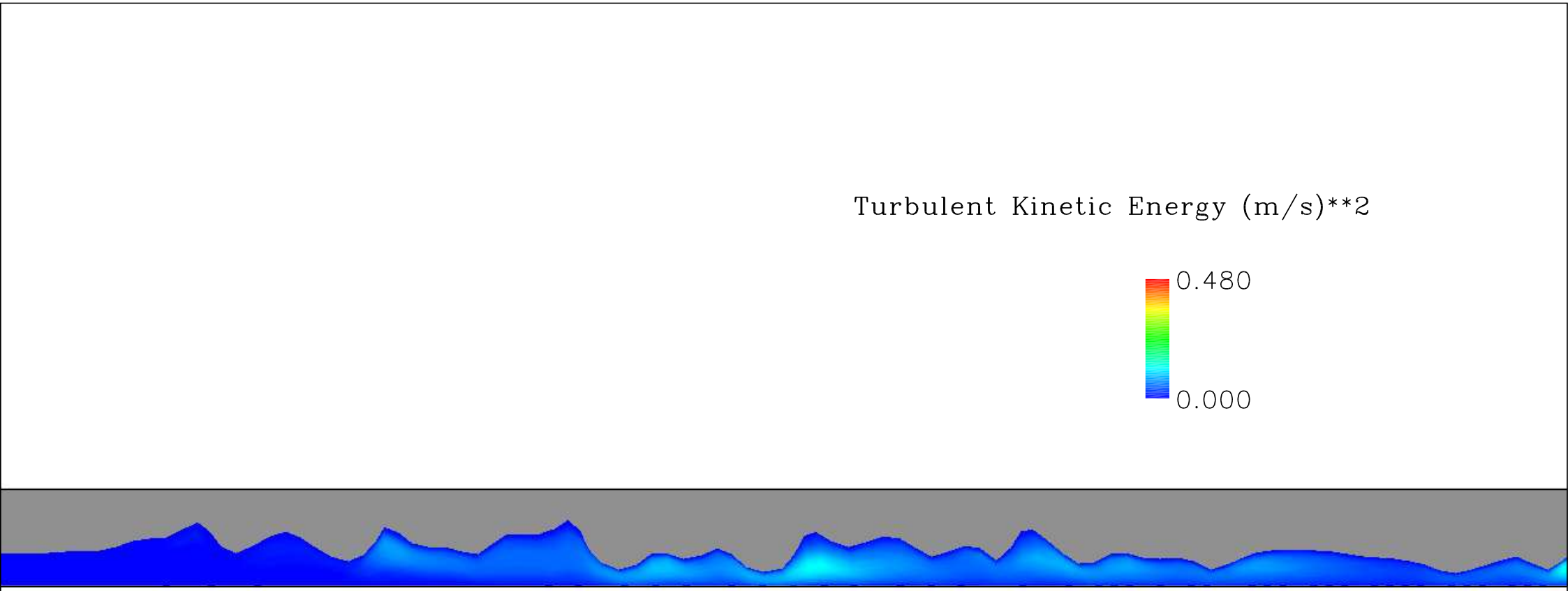

Figure 6-8. Predicted TKE during T16-2003 event: 0-75 m section.
Flow from left to right.

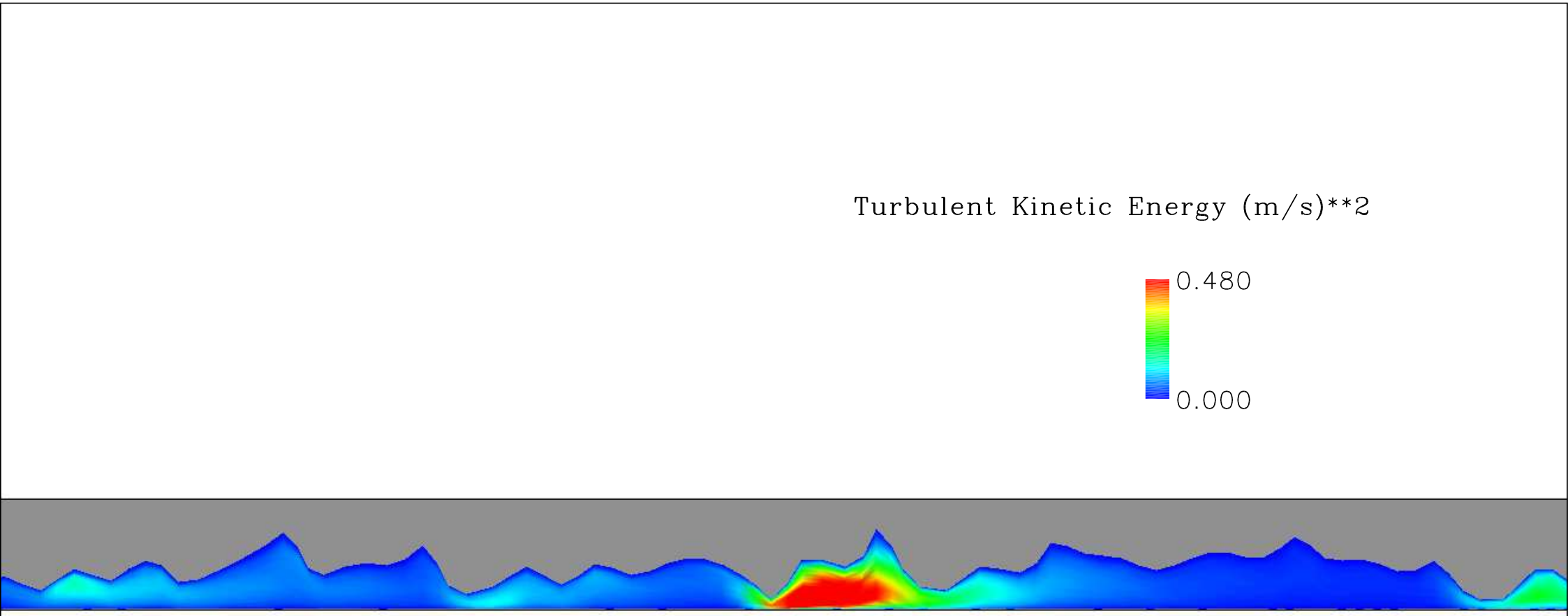

Figure 6-9. Predicted TKE during T16-2003 event: 75 - 150 m section.
Flow from left to right.

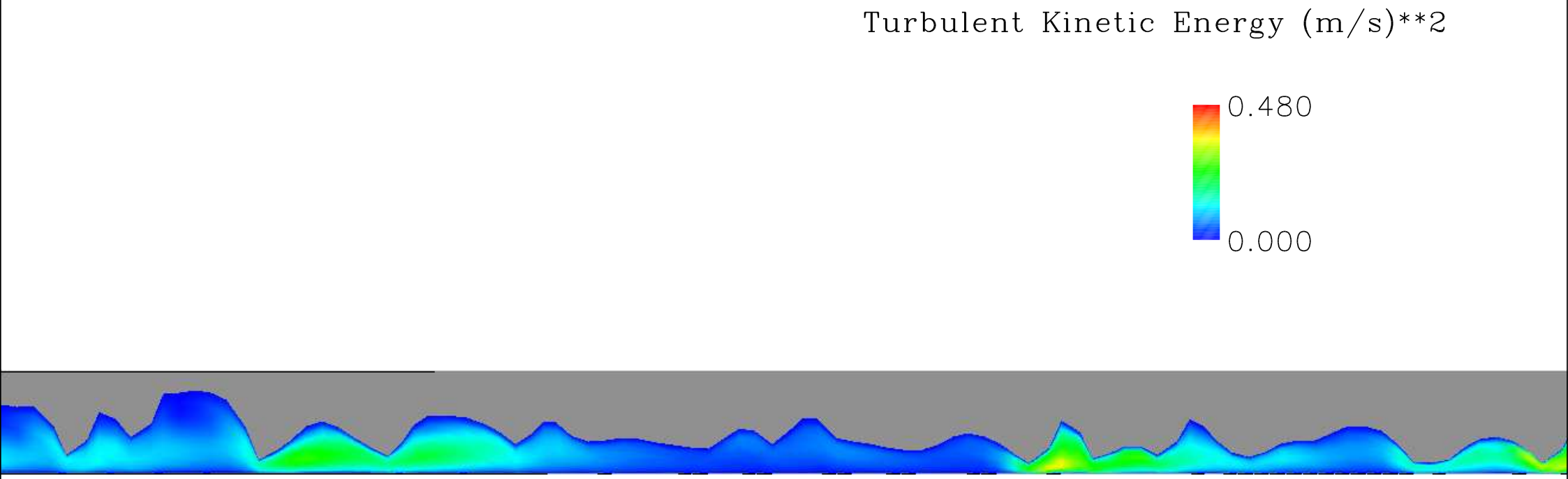

Figure 6–10. Predicted TKE during T16–2003 event: 150 – 225 m section.

Flow from left to right.

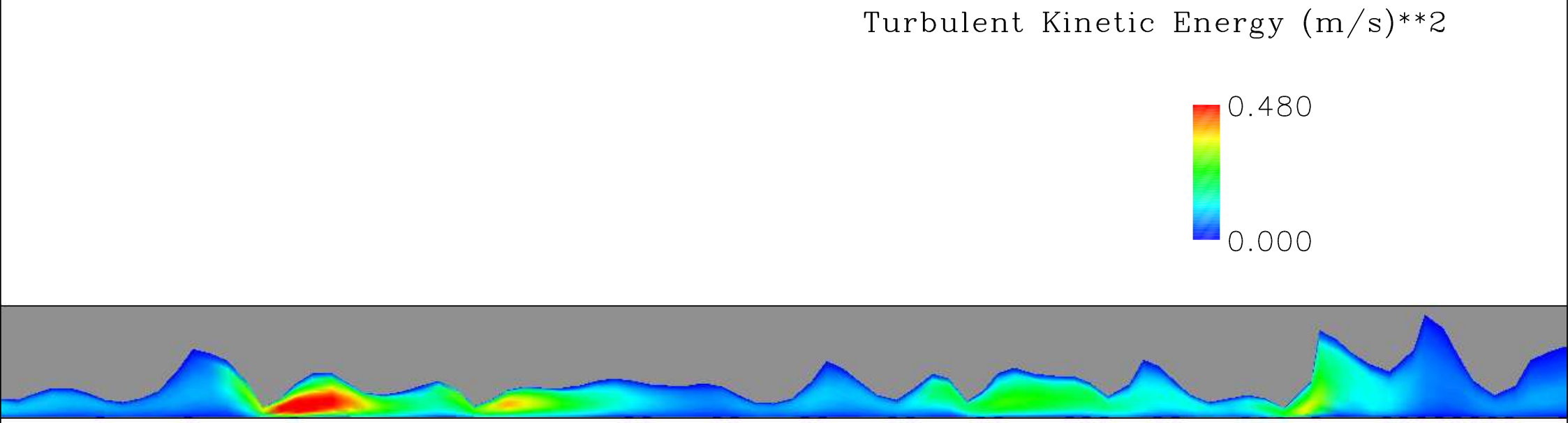

Figure 6-11. Predicted TKE during T16-2003 event: 225 - 300 m section.

Flow from left to right.

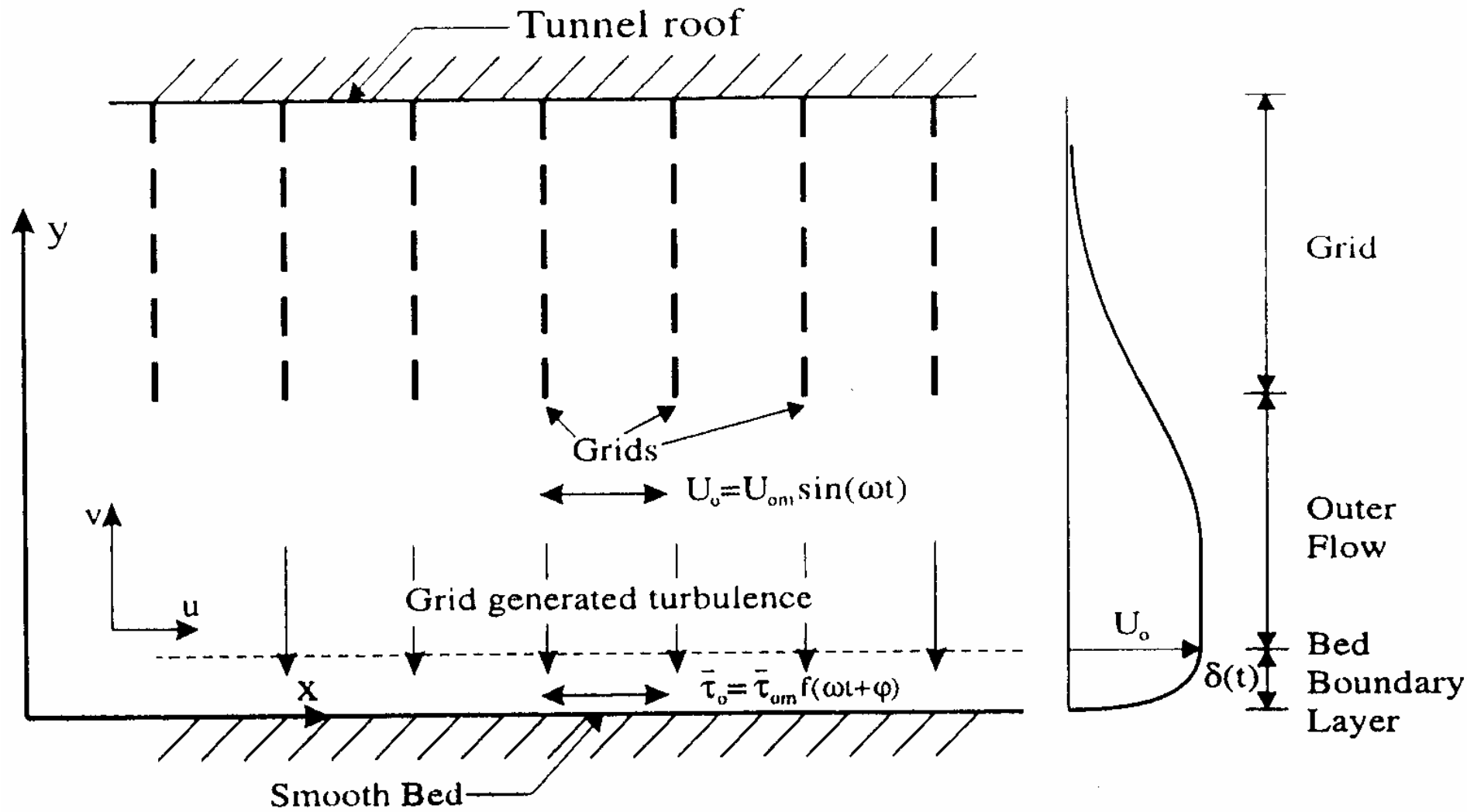

Figure 7-1. Configuration of water tunnel used in experiments conducted by Fredsoe et al. (2003).

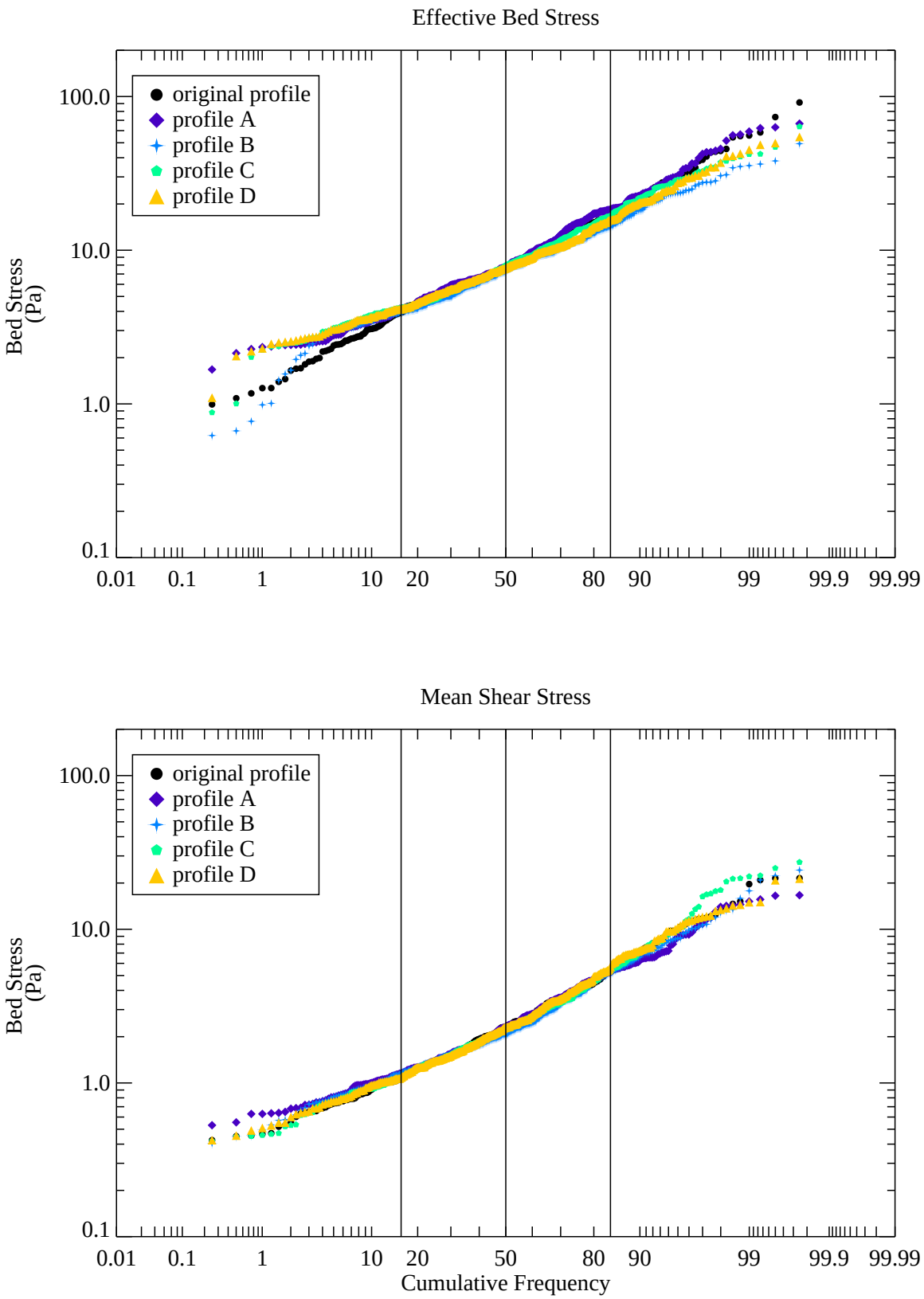

Figure 7-2. Frequency distributions of bed stress during T16-2003 event for five ice profiles.

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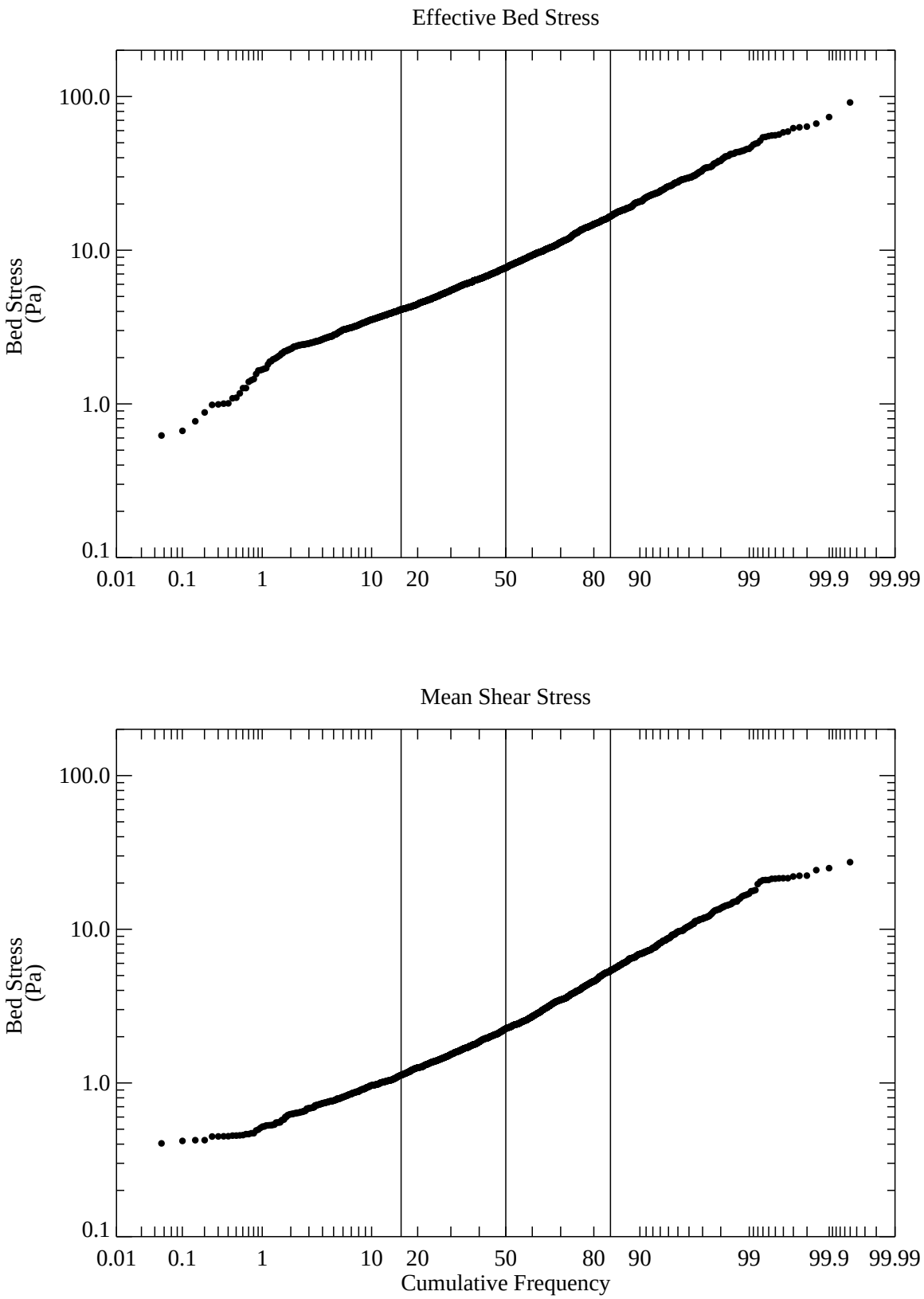

Figure 7-3. Frequency distributions of bed stress during T16-2003 event for combined ice profiles.

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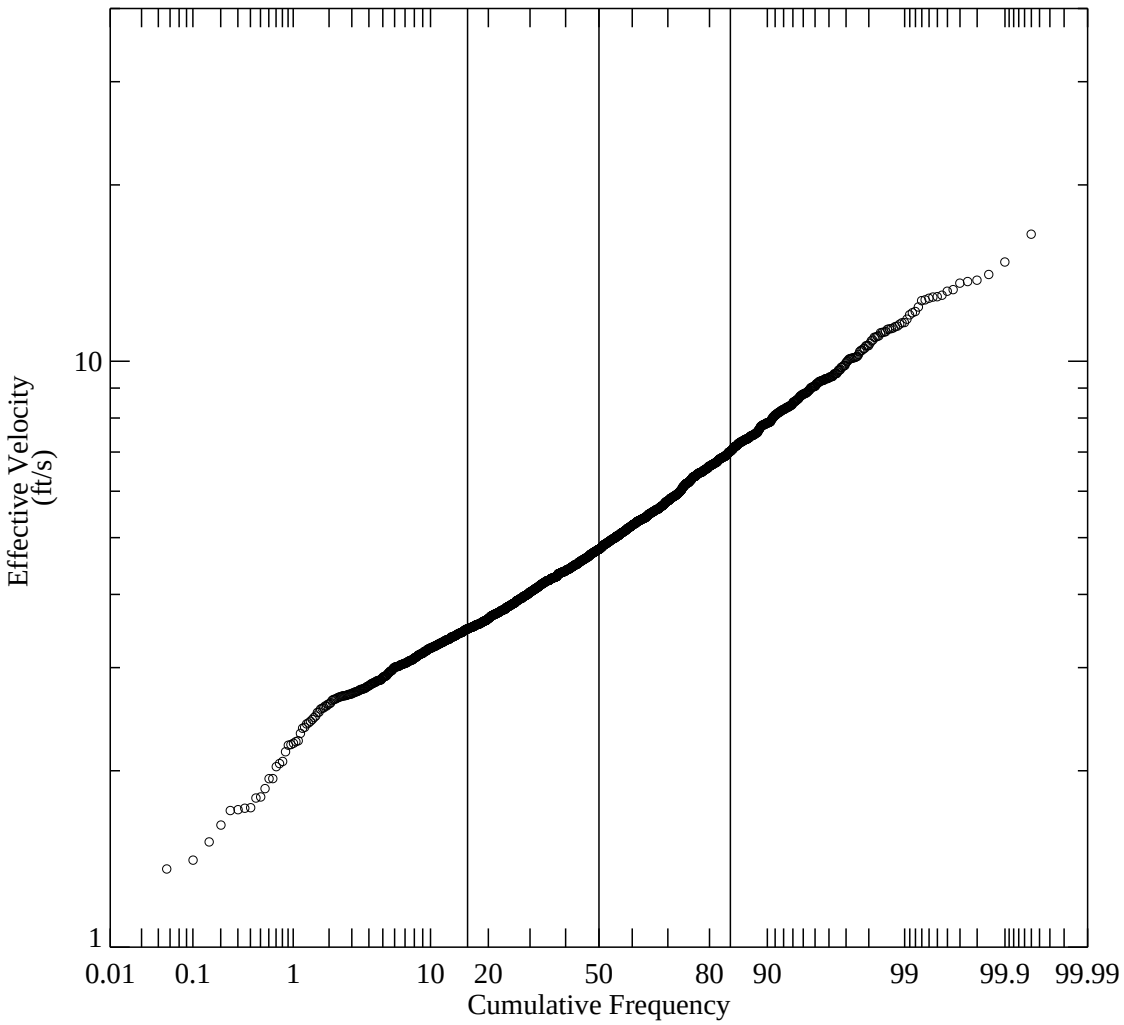

Figure 7-4. Frequency distribution of effective velocity during T16-2003 event. Results represent combination of effective velocities computed for five simulations, each with different underside ice distributions.

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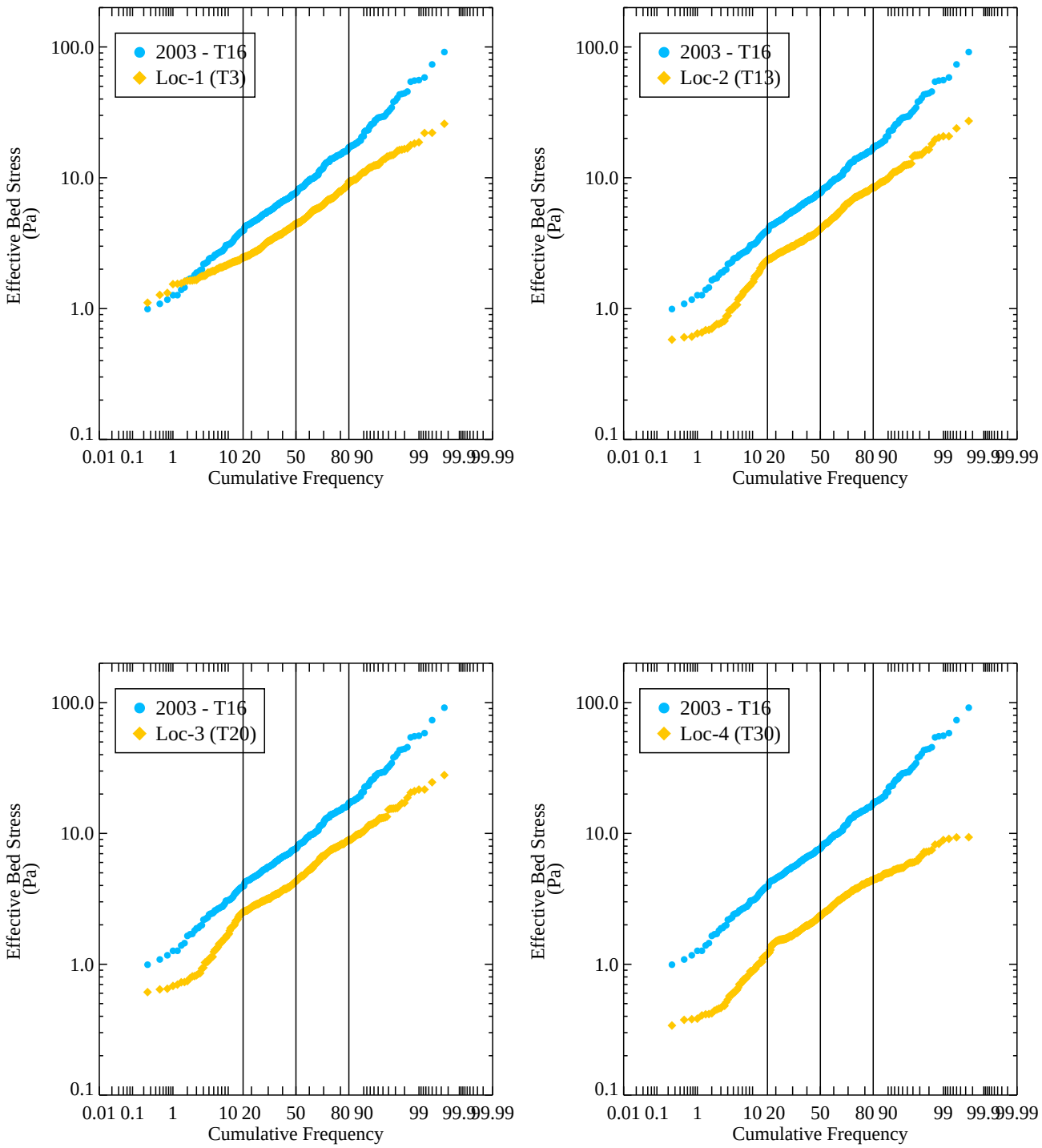

Figure 7-5. Comparison of frequency distributions of effective bed stress for location scenarios to T16-2003 event: Loc-1, Loc-2, Loc-3 and Loc-4.

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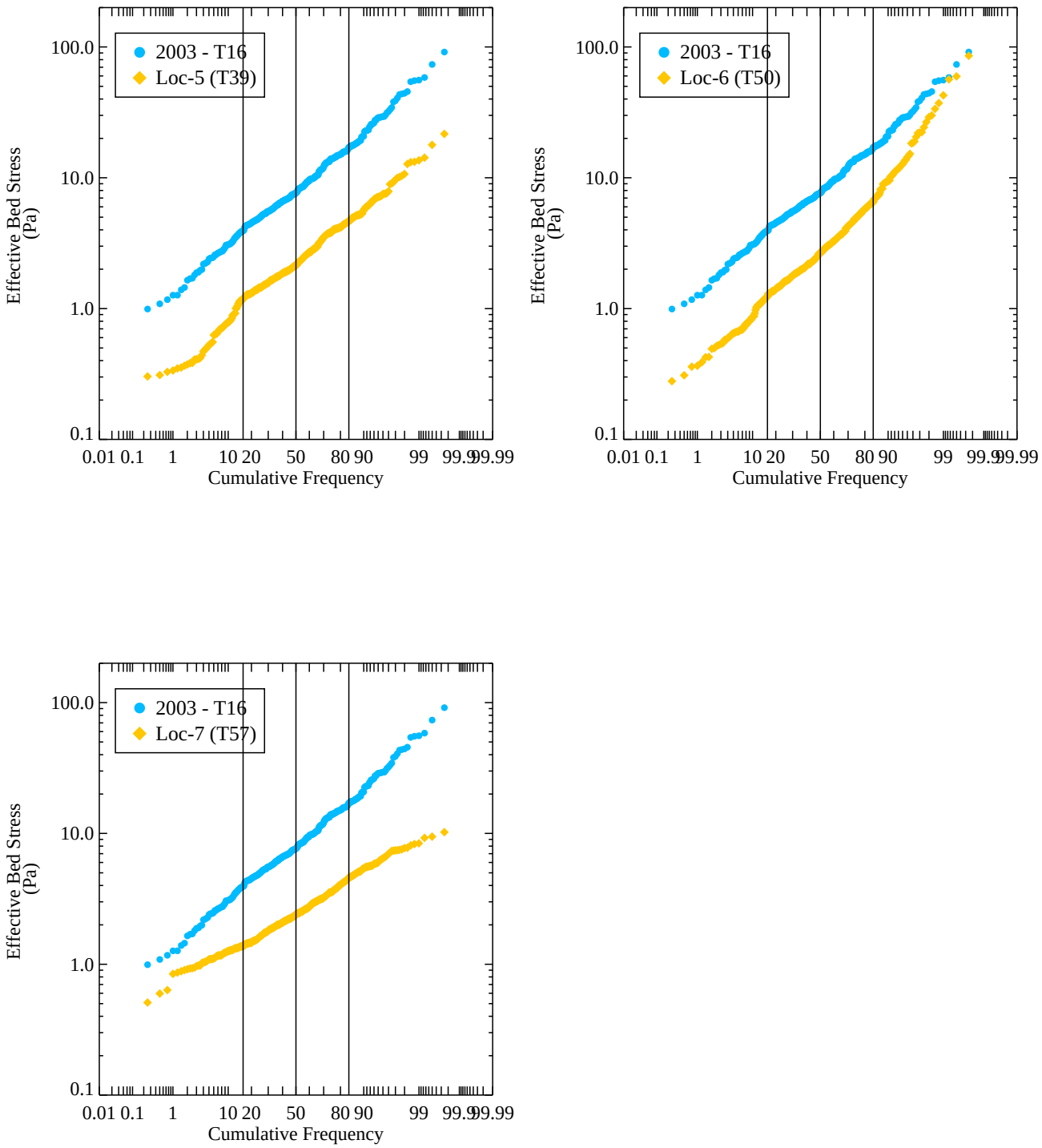

Figure 7-6. Comparison of frequency distributions of effective bed stress for location scenarios to T16-2003 event: Loc-5, Loc-6 and Loc-7.

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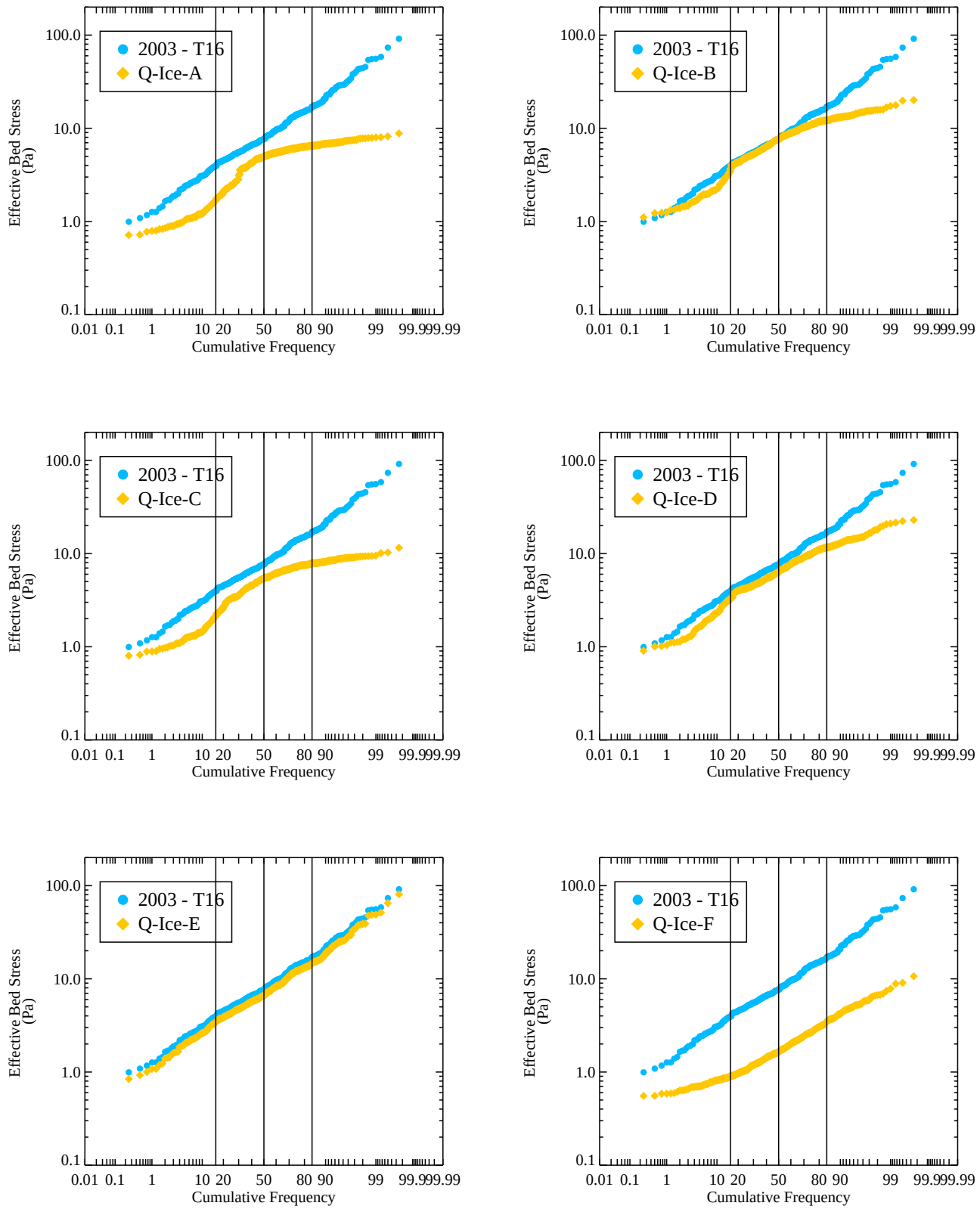

Figure 7-7. Comparison of frequency distributions of effective bed stress for discharge-ice-supply scenarios to T16-2003 event.

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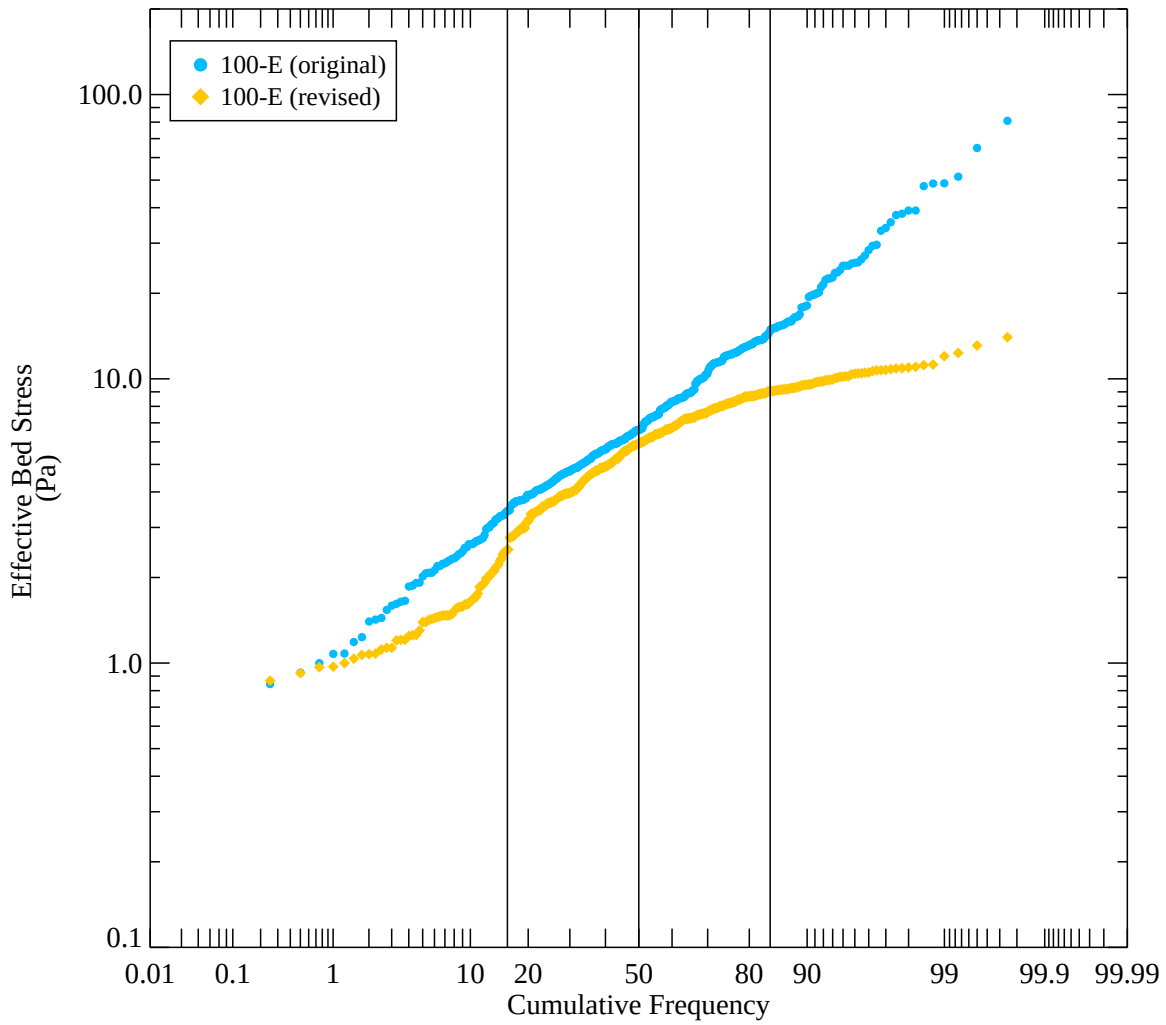

Figure 7-8. Comparison of bottom stress distribution for the original and revised Q-Ice-E scenarios.

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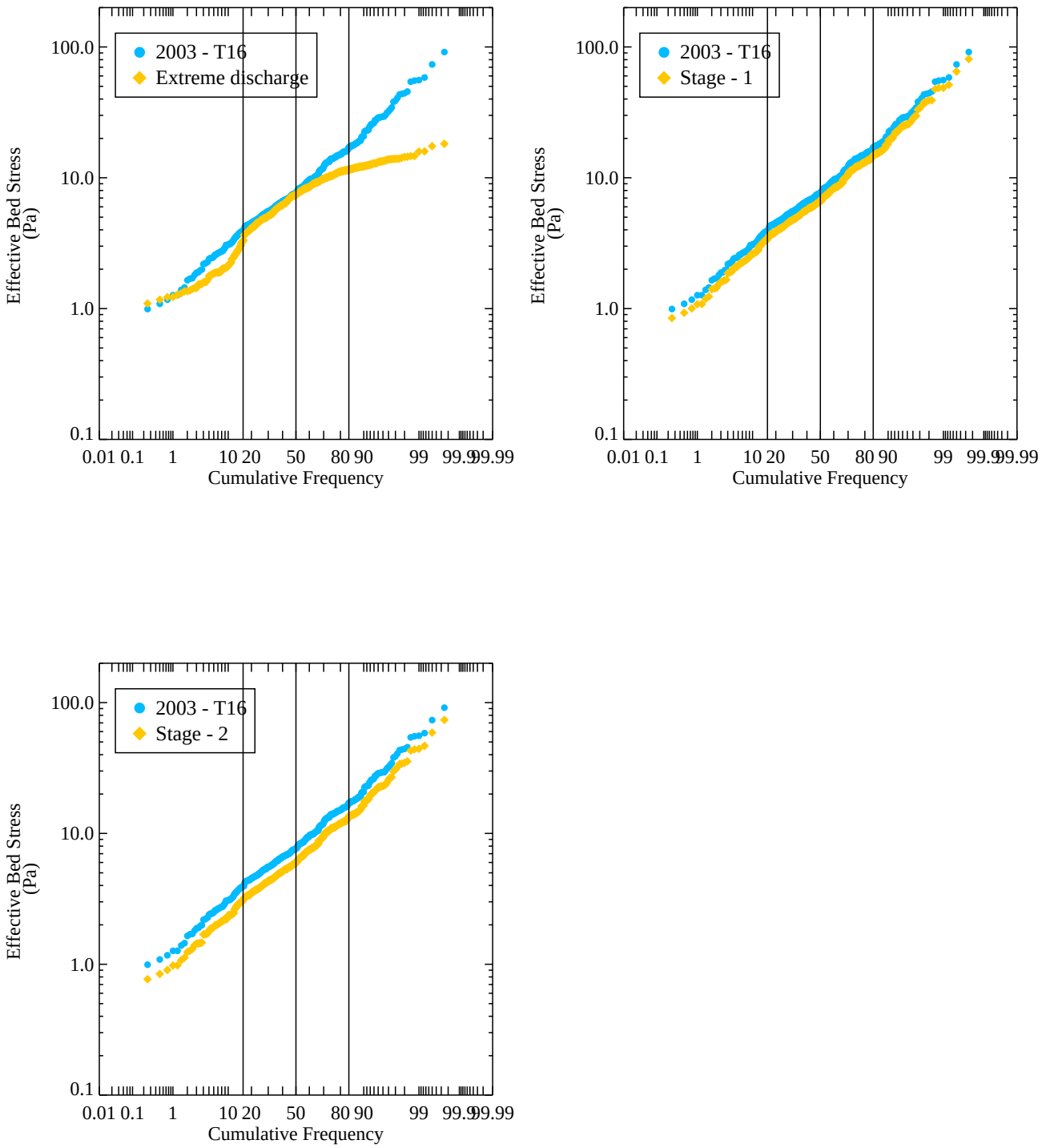

Figure 7-9. Comparison of frequency distributions of effective bed stress to T16-2003 event: extreme discharge, stage-1 and stage-2 scenarios.

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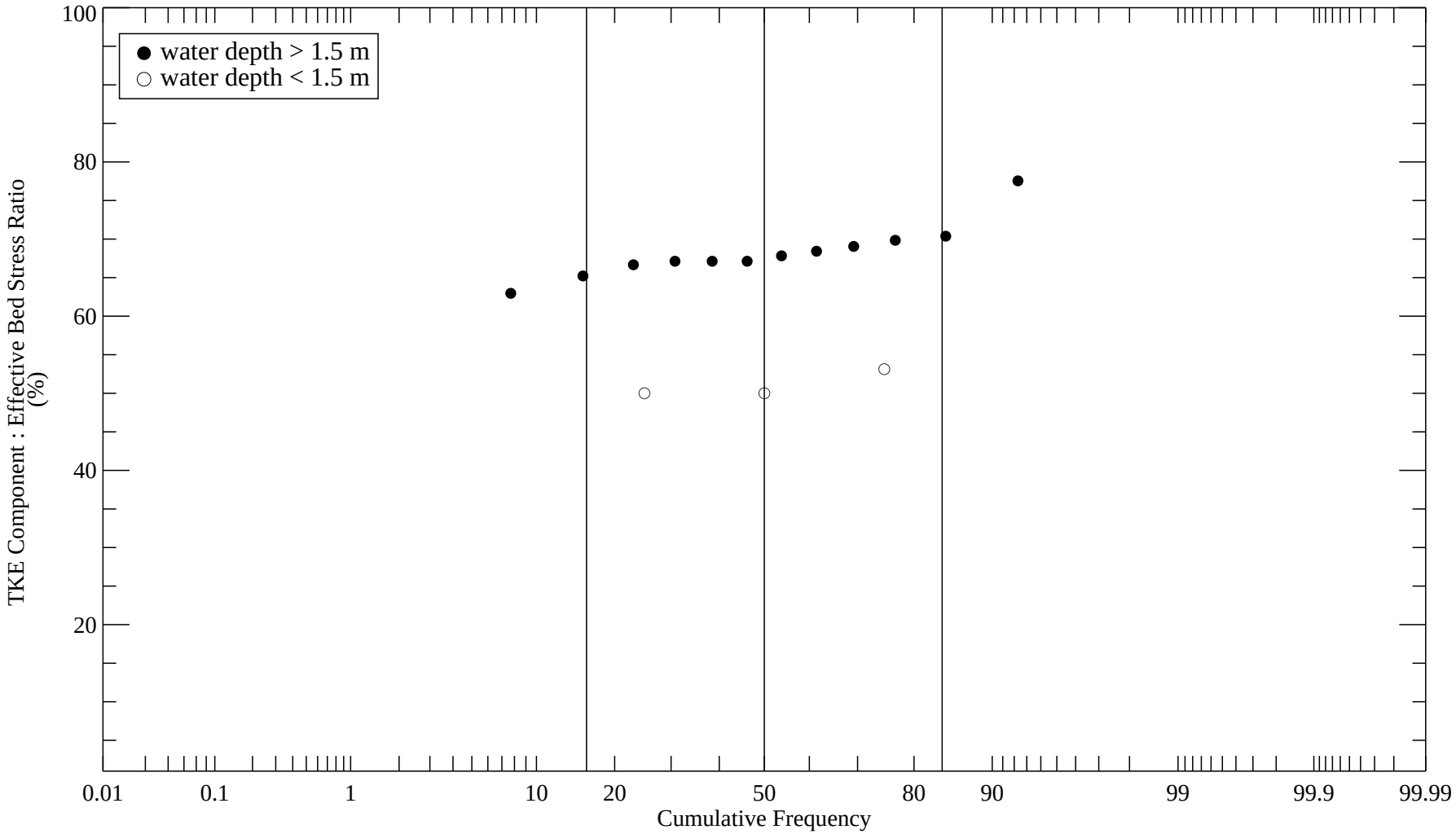

Figure 7-10. Cumulative frequency distribution of ratio of TKE component to effective bed stress.

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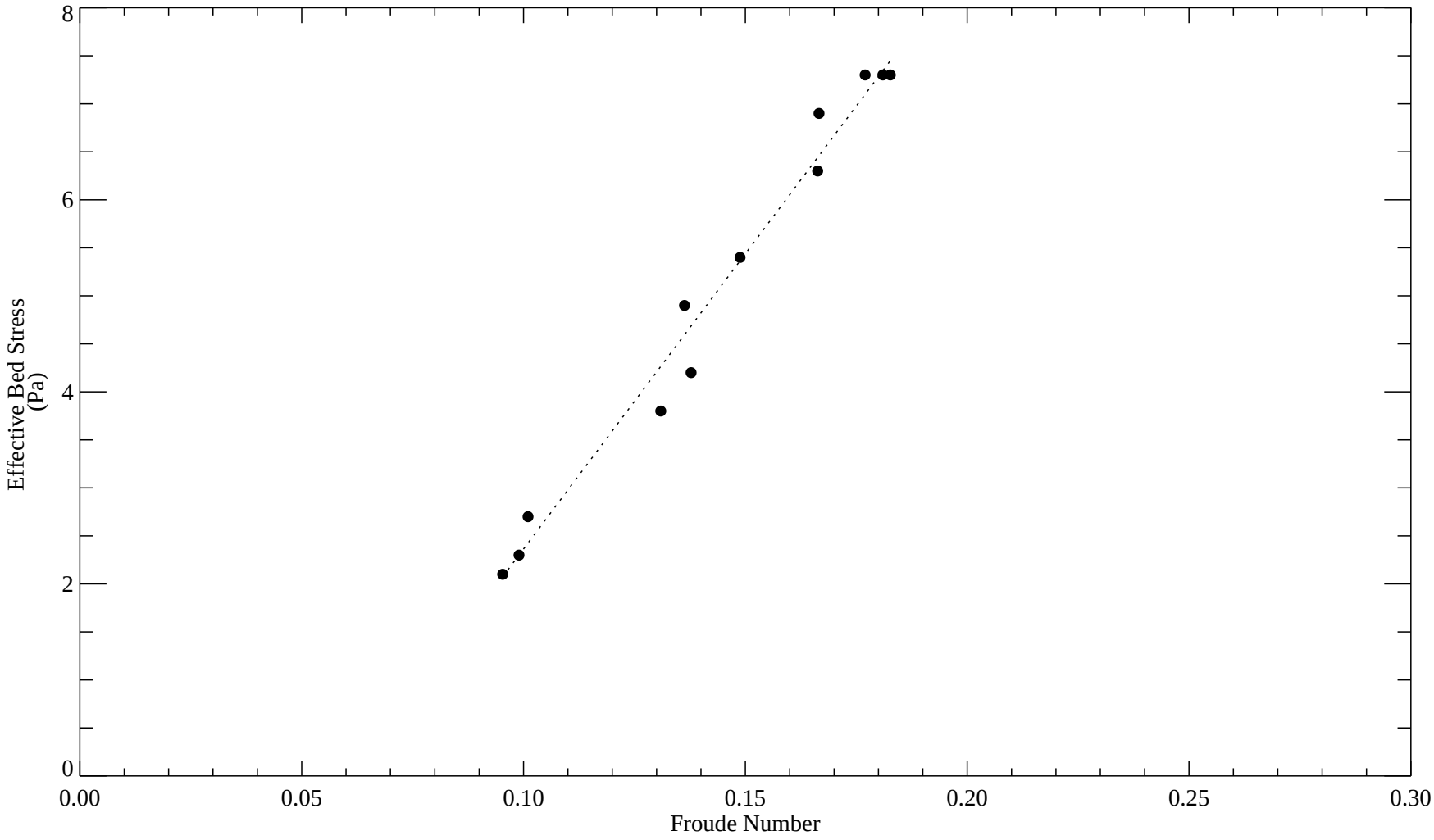

Figure 7-11. Correlation between effective bed stress and Froude number.

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2003/2004 Grasse River Ice Monitoring Work Plan
December 2003

1.0 Introduction

This plan presents the scope of work for monitoring the river ice cover and subsequent ice breakup on the Grasse River during the 2003/2004 winter season. The objective of this effort is to gather data to support an understanding of the potential impacts of river ice processes on sediment stability in the lower Grasse River. The monitoring locations and protocols for each component of the work are described below.

The 2003/2004 river ice monitoring on the Grasse River includes the following tasks:

- monitoring/recording of climatological conditions;
- river stage monitoring;
- monitoring of river ice cover extent, type, and thickness during the formation and mid-winter periods;
- river ice cover and thickness monitoring during ice breakup; and
- documentation of 2003/2004 river ice conditions.

2.0 Climatological Conditions

The climatological conditions in Massena, New York will be monitored and compiled for the winter and spring of 2003/2004. The maximum, minimum, and average air temperatures and precipitation data will be cataloged and plotted. The 2003/2004 data will be compared to historical data.

3.0 River Stage Monitoring

River stage data for the Grasse River will be monitored and compiled during the winter and spring of 2003/2004. River stage (and the resultant discharge as available) will be monitored both at the USGS gaging station located in Chase Mills, New York, and at the staff gage/stage recorder installed at Outfall 001 (*Phase II Grasse River Sampling Work Plan* [Alcoa, November 2003]). Data are recorded at the Chase Mills location every four hours (and every one hour during high flow periods). Data will be recorded at the Outfall 001 location every hour during December and every 15 minutes for January through April.

Where observations are made from bridges (Table 1), relative stage will be monitored periodically by measuring the distance from a reference point on the bridge rail to the water or ice surface below using a weight suspended on a cloth tape.

4.0 Monitoring of River Ice Formation

The extent, type and thickness of the ice cover on the Grasse River will be periodically monitored from December 2003 through April 2004.

4.1 Extent of Ice Cover

Periodic monitoring of the extent of the ice cover will be performed at the 20 locations listed in Table 1 and shown in Figure 1. Dated photographs will be taken at each location looking upstream and downstream. Monitoring will be performed at least once

a month beginning the first week of December. While the ice cover is actively forming (typically late-November through January), field observations will be more frequent as needed. Once a complete ice cover has formed upstream and downstream of a site, time intervals between observations will revert back to a once per month frequency.

Figure 2 shows a longitudinal profile of the Grasse River from the St. Lawrence River to the dam at Pyrites, New York. The profile portrays the Grasse River as a series of pools and riffles or rapids, with bridges and settled areas typically at the downstream ends of pools. Sheet ice covers are expected to develop at the downstream ends of these pools, and progress upstream through a combination of thermal border ice growth and juxtaposition of frazil slush and flows arriving from steeper, faster flowing upstream reaches. Periodic field observations at these sites along the upper river, i.e., upstream of Massena, will aid in understanding the ice formation process. Field observations, photographs and measurements of how the ice cover forms and the ice type (whether it is thermally grown sheet ice, juxtaposed frazil, frazil deposits beneath the ice cover) will be collected.

Understanding the nature of ice cover formation will help better understand the breakup process. Breakup can be either thermal or mechanical. A thermal breakup is essentially a melt-out process where the ice cover deteriorates and melts in place without significant movement or jamming. In the years where climatic and river flow conditions are such that a thermal melt-out occurs, the reverse of the ice formation sequence is expected; the faster flowing sections melt-out first and the pools melt-out last.

During a mechanical breakup, a relatively competent ice cover fragments under hydraulic forces, associated with a significant rise in river stage. The stage rise typically results from a rapid increase river discharge due to spring snowmelt runoff, often accompanies by rainfall. Ice runs produced by a mechanical breakup leads to ice jams when the ice discharge exceeds the ice conveyance capacity of the river channel. For the years in which climatic and river flow conditions are such that a mechanical breakup occurs, it is expected that the ice releases from the steeper sections of the river and jams, at least temporarily, in the pools upstream of bridges and weirs, particularly if those areas with sheet ice are thickened by frazil deposits. Once enough ice rubble and hydraulic head builds behind these jams, the ice will release and possibly re-jam at downstream locations. Ice monitoring data will be used to assess questions regarding the extent of the upstream ice cover supplying ice to the lower river and the portion of the total breakup ice volume lost en-route via melting and over-bank deposition.

4.2 Measure Ice Thickness

Ice thickness on the river will be measured prior to spring thaw conditions. Thickness will be measured at a location near river transect T71 (near the Amvet's property) and near river transect T5 (near Outfall 001)). On the upper river, attempts will be made to measure ice thickness at the Rod and Gun Club, upstream of the Madrid Bridge, and upstream of the Canton Route 68 Bridge. Any frazil slush beneath the solid ice cover will be noted, and if possible, its thickness measured. The thickness will be measured at distances approximately 50 and 100 feet from the accessible shore as ice

conditions/thickness allow for safety. The thickness of snow cover and snow pack will also be measured. The ice thickness will be measured two times, once in early February, and once prior to ice melt/breakup during the spring of 2004 assuming that this measurement can be performed safely.

5.0 Monitoring of River Ice Breakup

More frequent monitoring of ice cover conditions will be performed during the expected period of ice breakup, which typically occurs in mid-to-late March or early-April. Detailed monitoring will also be performed during the "January thaw," if this phenomenon occurs.

5.1 Daily Documentation of Changes in Ice Cover

Ice melting and breakup on the river will be monitored in more detail using daily photographs and sketches. Photographs will be taken looking both upstream and downstream at each location. This monitoring schedule will include weekends, as needed. Daily monitoring will be performed at Locations 1 through 11 (as provided in Table 1 and Figure 1). Locations 6 and 7 are directly on the riverbank and close attention will be given to the interface between the ice and the shoreline. More frequent monitoring (i.e., twice per day) will be performed at locations 1 through 11 during the final stages of ice breakup.

The frequency of monitoring at Locations 12 through 20 will also be increased depending on travel time and weather conditions. Sketches of ice break up on the river will be developed daily during the ice melt/breakup period. Any exceptional conditions seen on the river will be documented.

The planned observations will be conducted to the extent that weather and road conditions allow safe conduct of the work.

5.2 Automated Photography

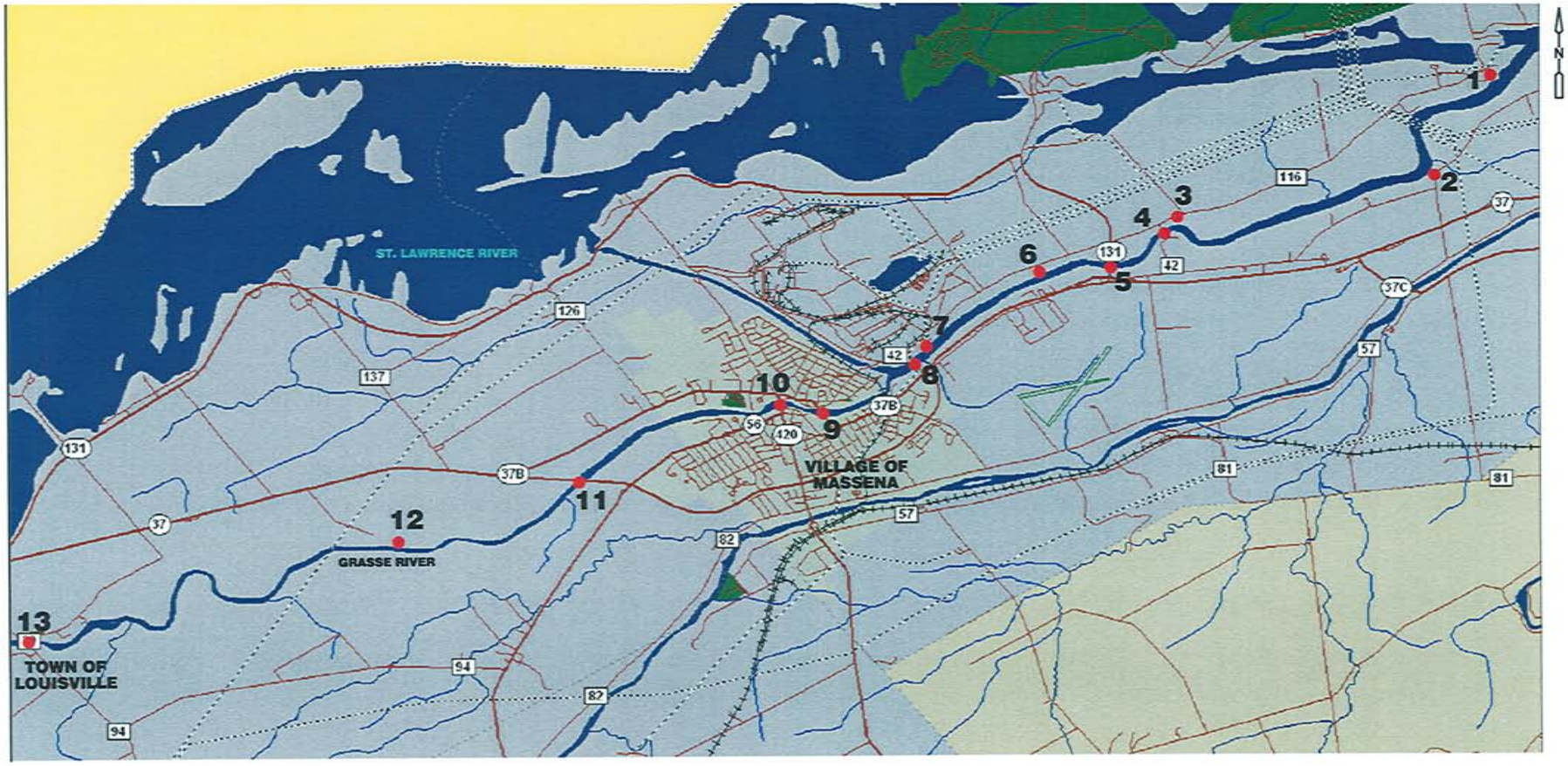
The feasibility of installing a web-based video camera at Location 7, i.e., near Outfall 001, will be explored to take video photographs of the entire ice breakup process along this section of the lower Grasse River. If this is determined to be feasible, the web-based camera would be operated during the period of March 1 through the end of the ice breakup process.

6.0 Documentation Report

The river ice monitoring will be documented in a report following ice melt/breakup during the spring of 2004. This report will include an assessment of the climatological data and river stage data (and discharge data as available), overview of the ice cover and the subsequent ice melt/breakup, sketches of the ice melt/breakup, and key photographs taken during monitoring.

Table 1
2003/2004 River Ice Monitoring Locations

Location Number	Ice Monitoring Location	Road Designation
1	Amvets Property	---
2	Haverstock Road	---
3	Massena Center	---
4	Closed Massena Center Bridge	---
5	Route 131 Bridge	Route 131
6	Capping Pilot Study Area	---
7	Outfall 001	---
8	Alcoa Bridge	Alcoa Road
9	Parker Street Bridge	Route 37B
10	Main Street Bridge	Route 420
11	Route 37 Bridge	Route 37
12	Massena Rod and Gun Club	---
13	Louisville Bridge	Route 39
14	Chase Mills Bridge, USGS Gage	Route 36
15	Chamberlain Corners Bridge	Route 44
16	Madrid Bridge	Route 345
17	Bucks Road Bridge	Route 34
18	Canton Bridge	Route 68
19	Bridge Downstream of Pyrites	Route 21
20	Dam at Pyrites	---



OTHER MONITORING LOCATIONS UPSTREAM OF LOUISVILLE BRIDGE, MONITORING LOCATION 13

No.	LOCATION	DISTANCE UPSTREAM *
14	CHASE MILLS BRIDGE, RT. 36	5 mi
15	CHAMBERLAIN CORNERS BRIDGE, RT. 44	6.75 mi
16	MADRID BRIDGE, RT. 345	12 mi
17	BUCKS BRIDGE, RT. 34	15.75 mi
18	CANTON BRIDGE, RT. 68	25.75 mi
19	BRIDGE BELOW PYRITES, RT. 21	32.5 mi
20	HYDRO DAM AT PYRITES	33.5 mi

* ALL DISTANCES ARE REFERENCED FROM LOUISVILLE BRIDGE AND ARE APPROXIMATE.

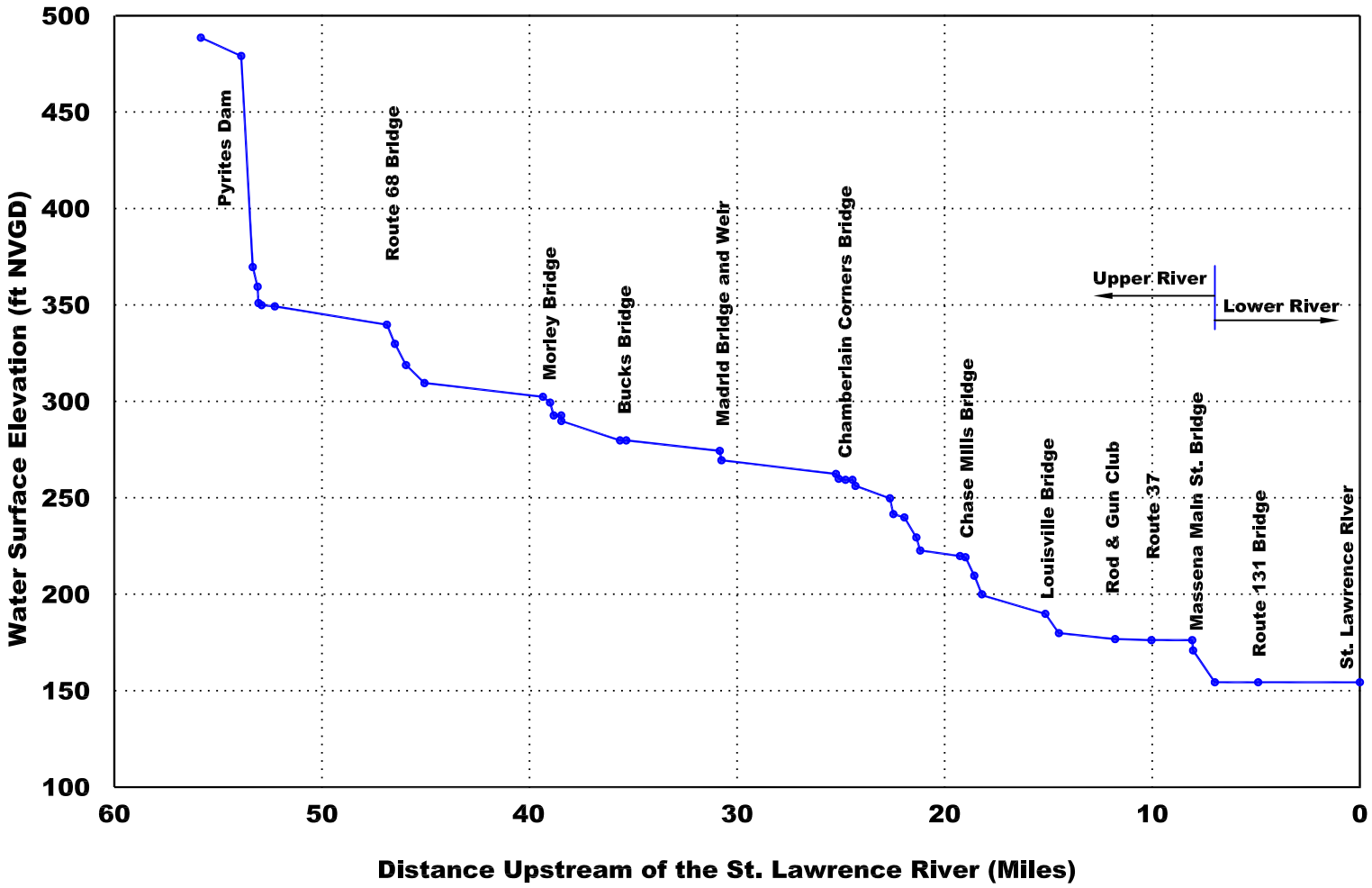
NEW YORK STATE LOCATION MAP

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

2003/2004 RIVER ICE MONITORING LOCATIONS

ALCOA

FIGURE
1



GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

PROFILE OF GRASSE RIVER ICE MONITORING LOCATIONS

ALCOA

FIGURE
2

Note:

1. Water surface elevations obtained from USGS 7.5 minute series topographic quadrangles.