RB&G
ENGINEERING
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1435 WEST 820 NORTH
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LEGACY PARKWAY

STRUCTURE F-718

500 SOUTH OVER LEGACY PARKWAY

STRUCTURE D-843

500 SOUTH OVER MULTI-USE TRAIL

Salt Lake & Davis Counties, Utah

Utah Department of Transportation
SP-0067(5)0

July 2006

Geotechnical Investigation Report for Structures

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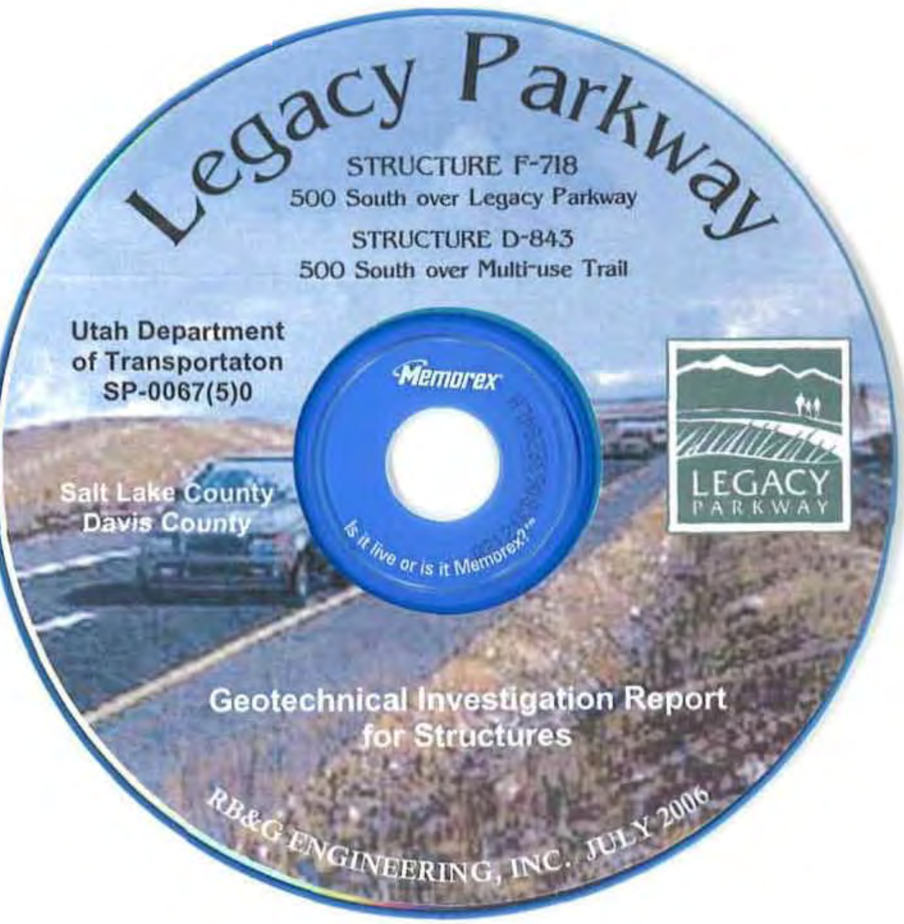
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500 South over Legacy Parkway
STRUCTURE D-843
500 South over Multi-use Trail
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Salt Lake County
Davis County
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Is it live or is it Memorex?
LEGACY
PARKWAY
Geotechnical Investigation Report
for Structures
RB&G ENGINEERING, INC. JULY 2006

RB&G
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INC.

July 31, 2006

Mr. Sohail Khan
Carter & Burgess
420 East South Temple Suite 342
Salt Lake City, Utah 84111-1321

Reference: Legacy Parkway Project No. SP-0067(5)0

Gentlemen:

A Geotechnical Investigation Report for Structures has been completed for Structure F-718, 500 South over Legacy Parkway, and Structure D-843, 500 South over Multi-Use Trail in Salt Lake and Davis Counties, Utah. The investigation has been conducted in accordance with a proposal submitted to your organization for the work, and the results of the study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

REGISTERED PROFESSIONAL ENGINEER
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Geotechnical Investigation Report for Structures

Legacy Parkway

Structure F-718
500 South over Legacy Parkway

Structure D-843
500 South over Multi-Use Trail

Salt Lake & Davis Counties, Utah

Utah Department of Transportation
SP-0067(5)0

July 2006

RB&G ENGINEERING, INC.

Professional Engineers

LEGACY PARKWAY

UTAH DEPARTMENT OF TRANSPORTATION
SP-0067(5)0

GEOTECHNICAL INVESTIGATION REPORT FOR STRUCTURES

Structure F-718 – 500 South over Legacy Parkway
Structure D-843 – 500 South over Multi-Use Trail

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LEGACY PARKWAY

UTAH DEPARTMENT OF TRANSPORTATION
SP-0067(5)0

GEOTECHNICAL INVESTIGATION REPORT FOR STRUCTURES

Structure F-718 – 500 South over Legacy Parkway
Structure D-843 – 500 South over Multi-Use Trail

1.0 GENERAL

This report presents the results of geotechnical investigations and provides foundation recommendations for the following structures located within the Legacy Parkway project:

- F-718 – 500 South over Legacy Parkway
- D-843 – 500 South over Multi-use Trail

The primary purpose of this investigation is to determine the characteristics of the subsurface material throughout the project area, and to make appropriate foundation design recommendations for the proposed structures. The report is intended to aid designers in evaluating the site and subsurface conditions for foundation design and potential construction problems.

1.1 PROJECT DESCRIPTION

The Legacy Parkway will be a four-lane, limited-access, divided highway extending approximately 14 miles from Interstate 215 at 2100 North in North Salt Lake, northward to the junction of Interstate 15 and U.S Highway 89 near Farmington (see Figure 1). A multiple-use pedestrian, bicycle, and horse trail will parallel the Parkway.

1.1.1 General

Bridge structures do not presently exist at the 500 South Bridge site, located in Davis County. The 500 South multi-use trail crossing (D-843) and bridge over Legacy Parkway (F-718) will be located approximately 1,600 to 2,000 feet west of the intersection of 500 South (Bountiful) and Redwood Road, respectively. The adjacent cities at this location are West Bountiful to the northeast and Woods

Cross to the southeast, with Great Salt Lake wetlands encountered west of the Parkway alignment in this area.

1.1.2 Proposed Improvements

New structures will be built at locations where the Legacy Parkway roadway and trail system will cross existing streets, waterways, and other facilities. Bountiful's 500 South Street approaches the Legacy Parkway from the east, but presently terminates at Redwood Road, some 2,000 feet east of the Parkway in this area. The street will be extended west to the Parkway and an interchange will be constructed at the intersection. It is our understanding that the 500 South Bridge over Legacy Parkway will be a two-span structure incorporating MSE walls at each abutment, and the multi-use trail will cross beneath 500 South in a tunnel/culvert type structure. Preliminary drawings of the proposed structures are included for reference in Appendix A.

1.1.3 Climatic Conditions

The climate in the project area is characterized by relatively warm summers and cold winters. The frost depth ranges between 20 to 30 inches. Winter snow often requires plowing, and de-icing salt is regularly deposited on major roadways during the winter months.

2.0 PREVIOUS REPORTS AND INVESTIGATIONS

The following geotechnical reports and investigations have been completed previously by others for this project.

2.1 PB/FAK GEOTECHNICAL INVESTIGATION REPORT

UDOT provided copies of the Geotechnical Reports prepared by Parsons Brinckerhoff Quade & Douglas (PB) for Fluor Ames Kraemer (FAK), LLC as a part of the Design-Build Legacy Parkway Project. The report includes the results of subsurface investigations performed by Kleinfelder, Inc. and provides geotechnical recommendations for the structures contemplated in the original project. It should be noted that the project was divided into five segments for the Design-Build Project. Segment 2 of the Design Build project was to begin about 1000 feet north of Center Street (North Salt Lake) and continue in a northwesterly direction to the vicinity of the Bountiful City landfill Borings and CPT soundings were performed for the bridge originally contemplated at 500 South Street, and a roadway boring was performed about 250 feet east of the bridge.

2.2 KLEINFELDER GEOTECHNICAL INVESTIGATION

It is our understanding the Kleinfelder, Inc. conducted an investigation of the preferred Legacy Parkway alignment for UDOT and the results were submitted in a report dated June 2, 2000. Some of its findings were reproduced in the PB/FAK Design Build reports referenced in Section 2.1 above.

2.3 DAMES & MOORE PRELIMINARY GEOTECHNICAL STUDY

It is our understanding that Dames & Moore completed a geotechnical study for the proposed preliminary Legacy Parkway corridor and presented the results in a 1998 report.

3.0 EXISTING FACILITIES

Five Hundred South is a two-lane paved road approaching the bridge site from the east before turning south onto Redwood Road about 2,000 feet east of the site. The proposed Parkway will travel in a generally north-south direction, with 500 South Street crossing over the parkway and trail. No buildings were observed within a 1,000-foot radius of the bridge site. Canal A1 flows from south to north about 600 feet west of the bridge site and crosses beneath the existing gravel access road (extension of 500 South from Redwood Road intersection). Three Hundred South is a dirt road running in an east-west direction about 600 feet to the north. Various utility lines exist in the area, including overhead power lines and buried utilities such as gas, oil, power, and communications lines.

4.0 FINDINGS

4.1 EXISTING SITE CONDITIONS

The topography is relatively flat throughout Segment 1 and generally slopes down to the west towards the Great Salt Lake. The proposed Legacy Parkway corridor begins just west of the existing I-215 / Redwood Road interchange on the south and continues northward. The southerly portion of the corridor travels along the westerly limits of North Salt Lake, Woods Cross, West Bountiful, and Centerville, about 0.5 to 2 miles west of I-15. North of Parrish Lane in Centerville, the Parkway corridor will be located less than about 0.25 miles west of I-15, with the two corridors essentially parallel continuing north to the I-15 / US-89 interchange in Farmington. The south and north interchanges are already partially constructed. A few industrial and commercial facilities are located along the alignment.

The 500 South site is relatively flat, with a mound of fill near the southeasterly corner of the proposed bridge location. Vegetation throughout this area consists of weeds and native grass. Some granular fill had been placed at the site during a previous phase of the project. A stockpile of steel pipe piles was observed immediately north of the boring locations at the time of drilling.

4.2 SURFACE DRAINAGE

Surface drainage in the area generally follows the topography to the west and northwest towards the Great Salt Lake. In addition to the Jordan River and Oil Drain at the south interchange, some creeks, streams, and canals cross the alignment at various locations, creating the potential for flooding Flooding and ponding on the soft surface soils can make access to bridge sites difficult.

4.3 GEOLOGY

The project is located within the Wasatch Front section of the Basin and Range physiographic region. The Wasatch Front consists of a series of down dropped valleys bounded primarily by the Wasatch Mountains on the east and the Great Salt Lake, Utah Lake and the Oquirrh Mountains on the west. The area extends from Juab County in the south up through Salt Lake, Davis, Weber and Box Elder counties to the north.

The general topography of the Wasatch Front is due, in large part, to Basin and Range extensional faulting. The Wasatch Fault is an extensional normal fault which trends northerly along the base of the Wasatch Mountains from Levan in the south, and up into Idaho to the north. Prior to extensional faulting, the region was subjected to compressional forces from the west resulting in extensive thrust faulting and mountain building. Extensional forces are still active today with various segments of the Wasatch Fault capable of generating large earthquakes with magnitudes near 7.4.

The Wasatch Mountains to the east consist predominately of Precambrian to Mesozoic, metamorphic and sedimentary bedrock. The valleys along the Wasatch Front are predominately covered with Pleistocene Lake Bonneville deposits, and younger alluvial fan and stream deposits. The Bonneville Lake Cycle began about 30,000 years ago when the climate was much cooler and wetter. The lake reached its highest elevation of about 5,100 feet, known as the Bonneville shoreline, between 16,000 to 14,500 years ago. From this shoreline, the lake eventually overtopped and breached through unconsolidated sediments near Red Rock Pass sending a catastrophic flood into the Snake River drainage system in southeastern Idaho, about 14,500 years before present. Within about a year, the lake had dropped to an elevation of about 4,740 feet, forming the Provo shoreline. Due to changing climatic conditions, the lake level gradually dropped to the historic levels of its modern day remnant, the Great Salt Lake. The last major high water shoreline of the lake was the Gilbert shoreline which reached an elevation of about 4,250 feet between 11,000 to 10,000 years ago. Historically, the Great Salt Lake has fluctuated between 4,211.9 and about 4,191 feet above sea level.

During Bonneville times thousands of feet of sediment were deposited in the valley. Deposits consist of deep-water silts and clays, shoreline sand and gravels and gravelly barrier beach and deltaic deposits. The unconsolidated to semi-consolidated valley fill deposits are thought to range from 2,000 to 5,000 feet thick (Black, and others, 2003; Currey, and others, 1984; Hintze, 1988; Stokes, 1986).

A geologic map of the Central Wasatch Front by Davis (1983) shows the surficial deposits in the proposed Parkway alignment to consist of floodplain and delta deposits (chiefly fine-grained and poorly drained sediments) in the vicinity of the south interchange, Provo Formation and younger lake bottom sediments (clays, silts, sands, and localized offshore bars) through the majority of the project, and landslide deposits near the north interchange. Newer maps of the area (Personius and Scott, 1992; Nelson and Personius, 1993), characterize the predominant surficial geologic deposits throughout the study area as Lake Bonneville lacustrine clay and silt, with Holocene to upper Pleistocene lateral spread deposits at some locations. Post-Bonneville lacustrine and marsh deposits are encountered along the easterly shores of the Great Salt Lake and encroach on the Parkway alignment from the west at some bridge sites. Localized upper Holocene stream alluvium associated with the Jordan River can be found along the shores of the river near the southerly terminus of the project. Bonneville lacustrine sand and gravel may be encountered near the northerly terminus, along with upper Holocene fan alluvium consisting of cobbles and gravel in a sandy matrix.

As shown on Figure 2a, the 500 South Street site lies near the border of two surficial units mapped by Davis (1983), with lake bottom sediments to the east of the site and floodplain/delta deposits west of the site. The site lies just beyond the borders of maps by Nelson and Personius (1993) and Personius and Scott (1992). Portions of these maps are overlaid on the Davis map on Figure 2b, and extrapolation of the two more recent maps suggest that lateral spread deposits may be encountered at the site. The deeper soils are likely lacustrine clays, silts, and sands.

Figure 2c shows landslide deposits mapped by Harty and Lowe (1992) in the North Salt Lake area. The authors of the map noted that they were unable to confirm that the North Salt Lake features are landslides; however, based on surface evidence and geologic evidence provided by others, the deposits were believed to be liquefaction-induced landslides. The deposits labeled Qmq_3 on Figure 2c are believed to predate the Gilbert shoreline (about 10,000 years ago); however, the Qml_1 zone may have moved more recently. It will be noted that the 500 South Site is located within these suspected younger Holocene lateral-spread landslide deposits. The literature accompanying the map indicates that the possibility still exists for recurrent movement of the North Salt Lake landslides during earthquake ground shaking.

4.4 GEOLOGIC HAZARDS

Geologic hazards identified within the Legacy Parkway project area include ground shaking, liquefaction-induced lateral spreading and landslides, and subsidence during a moderate to large seismic event on the Salt Lake or Weber segments of the WFZ. Large seismic events on one of the other surrounding less studied faults such as the Great Salt Lake fault may also trigger these hazards.

Due to the close proximity of the Parkway to the Great Salt Lake, tilting of the lake during tectonic subsidence will shift the lake toward the east. This subsidence will cause a rise in already high ground-water tables and cause the lake to inundate toward the east. Subsidence and tilting will be greatest nearest the fault and will taper off away from the fault toward the west. Studies by Keaton (1987), and Chang and Smith (1998) have compared the 7.5 magnitude earthquake at Hebgen Lake, Montana in 1959 to a maximum credible earthquake along the Wasatch Front. Keaton's study shows the area near the most eastern extent of Farmington Bay to have the greatest potential for flooding. It should be noted that the magnitude of this hazard is directly related to the level of the lake and the location and magnitude of the earthquake. Ground shaking from surrounding faults or rupture of the Great Salt Lake fault beneath the lake also has the potential to generate wave hazards in the form of seiche (water oscillation waves) or a lake tsunami The actual hazard potential to the Parkway from these waves is not known. Based on a study by Lin and Wang (1978) the hazard from seiche on the lake is likely low.

Other hazards include shallow ground water and potential flooding. A more detailed discussion of seismic hazards at the 500 South site is provided in Section 5.0.

4.5 SOIL MATERIALS

Much of the Segment 1 portion of the project has been covered with a layer of compacted granular fill, including the site of the proposed 500 South structures and the temporary gravel roadway extending west to the site from Redwood Road Borings completed at the 500 South site generally encountered soft to stiff clay and silt with loose to medium-dense sand layers in the upper 45 feet, followed by firm to stiff clay with fewer sand layers to about 95 feet. Below 95 feet the borings continued through predominantly stiff clay and silt with medium-dense to dense sand layers up to about 8 feet thick. The deepest boring extended to a depth of 253 feet (approximate elevation 3958 feet). Soil conditions are described in further detail in Section 7.1.2.

4.6 HYDROGEOLOGIC CONDITIONS

Groundwater in the Salt Lake Valley occurs in late Tertiary and Quaternary alluvial and lacustrine basin-fill deposits that range from coarse gravel to clay Four hydraulically connected aquifers have been identified in the basin sediments: 1) a deep, unconfined aquifer in gravelly deposits along the fronts of the Wasatch Range and Oquirrh Mountains; 2) a deep, confined aquifer in the center of the valley in gravel deposits beneath clay confined beds; 3) a shallow, unconfined aquifer in the center of the valley overlying the confined aquifer; and 4) local perched aquifers located primarily adjacent to mountain fronts.

The hydraulic gradient in the Parkway area generally slopes down in a westerly direction toward the Great Salt Lake. The depth to groundwater was measured at each boring location as indicated on the boring logs and was within about 4 to 7 feet of the ground surface at the 500 South site at the time of drilling (February-March 2006). Fluctuations of a few feet can be expected due to typical seasonal variations At some locations within Segment I, the existing ground is covered by water during at least part of the year, creating difficult access conditions. Artesian conditions were encountered in the lower confined aquifers at some locations.

4.7 POTENTIALLY HAZARDOUS MATERIALS

Potentially hazardous materials were not noted during the field investigation. All soil samples were re-examined in the laboratory and odors indicative of contamination were not noted. Potential sources of contamination include the oil drain at the southerly end of the project along with various past and present industrial sites located in the vicinity of the Parkway alignment. The apparent lack of contamination observed by field and lab personnel does not preclude the possible presence of potentially hazardous materials in the project area.

5.0 EARTHQUAKE CONSIDERATIONS

The study area is located within the seismically active Intermountain Seismic Belt which extends from Arizona to Canada. The nearest potentially active fault is the Weber Segment of the Wasatch Fault Zone (WFZ) located about 1.9 miles northeast of the 500 South site. The Weber segment is capable of generating a magnitude 7.4 earthquake. The Salt Lake City Segment of the WFZ is located about 2.4 miles to the southeast with the capability of a magnitude 7.2 earthquake. The West Valley Fault Zone is located about 6.3 miles to the south. It is uncertain whether the West Valley Fault Zone has a true independent seismogenic source or if it functions as an antithetic fault to the WFZ.

5.1 DESIGN CRITERIA

The site is located at latitude 40.884° North and longitude 111.937° West. USGS-NEHRP probabilistic peak ground acceleration (PGA) values are tabulated below:

Probabilistic ground motion values in %g.

	10%PE in 50 yr	2%PE in 50 yr
PGA	27.30	65.12
0.2 sec SA	64.38	154.49
1.0 sec SA	22.16	65.01

It should be noted that the USGS-NEHRP mapped values are calculated for "firm rock" sites having a shear wave velocity of 1500 feet per second in the upper 100 feet (MCEER Site Class B/C boundary), and that bedrock ground motions may amplify or attenuate as they propagate through overburden soils.

Borings and testing completed at the site of the proposed structures indicate that the clayey soils in the upper 100 feet have average undrained shear strengths of about 1,000 to 1,300 psf. Based on this information, it is recommended that MCEER Site Class D be used for seismic design.

As part of the current Legacy Parkway project, Kleinfelder, Inc. developed site specific horizontal and vertical acceleration response spectra for the 1250 West bridge site and the State Street bridge site. It is our understanding that Kleinfelder will provide a separate report with conclusions and recommendations for applying the site-specific spectra at other sites on the project.

5.2 LIQUEFACTION AND LATERAL SPREAD

Liquefaction analyses were performed using the "Simplified Procedure" developed by Seed and Idriss (1971). This procedure involves determining the seismic shear stress ratio induced by an earthquake and comparing it with the seismic shear stress ratio required to cause liquefaction. Recommended refinements for the "Simplified Procedure" for SPT data presented at the 1996 NCEER workshop (Youd et al., 1997) were applied.

An evaluation of borings and testing indicates that several soil layers may liquefy during the seismic event having a 2 percent probability of exceedance in 50 years. Soil layers showing potential for liquefaction during the design event are noted on the boring logs in Appendix B. Layer thicknesses and potential liquefaction-induced settlement corresponding to volumetric strain are summarized below.

Boring No.	Thickness of Liquefiable Layers (ft)		Calculated Liquefaction Settlement (in)	
	Within Depth Investigated	Within Upper 50 Feet	Within Depth Investigated	Within Upper 50 Feet
RSB-12-609	19.6	12.6	2.3	1.7
RSB-12-610	20.2	9.3	3.1	2.1
RSB-12-651 *	3.7	2.2	0.2	0.1

*Boring 651 only extended to a depth of 78 feet.

It has been noted that surficial soils in the area are mapped as suspected lateral spread deposits. A review of the boring logs does not identify a continuous layer susceptible to lateral spread in the upper 30 feet of the soil profile. Some deposits susceptible to lateral spread were encountered between depths of about 31 to 41 feet in Borings 609 and 610. Boring RSB-12-651 did not encounter soil layers exhibiting lateral spread potential. Empirical evidence indicates that significant lateral spread displacements usually are limited to sites where the top of the susceptible soil layer is within 10 meters (about 33 feet) of the ground surface (Bartlett and Youd, 1992). Due to the depths and apparent discontinuity of potentially susceptible soil layers, lateral spread mitigation is not considered necessary at this site.

6.0 FIELD AND LABORATORY TEST DATA

6.1 SUBSURFACE EXPLORATION

Subsurface investigations performed at the bridge sites include borings performed by Kleinfelder in conjunction with the Design-Build project, along with supplemental borings performed in 2006 for the current project.

Boring logs for bridge subsurface investigations performed in 2006 are included in Appendix B of this report. Test holes performed by RB&G Engineering in 2006 are labeled with the prefix "RSB" (or "RSC" for CPT holes, where applicable), followed by a number identifying the bridge site, then by a hole number in the 600 series. Logs of subsurface investigations performed by Kleinfelder are also reproduced in Appendix B and are labeled with the prefix "SB" for borings and "SC" for CPT holes, followed by the Design-Build bridge number, then the boring number. It will be noted that the 500 South site is number 12, based on the Design-Build bridge number. Roadway borings performed by Kleinfelder are labeled with the prefix "RB".

For all structure borings drilled in 2006, the subsurface investigation was performed using a CME 55 rotary drill rig with a tri-cone rock bit and NW casing to advance the boring and water as the drilling fluid. Sampling was generally performed at 5-foot intervals. At some locations, sampling was performed at closer intervals to evaluate liquefaction hazard for loose cohesionless soils in the upper 30 to 40 feet. Disturbed samples were obtained by driving a 2-inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The drill rig used for each boring is noted on the boring log. The automatic trip hammer on the CME-55 No. 1 rig was evaluated by UDOT using Pile Driving Analyzer equipment in March 2006 and the energy ratio was determined to be about 72%. The CME-55 No. 2 rig uses a rope and cathead hammer which was determined by UDOT to have an average energy ratio of about 55%.

The number of hammer blows required to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value, corrected for overburden and hammer energy, provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of cohesive material, since the penetration resistance of materials of this type is a function of the moisture content. Considerable care must be exercised in interpreting the standard penetration value in gravelly-type soils, particularly where the size of granular particles exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with a reasonable core recovery, the standard penetration value provides a good indication of the in-place density of gravelly-type material. For materials containing more than 35% gravel size particles, the density descriptions shown on the boring logs were developed based on correlations between relative density and standard penetration value for gravelly soils.

At some locations within the project it was not possible to drive the sampling spoon through the full 18 inches at some sampling depths. Where the sampling tube could not be driven through the full 18 inches, the number of blows to drive the spoon through a given depth of penetration is shown on the boring logs.

Undisturbed samples were obtained by pushing a 2.62-inch (inside diameter) thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. The locations at which the undisturbed samples were obtained are shown on the boring logs.

Miniature vane shear (torvane) tests, which provide an indication of the undrained shearing strength of cohesive materials, were performed on samples of the cohesive soils during the field investigations. The results of these tests are shown on the boring logs as the torvane value in tsf.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbols designating soil types according to this system are presented on the boring logs. A description of the Unified Soil Classification System is included with the logs (see Appendix B), and the meaning of the various symbols shown on the logs can be obtained from this figure. Laboratory-tested samples were also classified according to the AASHTO Classification System, and the symbols designating the soil types according to this system are also presented on the boring logs.

6.2 LABORATORY TESTING

Laboratory tests performed during this investigation to define the characteristics of the subsurface material included:

1) Mechanical Analysis
2) Density

3) Natural Moisture Content
4) Atterberg Limits
5) Unconfined Compressive Strength
6) Triaxial Shear
7) Consolidation
8) Direct Shear
9) pH, Resistivity, Sulfates, and Chlorides

Laboratory testing was performed in accordance with applicable standards published by the American Society for Testing and Materials (ASTM) and/or the American Association of State Highway and Transportation Officials (AASHTO).

The results of laboratory tests performed during this investigation are presented on the boring logs and summarized on tables located in Appendix C of this report. Plots of applicable test data are also included in Appendix C.

7.0 STRUCTURES

7.1 DESCRIPTION

7.1.1 General

It is our understanding that Structure F-718 will be a two-span concrete bridge structure with MSE walls at each abutment. The bridge is expected to be about 55 feet wide with two 90-foot long spans, for a total bridge length of about 180 feet. Structure D-843 will be a culvert/tunnel type structure approximately 27 feet wide by 144 feet long. Controlling loads for the F-718 bridge have been provided by the structural engineer and are shown on the table below. Loads for Structure D-843 have not been provided

Structure	Foundation	Strength I (kips)	Service I (kips)
F-718 500 South over LP	Abut 1	3225	2505
	Bent 2	6464	5036
	Abut 3	3225	2505

7.1.2 Subsurface Conditions

Borings completed at the site by Kleinfelder encountered primarily medium-stiff to stiff lean to fat clay and silt interbedded with some silty sand layers in the upper 50 feet, followed by medium-stiff to very stiff clay and silt with some sand to about 100 feet. Soils encountered below 100 feet were predominantly stiff clays and silts, with occasional medium-dense sand layers up to about 8 feet thick. Boring 263 extended to a depth of 202 feet. Boring 265 extended to 253 feet. Boring 371 extended to 102 feet.

The log for CPT SC-12-264 provided in the Kleinfelder report interpreted the subgrade soils as interbedded clay and silt in the upper 9 meters (about 30 feet), followed by sand from 9 to about 11.2 meters (about 37 feet), then interbedded clay and silt to about 29 meters (95 feet). Below 29 meters, the soils were characterized as layers of sand and silt to the bottom of the sounding at a depth of about 33.7 meters (110.5 feet) below the ground surface, where the CPT probe encountered refusal.

Boring RSB-12-609 was drilled near the proposed west abutment (Abutment 1) of Structure F-718, while Boring RSB-12-610 was drilled at the proposed center bent location (Bent 2). Both borings encountered some gravel fill at the ground surface (up to about 4.5 feet thick), followed generally by soft to stiff lean clay with silty sand layers up to about 2 feet thick to a depth of 25 feet. Between 25 and 42 feet, the predominant soil type was silty sand and sand with silt, with interbedded soft to firm clay layers up to about 3 feet thick. The sands in these zones were generally in a medium-dense condition and susceptible to liquefaction. As noted above in Section 5.0, some deposits between about 31 and 41 feet were loose enough to indicate lateral spread potential; however, the depth and general discontinuity of these deposits reduces the likelihood of lateral spreading. The borings encountered primarily stiff lean clay from 42 to 100 feet. Below 100 feet, stiff lean clay remained the predominant soil type, with occasional layers of relatively dense sand and non-plastic sandy silt up to about 8 feet thick. Boring 609 terminated in sandy lean clay at a depth of 150 feet, while Boring 610 terminated in fat clay at 155 feet.

Boring RSB-12-651 was drilled at the proposed multi-use trail undercrossing location, and below a 2-foot surface layer of clayey gravel fill encountered primarily firm to stiff lean clay with relatively infrequent sand and silt layers up to 2.5 feet thick to the bottom of the boring at a depth of 78 feet.

It should be noted that some fat clay layers were encountered at various depths in each boring. Boring 609 encountered fat clay layers 3 to 5 feet thick at depths of about 95 and 105 feet. Boring 610 identified fat clay between depths of 149 and 155 feet. Boring 651 encountered fat clay between about 16.5 and 23 feet. The liquid limit of the fat clay samples tested in the laboratory ranged from 50 to 60, while the plasticity index was between 26 and 38.

7.1.3 Groundwater Conditions

Groundwater was encountered at a depth of 4.0 feet (about elev. 4219 feet) in RSB-12-609, at a depth of 6.7 feet (about elev. 4216.7 feet) in RSB-12-610, and at a depth of 7.2 feet (about elev. 4216.8 feet) in RSB-12-651 at the time of drilling (February-March 2006). It is anticipated that up to two feet of fluctuation may occur due to typical seasonal variations in precipitation and climatic cycles.

7.2 RECOMMENDATIONS

7.2.1 Bridge Structures

Potential foundation types at this site include shallow foundations, such as spread footings, and deep foundations, such as drilled shafts or driven piles. Due to the magnitude of structural loads (including seismic design requirements) and generally low bearing resistance of shallow soils, deep foundations are expected to be the most efficient foundation type for major bridge structures on the project. The depth to competent bearing layers, along with foundation settlement considerations, favors the use of driven piles rather than drilled shafts. Given the anticipated subsurface soil and groundwater conditions, driven piles can be more readily installed to greater depths than drilled shaft foundations.

It is our understanding that the abutment foundations for Structure F-718 are expected to consist of a single line of 15 piles, while the bent loads will be supported by four columns on separate footings, with 20 piles beneath each footing on a 4 by 5 grid. Preliminary structure drawings indicate that large monuments to be installed at the corners and ends of abutment MSE walls will also be pile-supported, as will the culvert type multi-use trail undercrossing (D-843). The loading for the "minor" monuments at the ends of the abutment MSE walls is expected to be 52 kips Strength I and 40 kips Service Load per pile.

Recommendations for driven pile foundations are summarized below. Recommendations for shallow foundations, which may be considered for the multi-use trail underpass, are provided in Section 7.2.4.

7.2.1.1 Driven Piles

Axial compression resistance values have been estimated for 16-inch OD concrete-filled steel pipe piles. The analyses were performed using the FHWA program SPILE. Geotechnical resistance factors were selected from the 2006 Interim AASHTO LRFD Bridge Design Specifications. Estimated driving depths and factored resistance values are summarized below.

Pile Data Parameters	Location			
	F-718 Abut 1	F-718 Bent 2	F-718 Abut 3	Minor Monuments
Estimated Pile Tip Elevation (ft)	4105	4102	4101	4182
Elev. of Min. Acceptable Pile Penetration (ft)	4108	4105	4104	4182
Strength I Axial Compression Resistance (kip)	335	335	335	79
Extreme Event I Compression Resistance (kip)	484	484	484	90
Required Driving Resistance (kip)	516	516	516	122

It will be noted that the resistance values are the same for each abutment and bent; however, the recommended tip elevations vary across the site. If piles are used to support the D-843 trail culvert, the values shown on the table above for F-718 Abutment 3 may be used.

The recommended pile tip elevations for the minor monuments are only about 41 feet below the existing ground surface. The Strength I Resistance of 79 kips is significantly greater than the Strength I Pile load of 52 kips per pile; however, we recommend that all piles supporting axial loads extend to a tip elevation of 4182 feet or deeper to avoid bearing in or above significant liquefiable layers identified in the borings.

The estimated tip elevations for bridge foundations are located within zones of sand shown on the boring logs. While it is preferred that the observed pile driving resistance demonstrate a noticeable increase over the last 2 to 3 feet of driving (indicating that the pile tip has encountered the sand layer), such an increase is not expected to be necessary to meet pile capacity requirements. Because the sand layers at the pile tip elevations are relatively thin (only about 5 to 8 feet thick), the pile tips were assumed to be located in clay for computations of anticipated end bearing resistance. The elevation of minimum acceptable pile penetration is 3 feet above the estimated tip elevation at each foundation location. All piles should be driven to at least the minimum penetration elevation unless the geotechnical engineer approves shorter piles based on a review of tested pile driving resistance and other foundation considerations, including foundation uplift resistance and settlement.

The estimates listed above assume that new embankments will be constructed with lightweight material and/or surcharged such that significant embankment settlement will be completed or otherwise mitigated prior to placement of structural loads on the piles.

We recommend that piles be spaced at least 3 diameters apart (center-to-center) to reduce group effects. Potential for pile group failure under axial compression loads was checked for the following proposed pile group layouts.

- Abutments with a single row of 15 piles spaced at 4.25 feet on centers
- Bent pile groups having 20 piles on a 5 x 4 grid in an area measuring about 17.3 feet square (to outer edges of piles).

In both cases, the potential for group (block) failure was found to be less critical than the axial compressive resistance of individual piles. Group resistance can therefore be determined by multiplying the single-pile resistance by the number of piles in the group for both the Strength I and Extreme Event limit states.

A preliminary pile drivability analysis has been performed using the program GRLWEAP 2005. The analysis was performed for closed-end 16-inch OD steel pipe piles having wall thicknesses of 3/8 and 1/2 inch. The analyzed driving systems were a Delmag D 25-32 diesel hammer with the manufacturer's recommended hammer cushion, and an IHC S-90 Hydrohammer, without cushioning. The results of the analyses are summarized below.

Hammer	3/8" Pipe Thickness					1/2" Pipe Thickness				
	Ultimate Capacity (kips)	Maximum Compress. Stress (ksi)	Blow Count (per foot)	Stroke (ft)	Energy (kip-ft)	Ultimate Capacity (kips)	Maximum Compress. Stress (ksi)	Blow Count (per foot)	Stroke (ft)	Energy (kip-ft)
D 25-32	300	25.6	34	7.3	31	350	25.1	42	7.6	30
	350	26.3	52	7.5	32	400	25.6	61	7.8	30
	400	26.9	88	7.7	33	450	26.1	94	7.9	31
	430	27.2	124	7.8	33	480	26.3	122	8.0	31
IHC S-90*	400	46.4	40	6.6	58	400	44.1	30	6.6	59
	450	46.5	64	6.6	58	450	44.1	40	6.6	59
	500	46.6	109	6.6	58	515	44.2	64	6.6	59
	515	46.6	125	6.6	58	585	44.2	117	6.6	59

* S-90 assumed to operate at 95% efficiency.

It will be observed from the table that only the IHC S-90 hammer appears capable of driving piles to the required driving resistance of 516 kips without significantly exceeding a hammer blow count of about 10 blows per inch. The calculated driving stresses are greater for the IHC S-90 hammer than for the diesel hammer, due to the lack of cushioning and greater energy transfer to the pile.

Based upon the results of the WEAP analysis, pipe piles with 3/8" wall thickness can be successfully driven to the required driving resistance with either hammer system. A refined wave equation analysis should be performed for the proposed pile driving system prior to mobilizing the pile driving rig to the site.

Pile driving should be monitored to ensure that driving stresses do not exceed 90 percent of the yield strength of the steel piles. Based on the WEAP analysis, the yield strength of the steel pipe should be at least 52 ksi. The pile driving hammer should have an operating energy of at least 60 kip-ft. Special care should be taken to align the hammer properly with the pile head to limit the possibility of eccentric driving stresses, which can result in over-stressing of one side of the pile. Driving should be performed only with smooth, square ends of the piles (preferable the factory-cut ends) rather than rough field-cut pile ends.

It should be noted that piles are not expected to demonstrate the required driving resistance during initial driving. Significant set-up is likely to occur as pore pressures dissipate in the hours and days following driving, increasing the geotechnical resistance of the pile. It is anticipated that piles may be driven to the estimated tip elevation with less difficulty during initial driving conditions (prior to set-up). After set-up has occurred, it may be much more difficult to re-mobilize the pile.

7.2.1.2 Foundation Settlement

Pile resistance analyses were performed based on the neutral plane method. In this method, downdrag loads are not considered detrimental to the geotechnical pile resistance, and the resistance values above need not be reduced to account for downdrag. The effects of downdrag should, however, be accounted for in evaluations of the structural resistance of the pile section. For each of the foundation locations listed above, the axial structural resistance of the concrete-filled pipe pile section should be checked to verify that the pile section can resist the Service I Load plus a factored downdrag load of 320 kips per pile. To account for potential corrosion, we recommend that the structural capacity evaluation be performed assuming 1/16 inch of corrosion will occur on the exterior of the steel pipe.

The Extreme Event I Resistance shown above assumes that liquefiable layers will not provide resistance during seismic loading. If this value is not exceeded, it is anticipated that the principle consequences of liquefaction will be pile group settlement resulting from downdrag loads transferred from settling soil above the liquefiable layers. The pile group could potentially settle as much as the surrounding ground surface during liquefaction before the temporary downdrag loads are neutralized and the piles regain the full Extreme Event I Resistance; however, actual pile group settlement during liquefaction is expected to be somewhat less than the settlement of the surrounding ground surface. The maximum estimated ground settlement due to liquefaction at this site is about 2 inches.

Consolidation settlement of an individual bent foundation at Structure F-718 was estimated assuming a 5 x 4 grid of 20 piles in an area measuring 17.3 feet square. Assuming an axial compression service load of 1259 kips acts on the footing, the calculated consolidation settlement of the pile group is about 0.8 inches. It is therefore anticipated that pile group settlement for bent footings will be less than 1 inch.

Consolidation settlement of abutment pile groups at Structure F-718 was estimated assuming a single row of 15 piles spaced at 4.25 feet on centers. In the analysis it was assumed that settlements caused by placement of embankment and MSE fill will be mitigated/completed prior to placement of bridge loads on the piles. It was also assumed that the placement of embankment fill would leave the subgrade soils in a normally-consolidated state. Assuming an axial compression service load of 2505 kips acts on the footing, the calculated settlement of the pile group is 1.5 inches. The cohesive soil layers contributing to the pile group settlement were noted to have relatively frequent sand and silt lenses and layers, and it is expected that at least 1/2 inch of the calculated consolidation settlement will occur prior to final paving of the bridge. It is also our understanding that the 2505-kip abutment service load includes some transient loads. Transient loads are not expected to contribute significantly to pile group settlement. It is therefore anticipated that the post-construction pile group settlement will not exceed one inch.

Consolidation settlement of the pile groups supporting minor monuments was calculated assuming a group of six piles in a plan area 15.3 feet long by 10.3 feet wide supporting total group service load of 240 kips. In the analysis it was assumed that settlements caused by placement of embankment and MSE fill will be mitigated/completed prior to placement of bridge loads on the piles. It was also assumed that the placement of embankment fill would leave the subgrade soils in a normally-consolidated state. The calculated pile group settlement for the minor monument foundations was 1.25 inches. It is anticipated that at least 1/4 inch of this settlement will occur prior to completion of the project, and that the post-construction settlement will not exceed one inch.

7.2.1.3 *Uplift*

Uplift capacities for individual piles computed using LRFD Procedures are 131 kips per pile for the Strength I limit state and 466 kips per pile for Extreme Event I. A resistance factor of 0.35 was used for sandy soils, and a factor of 0.25 was used for clayey soils at the Strength I limit state.

Group uplift resistance for the case of block failure was evaluated by estimating the weight of each pile group plus the shear resisting force around the perimeter of the pile group for the proposed pile groups as follows:

- Abutments with a single row of 15 piles spaced at 5.25 feet on centers
- Bent pile groups having 20 piles on a 5 x 4 grid in an area measuring about 17.3 feet square (to outer edges of piles).

In each case, the uplift resistance of the group (block failure) was found to be greater than the sum of the uplift resistance values of individual piles in the group. It is therefore recommended that the uplift resistance for pile groups at these structures be assumed equal to the uplift resistance of a single pile multiplied by the number of piles in the group.

7.2.1.4 *Lateral Loading*

Soil parameters and other recommendations for evaluation of lateral load response using the computer programs LPILE and GROUP are included on a summary sheet in Appendix D. Needs to provide the lateral pile analysis to us ASAP.

7.2.1.5 *Load Tests*

Table 10.5.5.2.3-3 of the 2006 AASHTO LRFD Interim Specifications shows the number of dynamic pile load tests with signal matching required at each site. The number of required PDA tests depends on site variability and the number of piles to be driven. With respect to the AASHTO table, the sites of the proposed 500 South Street structures can be considered to have low variability. For Structure F-718, the minimum number of tests is 4. Additional PDA testing may be necessary if pile driving conditions indicate significant variability in the soil profile at a given abutment or bent.

Pile resistance and driving criteria from PDA testing should be determined from "Beginning of Restrike" conditions. A minimum of 24 hours set-up time will likely be required after initial driving before piles demonstrate the required driving resistance, and additional time may be necessary in some instances.

7.2.1.6 Construction Considerations

Groundwater was encountered within 4 to 7 feet of the existing ground surface at the time of drilling, and dewatering may be required for construction of pile caps at Bent 2 and other construction activities.

It is recommended that the groundwater be lowered to a depth of 2 feet below the bottom of the excavations. It is anticipated that dewatering can best be achieved using sumps and drain trenches where clay exists at the foundation level.

Soils at the bottom of excavations may be too soft to provide an adequate working surface. Stabilization methods will depend upon conditions encountered. Moderately soft areas can be stabilized by over excavating the foundation footprint to a depth of about 1 foot, placing a geotextile fabric such as Mirafi 500X or equal and backfilling with compacted sandy gravel. Very soft areas may be stabilized by tamping cobble rock (preferably angular to subangular) into the subgrade as needed. As a minimum, it is recommended that an 8 inch layer of granular borrow be placed below the pile cap to provide a working platform.

Depending upon construction sequence and methods employed, excavation and shoring of embankment preload fill may be necessary. Maximum excavation slopes in compacted granular fill material of 1H:1V can be used for temporary cuts less than 20 feet deep. For temporary cuts between 20 and 30 feet deep, 1.5H:1V cut slopes should be used. The stability of cuts in uncompacted fill and/or natural subgrade soils should be evaluated on a case-by-case basis.

We recommend that preconstruction surveys and vibration monitoring be performed for any critical utilities located within 500 feet of the construction area.

7.2.2 Embankments

Analyses and recommendations for embankments are provided in a separate report by Kleinfelder.

7.2.3 Retaining Walls

Analyses and recommendations for retaining walls are provided in a separate report by Kleinfelder.

7.2.4 Tunnels / Culverts

The Multi-Use Trail undercrossing structure at 500 South Street (D-843) may be supported on pile foundations using the recommendations of Section 7.2.1 above. Alternatively, consideration may be given to supporting the structure on the clayey natural subgrade soils using the culvert floor as a mat-type foundation. Recommended subgrade parameters for this option are as follows:

Average Undrained Shear Strength: 600 psf
Nominal Bearing Resistance: 3084 psf
Coefficient of Subgrade Reaction: 35 pci

The Strength I Bearing Resistance can be estimated by multiplying the nominal resistance shown above by a resistance factor of 0.50. The bearing resistance values listed herein are applicable to structures placed on the existing subgrade soils prior to placement of roadway embankment fill around the structures. It should be noted that the placement of roadway embankment fill will consolidate subgrade soils, and the clayey and silty soils will gain strength with consolidation. If roadway embankments adjacent to the culverts are constructed in such a manner that loads from the roadway fill weight do not exceed the bearing resistance of the subgrade, bearing resistance will not be critical for the culverts. At some locations, staged construction, lightweight embankment fill, or subgrade reinforcement/modification may be necessary to provide sufficient bearing capacity for the new fill and the buried culverts.

The estimated coefficient of subgrade reaction shown above is for a 12-inch square footing area and is based on typical values for the shallow subgrade soils encountered at the site. The coefficient of subgrade reaction can be increased to

70 pci by over-excavating and placing 12 inches of compacted granular fill beneath the structure

It is anticipated that significant consolidation settlement may occur due to placement of new roadway embankment at some locations, and that differential and total settlement considerations may control the design of the box culverts If structures cannot be designed to tolerate the anticipated settlements, it may be advisable to preload the culvert subgrade area with temporary embankment fill, allow consolidation to occur, and then excavate the temporary fill to construct the culverts

7 2 5 Lateral Earth Pressures

Lateral earth pressures can generally be calculated usıng the equatıon

$$P = \frac{1}{2} \gamma K H^2$$

Where P = total lateral force on the wall, plf
K = earth pressure coefficıent
γ = unıt weıght of the soıl (depends on fill materıal)
H =heıght of the wall

The earth pressure coefficıent used ın desıgnıng the walls wıll depend upon whether the wall ıs free to move durıng backfillıng operatıons, or whether the wall ıs restraıned durıng backfillıng If the wall ıs free to move away from the soıl durıng backfillıng operatıons, we recommend that an actıve earth pressure coefficıent be used ın the above equatıon to calculate the lateral earth pressures If the walls are restraıned or braced from movement durıng backfillıng (as ıs generally the case wıth box culverts and sımılar structures), we recommend that an at-rest earth pressure coefficıent be used to calculate the lateral earth pressures A passıve earth pressure coefficıent should be used to calculate the lateral soıl resıstance where the wall ıs beıng pushed toward the soıl It should be recognızed that the pressures, calculated by the above equatıon, are earth pressures only and do not ınclude hydrostatıc pressures Where hydrostatıc pressures may exıst behınd a retaınıng structure, we recommend eıther the wall be desıgned to resıst hydrostatıc pressure, or that a draınage system be placed behınd the wall to prevent the development of hydrostatıc pressures

Lateral earth pressure coefficıents and other recommendatıons for computıng lateral earth pressures are ıncluded ın Appendıx D A general earth pressure coefficıent has been provıded for calculatıon of earth pressures where mechanıcal compactıon equıpment ıs expected to be operated near non-yıeldıng walls less than about 8 feet hıgh Thıs scenarıo ıs antıcıpated durıng placement of fill around culverts The resıdual pressure from compactıon equıpment can be reduced by lımıtıng the proxımıty and weıght of compactıng equıpment near culvert walls

Recommendatıons based on the Mononobe-Okabe approach for actıve and passıve seısmıc lateral earth forces are ıncluded ın Appendıx D For non-yıeldıng walls, recommended equatıons for calculatıng the dynamıc thrust and dynamıc overturnıng moment are also provıded

8.0 CORROSION INVESTIGATIONS

In order to obtain an indication of the corrosive nature of the subsurface material at these sites, resistivity, pH, sulfate, and chloride tests were performed on soil samples obtained in the Test Holes The results of these tests are tabulated below

Test Hole	Depth (ft)	Soil Type	Resistivity ohm-cm	pH	Sulfate (ppm)	Chloride (ppm)
RSB-12-609	5-6 5	Lean Clay	15,578	9 5	113	142
RSB-12-609	58 5-60	Silty Clay	19,467	8 1		78
RSB-12-610	98 5-100	Silty Sand	20,765	7 7		54

The 2006 Interim LRFD specifications state that resistivity less than 2,000 ohm-cm, sulfate concentration greater than 1,000 ppm, and pH less than 5 5 (8 5 in highly organic soils) are all indicative of potential pile corrosion or deterioration Due to the high resistivity and pH of tested samples, unusual potential for corrosion/deterioration of steel piles is not anticipated at this site Type I or Type II cement may be used for concrete at this site, however Type II cement is preferred for its superior resistance to deterioration For design of driven piles, it is recommended that 1/16 inch of corrosion be assumed for all surfaces in contact with soil or groundwater This reduction has been accounted for in the pile analyses described in Section 7 2 1 1

9.0 LIMITATIONS

The conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout this site which were not defined during this investigation If during construction, conditions are encountered which appear to be different than those presented in this report, it is requested that we be advised in order that appropriate action may be taken

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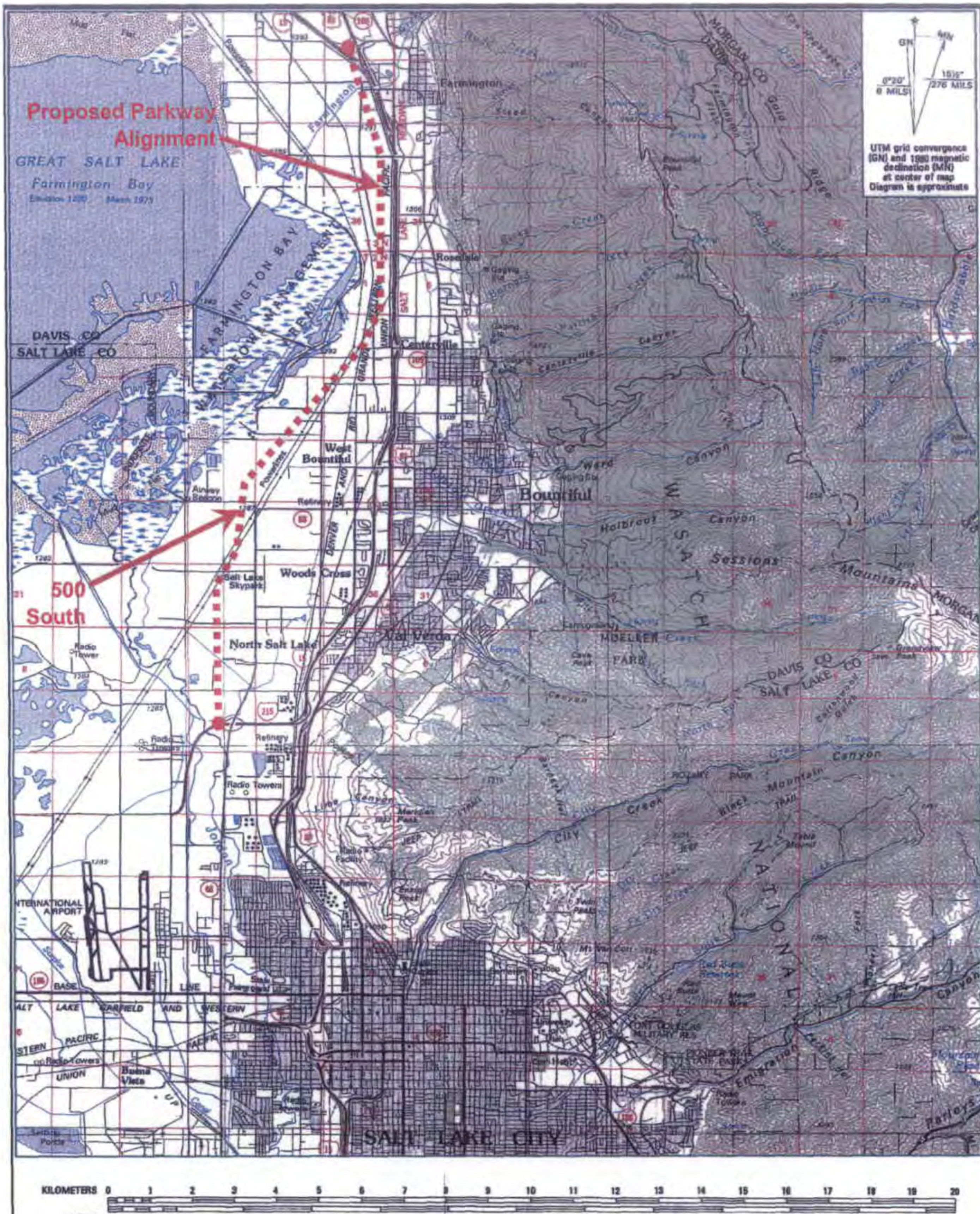

Portion of 1980 USGS 30 X 60 minute Salt Lake City (Utah-Wyoming) Quadrangle

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Figure 1 Vicinity Map
Proposed Legacy Parkway Alignment
Legacy Parkway
Salt Lake / Davis Counties, Utah

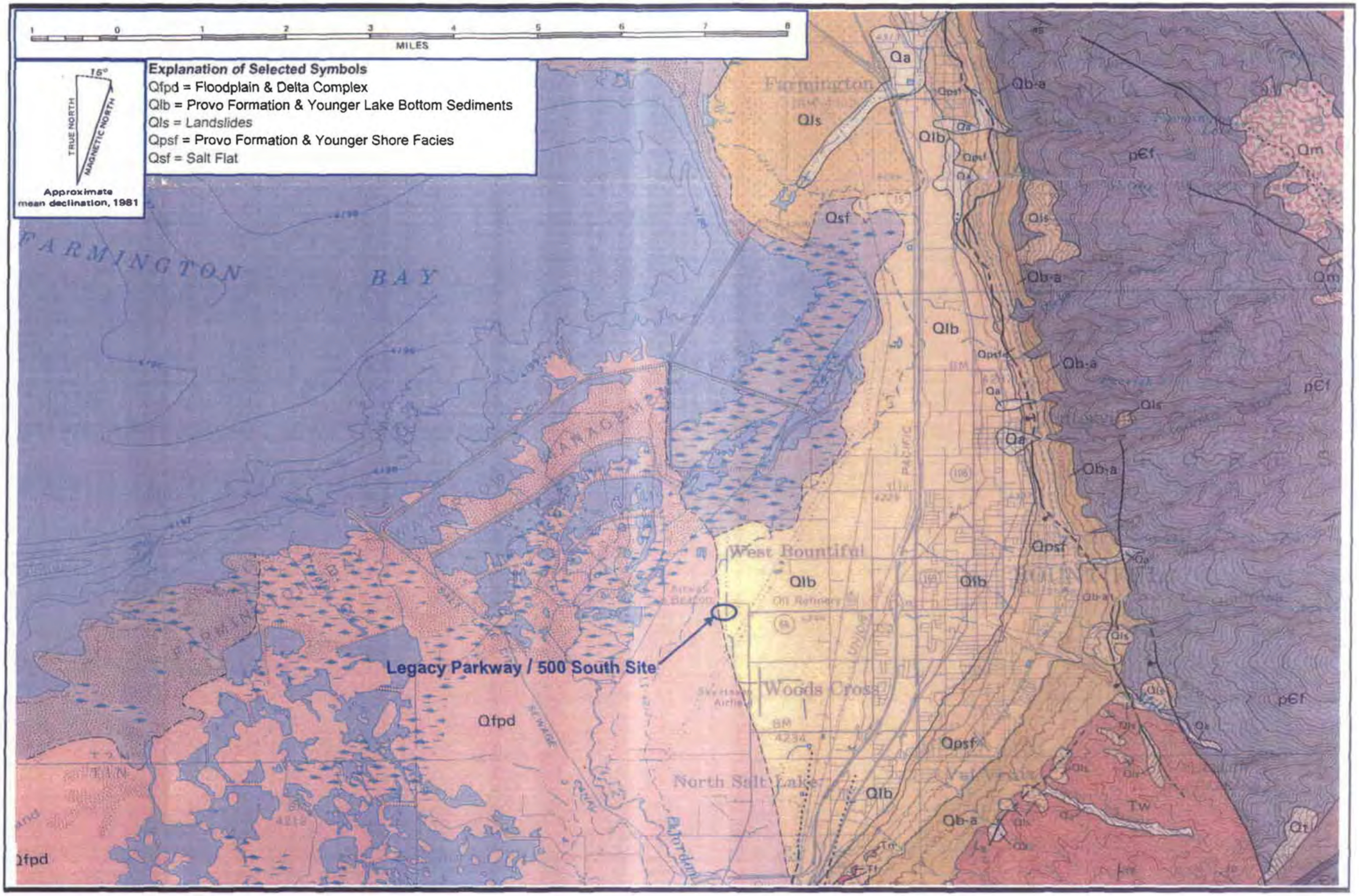

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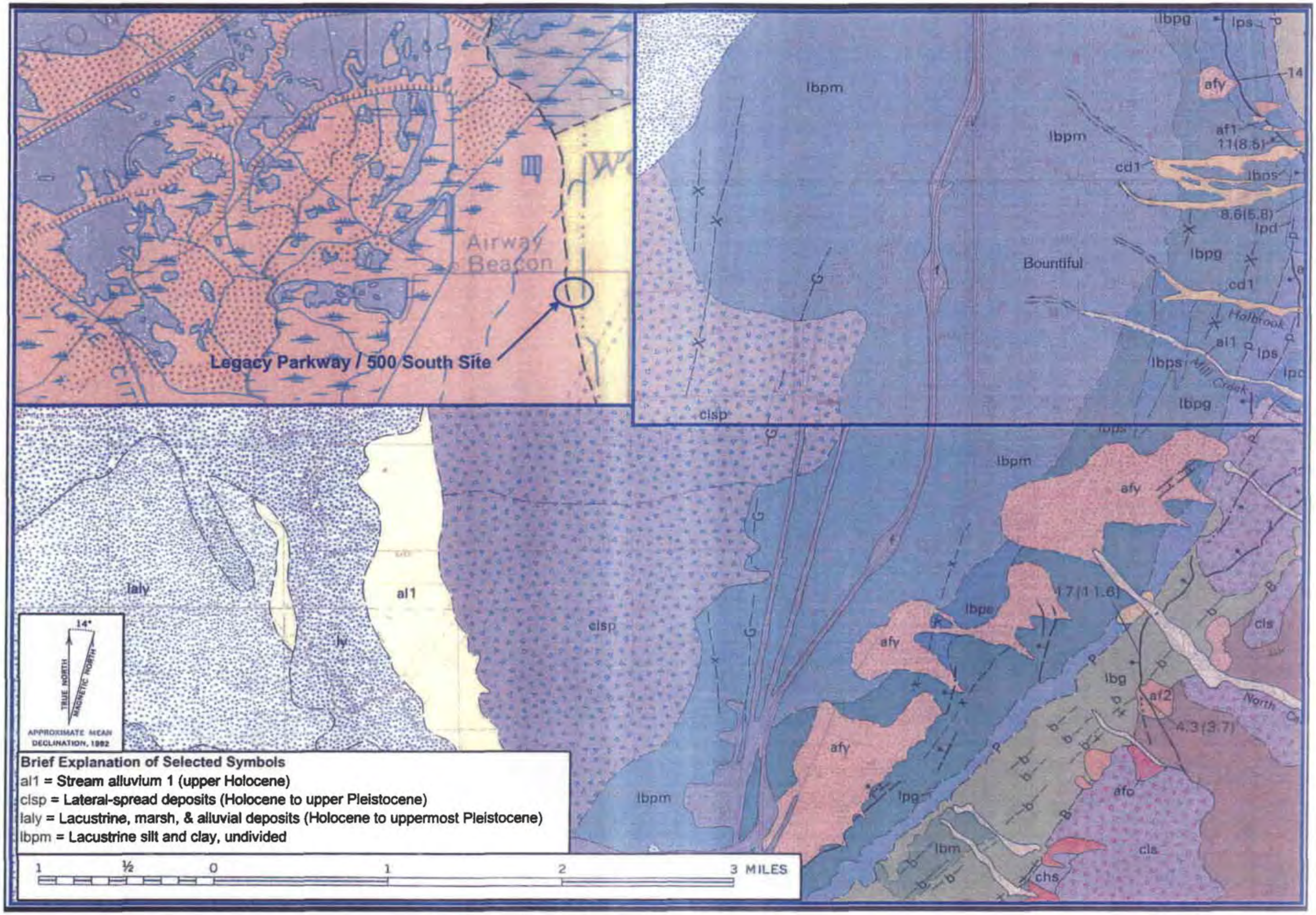
Figure 2a Geologic Map A
500 South Structures
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Davis, 1983
Utah Geological and Mineral Survey



RB&G ENGINEERING INC.
Provo, Utah

Figure 2b Geologic Map B
500 South Structures
Legacy Parkway
Salt Lake / Davis Counties, Utah

Maps modified from:
Upper Left - Davis, 1983 (Utah Geological & Mineral Survey)
Uppper Right - Nelson & Personius, 1993 (US Geological Survey)
Bottom - Personius & Scott, 1992 (US Geological Survey)

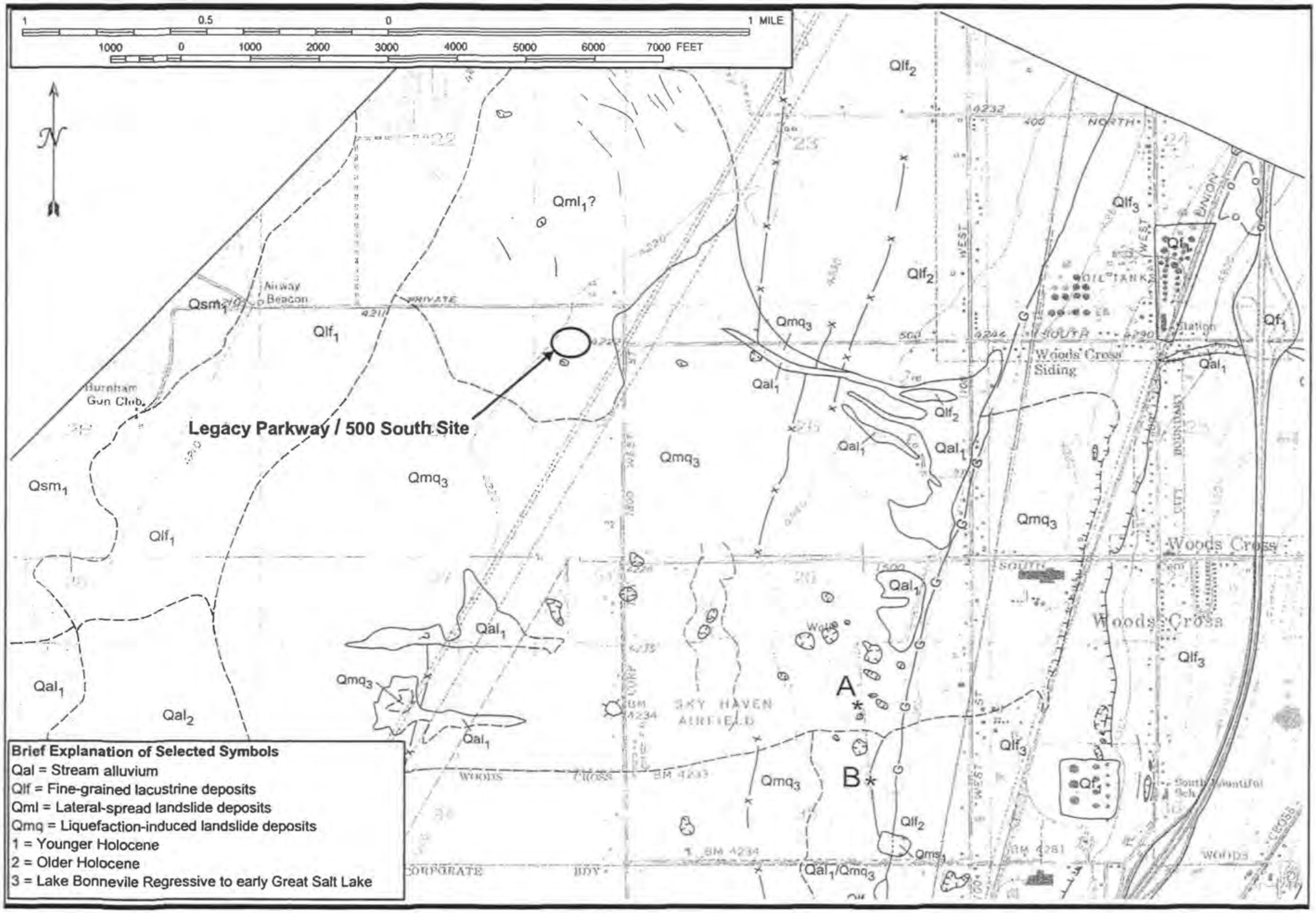


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Figure 2c Geologic Map C
North Salt Lake Landslides
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Harty & Lowe, 1992

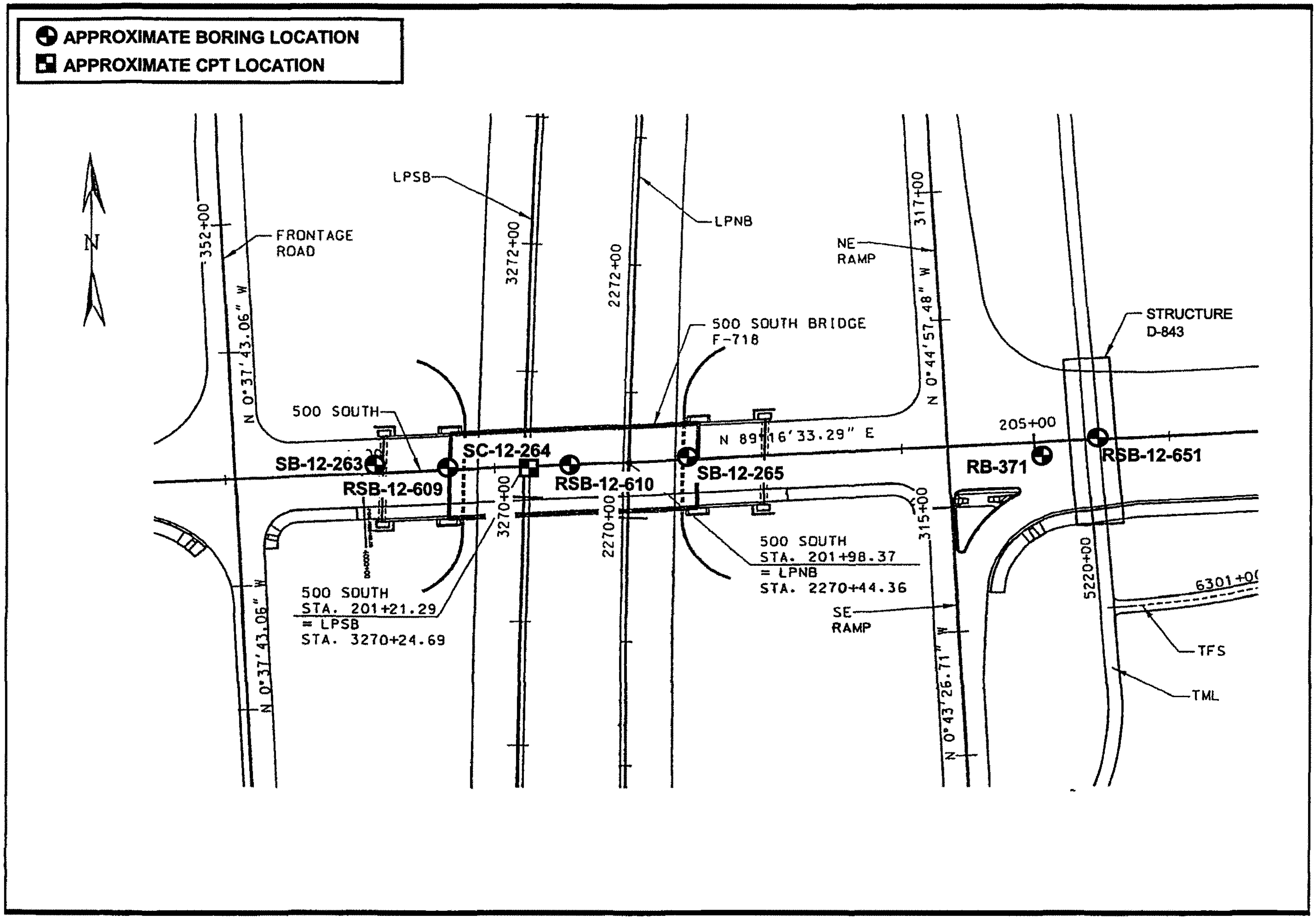

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Figure 3 Site Plan and Approximate Test Hole Locations
500 South Structures
Legacy Parkway
Salt Lake / Davis Counties, Utah

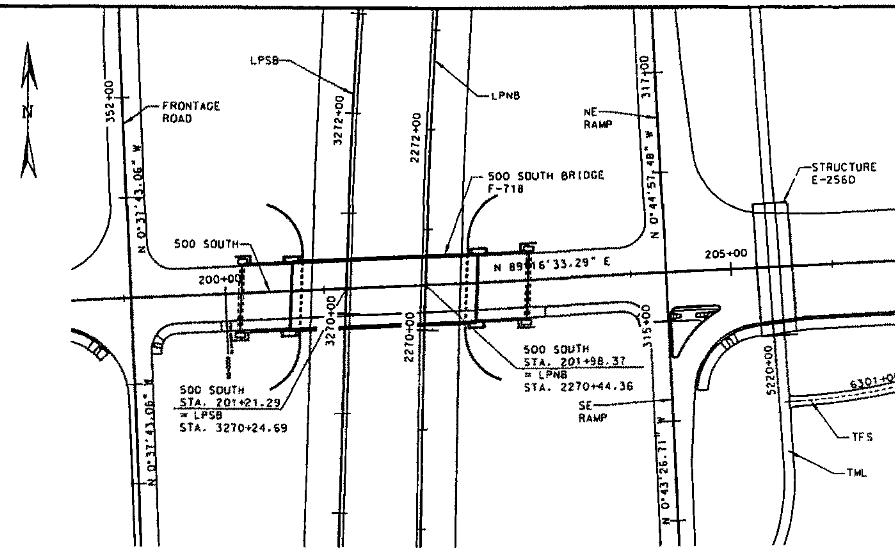
APPENDIX A

Structure Drawings

F-718

500 South over Legacy Parkway

INDEX OF SHEETS



LOCATION PLAN

GENERAL NOTES

1. USE COATED, DEFORMED BILLET-STEEL BARS CONFORMING TO AASHTO M 284 OR M 111 AND M 31 GRADE 60 FOR ALL REINFORCING STEEL.
2. USE STRUCTURAL STEEL CONFORMING TO AASHTO M 270 GRADE 36 EXCEPT WHERE NOTED OTHERWISE.
3. CHAMFER ALL EXPOSED CONCRETE CORNERS ¾" EXCEPT WHERE NOTED OTHERWISE.
4. PROVIDE 2" CONCRETE COVER TO REINFORCING STEEL EXCEPT WHERE NOTED OTHERWISE.
5. USE CLASS AA (AE) CAST-IN-PLACE CONCRETE EXCEPT WHERE NOTED OTHERWISE.
6. HORIZONTAL DIMESIONS ARE PLAN. VERICAL DIMENSIONS ARE PLUMB.

DESIGN DATA

HL-93 IN ACCORDANCE WITH 3rd EDITION AASHTO LRFD AND INTERIM SPECIFICATIONS THROUGH 2006.

CAST-IN-PLACE CONCRETE: f'c = 4000 PSI: Fy (REINF.) = 60,000 PSI: n = 8

PRESTRESSED CONCRETE: f'c= 7500 PSI: Fy (NONPRESTRESSED) = 60,000 PSI: n = 6
Fs (PRESTRESSED) = 270,000 PSI

STRUCTURAL STEEL: Fy = 36,000 PSI

WEARING SURFACE: ½" CONCRETE: 35 PSF (FUTURE)

DESIGN SPEED: 35 mph - 500 SOUTH
70 mph - LEGACY PARKWAY

SEISMIC DESIGN DATA: SEISMIC DESIGN PER MCEER/ATC 49
(2475 YR. RETURN PERIOD. 3% PE IN 75 YRS.)
Ss = MAX CONSIDERATION EQ GROUND MOTION AT 0.2 = 1.41 g
S1 = MAX CONSIDERATION EQ GROUND MOTION AT 1.0 = 0.59 g
SITE CLASS X

TRAFFIC DATA: 2008 ADT = 8,400 500 SOUTH
2020 ADT = 12,000 500 SOUTH
2020 ADT = 37300 LEGACY PARKWAY NORTHBOUND
2020 ADT = 37300 LEGACY PARKWAY SOUTHBOUND

PARAPET TEST LEVEL: TL-3

BRIDGE LOAD RATING

	HL-93	
	RATING	LOCATION
INV.	1.12	46.53
OPER.	1.49	83.75

F DENOTES RATING CONTROLLED BY FLEXURE
S DENOTES RATING CONTROLLED BY SHEAR
My AT XX.XX' = XXX.X K-FT
Vy AT XX.XX' = XXX.X KIPS

QUANTITIES

ITEM	ESTIMATED	UNIT	AS CONSTRUCTED
GRANULAR BACKFILL BORROW (PLAN QUANTITY)	216	CU. YDS.	
PILE DRIVING EQUIPMENT	1	LUMP	
DRIVEN PILES (16 INCH)	11,888	FT.	
STRUCTURAL CONCRETE (SUBSTRUCTURE EST. LUMP QTY 569.7 CU. YDS.)	1	LUMP	
STRUCTURAL CONCRETE (SUPERSTRUCTURE EST. LUMP QTY 1143.4 CU. YDS.)	1	LUMP	
REINFORCING STEEL (EPOXY COATED)	419666.5	LBS.	
PRESTRESSED CONCRETE MEMBERS (88'-0") TYPE V	16	EACH	
STRUCTURAL STEEL (EST. LUMP QTY. XXX LBS.)	1	LUMP	
ELECTRICAL WORK - BRIDGES	1	LUMP	
PEDESTRIAN FENCE	568	FT.	

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS
NO. | DATE | BY | REMARKS

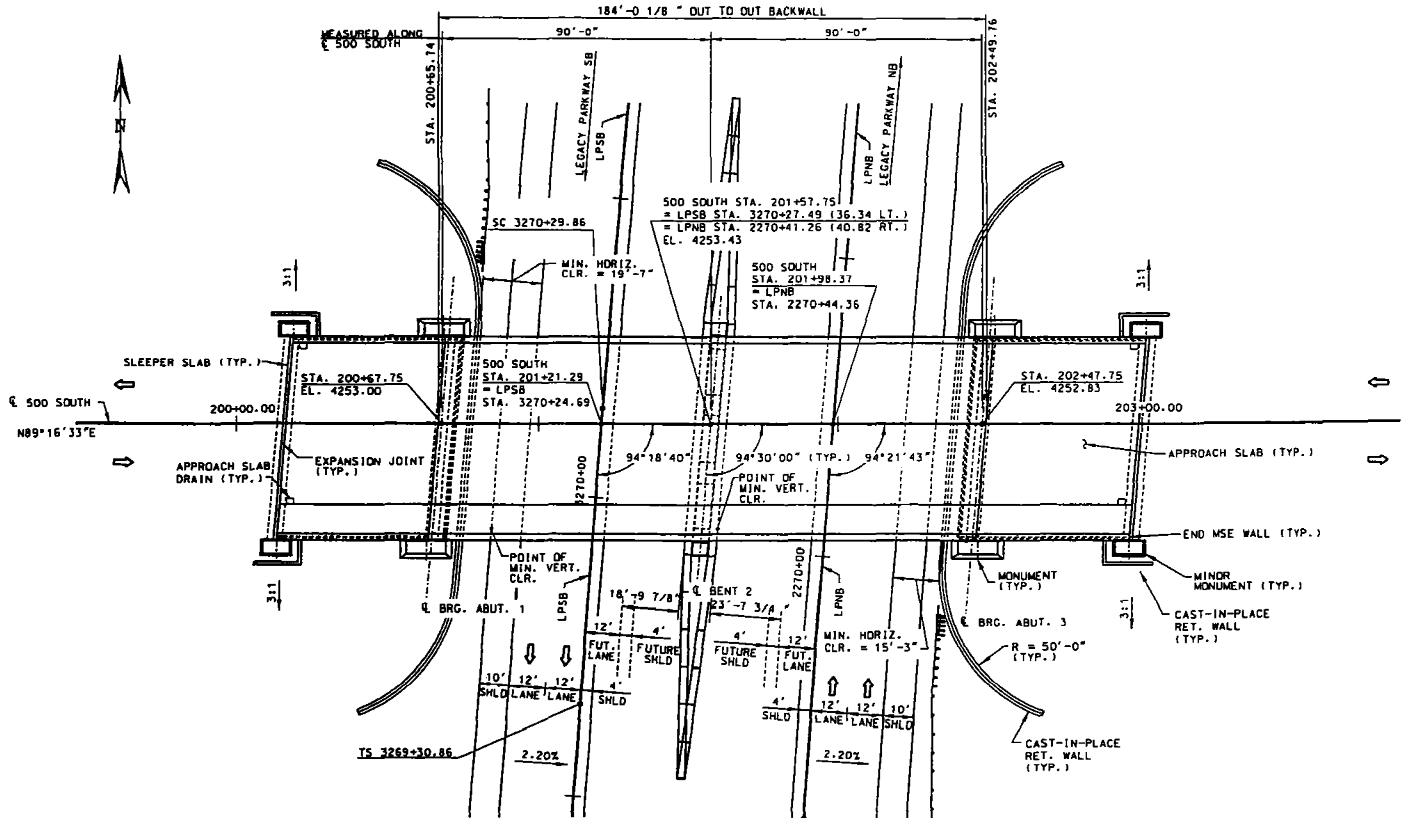
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN DVP 6/06 | CHECK SKD 6/06
DRAWN JLH 6/06 | CHECK DVP 6/06
QUANT. DVP 6/06 | CHECK SKD 6/06

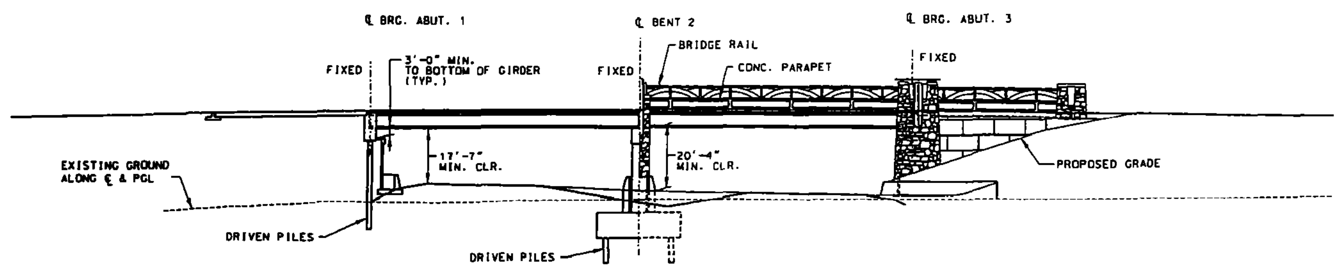
APPROVAL RECOMM. — SENIOR DESIGN ENGINEER — DATE
APPROVED — UDOT BRIDGE ENGINEER — DATE

LEGACY PARKWAY
500 SOUTH OVER LEGACY PKWY
SITUATION & LAYOUT 1
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
F-718
BRIDGE NO.
SHT. 1 OF 3



PLAN



ELEVATION

PRELIMINARY
NOT FOR CONSTRUCTION

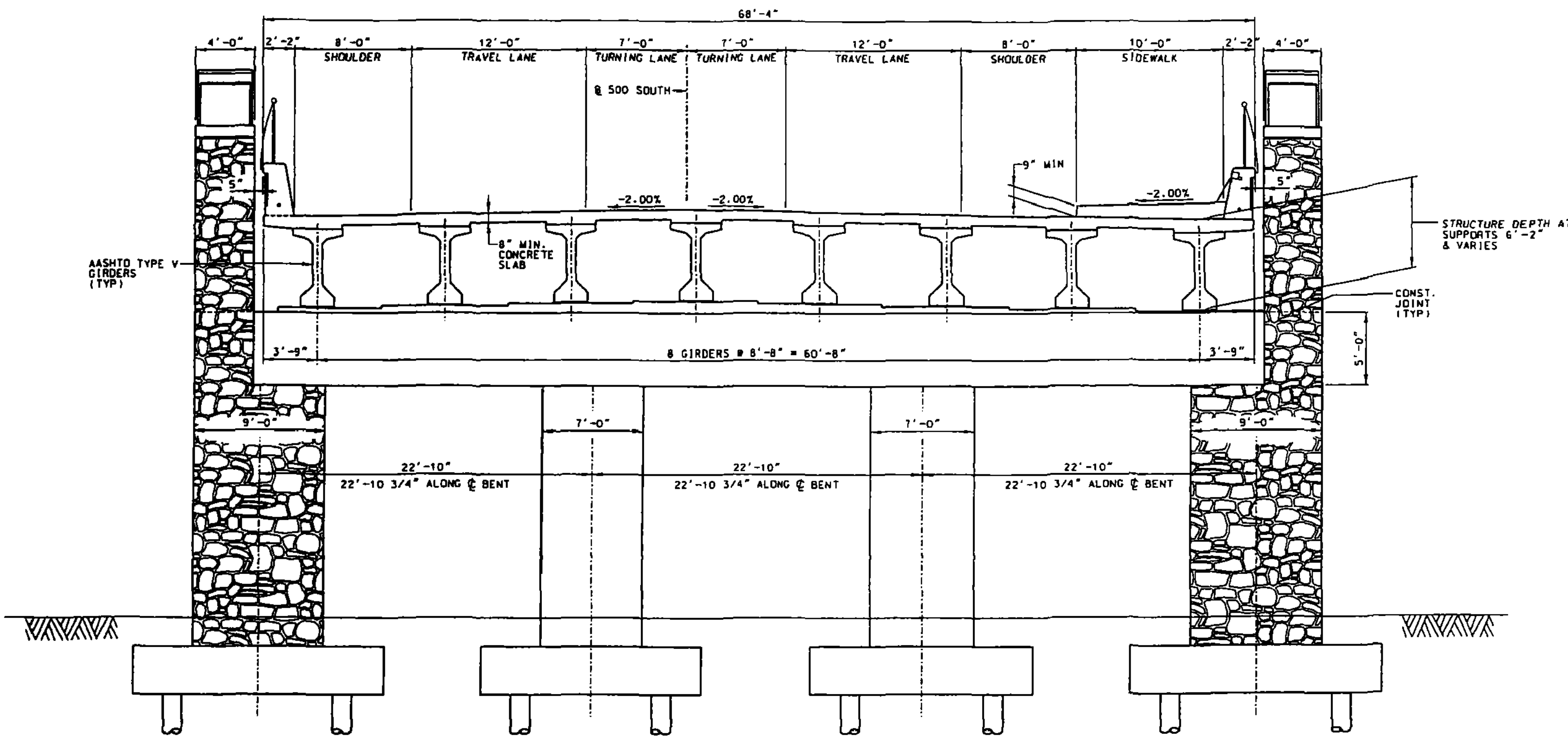
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN DVP 6/06 | CHECK SKD 6/06
DRAWN BAH 6/06 | CHECK DVP 6/06
QUANT. DVP 6/06 | CHECK SKD 6/06

REVISIONS

LEGACY PARKWAY
500 SOUTH OVER LEGACY PKWY
SITUATION & LAYOUT 2
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
F-718
BRIDGE NO.
SHT. 2 OF 3



SECTION THRU STRUCTURE

LOOKING UP STATION

CURVE DATA

(1-LPNB-09)

Δ = 20°33'48" RT
R = 9198.16'
L = 3301.21'
T = 1668.55'
PI STA. 2285+80.69
PC STA. 2269+12.14
PT STA. 2302+13.34

CURVE DATA

(1-LPNB-S09)

Δ = 0°18'30" RT
L = 99.00'
ENT. R = 0.00'
EXIT R = 9198.16'
LONG T = 66.00'
SHORT T = 33.00'
TS STA. 2268+13.14
SPI STA. 2268+79.14
SC STA. 2269+12.14

CURVE DATA

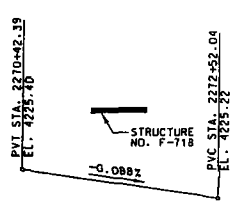
(1-LPSB-S09)

Δ = 0°18'24" RT
L = 99.00'
ENT. R = 0.00'
EXIT R = 9249.67'
LONG T = 66.00'
SHORT T = 33.00'
TS STA. 3269+30.86
SPI STA. 3269+96.86
SC STA. 3270+29.86

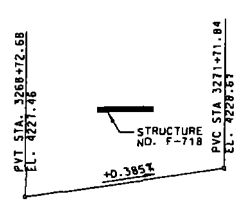
CURVE DATA

(1-LPSB-09)

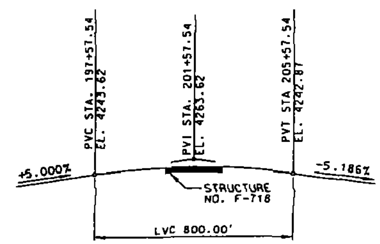
Δ = 20°02'19" RT
R = 9249.67'
L = 3235.00'
T = 1634.19'
PI STA. 3286+64.05
PC STA. 3270+29.86
PT STA. 3302+64.85



LPNB PROFILE



LPSB PROFILE



500 SOUTH PROFILE

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS
NO. | DATE | BY | REMARKS

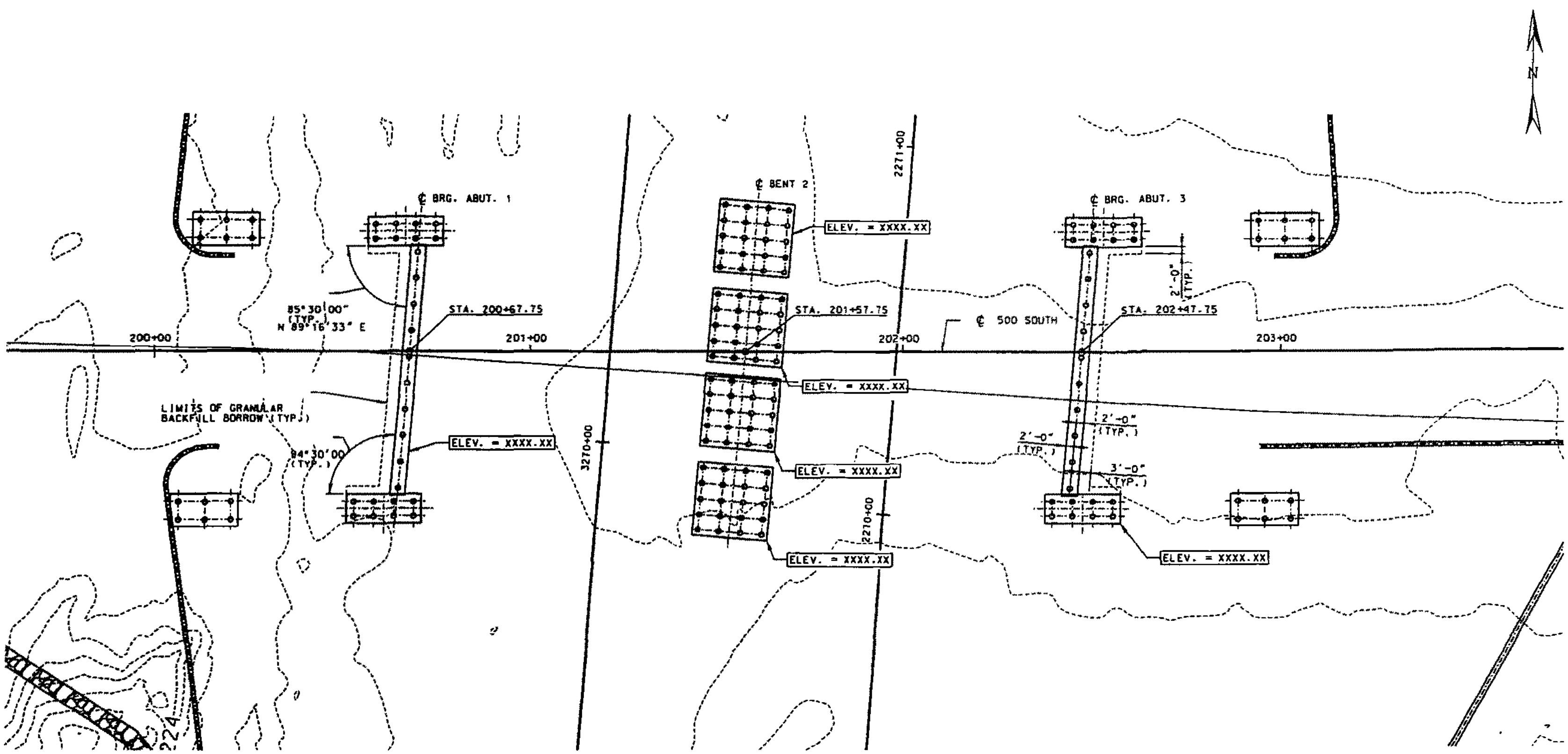
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN DVP 6/06 | CHECK SKD 6/06
DRAWN BAH 6/06 | CHECK DVP 6/06
QUANT. DVP 6/06 | CHECK SKD 6/06

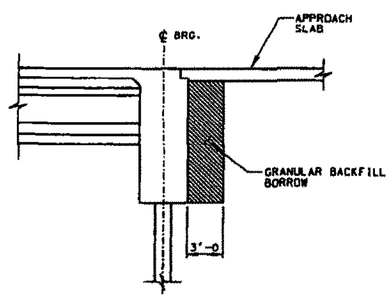
APPROVAL RECOMM. | DATE | SENIOR DESIGN ENGINEER
APPROVED | DATE | UDOT BRIDGE ENGINEER

LEGACY PARKWAY
500 SOUTH OVER LEGACY PKWY
SITUATION & LAYOUT 3
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
F-718
BRIDGE NO.
SHT. 3 OF 3



PLAN



NOTE:
GRANULAR BACKFILL BORROW LIMITS EXTEND FROM BOTTOM OF ABUTMENT TO BOTTOM OF APPROACH SLAB.

GRANULAR BACKFILL BORROW PAY LIMITS

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

1. ELEVATIONS AT BOTTOM OF ABUTMENTS, MONUMENTS AND BENTS ARE SHOWN THUS: ELEV. = XXXX.XX
2. ALL PILES ARE 16 INCH DIAMETER. DRIVE IN ORIENTATION SHOWN.
3. ALL ABUTMENTS AND BENTS ARE PARALLEL TO BRG. N 10°02'44" W.

NO.	DATE	BY	REMARKS

REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN DVP 6/06 | CHECK SKD 6/06
DRAWN JLH 6/06 | CHECK DVP 6/06
QUANT. DVP 6/06 | CHECK SKD 6/06

APPROVAL RECOM. ___ DATE ___ SENIOR DESIGN ENGINEER
APPROVED ___ DATE ___ UDOT BRIDGE ENGINEER

LEGACY PARKWAY
500 SOUTH OVER LEGACY PKWY
FOUNDATION PLAN
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
F-718
BRIDGE NO.
SHT. 5 OF 50

D-843

500 South over Multi-Use Trail

INDEX OF SHEETS

QUANTITIES

ITEM	QUANT.	UNIT	AS CONST.
STRUCTURAL CONCRETE (EST. QTY. 425 CU YD)	1	LS	
REINFORCING STEEL (EPOXY COATED)	106250	LB	
GRANULAR BACKFILL BORROW	XX	CY	
PILE DRIVING EQUIPMENT	1	LS	
DRIVEN PILES	X	FT	

GENERAL NOTES

1. USE COATED, DEFORMED BILLET-STEEL BARS IN ACCORDANCE WITH ASTM A615, GRADE 60. EPOXY COATED IN ACCORDANCE WITH AASHTO M 284.
2. PROVIDE STEEL FOR DRIVEN PIPE PILES CONFORMING TO ASTM A-252, GRADE 3, fy= 45,000 PSI.
3. PROVIDE 2 INCH COVER TO REINFORCING STEEL EXCEPT WHERE NOTED OTHERWISE.
4. CHAMFER EXPOSED CONCRETE CORNERS 3/4 INCH EXCEPT WHERE NOTED OTHERWISE.
5. USE CLASS AA (AE) CAST-IN-PLACE CONCRETE.
6. ALL DIMENSIONS ARE IN FEET AND INCHES. ALL STATIONS AND ELEVATIONS ARE IN FEET.
7. SEE ROADWAY PLANS FOR TRAIL DETAILS.
8. DRAWINGS ARE NOT TO SCALE. HORIZONTAL DIMENSIONS ARE PLAN DIMENSIONS AND VERTICAL DIMENSIONS ARE PLUMB.
9. PROVIDE GRANULAR BACKFILL BORROW TO MEET UDOT'S CRITERIA FOR FREE DRAINING GRANULAR BACKFILL BORROW. SPECIFICATION 02061.

DESIGN DATA

HL-93 IN ACCORDANCE WITH 3rd EDITION AASHTO LRFD AND INTERIM SPECIFICATIONS THROUGH 2006.

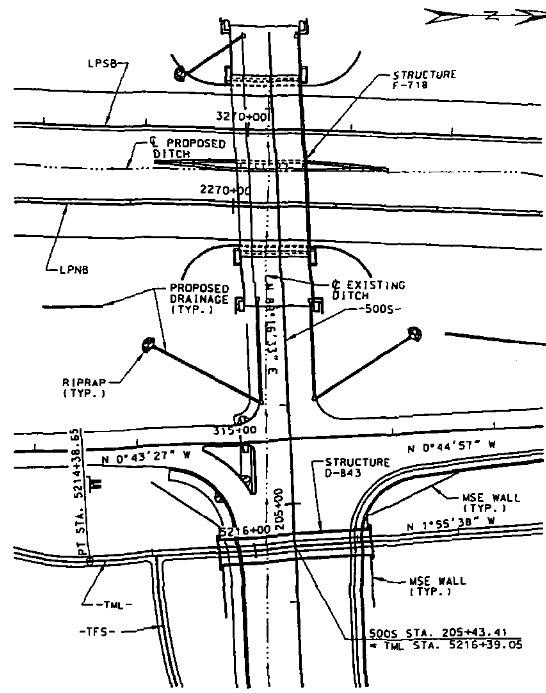
CAST-IN-PLACE CONCRETE: f'c = 4000 PSI; fy (REINF.) = 60,000 PSI; n = 8

DESIGN MAXIMUM COVER = 7.10'

DESIGN MINIMUM COVER = 5.72'

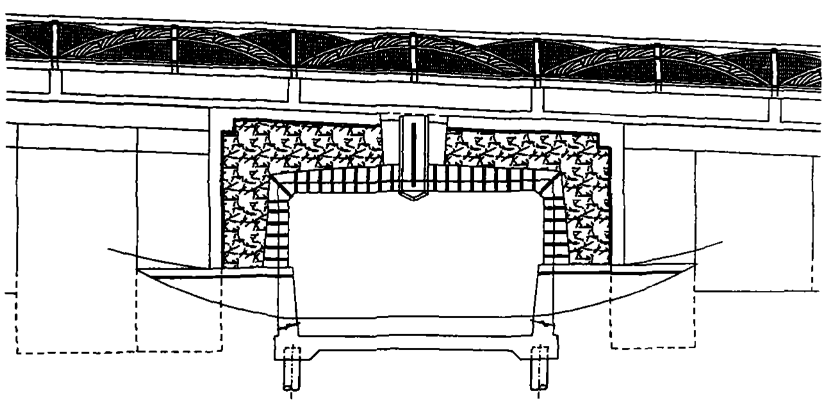
SOIL DRY UNIT WEIGHT = XX #/CF

SOIL SUBMERGED UNIT WEIGHT = XX #/CF

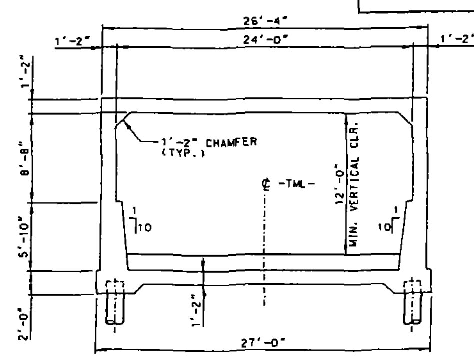


LOCATION PLAN

PRELIMINARY
NOT FOR CONSTRUCTION



ENTRANCE ELEVATION



SECTION THRU STRUCTURE

NO.	DATE	BY	REVISIONS / REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER

APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

DESIGN JBT 6/06 | CHECK DVP 6/06
DRAWN BAH 6/06 | CHECK JBT 6/06
QUANT. JBT 6/06 | CHECK DVP 6/06

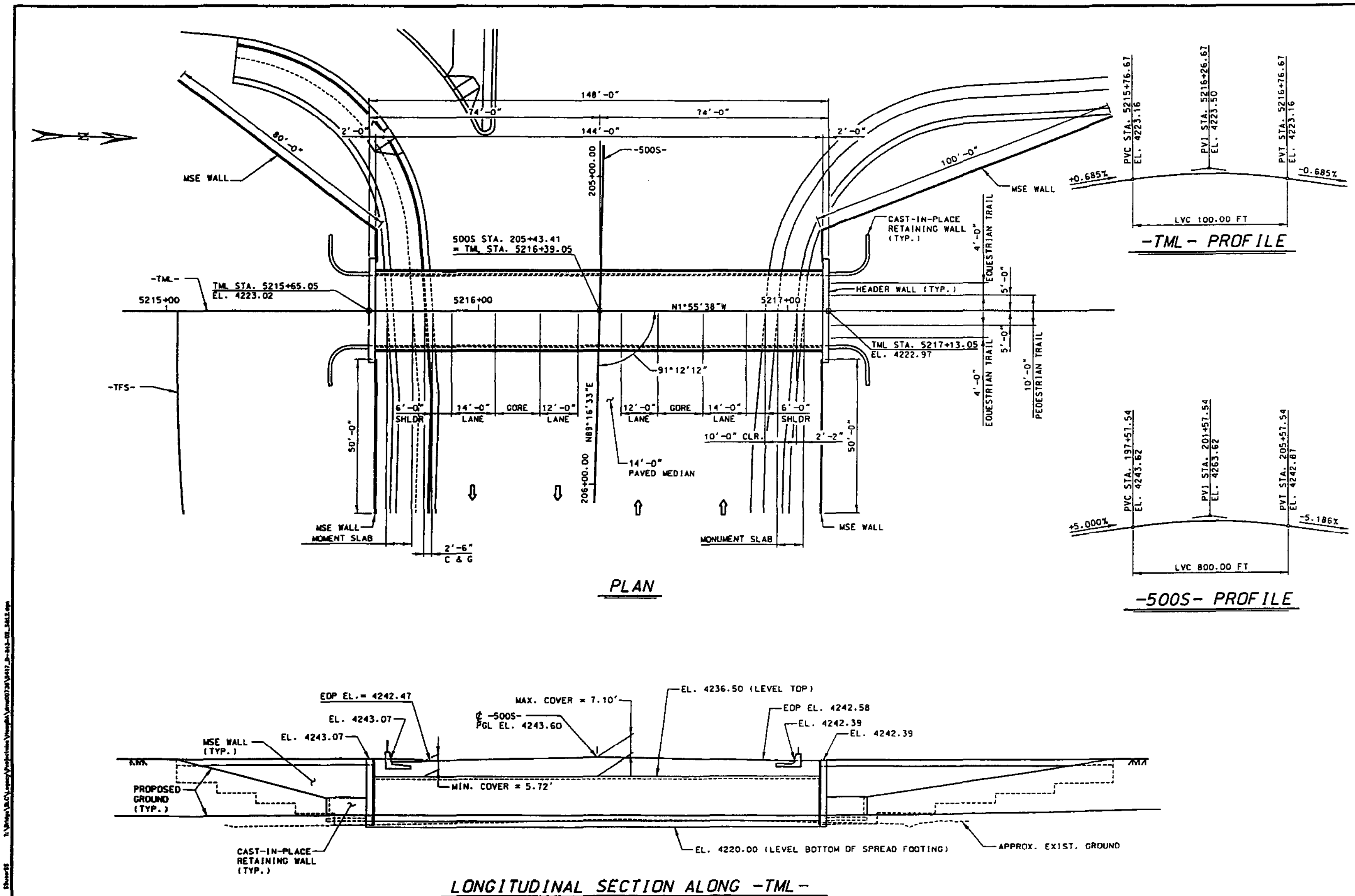
LEGACY PARKWAY
500 S. OVER MULTI-USE TRAIL
SITUATION LAYOUT 1

PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY

D-843
DRG. NO.

SHT. 1 OF X



PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS
NO. | DATE | BY | REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JBT 6/06 | CHECK DVP 6/06
DRAWN JLH 6/06 | CHECK JBT 6/06
QUANT. JBT 6/06 | CHECK DVP 6/06

APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

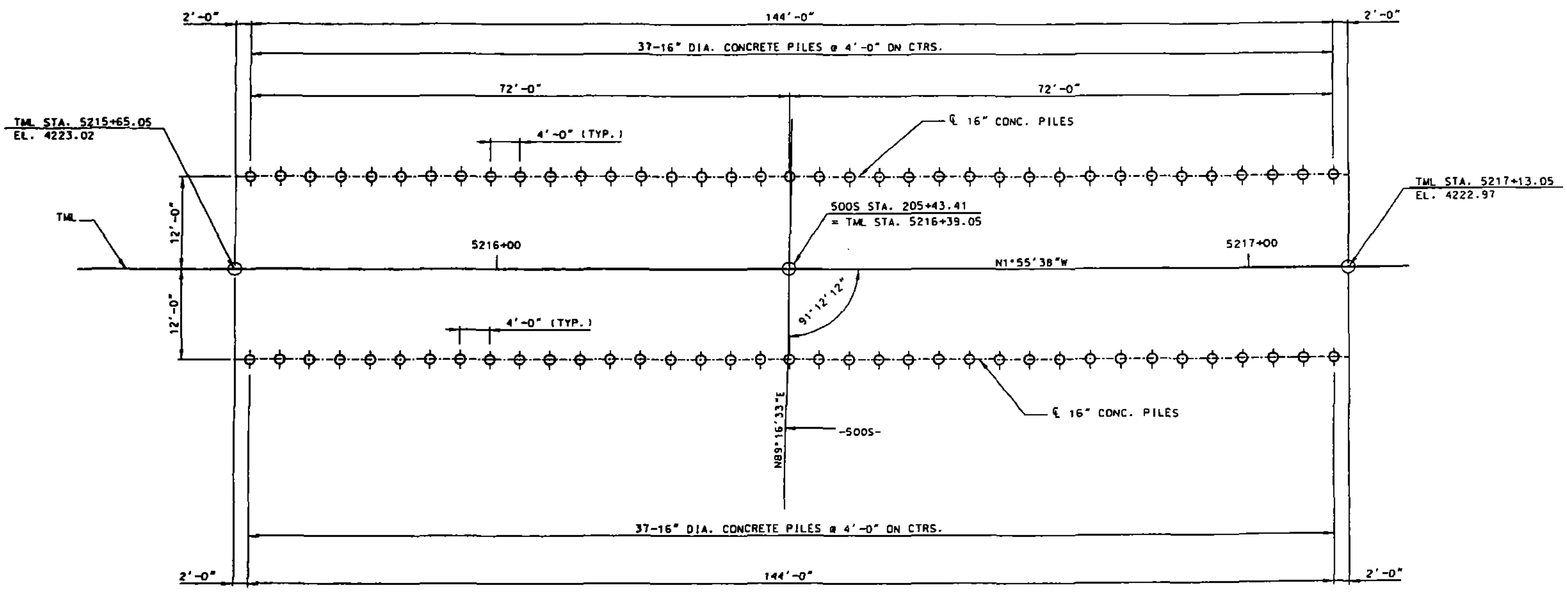
LEGACY PARKWAY
500 S. OVER MULTI-USE TRAIL
SITUATION LAYOUT 2

PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY

D-843
DRG. NO.

SHT. 2 OF X



PLAN

PILE DATA

LOCATION	PILE SIZE (IN)	ESTIMATED PILE TIP ELEVATION (FT)	MINIMUM PILE TIP ELEVATION (FT)	SERVICE LOAD (DL + LL) PER PILE (KIP)	REQUIRED DRIVING RESISTANCE (KIP)
ABUT 1	16	XXXX.X	XXXX.X	160	XXX
ABUT 2	16	XXXX.X	XXXX.X	160	XXX

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS
NO. | DATE | BY | REMARKS

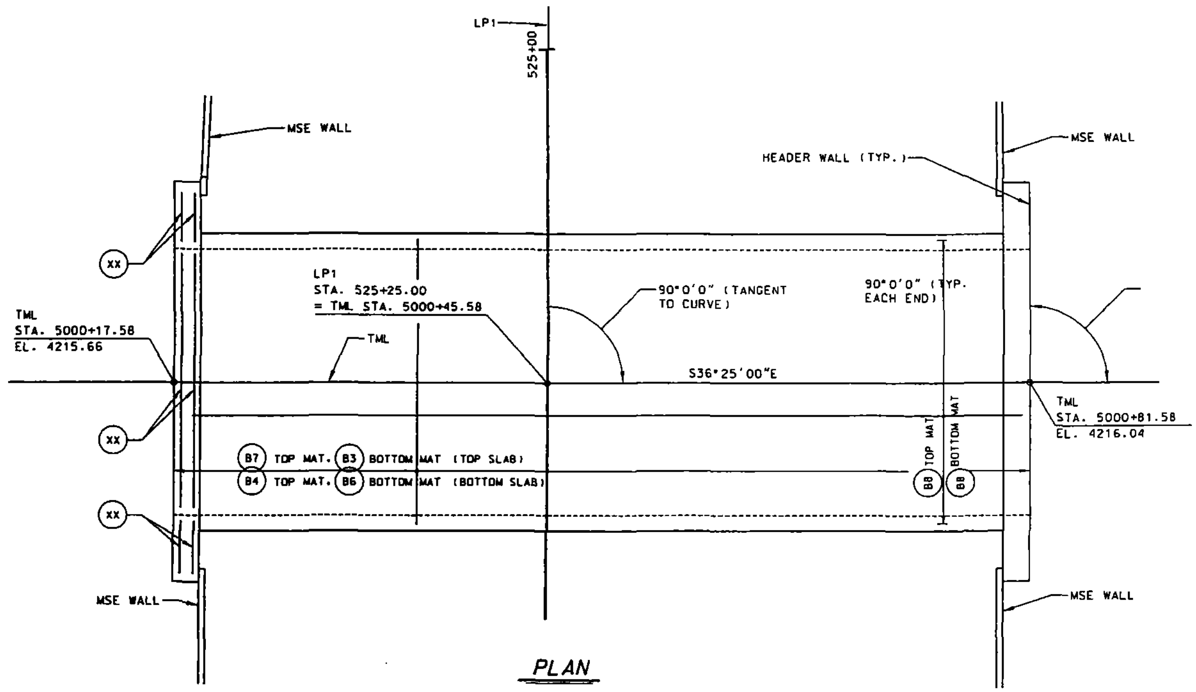
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN VLG 6/06 | CHECK XXX 6/06
DRAWN STH 6/06 | CHECK XXX 6/06
QUANT. XXX 6/06 | CHECK XXX 6/06

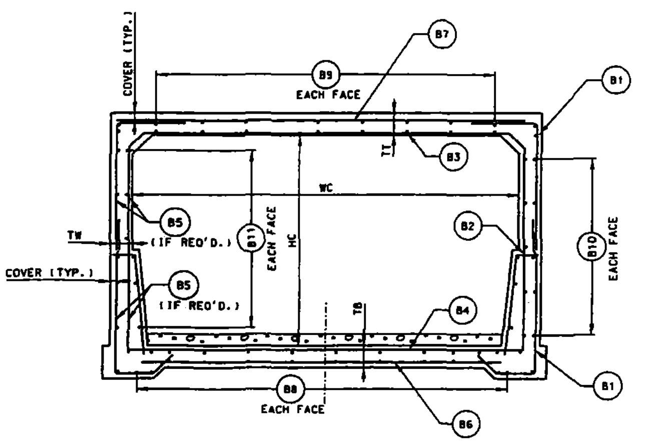
APPROVAL RECOMM. ___ DATE ___ SENIOR DESIGN ENGINEER
APPROVED ___ DATE ___ UDOT BRIDGE ENGINEER

LEGACY PARKWAY
500 S. OVER MULTI-USE TRAIL
FOUNDATION PLAN
PROJECT NUMBER SP-0067(5)0

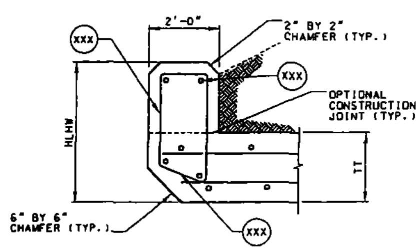
SL / DAVIS
COUNTY
D-843
BRIDGE NO.
SHT. 4 OF X



PLAN



SECTION THRU STRUCTURE



LEFT HEADWALL SECTION

(RIGHT HEADWALL SIMILAR)

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES:

1. DESIGN SPECIFICATION: AASHTO LRFD 2004 W/ 2005, 2006 INTERIMS
   DESIGN LOADING: HL-93
   REINFORCING STEEL: ASTM A615/A615-96a
   SURFACE TREATMENT: ALL CONCRETE SURFACE SHALL RECIEVE A GENERAL SURFACE FINISH
2. SEE ROADWAY PLANS FOR CULVERT LOCATION, ROADWAY SKEW ANGLE AND ROADWAY CROSS SECTION.
3. DURING CONSTRUCTION PROVIDE SUPPORT FOR LOADS IN EXCESS OF AASHTO HL-93
4. PROVIDE A 6" CHAMFER WHEN ANGLE "A" IS GREATER THAN 45° MAINTAIN WALL THICKNESS FIELD ADJUST REINFORCING TO MAINTAIN COVER
5. SPACE BARS B8 (TOP) AND B9 (BOTTOM) WITH A BAR IN EACH CORNER AND THE REMAINING BARS PLACED AT EQUAL SPACING.
6. PLACE BARS B10 AT EVEN SPACES BETWEEN CORNER BARS B8 (TOP) AND B9 (BOTTOM).
7. FOR CULVERT EXTENSIONS,REMOVE HEADWALL AND WINGWALLS SUFFICIENT FOR NEW CONSTRUCTION. CUT BACK 2'-0" OF EXISTING CULVERT WHILE AVOIDING DAMAGE TO EXISTING REINFORCEMENT. CLEAN AND STRAIGHTEN EXISTING REINFORCEMENT. LAP AND TIE EXTENSION REINFORCEMENT ONTO EXISTING.
8. THE COST FOR REMOVAL AND DISPOSAL OF MATERIAL FROM THE EXISTING HEADWALLS, WINGWALLS, AND BOX, AND THE COST FOR CLEANING, STRAIGHTENING AND EXTENDING LONGITUDINAL REINFORCEMENT IS INCLUDED IN THE COST FOR CONCRETE AND STEEL IN THE CULVERT EXTENSION.

REVISIONS

NO.	DATE	BY	REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN VLC 6/06 — CHECK XXX 6/06
DRAWN STM 6/06 — CHECK XXX 6/06
QUANT. XXX 6/06 — CHECK XXX 6/06

APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

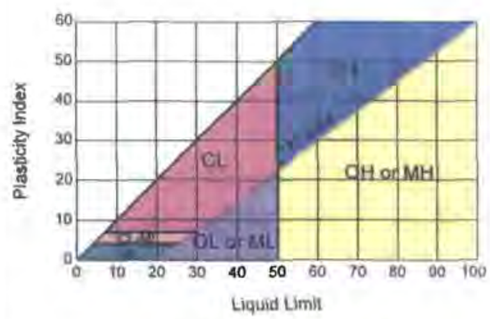
LEGACY PARKWAY
500 S. OVER MULTI-USE TRAIL
BRIDGE DETAILS
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
D-843
BRIDGE NO.
SHT. 5 OF X

APPENDIX B
Test Hole Logs

Unified Soil Classification System

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	**Gravels** *more than half of coarse fraction is larger than No. 4 sieve size*	Clean Gravels *little or no fines*	GW		Well graded gravels, gravel-sand mixtures, little or no fines	*For laboratory classification of coarse-grained soils*	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Determine percentage of gravel and sand from grain-size curve. Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows: **Less than 5%** GW, GP, SW, SP **More than 12%** GM, GC, SM, SC **5% to 12%** Borderline cases requiring use of dual symbols**	Not meeting all gradation requirements for GW	
		Gravels With Fines *appreciable amount of fines*	GM*	d u	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	Clean Sands *little or no fines*	SW		Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with Fines *appreciable amount of fines*	SM*	d u	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			SC		Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	**Silts and Clays** *liquid limit is less than 50*		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	*For laboratory classification of fine-grained soils*		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silt-clays of low plasticity			
	Silts and Clays *liquid limit is greater than 50*		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			Pt		Peat and other highly organic soils			



Plasticity Chart

*Division of **GM** and **SM** groups into subdivisions of **d** and **u** for roads and airfields only. Subdivision is based on Atterberg limits; suffix **d** used when liquid limit is 28 or less and the PI is 6 or less, the suffix **u** used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example **GW-GC**, well graded gravel-sand mixture with clay biner.)

NEW TEST HOLES

(2006)

F-718

500 South over Legacy Parkway

DRILL HOLE LOG

BORING NO. RSB-12-609

SHEET 1 OF 3

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 369,788, E 52,813
DRILLING METHOD: CME-55 NO. 1 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 4.0' **AFTER 24 HOURS:** ▼ 4.0'

PROJECT NUMBER: 200601.112
DATE STARTED: 2/27/06
DATE COMPLETED: 2/28/06
GROUND ELEVATION: ~4223'
LOGGED BY: B. HORROCKS, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Disturbed	11	10,11,10,(43)	GM	reddish-brown, moist, med. dense — SILTY GRAVEL W/SAND								
4220															
	5		Disturbed	13	5,7,9,(33) 0.53	CL	red to gray, moist, stiff								pH Resist. Sulfate
4215							LEAN CLAY								
	10		Pushed	17	Pushed 0.23	CL (A-6(20))	gray, very moist, soft	93.3	27	39	20	0	4	96	UC
4210															
	15		Disturbed	15	5,4,2,(11) 0.27	SM / CL	brown, wet, loose — SILTY SAND / gray, moist, soft								
4205															
	20		Pushed	16	Pushed 0.34	CL (A-7-6(21))	gray, moist, firm — LEAN CLAY	72.2	45.7	43	25	0	17	83	CT
4200															
	25		Disturbed	16	2,4,4,(12) 0.60	CL	gray, moist, stiff								
4195															
	30		Pushed	18	Pushed	SM	gray, wet, med. dense — SILTY SAND								
			Disturbed	13	5,7,10,(22)	SM (A-4(0))	dk. gray, wet, med. dense		25.2		NP	0	57	43	
4190															
	35		Disturbed	18	6,6,9,(18) 0.27	SM / CL	dk. gray, wet, med. dense / brown, moist, soft — LEAN CLAY								
4185							SAND W/SILT								
	40		Disturbed	18	1,3,4,(8) 0.59	SP-SM (A-2-4(0)) / CL	gray, wet, loose / grayish-brown, moist, stiff		27.1		NP	0	89	11	
4180															
	45		Pushed	12	Pushed 0.54	CL (A-6(19))	gray, moist, stiff — LEAN CLAY	99.1	25.7	37	18	0	1	99	CT
4175															
			Disturbed	18	4,5,5,(10) 0.74	CL	gray, moist, stiff								

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE 2,3,2,(6) — Blow Count per 6"; $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)

UNDISTURBED SAMPLE PUSHED 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-12-609

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.112

LOCATION: N 369,788, E 52,813

DATE STARTED: 2/27/06

DRILLING METHOD: CME-55 NO. 1 / N.W. CASING

DATE COMPLETED: 2/28/06

DRILLER: T. KERN

GROUND ELEVATION: ~4223'

DEPTH TO WATER - INITIAL: ▽ 4.0' **AFTER 24 HOURS:** ▼ 4.0'

LOGGED BY: B. HORROCKS, J. BOONE

Elev. (ft)	Depth (ft)	Rec. (in)	Sample: See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						LEAN CLAY								
4170	55	12	Pushed 0.65	CL-ML (A-4(1))	gray, moist, stiff	SANDY SILTY CLAY	114.9	16.3	24	6	0	47	53	UC
4165	60	15	7,8,9,(16) 0.71	CL-ML	gray, moist, stiff									
4160	65	12	Pushed 0.86	CL (A-6(18))	gray, moist, stiff	LEAN CLAY W/SILT LENSES 0.13" TO 0.5" APART	113.1	16.5	35	20	0	6	94	
4155	70	15	3,8,7,(13) 0.82 0.65	CL	gray to brown, moist, stiff									
4150	75	18	Pushed 0.40	CL (A-6(11))	gray-brown, moist, firm	LEAN CLAY	107.2	21.7	30	13	0	8	92	TS
4145	80	18	3,6,7,(10) 1.21 0.74	CL	gray-brown, moist, stiff									
4140		18	0.87 Pushed	CL	gray-brown, moist, stiff									
	85	16	5,12,11,(17) 1.07 0.68	CL,SM CL,SM	green, moist/wet, stiff/med. dense green & brown, moist/wet, stiff/med. dense	INTERBEDDED LEAN CLAY & SILTY SAND LAYERS 1" TO 2" THICK								
4135				SM	gray, wet, med. dense	SILTY SAND								
	90	18	4,8,7,(11) 0.50	CL	blue-green, moist, stiff	LEAN CLAY W/FEW VERY THIN SILTY SAND LENSES								
4130	95	18	Pushed 0.86	CH (A-7-6(43))	blue-gray, moist, stiff	FAT CLAY	87.6	34.2	60	38	0	0	100	CT
4125		18	6,10,16,(18) 0.85	CL,SM	brown & gray, moist/wet, stiff	LEAN CLAY W/SILTY SAND LAYERS 1" TO 3" THICK								

_OGV1 COLOR 112_F LOGS_COLOR.GPJ US EVAL.GDT 7/12/06

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-12-609

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.112

LOCATION: N 369,788, E 52,813

DATE STARTED: 2/27/06

DRILLING METHOD: CME-55 NO. 1 / N.W. CASING

DATE COMPLETED: 2/28/06

DRILLER: T. KERN

GROUND ELEVATION: ~4223'

DEPTH TO WATER - INITIAL: ∇ 4.0' **AFTER 24 HOURS:** ▼ 4.0'

LOGGED BY: B. HORROCKS, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
								LEAN CLAY W/SILTY SAND LAYERS 1" TO 3" THICK								
4120			Pushed	18	Pushed 0.86	SP (A-3(0))	gray, wet	SAND		19.2		NP	0	96	4	
	105					CH (A-7-6(28))	slight greenish-gray, moist, stiff	FAT CLAY	97.3	28.3	50	26	0	5	95	UC
4115	110		Disturbed	16	4,9,12,(14) 0.70	CL	brown-gray, moist, stiff	LEAN CLAY								
4110	115		Pushed	12	Pushed 0.76	CL (A-6(11))	brown-gray, moist, stiff	SANDY LEAN CLAY		22.1	35	16	2	21	77	
4105	120		Disturbed	16	17,26,25,(33)	SM (A-2-4(0))	green-gray, wet, very dense	SILTY SAND		19.8		NP	0	87	13	
4100	125		Pushed	16	Pushed 0.74	CL (A-4(6))	brown-gray, moist, stiff		102.6	23.9	29	7	0	6	94	CT
4095	130		Disturbed	18	5,6,7,(8) 0.65	CL	gray, moist, stiff	LEAN CLAY W/OCCASIONAL SILT LENSES								
4090	135		Pushed	18	Pushed 0.76	CL (A-6(11))	gray, moist, stiff		92	27.2	32	12	0	5	95	CT
4085	140		Disturbed	16	5,10,14,(14) 0.81	CL	gray to brown, moist, stiff									
4080	145		Disturbed	18	9,13,23,(21)	ML (A-4(0))	brown, moist, dense	SANDY SILT W/SILT LENSES		26.6		NP	1	19	80	
4075			Disturbed	17	18,14,14,(16) 1.26	SP-SM	gray, wet, dense	SAND W/SILT								
						CL	gray, moist, very stiff	SANDY LEAN CLAY								

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6"; (6) — $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; 0.45 — Torvane (tsf)

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- TS = Triaxial Shear
- CBR = California Bearing Ratio
- (pink) = Potential Liquefaction
- (blue) = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-12-610

SHEET 1 OF 4

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 369,789, E 52,903
DRILLING METHOD: CME-55 NO. 2 TO 72' THEN CME-55 NO. 1 / N.W. CASING
DRILLER: D. SAMPSON, T. KERN
DEPTH TO WATER - INITIAL: ∇ 7.5' **AFTER 24 HOURS:** ▼ 6.7'

PROJECT NUMBER: 200601.112
DATE STARTED: 2/28/06
DATE COMPLETED: 3/3/06
GROUND ELEVATION: 4223.4'
LOGGED BY: C.S., G.P., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				17	12,24,32,(87)	GM	tan, dry, very dense	SILTY GRAVEL W/SAND								
						ML	gray/black, dry, very dense	SANDY SILT W/GRAVEL								
4220																
	5			12	Pushed 0.90	CL (A-7-6(23))	gray-brown, moist, stiff		98.4	27.3	41	22	0	2	98	CT UC
4215								LEAN CLAY								
	10			17	3,2,1,(4) 0.21	CL	gray-brown, moist, soft									
4210																
	15			20	Pushed 0.47	CL (A-6(17))	blue-gray, moist, firm		101.1	28.6	36	17	0	3	97	UC
4205								LEAN CLAY W/SILTY SAND LAYERS TO 1.5" THICK								
	20			19	2,2,2,(4) 0.39	CL	blue-gray, moist, firm									
4200				15	3,6,9,(15) 0.39	CL	blue-gray, moist, firm									
	25			10	Pushed	SM (A-2-4(0))	blue-gray, wet	SILTY SAND W/CLAY LAYERS TO 1" THICK		22.1		NP	0	79	21	
4195																
	30			16	3,2,3,(4) 0.47	CL CL	blue-gray, moist, firm blue-gray, moist, firm	LEAN CLAY								
				18	5,4,8,(10) 0.25	SM	gray & dk. brown, wet, med. dense	SILTY SAND								
4190						ML (A-7-5(12))	gray, wet, med. dense	SANDY SILT W/DARK BROWN ORGANIC LENSES & LAYERS		36.5	43	12	0	14	86	
						SM	gray & dk. brown, wet, med. dense									
	35			17	Pushed	SM	gray, wet	SILTY SAND								
				18	3,4,2,(5)	SM	gray, wet, loose									
4185				18	9,18,21,(31) 0.12	SP-SM (A-2-4(0))	gray, wet, dense			21.2		NP	0	89	11	
	40							SAND W/SILT								
				20	4,7,11,(14) 0.88	SP-SM	gray, wet, med. dense									
						CL	brown-gray, moist, stiff									
4180																
	45			16	Pushed 0.78	CL (A-6(10))	gray, moist, stiff	LEAN CLAY	90.7	28.2	29	11	0	2	98	CT UC
4175								LEAN CLAY W/SAND LENSES								

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) ← Blow Count per 6"; (N₁)₆₀ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-12-610

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.112

LOCATION: N 369,789, E 52,903

DATE STARTED: 2/28/06

DRILLING METHOD: CME-55 NO. 2 TO 72' THEN CME-55 NO. 1 / N.W. CASING

DATE COMPLETED: 3/3/06

DRILLER: D. SAMPSON, T. KERN

GROUND ELEVATION: 4223.4'

DEPTH TO WATER - INITIAL: ∇ 7.5' **AFTER 24 HOURS:** ▼ 6.7'

LOGGED BY: C.S., G.P., J.B.

Elev. (ft)	Depth (ft)	Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
		Disturbed	13	0.27 6,8,14,(16)	CL ML	gray, moist, soft gray, moist, med. dense — SILT W/CLAY LENSES								
4170	55	Undisturbed	18	Pushed 0.55	CL (A-6(5))	gray, moist, stiff — SANDY LEAN CLAY W/SAND LAYERS TO 6" THICK	104.8	18.2	29	13	0	42	58	CT
4165	60	Disturbed	8	8,12,15,(18) 0.89	CL	gray, moist, stiff								
4160	65	Undisturbed	19	Pushed 0.75	CL (A-6(17))	gray to brown, moist, stiff	107.7	21.9	34	19	0	8	92	CT UC
4155	70	Disturbed	16	10,20,28,(29) 1.27	CL	brown to gray, moist, very stiff								
4150	75	Undisturbed	18	Pushed 0.59	CL (A-6(14))	gray, moist, stiff — LEAN CLAY W/OCCASIONAL SILT & SAND LENSES	111.7	18.7	33	18	0	15	85	UC
4145	80	Disturbed	19	3,5,9,(10) 0.44 0.90	CL	brown, moist, stiff								
4140	85	Undisturbed	16	Pushed 0.90	CL (A-6(18))	brown, moist, stiff	105.2	22	36	19	0	7	93	CT
4135	90	Disturbed	21	4,5,7,(8) 0.85	CL	gray, moist, stiff								
4130	95	Undisturbed	13	Pushed 0.95	CL	dk. gray, moist, stiff								
4125		Disturbed	18	3,12,24,(24)	SM	dk. gray, wet, dense — SILTY SAND								

JGV1_COLOR_112_F_LOGS_COLOR.GPJ US EVAL.GDT 7/12/06

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) Blow Count per 6" / $(N_1)_{60}$ Value; 0.45 Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-12-610

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 369,789, E 52,903
DRILLING METHOD: CME-55 NO. 2 TO 72' THEN CME-55 NO. 1 / N.W. CASING
DRILLER: D. SAMPSON, T. KERN
DEPTH TO WATER - INITIAL: ∇ 7.5' **AFTER 24 HOURS:** ▼ 6.7'

PROJECT NUMBER: 200601.112
DATE STARTED: 2/28/06
DATE COMPLETED: 3/3/06
GROUND ELEVATION: 4223.4'
LOGGED BY: C.S., G.P., J.B.

Elev. (ft)	Depth (ft)	Rec. (in)	Sample (See Legend)	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
						SILTY SAND								
4120	105	12	Pushed 0.90	CL (A-7-6(24))	dk. gray, moist, stiff	LEAN CLAY	89.2	30.1	44	24	0	5	95	CT UC
4115	110	16	10,15,21,(24) 0.30	ML (A-4(3))	brown, moist, firm/dense	SILT		22.8	25	4	0	6	94	
4110	115	19	4,7,11,(12) 0.78	CL	gray, moist, stiff	LEAN CLAY								
4105		14	Pushed	CL										
	120	16	3,8,14,(13)	SM SM (A-2-4(0))	gray to black, wet, med. dense	SILTY SAND		26.2		NP	0	88	12	
4100	125	17	24,30,33,(38)	SM	gray, wet, very dense									
4095	130	19	7,11,15,(15) 1.42	CL	gray, moist, very stiff	LEAN CLAY								
4090	135	18	Pushed 1.12	ML (A-4(6))	brown, very moist, very stiff	SILT	103.2	22.7	31	6	5	3	92	CT UC
4085	140	18	8,14,21,(20) 0.75 0.85	CL	gray-brown, very moist, stiff	LEAN CLAY								
4080	145	16	15,21,23,(25)	ML (A-4(0))	brown, very moist, stiff	SANDY SILT		24.7		NP	0	48	52	
4075		15	26,26,19,(25) 0.90	SM	brown, wet, very dense	SILTY SAND								
						FAT CLAY								

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) ← Blow Count per 6"; ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-12-610

SHEET 4 OF 4

PROJECT: LEGACY PARKWAY - STRUCTURE F-718 (500 S. OVER LEGACY PARKWAY)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.112

LOCATION: N 369,789, E 52,903

DATE STARTED: 2/28/06

DRILLING METHOD: CME-55 NO. 2 TO 72' THEN CME-55 NO. 1 / N.W. CASING

DATE COMPLETED: 3/3/06

DRILLER: D. SAMPSON, T. KERN

GROUND ELEVATION: 4223.4'

DEPTH TO WATER - INITIAL: ∇ 7.5' **AFTER 24 HOURS:** ▼ 6.7'

LOGGED BY: C.S., G.P., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CH	gray, moist, stiff								
							FAT CLAY								
4070				16	9,16,22,(21) *0.92*	CH (*A-7-6(34)*)	lt. gray, moist, stiff		23.3	52	34	0	6	94	
	155														
4065															
	160														
4060															
	165														
4055															
	170														
4050															
	175														
4045															
	180														
4040															
	185														
4035															
	190														
4030															
	195														
4025															

JGV1 COLOR 112_F_LOGS_COLOR.GPJ US EVAL.GDT 7/12/06

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) *0.45* — Blow Count per 6"; $(N_1)_{60}$ Value; Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED *0.45* — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

D-843

500 South over Multi-Use Trail

DRILL HOLE LOG

BORING NO. RSB-12-651

SHEET 1 OF 2

PROJECT: LEGACY PARKWAY - D-843 (500 SOUTH OVER MULTI-USE TRAIL)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

LOCATION: N ~369,794, E ~53,289

DRILLING METHOD: CME-55 NO. 2 / N.W. CASING

DRILLER: D. SAMPSON

DEPTH TO WATER - INITIAL: 7.2' **AFTER 24 HOURS:** N.M.

PROJECT NUMBER: 200601.146

DATE STARTED: 3/8/06

DATE COMPLETED: 3/9/06

GROUND ELEVATION: ~4224'

LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Rec. (in)	Sample (See Legend)	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
		16	14,19,15,(53)	GC	lt. brown, dry, med. dense	CLAYEY GRAVEL W/SAND								
4220	5	9	6,12,11,(36) 0.75	CL	lt. gray-brown, dry to slightly moist, very stiff	LEAN CLAY								
		12	Pushed 0.36	CL (A-6(13))	lt. gray & rusty-brown, slightly moist, firm		102.1	23.4	32	13	0	1	99	UC
4215	10	16	2,1,2,(4) 0.21	CL	brown to lt. green, moist, soft									
		18	Pushed	CL										
4210				SM	brown, wet, med. dense	SILTY SAND								
	15	14	2,4,7,(13)	CL (A-4(3))	brown, wet, stiff	LEAN CLAY		26.6	27	7	0	33	67	
		18	Pushed	CL										
		18	2,2,2,(5) 0.20	CH	gray, moist, soft	FAT CLAY								
4205		10	Pushed 0.65	CH (A-7-6(30))	stiff		86.1	30.8	51	28	0	4	96	CT UC
	20	18	2,3,3,(6) 0.63	CH	firm to stiff									
4200	25	17	Pushed 0.64	CL	gray, moist, stiff	LEAN CLAY								
4195		12	12,13,13,(24)	SM	gray, wet, dense	SILTY SAND								
	30	8	5,5,5,(9) 0.70	CL	lt. blue-green to lt. brown, moist, stiff	LEAN CLAY								
4190	35	9	Pushed 0.76	CL (A-6(16))	stiff		101.6	20.3	34	18	0	8	92	CT UC
4185	40	18	3,4,4,(6) 0.54	CL	firm to stiff, w/silt lenses									
4180	45	16	Pushed 0.20	CL	soft									
		16	2,4,10,(11)	CL (A-4(5))	stiff			26.1	28	7	0	12	88	
4175		18	5,12,15,(20)	CL	very stiff									

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) Blow Count per 6", $(N_1)_{60}$ Value; 0.45 Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED 0.45 Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

RB&G ENGINEERING INC.
PROVO, UTAH

DRILL HOLE LOG

BORING NO. RSB-12-651

PROJECT: LEGACY PARKWAY - D-843 (500 SOUTH OVER MULTI-USE TRAIL)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N ~369,794, E ~53,289
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ 7.2' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.146
DATE STARTED: 3/8/06
DATE COMPLETED: 3/9/06
GROUND ELEVATION: ~4224'
LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Disturbed	18	3,7,7,(10) 0.48	CL	gray-brown, moist to wet, stiff								
4170	55						LEAN CLAY								
			Undisturbed	-	Pushed 0.63	CL (A-6(18))	stiff	96.2	24.2	38	20	0	10	90	UC
4165	60														
			Disturbed	12	13,10,12,(15) 0.50	CL	brown								
						CL	brown, moist, stiff								
4160	65		Undisturbed	18	Pushed 0.60	CL	stiff								
							SANDY LEAN CLAY W/SAND LENSES								
4155	70		Undisturbed	12	Pushed 0.28	CL	firm								
4150	75		Undisturbed	15	Pushed	CL									
			Disturbed	18	6,12,13,(15)	ML (A-4(0))	brown, wet, very stiff SANDY SILT		24.4	22	1	0	22	78	
4145	80														
4140	85														
4135	90														
4130	95														
4125															

LOGV1 COLOR 146 LOGS COLOR.GPJ US EVAL.GDT 7/25/06

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — 2,3,2,(6) 0.45 — Blow Count per 6"; $(N_1)_{60}$ Value; Torvane (tsf)
UNDISTURBED SAMPLE — PUSHED 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
= Potential Liquefaction
= Potential Liquefaction & Lateral Spread

PREVIOUS TEST HOLES

(by others)

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: SB-12-263

Sheet 1 of 4

Logged by:	S. Lewis
Date Start:	1/31/00
Date Finish:	2/4/00
Station:	70+189.825 4.65 LT
Line:	500 SOUTH
Coordinates (m):	N 112,713.423 E 16,081.296
Elevation (m):	1286.517
Total Depth Drilled (m):	61.6
Drill Contractor:	Layne Christensen
Driller:	C. Davis
Rig Type:	Mobile B-59
Drilling Method:	Mud Rotary
Hammer Type:	Rope and Cat Head
Rod Type:	AW
Boring Diameter:	133 mm

Boring: SB-12-263
Sheet 1 of 4

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	SPT $(N_1)_{60}$	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	Lean CLAY - stiff, moist, light gray, with light brown mottling, trace silt	0		SPT	254	CL	A-6	4 3 4 7	11							
1285	- wet	5	2	SH	610					*62*						pH WSS R
	- very soft, wet, light grayish-brown, with 6 mm seams of olive-gray silty sand	10	3	SPT	610			1 1 1 1	2							
	SILT - medium stiff, wet, dark olive-gray, with fine-grained sand, trace clay	15	5	SPT	508	ML	A-4	4 5 2 2	8							
	Lean CLAY - medium stiff, wet, dark gray, with trace of organics			SH	610	CL	A-6			37 *48*	13.1	38	41	22		C SG
1280		20	6	SPT	457			1 1 2 3	3							
	SILT - soft, wet, dark olive-gray, with mica flakes, trace clay	25	8	SH	610	ML	A-4			*48*						
	- stiff	30	9	SPT	559			2 6 7 7	13							
	Silty SAND - medium dense, wet, olive-gray, fine-grained	35	11	SH	610	SM	A-2-4									
1275	Sandy SILT - soft, wet, olive-gray, fine-grained sand	40	12	SPT	584	ML	A-4	3 2 2 3	4							
		45	14	SH	610											
	Silty SAND - medium dense, wet, light brownish-gray, fine-grained sand					SM	A-2-4									
	Lean CLAY - medium stiff, wet, dark gray, with fine-grained sand, with mica flakes	50	15	SPT	610	CL	A-6	2 3 4 6	5							
1270		55	17													
		60	18	SH	381					52 *57*	16.5	22	42	23	94	
		65	19													

● SPT $(N_1)_{60}$
○ SPT $(N_1)_{60}$ (Greater than 50 Blows)

Test Results *

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

∇ = Observed Groundwater depth at time of drilling

Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown

USCS = Unified Soil Classification System

AASHTO = American Association of State Highway and Transportation Officials

* = See Key to Soil Logs for list of abbreviations and descriptions of tests

SAMPLE TYPE

SPT = Standard Penetration Test, 34.9mm ID and 50.8mm OD split spoon sampler

MC = Modified California Sampler, 50.8mm ID and 63.5mm OD split spoon sampler

P = Piston Sampler, 76.2 mm OD

SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-263**

Sheet 2 of 4

Boring: SB-12-263
Sheet 2 of 4

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Sample Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	S_u kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No 200	Other Tests
	Lean CLAY - medium stiff, wet, dark gray, with fine-grained sand, with mica flakes (continued)														
1265	- olive-gray to light brown, mottled, 25 mm seam of light brown lean clay	70	21–22	SPT	483			3 5 6 8							
	- light gray	80	24–25	SH	610				*38*						
1260	- light olive-gray	90	27–28	SPT	508			4 4 8 10							
	Poorly Graded SAND with silt - medium dense, wet, gray, fine to coarse-grained, with layers of fine to medium-grained, with mica flakes, shell fragments	100	30–31	SPT	559	SP-SM	A-3	4 14 24 25							
1255	SILT - medium stiff, wet, gray, with light brown mottling, with trace organics	105	32	SPT	610	ML	A-4	2 5 7 10							
	Sandy SILT - wet, gray, fine-grained sand	115	35	SH	330	ML	A-4		*57*						
1250		120	37												
	SILT - medium stiff, wet, dark gray, with mica flakes, fine-grained	125	38	SPT	610	ML	A-4	3 6 7 6							
		130	39												

● SPT $(N_1)_{60}$
○ SPT $(N_1)_{60}$ (Greater than 50 Blows)

Test Results *

Logged by: S. Lewis
Date Start: 1/31/00
Date Finish: 2/4/00
Station: 70+189.825 4.65 LT
Line: 500 SOUTH
Coordinates (m): N 112,713.423 E 16,081.296
Elevation (m): 1266.517
Total Depth Drilled (m): 61.6
Drill Contractor: Layne Christensen
Driller: C. Davis
Rig Type: Mobile B-59
Drilling Method: Mud Rotary
Hammer Type: Rope and Cat Head
Rod Type: AW
Boring Diameter: 133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

⊻ = Observed Groundwater depth at time of drilling

Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown

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P = Piston Sampler, 76.2 mm OD

SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-263**

Sheet 3 of 4

Boring: SB-12-263
Sheet 3 of 4

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Type	Recovery (mm)	Soil Classification USCS	Soil Classification AASHTO	N, Blows per 0.15 m (or interval shown)	● SPT $(N_1)_{60}$ / ○ SPT $(N_1)_{60}$ (Greater than 50 Blows)	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	SILT - medium stiff, wet, dark gray, with mica flakes, fine-grained (continued)															
1245	- stiff, wet, dark olive-gray	135	41	SH	610					131 *67*	15.1	28			99	C SG
	Poorly Graded SAND with silt - medium dense, wet, light gray, fine to medium-grained sand, with gray silt at top	145	44	SPT	610	SP-SM	A-3	13 23 33 35	27							
1240	Lean CLAY - very stiff, wet, light olive-gray, with white mottling	150	46	SPT	610	CL	A-6	5 8 13 17	14							
	- chalky light gray	160	49	SH	457											
1235	Silty SAND - loose, wet, olive-gray, fine to medium-grained sand, with mica flakes, with silt layers	170	52	SPT		SM	A-2-4	4 5 7 10	5							
	SILT - very stiff, wet, olive-gray, with fine-grained sand, mica flakes, shell fragments	175	53	SPT	610	ML	A-4	8 18 23 35	16							
1230		185	56	SH	610											
	Silty SAND - wet, dark gray, fine-grained, with mica flakes		57			SM	A-2-4									
	Poorly Graded SAND with silt - medium dense, wet, brown-gray, fine to medium-grained	190	58	SPT	457	SP-SM	A-3	16 35 50	32							
	SILT - very stiff, wet, mottled grayish-brown and light olive-gray, with mica flakes	195	59	SPT	610	ML	A-4	10 18 23 26	16							

Logged by: S. Lewis
Date Start: 1/31/00
Date Finish: 2/4/00
Station: 70+189.825 4.65 LT
Line: 500 SOUTH
Coordinates (m): N 112,713.423 E 16,081.296
Elevation (m): 1286.517
Total Depth Drilled (m): 61.6
Drill Contractor: Layne Christensen
Driller: C. Davis
Rig Type: Mobile B-59
Drilling Method: Mud Rotary
Hammer Type: Rope and Cat Head
Rod Type: AW
Boring Diameter: 133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

- ▽ = Observed Groundwater depth at time of drilling
- Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown
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- AASHTO = American Association of State Highway and Transportation Officials
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SAMPLE TYPE

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- P = Piston Sampler, 76.2 mm OD
- SH = Shelby Tube, 76.2mm OD, pushed
- BAG = Bulk Sample

UTDOT Z003881.GPJ 8/3/00

Elevation (m)	Boring: SB-12-263 Sheet 4 of 4 SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Graphic Log	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	SPT	Su kPa	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	SILT - very stiff, wet, mottled grayish-brown and light olive-gray, with mica flakes (continued)	200	61														
	- medium stiff, gray, with fine-grained sand				SPT	610			5 6 15 18								
1225		205	62														
		210	63, 64														
1220		215, 220	65, 66, 67														
1215		225, 230, 235	68, 69, 70, 71, 72														
1210		240, 245, 250, 255, 260	73, 74, 75, 76, 77, 78, 79														

SPT chart: ● SPT $(N_1)_{60}$; ○ SPT $(N_1)_{60}$ (Greater than 50 Blows); scale 0, 25, 50

Test Results *

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-263**

Sheet 4 of 4

Logged by:	S. Lewis
Date Start:	1/31/00
Date Finish:	2/4/00
Station:	70+189.825 4.65 LT
Line:	500 SOUTH
Coordinates (m):	N 112,713.423 E 16,081.296
Elevation (m):	1286.517
Total Depth Drilled (m):	61.6
Drill Contractor:	Layne Christensen
Driller:	C. Davis
Rig Type:	Mobile B-59
Drilling Method:	Mud Rotary
Hammer Type:	Rope and Cat Head
Rod Type:	AW
Boring Diameter:	133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

▽ = Observed Groundwater depth at time of drilling

Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown

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SH = Shelby Tube, 76.2mm OD, pushed

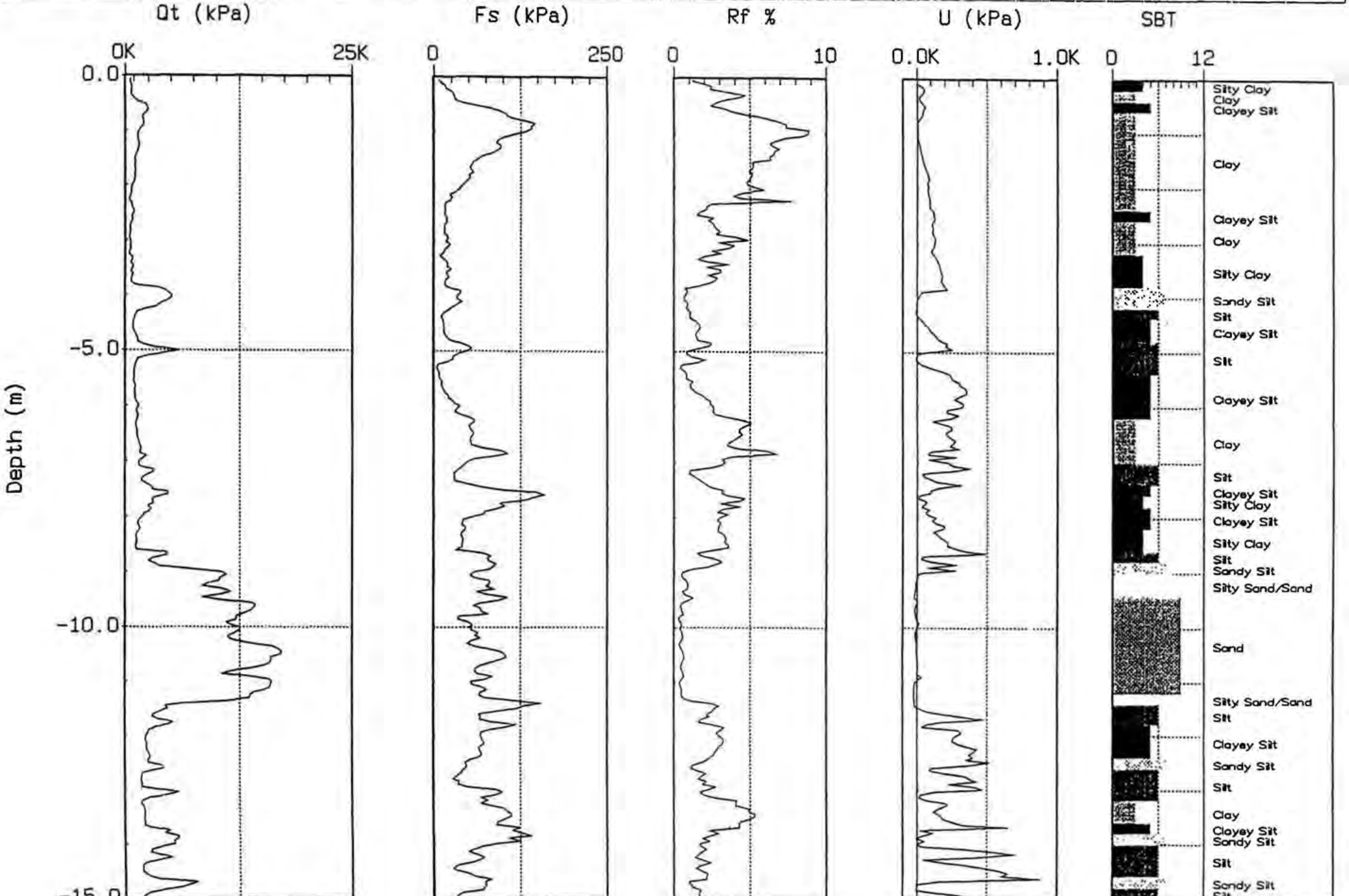
BAG = Bulk Sample

UTDOT Z003SB1.GPJ 8/30/00

Legacy Parkway

Site: SC-12-264
Station: 70+224.505 2.59 LT
Elevation: 1286.546

Cone: 20 TON A 058
Date: 01:26:00 09:47



Max. Depth: 33.70 (m)

Depth Inc.: 0.050 (m)

SBT: Soil Behavior Type (Robertson 1990)

● Equilibrium (or near) Pore Pressure from Dissipation

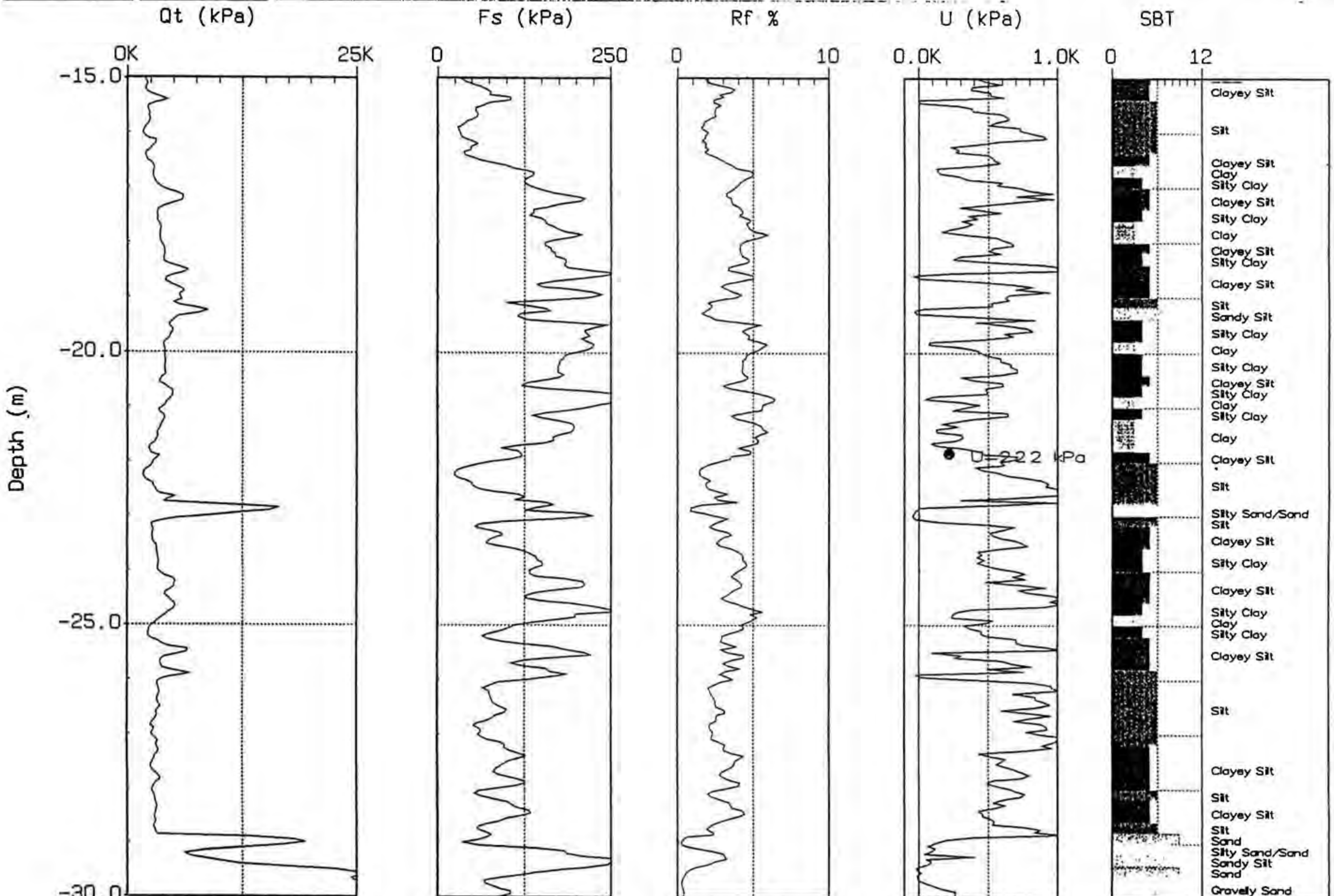
PLATE B-112

CONETEC

Legacy Parkway

Site: SC-12-264
Station: 70+224.505 2.59 LT
Elevation: 1286.546

Cone: 20 TON A 058
Date: 01:26:00 09:47



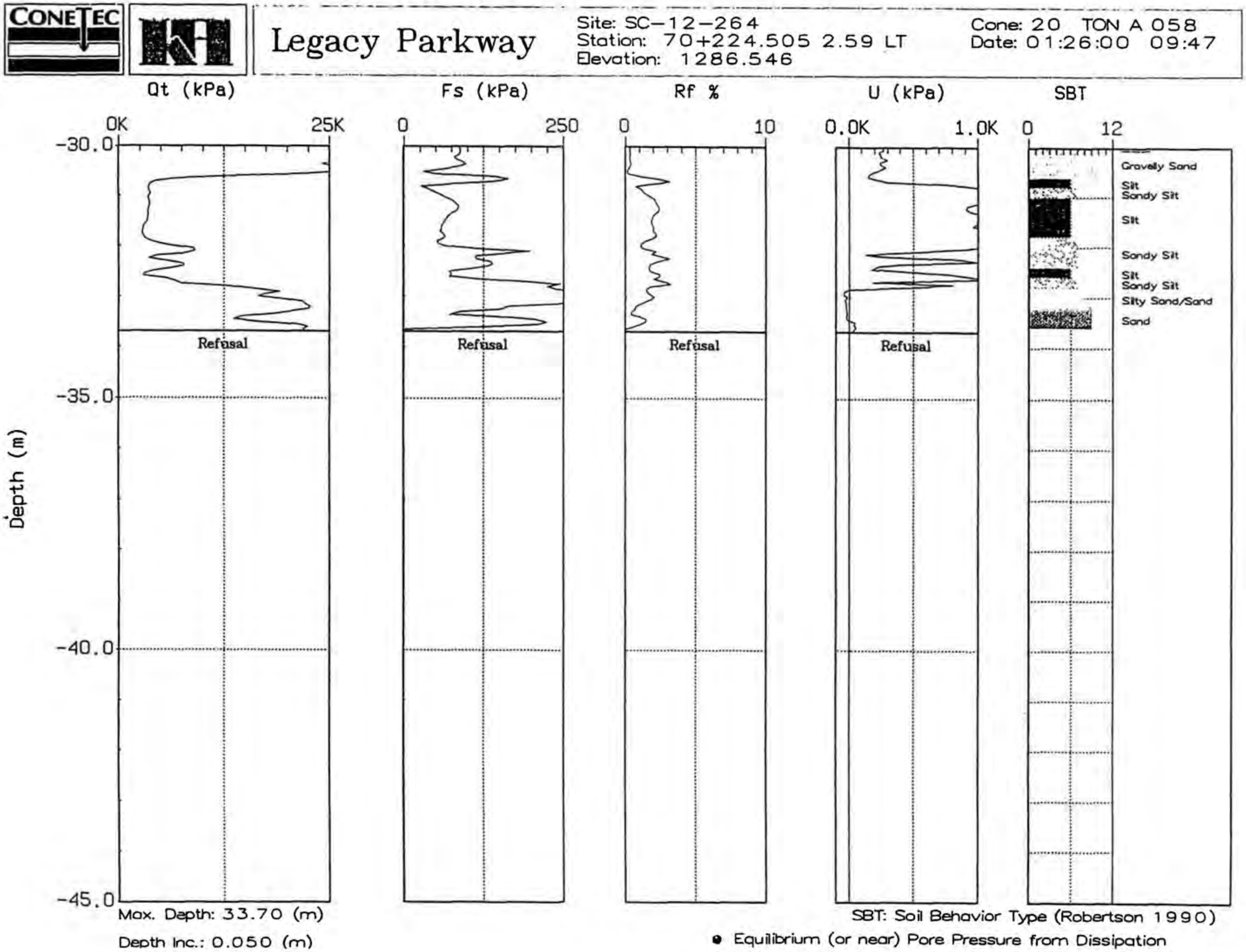
Max. Depth: 33.70 (m)

Depth Inc.: 0.050 (m)

SBT: Soil Behavior Type (Robertson 1990)

● Equilibrium (or near) Pore Pressure from Dissipation

PLATE B-113


CONETEC
Legacy Parkway
Site: SC-12-264
Station: 70+224.505 2.59 LT
Elevation: 1286.546
Cone: 20 TON A 058
Date: 01:26:00 09:47
Qt (kPa)
Fs (kPa)
Rf %
U (kPa)
SBT
0K
25K
0
250
0
10
0.0K
1.0K
0
12
-30.0
-35.0
-40.0
-45.0
Depth (m)
Refusal
Refusal
Refusal
Refusal
Gravelly Sand
Silt
Sandy Silt
Silt
Sandy Silt
Silt
Sandy Silt
Silty Sand/Sand
Sand
Max. Depth: 33.70 (m)
Depth Inc.: 0.050 (m)
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium (or near) Pore Pressure from Dissipation

PL⁄' ⁼ B-114

Boring: SB-12-265
Sheet 1 of 4

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	SPT $(N_1)_{60}$	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	SILT - stiff, moist, dark brown, with organics			SPT	457	ML	A-4	2 3 3 5	10							
1285	Lean CLAY - stiff, wet, light gray to light brown, mottled, occasional fine-grained sand	5	2	SH	610	CL	A-6			*67*						pH WSS R
	- soft, with trace organics	10	3	SPT	584			1 2 2 2	4							
	- stiff	15	5	SH	610					83 *4*	15.7	27	39	17	97	C SG
1280	SILT - medium stiff, wet, olive-gray	20	6	SPT	559	ML	A-4	1 3 3 4	8							
	- with sand	25	8	SH	610											
	- light brown to olive-gray	30	9	SPT	584			2 3 3 6	6							
		35	11	SH	483											
1275		40	12	SPT	610			2 3 2 4	5							
	- grayish-brown	45	14	SH	610					*62*						
	- soft, 10 mm seam of fine sand	50	15	SPT	610			2 2 3 4	4							
1270		55	17													
	Lean CLAY - wet, light grayish-brown	60	18	SH	508	CL	A-6									
	SILT - wet, olive-gray, with occasional fine-grained sand and trace of clay	65	19			ML	A-4									

● SPT $(N_1)_{60}$
○ SPT $(N_1)_{60}$ (Greater than 50 Blows)
0 25 50

Test Results *

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange
KLEINFELDER
Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-265**
Sheet 1 of 4

Logged by:	W. Lewis
Date Start:	1/22/00
Date Finish:	1/26/00
Station:	70+260.053 3.46 LT
Line:	500 SOUTH
Coordinates (m):	N 112,713.116 E 16,151.533
Elevation (m):	1286.640
Total Depth Drilled (m):	77.1
Drill Contractor:	Layne Christensen
Driller:	C. Davis
Rig Type:	Mobile B-59
Drilling Method:	Mud Rotary
Hammer Type:	Rope and Cathead
Rod Type:	AW
Boring Diameter:	133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

∇ = Observed Groundwater depth at time of drilling

Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown

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SAMPLE TYPE

SPT = Standard Penetration Test, 34.9mm ID and 50.8mm OD split spoon sampler

MC = Modified California Sampler, 50.8mm ID and 63.5mm OD split spoon sampler

P = Piston Sampler, 76.2 mm OD

SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

UTDOT Z903SB1.GPJ 5/3/00

Boring: SB-12-265
Sheet 2 of 4

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange
KLEINFELDER
Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-265**
Sheet 2 of 4

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Type	Recovery (mm)	Soil Classification USCS	Soil Classification AASHTO	N, Blows per 0.15 m (or interval shown)	● SPT (N₁)₆₀ / ○ SPT (N₁)₆₀ (Greater than 50 Blows)	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	Lean CLAY - soft, wet, light brown with trace organics and light gray mottling		21			CL	A-6									
1265		70	22	SPT	610			4 3 3 3	4							
		75	23													
		80	24, 25	SH	533					57						
1260		85	26, 27													
	- stiff	90	28	SPT	610			4 6 9 11	19							
		95	29, 30													
	Silty CLAY - *stiff, wet, gray, trace of organics*	100	31	*SH*	*610*	*CL-ML*	*A-7-6*			136 *43*	16 1	26	43	17	99	C SG
1255		105	32, 33													
	SILT - medium stiff, wet, light olive-gray with white chalky mottling	110	34	SPT	610	ML	A-4	3 4 5 7	5							
		115	35, 36													
1250	Poorly Graded SAND - medium dense, wet, gray	120	37	SH	508	SP	A-3									
	Lean CLAY - stiff, wet, mottled light brown to light gray	125	38			CL	A-6									
	Poorly Graded SAND - medium dense, wet, dark gray		39	SPT	610	SP	A-3	3 4 16 16	10							
		130		SPT					15							

Test Results *

Logged by:	W. Lewis
Date Start:	1/22/00
Date Finish:	1/26/00
Station:	70+260.053 3.46 LT
Line:	500 SOUTH
Coordinates (m):	N 112,713.116 E 16,151.533
Elevation (m):	1286.640
Total Depth Drilled (m):	77.1
Drill Contractor:	Layne Christensen
Driller:	C. Davis
Rig Type:	Mobile B-59
Drilling Method:	Mud Rotary
Hammer Type:	Rope and Cathead
Rod Type:	AW
Boring Diameter:	133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

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SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-265**

Sheet 3 of 4

Logged by: W. Lewis
Date Start: 1/22/00
Date Finish: 1/26/00
Station: 70+260.053 3.46 LT
Line: 500 SOUTH
Coordinates (m): N 112,713.116 E 16,151.533
Elevation (m): 1286.640
Total Depth Drilled (m): 77.1
Drill Contractor: Layne Christensen
Driller: C. Davis
Rig Type: Mobile B-59
Drilling Method: Mud Rotary
Hammer Type: Rope and Cathead
Rod Type: AW
Boring Diameter: 133 mm

Boring: SB-12-265
Sheet 3 of 4

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth ft	Depth m	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	● SPT $(N_1)_{60}$ ○ SPT $(N_1)_{60}$ (Greater than 50 Blows)	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	%, Passing No. 200	Other Tests
	SILT with sand - very stiff, wet, dark gray-brown				610	ML	A-4	8 12 18 25								
1245	Lean CLAY - wet, gray		42			CL	A-6									
		140	43	SH	356											
	Silty SAND - medium dense, wet, light gray, occasional poorly graded sand layers		43			SM	A-2-4									
	- 25 mm clay layer	145	44	SPT	533			11 34 25 26	28							
	SILT - stiff, wet, olive-gray, with minor chalky white mottling	150	46	SPT	508	ML	A-7-6	4 8 13 26	[illegible]							
1240																
	- gray	160	49	SH	381					110 *62*	15.1	27	44	17	100	C SG
1235	- medium stiff, with occasional silty sand layers	170	52	SPT	610			4 5 15 14	8							
		180	55	SH	508											
1230																
	Lean CLAY - stiff, wet, light brown, 0.3 m poorly graded sand layer	190	58	SPT	584	CL	A-6	8 17 16 15	12							

Depth scale: 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195 ft; 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59 m. SPT plot scale: 0, 25, 50. Elevation scale: 1245, 1240, 1235, 1230.

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

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P = Piston Sampler, 76.2 mm OD

SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

Boring: SB-12-265
Sheet 4 of 4

SAMPLE DESCRIPTION
(ASTM D 2488/D 2487)

Elevation (m) scale: 1225, 1220, 1215, 1210
Depth scale (ft): 200, 205, 210, 215, 220, 225, 230, 235, 240, 245, 250, 255, 260
Depth scale (m): 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79

Sample Description	Depth (m)	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	● SPT $(N_1)_{60}$ / ○ SPT $(N_1)_{60}$ (Greater than 50 Blows)	S_U, kPa (torvane in italics)	Dry Density, kN/m^3	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
Lean CLAY - stiff, wet, light brown (continued)														
	61	SH	457											
Silty SAND - dense, wet, light grayish-brown	64	SPT	610	SM	A-2-4	15 27 12 16	13							
Lean CLAY - stiff, wet, dark gray, with fine-grained sand seams				CL	A-6									
	67	SH	356											
- medium stiff, light grayish-brown with occasional olive-gray coloring	70	SPT	610			6 10 14 20	8							
	73	SH	381					99 *120*	16.4	26	39	16	96	C SG
- very stiff, light olive gray	76	SPT	432			11 22 50/ 125mm	○							

Test Results *

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange
KLEINFELDER
Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **SB-12-265**
Sheet 4 of 4

Logged by:	W. Lewis
Date Start:	1/22/00
Date Finish:	1/26/00
Station:	70+260.053 3.46 LT
Line:	500 SOUTH
Coordinates (m):	N 112,713.116 E 16,151.533
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Drill Contractor:	Layne Christensen
Driller:	C. Davis
Rig Type:	Mobile B-59
Drilling Method:	Mud Rotary
Hammer Type:	Rope and Cathead
Rod Type:	AW
Boring Diameter:	133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

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SAMPLE TYPE

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SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

UTDOT Z0038B1.GPJ 5/3/00

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **RB-371**

Sheet 1 of 2

Logged by:	A. Waldman
Date Start:	2/28/00
Date Finish:	2/29/00
Station:	70+338.171 0.29 RT
Line:	500 South
Coordinates (m):	N 112,710.357 E 16,229.692
Elevation (m):	1286.826
Total Depth Drilled (m):	31.1
Drill Contractor:	Layne Christensen
Driller:	C. Davis
Rig Type:	Mobile B-53
Drilling Method:	Mud Rotary
Hammer Type:	Safety
Rod Type:	AW
Boring Diameter:	133 mm

Boring: RB-371
Sheet 1 of 2

SAMPLE DESCRIPTION (ASTM D 2488/D 2487)

Sample Description	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	SPT $(N_1)_{60}$	S_u kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
Lean CLAY - stiff, wet, dark brown	P	610	CL	A-7-6									
- light reddish-brown	SPT	305			4 5 8 10	18	*29*						
	MC	508			1 2 2 2	4							
	SPT	610			1 2 3 3	7							
	P	533					22 *38*	14.3	34	42	22	97	C SG DS
SILT - medium stiff, gray / Silty SAND - dense, wet, gray, fine-grained	SPT	610	ML / SM	A-4 / A-2-4	0 2 6 5	8							
	MC	356			5 19 20 20	35							
Fat CLAY - medium stiff, wet, olive, frequent fine-grained sand and silt lenses	SPT	305	CH	A-7-6	4 3 4 3	7							
	P	610					*62*						
	SPT	432			2 3 5 6	8							
	MC	610			9 7 15 23	18							
- very stiff / Silty SAND - medium dense, wet, gray, with trace gravel	SPT	305	SM	A-2-4	3 4 10 17	14							
	P	610					*86*						
Lean CLAY - very stiff, wet, reddish-brown	SPT	508	CL	A-6	3 7 9 13	14							
	MC	508			4 6 11 16	12							
Sandy Lean CLAY - stiff, wet, reddish-brown	SPT	508	CL	A-6	7 8 9 11	15							
	P	610					*38*						
	SPT	610			2 1 4 5	4							
Silty SAND - dense, wet, gray	MC	406	SM	A-2-4	5 15 38 40	35							
Lean CLAY - very stiff, wet, olive-gray	SPT	508	CL	A-6	5 7 10 14	14							
	P	610					*48*						
	SPT	508			6 9 12 18	16							
	P	102					*96*						
Sandy Lean CLAY - stiff, wet, grayish-brown	P	610	CL	A-6			*96*						
Lean CLAY - very stiff, olive-gray, caliche rich	SPT	457	CL	A-6	4 8 10 15	14							

Elevation (m): 1285, 1280, 1275, 1270. Depth (ft): 5–65; Depth (m): 1–19.

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

∇ = Observed Groundwater depth at time of drilling

Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown

USCS = Unified Soil Classification System

AASHTO = American Association of State Highway and Transportation Officials

* = See Key to Soil Logs for list of abbreviations and descriptions of tests

SAMPLE TYPE

SPT = Standard Penetration Test, 34.9mm ID and 50.8mm OD split spoon sampler

MC = Modified California Sampler, 50.8mm ID and 63.5mm OD split spoon sampler

P = Piston Sampler, 76.2 mm OD

SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

UTDOT Z003RB.GPJ 5/3/00

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **RB-371**

Sheet 2 of 2

Boring: RB-371
Sheet 2 of 2

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Depth (m)	Type	Recovery (mm)	USCS	AASHTO	N, Blows per 0.15 m (or interval shown)	SPT $(N_1)_{60}$	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	Lean CLAY - very stiff, olive-gray, caliche rich (continued)		P	330					32 *86*	18.5	17	29	13	86	C TR SG
	Sandy CLAY - medium stiff to stiff, wet, grayish-brown	21			CL	A-6									
1265			SPT	610			2 4 4 7	8							
		23	P	610											
	- olive gray	24	SPT	508			7 9 12 20	15							
		26	P	406					*86*						
1260		27	SPT	610			3 5 8 10	8							
		29	P	483											
	Clayey SAND - medium dense, wet, olive, fine-grained				SC	A-2-6									
	Lean CLAY - stiff, wet, olive	30			CL	A-6									
		31	SPT	508			3 8 11 15	12							
1255		32													
1250		37													

Depth scale: ft 70–130; m 21–39. SPT plot scale: 0, 25, 50. ● SPT $(N_1)_{60}$; ○ SPT $(N_1)_{60}$ (Greater than 50 Blows)

Test Results *

Logged by:	A. Waldman
Date Start:	2/28/00
Date Finish:	2/29/00
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Line:	500 South
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Driller:	C. Davis
Rig Type:	Mobile B-53
Drilling Method:	Mud Rotary
Hammer Type:	Safety
Rod Type:	AW
Boring Diameter:	133 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

▽ = Observed Groundwater depth at time of drilling

Blows = Number of blows required to drive split spoon sampler 150 mm or interval shown

USCS = Unified Soil Classification System

AASHTO = American Association of State Highway and Transportation Officials

* = See Key to Soil Logs for list of abbreviations and descriptions of tests

SAMPLE TYPE

SPT = Standard Penetration Test, 34.9mm ID and 50.8mm OD split spoon sampler

MC = Modified California Sampler, 50.8mm ID and 63.5mm OD split spoon sampler

P = Piston Sampler, 76.2 mm OD

SH = Shelby Tube, 76.2mm OD, pushed

BAG = Bulk Sample

UTDOT 2363RB.GPJ 5/30/00

APPENDIX C
Laboratory Testing

F-718

500 South over Legacy Parkway

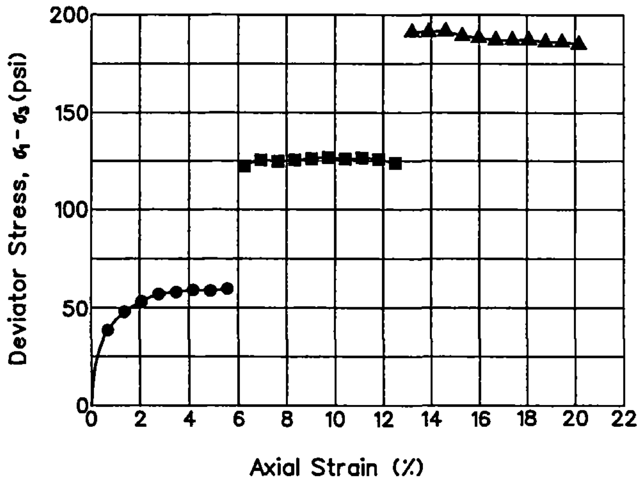
Table 1

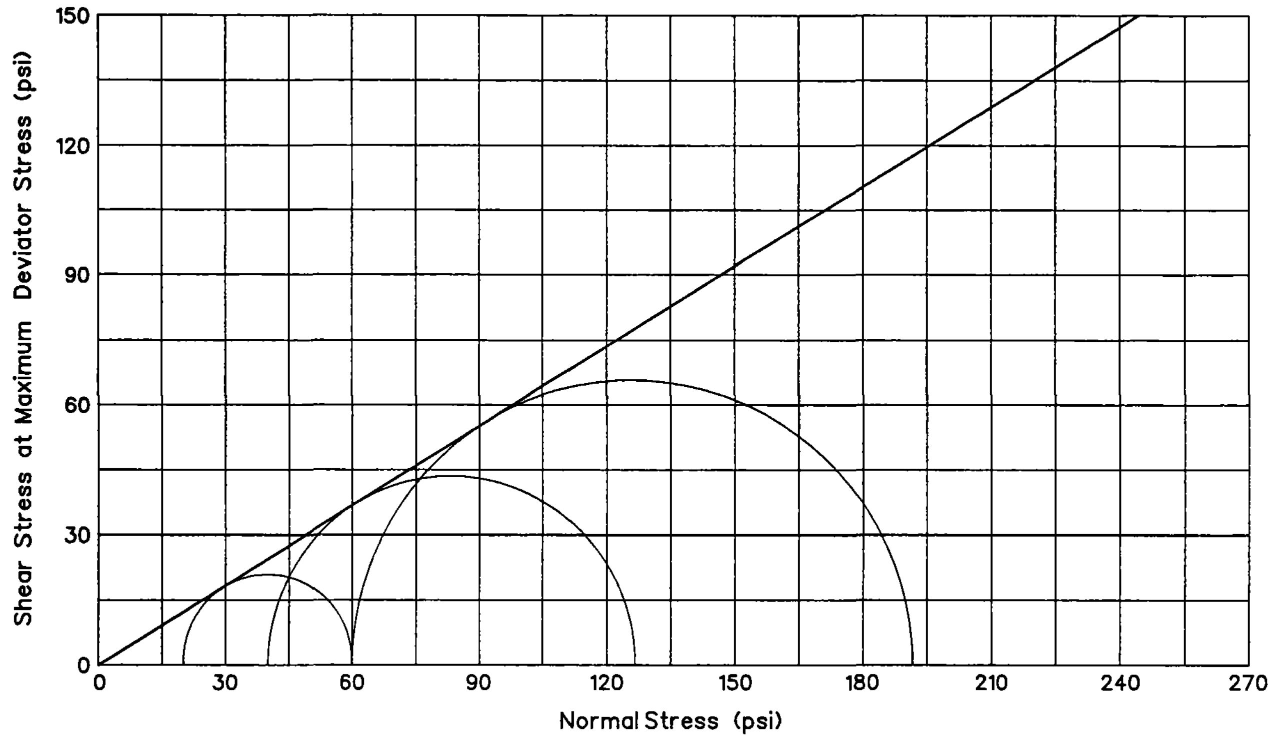
SUMMARY OF TEST DATA

PROJECT	Legacy Parkway	PROJECT NO.	200601-112
LOCATION	Structure F-718 (500 South over Legacy Parkway)	FEATURE	Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO Classification)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
RSB-12-609	10-11.5	Shelby	93.3	27.0	1482	39	19	20	0	4	96	CL / A-6(20)
	20-21.5	Shelby	72.2	45.7		43	18	25	0	17	83	CL / A-7-6(21)
	31.5-33	17		25.2				NP	0	57	43	SM / A-4(0)
	40-41.5	7		27.1				NP	0	89	11	SP-SM / A-2-4(0)
	43.5-45	Shelby	99.1	25.7		37	19	18	0	1	99	CL / A-6(19)
	53.5-55	Shelby	114.9	16.3	1859	24	18	6	0	47	53	CL-ML / A-4(1)
	63.5-64.5	Shelby	113.1	16.5		35	15	20	0	6	94	CL / A-6(18)
	73.5-75	Shelby	107.2	21.7		30	17	13	0	8	92	CL / A-6(11)
	93.5-95	Shelby	87.6	34.2		60	22	38	0	0	100	CH / A-7-6(43)
	103.5-104.3	Shelby		19.2				NP	0	96	4	SP / A-3
	104.3-105.0	Shelby	97.3	28.3	1695	50	24	26	0	5	95	CH / A-7-6(28)
	113.5-115	Shelby		22.1		35	19	16	2	21	77	CL / A-6(11)
	118.5-120	51		19.8				NP	0	87	13	SM / A-2-4(0)
	123.5-125	Shelby	102.6	23.9		29	22	7	0	6	94	CL / A-4(6)
	133.5-135	Shelby	92.0	27.2		32	20	12	0	5	95	CL / A-6(11)
	143.5-145	36		26.6				NP	1	19	80	ML / A-4(0)
RSB-12-610	5-6.5	Shelby	98.4	27.3	3169	41	19	22	0	2	98	CL / A-7-6(23)
	15-16.5	Shelby	101.1	28.6	720	36	19	17	0	3	97	CL / A-6(17)
	26-27.5	Shelby		22.1				NP	0	79	21	SM / A-2-4(0)
	32-33.5	12		36.5		42	31	12	0	14	86	ML / A-7-5(12)
	38-39.5	39		21.2				NP	0	89	11	SP-SM / A-2-4(0)
	45-46.5	Shelby	90.7	28.2	3475	29	18	11	0	2	98	CL / A-6(10)
	55-56.5	Shelby	104.8	18.2		29	16	13	0	42	58	CL / A-6(5)
	65-66.5	Shelby	107.7	21.9	2850	34	15	19	0	8	92	CL / A-6(17)
	74-75.5	Shelby	111.7	18.7	3798	33	15	18	0	15	85	CL / A-6(14)
	83.5-85	Shelby	105.2	22.0		36	17	19	0	7	93	CL / A-6(18)
	98.5-100	36		19.3				NP	0	86	14	SM / A-2-4(0)
	103.5-105	Shelby	89.2	30.1	4109	44	20	24	0	5	95	CL / A-7-6(24)
	108.5-110	36		22.8		25	21	4	0	6	94	ML / A-4(3)
	120-121.5	22		26.2				NP	0	88	12	SM / A-2-4(0)
	133.5-135	Shelby	103.2	22.7	2910	31	25	6	5	3	92	ML / A-4(6)
	143.5-145	44		24.7				NP	0	48	52	ML / a-4(0)
	153.5-155	38		23.3		52	18	34	0	6	94	CH / A-7-6(34)

NP=Nonplastic





MULTI-STAGE CONSOLIDATED UNDRAINED W/PORE PRESSURE MEASUREMENTS:

TOTAL STRESS FAILURE ENVELOPE

Test No. or Symbol	Sample Data		Degree of Saturation (%)	Confining Pressure (psi)	Maximum Deviator Stress (psi)	Strength Values at Failure		Sample Size, L/D (inches)	Strain Rate (inches/minute)
	Dry Density (pcf)	Moisture Content (%)				Friction Angle ϕ (degrees)	Cohesion (c/psi)		
●	94.7	21.7	~100	20	59.9	31.5	0	2.88/1.38	0.001
■	94.7	21.7	~100	40	126.6				
▲	94.7	21.7	~100	60	191.5				

RB&G ENGINEERING INC.
Provo, Utah

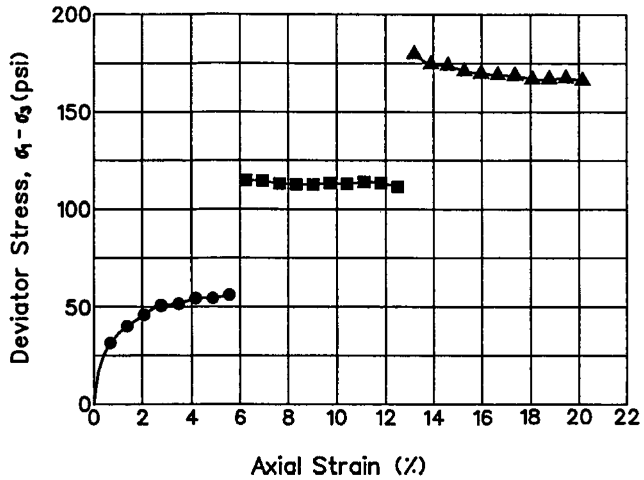
TRIAXIAL SHEAR TEST

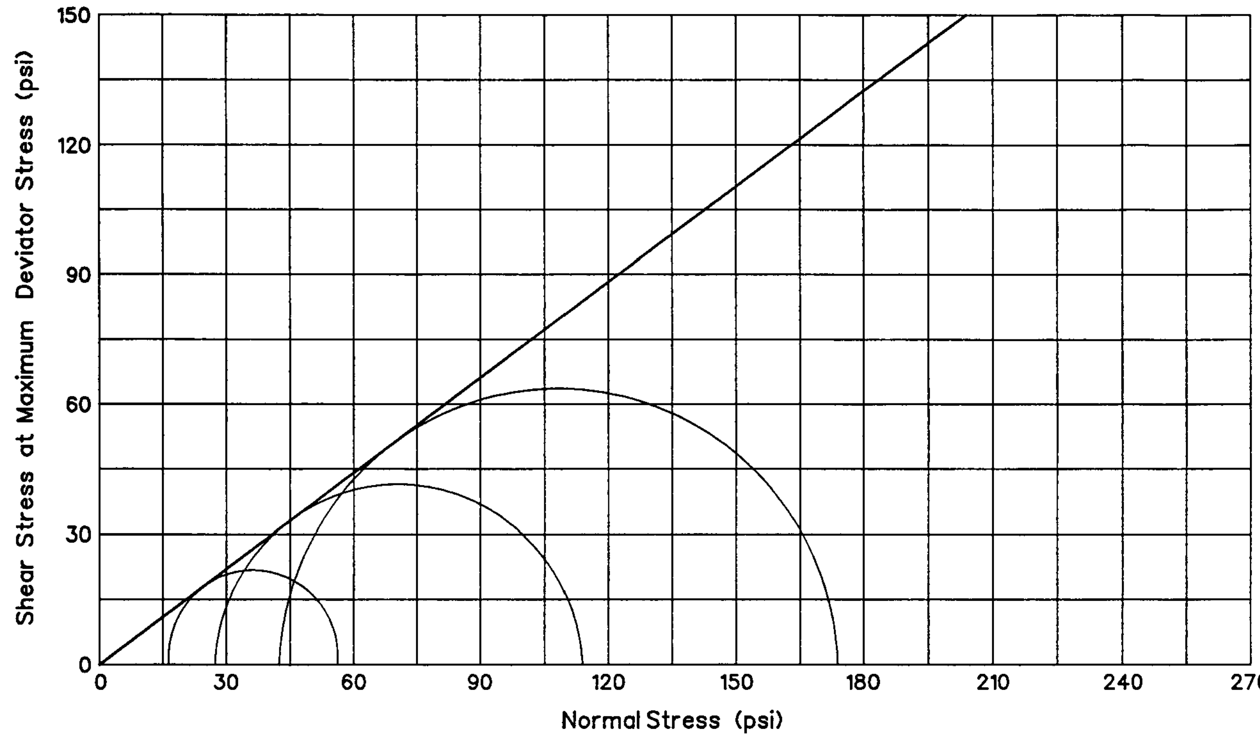
Project: *Legacy Parkway - Structure F-718*
(500 South Over Legacy Parkway)
Davis County, Utah

HOLE NO.: RSB-12-609

DEPTH: 73.5'-75'

Figure





MULTI-STAGE CONSOLIDATED UNDRAINED W/PORE PRESSURE MEASUREMENTS:

EFFECTIVE STRESS FAILURE ENVELOPE

Test No. or Symbol	Sample Data		Degree of Saturation (%)	Confining Pressure (psi)	Maximum Deviator Stress (psi)	Strength Values at Failure		Sample Size, L/D (inches)	Strain Rate (inches/minute)
	Dry Density (pcf)	Moisture Content (%)				Friction Angle ϕ (degrees)	Cohesion (c/psi)		
●	94.7	21.7	~100	16.3	56.2	36.4	0	2.88/1.38	0.001
■	94.7	21.7	~100	27.2	113.8				
▲	94.7	21.7	~100	42.4	173.9				

RB&G ENGINEERING INC.
Provo, Utah

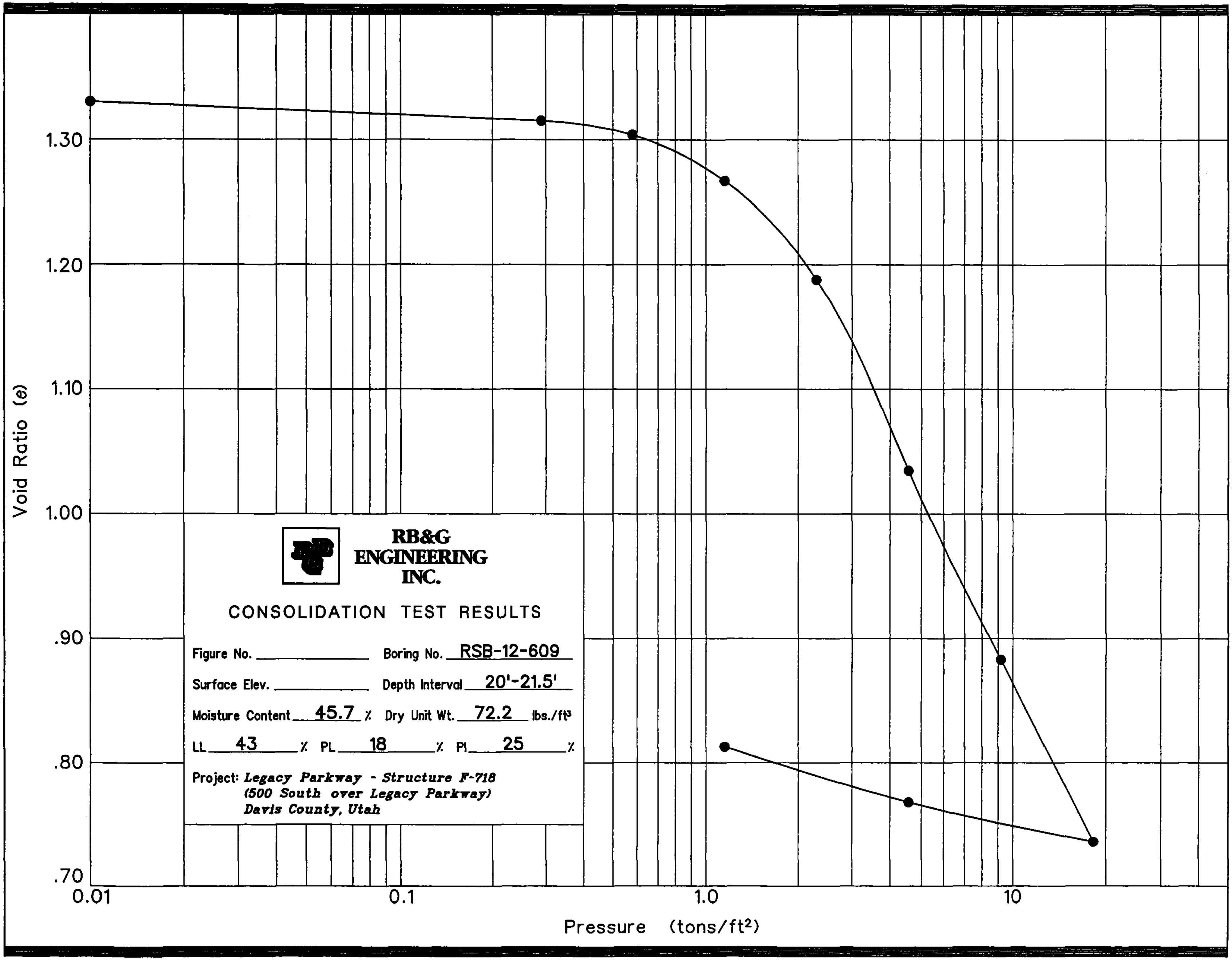
TRIAXIAL SHEAR TEST

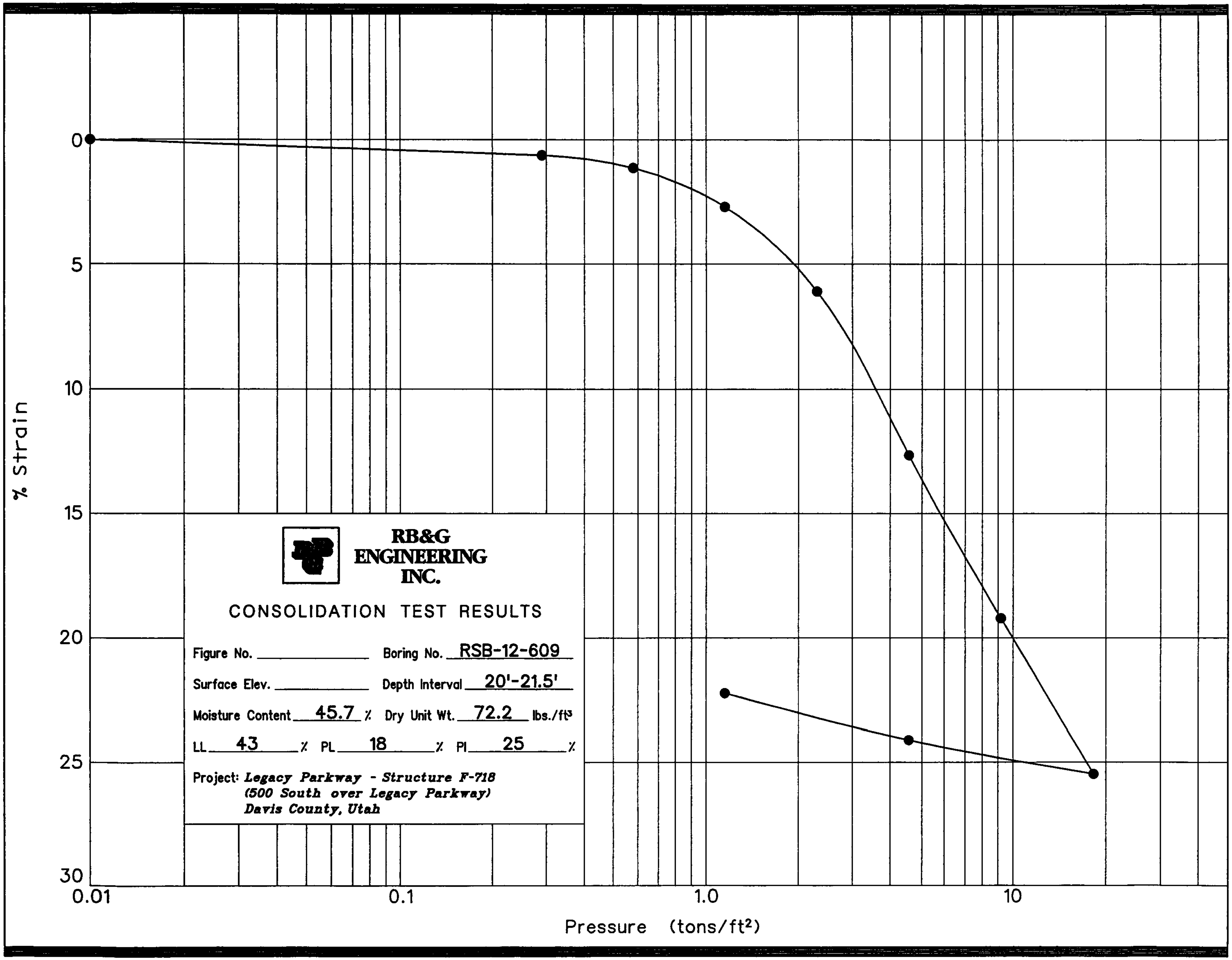
Project: *Legacy Parkway - Structure F-718*
(500 South Over Legacy Parkway)
Davis County, Utah

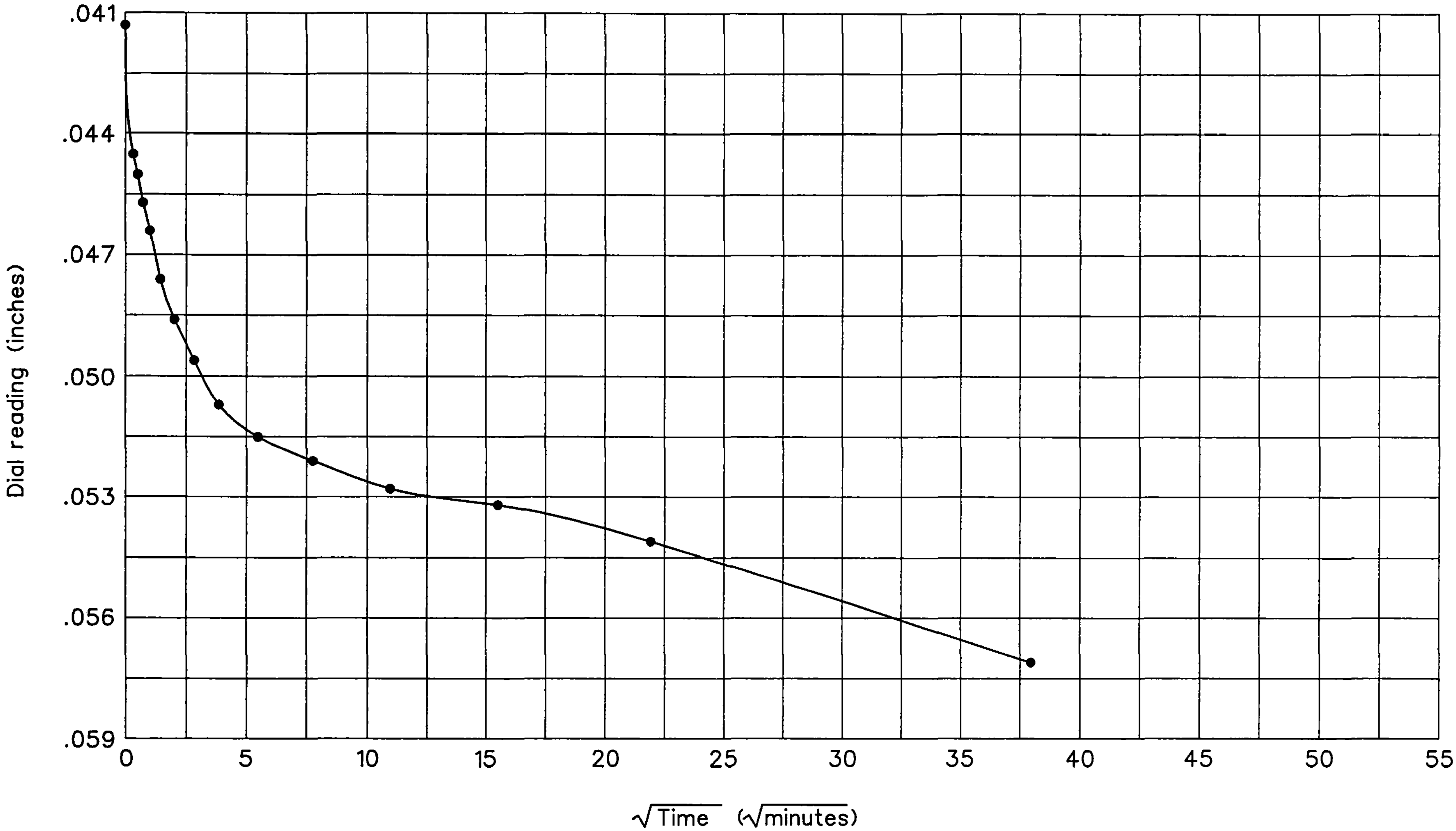
HOLE NO.: RSB-12-609

DEPTH: 73.5'-75'

Figure


1.30
1.20
1.10
1.00
.90
.80
.70
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No. ______ Boring No. RSB-12-609
Surface Elev. ______ Depth Interval 20'-21.5'
Moisture Content 45.7 % Dry Unit Wt. 72.2 lbs./ft³
LL 43 % PL 18 % PI 25 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 20'-21.5'
Moisture Content 45.7 %
Dry Unit Wt. 72.2 lbs./ft³
LL 43 %
PL 18 %
PI 25 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
% Strain
0
5
10
15
20
25
30
0.01
0.1
1.0
10
Pressure (tons/ft²)



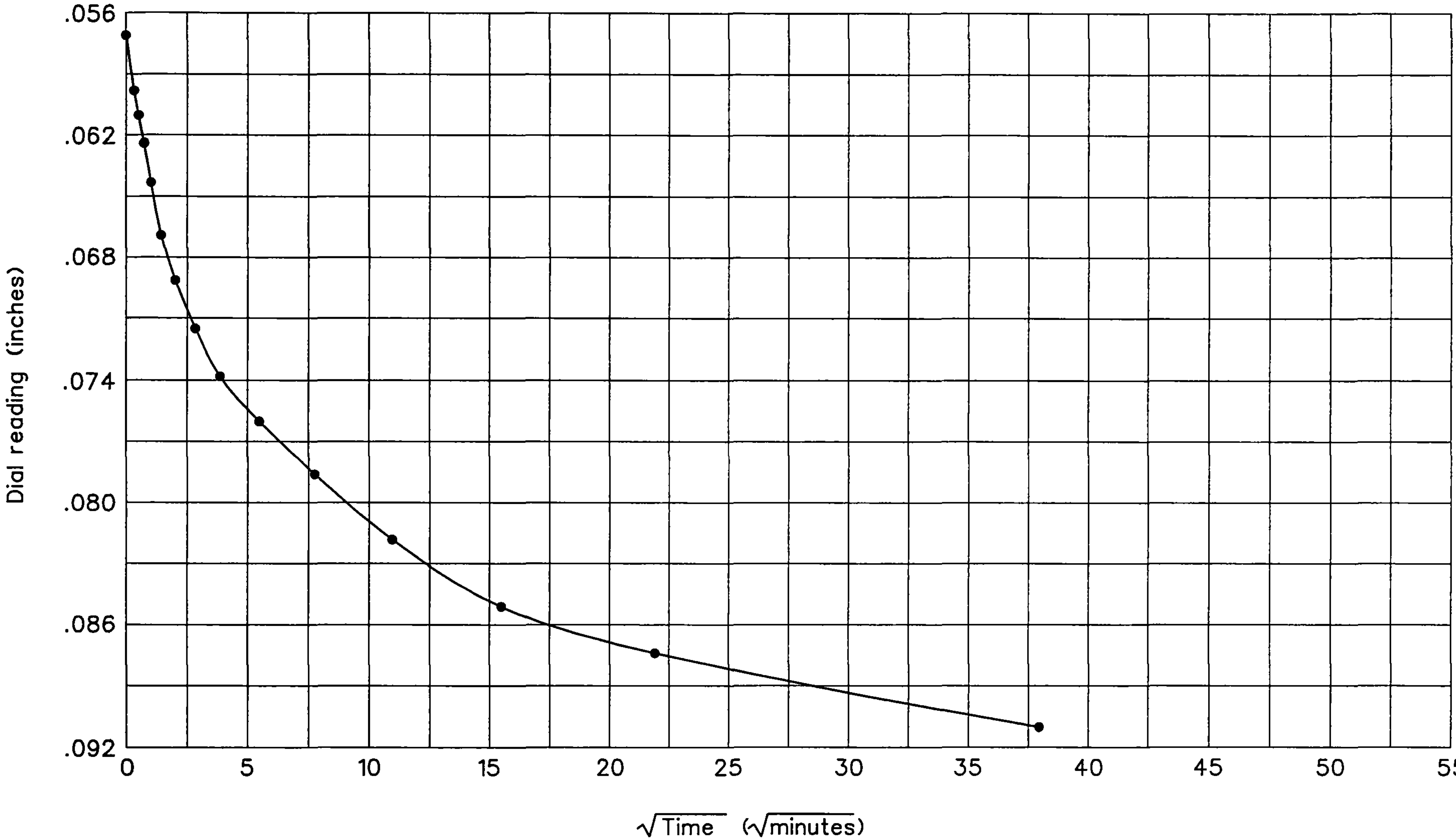
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 20'-21.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



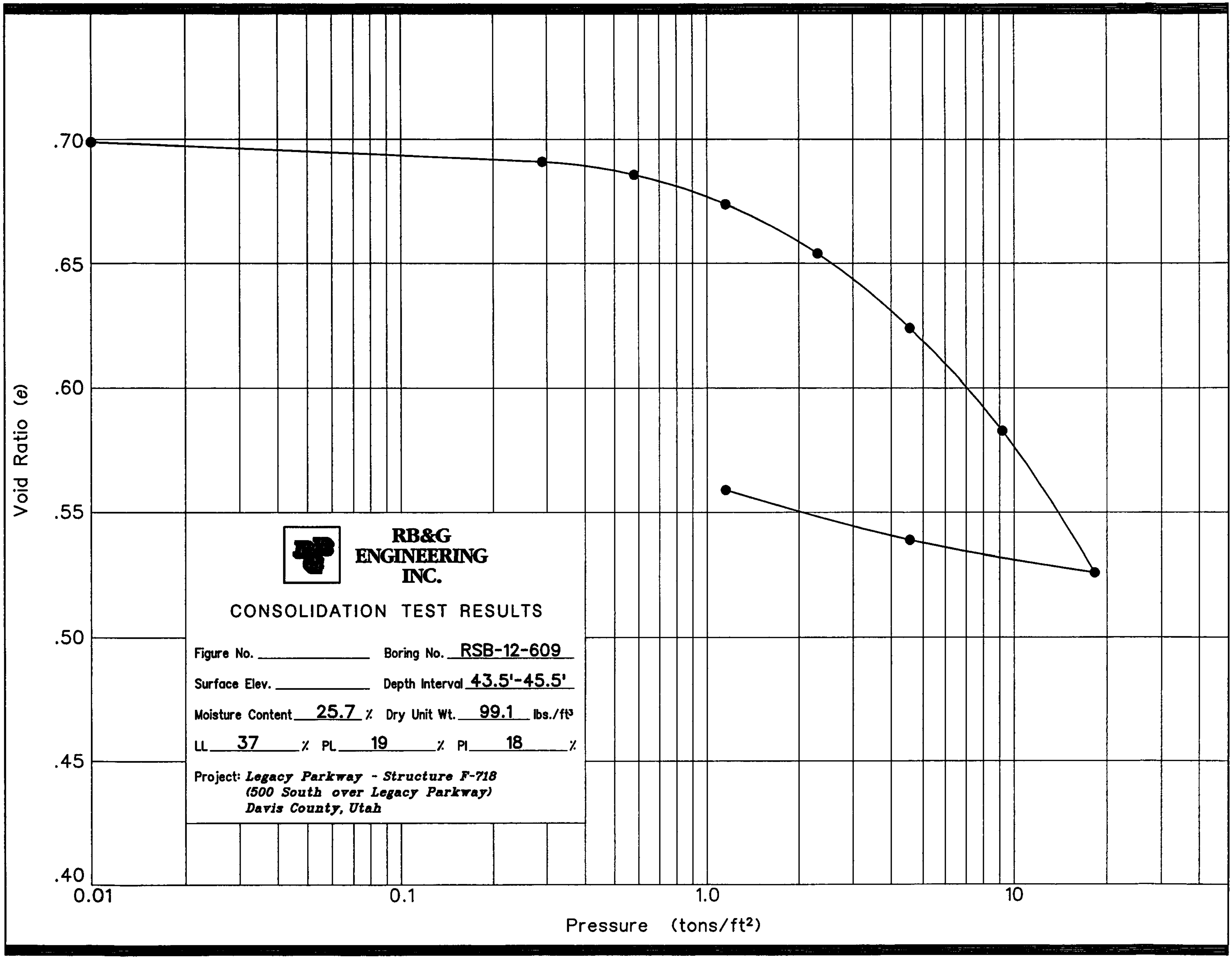
RB&G ENGINEERING INC.
Provo, Utah

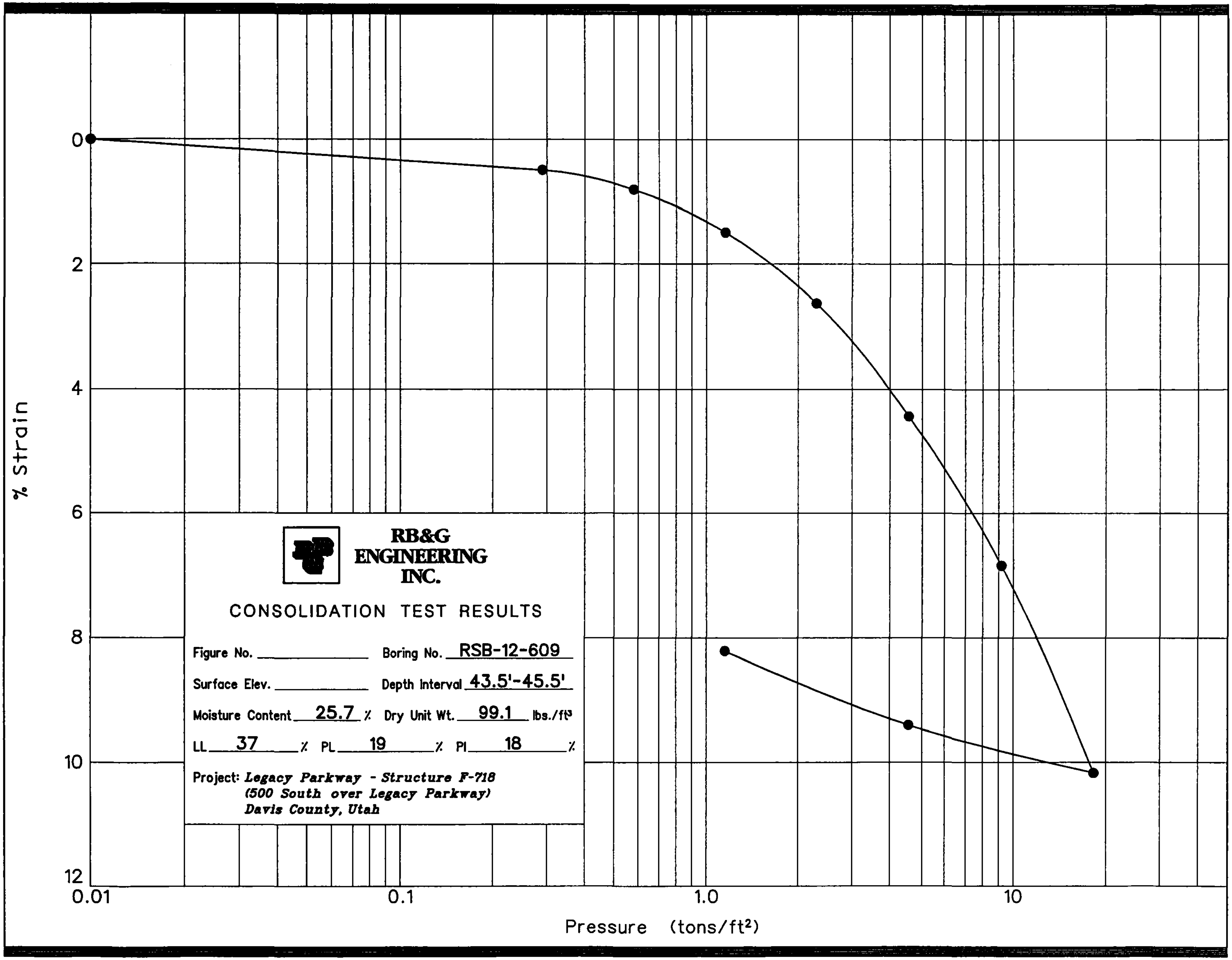
Hole no.: RSB-12-609
Depth: 20'-21.5'
Load: 2.30 to 4.60 tons

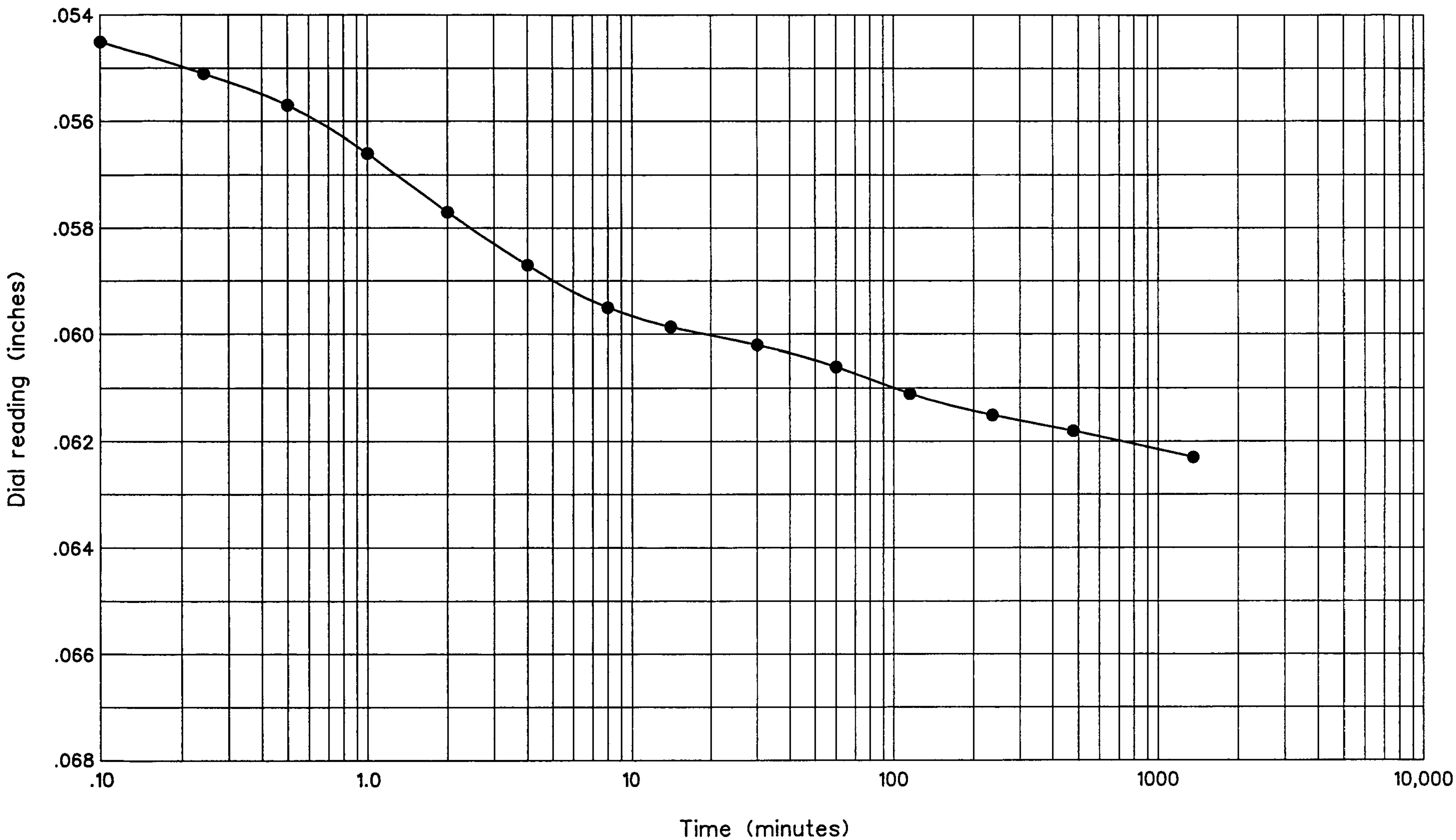
TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No. ______ Boring No. RSB-12-609
Surface Elev. ______ Depth Interval 43.5'-45.5'
Moisture Content 25.7 % Dry Unit Wt. 99.1 lbs./ft³
LL 37 % PL 19 % PI 18 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
Void Ratio (e)
.70
.65
.60
.55
.50
.45
.40
0.01
0.1
1.0
10
Pressure (tons/ft²)


% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 43.5'-45.5'
Moisture Content 25.7 %
Dry Unit Wt. 99.1 lbs./ft³
LL 37 %
PL 19 %
PI 18 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



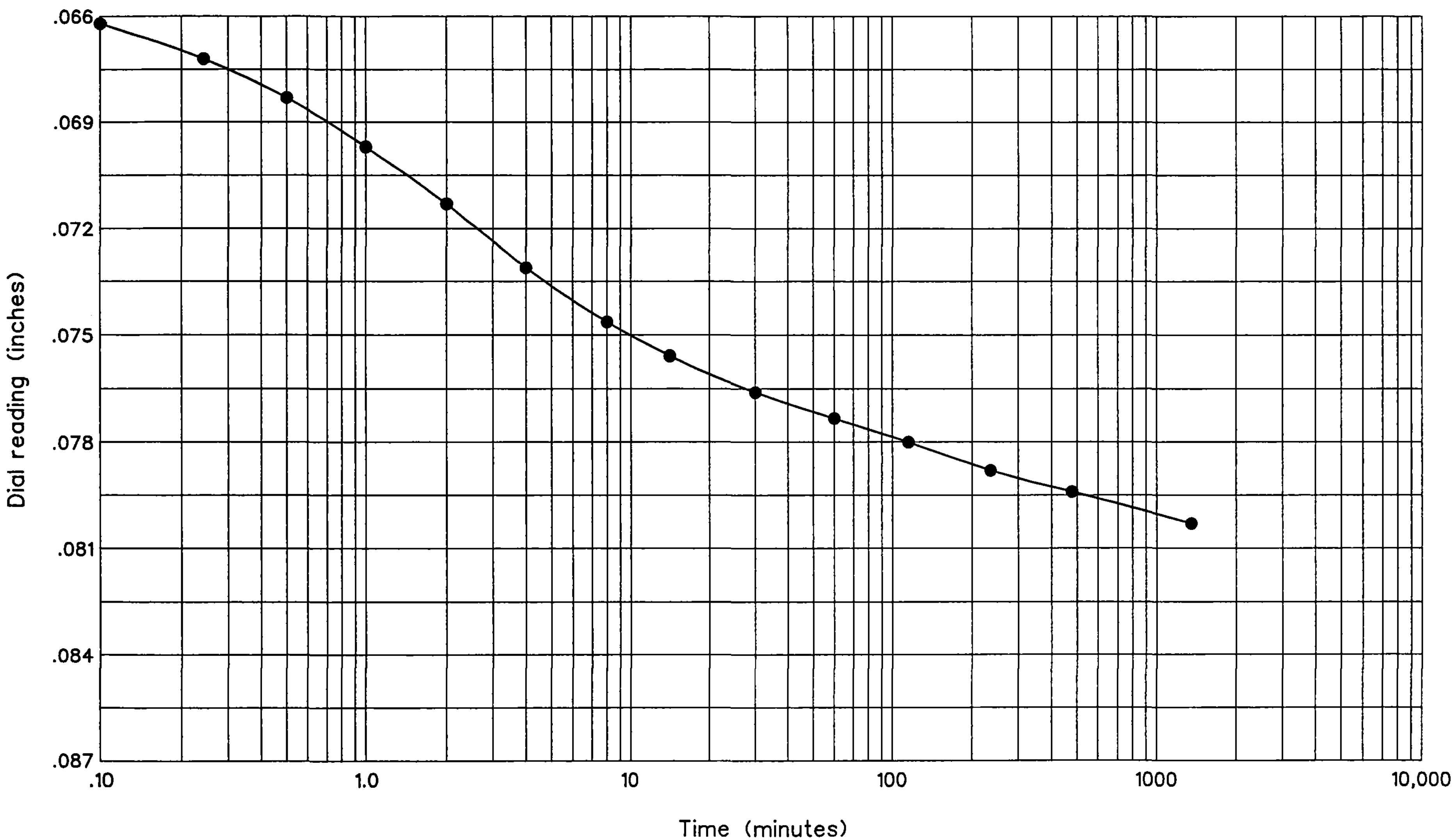
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 43.5'-45.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



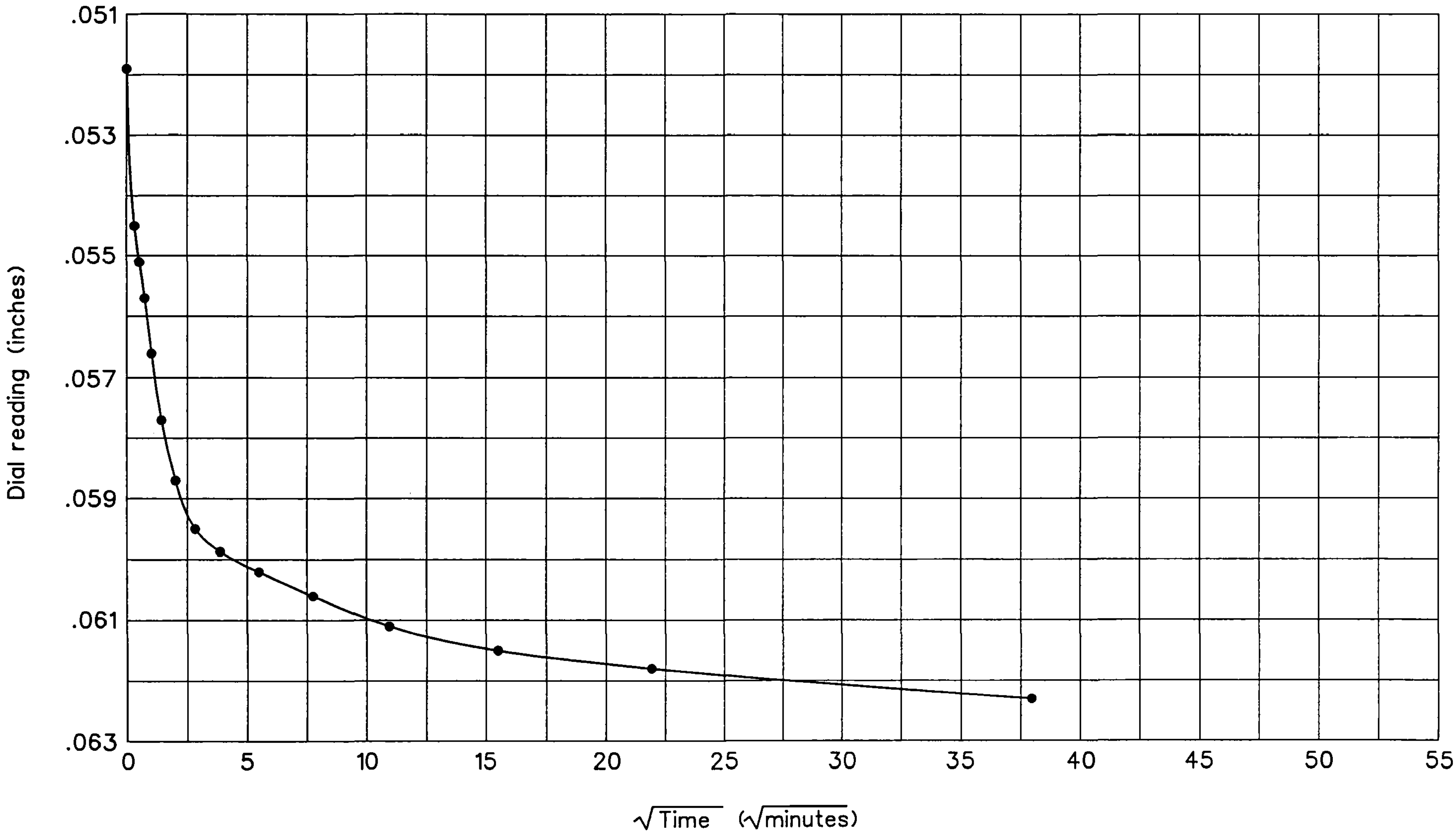
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 43.5'-45.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



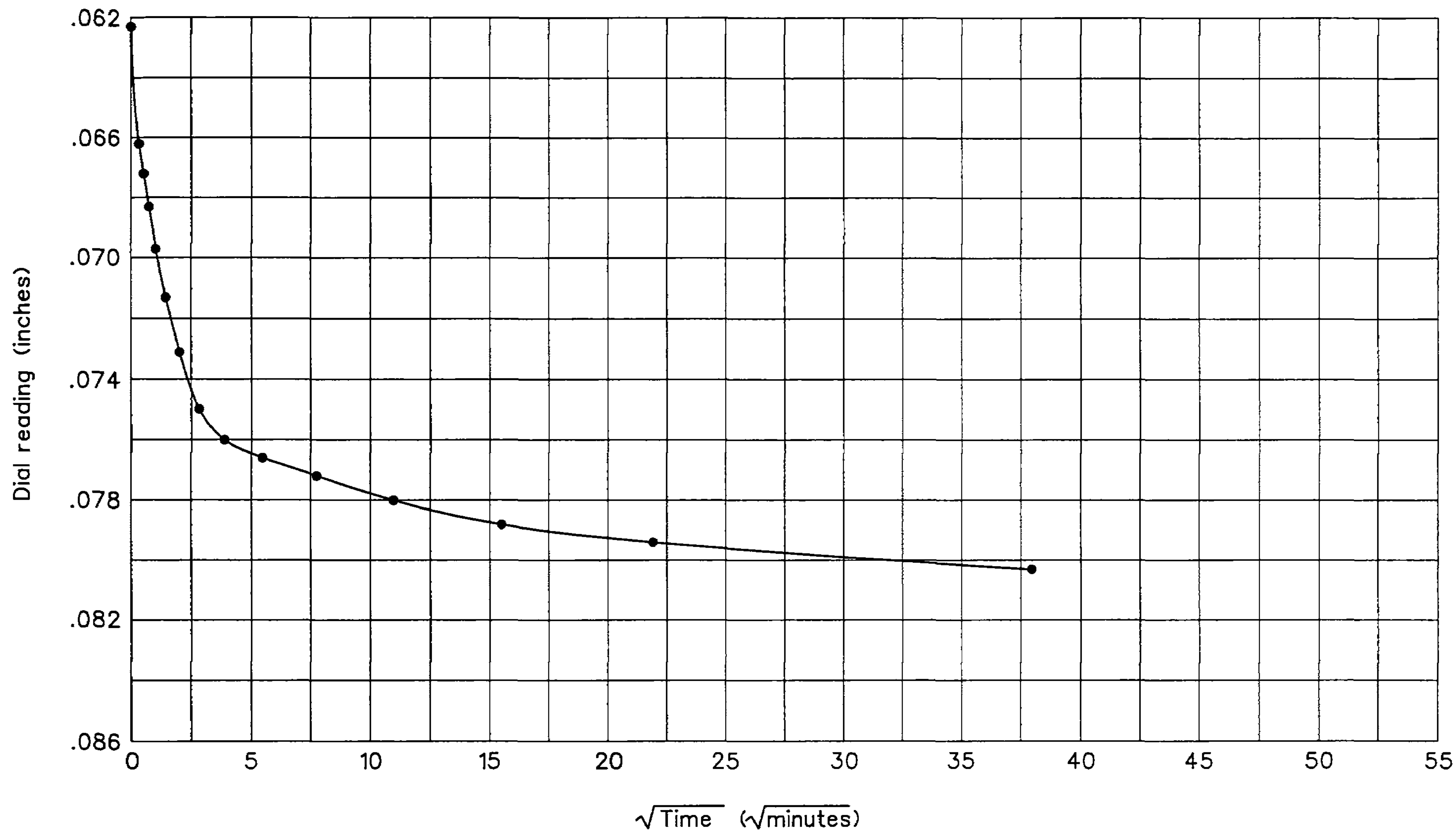
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 43.5-45.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



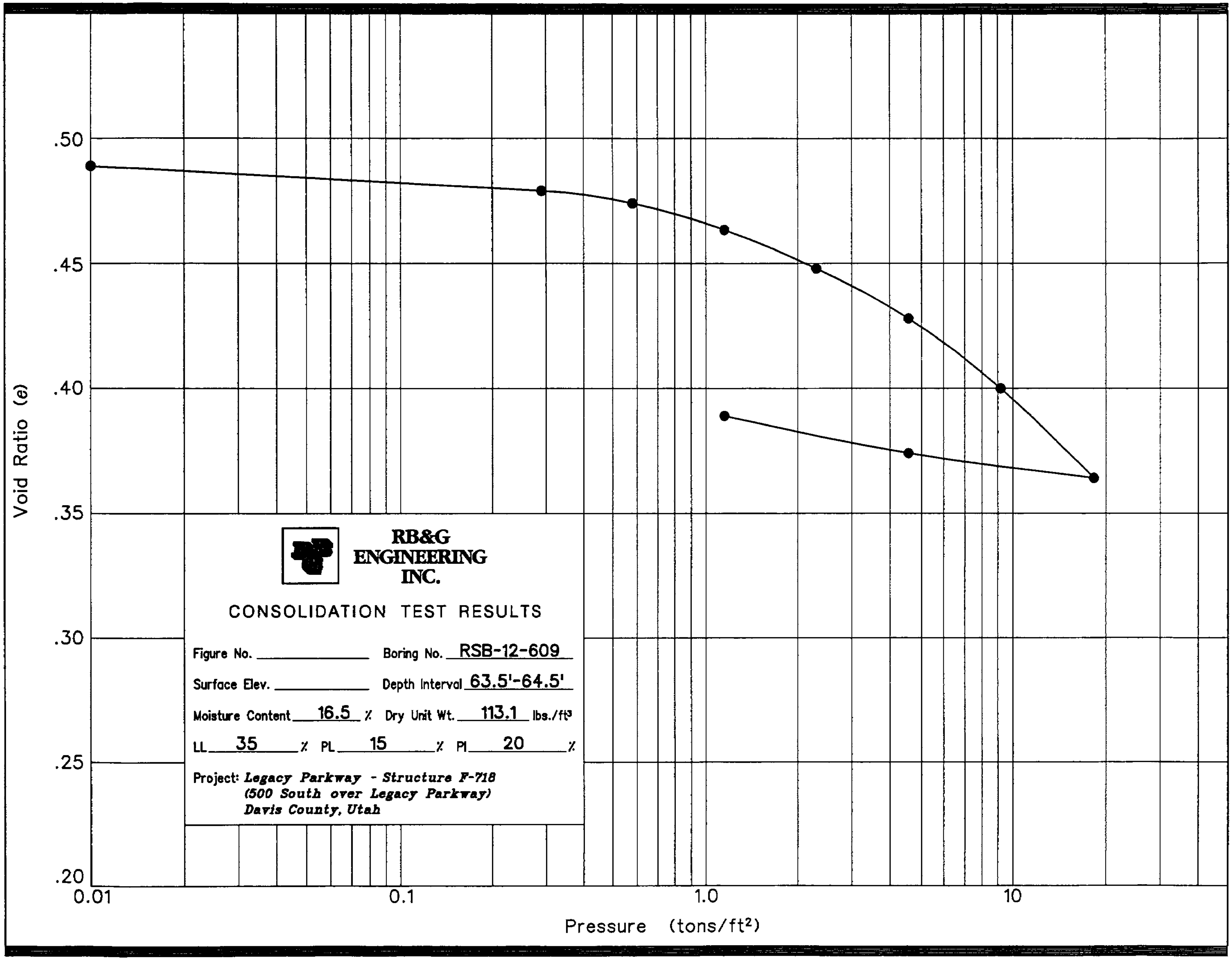
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 43.5-45.5'
Load: 4.60 to 9.20 tons

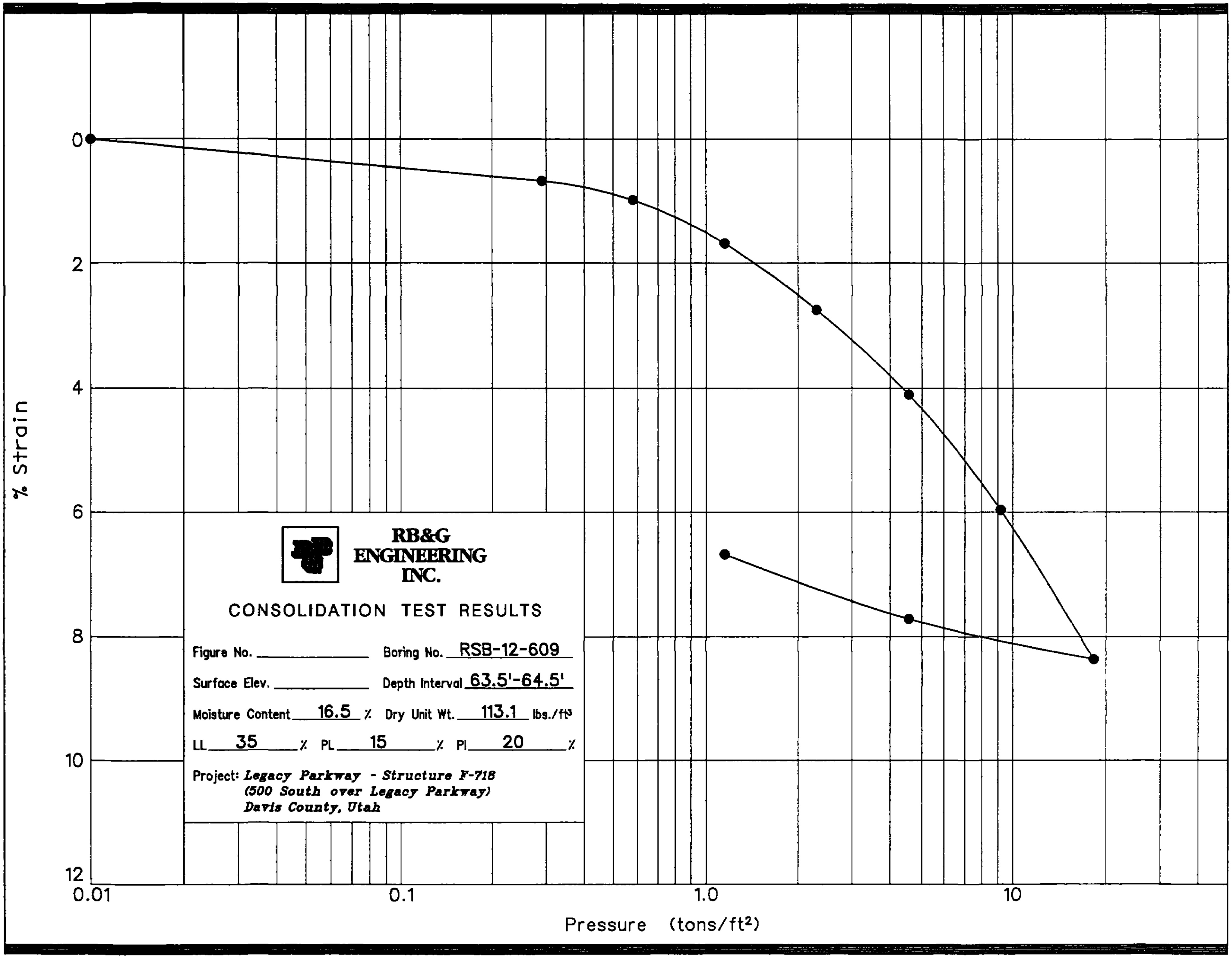
TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

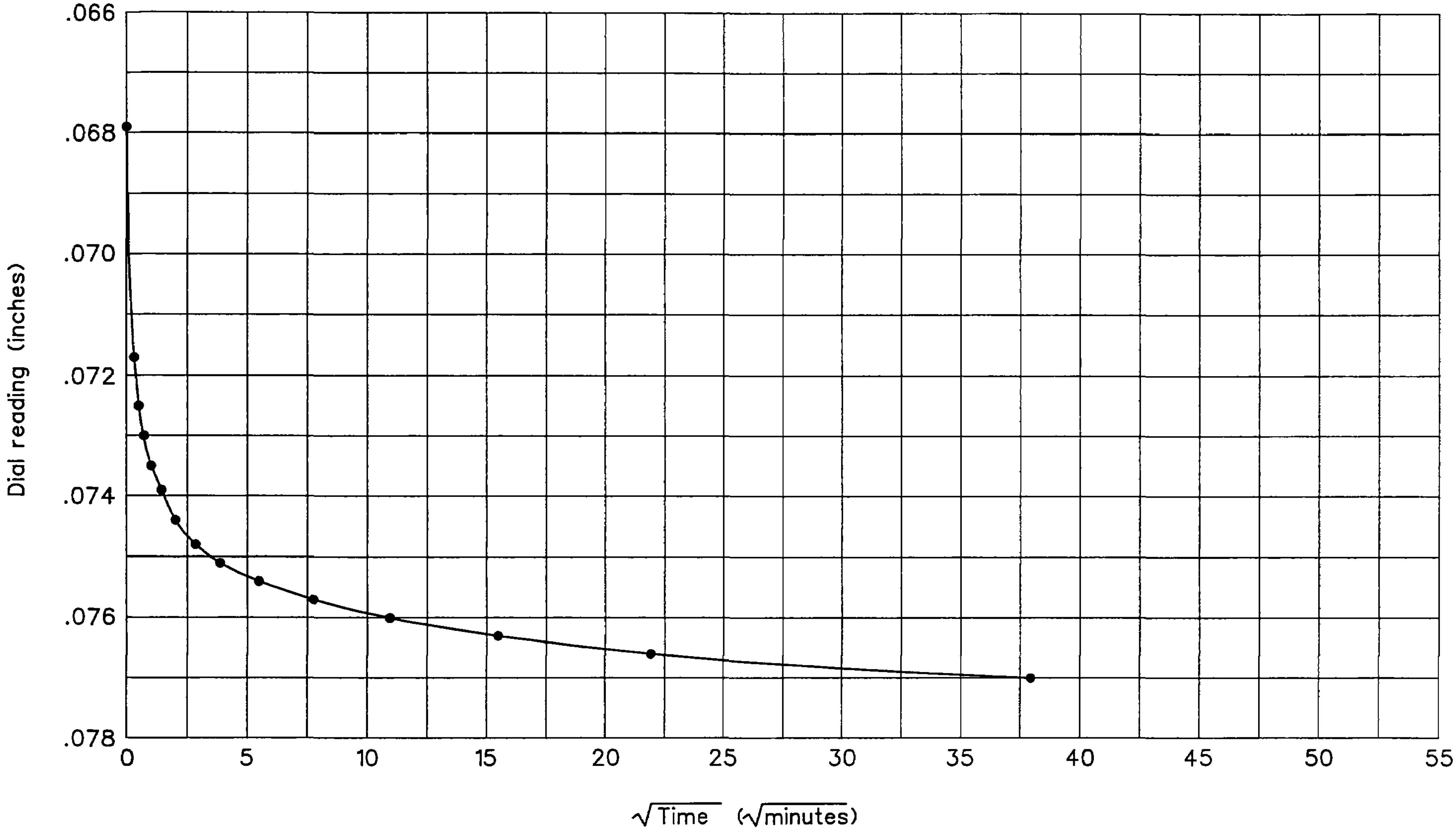
Figure



.50
.45
.40
.35
.30
.25
.20
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 63.5'-64.5'
Moisture Content 16.5 % Dry Unit Wt. 113.1 lbs./ft³
LL 35 % PL 15 % PI 20 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No. ______ Boring No. RSB-12-609
Surface Elev. ______ Depth Interval 63.5'-64.5'
Moisture Content 16.5 % Dry Unit Wt. 113.1 lbs./ft³
LL 35 % PL 15 % PI 20 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)



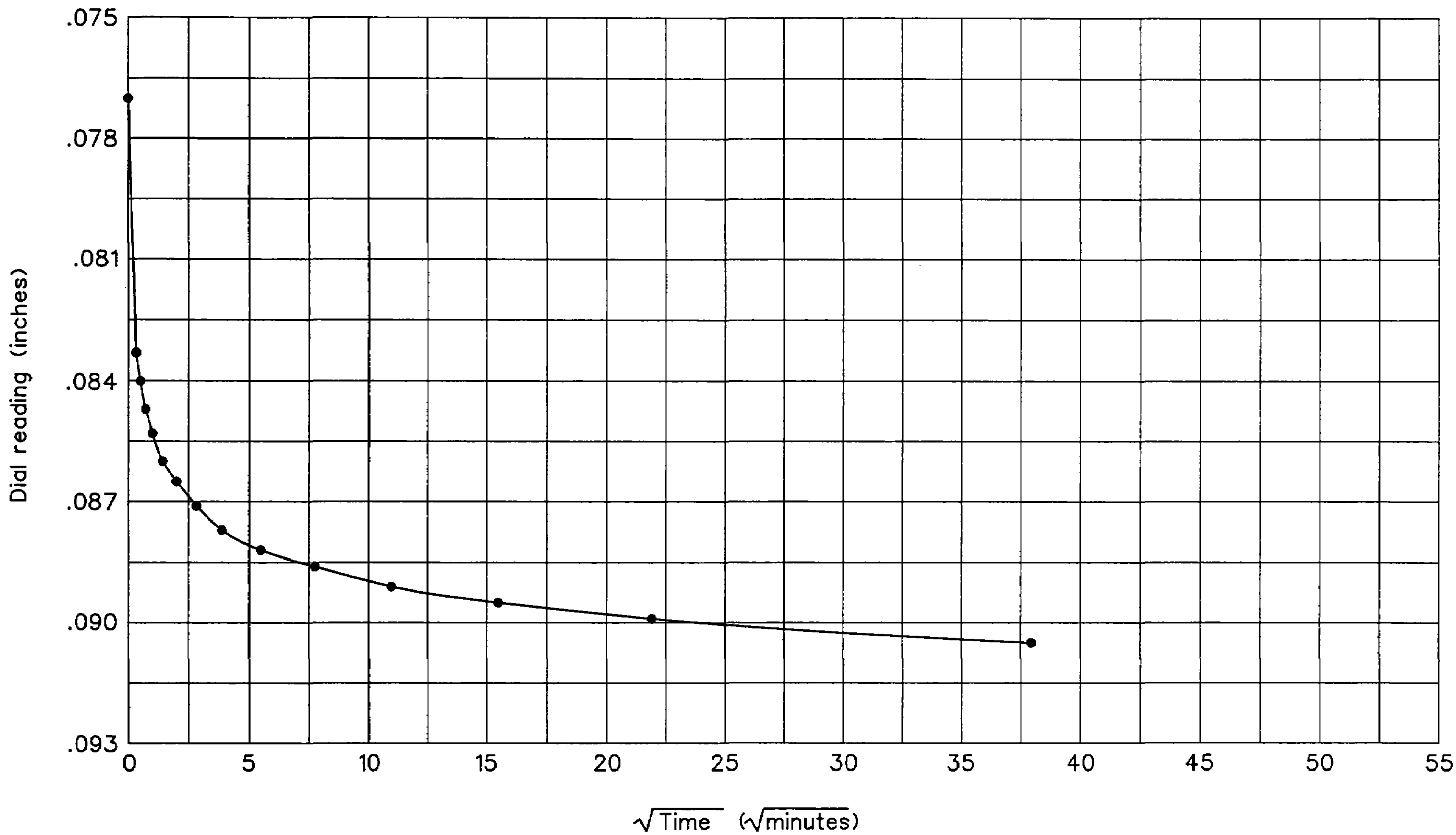
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 63.5'-64.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



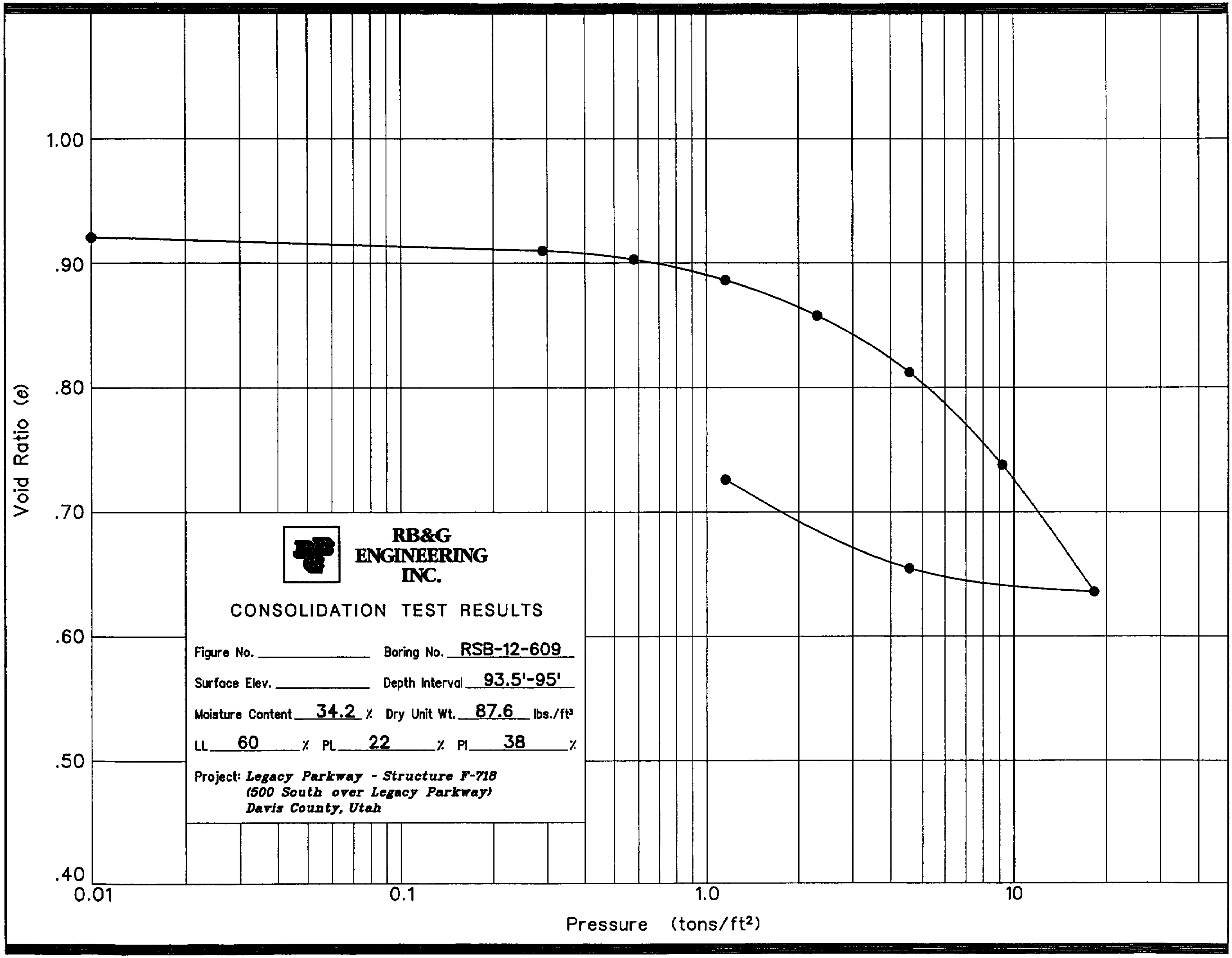
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 63.5'-64.5'
Load: 4.60 to 9.20 tons

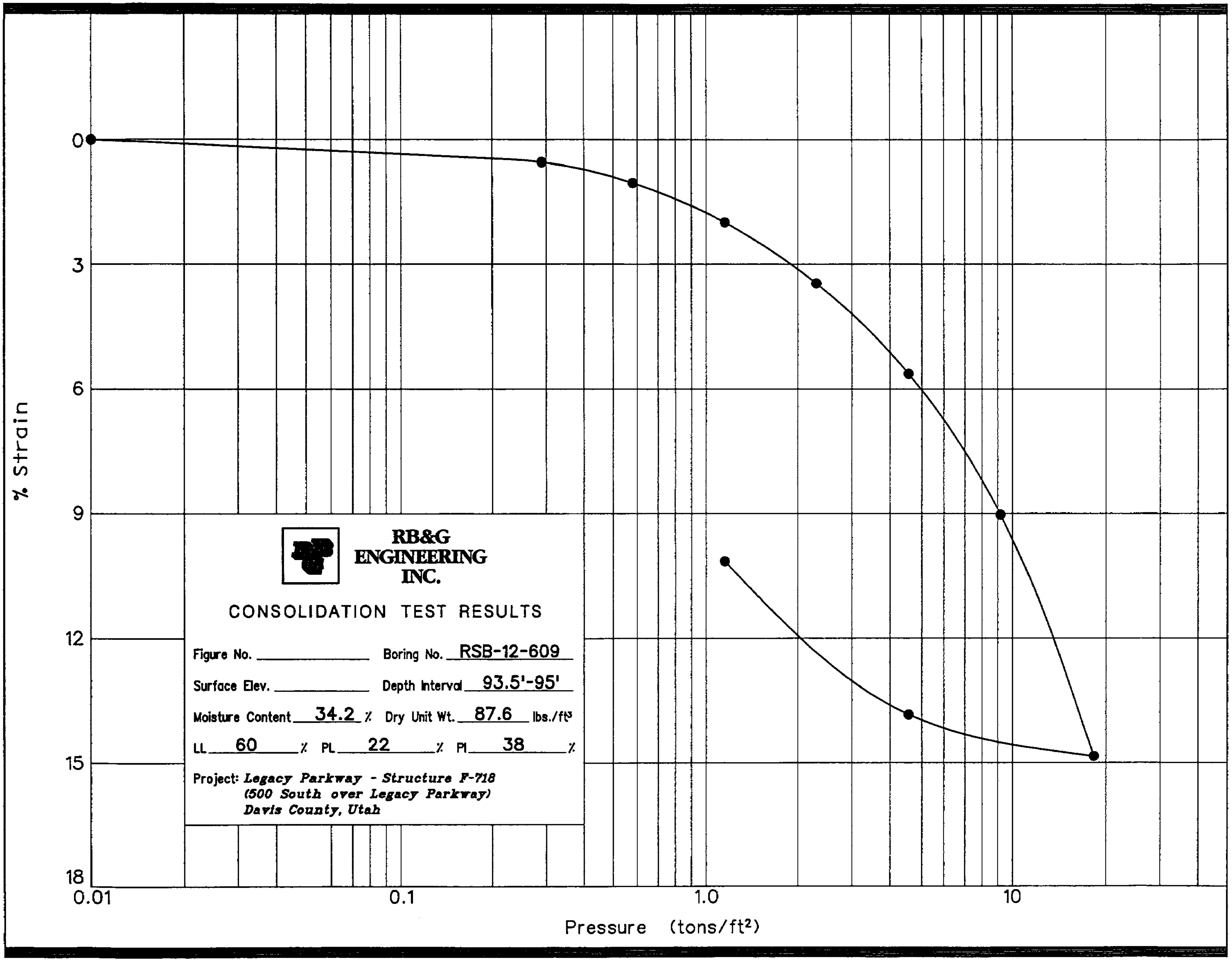
TIME CONSOLIDATION

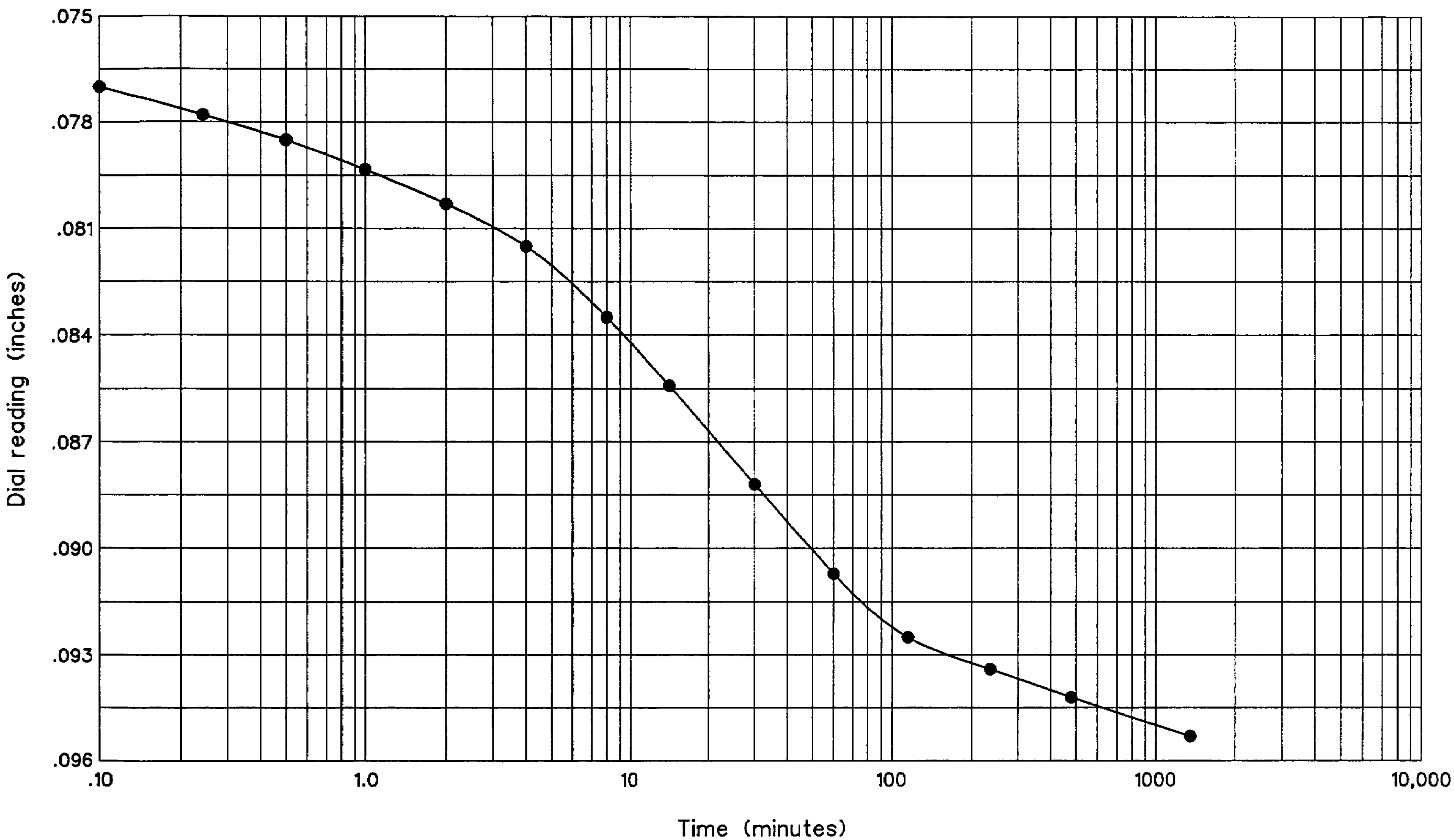
Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



Void Ratio (e)
1.00
.90
.80
.70
.60
.50
.40
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 93.5'-95'
Moisture Content 34.2 % Dry Unit Wt. 87.6 lbs./ft³
LL 60 % PL 22 % PI 38 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No. ____ Boring No. RSB-12-609
Surface Elev. ____ Depth Interval 93.5'-95'
Moisture Content 34.2 % Dry Unit Wt. 87.6 lbs./ft³
LL 60 % PL 22 % PI 38 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
% Strain
0
3
6
9
12
15
18
0.01
0.1
1.0
10
Pressure (tons/ft²)



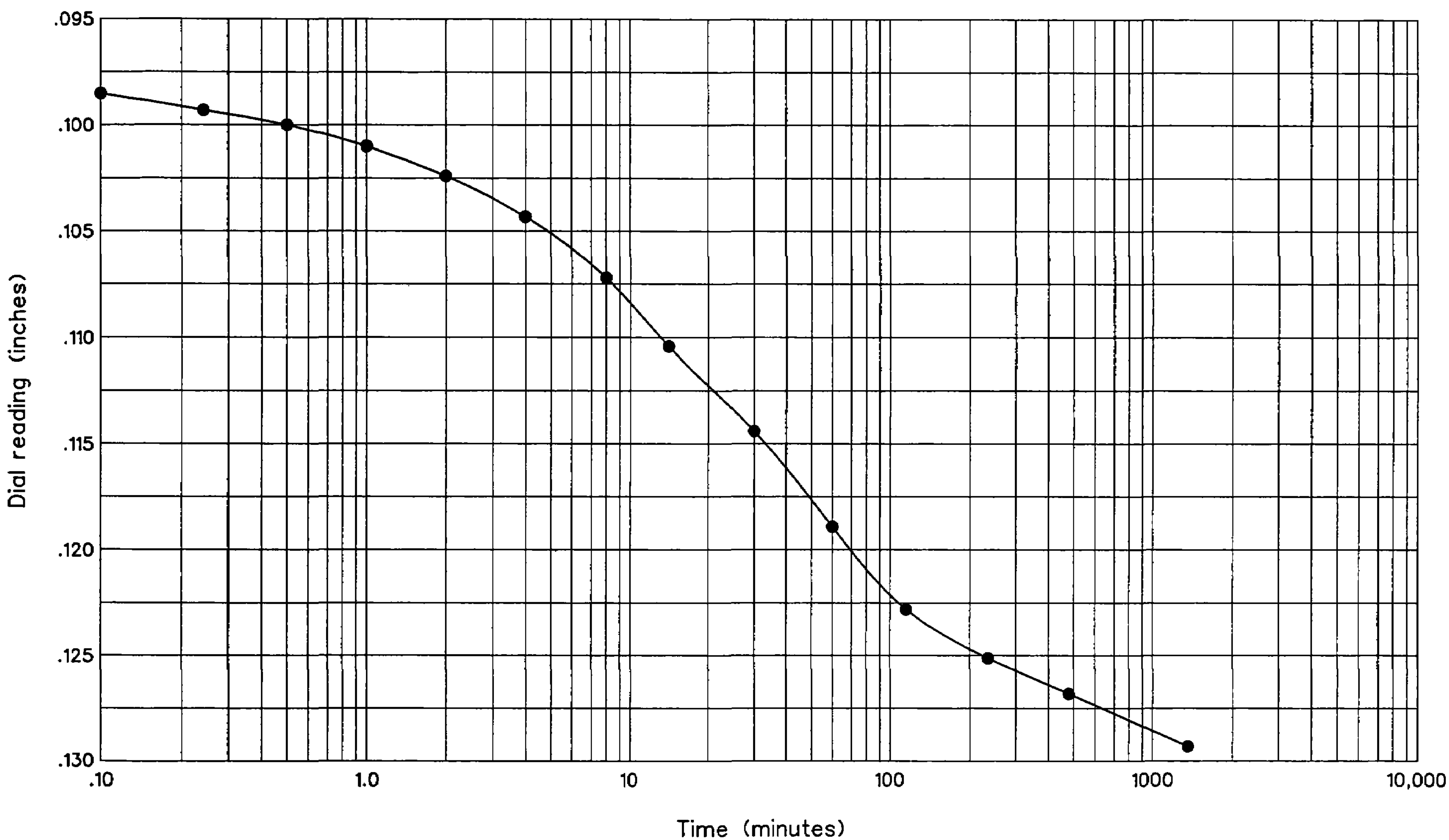
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 93.5'-95'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



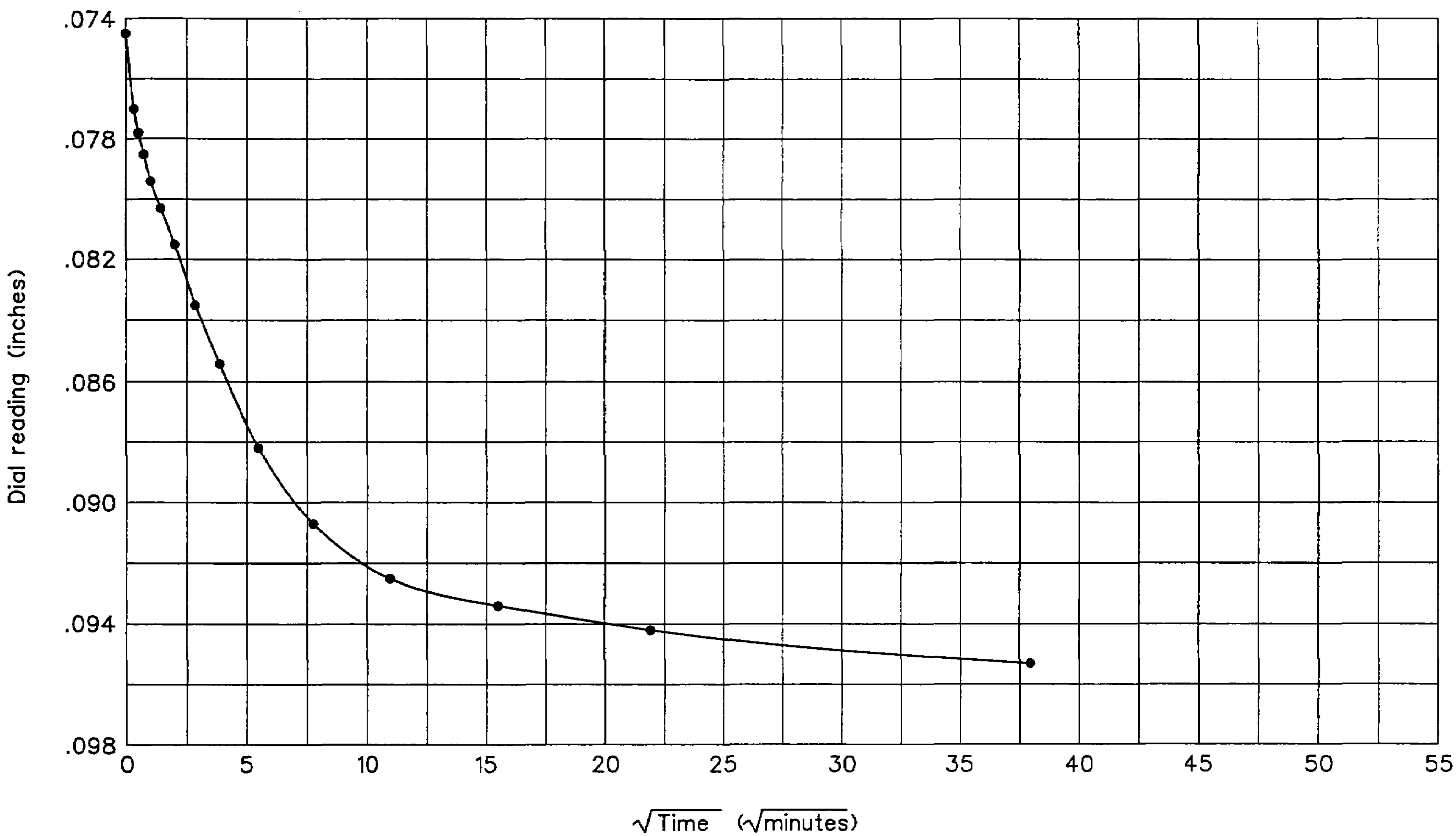
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 93.5'-95'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



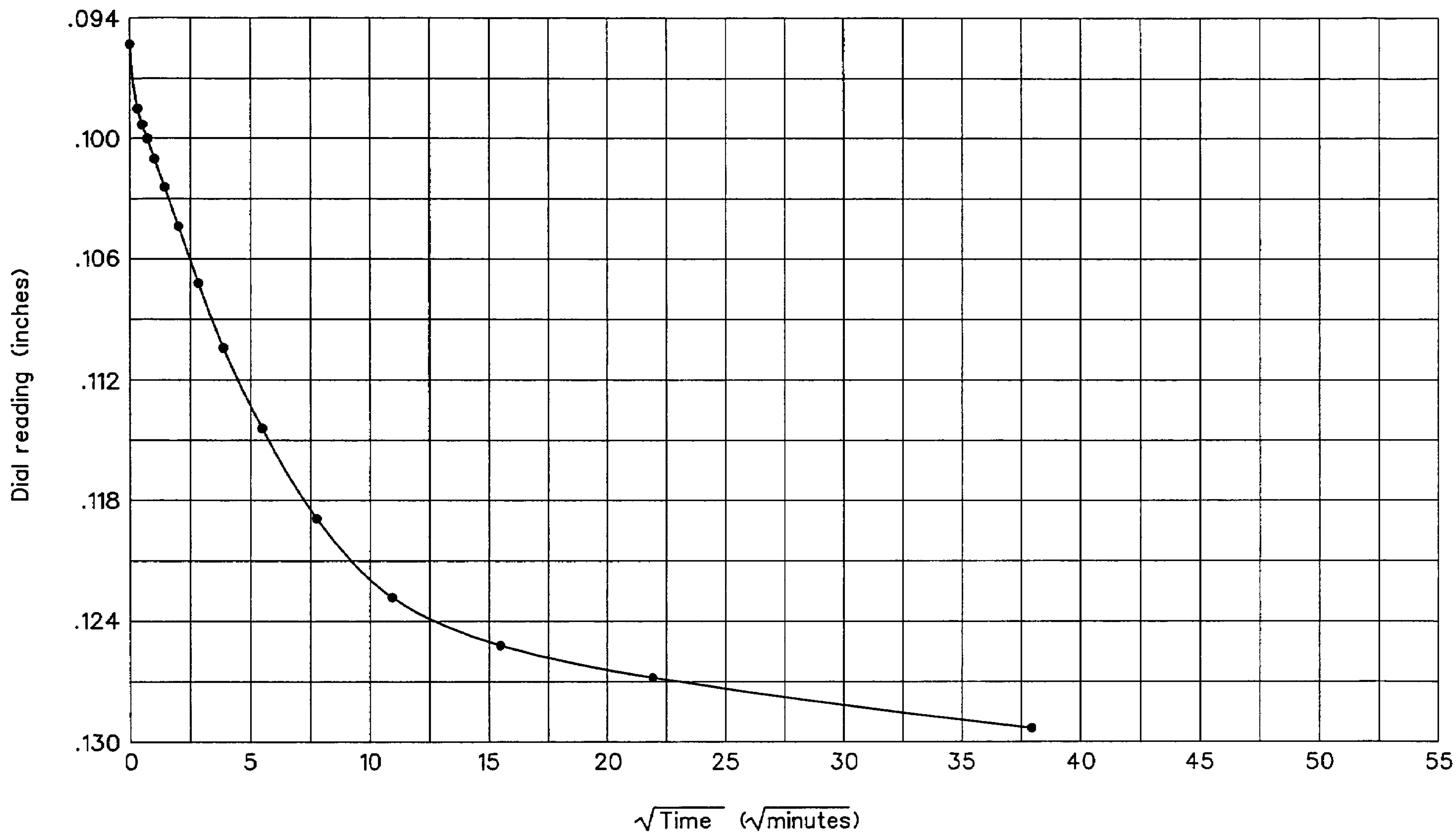
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 93.5'-95'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



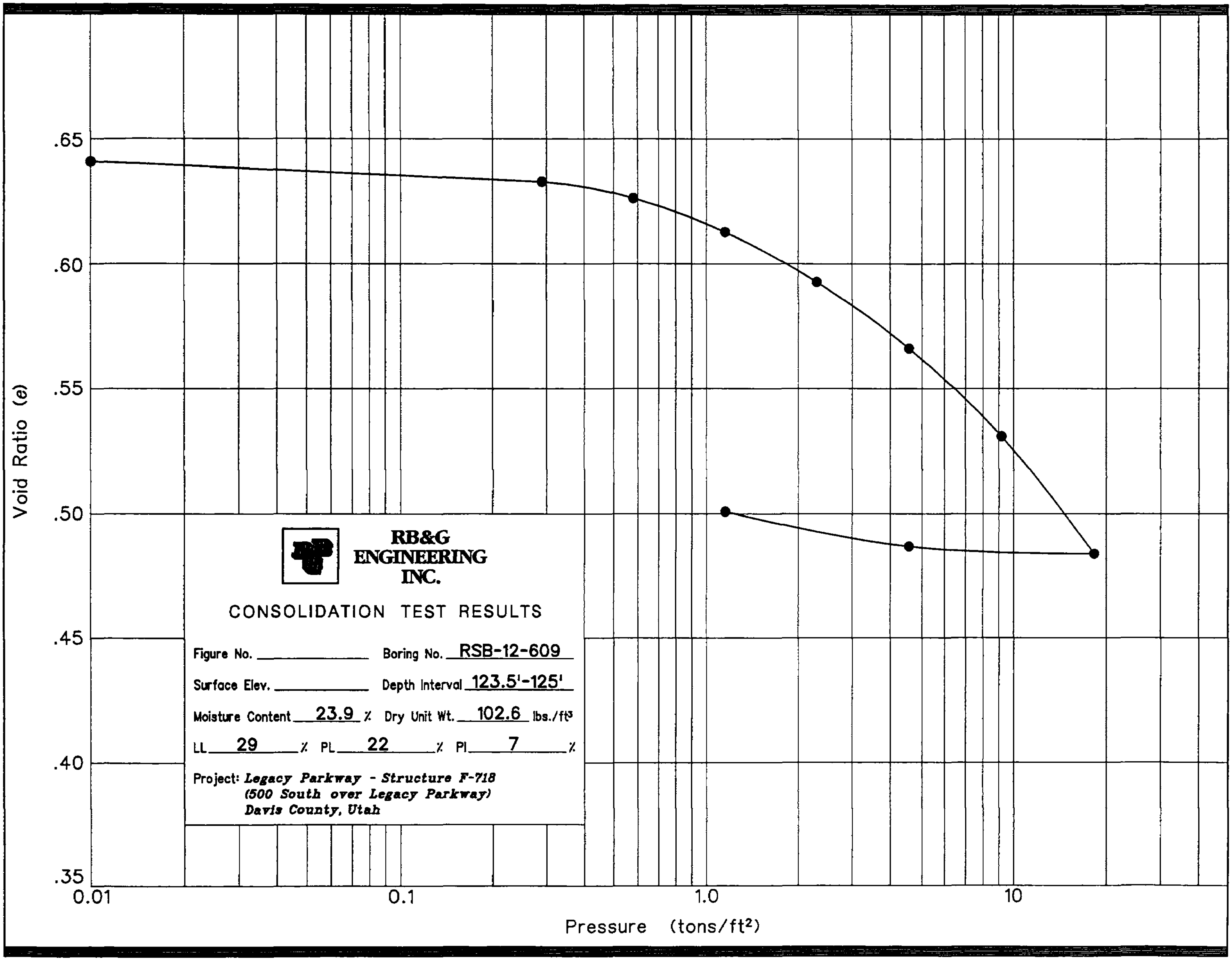
RB&G ENGINEERING INC.
Provo, Utah

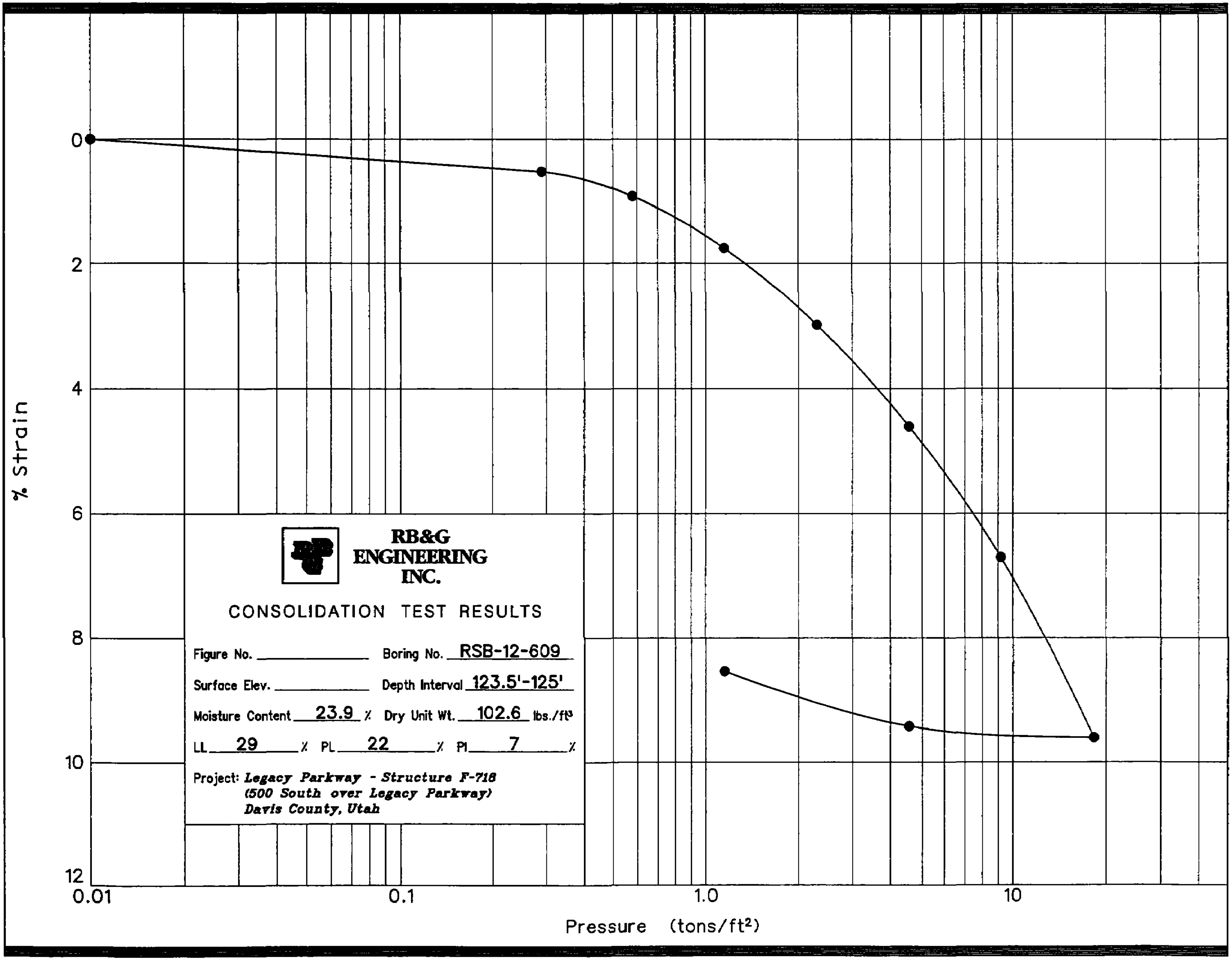
Hole no.: RSB-12-609
Depth: 93.5'-95'
Load: 9.20 to 18.40 tons

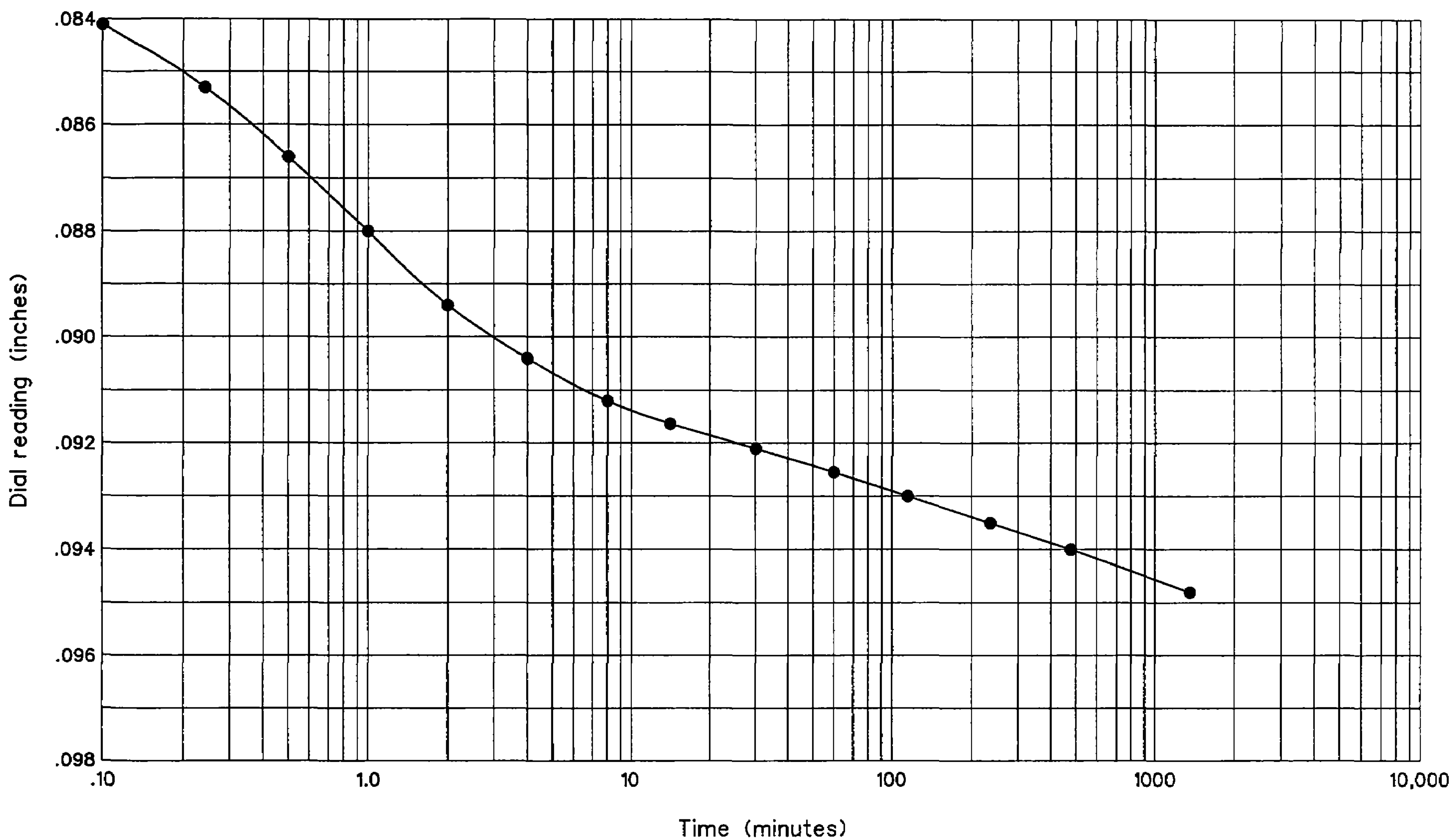
TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure


.65
.60
.55
.50
.45
.40
.35
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 123.5'-125'
Moisture Content 23.9 %
Dry Unit Wt. 102.6 lbs./ft³
LL 29 %
PL 22 %
PI 7 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah


0
2
4
6
8
10
12
% Strain
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 123.5'-125'
Moisture Content 23.9 %
Dry Unit Wt. 102.6 lbs./ft³
LL 29 %
PL 22 %
PI 7 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



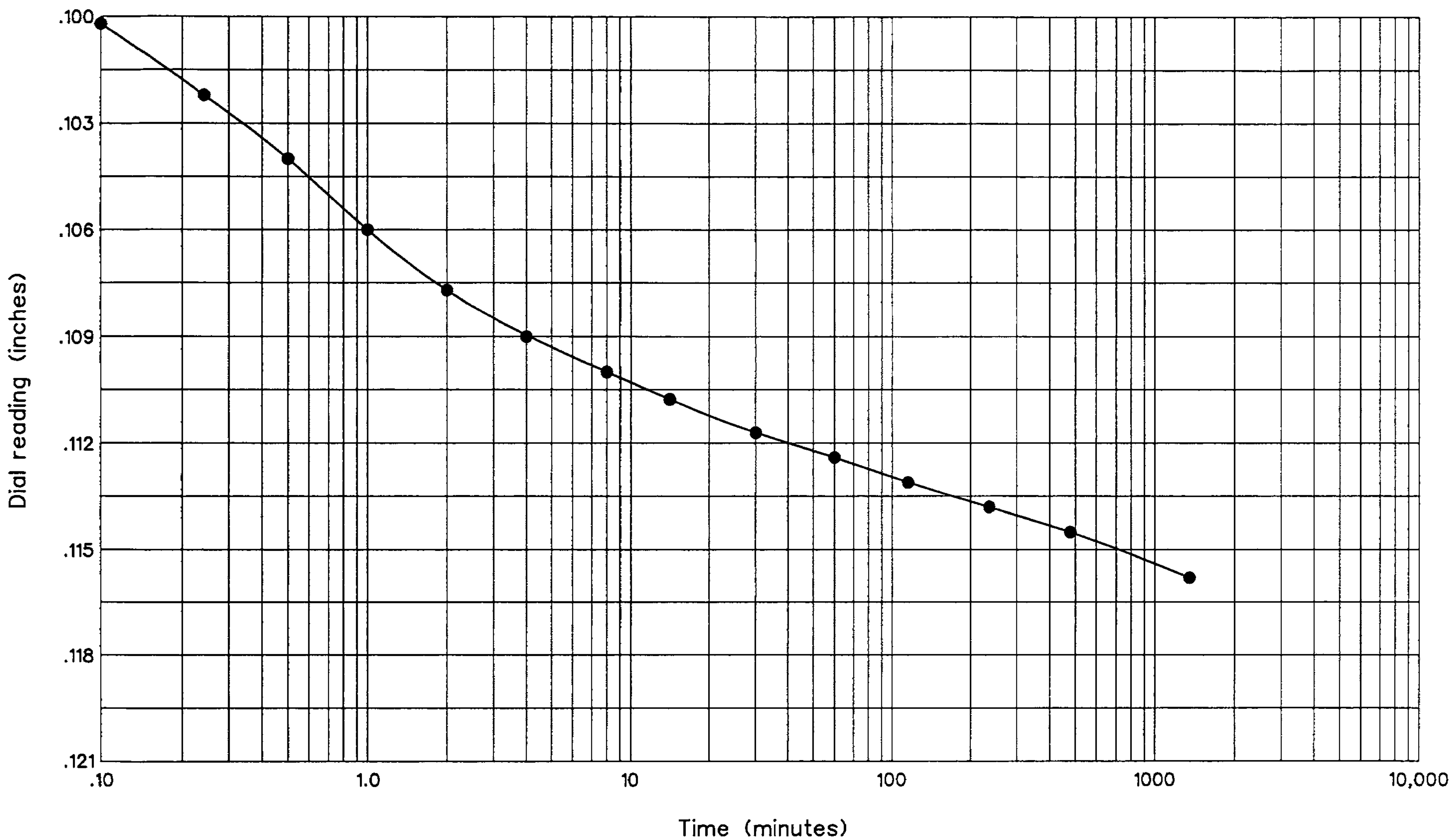
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 123.5'-125'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



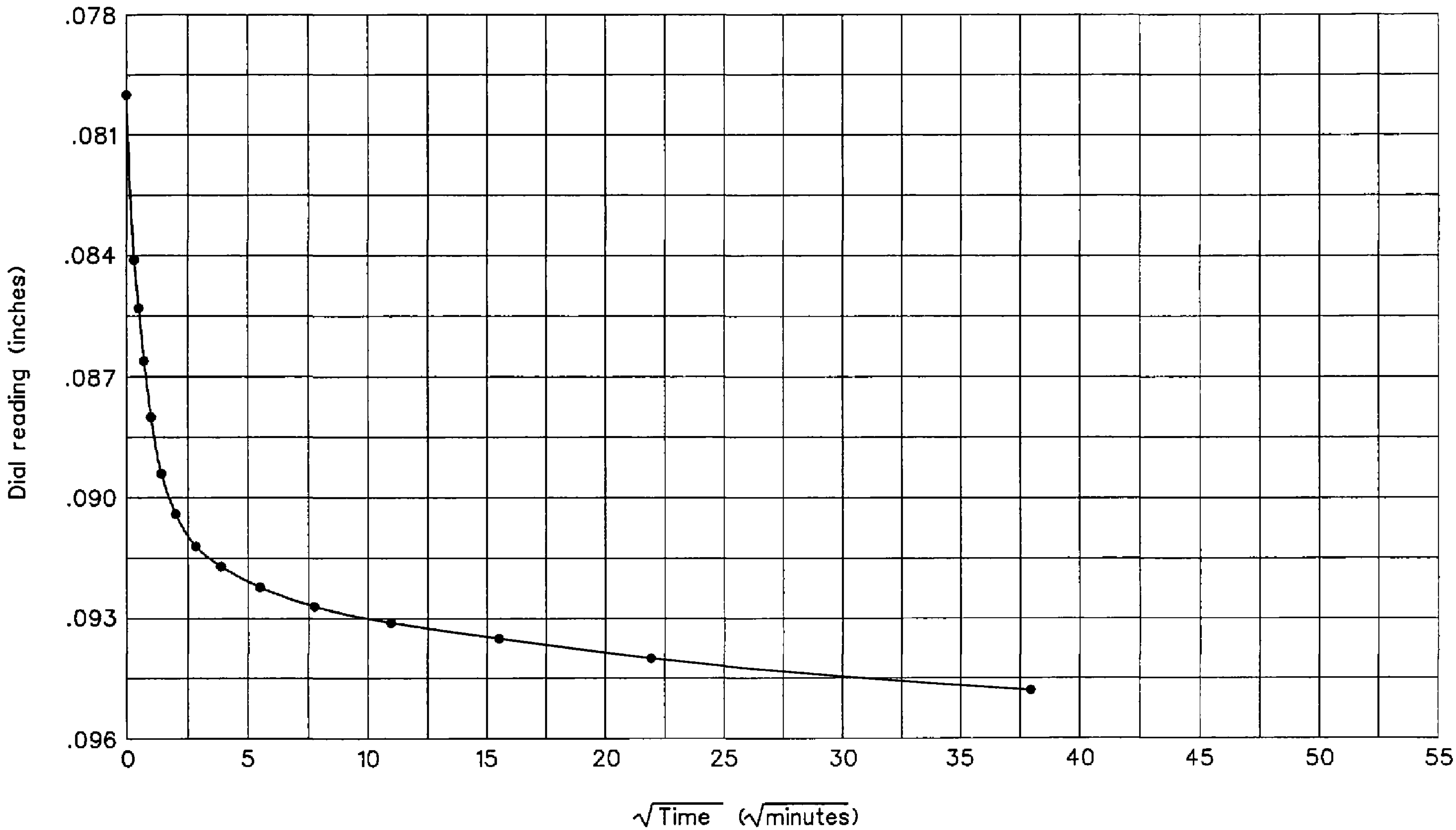
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 123.5'-125'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



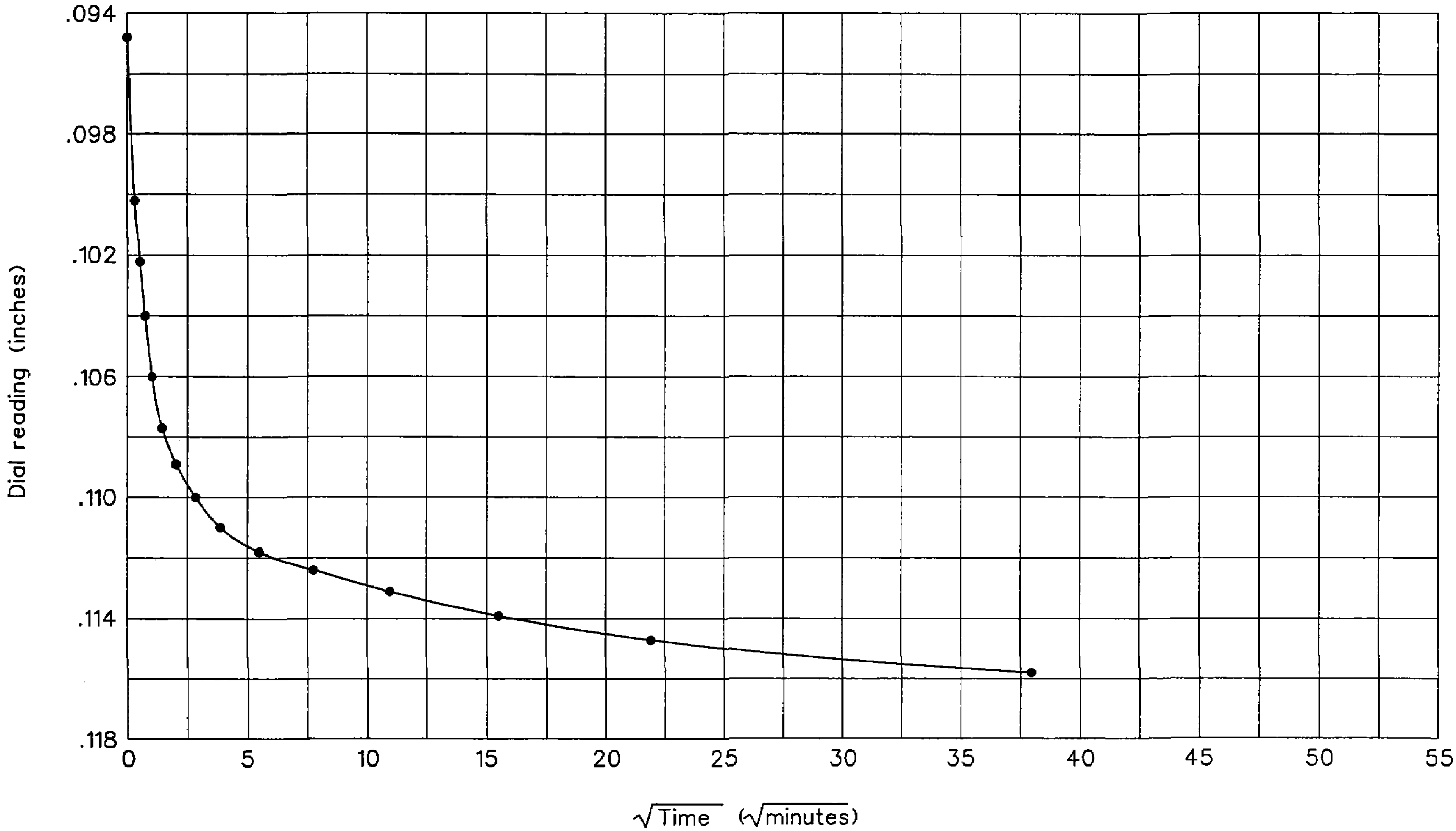
RB&G ENGINEERING INC.
Provo, Utah

Hole no.:	RSB-12-609
Depth:	123.5'-125'
Load:	4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



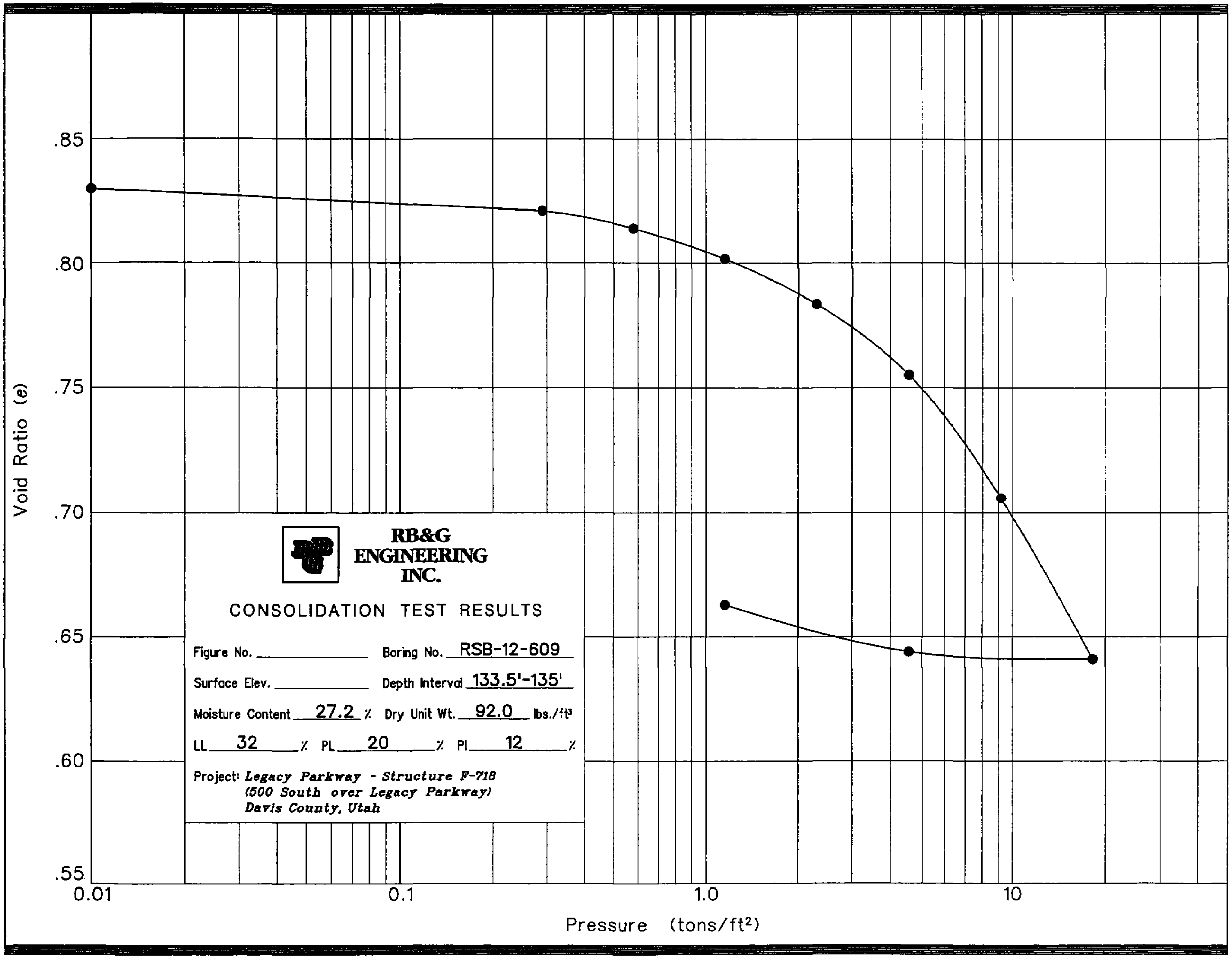
RB&G ENGINEERING INC.
Provo, Utah

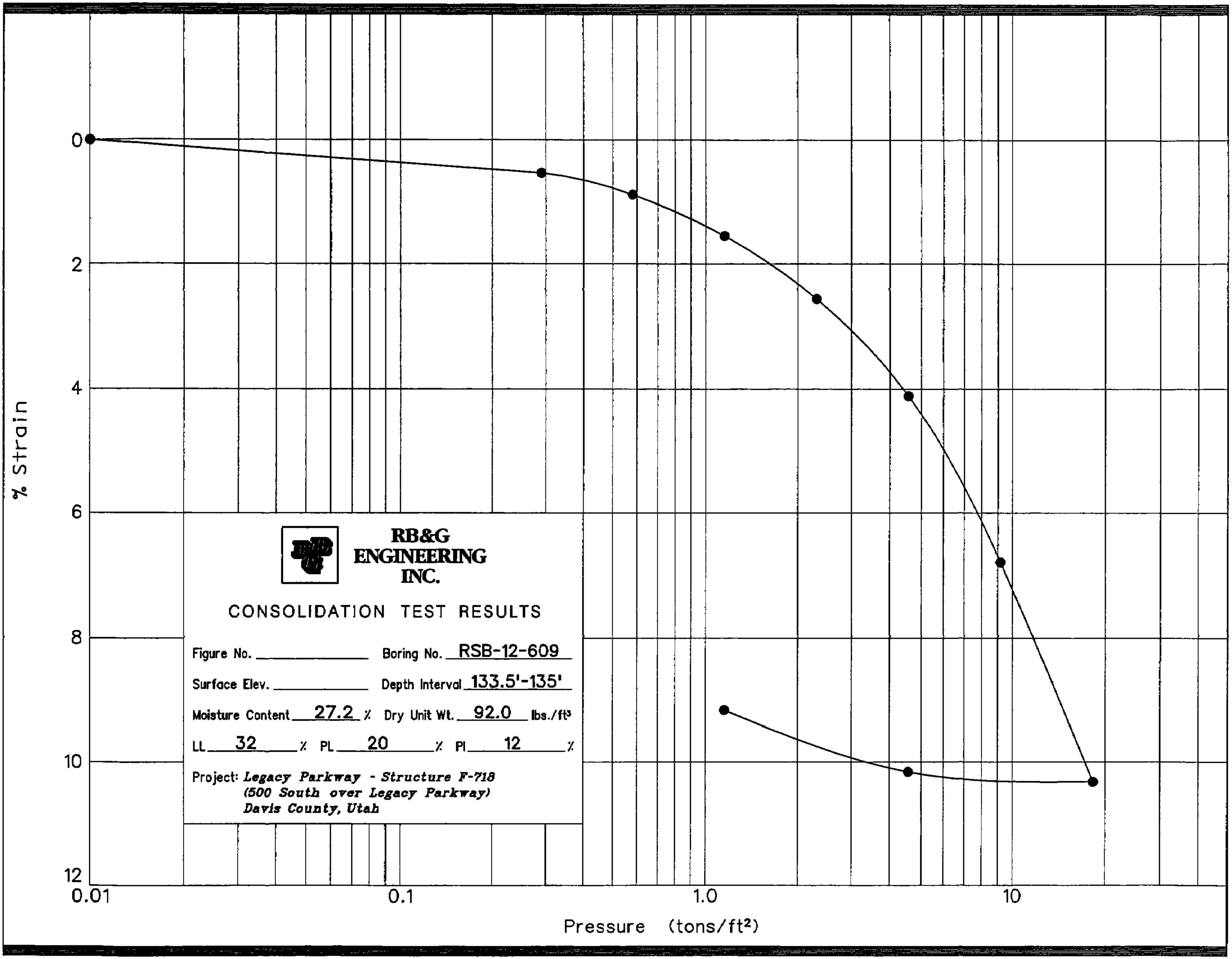
Hole no.: RSB-12-609
Depth: 123.5'-125'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure


RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-609
Surface Elev.
Depth Interval 133.5'-135'
Moisture Content 27.2 %
Dry Unit Wt. 92.0 lbs./ft³
LL 32 %
PL 20 %
PI 12 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
Void Ratio (e)
.85
.80
.75
.70
.65
.60
.55
0.01
0.1
1.0
10
Pressure (tons/ft²)



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

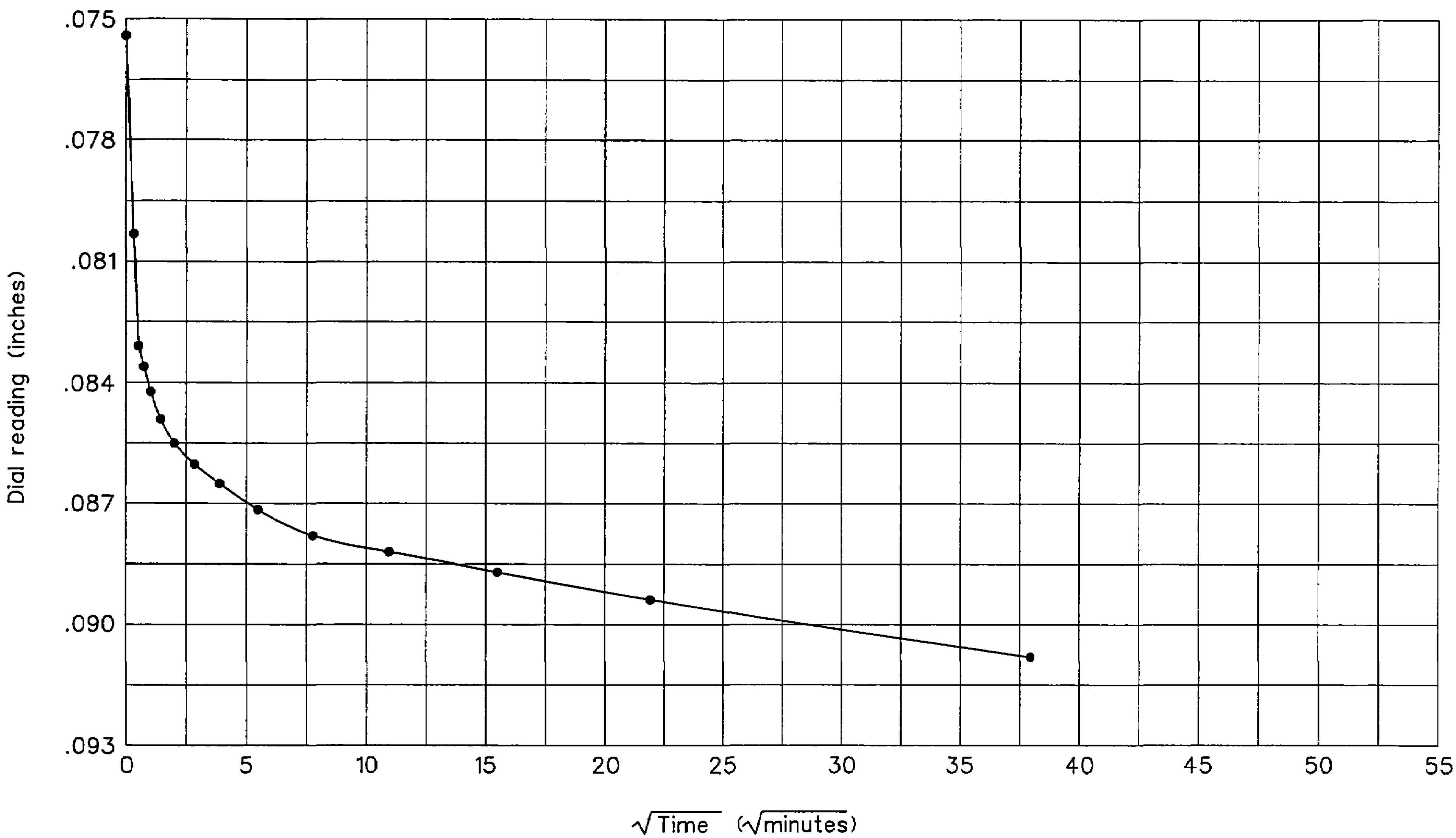
Figure No. ______ Boring No. RSB-12-609

Surface Elev. ______ Depth Interval 133.5'-135'

Moisture Content 27.2 % Dry Unit Wt. 92.0 lbs./ft³

LL 32 % PL 20 % PI 12 %

Project: *Legacy Parkway - Structure F-718*
(500 South over Legacy Parkway)
Davis County, Utah



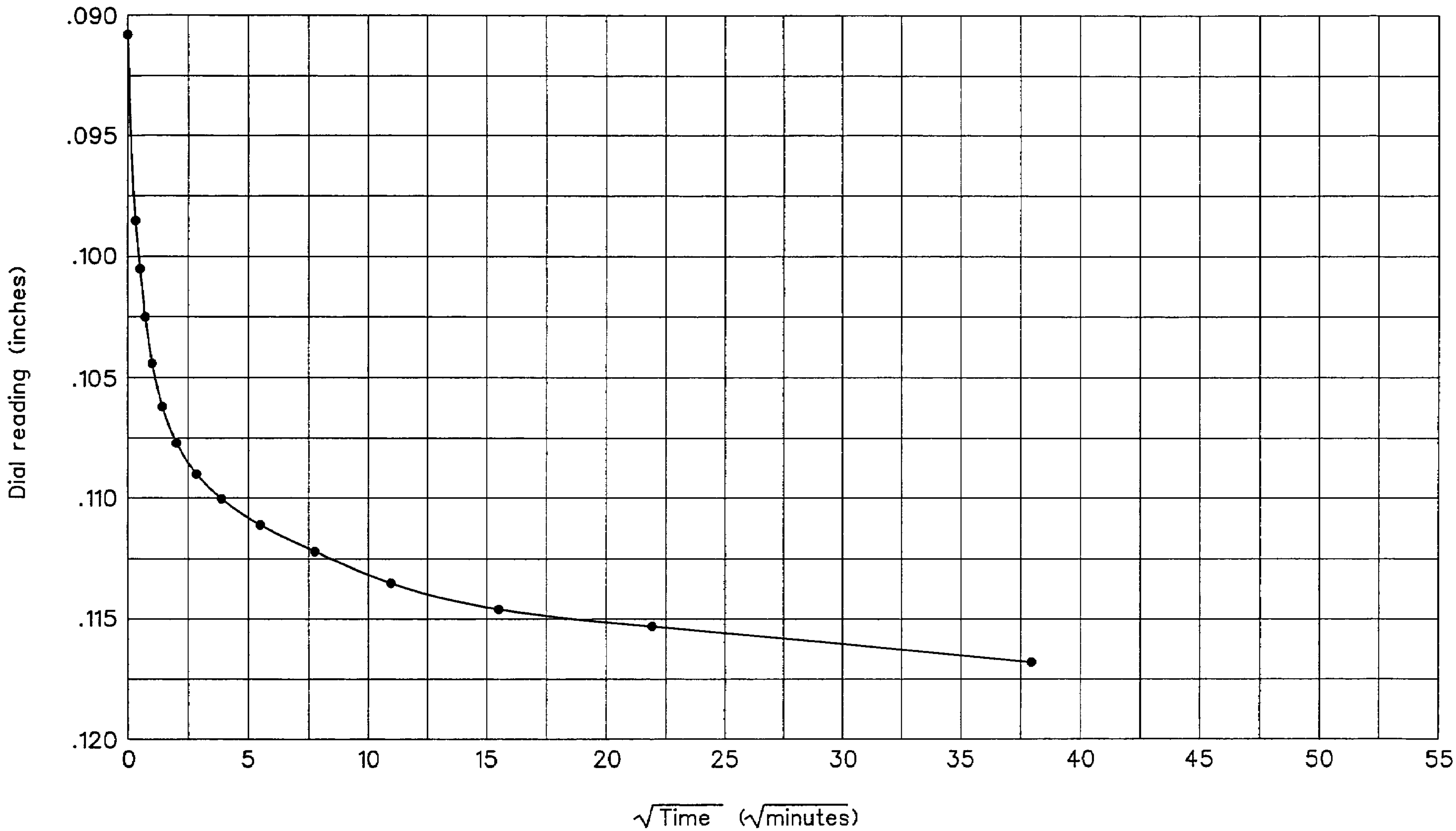
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-609
Depth: 133.5'-135'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



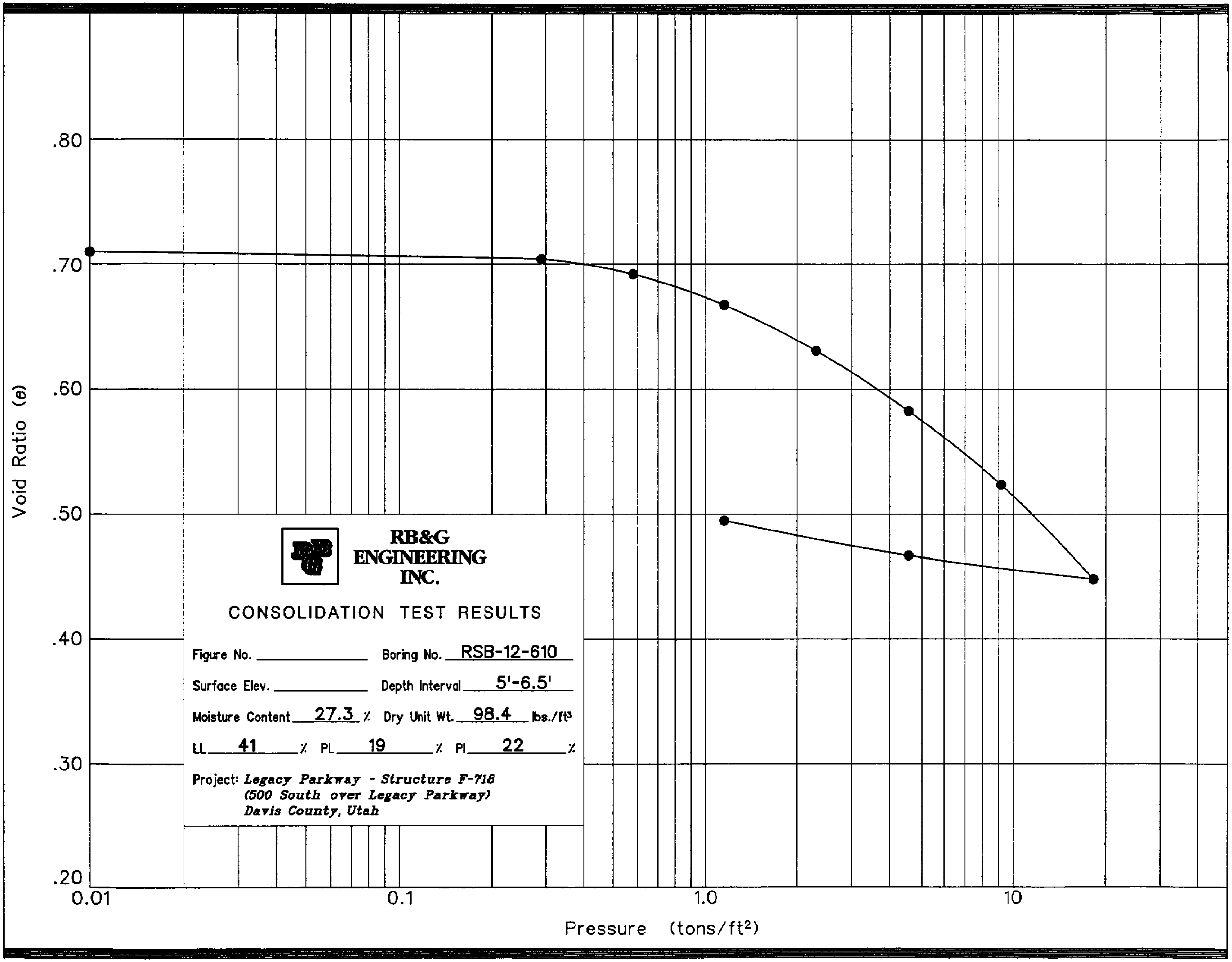
RB&G ENGINEERING INC.
Provo, Utah

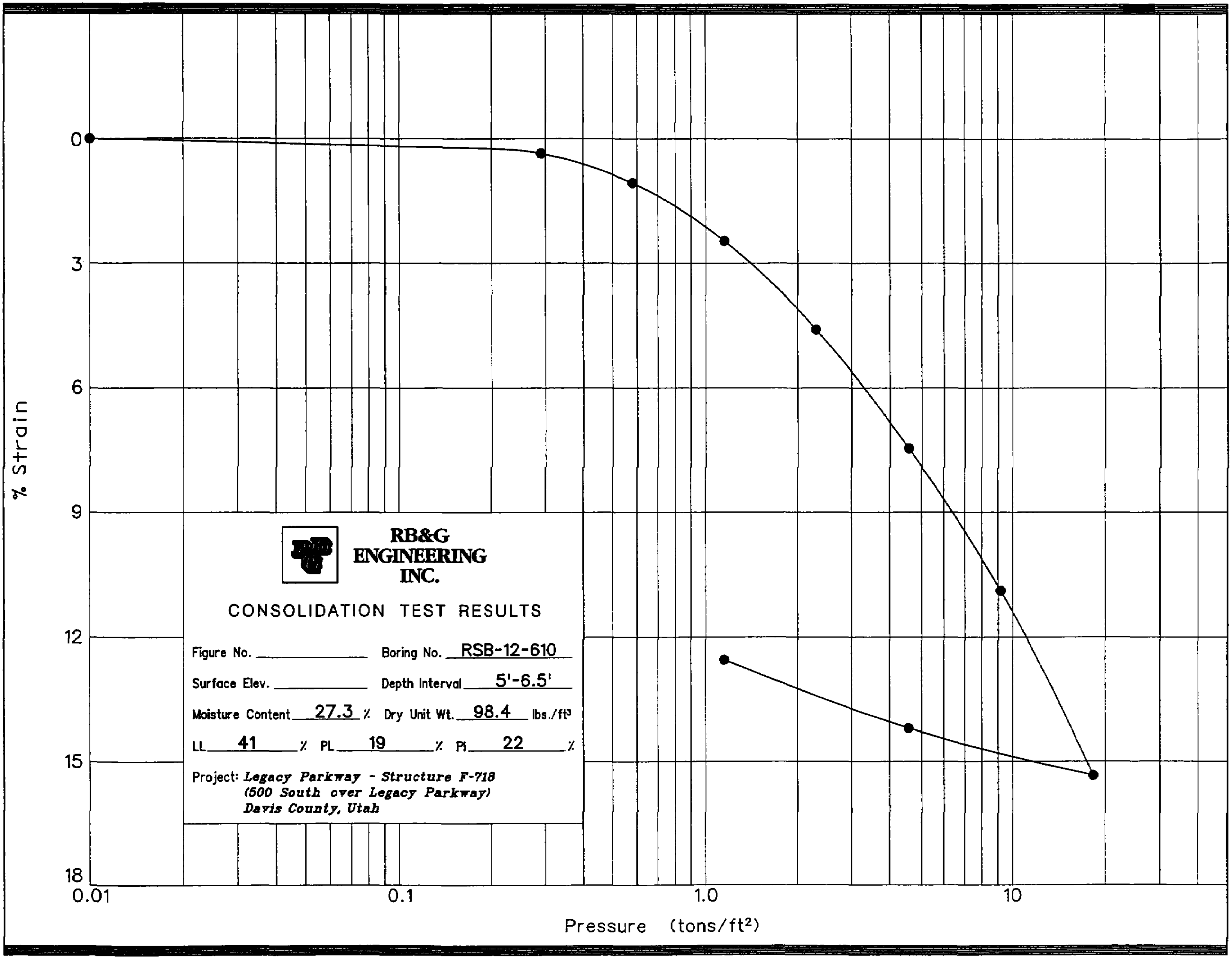
Hole no.: RSB-12-609
Depth: 133.5'-135'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

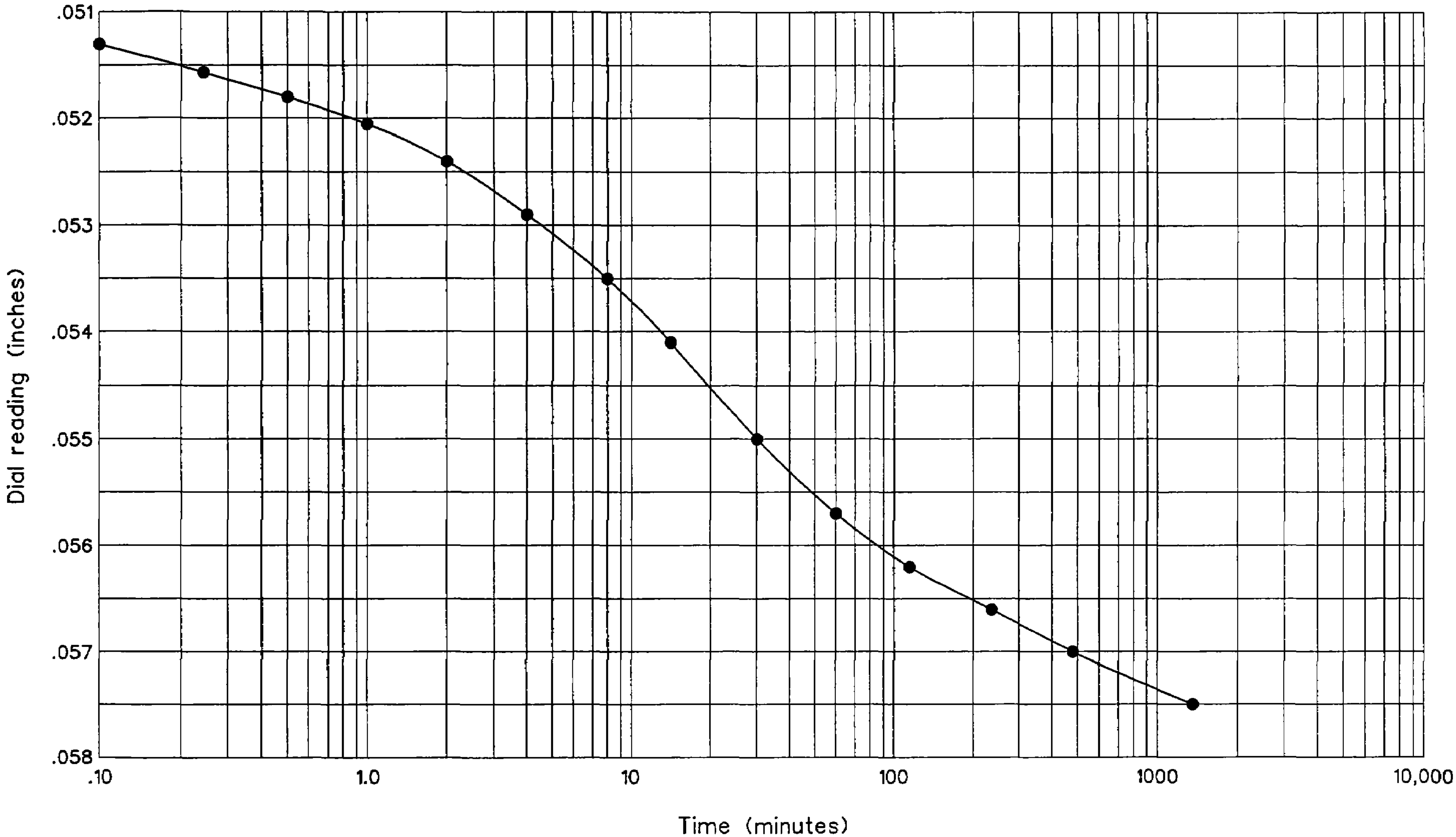
Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 5'-6.5'
Moisture Content 27.3 % Dry Unit Wt. 98.4 lbs./ft³
LL 41 % PL 19 % PI 22 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
Void Ratio (e)
.80
.70
.60
.50
.40
.30
.20
0.01
0.1
1.0
10
Pressure (tons/ft²)



0
3
6
9
12
15
18
% Strain
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 5'-6.5'
Moisture Content 27.3 %
Dry Unit Wt. 98.4 lbs./ft³
LL 41 %
PL 19 %
PI 22 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



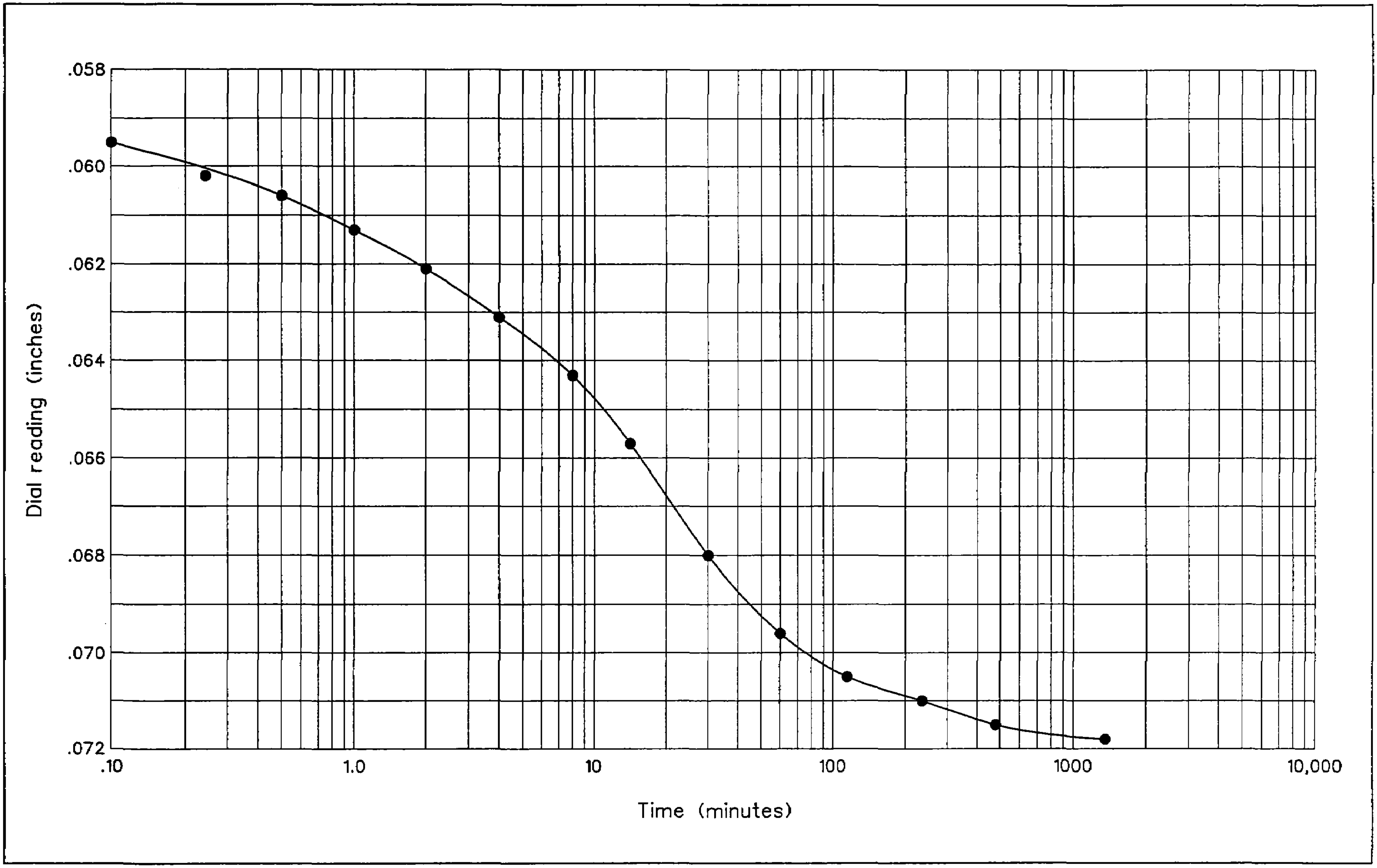
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 5'-6.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



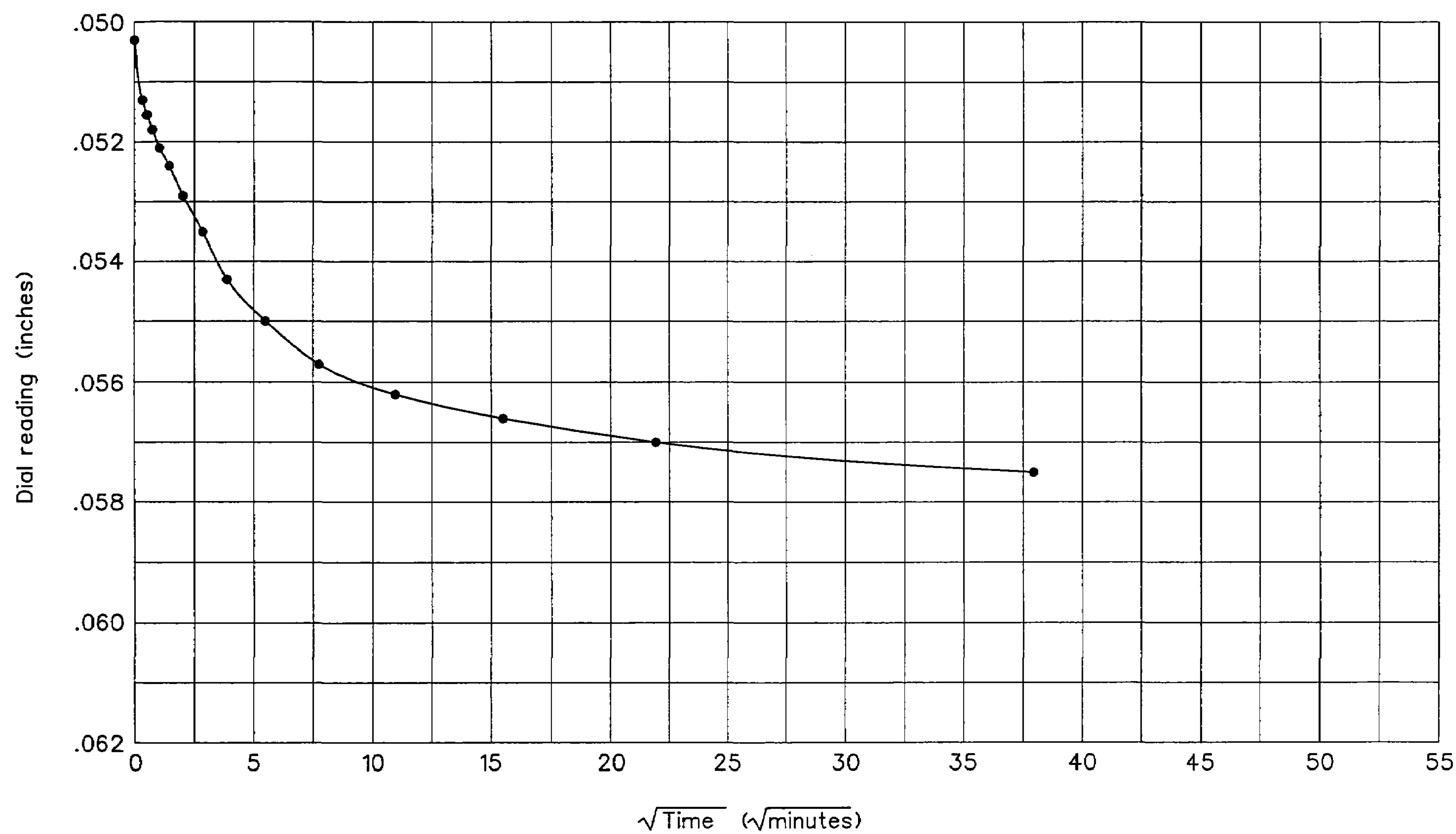
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 5'-6.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



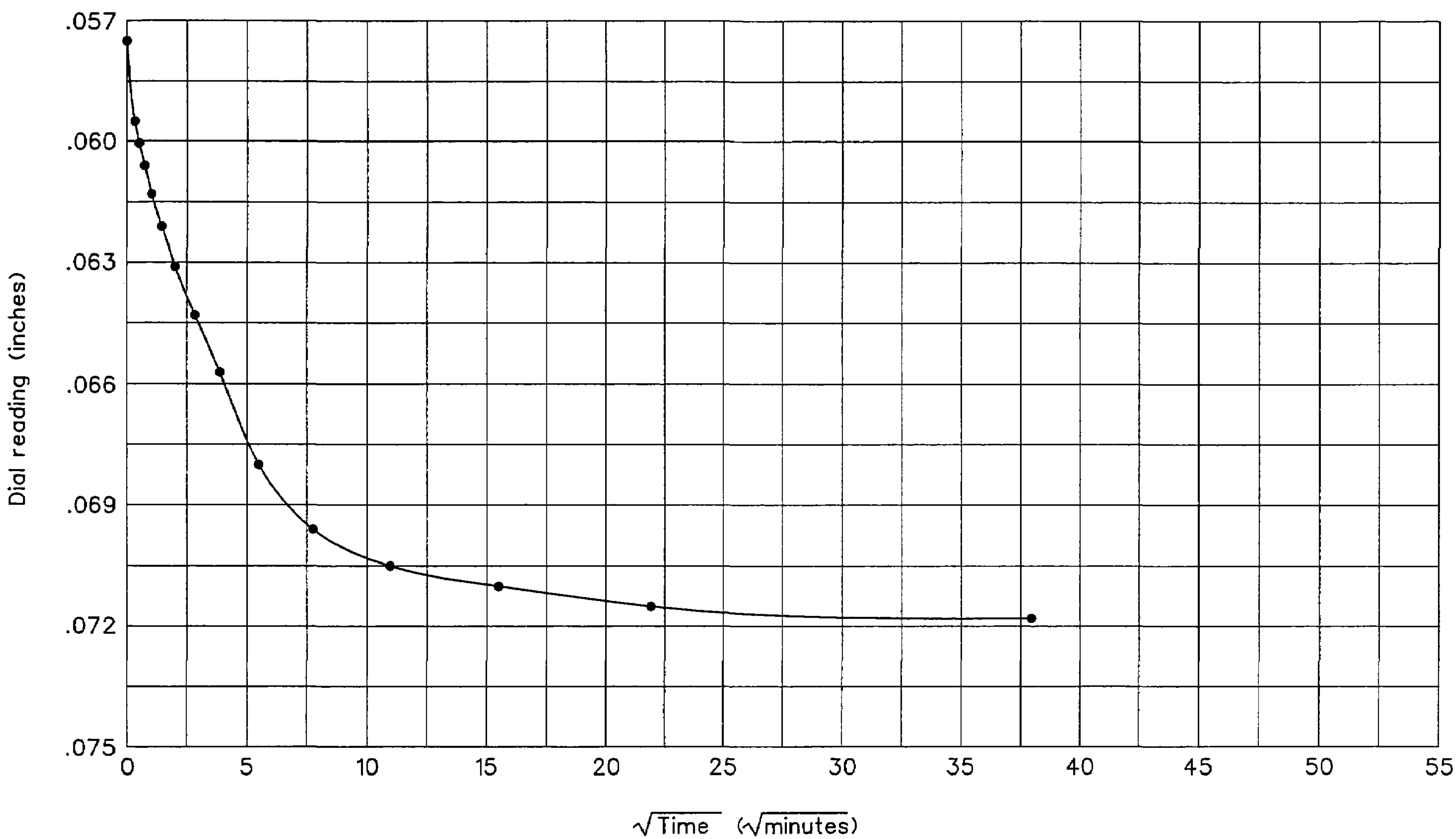
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 5'-6.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



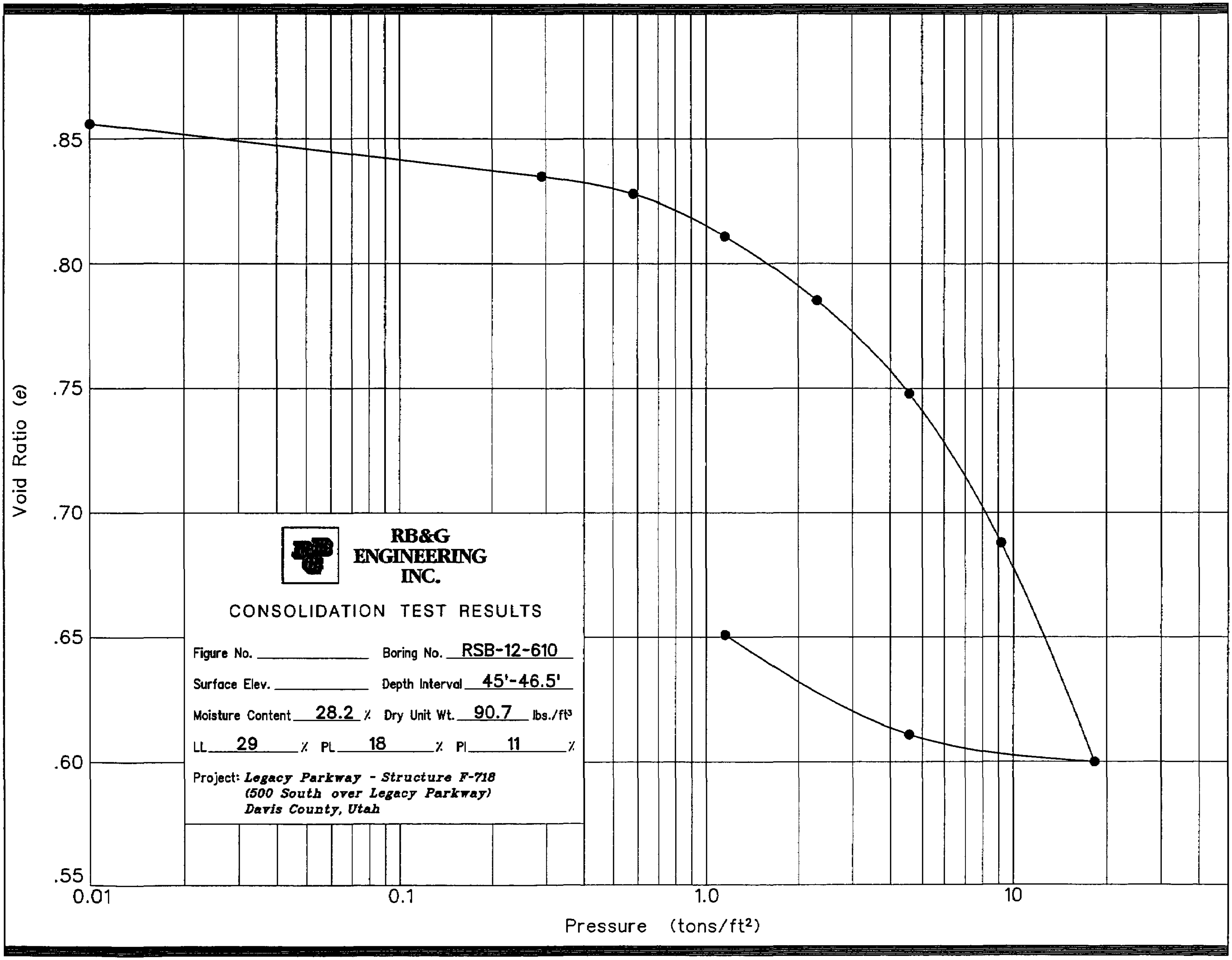
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 5'-6.5'
Load: 1.15 to 2.30 tons

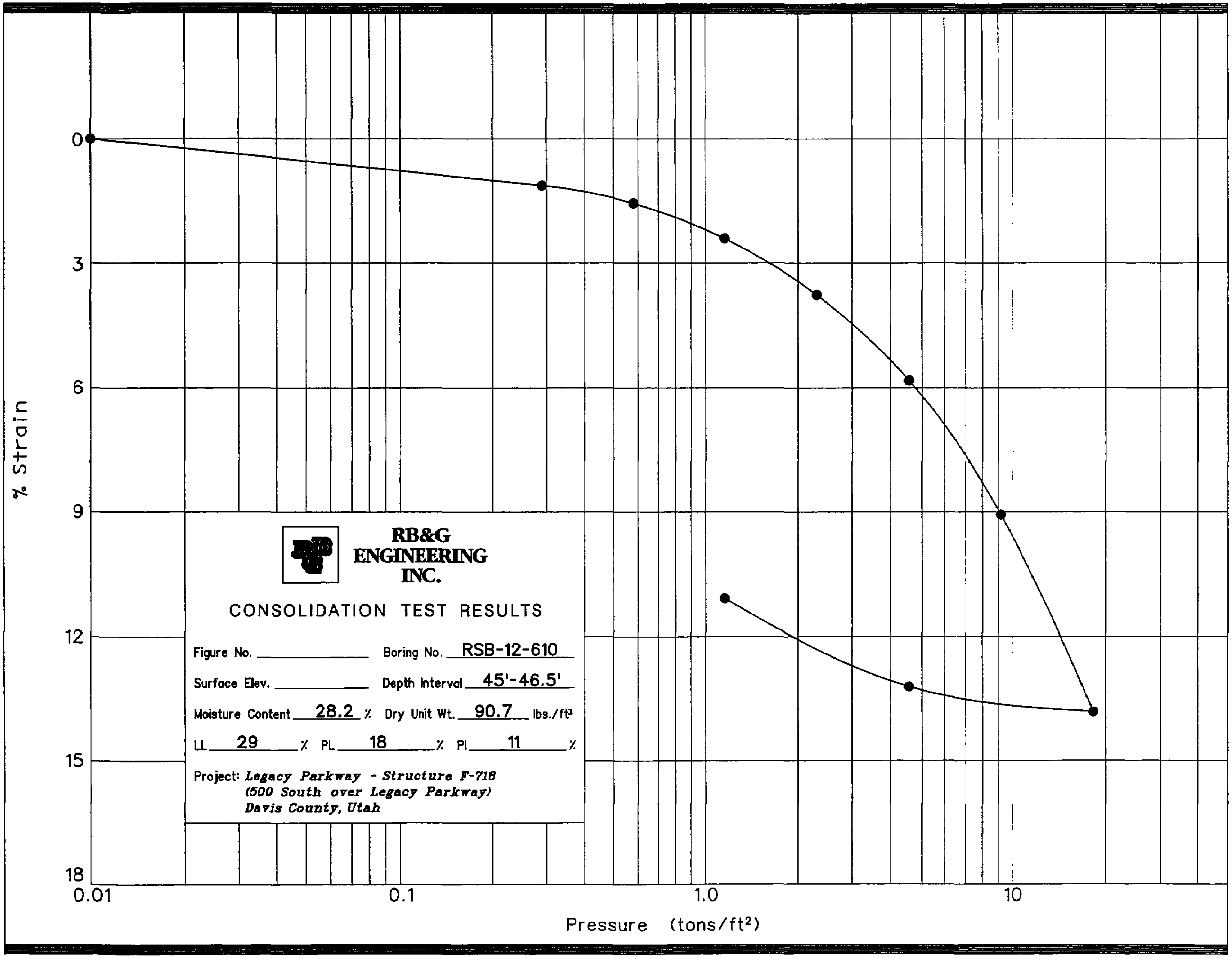
TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

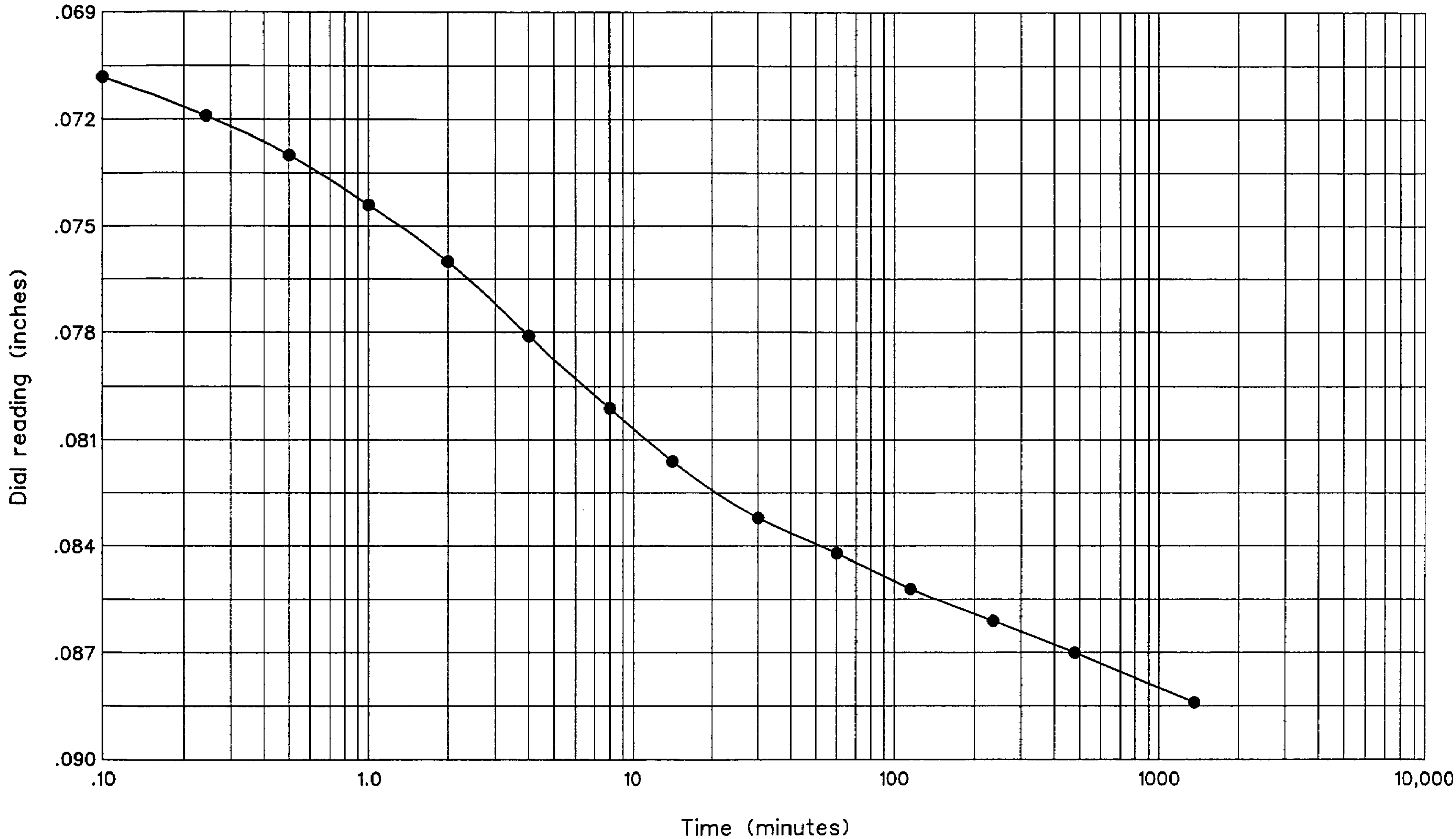
Figure



Void Ratio (e)
.85
.80
.75
.70
.65
.60
.55
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 45'-46.5'
Moisture Content 28.2 %
Dry Unit Wt. 90.7 lbs./ft³
LL 29 %
PL 18 %
PI 11 %
Project: Legacy Parkway - Structure F-718 (500 South over Legacy Parkway) Davis County, Utah



RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 45'-46.5'
Moisture Content 28.2 %
Dry Unit Wt. 90.7 lbs./ft³
LL 29 %
PL 18 %
PI 11 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
% Strain
0
3
6
9
12
15
18
0.01
0.1
1.0
10
Pressure (tons/ft²)



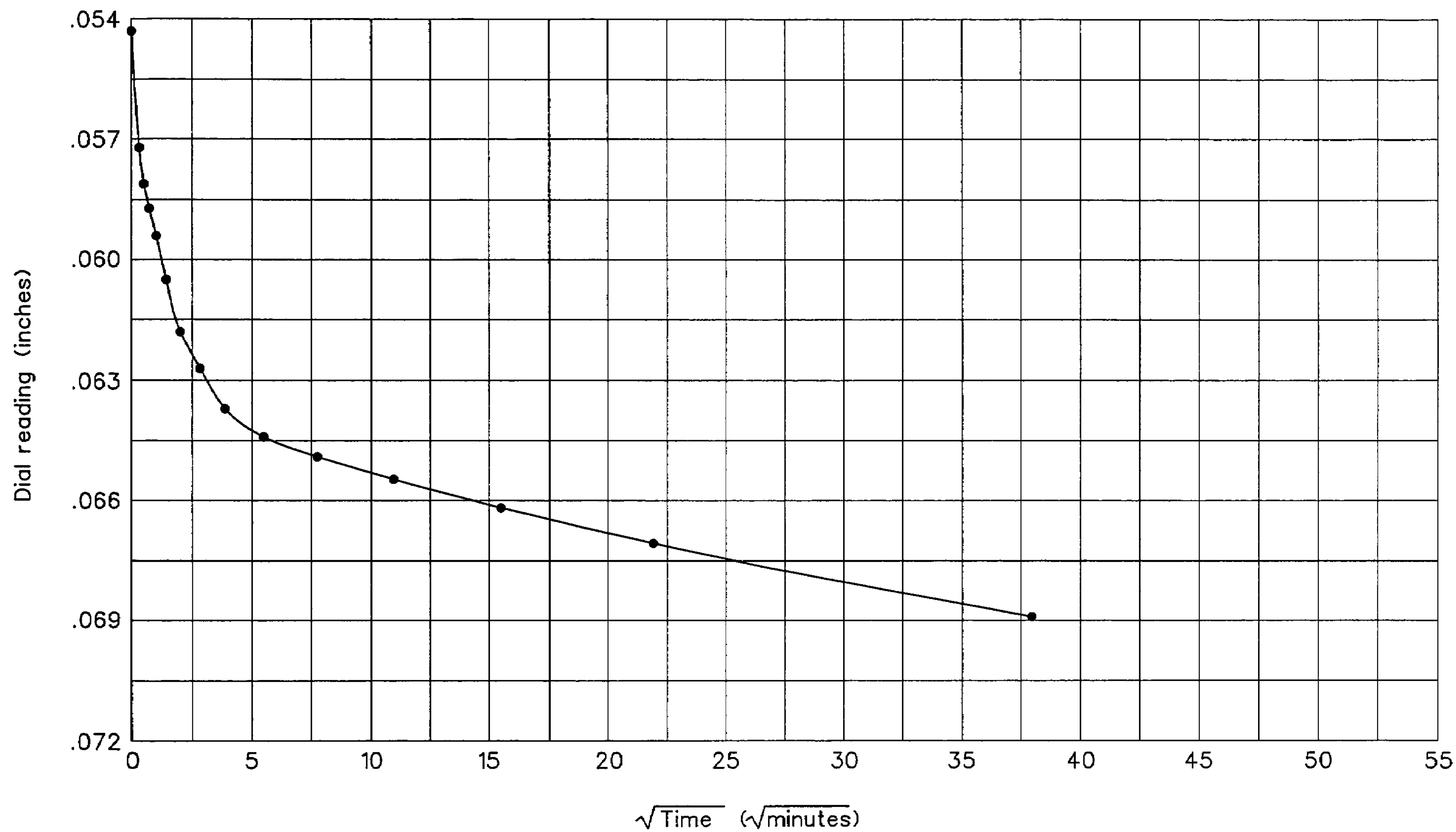
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 45'-46.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



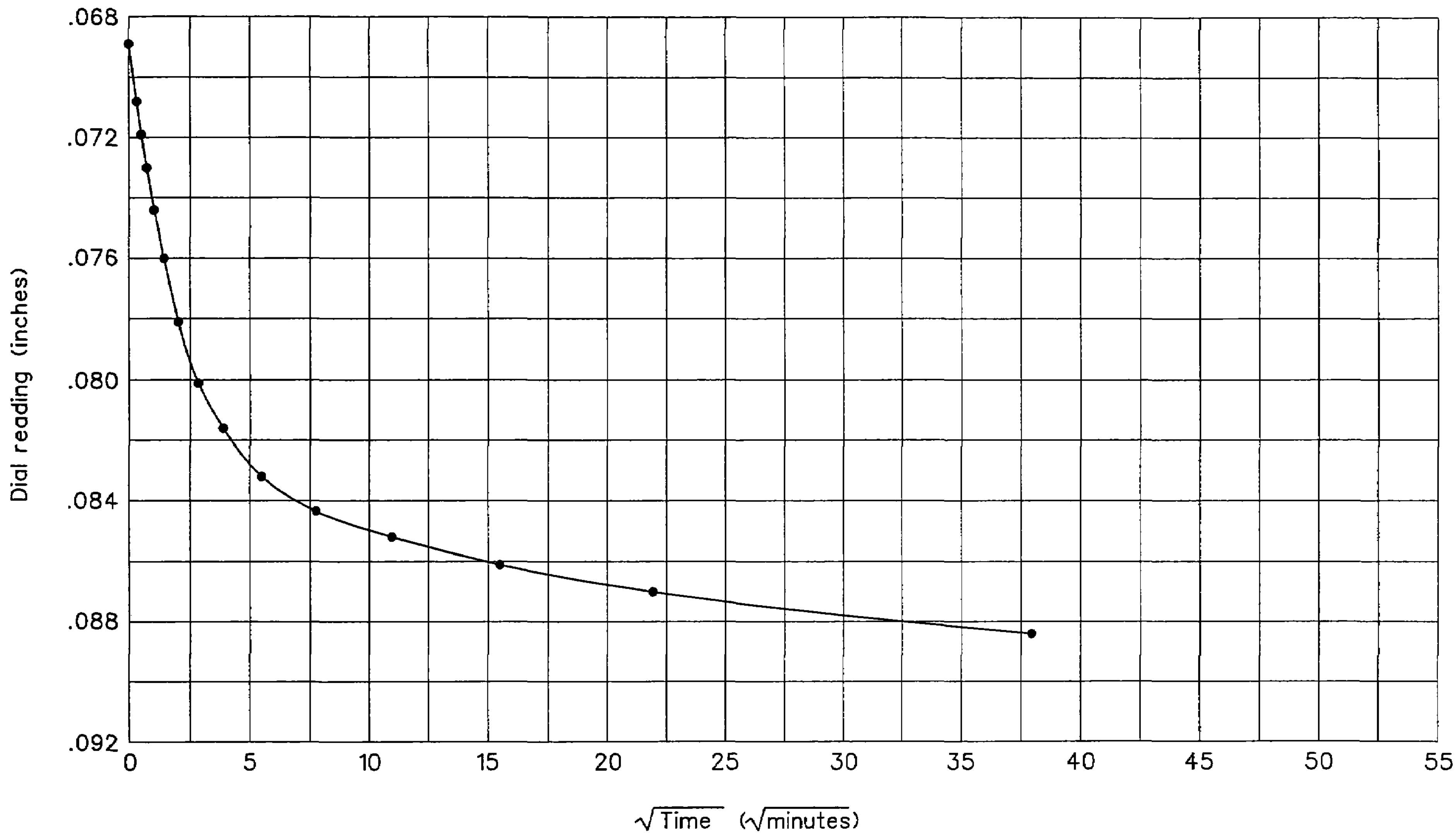
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 45'-46.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



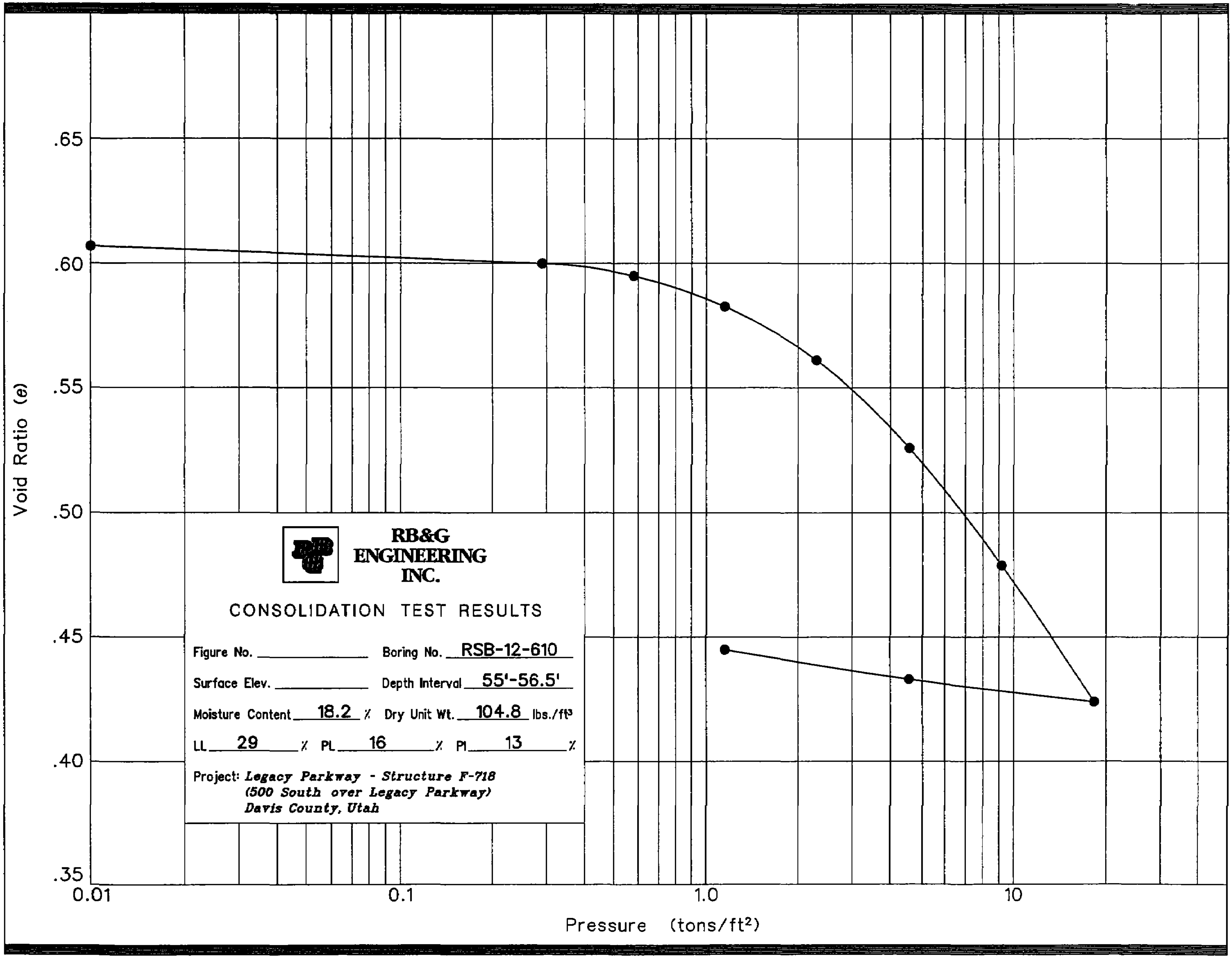
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 45'-46.5'
Load: 4.60 to 9.20 tons

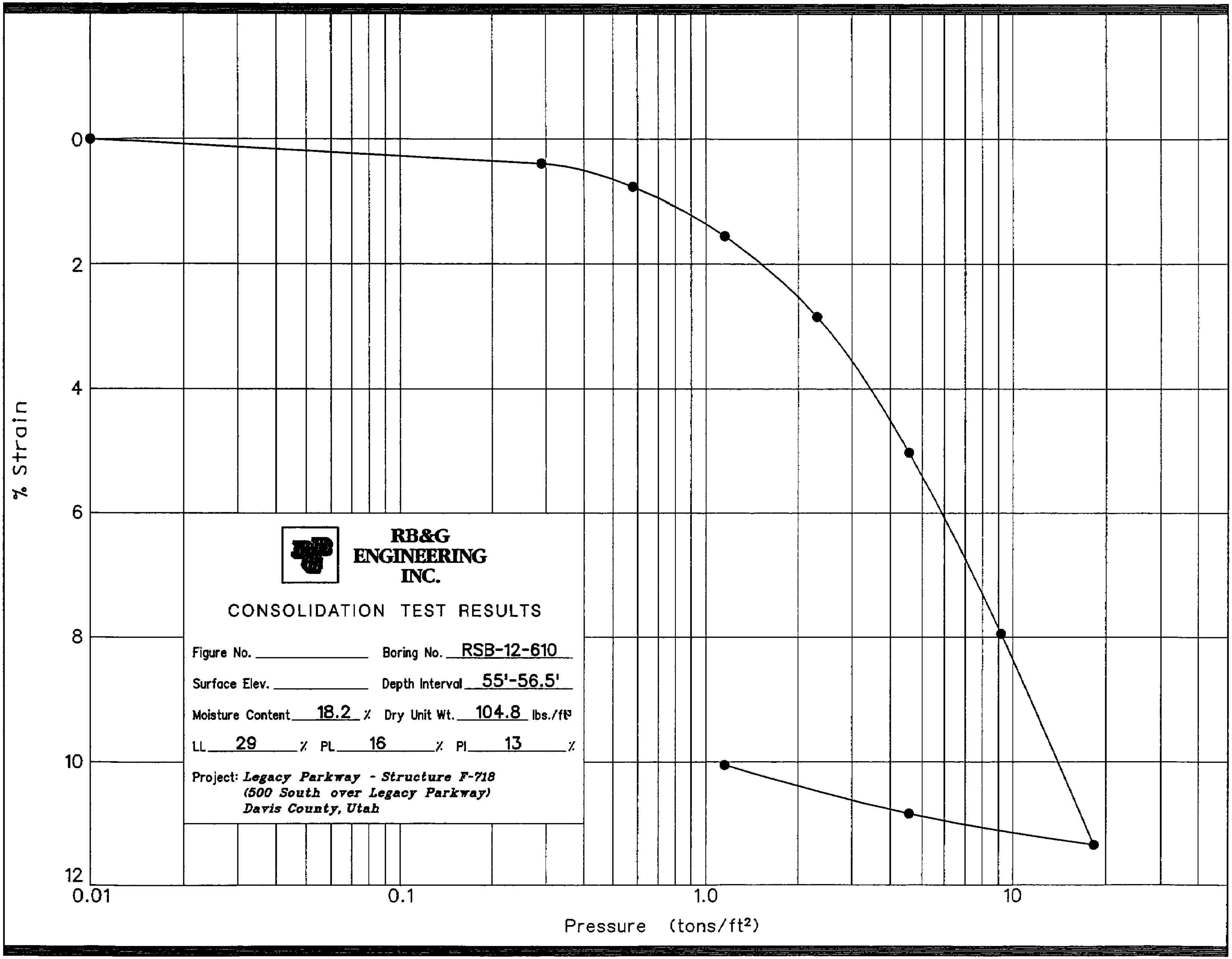
TIME CONSOLIDATION

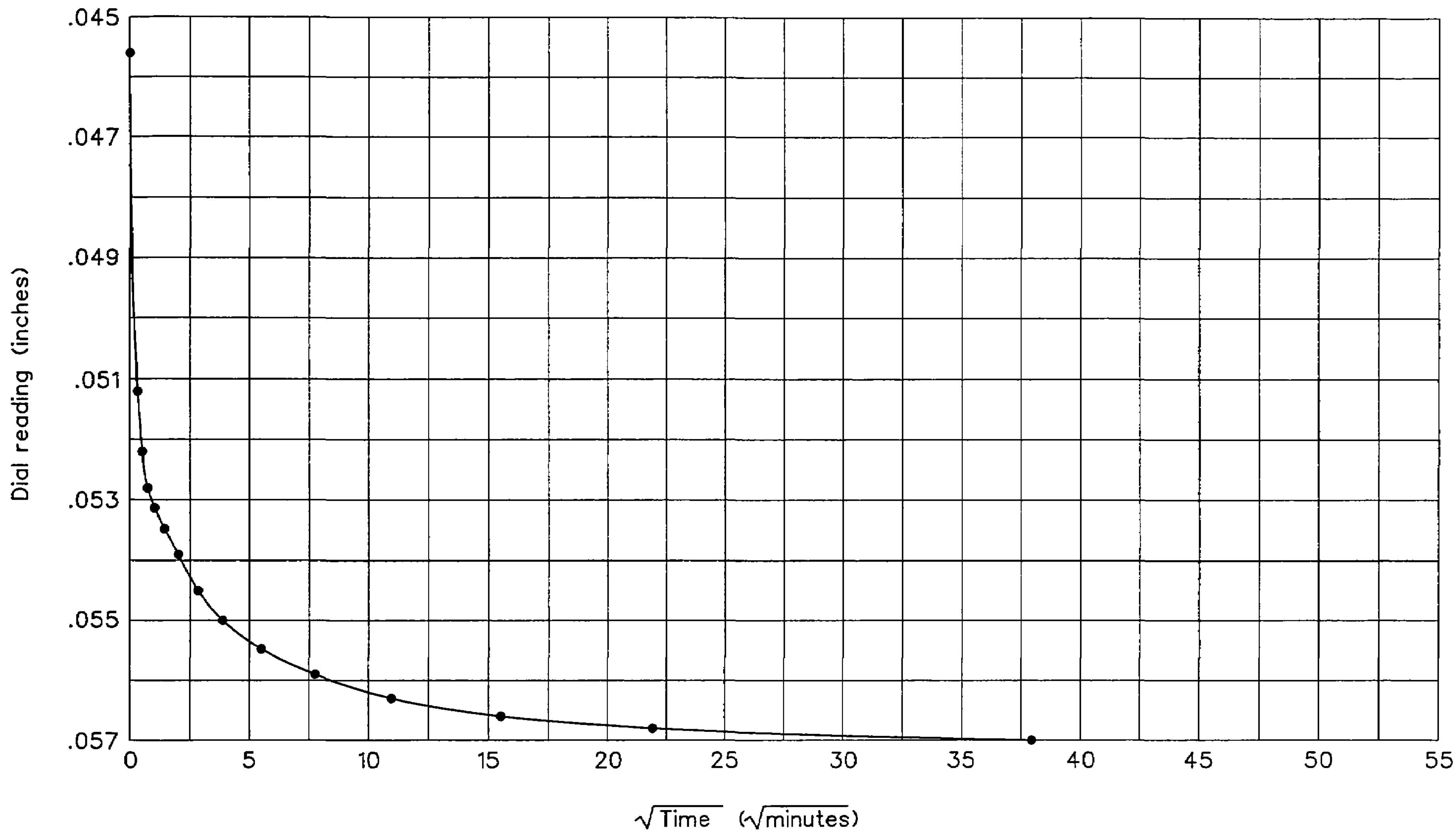
Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



Void Ratio (e)
.65
.60
.55
.50
.45
.40
.35
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 55'-56.5'
Moisture Content 18.2 % Dry Unit Wt. 104.8 lbs./ft³
LL 29 % PL 16 % PI 13 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 55'-56.5'
Moisture Content 18.2 %
Dry Unit Wt. 104.8 lbs./ft³
LL 29 %
PL 16 %
PI 13 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)

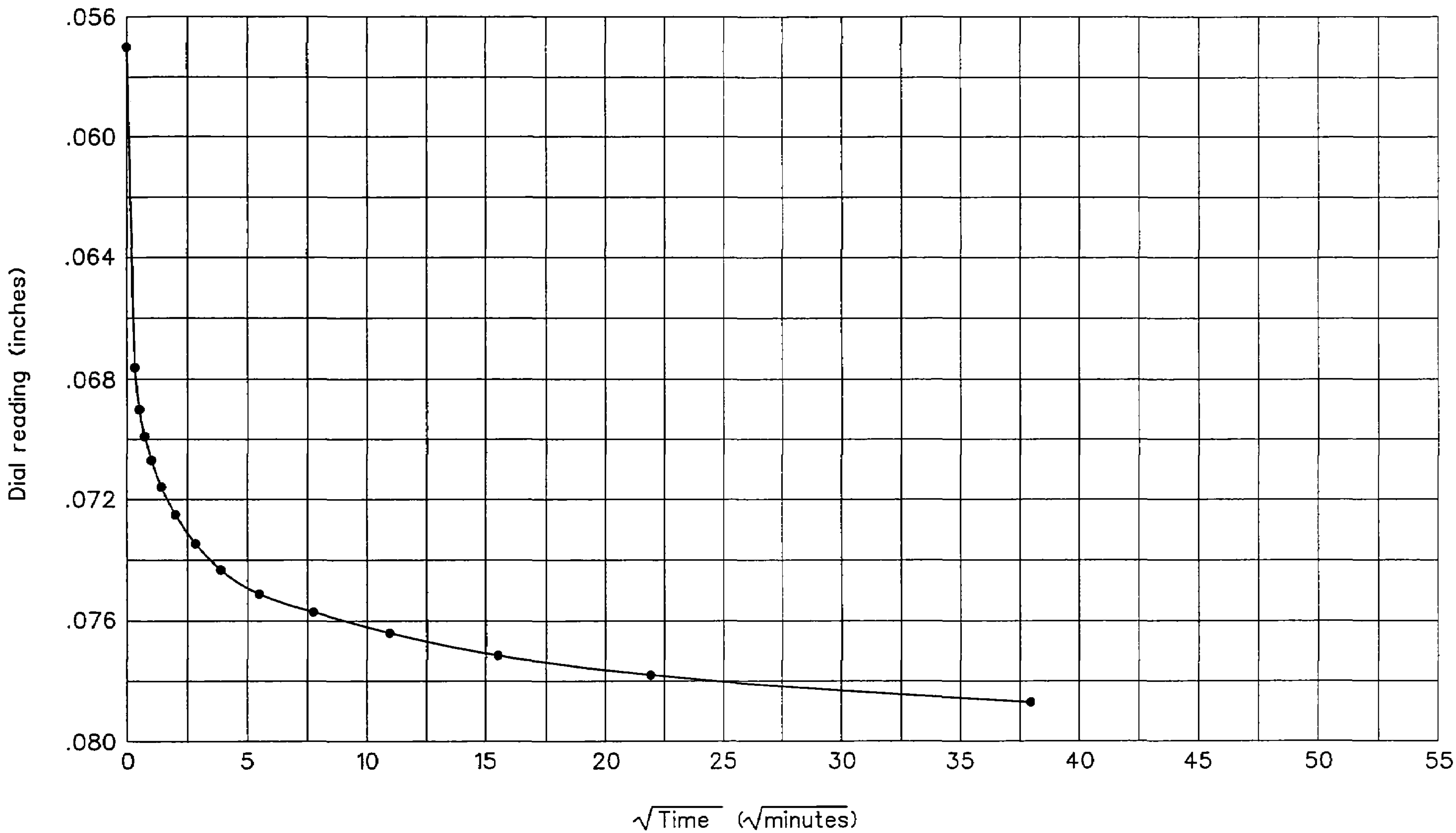


RB&G ENGINEERING INC. Provo, Utah	Hole no.: RSB-12-610 Depth: 55'-56.5' Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



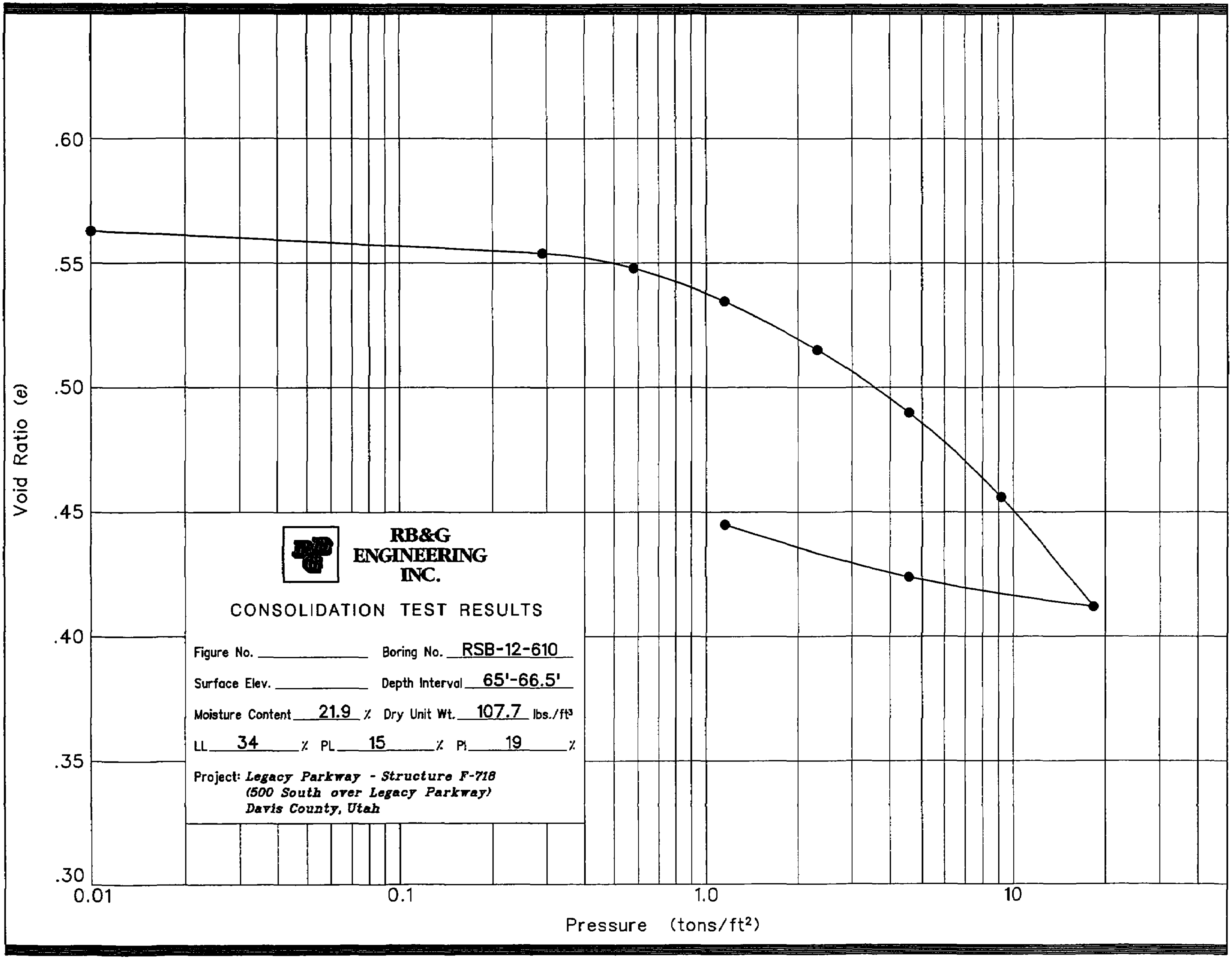
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 55'-56.5'
Load: 4.60 to 9.20 tons

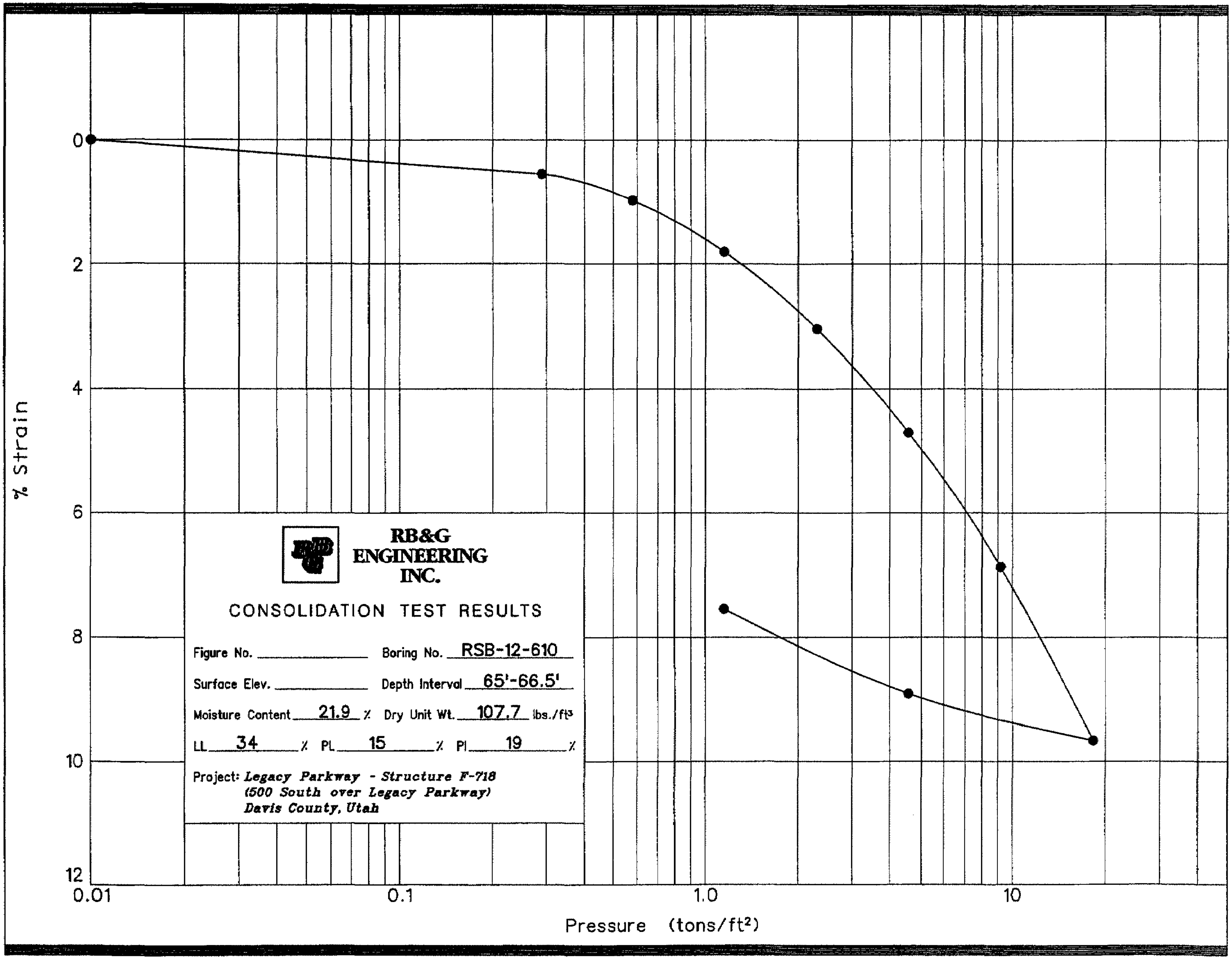
TIME CONSOLIDATION

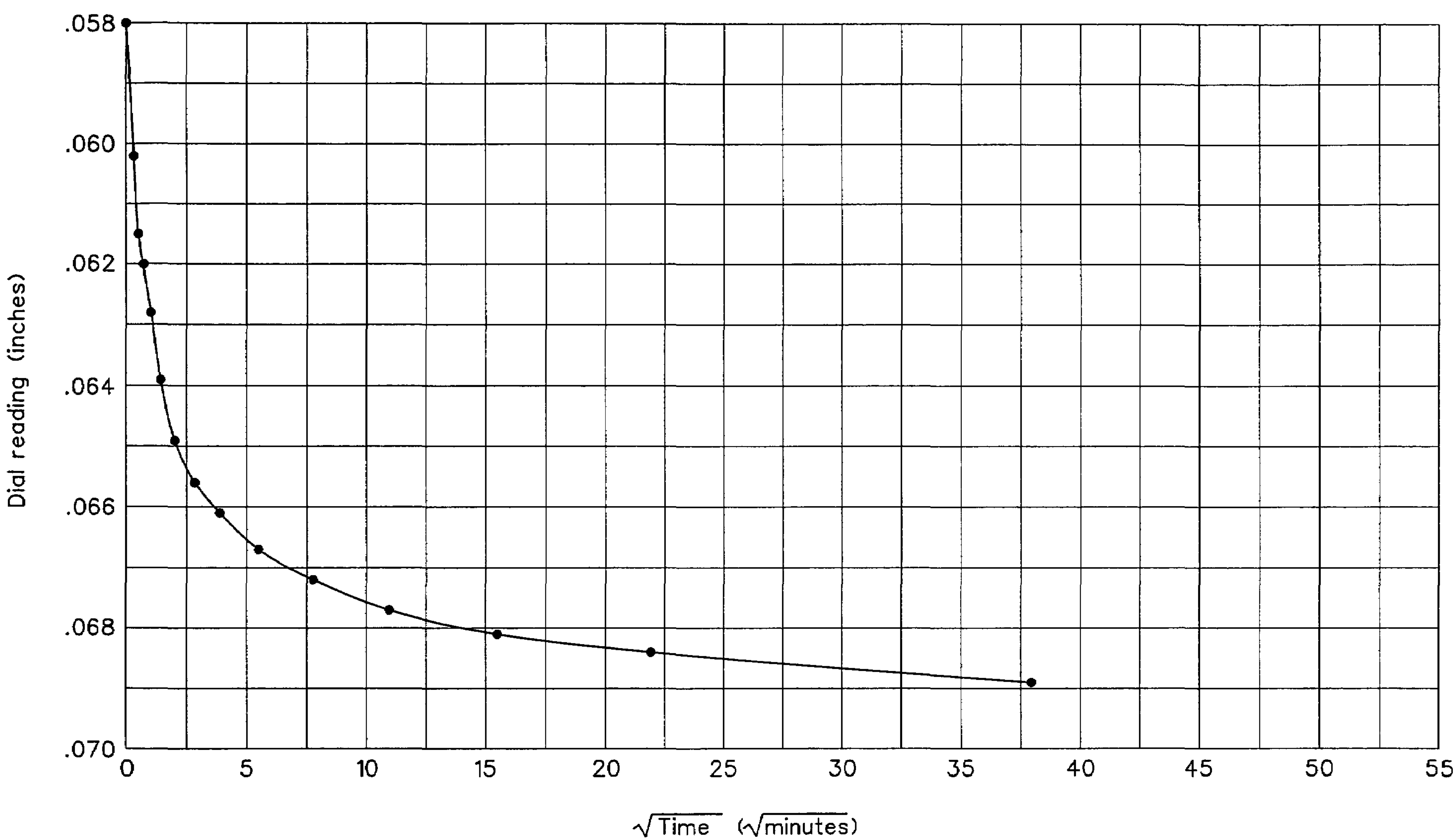
Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



.60
.55
.50
.45
.40
.35
.30
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 65'-66.5'
Moisture Content 21.9 %
Dry Unit Wt. 107.7 lbs./ft³
LL 34 % PL 15 % PI 19 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 65'-66.5'
Moisture Content 21.9 %
Dry Unit Wt. 107.7 lbs./ft³
LL 34 %
PL 15 %
PI 19 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)



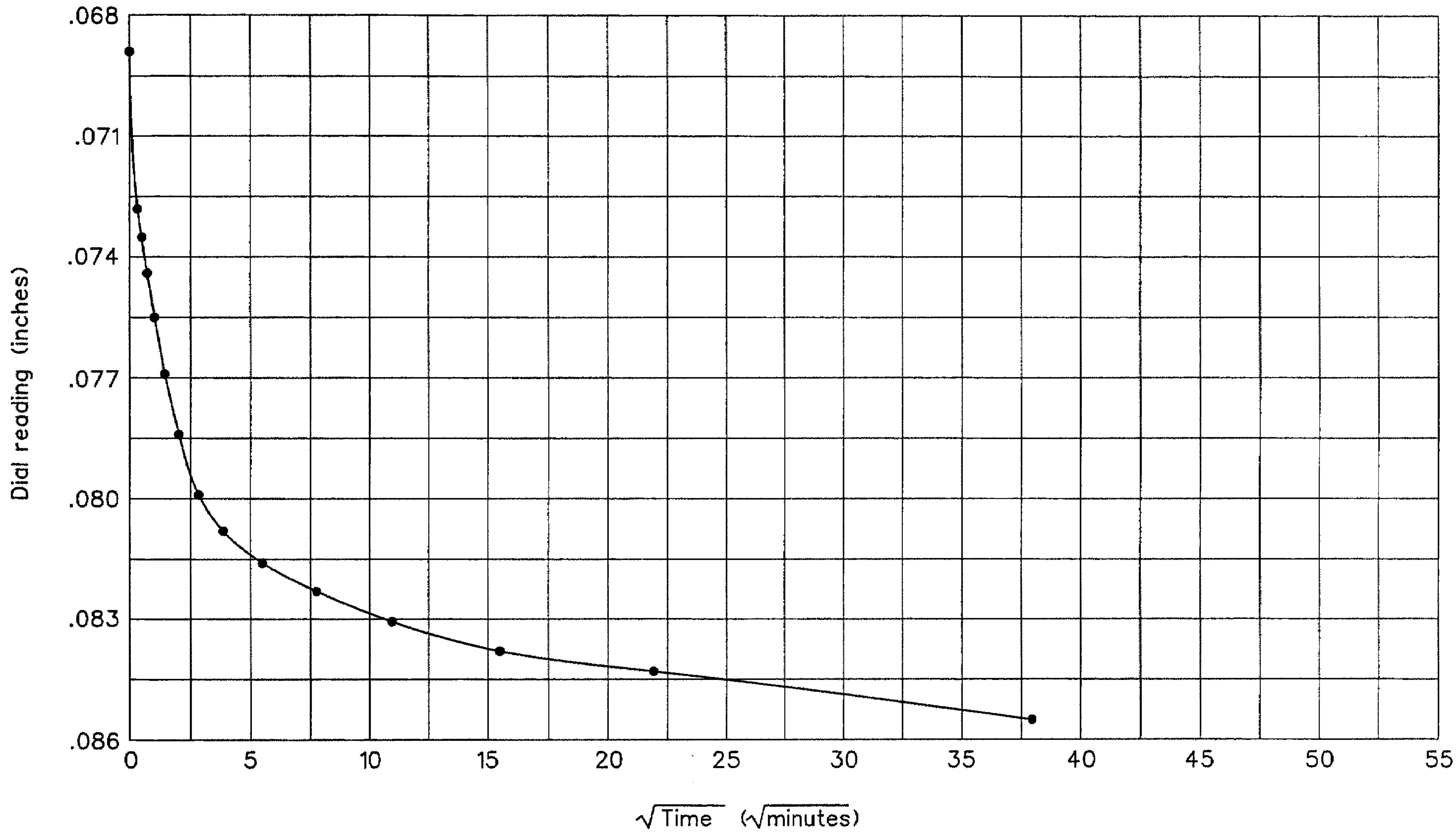
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 65'-66.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



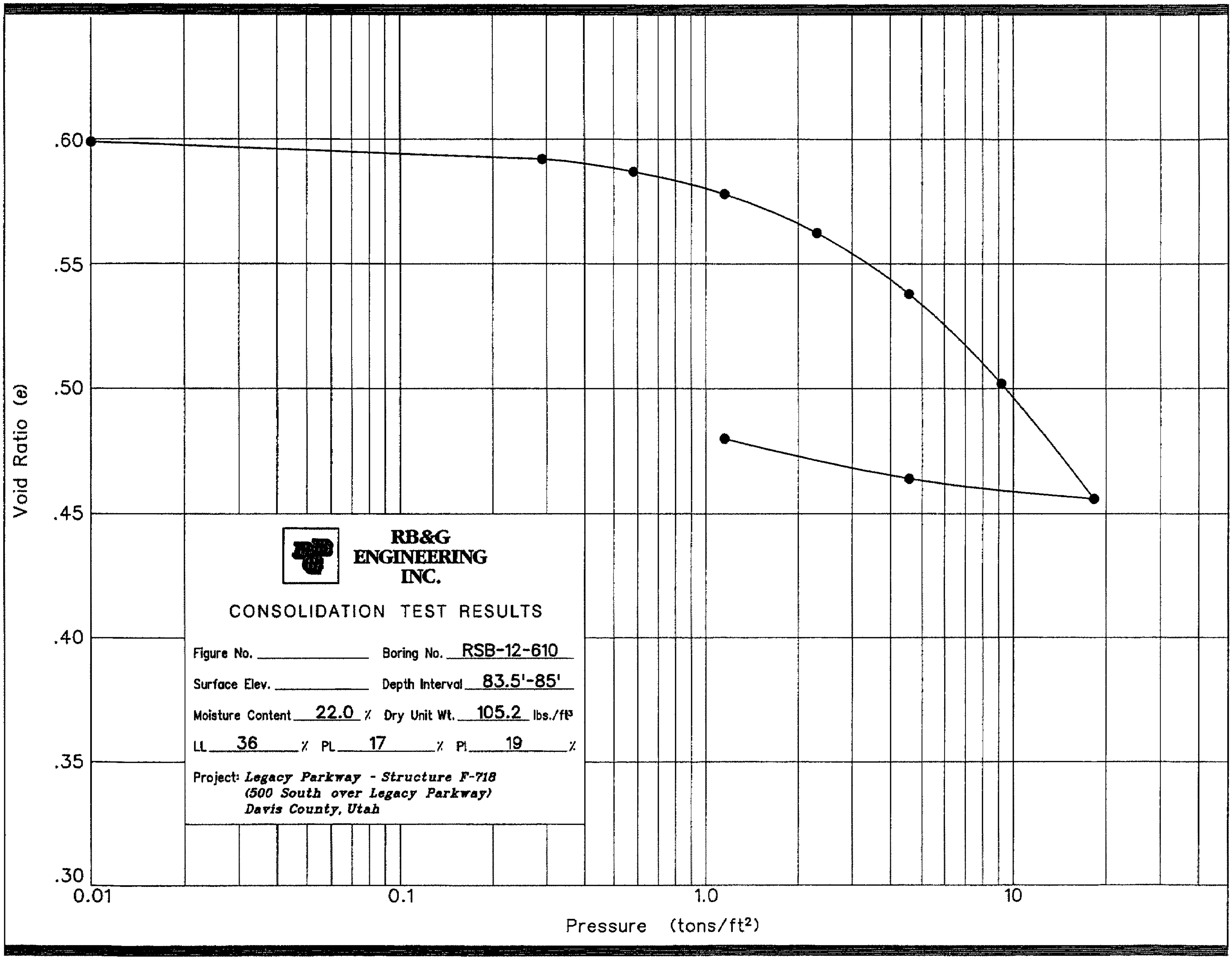
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 65'-66.5'
Load: 4.60 to 9.20 tons

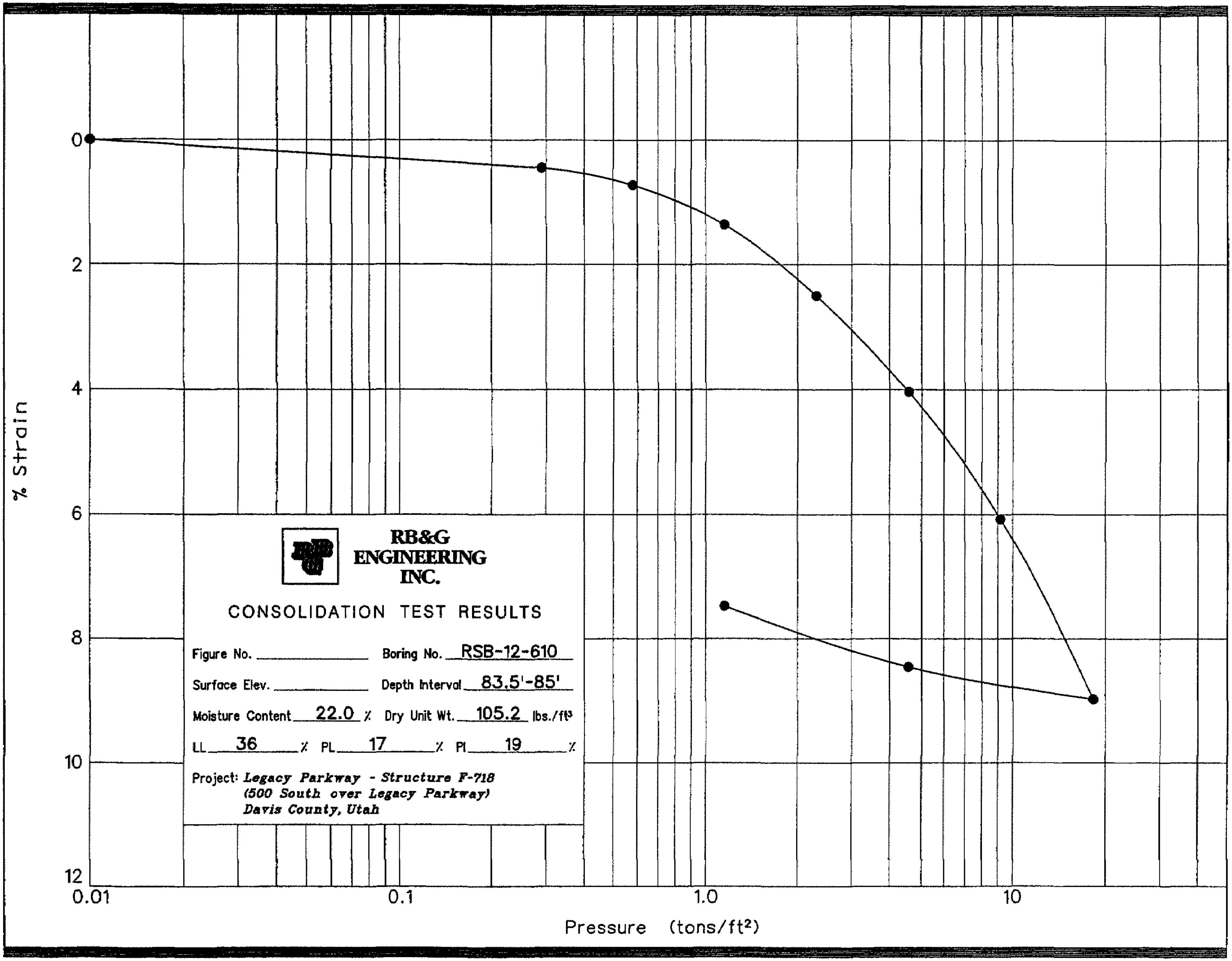
TIME CONSOLIDATION

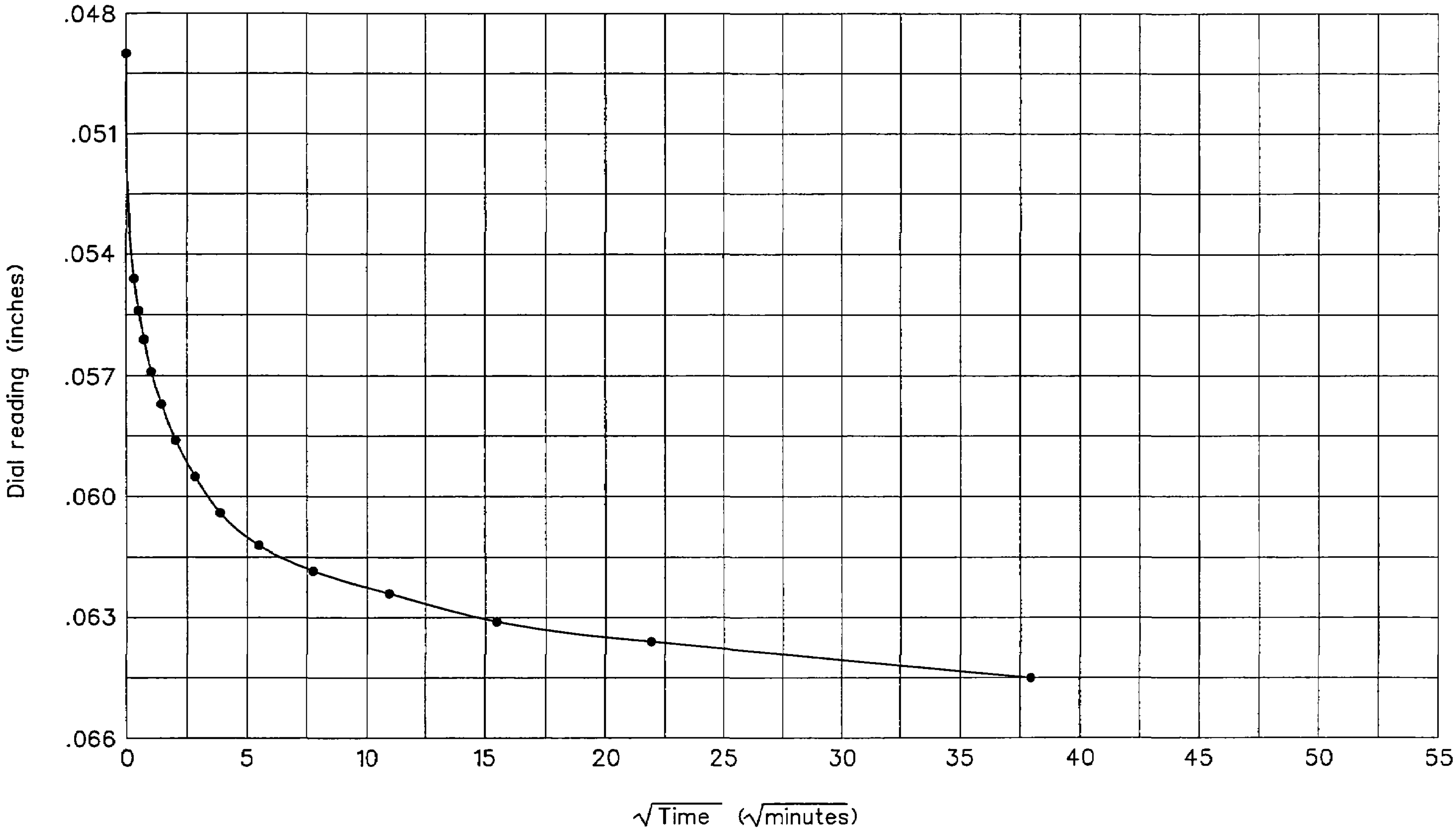
Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



.60
.55
.50
.45
.40
.35
.30
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 83.5'-85'
Moisture Content 22.0 %
Dry Unit Wt. 105.2 lbs./ft³
LL 36 %
PL 17 %
PI 19 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah


% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 83.5'-85'
Moisture Content 22.0 % Dry Unit Wt. 105.2 lbs./ft³
LL 36 % PL 17 % PI 19 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



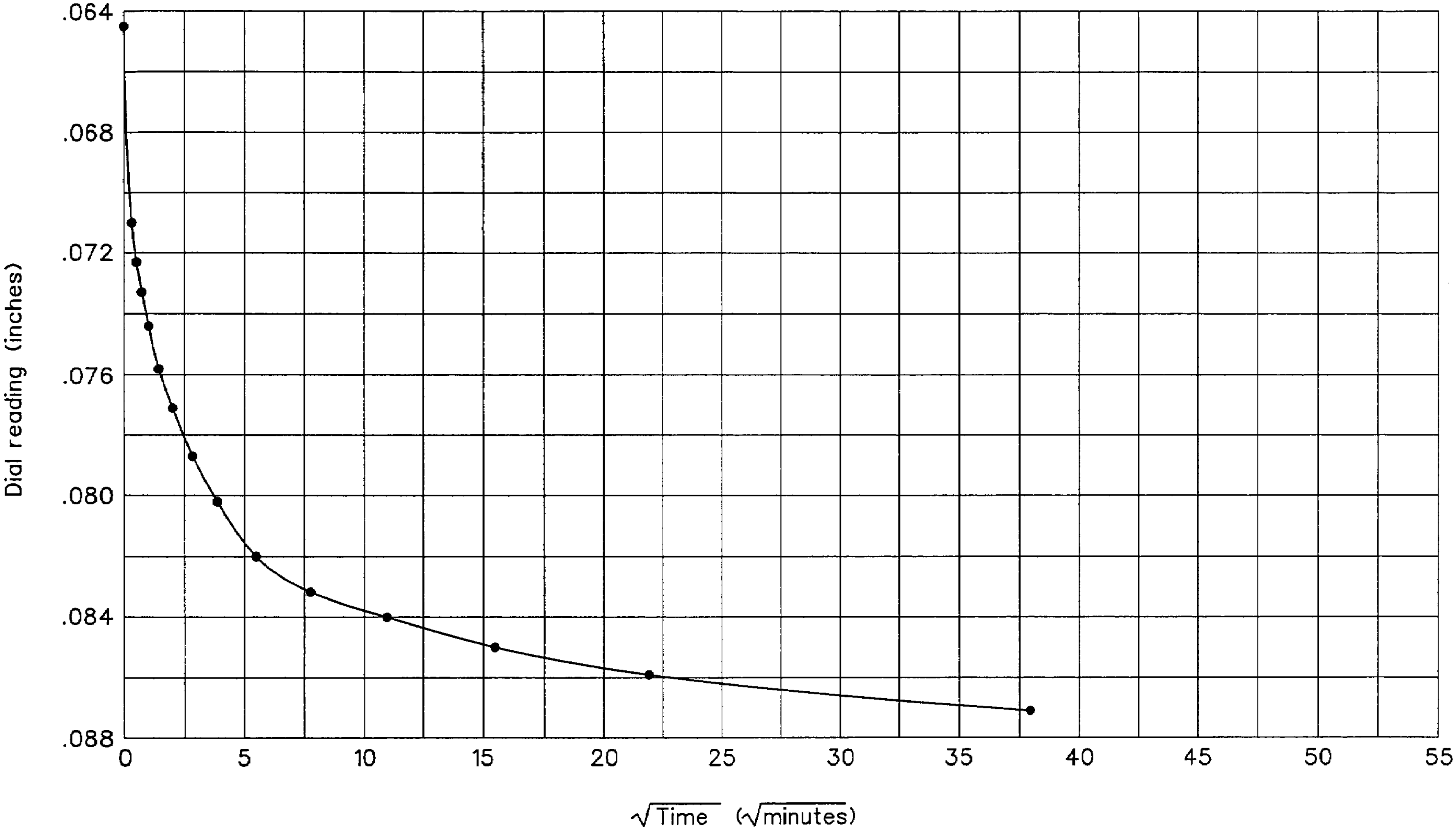
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 83.5'-85'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



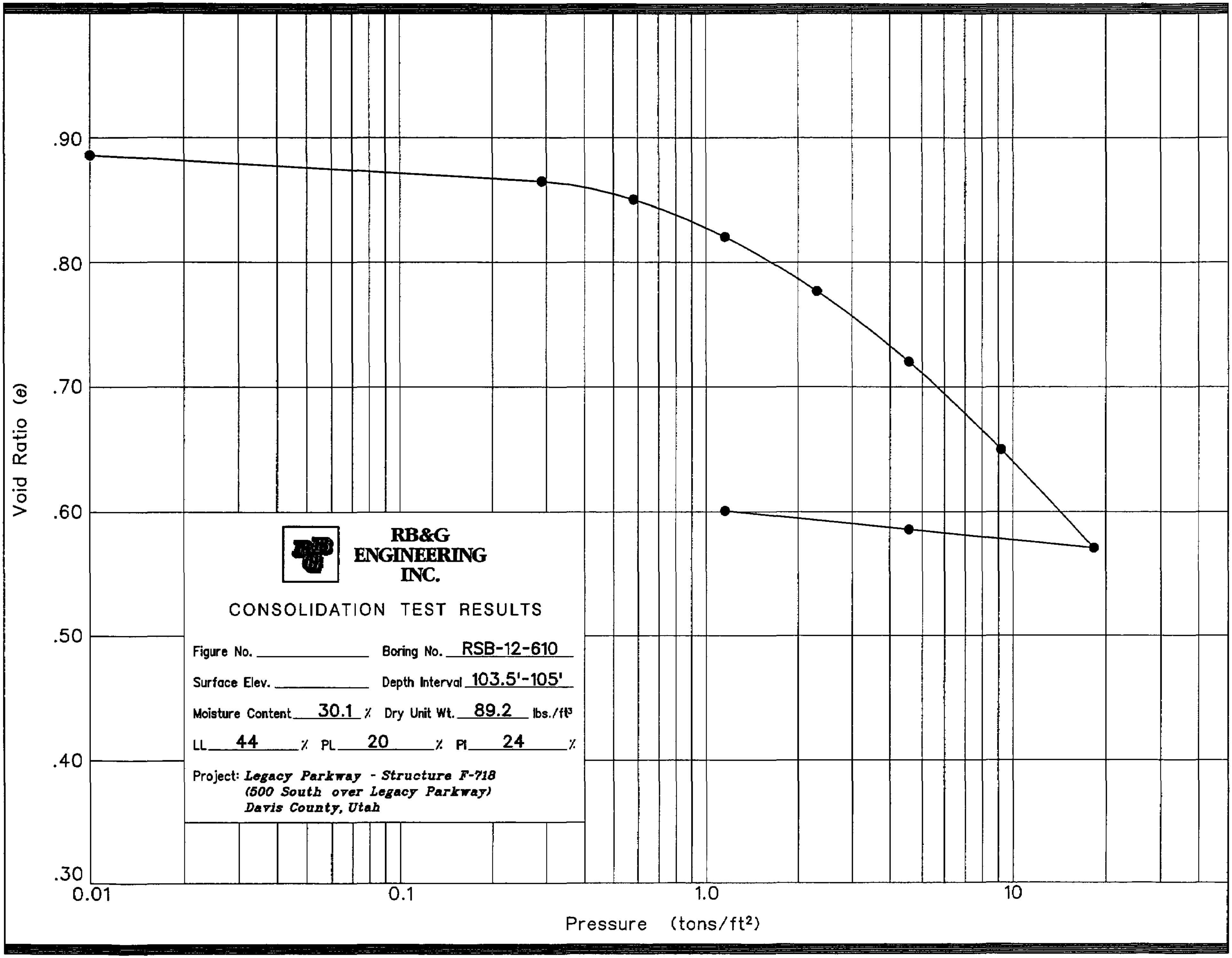
RB&G ENGINEERING INC.
Provo, Utah

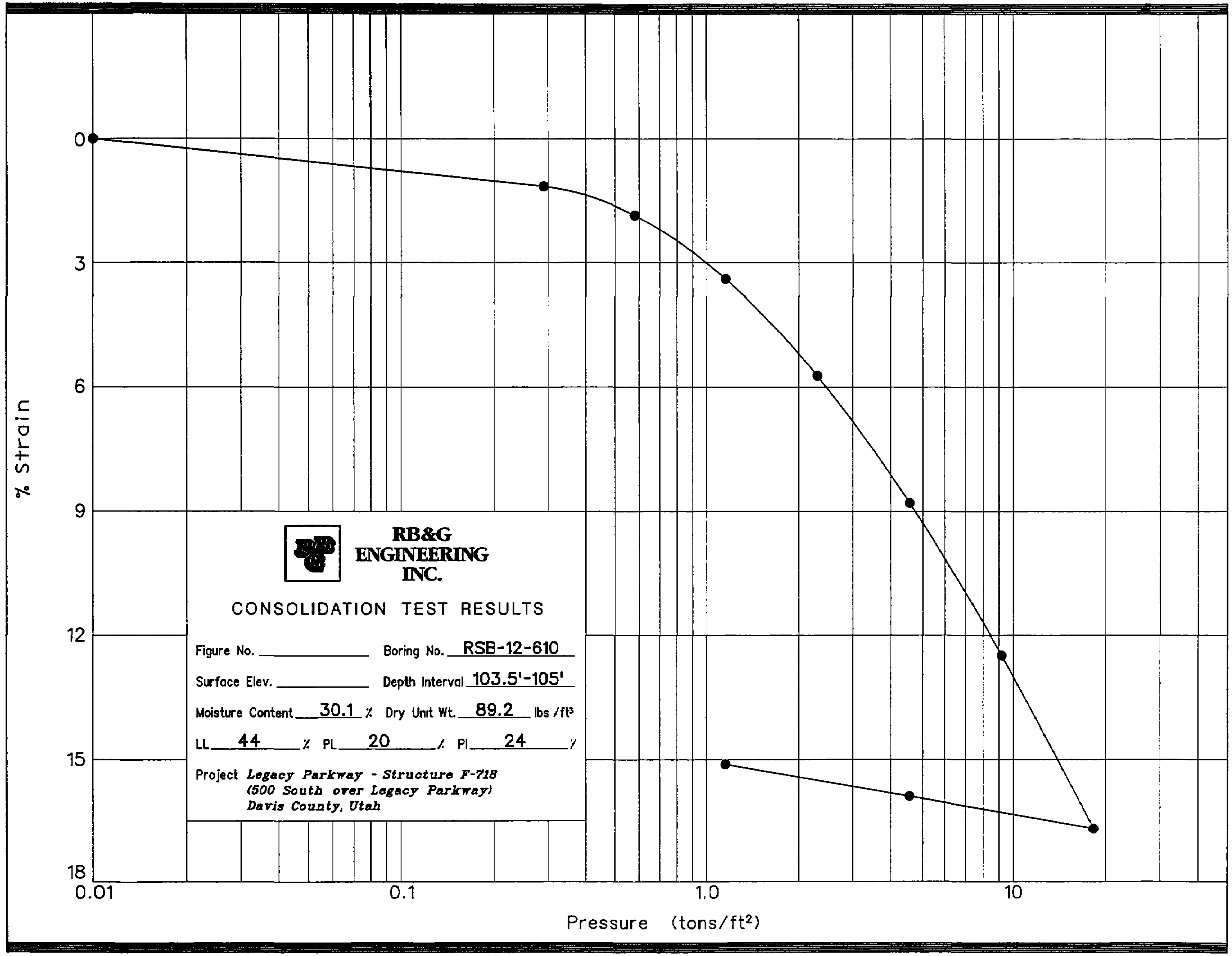
Hole no.:	RSB-12-610
Depth:	83.5'-85'
Load:	9.20 to 18.40 tons

TIME CONSOLIDATION

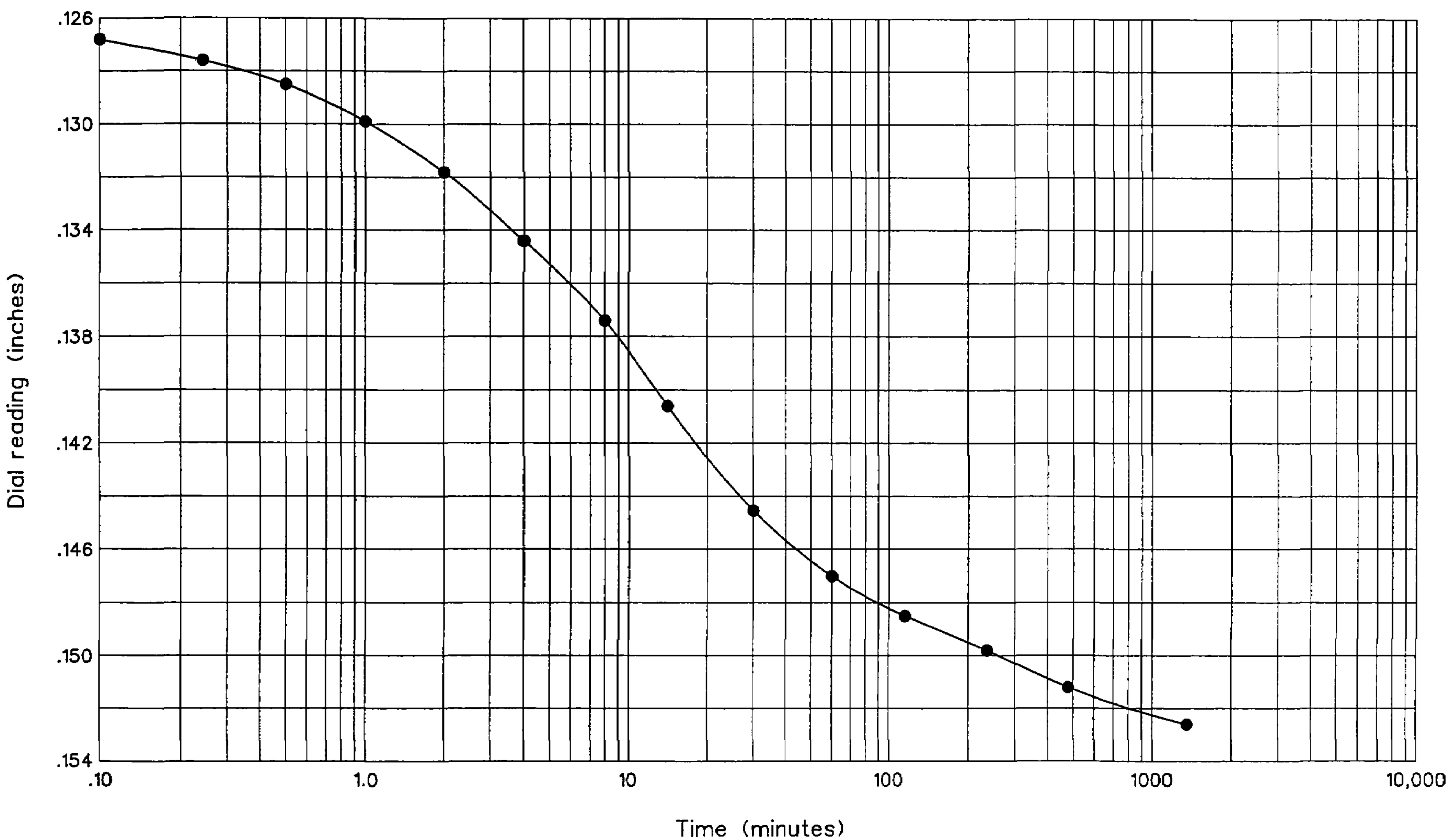
Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 103.5'-105'
Moisture Content 30.1 % Dry Unit Wt. 89.2 lbs./ft³
LL 44 % PL 20 % PI 24 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah
Void Ratio (e)
.90
.80
.70
.60
.50
.40
.30
0.01
0.1
1.0
10
Pressure (tons/ft²)



% Strain
0
3
6
9
12
15
18
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 103.5'-105'
Moisture Content 30.1 % Dry Unit Wt. 89.2 lbs /ft³
LL 44 % PL 20 % PI 24 %
Project Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



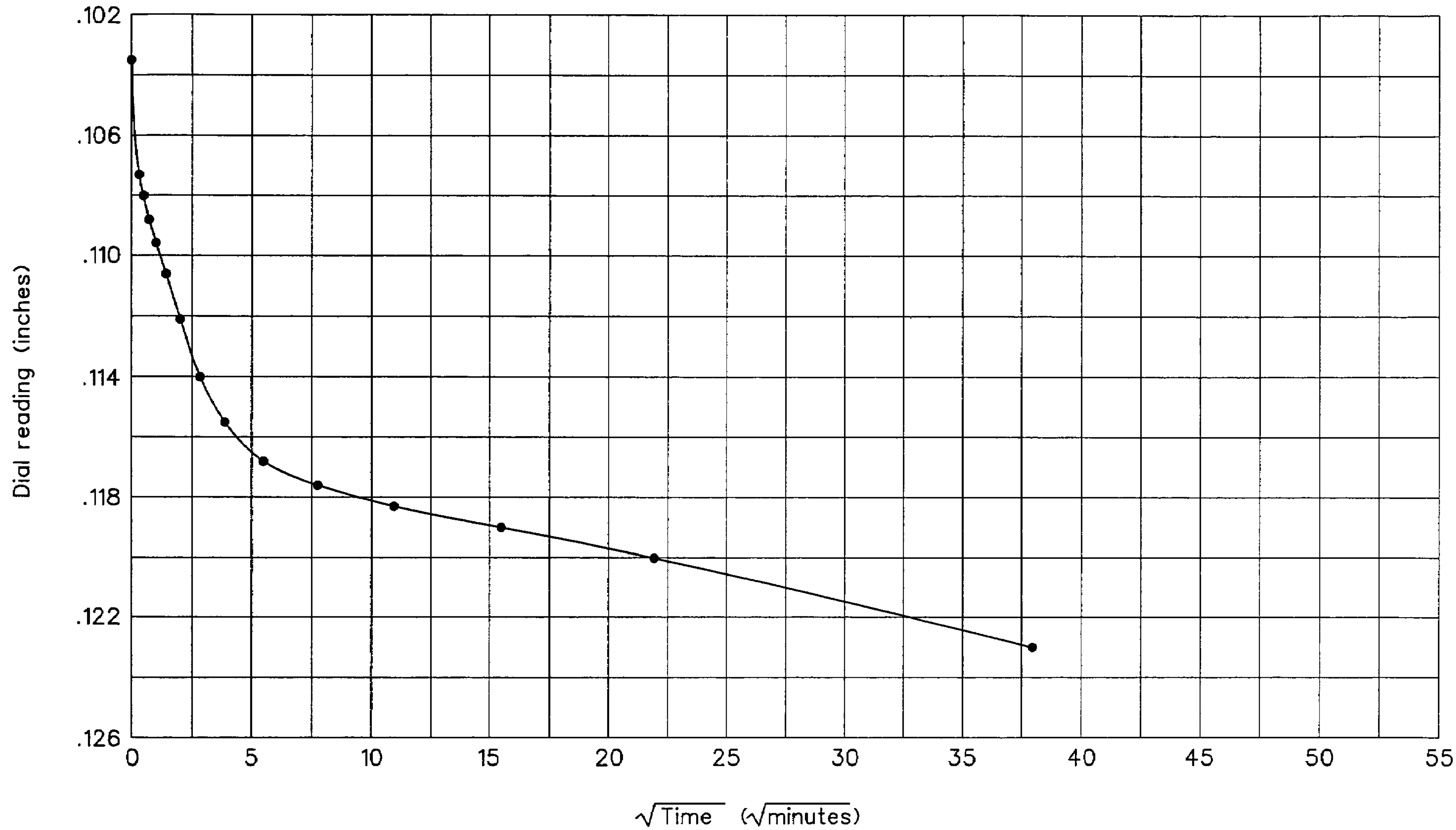
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 103.5'-105'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



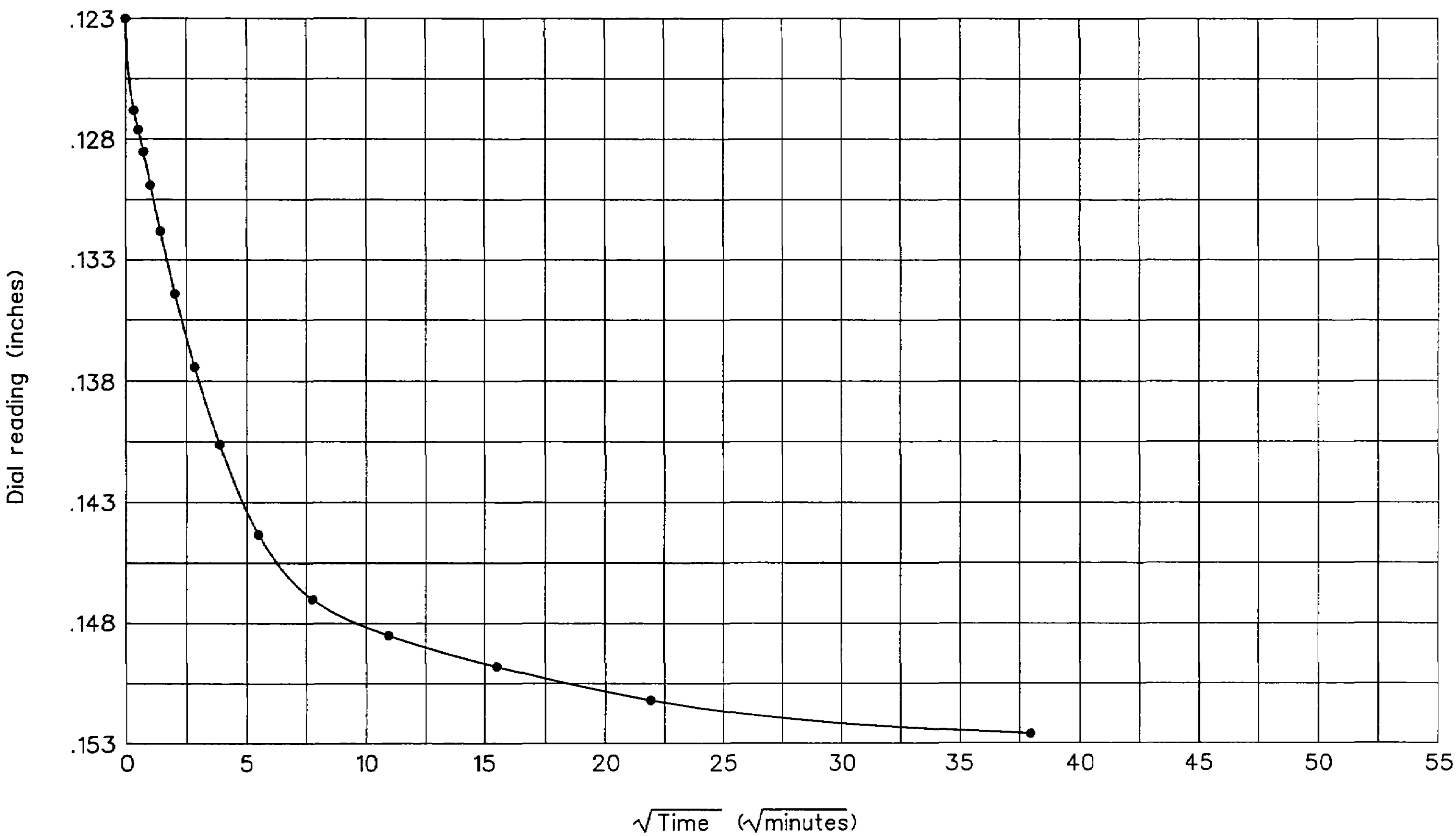
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 103.5'-105'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



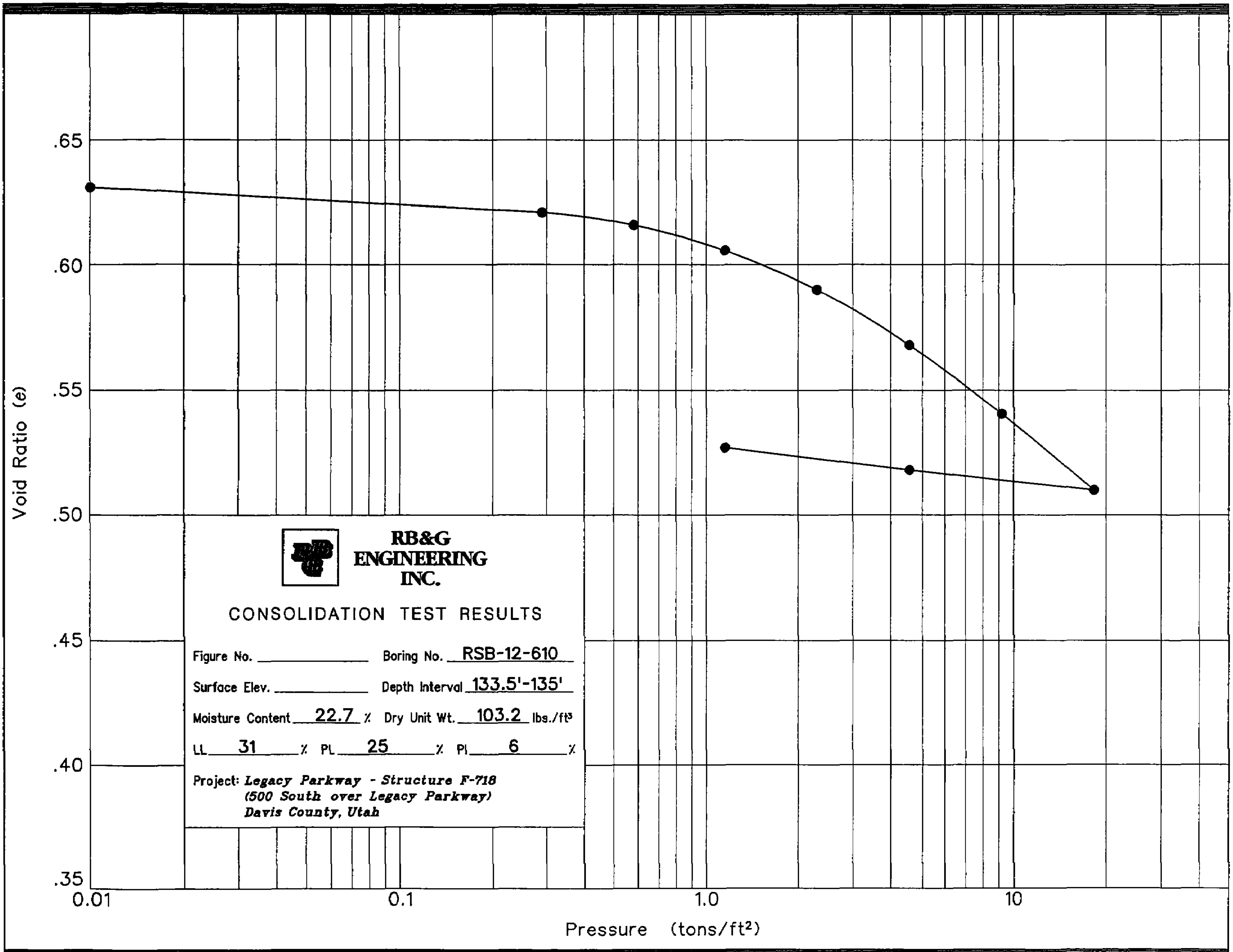
Hole no.:	RSB-12-610
Depth:	103.5'-105'
Load:	9.20 to 18.40 tons

RB&G ENGINEERING INC.
Provo, Utah

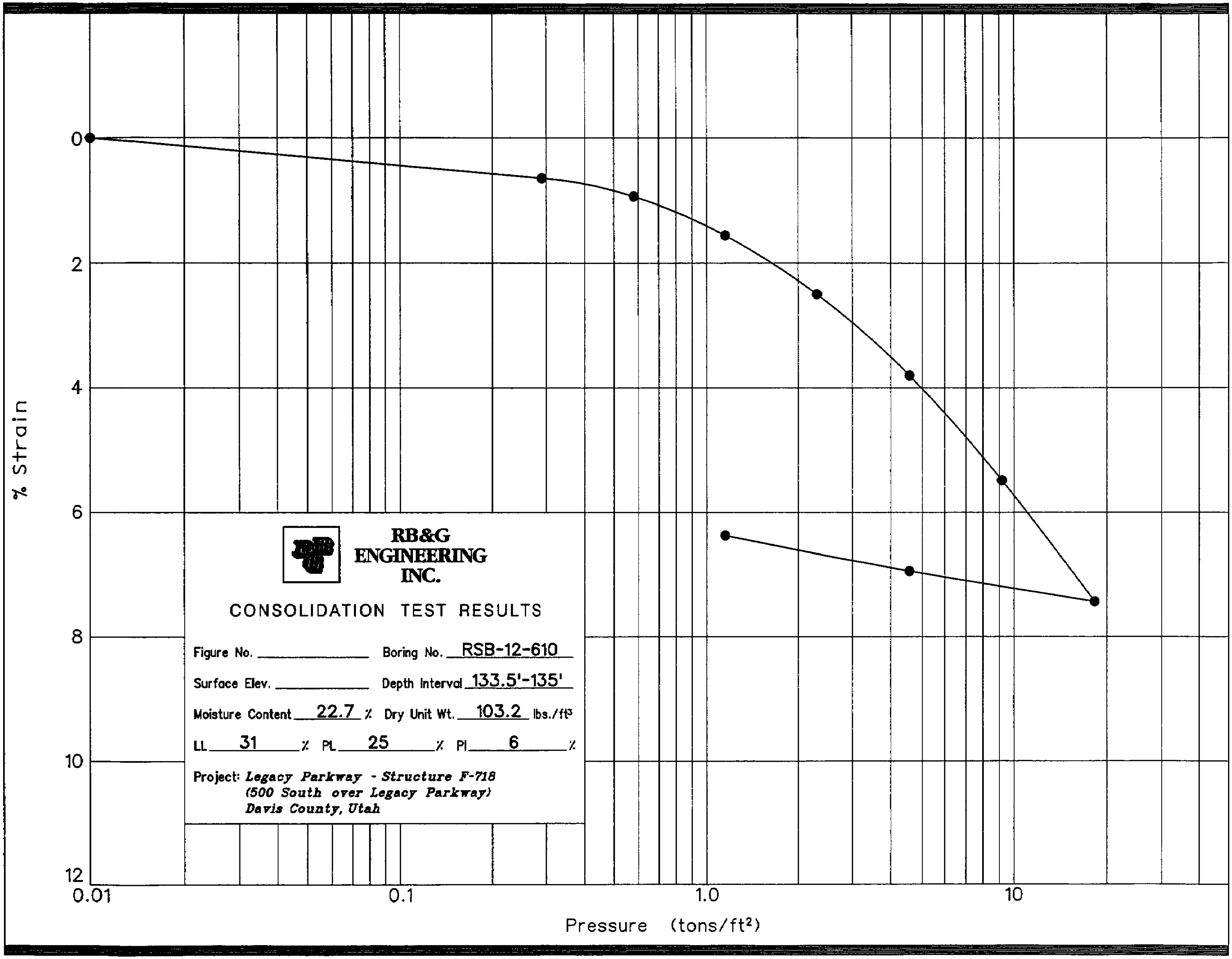
TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

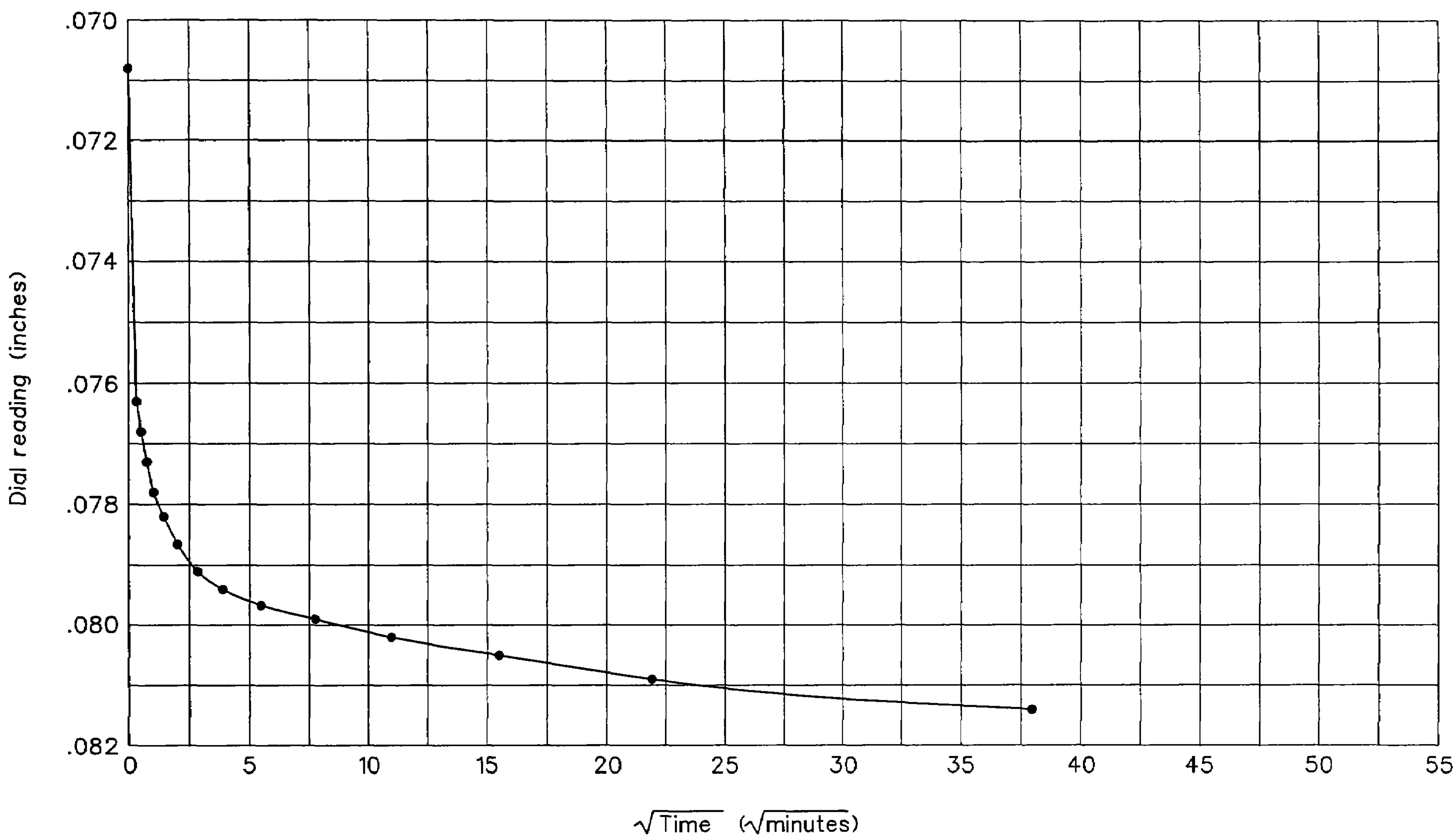
Figure



.65
.60
.55
.50
.45
.40
.35
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 133.5'-135'
Moisture Content 22.7 %
Dry Unit Wt. 103.2 lbs./ft³
LL 31 %
PL 25 %
PI 6 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-610
Surface Elev.
Depth Interval 133.5'-135'
Moisture Content 22.7 % Dry Unit Wt. 103.2 lbs./ft³
LL 31 % PL 25 % PI 6 %
Project: Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah



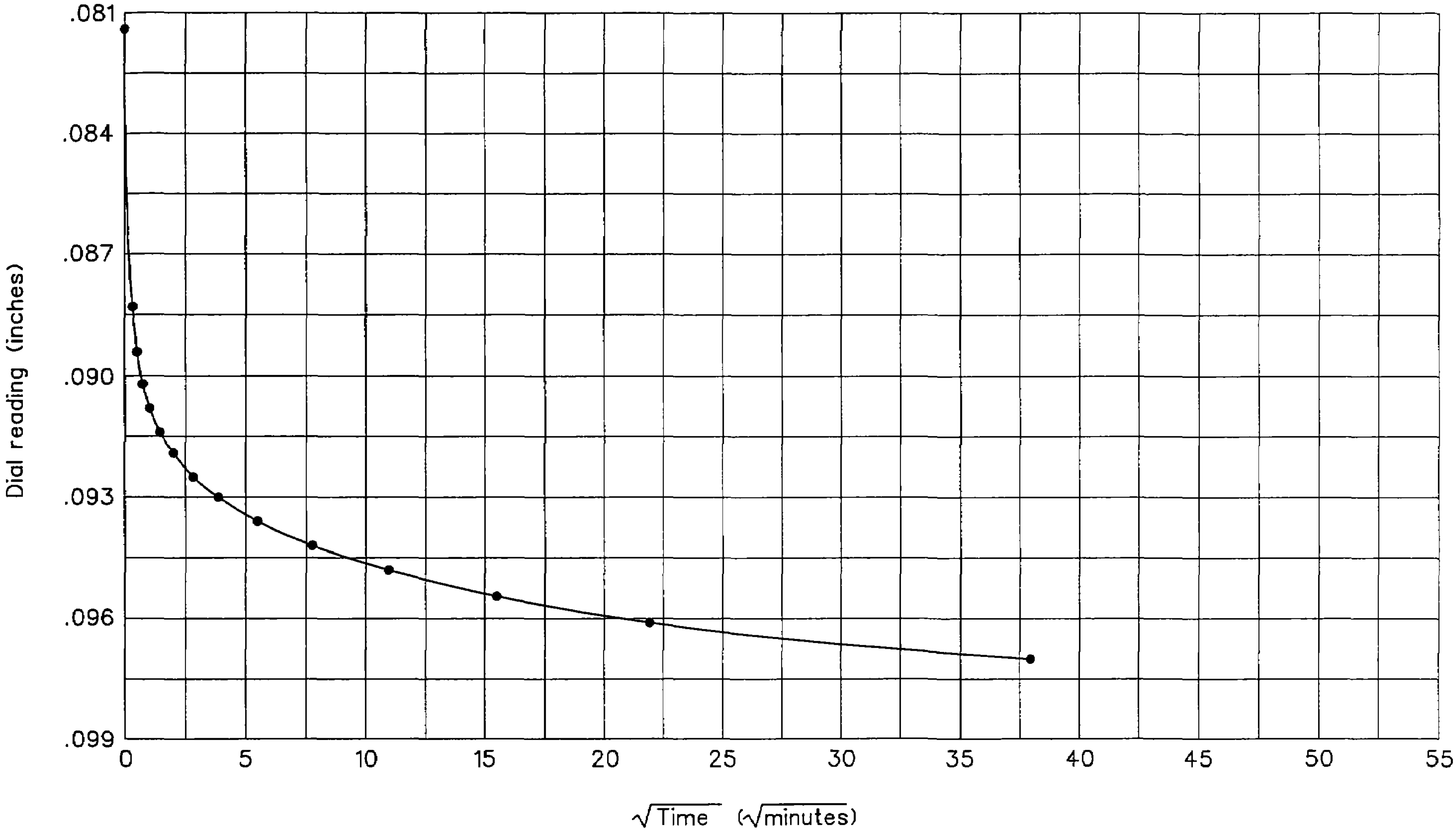
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 133.5'-135'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-610
Depth: 133.5'-135'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure F-718
(500 South over Legacy Parkway)
Davis County, Utah

Figure

D-843

500 South over Multi-Use Trail

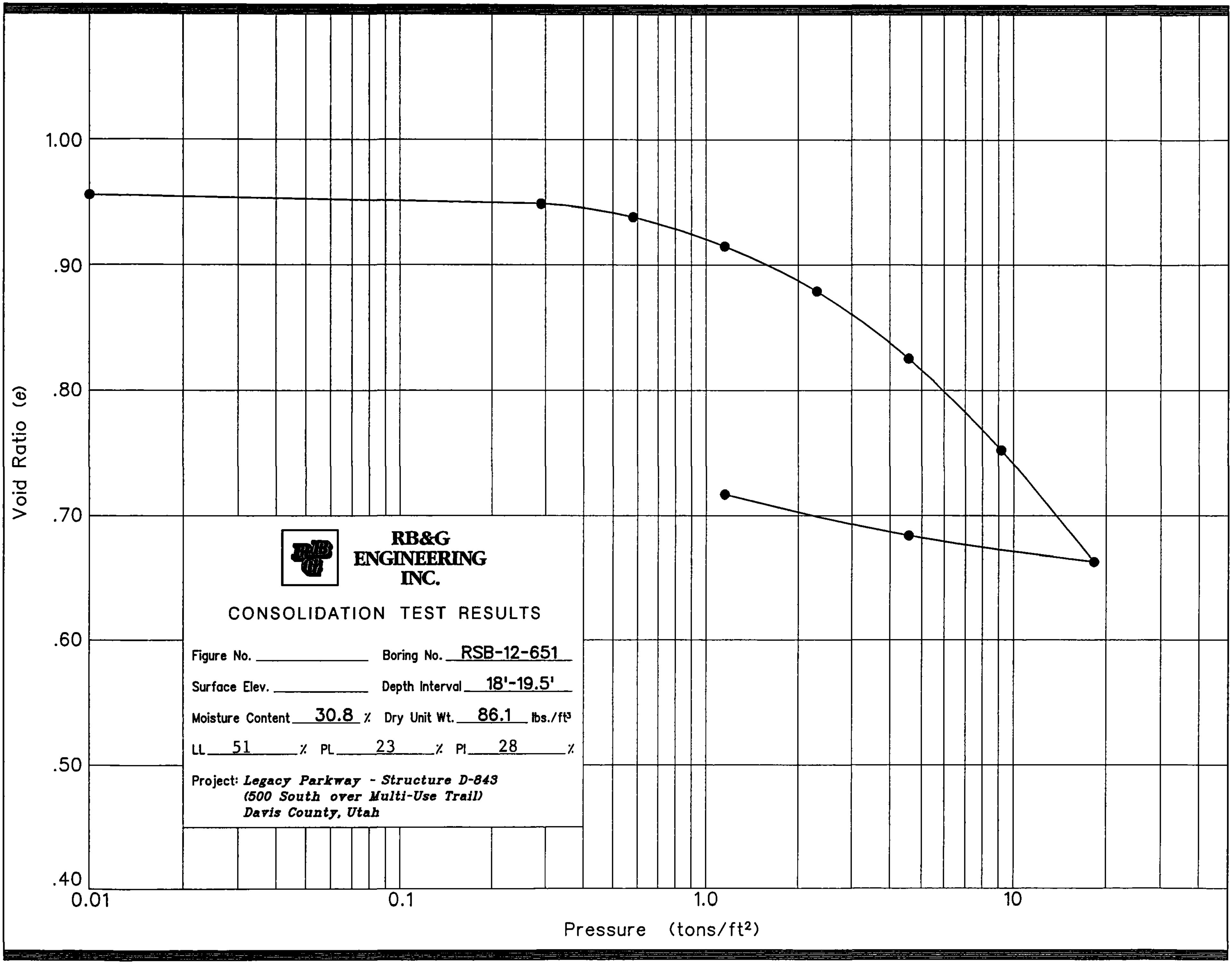
Table 1

SUMMARY OF TEST DATA

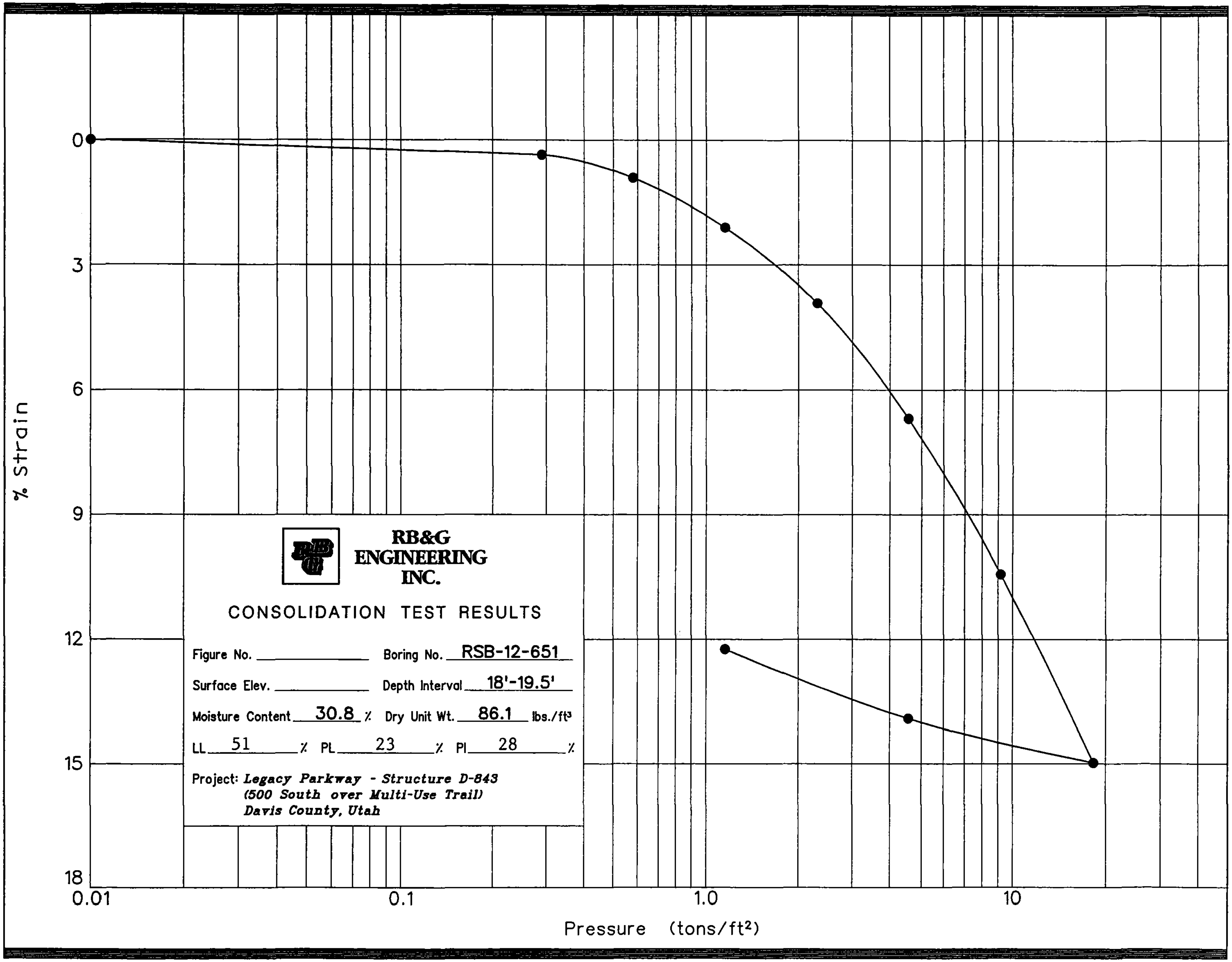
PROJECT Legacy Parkway Structure No. D-843 PROJECT NO. 200601-146
LOCATION 500 South over Multi-Use Trail FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO Classification)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
RSB-12-651	6-7.5	Shelby	102.1	23.4	2568	32	19	13	0	1	99	CL / A-6(13)
	13.5-15	11		26.6		27	20	7	0	33	67	CL / A-4(3)
	18-19.5	Shelby	86.1	30.8	1258	51	23	28	0	4	96	CH / A-7-6(30)
	35-36.5	Shelby	101.6	20.3	3177	34	16	18	0	8	92	CL / A-6(16)
	46.5-48	14		26.1		28	21	7	0	12	88	CL / A-4(5)
	55-56.5	Shelby	96.2	24.2	3435	38	18	20	0	10	90	CL / A-6(18)
	76.5-78	25		24.4		22	21	1	0	22	78	ML / A-4(0)

NP=Nonplastic



1.00
.90
.80
.70
.60
.50
.40
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-651
Surface Elev.
Depth Interval 18'-19.5'
Moisture Content 30.8 %
Dry Unit Wt. 86.1 lbs./ft³
LL 51 %
PL 23 %
PI 28 %
Project: Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

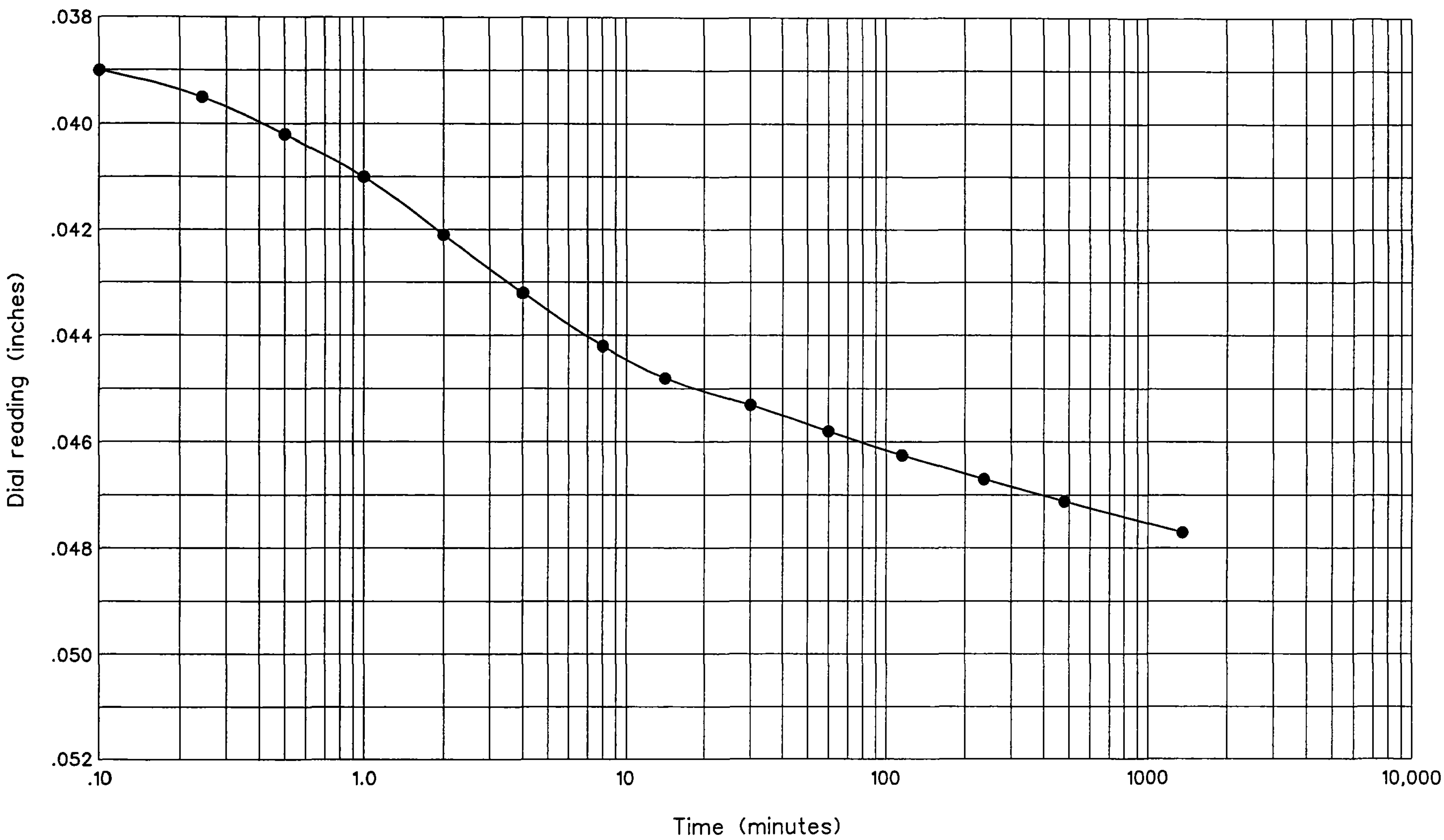
Figure No. ________ Boring No. RSB-12-651

Surface Elev. ________ Depth Interval 18'-19.5'

Moisture Content 30.8 % Dry Unit Wt. 86.1 lbs./ft³

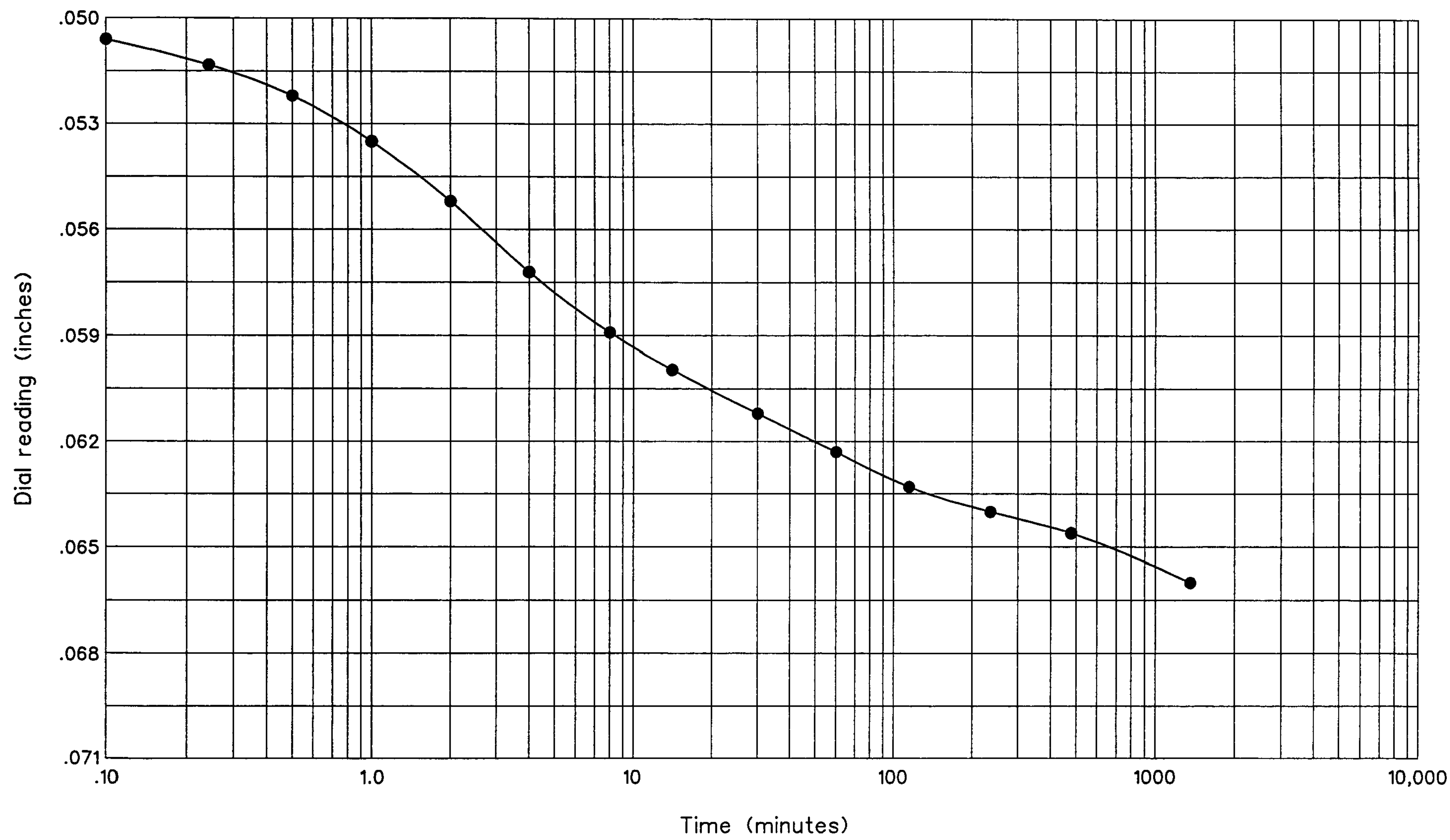
LL 51 % PL 23 % PI 28 %

Project: *Legacy Parkway - Structure D-843*
(500 South over Multi-Use Trail)
Davis County, Utah



RB&G ENGINEERING INC. Provo, Utah	Hole no.: RSB-12-651 Depth: 18'-19.5' Load: 1.15 to 2.30 tons	TIME CONSOLIDATION *Legacy Parkway - Structure D-843* *(500 South over Multi-Use Trail)* *Davis County, Utah*

Figure



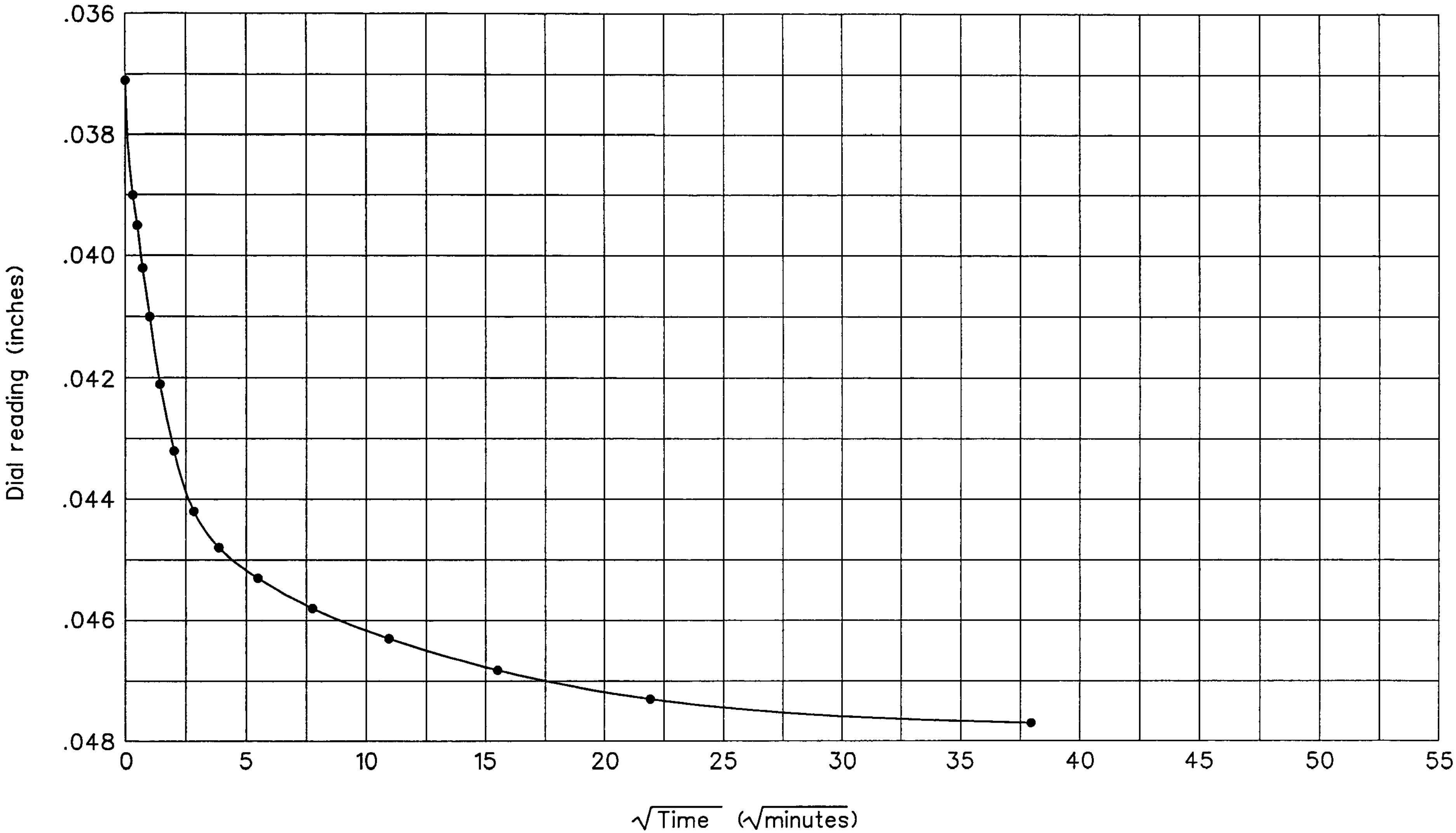
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-651
Depth: 18'-19.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure



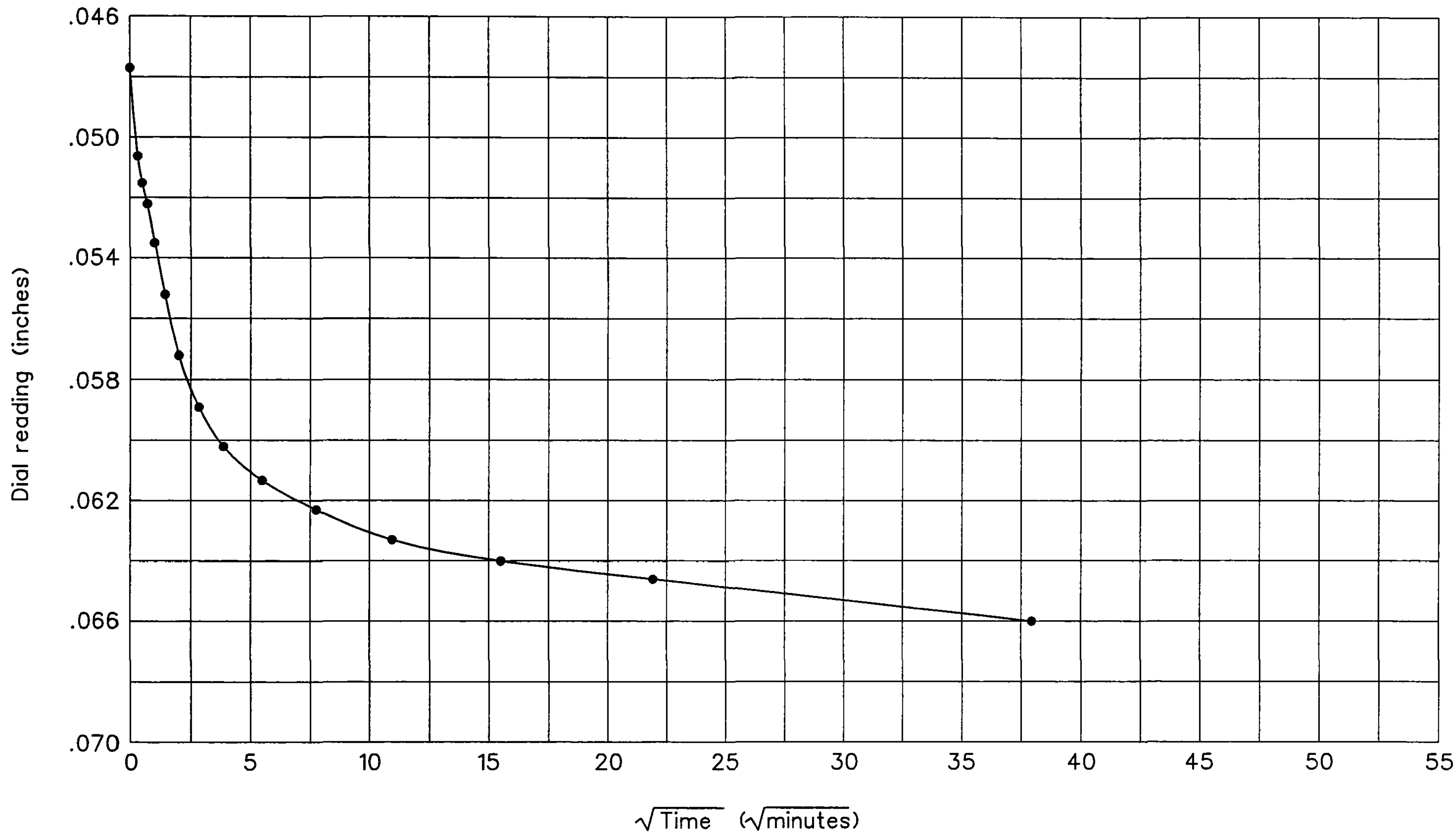
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-651
Depth: 18'-19.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure



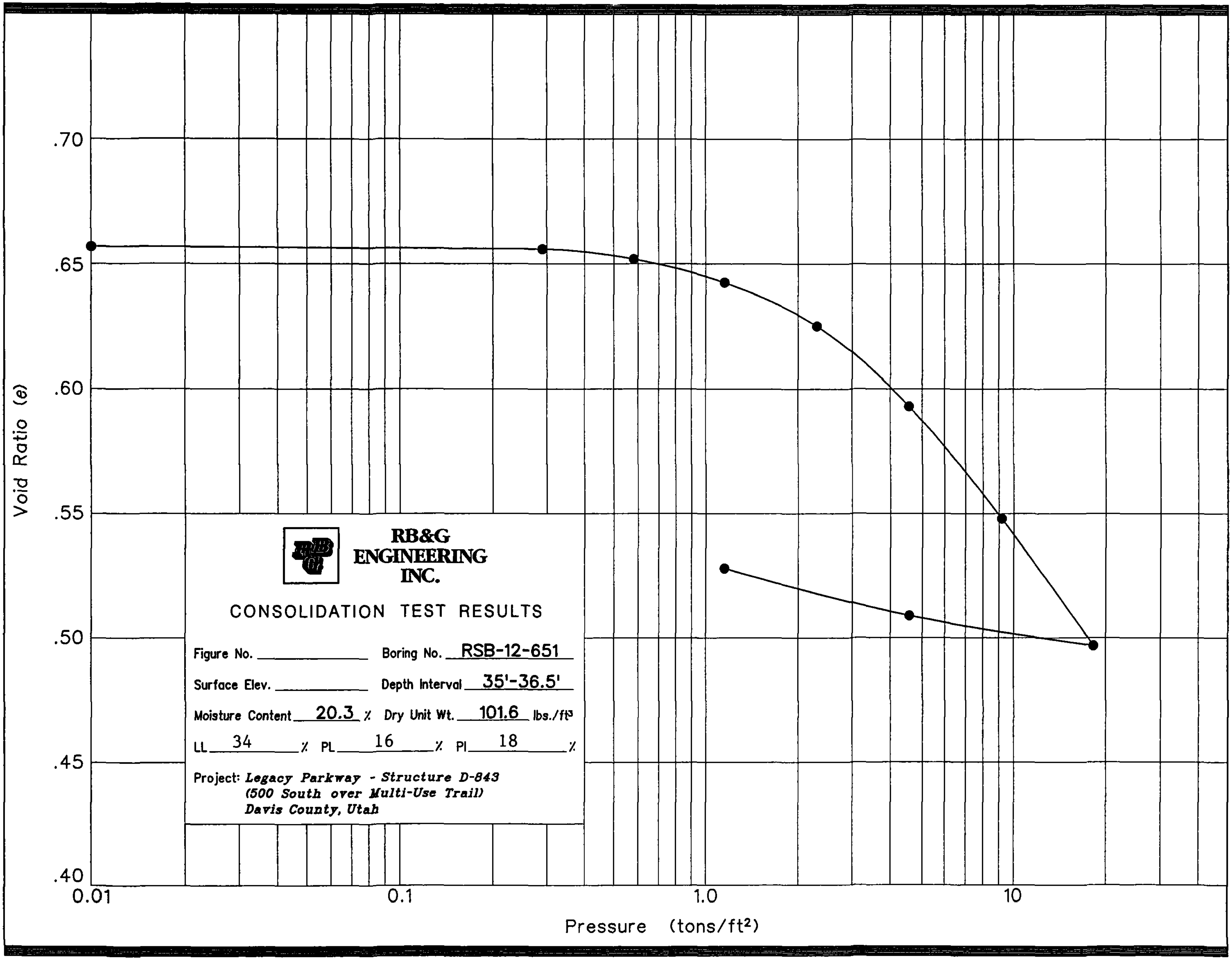
RB&G ENGINEERING INC.
Provo, Utah

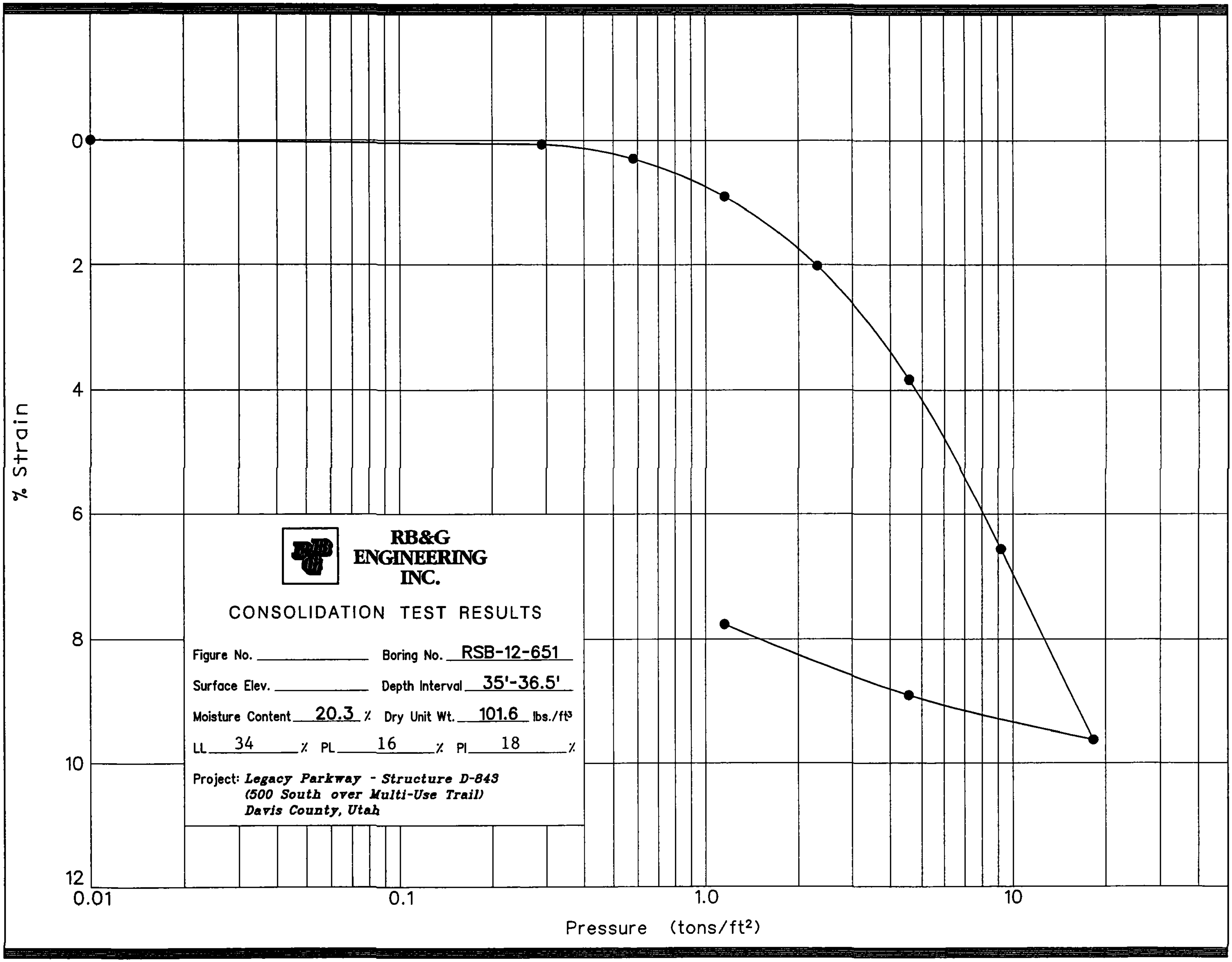
Hole no.: RSB-12-651
Depth: 18'-19.5'
Load: 2.30 to 4.60 tons

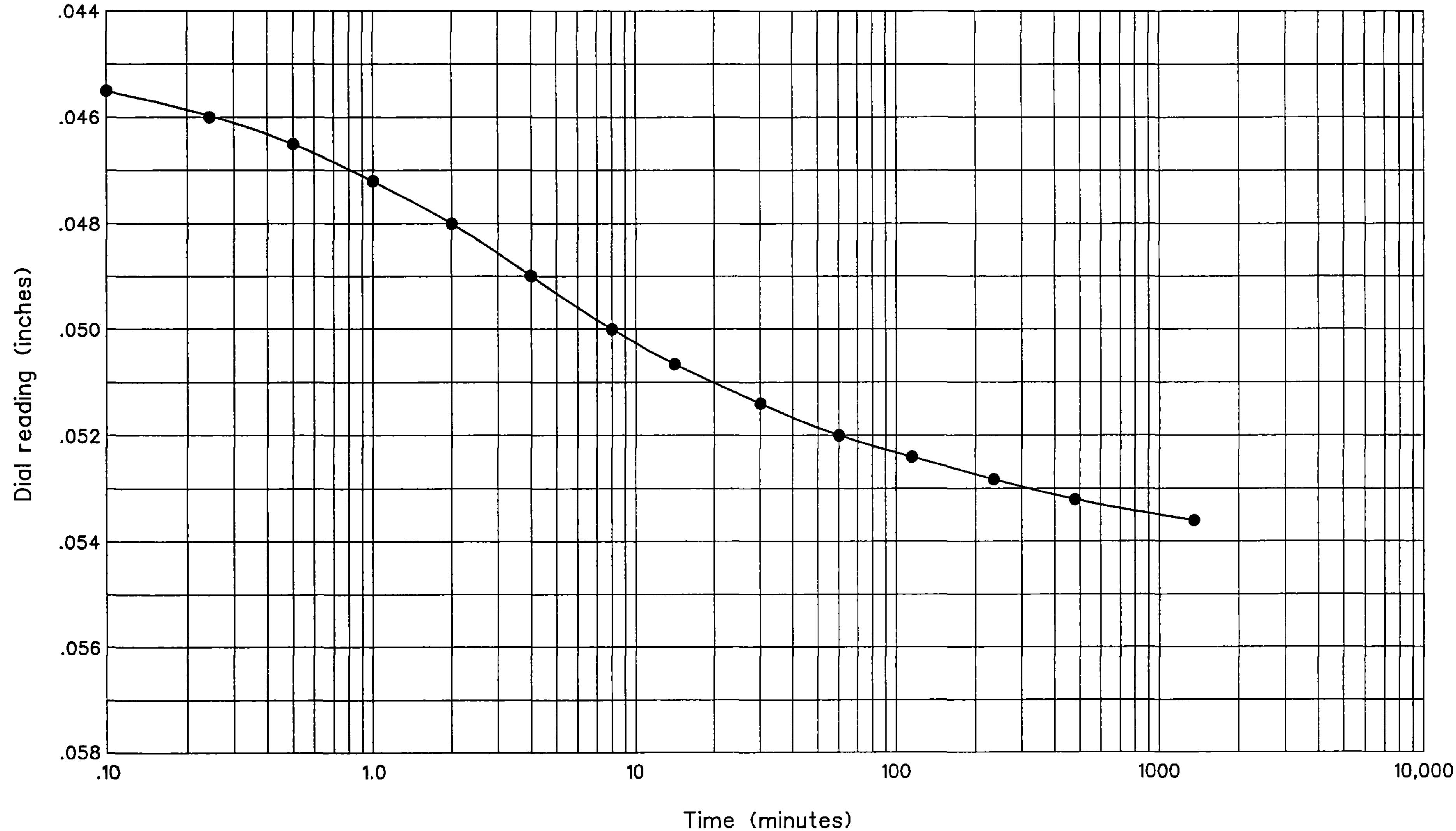
TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure


.70
.65
.60
.55
.50
.45
.40
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No. ______ Boring No. RSB-12-651
Surface Elev. ______ Depth Interval 35'-36.5'
Moisture Content 20.3 % Dry Unit Wt. 101.6 lbs./ft³
LL 34 % PL 16 % PI 18 %
Project: Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah


RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. RSB-12-651
Surface Elev.
Depth Interval 35'-36.5'
Moisture Content 20.3 %
Dry Unit Wt. 101.6 lbs./ft³
LL 34 %
PL 16 %
PI 18 %
Project: Legacy Parkway - Structure D-843 (500 South over Multi-Use Trail) Davis County, Utah
% Strain
0
2
4
6
8
10
12
0.01
0.1
1.0
10
Pressure (tons/ft²)



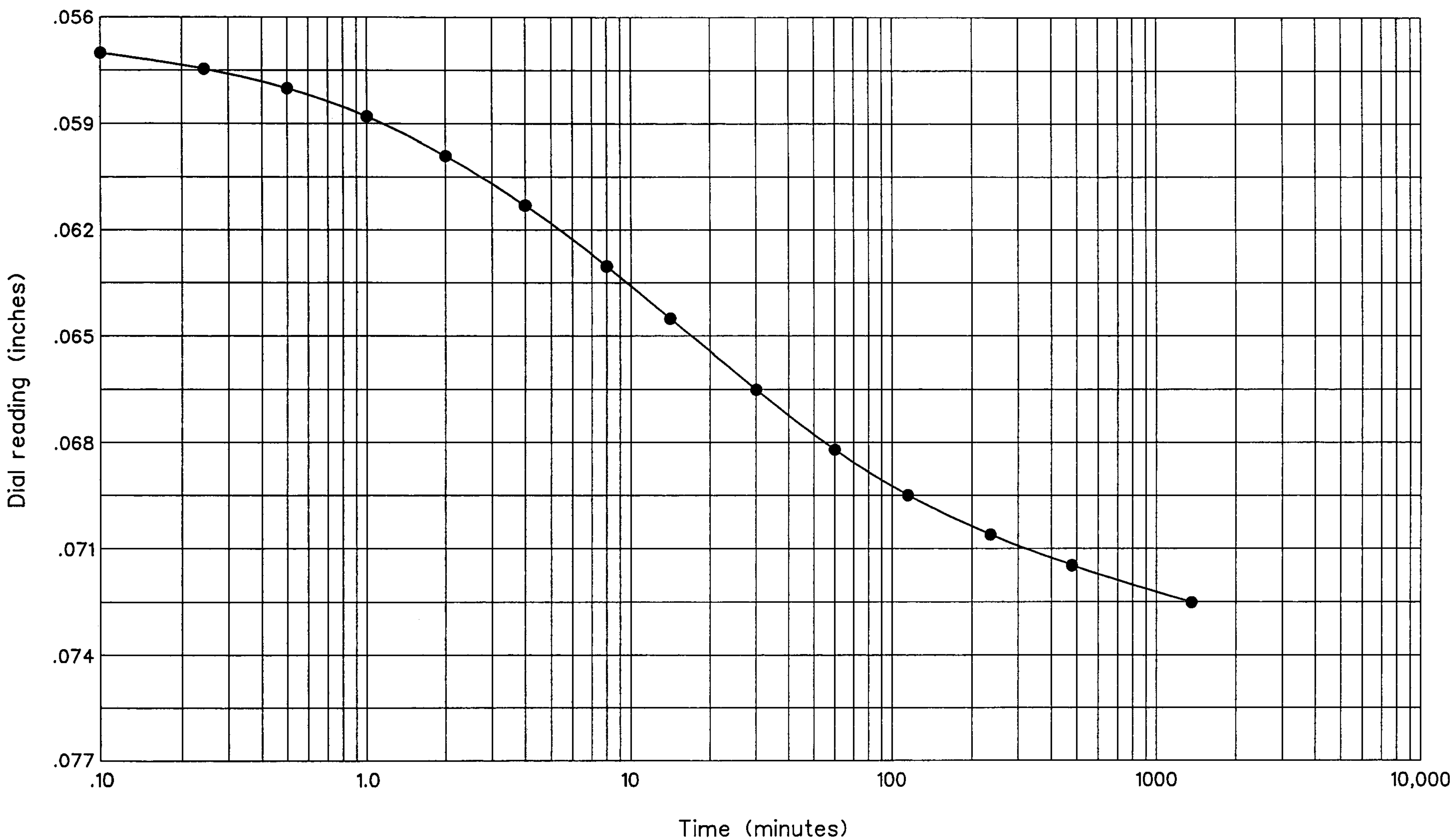
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-651
Depth: 35'-36.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure



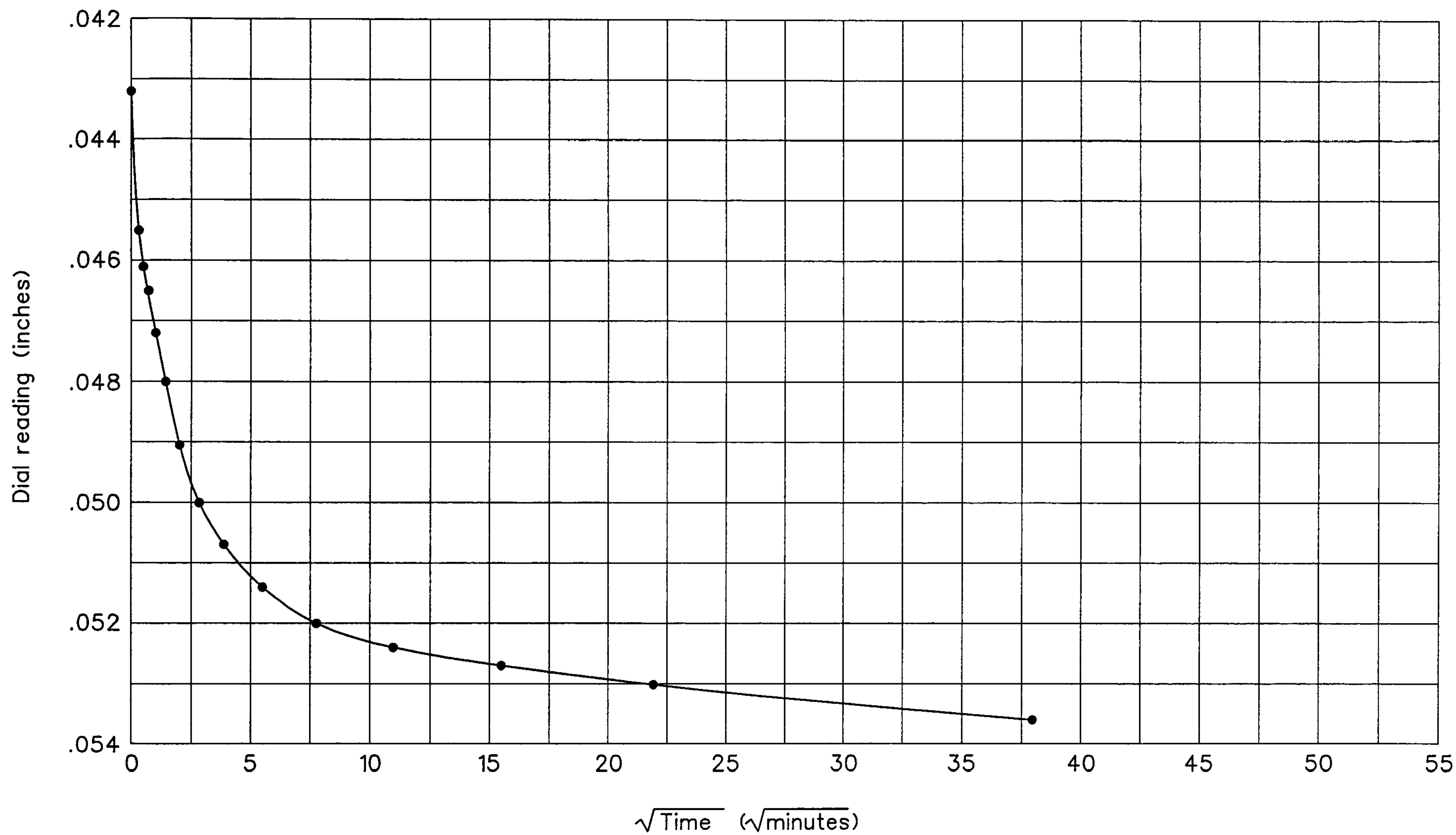
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-651
Depth: 35'-36.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure



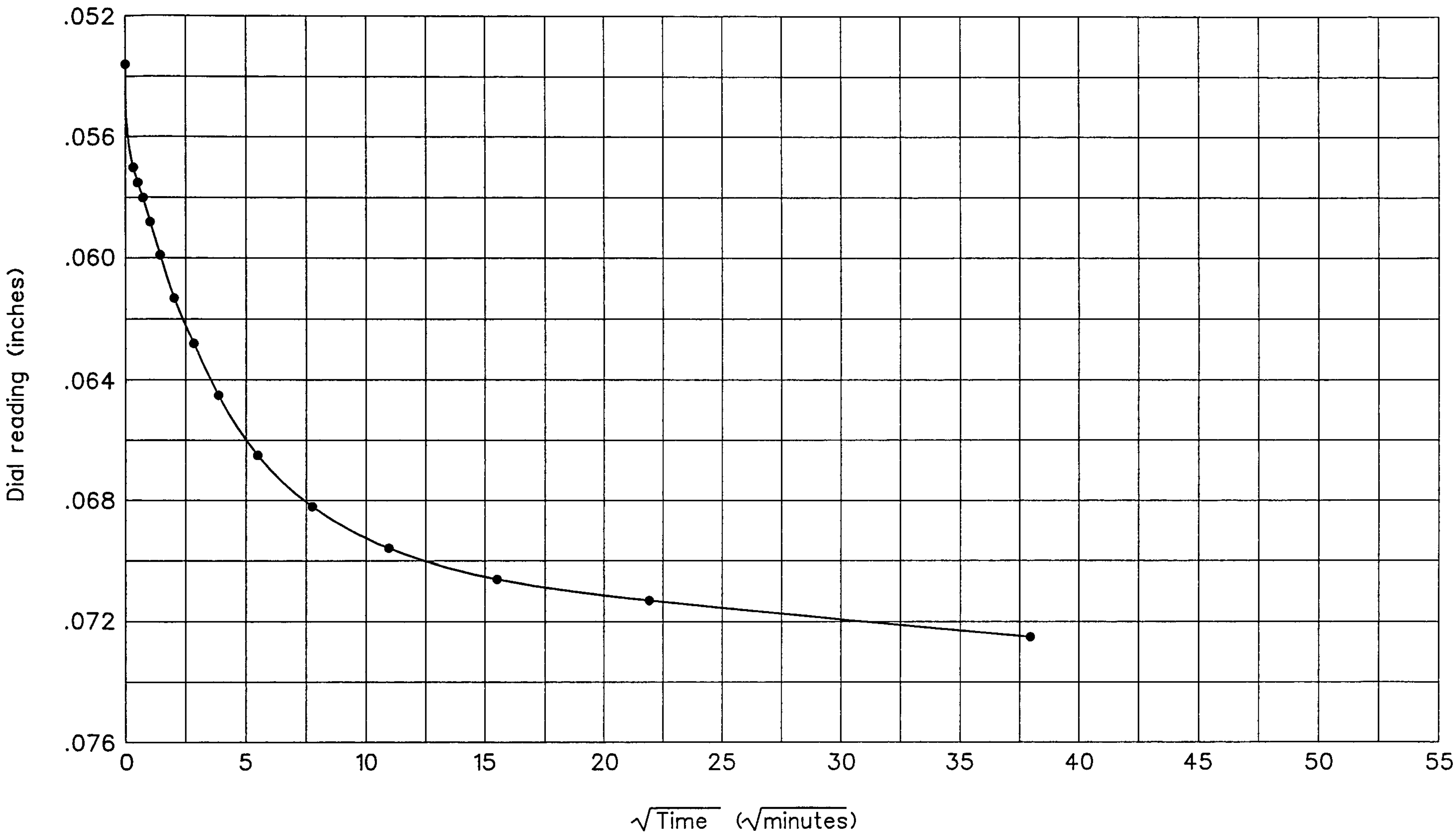
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-651
Depth: 35'-36.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure



RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-12-651
Depth: 35'-36.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure D-843
(500 South over Multi-Use Trail)
Davis County, Utah

Figure

Recommendations for LPILE and GROUP analyses.

Project: Legacy Parkway
Structure No: F-718 FAK No: 12
Description: 500 South over Legacy Parkway

by: srj
date: 7/22/2006

Exist. Ground Surface Elev: 4223 ft
Est. Pile Tip Elev: 4105 ft
Pile Length Below Ground: 118 ft

Pile Type: Closed-End Pipe Pile
Size: 16 inch O.D.
Water Table: Upper 5 feet

Soil Layers

Thickness (ft)	Top Elev (ft)	Bottom Elev (ft)	Soil Type (p-y model)	Eff. Unit Wt. (pci)	Cohesion (psi)	Strain Factor ε_{50}	Friction Angle (degrees)	p-y Modulus, k (pci)	Max Unit Resistance Side (psi)	Max Unit Resistance End (psi)
18	4223	4205	Soft Clay (Matlock)	0.033	3.5	0.020	0	30	3.4	0
12	4205	4193	Soft Clay (Matlock)	0.025	5.5	0.015	0	45	5.2	0
8	4193	4185	Liquefiable Sand	0.030	0	0	0	10	2.0	0
22	4185	4163	Soft Clay (Matlock)	0.033	9.7	0.01	0	100	8.0	0
22	4163	4141	Soft Clay (Matlock)	0.039	10.0	0.01	0	100	8.9	0
18	4141	4123	Soft Clay (Matlock)	0.032	5.5	0.015	0	45	5.5	0
30	4123	4093	Soft Clay (Matlock)	0.033	9.7	0.010	0	100	8.0	87.4

Other Considerations

Corrosion of Pipe Pile

Reduce Pipe pile wall thickness by 1/16 inch to account for corrosion.

Group Effects

Use P-Multipliers for pile groups as outlined in AASHTO LRFD 2006 Interim Section 10.7.2.4

Abutment Fill

For the length of the pile extending through the abutment fill:
For Effective Unit Weights use 0.069 pci (regular weight) or 0.046 pci (pumice)
Assume Friction Angle of 38 degrees. Consider reduced parameters for loading towards MSE wall face.

MSE Walls

For piles located less than 6B from MSE wall, use P-Multiplier of 0.3 or less for the MSE fill layer when loading is perpendicular to MSE wall face. MSE wall designer should be notified if MSE fill will be relied upon for lateral pile resistance.

Legacy Parkway Project

Summary of Lateral Earth Pressure Recommendations

Recommended Soil Parameters

Fill Description	Total Unit Weight (pcf)	Internal Friction Angle (degrees)	Cohesion (psf)	Comments
Sandy Gravel	150	38	0	Recommend 150 pcf and 38 degrees for loads, and 125 pcf and 34 degrees for resistance.*
Silty Sand	125	34	0	
Pumice	85	38	0	Recommend 85 pcf for loads and 80 pcf for resistance.*

*Recommendations per Memo dated April 18, 2006

In the equations listed herein:
- γ = effective unit weight of soil
- H = height of wall

(1) Active Lateral Earth Force (yielding walls)

$P_A = 0.5K_A\gamma H^2$ (triangular distribution)

K_A = 0.24 for Sandy Gravel and Pumice
0.28 for Silty Sand

(2) Passive Lateral Earth Force (yielding walls)

$P_P = 0.5K_P\gamma H^2$ (triangular distribution)

K_P = 4.2 for Sandy Gravel and Pumice
3.5 for Silty Sand

(3) At-Rest Lateral Earth Force (non-yielding walls)

$P_O = 0.5K_O\gamma H^2$ (triangular distribution)

K_O = 0.38 for Sandy Gravel and Pumice
0.44 for Silty Sand

(4) At-Rest Lateral Earth Force Modified for Compaction (non-yielding walls)

Use if activity of mechanical compaction equipment is anticipated within a distance equal to half the wall height.

General Equations for walls less than about 8 feet high

$P_O{}^* = 0.5K_O\gamma H^2$ (triangular distribution)

$K_O{}^*$ = 2.8 for Sandy Gravel and Pumice

Walls greater than 8 feet high should be considered on a case-by-case basis. Pressures listed above may be reduced by limiting size of compaction equipment permitted within a distance equal to half the wall height.

(5) Seismic Lateral Earth Forces (yielding walls)

Probabilistic Peak Ground Accelerations

General Bridge Site Location	10% PE in 50 Years	2% PE in 50 Years
From Mill Creek North	0.22g - 0.26g	0.60g - 0.63g
South of Mill Creek	0.26g - 0.30g	0.65g - 0.73g

Equations by Okabe (1926) and Mononobe and Matsuo (1929), referenced in Kramer (1996)

Total Active Thrust

$P_{AE} = 0.5K_{AE}\gamma H^2$

K_{AE} = (see table below)

Dynamic Component

$\Delta P_{AE} = P_{AE} - P_A$

P_A has triangular distribution (resultant at H/3 above base of wall)

ΔP_{AE} acts at about 0.6H above base of wall (same direction as P_A)

(5) Seismic Lateral Earth Forces (continued from previous page)

Total Passive Thrust

$P_{PE} = 0.5K_{PE}\gamma H^2$

K_{PE} = (see table below)

Dynamic Component

$\Delta P_{PE} = P_P - P_{PE}$

P_P has triangular distribution (resultant at H/3 above base of wall)

ΔP_{PE} acts at about 0.6H above base of wall (opposite P_P)

Dynamic Earth Pressure Coefficients (for minimal wall displacement)*

Case	Friction Angle	Peak Ground Acceleration			
		0.25	0.30	0.63	0.73
Active (K_{AE})	38	0.35	0.38	0.65	0.77
	34	0.41	0.44	0.75	0.92
Passive (K_{PE})	38	3.77	3.68	3.01	2.76
	34	3.14	3.05	2.39	2.11

* Assumes k_h = 0.8PGHA. See memo dated April 18, 2006

*Dynamic Earth Pressure Coefficients (for wall displacement up to 10A inches**)*

Case	Friction Angle	Peak Ground Acceleration			
		0.25	0.30	0.63	0.73
Active (K_{AE})	38	0.31	0.32	0.44	0.49
	34	0.36	0.37	0.51	0.56
Passive (K_{PE})	38	3.94	3.89	3.51	3.38
	34	3.29	3.24	2.89	2.77

** Assumes k_h = 0.5PGHA. See memo dated April 18, 2006

(6) Seismic Lateral Earth Pressures (non-yielding walls)

Equations by Wood (1973), referenced in Kramer (1996)

Dynamic Thrust

$\Delta P_{eq} = a_h\gamma H^2$

a_h= Peak Ground Acceleration Coefficient (PGA/g)

Dynamic Overturning Moment

$\Delta M_{eq} = 0.53a_h\gamma H^3$

Point of Application of Dynamic Thrust

$h_{eq} = \Delta M_{eq}/\Delta P_{eq}$

$\approx 0.53H$

References

Kramer, S. (1996). "Geotechnical earthquake engineering," Prentice Hall, Upper Saddle River, NJ.

Mononobe, N. and Matsuo, H. (1929). "On the determination of earth pressures during earthquakes," *Proceedings, World Engineering Congress,* 9 p.

Okabe, S. (1926). "General theory of earth pressures," *Journal of the Japan Society of Civil Engineering*, Vol. 12, No. 1.

RB&G Engineering, Inc.

Memo

To: Sohail T. Khan, P.E; Larry Reasch, P.E.
From: Brad Price / Rob Johnson
CC: Steven K. Doerrer, PE; Brian Byrne, PE
Date: April 18, 2006
Re: Response to Design Criteria Questions

Responses to the questions submitted by Steven Doerrer are listed below. The email listing the questions is also attached for reference:

1) As discussed on last week's conference call (4/26/06), recommended total unit weights for fill material are as follows:

   - Regular-Weight Fill – 150 pcf for load calculations, 125 pcf for resistance calculations
   - Lightweight Fill (Pumice) – 85 pcf for load calculations, 80 pcf for resistance calculations

   It has been noted that the unit weight of regular-weight fill varies widely depending upon the source. However, it is our understanding that it is not desirable to limit the potential regular-weight borrow sources by specifying a permissible range of fill unit weight. In the interest of conservatism, we recommend using the larger unit weight to calculate soil loads, and the smaller unit weight to calculate soil resistance. The following values are recommended for fill friction angle:

   - Regular-Weight Fill – 38 degrees for load calculations, 34 degrees for resistance
   - Lightweight Fill (Pumice) – 38 degrees for load and resistance calculations

2) The Mononobe-Okabe equations are in accordance with AASHTO LRFD A11.1.1.1 and do not include inertia forces. Page 11-85 of the AASHTO LRFD states that it is not conservative to neglect inertia forces of the abutment mass. We believe it is appropriate to add seismic inertia forces of the heel backfill and concrete abutments.

3) The dynamic earth pressure coefficients provided previously, K_{AE} and K_{PE}, are for total active and passive thrust, respectively, and include both static and dynamic components. The dynamic components are ΔK_{AE} and ΔK_{PE} and are computed by subtracting the static force from the total thrust as shown on the memo. It should be noted that the equations by Wood (1973) for non-yielding walls provide only the dynamic thrust components of force and moment, and do not include static components.

4) In the memo dated 04/17/06, the horizontal acceleration coefficient k_h was assumed to be 80% of the peak horizontal ground acceleration coefficient for calculation of the Mononobe-

Okabe coefficients K_{AE} and K_{PE}. AASHTO LRFD A11.1.1.2 states that a k_h value equal to ½ the PHGA is adequate for most design purposes, provided that allowance is made for an outward displacement of the abutment of up to 10A inches (see page 11-88), where A is the maximum acceleration coefficient (PHGA). Mononobe-Okabe coefficients *for the 50% reduction* are summarized below, and may be used if allowance is made for the corresponding displacement.

Case	Friction Angle	Peak Ground Acceleration Coefficient			
		0.25	0.30	0.63	0.73
Active (K_{AE})	38	0.31	0.32	0.44	0.49
	34	0.36	0.37	0.51	0.56
Passive (K_{PE})	38	3.94	3.89	3.51	3.38
	34	3.29	3.24	2.89	2.77

If displacement must be minimized, we recommend that the factors shown in the initial memo (04/17/06) be used.

It should be noted that the Mononobe-Okabe factors provided to date neglect vertical acceleration. Seed and Whitman (1970) concluded that vertical accelerations can be ignored when the Mononobe-Okabe analysis is used to estimate P_{AE} for typical wall design (see Kramer, 1996). It is estimated that positive vertical accelerations, if considered, may increase the Seismic Active Thrust coefficient (K_{AE}) by as much as 30%. If desired, the coefficients on the table above can be refined to consider vertical acceleration once Peak Vertical Ground Accelerations have been determined (see Response No. 7 below).

5) We can evaluate the potential pile capacities at different depths and provide results along with uplift. It is assumed that the request of estimated pile tip elevations for compression resistance of 70, 100, and 120 tons applies only to the Pedestrian Bridge over Legacy Parkway (P-21). At any bridge we can evaluate the potential for providing a specific resistance per pile if we are provided with the desired resistance values (see also Response No. 6 below). The given extreme event capacities assume a resistance factor of 1.0, and are reduced for potential liquefaction.

6) It is possible to consider pile diameters larger than 16", although driven piles with diameters/widths greater than 16" are somewhat rare locally and local pile driving capabilities may be limited. Also, it is our understanding that a consistent pile section is preferred for the project to limit potential errors and confusion (primarily during construction). Is increased axial resistance the only reason for considering larger diameter piles? We would like to know the specific purpose for considering other diameters (such as target resistance values), as it would be inefficient to estimate capacities for an unlimited range of diameters, toe elevations, etc.

7) Kleinfelder is working on site-specific response spectra for 1250 West and State Street. It is our understanding that this data will be used to develop general response spectra (including vertical accelerations) for use at all bridge sites.

8) It was agreed at a previous meeting that the structural firms would perform the LPILE analysis using soil parameters provided by the geotechnical engineer. We recommend that p-

multipliers be used as input in LPILE or GROUP to account for group effects. As noted on the LPILE parameters sheet included with the initial recommendations for each structure, p-multipliers for laterally-loaded pile groups are outlined in AASHTO LRFD 10.7.2.4. The factors listed in the 2006 LRFD interim are in relatively good agreement with full-scale pile group lateral load tests performed at the Salt Lake City International Airport, where shallow soils are reasonably representative of the shallow soils typically encountered at the Legacy bridge sites.