**RB&G
ENGINEERING
INC.**

1485 WEST 820 NORTH
PROVO, UT 84601-1343
801 374-5771 Provo
801 521-5771 SLC

LEGACY PARKWAY

STRUCTURE C-943
MULTI-USE TRAIL OVER CITY CANAL

STRUCTURE C-946
TRAIL OVER RICK'S CREEK

STRUCTURE C-947
TRAIL OVER STEED/DAVIS CREEK

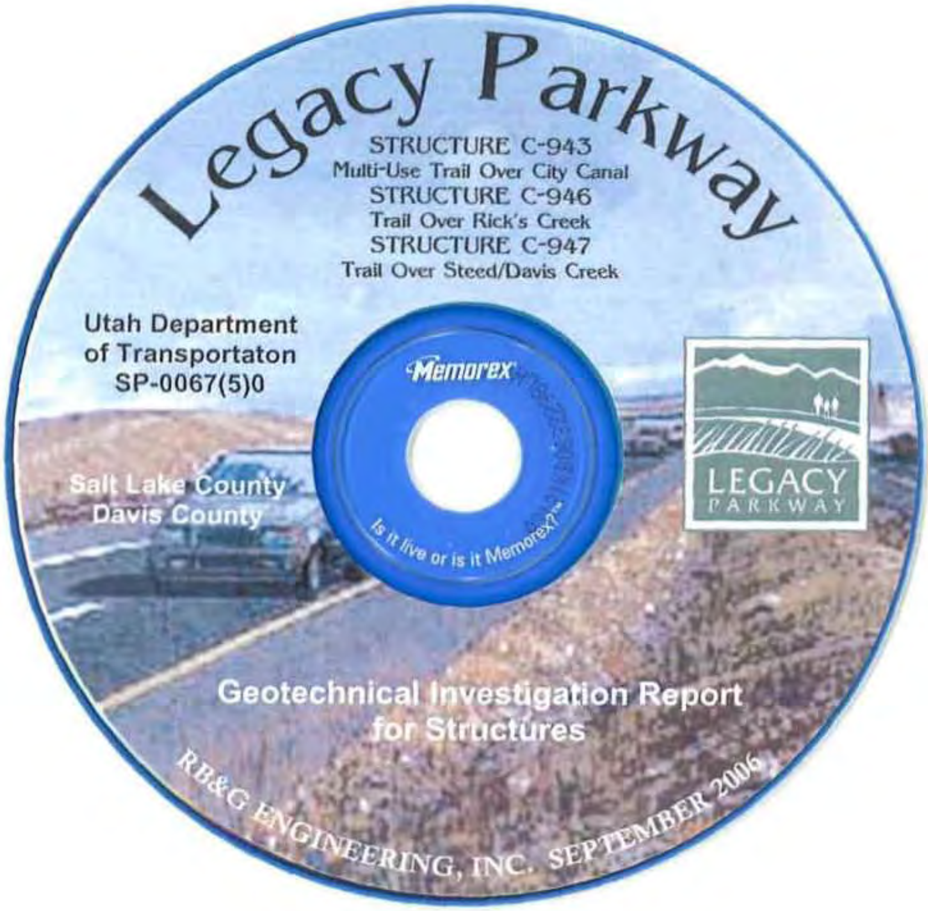
Salt Lake & Davis Counties, Utah

Utah Department of Transportation
SP-0067(5)0

September 2006

Geotechnical Investigation Report for Structures

200601-144, 147, 148



Legacy Parkway

STRUCTURE C-943
Multi-Use Trail Over City Canal
STRUCTURE C-946
Trail Over Rick's Creek
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Trail Over Steed/Davis Creek

Utah Department
of Transportaton
SP-0067(5)0

Salt Lake County
Davis County

Geotechnical Investigation Report for Structures

RB&G ENGINEERING, INC. SEPTEMBER 2006

RB&G
ENGINEERING
INC.

September 14, 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 C-943, Multi-Use Trail over City Canal, Structure C-946, Trail over Rick's Creek, and Structure C-947, Trail over Steed/Davis Creek 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.

Bradford

Bradford E. Price, P.E.

REGISTERED PROFESSIONAL ENGINEER
NO. 162291
BRADFORD E.
PRICE
9/14/06
STATE OF UTAH

bep/jag

1435 WEST 820 NORTH
PROVO, UT 84601-1343

PROVO 801-374-5771
SALT LAKE CITY 801-521-5771

Geotechnical Investigation Report for Structures

Legacy Parkway

Structure C-943
Multi-Use Trail over City Canal

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Salt Lake & Davis Counties, Utah

Utah Department of Transportation
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September 2006

RB&G ENGINEERING, INC.

Professional Engineers

LEGACY PARKWAY

UTAH DEPARTMENT OF TRANSPORTATION
SP-0067(5)0

GEOTECHNICAL INVESTIGATION REPORT FOR STRUCTURES

Structure C-943 – Multi-Use Trail over City Canal
Structure C-946 – Trail over Rick's Creek
Structure C-947 – Trail over Steed/Davis Creek

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LEGACY PARKWAY

UTAH DEPARTMENT OF TRANSPORTATION
SP-0067(5)0

GEOTECHNICAL INVESTIGATION REPORT FOR STRUCTURES

Structure C-943 – Multi-Use Trail over City Canal
Structure C-946 – Trail over Rick's Creek
Structure C-947 – Trail over Steed/Davis Creek

1.0 GENERAL

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

- Structure C-943 – Multi-Use Trail over City Canal
- Structure C-946 – Trail over Rick's Creek
- Structure C-947 – Trail over Steed/Davis Creek

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 three prefabricated pedestrian bridge sites, which are all located in Davis County. The City Canal (C-943) site is located approximately 600 feet north of the existing I-215 / Redwood Road intersection in the city of North Salt Lake. This structure will be located in Segment 1 of the project, which extends from the project's southerly limits to north of the 500 South interchange in the West Bountiful area.

The other two bridges are located in Segment 2 of the project, which begins at the northerly limit of Segment 1 on the south, and extends north to about LP SB Station 3610+00 (LP NB Station 2610+00), about 1800 feet south of Glover's Lane in Farmington. The Rick's Creek (C-946) site is about 500 feet west of I-15 in Centerville, near LP SB Station 3540+00. The Steed/Davis Creek structure will also be located approximately 500 feet west of I-15, near LP SB Station 3595+00 in Farmington.

1.1.2 Proposed Improvements

The proposed prefabricated steel bridge structures will be installed to allow pedestrians and other light traffic to cross minor waterways encountered along the multi-use trail. It is our understanding that the pedestrian bridges will each be single-span structures with span lengths ranging from about 30 to 55 feet. Preliminary drawings of the proposed structure 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. The City Canal trail bridge site is located in Segment 1, while the Rick's Creek and Steed/Davis Creek sites are located in Segments 3 and 4, respectively, of the Design-Build project area.

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

Bridge facilities do not presently exist at any of the three prefabricated bridge sites. City Canal, Rick's Creek, and Steed/Davis Creek all flow roughly east to west at the proposed trail crossings, where the pedestrian bridges are expected to be oriented in a north-south direction. The existing canals and creeks are unlined at the bridge sites.

The existing I-215 West/Southbound on-ramp is located about 150 feet south of the City Canal site, while Redwood Road is located about 300 feet east of the site. The nearest building is on the east side of Redwood Road, approximately 500 east of the City Canal bridge site. It is our understanding that the C-943 site is in an archaeologically sensitive area.

The Rick's Creek and Steed/Davis Creek sites are both within 500 feet of I-15 and the UPRR tracks the run between I-15 and the Legacy Parkway right-of-way. The nearest observed buildings are between 700 and 900 feet east of the trail bridge sites, on the east side of I-15.

Various utility lines exist throughout the project area, including the 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 Segments 1 and 2, 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. Some industrial and commercial facilities are located along the alignment.

Each of the bridge sites is relatively flat, with the canal/creeks cutting several feet below the surrounding ground surface. The height of the bridges above the bottom of the canal/creek beds is expected to be less than about 8 feet. Significant quantities of new fill have been placed in the Parkway's south interchange area, located within about 1,000 feet south and west of the City Canal bridge site. Construction of a UTA rail line between I-15 and the UPRR tracks (about 500 feet east of the Rick's Creek and Steed/Davis Creek sites) was also underway at the time of this investigation.

Vegetation at all three sites consists primarily of weeds and wild grasses. Willow bushes were observed along the banks of City Canal. A few trees lined the banks of Rick's Creek, while the area surrounding Steed-Davis Creek west of I-15 was relatively thickly forested at the time of the site visits and subsurface investigations (Spring and Summer 2006).

4.2 SURFACE DRAINAGE

Surface drainage in the project 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 (including City Canal, Rick's Creek, and Steed/Davis Creek) 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.

Davis (1983) shows the surficial geology of the City Canal site to consist of floodplain and delta complex deposits associated with the Jordan River (see Figure 2a). Deeper deposits are likely Provo Formation and younger lake bottom sediments, shown mapped less than a mile east of the site. These lake bottom sediments are mapped over much of the Legacy Parkway alignment, including the Rick's and Steed/Davis Creek sites. Salt Flat deposits from Farmington Bay of the Great Salt Lake are also mapped within about ½ mile west of the Parkway in this area.

Figure 2b shows the City Canal site to lie within lacustrine clay and silt surficial deposits mapped by Personius and Scott (1992), with lateral spread deposits mapped within a few hundred feet west of the site. The surficial deposits at the Rick's and Steed/Davis Creek sites are likely either lacustrine clay and silt from the Bonneville lake cycle, or younger (Post-Bonneville) lacustrine and marsh deposits, according to a 1993 map by Nelson and Personius (see Figure 2c).

Figure 2d 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 are 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). It will be noted that the City Canal bridge site is likely located within artificial fill underlain by older Holocene fine-grained lacustrine deposits, consisting primarily of interbedded clay, silt, and fine sand deposited in the

Great Salt Lake. Liquefaction-induced landslide deposits from the Lake Bonneville Regressive Phase to early Great Salt Lake period (Qmq_3) are mapped within a few hundred feet west and north of the site.

Figure 2e shows portions of the Farmington Siding Landslide Complex, also mapped by Harty and Lowe (1992). The liquefaction-induced landslide deposits on this map are scattered throughout the area west of Farmington; however, they do not appear to encroach upon the Steed-Davis Creek bridge site, which is mapped as Holocene fine-grained lacustrine soils.

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 Pedestrian Trail bridge site is provided in Section 5.0.

4.5 SOIL MATERIALS

Borings at the three sites encountered primarily lean clay, silt, and fat clay with interbedded sand layers. In general, the stiffness of the cohesive soils and the frequency of moderately dense sand layers were found to increase with depth below the ground surface. Soil conditions at each site 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 1 to 4 feet of the ground surface at the Pedestrian Trail bridge site at the time of drilling (March-April 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

Some evidence of methane gas was noted at a depth of about 115 feet in a boring at the Steed/Davis Creek trail bridge site. With the exception of this methane gas, potentially hazardous materials were not noted during the field investigation. All soil samples were re-examined in the laboratory and no odors indicative of contamination were 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 faults are the Salt Lake City Segment and the Weber Segment of the Wasatch Fault Zone (WFZ). The Salt Lake City segment is capable of generating a magnitude 7.2 earthquake. The Weber Segment of the WFZ is capable of generating a magnitude 7.4 earthquake. The West Valley Fault Zone is located about 3.1 miles south of the City Canal site. 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

5.1.1 MCEER Site Class

At the City Canal bridge site (Boring RB-389), tests performed on soil samples in the upper 30 feet indicate that the average undrained shear strength is substantially less than 1,000 psf. Shear strength tests were not performed on samples below 30 feet. The sample descriptions, along with testing of deeper samples from other borings in the general area, suggest that the average shear strength in the upper 100 feet may exceed 1000 psf. Based on these observations, the appropriate MCEER site class would be either D or E. We recommend that the site class resulting in the more conservative design be used for seismic design at this site, unless a boring is drilled at one of the bridge abutments with strength testing performed to determine the site class.

At Rick's Creek, tests performed on soil samples obtained from Boring RSB-X5-652 indicate that the average undrained shear strength in the upper 86.5 feet is less than 1,000 psf, corresponding to MCEER Site Class E.

At the Steed/Davis Creek bridge site, tests performed on soil samples obtained from Boring RSB-X6-653 indicate that the average undrained shear strength in the upper 100 feet is substantially less than 1,000 psf, and the site is therefore categorized as MCEER Site Class E.

5.1.2 Ground Acceleration Values

The City Canal (C-943) site is located at latitude 40.836° North and longitude 111.936° West, which is approximately 1.0 miles west of the Salt Lake City

Segment, and about 2.3 miles southwest of the Weber Segment of the WFZ. 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	30.01	72.88
0.2 sec SA	69.78	170.99
1.0 sec SA	24.50	71.88

The Rick's Creek (C-946) site is located at latitude 40.943° North and longitude 111.893° West, approximately 0.8 miles west of the Weber Segment, and about 6.2 miles northwest of the Salt Lake City Segment of the WFZ. 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	23.35	61.28
0.2 sec SA	55.95	143.84
1.0 sec SA	19.28	59.61

The Steed/Davis Creek (C-947) site is located at latitude 40.958° North and longitude 111.893° West, approximately 0.9 miles west of the Weber Segment, and about 7.1 miles northwest of the Salt Lake City Segment of the WFZ. 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	22.61	60.49
0.2 sec SA	54.33	141.57
1.0 sec SA	18.80	58.67

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 the softer overburden soils existing in the Legacy Parkway area.

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 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 also applied in the analyses.

City Canal Site (C-943)

An assessment of the boring log for Boring RB-389 shows that a loose silty sand layer between depths of about 26.5 to 29.5 feet would likely liquefy during the seismic event having a 2 percent probability of exceedance in 50 years (PGA = 0.73g). The same layer was found to be liquefiable for the event having a 10% probability of exceedance in 50 years (PGA = 0.30g). Liquefaction of this three-foot layer may cause ground settlement estimated to be in the order of 0.8 inches. The clayey sand layer between 75 and 79 feet also presents the potential for an estimated additional 0.6 inches of liquefaction settlement; however, it should be noted that estimates of liquefaction potential and related settlement become less certain with depth. The $(N_1)_{60}$ blow counts in the silty sand layer between 26.5 and 29.5 feet were less than 15, indicating potential for lateral spread.

Rick's Creek Site (C-946)

An evaluation of borings in the vicinity of the C-946 site indicates that several soil layers may liquefy during the seismic event having a 2 percent probability of exceedance in 50 years (PGA = 0.61g). The same layers were found to be liquefiable for the event having a 10% probability of exceedance in 50 years (PGA = 0.23g). 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-X5-652	5.5	5.5	1.2	1.2

The liquefiable soils in Boring RSB-X5-652 were primarily encountered between about 29 to 39 feet. Boring RB-412 also identified some loose sand deposits, primarily between depths of about 17 to 26 feet. Some $(N_1)_{60}$ blow counts in the liquefiable layers were less than or equal than 15, indicating potential for lateral spread.

Steed/Davis Creek Site (C-947)

An evaluation of borings near the C-947 site suggests that several soil layers may liquefy during the seismic event having a 2 percent probability of exceedance in 50 years (PGA = 0.6g). The same layers were found to be liquefiable for the event having a 10% probability of exceedance in 50 years (PGA = 0.23g). 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-X65-653	7.5	7.5	2.6	2.6

The primary liquefiable zones in Boring RSB-X6-653 were encountered between depths of about 17 and 21 feet and between about 31 and 35 feet. The $(N_1)_{60}$ blow counts in these layers were less than 15, indicating potential for lateral spread. Borings RB-417 and RB-718 were located within about 500 feet south and north of the site, respectively. These borings also identified some loose sand deposits, primarily between depths of about 15 to 30 feet.

Based on the information available, some potential for lateral spreading may exist at each of the prefabricated pedestrian bridge sites; however, it is not anticipated that further lateral spread investigation or subgrade mitigation will be desired for these structures, due to the non-critical nature of the trail bridges.

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 by RB&G Engineering 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. It will be noted that the Rick's Creek and Steed/Davis Creek sites were numbered "X5" and "X6", respectively. These bridge numbers were arbitrarily assigned because neither site was assigned a number in the Design-Build project.

Kleinfelder, Inc. performed roadway borings near several of the sites discussed herein, and copies of applicable boring logs are also included in Appendix B. Roadway borings performed by Kleinfelder are labeled with the prefix "RB". Due to archaeological restrictions, a subsurface investigation at the City Canal site was not permitted in 2006. For the purposes of this report, subsurface data for the City Canal trail bridge has been estimated based on borings performed previously by Kleinfelder in the vicinity of the site.

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 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) Consolidation
7) 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 the pedestrian trail bridge structures at the City Canal, Rick's Creek, and Steed/Davis Creek sites will be single-span prefabricated steel structures designed primarily to support pedestrian and bicycle loadings. Approximate foundation loads and structure dimensions are summarized on the table below:

Structure Number	C-943	C-946	C-947
Location	City Canal	Rick's Creek	Steed/Davis Creek
Span Length (ft)	50	41	33
Width (ft)	13.5	13.5	13.5
Strength I Abutment Load (kip)	186	107	96
Service I Abutment Dead Load (kip)	110	54	53
Service I Abutment Live Load (kip)	26	23	17

7.1.2 Subsurface Conditions

Boring RB-389, completed about 80 feet south of the City Canal bridge site by Kleinfelder in February 2000, encountered medium-stiff to stiff silt and clay in the upper 11 feet, followed by soft clay with interbedded loose sand layers up to 3 feet thick from about 11 to 30 feet. Below 30 feet, the boring log shows stiff sandy lean clay to 35 feet, then dense silty sand to 41 feet, followed by stiff to hard clay and silt to about 75 feet. Medium-dense clayey sand was identified from 75 to 79 feet, followed by very dense silty sand from about 79 to 94 feet. The boring terminated after continuing through about 5 feet of very stiff lean clay from 94 to 99 feet. Liquid limits of the clay in the upper 35 feet ranged from 37 to 45, with plasticity indices between 14 and 21.

Boring RSB-X5-652 was drilled near the southeast corner of the proposed Rick's Creek Trail bridge location. The subsurface profile encountered in the boring consisted of firm to stiff layers of clay and silt in the upper 10 to 15 feet, underlain by softer clay and silt with interbedded sand layers to about 70 feet. Between 75 and 86.5 feet, Boring RSB-X5-652 encountered stiffer clay deposits with some interbedded silt and sand layers. The soil samples classifying as lean clay had liquid limits between 32 and 47 and plasticity indices between 12 and 27. The liquid limit of the fat clay samples ranged from 50 to 65, and the plasticity index varied from 28 to 41. The tested sand layers between depths of 35 and 40 feet were relatively clean, with 4 to 10 percent passing the No. 200 sieve.

At the Steed/Davis Creek bridge site, the subsurface profile generally consisted of soft to very soft layers of clay and silt with some liquefiable sand layers in the upper 35 feet. Below 34 feet, Boring RSB-X6-653 encountered soft clay to about 70 feet, underlain by firmer clay to about 105 feet, and stiff clay between 105 and 120 feet. The lean clay had liquid limits between 30 and 45, with plasticity indices between 12 and 26. Samples of fat clay, encountered below a depth of 50 feet, had liquid limits ranging from 52 to 76 and plasticity indices between 30 and 51.

7.1.3 Groundwater Conditions

The reported groundwater levels at each site are summarized on the table below:

Structure Number	Location	Boring	Depth to Groundwater	Groundwater Elevation	Month of Reading
C-943	City Canal	RB-389	8'	4211'	Feb 2000
C-946	Rick's Creek	RSB-X5-652	3.9'	4215.4'	June 2006
C-947	Steed/Davis Creek	RSB-X6-653	approx. 3'	~4211'	June 2006

It should be noted that artesian flow with greater than 5 feet of head above the ground surface was observed at Boring RSB-X6-653, prior to grouting the hole. Artesian flow was also observed at various other locations throughout the Legacy Parkway project.

It is anticipated that the groundwater level may rise by about 2 feet at each site due to typical seasonal changes. The groundwater level immediately adjacent to the bridge abutments is expected to coincide with the water level in the canal or creek at each site.

7.2 RECOMMENDATIONS

7.2.1 Bridge Structures

Potential foundation types at the pedestrian bridge sites include shallow foundations, such as spread footings, and deep foundations, such as drilled shafts or driven piles. The soils encountered between depths of about 11 to 30 feet at the

City Canal site, and in the upper 50 feet at the Steed/Davis Creek site, have very low bearing resistance. It is not recommended that spread footings be used to support structures at these two sites. The shallow soils at the Rick's Creek site are somewhat more competent, and spread footings may be considered for Bridge C-946, as discussed in Section 7.2.4.

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.

Each abutment at the three prefabricated pedestrian bridges is expected to be supported by two piles spaced 10 to 12 feet apart on centers. Recommendations for driven pile foundations are summarized below.

7.2.1.1 Driven Piles

Axial compression resistance values have been estimated for concrete-filled steel pipe piles of various diameters and embedment depths. The analyses were performed using the FHWA program SPILE. Geotechnical resistance factors were selected from the 2006 Interim AASHTO LRFD Bridge Design Specifications. Estimated resistance values and tip elevations are listed on the table below.

Pile Data Parameters	**City Canal (C-943)**		**Rick's Creek (C-946)**	**Steed/Davis Creek (C-947)**
Pipe Pile Outside Diameter (in)	12.75	16	12.75	12.75
Estimated Pile Tip Elevation (ft)	4164	4160	4142	4142
Elev. of Min. Acceptable Pile Penetration (ft)	4165	4165	4145	4144
Strength I Axial Compression Resistance (kip)	65	94	90	56
Extreme Event I Compression Resistance (kip)	97	140	122	76
Required Driving Resistance (kip)	101	145	140	86

The elevation of minimum acceptable pile penetration is a few feet above the estimated tip elevation to allow some flexibility in actual pile driving depths. 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.

Pile resistance values for the pedestrian trail bridges were initially calculated for 12.75-inch OD pipe piles. The recommendations for slightly deeper 16-inch OD pipe piles at the City Canal bridge were provided at the request of the structural engineer, who indicated that the required Strength I Resistance would be about 93 kips per pile.

The estimates listed above assume that new embankments will be constructed with lightweight material and/or surcharged where necessary, such that any 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. It is our understanding that this will be the case. At the anticipated center-to-center pile spacing of 10 feet or greater, the potential for group (block) failure is 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-70 Hydrohammer, without cushioning. The results of the analyses are summarized below.

C-943 – City Canal Site - 16-inch OD closed-end pipe										
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	150	24.8	13	6.6	29.2	150	23.6	13	6.8	28.6
	300	28.9	31	7.6	30.5	300	27.0	30	7.7	28.4
	400	32.2	57	8.3	32.4	400	28.8	50	5.2	29.8
	495	35.1	120	8.9	34.1	540	30.8	122	8.7	31.5
IHC S-70*	150	33.3	17	6.6	24.3	150	30.8	17	6.6	24.4
	300	34.0	50	6.6	23.8	300	31.3	43	6.6	23.8
	350	34.3	80	6.6	23.5	400	31.6	88	6.6	23.5
	385	34.5	117	6.6	23.5	435	31.7	119	6.6	23.5

* IHC S-70 assumed to operate at 50% efficiency.

C-946 – Rick's Creek Site – 12.75-inch OD closed-end pipe

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	140	25.7	12	6.4	29.6	140	23.5	11	6.5	29.2
	200	28.7	17	6.8	29.3	200	25.0	17	7.0	28.0
	300	33.2	32	7.6	30.8	300	27.1	29	7.6	29.0
	445	38.4	124	8.3	32.5	490	31.4	117	8.5	31.1
IHC S-70*	140	43.3	11	6.6	38.6	140	40.7	11	6.6	39.1
	200	43.5	15	6.6	38.5	200	40.8	15	6.6	39.0
	300	43.8	29	6.6	37.9	300	41.0	25	6.6	37.8
	450	44.2	122	6.6	37.3	510	41.4	120	6.6	37.5

* IHC S-70 assumed to operate at 80% efficiency.

C-947 – Steed-Davis Creek Site – 12.75-inch OD closed-end pipe

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	90	22.5	7	5.8	31.7	90	21.3	7	6.0	31.2
	150	25.9	12	6.4	29.6	150	23.7	13	6.6	29.0
	300	32.5	31	7.6	31.2	300	27.0	29	7.6	29.2
	450	37.7	121	8.4	33.3	495	30.7	120	8.5	31.5
IHC S-70*	90	43.2	8	6.6	38.6	90	40.7	7	6.6	38.8
	150	43.4	12	6.6	38.6	150	40.8	11	6.6	39.1
	300	44.0	29	6.6	38.0	300	41.2	25	6.6	38.3
	450	44.5	119	6.6	37.4	510	41.7	121	6.6	37.5

* IHC S-70 assumed to operate at 80% efficiency.

It will be observed from the table that both hammers appear capable of driving the piles at these sites to significantly greater resistance values than the required driving resistance, without exceeding a hammer blow count of about 120 blows per foot. The calculated driving stresses are significantly greater for the IHC S-70 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 analyses, the yield strength of the steel pipe need not exceed 35 ksi to resist properly-monitored driving stresses. The pile driving hammer should have an operating energy of at least 25 kip-ft for these sites. 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, thus increasing the geotechnical resistance of 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 driven piles at 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 150 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 groups 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 discussed in Section 5.0.

Consolidation settlement of abutment foundations at Structures C-943, C-946, and C-947 was estimated based on pile group layouts provided by the structural engineers. In order to limit post-construction foundation settlement to less than one inch, we recommend that non-transient service loads not exceed the maximum values shown on the following table.

Structure Number	Approx. Pile Spacing (ft)	Maximum Non-Transient Service Load (kips per pile)
C-943	10	60
C-946	11.4	45
C-947	11.4	40

Transient loads are not expected to contribute significantly to pile group settlement at these structures. The Service I Resistance values shown on the plans may exceed the values shown above if necessary to support transient service loads, under the condition that the non-transient service loads do not exceed the values on the table above.

7.2.1.3 Uplift

Uplift capacities for individual piles computed using LRFD Procedures are summarized on the table below. 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.

Pile Data Parameters	**City Canal (C-943)**	**Rick's Creek (C-946)**	**Steed/Davis Creek (C-947)**
Pipe Pile Outside Diameter (in)	16	12.75	12.75
Estimated Pile Tip Elevation (ft)	4160	4142	4142
Strength I Axial Uplift Resistance (kip)	32	28	18
Extreme Event I Uplift Resistance (kip)	130	113	72

For the anticipated pile layouts, with two piles at each abutment spaced at least 10 feet on centers, the pile group uplift resistance can be taken as the single-pile uplift resistance 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 summary sheets in Appendix D.

7.2.1.5 Load Tests

The Strength I Pile Resistance estimates provided above are based on an LRFD resistance factor of 0.65. 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 for use of this resistance factor. Based on the table, PDA testing would be required for 3 of the 4 piles expected to be driven at each site.

Due to the relatively soft consistency of the soil profile, lack of reliable bearing layer and the light loads proposed for the structures at these sites, pile resistance will rely almost exclusively on skin resistance. It is anticipated that pile driving will require minimal effort. Skin resistance will increase in the hours and days following pile driving. PDA testing should be performed at least 24 hours after initial driving, and more time (up to a few days) may be required for the piles to achieve their required driving resistance.

7.2.1.6 Construction Considerations

Dewatering may be necessary for foundation excavations. 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 bottom of the excavation.

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 (preferable 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.

We recommend that preconstruction surveys and vibration monitoring be performed for any critical structures or 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 Spread Footings for Bridge Abutments

Spread footings appear to be a viable foundation option for supporting vertical loads at the Rick's Creek pedestrian bridge site. Soils in the upper 6 feet were found to be relatively soft and loose; however, the cohesive soils from about 6 to 15 feet have a Strength I bearing resistance of about 1800 psf. To provide uniform support, we recommend that the soils in the footing area be over-excavated to a depth of at least 3 feet below the footing and replaced with compacted granular fill. The over-excavated area should include the foundation footprint area plus a lateral distance equal to half the over-excavation depth on all sides. The 3-foot layer of replacement fill will increase the Strength I bearing resistance to 2500 psf for footings ranging from 2 to 4 feet in width. If this option is considered, consolidation settlement of the footing can be evaluated to check the potential for excessive settlement under non-transient loads.

It should be noted that liquefaction settlement is expected to be more pronounced for shallow foundations than for deep foundations. Short drilled shafts may be attached to the bottom of the footing if necessary to resist lateral loads. The construction considerations listed in Section 7.2.1.6 are generally applicable spread footings as well as deep foundations.

7.2.5 Lateral Earth Pressures

Lateral earth pressures can generally be calculated using the equation

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

Where
P = total lateral force on the wall, plf
K = earth pressure coefficient
γ = unit weight of the soil (depends on fill material)
H =height of the wall

The earth pressure coefficient used in designing the walls will depend upon whether the wall is free to move during backfilling operations, or whether the wall is restrained during backfilling. If the wall is free to move away from the soil during backfilling operations, we recommend that an active earth pressure coefficient be used in the above equation to calculate the lateral earth pressures. If the walls are restrained or braced from movement during backfilling (as is generally the case with box culverts and similar structures), we recommend that an at-rest earth pressure coefficient be used to calculate the lateral earth pressures. A passive earth pressure coefficient should be used to calculate the lateral soil resistance where the wall is being pushed toward the soil. It should be recognized that the pressures, calculated by the above equation, are earth pressures only and do not include hydrostatic pressures. Where hydrostatic pressures may exist behind a retaining structure, we recommend either the wall be designed to resist hydrostatic pressure, or that a drainage system be placed behind the wall to prevent the development of hydrostatic pressures.

Lateral earth pressure coefficients and other recommendations for computing lateral earth pressures are included in Appendix D. A general earth pressure coefficient has been provided for calculation of earth pressures where mechanical compaction equipment is expected to be operated near non-yielding walls less than about 8 feet high. This scenario is anticipated during placement of fill around culverts. The residual pressure from compaction equipment can be reduced by limiting the proximity and weight of compacting equipment near culvert walls.

Recommendations for computing passive lateral earth pressures for the native clay subgrade on bent piles caps at the Pedestrian Trail bridge site are also included in Appendix D.

Recommendations based on the Mononobe-Okabe approach for active and passive seismic lateral earth forces are included in Appendix D. For non-yielding walls, recommended equations for calculating the dynamic thrust and dynamic overturning moment are also provided.

8.0 CORROSION INVESTIGATIONS

In order to obtain an indication of the corrosive nature of the subsurface material at the Rick's Creek and Steed/Davis Creek 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:

Site	Test Hole	Depth (ft)	Soil Type	Resistivity ohm-cm	pH	Sulfate (ppm)	Chloride (ppm)
Rick's Creek (C-946)	RSB-X5-652	0-1.5	Silty Sand	16,843	7.4	250	16
		35-36.5	Sand	23,580	8.5	217	22
		80-81.5	Lean/Fat Clay	---	---	173	25
Steed/Davis Creek (C-947)	RSB-X6-653	3-4.5	Lean Clay	14,316	8.3	55	2
		31.5-33	Clayey Sand	18,528	8.4	546	64
		60-61.5	Fat Clay	13,138	8.8	1889	293

A subsurface investigation was not permitted at the City Canal site, and no chemical analyses were performed for this site.

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 these two sites. Type I or Type II cement may be used for concrete; 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.

Soil sampling and testing was not performed at the City Canal (C-943) site during this investigation, due to archaeological restrictions on excavation at the site. Recommendations provided regarding structures at the City Canal site were formulated based on subsurface investigations performed previously by others in the general vicinity of the site. The assumed subsurface conditions at this site may differ significantly from actual conditions. If bridge construction or other activities at the site indicate that this is the case, the geotechnical engineer should be notified so that foundation recommendations can be re-evaluated and modified as necessary.

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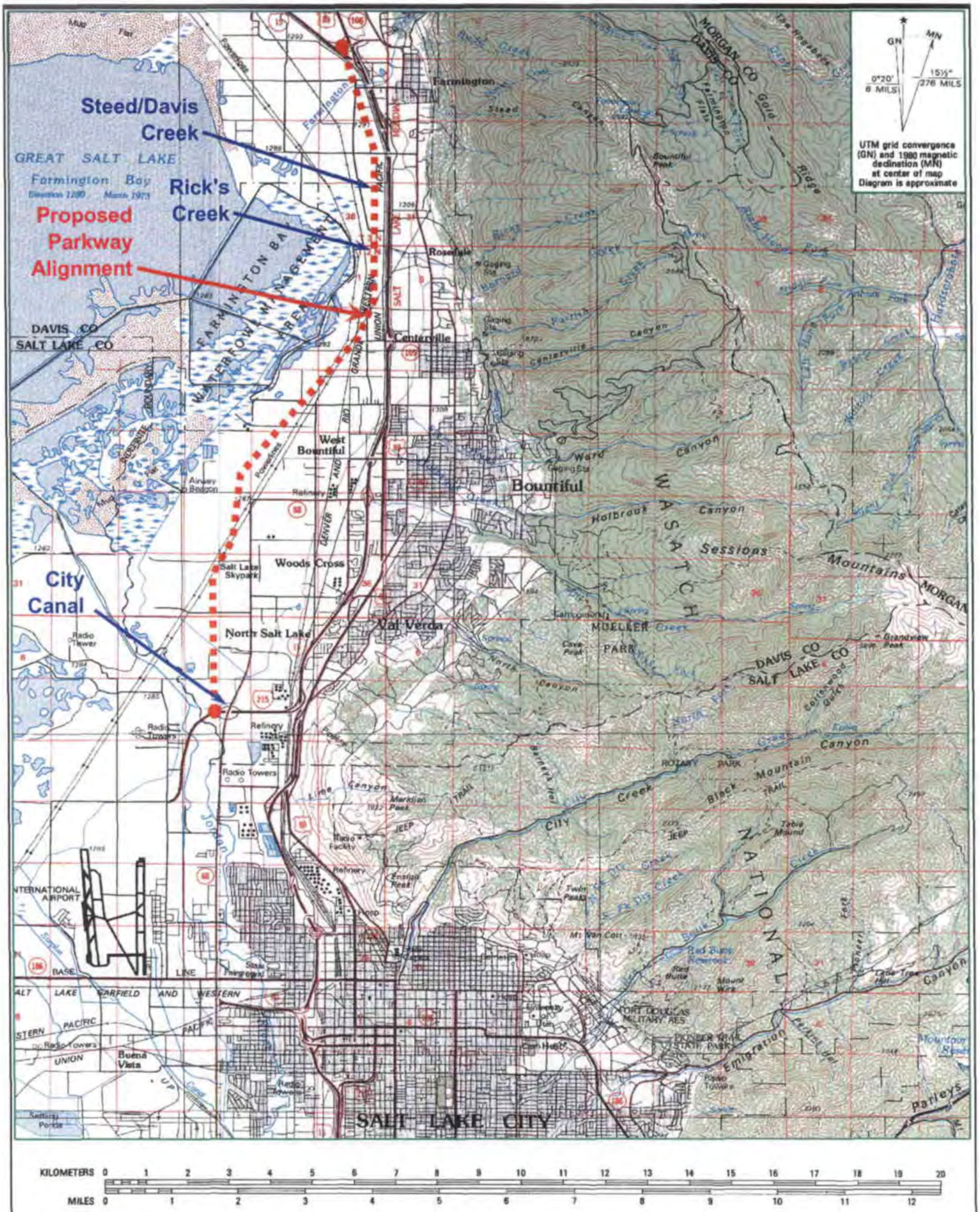
FIGURES



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

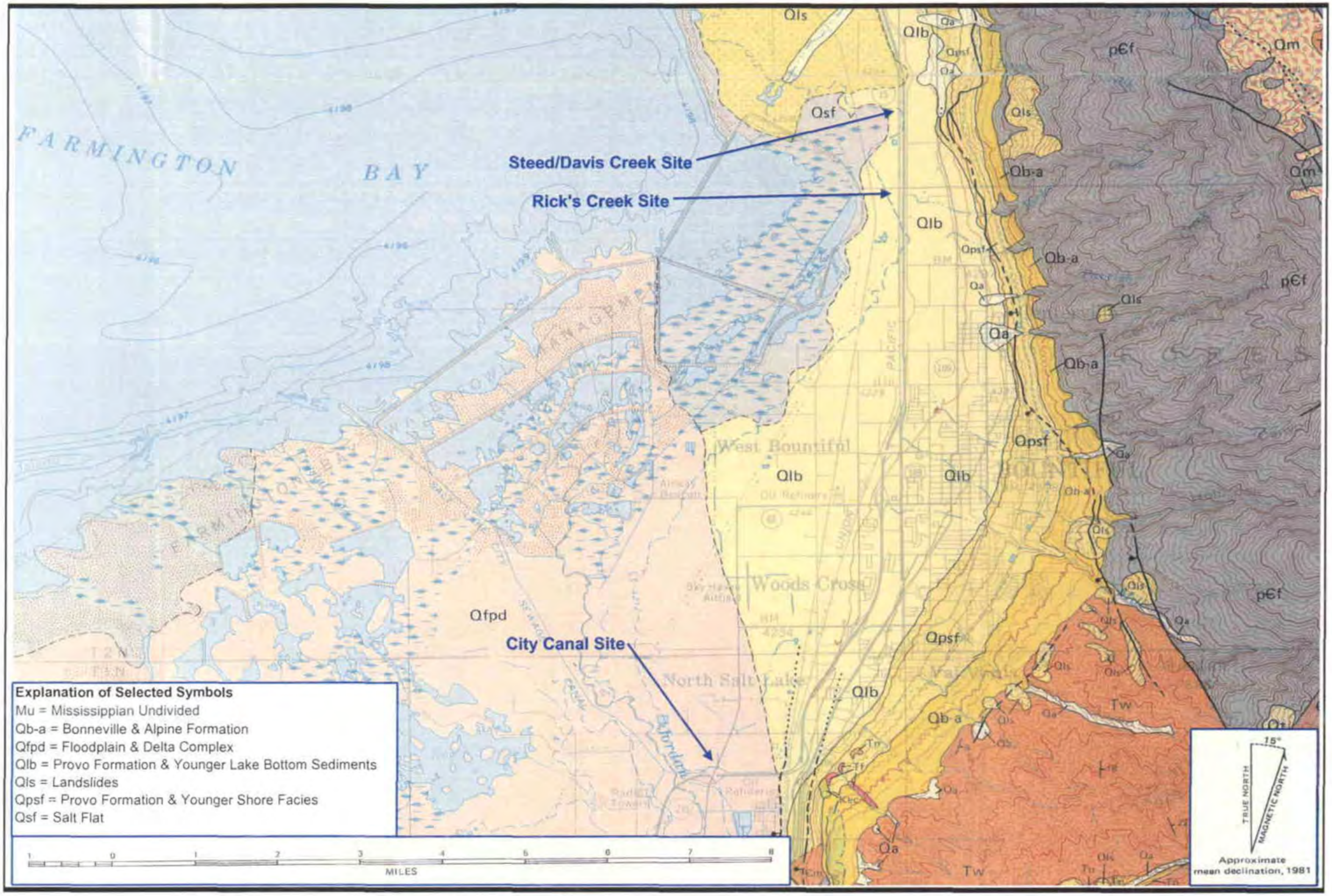

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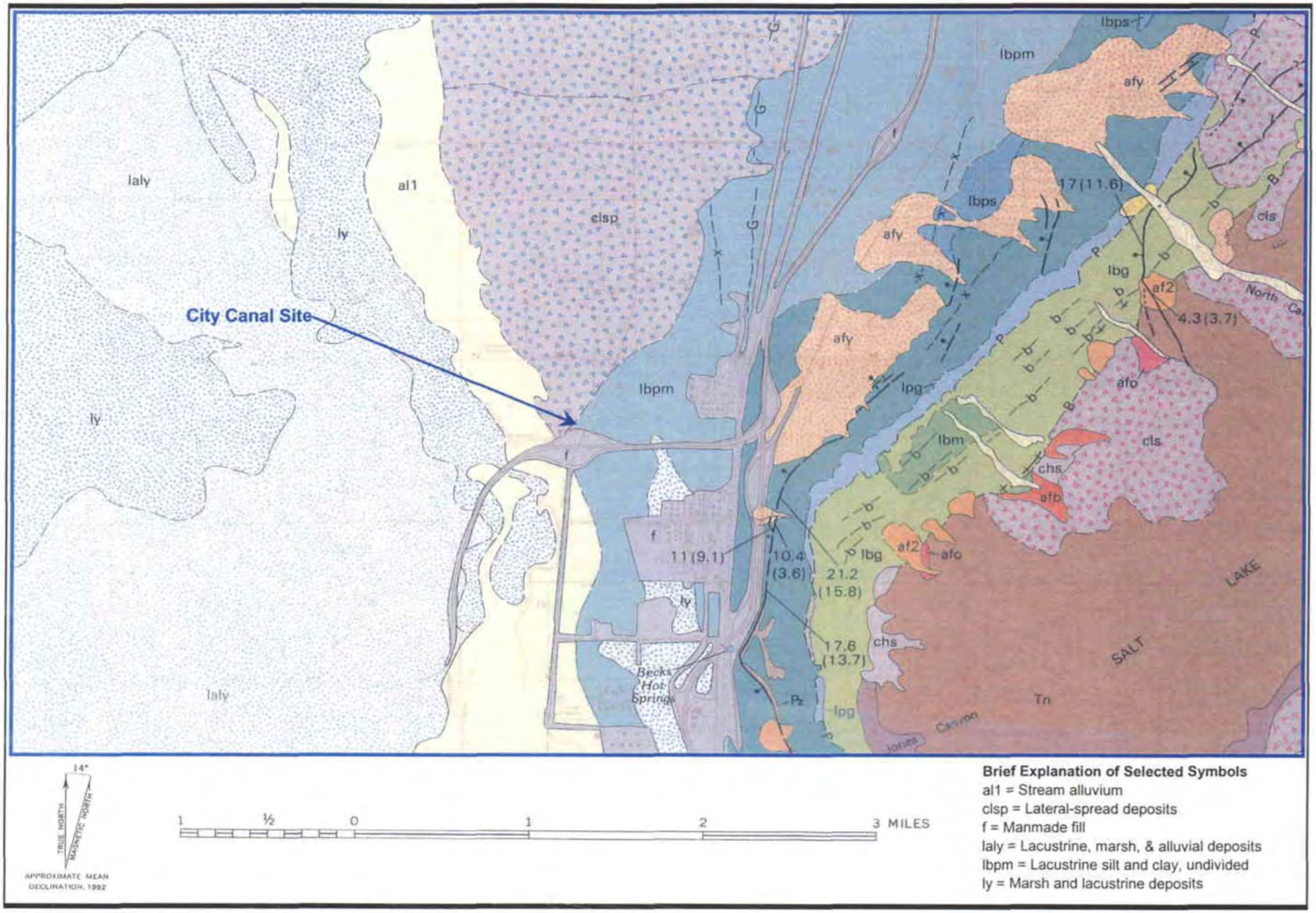
Figure 2a Geologic Map A
Prefabricated Trail Bridge Sites
Legacy Parkway
Salt Lake / Davis Counties, Utah

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



Brief Explanation of Selected Symbols

al1 = Stream alluvium
clsp = Lateral-spread deposits
f = Manmade fill
laly = Lacustrine, marsh, & alluvial deposits
lbpm = Lacustrine silt and clay, undivided
ly = Marsh and lacustrine deposits

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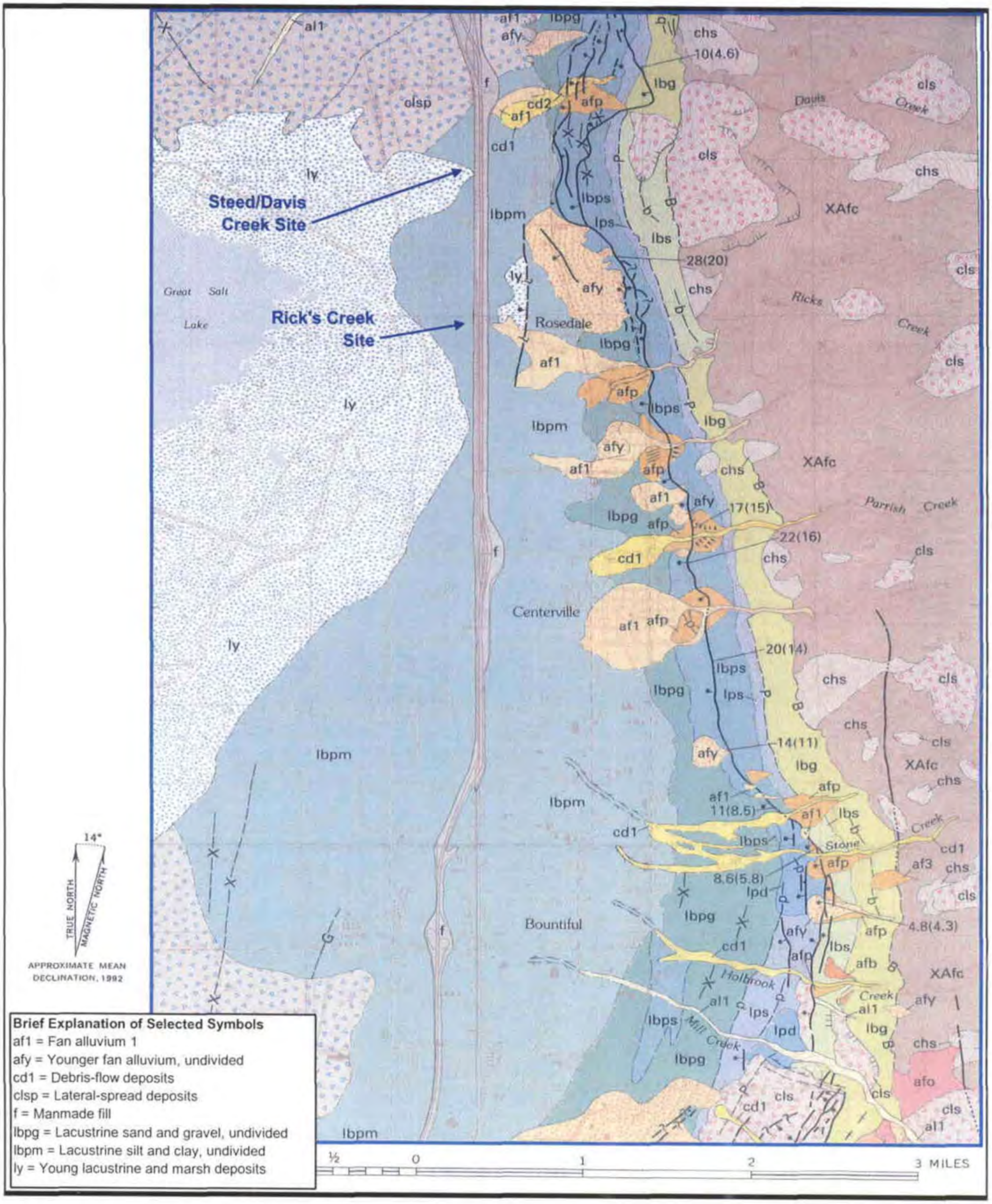
Figure 2b Geologic Map B
City Canal Site
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Personius & Scott, 1992 (US Geological Survey)



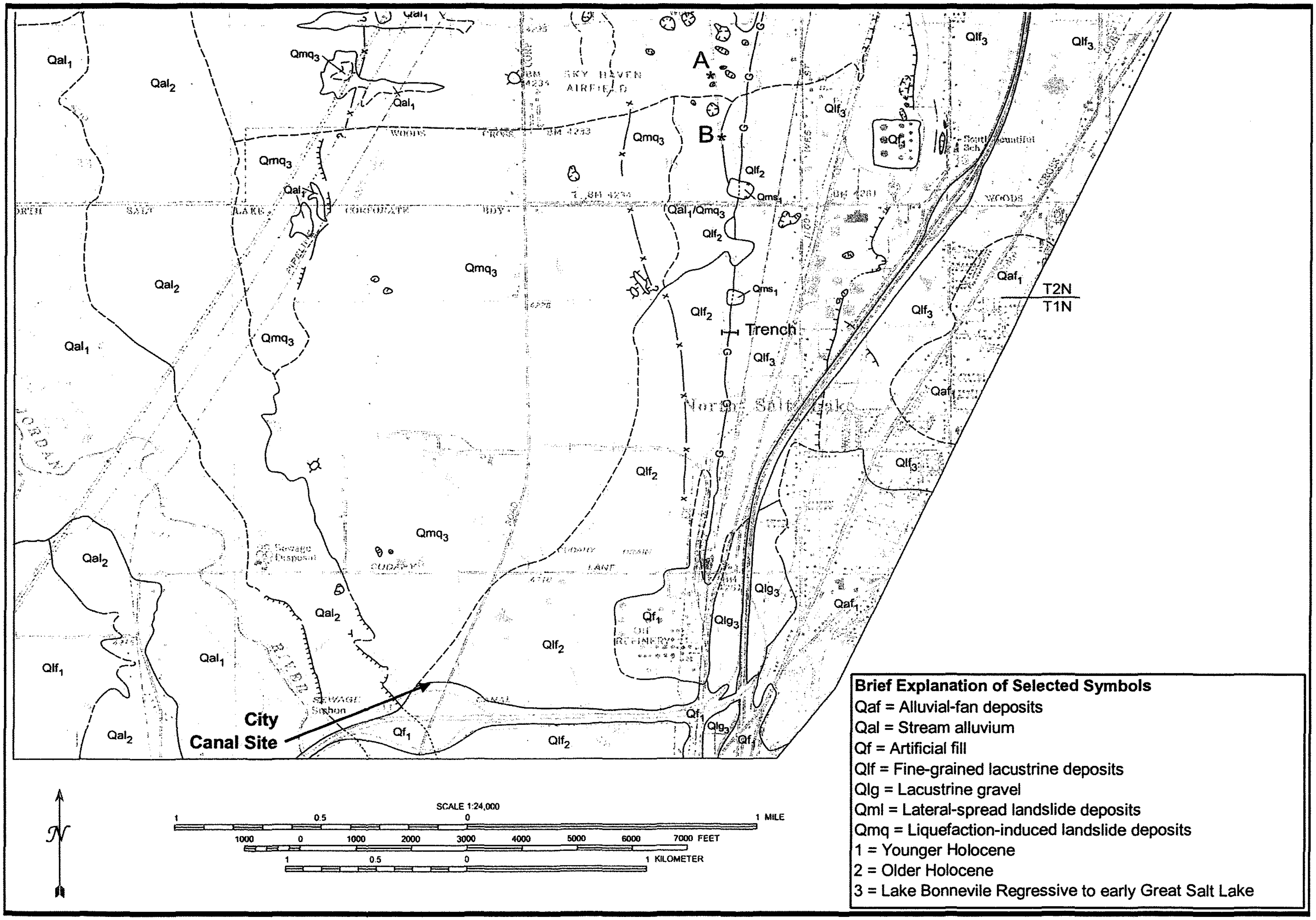
Brief Explanation of Selected Symbols

af1 = Fan alluvium 1
afy = Younger fan alluvium, undivided
cd1 = Debris-flow deposits
clsp = Lateral-spread deposits
f = Manmade fill
lbpg = Lacustrine sand and gravel, undivided
lbpm = Lacustrine silt and clay, undivided
ly = Young lacustrine and marsh deposits

RB&G ENGINEERING INC.
Provo, Utah

Figure 2c Geologic Map C
Rick's and Steed/Davis Creek Sites
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Nelson & Personius, 1993
Utah Geological Survey



Brief Explanation of Selected Symbols

Qaf = Alluvial-fan deposits
Qal = Stream alluvium
Qf = Artificial fill
Qlf = Fine-grained lacustrine deposits
Qlg = Lacustrine gravel
Qml = Lateral-spread landslide deposits
Qmq = Liquefaction-induced landslide deposits
1 = Younger Holocene
2 = Older Holocene
3 = Lake Bonnevile Regressive to early Great Salt Lake

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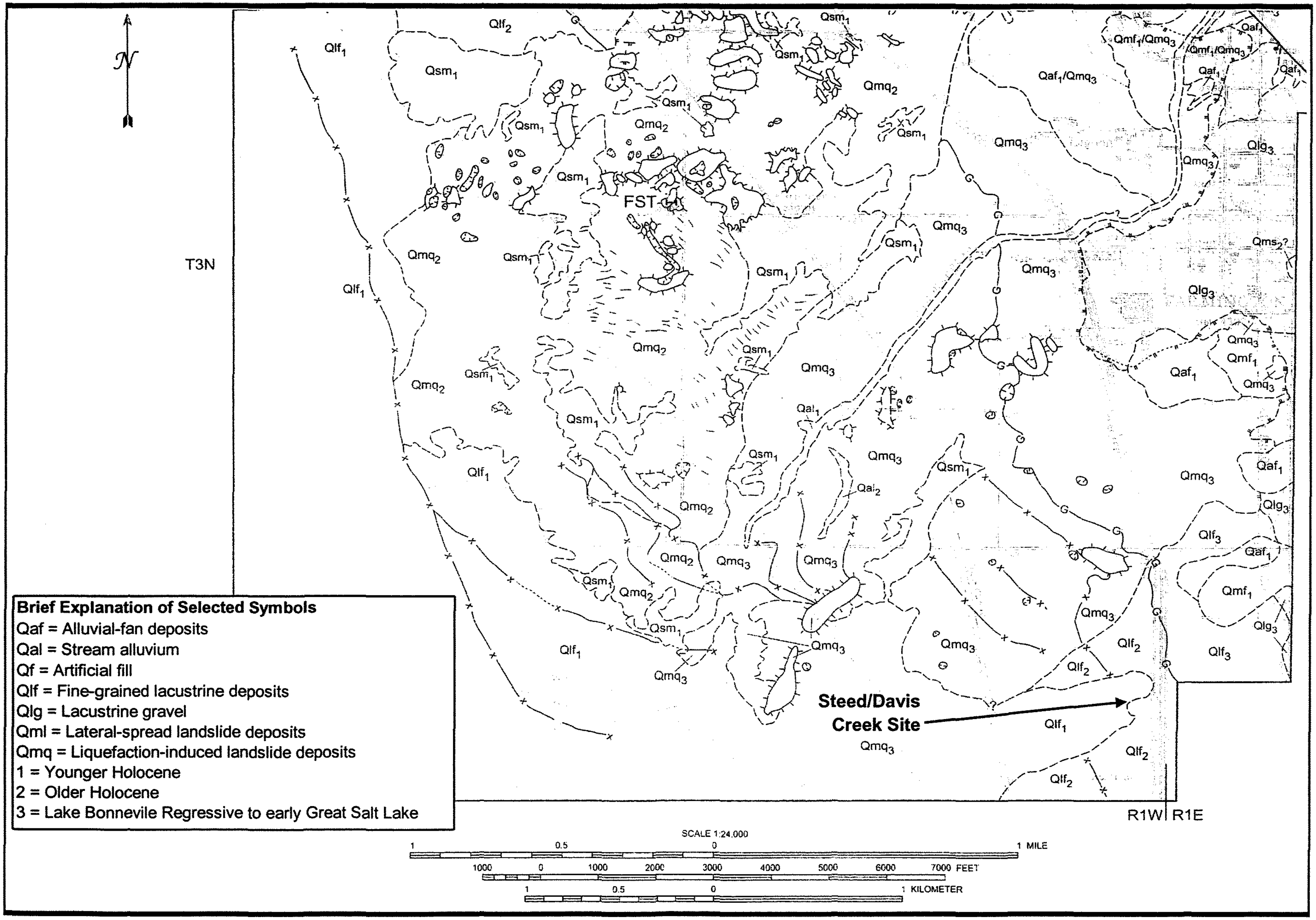
Provo, Utah

Figure 2d Geologic Map D
North Salt Lake Landslides
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Harty & Lowe, 1992



Brief Explanation of Selected Symbols

Qaf = Alluvial-fan deposits
Qal = Stream alluvium
Qf = Artificial fill
Qlf = Fine-grained lacustrine deposits
Qlg = Lacustrine gravel
Qml = Lateral-spread landslide deposits
Qmq = Liquefaction-induced landslide deposits
1 = Younger Holocene
2 = Older Holocene
3 = Lake Bonnevile Regressive to early Great Salt Lake

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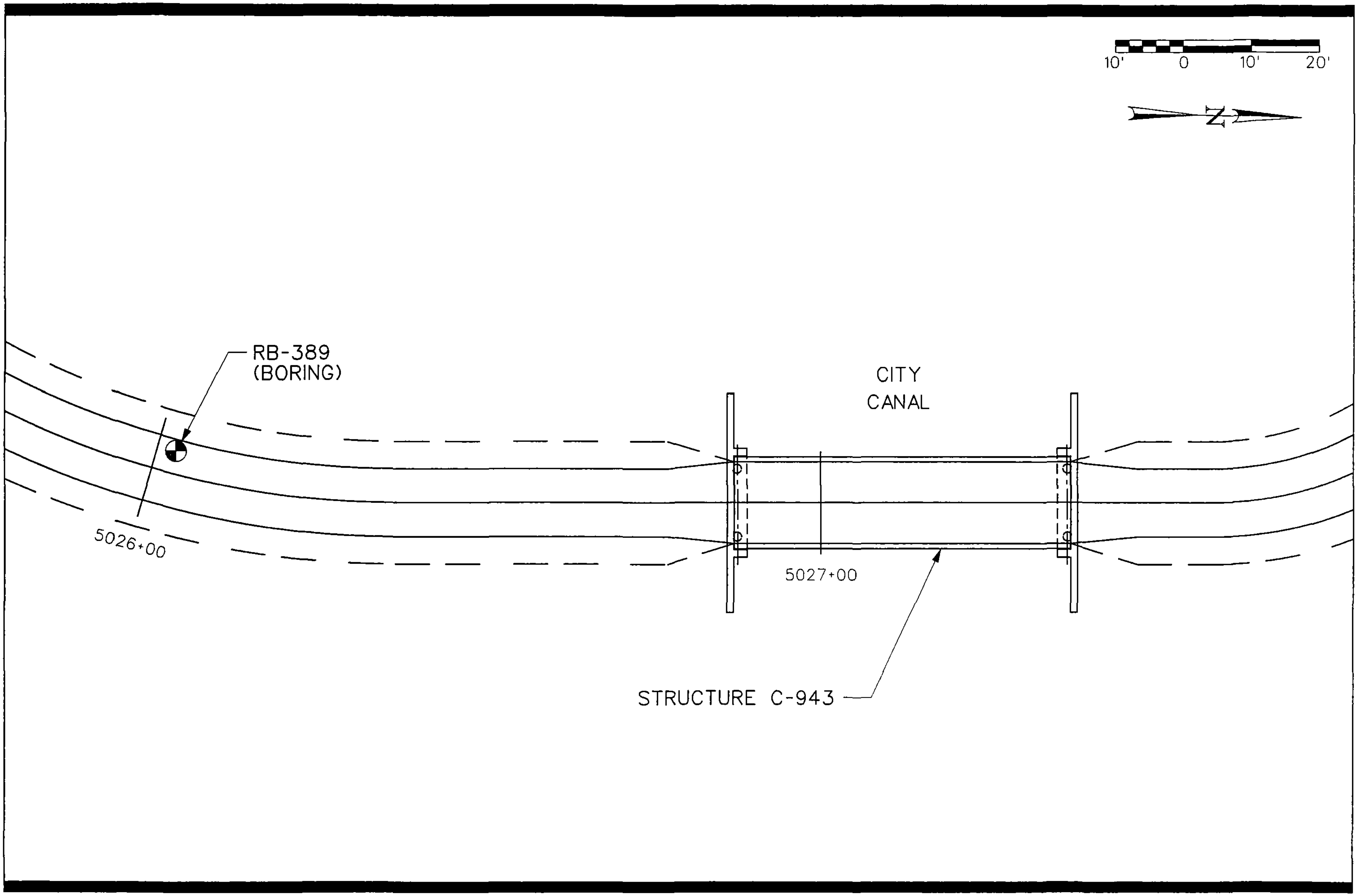
Provo, Utah

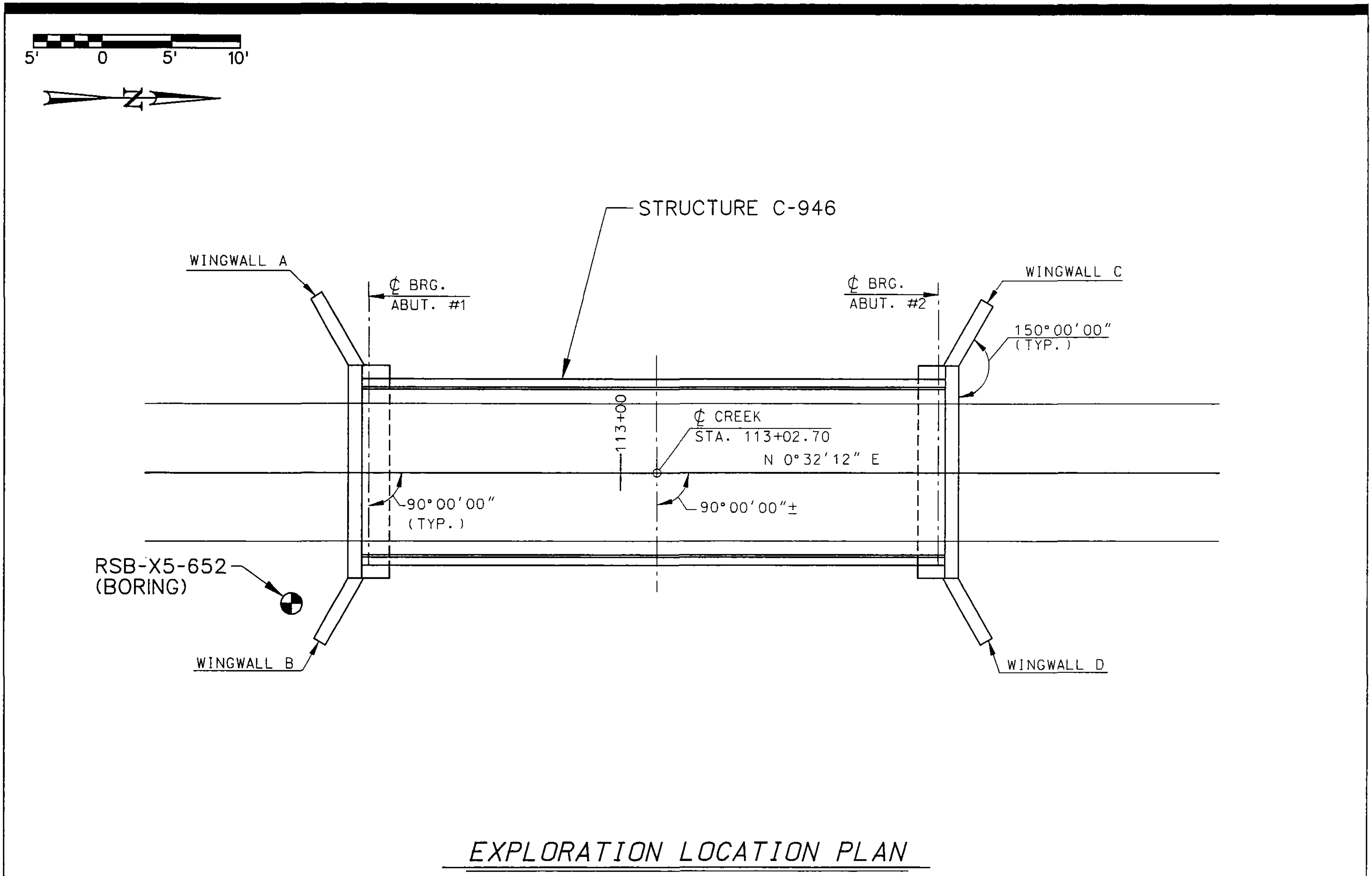
Figure 2e Geologic Map E
Farmington Siding Landslide Complex
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Harty & Lowe, 1992



RB&G ENGINEERING INC.
Provo, Utah

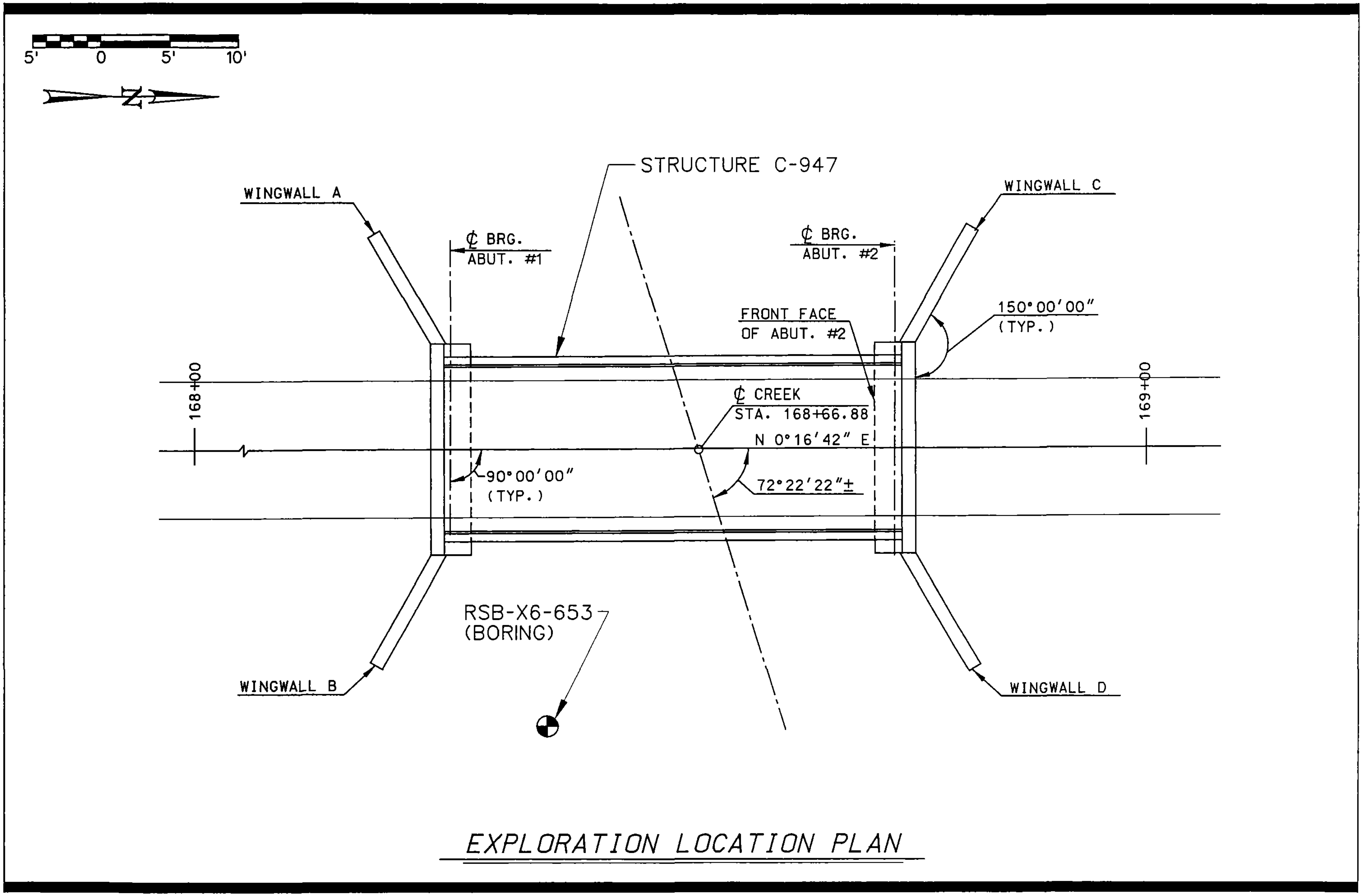
Figure 3a. SITE PLAN & TEST HOLE LOCATIONS
Legacy Parkway - Structure C-943
(Multi-Use Trail Over City Canal
Davis/Salt Lake County, Utah



EXPLORATION LOCATION PLAN

RB&G ENGINEERING INC.
Provo, Utah

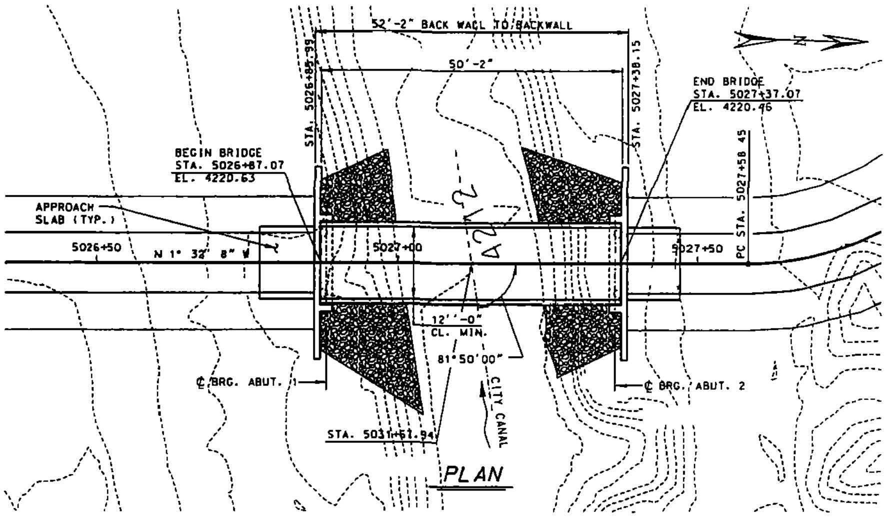
Figure 3b. SITE PLAN & TEST HOLE LOCATIONS
Legacy Parkway - Structure C-946
(LP Trail Over Rick's Creek)
Davis/Salt Lake County, Utah



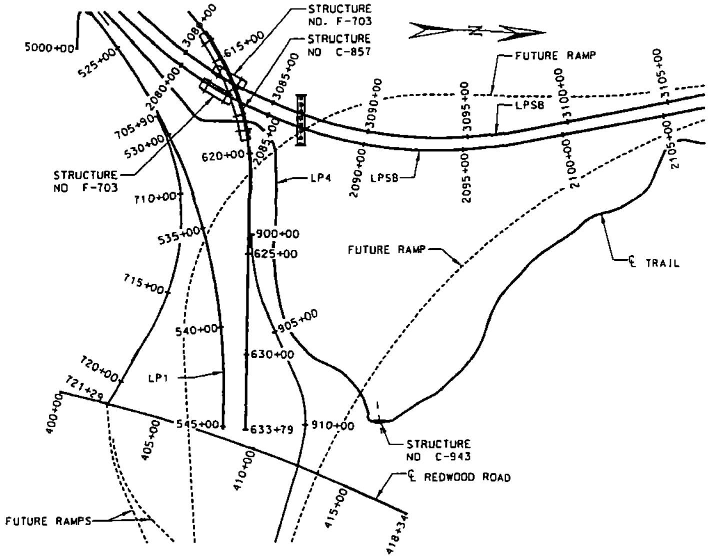
RB&G ENGINEERING INC.
Provo, Utah

Figure 3c. SITE PLAN & TEST HOLE LOCATIONS
Legacy Parkway - Structure C-947
(LP Trail Over Steed-Davis Creek)
Davis/Salt Lake County, Utah

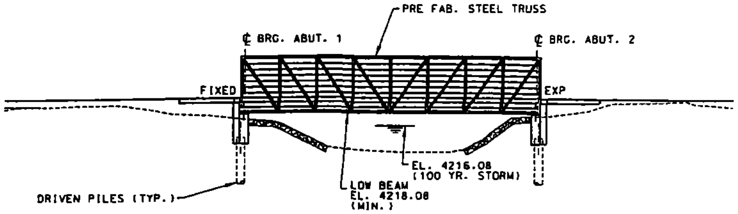
APPENDIX A
Structure Drawings



PLAN



LOCATION PLAN



ELEVATION

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 50 EXCEPT WHERE NOTED OTHERWISE.
3. CHAMFER ALL EXPOSED CONCRETE CORNERS 3/4 " 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 DIMENSIONS ARE PLAN. VERTICAL DIMENSIONS ARE PLUMB.

DESIGN DATA

PEDESTRIAN & BICYCLE LOADINGS IN ACCORDANCE WITH 3rd EDITION AASHTO LRFD AND INTERIM SPECIFICATIONS THROUGH 2006 AND IN ACCORDANCE WITH AASHTO GUIDE SPECIFICATIONS FOR DESIGN OF PEDESTRIAN BRIDGES (1st EDITION. 1997).

DESIGN VEHICULAR LIVE LOAD· H5 (10K VEHICLE)

CAST-IN-PLACE CONCRETE: f'c = 4000 PSI: Fy (REINF.) = 60.000 PSI: n = 8

STRUCTURAL STEEL: Fy = 50.000 PSI

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

INDEX OF SHEETS

SHEET NO.	TITLE
1	SITUATION & LAYOUT 1
2	SITUATION & LAYOUT 2
3	SOIL DATA I
4	SOIL DATA II
5	FOUNDATION PLAN
6	DRIVEN PILE DETAILS
7	ABUTMENT PLAN, ELEVATION & DETAILS
8	ABUTMENT DETAILS
9	REINFORCING STEEL SCHEDULE

HYDRAULIC DATA

1.	DRAINAGE AREA	1291.126 acre
2.	INLET FLOW LINE ELEVATION	4210.91 FT
3.	OUTLET FLOW LINE ELEVATION	4210.89 FT
4.	DESIGN FREQUENCY	100 yr
5.	DESIGN DISCHARGE (Qd)	501.47 CFS
6.	INLET WATER SURFACE ELEVATION FOR Qd	4216.08 FT
7.	OUTLET WATER SURFACE ELEVATION FOR Qd	4215.88 FT
8.	OUTLET VELOCITY FOR Qd	2.29 FT/S
9.	100-YEAR DISCHARGE (Q100)	501.47 CFS
10.	INLET WATER SURFACE ELEVATION FOR Q100	4216.08 FT
11.	OUTLET WATER SURFACE ELEVATION FOR Q100	4215.88 FT
12.	OVERTOPPING DISCHARGE (Qover)	3058.25 CFS
13.	FREQUENCY OF Qover (500-YEAR MAX)	500 yr
14.	OVERTOPPING ELEVATION	4232.28 FT

PRELIMINARY
NOT FOR CONSTRUCTION

QUANTITIES

ITEM	ESTIMATED	UNIT	AS CONSTRUCTED
GRANULAR BACKFILL BORROW (PLAN QUANTITY)	XX	CU. YDS.	
E DRIVING EQUIPMENT	1	LUMP	
EN PILES (16 INCH)	1200	FT.	
CTURAL CONCRETE (SUBSTRUCTURE EST. LUMP QTY 15 0 CU YDS)	1	LUMP	
INFORCING STEEL (EPOXY COATED)	4500	LBS.	

NO.	DATE	BY	REMARKS

REVISIONS

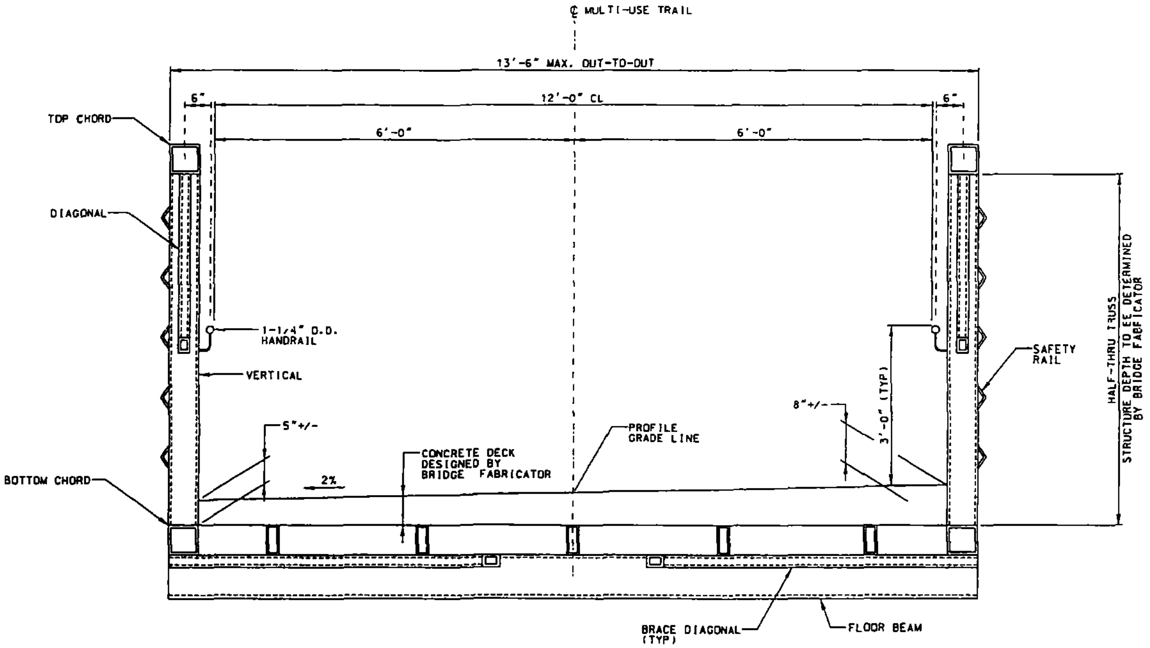
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN DVP 6/06	CHECK SKD 6/06	APPROVAL RECOMM. ____ DATE ____	SENIOR DESIGN ENGINEER
DRAWN JLH 6/06	CHECK DVP 6/06	APPROVED ____ DATE ____	UDOT BRIDGE ENGINEER
QUANT DVP 6/06	CHECK SKD 6/06		

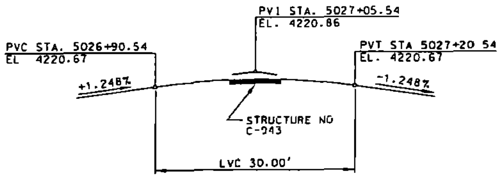
LEGACY PARKWAY
MULTI-USE TRAIL OVER CITY CANAL
SITUATION & LAYOUT 1
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY

SHT 1 OF 9



SECTION THRU STRUCTURE



MULTI-USE TRAIL PROFILE

PRELIMINARY
NOT FOR CONSTRUCTION

NO.	DATE	BY	REMARKS

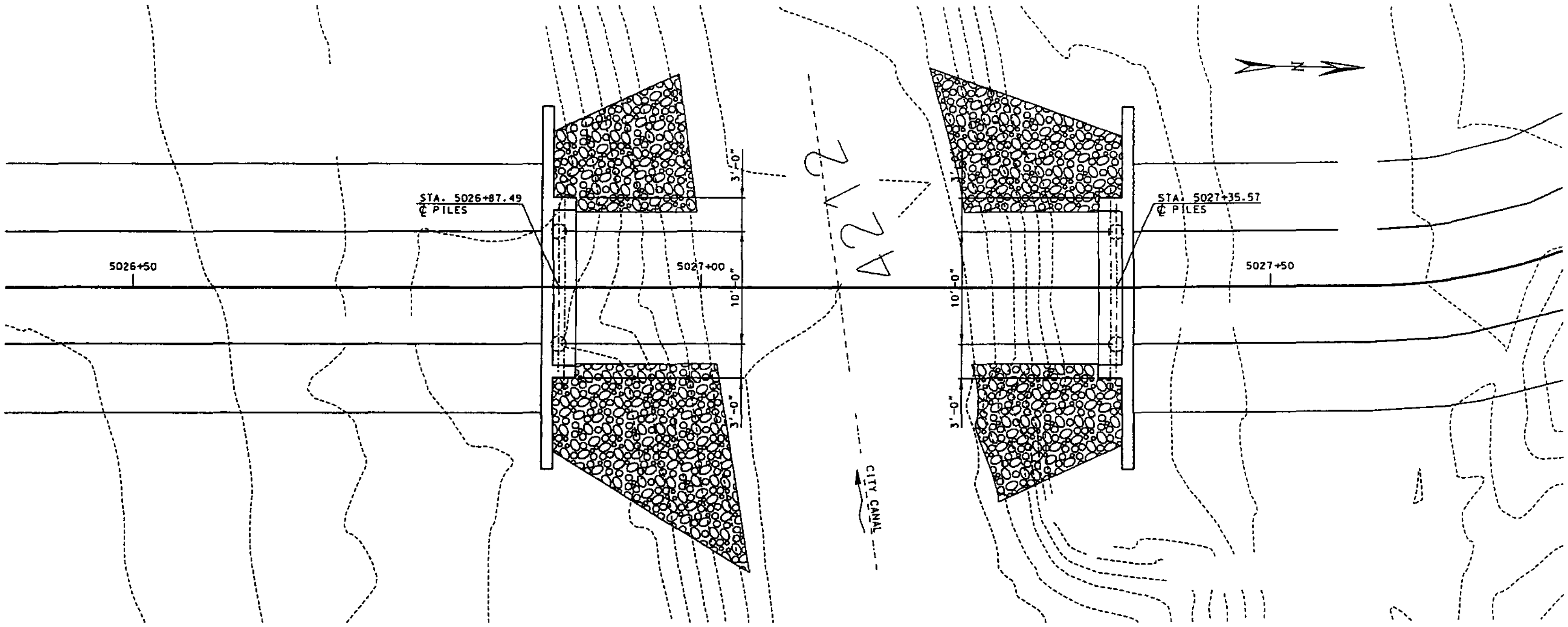
REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN XXX 6/06	CHECK XXX 6/06	APPROVAL RECOMM. ___ DATE ___ SENIOR DESIGN ENGINEER
DRAWN XXX 6/06	CHECK XXX 6/06	
QUANT XXX 6/06	CHECK XXX 6/06	APPROVED ___ DATE ___ UDOT BRIDGE ENGINEER

LEGACY PARKWAY
MULTI-USE TRAIL OVER CITY CANAL
SITUATION & LAYOUT 2
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
C-943
BRIDGE NO
SHT 2 OF 9



PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES:

1. SEE DRIVEN PILE SHEET FOR PILE DETAILS.
2. STATIONS ARE ALONG ℄ MULTI-USE TRAIL

NO.	DATE	BY	REVISIONS REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

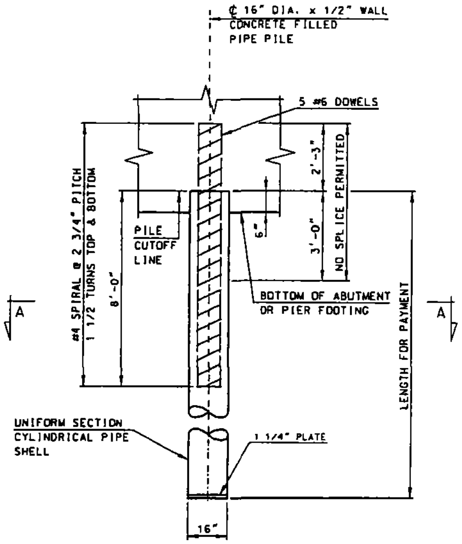
APPROVAL RECOMM. ___ DATE ___ SENIOR DESIGN ENGINEER	DESIGN DVP 6/06	CHECK SKD 6/06
	DRAWN RGP 6/06	CHECK DVP 6/06
APPROVED ___ DATE ___ UDOT BRIDGE ENGINEER	QUANT. DVP 6/06	CHECK SKD 6/06

LEGACY PARKWAY
MULTI-USE TRAIL OVER CITY CANAL
FOUNDATION PLAN
PROJECT NUMBER SP-0067(5)0

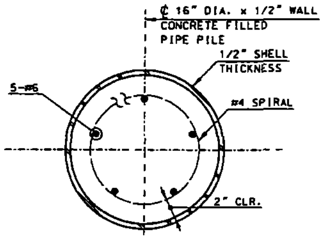
SL / DAVIS

SHT 5 OF 9

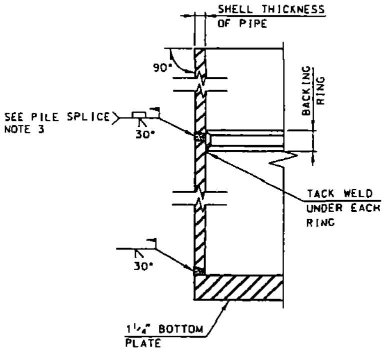
6/6/2006 3:04:28 PM



PIPE PILE DETAIL



SECTION A-A



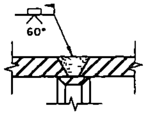
PILE SECTION

PILE SPLICE AND BOTTOM PLATE NOTES:

1 PROVIDE EACH BACKING RING WITH EQUALLY SPACED PINS

2 CONFORM TO THE AASHTO/AWS BRIDGE WELDING CODE.

3. USE THE FOLLOWING WELD FOR FLAT WELD POSITION:



PILE SPLICE AND BOTTOM PLATE DETAILS

NOTES:

1. FILL PILE SHELLS WITH CLASS "A(AE)" CONCRETE. f'c = 3000 psi.
2. HOLD THE REINFORCING STEEL ADEQUATELY IN FINAL POSITION DURING PLACEMENT OF CONCRETE AROUND BARS.
3. PROVIDE PIPE MATERIAL CONFORMING TO ASTM A252 GRADE 3. Fy = 45 ksi.
4. NOTIFY THE DEPARTMENT AT LEAST FIVE WORKING DAYS PRIOR TO DRIVING PILES.
5. PROVIDE UNCOATED REINFORCEMENT FOR PLACEMENT INTO PILES.
6. MONITOR THE INSTALLATION OF ONE PILE AT ABUTMENT NO. 1 USING A PILE DRIVING ANALYZER (PDA).
7. ESTIMATED PILE TIP ELEVATIONS SHOWN ARE APPROXIMATE AND WILL BE VERIFIED AT THE TIME OF CONSTRUCTION IN ACCORDANCE WITH THE SPECIFICATIONS.
8. REINFORCING STEEL AND CONCRETE FOR PILES SHALL BE INCLUDED IN CONTRACT PRICE FOR DRIVEN PILES.

PILE DATA

LOCATION	PILE DIAMETER (IN)	PILE SHELL THICKNESS (IN)	ESTIMATED PILE TIP ELEVATION (FT)	ELEVATION OF MIN. ACCEPTABLE PILE PENETRATION (FT)	ULTIMATE SOIL CAPACITY Qult (KIPS)	FACTORED SOIL CAPACITY Qr (KIPS) *	MIN. DRIVING RESISTANCE Qdr (KIPS)	MAXIMUM DRIVING LOAD Qdl (KIPS)	STRENGTH 1 DESIGN LOAD (KIPS) **	AS CONSTRUCTED PILE TIP ELEVATION (FT)
ABUT. NO. 1	16	1/2	***	***	709	567	693	986	554	
ABUT. NO. 2	16	1/2	***	***	709	567	693	986	554	

* A FACTORED DOWNDRAG OF 229 KIPS IS NOT INCLUDED.
** A FACTORED DOWNDRAG OF 229 KIPS IS INCLUDED. THIS INCLUDES A FACTOR OF 1.3.

PRELIMINARY
NOT FOR CONSTRUCTION

NO	DATE	BY	REMARKS

REVISIONS

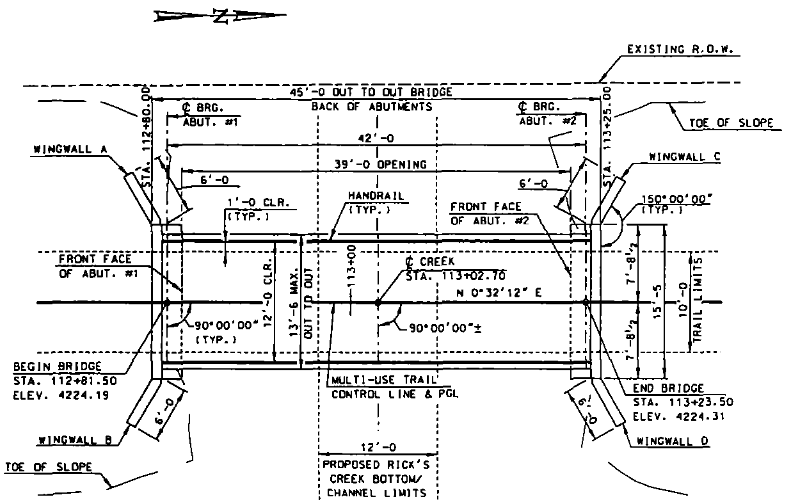
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

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

DESIGN DVP 6/06	CHECK SKD 6/06
DRAWN RGP 6/06	CHECK DVP 6/06
QUANT DVP 6/06	CHECK SKD 6/06

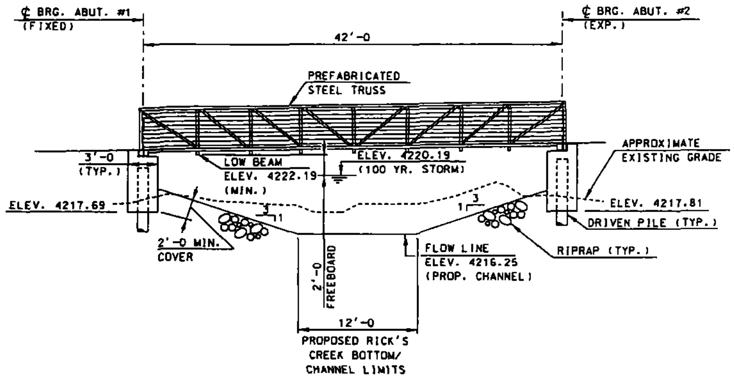
LEGACY PARKWAY
MULTI-USE TRAIL OVER CITY CANAL
DRIVEN PILE DETAILS
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
C-943
BRIDGE NO
SHT 6 OF 9

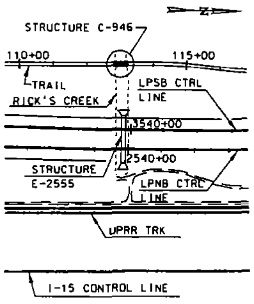


NOTE: NO KNOWN UTILITIES IN THIS AREA

PLAN



ELEVATION



LOCATION PLAN

INDEX OF SHEETS

1 SITUATION & LAYOUT 1
2 SITUATION & LAYOUT 2
3 SOIL DATA
4 FOUNDATION PLAN
5 DRIVEN PILE DETAILS
6 ABUTMENT PLAN & ELEVATION
7 ABUTMENT DETAILS
8 REINFORCING STEEL SCHEDULE

GENERAL NOTES

1. USE COATED, DEFORMED BILLET-STEEL BARS CONFORMING TO AASHTO M284 OR M111 AND M31 GRADE 60 FOR ALL REINFORCING STEEL.
2. USE STRUCTURAL STEEL CONFORMING TO AASHTO M270 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 DIMENSIONS ARE PLAN. VERTICAL DIMENSIONS ARE PLUMB.

DESIGN DATA

PEDESTRIAN & BICYCLE LOADINGS IN ACCORDANCE WITH 3RD EDITION AASHTO LRFD AND INTERIM SPECIFICATIONS THROUGH 2006 AND IN ACCORDANCE WITH AASHTO GUIDE SPECIFICATION FOR DESIGN OF PEDESTRIAN BRIDGES (1ST EDITION, 1997).

DESIGN VEHICULAR LIVE LOAD: H5 (10 K VEHICLE)

CAST-IN-PLACE CONCRETE: f'c= 4000 psi (EXCEPT WHERE NOTED OTHERWISE): fy (REINF.) = 60,000 psi: n=8

TIMBER DECK: DOUGLAS FIR-LARCH NO. 1 OR BETTER

SEISMIC: SEISMIC DESIGN PER MCEER/ATC 49: 3% PE IN 75 YEARS
(2% PE IN 50 YEARS, 2475 YR. RETURN PERIOD)
PEAK HORIZ. GROUND ACCEL. (PHGA) = 0.6 g
Ss = MAX CONSIDERED EQ GROUND MOTION AT 0.2S = 1.44g
S1 = MAX CONSIDERED EQ GROUND MOTION AT 1.0S = 0.60g
SITE CLASS E

QUANTITIES

ITEM	ESTIMATED	UNIT	AS CONSTRUCTED
GRANULAR BACKFILL BORROW (PLAN QUANTITY)	30	CU YD	
PILE DRIVING EQUIPMENT	1	LUMP	
DRIVEN PILES 12¾ INCH	316	FEET	
REINFORCING STEEL - COATED	3352	LB	
STRUCTURAL CONCRETE (EST. QTY. 22 YD^3)	1	LUMP	
STEEL TRUSS (42 FEET - 0 INCH)	1	EACH	

NO.	DATE	BY	REMARKS

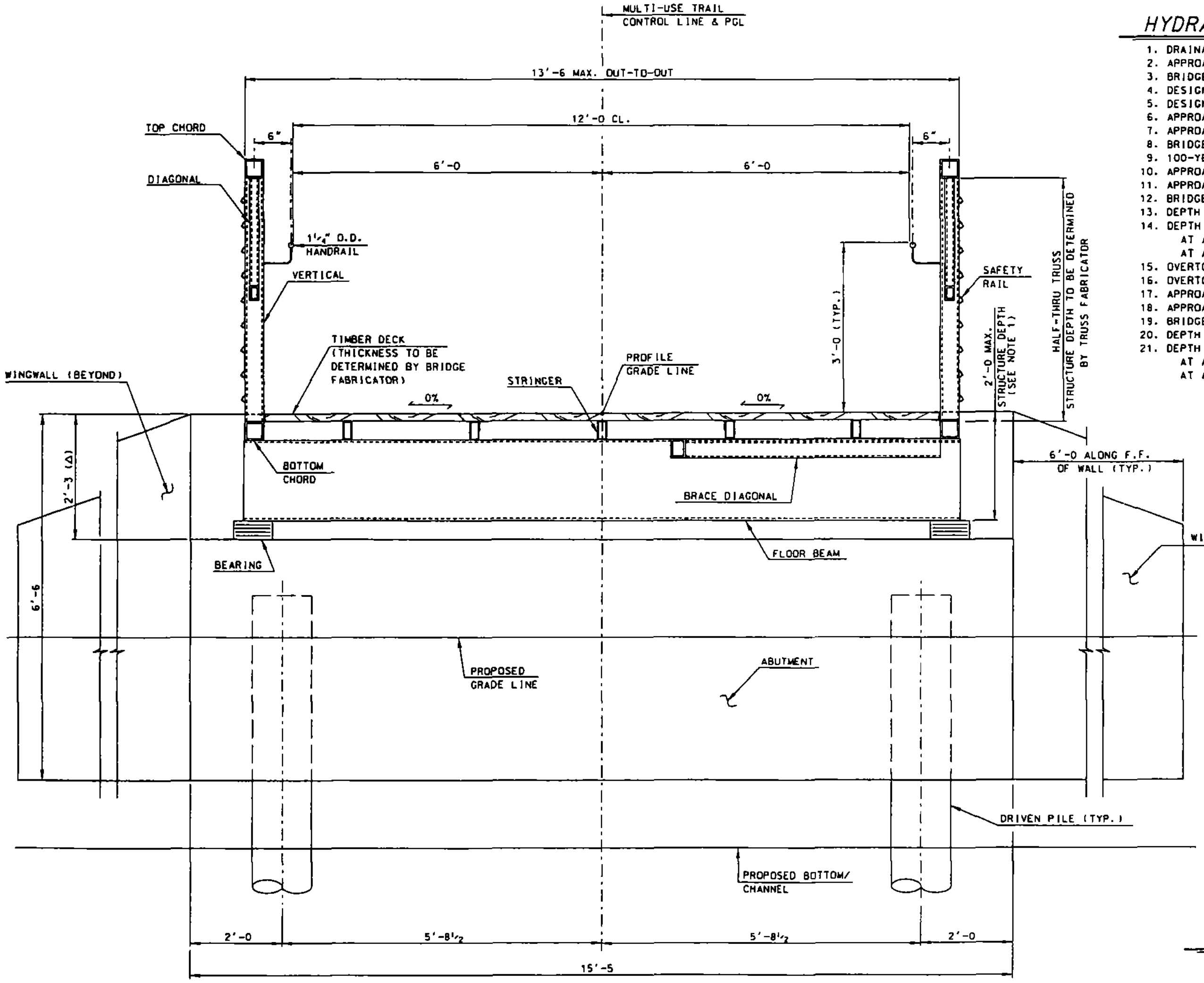
REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JSD 03/06
CHECK RH 03/06
DRAWN CS 03/06
CHECK RH 03/06
QUANT. ____
CHECK ____
APPROVAL RECOM. ____ DATE ____ CONSULTANT DESIGN ENGR.
APPROVED ____ DATE ____ CONSULTANT PROJ. MANAGER

LEGACY PARKWAY
TRAIL OVER RICK'S CREEK
SITUATION & LAYOUT 1
PROJECT NUMBER SP-0067 (10) 4

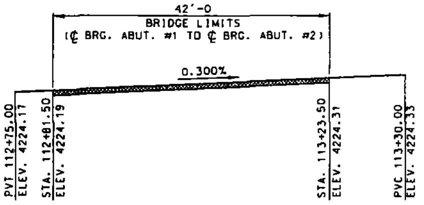
SL / DAVIS
COUNTY
C-946
DWG. NO.
SHT. 1 OF 8



SECTION THRU STRUCTURE

HYDRAULIC DATA

1. DRAINAGE AREA	2.5 SQ MI
2. APPROACH SECTION FLOW LINE	4216.08 FT
3. BRIDGE SECTION FLOW LINE	4215.91 FT
4. DESIGN FREQUENCY	100-YR
5. DESIGN DISCHARGE (Qd)	300 CFS
6. APPROACH SECTION WSE FOR Qd IN NATURAL CHANNEL	N/A
7. APPROACH SECTION WSE FOR Qd WITH BRIDGE	4219.75
8. BRIDGE SECTION VELOCITY FOR Qd	3.76 FPS
9. 100-YEAR DISCHARGE (Q100)	300 CFS
10. APPROACH SECTION WSE FOR Q100 IN NATURAL CHANNEL	N/A
11. APPROACH SECTION WSE FOR Q100 WITH BRIDGE	4219.75 FT
12. BRIDGE SECTION VELOCITY FOR Q100	3.76 FPS
13. DEPTH OF CONTRACTION SCOUR FOR Q100	0.09 FT
14. DEPTH OF TOTAL SCOUR FOR Q100:	
AT ABUTMENT #1	0.09 FT
AT ABUTMENT #2	0.09 FT
15. OVERTOPPING FREQUENCY (500-YR MAX)	500-YR
16. OVERTOPPING DISCHARGE Qover OR Q500	520 CFS
17. APPROACH SECTION FOR WSE FOR Q500 IN NATURAL CHANNEL	N/A
18. APPROACH SECTION FOR WSE FOR Q500 WITH BRIDGE	4220.76
19. BRIDGE SECTION VELOCITY FOR Q500	4.46 FPS
20. DEPTH OF CONTRACTION SCOUR FOR Q500	0.10 FT
21. DEPTH OF TOTAL SCOUR FOR Qover:	
AT ABUTMENT #1	0.10 FT
AT ABUTMENT #2	0.10 FT



MULTI-USE TRAIL PROFILE

NOTES

1. FINAL DIMENSIONS TO BE SPECIFIED BY TRUSS FABRICATOR.
2. SEE SITUATION & LAYOUT 1 FOR ADDITIONAL NOTES.
3. F.F. = FRONT FACE. SEE ABUTMENT PLAN AND ELEVATION SHEET FOR DETAILS.
4. ADJUST ELEVATIONS AND DIMENSIONS PRECEDED BY A DELTA (Δ) TO FIT FINAL DIMENSIONS REQUIRED BY TRUSS FABRICATOR.

REVISIONS
NO. DATE BY REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

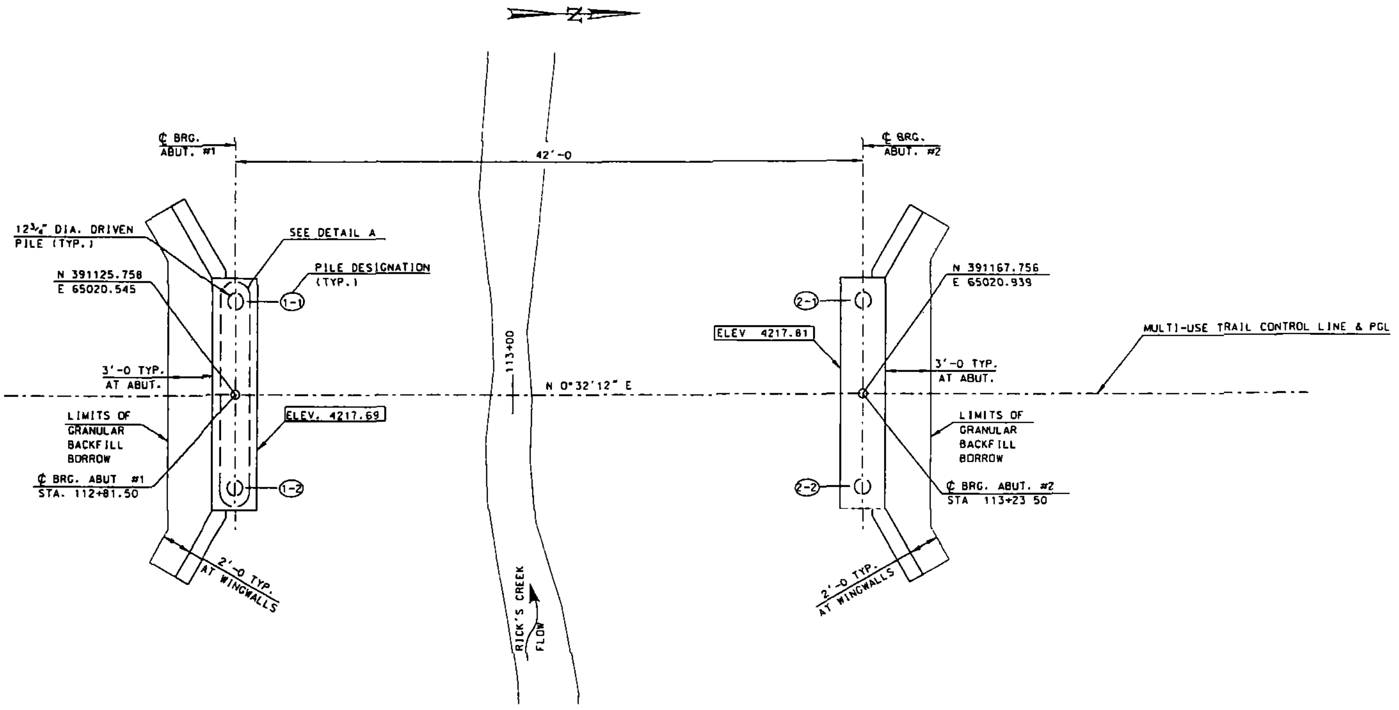
APPROVAL RECOMM. ____ DATE ____ CONSULTANT DESIGN ENGR.
APPROVED ____ DATE ____ CONSULTANT PROJ. MANAGER
DESIGN JSD 03/08 CHECK RH 03/08
DRAWN DS 03/08 CHECK RH 03/08
QUANT. ____ CHECK ____

LEGACY PARKWAY
TRAIL OVER RICK'S CREEK
SITUATION & LAYOUT 2
PROJECT NUMBER SP-0067 (10) 4

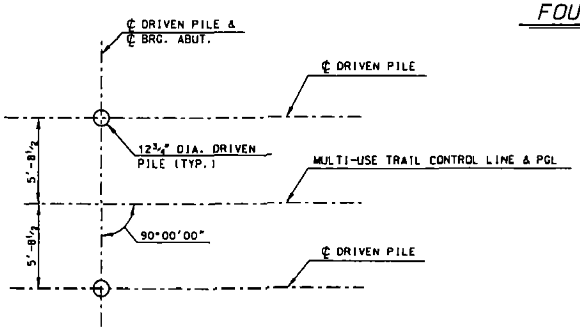
SL / DAVIS
COUNTY
C-946
DWG. NO.
SHT. 2 OF 8

I:\UTAH_LEGACY_PARKWAY\8417_08\SHEET_FILES\STRUCTURES\TBRC\8417_TBRC02.DGN

7/27/2006



FOUNDATION PLAN



DETAIL A

NOTES

1. ELEVATIONS AT BOTTOMS OF ABUTMENTS SHOWN IN RECTANGLES.
2. SEE SHEET NO. 5 FOR DRIVEN PILE DETAILS AND TIP ELEVATIONS
3. TOLERANCE LIMIT OF DRIVEN PILE VERTICAL PLUMBNESS IS 6". TOLERANCE LIMIT OF EXPOSED PORTION OF PILE IS ¼" PER 1'-0" VERTICAL
4. BRIDGE FOUNDATION DESIGN PERFORMED ASSUMING DIMENSIONS AS SHOWN.

REVISIONS

NO.	DATE	BY	REMARKS

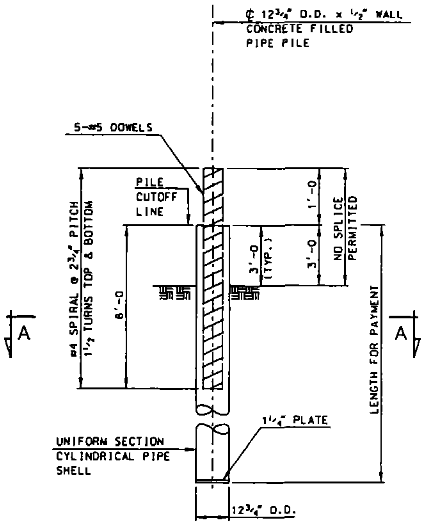
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JSH 06/06 CHECK CMM 06/06
DRAWN EF 06/06 CHECK CMM 06/06
QUANT CHECK

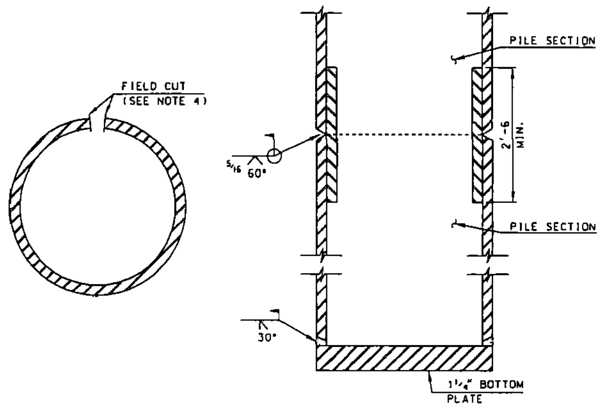
APPROVAL RECOMM. DATE CONSULTANT DESIGN ENGR
APPROVED DATE CONSULTANT PROJ MANAGER

LEGACY PARKWAY
TRAIL OVER RICK'S CREEK
FOUNDATION PLAN
PROJECT NUMBER SP-0067 (10) 4

SL / DAVIS
COUNTY
C-946
DWG. NO
SHT. 4 OF 8



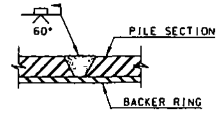
PIPE PILE DETAIL



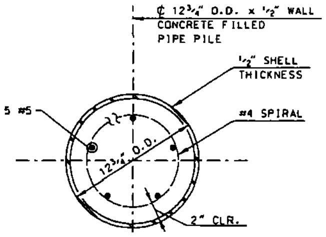
PILE SECTION

PILE SPLICE AND BOTTOM PLATE NOTES

1. FIELD CUT PIECE OF PIPE SO WHEN COMPRESSED IT WILL SLIDE INSIDE PIPE SECTIONS.
2. CONFORM TO THE AASHTO/AWS BRIDGE WELDING CODE.
3. USE FULL STRENGTH WELD SPLICES.
4. USE THE FOLLOWING WELD FOR FLAT WELD POSITION:



PILE SPLICE AND BOTTOM PLATE DETAILS



SECTION A-A

NOTES

1. FILL PILE SHELLS WITH CLASS "AA(AE)" CONCRETE, f'c = 4000 psi.
2. HOLD THE REINFORCING STEEL ADEQUATELY IN FINAL POSITION DURING PLACEMENT OF CONCRETE AROUND BARS.
3. PROVIDE PIPE MATERIAL CONFORMING TO ASTM A252 GRADE 3 (MOD). Fy = 65 ksi.
4. NOTIFY THE DEPARTMENT AT LEAST FIVE WORKING DAYS PRIOR TO DRIVING PILES.
5. PROVIDE UNCOATED REINFORCEMENT FOR PLACEMENT INTO PILES.

PILE DATA

LOCATION	PILE DIAMETER (IN)	PILE SHELL THICKNESS (IN)	ESTIMATED PILE TIP ELEVATION (FT)	ELEVATION OF MIN. ACCEPTABLE PILE PENETRATION (FT)	STRENGTH I PILE LOAD (KIPS)	SERVICE I PILE RESISTANCE (KIPS)	STRENGTH I PILE RESISTANCE (KIPS)	ULTIMATE PILE RESISTANCE (KIPS)	REQ'D DRIVING RESISTANCE (KIPS)	MAXIMUM DRIVING LOAD (KIPS)	AS CONSTRUCTED PILE ELEVATION (FT) PILE 1	AS CONSTRUCTED PILE ELEVATION (FT) PILE 2
ABUT. NO. 1	12¾	½	4142	XXXX	53.4	XXX	90	122	140	489.6		
ABUT. NO. 2	12¾	½	4142	XXXX	53 4	XXX	90	122	140	489 6		

NO	DATE	BY	REMARKS

REVISIONS

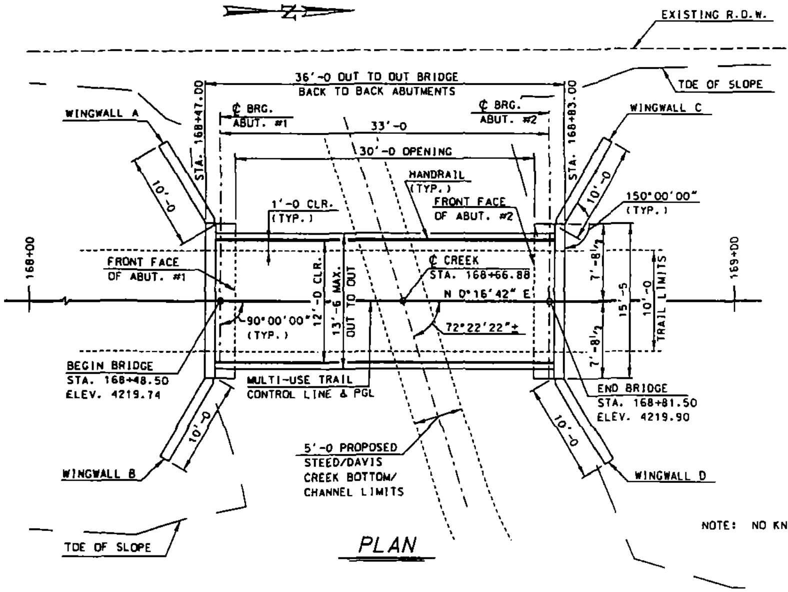
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

APPROVAL RECOM. ______ DATE ______ CONSULTANT DESIGN ENGR
APPROVED ______ DATE ______ CONSULTANT PROJ. MANAGER

DESIGN JSD 08/08 CHECK CMM 08/08
DRAWN EF 08/08 CHECK CMM 08/08
QUANT ______ CHECK ______

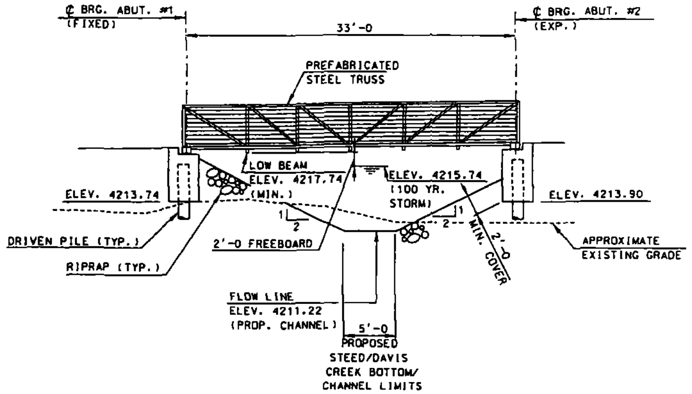
LEGACY PARKWAY
TRAIL OVER RICK'S CREEK
DRIVEN PILE DETAILS
PROJECT NUMBER SP-0067 (10) 4

SL / DAVIS
COUNTY
C-946
DWG. NO
SHT. 5 OF 8

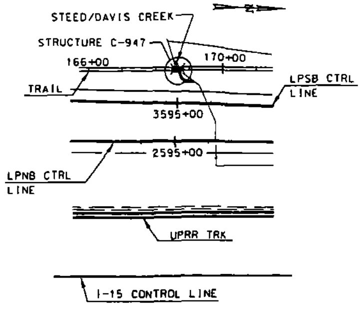


NOTE: NO KNOWN UTILITIES IN THIS AREA

PLAN



ELEVATION



LOCATION PLAN

INDEX OF SHEETS

GENERAL NOTES

1. USE COATED, DEFORMED BILLET-STEEL BARS CONFORMING TO AASHTO M284 OR M111 AND M31 GRADE 60 FOR ALL REINFORCING STEEL.

2. USE STRUCTURAL STEEL CONFORMING TO AASHTO M270 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 DIMENSIONS ARE PLAN. VERTICAL DIMENSIONS ARE PLUMB.

DESIGN DATA

PEDESTRIAN & BICYCLE LOADINGS IN ACCORDANCE WITH 3RD EDITION AASHTO LRFD AND INTERIM SPECIFICATIONS THROUGH 2006 AND IN ACCORDANCE WITH AASHTO GUIDE SPECIFICATION FOR DESIGN OF PEDESTRIAN BRIDGES (1ST EDITION, 1997).

DESIGN VEHICULAR LIVE LOAD: H5 (10 K VEHICLE)

CAST-IN-PLACE CONCRETE: f'c= 4000 psi (EXCEPT WHERE NOTED OTHERWISE):
fy (REINF.) = 60,000 psi: n=8

TIMBER DECK: DOUGLAS FIR-LARCH NO. 1 OR BETTER

SEISMIC: SEISMIC DESIGN PER MCEER/ATC 49: 3% PE IN 75 YEARS
(2% PE IN 50 YEARS, 2475 YR. RETURN PERIOD)
PEAK HORIZ. GROUND ACCEL. (PHGA) = 0.6 g
Ss = MAX CONSIDERED EQ GROUND MOTION AT 0.2S = 1.44g
S1 = MAX CONSIDERED EQ GROUND MOTION AT 1.0S = 0.60g
SITE CLASS E

QUANTITIES

ITEM	ESTIMATED	UNIT	AS CONSTRUCTED
GRANULAR BACKFILL BORROW (PLAN QUANTITY)	32	CU YD	
PILE DRIVING EQUIPMENT	1	LUMP	
DRIVEN PILES 12¾ INCH	300	FEET	
REINFORCING STEEL - COATED	3824	LB	
STRUCTURAL CONCRETE (EST. QTY. 23 YD³)	1	LUMP	
STEEL TRUSS (33 FEET - 0 INCH)	1	EACH	

NO.	DATE	BY	REMARKS

REVISIONS

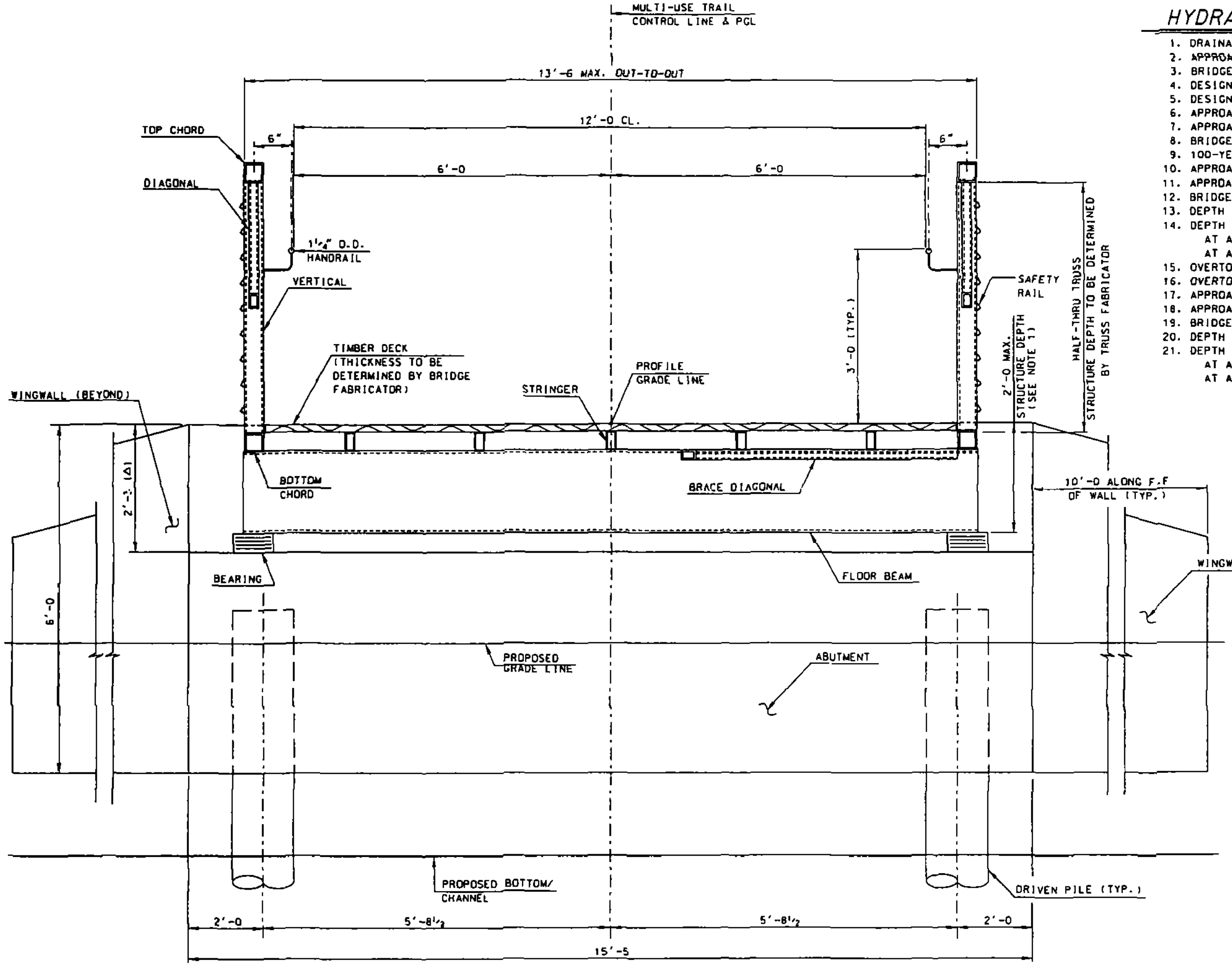
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JSD 06/06 CHECK RH 06/06
DRAWN DS 06/06 CHECK RH 06/06
QUANT. ____ CHECK ____
APPROVAL RECOM. ____ DATE ____ CONSULTANT DESIGN ENGR.
APPROVED ____ DATE ____ CONSULTANT PROJ. MANAGER

LEGACY PARKWAY
TRAIL OVER STEED/DAVIS CREEK
SITUATION & LAYOUT 1
PROJECT NUMBER SP-0067 (10) 4

SL / DAVIS
COUNTY
C-947
DWG. NO.
SHT. 1 OF 8

7/27/2006

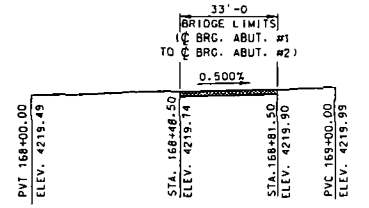


SECTION THRU STRUCTURE

HYDRAULIC DATA

1. DRAINAGE AREA	5.4 SQ MI
2. APPROACH SECTION FLOWLINE ELEVATION	4211.55
3. BRIDGE SECTION FLOWLINE ELEVATION	4211.22
4. DESIGN FREQUENCY	100-YR
5. DESIGN DISCHARGE (Qd)	364 CFS
6. APPROACH SECTION WSE FOR Qd IN NATURAL CHANNEL	N/A
7. APPROACH SECTION WSE FOR Qd WITH BRIDGE	4215.69
8. BRIDGE SECTION VELOCITY FOR Qd	6.18 FPS
9. 100-YEAR DISCHARGE (Q100)	364 CFS
10. APPROACH SECTION WSE FOR Q100 IN NATURAL CHANNEL	N/A
11. APPROACH SECTION WSE FOR Q100 WITH BRIDGE	4215.69
12. BRIDGE SECTION VELOCITY FOR Q100	6.18 FPS
13. DEPTH OF CONTRACTION SCOUR FOR Q100	0.52 FT
14. DEPTH OF TOTAL SCOUR FOR Q100:	
AT ABUTMENT #1	0 FT
AT ABUTMENT #2	2.97 FT
15. OVERTOPPING FREQUENCY	*
16. OVERTOPPING DISCHARGE (Qover)	1510 CFS
17. APPROACH SECTION FOR WSE FOR Qover IN NATURAL CHANNEL	N/A
18. APPROACH SECTION FOR WSE FOR Qover WITH BRIDGE	4222.24
19. BRIDGE SECTION VELOCITY FOR Qover	9.72 FPS
20. DEPTH OF CONTRACTION SCOUR FOR Qover	4.14 FT
21. DEPTH OF TOTAL SCOUR FOR Qover:	
AT ABUTMENT #1	0 FT
AT ABUTMENT #2	13.37 FT

* INFORMATION NOT AVAILABLE



MULTI-USE TRAIL PROFILE

NOTES

1. FINAL DIMENSIONS TO BE SPECIFIED BY TRUSS FABRICATOR.
2. SEE SITUATION & LAYOUT 1 FOR ADDITIONAL NOTES.
3. F.F. = FRONT FACE. SEE ABUTMENT PLAN AND ELEVATION SHEET FOR DETAILS.
4. ADJUST ELEVATIONS AND DIMENSIONS PRECEDED BY A DELTA (Δ) *TO FIT FINAL DIMENSIONS REQUIRED BY TRUSS FABRICATOR.*

NO.	DATE	BY	REMARKS

REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JSD 03/06 CHECK RH 03/06
DRAWN DB 03/06 CHECK RH 03/06
QUANT. CHECK
APPROVAL RECOMM. DATE CONSULTANT DESIGN ENGR.
APPROVED DATE CONSULTANT PROJ. MANAGER

LEGACY PARKWAY
TRAIL OVER STEED/DAVIS CREEK
SITUATION & LAYOUT 2

PROJECT NUMBER SP-0067 (10) 4

SL / DAVIS
COUNTY
C-947
DWG. NO.
SHT. 2 OF 8

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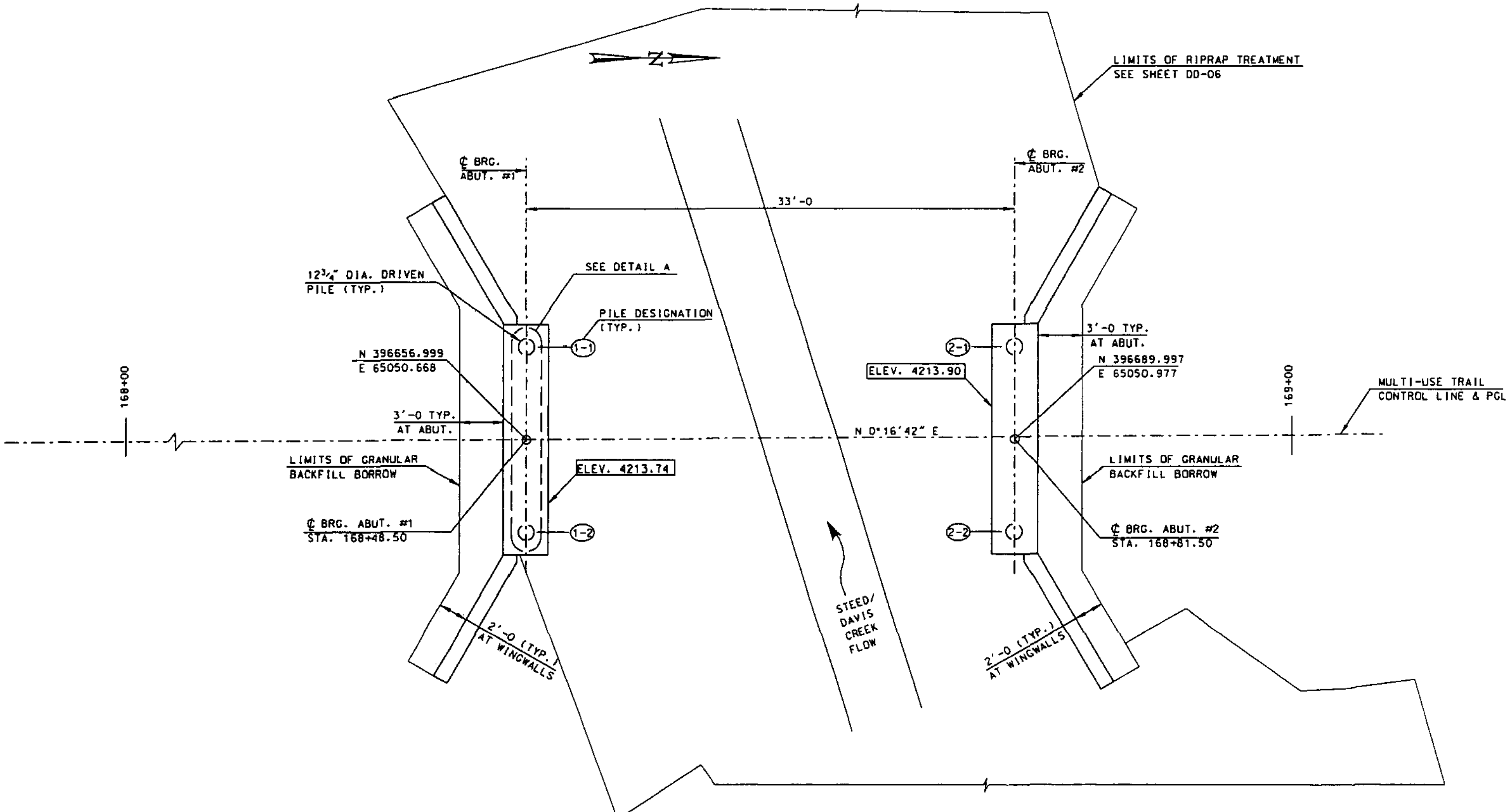
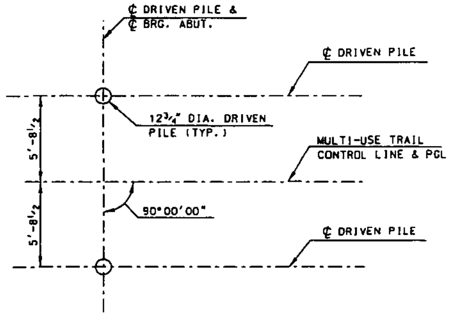
7/27/2006



FOUNDATION PLAN



DETAIL A

NOTES

1. ELEVATIONS AT BOTTOMS OF ABUTMENTS SHOWN IN RECTANGLES.
2. SEE SHEET NO. 5 FOR DRIVEN PILE DETAILS AND TIP ELEVATIONS.
3. TOLERANCE LIMIT OF DRIVEN PILE VERTICAL PLUMBNESS IS 6". TOLERANCE LIMIT OF EXPOSED PORTION OF PILE IS ¼" PER 1'-0" VERTICAL.
4. BRIDGE FOUNDATION DESIGN PERFORMED ASSUMING DIMENSIONS AS SHOWN.
5. FOR RIPRAP TREATMENT LIMITS AND DETAILS. SEE SHEETS DD-06 AND DD-07.

NO.	DATE	BY	REMARKS

REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JSD 06/06 CHECK RH 06/06
DRAWN OB 06/06 CHECK RH 06/06
QUANT. ____ CHECK ____
APPROVAL RECOM. ____ DATE ____ CONSULTANT DESIGN ENGR.
APPROVED ____ DATE ____ CONSULTANT PROJ. MANAGER

LEGACY PARKWAY
TRAIL OVER STEED/DAVIS CREEK
FOUNDATION PLAN

PROJECT NUMBER SP-0067 (10) 4

SL / DAVIS
COUNTY
C-947
DWG. NO.
SHT. 4 OF 8

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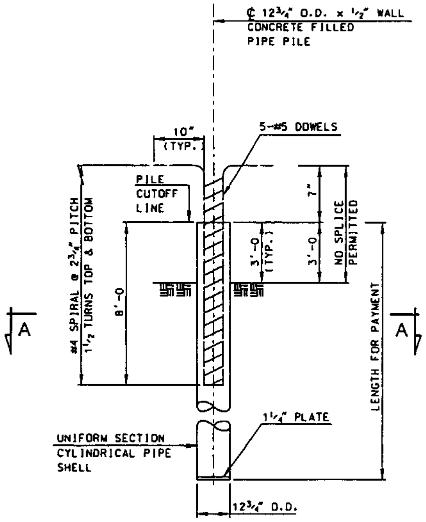
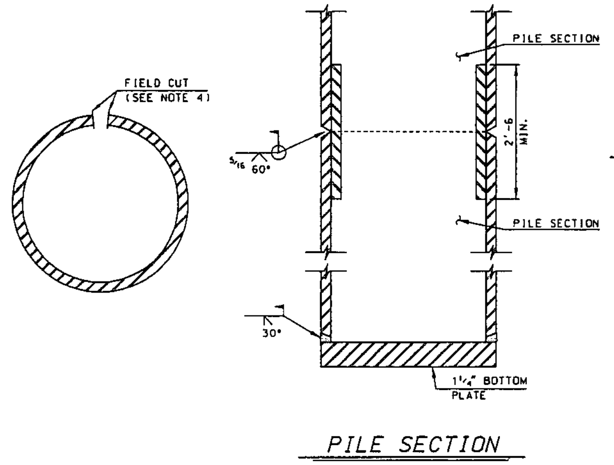
7/27/2006



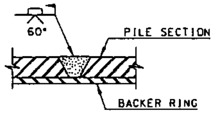
PIPE PILE DETAIL



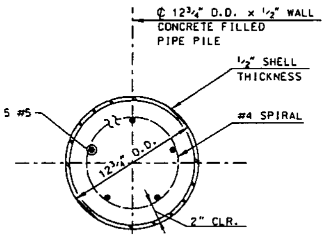
PILE SECTION

PILE SPLICE AND BOTTOM PLATE NOTES

1. FIELD CUT PIECE OF PIPE SO WHEN COMPRESSED IT WILL SLIDE INSIDE PIPE SECTIONS.
2. CONFORM TO THE AASHTO/AWS BRIDGE WELDING CODE.
3. USE FULL STRENGTH WELD SPLICES.
4. USE THE FOLLOWING WELD FOR FLAT WELD POSITION:



PILE SPLICE AND BOTTOM PLATE DETAILS



SECTION A-A

NOTES

1. FILL PILE SHELLS WITH CLASS "AA(AE)" CONCRETE. f'c = 4000 psi.
2. HOLD THE REINFORCING STEEL ADEQUATELY IN FINAL POSITION DURING PLACEMENT OF CONCRETE AROUND BARS.
3. PROVIDE PIPE MATERIAL CONFORMING TO ASTM A252 GRADE 3 (MOD). Fy = 65 ksi.
4. NOTIFY THE DEPARTMENT AT LEAST FIVE WORKING DAYS PRIOR TO DRIVING PILES.
5. PROVIDE UNCOATED REINFORCEMENT FOR PLACEMENT INTO PILES.

PILE DATA

LOCATION	PILE DIAMETER (IN)	PILE SHELL THICKNESS (IN)	ESTIMATED PILE TIP ELEVATION (FT)	ELEVATION OF MIN. ACCEPTABLE PILE PENETRATION (FT)	STRENGTH I PILE LOAD (KIPS)	SERVICE I PILE RESISTANCE (KIPS)	STRENGTH I PILE RESISTANCE (KIPS)	ULTIMATE PILE RESISTANCE (KIPS)	REQ'D DRIVING RESISTANCE (KIPS)	MAXIMUM DRIVING LOAD (KIPS)	AS CONSTRUCTED PILE ELEVATION (FT) PILE 1	AS CONSTRUCTED PILE ELEVATION (FT) PILE 2
ABUT. NO. 1	12¾	½	4142	XXXX	47.9	XXX	56	76	86	489.6		
ABUT. NO. 2	12¾	½	4142	XXXX	47.9	XXX	56	76	86	489.6		

NO.	DATE	BY	REMARKS

REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN JSD 08/06 CHECK CMM 08/06
DRAWN EF 08/06 CHECK CMM 08/06
QUANT. CHECK
APPROVAL RECOMM. DATE CONSULTANT DESIGN ENGR.
APPROVED DATE CONSULTANT PROJ. MANAGER

LEGACY PARKWAY
TRAIL OVER STEED/DAVIS CREEK
DRIVEN PILE DETAILS
PROJECT NUMBER SP-0067 (10) 4

SL / DAVIS
COUNTY
C-947
DWG. NO.
SHT. 5 OF 8

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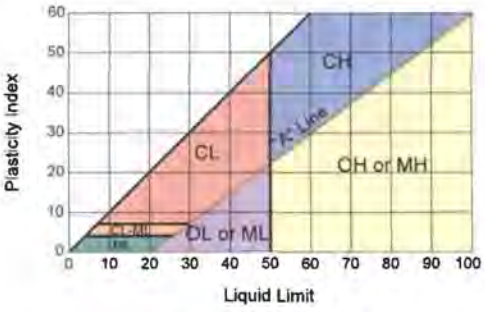
7/27/2006

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*	$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 4 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**	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
				u				
			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		$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 6 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**	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
				u				
			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*  Plasticity Chart		
			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			

*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.)

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

FIELD TEST BORING LOG

Boring: **RB-389**
Sheet 1 of 2

Logged by:	M. Hislop
Date Start:	2/16/00
Date Finish:	2/17/00
Station:	51+019.953 0.01 RT
Line:	I-15 NB to LP NB
Coordinates (m):	N 107,347.322 E 16,199.835
Elevation (m):	1286.013
Total Depth Drilled (m):	30.2
Drill Contractor:	RC Exploration
Driller:	M. Labenski
Rig Type:	Diedrich D-120 ATV
Drilling Method:	Hollow-Stem Auger
Hammer Type:	Automatic
Rod Type:	AW
Boring Diameter:	152 mm

Boring: RB-389
Sheet 1 of 2

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	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 - stiff, moist, dark to light brown, with common roots	MC	305	ML	A-4	3 5 7 7	18							
1285		SPT	305			4 4 3 5	14							
	CLAY - medium stiff, wet, gray-brown			CL	A-7-6									
∇		SH	457					53	15.3	27	45	21	94	C TR SG
		MC	457			2 12 5 2	21							
	Silty SAND - medium dense, wet, light brown to gray	SPT	610	SM	A-2-4	1 1 1 2	2							
	Lean CLAY - soft, wet, gray mottled black			CL	A-7-6									
		SH	610					14 *24*	12.3	45	45	20	97	C SG
		SPT	610			0 0 8 6	12							
1280		MC	610			4 5 3 5	9							
		SPT	610			2 4 3 4	9							
		SH	610					28 *19*	15.4	29				
	Silty SAND - loose, wet, gray	SPT	305	SM	A-2-4	7 4 4 3	10							
	Sandy Lean CLAY - stiff, wet, gray	MC	610	CL	A-6	2 5 5 12	10				37	14	56	
1275	Silty SAND - dense, wet, grayish-brown	SH	0	SM	A-2-4									
		SPT	610			5 7 21 27	32							
	- coarse sand	MC	508			5 8 10 12	15						76	
	Lean CLAY - very stiff, wet, gray-brown	SPT	610	CL	A-7-6	9 8 7 8	17							
	Sandy SILT - stiff, wet, light brown	SH	0	ML	A-4									
	Lean CLAY - medium stiff, wet, gray	SPT	457	CL	A-7-6	4 3 3 4	6							
		SH	0											
1270	SILT - very stiff, wet, gray , with frequent silty lean clay throughout			ML	A-4									
		MC	610			8 7 19 18	22							
		SPT	610			7 8 10 20	18							
	Sandy SILT - hard, wet, light brown mottled gray-brown, with frequent			ML	A-4									

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: **RB-389**

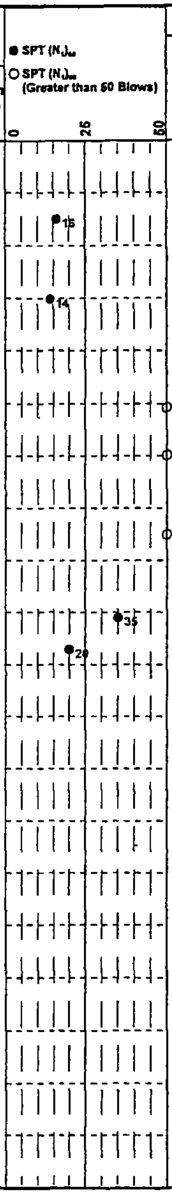
Sheet 2 of 2

Boring: RB-389
Sheet 2 of 2

SAMPLE DESCRIPTION
(ASTM D 2488/D 2487)

Elevation (m)	Sample Description	Depth ft	Depth m	Type	Recovery (mm)	Soil Classification USCS	Soil Classification AASHTO	N, Blows per 0.15 m (or interval shown)	Su, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	lean clay and silty sand throughout Sandy SILT - hard, wet, light brown mottled gray-brown, with frequent lean clay and silty sand throughout (continued)			MC	457			20 35 40 27							
1265		70	21												
	Lean CLAY - very stiff, wet, gray-brown			SPT	610	CL	A-7-6	4 5 11 12							
			22												
	Clayey SAND - medium dense, wet, gray-brown	75	23	MC	457	SC	A-2-6	4 5 12 10				NP	NP	58	
			24												
	Silty SAND - very dense, wet to wet, gray	80		SH	0	SM	A-2-4								
			25	MC	457			12 24 55 50							
1260		85	26	SPT	457			25 44 48 50							
			27												
		90		MC	305			29 50/ 125mm							
			28												
	Lean CLAY - very stiff, wet, gray	95	29	MC	559	CL	A-7-6	7 12 34 54							
				SPT	610			10 10 12 21							
			30												
		100													
1255			31												
		105	32												
			33												
		110	34												
		115	35												
1250			36												
		120	37												
		125	38												
			39												
		130													

Test Results *



Logged by:	M. Hislop
Date Start:	2/16/00
Date Finish:	2/17/00
Station:	51+019.953 0.01 RT
Line:	I-15 NB to LP NB
Coordinates (m):	N 107,347.322 E 16,199.835
Elevation (m):	1286.013
Total Depth Drilled (m):	30.2
Drill Contractor:	RC Exploration
Driller:	M. Labenski
Rig Type:	Diedrich D-120 ATV
Drilling Method:	Hollow-Stem Auger
Hammer Type:	Automatic
Rod Type:	AW
Boring Diameter:	152 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 P	= Piston Sampler, 76.2 mm OD
▯ SH	= Shelby Tube, 76.2mm OD, pushed
B BAG	= Bulk Sample

UTDOT Z003RB.GPJ 6/30/00

DRILL HOLE LOG

BORING NO. RSB-X5-652

SHEET 1 OF 2

PROJECT: LEGACY PARKWAY - C-946 (LEGACY PKWY TRAIL OVER RICK'S CREEK)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 391,120, E 65,030
DRILLING METHOD: CME-55 NO. 1 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 3.9'   **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.147
DATE STARTED: 6/14/06
DATE COMPLETED: 6/15/06
GROUND ELEVATION: 4219.3'
LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
			■	10	2,4,2,(12)	SM (A-3(0))	dk. gray-brown	SILTY SAND		17.6		NP	10	65	25	
						CL										
4215 ∇			■	0	1,1,2,(6)	-										
	5		■	1	1/12",1,(2)	-	gray-brown									
			☒	17	Pushed *0.65*	CL (A-6(18))	white-brown, moist to wet, stiff		97.1	27.2	37	19	1	6	93	CT UC
4210	10		☒	15	Pushed *0.56*	CL	lt. brown, moist, stiff, w/rusty sand lenses									
			☒	17	Pushed *0.57*	CL (A-6(17))	moist to wet, w/micaceous sand lenses			24.5	37	18	0	10	90	UC
4205	15		■	17	0/15",1/3",(2) *0.30*	CL	gray-brown, moist to wet, firm	LEAN CLAY								
4200	20		☒	15	Pushed *0.36*	CL (A-6(11))	lt. gray, moist to wet, firm, w/silty sand lenses		84.8	37.6	32	12	0	9	91	CT
4195	25		■	18	0,1/12",(1) *0.14*	CL	mottled lt. & dk. gray, wet, soft									
4190	30					SM	dk. gray, loose	SILTY SAND								
			■	7	3,1,1,(2)	CL	soft	LEAN CLAY								
4185	35		■	17	3,5,8,(15)	SP (A-3(0))	gray, wet, med. dense	POORLY GRADED SAND		26.8		NP	0	96	4	
			■	11	7,11,4,(17)	SP-SM (A-3(0))	med. dense	POORLY GRADED SAND W/SILT		24.7		NP	0	90	10	
4180						CL		CLAY W/SAND LAYERS								
	40		■	24	0/24",(0) *0.13*	CH	green-gray, wet, soft black	FAT CLAY								
			☒	18	Pushed *0.36*	CH (A-7-5(47))	dk. gray, wet, firm		66.8	55.4	64	41	0	0	100	CT UC
4175	45		■	16	0/10",1,6,(7) *0.31*	CL		LEAN CLAY								
						SP	dk. gray, wet	COARSE SAND								
								FAT CLAY								
4170																

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-X5-652

SHEET 2 OF 2

PROJECT: LEGACY PARKWAY - C-946 (LEGACY PKWY TRAIL OVER RICK'S CREEK)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 391,120, E 65,030
DRILLING METHOD: CME-55 NO. 1 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 3.9' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.147
DATE STARTED: 6/14/06
DATE COMPLETED: 6/15/06
GROUND ELEVATION: 4219.3'
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
			☒	17	Pushed *0.20*	CH *(A-7-5(24))*	gray, wet, soft	FAT CLAY		47.8	53	28	0	20	80	UC
4165	55		■	18	0/18",(0) *0.30*	CL	gray-lt. green, moist, firm, w/few thin sand lenses	LEAN CLAY								
4160	60		☒	15	Pushed *0.40*	CL *(A-7-5(30))*	gray-lt. green, moist, firm		82.5	36.7	47	27	0	0	100	CT
4155	65		■	18	0/18",(0) *0.30*	CL/CH	green, moist, firm	LEAN TO FAT CLAY								
4150	70		☒	15	Pushed *0.49*	CH *(A-7-5(45))*	mottled dk. gray, moist, firm	FAT CLAY		57.5	65	39	0	1	99	UC
4145	75		■	18	0/8",2,6,(7) *0.75*	CL/CH	dk. gray, wet, stiff, 8" silty sand layer	LEAN TO FAT CLAY								
4140	80		☒	17	Pushed *0.72*	CL/CH *(A-7-5(39))*	green-gray, moist, stiff		83.1	35	50	37	0	1	99	CT
4135	85		■	18	7,10,17,(13) *0.71* *0.90+*	CL	green-gray, moist, stiff, 5" sand layer	LEAN CLAY								
4130	90															
4125	95															
4120																

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

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

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **RB-412**

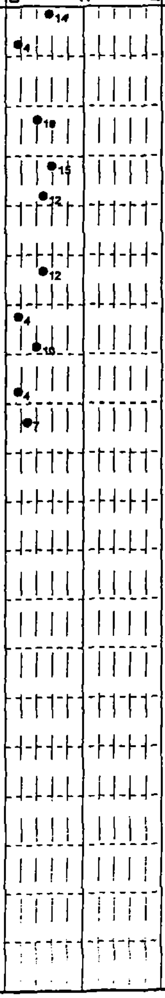
Sheet 1 of 1

Logged by:	R. Khandokar
Date Start:	5/18/00
Date Finish:	5/18/00
Station:	6016+150.000 0.00 RT
Line:	D Mainline
Coordinates (m):	N 119,225.500 E 19,868.686
Elevation (m):	1286.314
Total Depth Drilled (m):	8.7
Drill Contractor:	RC Exploration
Driller:	M. Labenski
Rig Type:	Diedrich D-120 ATV
Drilling Method:	Hollow-Stem Auger
Hammer Type:	Automatic
Rod Type:	AW
Boring Diameter:	152 mm

Boring: RB-412
Sheet 1 of 1

SAMPLE DESCRIPTION
(ASTM D 2488/D 2487)

Elevation (m)	Sample Description	Depth ft	Depth m
	SILT - stiff, moist, gray		
∇	SILT with sand - wet, gray, medium plasticity		1
1285		5	2
	- mottled gray and brown and reddish-brown		
	Lean CLAY - stiff, wet, gray and tan	10	3
	- occasional silty sand lenses		4
		15	5
	Silty SAND - loose, wet, gray, fine-grained sand	20	6
1280	Lean CLAY - soft, wet, gray		7
	Poorly Graded SAND - loose, wet, dark gray, fine-grained	25	
	Sandy SILT - soft, wet, gray		8
	Lean CLAY - medium stiff, wet, gray to dark gray		
		30	9
			10
		35	11
1275			
		40	12
			13
		45	14
		50	15
			16
1270		55	17
			18
		60	
			19
		65	



SAMPLE

Type	Recovery (mm)	Soil Classification USCS	Soil Classification AASHTO	N, Blows per 0.15 m (or interval shown)	SPT (N1)60	Su, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
MC	356	ML	A-4	4 4 4 5	14							
SPT	457	ML	A-4	1 1 1	4							
SH	610					*57*	15.3	28			85	
SPT	457			2 2 3	18							
MC	610	CL	A-6	4 4 6 3	15							
SPT	457			2 3 4	12							
SH	610					29	14.3	34	33	14	87	C SG
SPT	432	SM	A-2-4	3 4 3	12							
MC	457	CL	A-6	2 2 1 3	4							
SPT	457	SP	A-3	3 1 5	10							
MC	610	ML	A-4	3 2 2 2	4						73	
SPT	457	CL	A-6	3 1 4	7							

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 P = Piston Sampler, 76.2 mm OD

▯ SH = Shelby Tube, 76.2mm OD, pushed

B BAG = Bulk Sample

UTDOT Z003BUP.GPJ 8/31/00

PLATE D-92

DRILL HOLE LOG

BORING NO. RSB-X6-653

SHEET 1 OF 3

PROJECT: LEGACY PARKWAY - C-947 (L.P. TRAIL OVER STEED-DAVIS CRK.)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 396,664, E 65,071
DRILLING METHOD: CME-55 NO. 1 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ ARTESIAN' ***AFTER 24 HOURS:*** ▼ N.M.

PROJECT NUMBER: 200601.148
DATE STARTED: 6/12/06
DATE COMPLETED: 6/13/06
GROUND ELEVATION: 4214.3'
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
			■	18	1,1,1,(4)	SM	rusty-brown, moist, very loose	SILTY SAND								
						CL	dk. brown, moist, soft	LEAN CLAY								
4210	5		☒	14	Pushed *0.14*	CL *(A-7-5(21))*	lt. gray-brown, wet, soft		89.3	27.5	42	26	0	16	84	UC
			☒	14	Pushed *0.31*	CL-ML	firm	SILTY CLAY								
4205	10		☒	15	Pushed	CL	lt. green-gray, moist, firm									
			☒	16	Pushed	CL *(A-6(13))*	soft	LEAN CLAY	88.2	33.2	33	16	0	13	87	CT UC
4200	15		■	18	0/18",(0)	CL	very soft, 1" silty sand layer									
		🟦	■	18	1,1,1,(4) *0.11*	CL SM	gray-brown, wet, soft dk. gray, wet, very loose	SILTY SAND W/CLAY LENSES								
4195	20	🟦	■	5	0/18",(0)	SM CL-ML	dk. gray, wet, very loose very soft									
4190	25		■	18	0/18",(0) *0.08*	CL-ML	gray-brown, wet, very soft	SILTY CLAY W/SILTY SAND LAYERS 0.5" TO 1" THICK								
4185	30	🟦	☒	18	Pushed	CL-ML SC										
		🟦	■	18	3,0/12",(0)	SC *(A-2-7(3))*	black, wet, very loose	CLAYEY SAND W/SOME CLAY LAYERS 0.5" TO 2" THICK		24.4	47	25	0	81	19	
4180	35		■	18	0/18",(0) *0.16*	CL	gray-brown, wet, soft, w/disturbed bedding, vertical sand dikes									
4175	40		☒	18	Pushed *0.16*	CL *(A-6(11))*	gray-brown, wet, soft		89.5	33.6	30	12	0	3	97	UC
			■	18	0,1/12",(1)	CL	soft, w/silty sand layers 0.5" to 1" thick	LEAN CLAY								
4170	45		■	18	0/18",(0) *0.19*	CL	dk. & lt. gray, moist, soft, w/sand layers to 0.25" thick									
4165																

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
🟪 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X6-653

SHEET 2 OF 3

PROJECT: LEGACY PARKWAY - C-947 (L.P. TRAIL OVER STEED-DAVIS CRK.)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 396,664, E 65,071
DRILLING METHOD: CME-55 NO. 1 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ ARTESIAN' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.148
DATE STARTED: 6/12/06
DATE COMPLETED: 6/13/06
GROUND ELEVATION: 4214.3'
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
			☒	8	Pushed *0.24*	CL *(A-7-5(23))*	black, moist, soft, slight organic odor	LEAN CLAY		42.2	42	22	0	3	97	
4160	55		■	18	0/18",(0) *0.32*	CH	black, moist, firm									
								FAT CLAY								
4155	60		☒	16	Pushed *0.44*	CH *(A-7-5(59))*	firm		63.5	55	75	51	0	0	100	CT UC
4150	65		■	18	0/18",(0) *0.16*	CL/CH	black to gray, moist, soft	LEAN TO FAT CLAY								
4145	70		☒	15	Pushed *0.52*	CL *(A-7-5(26))*	gray, moist, stiff			42.5	45	23	0	0	100	
								LEAN CLAY								
4140	75		■	18	0/12",5,(4) *0.66*	CL	lt. & dk. gray, moist, stiff, one brown peat lens 0.06" thick									
4135	80		☒	-	Pushed *0.52*	CH *(A-7-5(33))*	gray, wet, stiff		66.1	51.8	52	30	0	1	99	CT UC
			■	18	0/18",(0) *0.42*	CH	firm									
4130	85		■	18	0/18",(0) *0.24*	CH	soft									
								FAT CLAY								
4125	90		☒	0	Pushed	-	air/gas bubbles at 90'									
			■	18	0/18",(0) *0.31*	CH	green-gray, moist, firm									
4120	95		☒	17	Pushed *0.45*	CH *(A-7-5(58))*	dk. gray to black, wet, firm		61	61.4	76	50	0	1	99	CT
4115								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
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X6-653

SHEET 3 OF 3

PROJECT: LEGACY PARKWAY - C-947 (L.P. TRAIL OVER STEED-DAVIS CRK.)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

LOCATION: N 396,664, E 65,071

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

DRILLER: T. KERN

DEPTH TO WATER - INITIAL: ▽ ARTESIAN' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.148

DATE STARTED: 6/12/06

DATE COMPLETED: 6/13/06

GROUND ELEVATION: 4214.3'

LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
		▨	■	18	0/12",0,(0) *0.22*	CL	dk. gray, soft								
4110	105	▨	☒ ■	9 18	Pushed 4,6,7,(9) *0.62*	CL (*A-6(18)*) CL	green-gray, moist, firm green-gray, moist, stiff LEAN CLAY		21.1	39	18	0	6	94	
4105	110	▨	■	18	0/15",1/3",(1) *0.71*	CL	green-gray, moist, stiff								
4100	115	▨	☒	18	Pushed *0.89*	CH (*A-7-5(44)*)	mottled dk. green & brown, moist, stiff FAT CLAY W/SOME SAND LAYERS artesian, methane gas	66.3	49	66	37	0	1	99	CT
4095	120	▨	■	18	1,4,8,(8) *0.61*	CL	LEAN CLAY lt. green, moist, stiff								
4090	125														
4085	130														
4080	135														
4075	140														
4070	145														
4065															

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

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

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **RB-417**

Sheet 1 of 1

Boring: RB-417
Sheet 1 of 1

SAMPLE DESCRIPTION (ASTM D 2488/D 2487)

Sample Description	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) 0 25 50	S_u, kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
SILT - very stiff to hard, moist, dark brown	MC	457	ML	A-4	8 14 20 17	42							
	SPT	610			3 2 3 4	8							
	SH	406					53					78	
	SPT	610			2 4 4 5	12							
Lean CLAY - medium stiff, wet, gray	MC	610	CL	A-6	1 3 3 4	8							
- grades to soft	SPT	610			2 2 1 2	4							
- with sand seams	SH	457					*24*			33	12		
SILT - medium stiff, moist to wet, gray, dilatant	SPT	610	ML	A-4	2 2 4 3	8							
Poorly Graded SAND - loose, wet, dark gray to black, with few clay interbeds	MC	610	SP	A-3	2 3 2 4	5						70	
	SPT	610			2 1 1 2	2							
Lean CLAY - soft, wet, olive-gray			CL	A-6									
Poorly Graded SAND - loose, wet, dark gray to black, fine-grained	SH	457	SP	A-3			17 *24*	13.3	38			97	C SG
Lean CLAY - very soft, wet, gray	SPT	610	CL	A-6	0 0 0 0	0							

Elevation (m): 1280, 1275, 1270, 1265

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

Test Results *

Logged by:	R. Davis
Date Start:	5/19/00
Date Finish:	5/19/00
Station:	6017+700.000 0.00 RT
Line:	D Mainline
Coordinates (m):	N 120,775.482 E 19,876.216
Elevation (m):	1284.895
Total Depth Drilled (m):	9.1
Drill Contractor:	RC Exploration
Driller:	M. Burns
Rig Type:	CME-750 Track
Drilling Method:	Hollow-Stem Auger
Hammer Type:	Automatic
Rod Type:	AW
Boring Diameter:	152 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 P = Piston Sampler, 76.2 mm OD

▯ SH = Shelby Tube, 76.2mm OD, pushed

B 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: **RB-418**

Sheet 1 of 1

Logged by:	R. Davis
Date Start:	5/10/00
Date Finish:	5/10/00
Station:	6017+960.001 0.19 RT
Line:	D Mainline
Coordinates (m):	N 121,035.479 E 19,877.674
Elevation (m):	1284.895
Total Depth Drilled (m):	9.4
Drill Contractor:	RC Exploration
Driller:	M. Burns
Rig Type:	CME-750 Track
Drilling Method:	Hollow-Stem Auger
Hammer Type:	Automatic
Rod Type:	AW
Boring Diameter:	152 mm

Boring: RB-418
Sheet 1 of 1

SAMPLE DESCRIPTION
(ASTM D 2488/D 2487)

Elevation (m)	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
	SILT with sand - soft, moist, dark gray	MC	457	ML	A-4	1 2 2 1	4							
	Silty SAND - soft, moist, light gray, micaceous	SPT	457	SM	A-2-4	1 1 2 3	5							
▽	Sandy SILT - soft to medium stiff, moist, dark gray			ML	A-4									
	Lean CLAY - soft, moist to wet, light gray, plastic	SH	457	CL	A-7-6			42 *77*	14.7	29	43	21		C SG
	Sandy Lean CLAY - medium stiff, moist, gray, plastic, sand is fragment	MC	457	CL	A-6	2 2 3 4	3							
	- black organics fragments	SPT	457			2 1 0 1	1							
	Silty CLAY - soft, moist, gray, plastic			CL-ML	A-6									
	Silty SAND - very loose, wet, olive-brown clayey silt, gray fine-grained sand, black organics	SPT	457	SM	A-2-4	0 0 1 2	1							
1280	Poorly Graded SAND - soft, wet, gray, fine to medium-grained	SH	610	SP	A-3			*19*	13.5	36			93	C SG
		SPT	610			2 1 1 2	2							
	- grades to interbedded silt, olive-brown, very soft, moist													
	Silty CLAY - very soft, wet, light gray, plastic	MC	610	CL-ML	A-6	0 0 1 4	1							
	- grades to interbeds of sandy silt, very soft, moist, black sand, gray silty clay, plastic	SPT	610			0 0 1 2	1							
	Poorly Graded SAND - soft, wet, black to gray	SH	610	SP	A-3									
		MC	610			0 1 1 2	2							
	Lean CLAY - very soft, wet, light gray			CL	A-6									
	SILT - medium stiff, wet, black	SPT	610	ML	A-4	3 5 7 9	12							
	Silty SAND - medium dense, wet, gray to black			SM	A-2-4									

○ 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 P	=	Piston Sampler, 76.2 mm OD
ǁ SH	=	Shelby Tube, 76.2mm OD, pushed
B BAG	=	Bulk Sample

APPENDIX C
Laboratory Testing

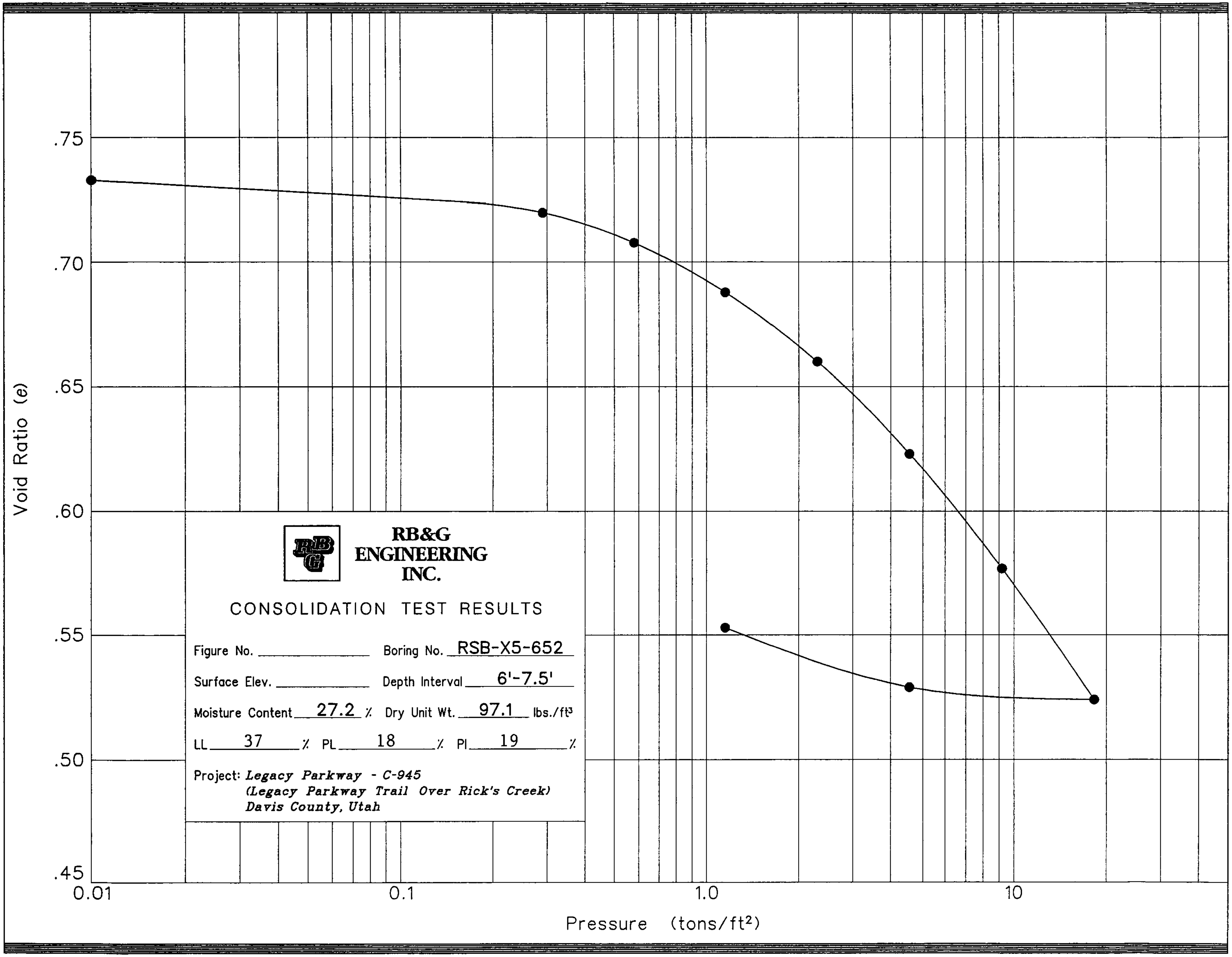
Table X5-1

SUMMARY OF TEST DATA

PROJECT	Legacy Parkway - C-946	PROJECT NO.	200601-147
LOCATION	Trail Bridge over Rick's Creek	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-X5-652	0-1.5			17.6				NP	10	65	25	SM / A-3(0)
	6-7.5		97.1	27.2	829	37	18	19	1	6	93	CL / A-6(18)
	12-13.5			24.5	1459	37	19	18	0	10	90	CL / A-6(17)
	20-21.5		84.8	37.6		32	20	12	0	9	91	CL / A-6(11)
	35-36.5	13		26.8				NP	0	96	4	SP / A-3(0)
	37.5-39	15		24.7				NP	0	90	10	SP-SM / A-3(0)
	42-43.5		66.8	55.4	1427	64	23	41	0	0	100	CH / A-7-5(47)
	50-51			47.8	1094	53	55	28	0	20	80	CH / A-7-5(24)
	60-61.5		82.5	36.7		47	20	27	0	0	100	CL / A-7-5(30)
	70-71.25			57.5	2009	65	26	39	0	1	99	CH / A-7-5(45)
	80-81.5		83.1	35.0		50	13	37	0	1	99	CL/CH / A-7-5(39)

NP=Nonplastic



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

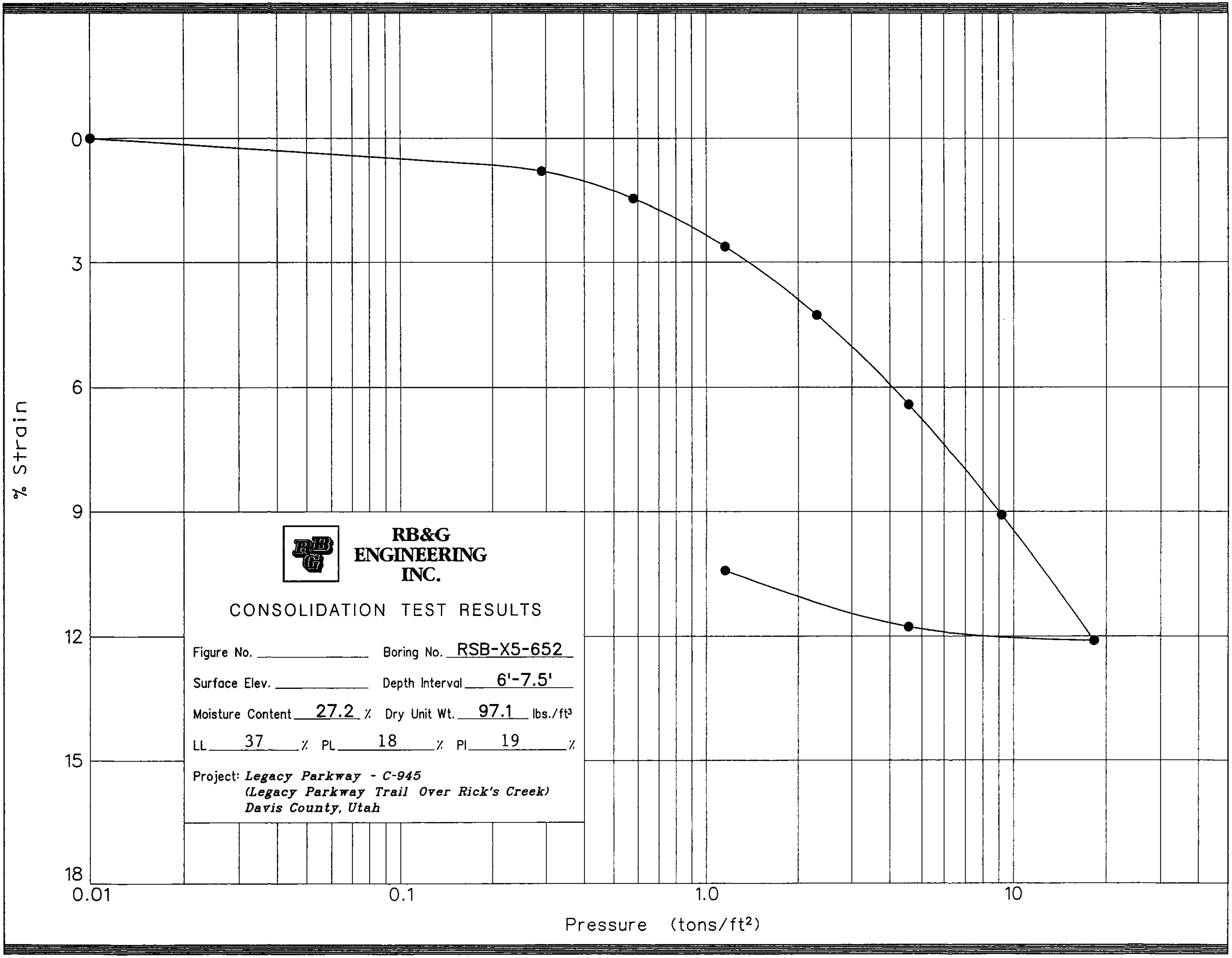
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 6'-7.5'

Moisture Content 27.2 % Dry Unit Wt. 97.1 lbs./ft³

LL 37 % PL 18 % PI 19 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ______________ Boring No. RSB-X5-652

Surface Elev. ______________ Depth Interval 6'-7.5'

Moisture Content 27.2 % Dry Unit Wt. 97.1 lbs./ft³

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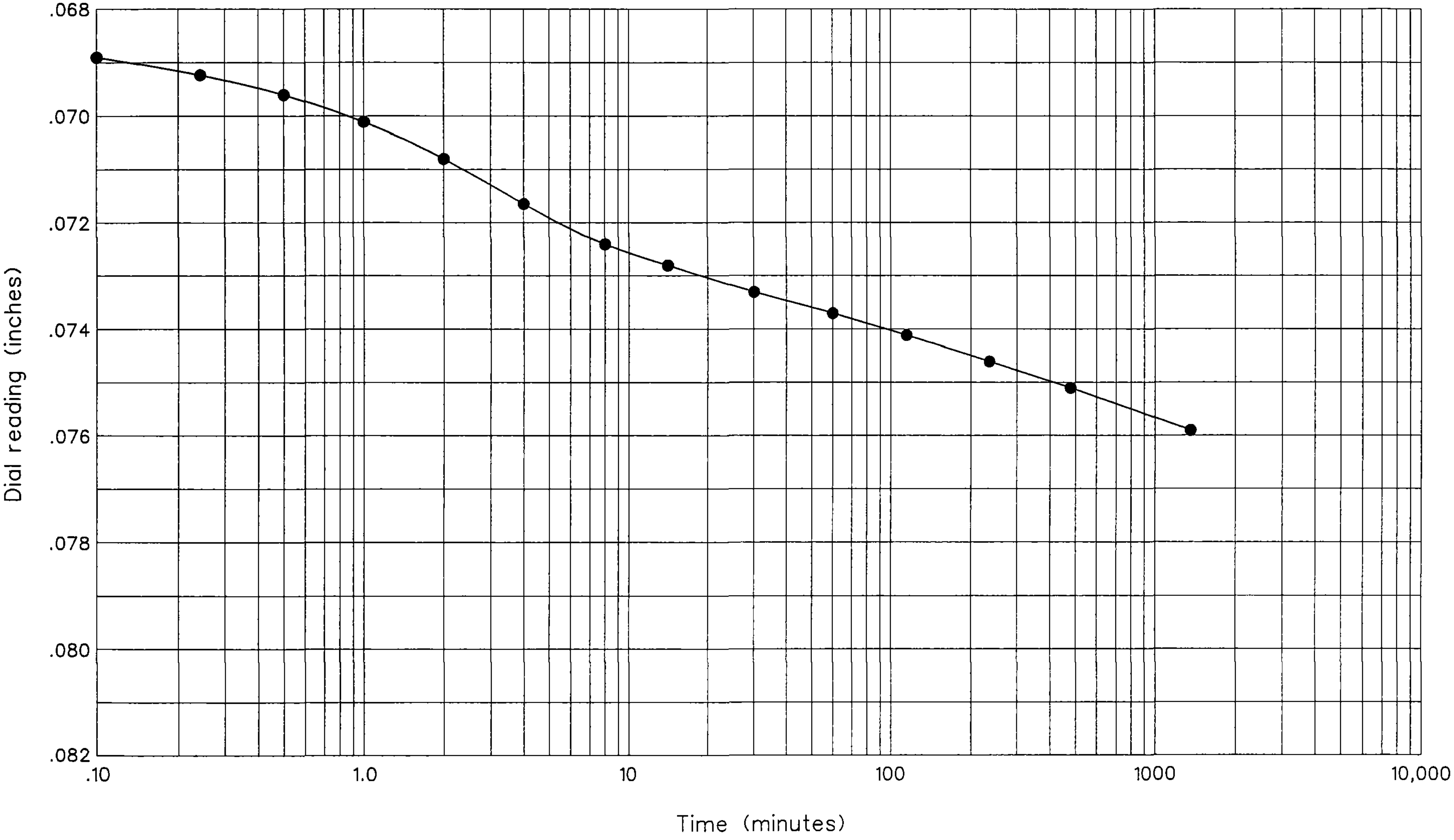
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



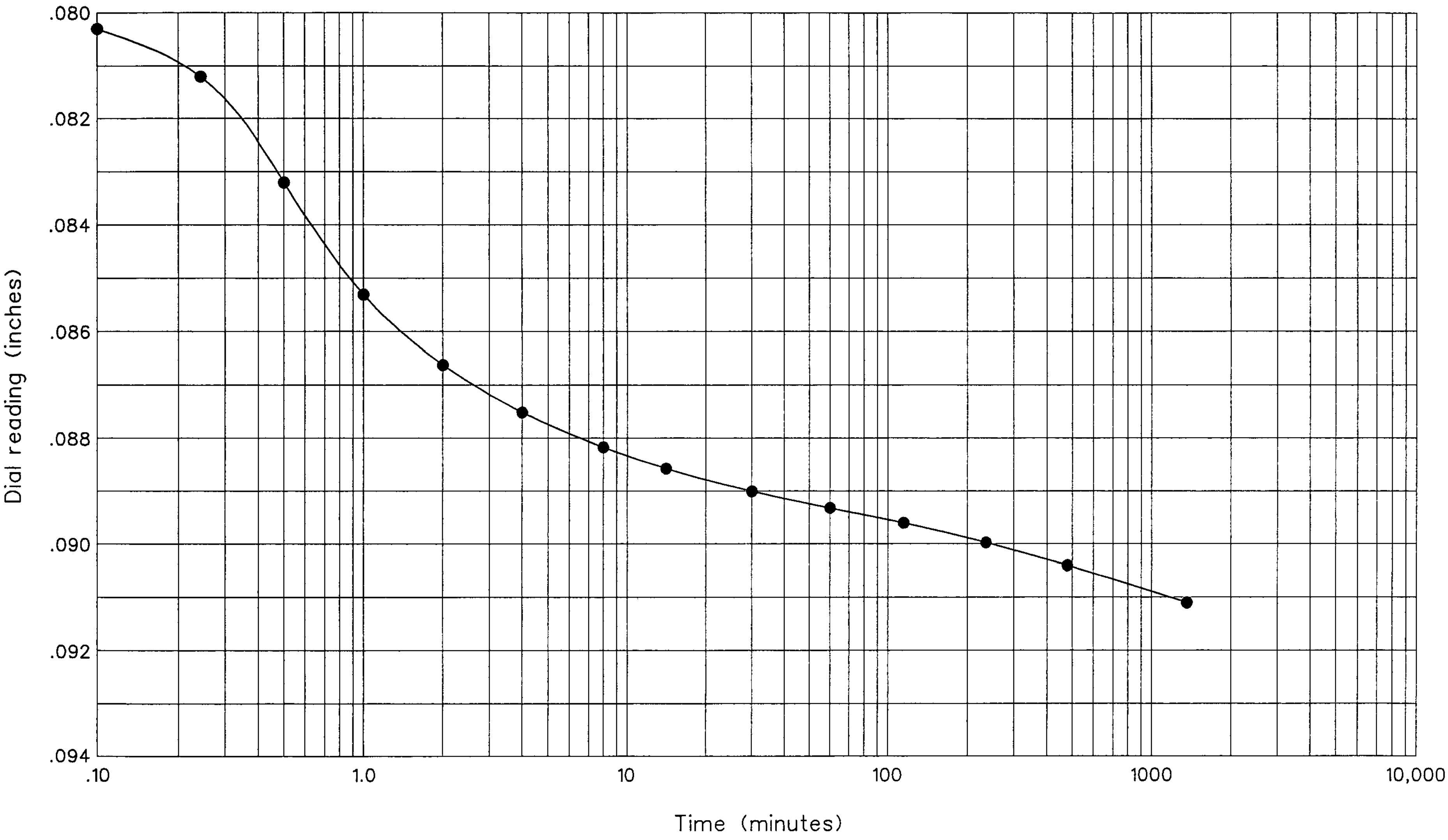
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 6'-7.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



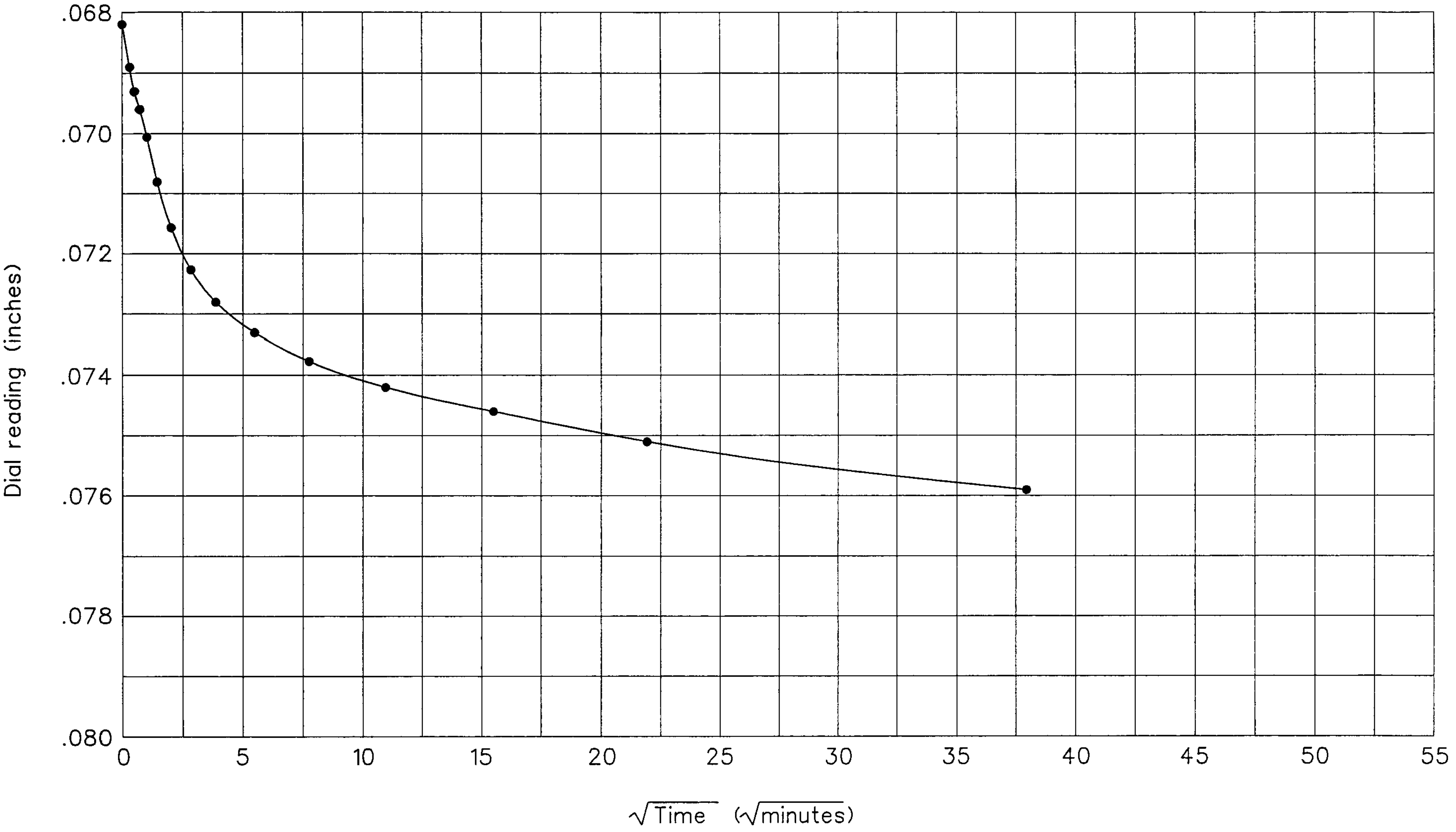
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 6'-7.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



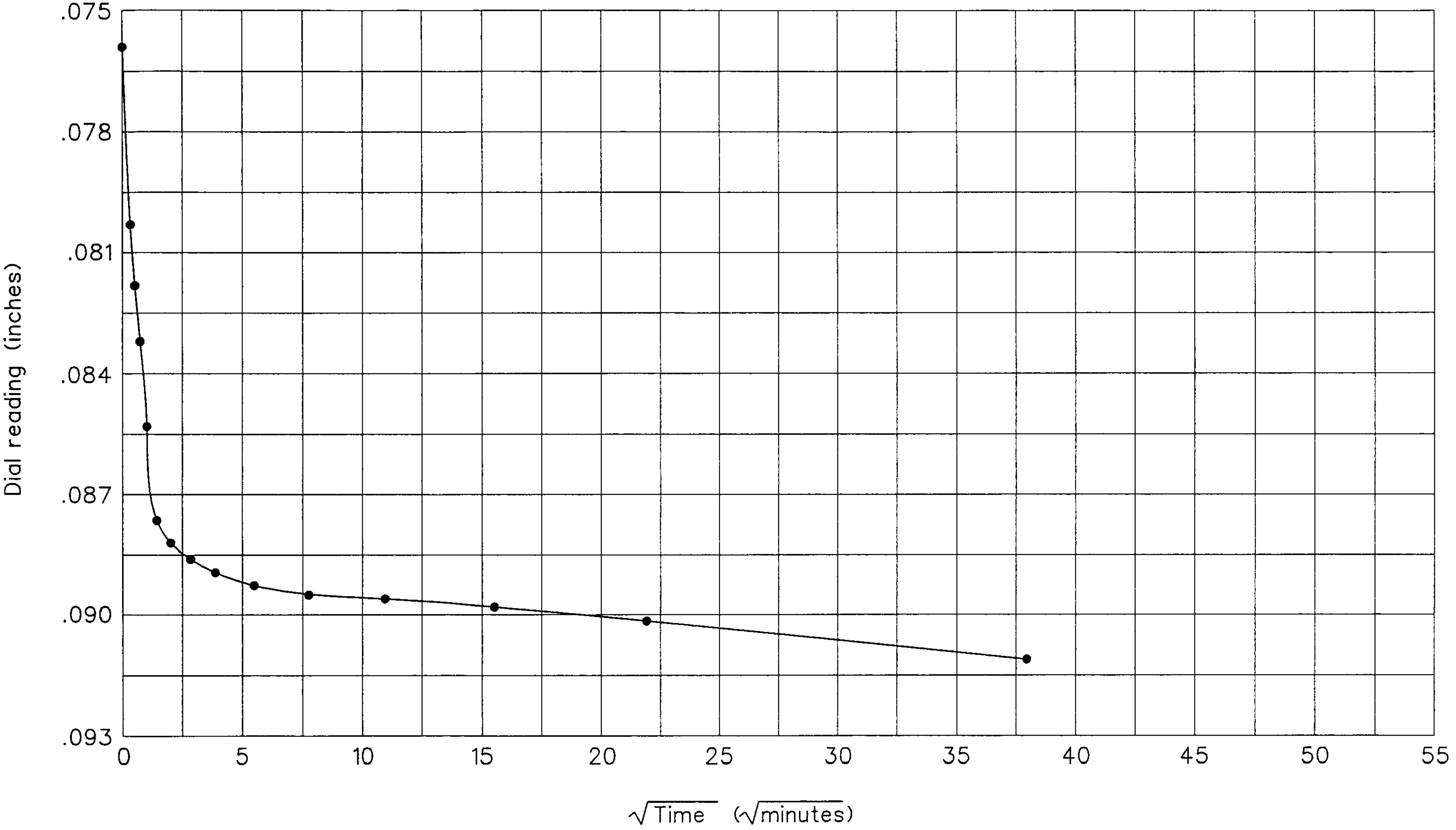
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 6'-7.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



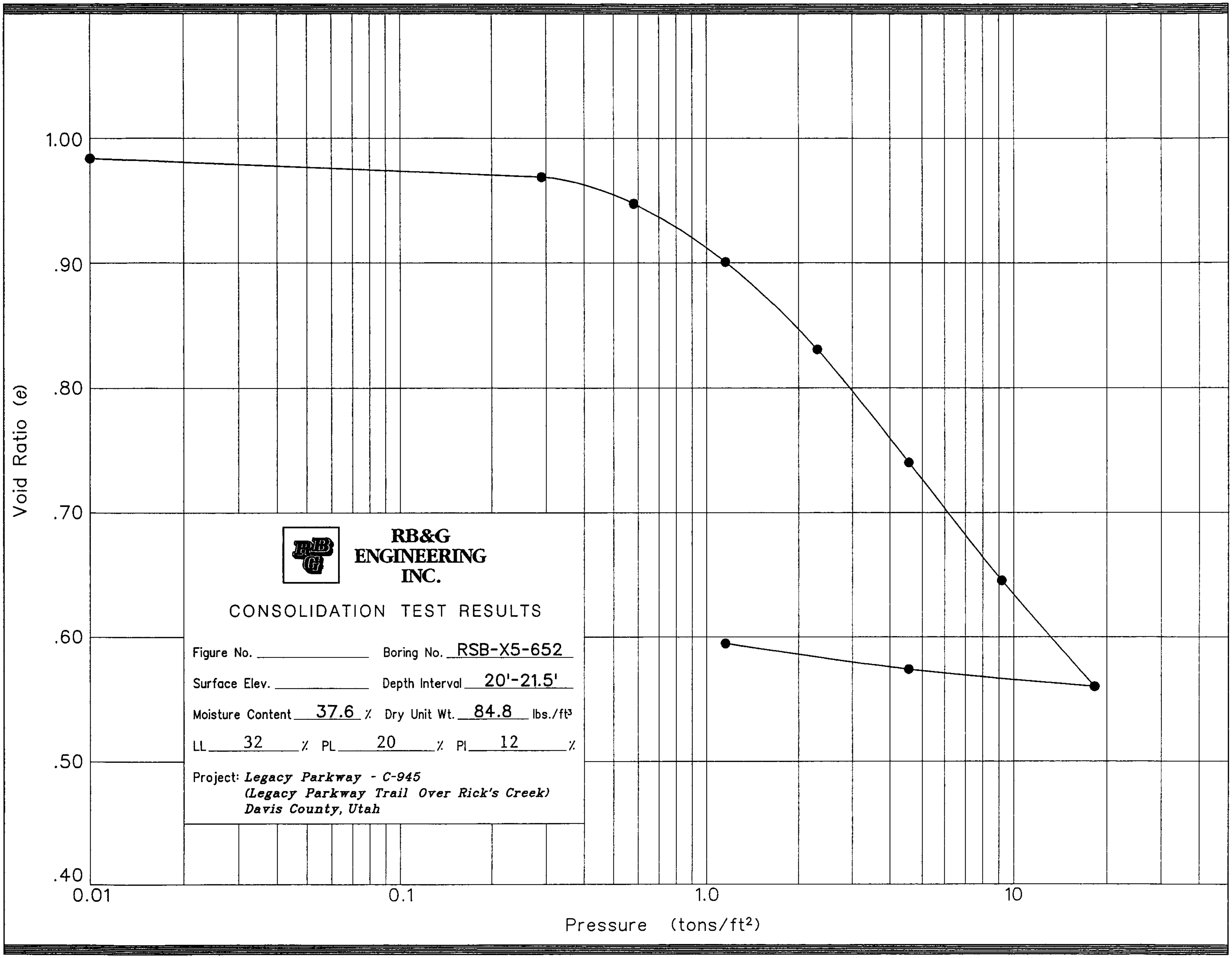
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 6'-7.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

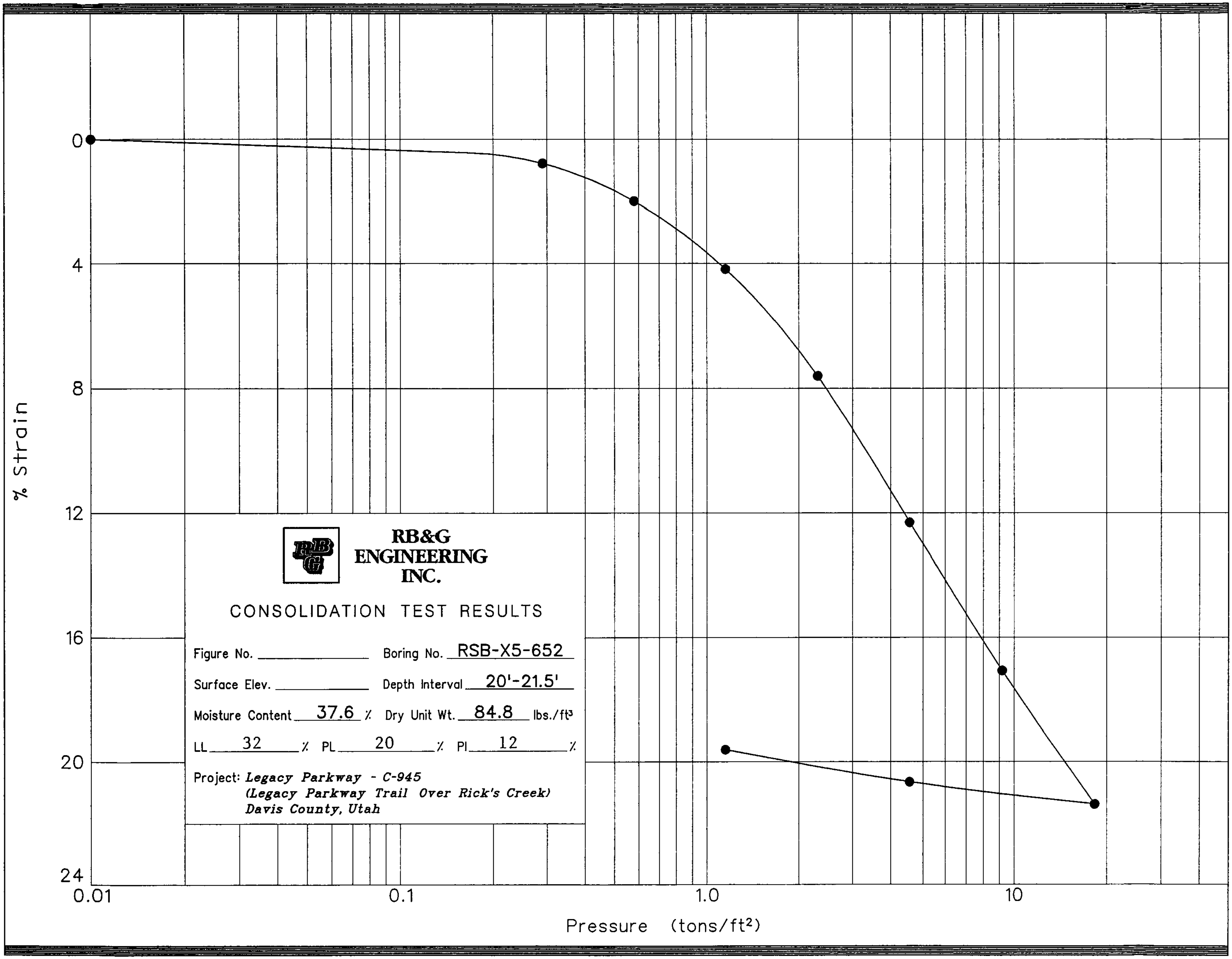
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 20'-21.5'

Moisture Content 37.6 % Dry Unit Wt. 84.8 lbs./ft³

LL 32 % PL 20 % PI 12 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

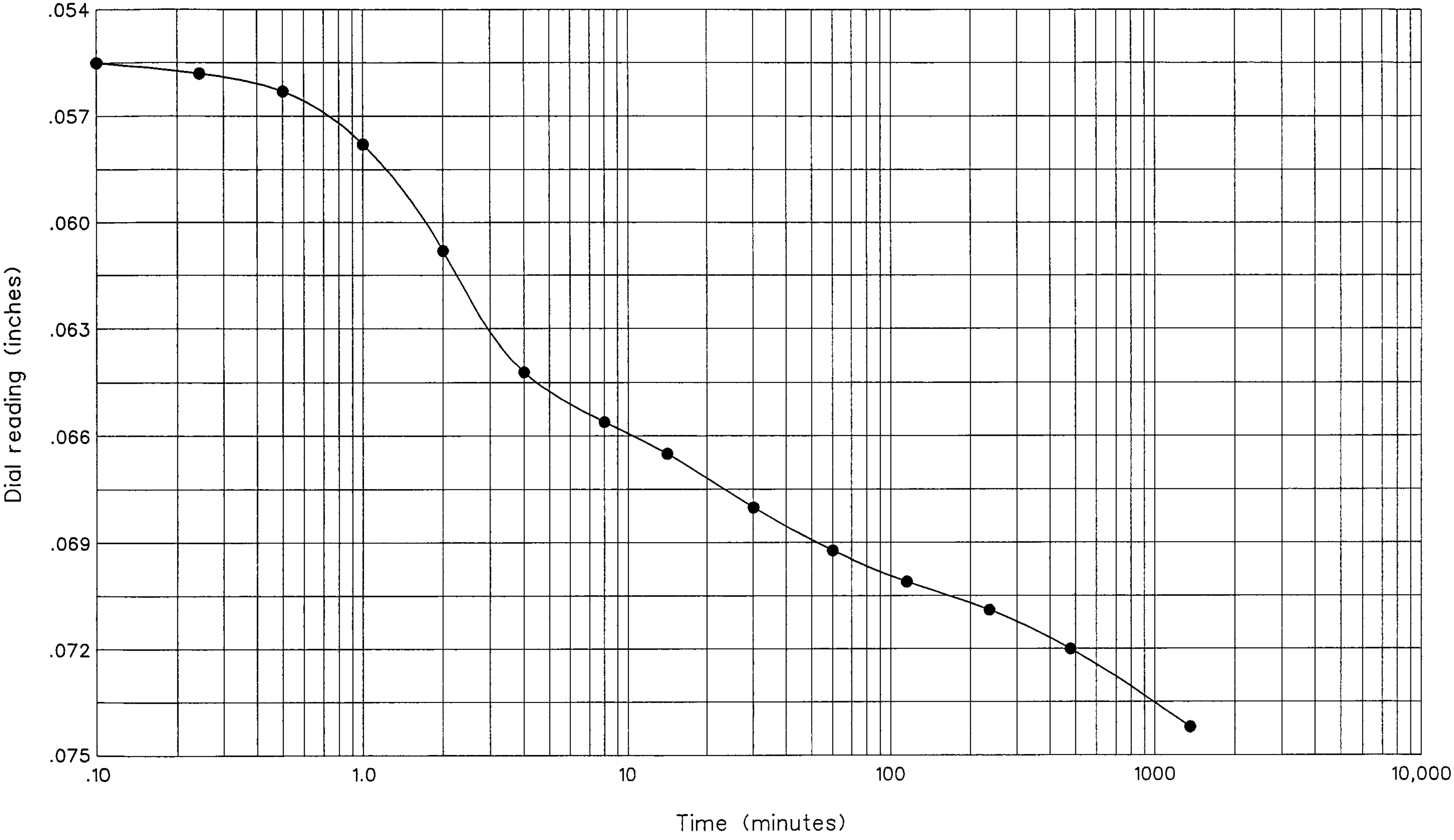
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 20'-21.5'

Moisture Content 37.6 % Dry Unit Wt. 84.8 lbs./ft^3

LL 32 % PL 20 % PI 12 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



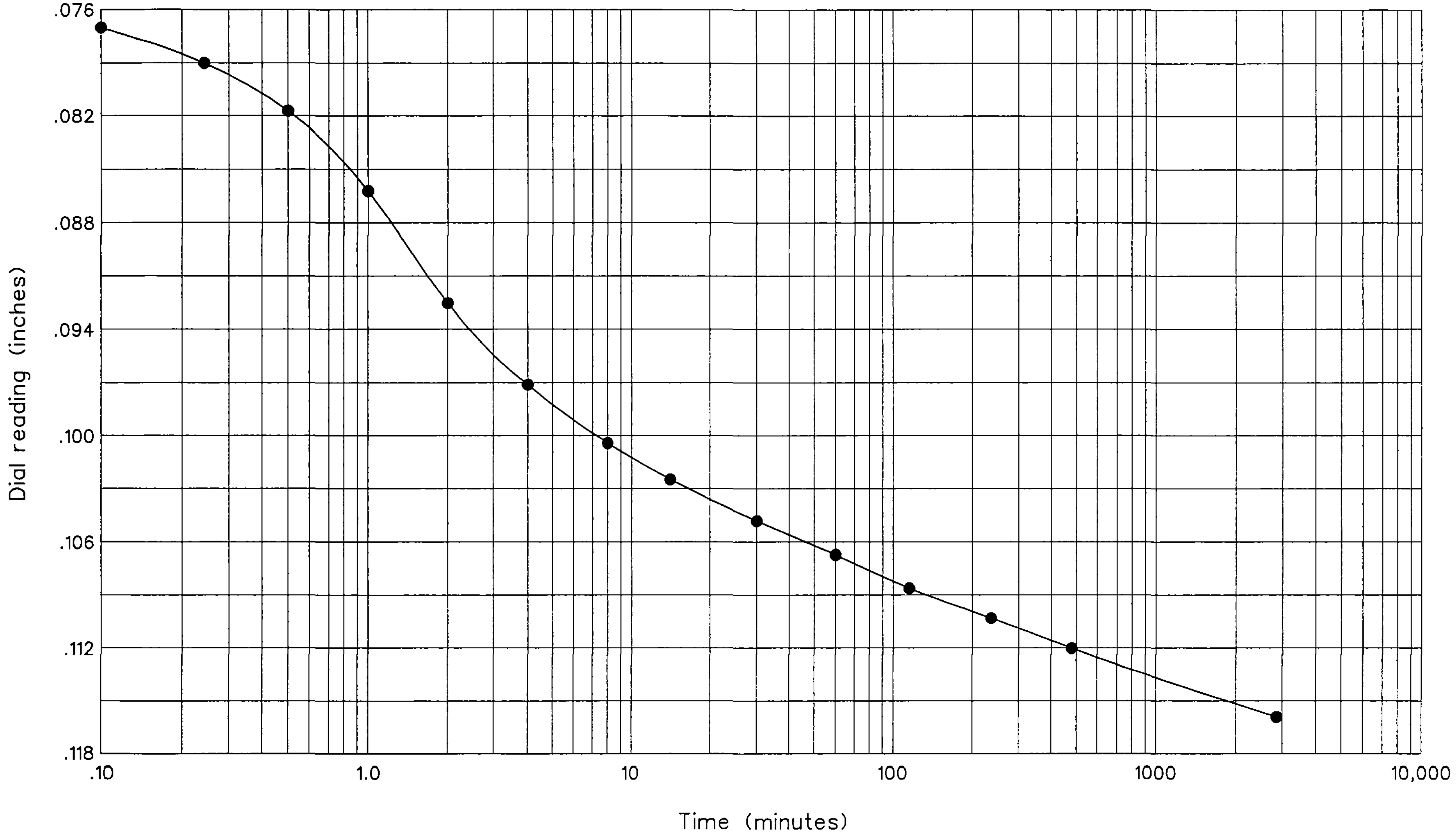
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 20'-21.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



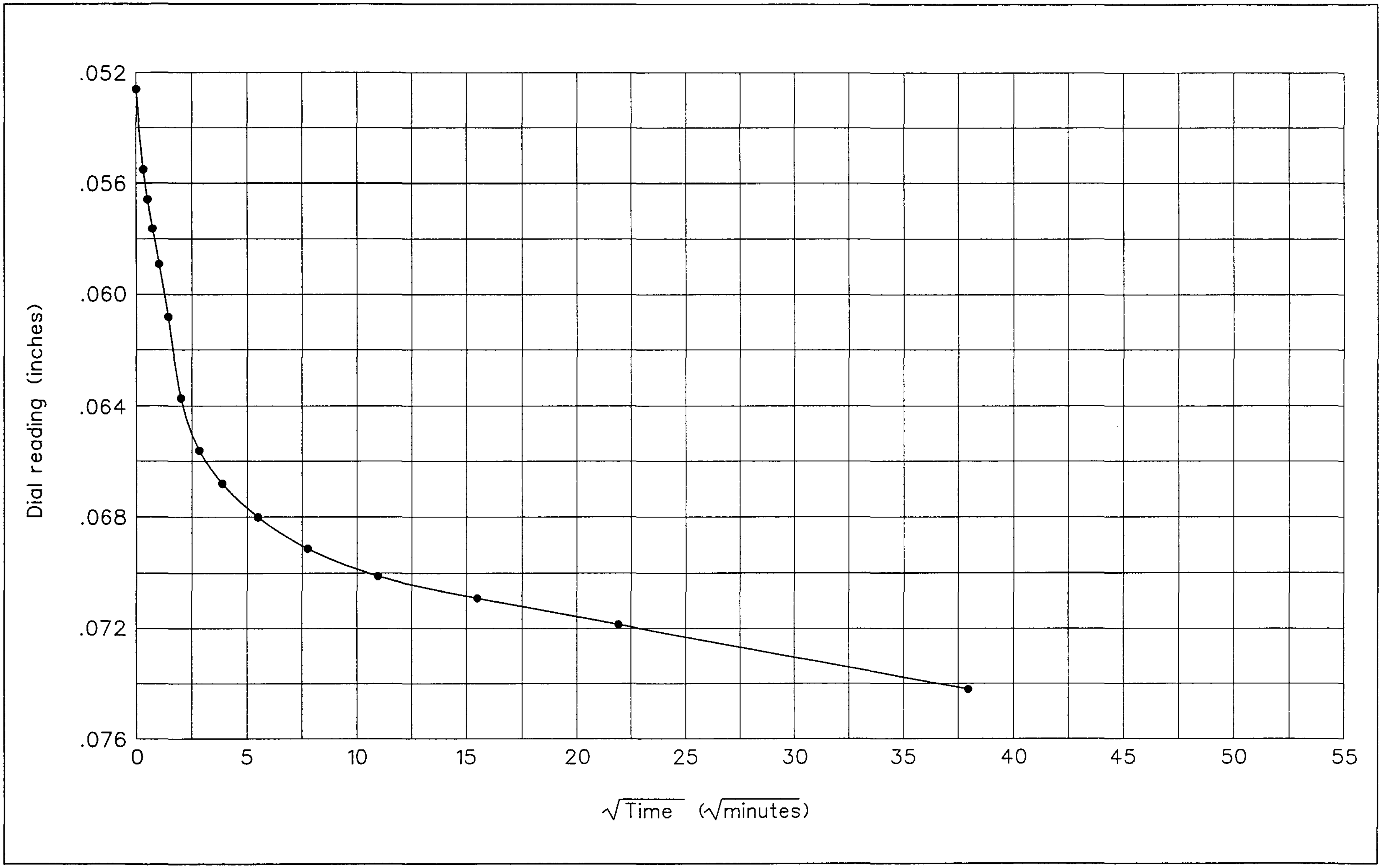
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 20'-21.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



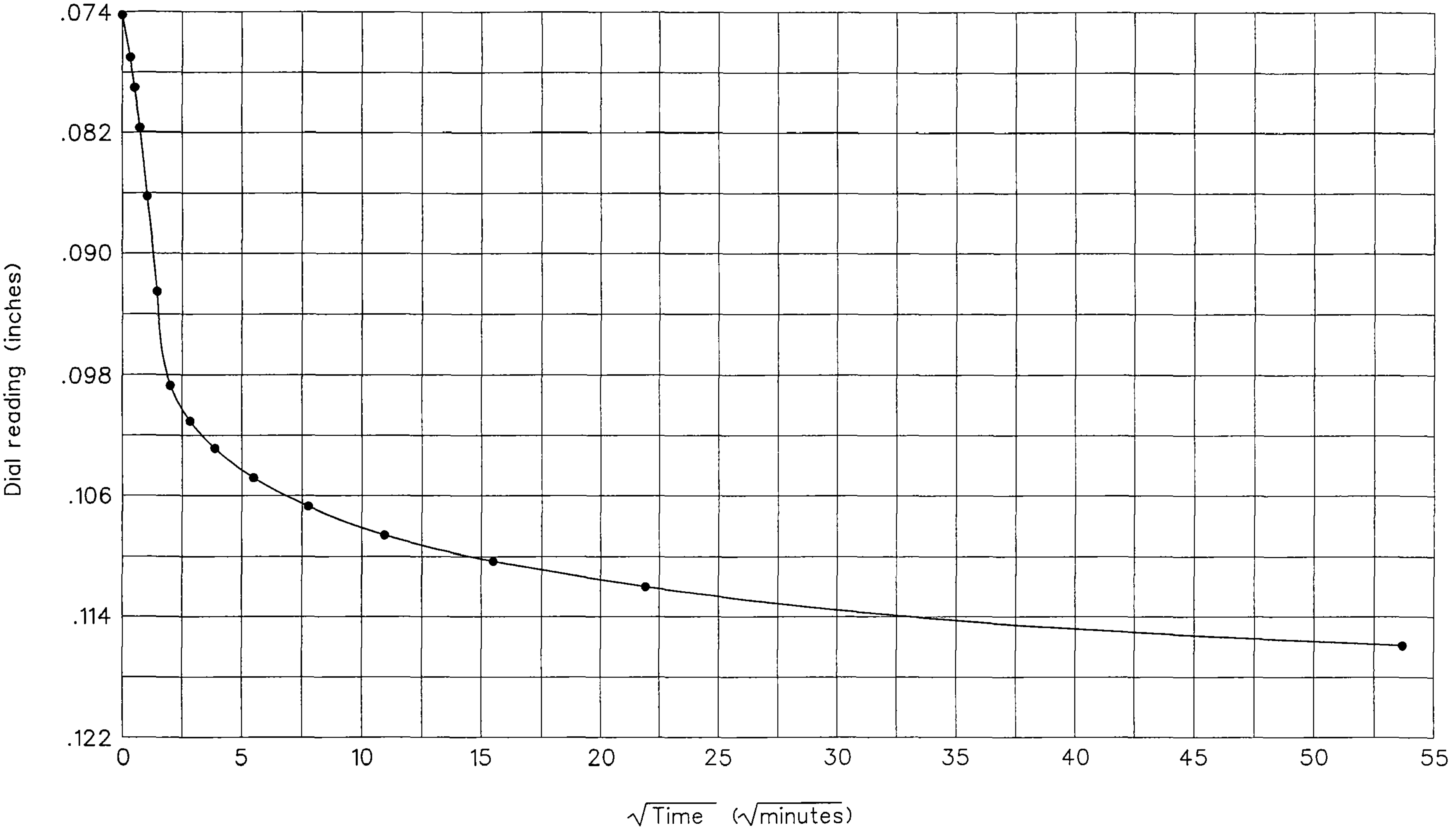
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 20'-21.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



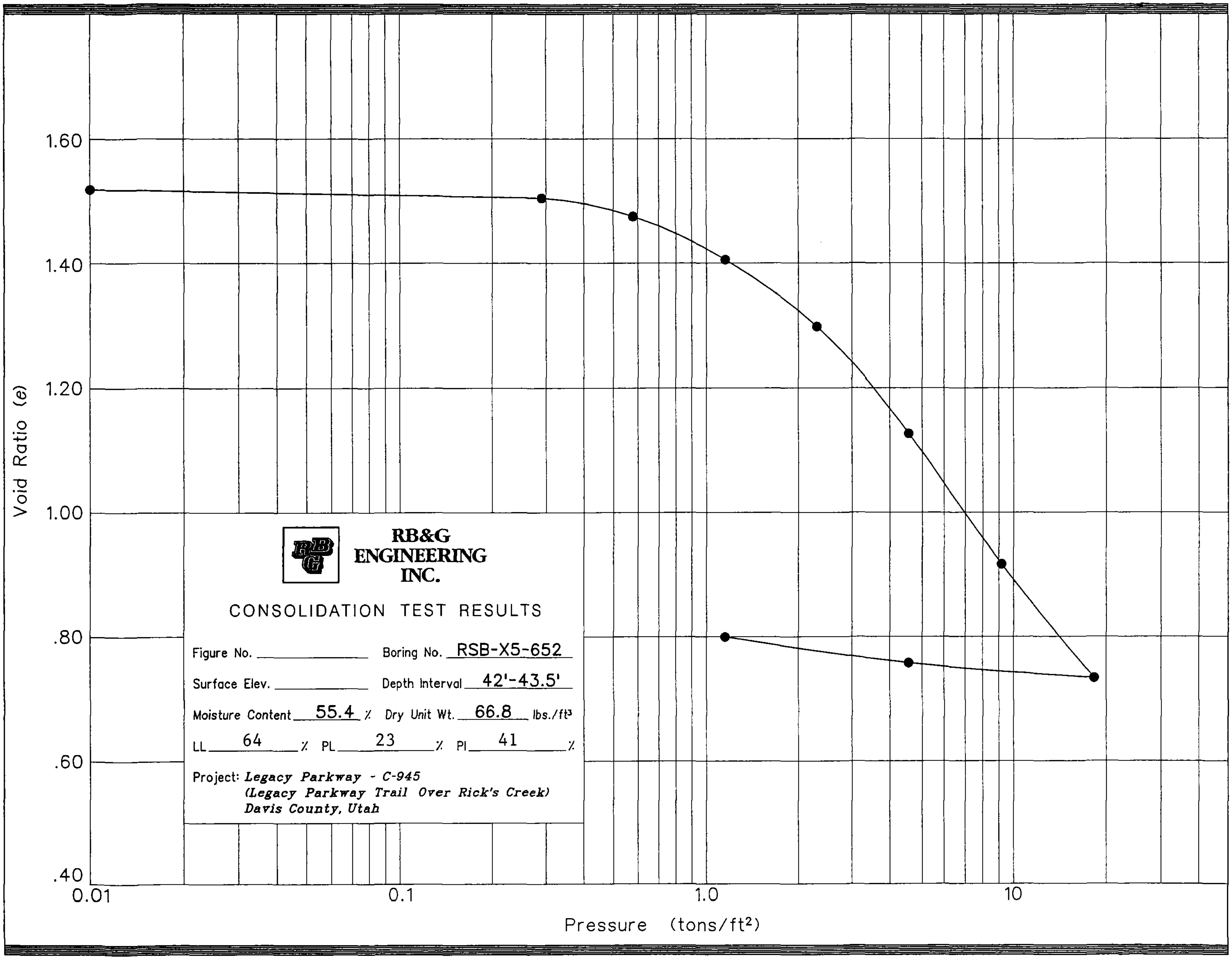
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 20'-21.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

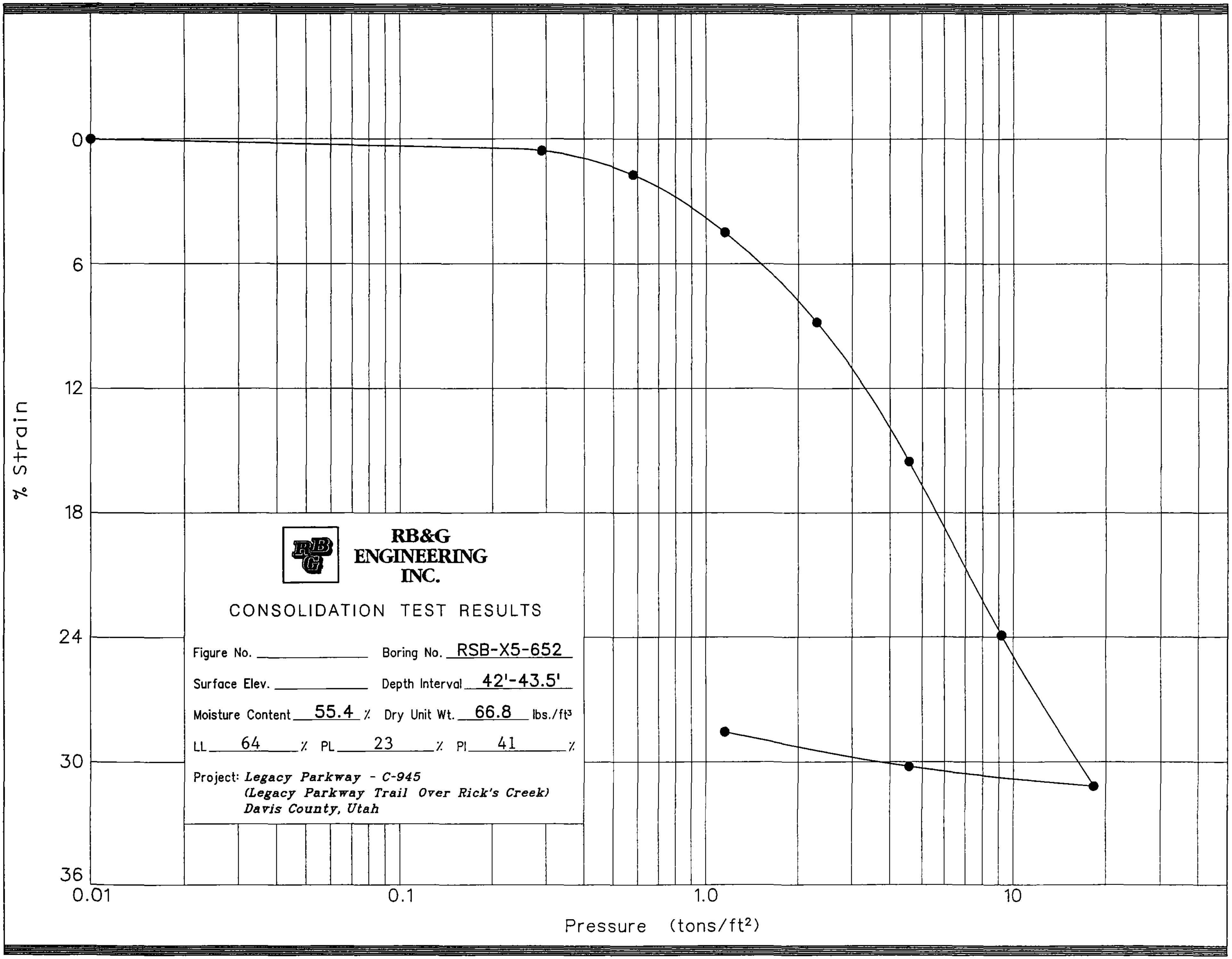
Figure No. ____________ Boring No. RSB-X5-652

Surface Elev. ____________ Depth Interval 42'-43.5'

Moisture Content 55.4 % Dry Unit Wt. 66.8 lbs./ft³

LL 64 % PL 23 % PI 41 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

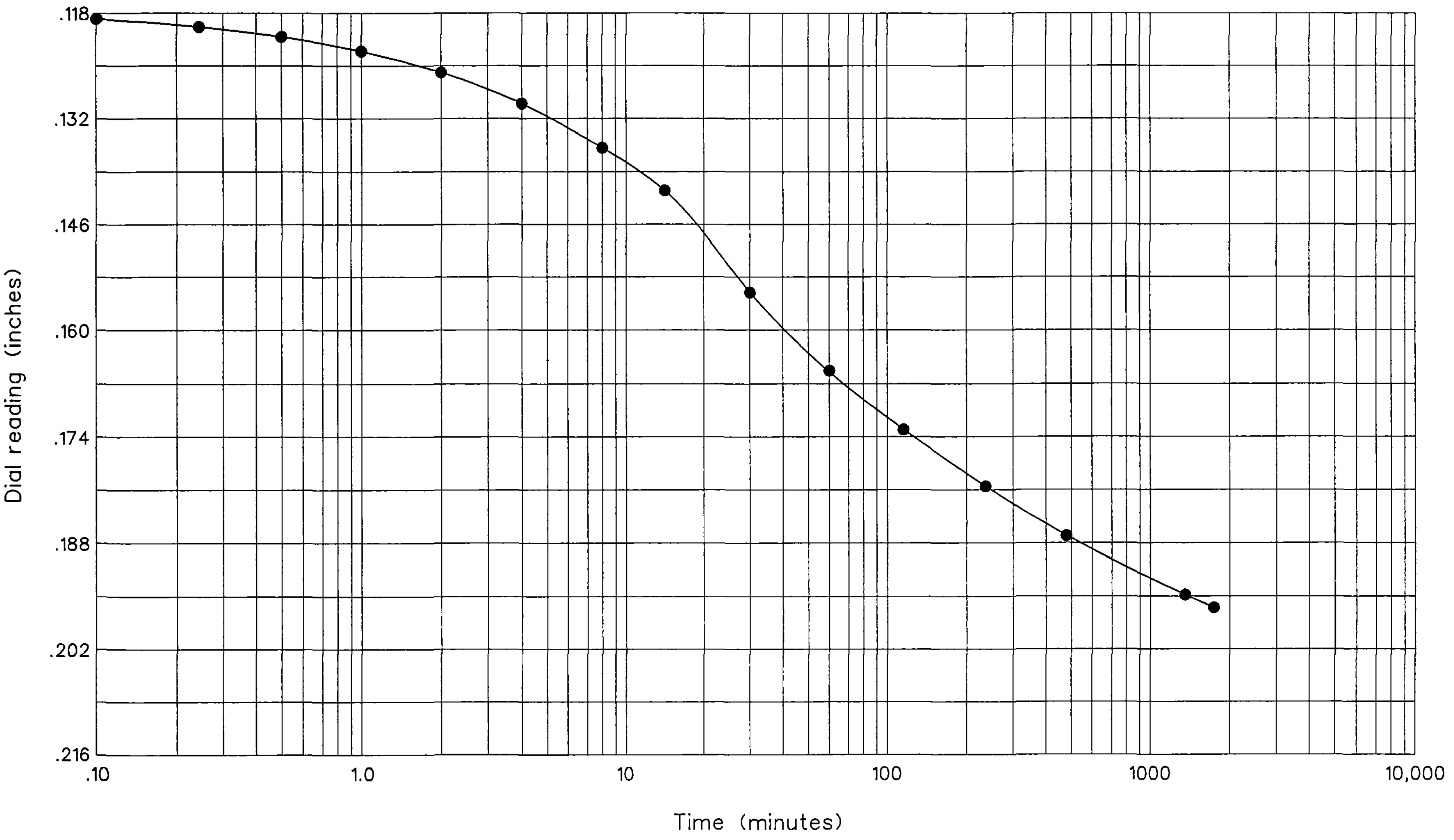
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 42'-43.5'

Moisture Content 55.4 % Dry Unit Wt. 66.8 lbs./ft^3

LL 64 % PL 23 % PI 41 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



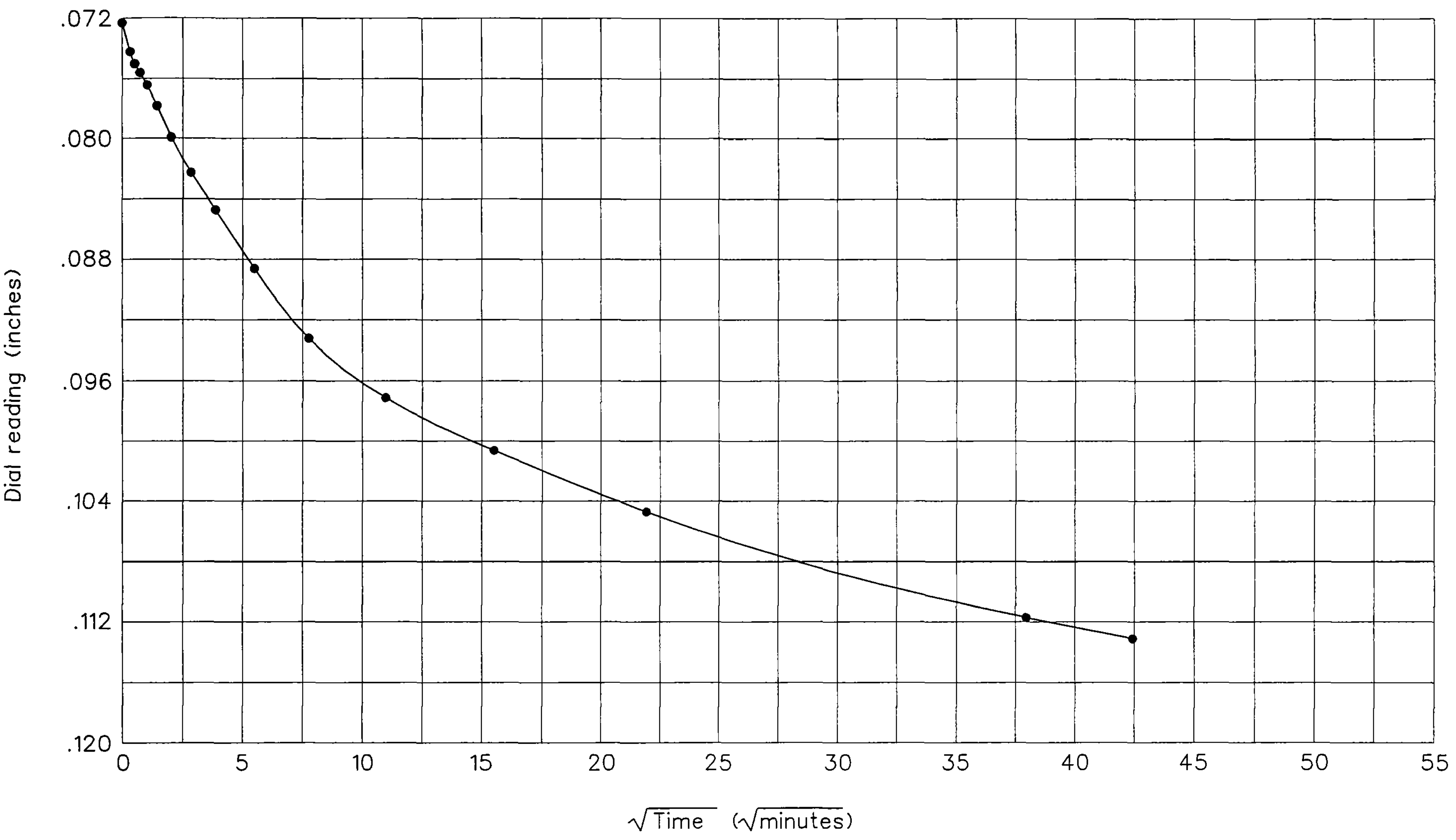
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 42'-43.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



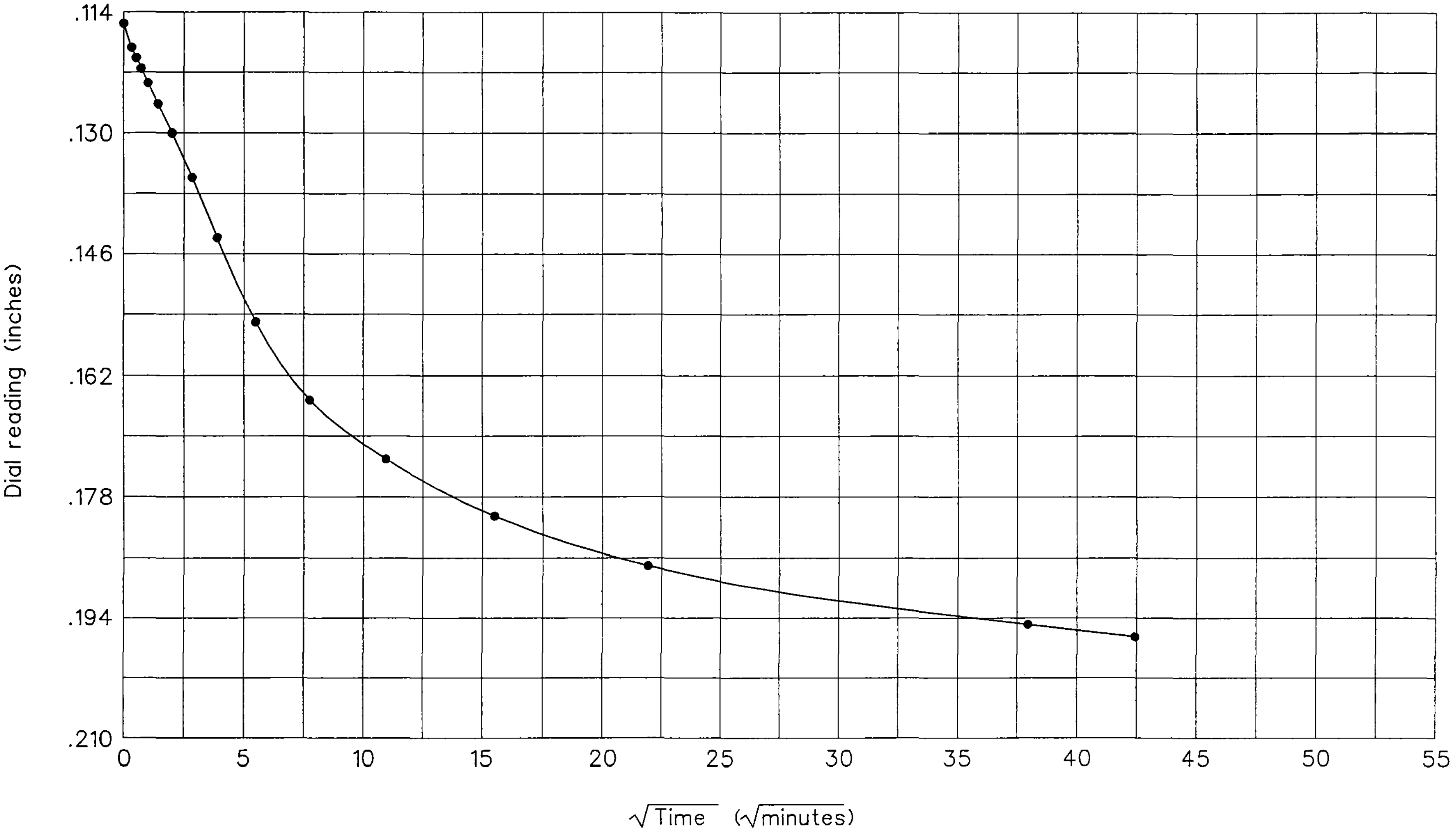
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 42'-43.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



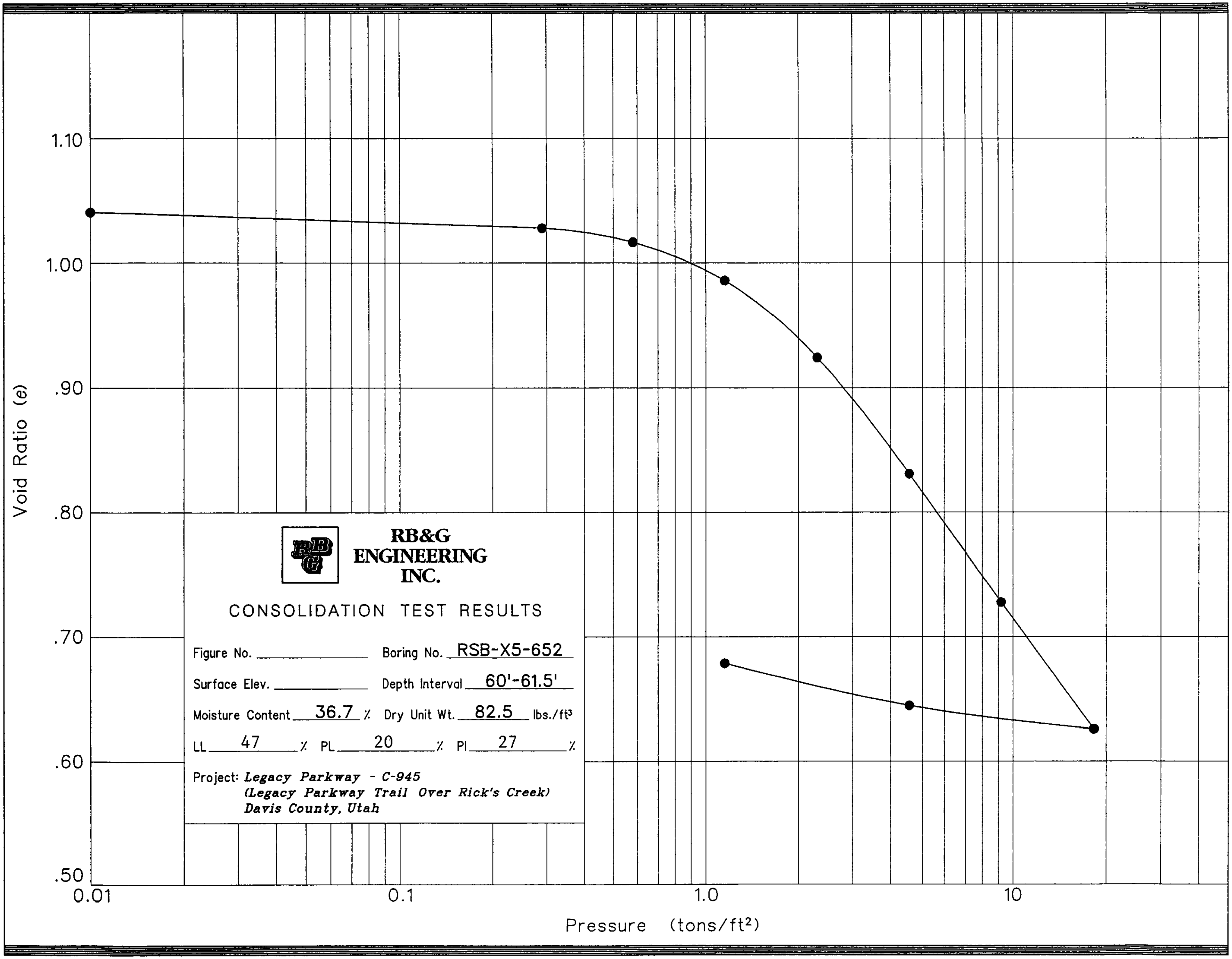
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 42'-43.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

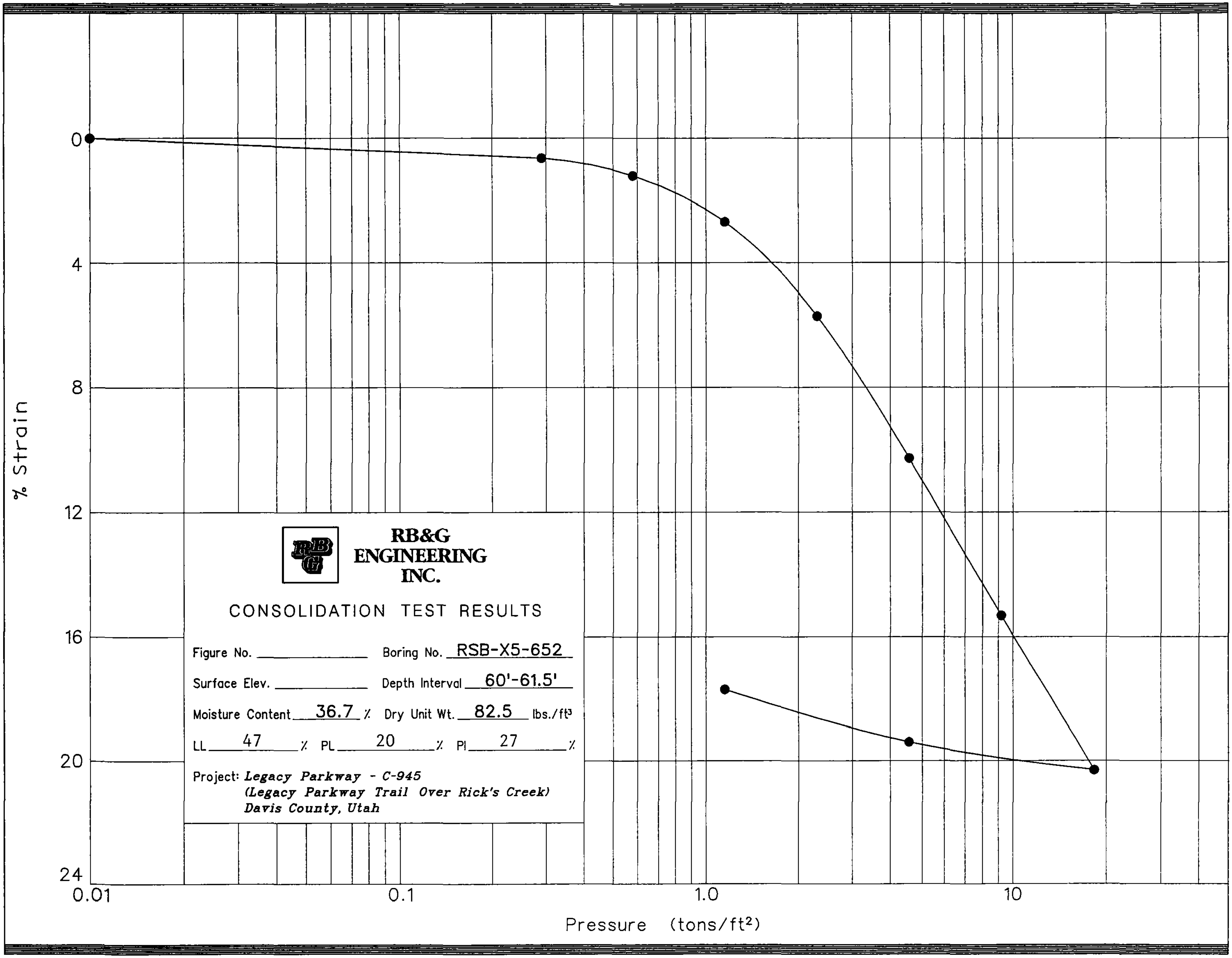
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 36.7 % Dry Unit Wt. 82.5 lbs./ft³

LL 47 % PL 20 % PI 27 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

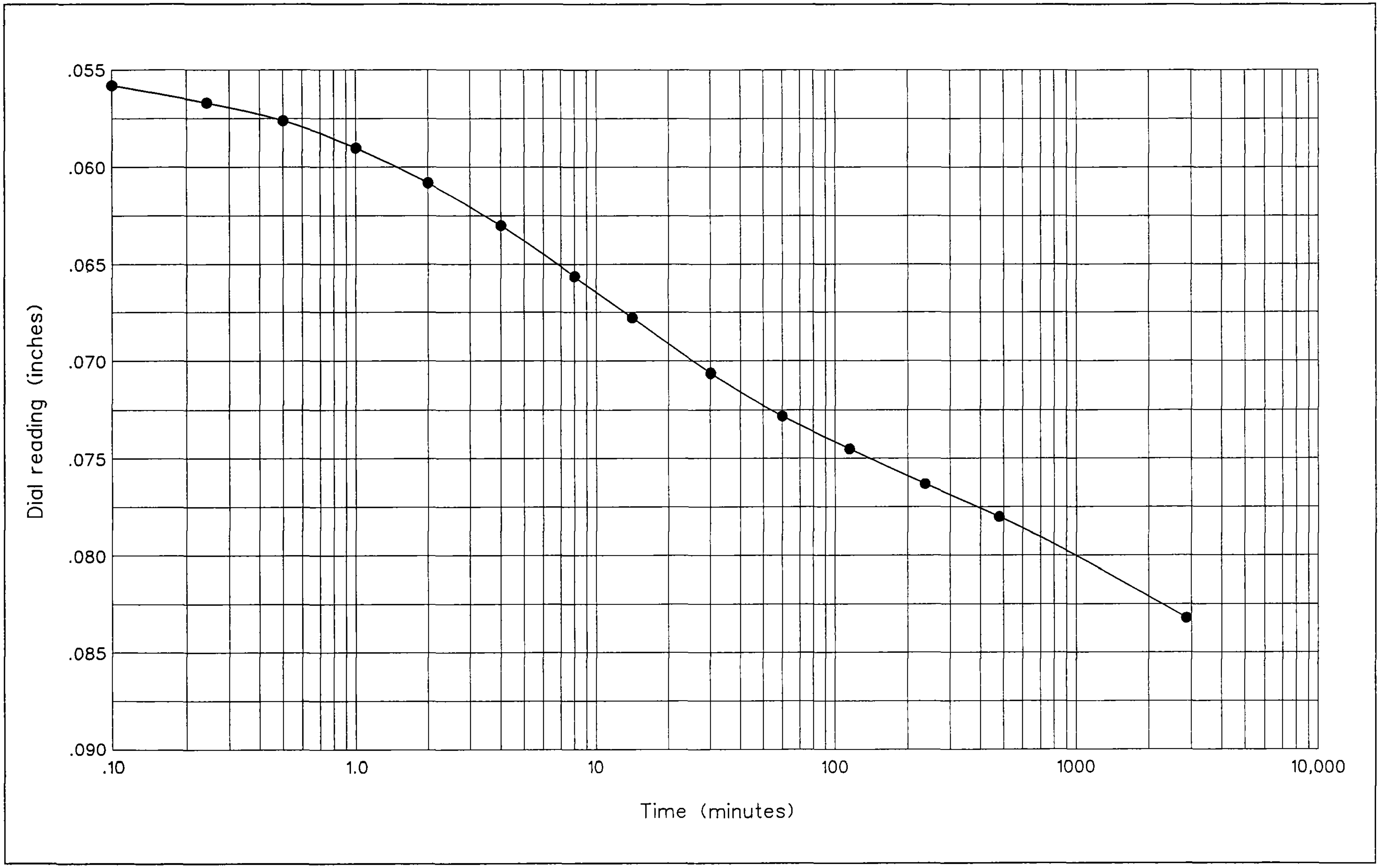
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 36.7 % Dry Unit Wt. 82.5 lbs./ft³

LL 47 % PL 20 % PI 27 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



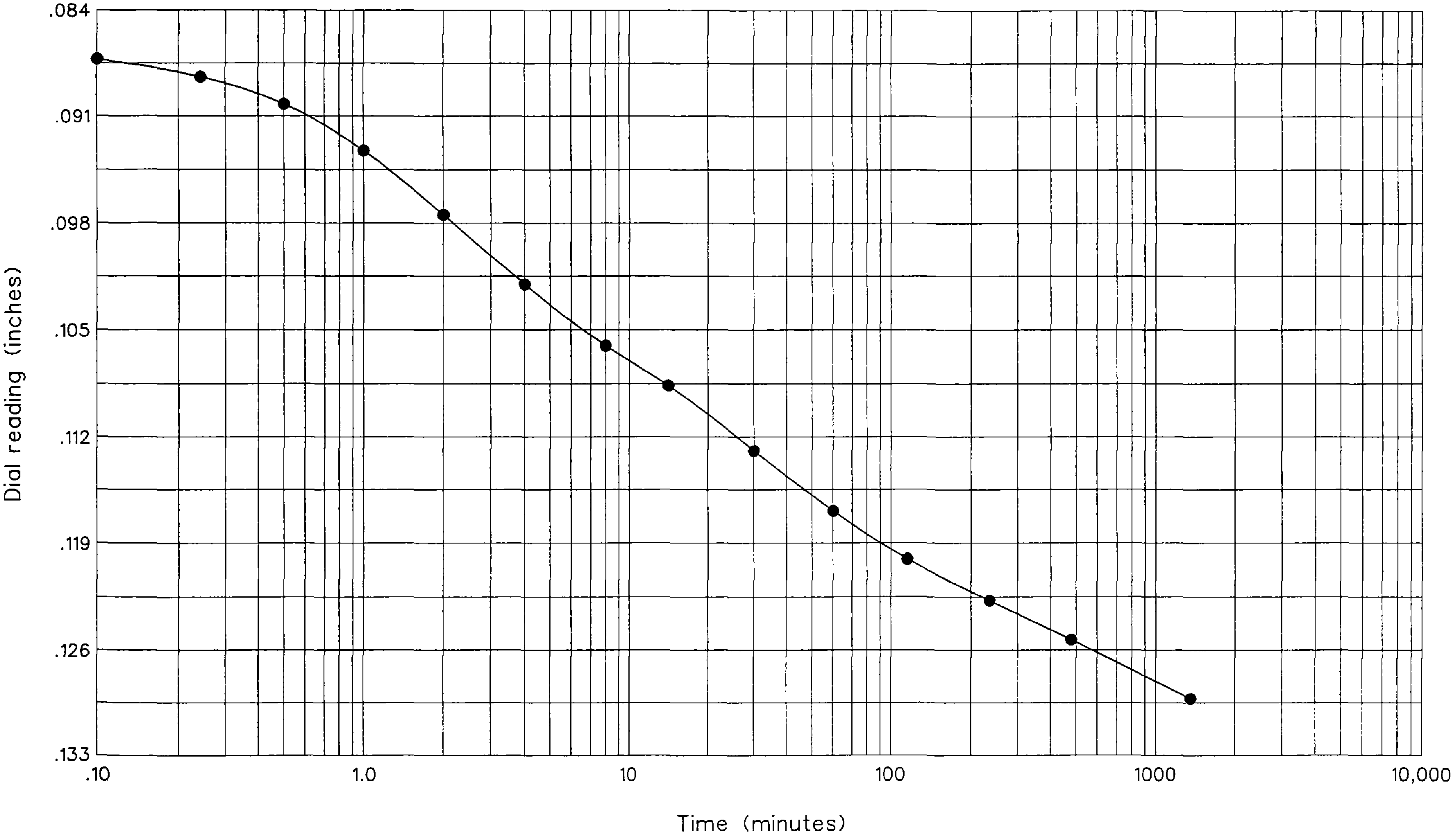
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 60'-61.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



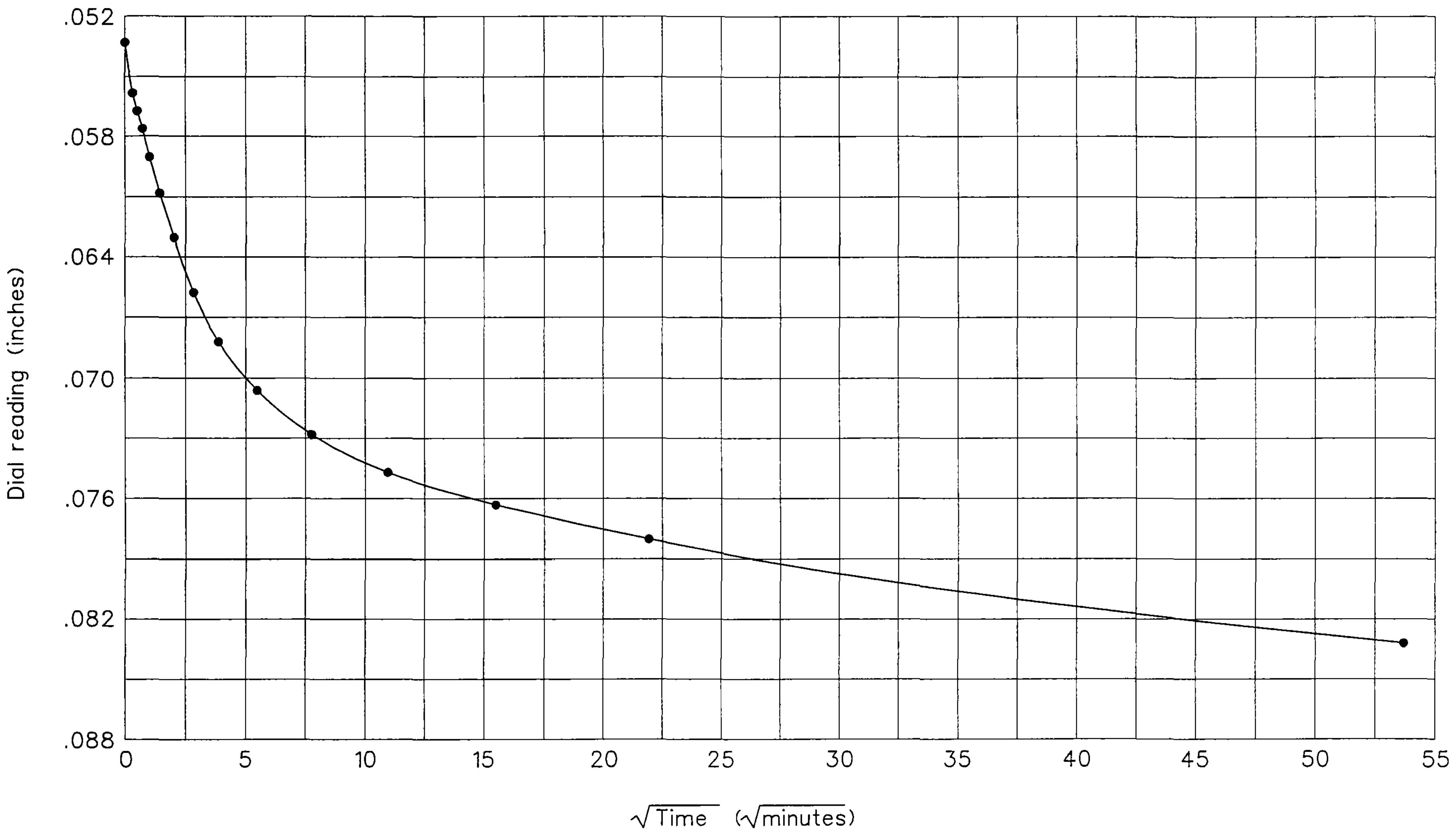
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 60'-61.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



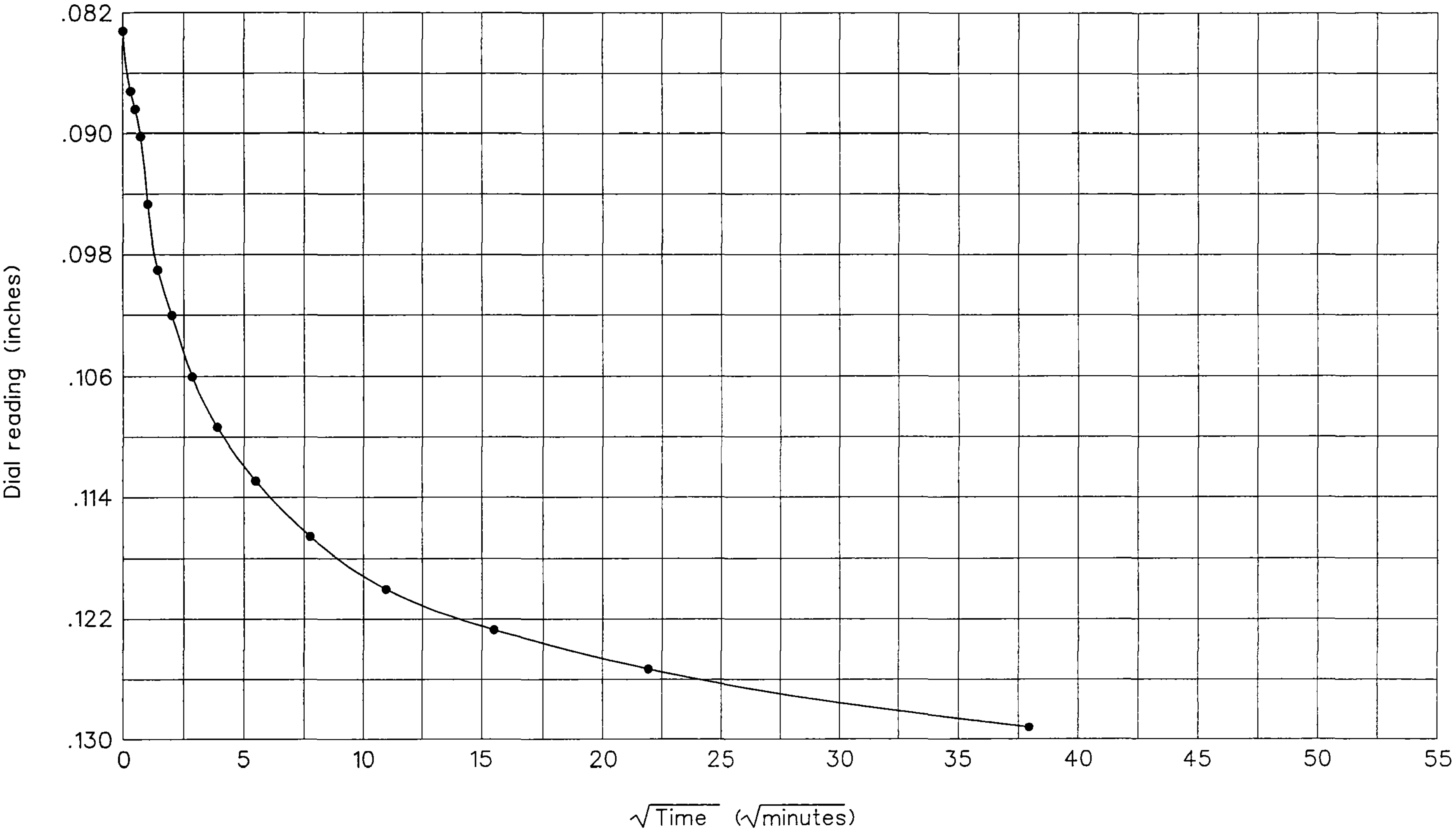
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 60'-61.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



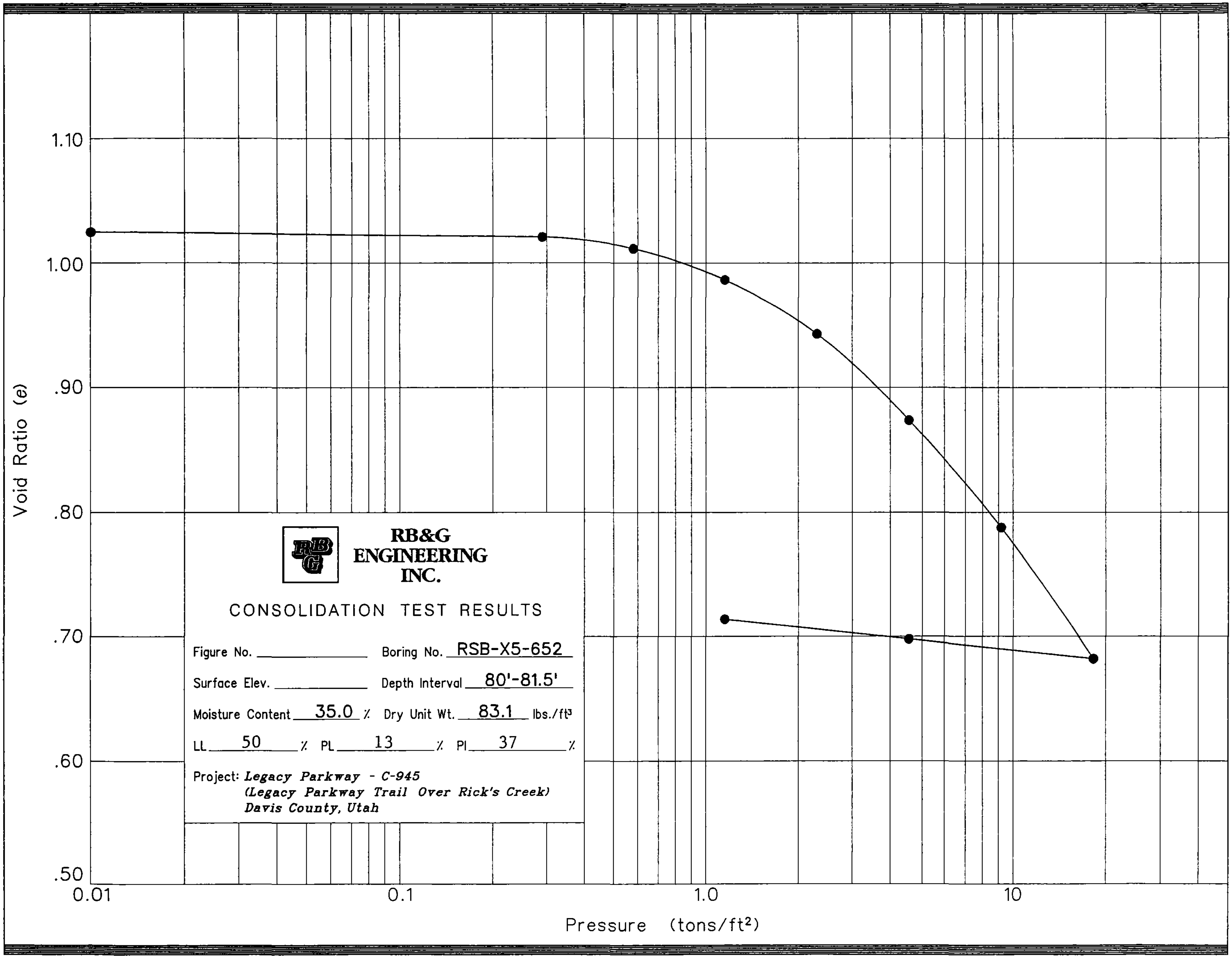
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 60'-61.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

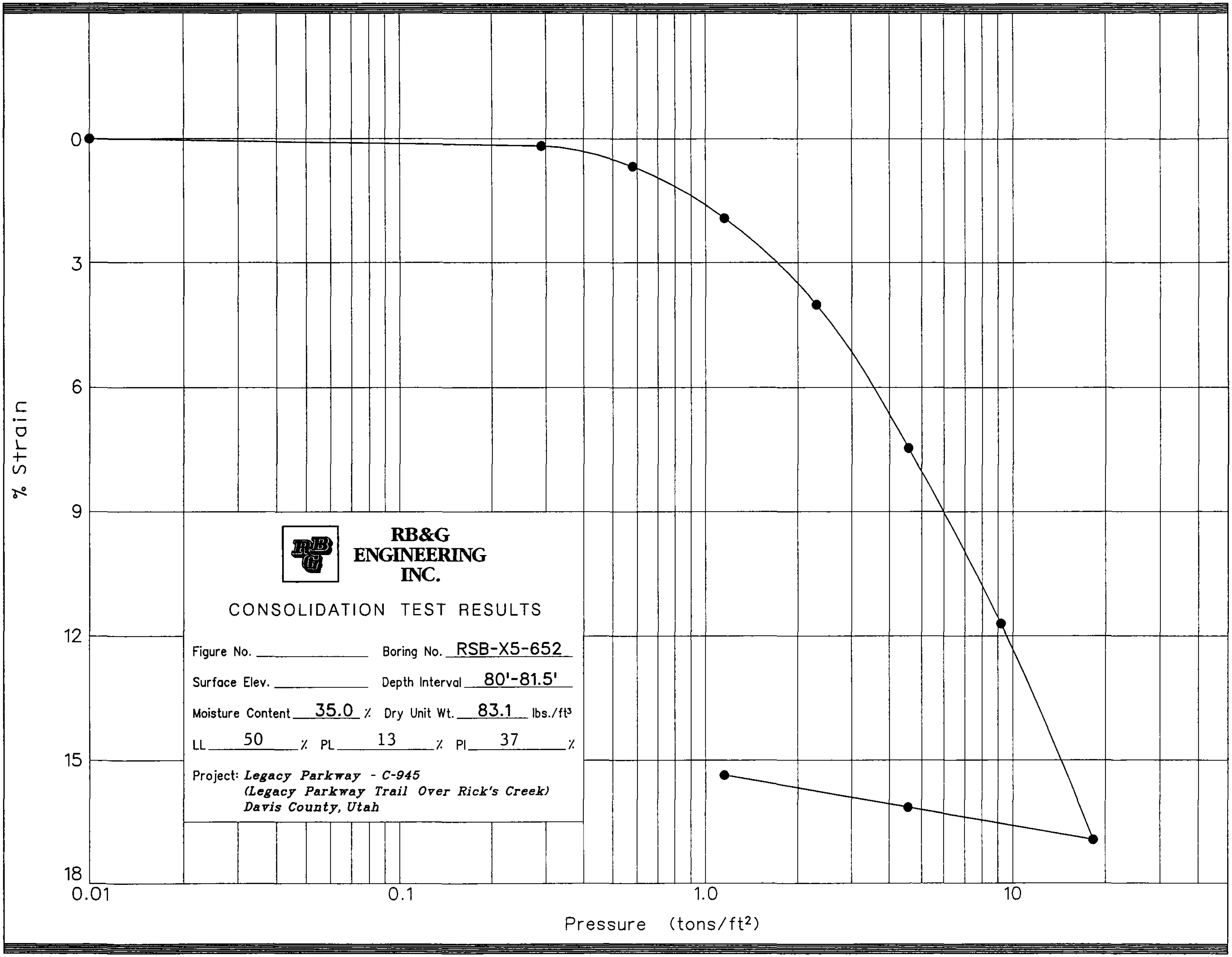
Figure No. ____________ Boring No. RSB-X5-652

Surface Elev. ____________ Depth Interval 80'-81.5'

Moisture Content 35.0 % Dry Unit Wt. 83.1 lbs./ft³

LL 50 % PL 13 % PI 37 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

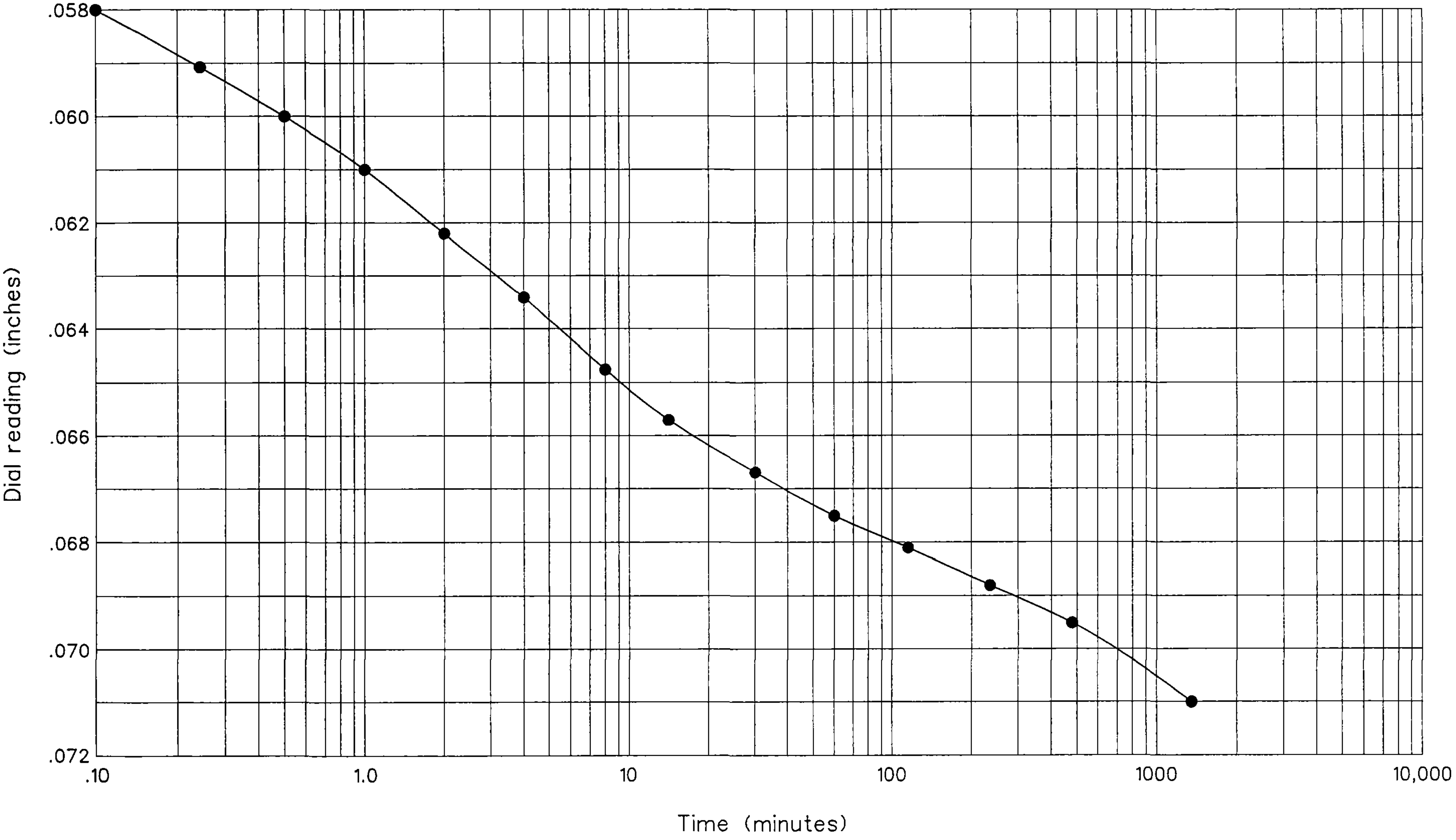
Figure No. ______ Boring No. RSB-X5-652

Surface Elev. ______ Depth Interval 80'-81.5'

Moisture Content 35.0 % Dry Unit Wt. 83.1 lbs./ft³

LL 50 % PL 13 % PI 37 %

Project: *Legacy Parkway - C-945*
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah



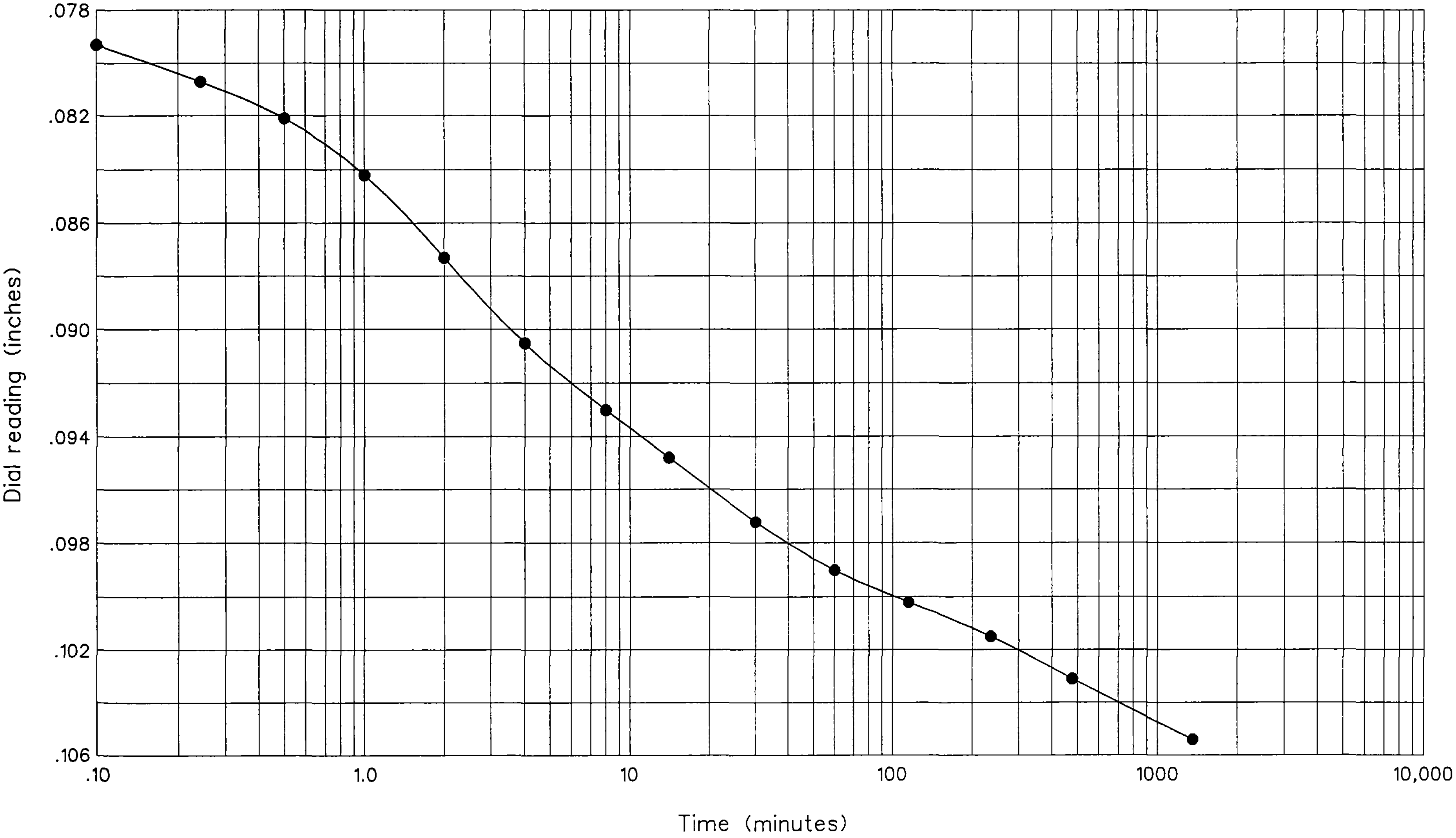
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 80'-81.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



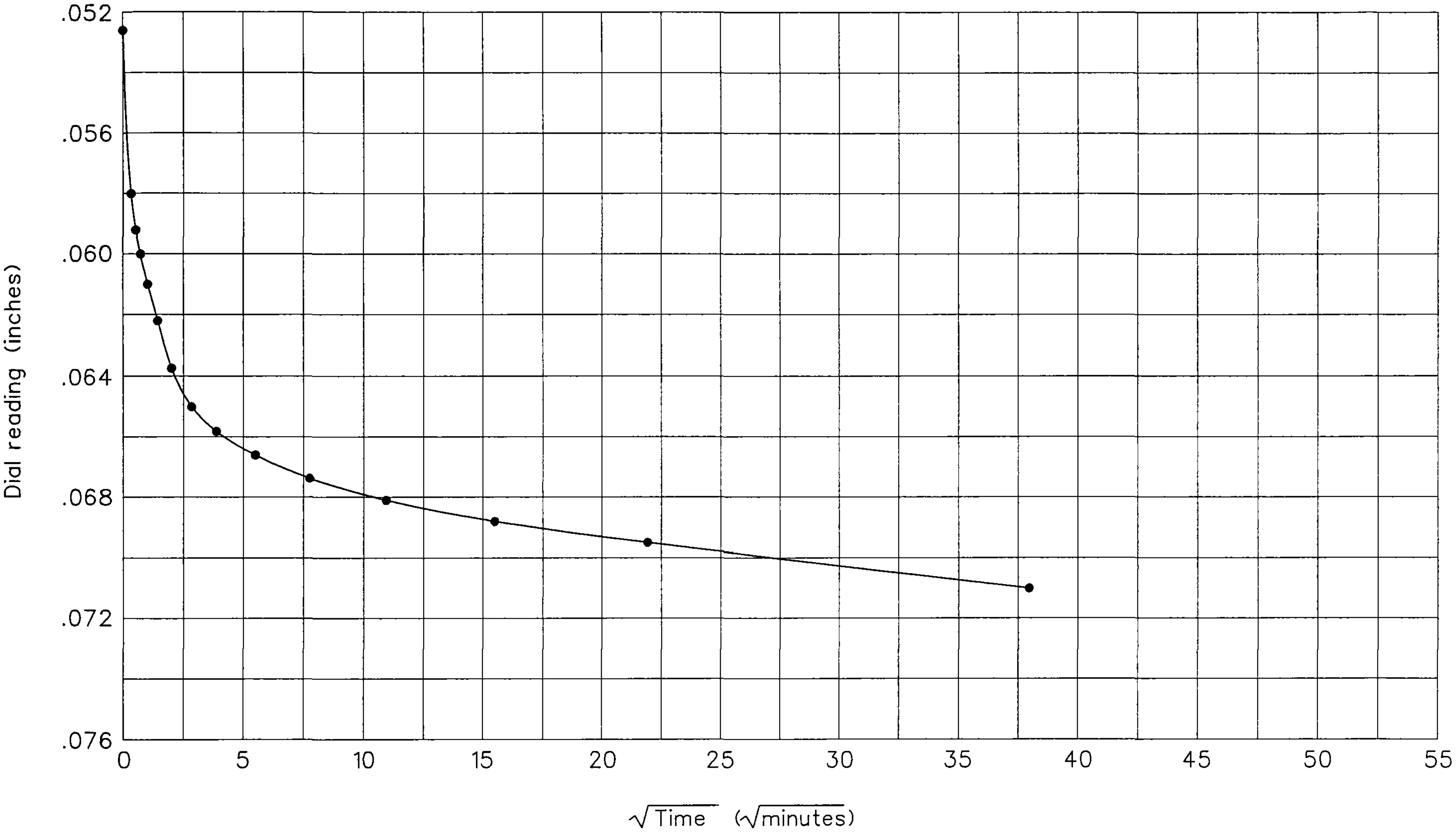
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 80'-81.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



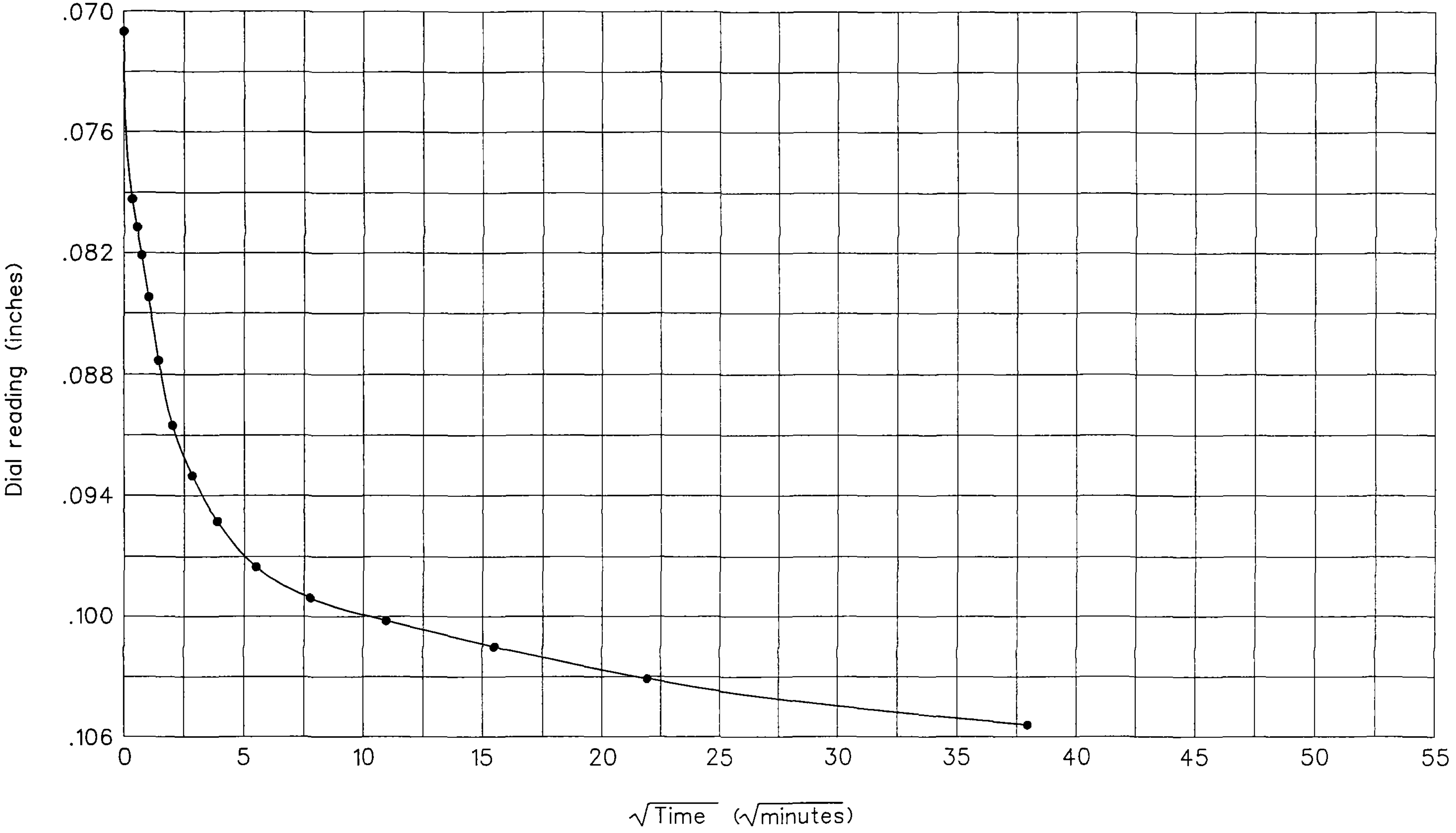
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 80'-81.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X5-652
Depth: 80'-81.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - C-945
(Legacy Parkway Trail Over Rick's Creek)
Davis County, Utah

Figure

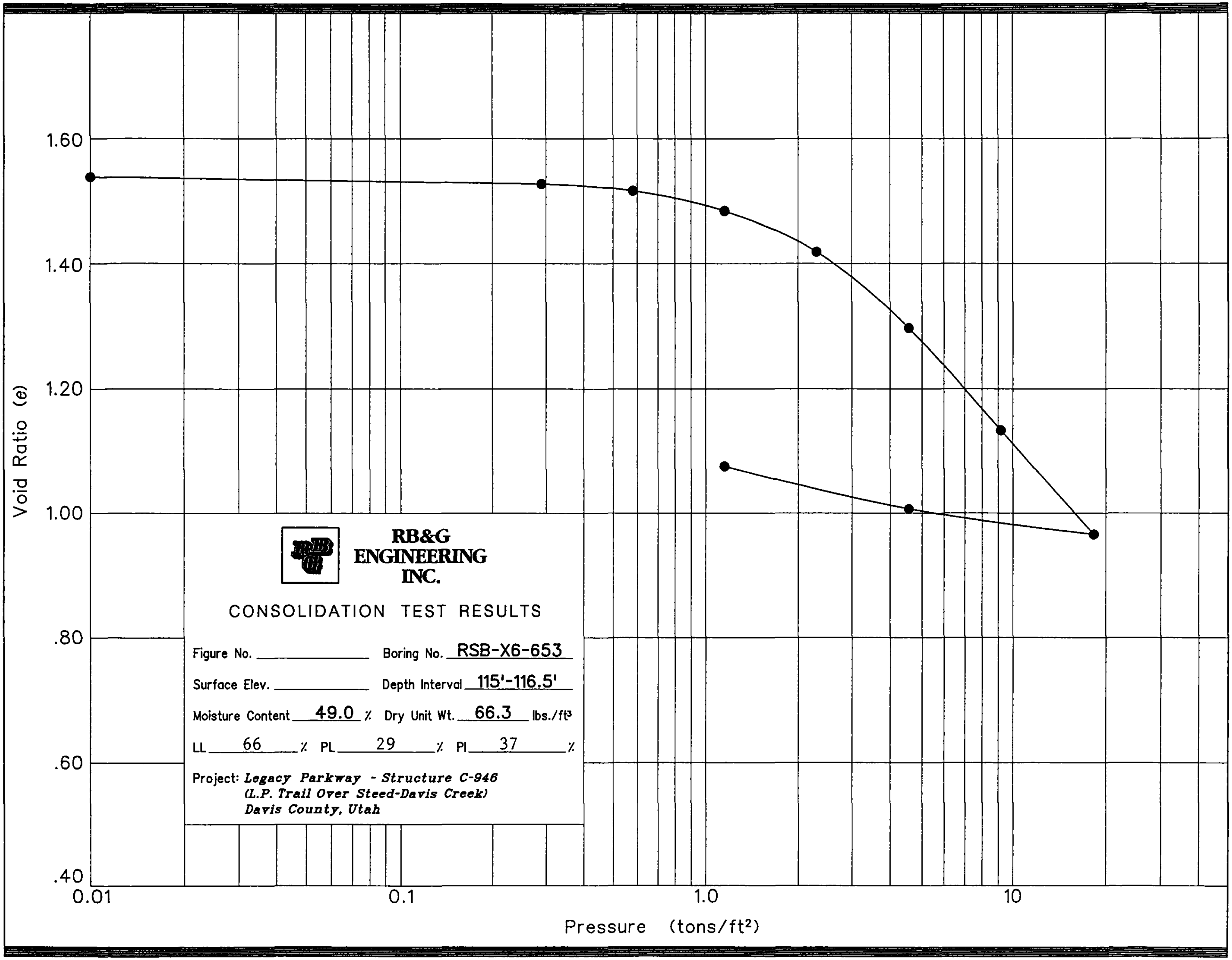
Table X6-1

SUMMARY OF TEST DATA

PROJECT	Legacy Parkway – Structure C-947	PROJECT NO.	200601-148
LOCATION	Trail Bridge over Steed-Davis Creek	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-X6-653	3-4.5		89.3	27.5	327	42	16	26	0	16	84	CL / A-7-5(21)
	12-13.5		88.2	33.2	858	33	17	16	0	13	87	CL / A-6(13)
	31.5-33	0		24.4		47	22	25	0	81	19	SC / A-2-7(3)
	40-41.5		89.5	33.6	745	30	18	12	0	3	97	CL / A-6(11)
	50-51			42.2		42	20	22	0	3	97	CL / A-7-5(23)
	60-61.5		63.5	55.0	861	75	24	51	0	0	100	CH / A-7-5(59)
	70-71.5			42.5		45	22	23	0	0	100	CL / A-7-5(26)
	80-81.5		66.1	51.8	714	52	22	30	0	1	99	CH / A-7-5(33)
	95-96.5		61.0	61.4		76	26	50	0	1	99	CH / A-7-5(58)
	105-106			21.1		39	21	18	0	6	94	CL / A-6(18)
	115-116.5		66.3	49.0		66	29	37	0	1	99	CH / A-7-5(44)

NP=Nonplastic



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

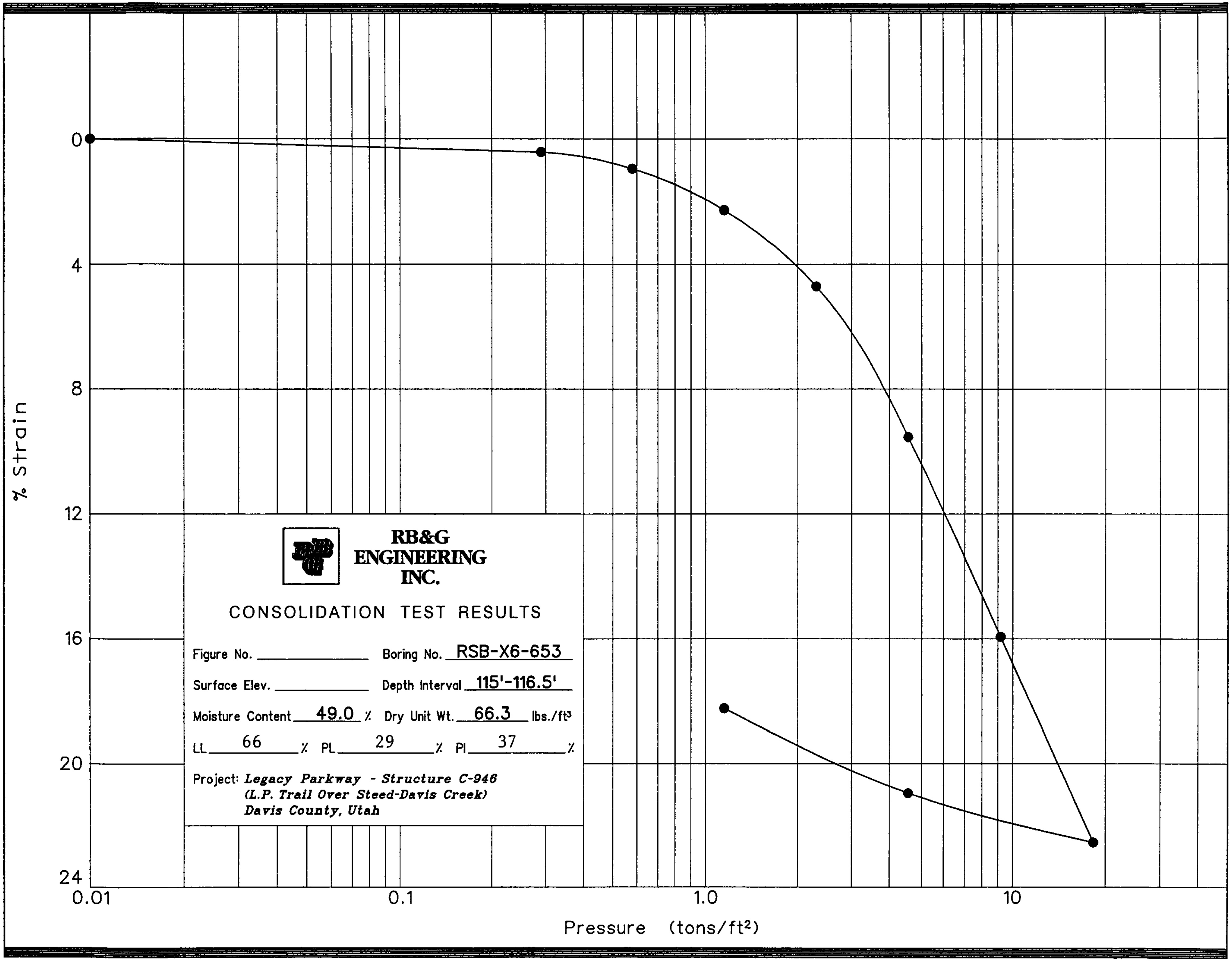
Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 115'-116.5'

Moisture Content 49.0 % Dry Unit Wt. 66.3 lbs./ft³

LL 66 % PL 29 % PI 37 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 115'-116.5'

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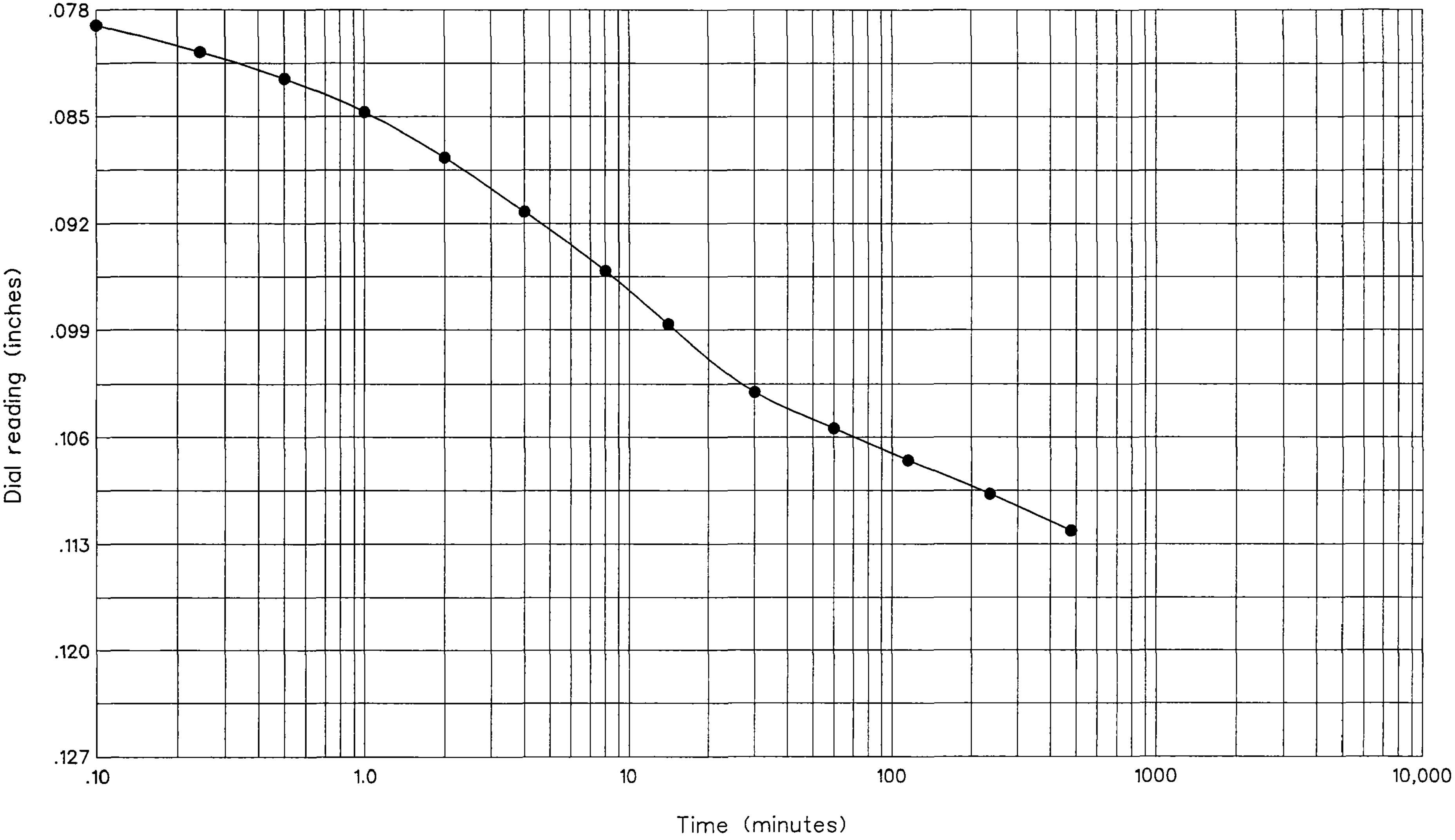
Project: ***Legacy Parkway - Structure C-946***
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



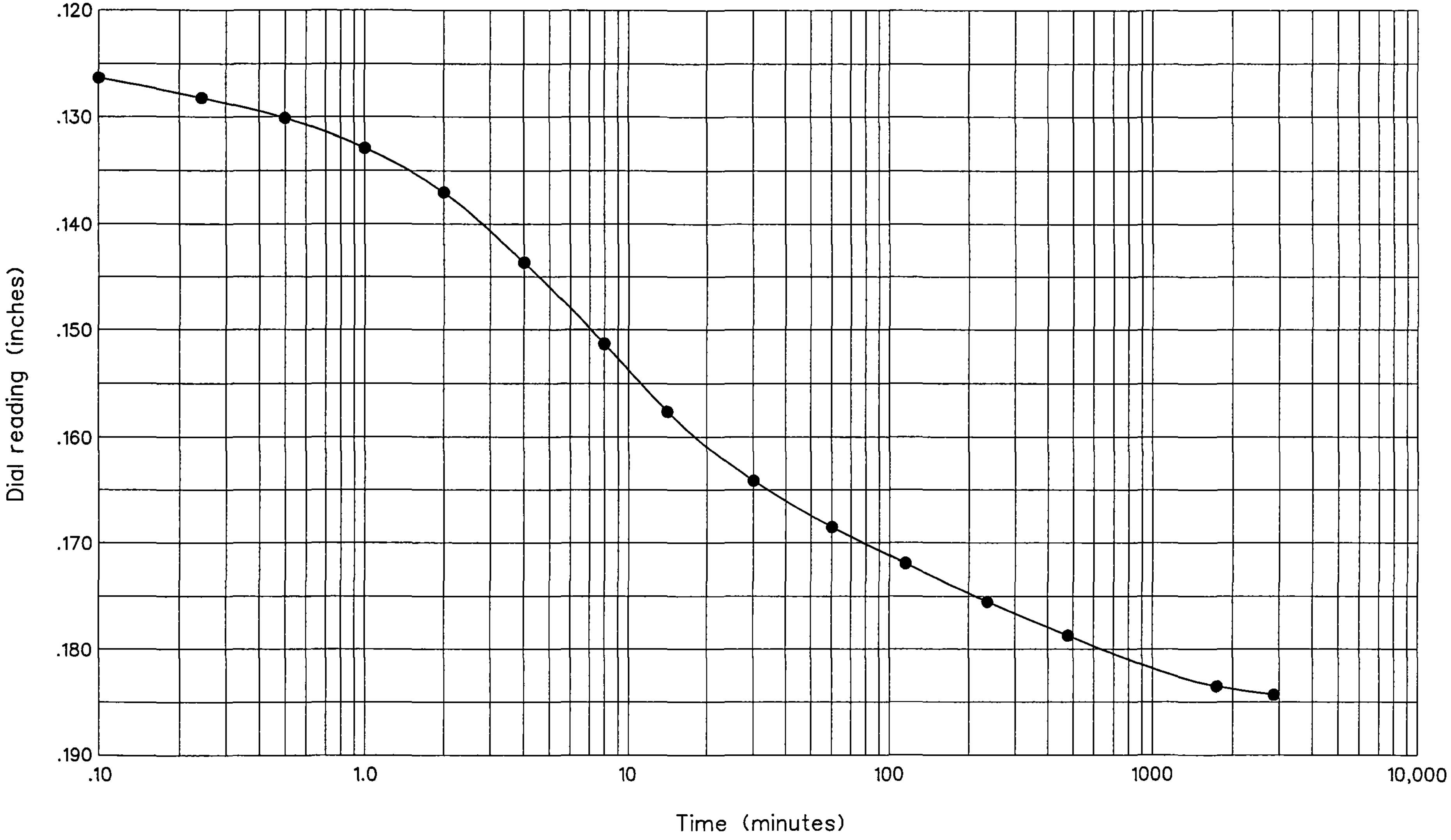
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 115'-116.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



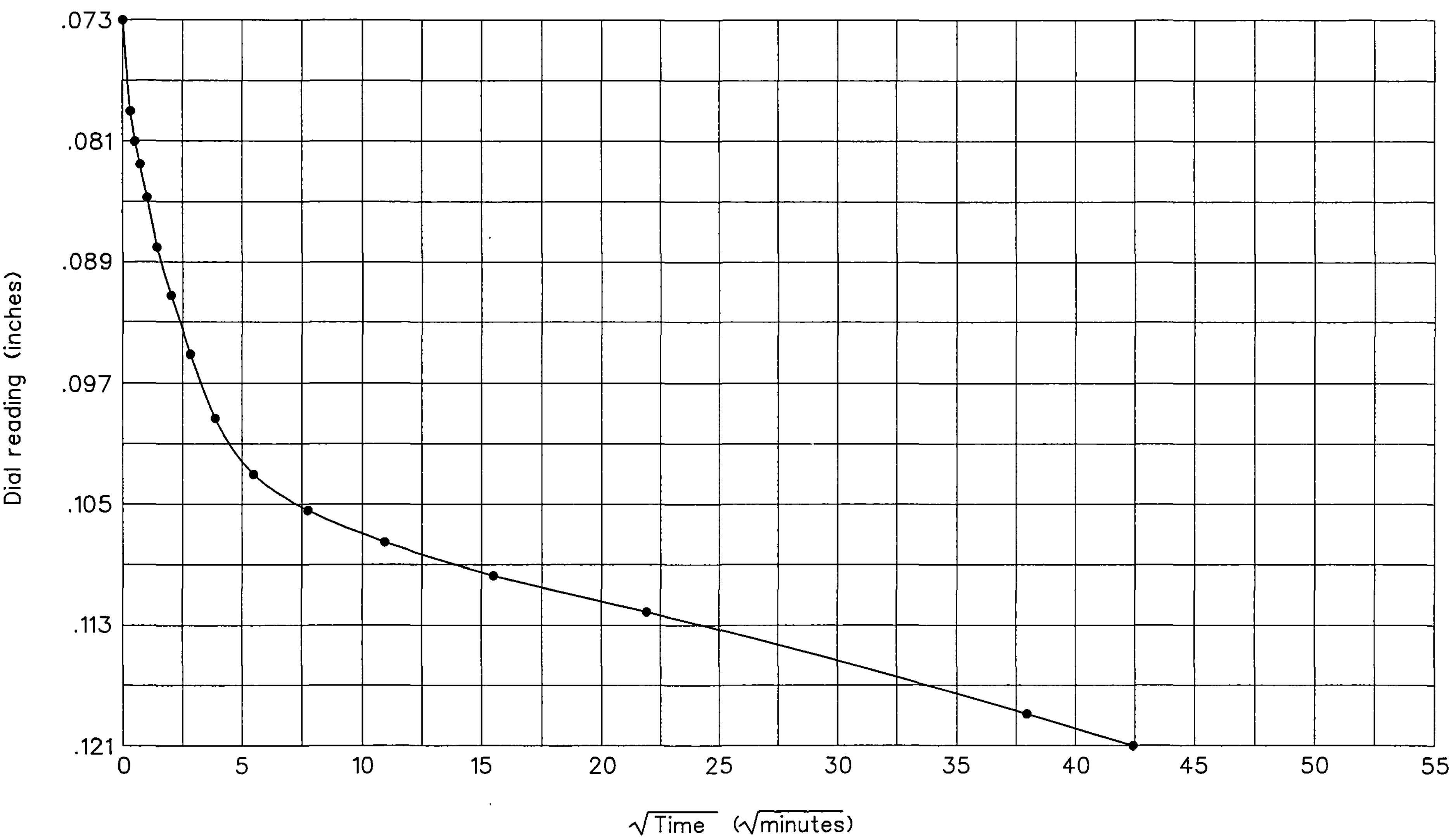
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 115'-116.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



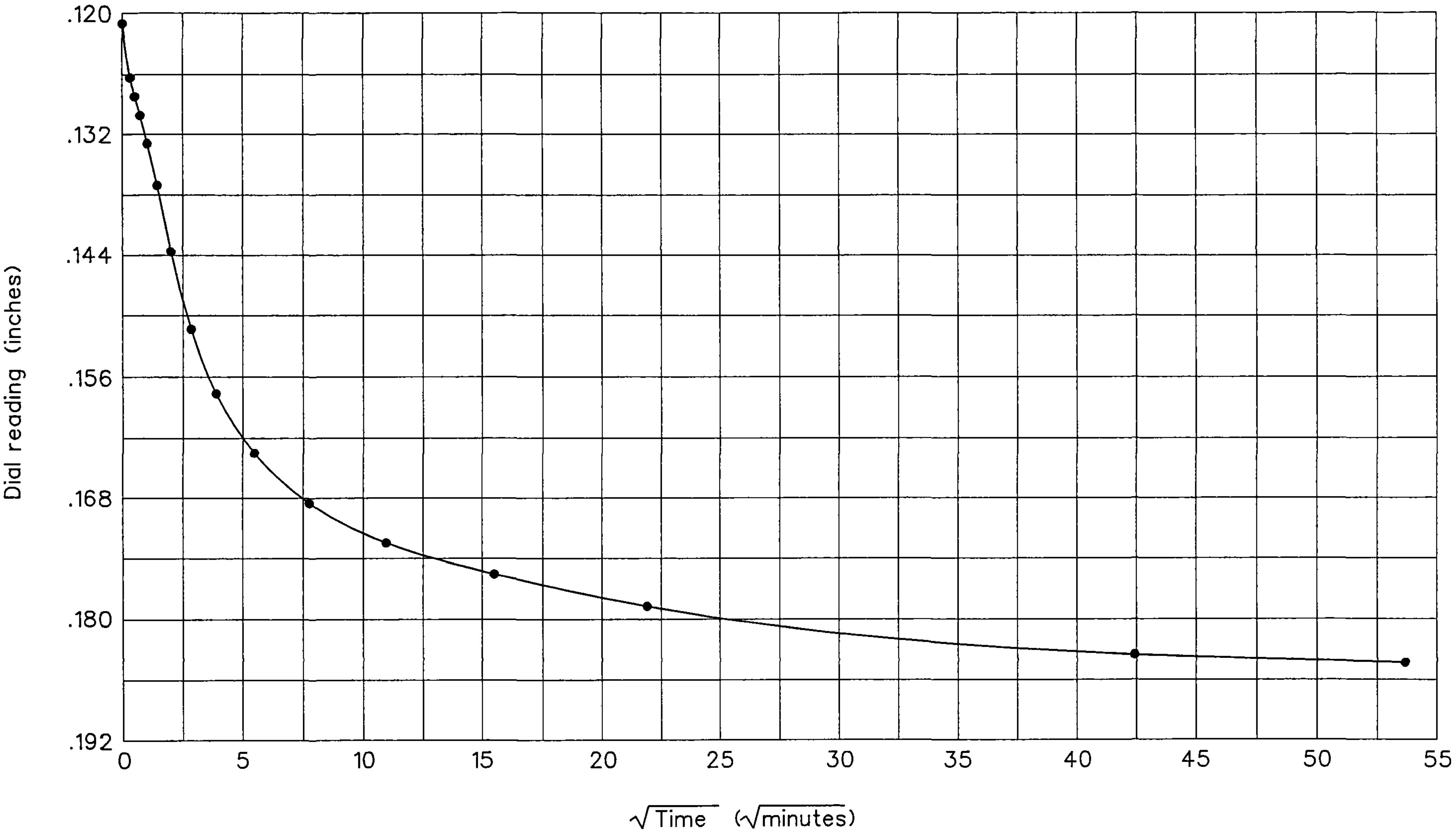
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 115'-116.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



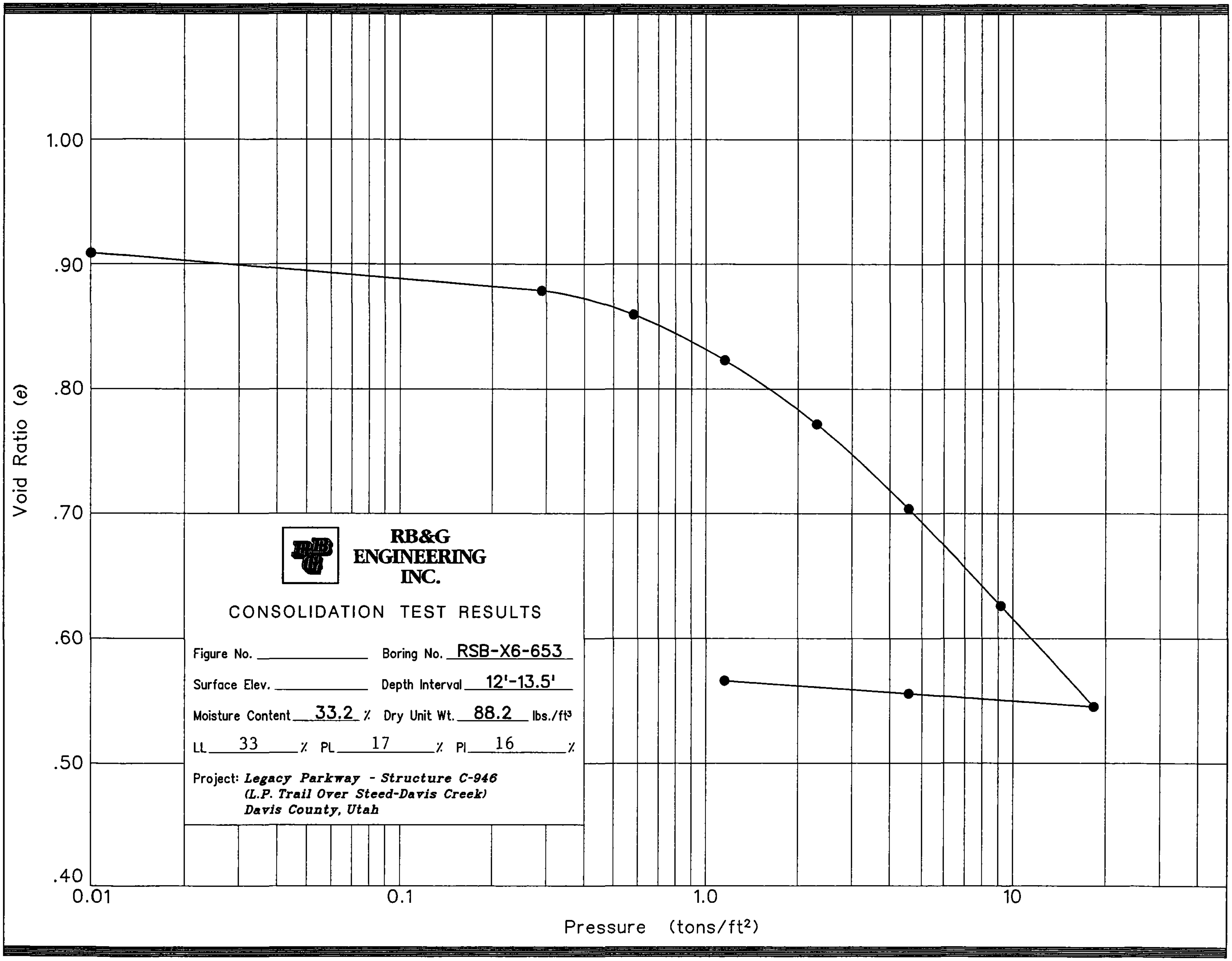
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 115'-116.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

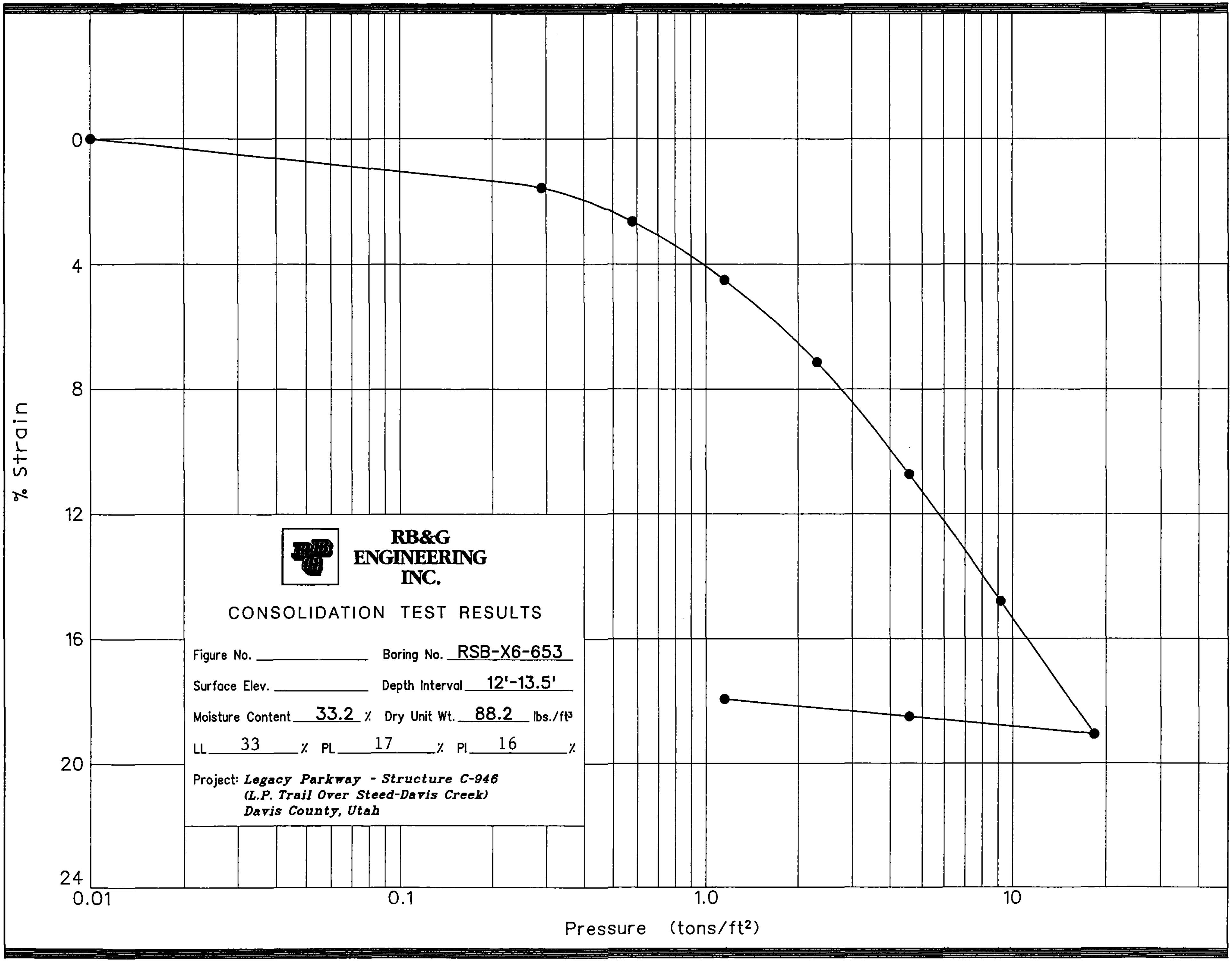
Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 12'-13.5'

Moisture Content 33.2 % Dry Unit Wt. 88.2 lbs./ft³

LL 33 % PL 17 % PI 16 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

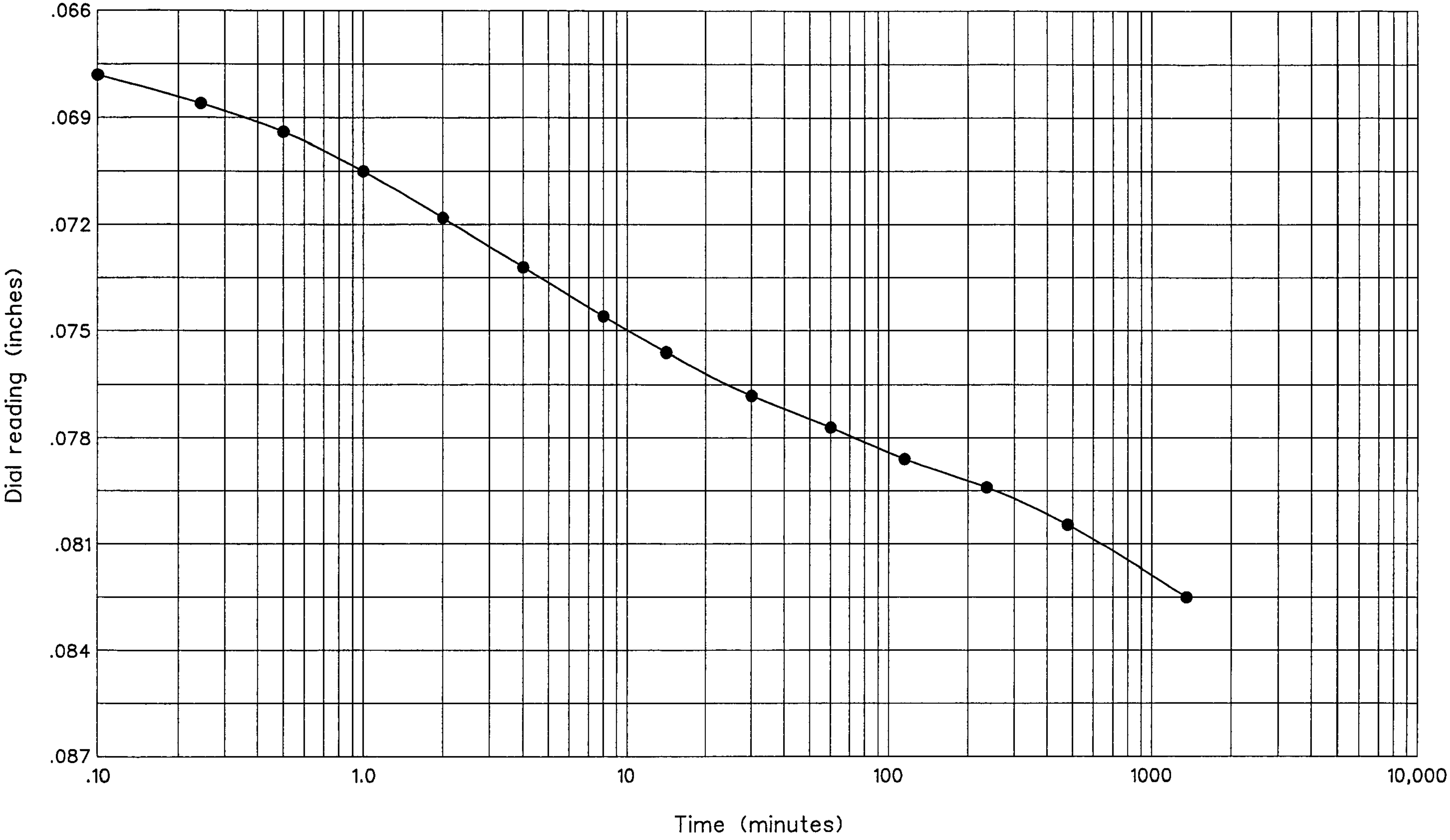
Figure No. ______________ Boring No. RSB-X6-653

Surface Elev. ______________ Depth Interval 12'-13.5'

Moisture Content 33.2 % Dry Unit Wt. 88.2 lbs./ft³

LL 33 % PL 17 % PI 16 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



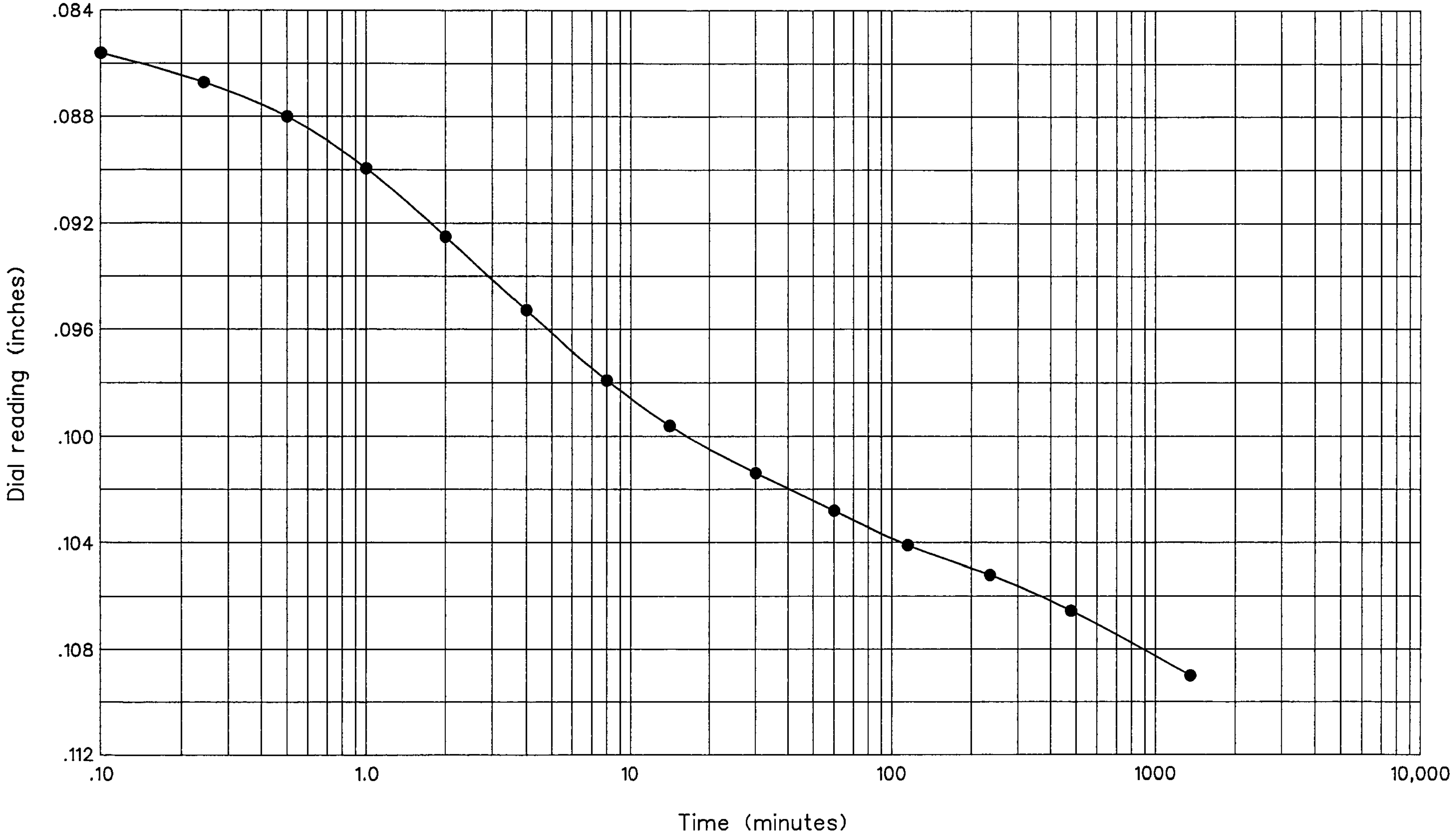
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 12'-13.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



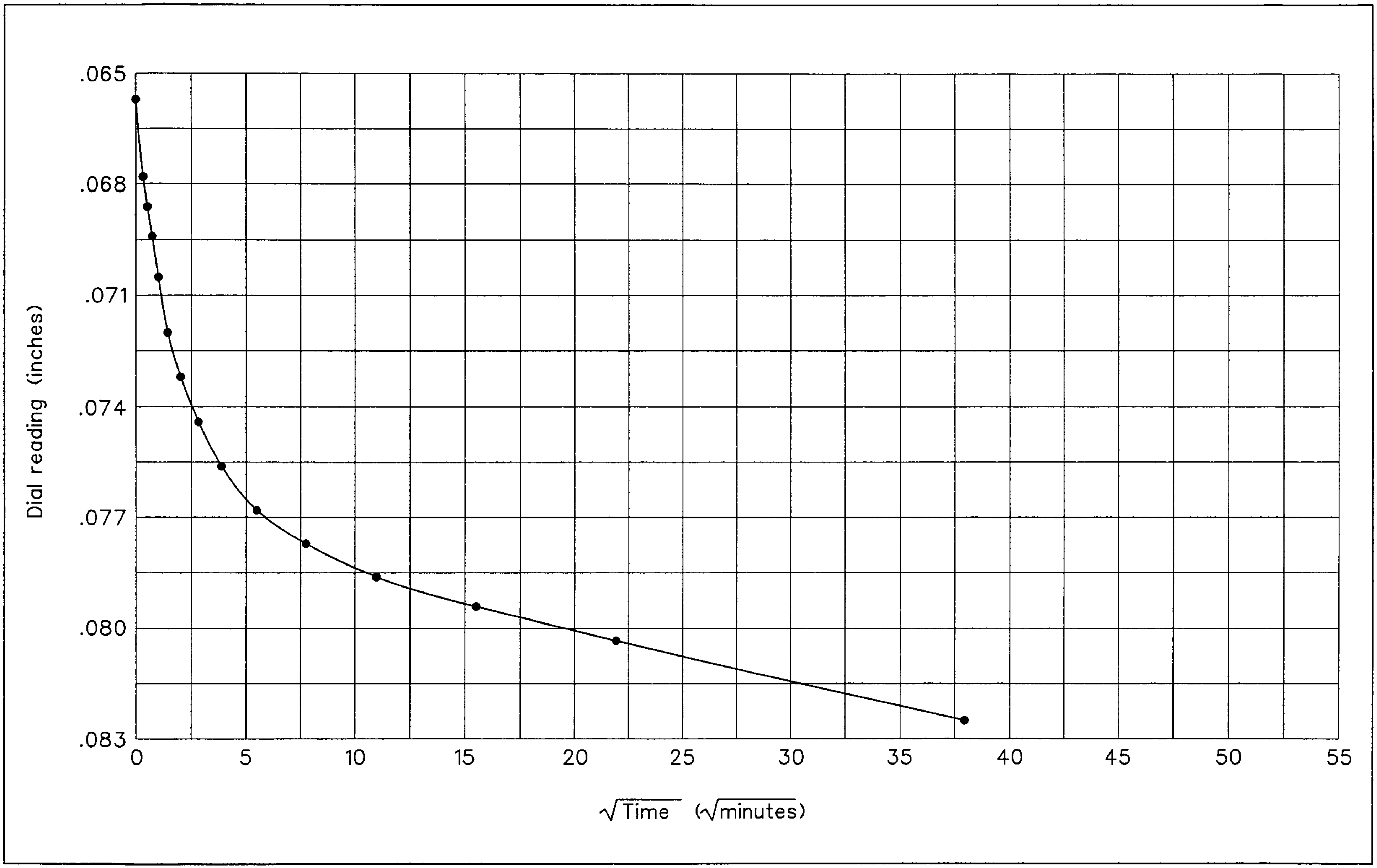
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 12'-13.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



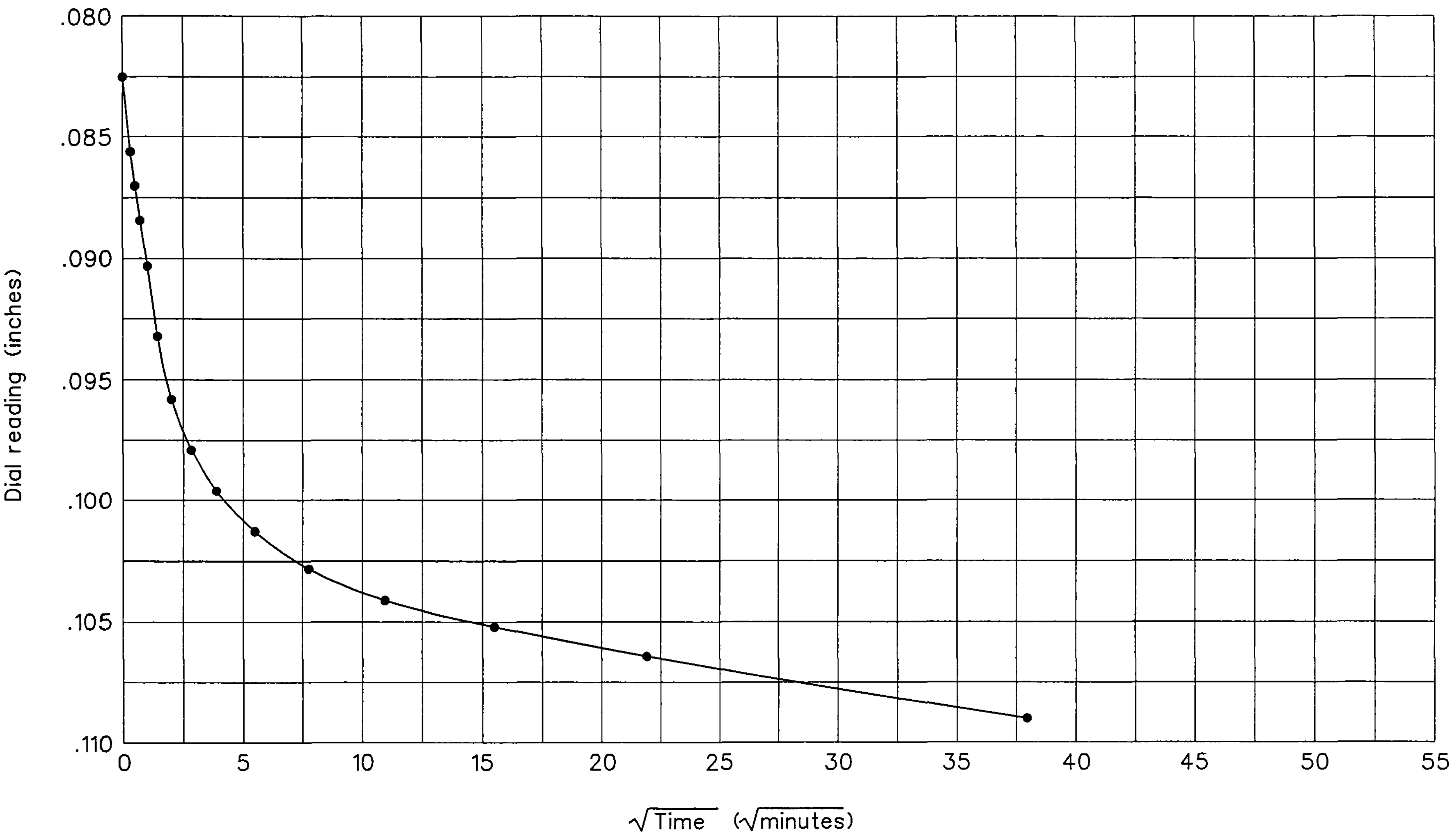
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 12'-13.5'
Load: 0.58 to 1.15 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



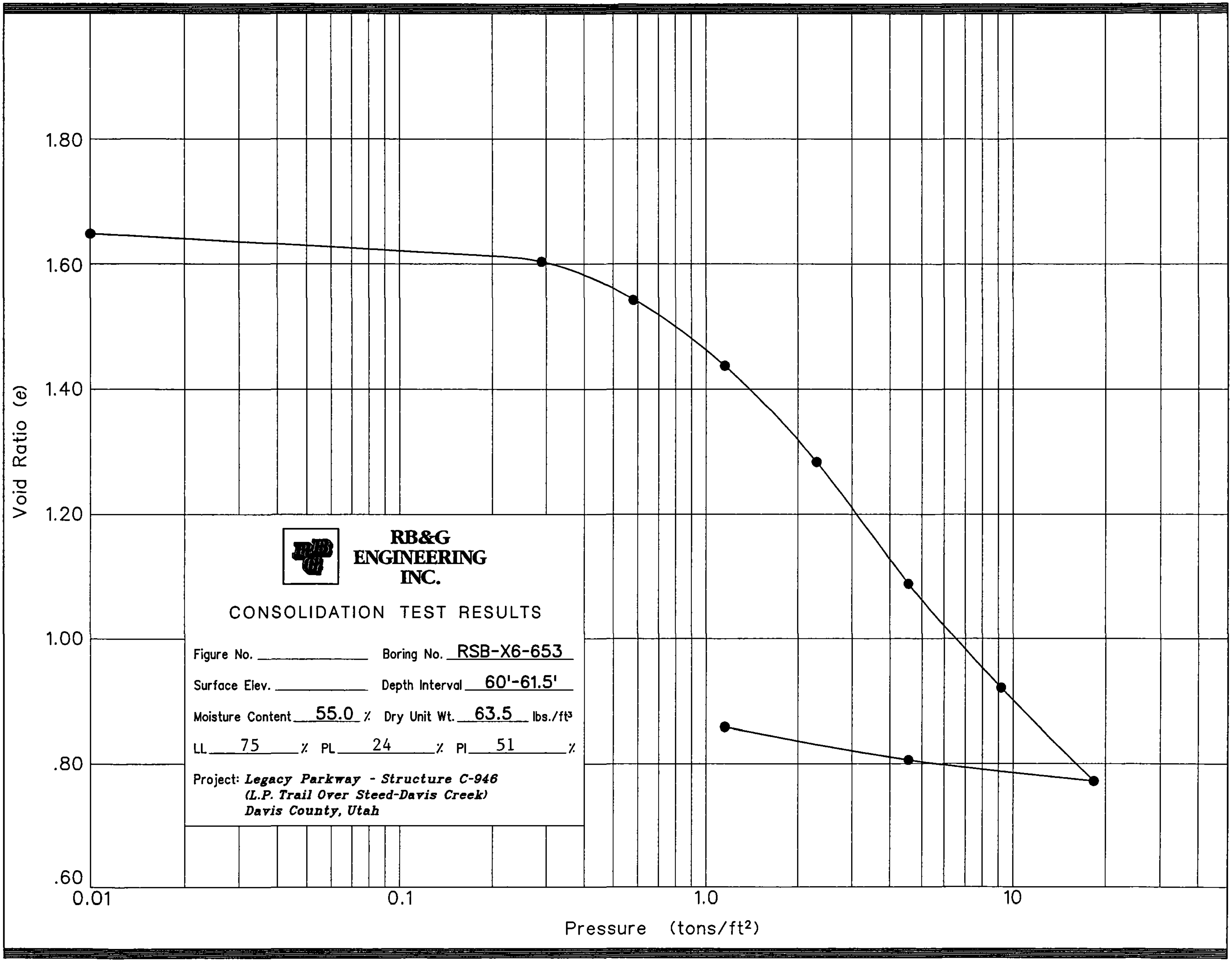
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 12'-13.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



RB&G
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INC.

CONSOLIDATION TEST RESULTS

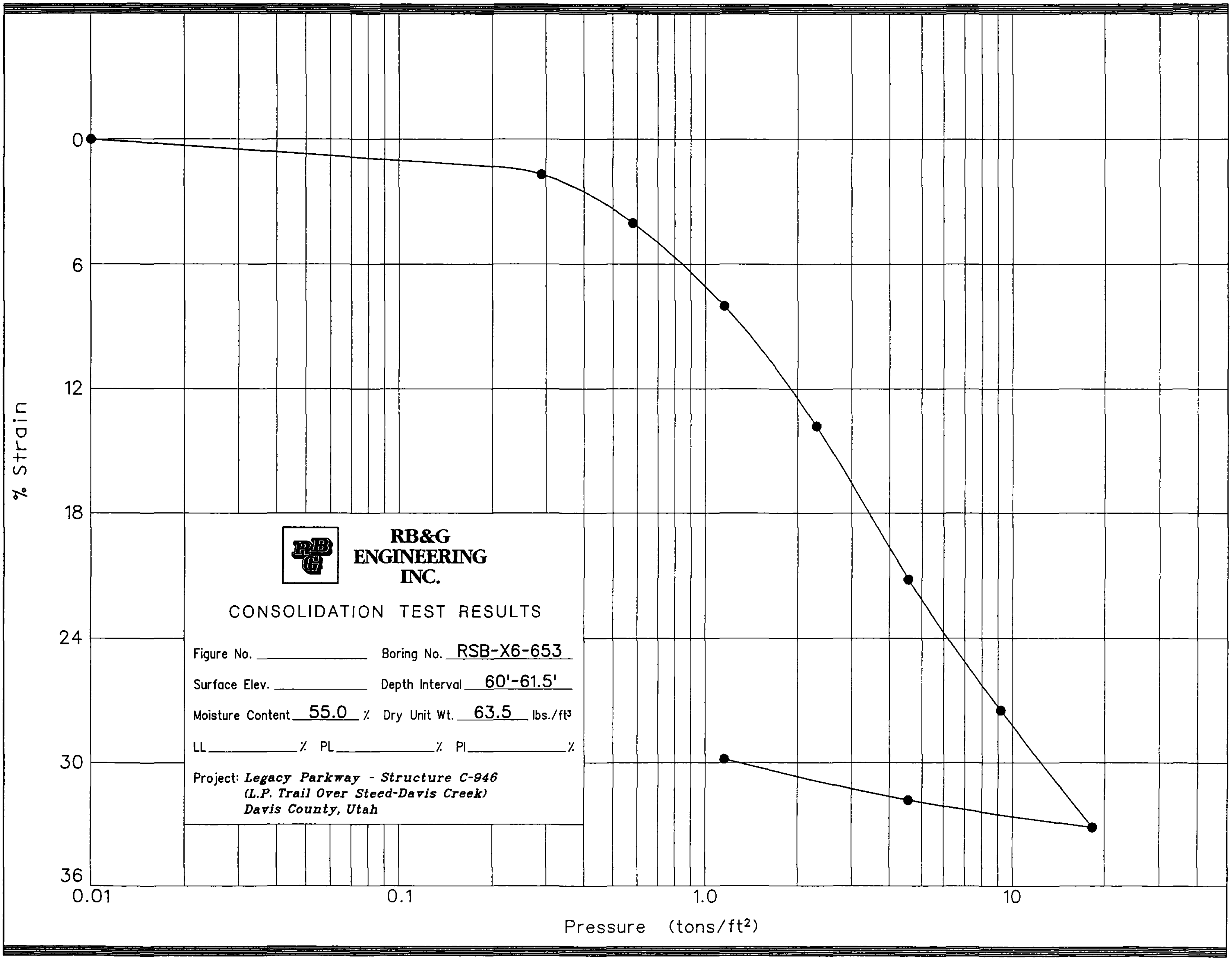
Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 55.0 % Dry Unit Wt. 63.5 lbs./ft³

LL 75 % PL 24 % PI 51 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

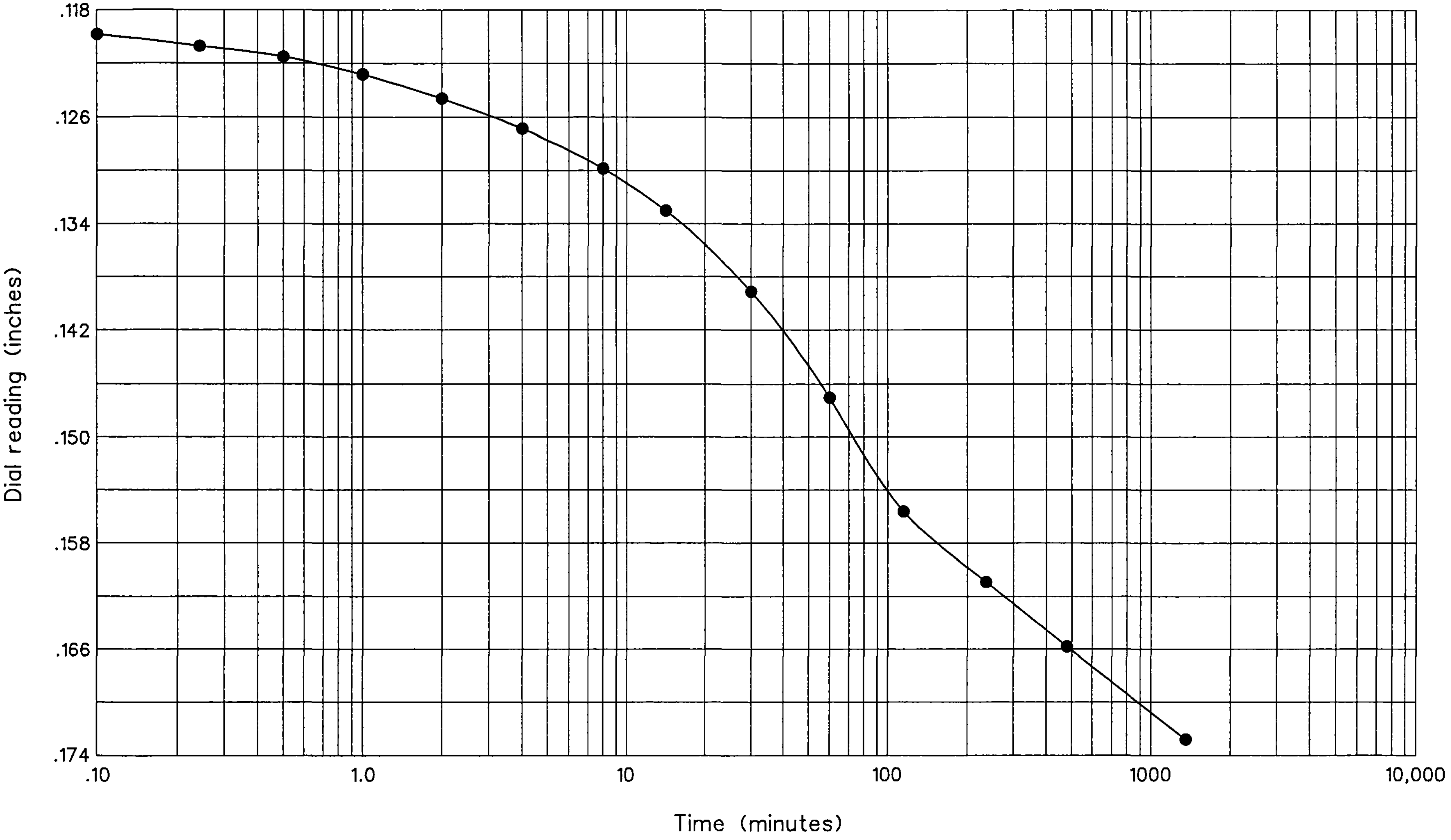
Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 55.0 % Dry Unit Wt. 63.5 lbs./ft³

LL ______% PL ______% PI ______%

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



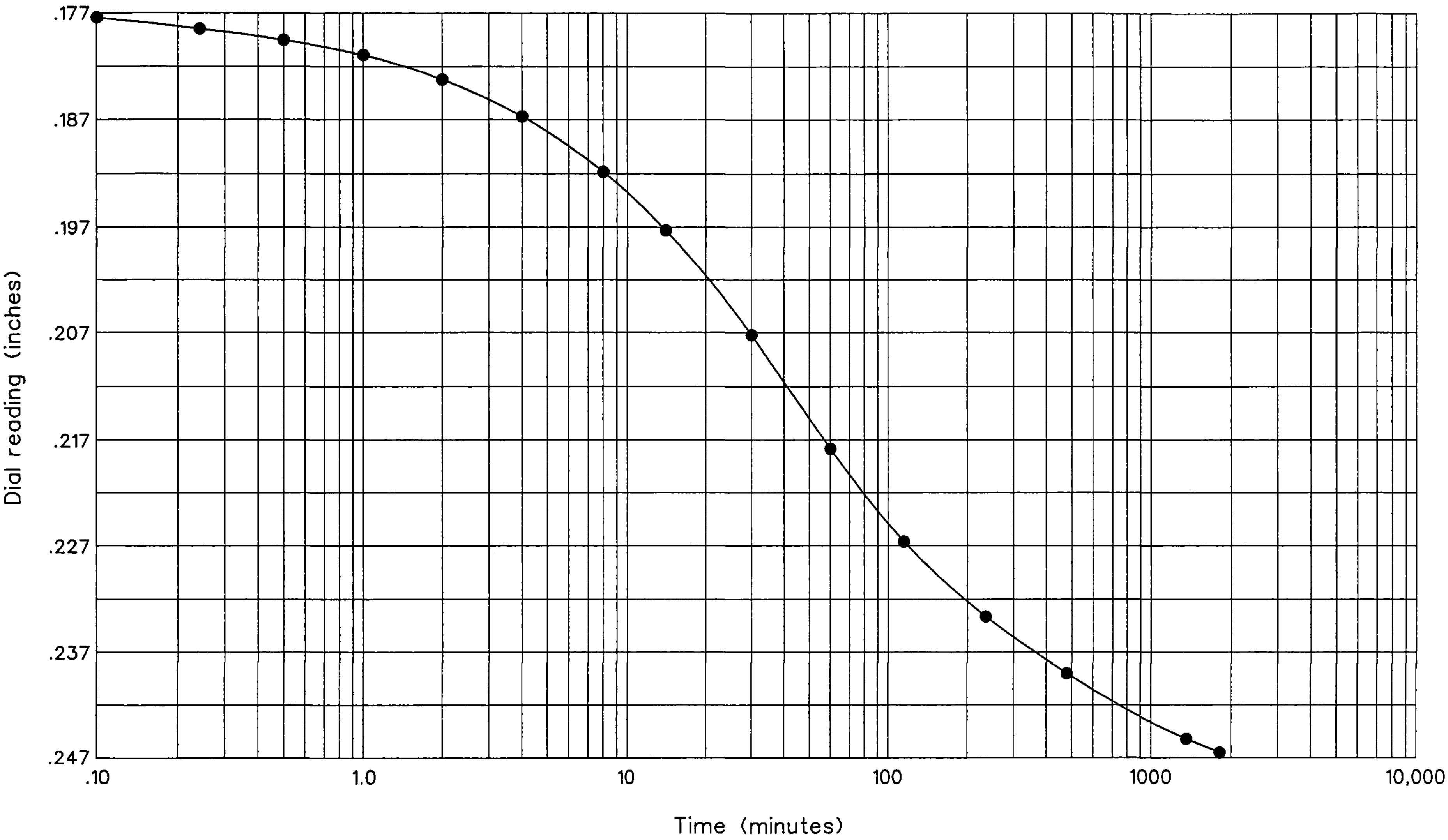
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 60'-61.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



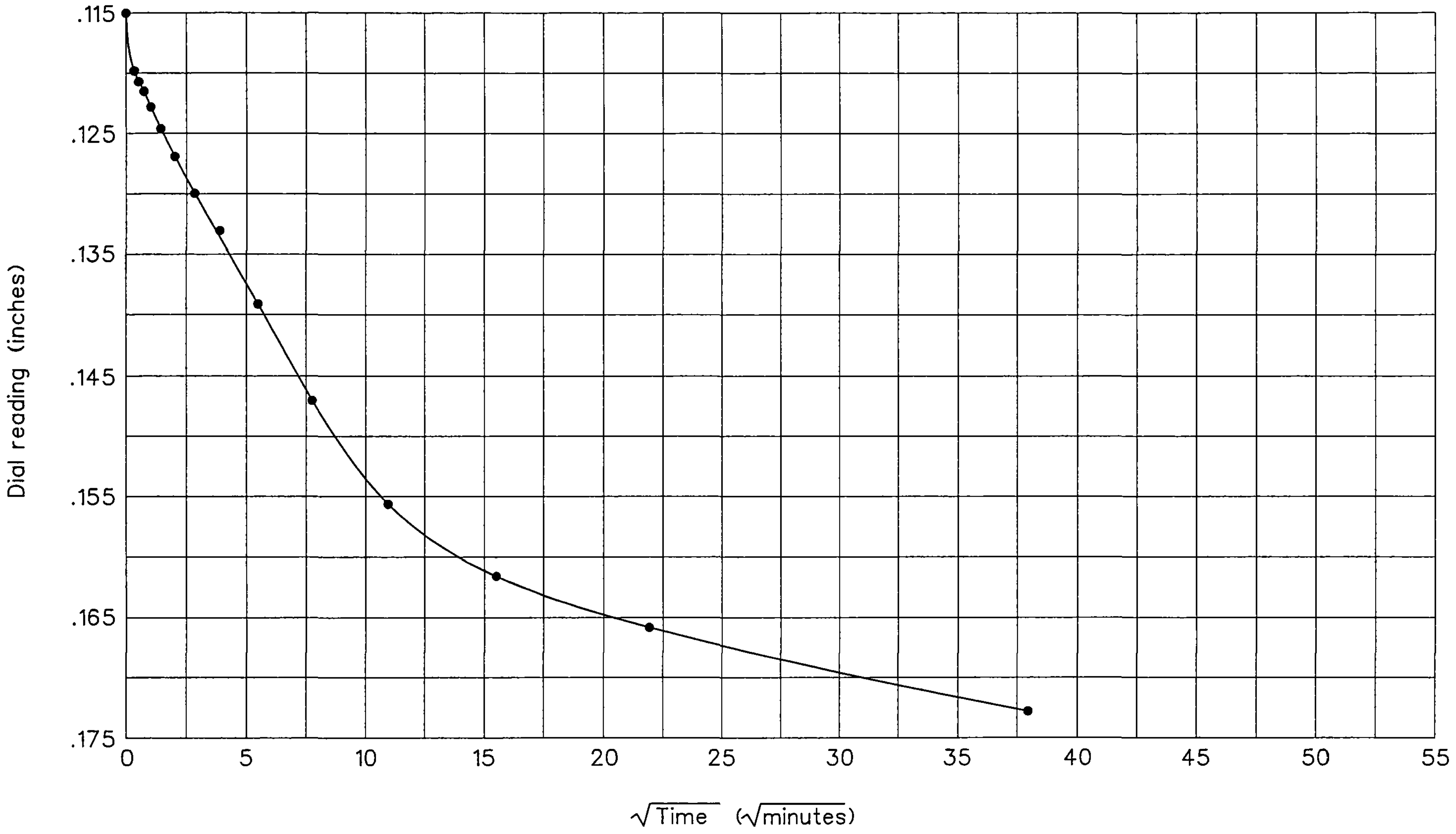
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 60'-61.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



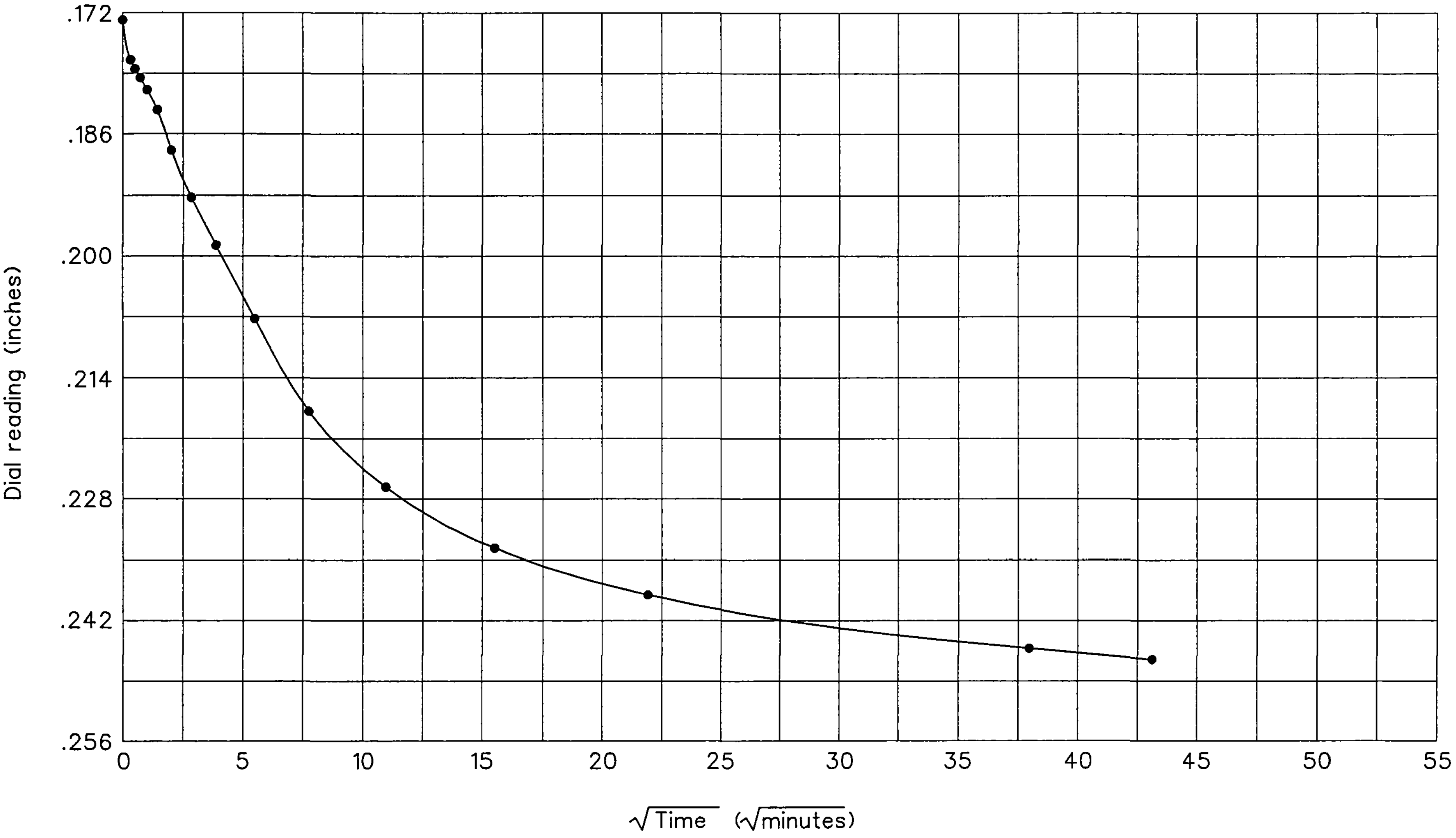
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 60'-61.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



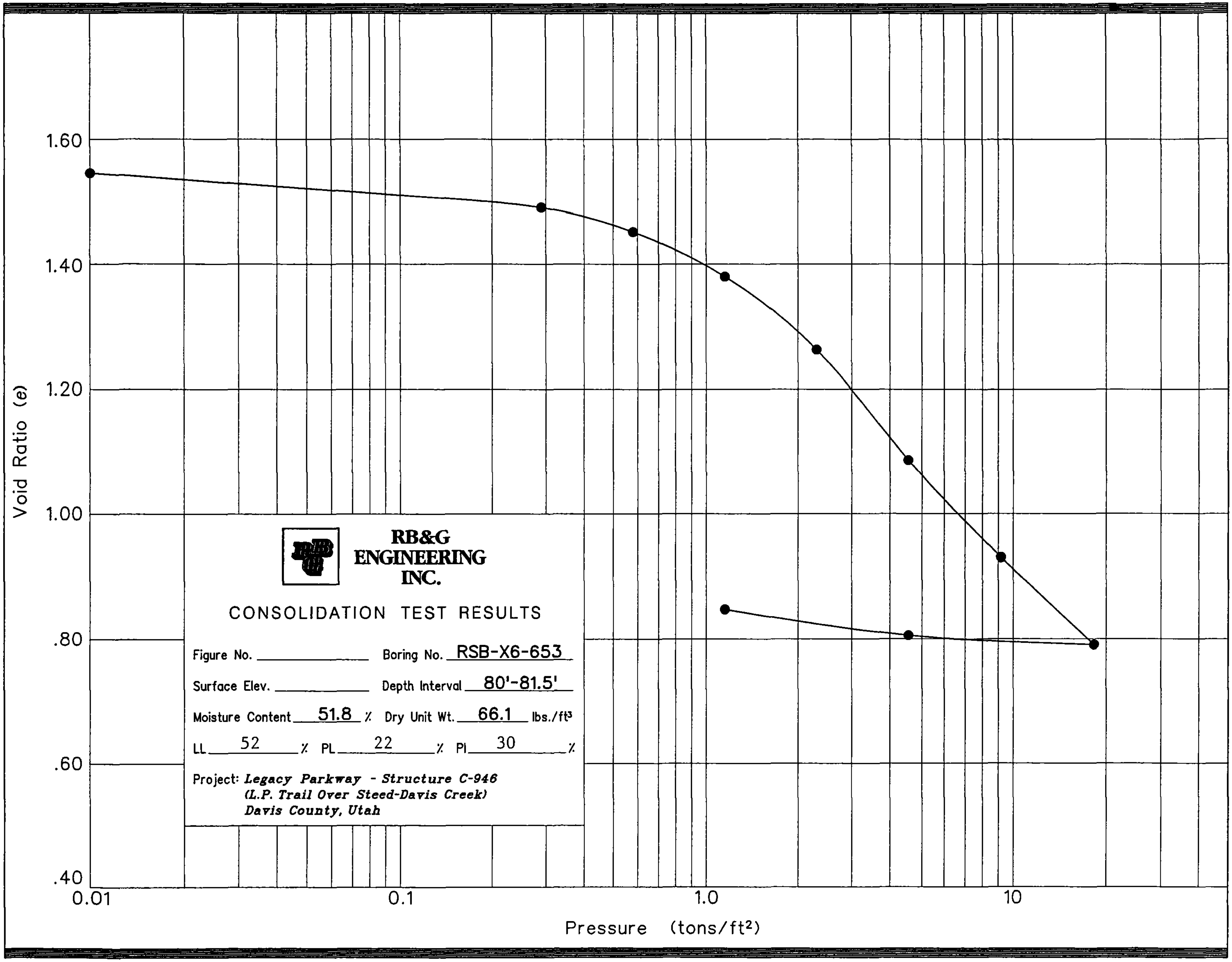
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 60'-61.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

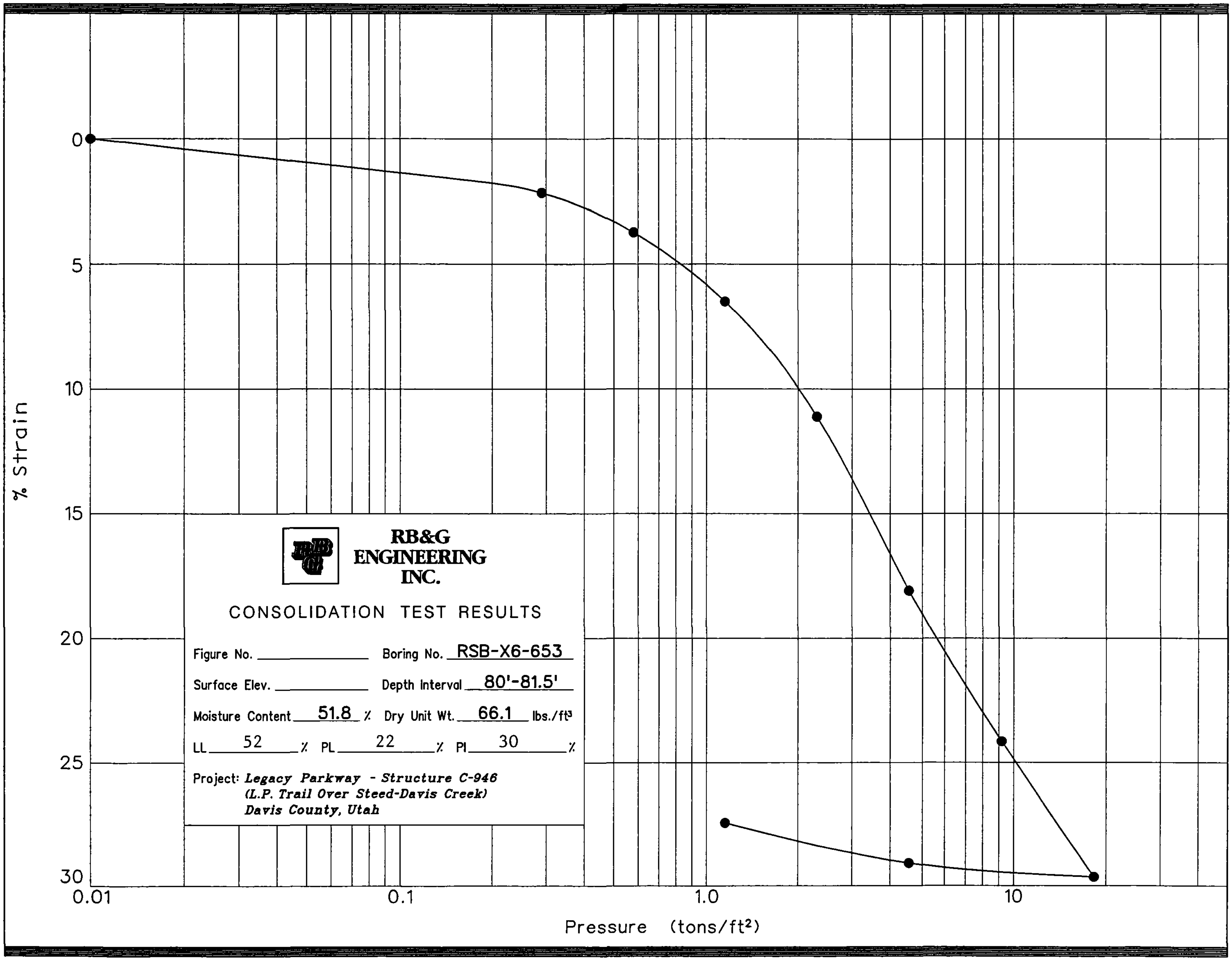
Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 80'-81.5'

Moisture Content 51.8 % Dry Unit Wt. 66.1 lbs./ft³

LL 52 % PL 22 % PI 30 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

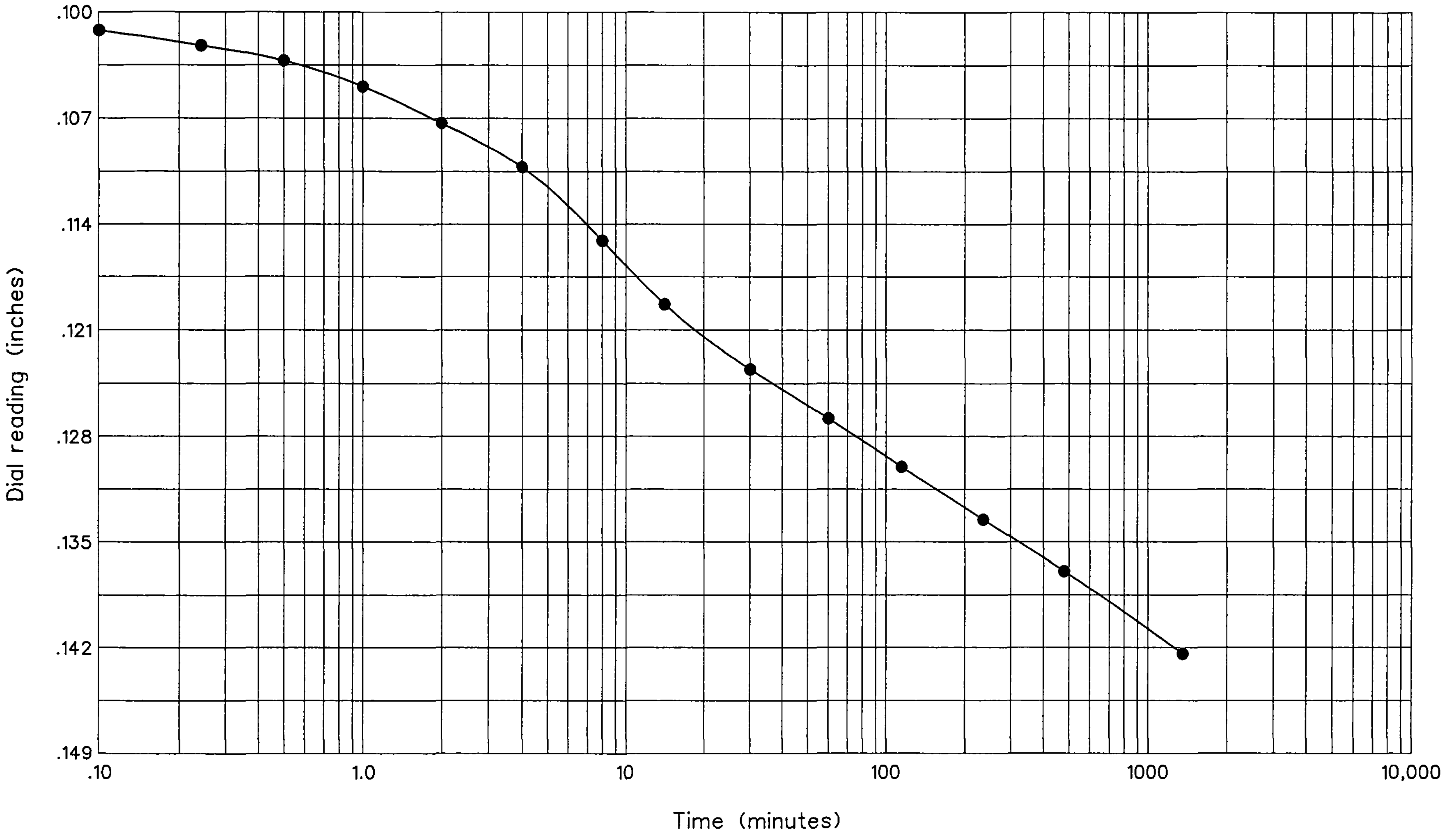
Figure No. __________ Boring No. RSB-X6-653

Surface Elev. __________ Depth Interval 80'-81.5'

Moisture Content 51.8 % Dry Unit Wt. 66.1 lbs./ft³

LL 52 % PL 22 % PI 30 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



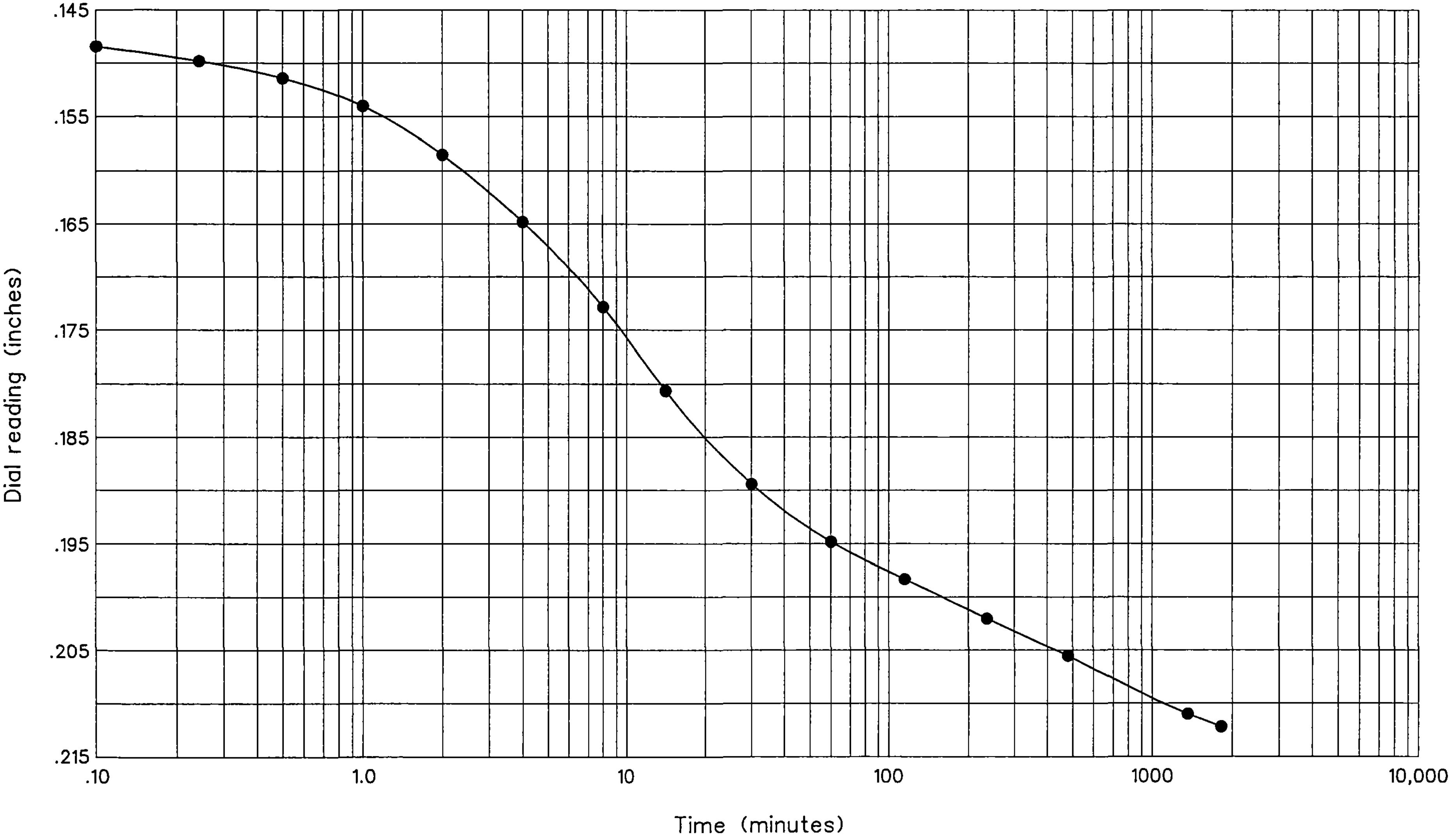
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 80'-81.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



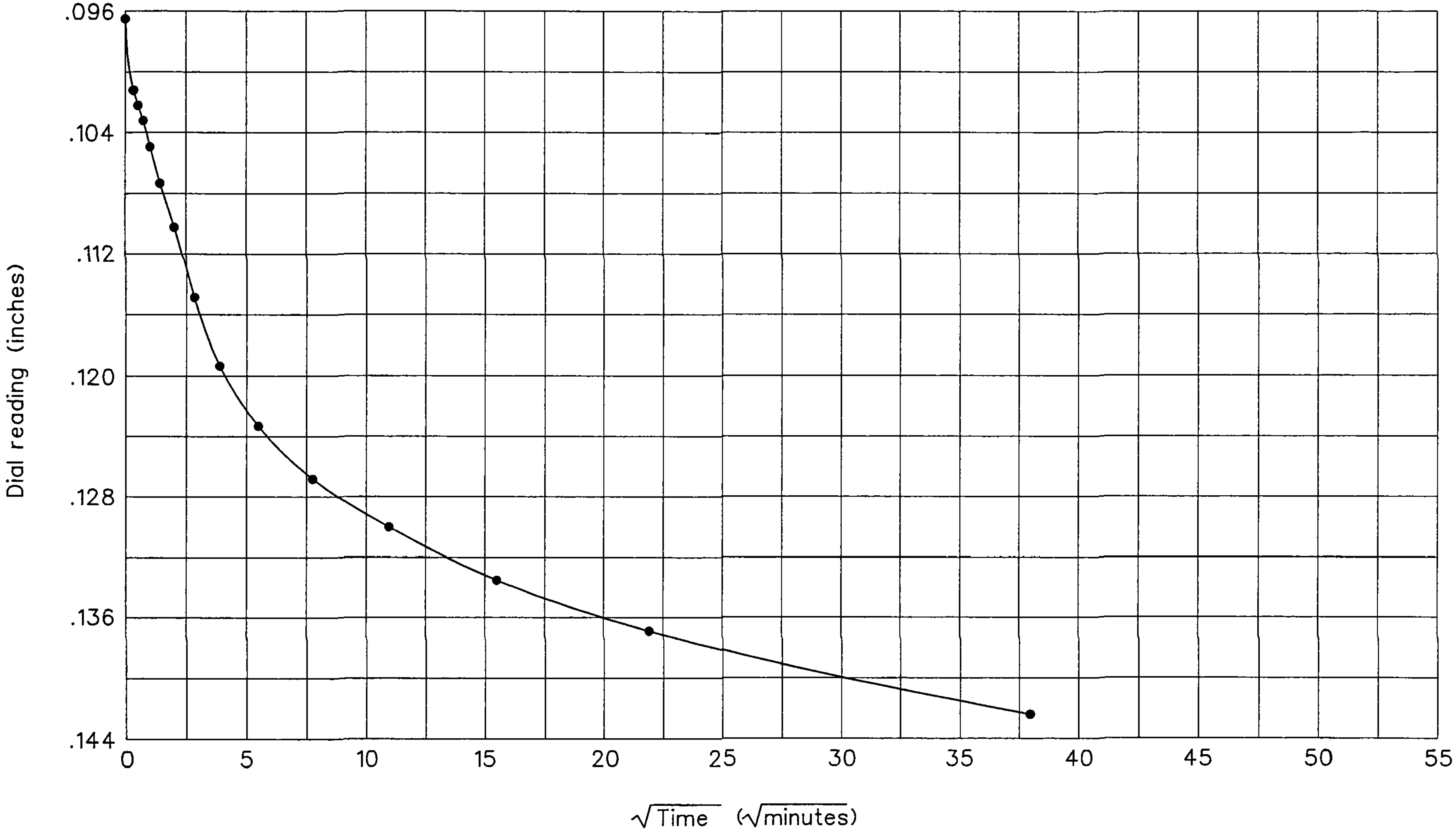
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 80'-81.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



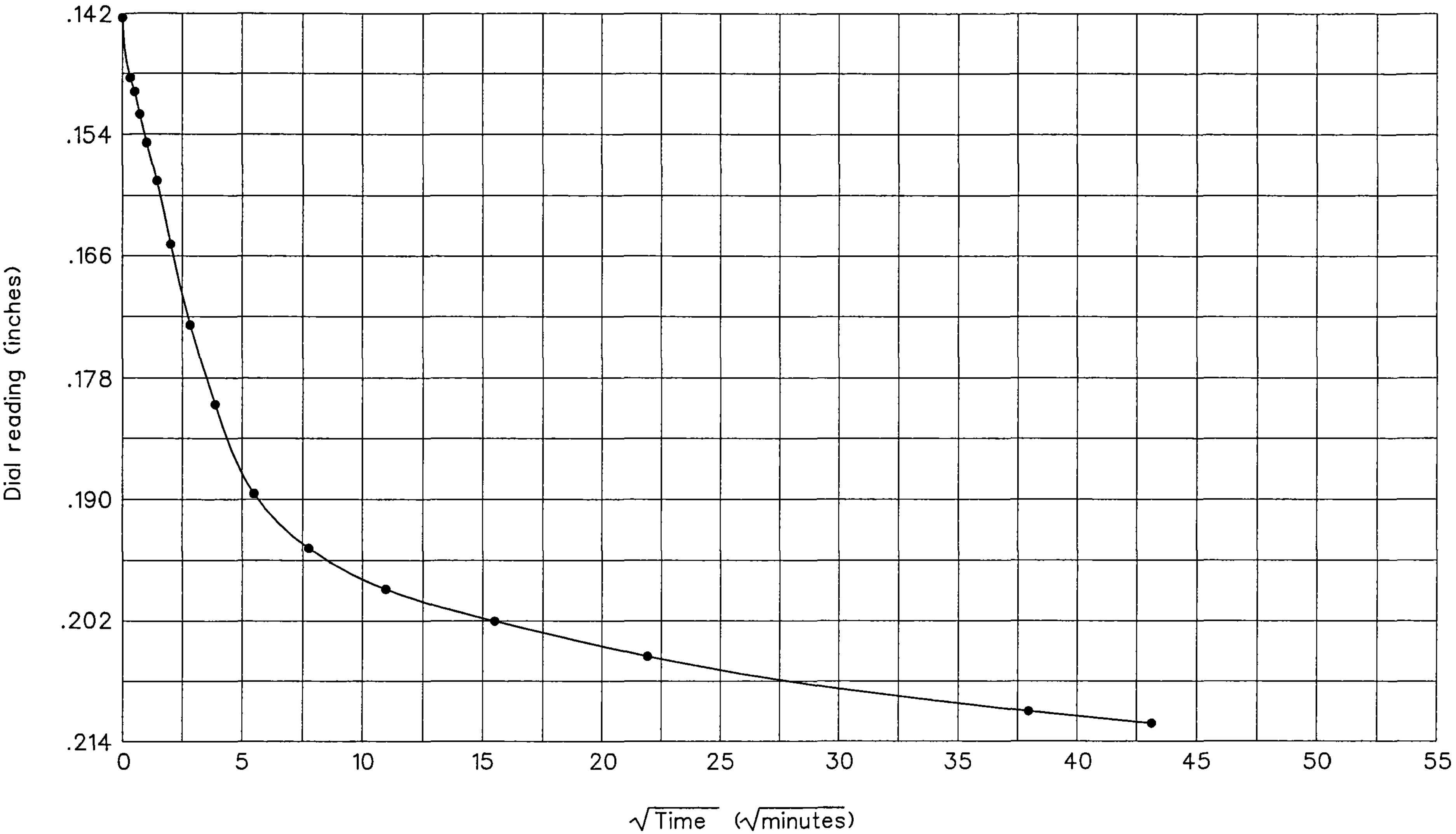
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 80'-81.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



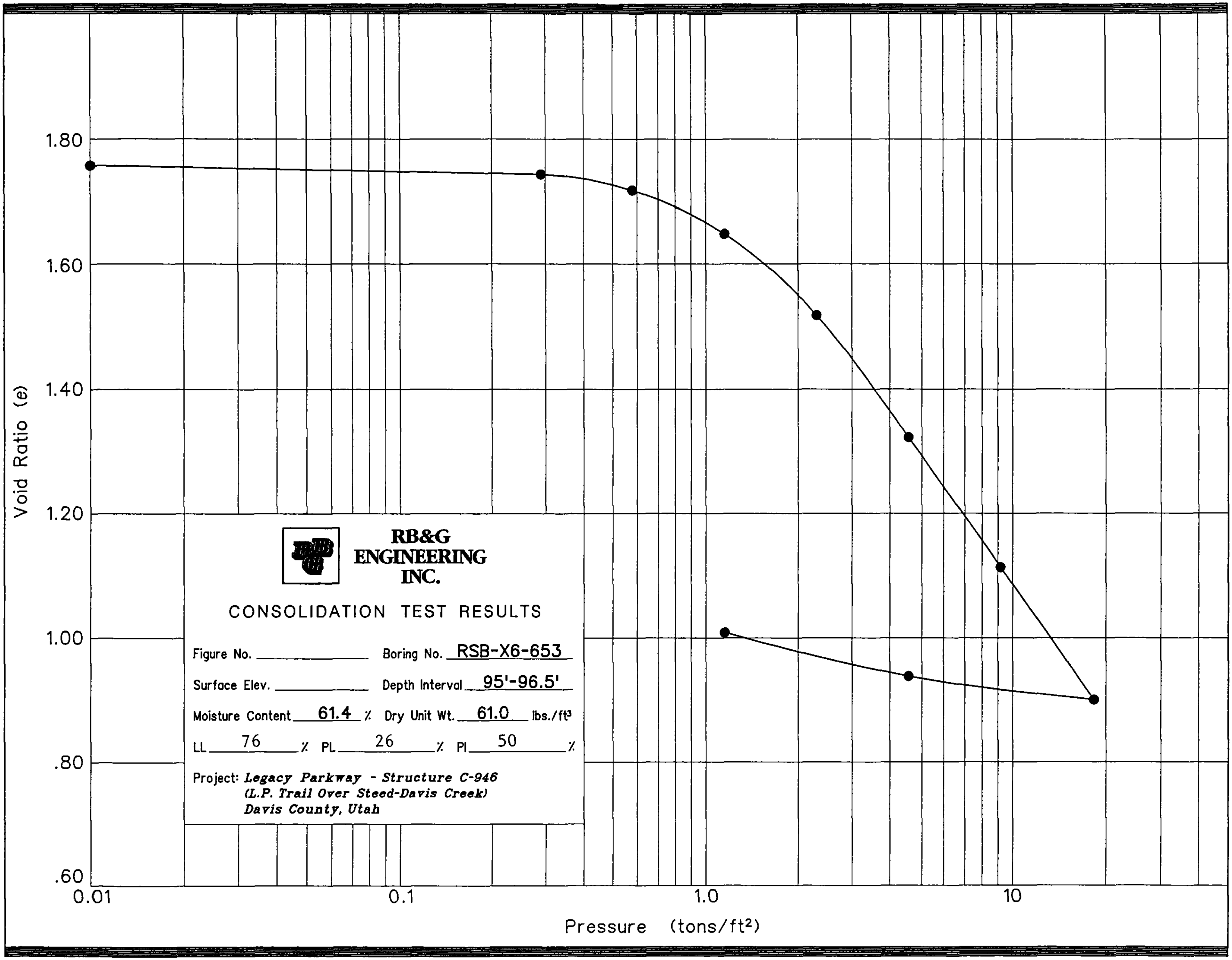
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 80'-81.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

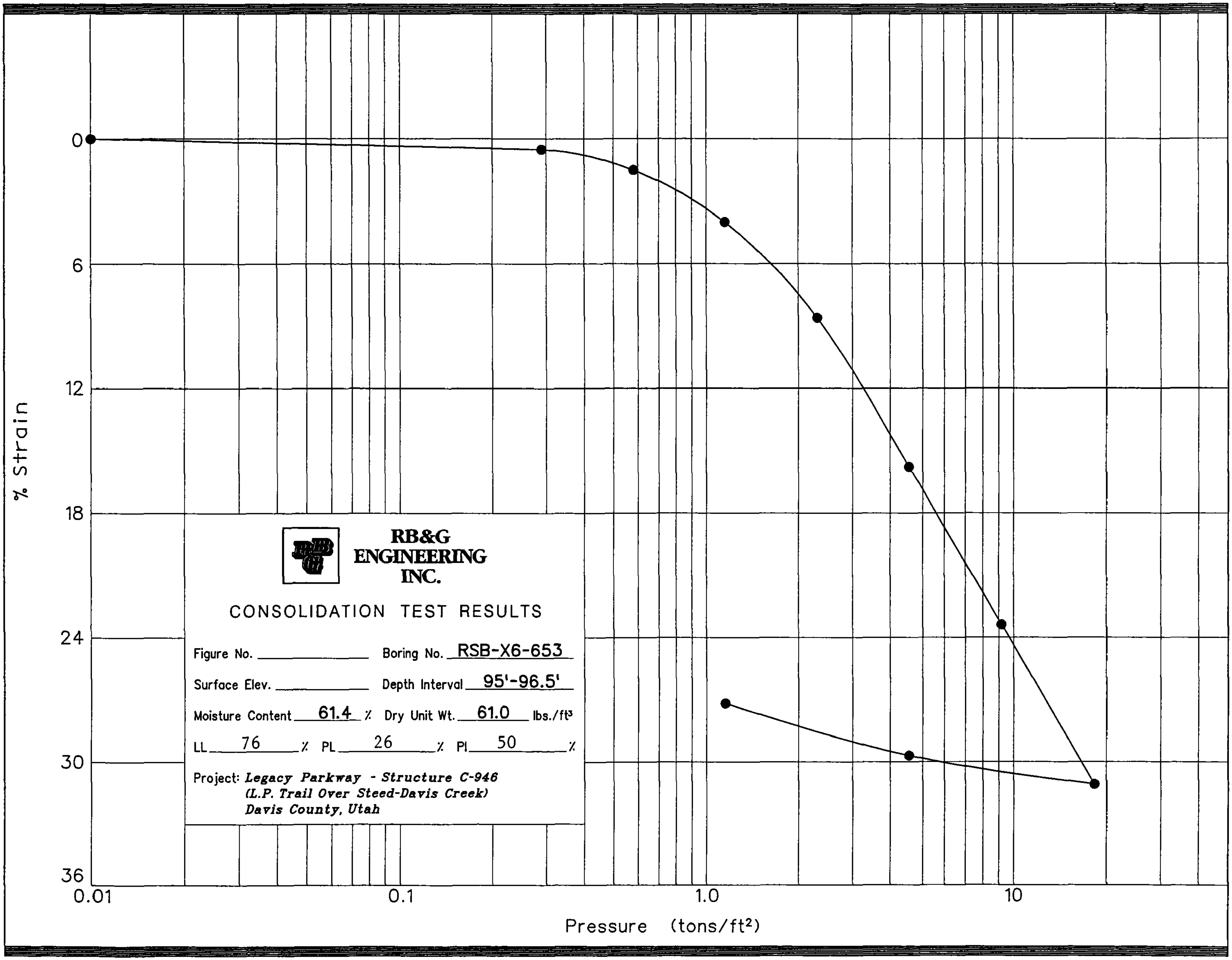
Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 95'-96.5'

Moisture Content 61.4 % Dry Unit Wt. 61.0 lbs./ft³

LL 76 % PL 26 % PI 50 %

Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X6-653

Surface Elev. ______ Depth Interval 95'-96.5'

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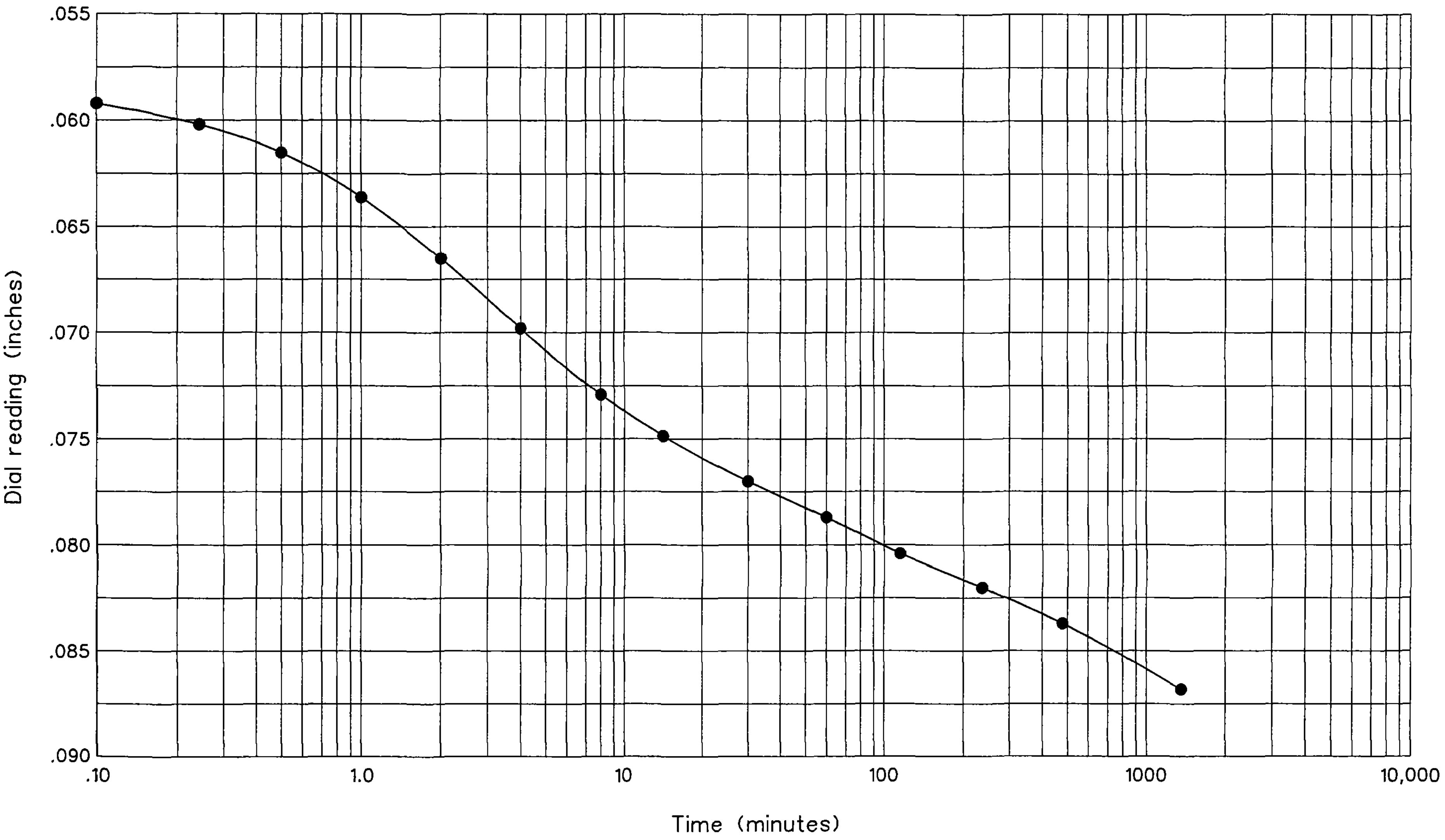
Project: *Legacy Parkway - Structure C-946*
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah



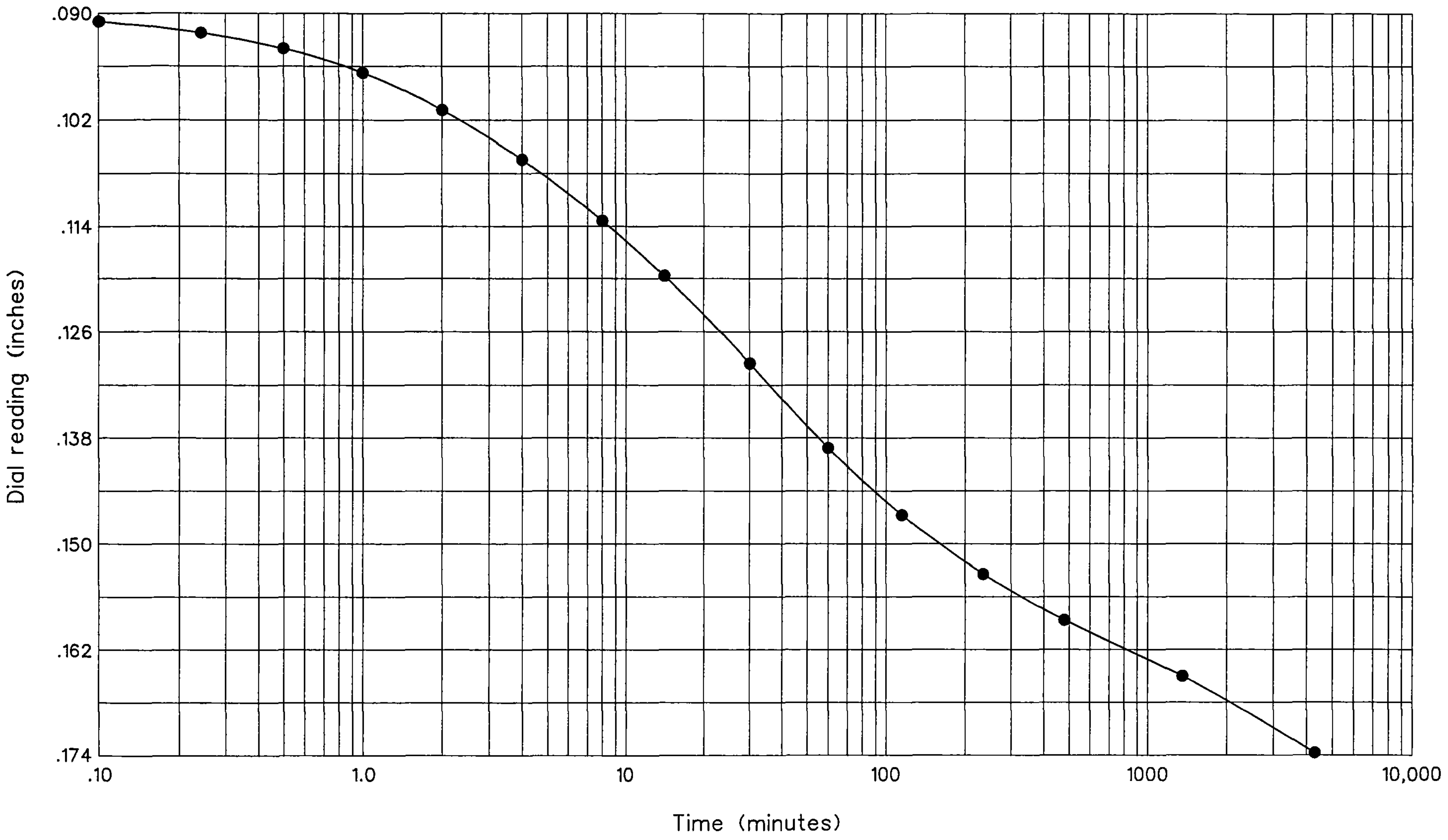
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 95'-96.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



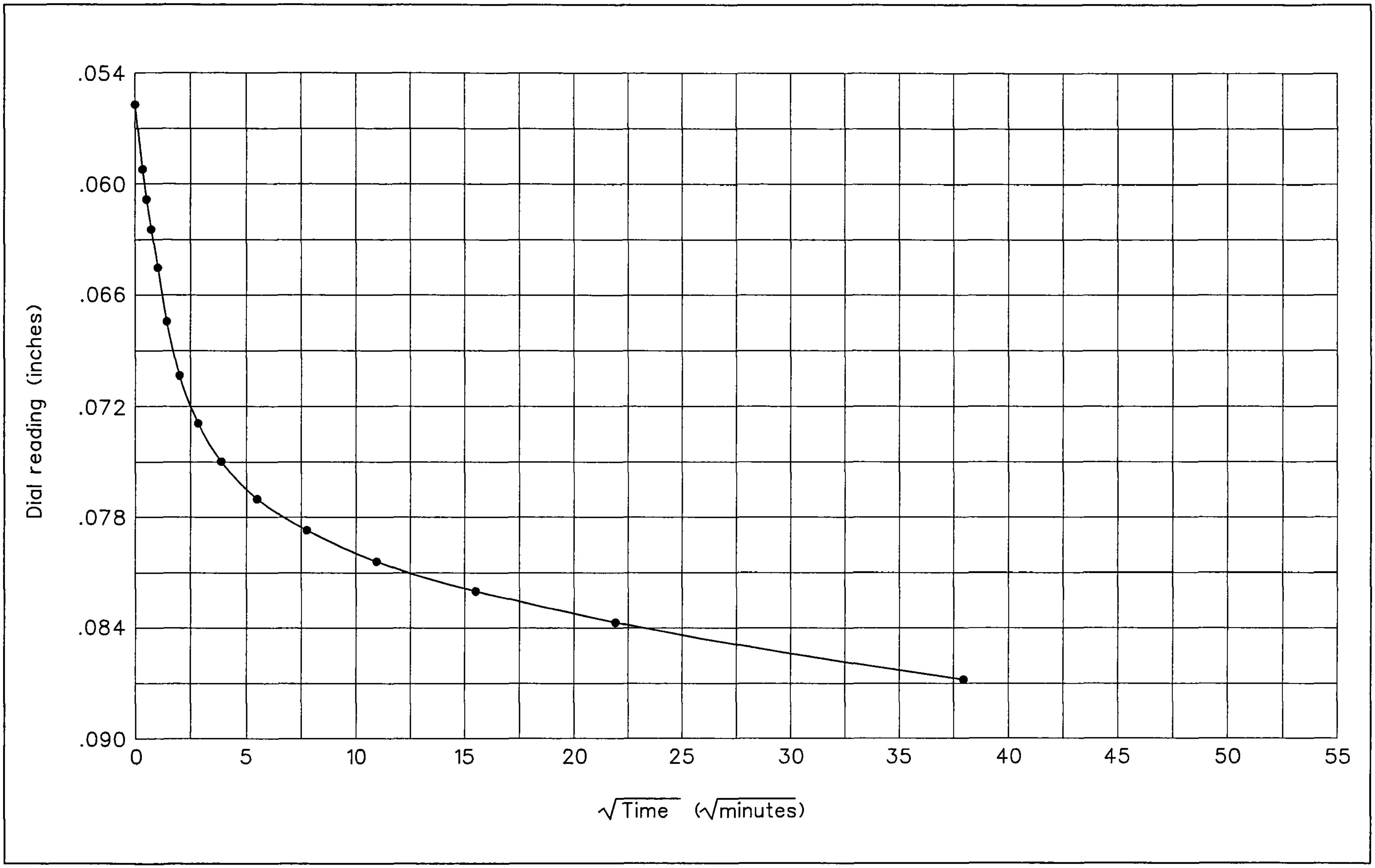
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 95'-96.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



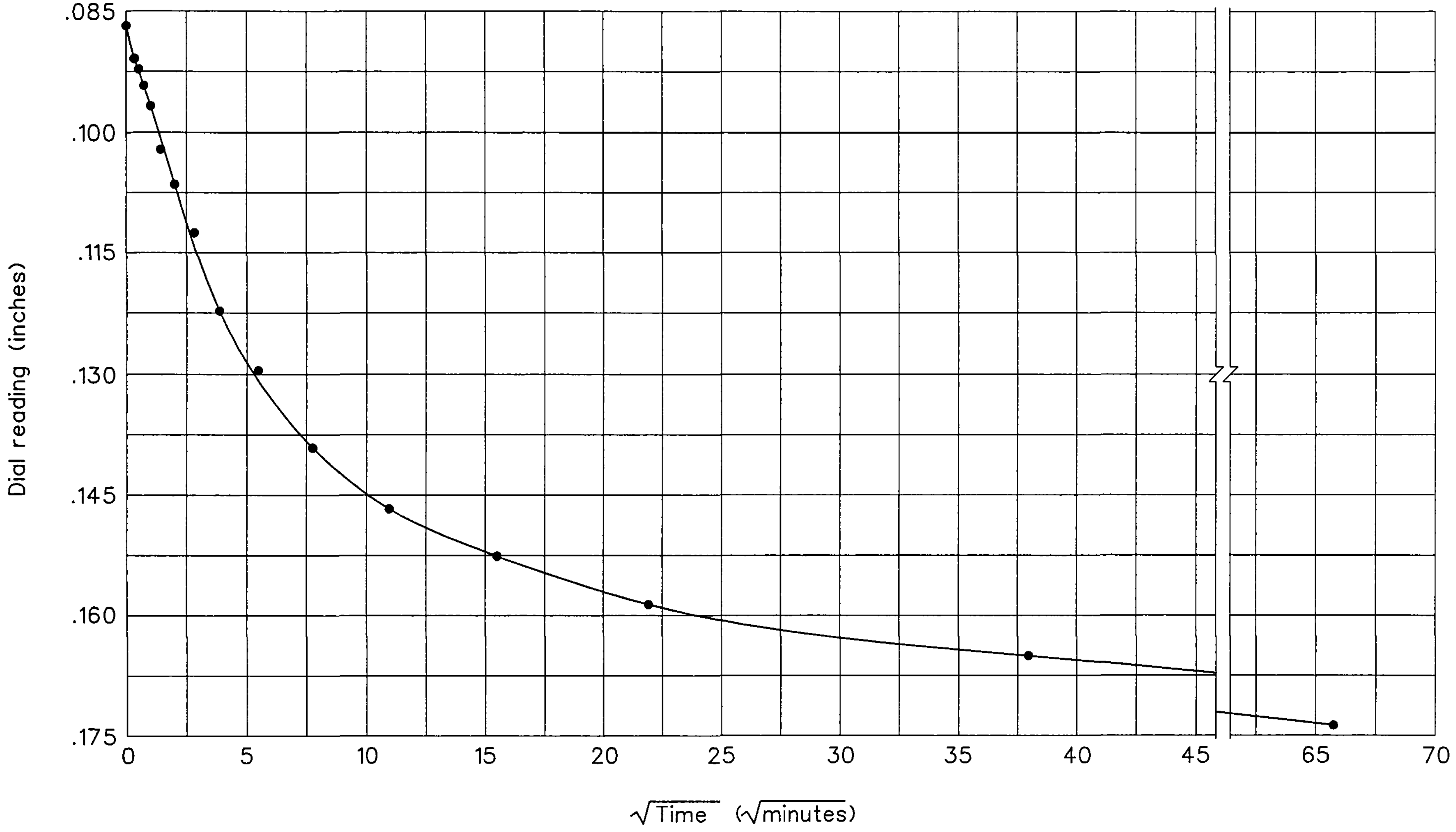
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 95'-96.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure



RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X6-653
Depth: 95'-96.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure C-946
(L.P. Trail Over Steed-Davis Creek)
Davis County, Utah

Figure

APPENDIX D
Supplemental Data

Recommendations for LPILE and GROUP analyses.

Project: Legacy Parkway
Structure No: C-943 FAK No: n/a
Description: Trail Bridge at City Canal

by: srj
date: 6/28/2006

Approx. Pile Cap Elev: 4215 ft
Est. Pile Tip Elev: 4164 ft
Pile Length Below Pile Cap: 51 ft

Pile Type: Closed-End Pipe Pile
Size: 12.75 inch O.D.
Water Table: assume 6 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)	End (psi)
7	4215	4208	Soft Clay (Matlock)	0.033	6.9	0.01	0	60	5.6	0
10	4208	4198	Soft Clay (Matlock)	0.028	2.1	0.02	0	25	2.0	0
14	4198	4184	Soft Clay (Matlock)	0.033	2.8	0.02	0	30	2.4	0
6	4184	4178	Soft Clay (Matlock)	0.033	2.8	0.02	0	30	2.3	0
19	4178	4159	Soft Clay (Matlock)	0.030	6.9	0.01	0	90	6.6	50

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 0.072 pci (regular weight) or 0.046 pci (pumice)
Assume Friction Angle of 34 degrees for conventional fill, and 38 degrees for pumice. Consider reduced parameters for loading towards MSE wall face.
Use Subgrade Modulus k = 90 pci for fill above water table, with Max. Unit Side Resistance of 2 psi.

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.

Recommendations for LPILE and GROUP analyses.

Project: Legacy Parkway
Structure No: C-946 FAK No: n/a
Description: Trail Bridge at Rick's Creek

by: srj
date: 6/21/2006

Est. Pile Cap Elev: 4218 ft
Est. Pile Tip Elev: 4142 ft
Pile Length Below Pile Cap: 76 ft

Pile Type: Closed-End Pipe Pile
Size: 12.75 inch O.D.
Water Table: 3 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)
5	4218	4213	Sand (Reese)	0.028	0	0	30	25	0.5	0
7	4213	4206	Soft Clay (Matlock)	0.030	7.6	0.01	0	60	2.8	0
17	4206	4189	Soft Clay (Matlock)	0.030	3.5	0.02	0	30	3.2	0
8.5	4189	4180.5	Liquefiable Sand	0.030	0	0	0	10	2.0	0
21.5	4180.5	4159	Soft Clay (Matlock)	0.030	3.5	0.02	0	30	3.5	0
15	4159	4144	Soft Clay (Matlock)	0.030	4.9	0.018	0	40	4.9	0
2	4144	4142	Soft Clay (Matlock)	0.033	10	0.01	0	90	8.5	62

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 0.072 pci (regular weight) or 0.046 pci (pumice)
Assume Friction Angle of 34 degrees for conventional fill, and 38 degrees for pumice. Consider reduced parameters for loading towards MSE wall face.
Use Subgrade Modulus k = 90 pci for fill above water table, with Max. Unit Side Resistance of 2 psi.

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.

Recommendations for LPILE and GROUP analyses.

Project: Legacy Parkway
Structure No: C-947 FAK No: n/a
Description: Trail Bridge at Steed-Davis Creek

by: srj
date: 6/23/2006

Approx Exist. Ground Elev: 4214 ft
Est. Pile Tip Elev: 4142 ft
Pile Length Below Ground: 72 ft

Pile Type: Closed-End Pipe Pile
Size: 12.75 inch O.D.
Water Table: upper 3 feet

Soil Layers

									Max Unit Resistance	
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)	Side (psi)	End (psi)
17	4214	4197	Soft Clay (Matlock)	0.028	1.7	0.02	0	20	1.7	0
6.5	4197	4190.5	Liquefiable Sand	0.025	0	0	0	10	2.0	0
7.5	4190.5	4183	Soft Clay (Matlock)	0.025	1.0	0.025	0	20	1.0	0
3	4183	4180	Liquefiable Sand	0.025	0	0	0	10	2.0	0
15	4180	4165	Soft Clay (Matlock)	0.028	2.2	0.02	0	25	2.1	0
21	4165	4144	Soft Clay (Matlock)	0.028	3.5	0.02	0	30	3.5	0
2	4144	4142	Soft Clay (Matlock)	0.030	5.6	0.015	0	50	5.6	31

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 0.072 pci (regular weight) or 0.046 pci (pumice)
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Use Subgrade Modulus k = 90 pci for fill above water table, with Max. Unit Side Resistance of 2 psi.

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.