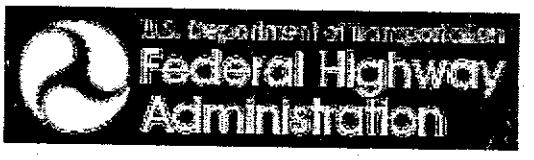
CHESAPEAKE AND OHIO NATIONAL PARK

PAVEMENT REHABILITATION

MONTGOMERY COUNTY, MARYLAND

FINAL
GEOTECHNICAL REPORT

Prepared for



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION -
EASTERN FEDERAL LANDS

Prepared By

URS

URS GROUP, INC.

FEBRUARY 2006

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INTRODUCTION

The project consists of pavement rehabilitation of approximately 1.15 miles of MacArthur Boulevard (extending from Falls Road to the west), rehabilitation of the northern parking area for the Chesapeake and Ohio National Park, the construction of a 4-foot widening along portions of MacArthur Boulevard (to be renamed Great Falls Entrance Road), the removal of the southern parking area, and the construction of a Portland cement concrete (PCC) roadway between traffic circle and the existing PCC boat yard driveway. The project area is defined on **Figure 1** in **Appendix A**.

The purposes of this study are to characterize subsurface conditions and develop recommendations for earthwork, PCC, and bituminous concrete pavements. The field investigation included non-destructive testing to determine material properties of the pavement layers, destructive testing to determine the thickness of each pavement layer, a subsurface investigation to characterize the subgrade and laboratory testing of selected soil samples.

Project Description

Currently, the section of MacArthur Boulevard under investigation consists of two-lane bituminous concrete paved surfaces without paved shoulders. Most, but not all of the project alignment is bordered by drainage ditches. Information regarding the as-built pavement sections was not available for our use.

The park entrance consists of a traffic circle with four access ramps leading to two parking areas. The two-tiered northern parking area sections are vertically offset by approximately 8 to 9 feet and measure about 1,350 feet by 55 feet. A 20-foot wide circular end road and one 20-foot wide ramp connect the sections. The two-tiered southern parking area sections are vertically offset by approximately 5 feet and are connected at the southern end by a 20-foot wide roadway. Within the southern parking area, the western section measures approximately 35 feet wide and 150 feet long and the eastern section measures about 55 feet wide by 175 feet long.

Geologic Setting

The site is located in the Piedmont Plateau physiographic province. Published geologic literature indicates that the site is underlain by two facies of the Wissahickon Formation, Upper Pelitic Schist and Metagraywacke. Upper Pelitic Schist underlies the parking area and the western portion of the roadway. It is comprised of schist with sporadic thin beds of quartzite. Metagraywacke underlies the remainder of the roadway and consists of interbedded metagraywacke and schist.

Site Conditions

Surface materials for the project area consist of thick layers of fill and saprolite, containing clay, silt, sand and angular quartz and rock fragments. Grades within the parking area gradually decrease from north to south, with a high at elevation 187 to a low at elevation 171. Centerline grades along the 1.15-mile section of MacArthur Boulevard gradually decrease from Elevation 388 at its intersection with Falls Road to Elevation 175 at the parking area.

Cut and fill slopes border MacArthur Boulevard, as required to make grade. The parking areas are bordered on the east by up-sloping hillsides of varying gradients, and to the west, the grade decreases to the elevation of the canal, which runs parallel to the parking lots.

PROCEDURE AND RESULTS

Subsurface Investigation

The subsurface investigation consisted of 28 borings drilled to depths ranging from 2.5 to 15 feet. Froehling and Robertson, Inc., performed the borings under the direction of an on-site URS Geotechnical Engineer. The borings were advanced with hollow stem augers and sampling, using a manually operated safety hammer, was conducted on intervals in general conformance with AASHTO T-206 "*Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils.*"

Field logs were prepared by the on-site URS Engineer. The logs include the thickness of the pavement and base material, Standard Penetration Test (SPT) values, sample recovery lengths, visual soil classifications, ground water and cave-in depth information, and an interpretation of the probable subsurface conditions between sampling intervals. At the completion of exploration, selected samples were tested in Froehling and Robertson's laboratory for determination of moisture content, grain-size distribution, Atterberg limits, modified Proctor moisture-density relationship and California Bearing Ratio.

Boring locations and elevations were determined by a URS survey. A boring location plan is included as **Figure 2**, in **Appendix A**, along with the boring logs. The laboratory test results are included in **Appendix B**.

Non-Destructive Testing Investigation

The Non-Destructive Test (NDT) investigation consisted of 56 tests performed in the parking areas and along the roadway by Roy D. McQueen & Associates under the field supervision of a URS Geotechnical Engineer. NDT locations were set at 250-foot intervals for both the parking areas and roadway. Along the roadway, the tests were completed alternating approximately 5 feet on either side of the centerline. Within the parking areas, tests were

completed at the approximate centerline. Non-destructive testing was conducted in general conformance with ASTM D 4695, "Standard Guide for General Pavement Deflection Measurements." All tests were conducted in an impulse mode; i.e., with a Falling Weight Deflectometer (FWD) using a dynamic force targeted at 10,000 pounds.

The purpose of the NDT is to determine the in-situ structural properties of the pavement system, including the surface, base course, and subgrade, for use in the structural analysis and design of the pavement. The dynamic loading system used for the NDT was designed to generate a dynamic load on the pavement surface and simultaneously measure the resultant vertical response of the pavement system. The NDT procedure consists of a weight falling on a load plate placed on the pavement surface and recording the resulting "deflection basin" by measuring the vertical displacement at the center of the machine's loading plate and at 8, 12, 24, 36, 48 and 60-inch distances from the center of the plate.

The deflection basin data, together with thickness data of the various pavement courses, obtained from pavement drilling, is processed, using closed form solutions contained in the AASHTO Design Guide, to determine the elastic moduli (E-value) of the subgrade for bituminous concrete pavements and Modulus of Subgrade Reaction (k) of PCC pavements. The AASHTO closed form solution also resulted in computation of the elastic modulus.

In addition to the deflection basins, the Impulse Stiffness Modulus (ISM) is also determined. The ISM is defined as the dynamic force divided by the pavement deflection at the center of the deflection basin. The ISM is a measure of the overall support condition from all influencing pavement and subgrade layers, and is used to identify limits of zones with similar pavement support. The pavements within each zone are then divided into areas according to pavement type and estimated traffic for structural analysis.

Pavement Condition Survey

In December 2004, a URS team consisting of two engineers conducted a Pavement Condition Survey (PCS) recording the distresses observed on randomly selected sample units over a period of two days. Prior to performing a PCS, the network of pavements must be subdivided into more manageable units. Therefore, the network is divided into branches. Each branch, an easily identifiable portion of the roadway system, that has a distinct function, is then divided into smaller units called sections based upon age, construction history and/or traffic. Each section is then divided into sample units for the performance of the PCS. A sampling plan, based upon a statistical sampling procedure, which reduces the number of sample units to be inspected within a section without a significant loss of accuracy, is used to select the number of sample units required to be inspected. During the inspection, the types of distress, the severity level (low, medium, high), and the density (percentage of the sample unit that each distress type occupies) are recorded on a pavement condition survey sheet. The project network was divided into three branches for the purpose of the investigation. The three branches were defined as such:

- MacArthur Boulevard
- North Parking Area
- South Parking Area, Traffic Circle and Access Ramps

Each branch was subdivided into sample units, approximately 5,000 square feet in area for the parking areas and approximately 4,000 square feet for the roadway. The PCS was performed to:

- determine the type, quantity and severity of the distresses present;
- aid in the assessment of the structural integrity of the pavement section and the operational condition of the pavement surface; and
- aid in the design of the required pavement overlay thickness.

The distresses recorded were those recognized and described in ASTM D 6433-03, "Standard Practice for Roads and Parking Lots." During the inspection, all visible distresses were measured and recorded on Sample Unit Data Sheets, included in **Appendix B**.

The Pavement Condition Index (PCI), as determined from the PCS performed in accordance with ASTM D 6433-03, is calculated from the distresses observed during the pavement inspection. The PCI is a numerical rating ranging from 0, a failed pavement, to 100, a pavement in perfect condition, which is indicative of the operational condition, or serviceability, of the existing pavement based on a visual survey of distress type, quantity and severity. For flexible pavements, 19 distress types, both load related and environmental/climate related, are considered when determining the PCI. Each type of distress reduces the PCI depending upon the quantity and severity of the particular distress. The PCI for each sample unit inspected is then calculated by converting the type quantity and severity of the individual distresses to numerical deduct values, which are weighted and summed. The total sum of deduct values is corrected based upon the number of distresses observed. The corrected deduct value is subtracted from 100 resulting in the PCI for the particular sample unit. The PCI of an entire section is the average of the PCI's for all sample units inspected in that section. Based upon the PCI, a characterization of the pavement condition by a single number ranging from 0 to 100, the Pavement Condition Rating (PCR), a qualitative description of the pavement condition corresponding to a range of PCI's, is assigned to the section.

If maintenance and repair (M&R) is applied to the appropriate distresses during the early stages of deterioration, that is, when the PCI is above the "critical PCI" at which deterioration is believed to accelerate, it is believed that the life expectancy of the pavement can be increased and that repairs are much less costly than if M&R is delayed. The "critical PCI" value is generally considered to be approximately 65.

Subsurface Conditions

The borings indicate that the existing pavement section in the north parking area consists of 4 to 5 inches of bituminous concrete underlain by 1 to 4 inches of granular base. The borings within the remainder of the parking area and traffic circle indicate that the pavement section consists of 1 to 2 inches of bituminous concrete, underlain by 7 to 8 inches of Portland cement concrete, underlain by 3 to 4 inches of granular base. The roadway borings indicate a pavement section consisting of 8 to 10 inches of bituminous concrete, underlain by 2 to 12 inches of granular base. The data is summarized in **Tables 1, 2,** and **3**, below.

TABLE 1

SUMMARY OF BITUMINOUS AND BASE COURSE THICKNESSES FOR NORTH PARKING AREA

Boring Designation	Thickness of Bituminous Pavement (Inches)	Thickness of Aggregate Base (Inches)
P-3	4	2
P-4	4	3
P-5	5	1
P-6	5	4
P-7	5	3
P-8	4	3
P-9	4	3
P-10	4	2

TABLE 2

SUMMARY OF PORTLAND CEMENT, BITUMINOUS AND BASE COURSE THICKNESSES FOR TRAFFIC CIRCLE AND SOUTH PARKING AREA

Boring Designation	Thickness of Bituminous Pavement (Inches)	Thickness of Portland Cement Concrete (Inches)	Thickness of Aggregate Base (Inches)
P-1	2	8	4
P-2	2	7	3
R-1	1	8	3
R-2	2	8	3
R-3	2	8	3

TABLE 3

SUMMARY OF BITUMINOUS AND BASE COURSE THICKNESSES FOR ROADWAY

Boring Designation	Thickness of Bituminous Pavement (Inches)	Thickness of Aggregate Base (Inches)
R-5	9	4
R-6	9	3
R-7	8	12
R-8	8	5
R-10	10	8
R-11	9	2
R-12	10	2
R-13	8	2
R-14	9	2
R-15	8	2

Site grades appear to be mostly in cut below original ground surface. However, fill was identified by the on-site Geotechnical Engineer in five of the 28 borings. The fill thicknesses range from 2.5 feet to 5.5 feet and consist of loose to medium dense, medium to fine-grained silty sand (SM), loose to dense, coarse to fine-grained silty sand (SM), and very stiff

clayey silt with sand (ML). The penetration resistance of the fill ranges from 9 to 30 blows per foot.

The fill is underlain by natural residual soils consisting of very loose to very dense silty sand (SM), medium stiff to hard lean clay with sand (CL) and medium stiff to very stiff sandy silt (ML). Atterberg Limit tests indicate the silt and clay possess slight to medium plasticity (PI = 3 to 16). Moisture contents for the natural soils generally range from 10% to 22%, which is judged to be at or above optimum moisture content for compaction. The penetration resistance of the natural soil ranges from 2 to over 50 blows per foot, but generally varies between 10 and 25 blows per foot.

The nine bulk soil samples were obtained and subject to moisture-density relationship and California Bearing Ratio (CBR) tests. For the CL-ML soils, maximum dry densities range from 117 to 125 pcf, optimum contents range from 10.5 to 13.7 percent, and soaked CBR values range from 3 to 13. For the SM-ML soils, maximum dry densities range from 122 to 137 pcf, optimum moisture contents range from 6.9 to 13.1 percent, and CBR values range from 2 to 15.

The borings were checked for groundwater immediately following the completion of each boring and, where possible, after 24 hours. In general, borings caved in about 3 to 6 feet above bottom depth and were dry.

ANALYSIS

Pavement Rehabilitation

The structural capacity of the existing pavement is estimated by visual survey of pavement distress and NDT, as described in the Pavement Condition Survey section. The structural overlay thickness required is based on the pavement structural deficiency approach, in which the required overlay is the difference between the structural capacity required for future

traffic and the present capacity of the existing pavement. The structural capacity of a pavement, per the *AASHTO Guide for Design of Pavement Structures, 1993*, is expressed in terms of a Structural Number (SN), which is the summation of the product of the layer coefficient and thickness of individual layers for a flexible pavement, and Slab Thickness, D, for rigid pavement. For flexible pavement, the SN is dependent on the level of traffic service, in terms of Total 18-kip Equivalent Single Axle Loads (ESAL), the Effective Roadbed Soil Resilient Modulus, Mr, the tolerable Serviceability Loss, the reliability and the overall standard deviation of the data. For rigid pavement, D is dependent on the level of traffic service, in terms of Total 18-kip Equivalent Single Axle Loads (ESAL), the Effective Modulus of Subgrade Reaction, k, the Modulus of Rupture of concrete, the Load Transfer Coefficient of the joint, the Drainage Coefficient, the tolerable Serviceability Loss, the reliability and the overall standard deviation of the data.

The primary measure of serviceability is the Present Serviceability Index (PSI), which ranges from 0 (impossible road) to 5 (perfect road). The terminal serviceability index (p_t), or the lowest index that will be tolerated before rehabilitation, is 2.0 for roadways with lesser traffic volumes. The difference between the initial serviceability (p_0) and the p_t is the design serviceability loss, which will determine the SN of the pavement section before rehabilitation is required. Composite pavements, consisting of PCC pavement with a bituminous concrete overlay, will be evaluated based on an equivalent slab thickness.

In the overlay design for bituminous concrete pavement, the effective structural number, SN_{eff} of the existing pavement can be determined by pavement thickness, and the effective elastic modulus, Ep, of all pavement layers above the subgrade. The required SN of the pavement is determined by the required future traffic. The required overlay thickness is then computed by dividing the difference in the structural numbers, $SN - SN_{eff}$, by the layer coefficient for new bituminous concrete. In the overlay design for PCC pavement, the effective slab thickness of the existing pavement, D_{eff}, will be compared to the slab thickness D_f, required for future traffic.

DISCUSSION

Pavement Condition

MacArthur Boulevard

The pavement section in this area is 8 to 10 inches of asphalt on 2 to 12 inches of aggregate base. Predominant pavement distresses include low to medium severity of roadway/weathering in general and alligator cracking occurring near the edge or centerline of the roadway. Other distresses include longitudinal and random cracking. The PCI of the samples range from 28 to 73, typically 40 to 55, with an average of 51. The overall rating, PCR, of the pavement section, based on the average PCI, is Poor.

Traffic Circle and Connector to the Northern Parking Lots

The pavement section in this area is a composite of bituminous concrete overlay on existing PCC pavement. Predominant pavement distresses include medium to high severity joint reflection cracking. Other distresses include low to medium severity block cracking, longitudinal, and transverse cracking. The PCI of the samples range from 47 to 67, with an average of 55. The overall rating, PCR, of the pavement section, based on the average PCI, is Poor.

Northern Parking Lot

The pavement section in this area is 4 to 5 inches of asphalt on 1 to 4 inches of aggregate base. Predominant pavement distresses include low to high severity raveling/weathering and block cracking. Other distresses include longitudinal, transverse, and random cracking. The PCI of the samples range from 13 to 81, typically 50 to 70, with an average of 56. The overall rating, PCR, of the pavement section, based on the average PCI, is Fair.

The overall condition rating of the pavement sections is poor to fair, and the overall average PCI of the pavement sections are 51 to 56, all below the "critical" PCI of 65, indicative of the need for rehabilitation. The predominant distresses, such as raveling, block cracking, and transverse cracking are weather and age related, the structural integrity of most of the pavement section appears to be adequate. In these areas, removing the surficial layers and replacing with bituminous concrete, sufficient to accommodate future traffic, should be satisfactory. Distresses that are load related, such as alligator cracking (also known as fatigue cracking), usually indicate the structural failure of the pavement. In these areas full depth reconstruction or repaving of the area may be required, as described herein.

Traffic Data for Pavement Design

Obtaining traffic data, by a traffic count survey, is not in the scope of work. The assumed traffic, equating to an average daily traffic (ADT) of 153, is as follows:

TABLE 4

ASSUMED TRAFFIC

Vehicle	Type of Axle	Load, lbs.	Movement Frequency of Vehicle	Movement/ Repetitions per Year
Passenger Car	Front - Single	2,000 or less	150/Day	54,750
	Rear - Single	2,000 or less		
Light Truck	Front - Single	8,000	10/Week	520
	Rear - Single	24,000		
Bus (Tour)	Front - Single	10,000	About 4/Day for 4 Months, Then 2/Month	500
	Rear - Single	20,000		
Heavy Maintenance Truck (Snow Plow)	Front - Single	21,000	10/Year, 5 Repetitions Each Operation	50
	Rear - Single	23,000		
Heavy Maintenance Truck (Fire Truck)	Front - Single	17,000	Less Than Once a Month	10
	Rear - Tandem	17,000		
Tractor Trailer	Front - Single	6,000	1 Per Week	50
	Mid - Tandem	24,000		
	Rear - Tandem	24,000		
TOTAL				55,800

Subgrade Evaluation

The structural capacity of the pavement section is evaluated based on NDT, as described previously. The reduced data developed by Roy McQueen and Associates based upon DARWIN Version 2.0 are included in Appendix C. The strength of the subgrade is defined in terms of subgrade resilient modulus, Mr. The Mr, determined by NDT, ranges from 2,764 to 3,166 psi. The modulus of subgrade reaction, k, used in the evaluation of the PCC pavement in the vicinity of the traffic circle, is estimated to be 82 pci by NDT. The strength of the subgrade is also evaluated by the laboratory CBR test, which can be empirically correlated with Mr and k values. Laboratory CBR test results range from 2 to 15, typically 3 to 5. In general, the strength of the subgrade from the NDT and laboratory CBR's appear to be comparable. In comparison of CBR and NDT derived data, we have deferred to the NDT measurements for design based upon the larger data set, as well as the more direct back-calculation of field conditions afforded by the NDT.

Pavement Distresses

The visual pavement condition survey revealed a general absence of routine maintenance, such as crack sealing or surface treatment. Weathering and raveling of the bituminous concrete pavement surface is common. Predominant distresses include block cracking, which is weather related, and alligator cracking, which commonly is considered load related. Alligator cracking along the edge of the roadway pavement was noted. This is probably due to the absence of pavement shoulders, which would provide lateral constraint of the pavement.

Reflection cracks, as observed in the bituminous concrete overlay, occur as the underlying PCC pavement expands and contracts along the joints. To reduce the risk of recurrence, the slab action of the underlying PCC pavement can be minimized by a "crack and seat" procedure, in which the slab is broken into roughly square pieces, approximately 24 to 42 inches in size, by fracturing equipment. Reflection cracking can be effectively eliminated by rubbilizing the PCC to 12 or less pieces. Milling of the existing asphalt surface prior to the crack

and seat or rubbilization procedure is required. Since the integrity of underlying PCC is destroyed by this procedure, thicker asphalt overlay will be required. For example, a 3-inch asphalt overlay will be required for the crack and seat, and 4-inch asphalt overlay will be required for the rubbilization compared to the 2-inch asphalt overlay required for the existing underlying PCC pavement, without the crack and seat or rubbilization. In view of the relatively small area of PCC pavement, the crack and seat procedure, or rubbilization, is not considered cost effective. An alternative is to seal the reflection cracks as they occur and maintain the sealant program to prevent water and debris from entering the pavement structure. An alternate on the assumption that routine maintenance will not be scheduled on regular seasonal intervals, is to cut the new bituminous concrete overlay along the underlying PCC pavement joints, and seal with sealant. This latter alternate, which reduces the required frequency of maintenance, is preferred based upon our observations.

Drainage

In view of the preponderance of thin, 2 to 3-inch thick, aggregate base below the pavement, (8 of 10 Parking lot, P-series borings, and 9 of 15 Roadway, R-series borings, see **Tables 1** to **3**), a subdrain system to convey trapped water within the pavement base is recommended, as discussed herein.

Repair of Existing Pavement Distresses Before Overlay

Because of pavement distress and deterioration, due mainly to weathering, it is recommended that the top 2 inches of the bituminous concrete surface in the entire roadway and parking lot areas, be removed before installing the overlay. Additional milling or full depth bituminous concrete surface removal may be required after revealing the condition of the remaining underlying pavement. This would primarily be due to remaining evidence of subgrade failure, such as alligator cracking. We have estimated the limits of a major area of full-depth removal on **Figure 2** in **Appendix A**, but smaller isolated areas will be encountered throughout, as referenced in the pavement condition survey in **Appendix B**. Within milled areas where full-

depth replacement is not warranted, isolated remaining cracks wider than 1/4-inch should be sealed before the overlay.

COMMENTS AND RECOMMENDATIONS

Earthwork and Subgrade Preparation

All existing paving materials and utilities should be removed from areas that require a full depth repair or shoulder additions. Any unpaved areas should likewise be stripped of vegetation, topsoil and any other organic or deleterious materials. Thereafter, exposed soil surfaces should be proofrolled with a loaded, tandem-axle dump truck to 18 tons, or similar heavily loaded rubber tired equipment to 15 tons to detect any soft, yielding or unstable areas. Areas of visible weakness should be undercut and replaced with engineered fill, under moisture-density control, as per Section 204 of the *"Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects"* (FP-03).

Based upon conditions revealed in the upper 2 to 4 feet of the profile, we anticipate subgrade repairs for pavements will be of minor extent and volume. Nevertheless, where conditions require repair, the depth of undercut below plan finish subgrade should be limited to 2 feet. If unsuitable conditions extend deeper than 2 feet, the exposed surface should be stabilized by scarification and recompaction or placement of a layer of woven geotextile over the excavated surface and backfilling with Base (C) Course Aggregate as defined in FP-03, Section 703.05. Specifically, when aggregates are placed as fill they should be compacted to the moisture -density standards stated previously.

The fill should be constructed of suitable soils, meeting the requirements for select borrow material as stated in FP-03, Section 704.7. Specifically, the fill should be constructed of granular soils, placed and compacted in lifts, with a maximum loose lift thickness of 8 inches. General fill construction shall be in accordance with Section 204 of FP-03. Cut and fill slopes shall be no steeper than 2H:1V. Toe drains and swales at the edge of the roadway along MacArthur Boulevard are also recommended.

Pavement Construction

Repair gutter and other drainage facilities before repaving.

Existing Pavement

For MacArthur Boulevard and the parking lot areas, mill off the top 2 inches of bituminous concrete pavement and identify areas that require full depth repair in addition to the area identified on **Figure 2** in **Appendix A** and areas with alligator cracking on MacArthur Boulevard. Remaining isolated cracks wider than 1/4-inch should be cleaned and sealed before installing the overlay. Thickness of the bituminous concrete overlay or full depth replacement should be such that the final grade will be 2 inches above the original pre-milled surface, i.e., mill 2 inches, replace with 4 inches. The new bituminous concrete shall be superpave performance grade PG 70-22, placed in two 2-inch lifts.

For the traffic circle and connector to the parking lot areas, mill out 2 inches of the existing bituminous concrete overlay and PCC. Clean and repair any remaining cracks wider than 1/4-inch or perform a full depth replacement with bituminous material, if necessary, before replacing with 2 inches of new bituminous concrete overlay. Cut the new overlay along the existing PCC pavement joints and seal with bituminous sealant material.

Proposed Widening of MacArthur Boulevard

In areas where the roadway is widened, bituminous concrete pavement of 11 inches with 8 inches of aggregate base is recommended. Geotextile, Type II-A non-woven per Section 714, FP-03 is recommended between the aggregate base and subgrade to accommodate the variably silty and clayey subgrade conditions that will be more highly susceptible to frost action.

Portland Cement Concrete Roadway for Proposed Boat Launching Ramp

New concrete pavements shall be 8-inch PCC on 8-inch of aggregate base to accommodate boat launching trailer and vehicles, as well as construction and other truck activities.

Proposed Bus Circle/Stand

New pavement for the bus circle/stand shall be 6 inches bituminous concrete on 8 inches of aggregate base. Geotextiles Type IIA, non-woven per Section 714, FP-03 is recommended between the aggregate base and subgrade to minimize migration of the silty and clayey subgrade fines into the aggregate base.

Subdrain and Shoulder Section for Roadway Pavement

In view of the thin subbase course underneath the bituminous concrete pavement, a subdrain system installed along the lower edge of the pavement roadway section to drain water from the pavement base is recommended. Pavement shoulders are also recommended, along the edge of the roadway section, to enhance the lateral constraint, and thus strengthen the pavement and facilitate drainage path.

Construction Monitoring

The earthwork and subgrade preparation at this site should be continuously monitored by knowledgeable testing personnel responsible to the owner. In view of the marginal soil conditions available for support, it would be desirable to schedule construction activities during the hot, dry summer months.

APPENDIX A

SITE LOCATION

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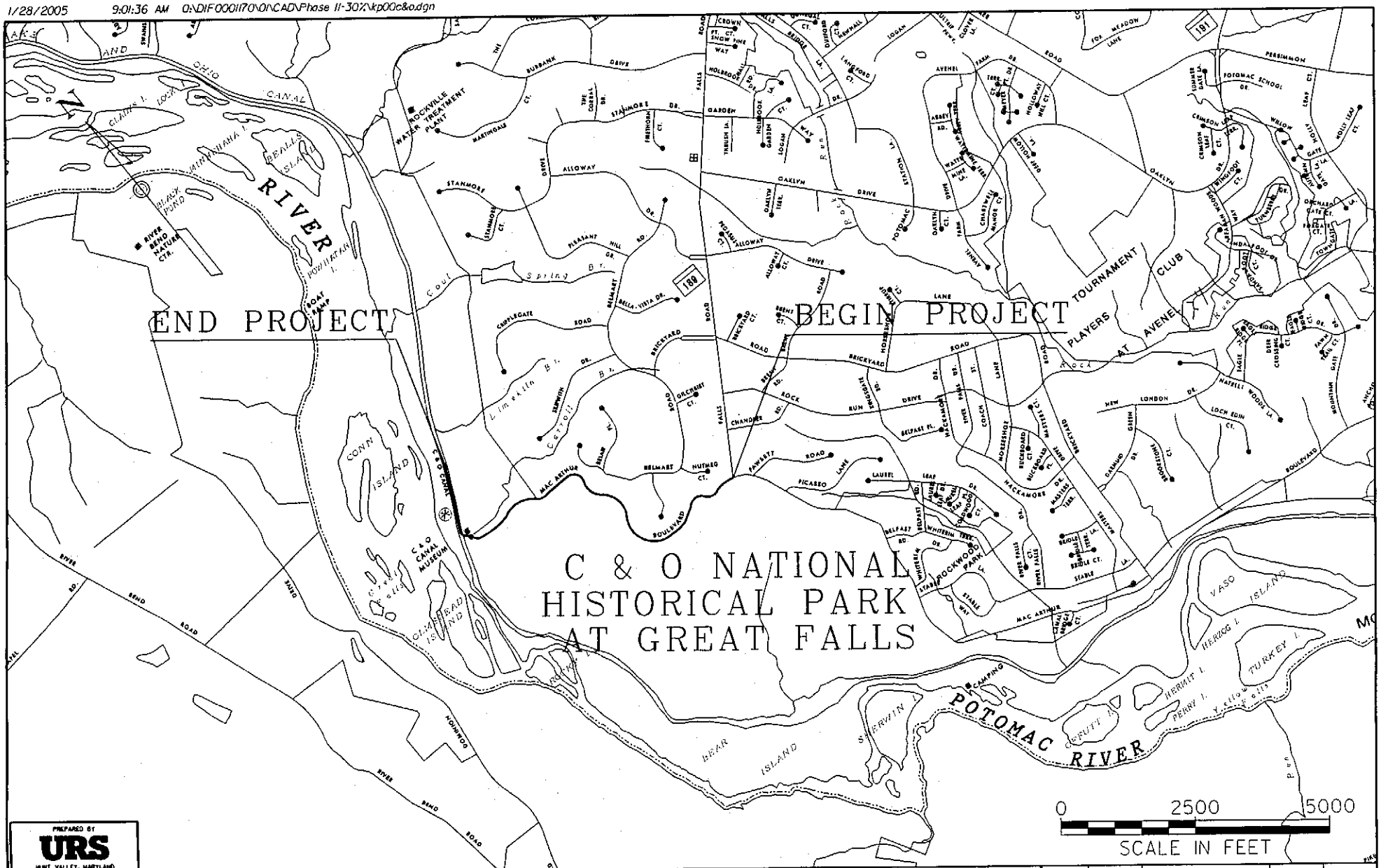

PREPARED BY URS HUNT VALLEY, MARYLAND

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EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

LOCATION MAP

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
NCR	MD	PRA-CHOH 102 (1)	1	3

NPS NO.	REG	STATE	PROJECT	SHEET NO.
———	NC	MD	PRA-CHOH 102 (1)	

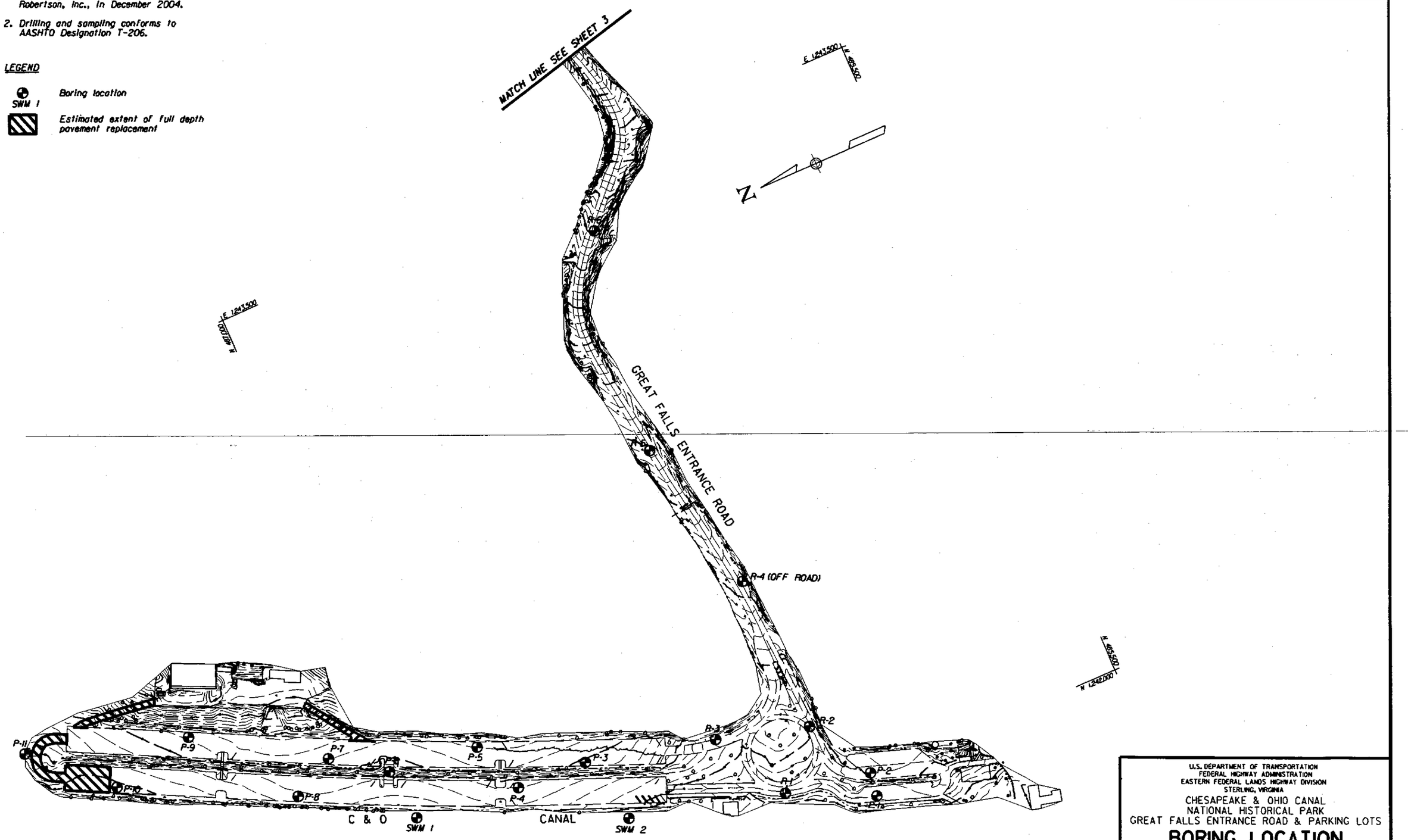
NOTES:

1. All borings drilled by Froehling & Robertson, Inc., in December 2004.
2. Drilling and sampling conforms to AASHTO Designation T-206.

LEGEND

SWM 1 — Boring location

Estimated extent of full depth pavement replacement



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STERLING, VIRGINIA

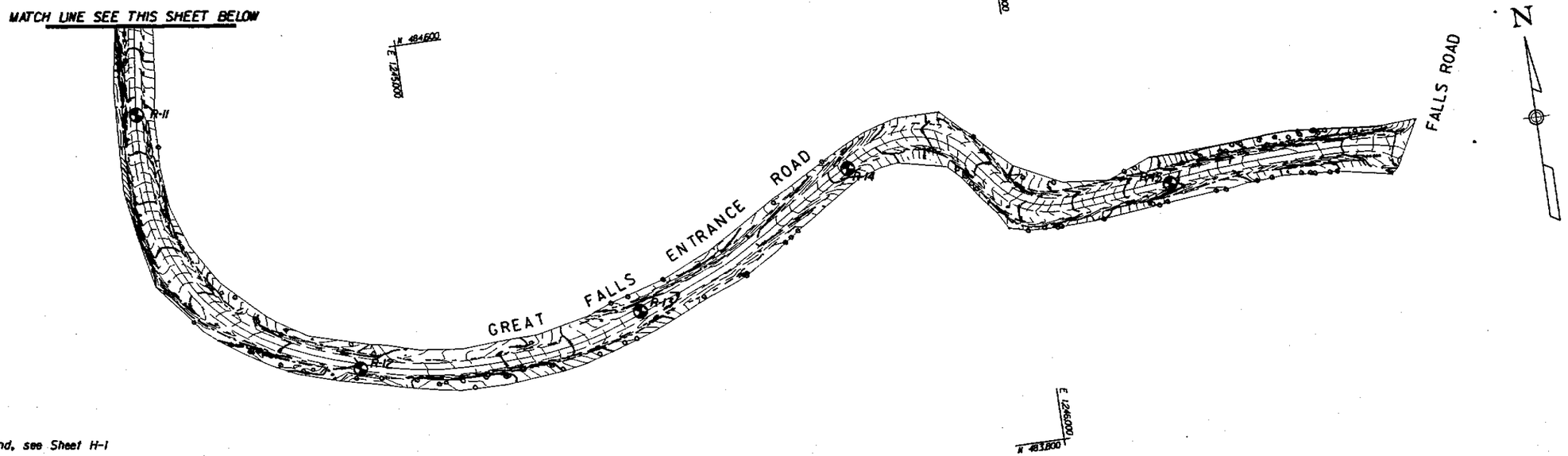
CHESAPEAKE & OHIO CANAL
NATIONAL HISTORICAL PARK
GREAT FALLS ENTRANCE ROAD & PARKING LOTS

BORING LOCATION PLAN

0 100 200
SCALE IN FEET

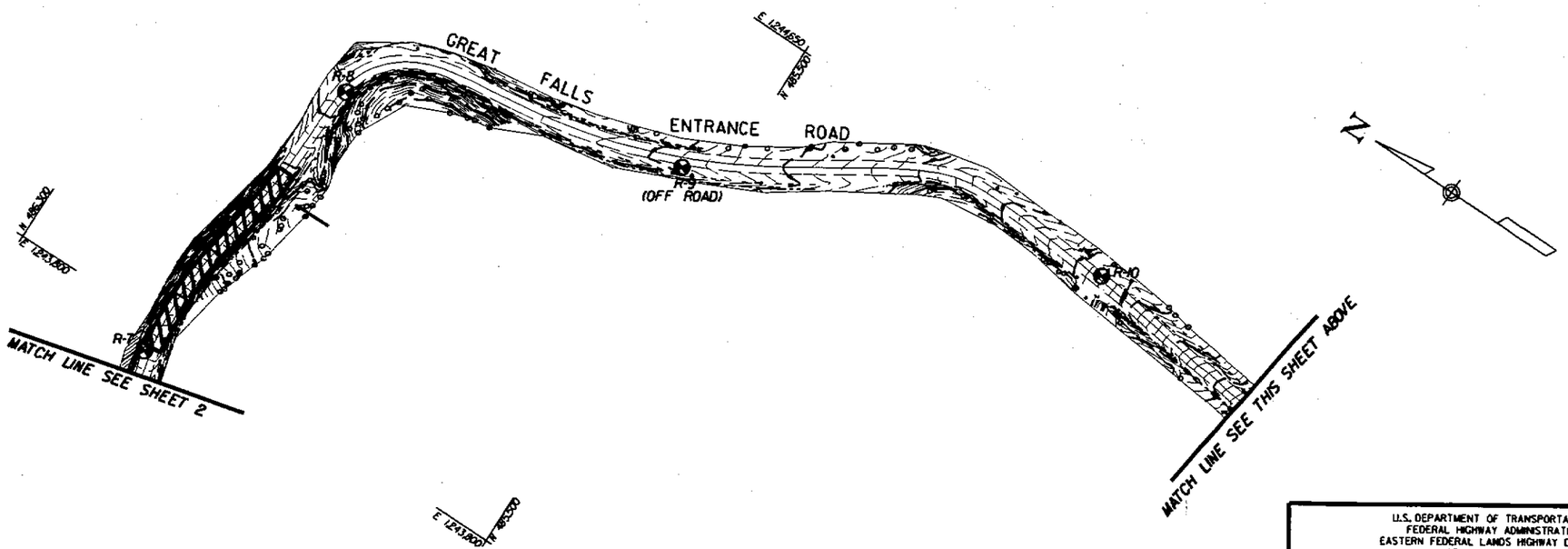
2/9/2006 2:45:07 PM G:\NJF\000117\DGN\CAD\Plans\sb02c&d.dgn

NPS NO.	REG	STATE	PROJECT	SHEET NO.
412 / 41911	NCR	MD	PRA-CHOH 102 (1)	



Note:

For Notes and legend, see Sheet H-1



Note:

For Notes and legend, see Sheet H-1

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STERLING, VIRGINIA

CHESAPEAKE & OHIO CANAL
NATIONAL HISTORICAL PARK
GREAT FALLS ENTRANCE ROAD & PARKING LOTS

BORING LOCATION PLAN

0 100 200
SCALE IN FEET

APPENDIX B

TEST DATA

Project Name: Chesapeake and Ohio National Park			Borehole No.: P-1
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/21/04	Date Completed: 12/21/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 171.3	Sheet 1 of 1
North: 486099	East: 1241958	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					2" Bituminous Concrete 8" Portland Cement Concrete 4" Gravel Base		CONC	
	1	8-5-8	12"	X	1.2			
					Brown, moist, mf SAND, some Clayey Silt		SM	
	2	9-16-20	4"	X				
5					5.5			
	3	4-10-14	18"	X	Tan and gray, moist, mf SAND, some Clayey Silt		SM	
	4	7-18-23	12"	X	10			Boring caved at 6.5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: P-2
Project Number: 20827492.00000	Location: Montgomery County, Maryland	
Date Started: 12/21/04	Date Completed: 12/21/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.	Elevation: 175.3	Sheet 1 of 1
North: 486092	East: 1242010	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					2" Bituminous Concrete 7" Portland Cement Concrete 3" Gravel Base		CONC	
	1	13-11-7	1"	X				
	2	4-7-8	12"	X	Brown, moist, mf SAND, some Clayey Silt		SM	
5								
	3	6-16-50/4"	16"	X				Auger refusal at 7.6'
					7.6			
10								Boring caved at 5' at completion Dry at completion
15								
20								

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Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: P-3
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 184.8	Sheet 1 of 1
North: 486662	East: 1242285	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.5 4" Bituminous Concrete 2" Gravel Base		ASPH	
	1	10-11-12	8"	X	Reddish brown, moist, mf SAND, some Silt		SM	
	2	5-8-9	6"	X				
5					5.5			
	3	4-8-10	18"	X	Reddish brown, moist, Silty CLAY with mf Sand		CL	
	4	5-10-12	18"	X	10			Boring caved at 5.7' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: P-4
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 178.9	Sheet 1 of 1
North: 486822	East: 1242291	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.6 4" Bituminous Concrete 3" Gravel Base		ASPH	
	1	13-8-5	12"	X	Gray, moist, CLAY and SILT, little mf Sand, trace Gravel		CL-ML	
					2.5			
	2	8-15-26	12"	X				
5					Tan and red-brown, moist, mf SAND, some Clayey Silt		SM	
	3	12-9-16	12"	X				
	4	50/5"	5"	X	8.9			Boring caved at 5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: P-5
Project Number: 20827492.00000	Location: Montgomery County, Maryland	
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.	Elevation: 187.0	Sheet 1 of 1
North: 486869	East: 1242411	Station: Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.5 5" Bituminous Concrete 1" Gravel Base		ASPH	
	1	10-23-12	1"	X	Tan, moist, GRAVEL, little cf Sand, little Silt		GM	
					2			
	2	8-11-14	18"	X	Reddish brown, moist, Silty CLAY, some mf Sand		CL	
5								
	3	5-7-10	8"	X				
					8			
	4	6-11-13	18"	X	Reddish brown, moist, mf SAND, some Clayey Silt		SM	
10					10			Boring caved at 4.7' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: P-6
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 182.0 / Sheet 1 of 1
North: 487067	East: 1242441	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.8 5" Bituminous Concrete 4" Gravel Base		ASPH	
	1	7-14-11	10"		2 Tan, moist, Silty CLAY, some cf Sand, little Gravel		CL	
	2	8-11-13	16"		Red-brown, moist, Silty CLAY with mf Sand		CL	Auger refusal at 6.0'
5					6			Boring caved at 4' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: P-7
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 186.3	Sheet 1 of 1
North: 487180	East: 1242521	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.7 5" Bituminous Concrete 3" Gravel Base		ASPH	
	1	3-4-4	8"	X	Tan, moist, Silty CLAY with mf Sand		CL	
					2.5			
	2	5-5-7	14"	X	Red-brown, moist, Silty CLAY with mf Sand		CL	
5					5.5			
	3	6-7-8	16"	X				
					Red-brown, moist, mf SAND with Clayey Silt		SM	
	4	9-11-16	12"	X				
10					10			Boring caved at 5' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: P-8
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 177.9	Sheet 1 of 1
North: 487274	East: 1242472	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.6 4" Bituminous Concrete 3" Gravel Base		ASPH	
	1	4-7-8	12"	X	Brown, moist, Clayey SILT, some Sand, little Gravel (Fill)		ML	
					2.5			
	2	3-3-4	14"	X				
5					Red-brown and tan, moist, Silty CLAY, some Sand		CL	
	3	3-5-7	14"	X				
					8			
	4	10-18-24	18"	X	Tan, moist, mf SAND with Clayey Silt		SM	
10					10			Boring caved at 6' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: P-9
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 186.3	Sheet 1 of 1
North: 487446	East: 1242689	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.6 4" Bituminous Concrete 3" Gravel Base		ASPH	
	1	3-6-10	18"	X	Reddish tan, moist, Silty CLAY, little mf Sand		CL	
	2	6-9-11	16"	X				
5					5.5			
	3	3-6-12	14"	X	Tan, moist, Silty CLAY, some f Sand		CL	
					8			
	4	16-50/5"	11"	X	Tan, moist, mf SAND, some Clayey Silt		SM	
					9.4			Boring caved at 7' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: P-10
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 174.8 / Sheet 1 of 1
North: 487636	East: 1242652	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.5 4" Bituminous Concrete 2" Gravel Base		ASPH	
	1	8-6-10	8"	X	Tan, moist, mf SAND, little Silt (Fill) 2.5		SM	
	2	4-7-5	12"	X	Gray, moist, Clayey SILT, some f Sand 5.5		ML	
5	3	3-5-9	10"	X	Brown-tan, moist, mf SAND, some Silt, little Gravel 8		SM	
	4	15-21-50/3"	10"	X	Gray and tan, moist, micaceous, mf SAND, some Clayey Silt 9.7		SM	
10								Boring caved at 6.5' at completion Dry at completion
15								
20								

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Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: P-11
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/16/04	Date Completed: 12/16/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 178.7 / Sheet 1 of 1
North: 487796	East: 1242801	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
	1	3-6-6	6"	X	0.3 4" Topsoil		TOPS	
					Tan, moist, mf SAND, some Clayey Silt		SM	
					2			
	2	4-6-5	16"	X	Tan and brown, moist, Clayey SILT with mf Sand		ML	
5					5.5			
	3	8-12-44	10"	X	Tan, moist, micaceous, mf SAND, some Clayey Silt		SM	Auger refusal at 8.5'
					8.5			Boring caved at 6.6' at completion Dry at completion
10								
15								
20								

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Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: R-1
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/20/04	Date Completed: 12/20/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 172.6	Sheet 1 of 1
North: 486283	East: 1242044	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					1" Bituminous Concrete 8" Portland Cement Concrete 3" Gravel Base		CONC	
	1	2-9-9	10"	X	Brown, moist, Clayey SILT, some mf Sand, trace Gravel (Fill)		ML	
					3.5			
	2	5-11-6	14"	X				
5								
	3	2-5-6	3"	X	Gray, moist, micaceous, mf SAND, some Silt		SM	
	4	2-15-50/4"	8"	X				
					9.8			
10								Boring caved at 7' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-2	
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/20/04	Date Completed: 12/20/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 175.4	Sheet 1 of 1
North: 486174	East: 1242158	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					2" Bituminous Concrete 8" Portland Cement Concrete 3" Gravel Base		CONC	
					1.1			
	1	7-6-3	6"	X	Brown, moist, cf SAND, some Silt (Fill)		SM	
					3			
	2	3-10-18	12"	X	Tan, moist, mf SAND, some Clayey Silt		SM	
5					5.5			
	3	4-12-50/4"	6"	X	Orange-tan, moist, cf SAND, some Silt, trace Gravel		SM	
	4	50/3"	3"	X	8.8			Boring caved at 6' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-3	
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/21/04	Date Completed: 12/21/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 175.8	Sheet 1 of 1
North: 486377	East: 1242214	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					2" Bituminous Concrete 8" Portland Cement Concrete 3" Gravel Base		CONC	
	1	8-9-6	6"		1.1 Orange-tan, moist, mf SAND with Clayey Silt		SM	
					3			
	2	30-50/5"	5"		Brown, moist, mf SAND, little Silt, little Gravel		SM	Auger refusal at 5.5' Boring caved at 5.5' at completion Dry at completion
5					5.5			
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: R-4
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 185.5	Sheet 1 of 1
North: 486180	East: 1242510	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
	1	5-7-5	10"	X	0.4 5" Topsoil		TOPS	
					Brown, moist, mf SAND, some Silt		SM	
					2			
	2	10-26-25	12"	X	Tan, moist, micaceous, mf SAND, some Silt		SM	
5								
	3	13-15-12	14"	X				Auger refusal at 7.6'
					7.6			Boring caved at 5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-5
Project Number: 20827492.00000	Location: Montgomery County, Maryland	
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.	Elevation: 194.6	Sheet 1 of 1
North: 486252	East: 1242858	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					9" Bituminous Concrete 4" Gravel Base 1.1		ASPH	
	1	20-9-7	8"	X	Tan, moist, Clayey SILT, some mf Sand, trace Gravel		ML	
	2	8-7-8	12"	X				
5					5.5			
	3	3-4-4	12"	X	Orange-tan, moist, micaceous, mf SAND, some Clayey Silt		SM	
					8			
	4	12-12-12	8"	X	Tan, moist, micaceous, mf SAND, some Clayey Silt		SM	
10					10			Boring caved at 5.5' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: R-6
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 220.4	Sheet 1 of 1
North: 486164	East: 1243349	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					9" Bituminous Concrete 3" Gravel Base		ASPH	
	1	10-6-6	5"	X				
	2	6-4-3	7"	X				
5					Orange-tan, moist, micaceous, mf SAND, some Silt		SM	
	3	1-1-1	7"	X				
	4	2-2-2	10"	X				
10								Boring caved at 6' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park			Borehole No.: R-7
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 249.5	Sheet 1 of 1
North: 486063	East: 1243757	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					8" Bituminous Concrete 12" Gravel Base		ASPH	Auger refusal at 2.5'
	1	18-32-40	10"		1.7 2.5 Brown, moist, mf SAND, some Clayey Silt		SM	Boring caved at 2' at completion Dry at completion
5								
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-8
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 276.7 / Sheet 1 of 1
North: 486025	East: 1244232	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					8" Bituminous Concrete 5" Gravel Base 1.1		ASPH	
	1	18-18-50/0"	7"	X	Orange-tan, moist, mf SAND, some Clayey Silt, little Gravel 3		SM	
	2	19-50/5"	8"	X	Tan, moist, mf SAND, little Silt 5.5		SM	
5	3	50/5"	5"	X	Tan, moist, mf SAND, little Silt, little Gravel		SM	
	4	19-50/4"	10"	X	9.3			Boring caved at 5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-9
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 280.4 / Sheet 1 of 1
North: 485559	East: 1244410	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
	1	5-7-8	12"	X	0.4 5" Topsoil		TOPS	
					Orange-tan, moist, mf SAND, little Silt		SM	
					2			
	2	3-10-12	16"	X	Orange-tan, moist, micaceous, mf SAND with Clayey Silt		SM	
5								
	3	8-12-12	0"	X	7			
					Orange-tan, moist, micaceous, mf SAND, little Silt		SM	
	4	6-6-7	14"	X	10			Boring caved at 5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: SWM-1
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 177 / Sheet 1 of 1
North: 487054	East: 1242323	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
	1	1-1-5	10"	X	0.4 5" Topsoil		TOPS	
	2	4-4-4	8"	X				
5								
	3	7-10-11	6"	X	Tan, moist, Silty CLAY, some mf Sand		CL	
	4	9-13-13	16"	X				
10					12			
					Gray and tan, moist, micaceous, mf SAND, some Silt, little Gravel		SM	
	5	21-34-50/2"	7"	X	14.7			Boring caved at 8.5' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: SWM-2
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 173.2 / Sheet 1 of 1
North: 486623	East: 1242134	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
	1	2-5-9	10"	X	0.5 6" Topsoil		TOPS	
					Tan, moist, mf SAND, some Clayey Silt, some Gravel (Fill)		SM	
	2	5-5-9	0"	X	4			
5								
	3	2-4-9	16"	X	Tan, moist, Silty CLAY, little mf Sand, trace Gravel		CL	
	4	9-15-20	18"	X	10			Boring caved at 5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-10
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 301.8 / Sheet 1 of 1
North: 484962	East: 1244617	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					10" Bituminous Concrete 8" Gravel Base		ASPH	
	1	22-28-8	10"	X	1.5			
					Orange-tan, moist, Clayey SILT, some mf Sand, trace Gravel		MH	
	2	5-6-5	8"	X				
5					5.5			
	3	3-3-3	12"	X	Orange-tan, moist, mf SAND, Some Clayey Silt		SM	
					8			
	4	2-3-3	18"	X	Orange-tan, moist, Clayey SILT with f Sand		ML	
10					10			Boring caved at 7' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-11
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/17/04	Date Completed: 12/17/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 326.5 / Sheet 1 of 1
North: 484547	East: 1244559	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.9 9" Bituminous Concrete 2" Gravel Base		ASPH	
	1	5-10-11	12"	X				
	2	12-12-11	12"	X				
5					Orange-tan, moist, mf SAND, some Clayey Silt, trace Gravel		SM	
	3	14-17-17	10"	X				
	4	11-21-26	14"	X				
10					10			Boring caved at 5' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-12
Project Number: 20827492.00000	Location: Montgomery County, Maryland	
Date Started: 12/20/04	Date Completed: 12/20/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.	Elevation: 349.8	Sheet 1 of 1
North: 484079	East: 1244864	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					10" Bituminous Concrete		ASPH	
					1 — 2" Gravel Base			
	1	4-5-4	1"	X				
	2	11-12-22	10"	X	Reddish tan and tan, moist, mf SAND, with Clayey Silt, trace Gravel		SM	
5								
	3	6-7-8	12"	X				
					8			
	4	20-15-6	12"	X	Tan, moist, cf SAND, some Silt, little Gravel		SM	
10					10			Boring caved at 6.5' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-13
Project Number: 20827492.00000	Location: Montgomery County, Maryland	
Date Started: 12/20/04	Date Completed: 12/20/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.	Elevation: 336.1	Sheet 1 of 1
North: 484108	East: 1245335	Station: Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.8 8" Bituminous Concrete 2" Gravel Base		ASPH	
	1	4-16-24	8"	X	Tan, moist, cf SAND, some Gravel, some Silt (Fill)		SM	
	2	14-8-6	8"	X				
5					5.5			
	3	3-4-6	10"	X	Reddish tan, moist, mf SAND, some Clayey Silt		SM	
	4	6-6-9	14"	X	10			Boring caved at 5.5' at completion Dry at completion
10								
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-14	
Project Number: 20827492.00000		Location: Montgomery County, Maryland	
Date Started: 12/20/04	Date Completed: 12/20/04	Driller: James McCabe	
Drilling Company: Froehling and Robertson, Inc.		Elevation: 341.5	Sheet 1 of 1
North: 484294	East: 1245711	Station:	Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.9 9" Bituminous Concrete 2" Gravel Base		ASPH	
	1	4-3-4	10"	X				
	2	2-4-5	12"	X				
5					Reddish tan, moist mf SAND with Clayey Silt		SM	
	3	4-5-6	16"	X				
	4	3-6-8	18"	X				
10					10			Boring caved at 6' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Project Name: Chesapeake and Ohio National Park		Borehole No.: R-15
Project Number: 20827492.00000		Location: Montgomery County, Maryland
Date Started: 12/20/04	Date Completed: 12/20/04	Driller: James McCabe
Drilling Company: Froehling and Robertson, Inc.		Elevation: 374.2 / Sheet 1 of 1
North: 484195	East: 1246238	Station: / Offset:

Depth:	Sample No.	Blow Count:	Recovery:	Sampled:	Description:	Graphic Log:	USCS:	Remarks:
					0.8 8" Bituminous Concrete 2" Gravel Base		ASPH	
	1	15-14-15	10"	X				
	2	12-10-10	0"	X				
5					Tan, moist, mf SAND, with Silt		SM	
	3	4-5-6	8"	X				
	4	8-8-9	1"	X	10			
10								Boring caved at 5.5' at completion Dry at completion
15								
20								

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Inspected By: Jason Kotova

Signature:

Laboratory Test Summary Sheet

Boring/ Sample No.	Depth	LL	PL	PI	% Natural Moisture	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
P- 1	2.0				15.6								
P- 2	4.0				20.9								
P- 3	1.0				15.9								
P- 3	9.0	31	21	10	19.5								
P- 4	1.0	29	22	7	23.6	1.8	17.0	81.3	CL-ML	A-4			
P- 4	4.0				14.5								
P- 5	4.0	35	21	15	19.7								
P- 5 Bulk	2.5				18.7	0.6	23.6	75.8			121.9	12.2	13.0
P- 6	4.0	32	19	13	17.9								
P- 7	4.0	37	22	15	8.9								
P- 8	4.0	34	18	16	22.1								
P- 8 Bulk	2.5				20.4	6.1	21.3	72.6			118.2	12.6	6.0
P- 9	1.0	36	22	14	20.5								
P- 9 Bulk	2.5				21.2	1.0	19.9	79.1			116.6	13.7	12.5
P-10	4.0	30	27	3	35.5								
P-11	4.0	39	27	13	19.8								
R- 1	4.0				18.5								
R- 1 Bulk	2.5				18.2	3.1	32.7	64.2			124.5	10.5	
R- 2	4.0				15.2								
R- 3	2.0				19.5								
R- 4	4.0				12.7								
R- 5	1.0				14.9								
R- 5	7.0				34.1								

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Lab Test Summary — Sheet 1 of 2

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

LAB SUMMARY F68-152D.GPJ F&R.GDT 1/18/05

Laboratory Test Summary Sheet

Boring/ Sample No.	Depth	LL	PL	PI	% Natural Moisture	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
R- 5 Bulk	2.5				21.6	3.7	32.6	63.8			117.4	11.6	3.1
R- 6	4.0				14.4								
R- 7	1.0				3.6								
R- 8	1.0				8.3								
R- 8 Bulk	2.5				5.8	11.1	58.3	30.6			137.4	6.9	15.0
R- 9	4.0				11.8								
R-10	1.0				3.5								
R-10	9.0	55	51	4									
R-10 Bulk	2.5				18.7	6.1	42.2	51.7			121.9	13.1	4.6
R-11	1.0				10.0	4.0	62.1	33.9					
R-11	9.0				13.1								
R-12	7.0				10.4								
R-12 Bulk	2.5				12.0	2.4	49.0	48.6			127.9	9.5	3.3
R-13	2.0				11.6								
R-14	7.0				34.8								
R-15	2.0				8.6								
R-15 Bulk	2.5				11.0	6.4	47.9	45.7			122.5	9.8	1.8
SWM-1	9.0				20.4	0.0	22.9	77.1					
SWM-1	14.0				10.3	11.1	63.5	25.4					
SWM-2	1.0				16.3	25.9	43.4	30.7					
SWM-2	7.0				21.6	2.8	20.6	76.7					

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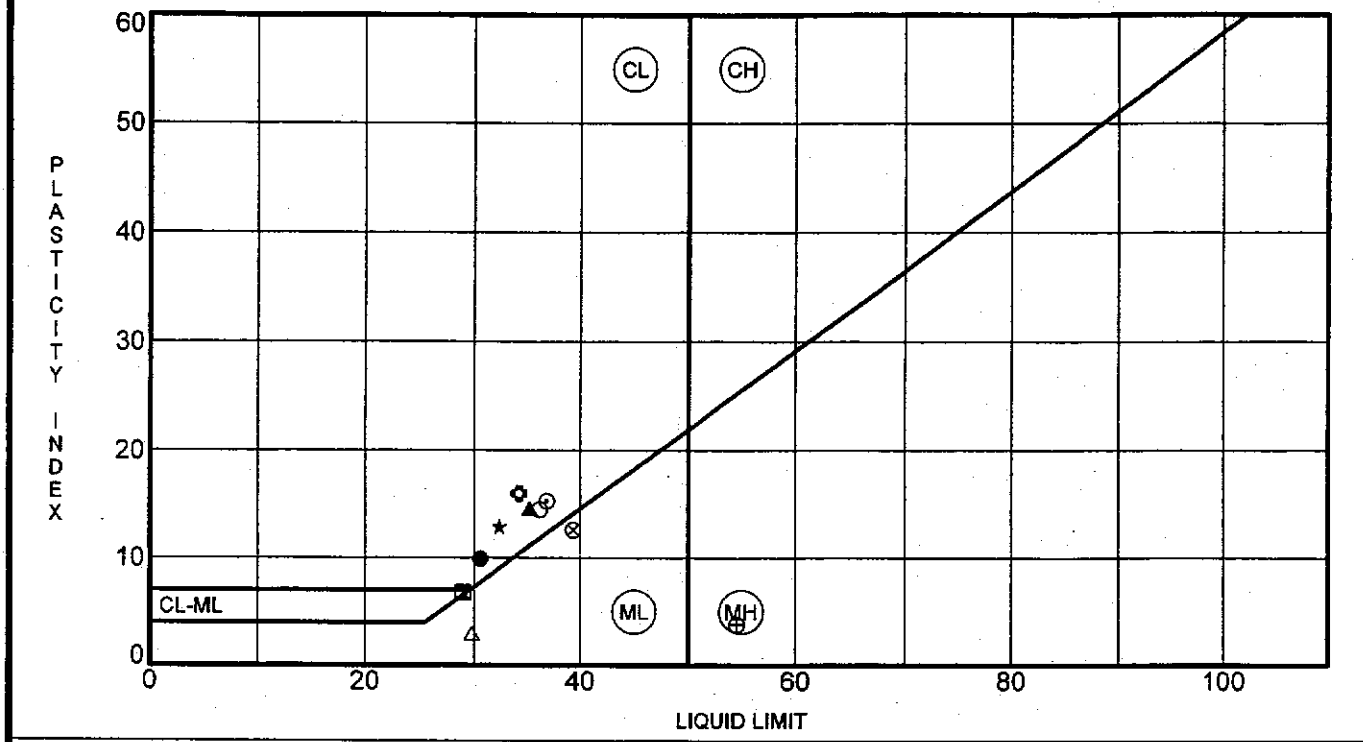
Lab Test Summary — Sheet 2 of 2

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

LAB SUMMARY F68-152D.GPJ F&R.GDT 1/18/05



Boring No.		Depth	LL	PL	PI	Fines	Classification
●	P- 3	at 9.0	31	21	10		0.0
⊠	P- 4	at 1.0	29	22	7	81	SILTY CLAY with SAND (CL-ML),{A-4}
▲	P- 5	at 4.0	35	21	14		0.0
★	P- 6	at 4.0	32	19	13		0.0
⊙	P- 7	at 4.0	37	22	15		0.0
✿	P- 8	at 4.0	34	18	16		0.0
○	P- 9	at 1.0	36	22	14		0.0
△	P-10	at 4.0	30	27	3		0.0
⊗	P-11	at 4.0	39	27	12		0.0
⊕	R-10	at 9.0	55	51	4		0.0

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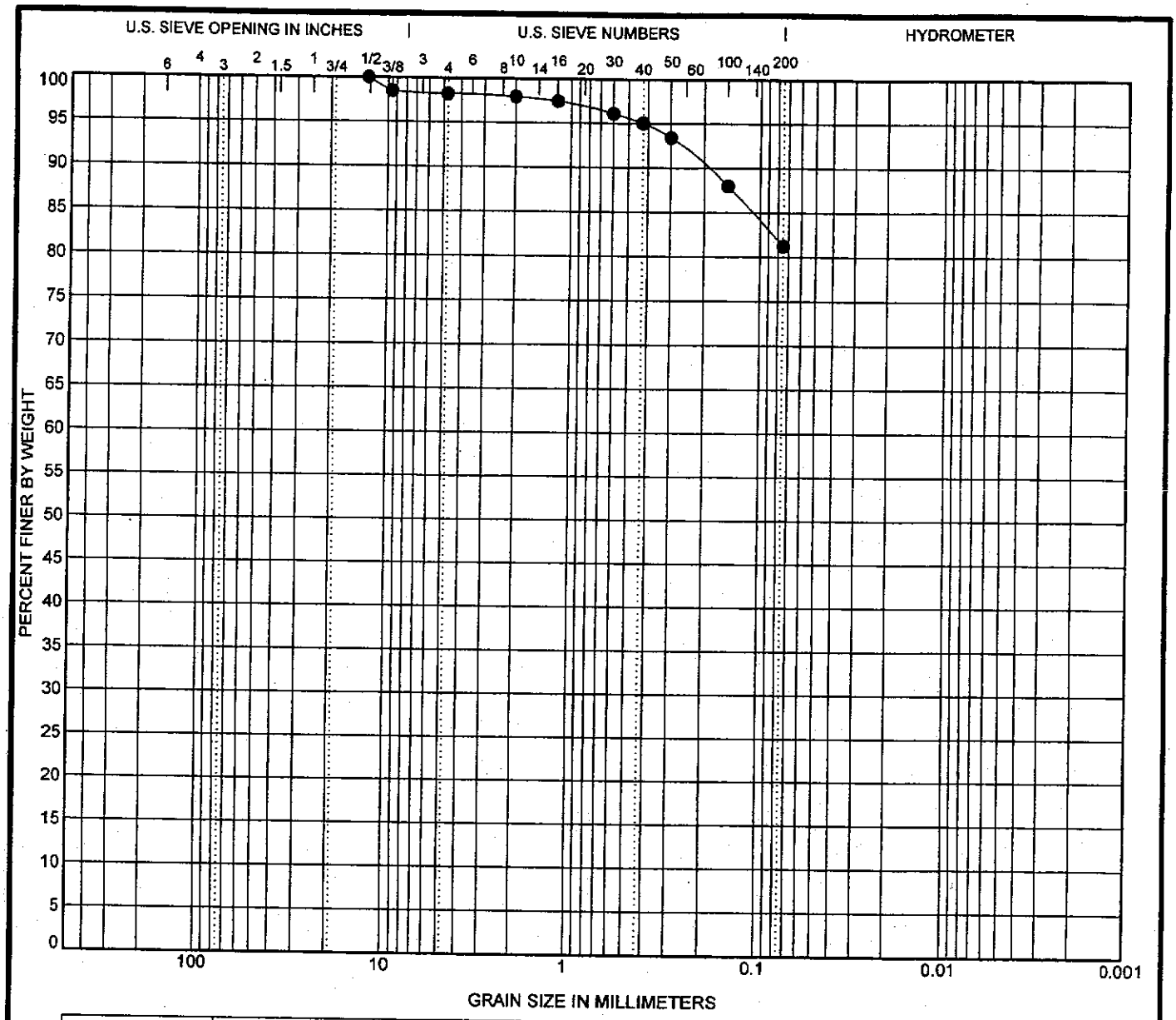
ATTERBERG LIMITS' RESULTS

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US ATTERBERG LIMITS F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	P- 4	at	1.0	SILTY CLAY with SAND (CL-ML)	29	22	7		
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P- 4	at	1.0	12.7				1.8	17.0	81.3	
		at									
		at									
		at									
		at									

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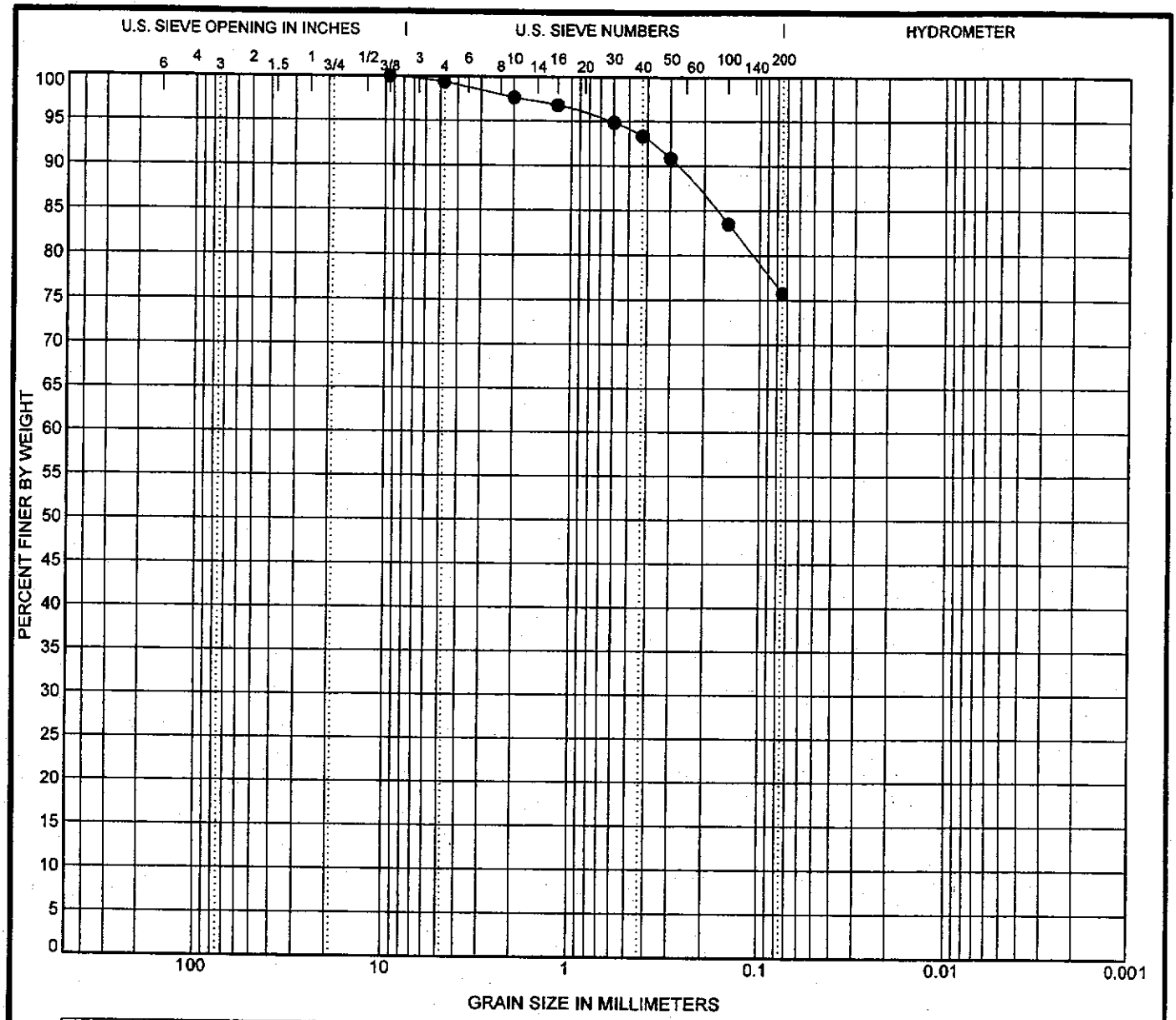
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	P- 5 Bulk at	2.5	0					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P- 5 Bulk at	2.5	9.52				0.6	23.6	75.8	
	at									
	at									
	at									
	at									

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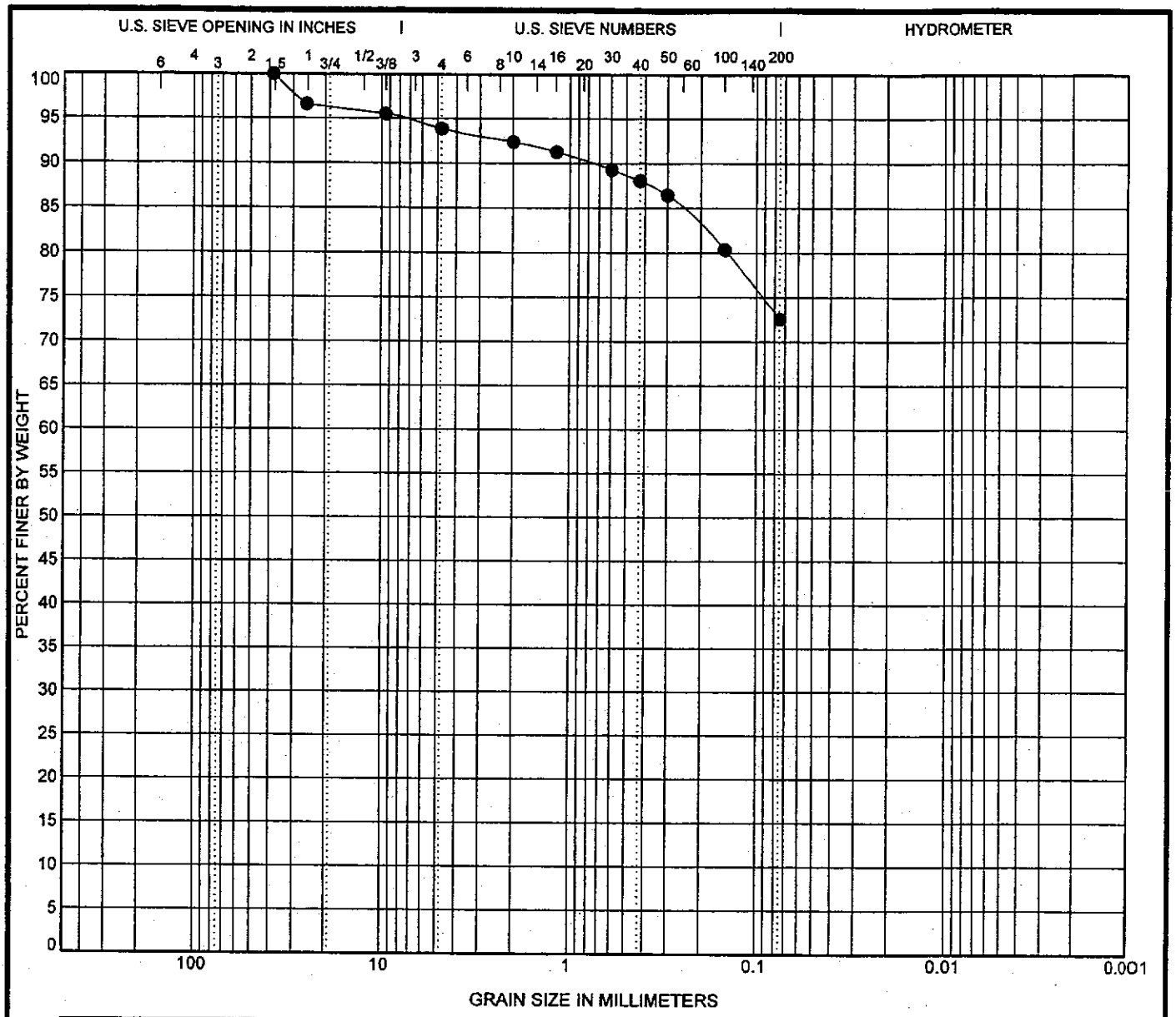
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	P- 8 Bulk at	2.5	0					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P- 8 Bulk at	2.5	38.1				6.1	21.3	72.6	
	at									
	at									
	at									
	at									

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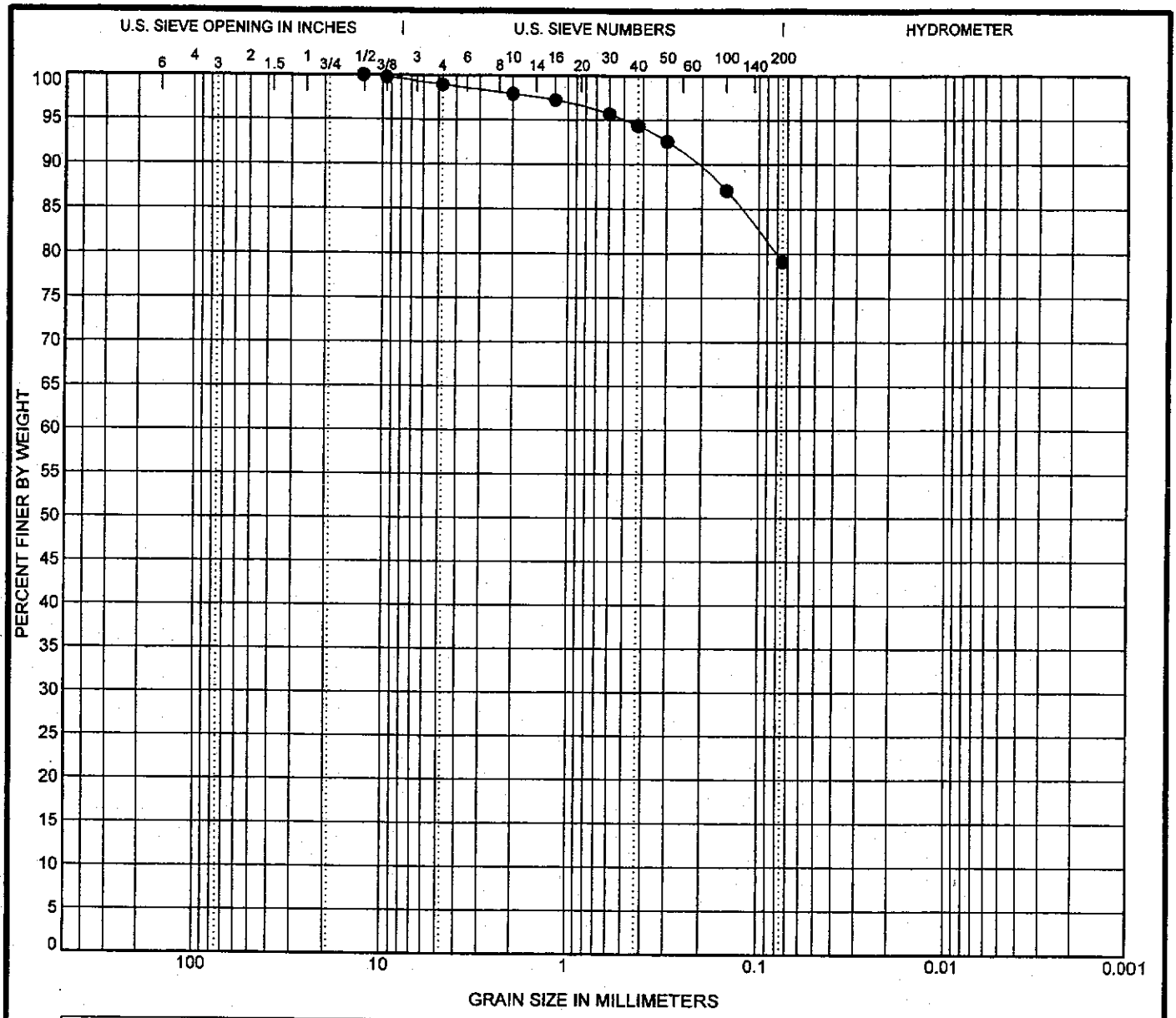
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	P- 9 Bulk at	2.5	()					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P- 9 Bulk at	2.5	12.7				1.0	19.9	79.1	
	at									
	at									
	at									
	at									

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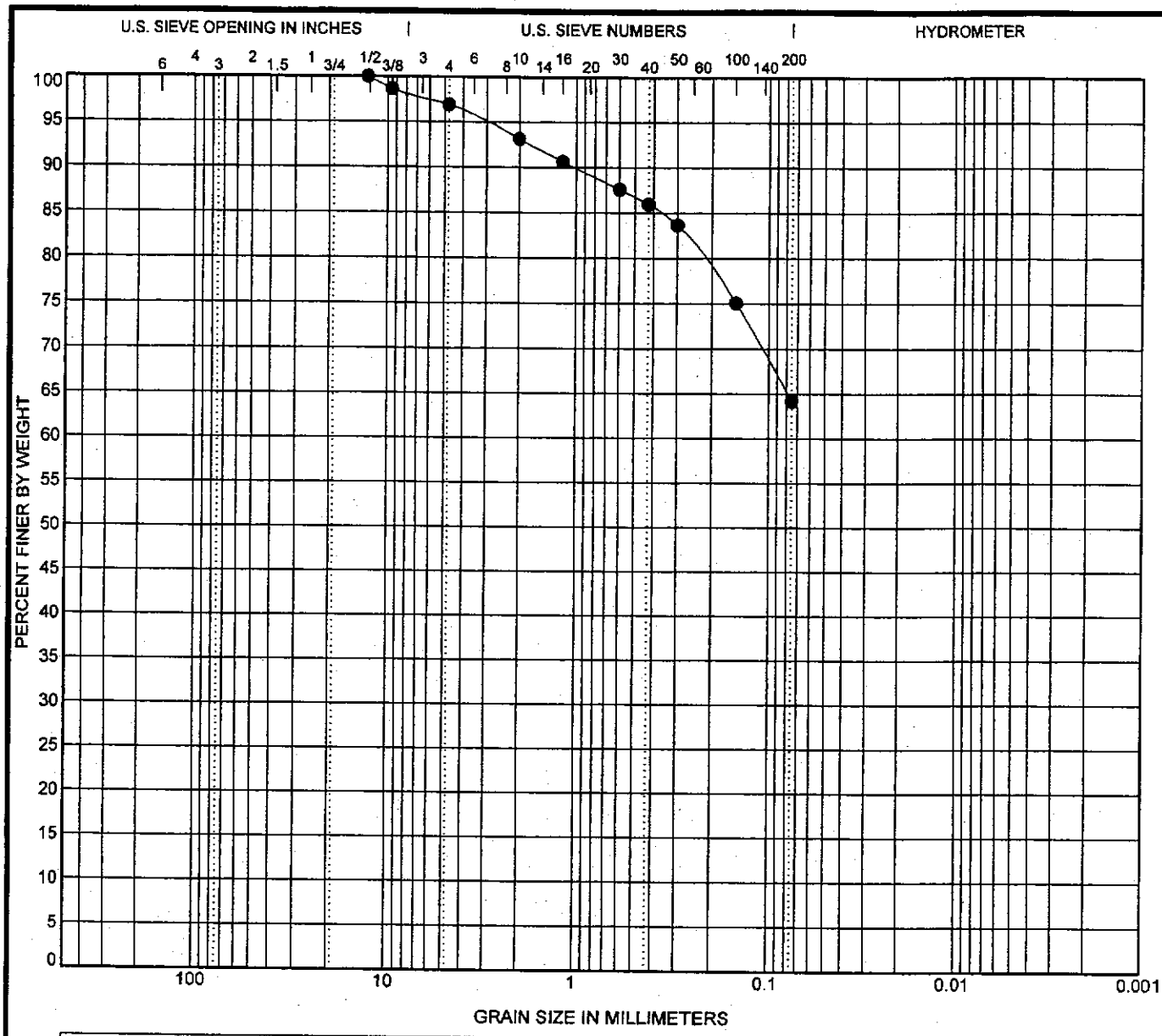
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	R- 1 Bulk at	2.5	0					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R- 1 Bulk at	2.5	12.7				3.1	32.7	64.2	
	at									
	at									
	at									
	at									

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Location: Gaithersburg, Maryland
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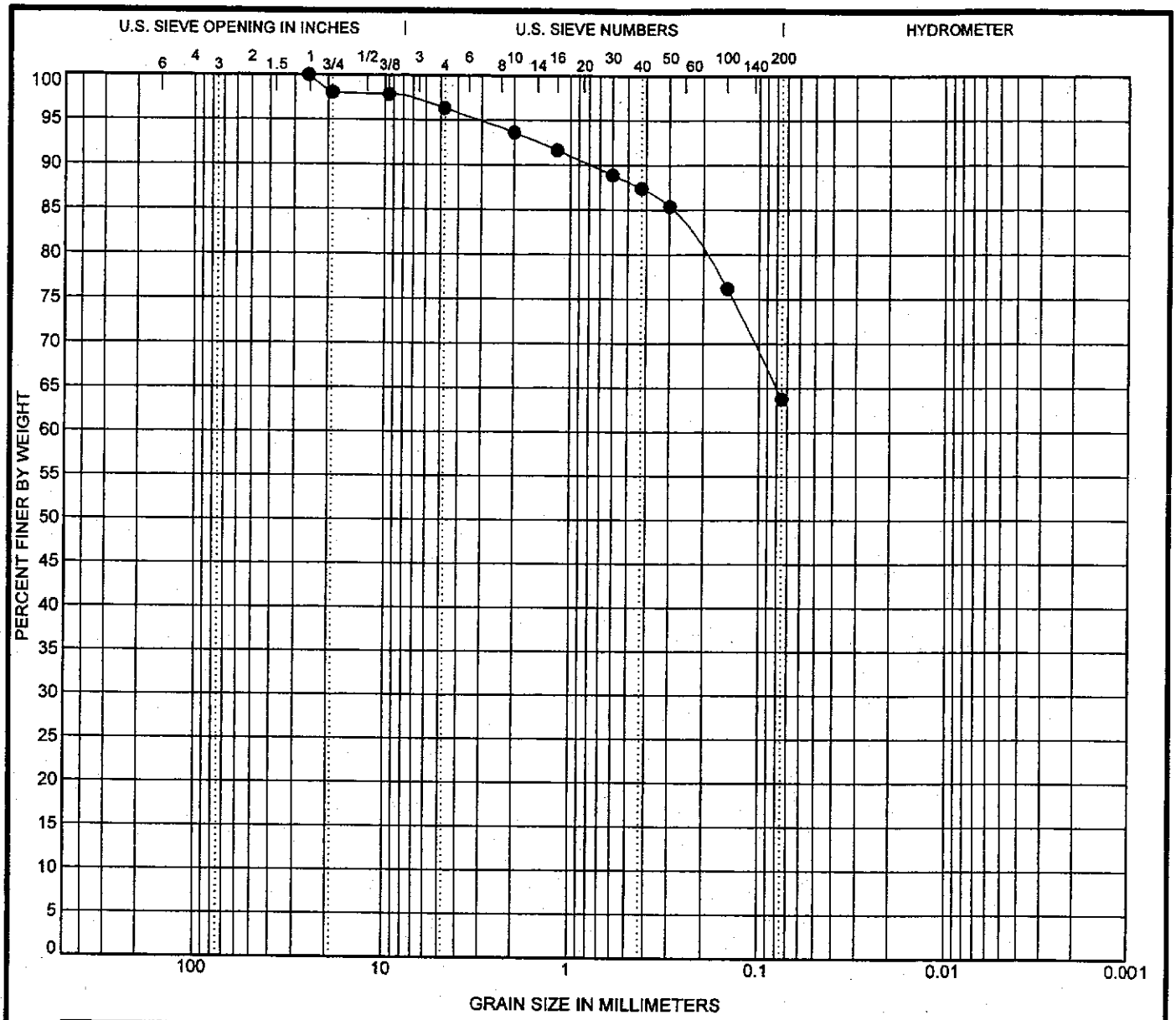

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	R- 5 Bulk at	2.5	()					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R- 5 Bulk at	2.5	25.4				3.7	32.6	63.8	
	at									
	at									
	at									
	at									

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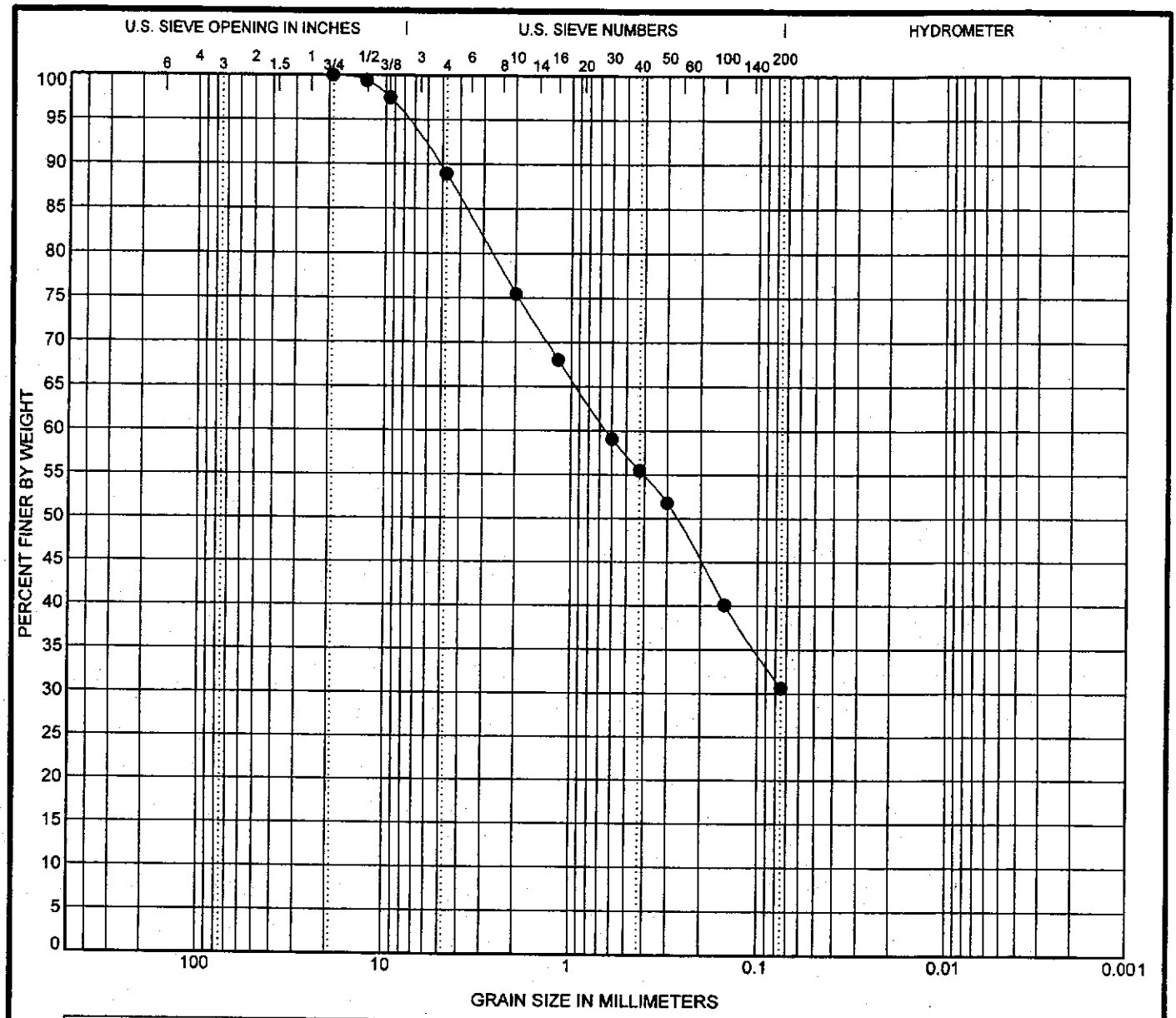
US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	R- 8 Bulk at	2.5	0					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R- 8 Bulk at	2.5	19.1	0.643			11.1	58.3	30.6	
	at									
	at									
	at									
	at									

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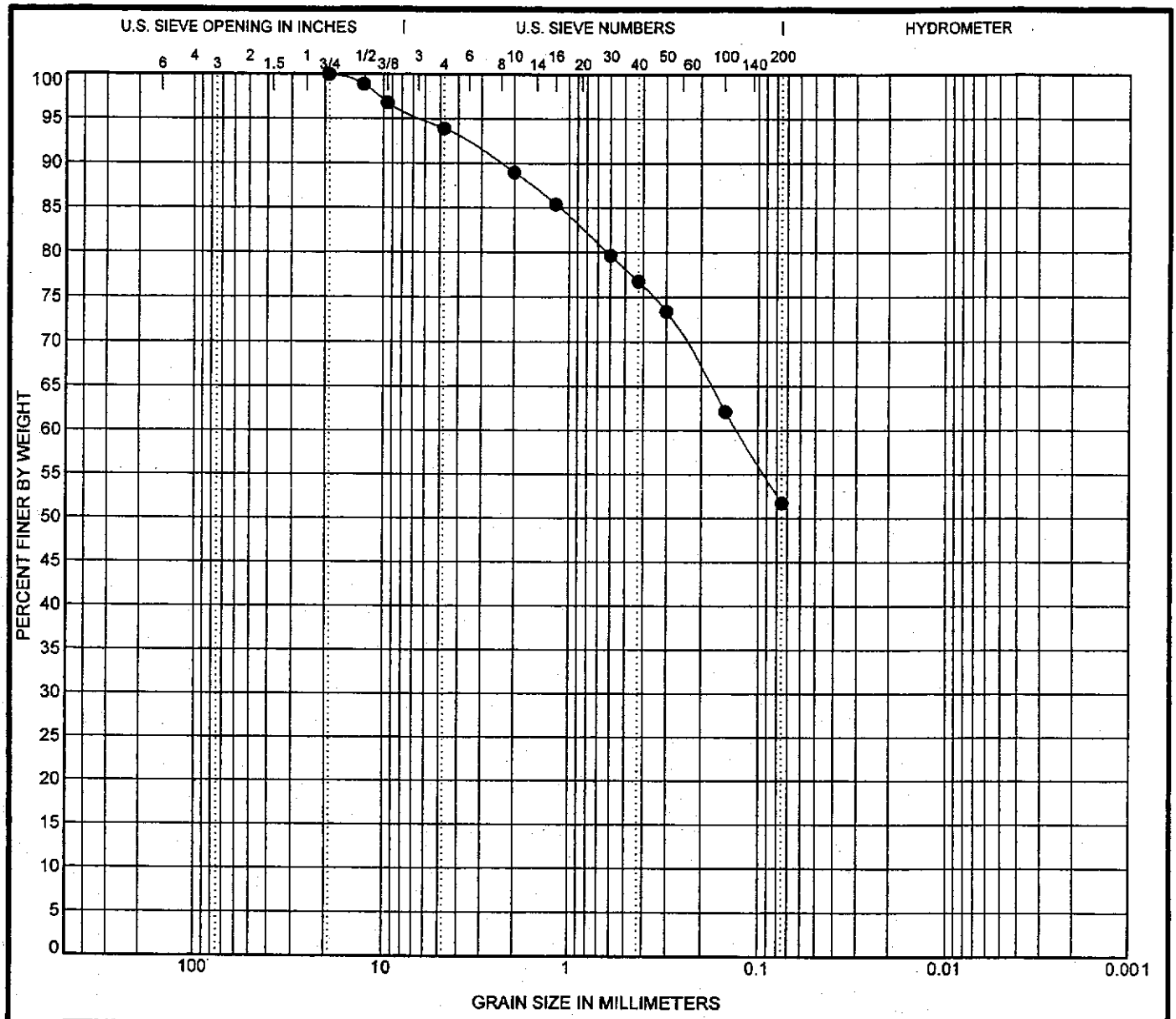
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	R-10 Bulkat	2.5	0					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-10 Bulkat	2.5	19.1	0.129			6.1	42.2	51.7	
	at									
	at									
	at									
	at									

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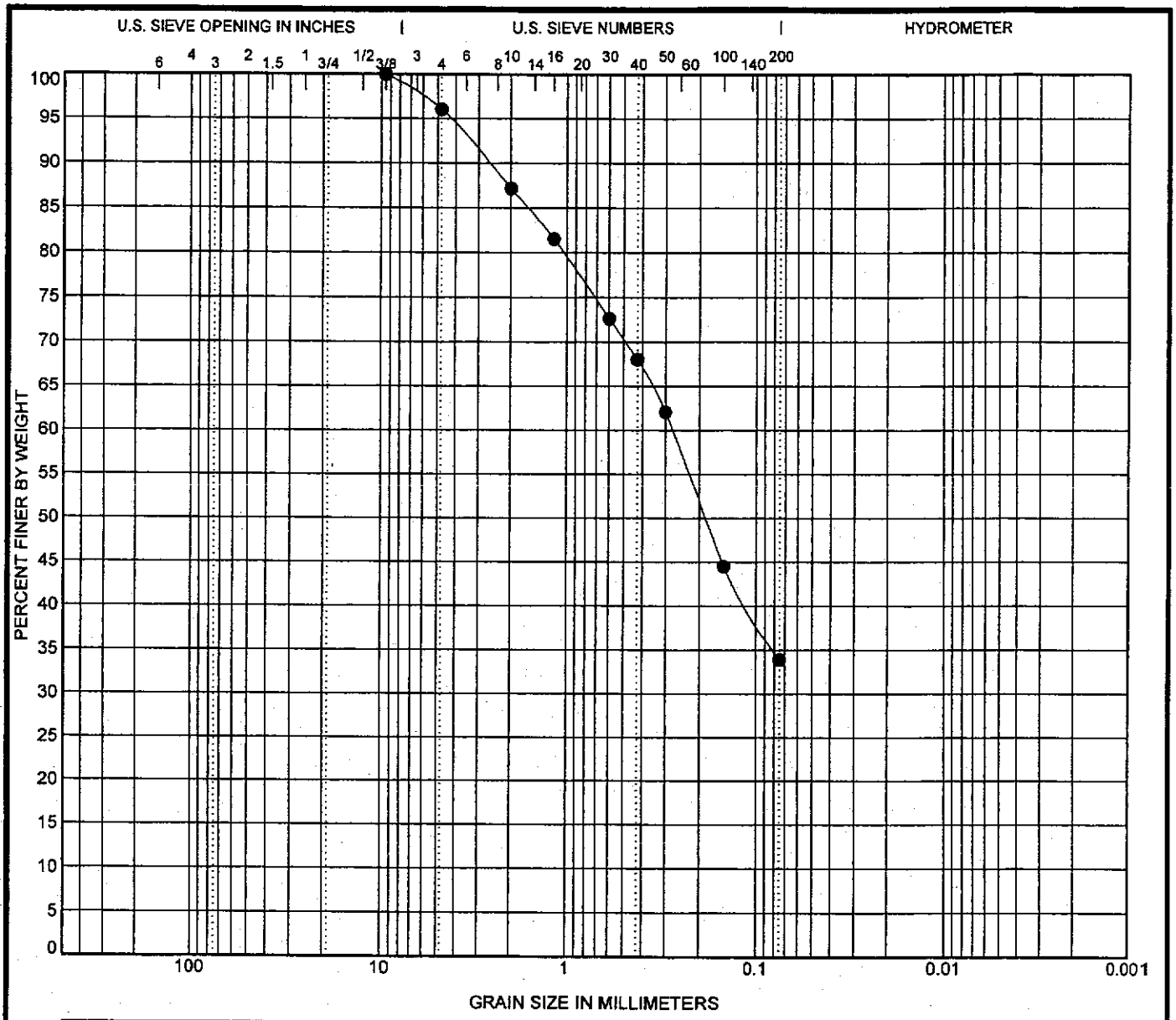
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	R-11	at	1.0	()					
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-11	at	1.0	9.52	0.276			4.0	62.1	33.9	
		at									
		at									
		at									
		at									

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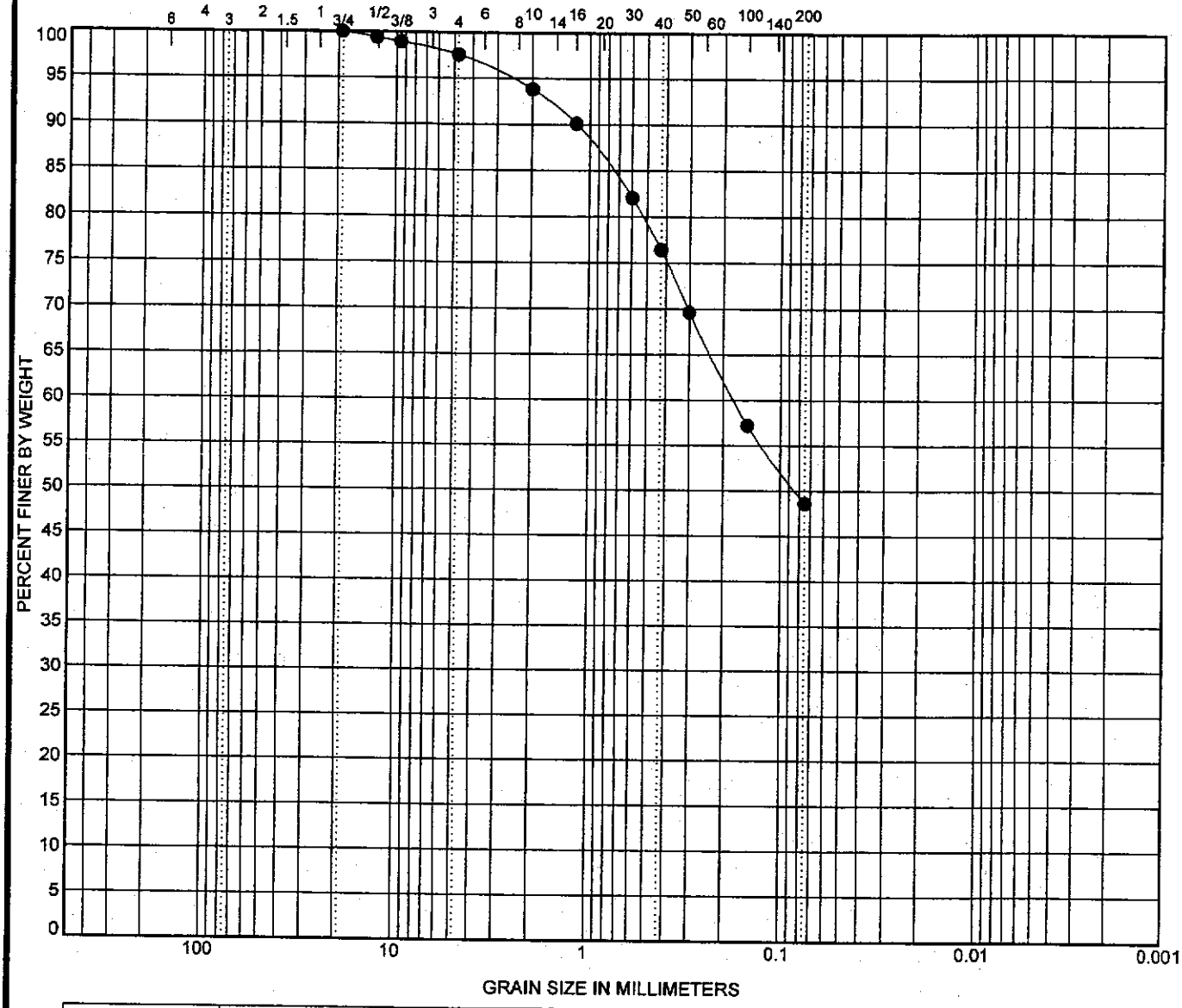
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	R-12 Bulkat	2.5	()					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-12 Bulkat	2.5	19.1	0.174			2.4	49.0	48.6	
	at									
	at									
	at									
	at									

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GRAIN SIZE DISTRIBUTION

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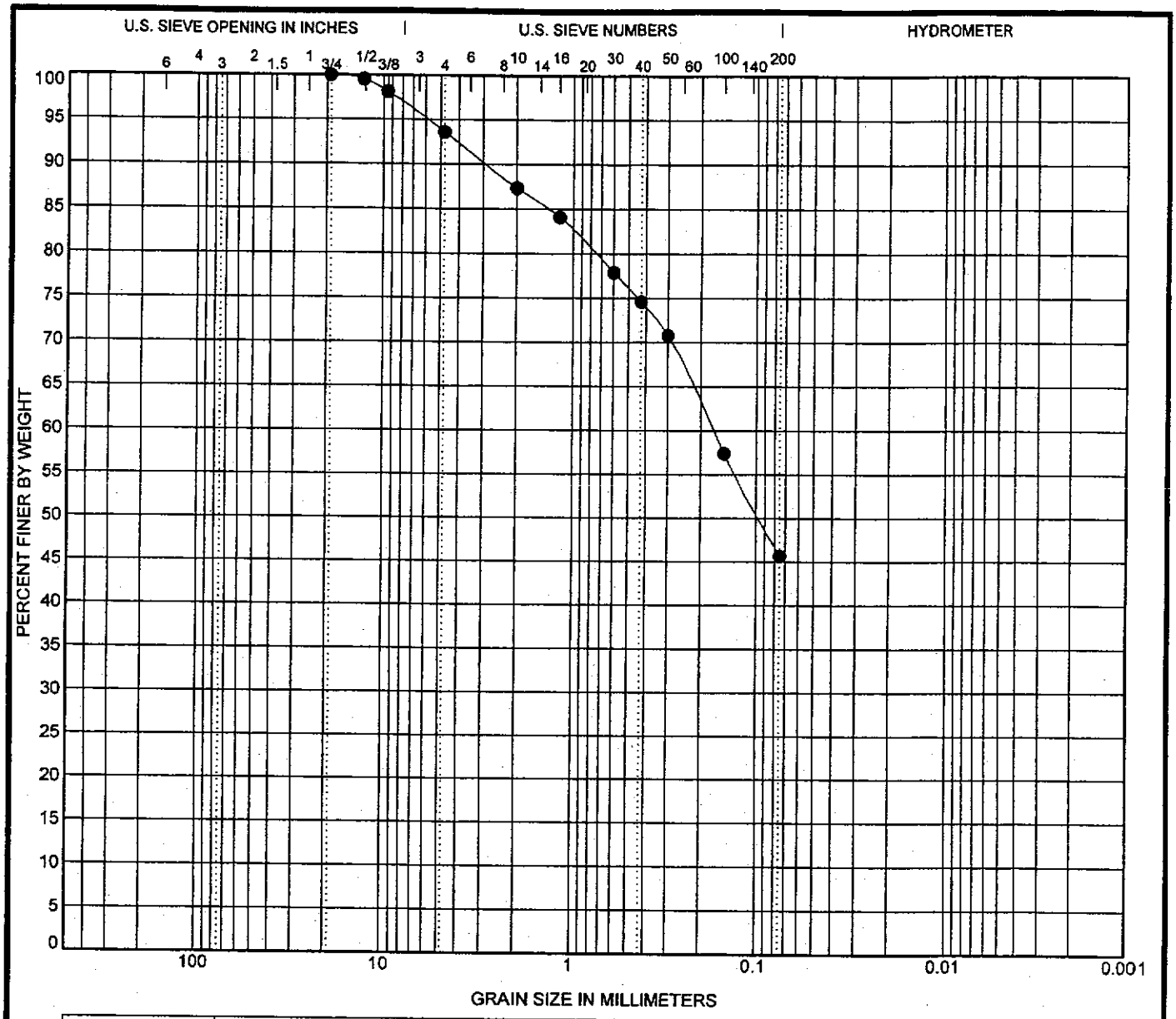
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	R-15 Bulkat	2.5	0					
	at							
	at							
	at							
	at							

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-15 Bulkat	2.5	19.1	0.171			6.4	47.9	45.7	
	at									
	at									
	at									
	at									

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GRAIN SIZE DISTRIBUTION

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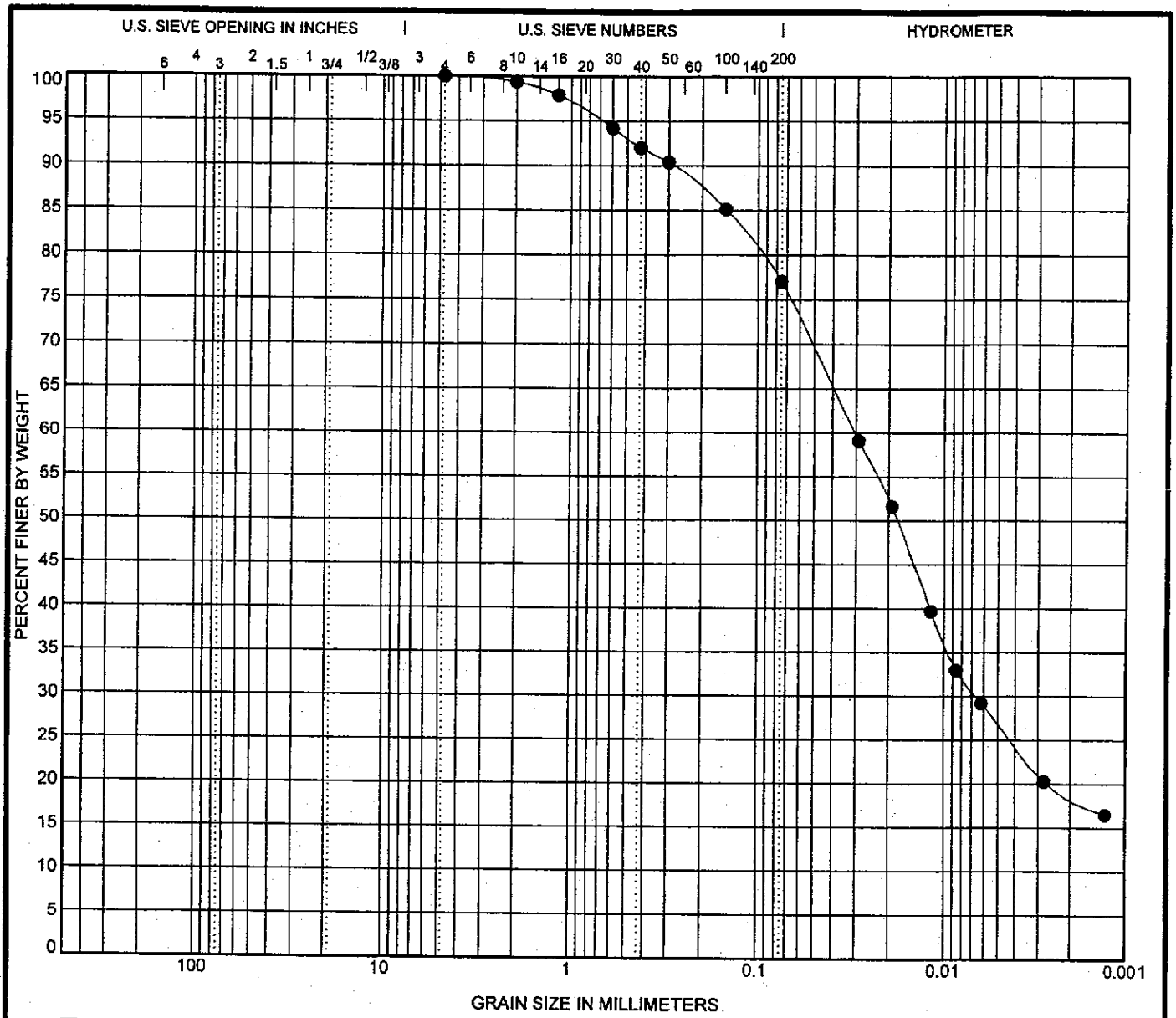
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	SWM-1	at	9.0	()					
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	SWM-1	at	9.0	4.76	0.031	0.007		0.0	22.9	50.3	26.8
		at									
		at									
		at									
		at									

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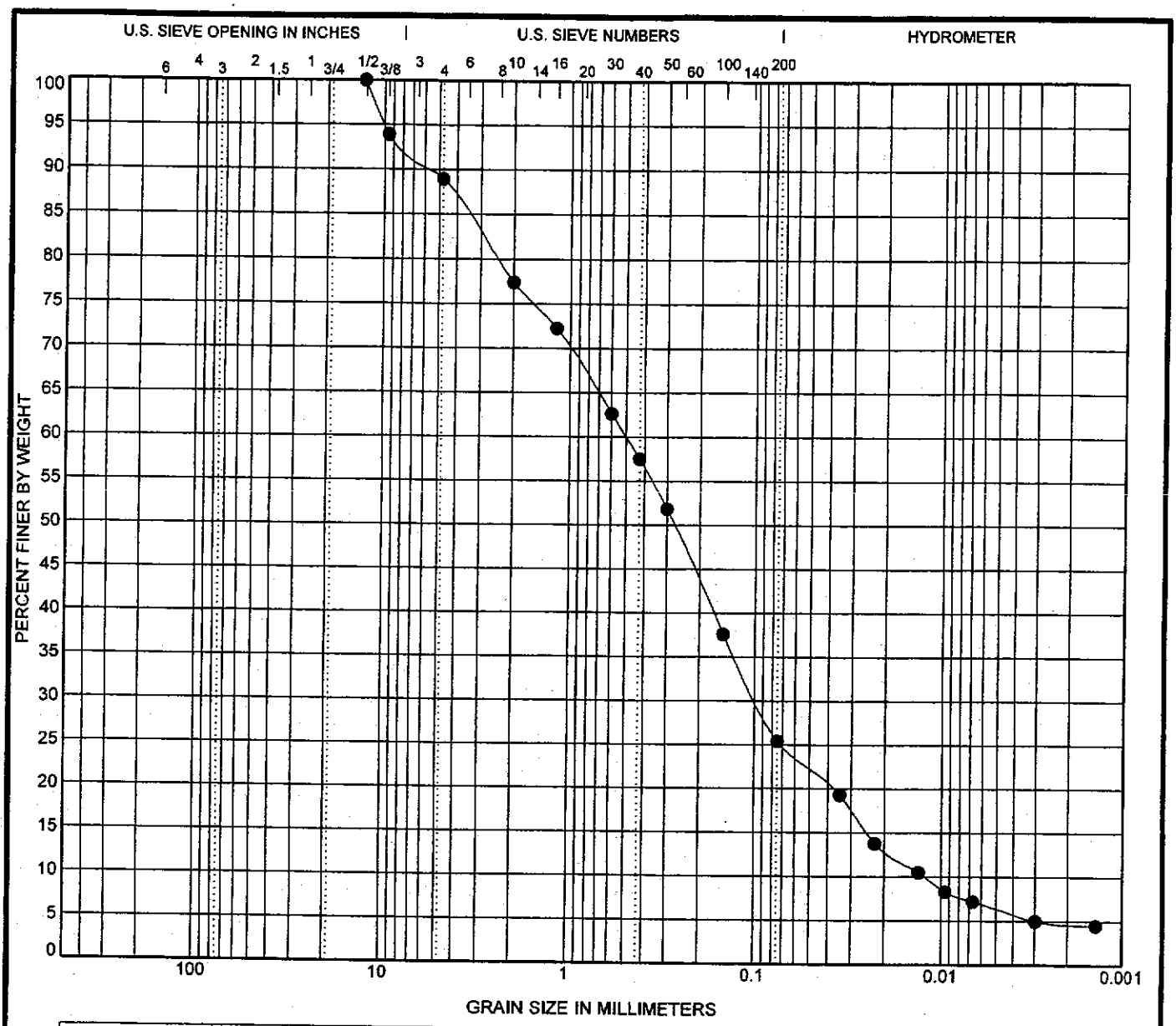
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	SWM-1	at	14.0	0				1.53	40.99
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	SWM-1	at	14.0	12.7	0.502	0.097	0.012	11.1	63.5	19.0	6.4
		at									
		at									
		at									
		at									

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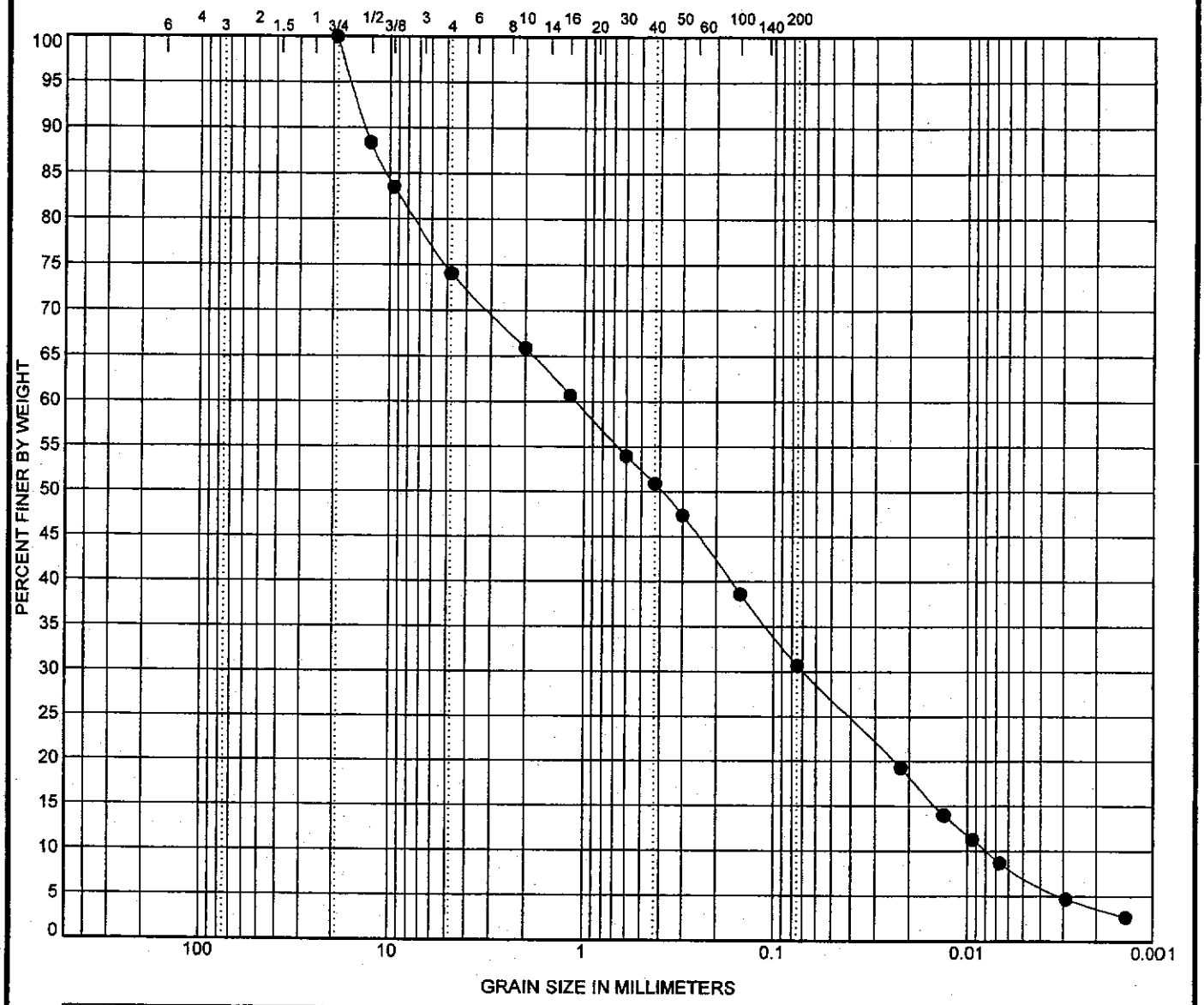
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	SWM-2	at	1.0	()				0.56	138.64
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	SWM-2	at	1.0	19.1	1.1	0.07	0.008	25.9	43.4	23.4	7.3
		at									
		at									
		at									
		at									

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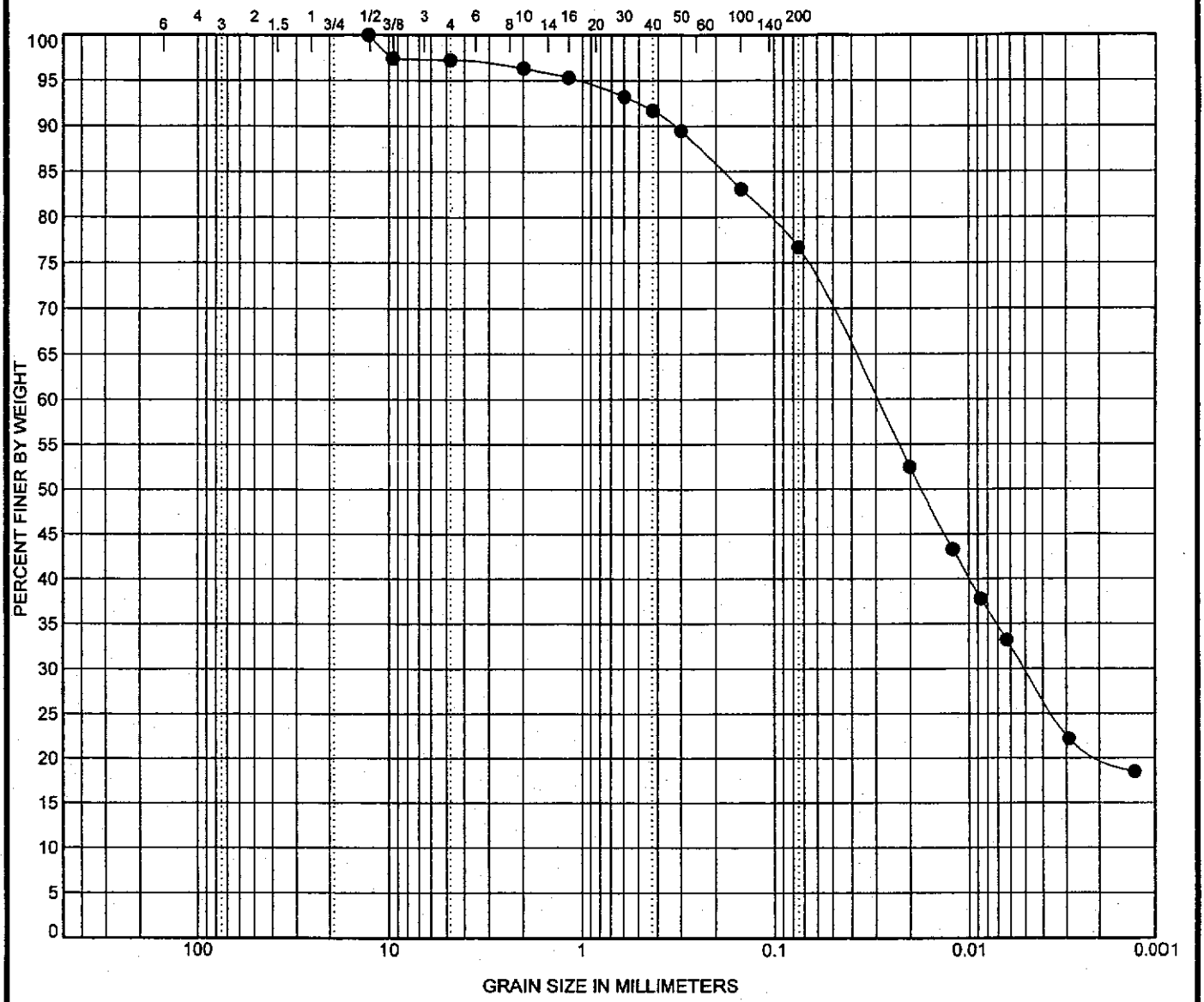
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	SWM-2	at	7.0	()					
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	SWM-2	at	7.0	12.7	0.03	0.005		2.8	20.6	46.8	29.9
		at									
		at									
		at									
		at									

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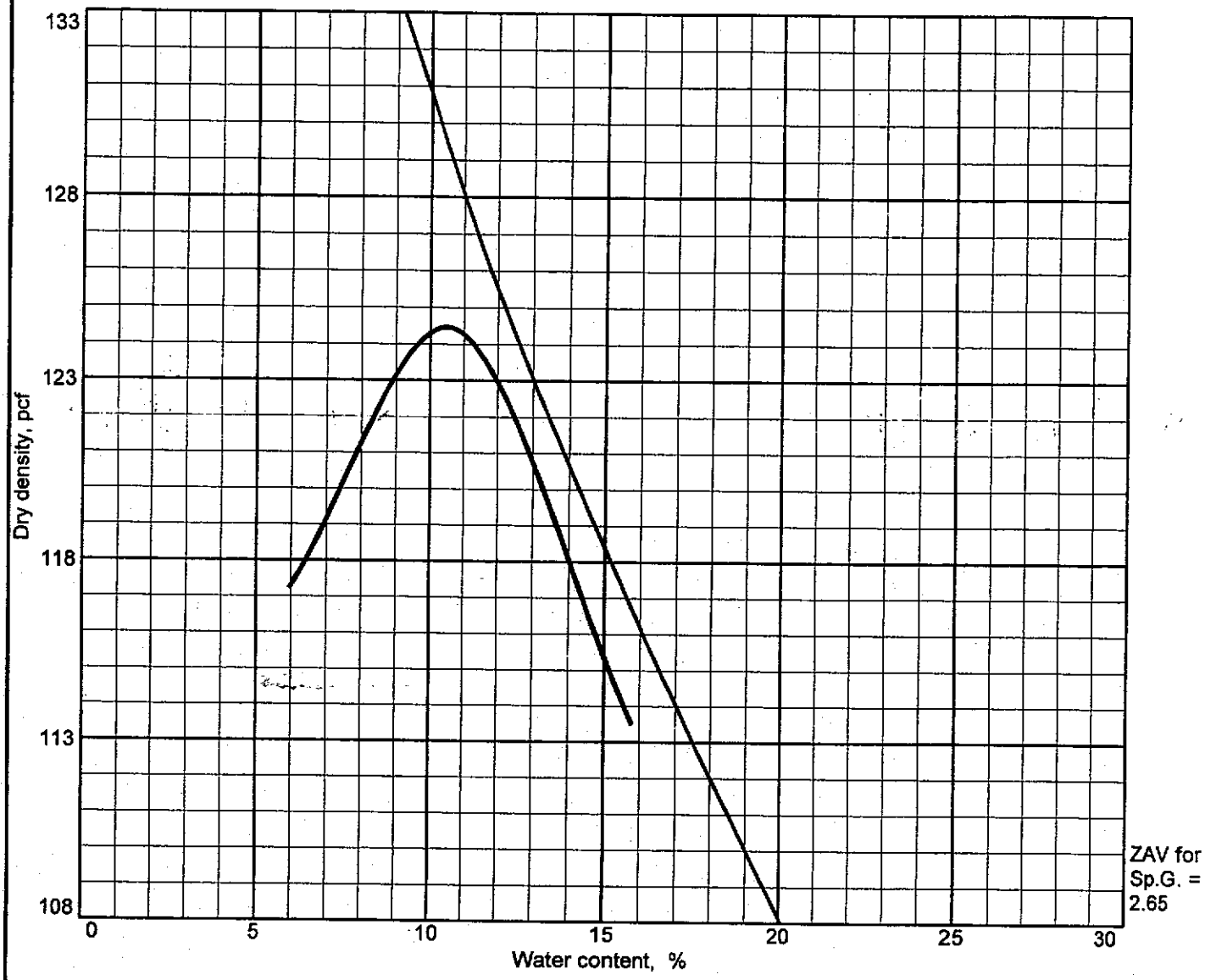
GRAIN SIZE DISTRIBUTION

Report No.: F68-152D
Client: URS Corp
Project: C&O Canal
Location: Gaithersburg, Maryland
Date: January 2005

US GRAIN SIZE F68-152D.GPJ F&R.GDT 1/18/05

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML		18.2	2.65			3.1	64.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 124.5 pcf Optimum moisture = 10.5 %	Brown, Fine sandy silt, trace gravel

Project No. F68-152D **Client:** URS Corporation
Project: C&O Canal

• **Location:** R-1 Bulk

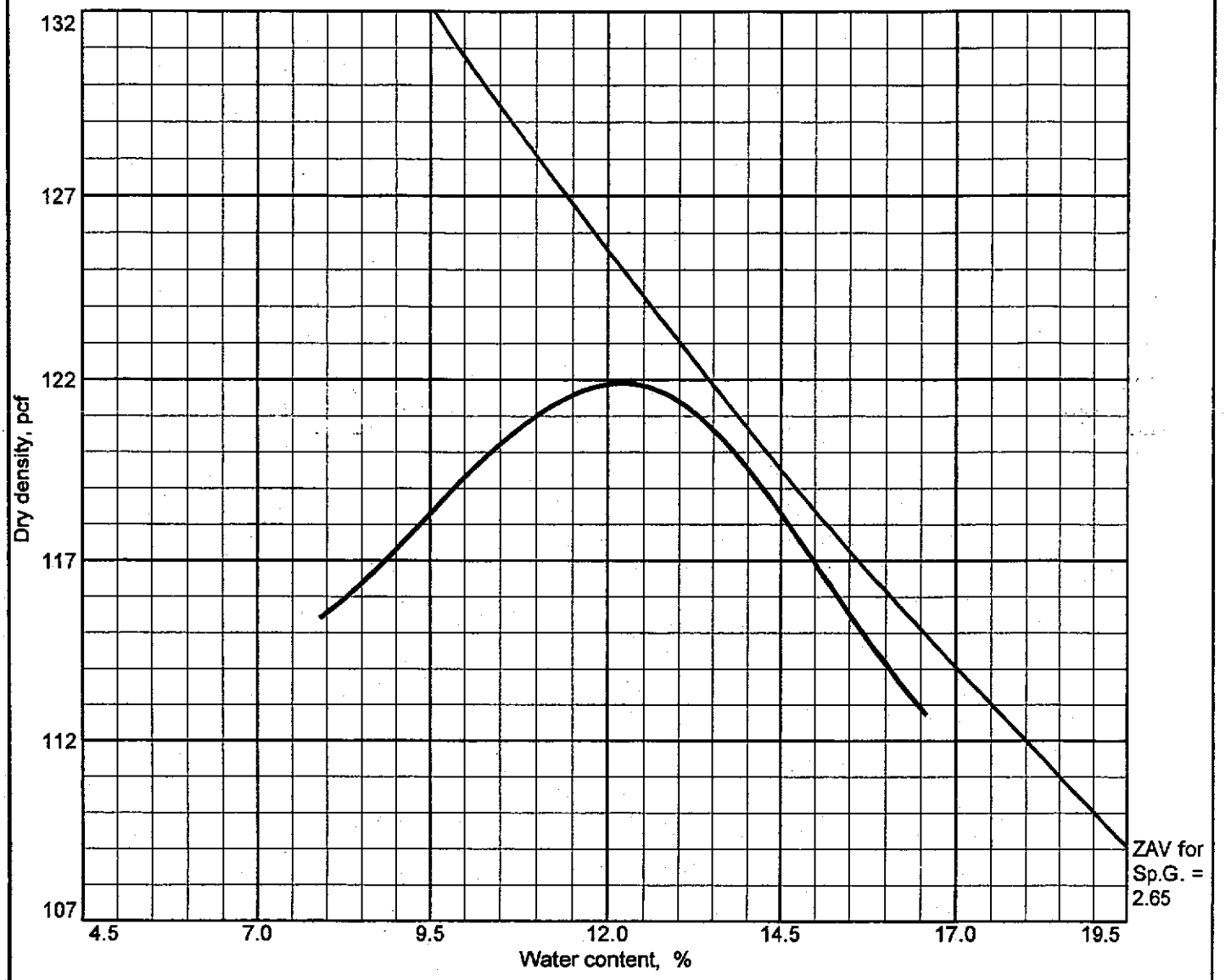
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

Plate

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	CL		18.7	2.65			.6	75.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 121.9 pcf Optimum moisture = 12.2 %	Brown Very silty clay with sand trace gravel

Project No. F68-152D **Client:** URS Corporation
Project: C&O Canal

● **Location:** P-5

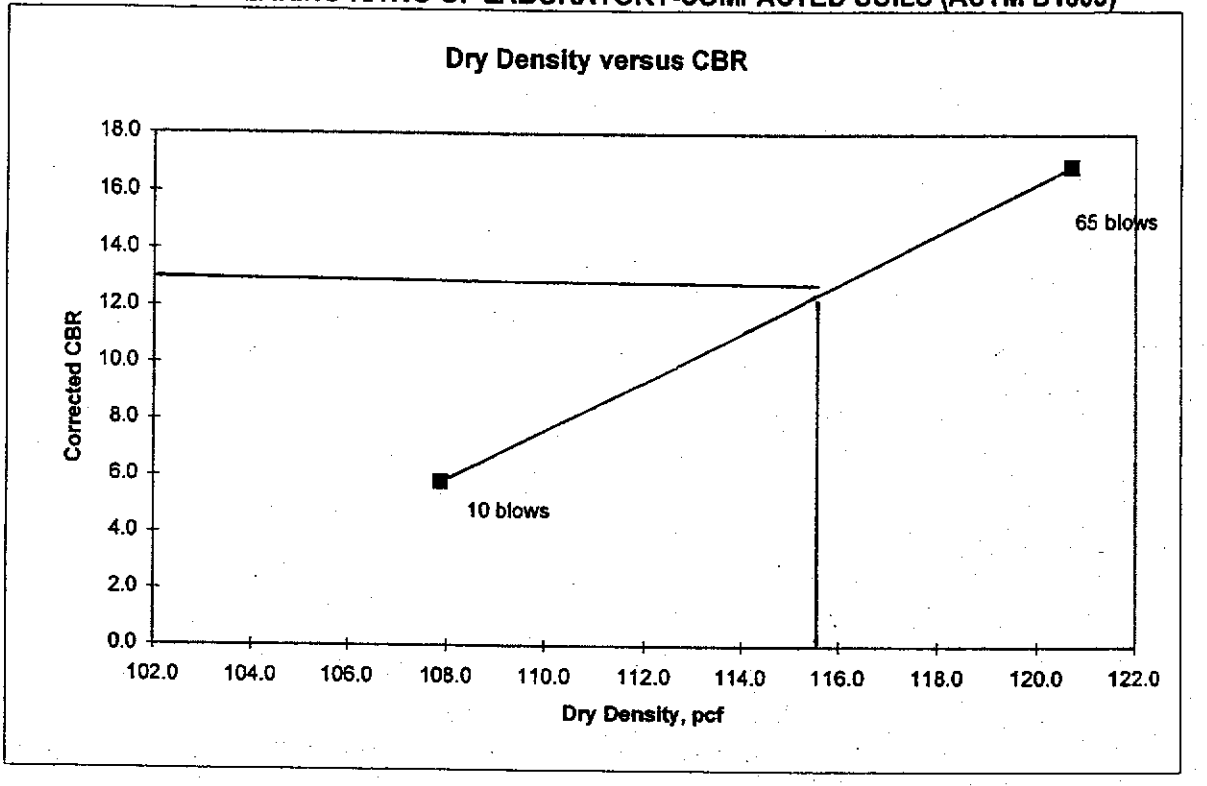
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

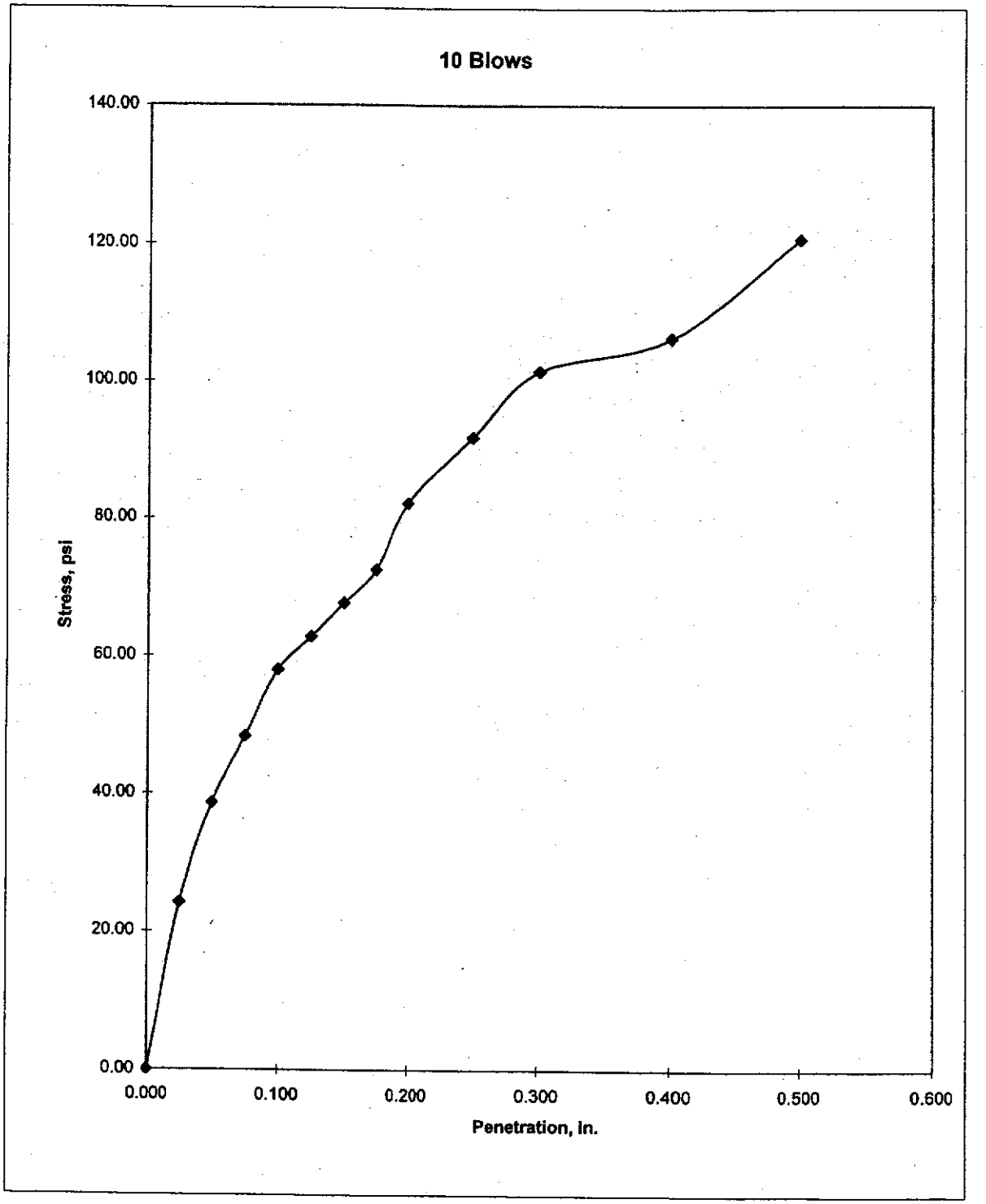
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



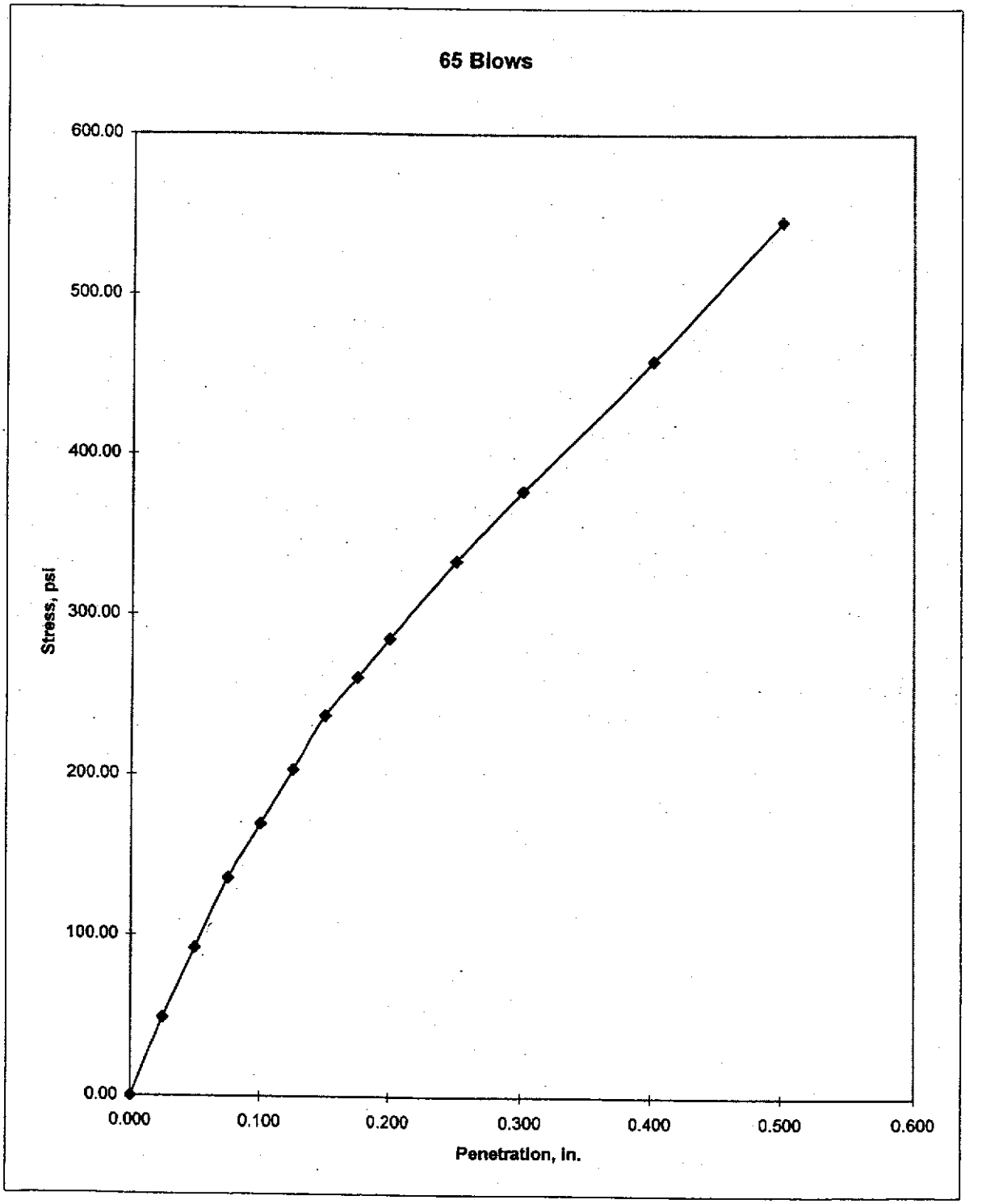
Project:	C&O Canal	
Project No:	URS	
Sample Location:	P-5	
CBR at 95% of maximum dry density:	13.0	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	121.9	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Silty clay with sand trace gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	P-5
Project No:	F68-152D	Dry density	107.9

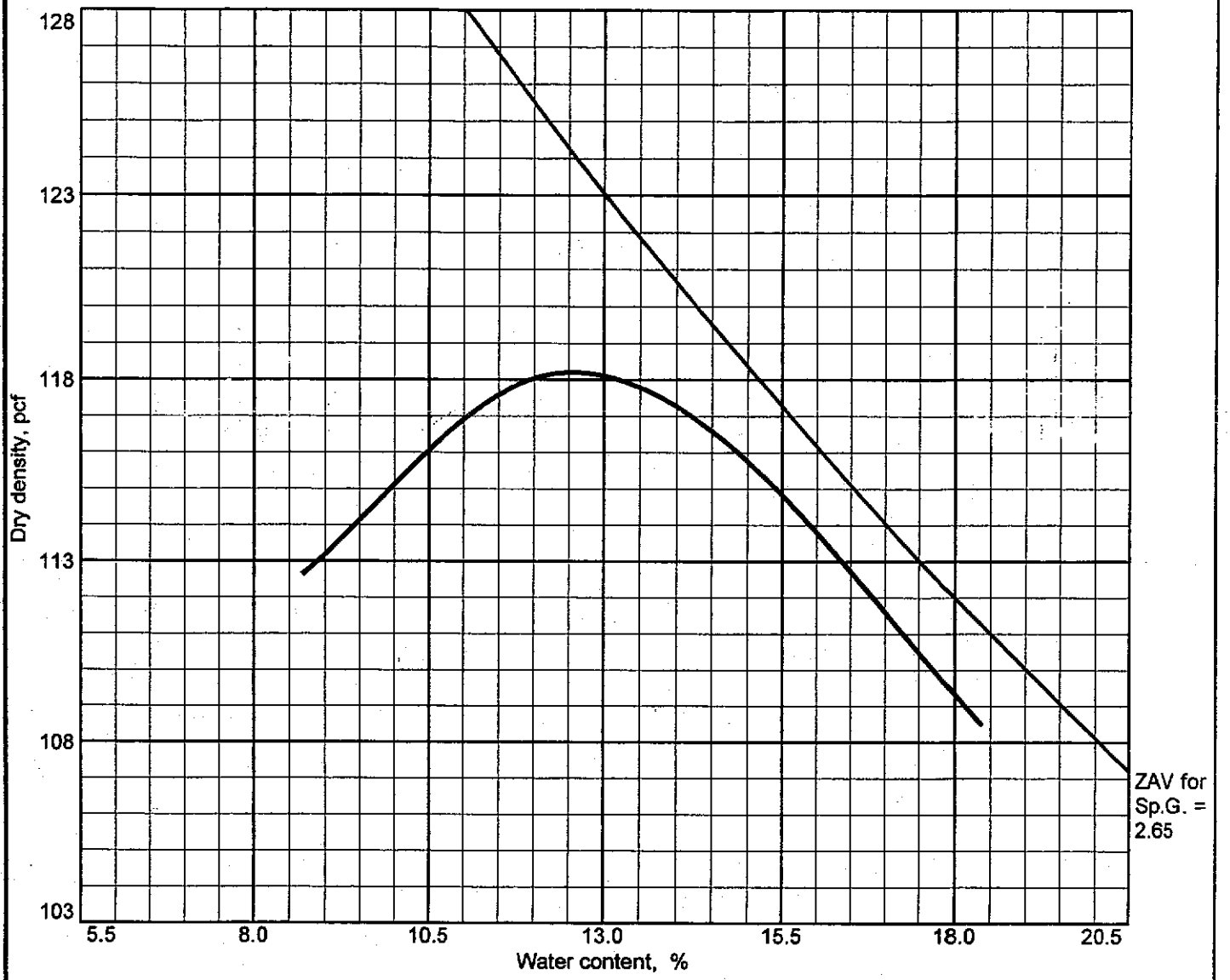


Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 120.7



COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	CL		20.4	2.65			6.1	72.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 118.2 pcf Optimum moisture = 12.6 %	

Project No. F68-152D **Client:** URS Corporation
Project: C&O Canal

● **Location:** P-8

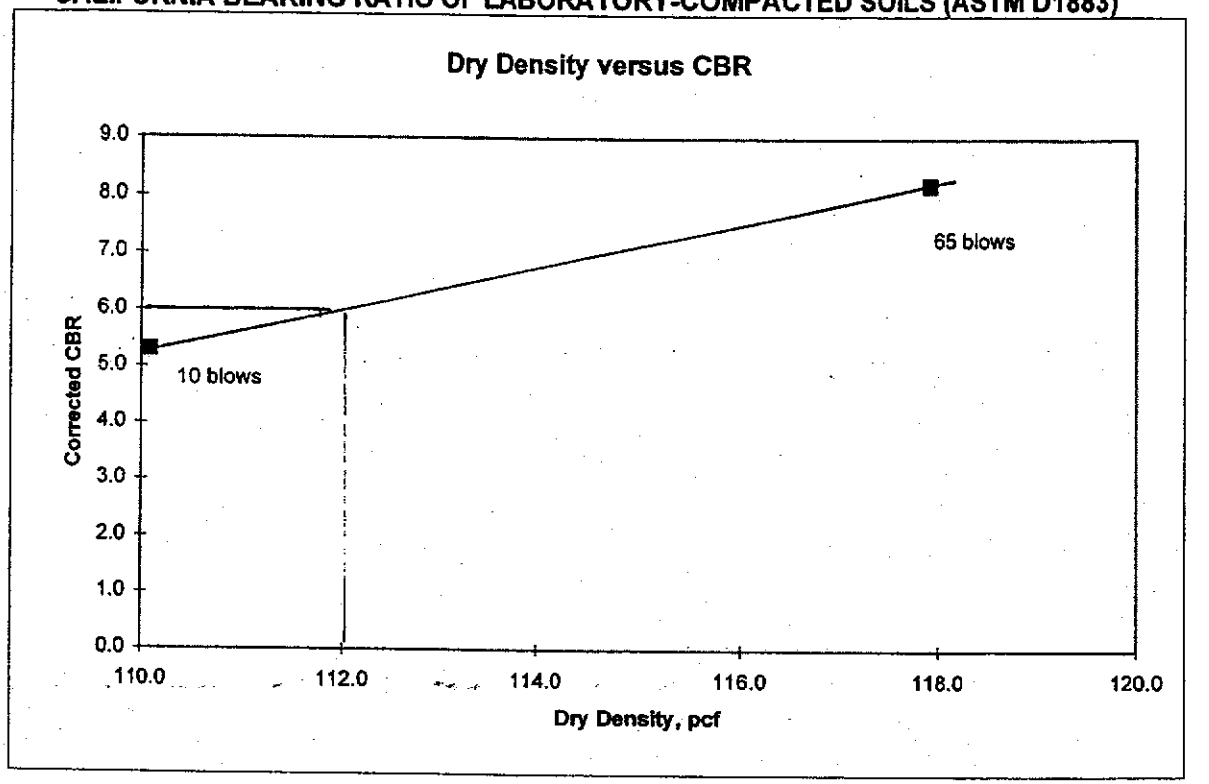
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

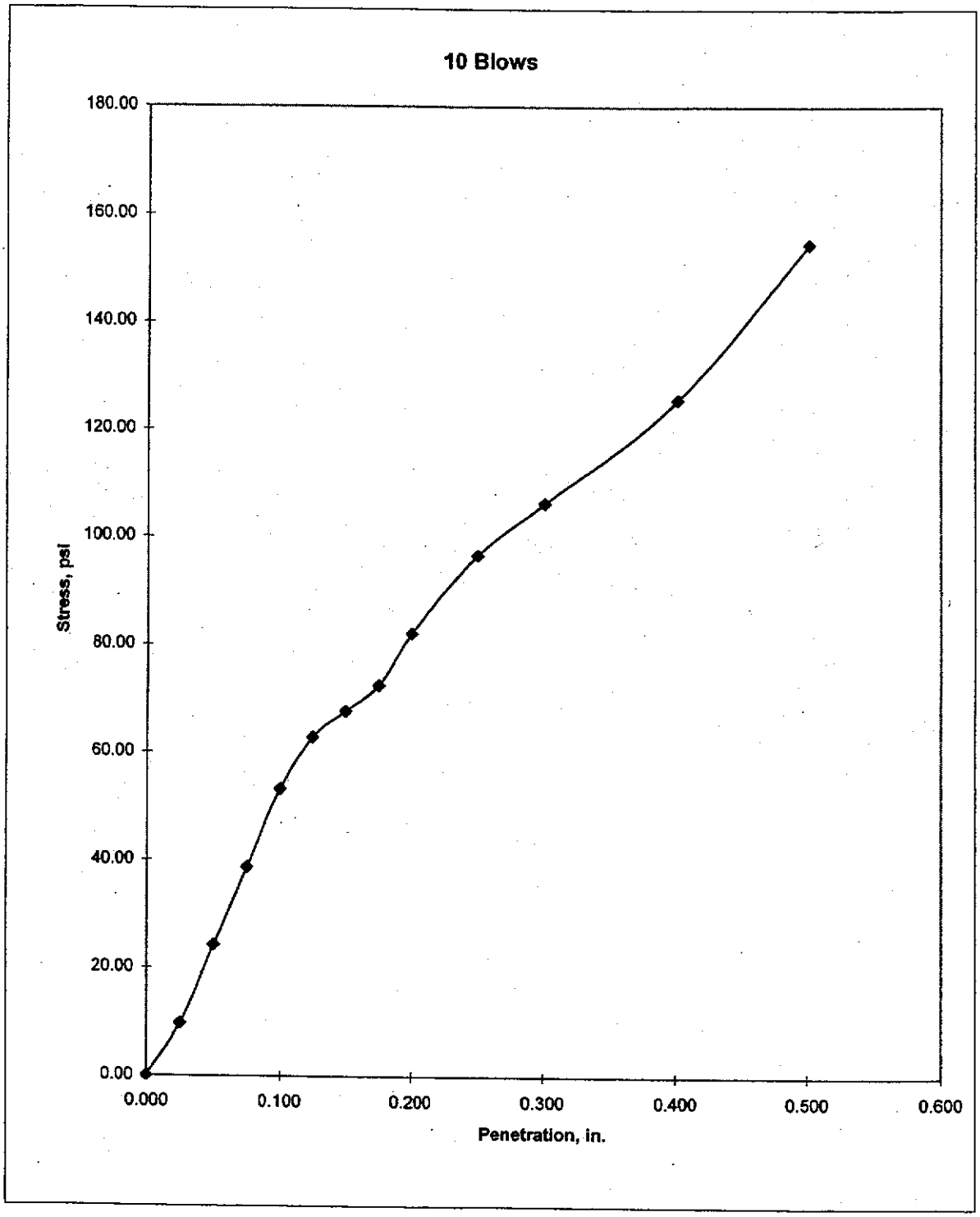
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



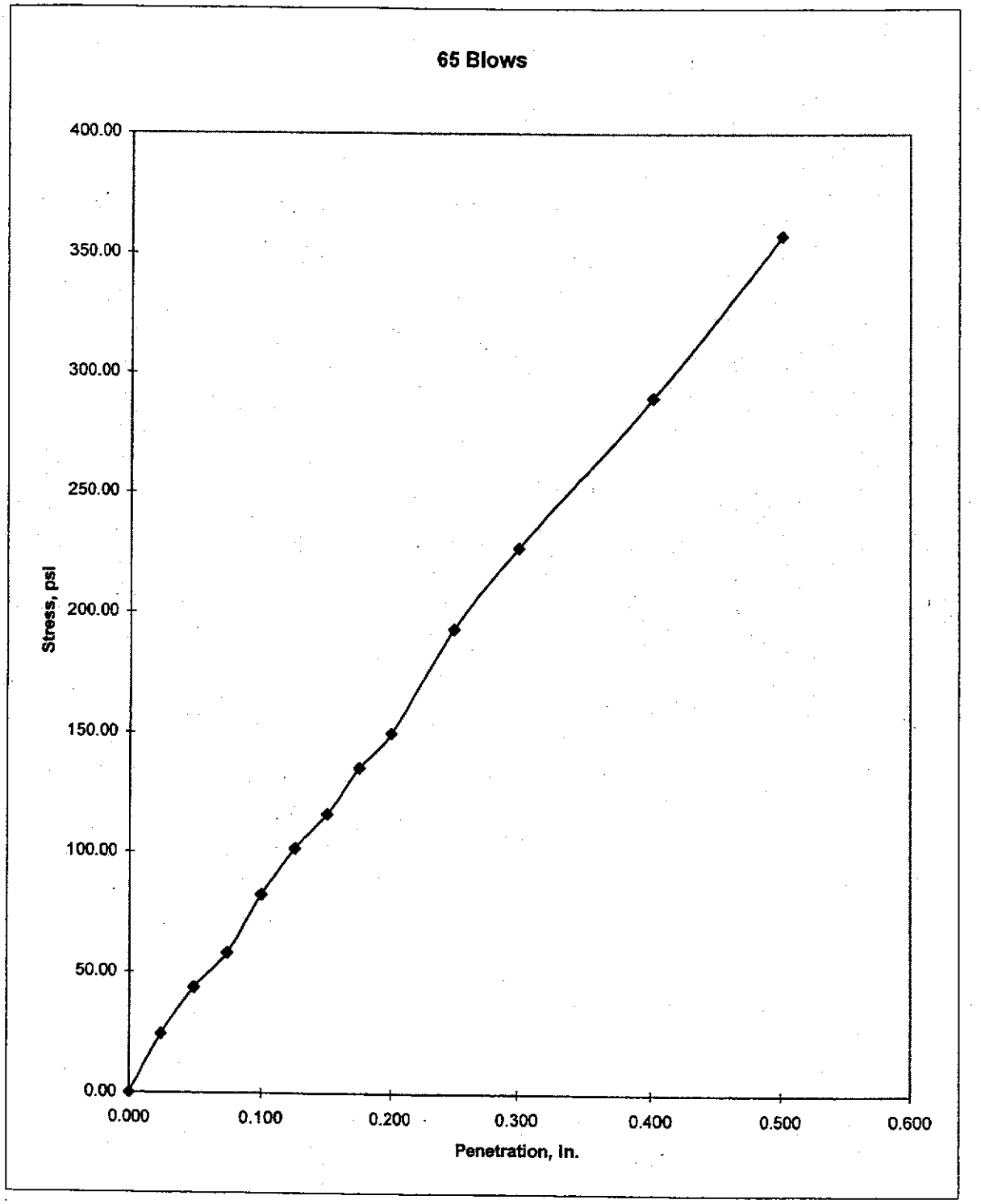
Project:	C&O Canal	
Project No:	URS	
Sample Location:	P-8	
CBR at 95% of maximum dry density:	6.0	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	118.2	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Silty clay with sand trace gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	P-8
Project No:	F68-152D	Dry density	110.1

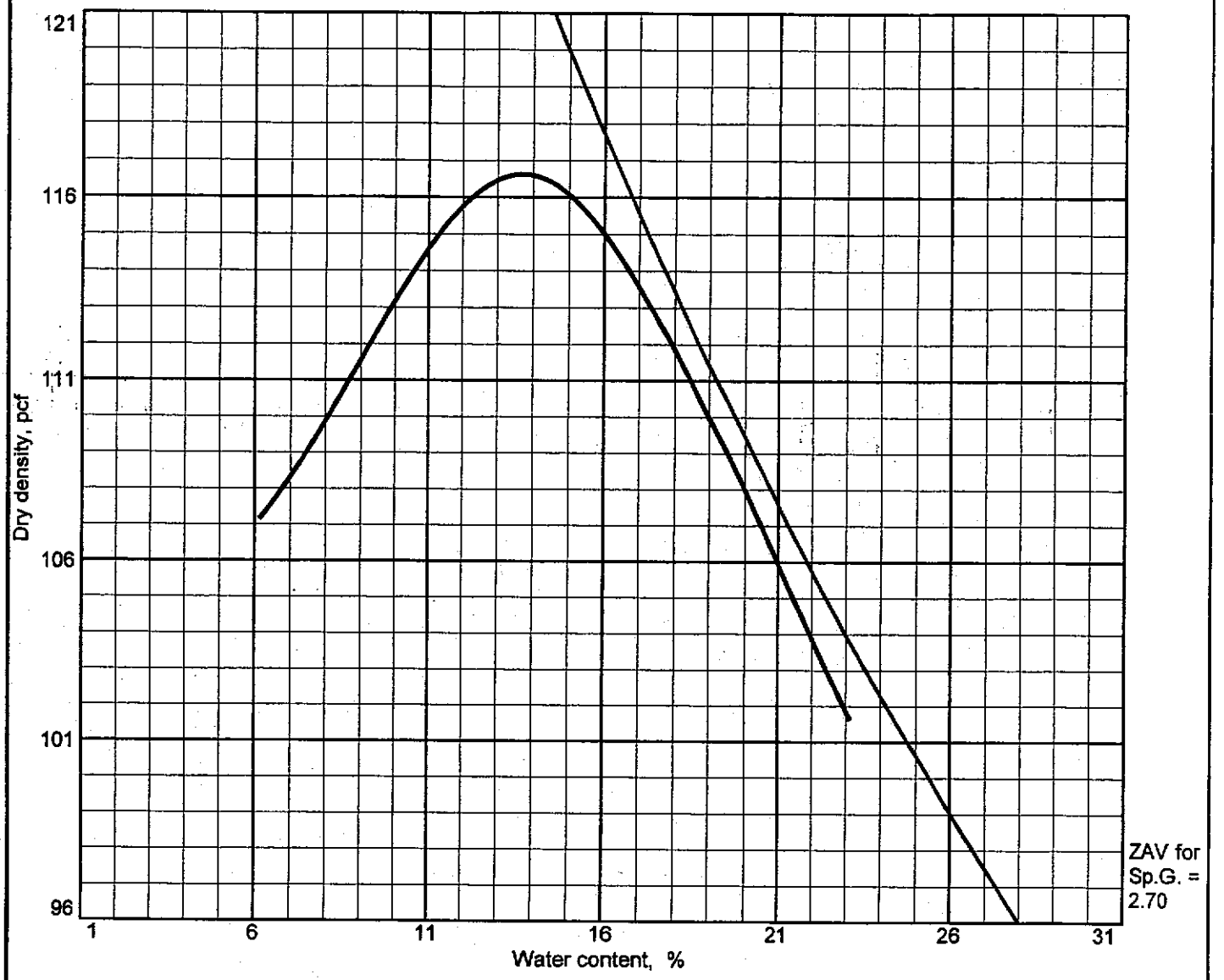


Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 117.9



COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	CL		21.2	2.70			1	79.1

TEST RESULTS

Maximum dry density = 116.6 pcf

Optimum moisture = 13.7 %

MATERIAL DESCRIPTION

Reddish brown very silty clay, with sand trace gravel

Project No. F68-152D **Client:** URS Corporation

Project: C&O Canal

• **Location:** P-9 Bulk

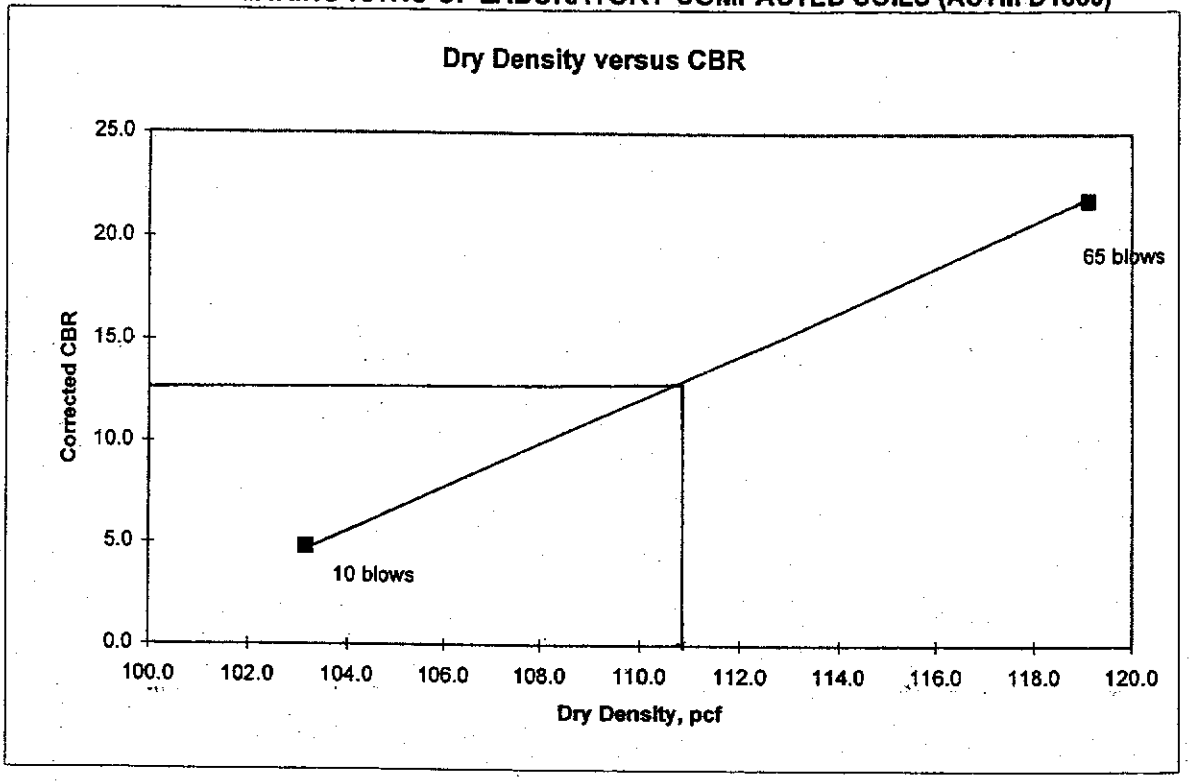
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

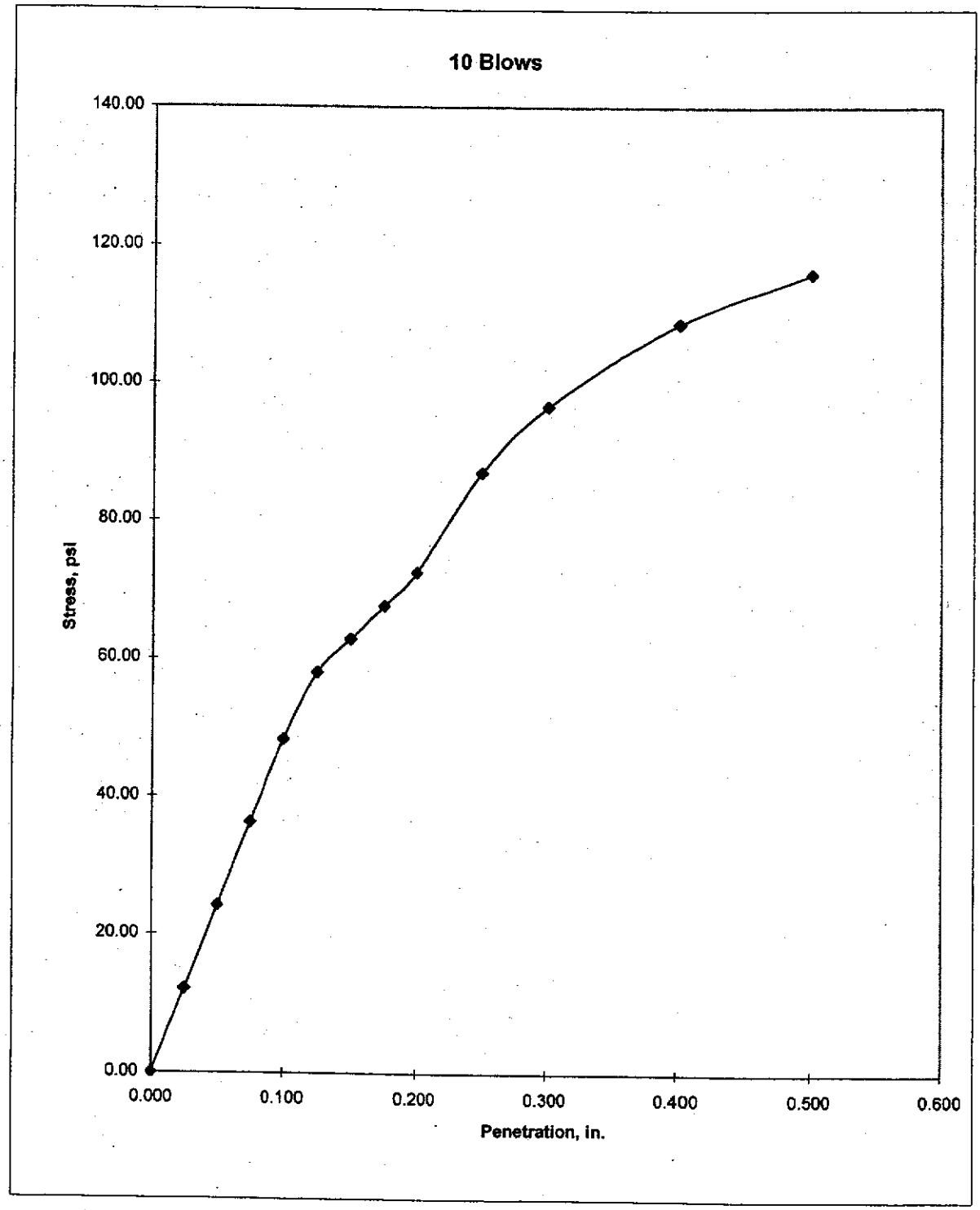
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



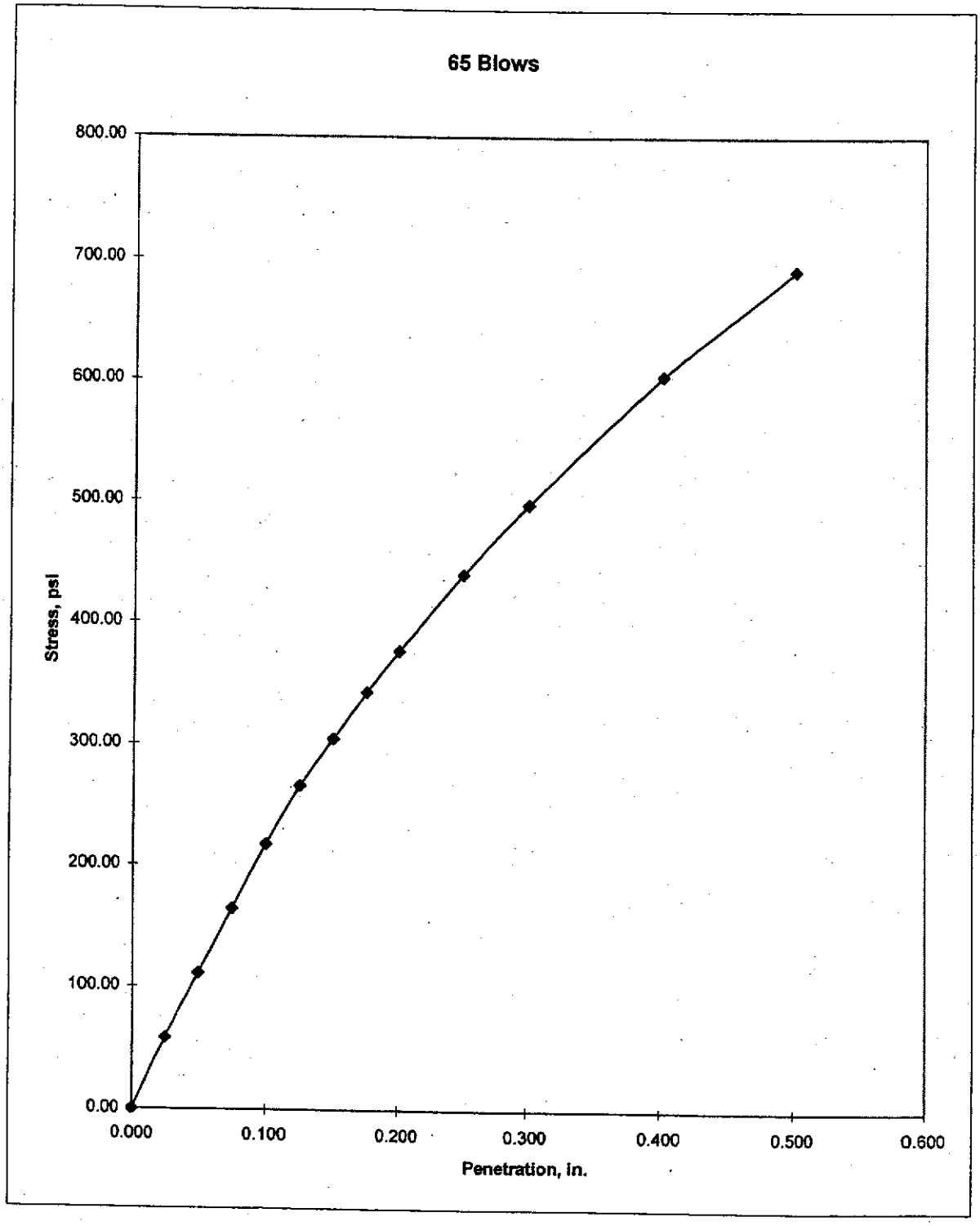
Project:	C&O Canal	
Project No:	URS	
Sample Location:	P-9	
CBR at 95% of maximum dry density:	12.5	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	116.6	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Silty clay with sand trace gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	P-9
Project No:	F68-152D	Dry density	103.2



Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 119.1



COMPACTION TEST REPORT

Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	CL		21.6	2.65			3.7	63.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 117.4 pcf Optimum moisture = 11.6 %	Brown Very Silty clay with sand trace gravel

Project No. F68-152D **Client:** URS Corporation
Project: C&O Canal

● **Location:** R-5

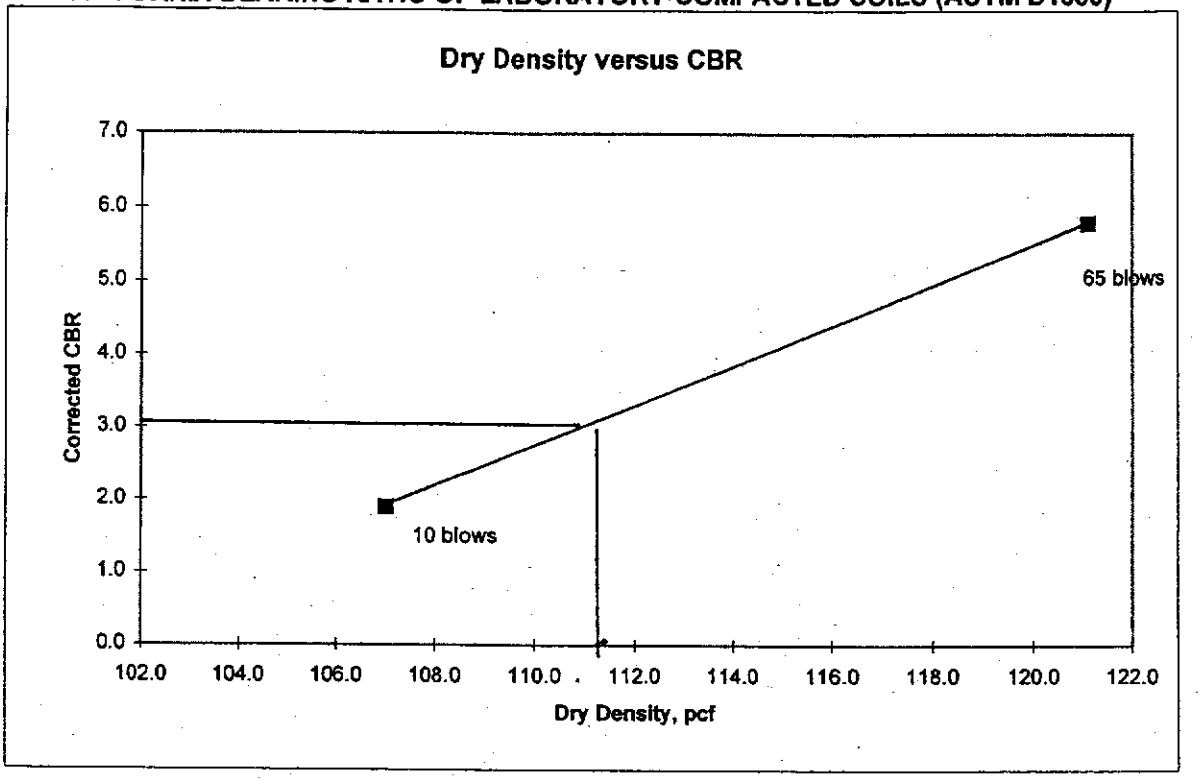
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

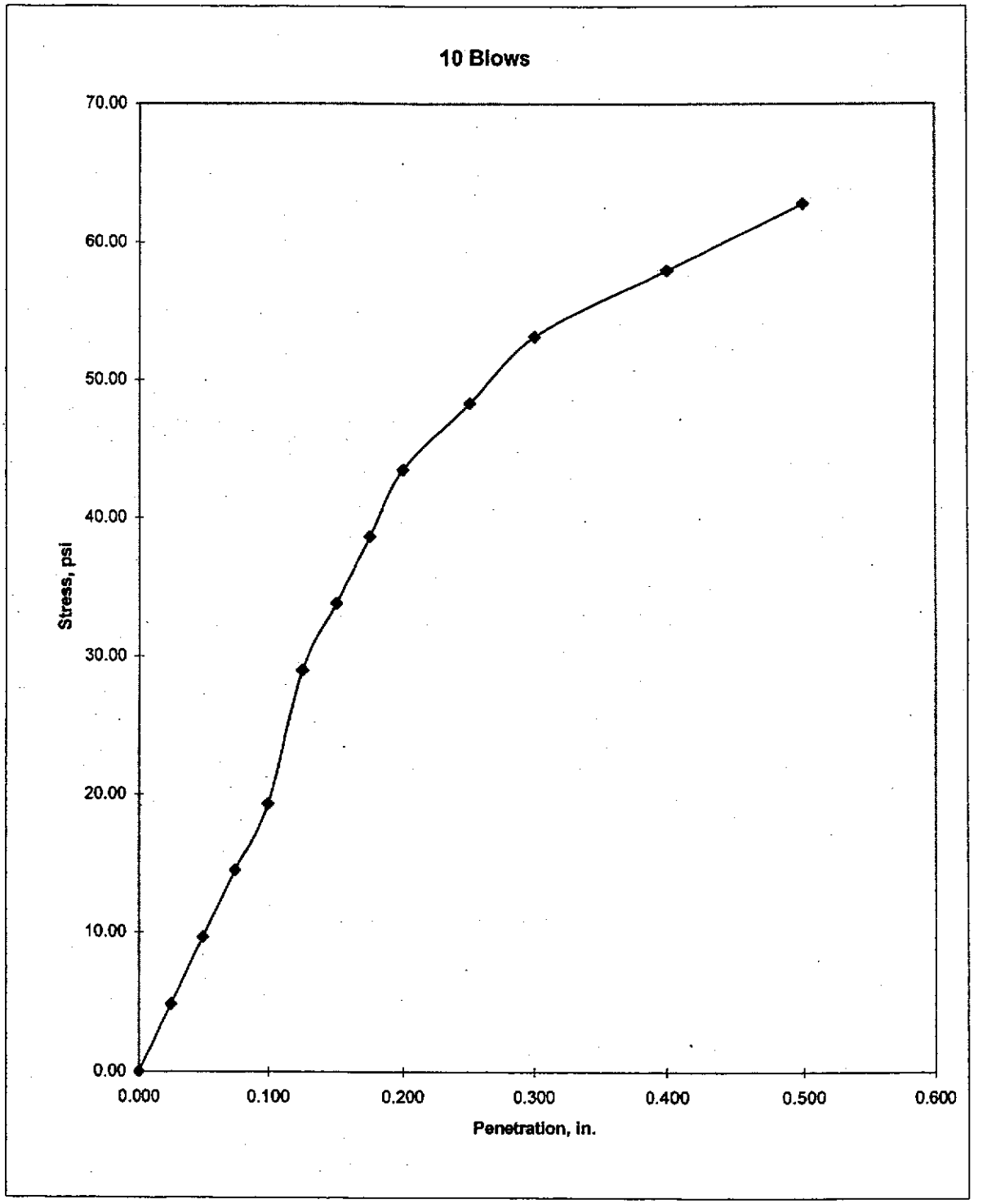
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



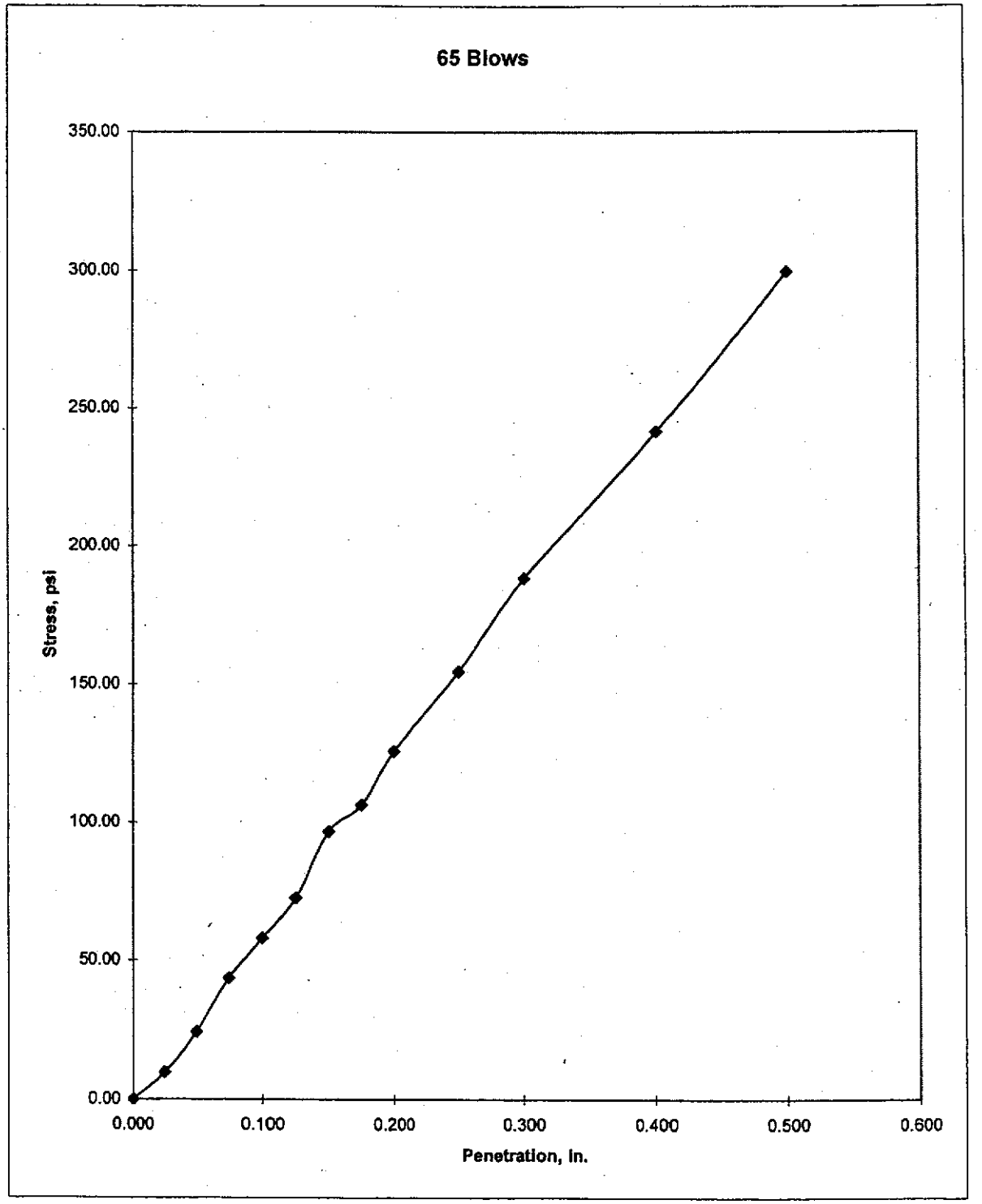
Project:	C&O Canal	
Project No:	URS	
Sample Location:	R-5	
CBR at 95% of maximum dry density:	3.1	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	117.4	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Silty clay with sand trace gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	R-5
Project No:	F68-152D	Dry density	107.0

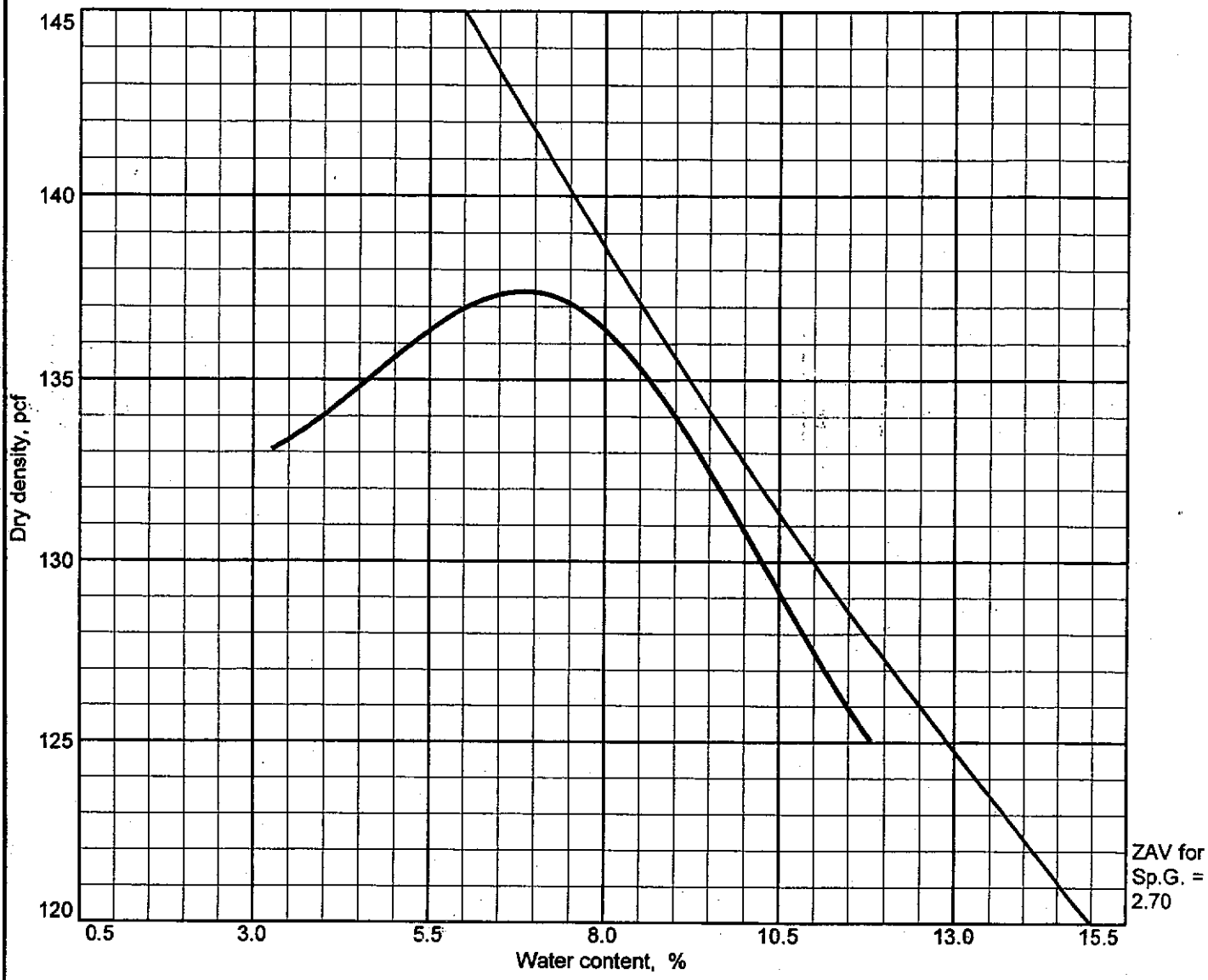


Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 121.1



COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	SM		5.8	2.70			3.7	30.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 137.4 pcf Optimum moisture = 6.9 %	Olive green, Very silty sand trace gravel

Project No. F68-152D **Client:** URS Corporation
Project: C&O Canal

● **Location:** R-8 Bulk

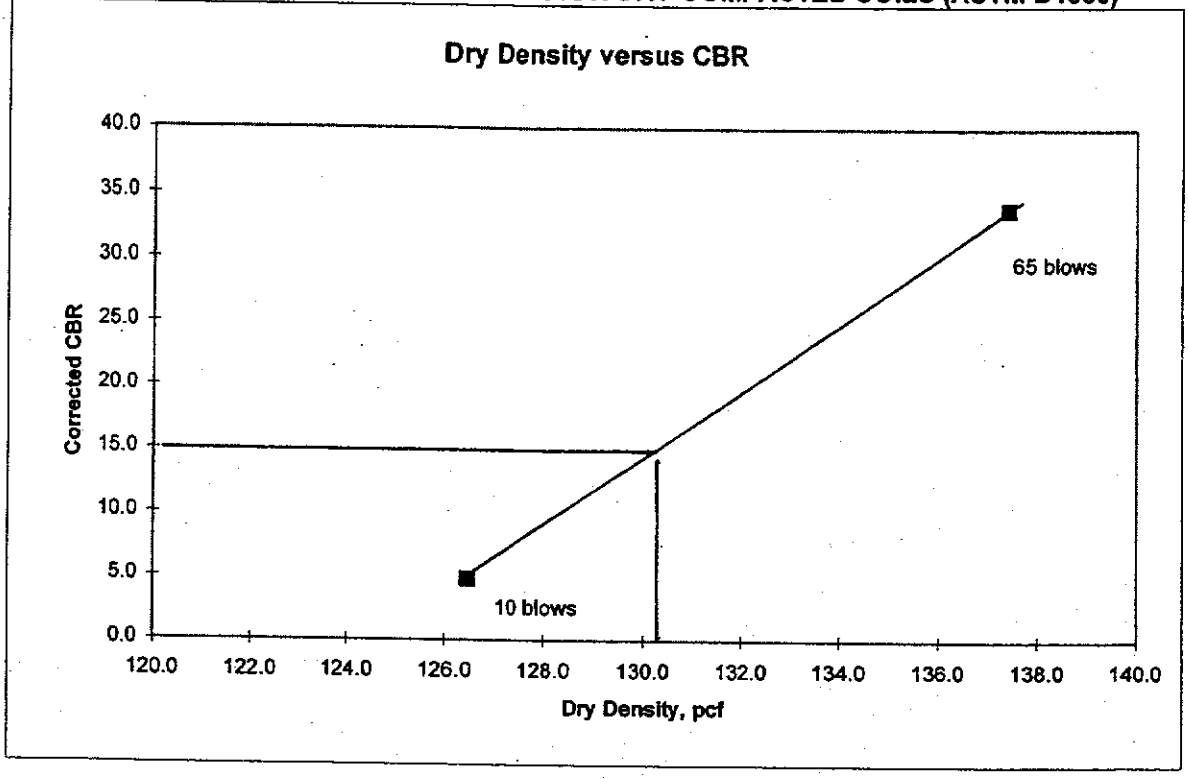
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

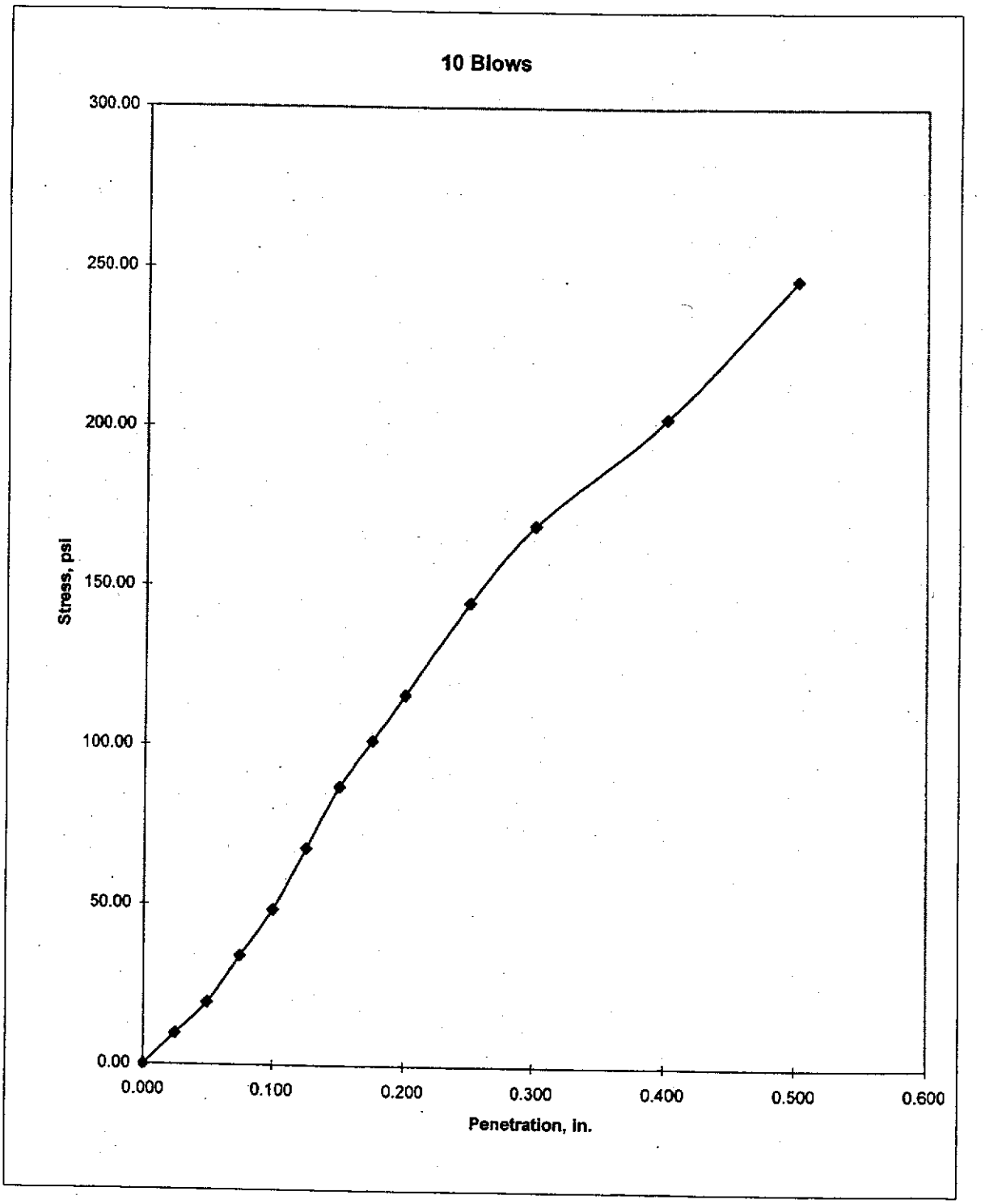
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



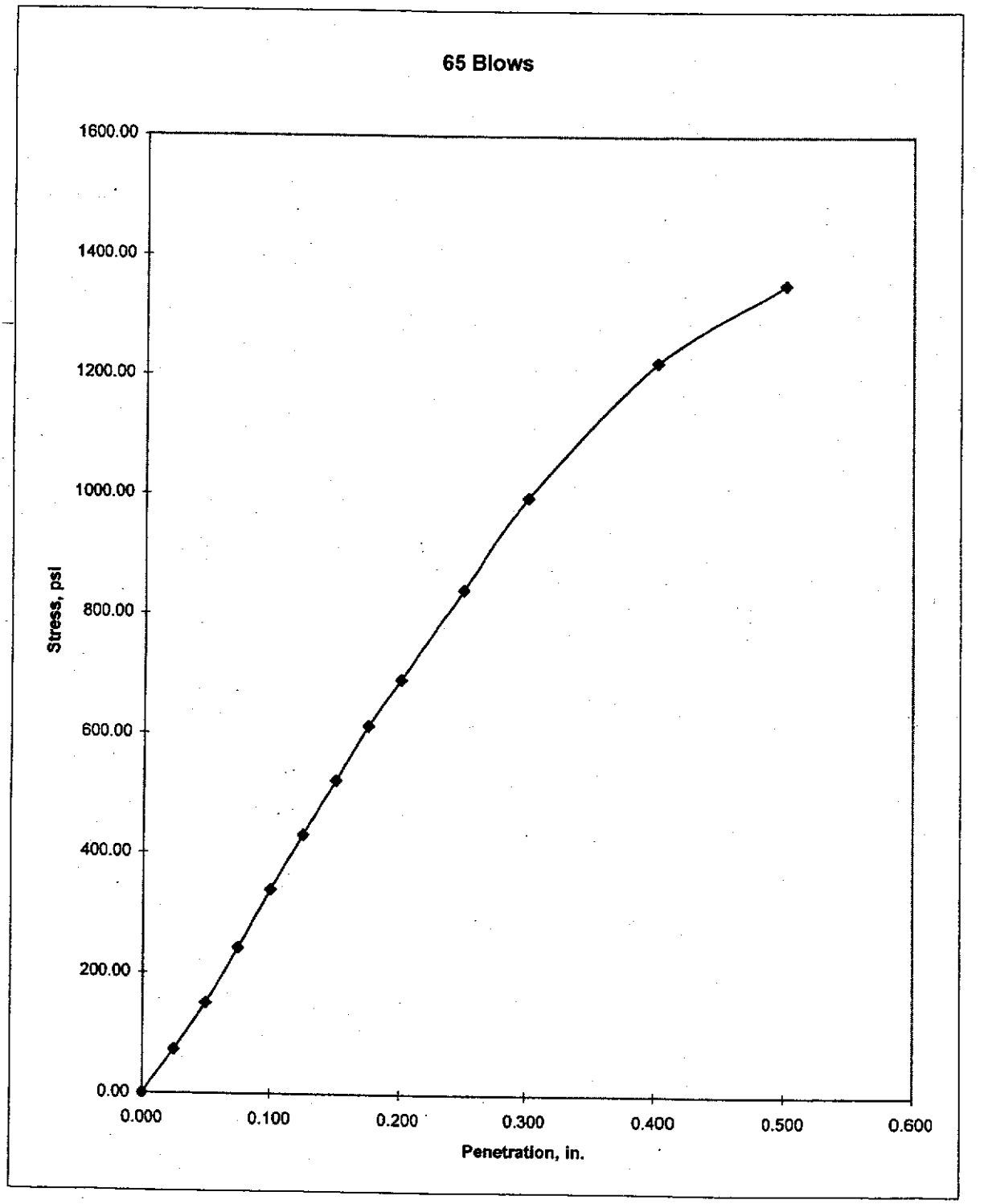
Project:	C&O Canal	
Project No:	URS	
Sample Location:	R-8	
CBR at 95% of maximum dry density:	15.0	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	137.4	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Very silty sand little gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	R-8
Project No:	F68-152D	Dry density	126.4

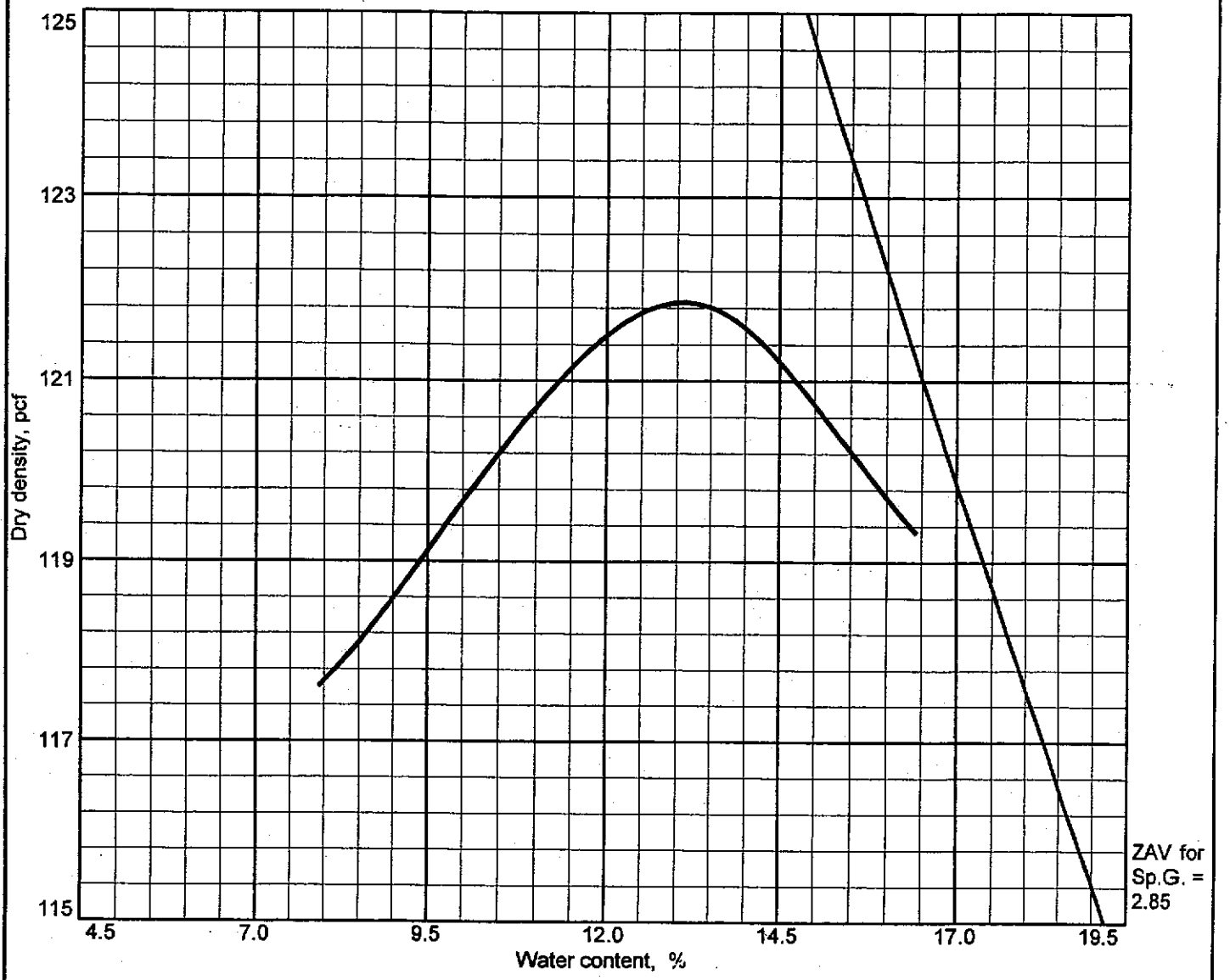


Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 137.4



COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML-SM		18.7	2.85			6.1	51.7

TEST RESULTS

Maximum dry density = 121.9 pcf

Optimum moisture = 13.1 %

MATERIAL DESCRIPTION

Brown Silt and fine sand trace gravel

Project No. F68-152D **Client:** URS Corporation

Project: C&O Canal

• **Location:** R-10

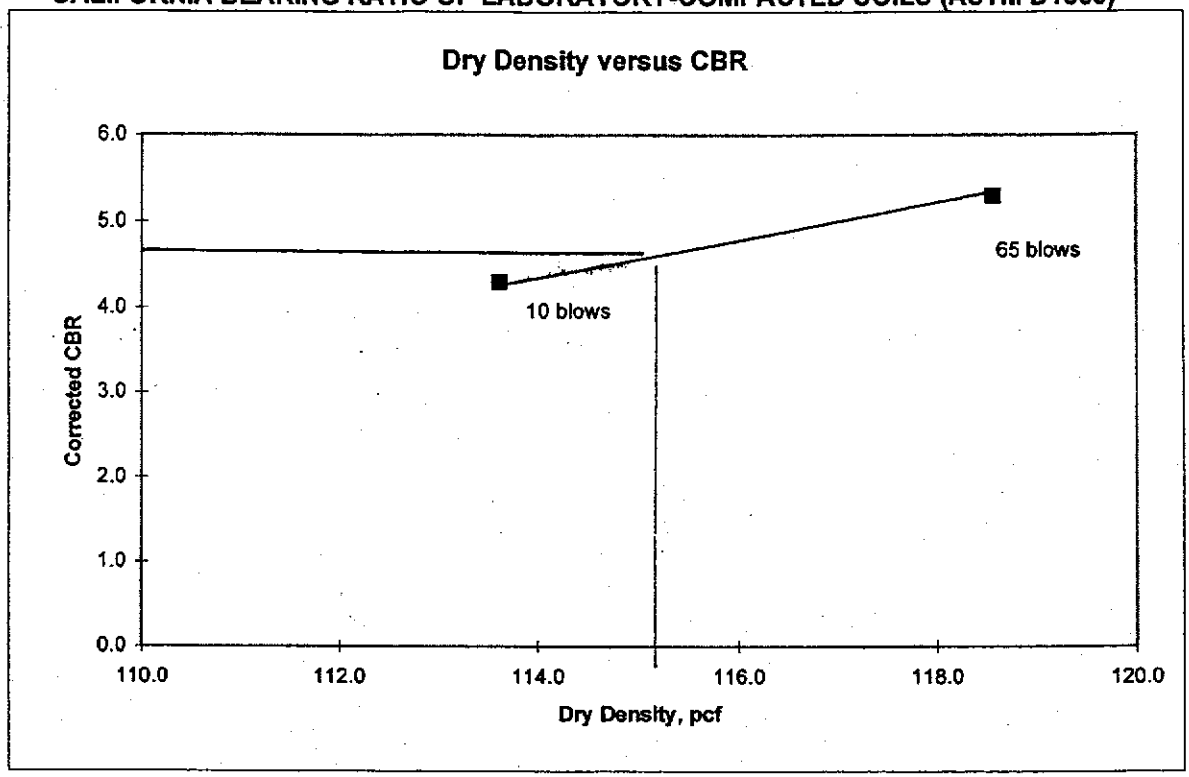
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

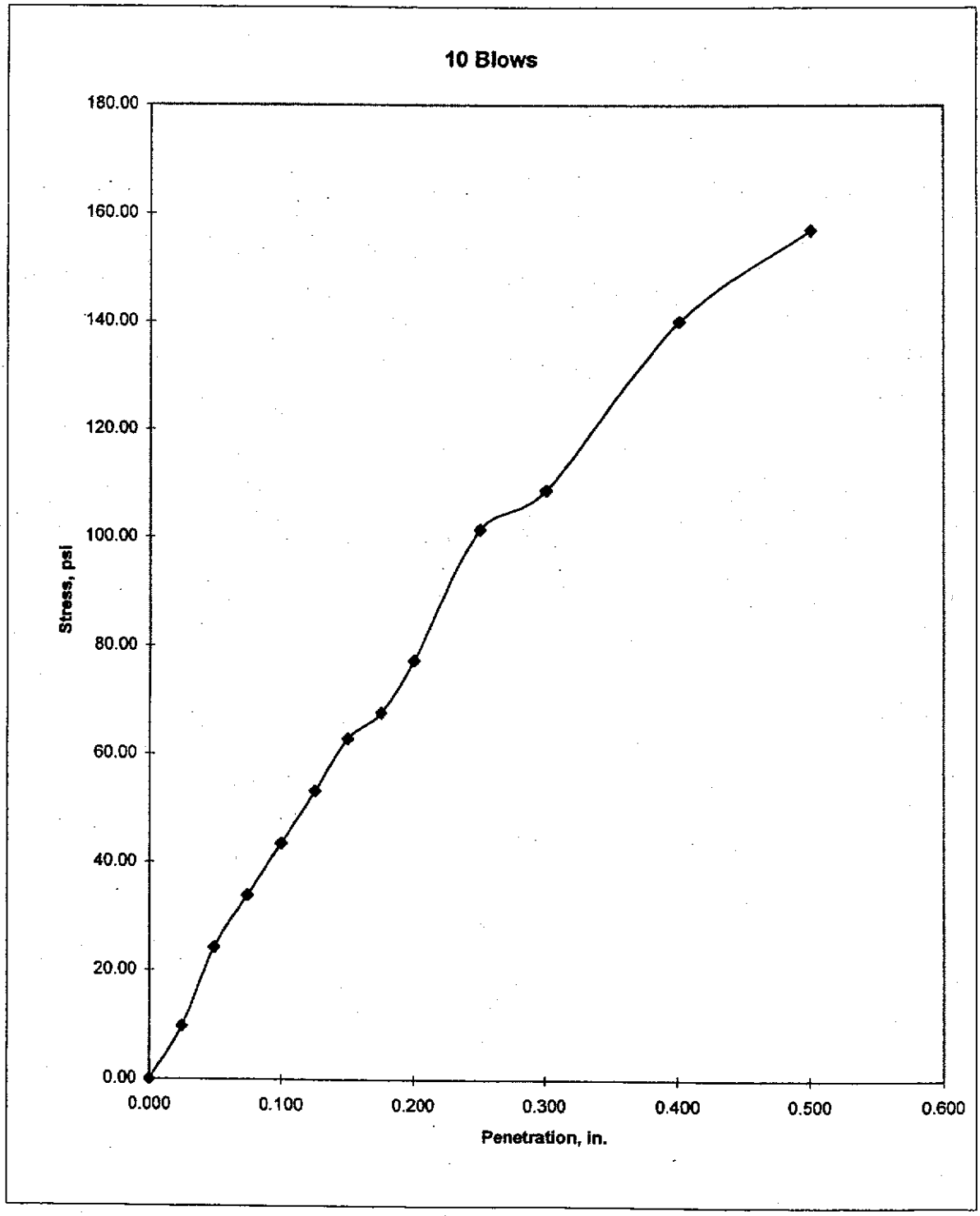
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



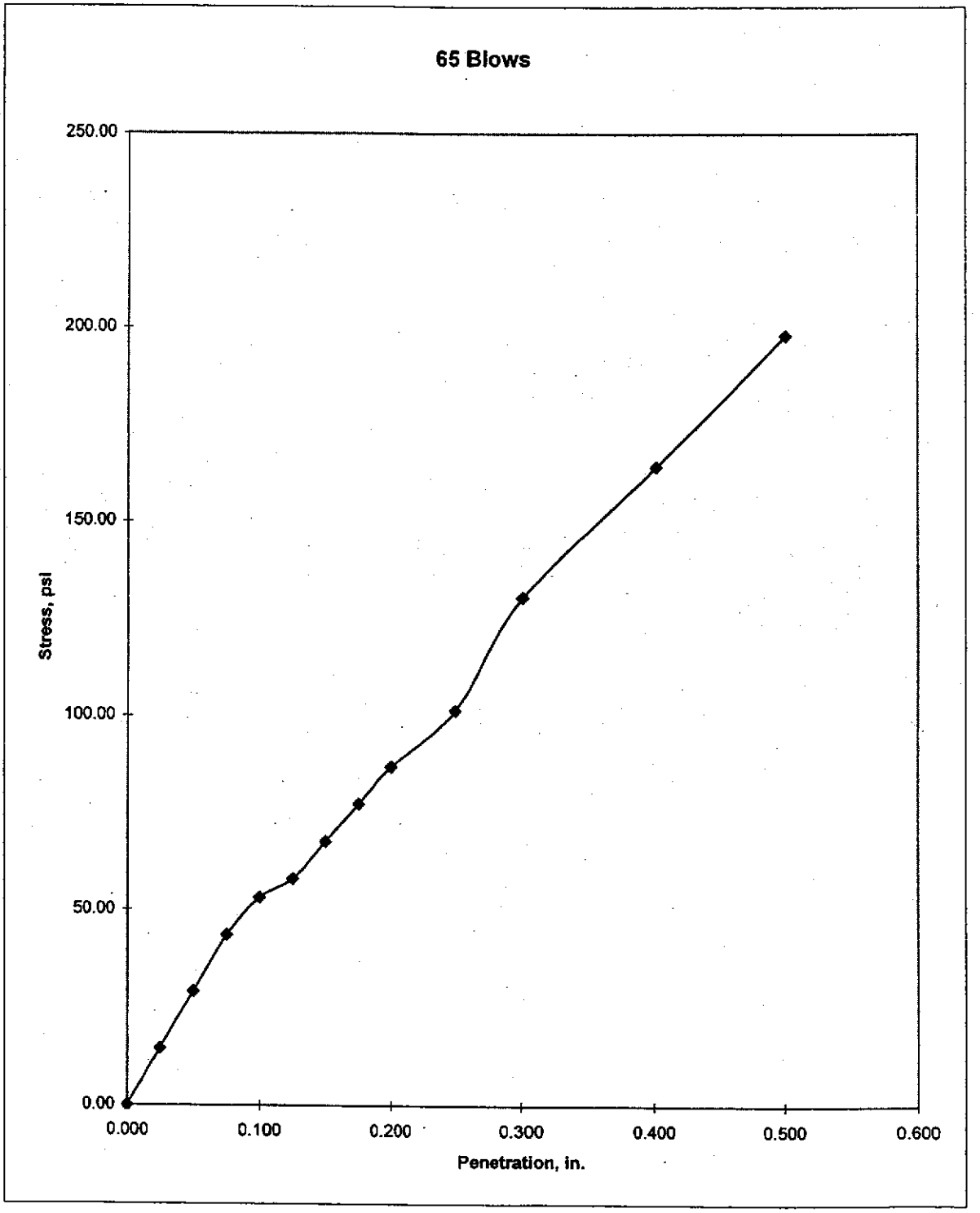
Project:	C&O Canal	
Project No:	URS	
Sample Location:	R-10	
CBR at 95% of maximum dry density:	4.6	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	121.9	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Silt and fine Sand, trace gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	R-10
Project No:	F68-152D	Dry density	113.6

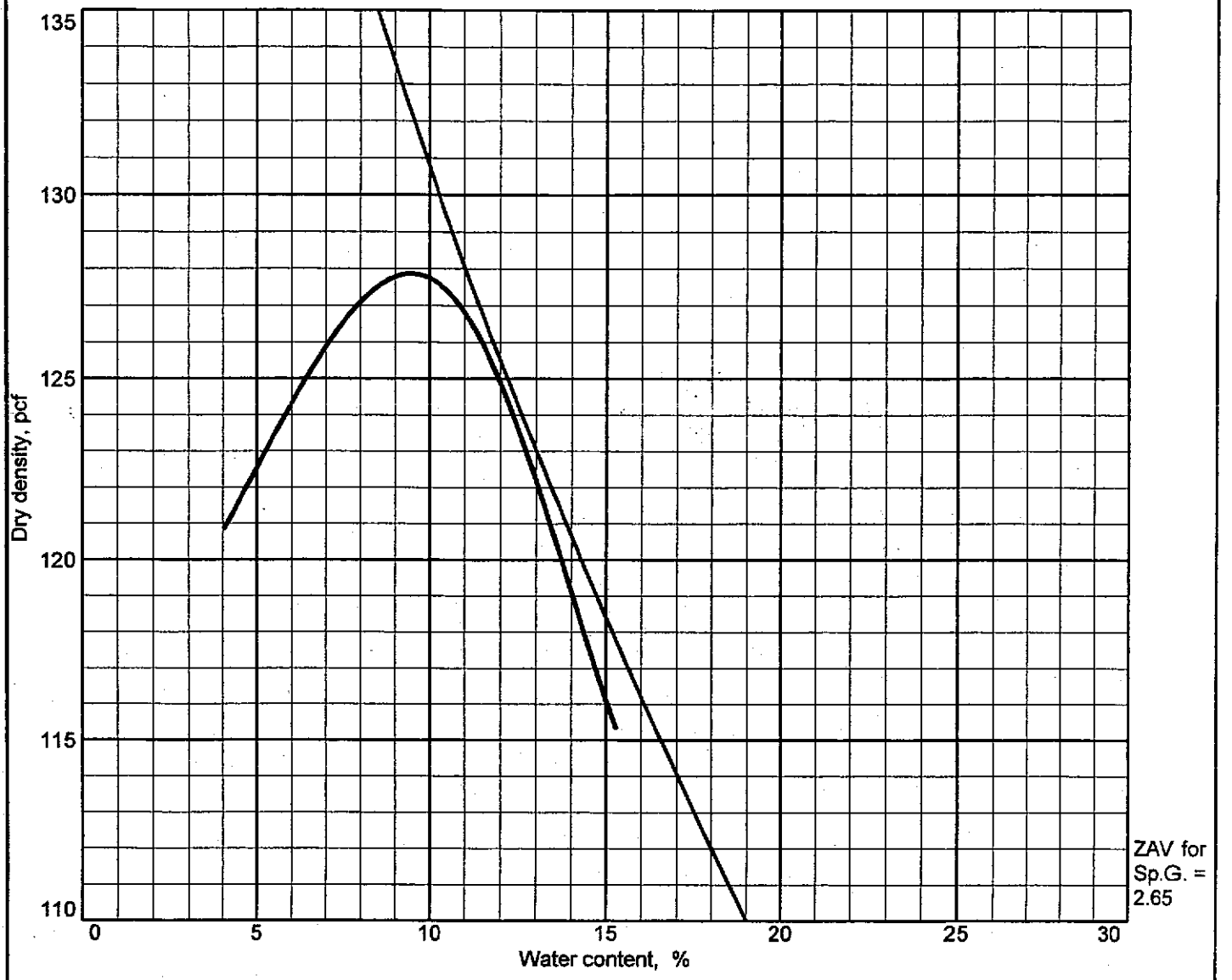


Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 118.6



COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	SM-ML		12	2.65			2.4	48.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 127.9 pcf Optimum moisture = 9.5 %	Brown Fine sand and silt, trace gravel

Project No. F68-152D **Client:** URS Corporation
Project: C&O Canal

• **Location:** R-12

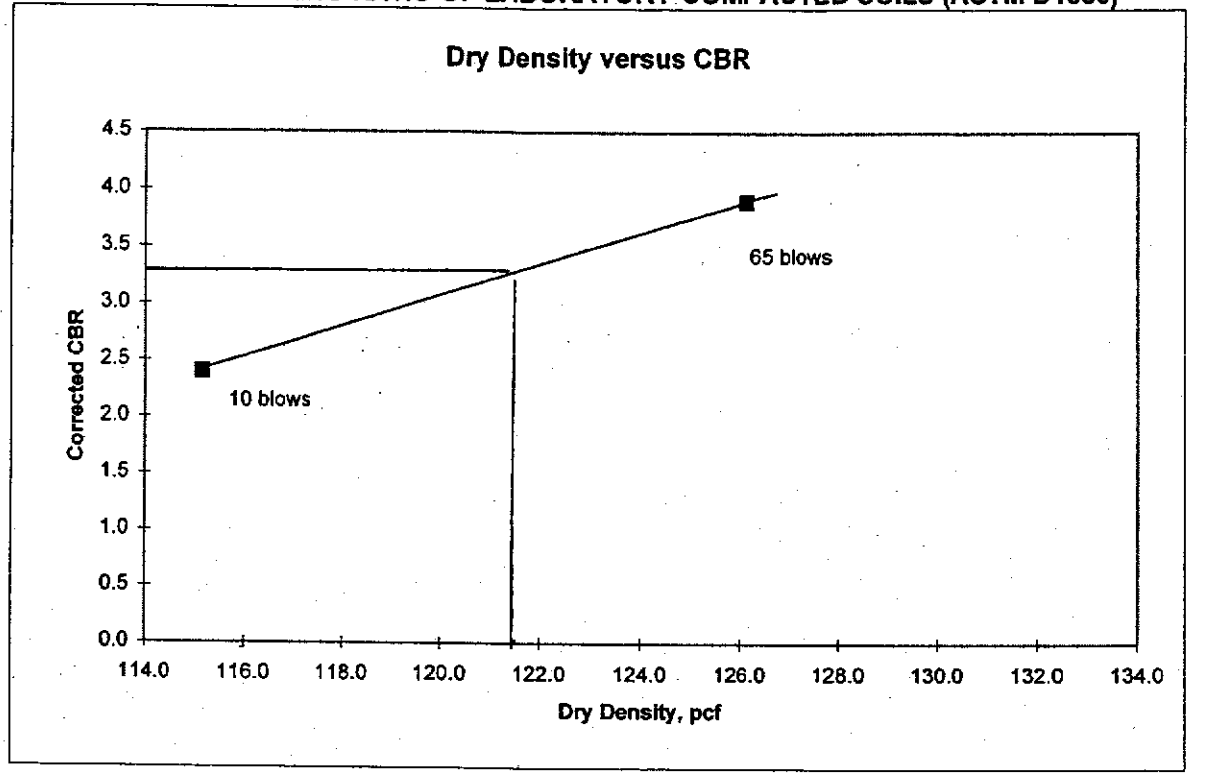
Remarks:

COMPACTION TEST REPORT

FROEHLING & ROBERTSON, INC.

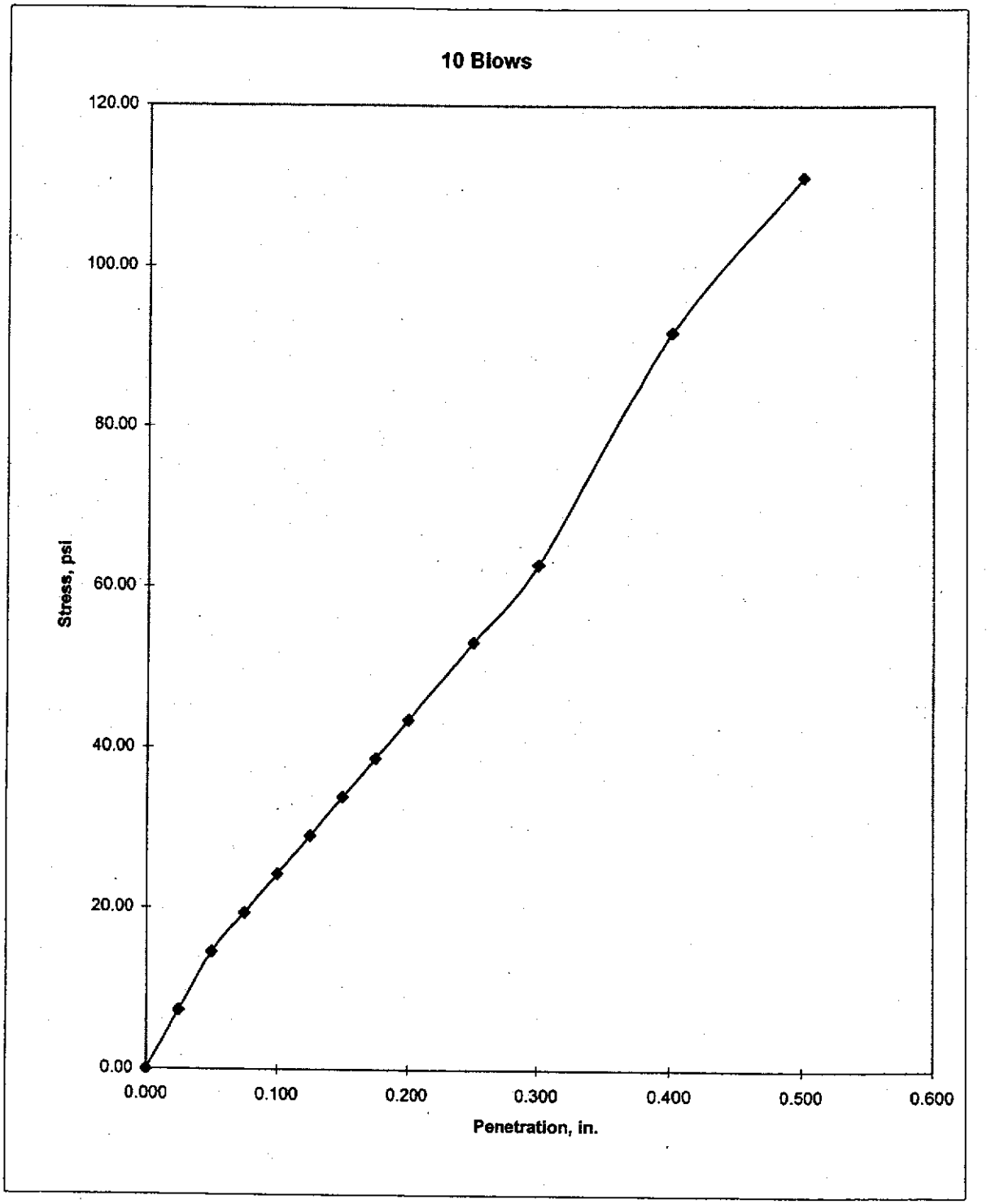
Plate

CALIFORNIA BEARING RATIO OF LABORATORY-COMPACTED SOILS (ASTM D1883)



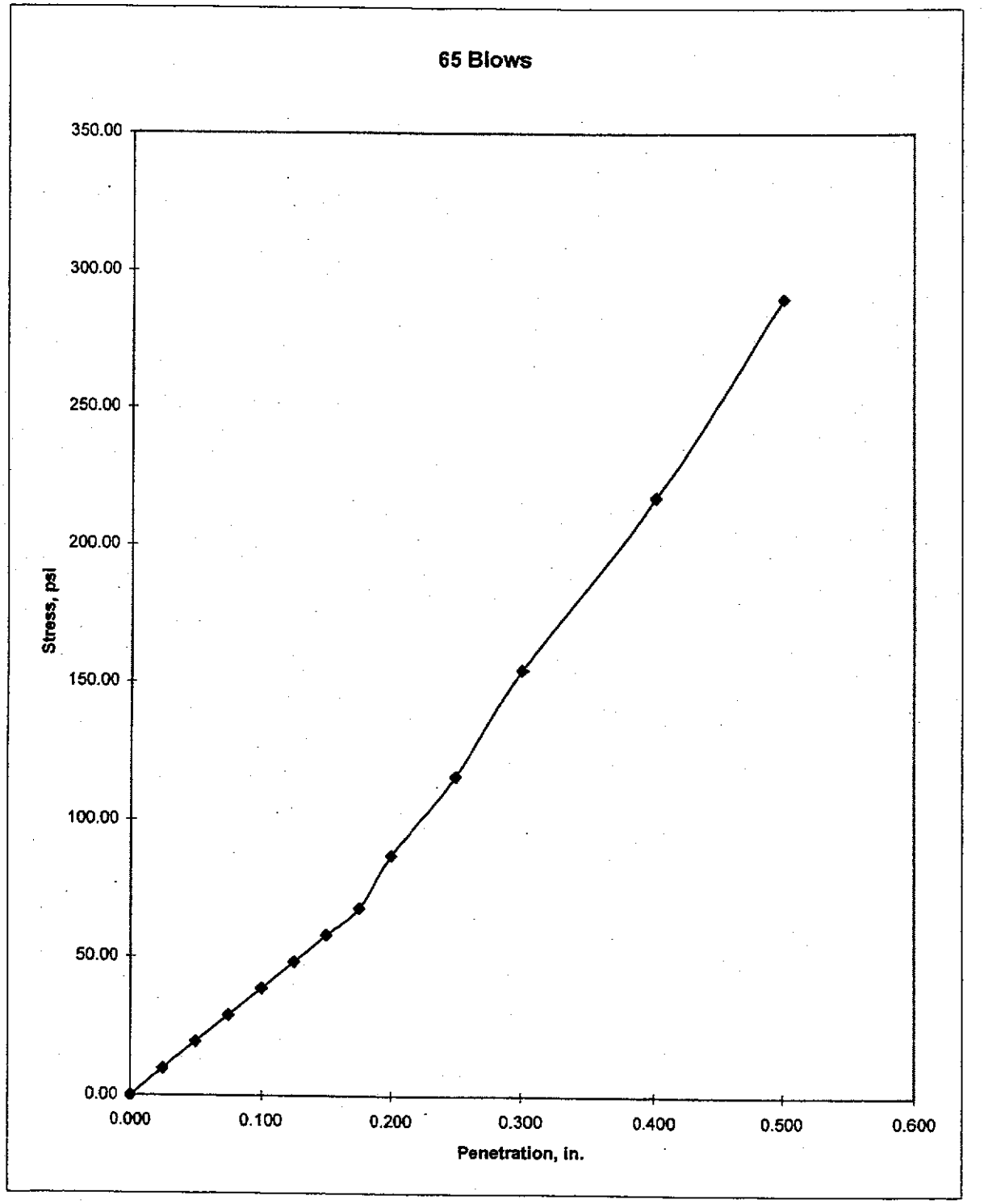
Project:	C&O Canal	
Project No:	URS	
Sample Location:	R-12	
CBR at 95% of maximum dry density:	3.3	CBR Values based on penetrations at 0.1"
Maximum Dry Density, (pcf):	127.9	
Sample Number:	Bulk No. 1	
Soil Description:	Brown Silt and fine sand trace gravel	

Project:	C&O Canal	Sample No:	Bulk No. 1
Client:	URS	Location:	R-12
Project No:	F68-152D	Dry density	115.2



Project: C&O Canal
Client: URS
Project No: F68-152D

Dry Density(pcf) 126.1



Flexible Pavement

Condition Survey Data Sheet for Sample Unit

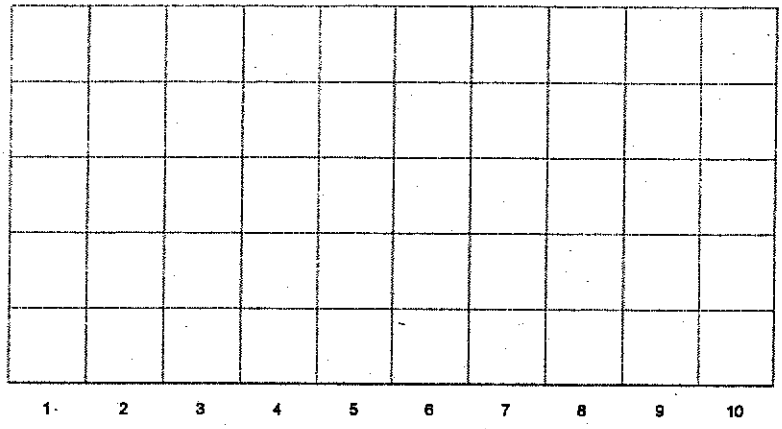
Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Roadway	Section	Sample Unit # 10
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 800 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

Sta.



Existing Distress Types

		①	⑩	⑲	⑲ Edge Spall	①	
		53'x1' L	73' L	28'x1' M	32'x1' M	36'x5' L	
		27'x1' L	10' M	11'x1' L			
				31'x1.5' L			
				15'x5' L			
Total Severity	L	80	73	147.5		180	
	M		10	28	32		
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 65

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Cheasbeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 13
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4,000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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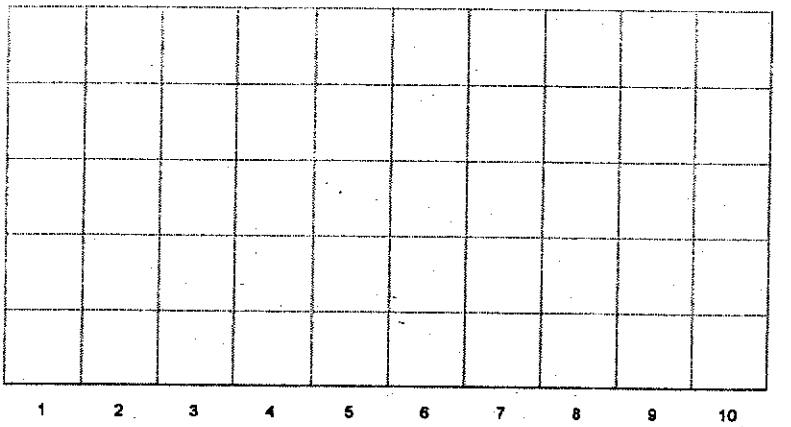


* edge of road

Existing Distress Types

		(19)	(11)	(1) *	(10)	(6)	(3)
		35 x 5 H	17 x 3 M		8 M	8 x 1 (1") M	4 x 16 L
		3 x 3 H		16 x 3 H	12 H		
		40 x 7 M		20 x 3 M	52 M		
		7 x 2 H		8 x 1 M			
		8 x 3 M		58 x 3 M			
		18 x 1 H					
		38 x 1 L					
Total Severity	L	38					56
	M	304	51	242	60	8	
	H	222		48	12		

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 28

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

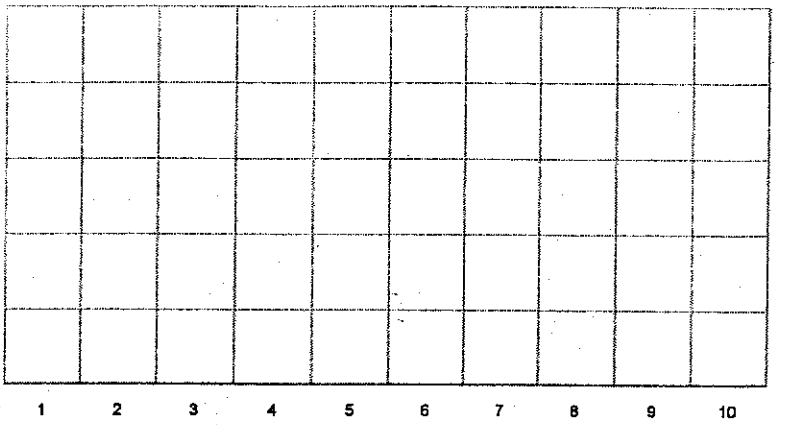
Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 16
Surveyed By Jason Kotova & Kwok-leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

Sta.



Existing Distress Types

		(10)	(1)	(19)	(12)		
		136 M	49 x 7 L	25 x 3 L	34 x 1 M		
			45 x 3 L	16 x 1 H			
				29 x 1 M			
Total Severity	L		478	75			
	M	136		29	34		
	H			16			

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 56

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

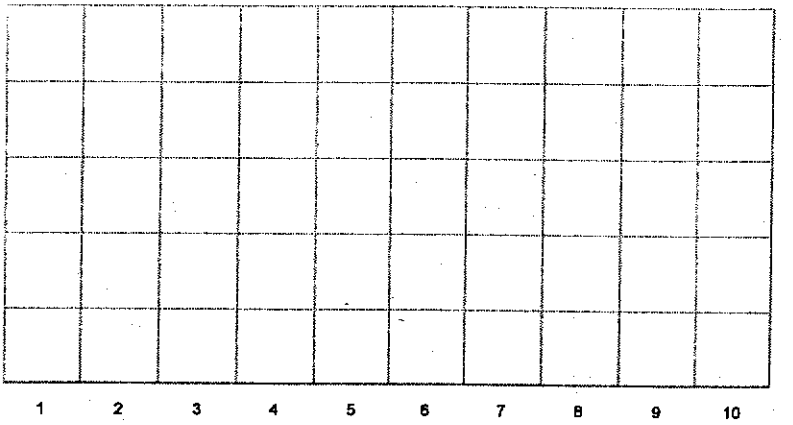
Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 18
Surveyed By Jason Kotova & Kwok-leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

Sta.



Existing Distress Types

		(19)	(1)				
		25x3 M	42x2 L				
		25x2 M	100x3 L				
		38x2 M	23x3 L				
		38x1 L					
		35x1 M					
		100x4 M					
		14x2 L					
		17x2 L					
Total Severity	L	100	459				
	M	636					
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 57

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/14/04
Branch	Roadway	Section	Sample Unit 21
Surveyed By	Jason Kotova & Kwok-leung Li	Area of Sample	4,000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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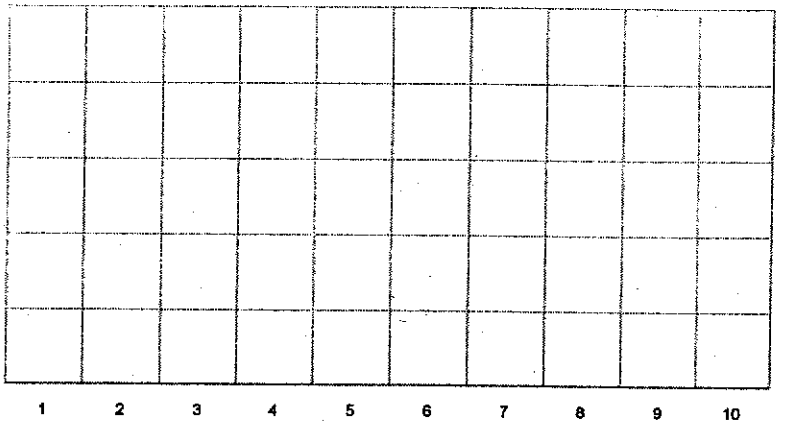


Note: Asphalt ditch west side

Existing Distress Types

		(1)	(1)	(19)	(10)	(1)	(6)
		60x2.5 L	27x2 L	58x1 L	60 L	18x0.5 L	2x0.5(1")M
			27x1.5 L	30x1 L	13 L		
			50x1 L	23x1 L	21 L		
			53x1 L		8 L		
Total Severity	L	150	212.5	111	102	9	
	M						1
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 63

Flexible Pavement

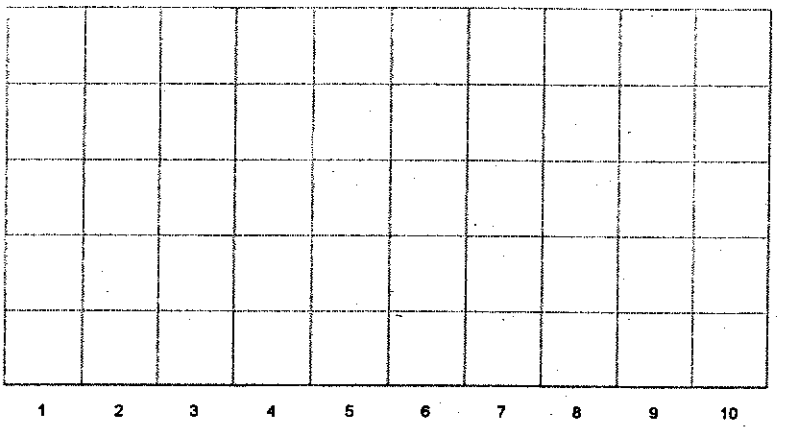
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park			Date 12/14/04
Branch Roadway	Section		Sample Unit 24
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4,000 ft²		

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(19)	(10)	(1)	(1)		
		26x3 L	17 L	33x2 L	54x2 M		
		13x2 L	24 M	11x2 L	56x1.5 M		
		20x2 L	30 L	45x1 L	27x1.5 H		
		30x1 M					
		18x2 L					
Total Severity	L	180	47	133			
	M	30	24		192		
	H				40.5		

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 39

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 27
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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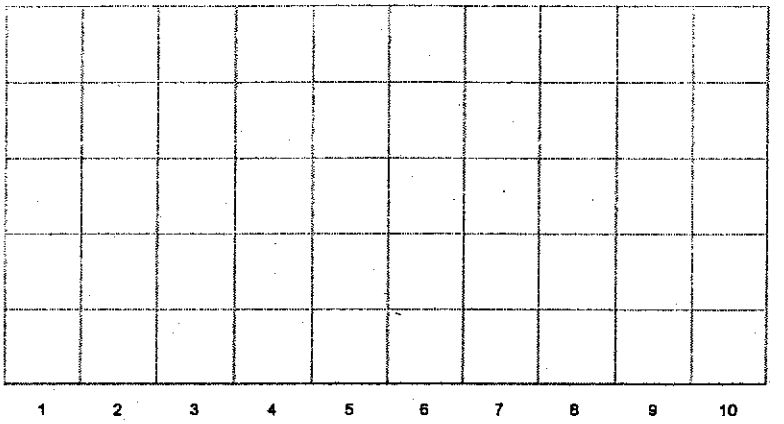


* Raveling within this section

Existing Distress Types

		(10)	(1)	(19)	(6)		
		14 L	23x0.5 L	26x1 H	40x1.5 (1") M*		
		91 M	160x35 M*				
		46 L	40x1.5 M				
		9 M					
Total Severity	L	60	11.5				
	M	100	620		60		
	H			26			

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 39

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

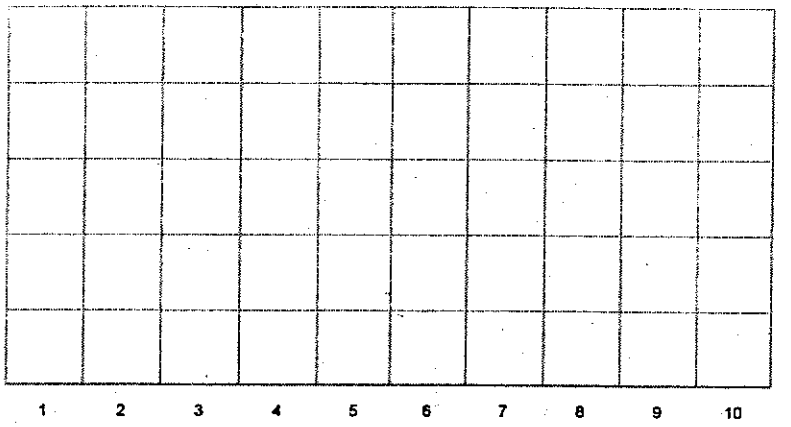
Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 30
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

Sta.



* near entrance

Existing Distress Types

		(10)	(19)	(1)	(11)*	(1)	
		10 M	35x2 M	34x2 M	9x2 L	27x25 L	
		38 M	1x0.5 H	45x2 L	16x3 L		
		17 M	12x3 M		3x1.5 L		
			17x4 M				
			8x1 L				
			3x2 L				
			7x2 L				
			4x1 H				
Total Severity	L		28	90	70.5	67.5	
	M	65	174	68			
	H		45				

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 55

Flexible Pavement

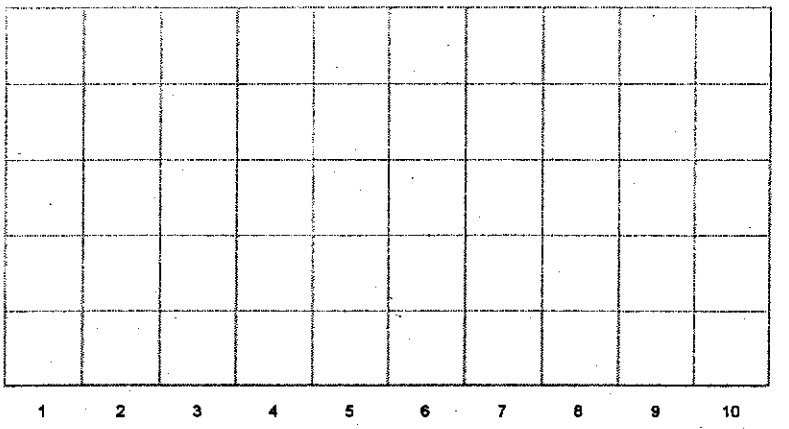
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 33
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(1)	(10)	(11)	(19)	(1)	(6)
		50x25M	20 M	3x2 L	5x2 M	18x2 L	3x2 (<1")
		42x1.5L	23 L		1x0.5H		
		23x1 L	17 M		30x4 L		
		60x1M	10 M				
		35x2 M					
		20x1.5M					
		17x1 L					
		20x1.5M					
Total Severity	L	103	23	6	120	36	6
	M	315	51		10		
	H				0.5		

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 46

Flexible Pavement

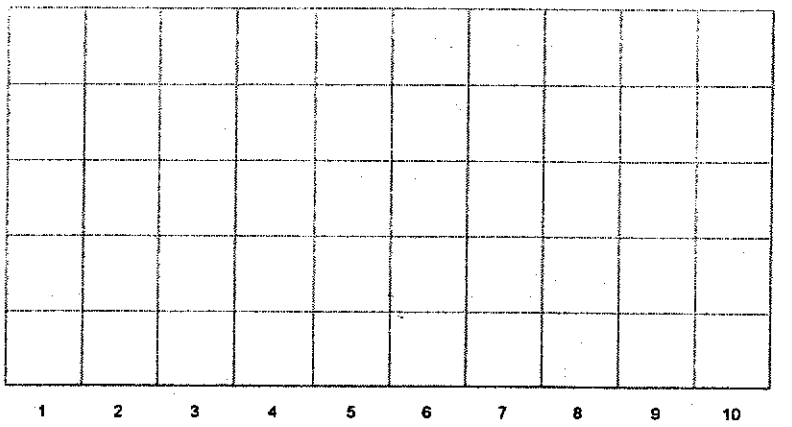
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 36
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4,000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(1)	(17)	(19)	(19)	(10)	
		45x1.5 M	20x1 M	15x2 L	9x1 H	15' L	
		24x1 M		31x2 L		11 L	
		52x1.5 M		13x1 L		28 M	
		21x1 M					
		35x1L					
		20x1.5 M					
Total Severity	L	35		105		26	
	M	922.5	20			28	
	H				9		

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 35

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/14/04
Branch Roadway	Section	Sample Unit 39
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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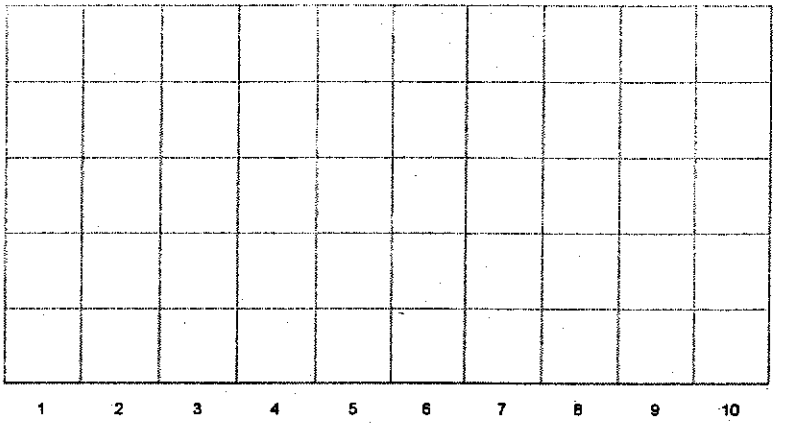


Existing Distress Types

		(10)	(1)	(19)	(1)		
		24 M	15x1 L	56x1 L	27x1 L		
		117 L	28x1 L	44x2 L			
		34 M					
		24 L					
		38 L					
		32 M					
		11 L					
Total Severity	L	182	43	144	27		
	M	96					
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 73

Flexible Pavement

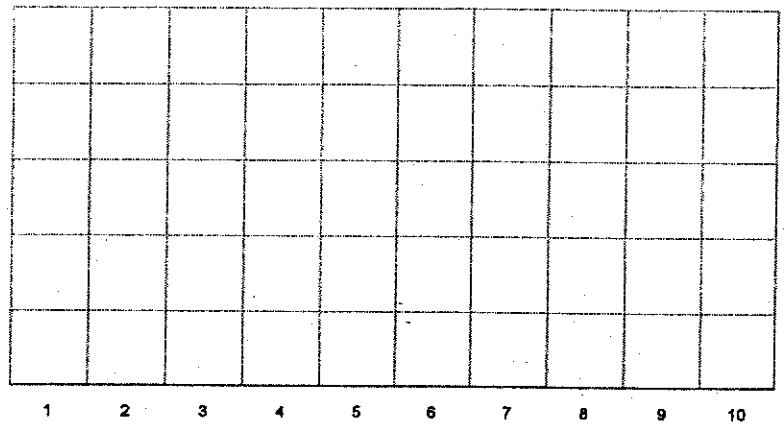
Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park	Date	12/14/04
Branch	Roadway / Parking Lot w/concrete	Section	Sample Unit 1
Surveyed By	Jason Kotova & Kwok-Leung Li	Area of Sample	4000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(8)	(10)	(1)	(10)	(3)	
		19'H	19'L	3'x1'M	18'H	19'x6'M	
		42'M	2'L		5'L		
		95'L	12'L		13'L		
		19'H	19'M				
		18'H	6'L				
		18'H	18'M				
		19'H	5+2'L				
		19'H					
Total Severity	L	95	46		18		
	M	42	37	3		114	
	H	112			18		

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 58

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park	Date 12/13/04
Branch Roadway / Parking Lot w/Concrete Section	Sample Unit #2
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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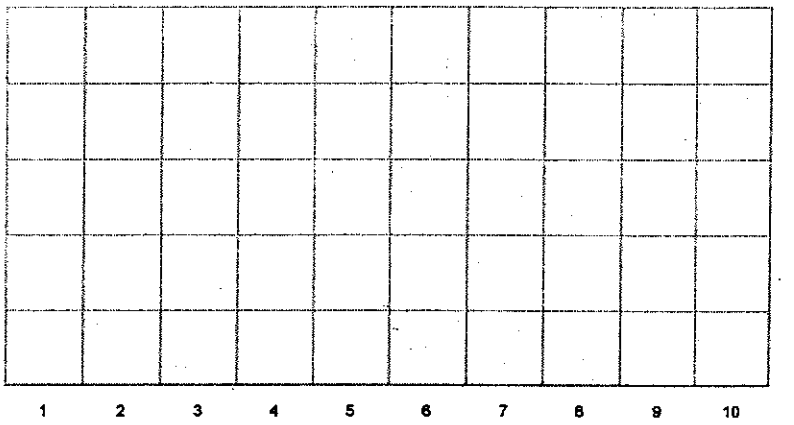

*(Likely Reflection)

Existing Distress Types

		(8) *	(1)				
		32' M	10'x0.5' L				
		30' H	4'x0.5' L				
		10' M					
		31' M					
		33' M					
		34' H					
		29' M					
		75' M					
Total Severity	L		1				
	M	210					
	H	64					

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 67

Flexible Pavement
Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/14/04
Branch	Roadway/Parking Lot w/ concrete	Section	Sample Unit 3
Surveyed By	Jason Kotova & Kwok-leung Li	Area of Sample	4000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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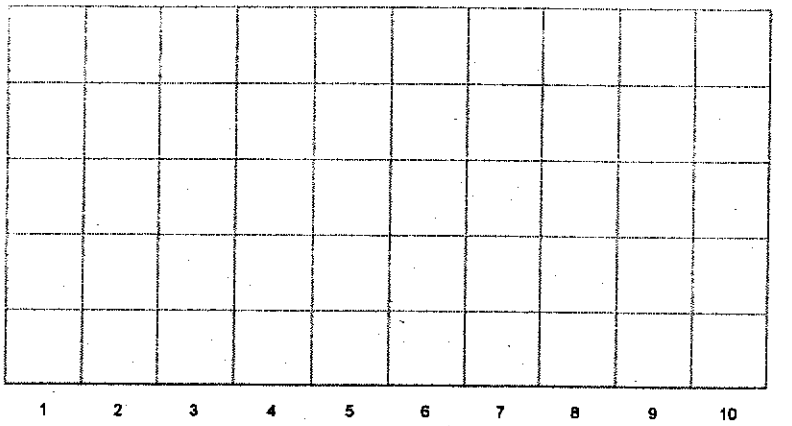


Existing Distress Types

		(10)	(8)	(10)	(1)	(3)	(19)
		28' H Paving ft	11' H	14' L	10'x2' M	26x20 L	26x17 L
		43' M Paving ft	10 M	10 H		20x15 L	5x40 L
			18 L	5 L		27x15 L	4x1 H
			30 H	14 L			
			32 H	9 L			
			32 H				
			22 H				
			32 H				
Total Severity	L		18	42		122	642
	M	43	10		20		
	H	28	159	10			4

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 47

Flexible Pavement

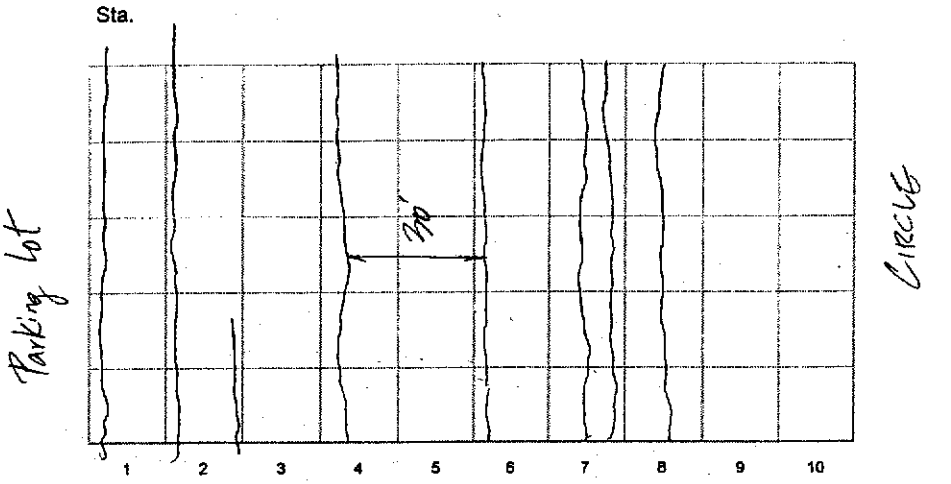
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Roadway/Parking Lot w/concrete	Section	Sample Unit 4
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



* Likely Reflection ** Crack open 5"

Existing Distress Types

		(13)*	(10)	(6)	(1)	(3)	(11)
		20' M	20' H**	20'x1' (1") M	12'x0.5' L	3'x3' L	0.5x20 M
		20' M	10' M		10'x3' L		0.5x20 M
		20' H	20' M				
		20' H	10' M				
		20' H					
		20' M					
		10' M					
		20' H					
Total Severity	L						
	M	10	200	20	36	9	20
	H	80	20				

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 54

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Roadway/Parking lot w/Concrete	Section	Sample Unit 5
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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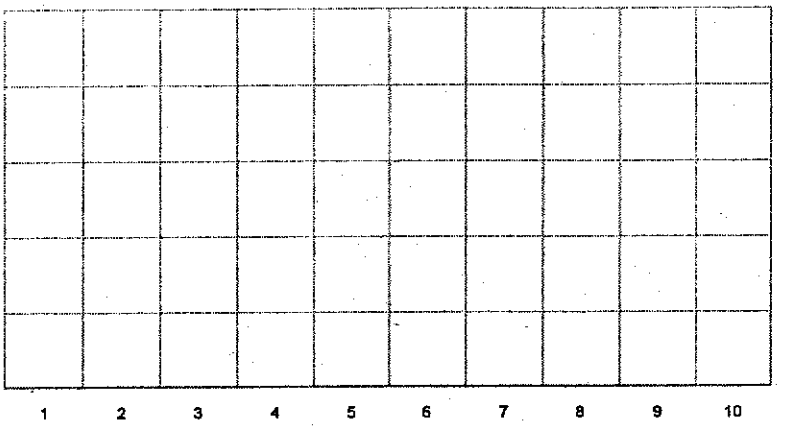


* Likely Reflection ** Concrete Exposed

Existing Distress Types

	(8)	(19)	(10)	(6)		
	170' M	4'x3' H**	61 M*	30x1 (4")L		
	30' H	50x2 L	37 L			
	30' H	50x1 L	73 L			
	14' L	1'x1' H	22 L			
	30' M	20x1 L				
	30' H	24x1 L				
	30' H					
	30' H					
Total Severity L	14	194	132	30		
M	200		61			
H	150	13				

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 50

Flexible Pavement

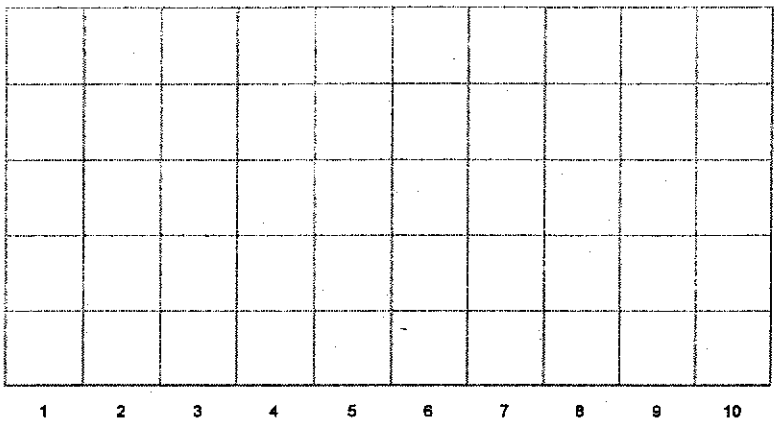
Condition Survey Data Sheet for Sample Unit

Project: Chesapeake and Ohio National Park		Date: 12/13/04
Branch: Parking Lot	Section	Sample Unit: 1
Surveyed By: Jason Kotova & Kwok-Leung Li	Area of Sample: 5,000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(3)	(1)	(11)	(19)		
		5% M	15% M	Gravel Infill	1'x1'		
		5% M		75% H	1'x2'		
Total Severity	L						
	M	500 ft²	750 ft²				
	H			3750 ft²	3 ft²		

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(3)	M	10	24
(1)	M	15	60
(11)	H	75	93
(19)	H	0.1	6
	Deduct Total		
	Corrected Deduct Value (CDV)		

PCI = 100 - CDV = _____

Rating = 13

Flexible Pavement

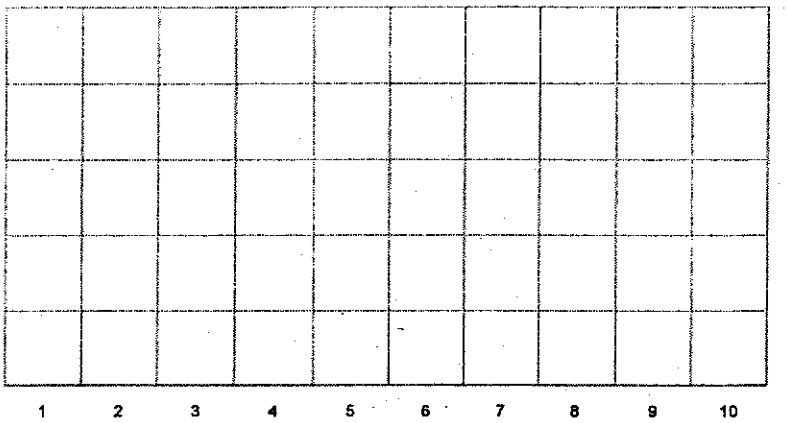
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Parking Lot	Section	Sample Unit 3
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 5000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

* Included with Alligator Cracking

		(3)	(1)	(19)	Gravel Infill*		
		19 x 100' L	12' x 100' H	19 x 100	7 x 100'		
		8' x 40' M		5% M			
				95% L			
				1' x 1'			
Total Severity	L	1900		1805			
	M	320		95			
	H		1200	1			

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(3)	L	38	26
(3)	M	6.4	20
(1)	H	24	87
(19)	L	1.9	25
(19)	M	36.1	38
(19)	H	0	0
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 22

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/13/04
Branch	Parking Lot	Section	Sample Unit 5
Surveyed By	Jason Kotova & Kwok-Leung Li	Area of Sample	000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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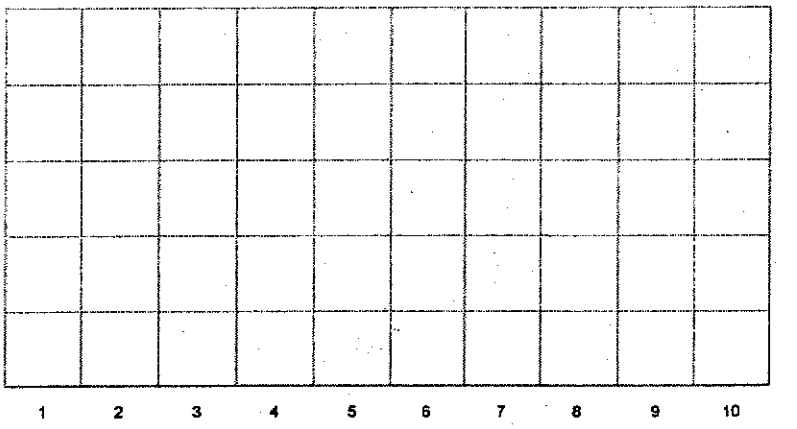


Existing Distress Types

		(3)	(6)	(1)	(10)		
		30'x14' L	6x3(1") M	10x11 H	61 L (Tree Root)		
		70'x18' L			73 M		
Total Severity	L	1680 ft²			61 ft		
	M		18 ft²		73 ft		
	H			110 ft²			

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(3)	L	33.6	25
(6)	M	3.6	27
(1)	H	2.2	47
(10)	L	1.2	5
(10)	M	1.5	13
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 51

Flexible Pavement

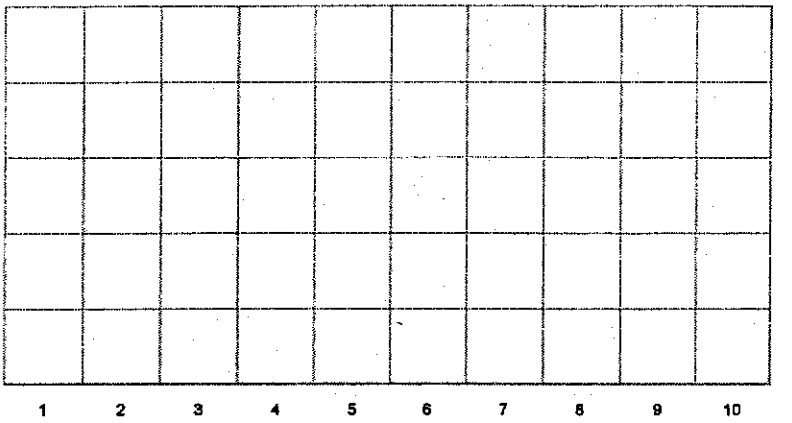
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Parking Lot	Section	Sample Unit 7
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 5000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(10)	(19)	(10)	(3)	(1)	(19)
		27' M Pavement	17'x100' L	20' L	80'x15' L	20'x4' L	15'x35' L
		24' M Pavement		22' M	20'x8' L		
		15' L Pavement		15' L			
				35' M (Tree Root)			
Total Severity	L	15	1700	35	1360	80	525
	M	61		57			
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	1	5
(10)	M	2.3	17
(19)	L	4.5	20
(3)	L	27.2	23
(1)	L	1.6	24
Deduct Total			
Corrected Deduct Value (CDV)			

PCI = 100 - CDV = _____

Rating = 68

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Parking Lot	Section	Sample Unit 9
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 5,000 ft^2	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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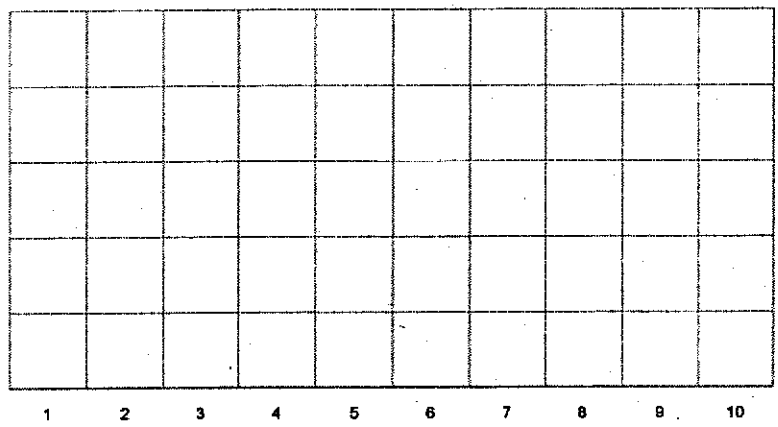

Existing Distress Types

		(10)	(10)	(3)	(19)	(1)	
		75' L Paving Jt.	55' M	100'x14' L	60'x9' L	17'x1' M	
			15' M	48'x10' M			
			22' L				
			16' M				
			5' L				
Total Severity	L	75	27	1400	540		
	M		86	480		17	
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	2.0	8
(10)	M	1.7	14
(3)	L	2.8	23
(3)	M	9.6	24
(19)	L	10.8	14
(1)	M	0.3	19
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 68

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Parking Lot	Section	Sample Unit 11
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 5,000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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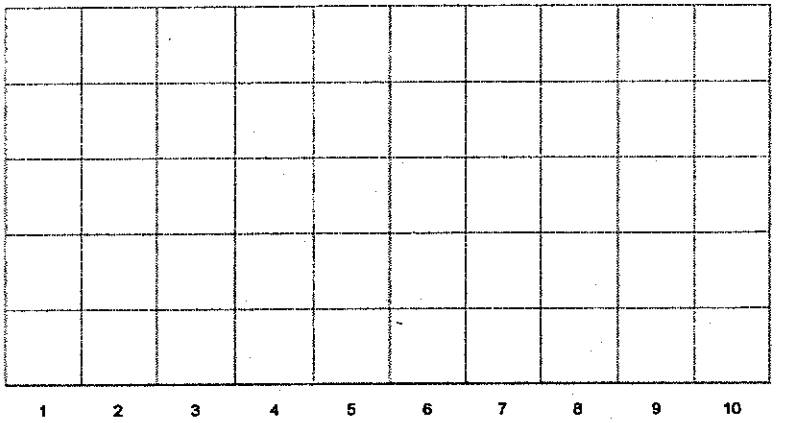

Existing Distress Types

	(10)	(3)	(10)	(19)		
	58L Paving #	13'x17' M	15' L	11'x38' L		
		11'x50' L	22' M	13'x100' L		
		17'x2' L	95' M			
			24' M			
Total Severity L	58	584	15	1718		
Total Severity M		221	141			
Total Severity H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	1.4	6
(10)	M	2.8	18
(3)	L	11.7	23
(3)	M	4.4	17
(19)	L	34.4	18
Deduct Total			
Corrected Deduct Value (CDV)			

PCI = 100 - CDV = _____

Rating = 75

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Parking Lot	Section	Sample Unit 13
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 000 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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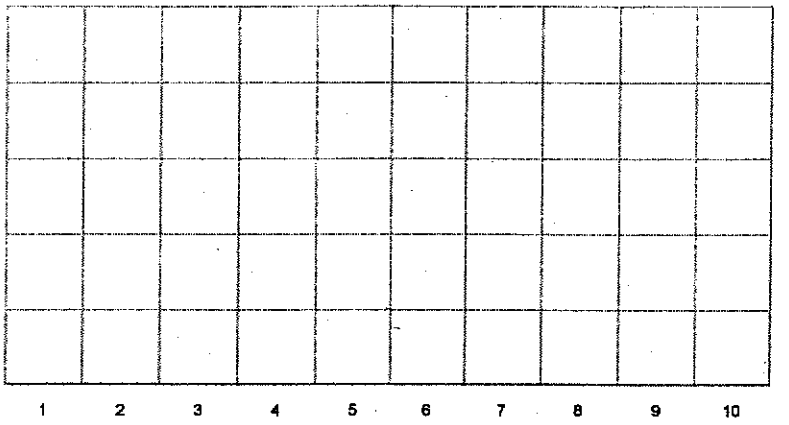


Existing Distress Types

		(10)	(3)	(11)	(1)	(6)	(19)
		72'L Paving Jt.	30'x19' L	12'x3.5' H	24'x3' L	10'x3'(2") M	4'x18'L
		100M Paving Jt.	21'x12' L				
		100L Paving Jt.	9'x18' L				
		45' L					
		38' M					
Total Severity	L	217	984		72		72
	M	138				30	
	H			42			

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(8)	L	4.3	12
(6)	M	2.8	18
(3)	L	19.7	20
(11)	H	0.8	19
(19)	L	1.4	4
(1)	L	1.4	18
(6)	M	0.6	11
	Deduct Total		
	Corrected Deduct Value (CDV)		

PCI = 100 - CDV = _____

Rating = 62

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

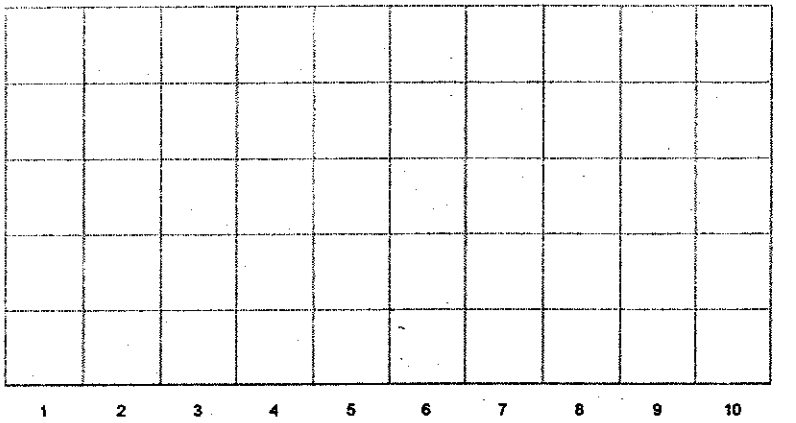
Project	Chesapeake and Ohio National Park		Date 12/13/04
Branch	Parking Lot	Section	Sample Unit #15
Surveyed By	Jason Kotova & Kwok-Leung Li	Area of Sample	5000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

Sta.



Existing Distress Types

		(10)	(3)	(1)	(19)	(10)	
		90'M Paving Jt.	20'x21'L	20'x3'L	13'x5'M	80'L	
		21'L Paving Jt.	11'x25'L	10'x15'L	1'x1'M		
			14'x17'L	16'x5'L			
				15'x4'M			
				9'x2'L			
Total Severity	L	21	933	173		80	
	M	90		60	66		
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	2	8
(10)	M	1.8	15
(3)	L	18.7	20
(1)	L	3.5	33
(1)	M	1.2	30
(19)	M	1.2	9
	Deduct Total		
	Corrected Deduct Value (CDV)		

PCI = 100 - CDV = _____

Rating = 59

Flexible Pavement

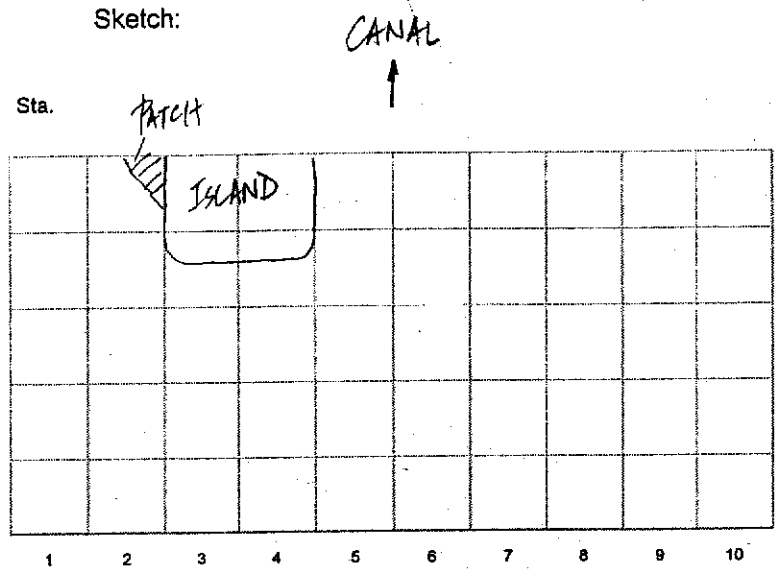
Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/13/04
Branch	Parking Lot	Section	Sample Unit 17
Surveyed By	Jason Kotova & Kwok-Leung Li	Area of Sample	4700 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(10)	(1)	(3)	(19)	(6)	(11)
		26'L Paving H	1 x 0.5' H	20'x25'L	5'x1' H	8'x6' H(3")	8'x6'
			11'x1' M	37'x6'	15'x20'L	4'x1' <1"	
				-10'x4' L			
				44'x10'L			
				4'x19'L			
Total Severity	L	26		277	300	9	
	M		11				48
	H		0.5		5	48	

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	26	4
(1)	M	0.2	15
(1)	H	0	0
(3)	L	5.8	29
(6)	L	6.4	8
(19)	H	0.1	8
(5)	L	0.2	1
(5)	H	1.0	25
(11)	M	1.9	10
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 59

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/13/04
Branch	Parking Lot	Section	Sample Unit 19
Surveyed By	Jason Kotova & Kwok-Leung Li	Area of Sample	5000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

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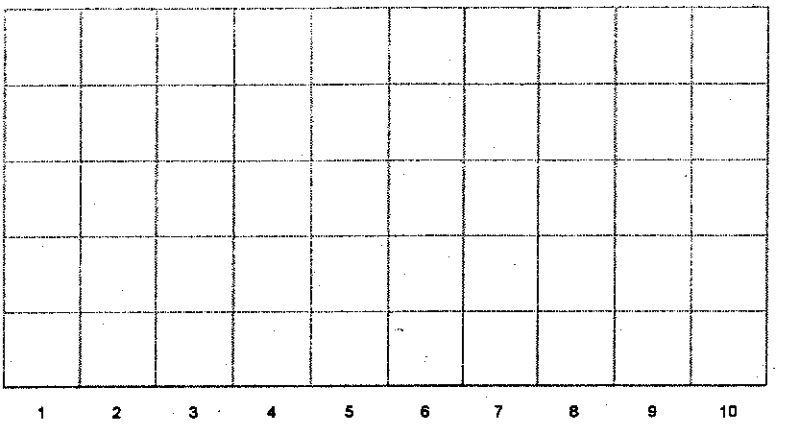


Existing Distress Types

		(10)	(3)	(19)	(10)		
		100'M Paving.lt	15'x55'L	35'x6'L	8'L		
		35'M Paving.lt.					
		10'L Paving.lt					
Total Severity	L	10	825	210	8		
	M	135					
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	0.4	3
(10)	M	2.7	18
(3)	L	16.5	19
(19)	L	4.2	7
	Deduct Total		
	Corrected Deduct Value (CDV)		

PCI = 100 - CDV = _____

Rating = 78

Flexible Pavement

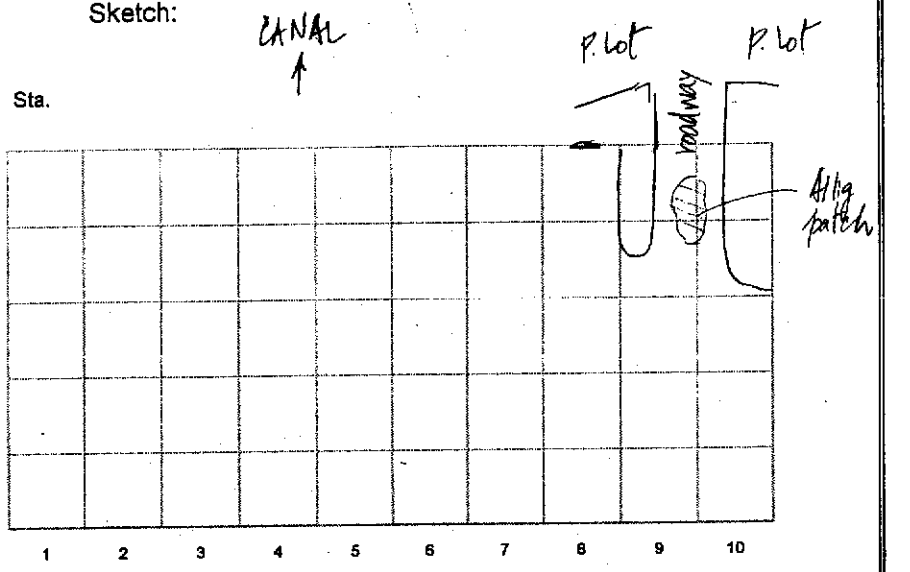
Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/13/04
Branch	Parking Lot	Section	Sample Unit 21
Surveyed By	Jason Kotova & Kwok-leung Li	Area of Sample	4,700 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(10)	(1)	(3)	(6)	(10)	(11)
		51' M Paving ft 15' L	9'x17' H	56 x 14' L	7'x5'(2") M	25' L	7% *
			26'x14' M *	13'x20' L	5'x6'(1") M		
			5'x16' M	12' x 10' L			
				26' x 20' L			
				15' x 19' L			
Total Severity	L	15		1939		25	
	M	51	430		65		263
	H		153				

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	0.9	4
(10)	M	1.1	11
(1)	M	9.1	55
(1)	H	3.3	51
(3)	L	41.3	27
(6)	M	1.4	17
(11)	L	5.6	10
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 23

Flexible Pavement

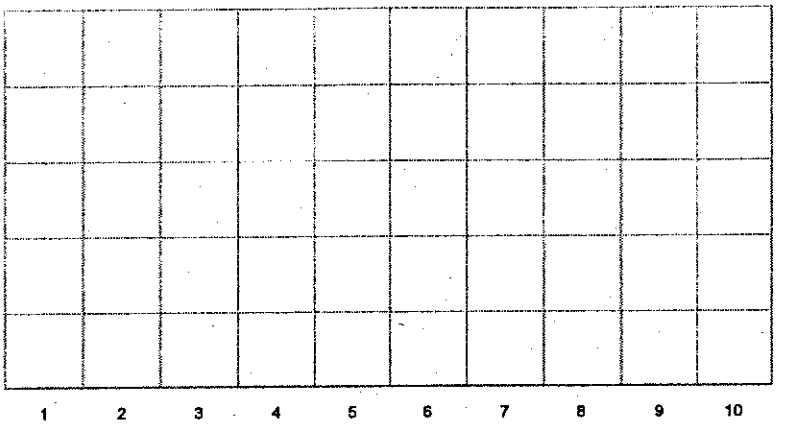
Condition Survey Data Sheet for Sample Unit

Project Chesapeake and Ohio National Park		Date 12/13/04
Branch Parking Lot	Section	Sample Unit 23
Surveyed By Jason Kotova & Kwok-Leung Li	Area of Sample 4,700 ft²	

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(10)	(3)	(10)			
		37'M Paving Jt.	38'x10'L	12'L			
		36'L Paving Jt.	15'x12'L				
		70'M Paving Jt.					
Total Severity	L	36	560	12			
	M	107					
	H						

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	1.0	5
(10)	M	2.3	17
(3)	L	11.9	24
	Deduct Total		
	Corrected Deduct Value (CDV)		

PCI = 100 - CDV = _____

Rating = 81

Flexible Pavement

Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park		Date 12/13/04
Branch	Parking Lot	Section	Sample Unit 25
Surveyed By	Jason Kotova & Kwok-Leung Li	Area of Sample	5,000 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:

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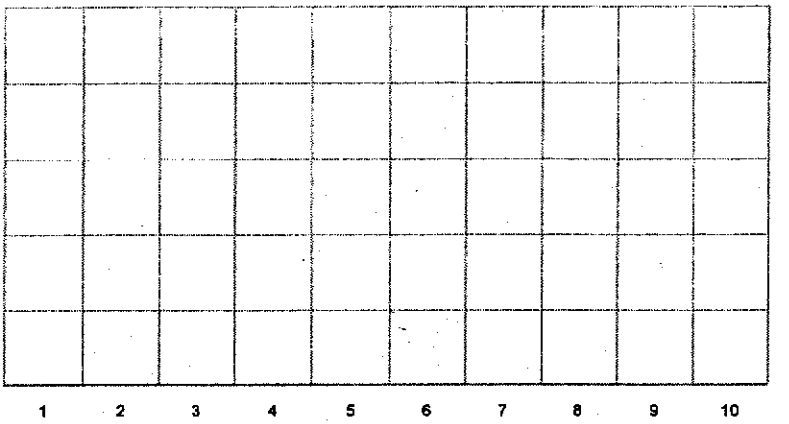


Existing Distress Types

		(10)	(19)	(3)	(10)	(19)
		100'M Paving Lt	1'x9'M	35'x10'L	100'L	20'x6'L
		40'L Paving Lt.		30'x8'L	17'L	
Total Severity	L	40		620	117	120
	M	100	9			
	H					

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(10)	L	3.1	10
(10)	M	2	16
(19)	M	0.2	5
(3)	L	12.4	17
(19)	L	24	5
		Deduct Total	
		Corrected Deduct Value (CDV)	

PCI = 100 - CDV = _____

Rating = 78

Flexible Pavement

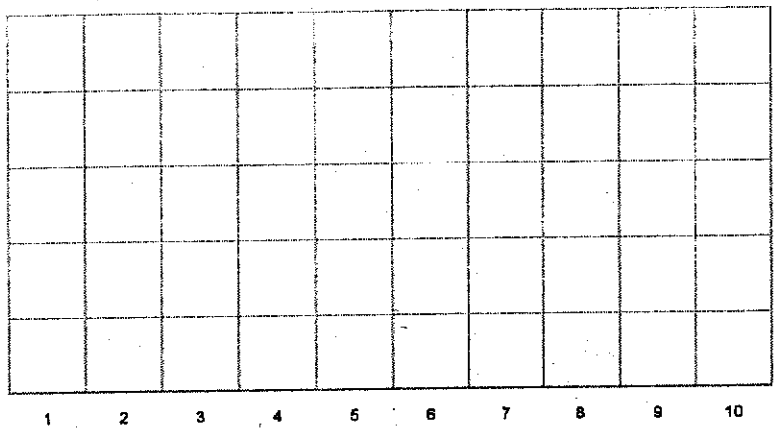
Condition Survey Data Sheet for Sample Unit

Project	Chesapeake and Ohio National Park	Date	12/13/04
Branch	Parking Lot	Section	Sample Unit 27
Surveyed By	Jason Kotova & Kwok-leung Li	Area of Sample	3,600 ft²

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
4. Bumps and Sags
5. Corrugation
6. Depression
7. Edge Cracking
8. Joint Reflection Cracking
9. Lane/Shoulder Drop Off
10. Long. & Trans. Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering/Raveling

Sketch:



Existing Distress Types

		(3)	(1)	(19)			
		8x26' L	6'x5' M	4'x5' H			
		25'x5' L		3'x3' H			
		8'x12' L					
		5'x25' L					
		6'x20' L					
		20'x103' L	7x31' M				1
Total Severity	L	2501 ft²					
	M		247 ft²				
	H			29 ft²			

PCI Calculation

Distress Type	Severity	Density %	Deduct Value
(3)	L	69.5	
(1)	M	6.9	
(19)	H	0.8	
Deduct Total			
Corrected Deduct Value (CDV)			

PCI = 100 - CDV = _____

Rating = 49

APPENDIX C

ROY MCQUEEN ASSOCIATES PAVEMENT REPORT

NONDESTRUCTIVE TESTING
AND
PAVEMENT EVALUATION SERVICES

FOR

CHESAPEAKE & OHIO NATIONAL PARK
GREAT FALLS, MARYLAND

JANUARY 2005

FOR

URS

Hunt Valley, Maryland

BY

Roy D. McQueen & Associates, Ltd.
22863Bryant Court; Suite 101
Dulles, Virginia 20166
Telephone 703-709-2540 • Fax 703-709-2535
www.rdmcqueen.com

TABLE OF CONTENTS

SECTION 1.0 INTRODUCTION

During January 2005, Roy D. McQueen & Associates, Ltd. (RDM), under contract to URS Corporation (URS) performed nondestructive testing (NDT) and pavement evaluation services for approximately 6,100 feet of the entrance road and two parking lots in Chesapeake & Ohio National Park (C&O) in Great Falls, Maryland. The primary objective of this study was to formulate pavement rehabilitation and/or strengthening requirements to accommodate future traffic demands.

To meet this overall objective, the following multi-phased program of testing and analysis was implemented to provide an integrated basis for developing the rehabilitation program:

- Measure existing pavement and subgrade strength by NDT.
- Verify pavement thickness and composition from geotechnical engineering provided by URS.
- Compute equivalent 18-kip axle loads (ESAL's) from data provided by URS.
- Develop rehabilitation requirements from results of structural and functional analyses.

The observations, comments, and recommendations contained in this report have been prepared for the exclusive use of URS for this project in accordance with generally accepted engineering practice. No other warranty is expressed or implied. Performance of any engineering investigation is subject to many qualifications inherent to the practice of that profession and to the accuracy of data obtained. Although a reasonable effort was made to interpret data, correctly depict existing conditions, and identify causes of current problems, variations could exist between tested locations. Additionally the historical documents provided by others could contain discrepancies.

SECTION 2.0 METHODS OF ANALYSIS

The technical approach to the pavement investigation study at C&O consisted of the following basic elements:

- **Nondestructive Testing (NDT)** - To measure existing pavement and subgrade strength.
- **Geotechnical Engineering** - To verify pavement thickness and composition from borings.
- **Traffic Analysis** - To compute equivalent 18-kip axle loads.
- **Pavement Analysis** - To determine rehabilitation needs, utilizing comprehensive computer analysis.

A brief description of each element is included below with details provided in subsequent sections.

2.1 Nondestructive Testing

A series of NDTs were performed to quantify the load/deformation properties of the road pavements. The NDT data were reduced to yield the elastic moduli of pavement layers and subgrade using closed form solutions detailed in the American Association State Highway and Transportation Officials (AASHTO) pavement design guide. The test sequences performed, as well as the Heavy Falling Weight Deflectometer (HWD) used for testing, conformed to Federal Highway Administration (FHWA) requirements for NDT.

2.2 Geotechnical Engineering

The pavement composition and thickness were evaluated from the boring data provided by URS. The pavement thickness and composition are used for back-calculation.

2.3 Traffic Analysis

Estimates of current traffic by vehicle type, frequency, and projected growth, were provided by URS. These data were used to compute equivalent 18-kip axle loads for pavement evaluation and design.

2.4 Pavement Analysis

The processed NDT data and traffic projections were used in comprehensive structural analysis to identify alternatives for rehabilitation using the 1998 Supplement to the 1993 AASHTO design procedures.

SECTION 3.0 NONDESTRUCTIVE TESTING

During January 2005, a series of approximately 56 NDTs were conducted on the entrance road and two parking lots at C&O.

The primary purpose of NDT is to determine the structural properties of pavement systems. The load response data resulting from the dynamic force simulates the effect of moving vehicle loads. These data can be used as reliable input for pavement analysis that utilizes both conventional and elastic theories for pavement design and evaluation. Additional advantages of NDT include:

- Minimal interference with roadway traffic;
- Measurement of in-situ structural response;
- Rapid data acquisition; and
- Low unit testing and data processing costs.

Generally speaking, about 50 NDTs can be performed for a cost approximately equivalent to one California Bearing Ratio (CBR) test. A primary value of NDT, then, is the ability to economically evaluate much broader areas of pavement in a short time to better define variability in pavement strength.

The NDT equipment used for the testing program was designed to generate a dynamic load on the pavement surface and measure the resultant vertical response of the pavement system, including subgrade, base courses, and surface layers. The equipment's microcomputer allows rapid data processing in the field. Thus, NDT results can be directly referenced to field conditions, improving the reliability and speed of data acquisition.

3.1 NDT Procedures

To provide a meaningful database for evaluation, the following NDT sequence was utilized:

- Deflection Basin
- Impulse Stiffness Modulus

All tests were conducted under an impulse (i.e., Falling Weight Deflectometer type) forcing function at a nominal amplitude of 10,000 lbs. The tests were conducted during daytime hours.

3.1.1 DEFLECTION BASIN

This test method involves measuring deflection at the center of the machine loading plate and at radial offset distances from center. After pavement thickness and composition is determined, closed form solutions contained in the AASHTO Design Guide were used to process deflection basin data to determine the elastic moduli (E-value) of the subgrade for asphalt (AC) pavements and Modulus of Subgrade Reaction (*k*) of asphalt overlay (APC) pavements. Deflection basins at each test point were processed to obtain design inputs for E and *k*.

The AASHTO closed form solution also resulted in computation of the elastic modulus AC and Portland cement concrete (PCC) layers for APC pavements. The effective moduli of the flexible pavements were also computed using standard AASHTO procedures.

3.1.2 IMPULSE STIFFNESS MODULUS (ISM)

The ISM is defined as dynamic force divided by pavement deflection. As such, it is a measure of overall support conditions from all influencing pavement and subgrade layers. The ISM data are used to identify patterns of variability in pavement support conditions.

3.2 Equipment Requirements

Roy D. McQueen & Associates' heavy falling weight deflectometer (HWD) was used for the testing program. The machine is well capable of exceeding the minimum pavement deflection referenced in U.S. Departments of Defense (DOD) and Transportation (DOT) publications. The equipment has a force range of 3,000 lbs. to 55,000 lbs. and records pavement responses on seven sensors extending outward from the center of the loading plate.

3.3 Conventional Testing

Additional investigation was performed by URS to measure existing pavement thickness and composition.

3.4 Data Analysis

For this study, the primary purpose of the NDT program was to develop inputs on the strength of pavement and subgrade layers for structural analysis. For the AASHTO procedure used for the pavement analysis, the primary strength characterization is the elastic modulus (E) of pavement layers and subgrade *k* or E for the APC pavements. The Modulus of Subgrade Reaction (*k*) is required for the AASHTO rigid pavement analysis.

3.4.1 IMPULSE STIFFNESS MODULUS (ISM)

Based on the computed ISM, the NDT field data were used to segment the road into analytical sections, based on the recorded variability in the ISM along the length of the roadway. Although pavement thicknesses were relatively consistent, the roadway pavement was segmented into several analytical sections, as necessary, based on the ISMs for structural analysis.

3.4.2 NDT DATA REDUCTIONS

Standard AASHTO closed-form back-calculation procedures were used to reduce the APC data to subgrade *k* and elastic moduli of AC and PCC, and subgrade resilient modulus (M_r) and effective pavement modulus (E). The APC reductions are based on the AREA method. This method recognizes the unique relationship between normalized area under the deflection basin and the radius of relative stiffness, ℓ. Once ℓ is known, subgrade *k* and pavement moduli are readily computed. The SHRP outer 5 sensor method for AREA computation was used to eliminate any effects of compression in the AC layer. For AC pavements, the resilient of subgrade was computed using the AASHTO equation:

$$M_r = C\ (0.24P / d_r r)$$

Where:

M_r = Design subgrade resilient modulus
C = correction factor of 0.33 to correlate back to the AASHTO road test results
P = NDT applied load (lbs.)
d_r = deflection at distance r from center of load (inches)
r = distance from center of load (inches)

The AASHTO back-calculation results are summarized in Table 1:

Facility	Pavement Thickness	M_r (psi)	*k* (pci)
Entrance Road	8.8" AC	2764	
North Parking Lot	4.4" AC	3166	
South Parking Lot	2" AC/8" PCC		82

Table 1 – Back-calculation Summary

Based on engineering experience and documented research results, it is believed that the back-calculated moduli from NDT are a reasonably conservative measure of pavement layer and subgrade support conditions, suitable for use as inputs for structural analysis.

SECTION 4.0 TRAFFIC

Traffic data was provided by URS as shown in Table 2:

Truck/Bus	Axle	Axle Load (lbs.)	EALF	Annual Rep	ESAL
Trucks	Front/Single	8,000	0.0343	520	17.836
	Rear/Single	24,000	3.03		1575.6
Buses	Front/Single	10,000	0.0877	500	43.85
	Rear/Single	20,000	1.51		755
Snow Plow	Front/Single	21,000	1.83	50	91.5
	Rear/Single	23,000	2.18		109
Fire Truck	Front/Single	17,000	0.796	10	7.96
	Rear/Tandem	17,000	0.0608		0.608
5-Axle Truck	Front/Single	6,000	0.01043	50	0.5215
	Mid/Tandem	24,000	0.26		13
	Rear/Tandem	24,000	0.26		13
Passenger Car	Front/Single	2,000	0.00018	54750	9.855
	Rear/Single	2,000	0.00018		9.855
Total					**2648**
20-Year Design ESAL					**71281**

Table 2 - Traffic

Legend:

EALF = Equivalent axle load factor

ESAL = Equivalent single axle load

SECTION 5.0 DESIGN CONCEPTS

In accordance with the project work scope, the procedures contained in the 1998 Supplement to the 1993 AASHTO Guide for the Design of Pavement Structures were employed to evaluate the expected performance of existing pavements and to design pavement strengthening for anticipated future loading conditions.

5.1 AASHTO Design Procedures

AASHTO details separate design procedures for flexible and rigid pavements as described below.

5.1.1 AASHTO FLEXIBLE PAVEMENT DESIGN

The effective structural number (SN_{eff}) of existing pavements was computed for the AC section of pavement. The effective structural number is a measure of the in-situ structural capacity of flexible pavements.

When NDT is part of the evaluation process, SN_{eff} can be computed from the NDT results. This assumes that the structural capacity of the pavement section is a function of its total thickness and utilizes pavement thickness (D) and effective elastic modulus (E_p) of all pavement layers above the subgrade. The effective structural number is computed from the equation on Page III-102 of the 1993 AASHTO design guide as:

$$SN_{eff} = 0.0045D\sqrt{E_p}$$

E_p can be computed from the center plate NDT deflection, computed M_r of the subgrade, plate radius (a), and total thickness of pavement above the subgrade. E_p can either be computed directly or from charts in the AASHTO Design Guide.

Next, the required, or design, structural number was computed from the AASHTO nomograph contained in Figure 3.1 of the 1993 Design Guide.
The design structural number is a function of the following:

- reliability (95%)
- overall standard deviation (0.45)
- estimated 18-kip axle loads as described in Section 4.0
- effective subgrade resilient modulus from NDT
- Initial Serviceability = 4.2
- Terminal Serviceability = 2.2

The difference between the design and effective structural numbers, relates to the requirements for strengthening the existing pavement. For asphalt overlay, the required thickness of the overlay is computed by dividing the difference in the structural numbers (i.e., $SN - SN_{eff}$) by the layer coefficient for new asphalt, i.e., $a_{01} = 0.44$.

5.1.2 AASHTO RIGID PAVEMENT DESIGN

The structural capacity of a concrete pavement can be estimated by comparing the effective slab thickness, D_{eff}, with the slab thickness D_f, required for future traffic. D_{eff} can be computed by several methods, including the following based on condition survey results which was used for this analysis:

$$D_{eff} = F_{jc} * F_{dur} * F_{fat} * D$$

Where:

D = existing slab thickness

F = adjustment factors based on joint condition ($_{jc}$), durability ($_{dur}$), and fatigue damage ($_{fat}$)

D_{eff} was computed based on the following factors:

F_{jc} = 0.9, assuming joint rehabilitation will be a part of the project
$_{dur}$ = 1.0, no sign of durability cracks present
F_{fat} = 0.90, mid-range

D_f was computed using the procedures contained in the 1998 Supplement to the 1993 Guide for rigid pavements for climatic conditions in Great Falls, Maryland area and *k* from the NDT back-calculation. Initial and terminal serviceability indexes of 4.2 and 2.2, respectively were used, along with 95% reliability and 0.45 standard deviation.

SECTION 6.0 STRUCTURAL ANALYSIS

Using the analytical methodologies described in Section 5.0, the AASHTO procedures were performed to:

- Evaluate the structural sufficiency of existing pavements; and
- Design asphalt overlays for structurally inadequate pavements.

A 20-year design life was assumed for the structural analysis. The rehabilitation options are summarized in Table 3.

Facility	Existing Pavement Thickness	Rehabilitation Option	*k* (pci)
Entrance Road	8.8" AC	2" AC overlay	
North Parking Lot	4.4" AC	2" AC overlay	
South Parking Lot	2" AC/8" PCC	None	82

Table 3 – Design Output

Based on the traffic, existing pavement thickness and composition provided by URS, the entrance road and north parking lot are structurally under-strength, therefore, a 2-inch AC overlay is required.

The south parking lot is structurally adequate and does not require major rehabilitation. However, a visual condition survey of the functional condition of the pavement is recommended. If functional repairing is suggested by the survey, the south parking lot may be repaired by milling the existing 2-inches of AC, repairing the PCC slabs and placing 2-inches AC.

M3
Date-Time: 1/6/2005 7:20:17
Sensors: CHOP CHOP CHOP CHOP CHOP CHOP CHOP
Weight/spr 4
Location: great falls
Temp: 42
Operator:
Comments circle & south parking 0+00 @ circle entrance
Force: 10

1	1	0	0	11.84	6.87	6.58	6.25	5.2	4.2	3.06	2.19	43 Note:	circle
2	1	0.125	0	12.23	8.68	8.07	7.59	6.22	5.14	3.98	3.07	43 Note:	circle
3	1	0.25	0	12.16	8.28	7.68	7.16	5.78	4.64	3.49	2.66	43 Note:	circle
4	1	0.3	0	12.3	5.41	5.11	4.78	3.86	3.09	2.36	1.81	43 Note:	parking
5	1	0.4	0	10.35	16.85	17.18	16.38	14.31	11.94	9.57	7.85	43 Note:	parking
6	1	0.425	0	11.84	7.12	6.87	6.57	5.71	4.84	3.78	3	43 Note:	parking
7	1	0.5	0	11.72	8.16	5.85	5.37	4.65	3.87	3.1	2.38	43 Note:	parking
8	1	0.513	0	10.79	16.38	5.75	3.36	2.64	2.05	1.54	1.17	43 Note:	parking joint
9	1	0.6	0	11.89	5.92	5.79	5.52	4.7	4.34	3.33	2.64	43 Note:	parking
10	1	0.7	0	11.87	8.46	7.46	6.79	5.02	3.67	2.37	1.44	43 Note:	paking upper
11	1	0.713	0	9.57	19.06	2.21	2.02	1.57	1.27	0.97	0.84	43 Note:	parking upper joint
12	1	0.8	0	12.11	9.58	9.2	8.63	7.32	5.96	4.51	3.19	43	
13	1	0.9	0	11.84	6.41	5.41	5.18	4.41	3.7	2.85	2.17	43 Note:	circle
14	1	1	0	10.55	7.69	7.45	7.04	6.13	3.59	4.04	3.17	43 Note:	circle

C&O Canal Project
South Parking NDT Field Data

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	Remarks
1	1	0	0	11.84	6.87	6.58	6.25	5.2	4.2	3.08	2.19	43	
2	1	0.125	0	12.23	8.68	8.07	7.59	6.22	5.14	3.98	3.07	43	
3	1	0.25	0	12.16	8.28	7.68	7.16	5.78	4.64	3.49	2.66	43	
4	1	0.3	0	12.3	5.41	5.11	4.78	3.86	3.09	2.36	1.81	43	
5	1	0.4	0	10.35	16.85	17.18	16.38	14.31	11.94	9.57	7.85	43	
6	1	0.425	0	11.84	7.12	6.87	6.57	5.71	4.84	3.78	3	43	
7	1	0.5	0	11.72	8.16	5.85	5.37	4.65	3.87	3.1	2.38	43	
8	1	0.513	0	10.79	16.38	5.75	3.36	2.64	2.05	1.54	1.17	43	
9	1	0.6	0	11.89	5.92	5.79	5.52	4.7	4.34	3.33	2.64	43	
10	1	0.7	0	11.87	8.46	7.46	6.79	5.02	3.87	2.37	1.44	43	
11	1	0.713	0	9.57	19.06	2.21	2.02	1.57	1.27	0.97	0.84	43	
12	1	0.8	0	12.11	9.58	9.2	8.63	7.32	5.96	4.51	3.19	43	
13	1	0.9	0	11.84	6.41	5.41	5.18	4.41	3.7	2.85	2.17	43	
14	1	1	0	10.55	7.69	7.45	7.04	6.13	3.59	4.04	3.17	43	

M3
Date-Time: 1/6/2005 6:51:36
Sensors: CHOP CHOP CHOP CHOP CHOP CHOP CHOP
Weight/spr 4
Location: great falls
Temp: 40
Operator:
Comments:
Force: 10

1	1	0.012	0	12.48	8.05	7.84	7.47	6.47	5.5	4.28	3.32	44
2	1	0.21	0	9.81	21.42	19.42	13.83	4.13	1	0.69	0.67	44
3	1	0.4	0	9.33	23.15	21.17	16.13	5.94	2.06	0.8	0.54	44
4	1	0.6	0	10.33	19.38	14.74	10.61	3.93	1.8	1.02	0.79	44
5	1	0.8	0	10.94	18.36	13.57	9.15	2.18	0.76	0.72	0.68	44
6	1	1	0	8.42	31.73	28.79	20.51	6.12	1.29	0.61	0.77	44
7	1	1.2	0	9.72	28.2	23.63	15.04	3.89	0.31	0.24	0.58	44
8	1	1.4	0	10.11	25.31	17.83	13.56	6.24	3.56	1.78	1.22	44
11	2	1.5	0	9.5	30.35	24.85	18.7	6.46	2.07	1.06	0.79	44
10	2	1.4	0	10.08	21.43	17.58	13.3	5.89	3.14	1.99	1.19	44
9	2	1.2	0	8.25	30.38	27.21	18.74	4.82	1	0.44	0.25	44
8	2	1	0	9.28	28.47	27.51	22.11	10.38	4.67	2.28	1.44	44
7	2	0.8	0	9.03	37.86	31.68	24.24	8.41	3.01	1.23	1.06	44
6	2	0.6	0	8.42	35.89	33.47	24.92	10.18	3.78	1.85	1.29	44
5	2	0.4	0	10.57	23.55	18.8	14.63	6.57	3.22	1.8	1.17	44
4	2	0.2	0	9.94	24.08	20.04	14.65	5.49	2.02	1	0.78	44
3	2	0.1	0	12.3	7.08	6.69	6.25	5.03	4.06	3.11	1	44

C&O Canal Project
North Parking NDT Field Data

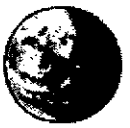
NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	Remarks
1	1	0.012	0	12.48	8.05	7.84	7.47	6.47	5.5	4.28	3.32	44	
2	1	0.21	0	9.81	21.42	19.42	13.83	4.13	1	0.69	0.67	44	
3	1	0.4	0	9.33	23.15	21.17	16.13	5.94	2.06	0.8	0.54	44	
4	1	0.6	0	10.33	19.38	14.74	10.61	3.93	1.8	1.02	0.79	44	
5	1	0.8	0	10.94	18.36	13.57	9.15	2.18	0.76	0.72	0.68	44	
6	1	1	0	8.42	31.73	28.79	20.51	6.12	1.29	0.61	0.77	44	
7	1	1.2	0	9.72	28.2	23.63	15.04	3.89	0.31	0.24	0.58	44	
8	1	1.4	0	10.11	25.31	17.83	13.56	8.24	3.56	1.78	1.22	44	
9	2	1.5	0	9.5	30.35	24.85	18.7	6.46	2.07	1.06	0.79	44	
1	2	1.4	0	10.08	21.43	17.58	13.3	5.89	3.14	1.99	1.19	44	
2	2	1.2	0	8.25	30.38	27.21	18.74	4.82	1	0.44	0.25	44	
3	2	1	0	9.28	28.47	27.51	22.11	10.38	4.67	2.28	1.44	44	
4	2	0.8	0	9.03	37.86	31.68	24.24	8.41	3.01	1.23	1.06	44	
5	2	0.6	0	8.42	35.89	33.47	24.92	10.18	3.78	1.85	1.29	44	
6	2	0.4	0	10.57	23.55	18.8	14.63	6.57	3.22	1.8	1.17	44	
7	2	0.2	0	9.94	24.08	20.04	14.65	5.49	2.02	1	0.78	44	
8	2	0.1	0	12.3	7.08	6.69	6.25	5.03	4.06	3.11	1	44	

M3
Date-Time 1/6/2005 5:53:38
Sensors: CHOP CHOP CHOP CHOP CHOP CHOP CHOP
Weight/spr 4
Location: great falls
Temp: 40
Operator:
Comments:
Force: 12
Force: 10

1	1	0.5	0	12.28	26.53	25.11	21.95	14.15	9.09	5.67	3.8	38
2	1	1	0	12.5	24.7	23.09	20.36	13.78	9.2	5.67	3.54	38
3	1	1.5	0	10.47	30.03	29.92	25.9	16.37	10.5	6.3	3.94	38
4	1	2	0	12.3	21.26	20.09	17.25	10.75	6.72	4.1	2.71	38 Note: vfw
5	1	2.5	0	11.79	19.05	18.68	13.97	7.86	4.18	2.06	1.13	38
6	1	3	0	11.84	22.89	19.3	16.23	9.44	5.73	3.55	2.49	38
7	1	3.5	0	12.72	17.88	16.18	14.48	10.01	6.72	4.2	2.72	38
8	1	4	0	12.77	17.37	15.01	13.02	8.44	5.49	3.39	2.15	38
9	1	4.5	0	11.94	18	15.09	12.95	8.63	5.89	3.79	2.57	38
10	1	5	0	12.04	18.67	16.36	15.01	11.45	8.62	5.99	4.29	38
11	1	5.5	0	12.62	13.24	11.45	10.15	7.29	5.26	3.71	2.74	38
12	1	6	0	12.38	20.65	19.18	17.15	11.52	7.48	4.75	3.2	38 Note: entrance gate
14	2	5.75	0	11.23	22.55	21.51	18.83	12.42	8.28	5.32	3.67	38
13	2	5.25	0	11.16	12.61	12.51	11.84	9.67	7.75	5.74	4.24	38
12	2	4.75	0	10.62	17.7	16.82	14.91	10.02	6.88	4.19	2.73	38
11	2	4.25	0	9.59	21.45	20.57	17.84	11.27	6.76	3.76	2.06	38
10	2	3.75	0	11.25	15.62	13.99	12.18	7.92	5.03	3.11	2.03	38
9	2	3.25	0	10.47	16.18	15.87	13.59	8.35	4.88	2.55	1.33	38
8	2	2.75	0	9.33	23.8	23.03	20.25	13.37	8.7	5.37	3.43	38
7	2	2.25	0	9.03	24.65	23.98	20.75	12.93	7.8	4.58	2.83	38
6	2	1.75	0	12.18	15.52	14.02	12.58	8.57	5.78	3.75	2.65	38
5	2	1.25	0	10.91	27.41	26.43	22.87	14.04	8.67	5.08	3.15	38
4	2	0.75	0	10.57	17.95	16.62	14.08	8.11	4.51	2.26	1.14	38
3	2	0.25	0	9.45	18.49	17.9	15.43	9.69	5.64	3.09	1.72	38
2	2	0.04	0	11.33	23.84	22.99	20.62	14.41	10.01	6.25	3.77	38

C&O Canal Project
Road NDT Field Data

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	Remarks
1	1	0.5	0	12.26	26.53	25.11	21.95	14.15	9.09	5.67	3.8	38	
2	1	1	0	12.5	24.7	23.09	20.36	13.78	9.2	5.67	3.54	38	
3	1	1.5	0	10.47	30.03	28.92	25.9	16.37	10.5	6.3	3.94	38	
4	1	2	0	12.3	21.26	20.09	17.25	10.75	6.72	4.1	2.71	38	
5	1	2.5	0	11.79	19.05	16.68	13.97	7.86	4.18	2.06	1.13	38	
6	1	3	0	11.84	22.89	19.3	16.23	9.44	5.73	3.55	2.49	38	
7	1	3.5	0	12.72	17.86	16.18	14.48	10.01	6.72	4.2	2.72	38	
8	1	4	0	12.77	17.37	15.01	13.02	8.44	5.49	3.39	2.15	38	
9	1	4.5	0	11.94	18	15.09	12.95	8.63	5.89	3.79	2.57	38	
10	1	5	0	12.04	18.67	16.36	15.01	11.45	8.62	5.99	4.29	38	
11	1	5.5	0	12.62	13.24	11.45	10.15	7.29	5.26	3.71	2.74	38	
12	1	6	0	12.38	20.65	19.18	17.15	11.52	7.48	4.75	3.2	38	
14	2	5.75	0	11.23	22.55	21.51	18.83	12.42	8.28	5.32	3.67	38	
13	2	5.25	0	11.16	12.61	12.51	11.84	9.67	7.75	5.74	4.24	38	
12	2	4.75	0	10.62	17.7	16.82	14.91	10.02	6.68	4.19	2.73	38	
11	2	4.25	0	9.59	21.45	20.57	17.84	11.27	6.76	3.76	2.06	38	
10	2	3.75	0	11.25	15.62	13.99	12.18	7.92	5.03	3.11	2.03	38	
9	2	3.25	0	10.47	16.18	15.87	13.59	8.35	4.88	2.55	1.33	38	
8	2	2.75	0	9.33	23.8	23.03	20.25	13.37	8.7	5.37	3.43	38	
7	2	2.25	0	9.03	24.65	23.98	20.75	12.93	7.8	4.58	2.83	38	
6	2	1.75	0	12.18	15.52	14.02	12.59	8.57	5.78	3.75	2.65	38	
5	2	1.25	0	10.91	27.41	26.43	22.87	14.04	8.67	5.08	3.15	38	
4	2	0.75	0	10.57	17.95	16.62	14.08	8.11	4.51	2.26	1.14	38	
3	2	0.25	0	9.45	18.49	17.9	15.43	9.69	5.64	3.09	1.72	38	
2	2	0.04	0	11.33	23.84	22.99	20.62	14.41	10.01	6.25	3.77	38	



"Peter Yip"
<pckyip@rdmcqueen.com>
01/27/2005 10:33 AM

To <Kwok-Leung_Li@urscorp.com>
cc
bcc
Subject C&O Calculated Values

Li,

I have Karen resent the report to you. There is a blank page in the file.

The calculated values for the design are as follows:

Entrance Road: SNreq = 3.08, SNeff = 2.25

North Parking Lot: SNreq = 2.03, SNeff = 1.16

South Parking Lot: k=82 psi/in, Epcc=2,174,000 psi, S'c=583 psi, Deff=7.83 in, Df< 7in

Please call if you have any question.

Peter Yip, P.E.
President
Roy D. McQueen & Associates, Ltd.
Tel: (703) 709-2540
Fax: (703) 709-2535
www.rdmcqueen.com