355 FOURTH STREET
BENNETT, COLORADO
80102-7806
(303) 644-3249
(303) 644-4125 – FAX

Town of Bennett

REQUEST FOR PROPOSALS

ADDENDUM #3

Date: April 18, 2016

Proposal Number: RFP 16-001
Proposal Title: **Street Improvement Project (SIP) - Asphalt Reconstruction**

For Additional Information Please Contact: Daymon Johnson, Public Works Director
(303) 644-3249
djohnson@bennett.co.us

Documents Included in Addendum #3:
New Instructions below
Pricing Form Update
Geotech Report Kumar 16-3-104.1 Asphalt Streets
Geotech Report Kumar 16-3-104.2 Concrete Streets
Addendum 3 Updates Construction Plan Set

This Addendum supersedes previously issued "Request for Proposal" (RFP) Documents by adding to, deleting from and/or modifying them as set forth herein. To the extent any such addition, deletion or modification result in any conflict or inconsistency between the previously issued RFP Documents and this Addendum, this Addendum shall take precedence.

If any of the documents listed above are missing from this package, they may be picked up at Bennett Public Works, 365 Palmer Avenue, Bennett, Colorado 80102. If you require additional information, call Daymon Johnson at (303) 644-3249.

Request for Proposals, various sections are modified as follows:

1. The Project Geotechnical Reports, Kumar Reports 16-3-104.1 and 16-3-104.2, for existing Town asphalt streets and concrete streets, respectively, are attached with this Addendum #3.
    - The reports show the Town's best investigation of existing pavement thicknesses and subgrade conditions.
    - The reports also discuss the Full-Depth Reclamation (FDR), Cement-Treated Subgrade (CTS), and all appropriate subgrade preparation for paving.
    - The reports indicate asphalt pavement thicknesses required, and call for an asphalt binder meeting PG 58-28 specifications.
    - Per CDOT specifications, the asphalt pavement will need to be placed in a minimum of two lifts, including a Grading S base HBP course and Grading Sx surface HBP course.
    - Per CDOT information, the asphalt may feature no more than 25 percent RAP in the base HBP course and 20 percent RAP in the surace HBP course.

2. Per the Geotech report recommendations,
    - Antelope Hills will utilize Full-Depth Reclamation (FDR) to 16-inch or 17-inch overall depth, to leave a 12-inch FDR material below proposed new asphalt pavement. The upper 4- to 5-inches of FDR for removal shall be the property of the Town, to be placed at the south end of the subdivision, at the location shown on the attached, updated Addendum 3 construction plan set.
    - Centennial Addition and Brothers Four will utilize Cement-Treated Subgrade (CTS) to 12-inch depth below proposed new asphalt pavement. The milled or removed asphalt will be the property of the Contractor and may be removed from Town.
    - Cordella, Eighth and West Lincoln will all utilize Cement-Treated Subgrade (CTS) to 12-inch depth below proposed new asphalt pavement. The demolished concrete pavements including curb and gutter may be removed and disposed at the Town Wastewater Treatment Facility (WWTF) site, located at the north end of 4th Street.
    - There will be no area of Town or this Project that will utilize both FDR and CTS processes together, contrary to prior Proposal instructions.
3. Pricing Form Item 306, Recondition per Geotech, is not required for any of these streets, and is supplanted by the Full-Depth Reclamation (FDR) and Cement-Treated Subgrade (CTS) treatments and paving preparation. Other trimming, prep and other pre-paving treatments are considered incidental to the work and Items shown and should be included in the prices shown for the work.
4. Utility conduit lengths shown on the Pricing Form are actual pipe lengths.
    - The utility conduits are to be laid in parallel, three per trench, per the attached construction detail plan sheet. As a result, the trench length is approximately 1/3 the indicated conduit length on the Pricing Form.
    - The utility conduits are to be placed at the locations shown in the attached Addendum 3 udpated construction plans.
5. The reconstructions of the existing concrete streets at Cordella, Eighth Street and West Lincoln Avenue involve the following:
    - The Pricing Form item for Reconditioning for these streets, page 12.2, is incorrect, and has been stricken.
    - The Pricing Form item for Full-Depth Reclamation (FDR) for these streets, page 12.2, is incorrect, and has been stricken.
    - Completely demolish and remove the existing concrete pavement, including curb & gutter. All valves, manholes and fire hydrants shall be noted and protected through demolition and construction.
        - The manhole and valve covers may be left in place. A concrete collar may be left in place if possible with the demolition activities.
    - The demolished concrete pavement can be placed at the Town's Wastewater Treatment Facility (WWTF), located on north 4th Street, and accessible via 4th Street through Old Town from Palmer Avenue.

- The exposed subgrade soils are to be conditioned as a Cement-Treated Subgrade (CTS) to 12-inch depth, and extending under the curb & gutter areas as well as the street areas. The quanitities shown in the Pricing Form reflect these extents.
- The Contractor is to install curb & gutter with 18-inch gutter pan and 8-foot concrete drainage cross-pans to replicate the previous street drainage. Quantities are shown for the curb & gutter, and the concrete drainage cross-pans.
- The Pricing Form does include a separate Item 608 and quantities for "8-ft Concrete Cross-Pan" for construction of the concrete drainage pans.
- The areas are to be paved with 4-inch asphalt HBP per the soils report and item 1 clarifications above in this Addendum #3.
- Manhole rims and covers, and water valve risers and covers, shall be reset to match final pavement grade, if needed.
    - There shall be a 2-foot diameter concrete collar provided around the valve covers.
    - There shall be a 1-foot width concrete collar provided around the manhole covers.
    - Existing concrete pavement around the valve and manhole covers may be used in lieu of new collars, if the existing concrete pavement can be successfully salvaged and protected through demolition and the new construction.
- The restoration behind the new concrete curb will be to same ground cover as pre-construction.

6. The working hours for the Project will be established as 7 am to 7 pm Monday through Saturday.
7. Individual streets may be closed off for work for no more than three consecutive days at a time. Sidewalks shall remain open and usable to the greatest extent safe pedestrian, bicycle and wheelchair access and use allows and shall be closed for the shortest time period possible.
8. Up to 1,000 feet of street may be closed at a time, indicating a maximum non-street access travel distance to an individual home or property of 500 feet.

Town of Bennett

355 FOURTH STREET
BENNETT, COLORADO
80102-7806
(303) 644-3249
(303) 644-4125 - Fax

REQUEST FOR PROPOSALS
PRICING FORM
MUST BE COMPLETED

I PRICING

ITEM NO.	ITEM DESCRIPTION	ITEM UNIT	ENGR EST QTY	BIDDER QTY *	UNIT PRICE	EXTENDED PRICE
Antelope Hills Subdivision						
~~306~~	~~Recondition per Geotech~~	~~SY~~	~~63,100~~	DELETED ITEM		
310	Full-Depth Reclamation	SY	**64,000**			
403	Hot Mix Asph (4" Gr S/Sx)	SY	**60,600**			
403	Hot Mix Asph (5" Gr S/Sx)	SY	3,400			
613	4-inc Sch 80 Elec Conduit	LF	**2,800**			
Centennial Addition Subdivision						
~~306~~	~~Recondition per Geotech~~	~~SY~~	~~40,000~~	DELETED ITEM		
~~310~~	~~Full-Depth Reclamation~~	~~SY~~	~~40,000~~	DELETED ITEM		
307	**4-pct Cmt Treat Subgrade**	SY	40,000			
403	Hot Mix Asph (4" Gr S/Sx)	SY	**26,600**			
403	Hot Mix Asph (5" Gr S/Sx)	SY	13,400			
608	8-ft Concrete Cross-Pan	SY	600			
613	4-inc Sch 80 Elec Conduit	LF	2,000			
Brothers Four Subdivision						
~~306~~	~~Recondition per Geotech~~	~~SY~~	~~17,300~~	DELETED ITEM		
~~310~~	~~Full-Depth Reclamation~~	~~SY~~	~~17,300~~	DELETED ITEM		
307	**4-pct Cmt Treat Subgrade**	SY	17,300			
403	Hot Mix Asph (4" Gr S/Sx)	SY	12,700			
403	Hot Mix Asph (5" Gr S/Sx)	SY	4,600			
608	8-ft Concrete Cross-Pan	SY	90			
613	4-inc Sch 80 Elec Conduit	LF	2,000			
				Page 12.1 Subtotal		

Items not shown shall be included in prices and costs for items indicated in the Schedule.

* Bidder shall fill in their computed or corrected quantity, unless they are in agreement with Engineer Quantity shown.

** Total shown must equal the Lump Sum Base Bid, and shall be the figure used on Page 13 of 15.

CONTRACT IS A LUMP SUM CONTRACT. SCHEDULE OF VALUES IS FOR INFORMATION ONLY.

Town of Bennett

355 FOURTH STREET
BENNETT, COLORADO
80102-7806
(303) 644-3249
(303) 644-4125 - Fax

REQUEST FOR PROPOSALS
PRICING FORM
MUST BE COMPLETED

I PRICING

ITEM NO.	ITEM DESCRIPTION	ITEM UNIT	ENGR EST QTY	BIDDER QTY *	UNIT PRICE	EXTENDED PRICE
Cordella Subdivision, 8th Street, West Lincoln Avenue						
202	Conc Demo & Removal	SY	15,800			
~~306~~	~~Recondition per Geotech~~	~~SY~~	~~15,800~~	DELETED ITEM		
~~310~~	~~Full-Depth Reclamation~~	~~SY~~	~~15,800~~	DELETED ITEM		
307	**4-pct Cmt Treat Subgrade**	SY	15,800			
403	Hot Mix Asph (4" Gr S/Sx)	SY	13,900			
403	Hot Mix Asph (5" Gr S/Sx)	SY	0			
608	8-ft Concrete Cross-Pan	SY	370			
608	5-ft Detach x 6-in Sidewalk	SY	350			
609	Curb&Gutter/Vert&18"pan	LF	7,700			
613	4-inc Sch 80 Elec Conduit	LF	**1,600**			
Shari's Court						
~~306~~	~~Recondition per Geotech~~	~~SY~~	~~2,500~~	DELETED ITEM		
~~310~~	~~Full-Depth Reclamation~~	~~SY~~	~~2,500~~	DELETED ITEM		
307	**4-pct Cmt Treat Subgrade**	SY	2,500			
403	Hot Mix Asph (5" Gr S/Sx)	SY	2,500			
608	8-ft Concrete Cross-Pan	SY	60			
613	4-inc Sch 80 Elec Conduit	LF	**240**			
General Project Costs						
620	Sanitary Facility	LS	1			
625	Construction Surveying	LS	1			
626	Mobilization	LS	1			
~~627~~	~~Pavement Marking~~	~~LS~~	~~1~~	DELETED ITEM		
630	Traffic Control	LS	1			
				Page 12.2 Subtotal		

TOTAL OF ALL Page Subtotals = 12.1 + 12.2 ** $ _____

Items not shown shall be included in prices and costs for items indicated in the Schedule.

* Bidder shall fill in their computed or corrected quantity, unless they are in agreement with Engineer Quantity shown.

** Total shown must equal the Lump Sum Base Bid, and shall be the figure used on Page 13 of 15.

CONTRACT IS A LUMP SUM CONTRACT. SCHEDULE OF VALUES IS FOR INFORMATION ONLY.

Kumar & Associates, Inc.
Geotechnical and Materials Engineers
and Environmental Scientists

ACEC
MEMBER

800 Stockton Avenue
Fort Collins, CO 80223
phone: (970) 416-9045
fax: (303) 742-9666
email: ftcollins@kumarusa.com
www.kumarusa.com

Office Locations: Denver (HQ), Colorado Springs, Fort Collins, and Frisco, Colorado

GEOTECHNICAL ENGINEERING STUDY AND PAVEMENT THICKNESS DESIGN TOWN OF BENNETT STREETS PROJECT ASPHALT PAVED ROADWAYS BENNETT, COLORADO

Prepared By:

Joshua L. Barker, P.E.

COLORADO LICENSED
JOSHUA L. BARKER
40174
PROFESSIONAL ENGINEER
Ap. 14. 16

Reviewed By:

James A. Noll, P.E.

Prepared for:

Town of Bennett Public Works
365 Palmer Avenue
Bennett, Colorado 80102

Attention: Mr. Daymon Johnson
Public Works Director

Project No. 16-3-104.1

April 14, 2016

TABLE OF CONTENTS

SUMMARY 1
PURPOSE AND SCOPE 2
PROPOSED CONSTRUCTION 2
SITE CONDITIONS 5
SUBSURFACE CONDITIONS 5
LABORATORY TESTING 7
PAVEMENT DESIGN 9
DESIGN AND CONSTRUCTION SUPPORT SERVICES 14
LIMITATIONS 14

FIGS. 1 AND 1A – LOCATION OF EXPLORATORY BORINGS
FIGS. 2 through 4 – LOGS OF EXPLORATORY BORINGS
FIG. 5 – LOGS, LEGEND AND NOTES OF EXPLORATORY BORINGS
FIGS. 6 through 15 – SWELL-CONSOLIDATION TEST RESULTS
TABLE I – SUMMARY OF LABORATORY TEST RESULTS

SUMMARY

1. A total of 76 exploratory borings were drilled within the project roadways. In general, the borings encountered a variable pavement section consisting of either full-depth hot mix asphalt or a flexible composite pavement section consisting of asphalt over aggregate base course. The thicknesses of the asphalt ranged from about 3 to 6.5 inches. Aggregate base course, where encountered was approximately 1 to 7.5 inches thick.

   Man-placed fill of various thickness was encountered beneath the pavement sections in the majority of the exploratory borings. The fill generally consisted of sandy lean clay, lean clay, and clayey sand. The clayey sand was fine to coarse-grained, and contained variable gravel content. The fill was moist to very moist, and brown to grey-brown and black. The vertical and horizontal limits, as well as the degree of compaction of the fill were not evaluated in detail as part of this study.

   The natural soils underlying the pavement sections and/or fill material was generally composed of sandy lean clay, lean clay with sand, and clayey sand. Lenses of silty sand were noted in some of the borings at the time of drilling. The natural soils were fine to coarse-grained with occasional gravel, and moist. Based on sampler penetration resistance values, the natural soils were very stiff to hard/loose to medium dense in consistency.

   Weathered claystone was encountered at a depth of about 7 feet in Boring A-6 and at a depth of about 4 feet in Boring A-32. The weathered claystone continued to the explored depths of 10 feet and 5 feet, respectively.

   Groundwater was not encountered in the borings at the time of drilling. All of the borings were backfilled and patched immediately after drilling and sampling due to safety concerns.

2. Rehabilitation and reconstruction alternatives for the project roadways were evaluated from an asphalt overlay approach as well as a total pavement reconstruction approach. The recommended overlay thicknesses are presented in the report. It is our opinion that the roadways within Brothers Four may be rehabilitated with a mill/overlay combination, assuming a possible reduction in pavement life expectancy (discussed herein) is accepted. Thin asphalt associated with the existing asphalt may make it difficult for proper milling. The remaining roadways should be completely reconstructed.

   Roadways within the Antelope Hills Subdivision should be provided with a full depth reclamation technique of the existing pavement surface to provide a stable paving platform for new asphalt pavement. The Centennial Subdivision and other ancillary roadways should be reconstructed using a cement treated subgrade technique to provide a stable paving surface within those areas.

   We recommend that roadways classifying as residential be provided with at least 4 inches of asphalt pavement placed on top of properly prepared subgrade. Properly prepared subgrade consist of full-depth reclamation of the existing pavement or a 12-inch chemically treated subgrade layer. Collector roadways should be paved with at least 5 inches of asphalt pavement placed on top of properly prepared subgrade.

PURPOSE AND SCOPE

This report presents the results of a geotechnical engineering study and pavement thickness design as part of the Town of Bennett Streets Project within the Town of Bennett, Colorado. The study was conducted for the purpose of obtaining subsurface data, developing subgrade preparation and paving recommendations for the identified street segments generally shown on Figs. 1 and 1A. The study was conducted in accordance with our proposal dated December 4, 2015 to the Town of Bennet in response to the Request for Proposal (RFP) identified as RFP: 15-009.

This study addresses only the existing asphalt paved roadways within the Town of Bennett as identified later in this report. The existing concrete paved roadways within the Town are addressed in a separate study under our Project No. 16-3-104.2.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subgrade materials obtained during the field exploration were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for possible pavement reconstruction and/or rehabilitation considerations. The results of the field exploration and laboratory testing are presented herein.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed roadway improvements are included in the report.

PROPOSED CONSTRUCTION

We understand that the Town of Bennett, Colorado has received voter approval for a one (1) percent sales tax increase to support Bond sales in the amount of $5.7 million, towards improvement of 17.5 miles of existing Town streets. The RFP indicated that the Town is including approximately 5.3 miles of existing concrete streets, 11.7 miles of existing asphalt-

paved streets and 0.5 miles of existing gravel streets in this project. This report addresses the asphalt paved roadways and some of the gravel surfaced roadways within the town.

The primary objective of this study is to help the Town identify roadways that need complete reconstruction and roadways that may be partially reconstructed by means of an asphalt overlay. The roadways included in this report are the asphalt roadways within the Antelope Hills Subdivision, the Centennial Subdivision, and the Brothers Four Subdivision. A short section of Palmer Avenue that is asphalt paved is included here along with ancillary roadways identified below. The roadway segments are outlined below:

Antelope Hills

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE ASPHALT PAVEMENT THICKNESS (INCHES)
Green Gables Circle	700	4
Green Gables Court	410	5
Pinehurst Court	2,070	4 to 5
Green Gables Way	1,460	4
Antelope Hills Boulevard	1,530	4 to 5
Columbine Drive	1,690	4.25 to 5
Valley Way	1,490	3 to 3.25
Antelope Drive West	11,325	3 to 5
Antelope Drive East	2,430	4
Approximate Total Centerline Lengths:	**23,105**	

Centennial

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE ASPHALT PAVEMENT THICKNESS (INCHES
Centennial Drive (East Segment)	1,380	3 to 6.5*
Centennial Drive (West Segment)	1,100	3 to 3.5
Centennial Way	825	3
Cleveland Court	870	2 to 2.5*
Coolidge Court	870	3 to 3.5*
Hancock Court	400	3.5
Madison Way	1,075	3
Harrison Drive	390	3
Hancock Way	440	3
Jackson Court	350	3
Jefferson Drive	720	3 to 3.5
Madison Drive	830	3
McKinley Drive	1,030	3
Approximate Total Centerline Lengths:	**10,280**	

* - Some aggregate base course encountered

Brothers Four

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE ASPHALT PAVEMENT THICKNESS (INCHES
Bennett Avenue	1,350	3 to 5.5
Ash Street	740	4
Birch Street	730	3.5
South Cherry Street	730	3.5
South Dahlia Street	730	3.5
South Elm Street (Asphalt Paved Portion Only)	730	3.5
Approximate Total Centerline Lengths:	**5,010**	

Ancillary Roadways

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE PAVEMENT THICKNESS (INCHES
Palmer Avenue (Asphalt Paved Portion West of Converse Road)	2,950	3 to 4
8th Street*	470	6 to 7
Shari's Court	580	3.5
Greg's Way*	450	*
Washington Way*	970	*
Approximate Total Centerline Lengths:	**5,420**	

* - 8th Street is currently paved with concrete, Washington Street and Greg's Way are currently gravel surfaced roadways

SITE CONDITIONS

The significant majority of the streets are local residential streets. Asphalt paved roadways within the town that are designated collector streets include Palmer Avenue, Centennial Drive, Ash Street, and Bennett Avenue, and Antelope Hills Boulevard. The street segments generally consist of two-lane facilities (a single travel lane in each direction). Surface drainage carrying sheet flow off of the pavement surface is contained within adjacent concrete gutters with the exception of the roads in the Antelope Hills Subdivision, where adjacent roadside ditches are present.

SUBSURFACE CONDITIONS

The field exploration for the study was conducted between January 15 and 29, 2016. A total of 76 exploratory borings were drilled for the geotechnical engineering study and pavement thickness design addressed in this report. The borings were drilled to depths ranging from approximately 5 to 10 feet. All of the borings were made to obtain information for use in the design or rehabilitation of the pavement section. The approximate locations of the exploratory borings are shown on Figs. 1 and 1A.

It should be noted that during contract negotiations with the Town, it was decided that Palmer Avenue west of 1st Street was a lower priority roadway and that a lower frequency of borings would be required along that stretch of roadway. Therefore, Borings P-2, and P-5 were eliminated from the scope of work and are not included in this report.

The borings were advanced through the pavement sections and into the overburden soils with 4-inch diameter continuous flight augers. The borings were logged by a representative of Kumar & Associates, Inc. The borings were generally drilled in the travel lanes of the pavement on alternating sides of the alignment, utilities permitting.

Samples of the soils were obtained with a 2-inch I.D. California liner sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. The test is similar to the standard penetration test described by ASTM Method D 1586. Penetration resistance values, when properly evaluated indicate the relative density or consistency of the soils. Large disturbed bulk samples were taken from the borings. Depths at which samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Figs. 2 through 4. The legend and explanatory notes associated with the graphic logs describing the soils encountered are presented on Fig. 5.

The borings encountered variable pavement sections consisting primarily of full-depth hot mix asphalt although a few areas encountered a flexible composite pavement section consisting of asphalt over aggregate base course. The thicknesses of the asphalt ranged from about 3 to 6.5 inches as generally described in the tables above. Aggregate base course was encountered in a few of the borings and was approximately 1 to 7.5 inches thick. The thicknesses of the pavement sections encountered are also shown on the Logs of Exploratory Borings, Figs. 2 through 4.

Man-placed fill of various thickness was encountered beneath the pavement sections in the majority of the exploratory borings. The fill generally consisted of sandy lean clay, lean clay, and clayey sand. The clayey sand was fine to coarse-grained, and contained variable gravel content. The fill was moist to very moist, and brown to grey-brown and black. The vertical and horizontal limits, as well as the degree of compaction of the fill were not evaluated in detail as part of this study.

The natural soils underlying the pavement sections and/or fill material was generally composed of sandy lean clay, lean clay with sand, and clayey sand. Lenses of silty sand were noted in some of the borings at the time of drilling. The natural soils were fine to coarse-grained with occasional gravel, and moist. Based on sampler penetration resistance values, the natural soils were very stiff to hard/loose to medium dense in consistency.

Weathered claystone was encountered at a depth of about 7 feet in Boring A-6 and at a depth of about 4 feet in Boring A-32. The weathered claystone continued to the explored depths of 10 feet and 5 feet, respectively.

Groundwater was not encountered in the borings at the time of drilling. All of the borings were backfilled and patched immediately after drilling and sampling due to safety concerns.

LABORATORY TESTING

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer and samples were selected for laboratory testing. Laboratory testing included moisture content and dry unit weight, liquid and plastic limits, and concentration of water soluble sulfates. The laboratory testing was conducted in general accordance with applicable ASTM standards.

Swell-consolidation testing was conducted on several samples of the natural soils and man-placed fill materials to determine their swell-consolidation characteristics when wetted under a static surcharge load. The samples obtained from the proposed pavement areas for swell-consolidation testing were loaded with a 200-psf surcharge pressure.

The swell-consolidation test results indicated that the on-site overburden natural soils and fill materials possess low consolidation to low swell potential. Results of the laboratory testing program are shown adjacent to the boring logs on Figs. 2 through 4, plotted graphically on Figs. 6 through 15 and are summarized in the attached Summary of Laboratory Test Results in Table I.

PAVEMENT CONDITION

Antelope Hills Subdivision: The majority of the roadway segments within the Antelope Hills Subdivision appeared to have pavement that was in poor to fair condition with observed distresses that included low to medium severity longitudinal and transverse cracking, and areas of low to medium severity patching. Evidence of previous crack sealing operations were observed on some of the roadways.

Much of the more severe pavement distress appeared to be closely associated with settlement of utility trench backfill. The asphalt pavement surface near many of the water valves in and around the subdivision had depressions ranging from about 1 to 3 inches. The depressions also appeared to range from about 1 to as much as 3 feet in diameter. The depressions are presumably a result of trench backfill settlement around the water valves. We also observed several areas of longitudinal depressions in the asphalt surface that were about an inch deep and 1 to 2 feet wide that appeared to follow the water line trenches.

As a result of the distresses to the pavement surface and the underlying subgrade conditions, we recommend complete reconstruction of the asphalt pavements within the Antelope Hills Subdivision. We recommend complete reconstruction based on our experience with asphalt overlays in areas of high severity pavement distress. Specifically, reflective cracking through an overlay is much more prevalent. Also, there is no economical method of stabilizing the areas where apparent backfill settlement has occurred.

Centennial Subdivision: The majority of the roadway segments within the Centennial Subdivision appeared to have pavement that was in poor condition with observed distresses that included low to medium severity longitudinal and transverse cracking, and low to high severity alligator and/or block cracking. Evidence of previous crack sealing operations were observed on some of the roadways.

It is our opinion that the paved surfaces within the Centennial Subdivision are beyond repair and require complete reconstruction.

Brothers Four: The majority of the roadway segments within the Brothers Four Subdivision appeared to have pavement that was in fair to good condition with observed distresses that included low severity longitudinal and transverse cracking. It should be noted that some areas

of medium to high severity alligator and/or block cracking were noted, but did not represent the majority of the paved surfaces within the subdivision. Evidence of previous crack sealing operations were observed on some of the roadways.

It is our opinion that the majority of the paved surfaces within the Brothers Four Subdivision may be suitable to be rehabilitated by milling and placement of an asphalt overlay. Thin asphalt thicknesses may make it difficult for proper milling. Areas within the subdivision that are showing signs of moderate to high severity distress should be saw cut and removed to a distance of at least 5 feet beyond the area of distress. The removed pavement should be completely reconstructed. Discussion of overlay thicknesses and design life expectancy are presented in the Pavement Design section of this report.

Ancillary Roadways: The asphalt paved portions of Palmer Avenue west of 1st Street were generally in fair to good condition, although some isolated areas along the southern roadway edge exhibited moderate to high severity alligator cracking. 8th Street is currently paved with concrete and is in poor to fair condition. Sheri's Court is currently paved with asphalt and is in poor condition exhibiting moderate to high severity alligator and/or block cracking along the entire length of the roadway. Washington Way and Greg's Way are both currently gravel surfaced roadways.

Based upon discussions with the town, we understand that Palmer Avenue is a low priority roadway and may have some of the distressed area patched; however, it is anticipated at this time that no additional rehabilitation will occur. If funds become available for repair, we recommend an asphalt overlay be applied to the roadway after the areas of moderate to high severity distresses have been patched with a full depth asphalt section.

We also understand that 8th Street, Sheri's Court, Washington Street and Greg's Way will be completely reconstructed with asphalt pavement

PAVEMENT DESIGN

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for pavement design purposes

by means of a resilient modulus for flexible pavements. This value is empirically related to strength.

Subgrade Materials: Samples of the subgrade materials were taken from the roadway segments. Based on the results of the field and laboratory studies, the soils obtained varied across the sites and classify between A-2-4 and A-7-6 soils with group indices between 0 and 35 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) classification system.

Subgrade support testing consisting of Hveem (R-value) was performed on bulk samples of the subgrade materials. The R-Value testing is presented under the concrete roadways report described above. R-value testing performed on four bulk samples of subgrade materials indicated R-values between 6 and 17 at exudation pressures of 300 psi. In accordance with Colorado Department of Transportation (CDOT) correlation procedures, the R-Values were converted to equivalent resilient modulus values ranging from 3,126 psi to 4,478 psi. Based on the high variability of the subgrade conditions encountered, we cannot assign specific R-Value (resilient modulus) values to certain parts of the Town; therefore, we elected to utilize the minimum R-Value and used a design resilient modulus value of 3,126 psi to determine the pavement sections below.

Design Traffic: We have not been provided with specific traffic counts or distributions for the roadways within the Town; however, we have been informed that the residential roadways receive traffic typical of residential roadways. As noted above, we have also been informed that Palmer Avenue, Centennial Drive, Ash Street, and Bennett Avenue, and Antelope Hills are classified as Collector Roadways.

Based on our past experience with similar facilities, we assumed an 18-kip equivalent single axle loading (ESAL) value of 36,500 for the residential roadways. An ESAL of 219,000 was assumed for the Collector Roadways. The ESAL values represent mid-life traffic loadings on a pavement that is designed to have a 20-year useful life. Routine maintenance is required during that 20-year period.

If the assumptions indicated above appear to be different than actual traffic values for the site, we should be notified to reevaluate pavement thickness requirements.

Asphalt Overlay: Areas that will receive an asphalt overlay within Brothers Four Subdivision were analyzed based on the AASHTO Component Analysis approach where a structural coefficient for the existing asphalt ranging from 0.2 to 0.3 was selected depending upon the condition of the asphalt.

The representative existing asphalt thickness were incorporated with the selected structural coefficients to determine the existing structural number of the roadway segments. Using the design subgrade resilient modulus of 3,126 psi along with the applicable ESAL, the DARWin™ computer software program was used to solve the AASHTO pavement design equation to determine the design structural number for the particular roadway segment. The deficiency between the design structural number and the calculated existing structural number is the required structural number needed for an asphalt overlay.

The analysis also included a 1-inch mill to be performed of the existing asphalt pavement in order for the new asphalt overlay to be placed.

Asphalt Overlay Analysis: Based on the overlay approach summarized above, we calculate that the Brothers Four asphalt pavement needs a pavement structural value of 2.33. Milling 1-inch from the existing asphalt surface leaves about 2.5 inches of pavement that will contribute a structural value of about 0.75. This means that the required thickness of asphalt to reach the design structural value is 3.6 inches. If 3.6 inches of asphalt were placed on the pavement surface after a 1-inch mill, than the proposed pavement surface would be as much as 2.6 inches higher than the existing pavement surface. Given that there is existing concrete curb and gutter along the roadways within Brothers Four, the added asphalt pavement surface may create drainage issues.

If the required thickness of asphalt overlay is not feasible, a reduced overlay thickness is an option. If an overlay thickness was selected such that the proposed roadway surface was 1-inch higher than the existing pavement surface to allow for drainages to be maintained, the design life of the pavement would be reduced. Given the above analysis and using a 1-inch mill and 2-inch overlay replacement, we estimate that the useful life of the roadways within Brothers Four to range from about 10 to 12 years. This estimated life can vary significantly based upon the actual traffic loading conditions.

If an asphalt overlay is not acceptable to the Town, then a complete reconstruction of the asphalt pavement section should be performed.

Asphalt Overlay Recommendations: If an asphalt mill is selected the following recommendations should be followed. At the completion of the milling operation and just prior to placement of the asphalt overlay, the pavement surface should be thoroughly clean and applied with a proper concentration of tack coat.

Based on the distresses observed at the time of the field study, it does not appear that significant repair of distressed areas will be required. Placement of an asphalt overlay fabric on the existing/milled surface will reduce the tendency for reflection of the underlying pavement cracking. The overlay fabric will reduce the ability for surface water migration into the underlying pavement layers and subgrade materials. We have been informed by several Public Works agencies that the "water barrier" characteristics of the overlay fabric can result in stripping and deterioration of the bottom of the asphalt overlay.

As mentioned above, small portions of the roadways have experienced high severity distresses. These areas should be properly reconstructed prior to placement of an overlay.

<u>Pavement Reconstruction</u>: As indicated above, we recommend complete roadway reconstruction for the roadways within the Antelope Hills Subdivision and the Centennial Subdivision as well as 8th Street, Washington Way, Sheri's Court and Greg's Way.

Our field evaluation of the project sites indicates a variety of subgrade treatments can be utilized during complete pavement reconstruction. Based upon our findings, we recommend that the roadways within the Antelope Hills Subdivision be reconstructed utilizing a full depth reclamation (FDR) technique for subgrade preparation. The new pavements within the Centennial Subdivision, in 8th Street, Washington Way, Greg's Way and Shari's Court should be provided with a cement treated subgrade below the new asphalt pavement. Discussion of the subgrade treatment alternatives are presented in the Subgrade Preparation section below.

We recommend that roadways classifying as residential be provided with at least 4 inches of asphalt pavement placed on top of properly prepared subgrade. Collector roadways should be

paved with at least 5 inches of asphalt pavement placed on top of properly prepared subgrade. As indicated, properly prepared subgrade consists of EDR or a 12-inch thick, chemically treated subgrade layer.

Subgrade Preparation: Areas of pavement subgrade within the Antelope Hills Subdivision should be conditioned with a full depth reclamation (FDR) technique. FDR utilizes specialty machinery that pulverizes and grinds the existing pavement such that the pavement particle sizes are smaller than about 2-inches in diameter. The machine then blends the pulverized pavement into the underlying subgrade to a depth of about 8 inches. The depth of treatment should be discussed with the specialty contractor and should be partially based upon the existing thickness of asphalt pavement.

The subgrade within the Centennial Subdivision, in 8th Street, Washington Way, Greg's Way and Shari's Court should be provided with a cement treated subgrade below the new asphalt pavement. Cement treatment is generally performed by a specialty contractor after the existing pavement is removed and rough grading has occurred. We recommend that the subgrade and cement be thoroughly mixed to a depth of at least 12 inches below the proposed subgrade elevation and that at least 4% cement be used based on a dry weight basis. The cement treatment process should meet the requirements of "Item 5, Stabilized Subgrade, Part 1, Chemically Stabilized Subgrade" of the Metropolitan Government Pavement Engineers Council (MGPEC) Pavement Design Standards and Specification.

Both FDR and chemically treated subgrades should be compacted to at least 95% of the standard Proctor (AASAHTO T 99) maximum dry density at moisture contents within -1 to +3 percentage points above the optimum moisture content.

Prior to placement of the asphalt, the pavement subgrade should be proof rolled with a heavily loaded pneumatic-tired vehicle such as a loaded water truck or paving truck prior to paving. Pavement design procedures assume a stable subgrade. Areas that deform under wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving.

There may be areas of soft subgrade encountered when the existing pavement is removed. These areas may be overexcavated to a depth where stable material is encountered. The

overexcavated material may be replaced with the removed material (adjusted for moisture content and compacted according to the criteria listed above). An alternative to significant overexcavation would be to span the soft areas with a biaxial geogrid. Aggregate base course would then be placed over the geogrid to provide a stable paving platform. We anticipate an aggregate base course thickness of 12 inches would be required.

Asphalt Mix Type: The asphalt pavement used for the roadways (both reconstruction and overlay) should consist of a Grading S or SX mix with an asphalt binder meeting PG 58-28 specifications. The asphalt pavement should be compacted in accordance with current CDOT guidelines.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary to accommodate possible changes in the proposed construction.

We recommend that Kumar & Associates, Inc. be retained to provide observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

LIMITATIONS

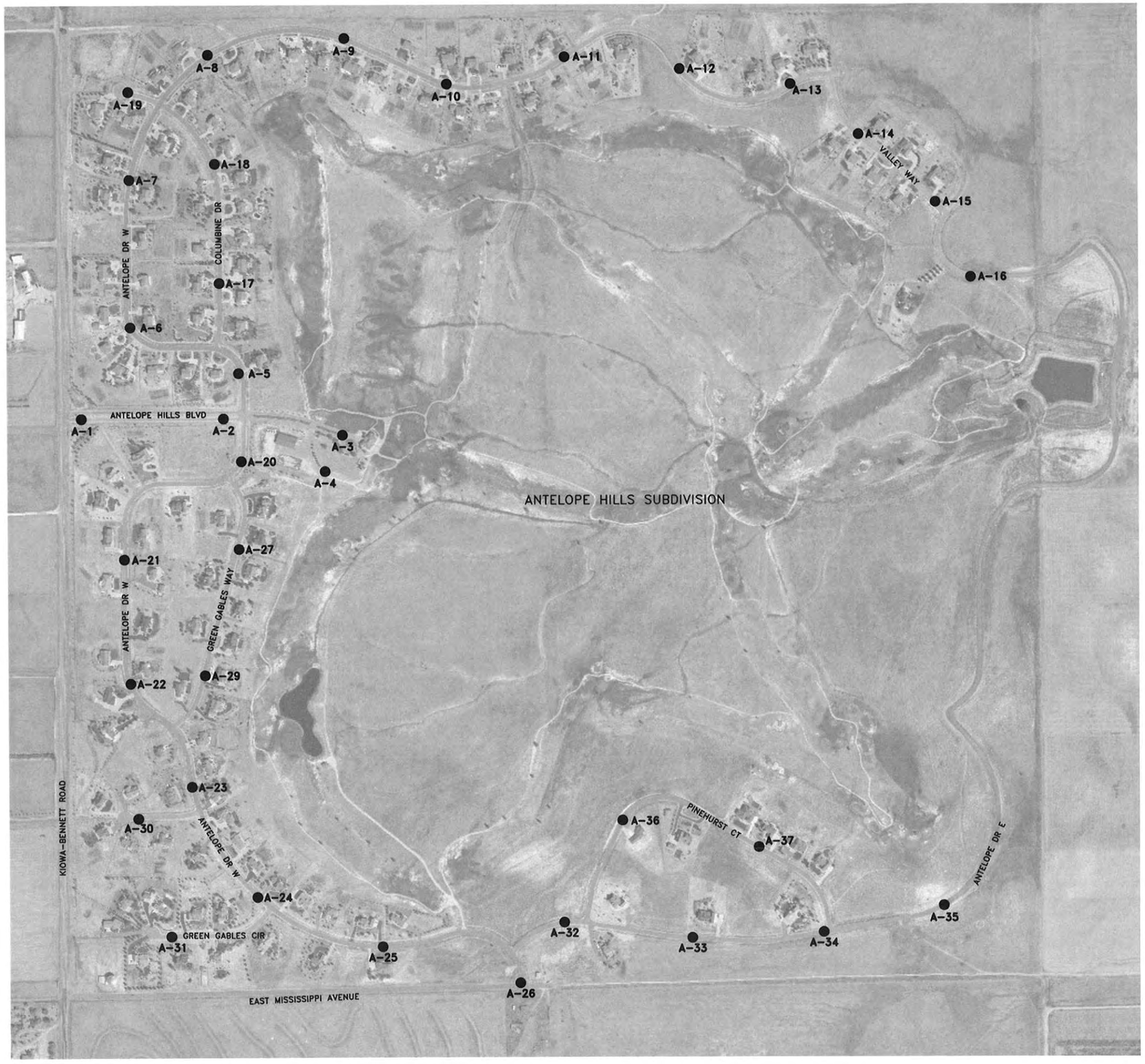
This study has been conducted in accordance with generally accepted geotechnical and pavement engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Figs. 1 and 1A, and the proposed type of construction. This report may not reflect subsurface variations that occur between the exploratory borings, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, existing pavement section type and thickness, fill, soil, bedrock or groundwater conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised

at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

JLB/jw
cc: Book, File

March 18, 2016 – 12:28pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-01A to 01.dwg

16-3-104.1	Kumar & Associates	TOWN OF BENNETT ASPHALT PAVED ROADWAYS	LOCATION OF EXPLORATORY BORINGS	Fig. 1

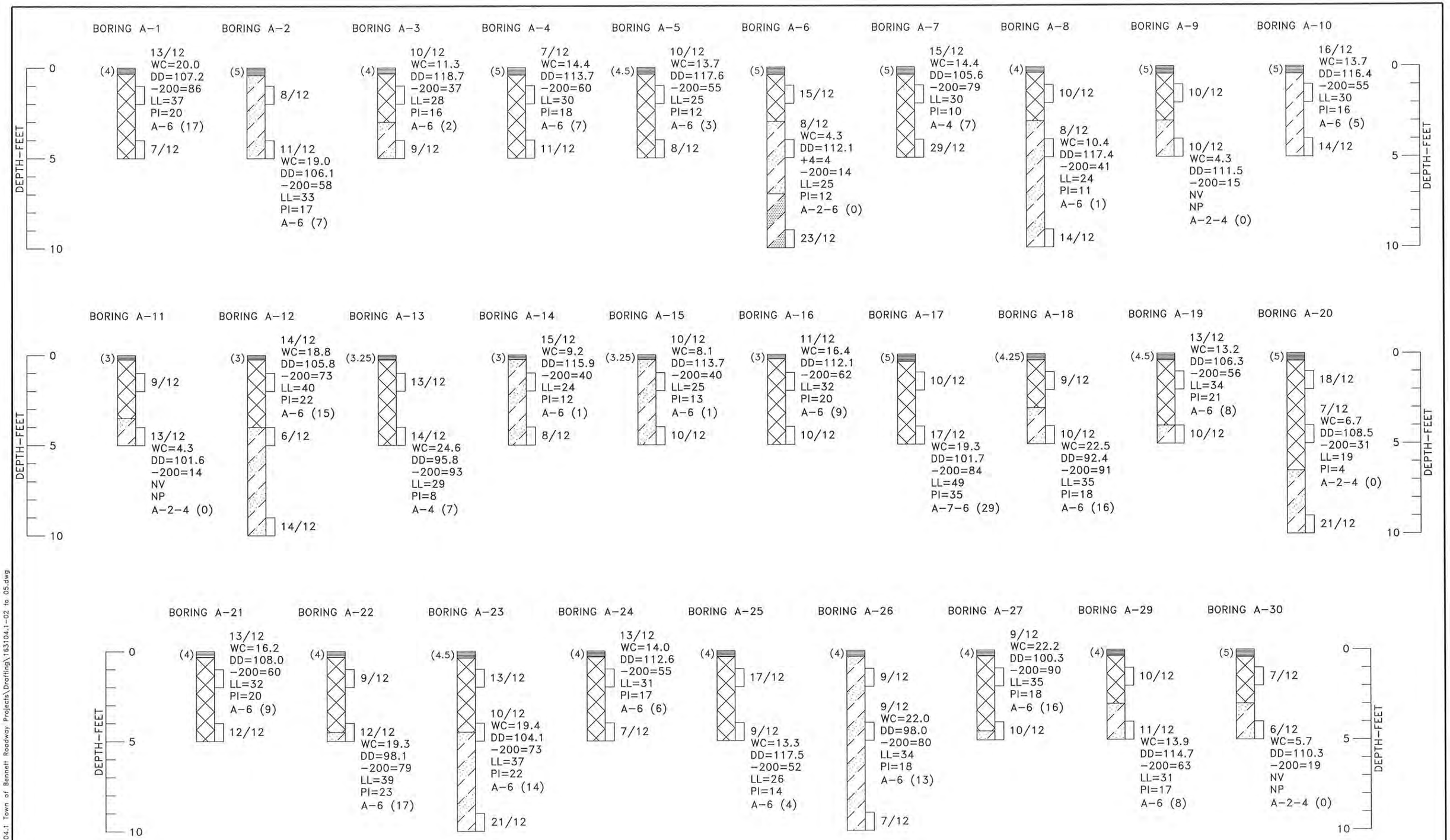


300 0 300 600

APPROXIMATE SCALE-FEET

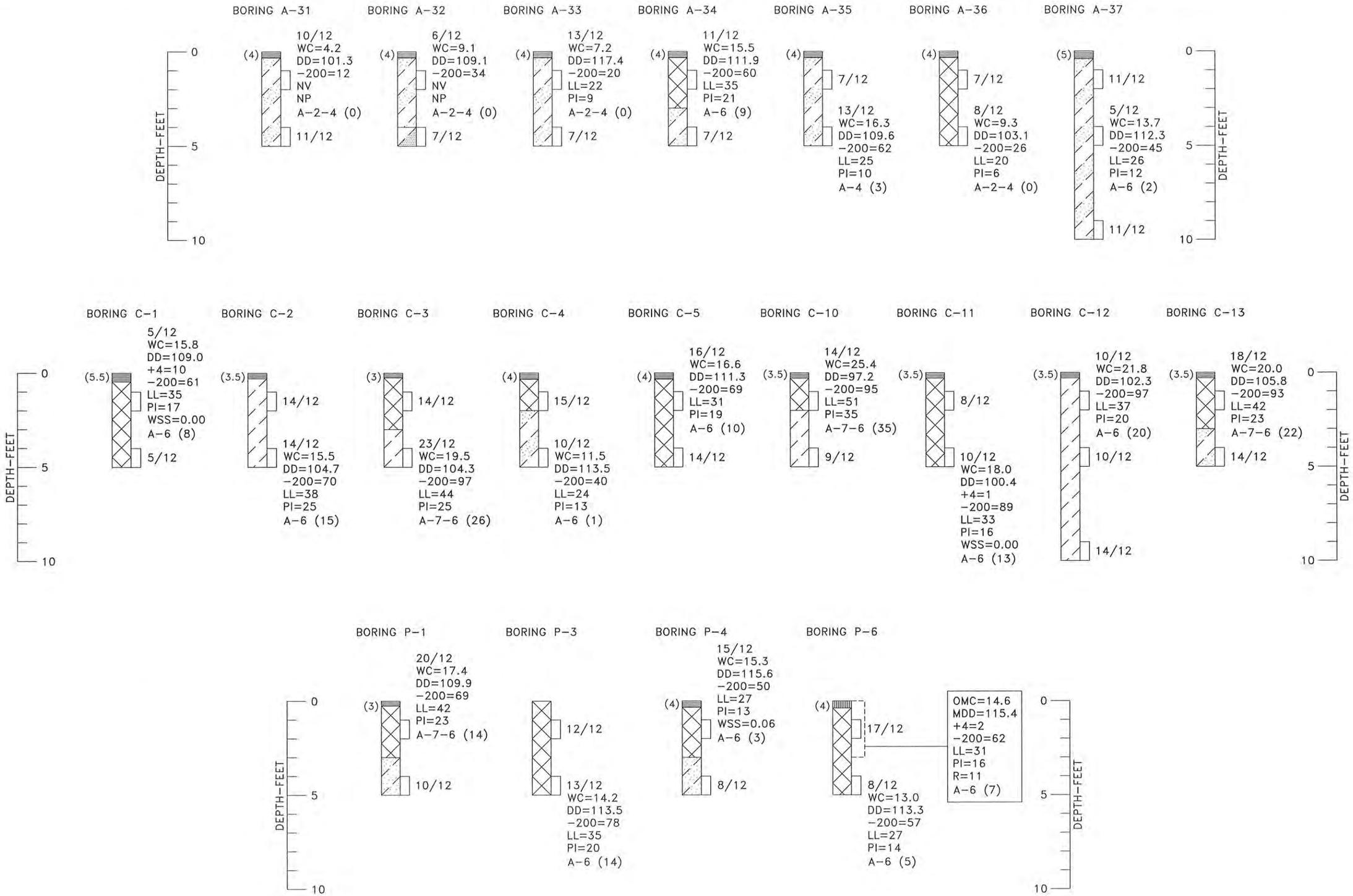
March 18, 2016 - 11:42am
C:\Users\mromero\appdata\local\temp\AcPublish_2052\163104.1-01A to 01.dwg

16-3-104.1	Kumar & Associates	TOWN OF BENNETT ASPHALT PAVED ROADWAYS	LOCATION OF EXPLORATORY BORINGS	Fig. 1A



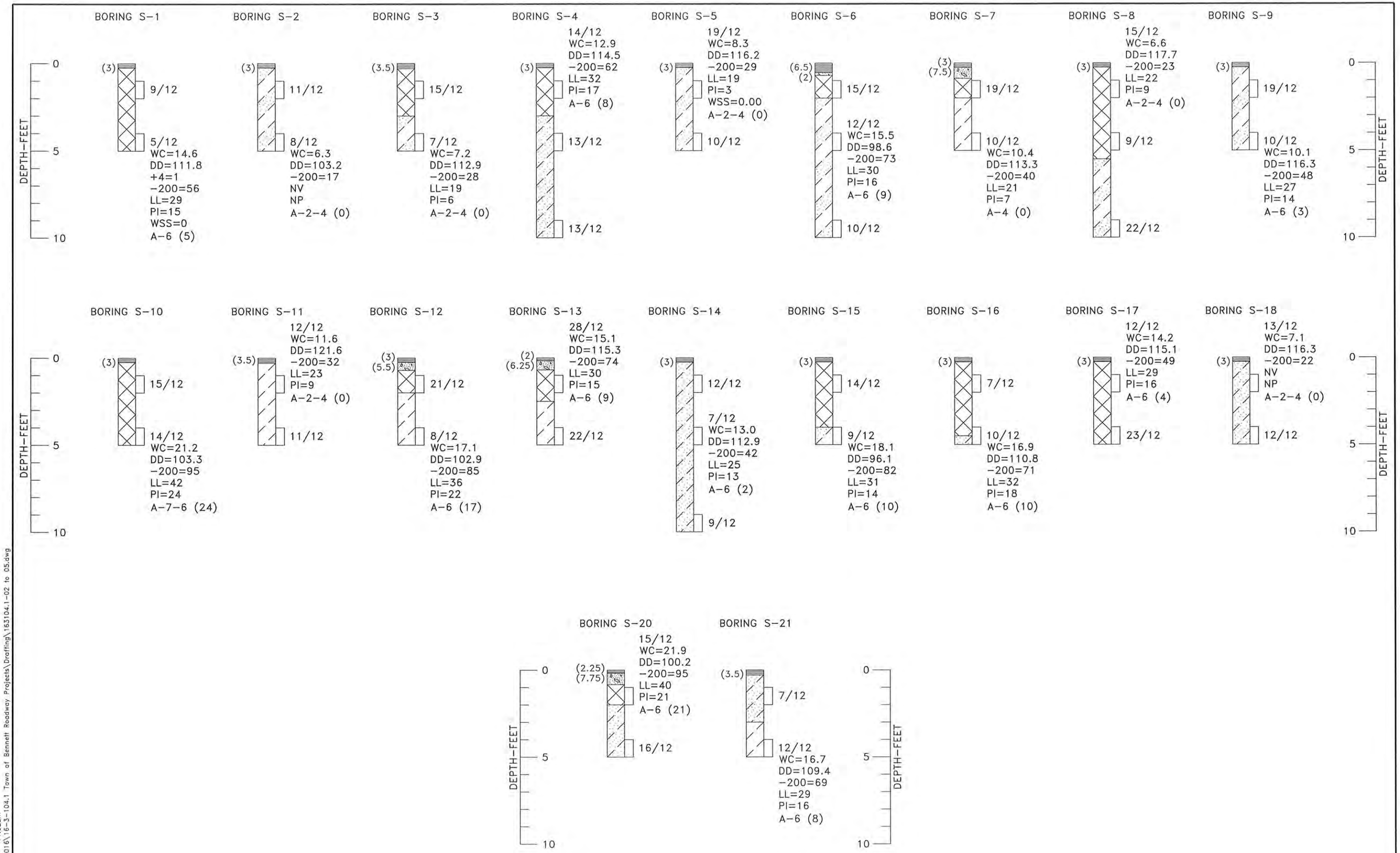
16-3-104.1	Kumar & Associates	TOWN OF BENNETT ASPHALT PAVED ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 2

Mar 18, 18Y - 11:32am
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-02 to 05.dwg



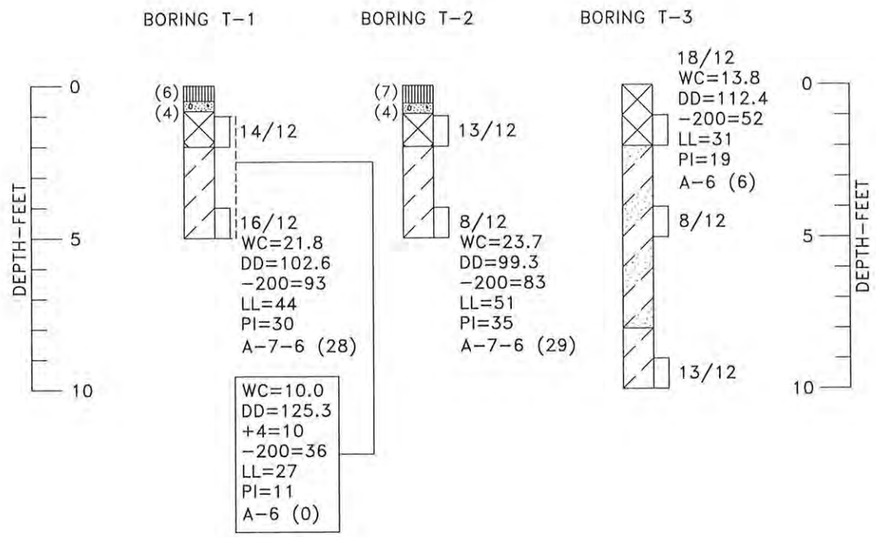
16-3-104.1	Kumar & Associates	TOWN OF BENNETT ASPHALT PAVED ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 3

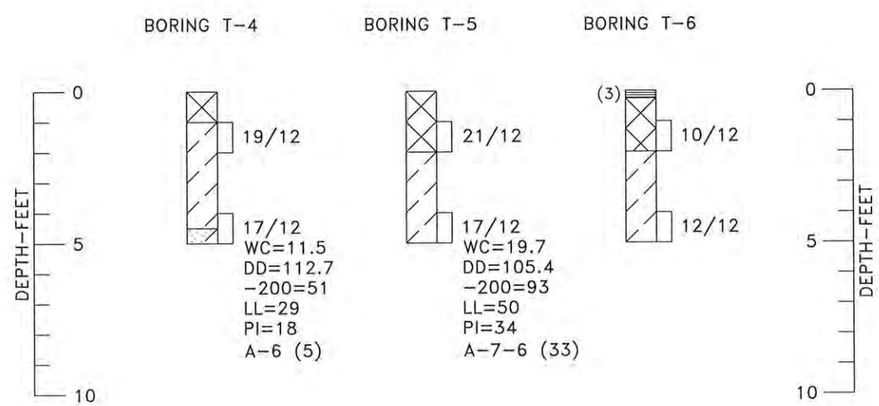
Mar 18, 16Y - 11:32am
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-02 to 05.dwg



16-3-104.1	Kumar & Associates	TOWN OF BENNETT ASPHALT PAVED ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 4

Mar 18, 16Y - 11:32am
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-02 to 05.dwg





LEGEND

(4) ASPHALT, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

FILL: LEAN TO FAT CLAY (CL TO CH), VARIABLE LAND AND GRAVEL CONTENTS, OCCASIONAL CLAYEY SAND (SC), FINE TO COARSE GRAINED, SLIGHTLY MOIST TO VERY MOIST, LIGHT BROWN TO BROWN TO DARK BROWN TO BLACK.

LEAN TO FAT CLAY (CL TO CH) TO SLIGHTLY LEAN CLAY (CL), FINE TO MEDIUM GRAINED, STIFF TO VERY STIFF, MOIST, LIGHT BROWN TO BROWN.

CLAYEY SAND (SC), FINE TO COARSE GRAINED, LOOSE TO MEDIUM DENSE, MOIST, BROWN.

INTERBEDDED SANDY CLAY (SC), SILTY CLAYEY SAND (SP-SM) AND LEAN CLAY (CL), OCCASIONAL SILTY SAND LENSES, FINE TO COARSE GRAINED, MEDIUM TO VERY STIFF, MOIST, LIGHT BROWN TO BROWN.

WEATHERED CLAYSTONE, FINE TO MEDIUM GRAINED, STIFF TO VERY STIFF, MOIST, LIGHT BROWN.

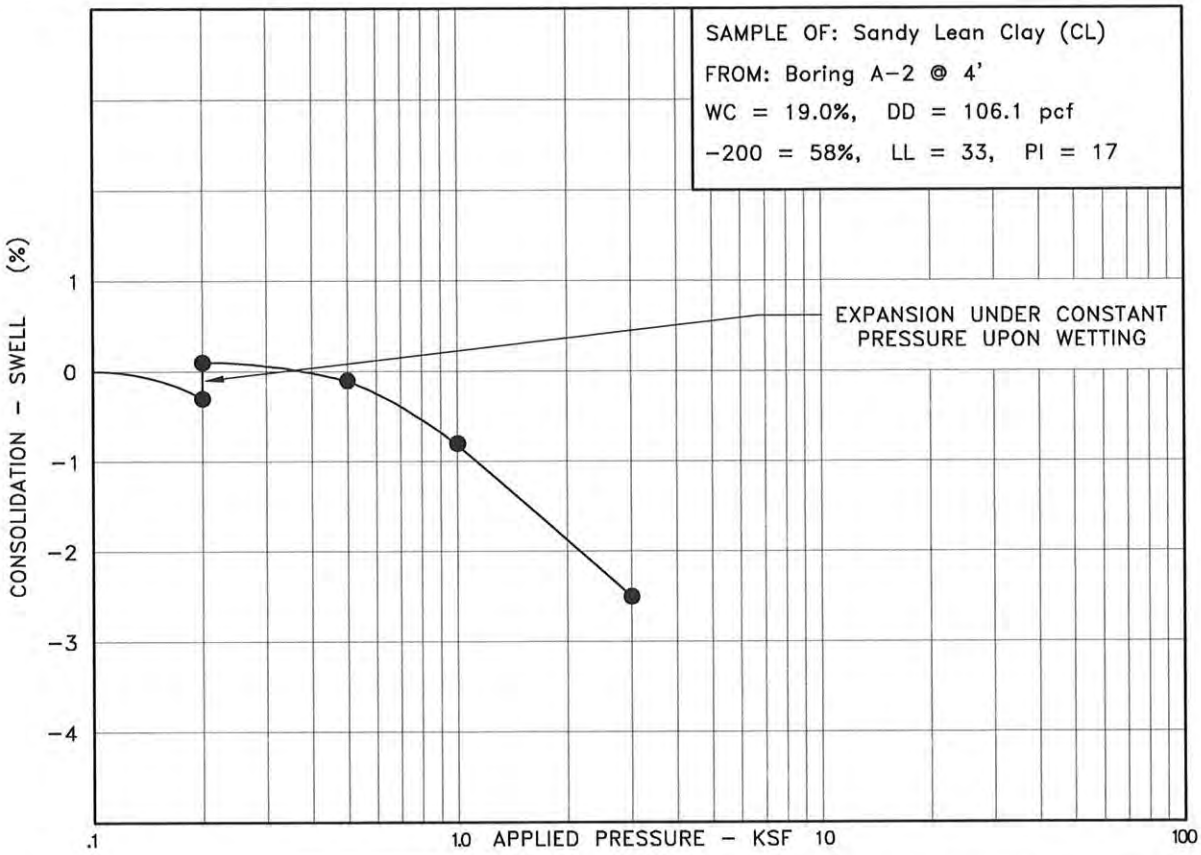
DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

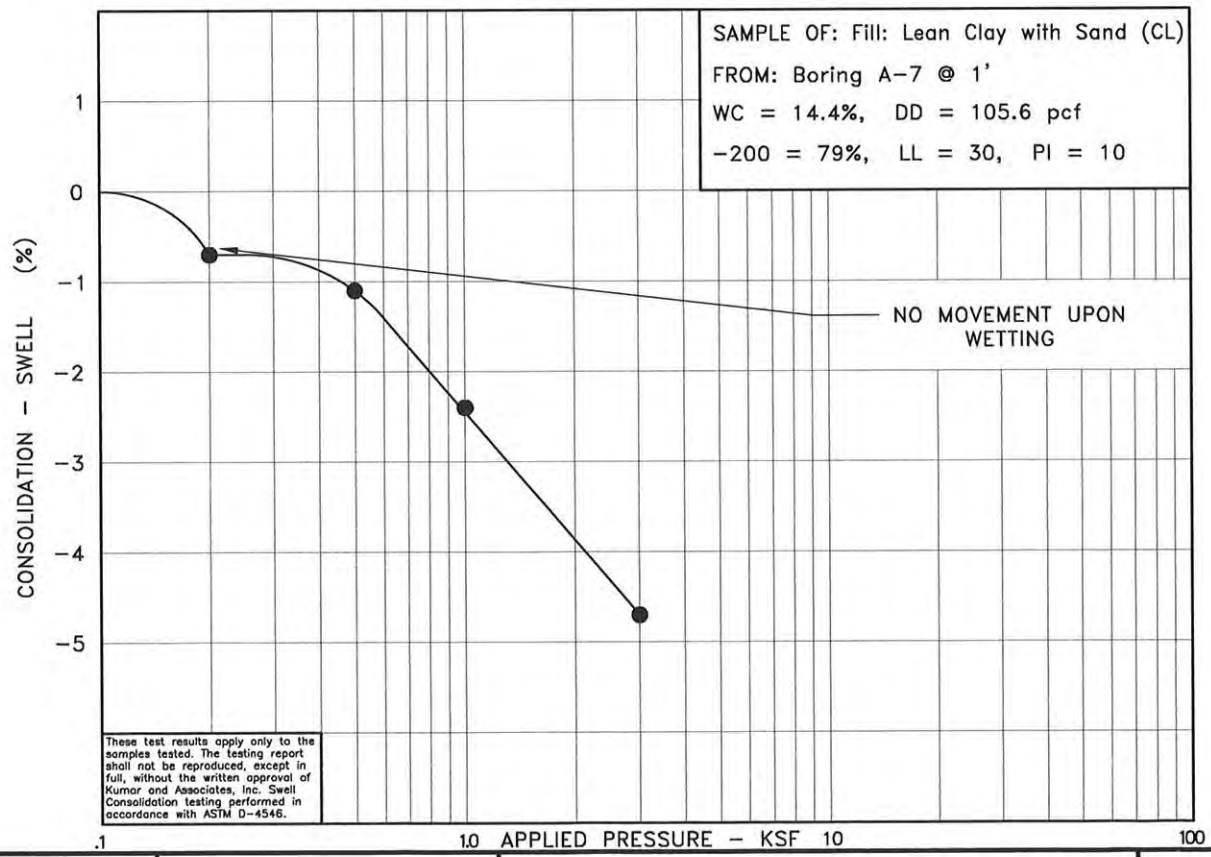
13/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 13 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED BETWEEN JANUARY 15 AND 29, 2016 WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.
4. THE EXPLORATORY BORING LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORINGS AT THE TIME OF DRILLING.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   DD = DRY DENSITY (pcf) (ASTM D 2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
   LL = LIQUID LIMIT (ASTM D 4318);
   PI = PLASTICITY INDEX (ASTM D 4318);
   NP = NON-PLASTIC (ASTM D 4318);
   NV = NO LIQUID LIMIT VALUE (ASTM D 4318);
   R = HVEEM R-VALUE (AT 300 psi) (ASTM D 2844);
   WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103);
   A-2-6 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145).

Mar 18, 16Y - 13:16pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-02 to 05.dwg

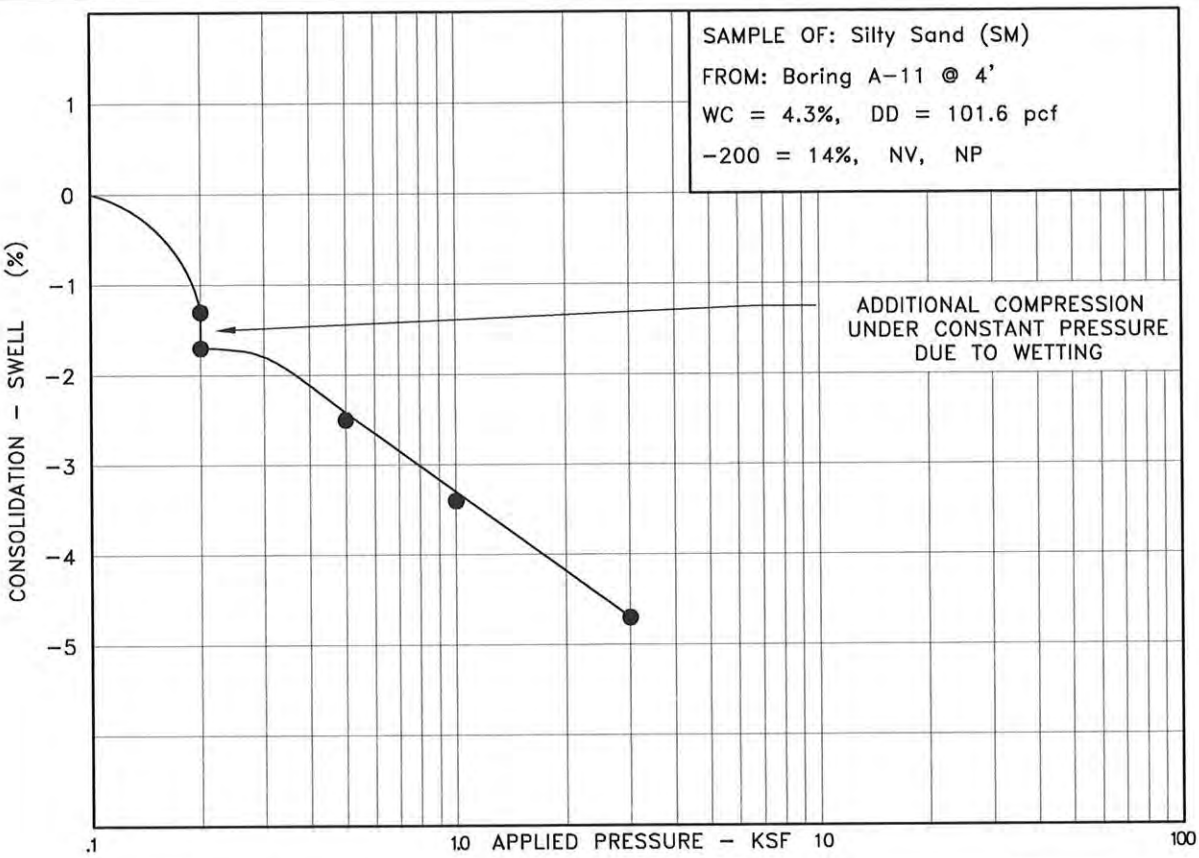


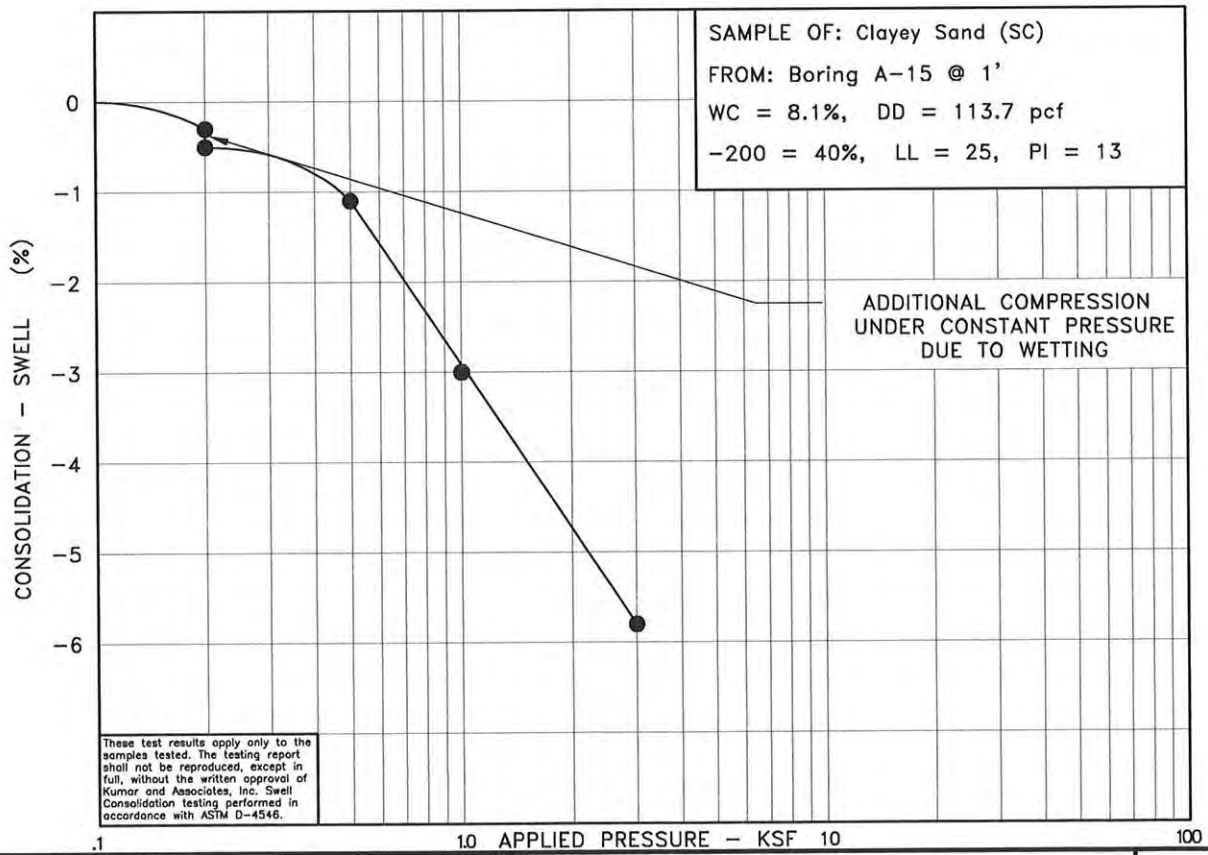


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 6

March 11, 2016 - 03:36pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-05 to 11.dwg

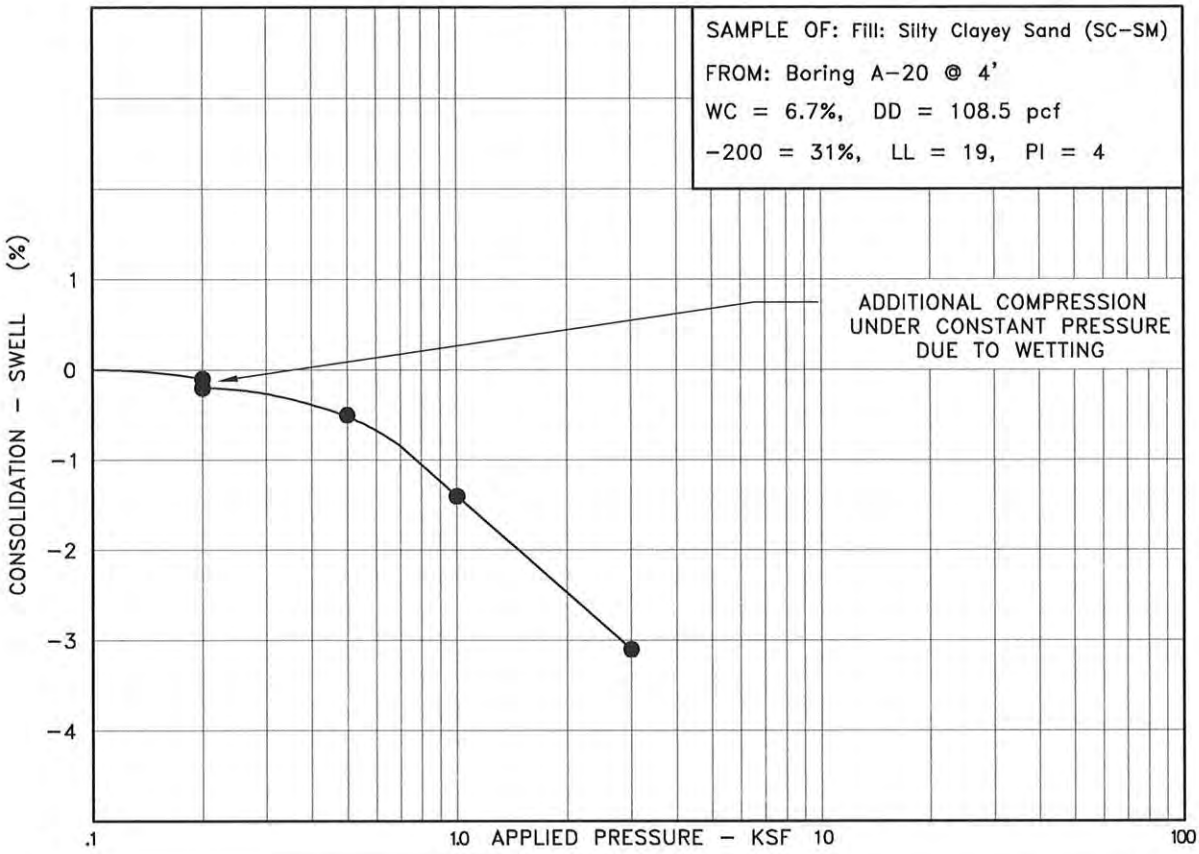


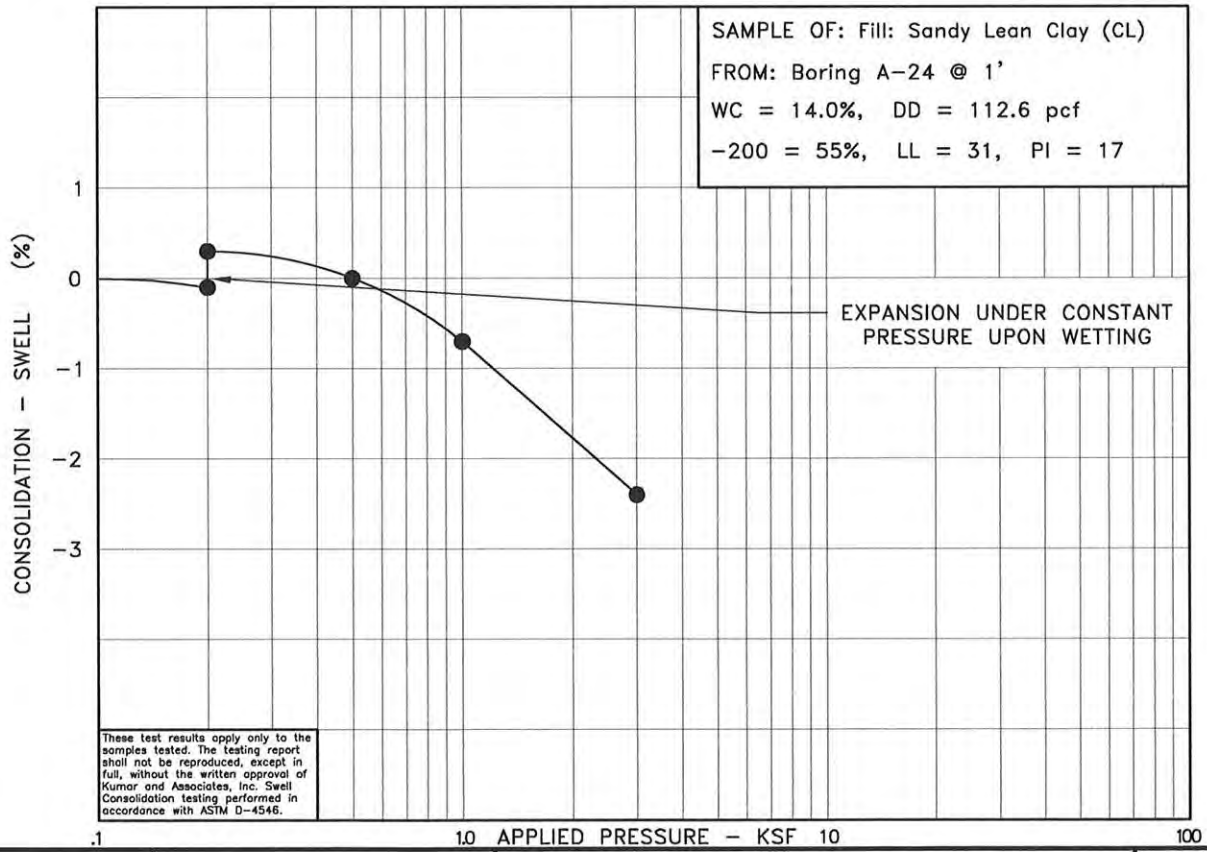


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 7

March 11, 2016 - 03:36pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\153104.1-05 to 11.dwg

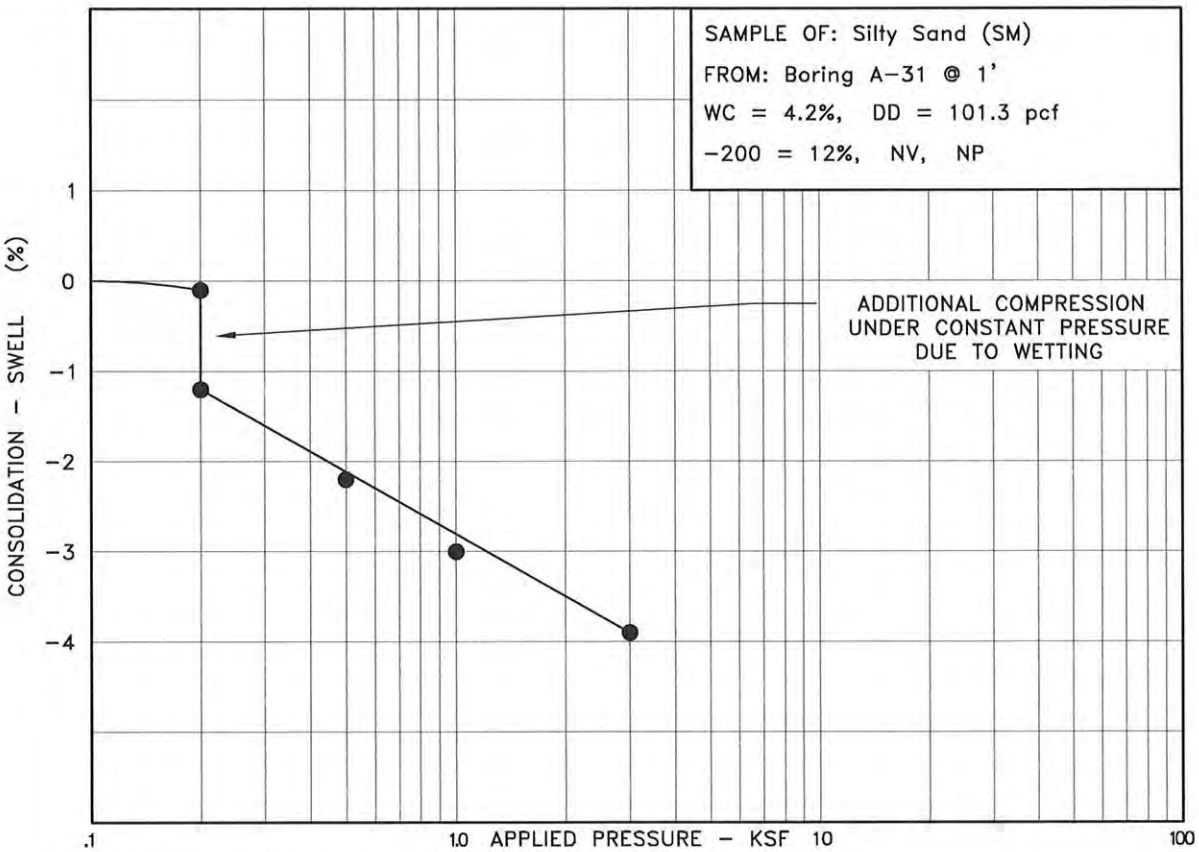


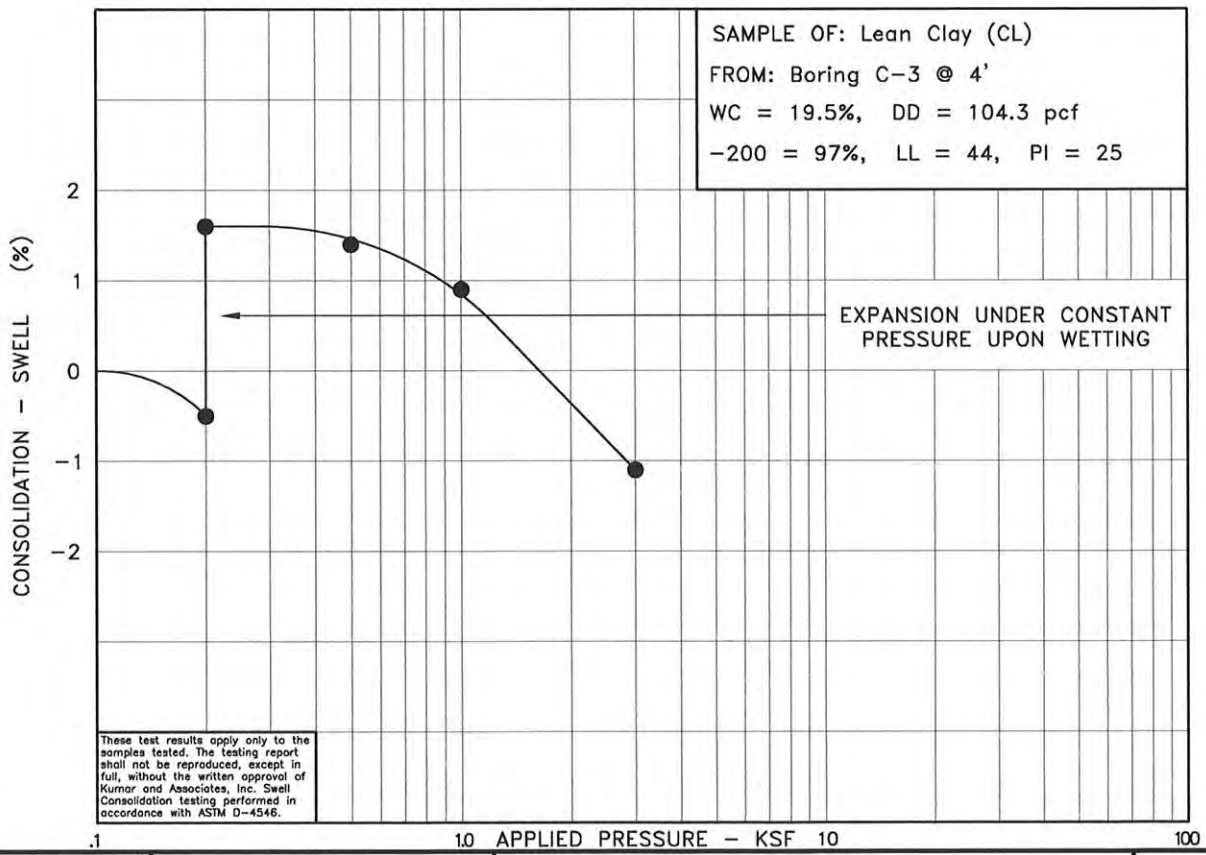


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 8

March 11, 2016 - 03:36pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-05 to 11.dwg

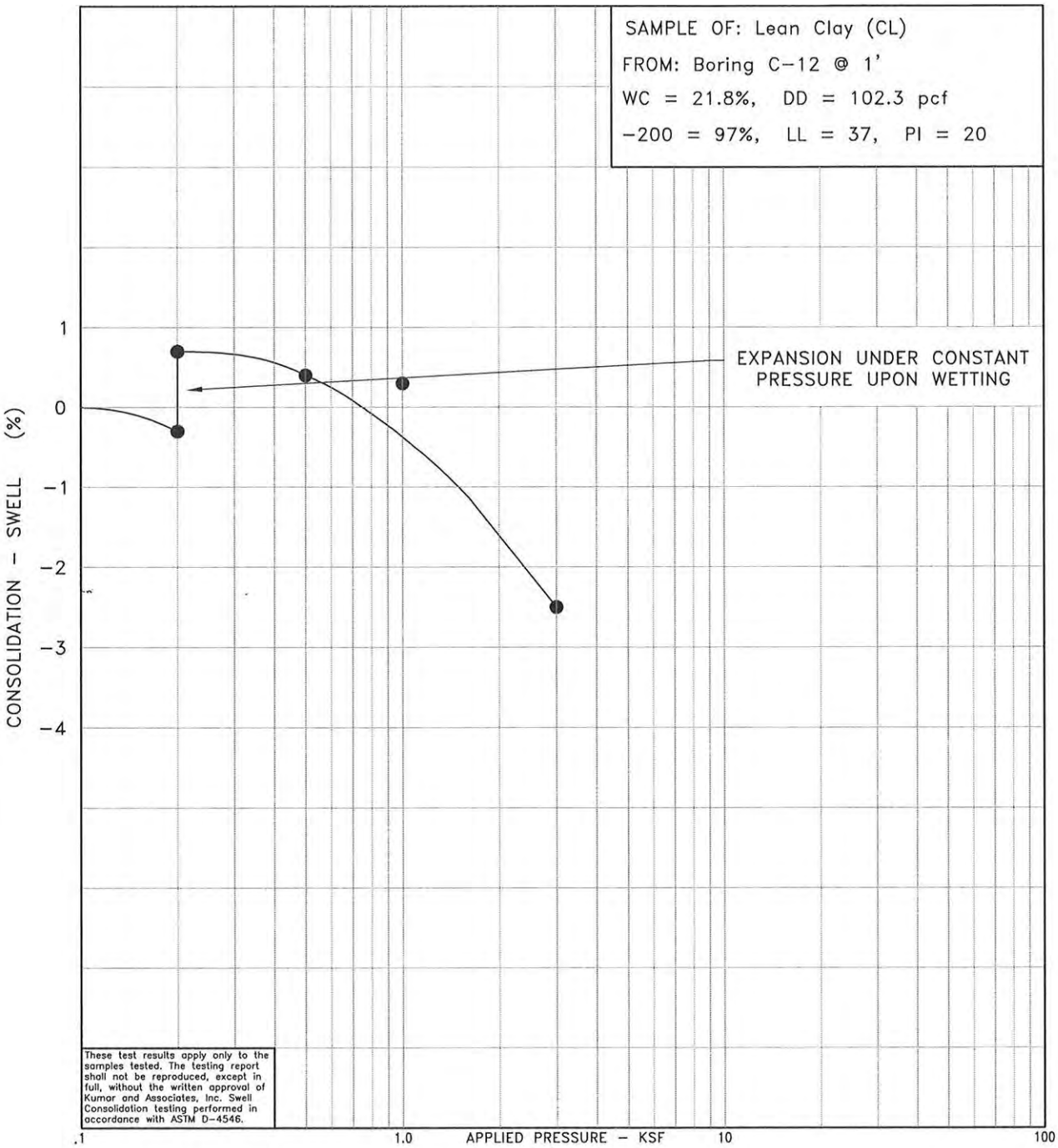




These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

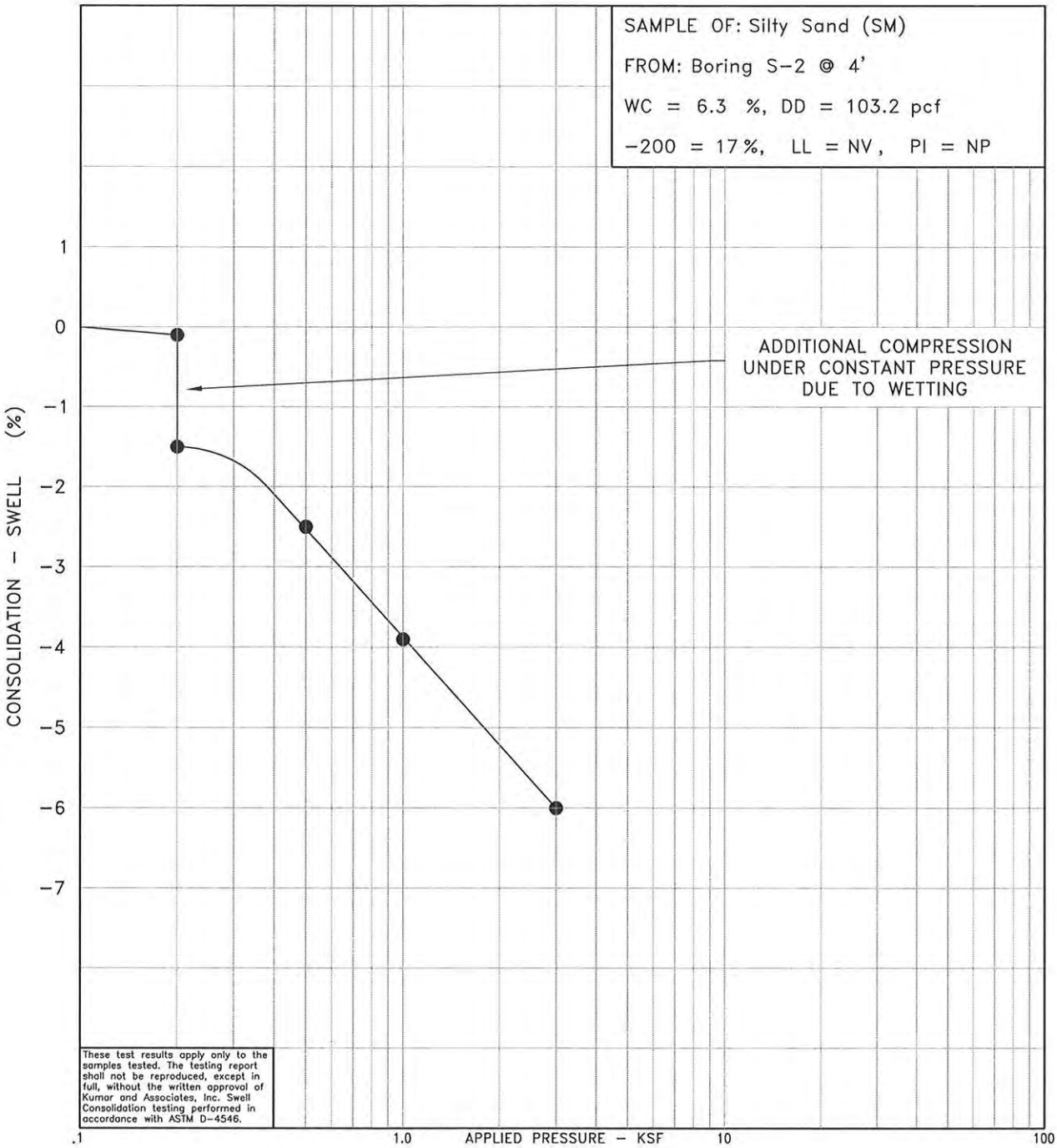
16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 9

March 11, 2016 - 03:36pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-05 to 11.dwg



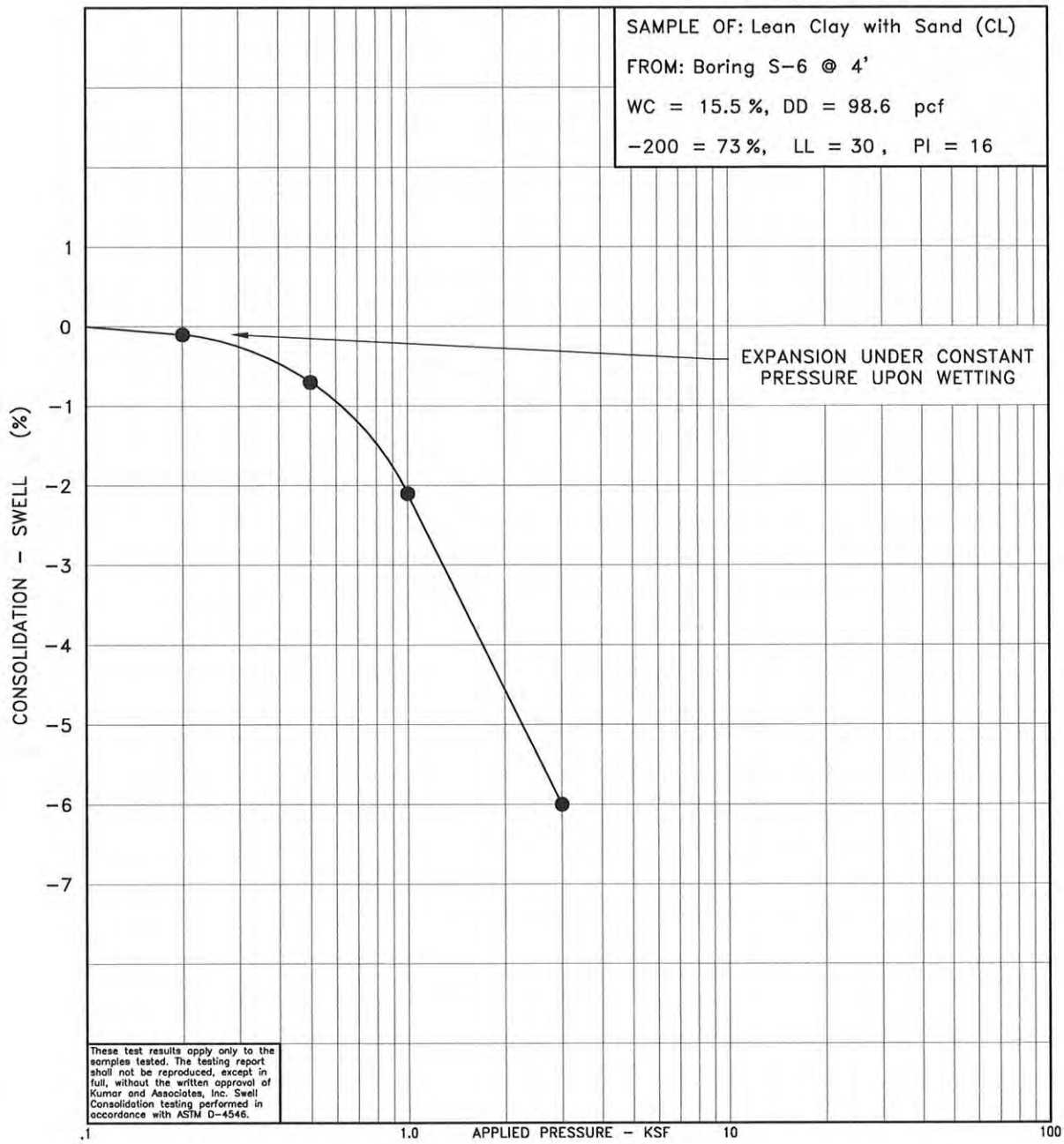
16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULT	Fig. 10

March 18, 2016 - 11:38am
C:\Users\mromero\appdata\local\temp\AcPublish_2052\163104.1-05 to 15.dwg



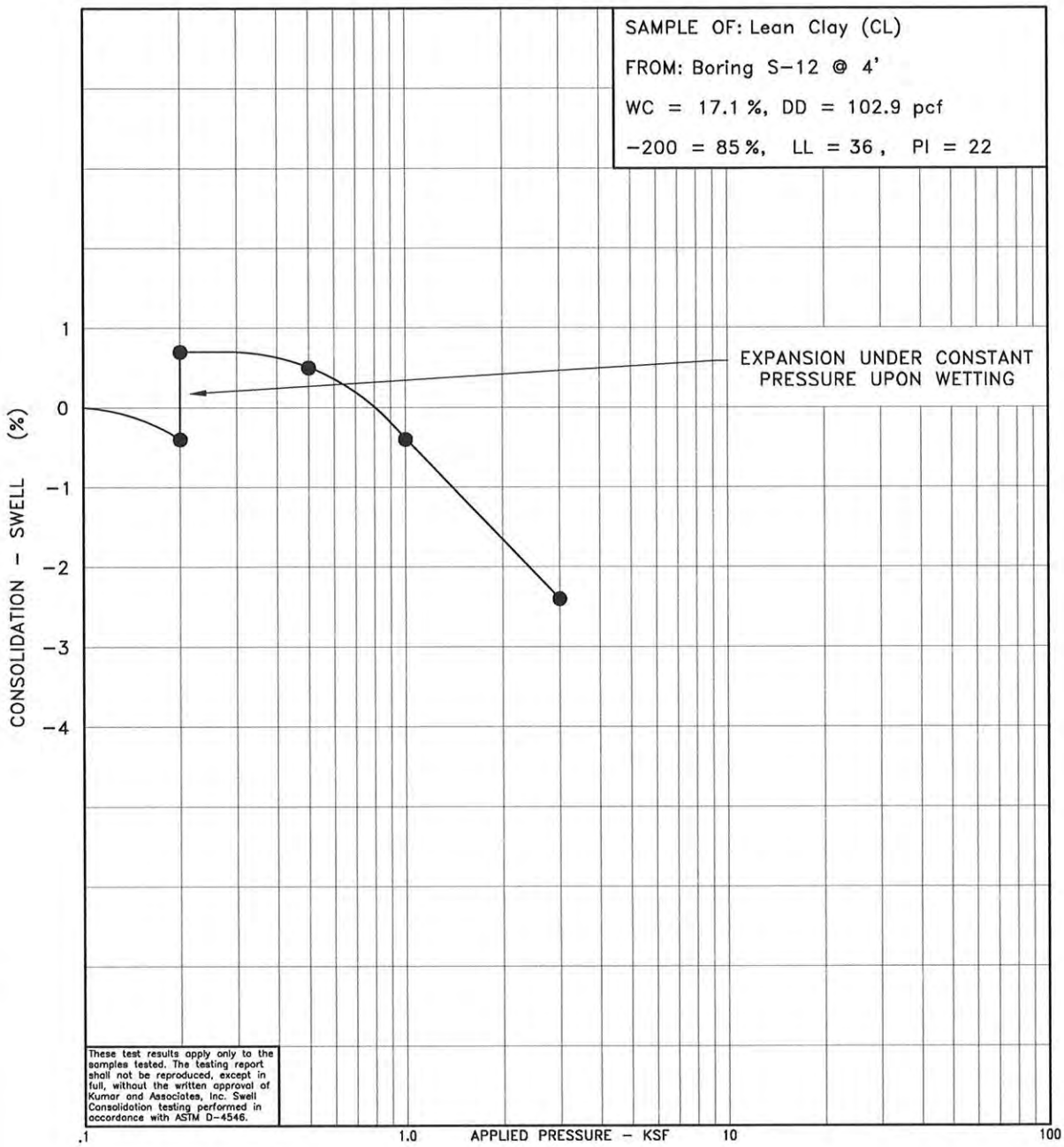
16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 11

March 18, 2016 - 11:38am
C:\Users\mromero\appdata\local\temp\AcPublish_2052\163104.1-05 to 15.dwg



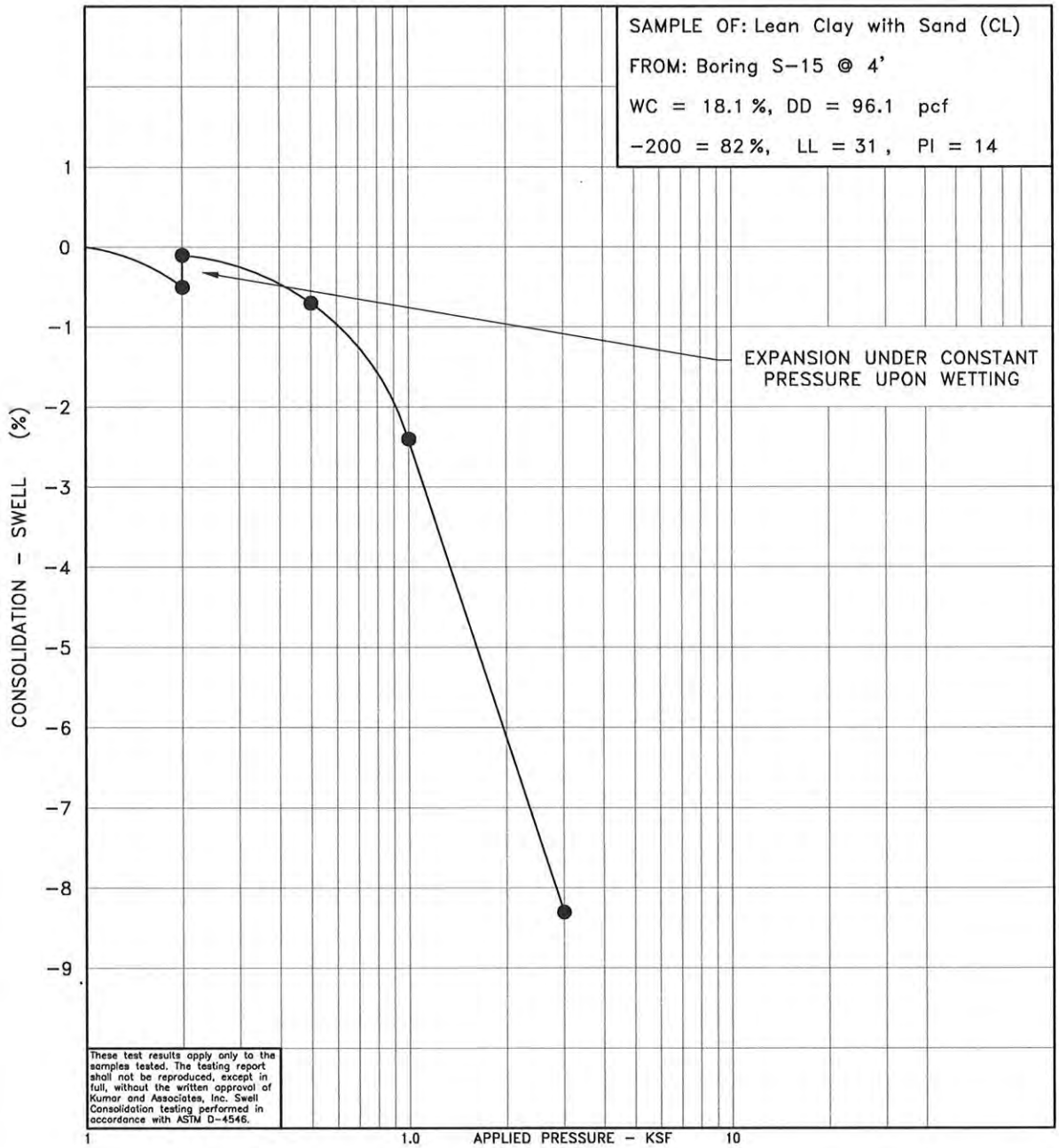
16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 12

March 11, 2016 - 03:37pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-05 to 11.dwg



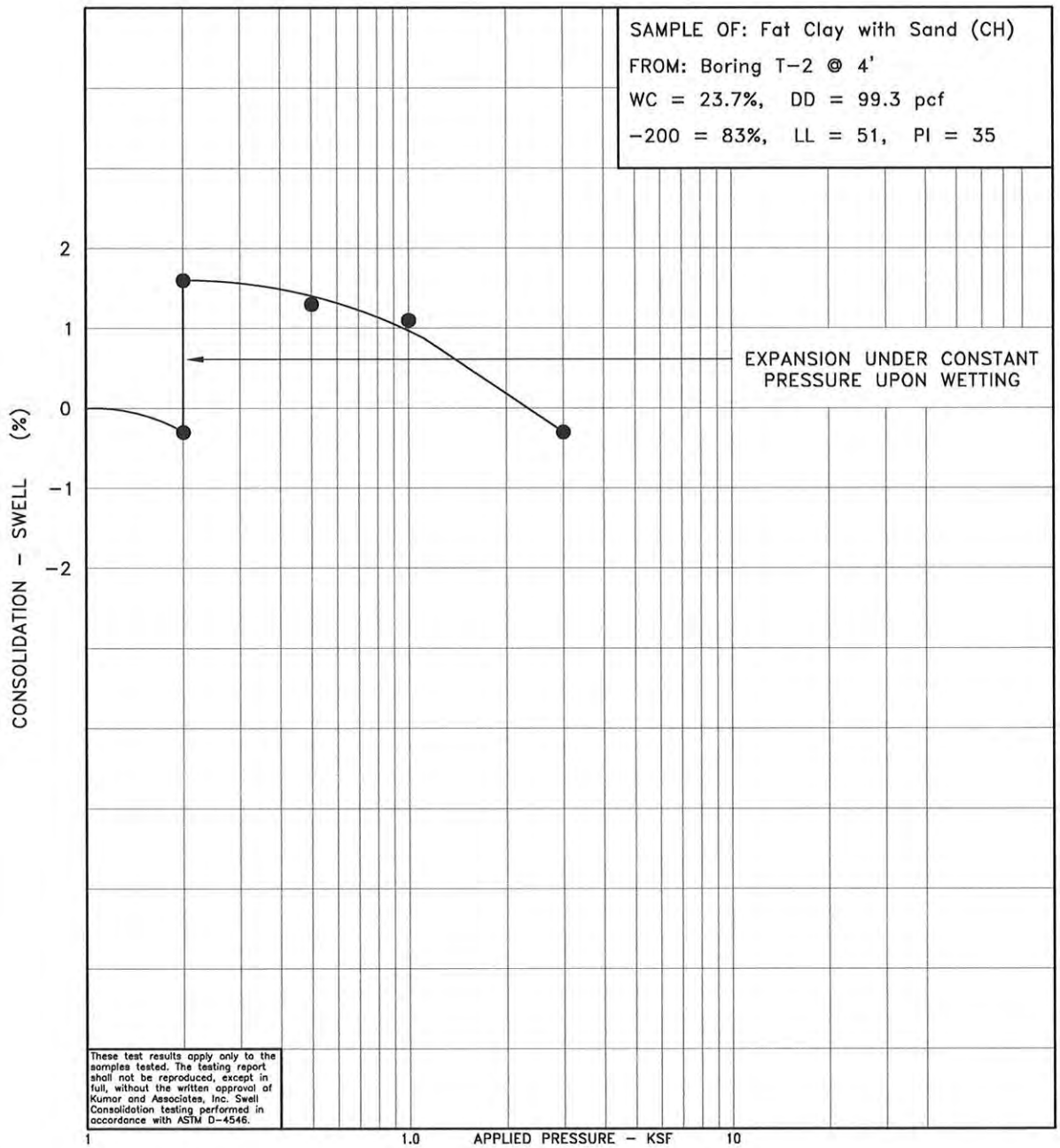
16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 13

March 11, 2016 - 03:37pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\153104.1-05 to 11.dwg



16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 14

March 11, 2016 - 03:37pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-05 to 11.dwg



16-3-104.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 15

March 11, 2016 - 03:37pm
V:\Projects\2016\16-3-104.1 Town of Bennett Roadway Projects\Drafting\163104.1-05 to 11.dwg

Table I
Summary of Laboratory Test Results

Project No.: 16-3-104.1
Project Name: Bennett Asphalt Roadways
Date Sampled: January 15 to January 29, 2016
Date Received: January 26 and February 17, 2016

Sample Location					Gradation			Atterberg Limits				
Boring	Depth (Feet)	Date Tested	Natural Moisture Content (%)	Natural Dry Density (pcf)	Gravel (%)	Sand (%)	Percent Passing No. 200 Sieve	Liquid Limit (%)	Plasticity (%)	Water Soluble Sulfates (%)	AASHTO Classification (Group Index)	Soil or Bedrock Type
A-1	1	1/28/16	20.0	107.2			86	37	20		A-6 (17)	Fill: Lean Clay (CL)
A-2	4	1/28/16	19.0	106.1			58	33	17		A-6 (7)	Sandy Lean Clay (CL)
A-3	1	1/28/16	11.3	118.7			37	28	16		A-6 (2)	Fill: Clayey Sand (SC)
A-4	1	1/28/16	14.4	113.7			60	30	18		A-6 (7)	Fill: Sandy Lean Clay (CL)
A-5	1	1/28/16	13.7	117.6			55	25	12		A-6 (3)	Fill: Sandy Lean Clay (CL)
A-6	4	1/28/16	4.3	112.1	4	81	14	25	12		A-2-6 (0)	Clayey Sand (SC)
A-7	1	1/28/16	14.4	105.6			79	30	10		A-4 (7)	Fill: Lean Clay with Sand (CL)
A-8	4	1/28/16	10.4	117.4			41	24	11		A-6 (1)	Clayey Sand (SC)
A-9	4	1/28/16	4.3	111.5			15	NV	NP		A-2-4 (0)	Silty Sand (SM)
A-10	1	1/28/16	13.7	116.4			55	30	16		A-6 (5)	Sandy Lean Clay (CL)
A-11	4	1/28/16	4.3	101.6			14	NV	NP		A-2-4 (0)	Silty Sand (SM)
A-12	1	1/28/16	18.8	105.8			73	40	22		A-6 (15)	Fill: Lean Clay with Sand (CL)
A-13	4	1/28/16	24.6	95.8			93	29	8		A-4 (7)	Fill: Lean Clay (CL)
A-14	1	1/28/16	9.2	115.9			40	24	12		A-6 (1)	Clayey Sand (SC)
A-15	1	1/28/16	8.1	113.7			40	25	13		A-6 (1)	Clayey Sand (SC)
A-16	1	1/28/16	16.4	112.1			62	32	20		A-6 (9)	Fill: Sandy Lean Clay (CL)
A-17	4	1/28/16	19.3	101.7			84	49	35		A-7-6 (29)	Fill: Lean Clay with Sand (CL)
A-18	4	1/28/16	22.5	92.4			91	35	18		A-6 (16)	Lean Clay (CL)
A-19	1	1/28/16	13.2	106.3			56	34	21		A-6 (8)	Fill: Sandy Lean Clay (CL)
A-20	4	1/28/16	6.7	108.5			31	19	4		A-2-4 (0)	Fill: Silty Clayey Sand (SC-SM)
A-21	1	1/28/16	16.2	108.0			60	32	20		A-6 (9)	Fill: Sandy Lean Clay (CL)
A-22	4	1/28/16	19.3	98.1			79	39	23		A-6 (17)	Fill: Lean Clay with Sand (CL)
A-23	4	1/28/16	19.4	104.1			73	37	22		A-6 (14)	Lean Clay with Sand (CL)
A-24	1	1/28/16	14.0	112.6			55	31	17		A-6 (6)	Fill: Sandy Lean Clay (CL)
A-25	4	1/28/16	13.3	117.5			52	26	14		A-6 (4)	Fill: Sandy Lean Clay (CL)
A-26	4	1/28/16	22.0	98.0			80	34	18		A-6 (13)	Lean Clay with Sand (CL)
A-27	1	1/28/16	22.2	100.3			90	35	18		A-6 (16)	Fill: Lean Clay (CL)
A-29	4	1/28/16	13.9	114.7			63	31	17		A-6 (8)	Sandy Lean Clay (CL)
A-30	4	1/28/16	5.7	110.3			19	NV	NP		A-2-4 (0)	Silty Sand (SM)
A-31	1	1/28/16	4.2	101.3			12	NV	NP		A-2-4 (0)	Silty Sand (SM)
A-32	1	1/28/16	9.1	109.1			34	NV	NP		A-2-4 (0)	Silty Sand (SM)
A-33	1	1/28/16	7.2	117.4			20	22	9		A-2-4 (0)	Clayey Sand (SC)
A-34	1	1/28/16	15.5	111.9			60	35	21		A-6 (9)	Fill: Sandy Lean Clay (CL)
A-35	4	1/28/16	16.3	109.6			62	25	10		A-4 (3)	Sandy Lean Clay (CL)
A-36	4	1/28/16	9.3	103.1			26	20	6		A-2-4 (0)	Fill: Silty Clayey Sand (SC-SM)
A-37	4	1/28/16	13.7	112.3			45	26	12		A-6 (2)	Clayey Sand (SC)

Table I
Summary of Laboratory Test Results
(continued)

Project No.: 16-3-104.1
Project Name: Bennett Asphalt Roadways
Date Sampled:
Date Received: January 26 and February 17, 2016

Sample Location			Natural	Natural	Gradation		Percent	Atterberg Limits		Water		
Boring	Depth (Feet)	Date Tested	Moisture Content (%)	Dry Density (pcf)	Gravel (%)	Sand (%)	Passing No. 200 Sieve	Liquid Limit (%)	Plasticity (%)	Soluble Sulfates (%)	AASHTO Classification (Group Index)	Soil or Bedrock Type
C-1	1	2/18/16	15.8	109.0	10	29	61	35	17	0	A-6 (8)	Fill: Sandy Lean Clay (CL)
C-2	4	2/18/16	15.5	104.7			70	38	25		A-6 (15)	Lean Clay with Sand (CL)
C-3	4	2/18/16	19.5	104.3			97	44	25		A-7-6 (26)	Lean Clay (CL)
C-4	4	2/3/16	11.5	113.5			40	24	13		A-6 (1)	Clayey Sand (SC)
C-5	1	2/3/16	16.6	111.3			69	31	19		A-6 (10)	Fill: Sandy Lean Clay (CL)
C-10	1	2/18/16	25.4	97.2			95	51	35		A-7-6 (35)	Fill: Fat Clay (CH)
C-11	4	2/18/16	18.0	100.4	1	10	89	33	16	0	A-6 (13)	Fill: Lean Clay (CL)
C-12	1	2/18/16	21.8	102.3			97	37	20		A-6 (20)	Lean Clay (CL)
C-13	1	2/18/16	20.0	105.8			93	42	23		A-7-6 (22)	Fill: Lean Clay (CL)
P-1	1	2/18/16	17.4	109.9			69	42	23		A-7-6 (14)	Fill: Sandy Lean Clay (CL)
P-3	4	2/18/16	14.2	113.5			78	35	20		A-6 (14)	Fill: Lean Clay with Sand (CL)
P-4	1	2/18/16	15.3	115.6			50	27	13	0.06	A-6 (3)	Fill: Sandy Lean Clay (CL)
P-6	4	2/18/16	13.0	113.3			57	27	14		A-6 (5)	Fill: Sandy Lean Clay (CL)
S-1	4	2/18/16	14.6	111.8	1	39	56	29	15	0	A-6 (5)	Fill: Sandy Lean Clay (CL)
S-2	4	2/18/16	6.3	103.2			17	NV	NP		A-2-4 (0)	Silty Sand (SM)
S-3	4	2/18/16	7.2	112.9			28	19	6		A-2-4 (0)	Silty Clayey Sand (SC-SM)
S-4	1	2/18/16	12.9	114.5			62	32	17		A-6 (8)	Fill: Sandy Lean Clay (CL)
S-5	1	2/18/16	8.3	116.2			29	19	3	0	A-2-4 (0)	Silty Sand (SM)
S-6	4	2/18/16	15.5	98.6			73	30	16		A-6 (9)	Lean Clay with Sand (CL)
S-7	4	2/18/16	10.4	113.3			40	21	7		A-4 (0)	Silty Clayey Sand (SC-SM)
S-8	1	2/18/16	6.6	117.7			23	22	9		A-2-4 (0)	Fill: Clayey Sand (SC)
S-9	4	2/18/16	10.1	116.3			48	27	14		A-6 (3)	Clayey Sand (SC)
S-10	4	2/18/16	21.2	103.3			95	42	24		A-7-6 (24)	Fill: Lean Clay (CL)
S-11	1	2/18/16	11.6	121.6			32	23	9		A-2-4 (0)	Clayey Sand (SC)
S-12	4	2/18/16	17.1	102.9			85	36	22		A-6 (17)	Lean Clay (CL)
S-13	1	2/18/16	15.1	115.3			74	30	15		A-6 (9)	Fill: Lean Clay with Sand (CL)
S-14	4	2/18/16	13.0	112.9			42	25	13		A-6 (2)	Clayey Sand (SC)
S-15	4	2/18/16	18.1	96.1			82	31	14		A-6 (10)	Lean Clay with Sand (CL)
S-16	4	2/18/16	16.9	110.8			71	32	18		A-6 (10)	Lean Clay with Sand (CL)
S-17	1	2/18/16	14.2	115.1			49	29	16		A-6 (4)	Fill: Clayey Sand (SC)
S-18	1	2/18/16	7.1	116.3			22	NV	NP		A-2-4 (0)	Silty Sand (SM)
S-19	4	2/18/16	12.8	119.4			52	33	20		A-6 (7)	Sandy Lean Clay (CL)
S-20	1	2/18/16	21.9	100.2			95	40	21		A-6 (21)	Fill: Lean Clay (CL)
S-21	4	2/18/16	16.7	109.4			69	29	16		A-6 (8)	Sandy Lean Clay (CL)

Table I
Summary of Laboratory Test Results
(continued)

Project No.: 16-3-104.1
Project Name: Bennett Asphalt Roadways
Date Sampled:
Date Received: January 26 and February 17, 2016

Sample Location			Natural	Natural	Gradation		Percent	Atterberg Limits		Water		
Boring	Depth (Feet)	Date Tested	Moisture Content (%)	Dry Density (pcf)	Gravel (%)	Sand (%)	Passing No. 200 Sieve	Liquid Limit (%)	Plasticity (%)	Soluble Sulfates (%)	AASHTO Classification (Group Index)	Soil or Bedrock Type
T-1	4	2/3/16	21.8	102.6			93	44	30		A-7-6 (28)	Lean Clay (CL)
T-1	1-5	1/27/16	10.0*	125.3*	10	54	36	27	11		A-6 (0)	Clayey Sand (SC)
T-2	4	2/3/16	23.7	99.3			83	51	35		A-7-6 (29)	Fat Clay with Sand (CH)
T-3	1	2/3/16	13.8	112.4			52	31	19		A-6 (6)	Fill: Sandy Lean Clay (CL)
T-4	4	2/3/16	11.5	112.7			51	29	18		A-6 (5)	Sandy Lean Clay (CL)
T-5	4	2/3/16	19.7	105.4			93	50	34		A-7-6 (33)	Fat Clay (CH)

Kumar & Associates, Inc.
Geotechnical and Materials Engineers
and Environmental Scientists

ACEC
MEMBER

800 Stockton Avenue
Fort Collins, CO 80223
phone: (970) 416-9045
fax: (303) 742-9666
email: ftcollins@kumarusa.com
www.kumarusa.com

Office Locations: Denver (HQ), Colorado Springs, Fort Collins, and Frisco, Colorado

GEOTECHNICAL ENGINEERING STUDY AND PAVEMENT THICKNESS DESIGN TOWN OF BENNETT STREETS PROJECT CONCRETE PAVED ROADWAYS BENNETT, COLORADO

Prepared By:

Joshua L. Barker, P.E.

COLORADO LICENSED
JOSHUA L. BARKER
40174
PROFESSIONAL ENGINEER

Apr-14-16

Reviewed By:

James A. Noll, P.E.

Prepared for:

Town of Bennett Public Works
365 Palmer Avenue
Bennett, Colorado 80102

Attention: Mr. Daymon Johnson
Public Works Director

Project No. 16-3-104.2

April 14, 2016

TABLE OF CONTENTS

SUMMARY 1
PURPOSE AND SCOPE 2
PROPOSED CONSTRUCTION 2
SITE CONDITIONS 4
SUBSURFACE CONDITIONS 4
LABORATORY TESTING 6
PAVEMENT DESIGN 7
DESIGN AND CONSTRUCTION SUPPORT SERVICES 10
LIMITATIONS 10

FIG. 1 – LOCATION OF EXPLORATORY BORINGS
FIGS. 2 through 5 –LOGS OF EXPLORATORY BORINGS
FIG 6 – LEGEND AND NOTES
FIGS. 7 through 18 – SWELL-CONSOLIDATION TEST RESULTS
FIGS. 19 and 20 – GRADATION TEST RESULTS
FIGS. 21 through 23 – MOISTURE-DENSITY RELATIONSHIPS
TABLE I – SUMMARY OF LABORATORY TEST RESULTS
APPENDIX A – R-VALUE TEST RESULTS

SUMMARY

1. A total of 64 exploratory borings were drilled within the project roadways. In general, the borings encountered variable thickness of full depth concrete pavement although a few areas encountered an aggregate base course below the pavement section. The thickness of the concrete pavement ranged from about 3 to 7 inches. Aggregate base course was encountered in a few of the borings and was approximately 1 to 3 inches thick.

   Man-placed fill of various thickness was encountered beneath the pavement sections in the majority of the exploratory borings. The fill generally consisted of sandy lean clay, lean clay, and clayey sand. The clayey sand was fine to coarse-grained, and contained variable gravel content. The fill was moist to very moist, and brown to grey-brown and black. The vertical and horizontal limits, as well as the degree of compaction of the fill were not evaluated in detail as part of this study.

   The natural soils underlying the pavement sections and/or fill material was generally composed of sandy lean clay, lean clay with sand, and clayey sand. Lenses of poorly graded sand were noted in some of the borings at the time of drilling. The natural soils were fine to coarse-grained with occasional gravel, and moist. Based on sampler penetration resistance values, the natural soils were very stiff to hard/medium dense to dense in consistency.

   Groundwater was not encountered in the borings at the time of drilling. All of the borings were backfilled and patched immediately after drilling and sampling due to safety concerns.

2. Rehabilitation and reconstruction alternatives for the project roadways were evaluated. Concrete pavement rehabilitation techniques typically involve complete reconstruction of the roadway or individual panel replacement as deemed necessary. The concrete pavement throughout the town ranged from poor to good condition. In general, most of the concrete pavements were in fair to good condition.

   There were sporadic panels within the concrete pavement that exhibited severe distresses that rendered the panel detrimental to the roadway. We recommend that the panels exhibiting severe distress be replaced. The identification of panels to be replaced should be performed on a panel by panel basis

3. New concrete pavements and replacement panels within the existing concrete streets should consist of 6 inches of full depth Portland Cement Concrete Pavement placed on properly prepared subgrade.

   The Town plans to reconstruct West Lincoln Avenue and all of the roadways within the Cordella Subdivision with asphalt pavement.

   We recommend that the roadway to be reconstructed with asphalt pavement be provided with at least 4 inches of asphalt pavement placed on top of at least 12 inches of chemically stabilized subgrade.

   Proper subgrade preparation is discussed herein.

PURPOSE AND SCOPE

This report presents the results of a geotechnical engineering study and pavement thickness design as part of the Town of Bennett Streets Project within the Town of Bennett, Colorado. The study was conducted for the purpose of obtaining subsurface data, developing subgrade preparation and paving recommendations for the identified street segments generally shown on Fig. 1. The study was conducted in accordance with our proposal dated December 4, 2015 to the Town of Bennet in response to the Request for Proposal (RFP) identified as RFP: 15-009.

This study addresses only the existing concrete paved roadways within the Town of Bennett as identified later in this report. The existing asphalt paved roadways within the Town are addressed in a separate study under our Project No. 16-3-104.1.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subgrade materials obtained during the field exploration were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for possible pavement reconstruction and/or rehabilitation considerations. The results of the field exploration and laboratory testing are presented herein.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed roadway improvements are included in the report.

PROPOSED CONSTRUCTION

We understand that the Town of Bennett, Colorado has received voter approval for a one (1) percent sales tax increase to support Bond sales in the amount of $5.7 million, towards improvement of 17.5 miles of existing Town streets. The RFP indicated that the Town is including approximately 5.3 miles of existing concrete streets, 11.7 miles of existing asphalt-

paved streets and 0.5 miles of existing gravel streets in this project. This report addresses the existing concrete paved roadways and some of the gravel surfaced roadways within the town.

The primary objective of this study is to help the Town identify roadways that need complete reconstruction and roadways that may be repaired by panel replacement techniques. The roadways included in this report are the concrete roadways within the main part of town, the Brothers Four Subdivision, and the Cordella Subdivision. The roadway segments are outlined below:

Main Part of Town

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE CONCRETE PAVEMENT THICKNESS (INCHES)
Palmer Avenue	1,735	4 to 5
1st Street	1,825	5
2nd Street	1,810	4 to 5
3rd Street	2,185	4 to 6.5
4th Street	2,200	4 to 6
5th Street	1,910	5 to 7
6th Street	1,660	5 to 5.5
7th Street	1,265	3 to 4
Washington Avenue	2,175	4.5 to 5
East Lincoln Avenue	2,200	4.5 to 6
West Lincoln Avenue	635	5
Grant Avenue	1,475	7
Roosevelt Avenue	1,450	5 to 7
Truman Avenue	1,245	6 to 7
Approximate Total Centerline Lengths:	**23,770**	

Brothers Four

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE CONCRETE PAVEMENT THICKNESS (INCHES)
Kiowa Street	2,265	4 to 5
Cherry Street	320	4
South Elm Street	310	5
Adams Street	310	6
Pike Street	305	6
Elbert Street	305	6
Custer Street	265	4
Approximate Total Centerline Lengths:	**4,080**	

Cordella

ROADWAY	APPROX. LENGTH (FT.)	APPROXIMATE CONCRETE PAVEMENT THICKNESS (INCHES)
Viewridge Drive	335	5.5
Viewridge Court	490	5
Viewridge Road	1,875	4 to 5.5
Approximate Total Centerline Lengths:	**2,700**	

We understand that 1st Avenue between Roosevelt Avenue and Truman Avenue (currently gravel surfaced) may be paved with concrete pavement.

Also, based on the findings of this study and discussions with the Town, we understand that West Lincoln Avenue and all of the paved surfaces within the Cordella Subdivision will be reconstructed with asphalt paved roadways.

SITE CONDITIONS

The significant majority of the streets are local residential streets. Concrete paved roadways within the town that are designated collector streets include 1st Street and Kiowa Street. The street segments generally consist of two-lane facilities (a single travel lane in each direction). Surface drainage associated with sheet flow off of the existing pavement are contained in adjacent concrete gutters.

SUBSURFACE CONDITIONS

The field exploration for the study was conducted between January 15 and 29, 2014. A total of 64 exploratory borings were drilled for the geotechnical engineering study and pavement thickness design addressed in this report. The borings were drilled to depths ranging from approximately 5 to 10 feet. All of the borings were made to obtain information for use in the design or rehabilitation of the pavement section. The approximate locations of the exploratory borings are shown on Fig. 1.

The borings were advanced through the pavement sections and into the overburden soils with 4-inch diameter continuous flight augers. The borings were logged by a representative of Kumar & Associates, Inc. The borings were generally drilled in the travel lanes of the pavement on alternating sides of the alignment, utilities permitting.

Samples of the soils were obtained with a 2-inch I.D. California liner sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. The test is similar to the standard penetration test described by ASTM Method D 1586. Penetration resistance values, when properly evaluated indicate the relative density or consistency of the soils. Large disturbed bulk samples were taken from the borings. Depths at which samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Figs. 2 through 5. The legend and explanatory notes associated with the graphic logs describing the soils encountered are presented on Fig. 6.

The borings encountered variable thickness of full depth concrete pavement, although a few areas encountered an aggregate base course below the pavement section. The thickness of the concrete pavement ranged from about 3 to 7 inches as generally described in the tables above. Aggregate base course was encountered in a few of the borings and was approximately 1 to 3 inches thick. The thicknesses of the pavement sections encountered are also shown on the Logs of Exploratory Borings, Figs. 2 through 5.

Man-placed fill of various thickness was encountered beneath the pavement sections in the majority of the exploratory borings. The fill generally consisted of sandy lean clay, lean clay, and clayey sand. The clayey sand was fine to coarse-grained, and contained variable gravel content. The fill was moist to very moist, and brown to grey-brown and black. The vertical and horizontal limits, as well as the degree of compaction of the fill were not evaluated in detail as part of this study.

The natural soils underlying the pavement sections and/or fill material was generally composed of sandy lean clay, lean clay with sand, and clayey sand. Lenses of poorly graded sand were noted in some of the borings at the time of drilling. The natural soils were fine to coarse-grained with occasional gravel, and moist. Based on sampler penetration resistance values, the natural soils were very stiff to hard/medium dense to dense in consistency.

Groundwater was not encountered in the borings at the time of drilling. All of the borings were backfilled and patched immediately after drilling and sampling due to safety concerns.

LABORATORY TESTING

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer and samples were selected for laboratory testing. Laboratory testing included moisture content and dry unit weight, liquid and plastic limits, and concentration of water soluble sulfates. The laboratory testing was conducted in general accordance with applicable ASTM standards.

Swell-consolidation testing was conducted on several samples of the natural soils and man-placed fill materials to determine their swell-consolidation characteristics when wetted under a static surcharge load. The samples obtained from the proposed pavement areas for swell-consolidation testing were loaded with a 200-psf surcharge pressure.

The swell-consolidation test results indicated that the on-site overburden natural soils and fill materials generally possess low consolidation to low swell potential, although two samples possessed moderate to high swell potential. Results of the laboratory testing program are shown adjacent to the boring logs on Figs. 2 through 5, plotted graphically on Figs. 7 through 23, attached in Appendix A and are summarized in the attached Summary of Laboratory Test Results in Table I.

PAVEMENT CONDITION

The concrete pavement throughout the town ranged from poor to good condition. In general, most of the concrete pavements were in fair to good condition. It should be noted that concrete pavement in fair to good condition can include cracking in the pavement surfaces. The widths of the cracking and differential movements across the cracking contribute to the severity of distress to the slab. Other distress criteria were also evaluated during a brief pavement condition survey that was performed as part of this study.

There were sporadic panels within the concrete pavement that exhibited severe distresses that rendered the panel detrimental to the roadway. We recommend that the panels exhibiting

severe distress be replaced. The identification of panels to be replaced should be performed on a panel by panel basis.

PAVEMENT DESIGN

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for pavement design purposes by means of a modulus of vertical subgrade reaction for concrete pavements and a resilient modulus for asphalt pavement.

Subgrade Materials: Samples of the subgrade materials were taken from the roadway segments. Based on the results of the field and laboratory studies, the soils obtained varied across the sites and classify between A-2-4 and A-7-6 soils with group indices between 0 and 29 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) soil classification system.

Subgrade support testing consisting of Hveem (R-value) was performed on bulk samples of the subgrade materials. The results of the R-Value testing is presented in Appendix A. R-value testing performed on four bulk samples of subgrade materials indicated R-values between 6 and 17 at exudation pressures of 300 psi. The R-Values correlate to effective modulus of vertical subgrade reaction values between 20 and 50 pci. Based on the high variability of the subgrade conditions encountered and our experience, we have selected a design modulus of vertical subgrade reaction for the project site of 20 pci.

In accordance with Colorado Department of Transportation (CDOT) correlation procedures, the R-Values were converted to equivalent resilient modulus values ranging from 3,126 psi to 4,478 psi for use in design of asphalt pavements to be constructed for the project. Based on the high variability of the subgrade conditions encountered, we cannot assign specific R-Value (resilient modulus) values to certain parts of the Town; therefore, we elected to utilize the minimum R-Value and used a design resilient modulus value of 3,126 psi to determine the flexible pavement sections below.

Design Traffic: We have not been provided with specific traffic counts or distributions for the roadways within the Town; however, we have been informed that the residential roadways receive traffic typical of residential roadways. As noted above, we have also been informed that 1st Street and Kiowa Street are classified as Collector Roadways.

Based on our past experience with similar facilities, we assumed an 18-kip equivalent single axle loading (ESAL) value of 36,500 for the residential roadways. An ESAL of 219,000 was assumed for the Collector Roadways. The ESAL values represent mid-life traffic loadings on a pavement that is designed to have a 20-year useful life. Routine maintenance is required during that 20-year period.

If the assumptions indicated above appear to be different than actual traffic values for the site, we should be notified to reevaluate pavement thickness requirements.

Pavement Thickness Design: New concrete pavements and replacement panels within the existing concrete street should consist of 6 inches of full depth Portland Cement Concrete Pavement placed on properly prepared subgrade.

As indicated above, is appears that the Town plans to reconstruct West Lincoln Avenue and all of the roadways within the Cordella Subdivision with asphalt pavement.

We recommend that the roadway to be reconstructed with asphalt pavement be provided with at least 4 inches of asphalt pavement placed on top of properly prepared subgrade.

Subgrade Preparation:

Concrete Subgrade: Prior to placing the pavement section, the entire subgrade area should be thoroughly scarified and well-mixed to a depth of at least 12 inches, adjusted to a moisture content within -1 and +3 percentage points the optimum moisture content and compacted to 95% of the standard Proctor (AASAHTO T 99) maximum dry density. Areas of soft or overly moist material should be replaced with properly moisture conditioned fill compacted as descried above. Pavement design procedures assume a stable subgrade.

Asphalt Subgrade: The pavement subgrade below asphalt roadways within this project area should be provided with a cement treated subgrade below the new asphalt pavement. Cement

treatment is generally performed by a specialty contractor after the existing pavement is removed and rough grading has occurred. We recommend that the subgrade and cement be thoroughly mixed to a depth of at least 12 inches below the proposed subgrade elevation and that at least 4% cement be used based on a dry weight basis. The cement-treated layer should meet a minimum unconfined compressive strength of 160 psi (5-day moist-cured at 100º F). The cement treatment process should meet the requirements of "Item 5, Stabilized Subgrade, Pat 1, Chemically Stabilized Subgrade" of the Metropolitan Government Pavement Engineers Council (MGPEC) Pavement Design Standards and Specifications.

The pavement subgrade for both pavement types should be proof rolled with a heavily loaded pneumatic-tired vehicle such as a loaded water truck or paving truck prior to paving. Pavement design procedures assume a stable subgrade. Areas that deform under wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving.

There may be areas of soft subgrade encountered when the existing pavement is removed. These areas associated with the streets to be reconstructed with concrete may be overexcavated to a depth where stable material is encountered. The overexcavated material may be replaced with the removed material (adjusted for moisture content and compacted according to the criteria listed above). An alternative to significant overexcavation would be to span the soft areas with a biaxial geogrid. Aggregate base course would then be placed over the geogrid to provide a stable paving platform. We anticipate an aggregate base course thickness of 12 inches would be required. An alternate stabilization method would be to cement-treat the unstable areas.

Paving Materials:

Asphalt Mix Type: The asphalt pavement used for the roadways should consist of a Grading S or SX mix. The asphalt binder selected for the proposed pavements should meet criteria for performance graded binders PG 58-28 that conform to requirements outlined in the CDOT Pavement Design Manual. The binder recommendations are based on the design 20-year 18-kip equivalent single axle load ($ESAL_{20}$) application values. The $ESAL_{20}$ values also indicate an N_{DESIGN} value for the gyratory method of compaction and design of 75. The asphalt pavement should be compacted in accordance with current CDOT guidelines.

Rigid Pavements: The above Portland cement concrete pavement thicknesses are presented as un-reinforced slabs. Based on projects with similar heavy vehicular loading, we recommend that dowels be provided at transverse joints within the slabs located in the travel lanes of heavily loaded vehicles and tie bars for the longitudinal joints. Additionally, curbs and/or pans should be tied to the slabs. The dowels and tie bars will help minimize the risk for differential movements between slabs to assist in more uniformly transferring axle loads to the subgrade. The Colorado Department of Transportation (CDOT) provides some guidance on dowel and tie bar placement in the current Standard Specifications for Road and Bridge Construction as well as in the current Standard Plans: M&S Standards. It is critical to the performance of the concrete pavement that the joints are properly sealed and maintained to minimize the infiltration of surface water, especially if dowels and tie bars are not installed.

All Portland cement concrete pavement (PCCP) should be based on a mix design established by a qualified engineer. Concrete used for the rigid pavement should meet the requirements established by CDOT for Class P concrete.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary to accommodate possible changes in the proposed construction.

We recommend that Kumar & Associates, Inc. be retained to provide observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

LIMITATIONS

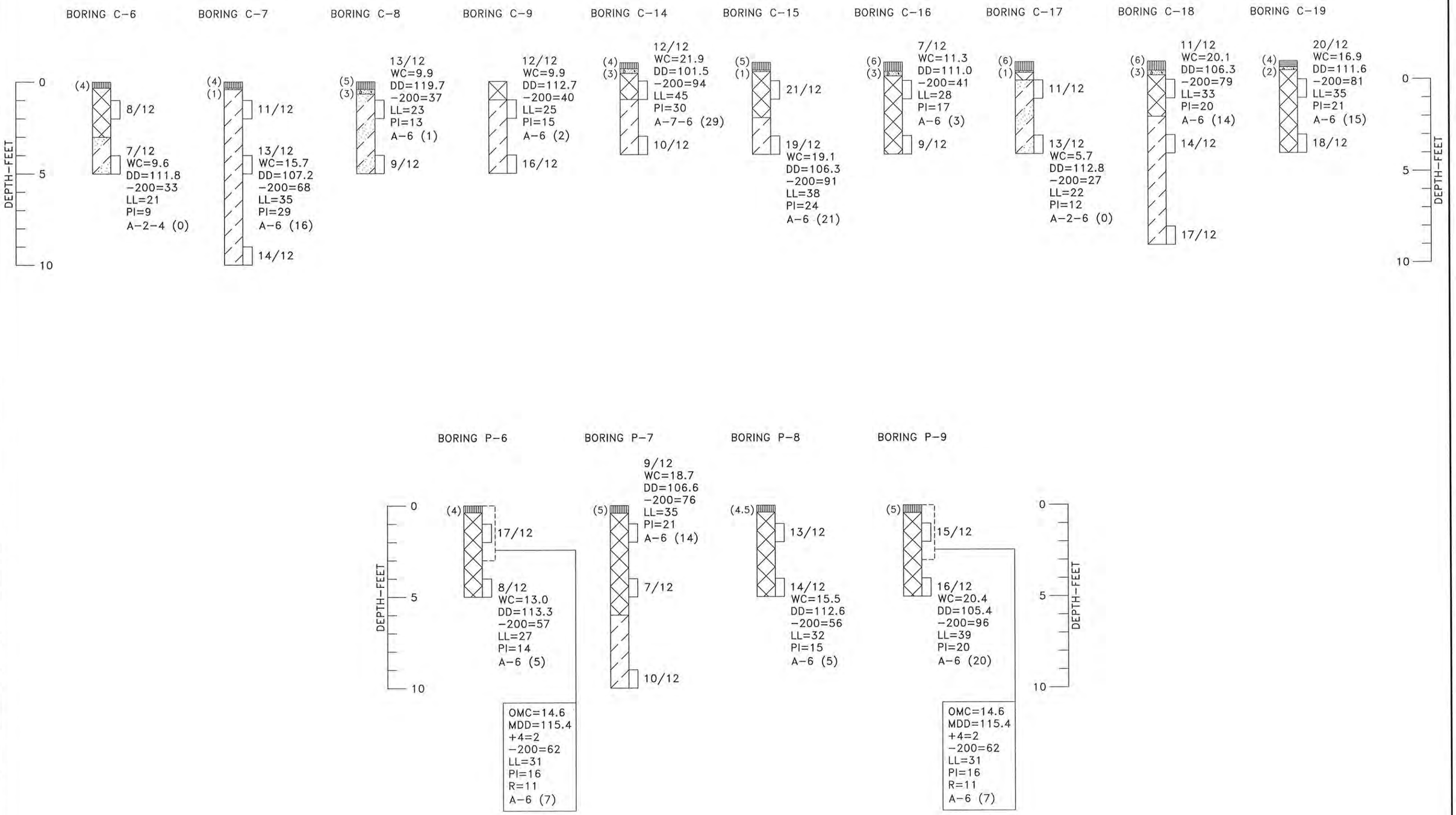
This study has been conducted in accordance with generally accepted geotechnical and pavement engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Fig. 1, and the proposed type

of construction. This report may not reflect subsurface variations that occur between the exploratory borings, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, existing pavement section type and thickness, fill, soil, or groundwater conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

JLB/jw
cc: Book, File

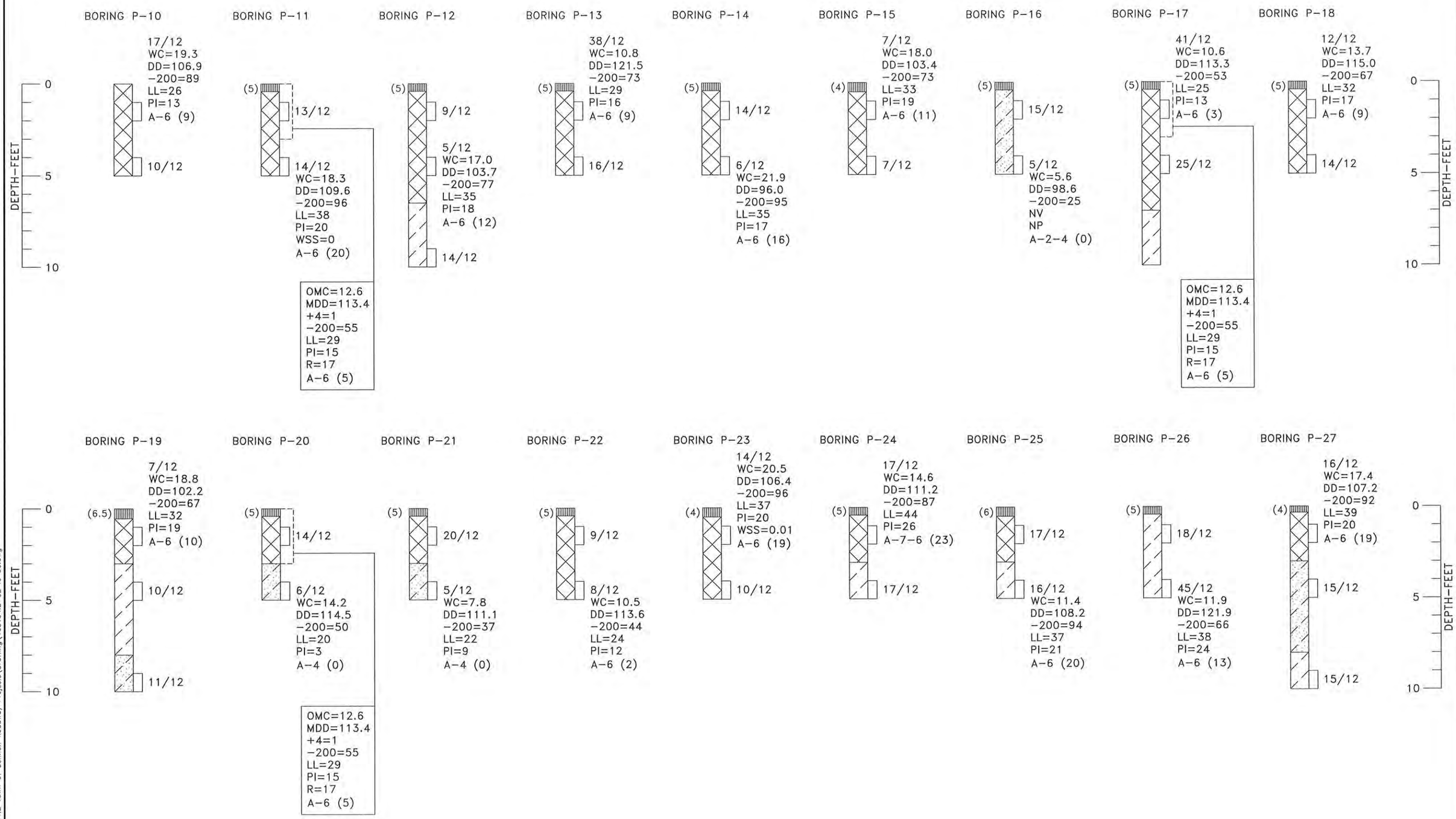
16-3-104.2	Kumar & Associates	BENNETT CONCRETE ROADWAYS	LOCATION OF EXPLORATORY BORINGS	Fig. 1

March 18, 2016 - 11:08am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-01.dwg



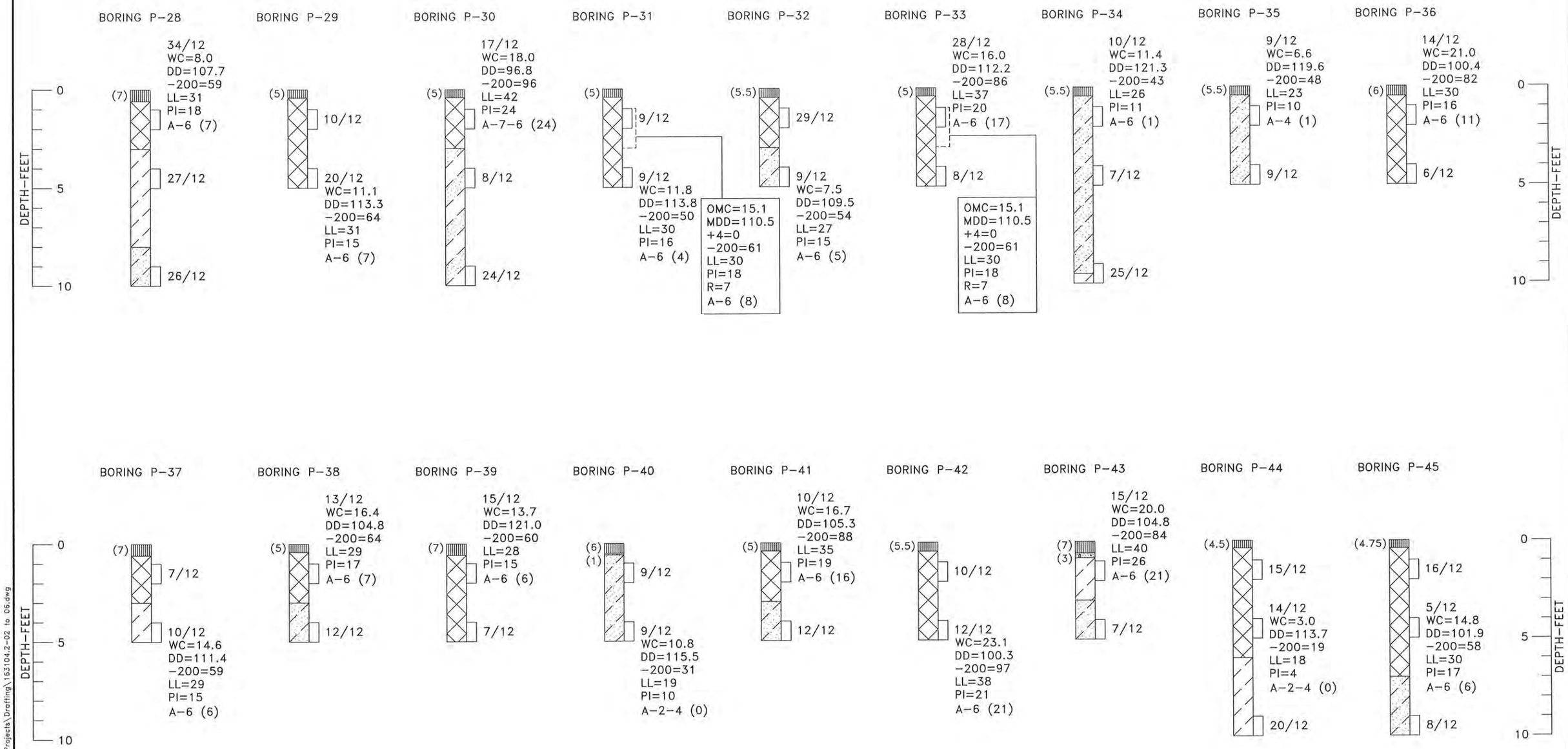
16-3-104.2	Kumar & Associates	BENNETT CONCRETE ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 2

Mar 18, 16Y - 10:48am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-02 to 06.dwg



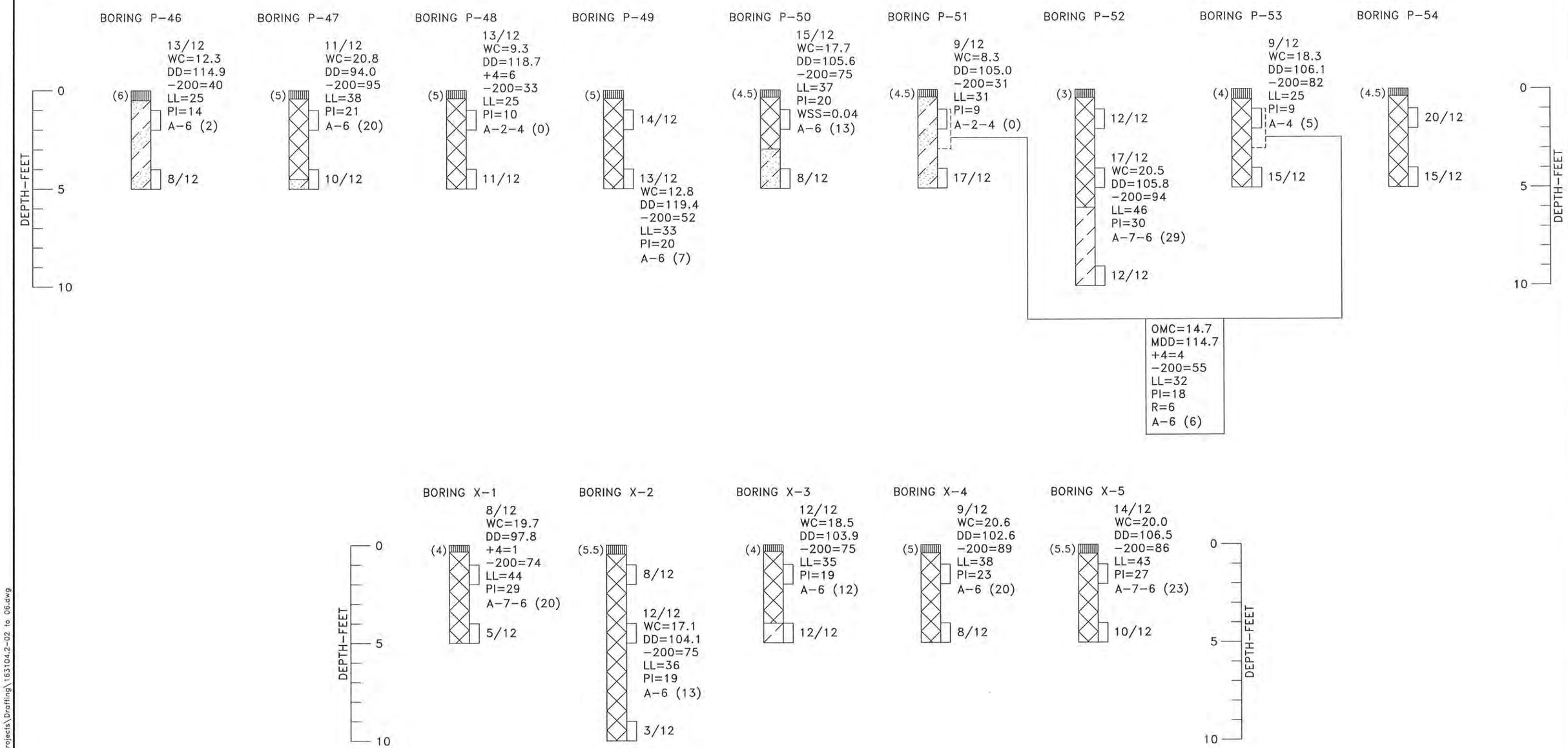
16-3-104.2	Kumar & Associates	BENNETT CONCRETE ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 3

Mar 18, 16V - 10:48am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-02 to 06.dwg



16-3-104.2	Kumar & Associates	BENNETT CONCRETE ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 4

Mar 18, 16Y - 10:48am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-02 to 06.dwg



16-3-104.2	Kumar & Associates	BENNETT CONCRETE ROADWAYS	LOGS OF EXPLORATORY BORINGS	Fig. 5

Mar 18, 16Y - 10:48am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-02 to 06.dwg

LEGEND

(4) CONCRETE, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

(1) AGGREGATE BASE COURSE, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

FILL: LEAN TO FAT CLAY (CL TO CH), VARIABLE LAND AND GRAVEL CONTENTS, OCCASIONAL CLAYEY SAND (SC), FINE TO COARSE GRAINED, SLIGHTLY MOIST TO VERY MOIST, LIGHT BROWN TO BROWN TO DARK BROWN TO BLACK.

LEAN TO FAT CLAY (CL TO CH) TO SLIGHTLY LEAN CLAY (CL), FINE TO MEDIUM GRAINED, STIFF TO VERY STIFF, MOIST, LIGHT BROWN TO BROWN.

CLAYEY SAND (SC), FINE TO COARSE GRIANED, MEDIUM TO DENSE, MOIST, LIGHT BROWN, OCCASIONAL LENSES OF POORLY GRADED SAND (SP) TO SILTY SAND (SM).

INTERBEDDED SANDY CLAY (SC), SILTY CLAYEY SAND (SP-SM) AND LEAN CLAY (CL), FINE TO COARSE GRAINED, MEDIUM TO VERY STIFF, MOIST, LIGHT BROWN TO BROWN.

DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

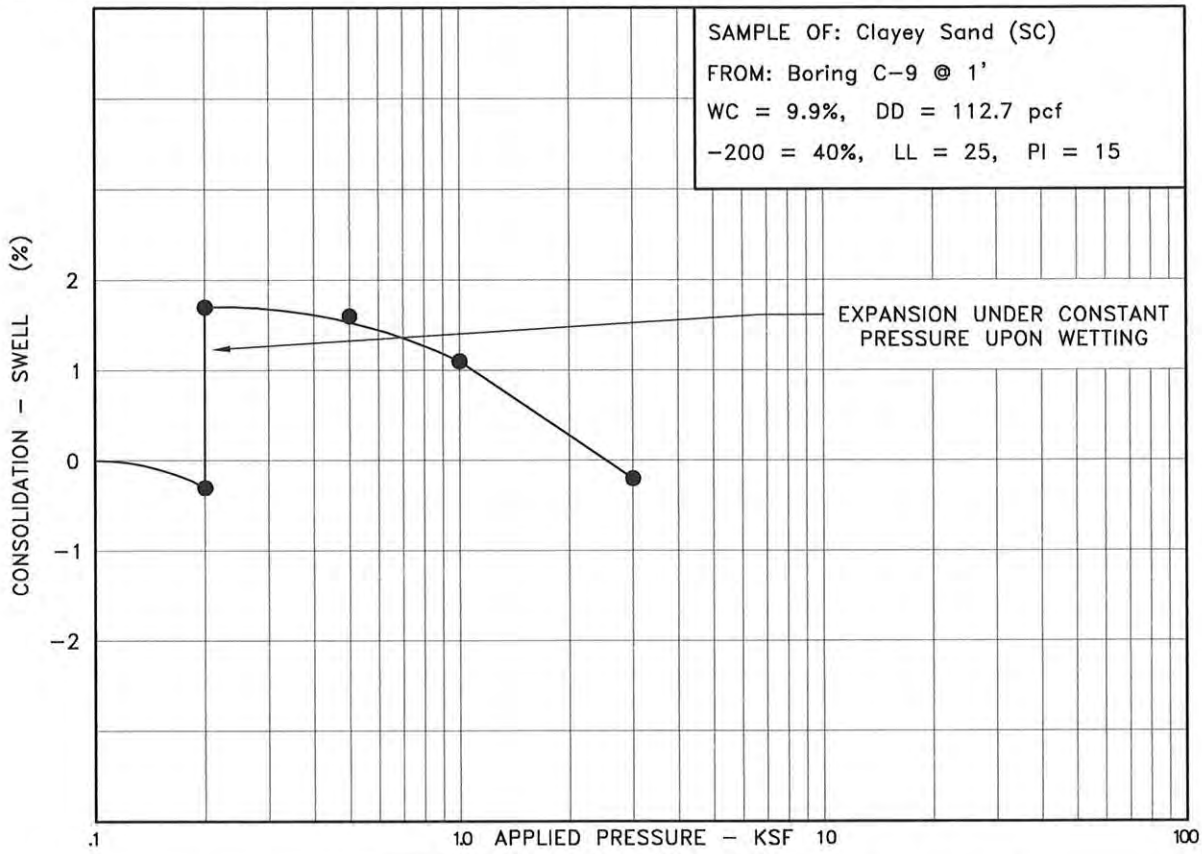
20/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 20 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

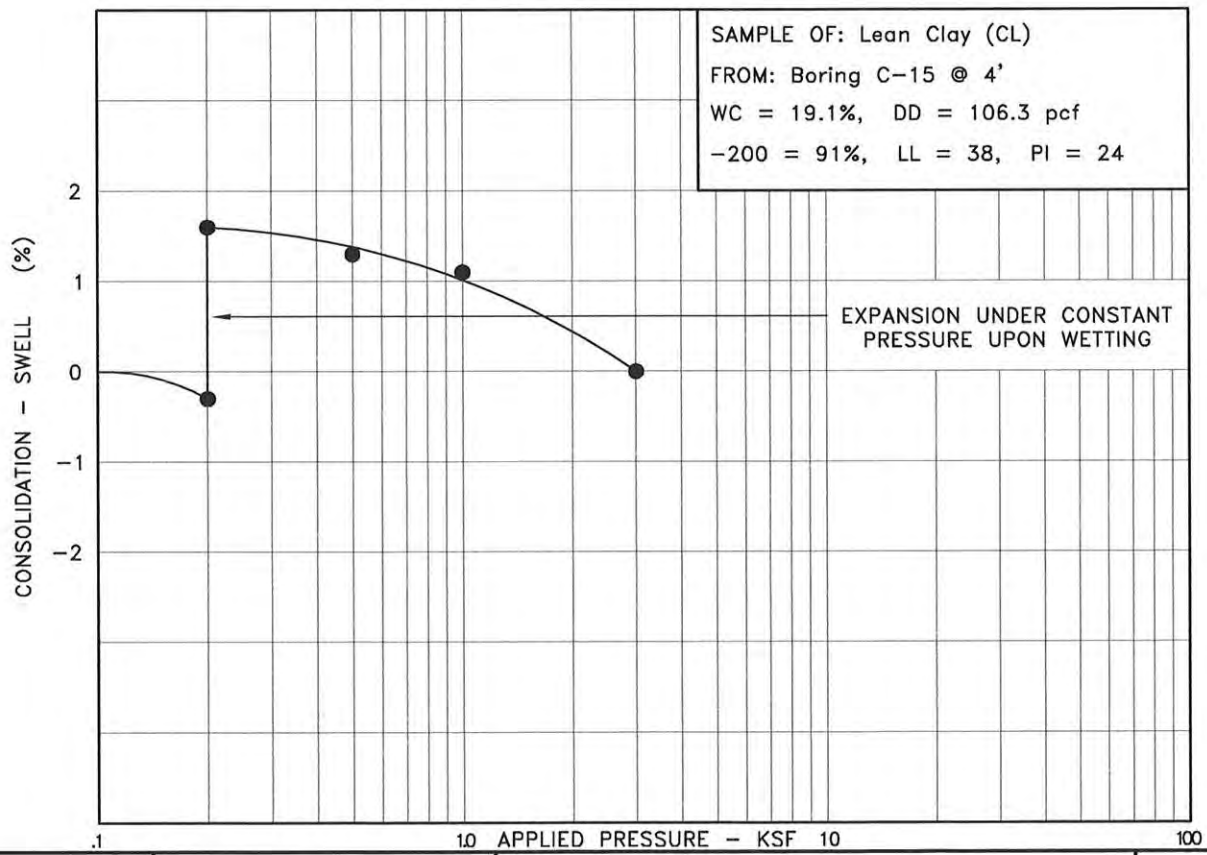
DISTURBED BULK SAMPLE.

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED BETWEEN JANUARY 20 AND 29, 2016 WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.
4. THE EXPLORATORY BORING LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORINGS AT THE TIME OF DRILLING.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   DD = DRY DENSITY (pcf) (ASTM D 2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
   LL = LIQUID LIMIT (ASTM D 4318);
   PI = PLASTICITY INDEX (ASTM D 4318);
   NP = NON-PLASTIC (ASTM D 4318);
   NV = NO LIQUID LIMIT VALUE (ASTM D 4318);
   R = HVEEM R-VALUE (AT 300 psi) (ASTM D 2844);
   WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103);
   A-2-6 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145);
   OMC = OPTIMUM MOISTURE CONTENT (%) (AASHTO T99);
   MDD = MAXIMUM DRY DENSITY (pcf) (AASHTO T99).

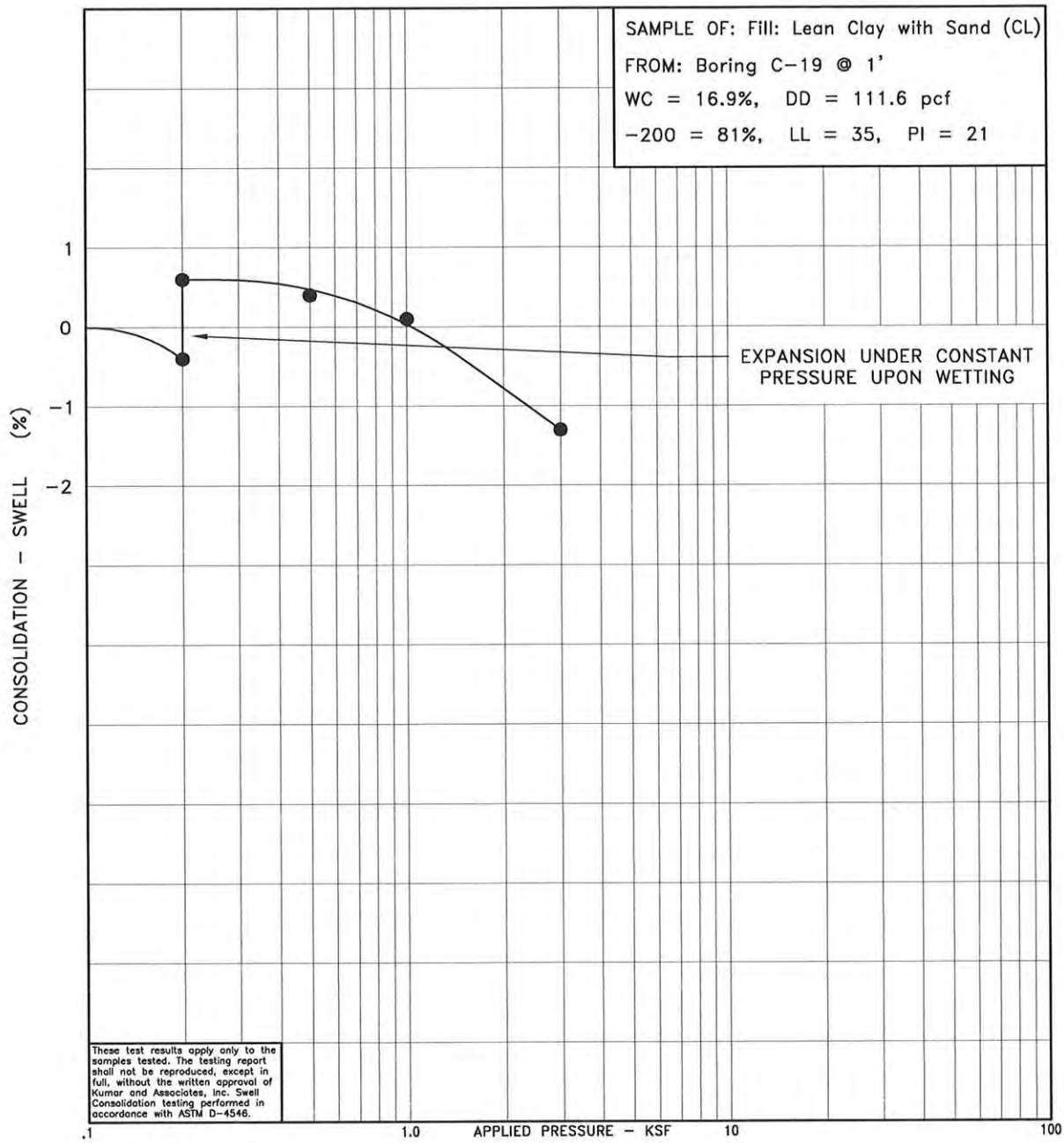
Mar 18, 16Y - 10:48am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-02 to 06.dwg





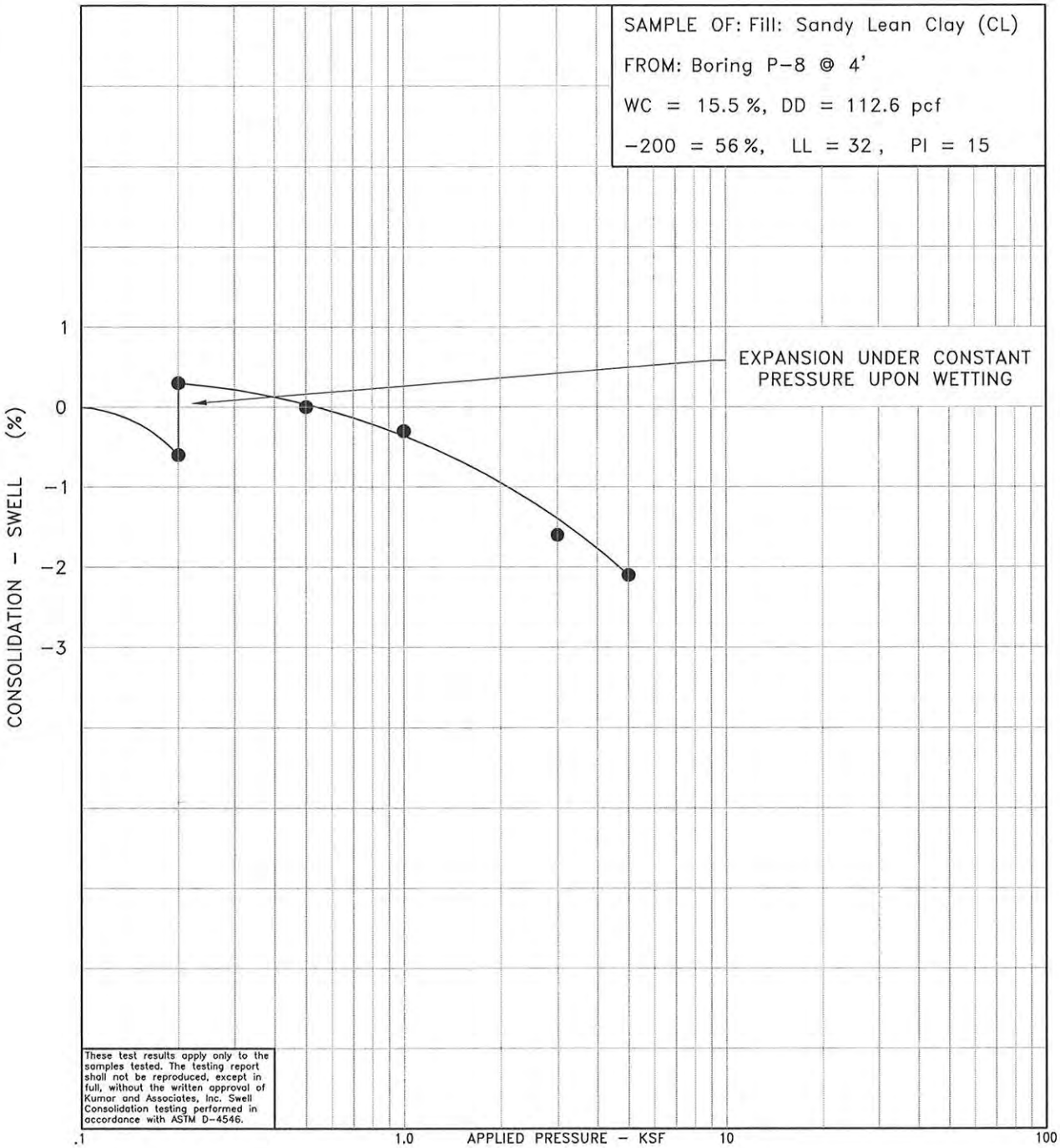
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 7

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



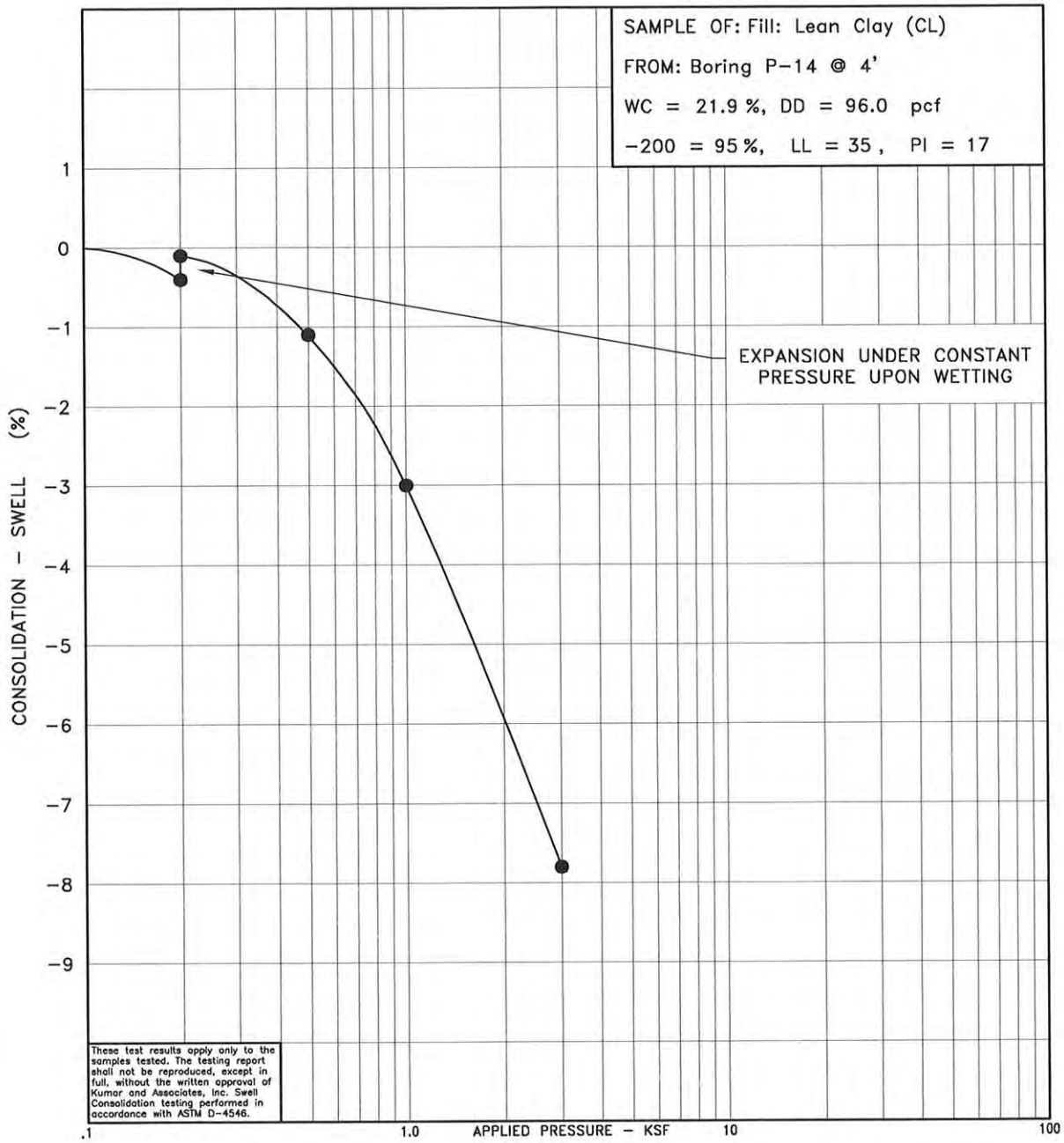
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 8

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



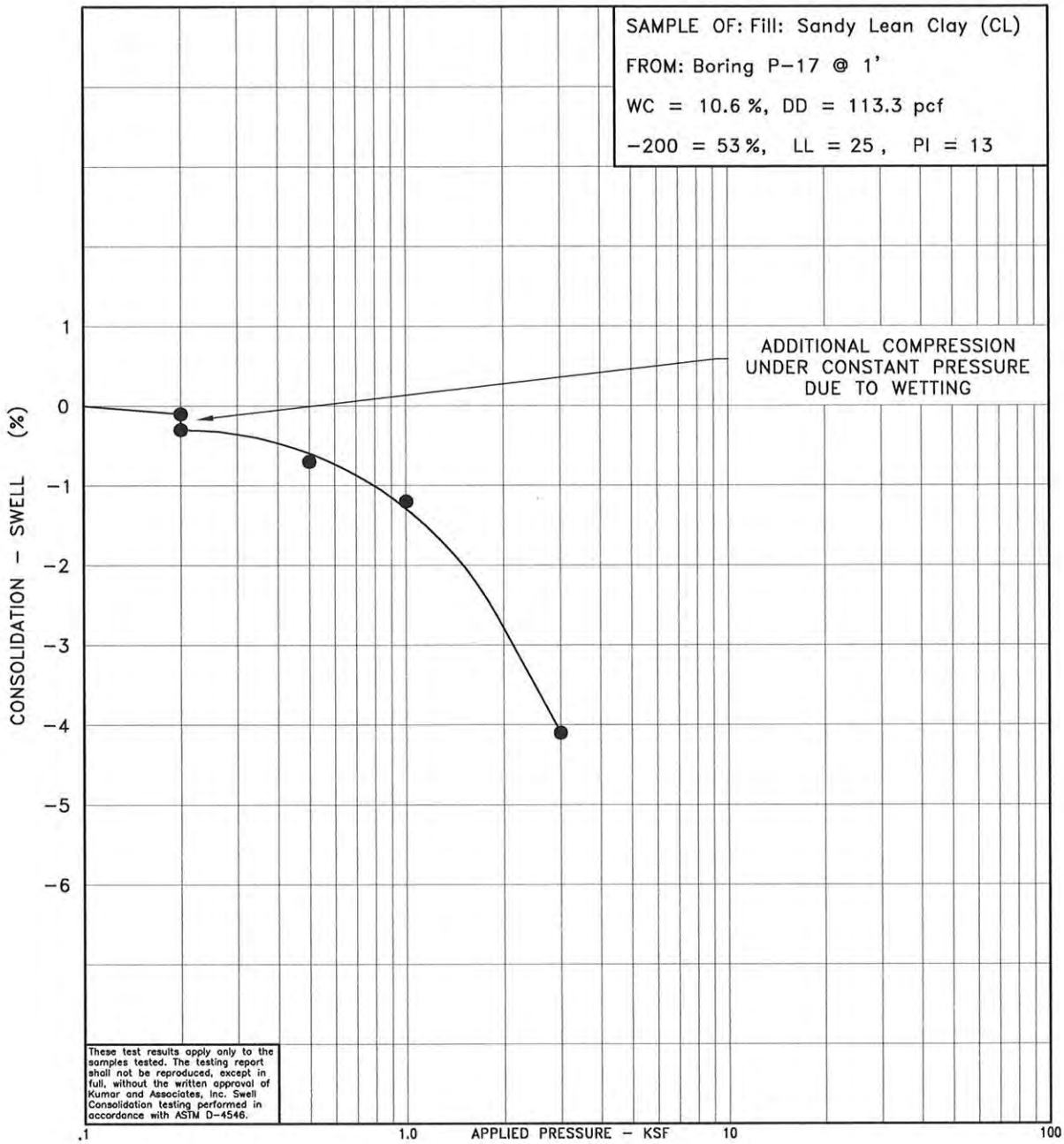
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULT	Fig. 9

March 18, 2016 - 10:56am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



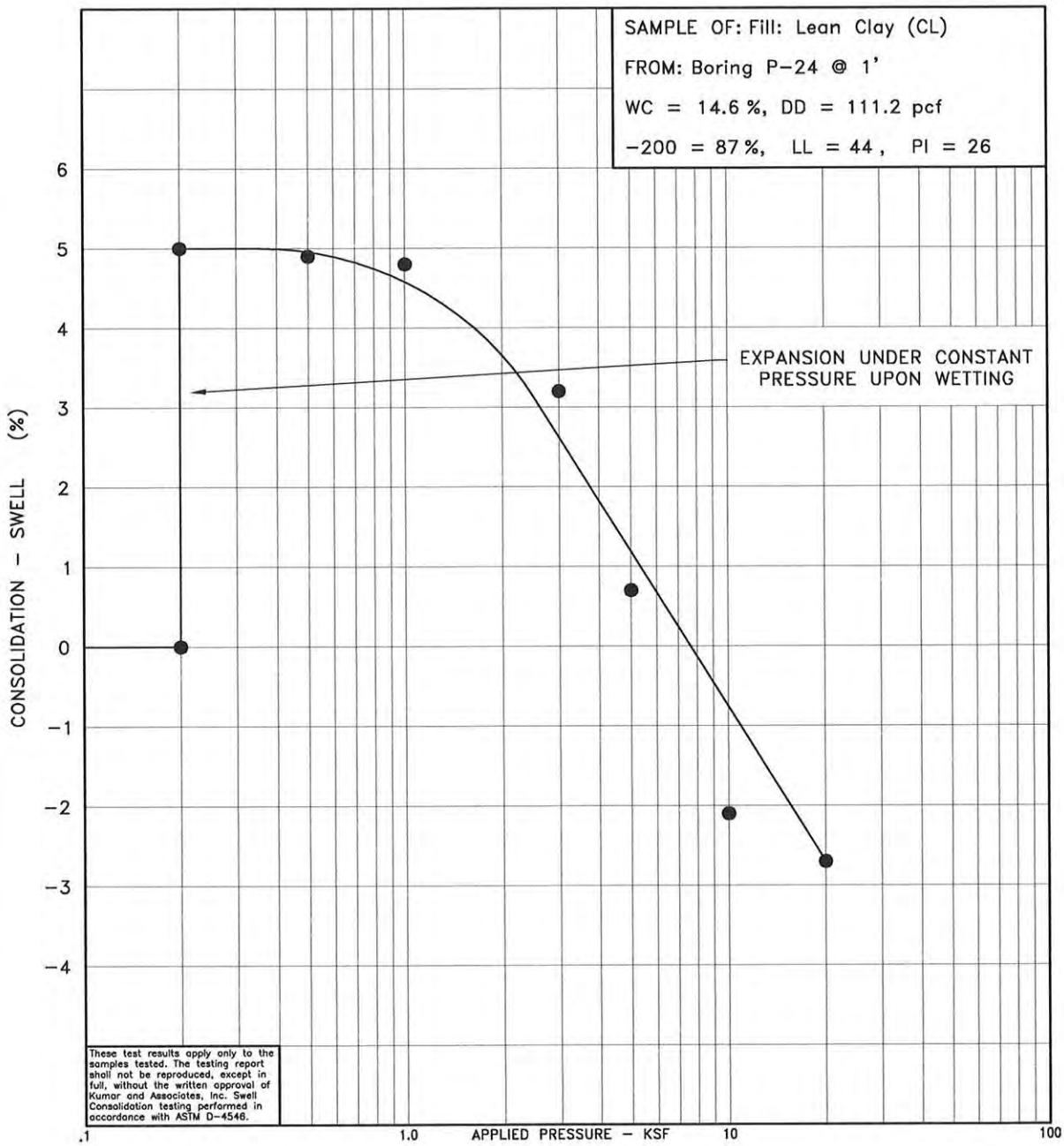
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 10

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



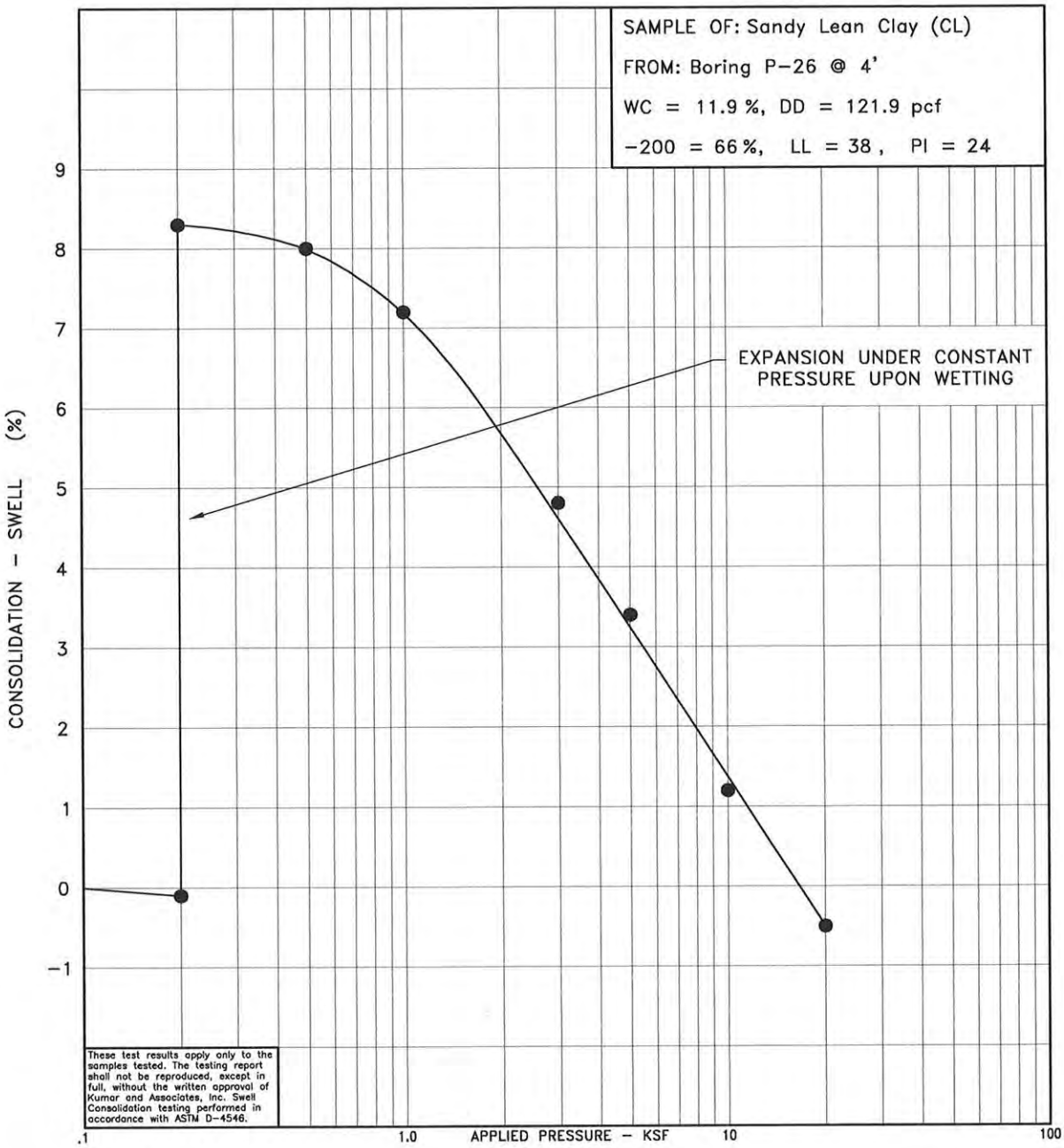
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 11

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



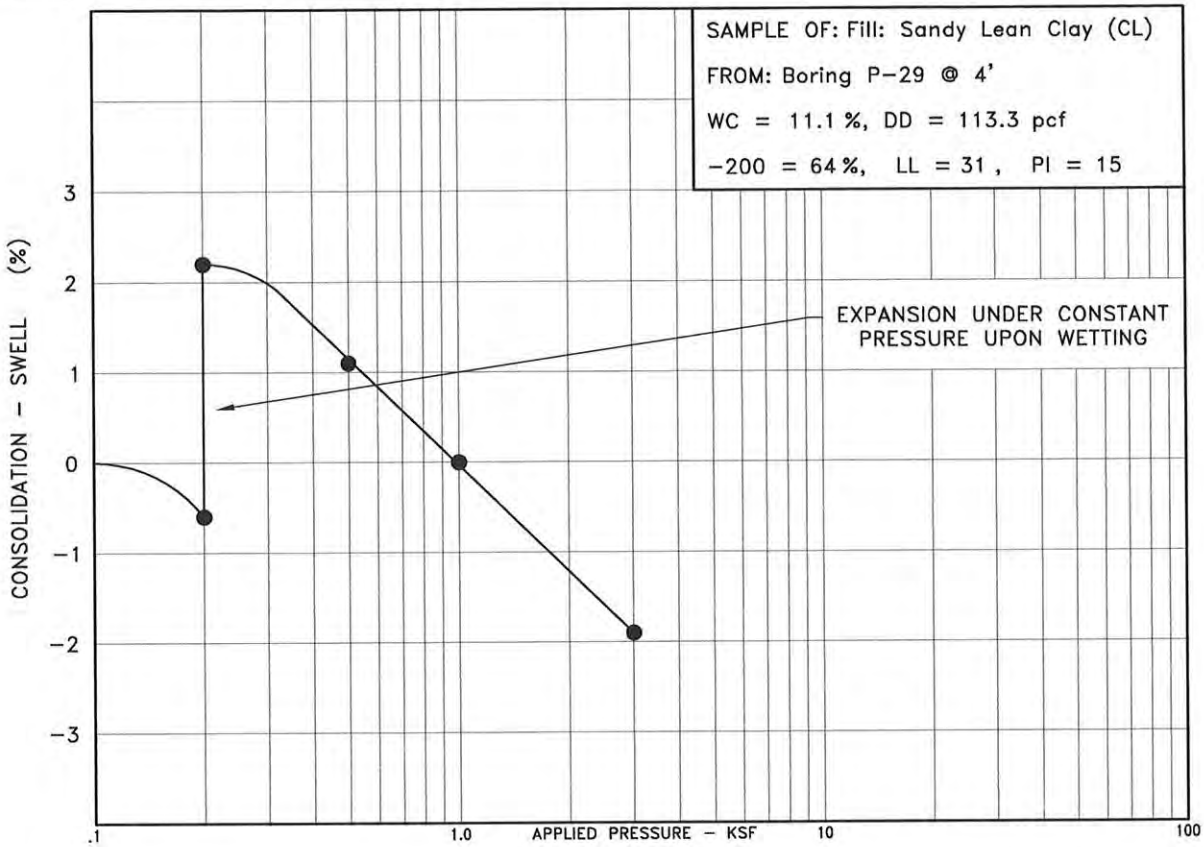
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 12

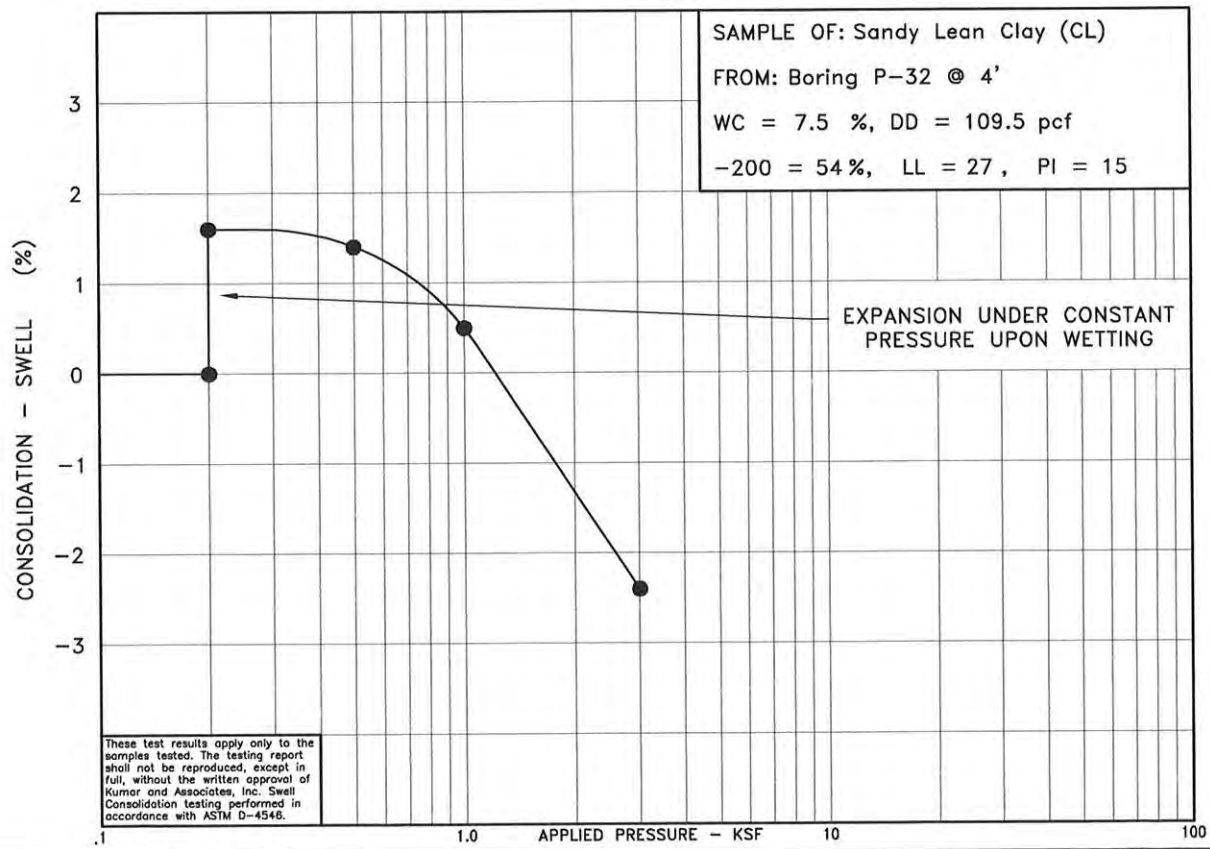
March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg

16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 13

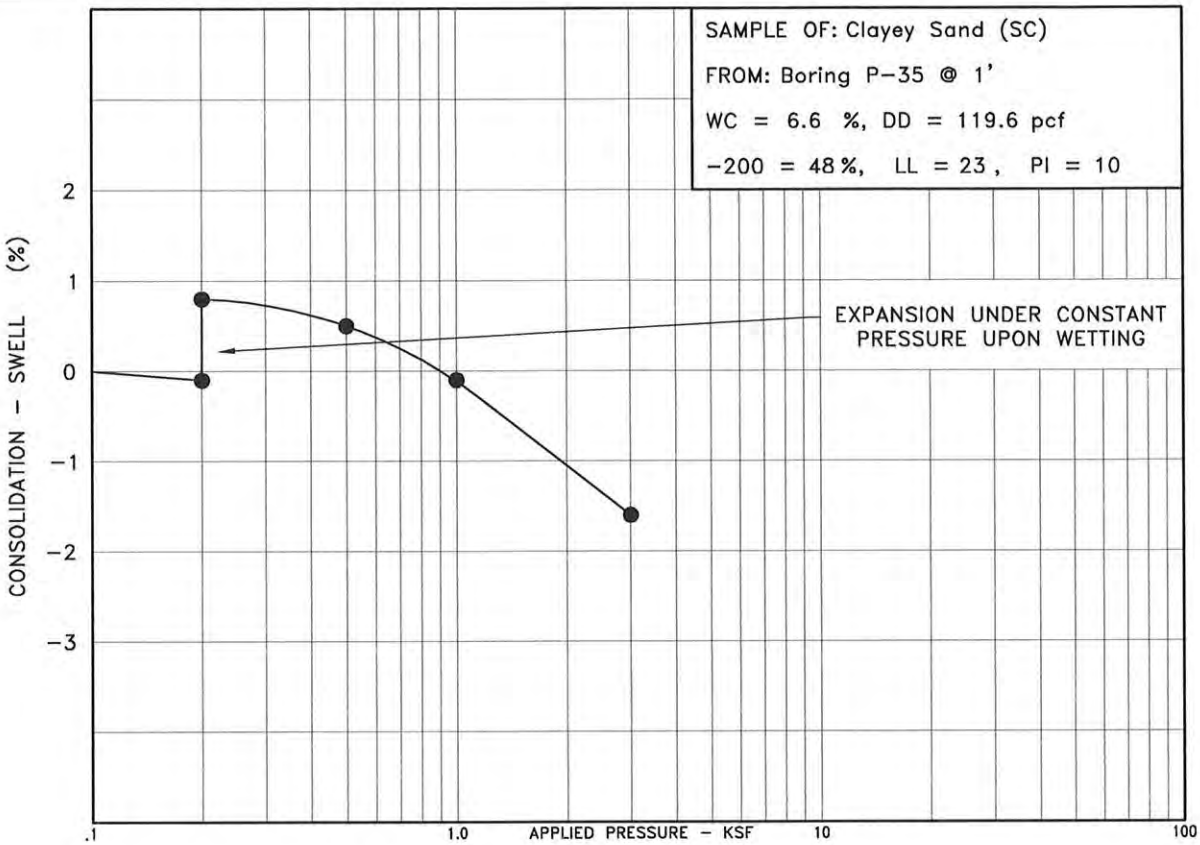


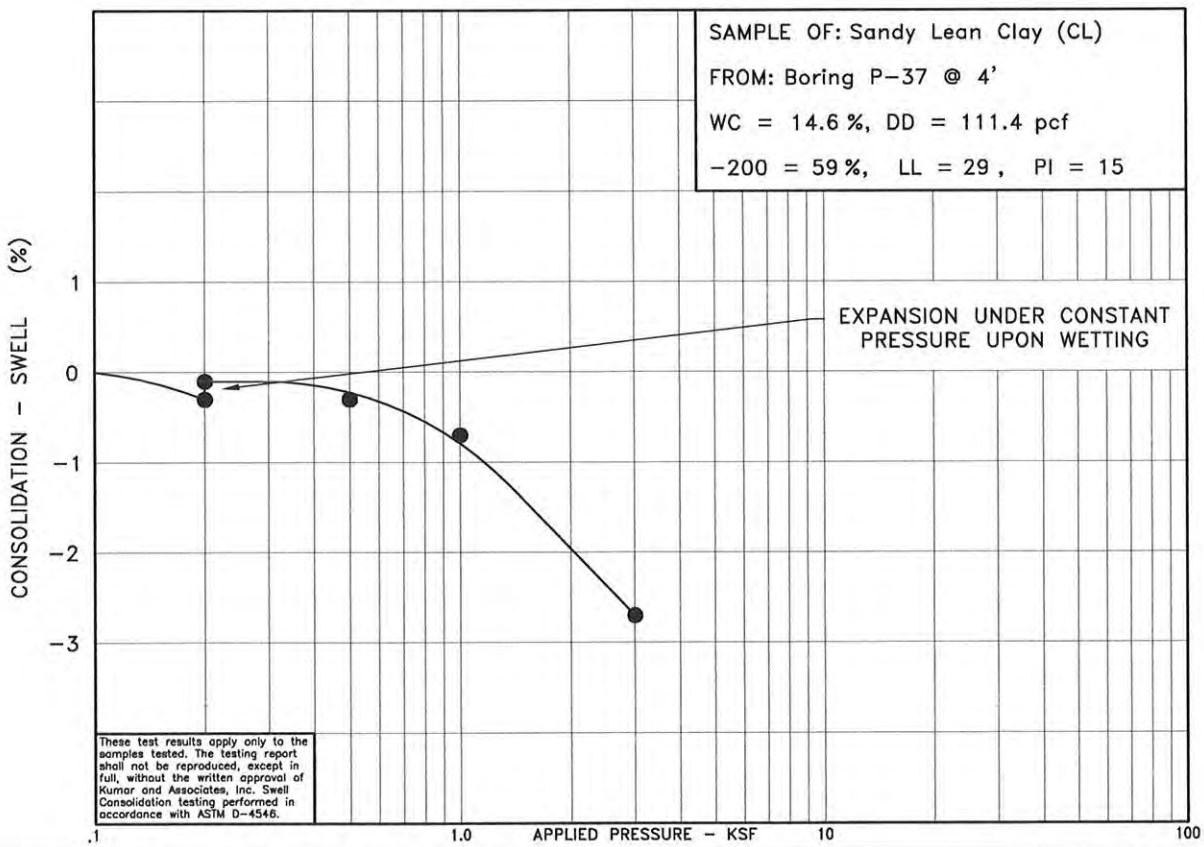


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 14

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg

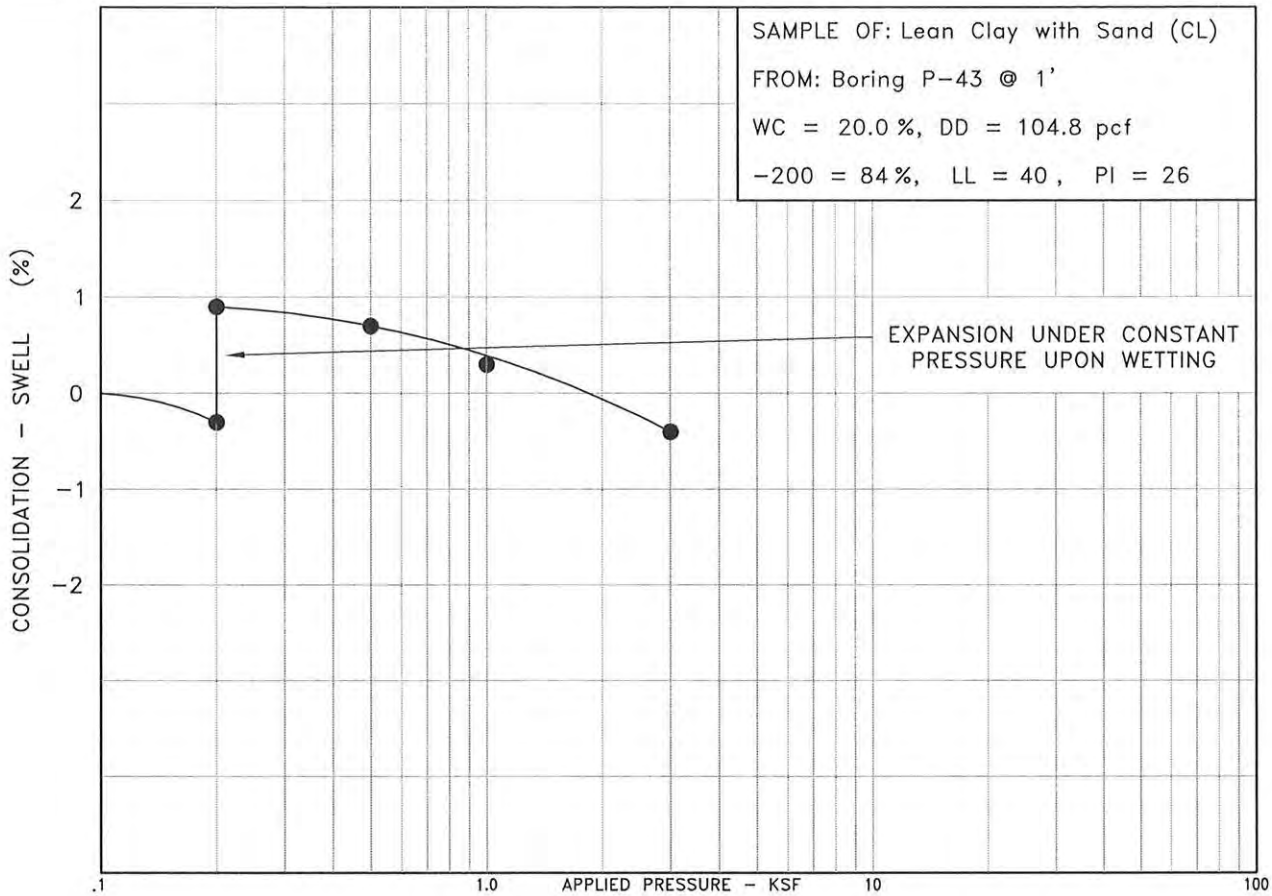


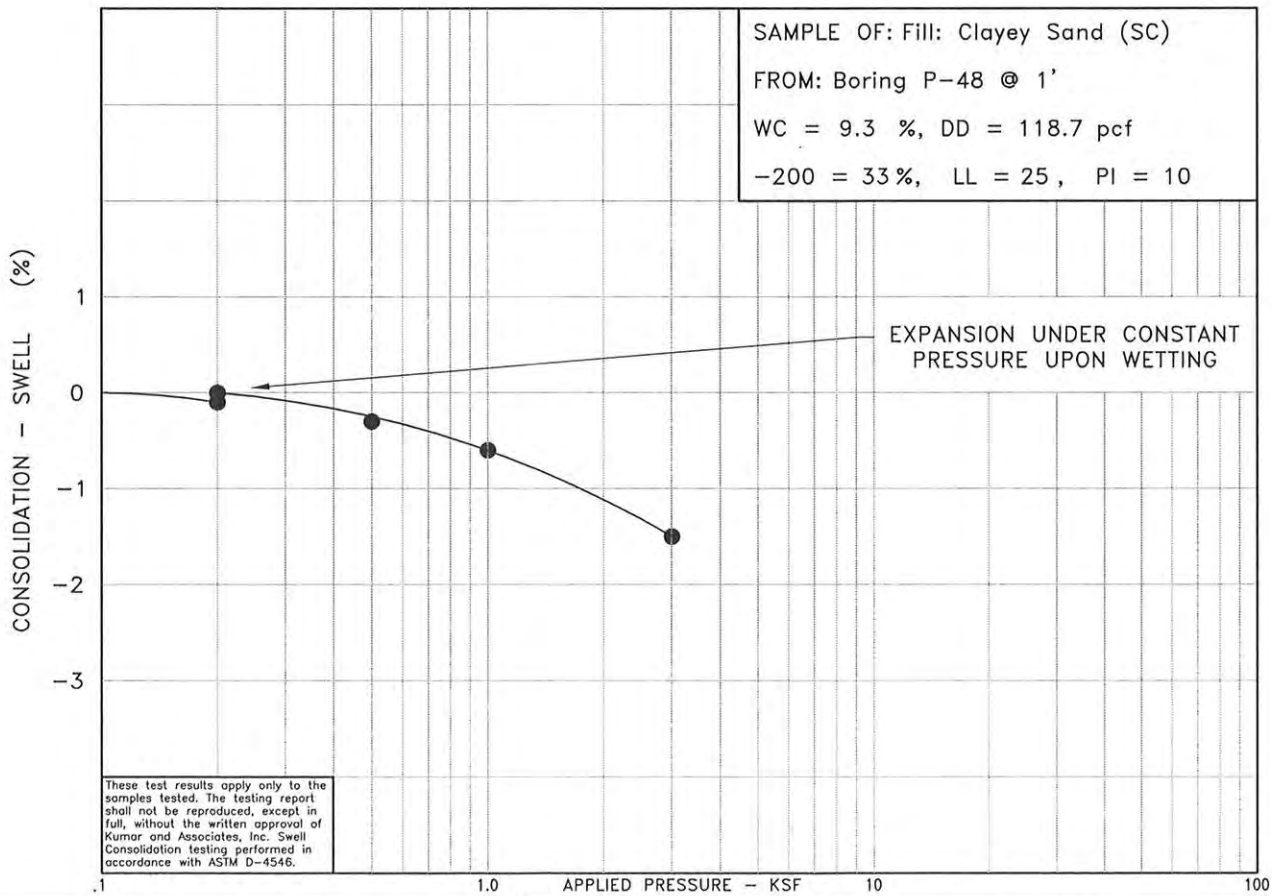


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 15

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg

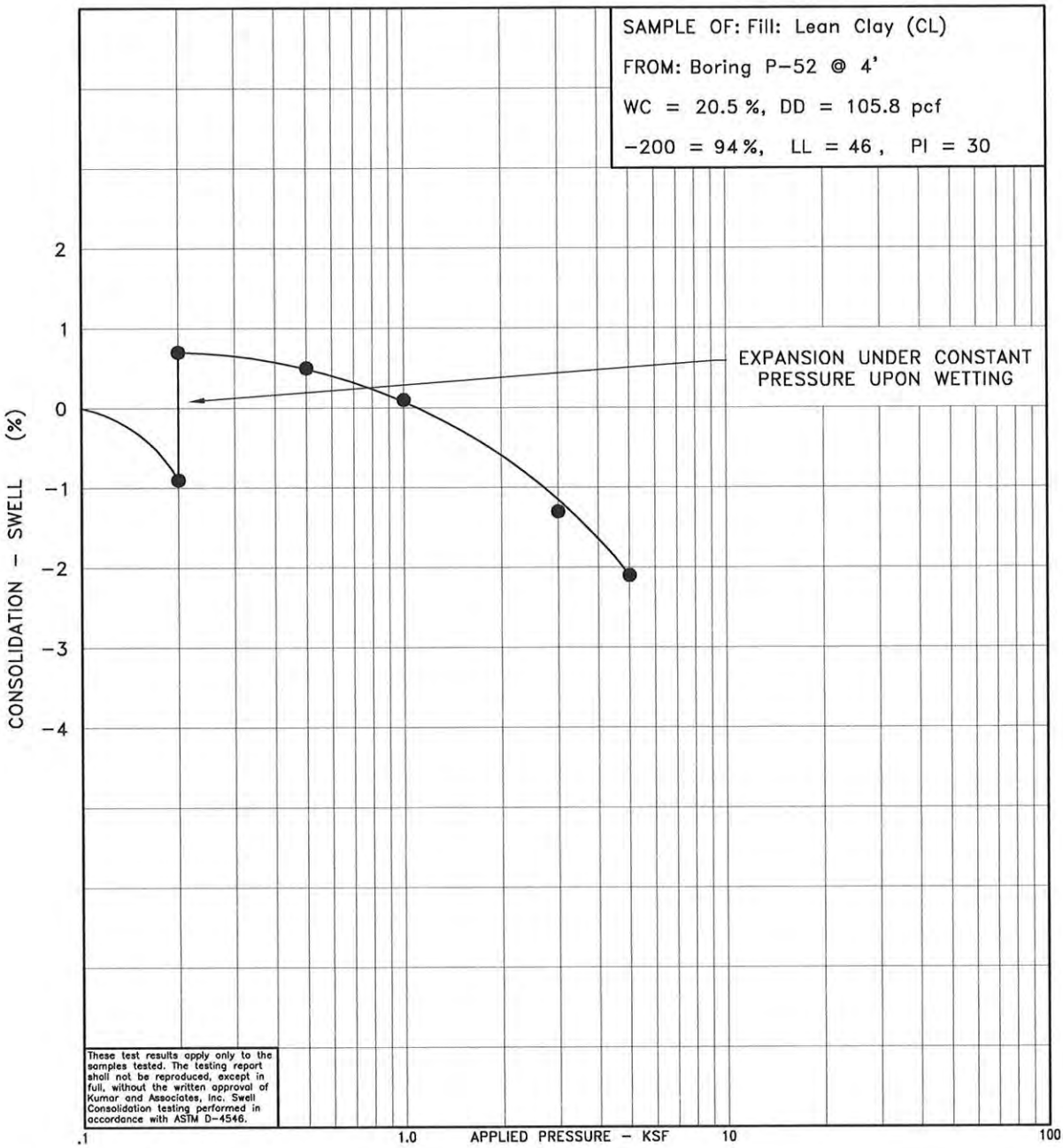




These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

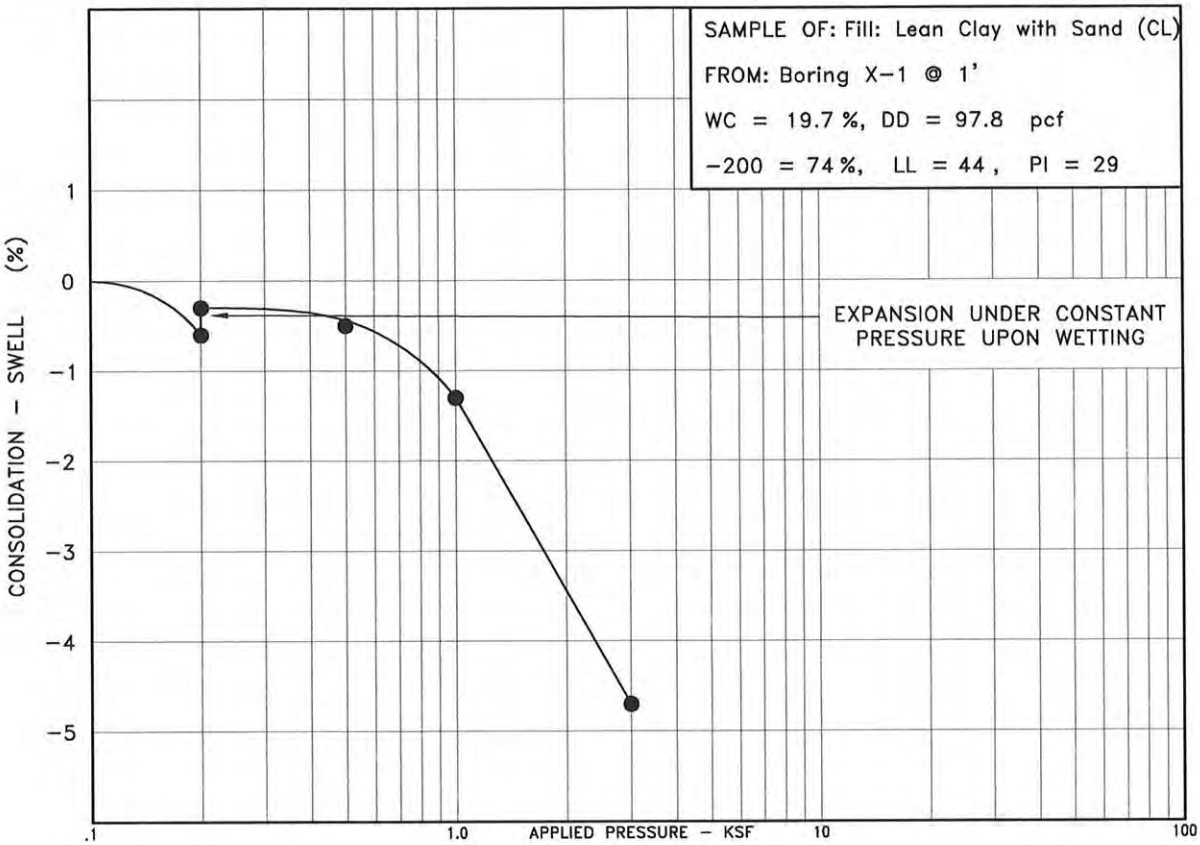
16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 16

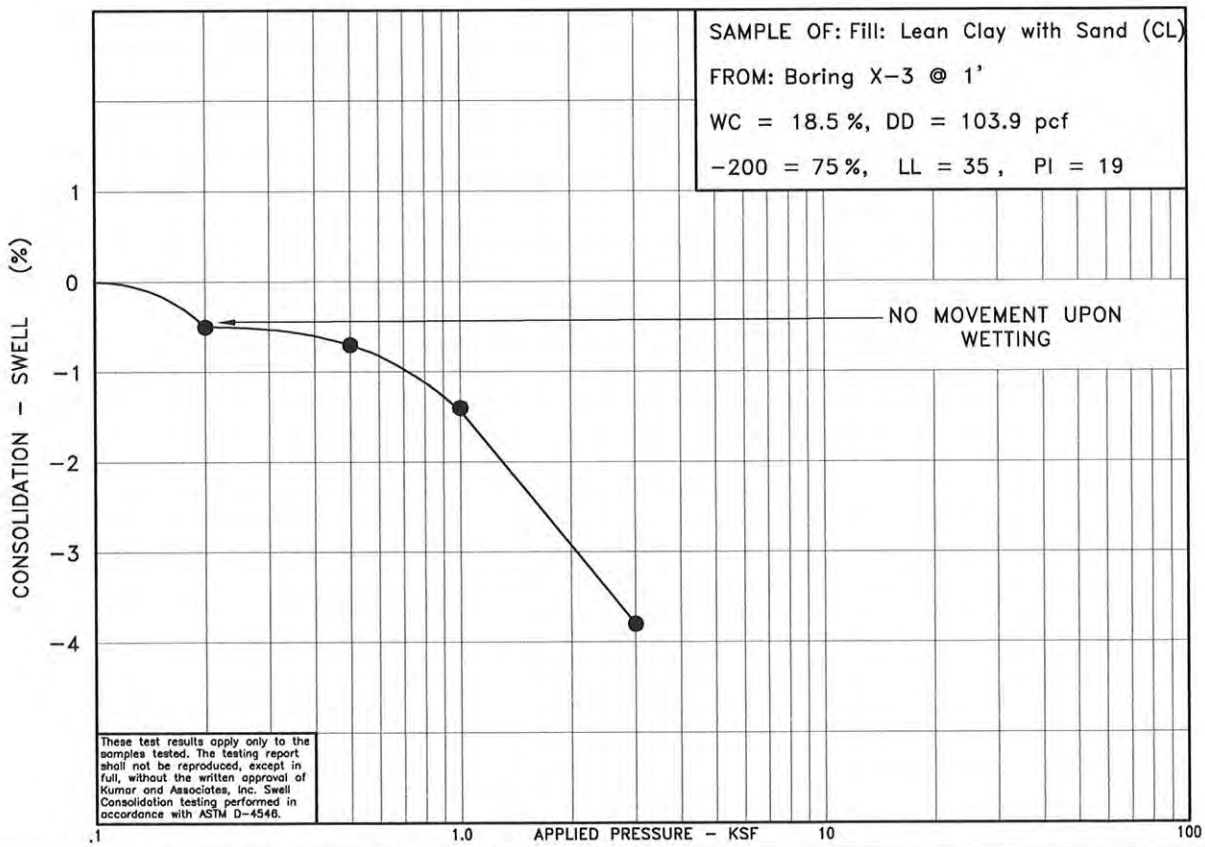
March 18, 2016 - 10:57am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 17

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg

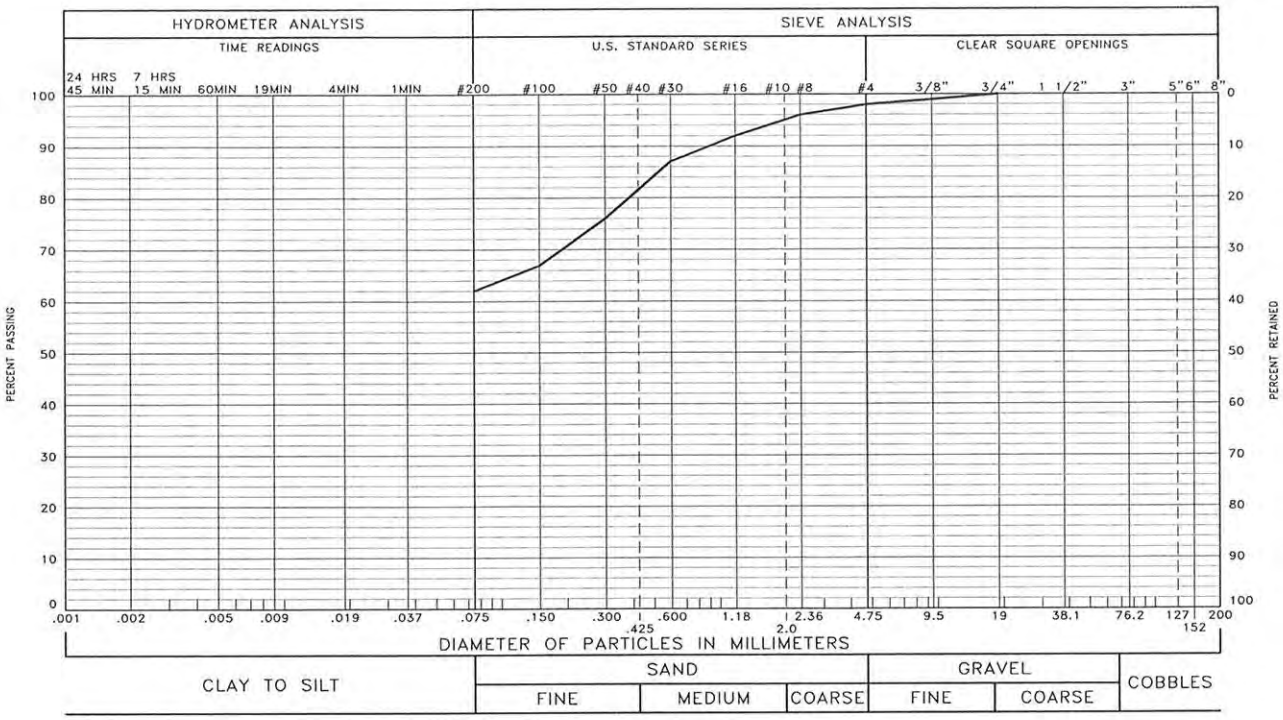




These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

16-3-104.2	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 18

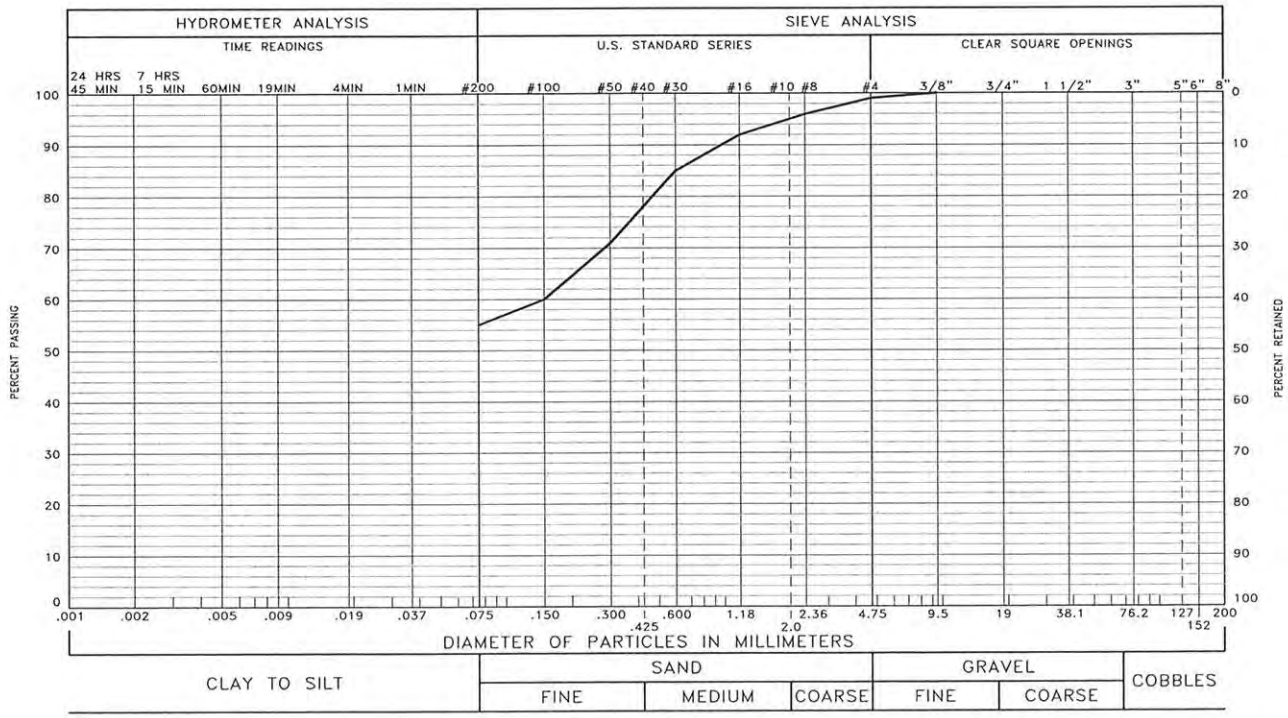
March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-07 to 18.dwg



GRAVEL 2 % SAND 36 % SILT AND CLAY 62 %

LIQUID LIMIT 31 PLASTICITY INDEX 16

SAMPLE OF: Fill: Sandy Lean Clay (CL) FROM: P-6 and P-9 @ 0-3'



GRAVEL 0 % SAND 44 % SILT AND CLAY 55 %

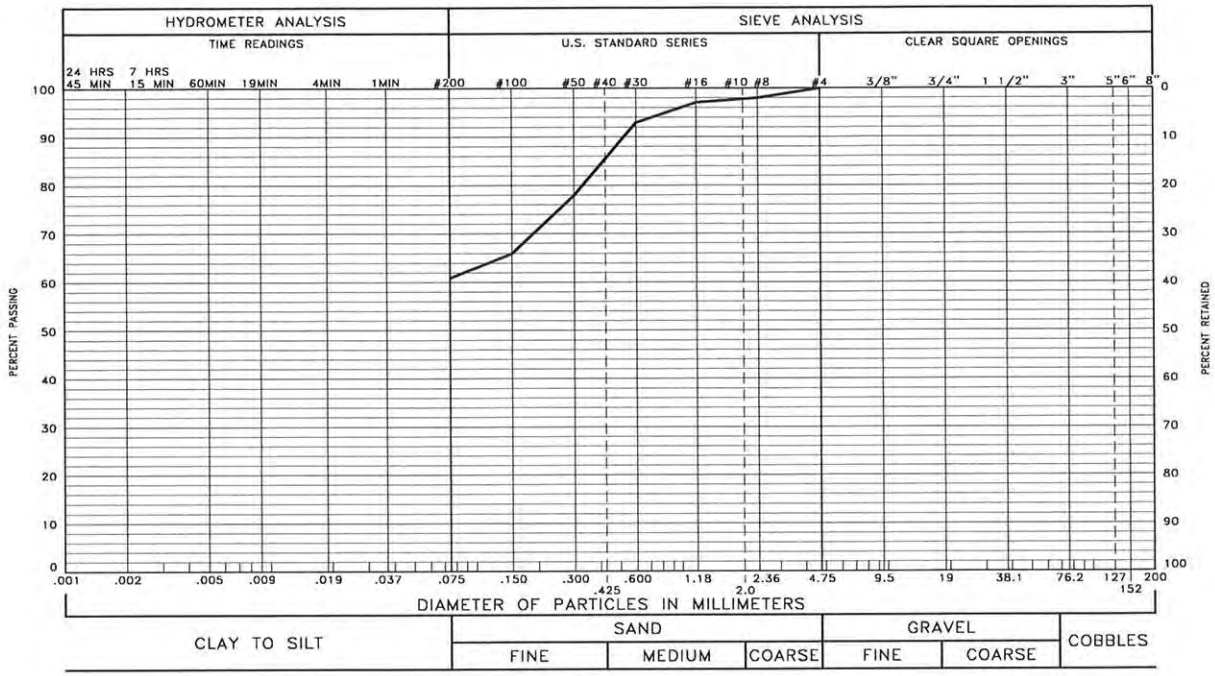
LIQUID LIMIT 29 PLASTICITY INDEX 15

SAMPLE OF: Fill: Sandy Lean Clay (CL) FROM: P-11, P-17, P-20 @ 0-3'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D422, ASTM C136 and/or ASTM D1140.

16-3-104.2	Kumar & Associates	GRADATION TEST RESULTS	Fig. 19

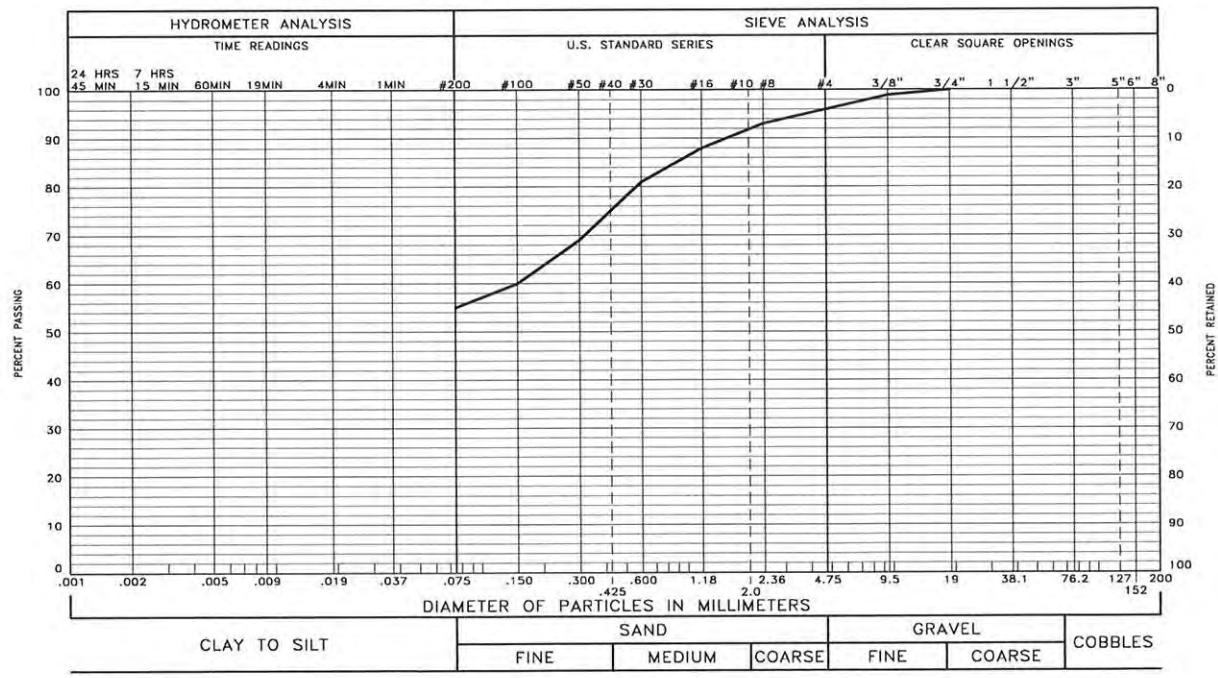
March 18, 2016 - 11:05am
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-19 to 20.dwg



GRAVEL 0 % SAND 39 % SILT AND CLAY 61 %

LIQUID LIMIT 30 PLASTICITY INDEX 18

SAMPLE OF: Fill: Sandy Lean Clay (CL) FROM: P-31 and P-35 @ 1'-3'



GRAVEL 4 % SAND 41 % SILT AND CLAY 55 %

LIQUID LIMIT 32 PLASTICITY INDEX 18

SAMPLE OF: Fill: Sandy Lean Clay (CL) FROM: P-51 and P-53 @ 1'-3'

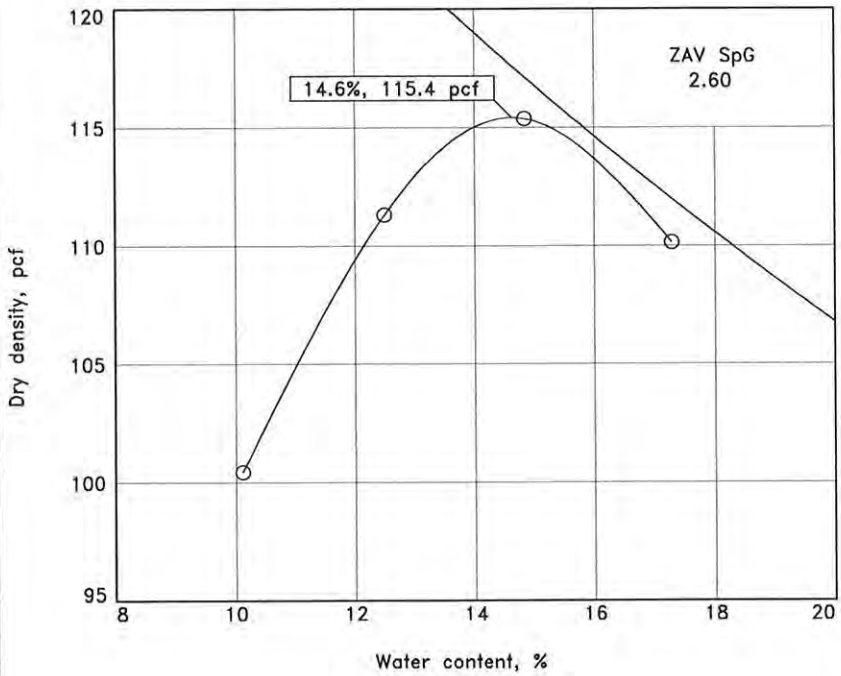
These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D422, ASTM C136 and/or ASTM D1140.

March 14, 2016 - 01:05pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-19 to 20.dwg

16-3-104.2	Kumar & Associates	GRADATION TEST RESULTS	Fig. 20

COMPACTION TEST REPORT

Curve No. 6022



Preparation Method	
Rammer: Wt.	5.50 lb.
Drop	12.00
Type	Manual
Layers: No.	3
Blows per	25
Mold Size	0.03333 cu. ft.
Test Performed on Material Passing	#4 Sieve
%>#4	2
%<No.200	62
Atterberg (D 4318): LL	31
PI	16
NM (D 2216)	
Sp.G. (D 854)	2.6
USCS (D 2487)	CL
AASHTO (M 145)	A-6(7)
Date: Sampled	2/17/16
Received	2/17/16
Tested	2/18/16
Tested By	EU

COMPACTION TESTING DATA
AASHTO T 99-10 Method A Standard

	1	2	3	4	5	6
WM + WS	4189.0	4139.0	4079.0	3858.0		
WM	2186.0	2186.0	2186.0	2186.0		
WW + T #1	703.7	697.8	683.0	678.0		
WD + T #1	635.8	616.3	631.8	633.2		
TARE #1	178.1	144.7	221.7	190.2		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	14.8	17.3	12.5	10.1		
DRY DENS.	115.4	110.1	111.3	100.4		

SIEVE TEST RESULTS
ASTM D 1140 ASTM D 422

Opening Size	% Passing	Specs.
3/4"	100	
3/8"	99	
#4	98	
#8	96	
#16	92	
#30	87	
#50	76	
#100	67	
#200	62	

TEST RESULTS

Maximum dry density = 115.4 pcf

Optimum moisture = 14.6 %

Project No. 16-3-104.2 Client:

Project: Bennett Paving

○ Location: P-6 through P-9 @ 0-3' Sample Number: 6022

Material Description

Fill: Sandy Lean Clay (CL)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: JC

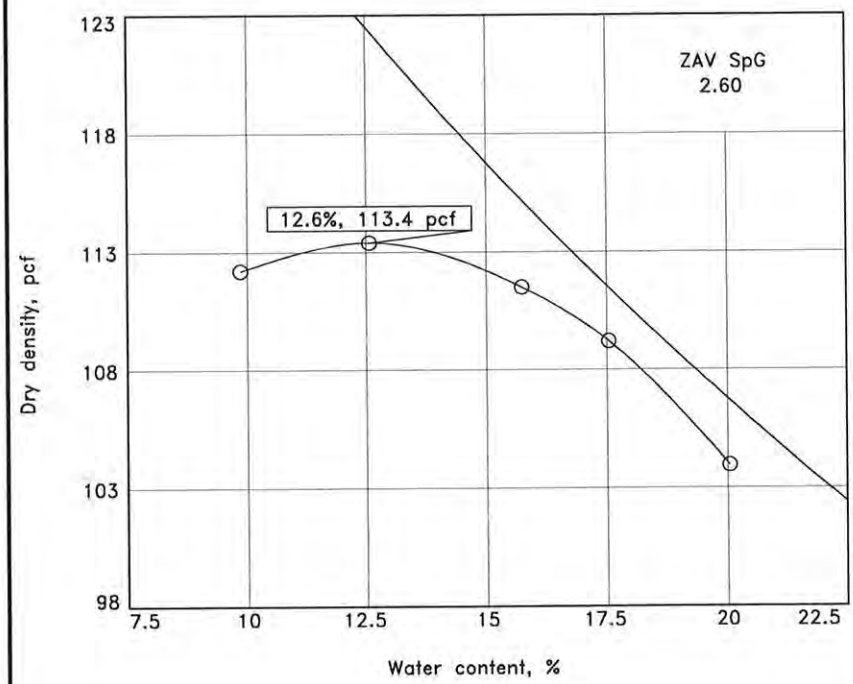
Title: Laboratory Manager

16-3-104.2	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 21

March 14, 2016 - 01:06pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-21 to 24.dwg

COMPACTION TEST REPORT

Curve No. 6021



Preparation Method	
Rammer: Wt.	5.50 lb.
Drop	12.00
Type	Manual
Layers: No.	3
Blows per	25
Mold Size	0.03333 cu. ft.
Test Performed on Material Passing	#4 Sieve
%>#4	1
%<No.200	55
Atterberg (D 4318): LL	29
PI	15
NM (D 2216)	
Sp.G. (D 854)	2.6
USCS (D 2487)	CL
AASHTO (M 145)	A-6(5)
Date: Sampled	2/17/16
Received	2/17/16
Tested	2/18/16
Tested By	BW

COMPACTION TESTING DATA
AASHTO T 99-10 Method A Standard

	1	2	3	4	5	6
WM + WS	4116.1	4137.4	4127.1	4073.1	4050.0	
WM	2186.4	2186.4	2186.4	2186.4	2186.4	
WW + T #1	420.9	652.3	483.4	539.7	598.6	
WD + T #1	388.4	583.3	432.8	477.1	558.9	
TARE #1	129.6	144.7	144.3	164.8	156.3	
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	12.6	15.7	17.5	20.0	9.9	
DRY DENS.	113.4	111.5	109.2	104.0	112.2	

SIEVE TEST RESULTS
ASTM D 1140 ASTM D 422

Opening Size	% Passing	Specs.
3/8"	100	
#4	99	
#8	96	
#16	92	
#30	85	
#50	71	
#100	60	
#200	55	

TEST RESULTS

Maximum dry density = 113.4 pcf

Optimum moisture = 12.6 %

Project No. 16-3-104.2 Client:

Project: Bennett Paving

○ Location: P-11, P-17, P-20 @ 0-3' Sample Number: 6021

Material Description

Fill: Sandy Lean Clay (CL)

Remarks:

These test results apply only to the samples which were tested, the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: JC

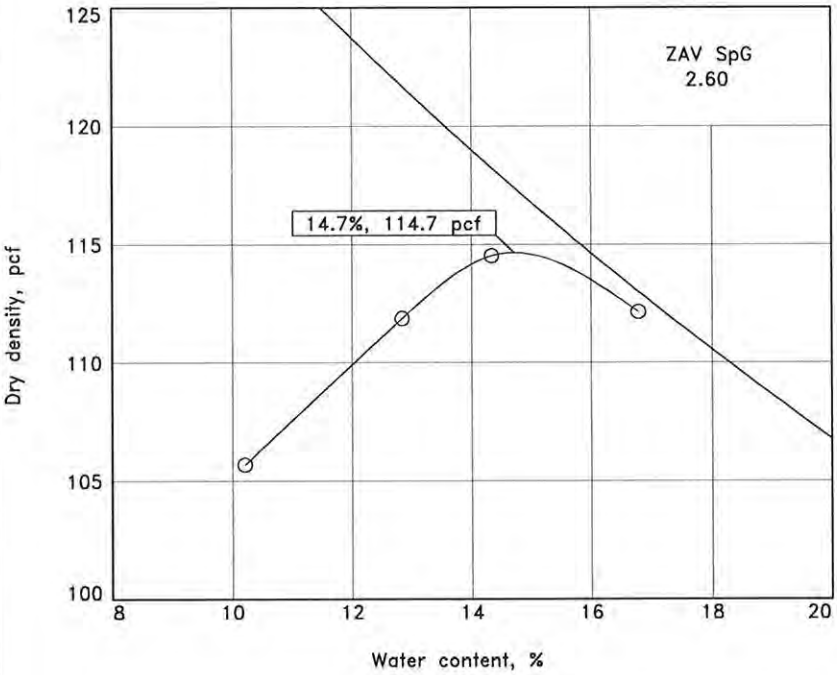
Title: Laboratory Manager

16-3-104.2	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 22

March 14, 2016 - 01:06pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-21 to 24.dwg

COMPACTION TEST REPORT

Curve No. 6023



Preparation Method	
Rammer: Wt.	5.50 lb.
Drop	12.00
Type	Manual
Layers: No.	3
Blows per	25
Mold Size	0.03333 cu. ft.
Test Performed on Material Passing	#4 Sieve
%>#4	4
%<No.200	55
Atterberg (D 4318): LL	32
PI	18
NM (D 2216)	
Sp.G. (D 854)	2.60
USCS (D 2487)	CL
AASHTO (M 145)	A-6(6)
Date: Sampled	2/17/16
Received	2/17/16
Tested	2/18/16
Tested By	BW

COMPACTION TESTING DATA
AASHTO T 99-10 Method A Standard

	1	2	3	4	5	6
WM + WS	3951.5	4099.0	4170.3	4170.7		
WM	2190.6	2190.6	2190.6	2190.6		
WW + T #1	578.7	631.6	577.8	624.6		
WD + T #1	539.1	577.1	524.9	557.2		
TARE #1	151.1	152.4	155.9	155.5		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	10.2	12.8	14.3	16.8		
DRY DENS.	105.7	111.9	114.5	112.2		

SIEVE TEST RESULTS
ASTM D 1140 ASTM D 422

Opening Size	% Passing	Specs.
3/4"	100	
3/8"	99	
#4	96	
#8	93	
#16	88	
#30	81	
#50	69	
#100	60	
#200	55	

TEST RESULTS

Maximum dry density = 114.7 pcf

Optimum moisture = 14.7 %

Project No. 16-3-104.2 Client:

Project: Bennett Paving

O Location: P-51 and P-53 @ 1-3' Sample Number: 6023

Material Description

Fill: Sandy Lean Clay (CL)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: JC

Title: Laboratory Manager

16-3-104.2	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 23

March 14, 2016 - 01:06pm
V:\Projects\2016\16-3-104.2 Town of Bennett Roadway Projects\Drafting\163104.2-21 to 24.dwg

Table I
Summary of Laboratory Test Results

Project No.: 16-3-104.2
Project Name: Bennett Concrete Roadways
Date Sampled: January 20 to January 29, 2016
Date Received: January 26 and February 17, 2016

Sample Location					Gradation			Atterberg Limits					
Boring	Depth (Feet)	Date Tested	Natural Moisture Content (%)	Natural Dry Density (pcf)	Gravel (%)	Sand (%)	Percent Passing No. 200 Sieve	Liquid Limit (%)	Plasticity (%)	Water Soluble Sulfates (%)	R-Value	AASHTO Classification (Group Index)	Soil or Bedrock Type
C-6	4	2/3/16	9.6	111.8			33	21	9			A-2-4 (0)	Clayey Sand (SC)
C-7	4	2/3/16	15.7	107.2			68	35	29			A-6 (16)	Sandy Lean Clay (CL)
C-8	1	2/3/16	9.9	119.7			37	23	13			A-6 (1)	Clayey Sand (SC)
C-9	1	2/3/16	9.9	112.7			40	25	15			A-6 (2)	Clayey Sand (SC)
C-14	1	2/3/16	21.9	101.5			94	45	30			A-7-6 (29)	Fill: Lean Clay (CL)
C-15	4	2/3/16	19.1	106.3			91	38	24			A-6 (21)	Lean Clay (CL)
C-16	1	2/3/16	11.3	111.0			41	28	17			A-6 (3)	Fill: Clayey Sand (SC)
C-17	4	2/3/16	5.7	112.8			27	22	12			A-2-6 (0)	Clayey Sand (SC)
C-18	1	2/3/16	20.1	106.3			79	33	20			A-6 (14)	Fill: Lean Clay with Sand (CL)
C-19	1	2/3/16	16.9	111.6			81	35	21			A-6 (15)	Fill: Lean Clay with Sand (CL)
P-6 and P-9	0-3	2/17/16	14.6*	115.4*	2	36	62	31	16		11	A-6 (7)	Fill: Sandy Lean Clay (CL)
P-7	1	2/18/16	18.7	106.6			76	35	21			A-6 (14)	Fill: Lean Clay with Sand (CL)
P-8	4	2/18/16	15.5	112.6			56	32	15			A-6 (5)	Fill: Sandy Lean Clay (CL)
P-9	4	2/18/16	20.4	105.4			96	39	20			A-6 (20)	Fill: Lean Clay (CL)
P-10	1	2/18/16	19.3	106.9			89	26	13			A-6 (9)	Fill: Lean Clay (CL)
P-11	4	2/18/16	18.3	109.6			96	38	20	0		A-6 (20)	Fill: Lean Clay (CL)
P-11, 17, 20	0-3	2/17/16	12.6*	113.4*	1	44	55	29	15		17	A-6 (5)	Fill: Sandy Lean Clay (CL)
P-12	4	2/18/16	17.0	103.7			77	35	18			A-6 (12)	Fill: Lean Clay with Sand (CL)
P-13	1	2/18/16	10.8	121.5			73	29	16			A-6 (9)	Fill: Lean Clay with Sand (CL)
P-14	4	2/18/16	21.9	96.0			95	35	17			A-6 (16)	Fill: Lean Clay (CL)
P-15	1	2/2/16	18.0	103.4			73	33	19			A-6 (11)	Fill: Lean Clay with Sand (CL)
P-16	4	2/2/16	5.6	98.6			25	NV	NP			A-2-4 (0)	Silty Sand (SM)
P-17	1	2/2/16	10.6	113.3			53	25	13			A-6 (3)	Fill: Sandy Lean Clay (CL)
P-18	1	2/18/16	13.7	115.0			67	32	17			A-6 (9)	Fill: Sandy Lean Clay (CL)
P-19	1	2/2/16	18.8	102.2			67	32	19			A-6 (10)	Fill: Sandy Lean Clay (CL)
P-20	4	2/2/16	14.2	114.5			50	20	3			A-4 (0)	Sandy Silt (ML)
P-21	4	2/2/16	7.8	111.1			37	22	9			A-4 (0)	Clayey Sand (SC)
P-22	4	2/18/16	10.5	113.6			44	24	12			A-6 (2)	Fill: Clayey Sand (SC)
P-23	1	2/18/16	20.5	106.4			96	37	20	0.01		A-6 (19)	Fill: Lean Clay (CL)
P-24	1	2/2/16	14.6	111.2			87	44	26			A-7-6 (23)	Fill: Lean Clay (CL)
P-25	4	2/2/16	11.4	108.2			94	37	21			A-6 (20)	Lean Clay (CL)
P-26	4	2/2/16	11.9	121.9			66	38	24			A-6 (13)	Sandy Lean Clay (CL)
P-27	1	2/18/16	17.4	107.2			92	39	20			A-6 (19)	Fill: Lean Clay (CL)
P-28	1	2/2/16	8.0	107.7			59	31	18			A-6 (7)	Fill: Sandy Lean Clay (CL)
P-29	4	2/18/16	11.1	113.3			64	31	15			A-6 (7)	Fill: Sandy Lean Clay (CL)
P-30	1	2/18/16	18.0	96.8			96	42	24			A-7-6 (24)	Fill: Lean Clay (CL)

Table I
Summary of Laboratory Test Results
(continued)

Project No.: 16-3-104.2
Project Name: Bennett Concrete Roadways
Date Sampled:
Date Received: January 26 and February 17, 2016

Sample Location					Gradation			Atterberg Limits					
Boring	Depth (Feet)	Date Tested	Natural Moisture Content (%)	Natural Dry Density (pcf)	Gravel (%)	Sand (%)	Percent Passing No. 200 Sieve	Liquid Limit (%)	Plasticity (%)	Water Soluble Sulfates (%)	R-Value	AASHTO Classification (Group Index)	Soil or Bedrock Type
P-31	4	2/18/16	11.8	113.8			50	30	16			A-6 (4)	Fill: Sandy Lean Clay (CL)
P-31 and 35	1-3	2/17/16	15.1*	110.5*	0	39	61	30	18		7	A-6 (8)	Fill: Sandy Lean Clay (CL)
P-32	4	2/18/16	7.5	109.5			54	27	15			A-6 (5)	Sandy Lean Clay (CL)
P-33	1	2/18/16	16.0	112.2			86	37	20			A-6 (17)	Fill: Lean Clay (CL)
P-34	1	2/18/16	11.4	121.3			43	26	11			A-6 (1)	Clayey Sand (SC)
P-35	1	2/18/16	6.6	119.6			48	23	10			A-4 (1)	Clayey Sand (SC)
P-36	1	2/2/16	21.0	100.4			82	30	16			A-6 (11)	Fill: Lean Clay with Sand (CL)
P-37	4	2/1/16	14.6	111.4			59	29	15			A-6 (6)	Sandy Lean Clay (CL)
P-38	1	2/2/16	16.4	104.8			63	29	17			A-6 (7)	Fill: Sandy Lean Clay (CL)
P-39	1	2/2/16	13.7	121.0			60	28	15			A-6 (6)	Fill: Sandy Lean Clay (CL)
P-40	4	2/3/16	10.8	115.5			31	19	10			A-2-4 (0)	Clayey Sand (SC)
P-41	1	2/18/16	16.7	105.3			88	35	19			A-6 (16)	Fill: Lean Clay (CL)
P-42	4	2/18/16	23.1	100.3			97	38	21			A-6 (21)	Fill: Lean Clay (CL)
P-43	1	2/3/16	20.0	104.8			84	40	26			A-6 (21)	Lean Clay with Sand (CL)
P-44	4	2/18/16	3.0	113.7			19	18	4			A-2-4 (0)	Fill: Silty Clayey Sand (SC-SM)
P-45	4	2/2/16	14.8	101.9			58	30	17			A-6 (6)	Fill: Sandy Lean Clay (CL)
P-46	1	2/2/16	12.3	114.9			40	25	14			A-6 (2)	Clayey Sand (SC)
P-47	1	2/18/16	20.8	94.0			95	38	21			A-6 (20)	Fill: Lean Clay (CL)
P-48	1	2/18/16	9.3	118.7	6	61	33	25	10			A-2-4 (0)	Fill: Clayey Sand (SC)
P-49	4	2/18/16	12.8	119.4			52	33	20			A-6 (7)	Fill: Sandy Lean Clay (CL)
P-50	1	2/18/16	17.7	105.6			75	37	20	0.04		A-6 (13)	Fill: Lean Clay with Sand (CL)
P-51	1	2/18/16	8.3	105.0			31	21	9			A-2-4 (0)	Clayey Sand (SC)
P-51 & 53	1-3	2/17/16	14.7*	114.7*	4	41	55	32	18		6	A-6 (6)	Fill: Sandy Lean Clay (CL)
P-52	4	2/18/16	20.5	105.8			94	46	30			A-7-6 (29)	Fill: Lean Clay (CL)
P-53	1	2/18/16	18.3	106.1			82	25	9			A-4 (5)	Fill: Lean Clay (CL)

Table I
Summary of Laboratory Test Results
(continued)

Project No.: 16-3-104.2
Project Name: Bennett Concrete Roadways
Date Sampled:
Date Received: January 26 and February 17, 2016

Sample Location					Gradation			Atterberg Limits					
Boring	Depth (Feet)	Date Tested	Natural Moisture Content (%)	Natural Dry Density (pcf)	Gravel (%)	Sand (%)	Percent Passing No. 200 Sieve	Liquid Limit (%)	Plasticity (%)	Water Soluble Sulfates (%)	R-Value	AASHTO Classification (Group Index)	Soil or Bedrock Type
X-1	1	2/18/16	19.7	97.8	1	25	74	44	29			A-7-6 (20)	Fill: Lean Clay with Sand (CL)
X-2	4	2/18/16	17.1	104.1			75	36	19			A-6 (13)	Fill: Lean Clay with Sand (CL)
X-3	1	2/18/16	18.5	103.9			75	35	19			A-6 (12)	Fill: Lean Clay with Sand (CL)
X-4	1	2/18/16	20.6	102.6			89	38	23			A-6 (20)	Fill: Lean Clay (CL)
X-5	1	2/18/16	20.0	106.5			86	43	27			A-7-6 (23)	Fill: Lean Clay (CL)

APPENDIX A

R-VALUE TEST RESULTS

R-Value
ASTM D 2844

Client: Kumar & Associates
Job No.: 2203-82
Project: Bennett Pavements
Location: --
Project No.: 16-3-104

Boring No.: P51-P53
Depth: 1-3'
Sample No.: 6023

Date Tested: 2/23/2016 By: BDF

Moisture Information

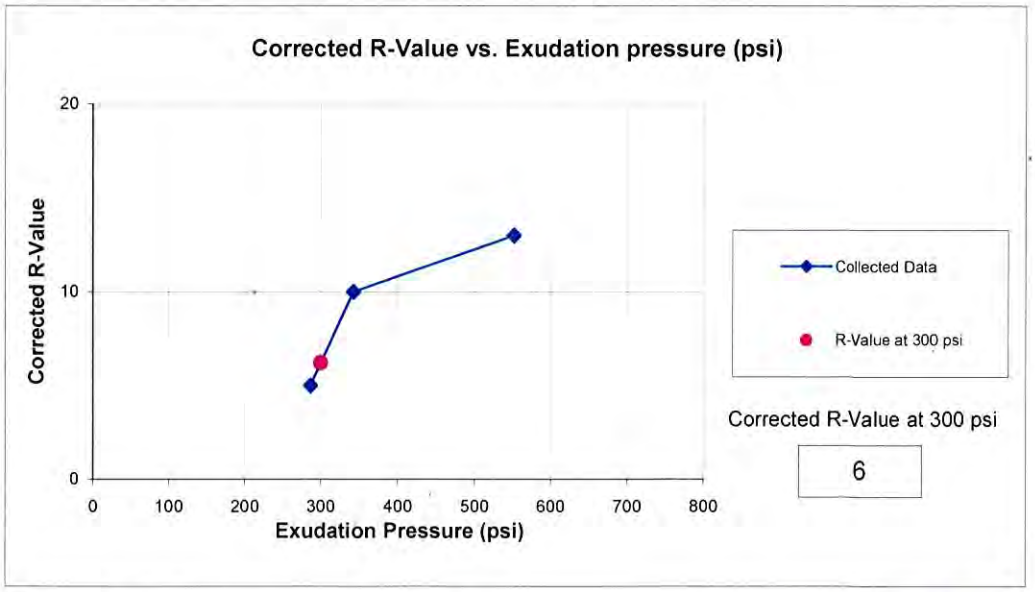
Sample:	1	2	3
Weight of Wet Soil & Dish (g):	1169.13	1092.08	1165.34
Weight of Dry Soil & Dish (g):	1006.02	913.26	988.12
Weight of Water Lost (g):	163.11	178.82	177.22
Weight of Dish (g):	15.59	15.59	15.64
Weight of Dry Soil (g):	990.43	897.67	972.48
Moisture Content:	16.47%	19.92%	18.22%

Density Information

Weight of Soil & Mold (g):	3280.1	3196.2	3264.9
Weight of Mold (g):	2115.2	2102.5	2100.7
Weight of Wet Soil (g):	1164.9	1093.7	1164.2
Sample Height (in):	2.68	2.59	2.70
Wet Density (pcf):	131.8	128.0	130.7
Dry Density (pcf):	113.1	106.8	110.6

R-Value Information

Exudation Pressure (lbs):	6930	3598	4305
Exudation Pressure (psi):	551	286.3	342.6
2000 lbs. Dial Reading (psi):	134	147	139
Displacement Turns:	3.41	3.87	3.98
Uncorrected R-Value:	12	5	9
Corrected R-Value:	13	5	10



Corrected R-Value at 300 psi: 6

Data Entered: 2/25/16 By: BDF
File Name: 2203_82_rvalue-ASTMD2844-R5_0.xls

Data Checked By: KR
Date: 3/4/16

ADVANCED TERRA TESTING

R-Value
ASTM D 2844

Client:	Kumar & Associates	Boring No.:	P16-P46
Job No.:	2203-82	Depth:	0-3'
Project:	Bennett Pavements	Sample No.:	6021
Location:	--		
Project No.:	16-3-104	Date Tested:	2/24/2016 By: BDF

Moisture Information

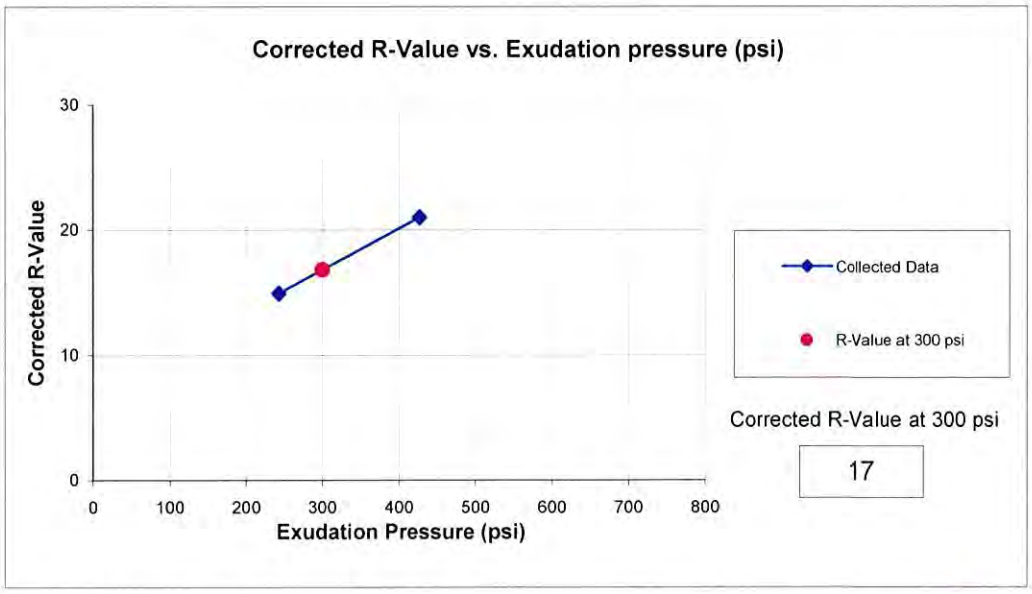
Sample:	1	2
Weight of Wet Soil & Dish (g):	1124.39	1103.62
Weight of Dry Soil & Dish (g):	977.76	943.65
Weight of Water Lost (g):	146.63	159.97
Weight of Dish (g):	15.61	15.71
Weight of Dry Soil (g):	962.15	927.94
Moisture Content:	15.24%	17.24%

Density Information

Weight of Soil & Mold (g):	3218.8	3197.5
Weight of Mold (g):	2102.4	2100.8
Weight of Wet Soil (g):	1116.4	1096.7
Sample Height (in):	2.54	2.54
Wet Density (pcf):	133.2	130.9
Dry Density (pcf):	115.6	111.6

R-Value Information

Exudation Pressure (lbs):	5368	3054
Exudation Pressure (psi):	427	243.0
2000 lbs. Dial Reading (psi):	120	131
Displacement Turns:	3.14	3.16
Uncorrected R-Value:	21	15
Corrected R-Value:	21	15



Corrected R-Value at 300 psi

17

Data Entered: 3/4/16 By: BDF

File Name: 2203_82_rvalue-ASTMD2844-R5_1.xls

Data Checked By: KR

Date: 3/4/16

ADVANCED TERRA TESTING

R-Value
ASTM D 2844

Client: Kumar and Associates
Job No.: 2203-82
Project: Bennett Pavements
Location: --
Project No.: 16-3-104

Boring No.: P6-P59
Depth: 0-3'
Sample No.: 6022

Date Tested: 2/25/2016 By: BDF

Moisture Information

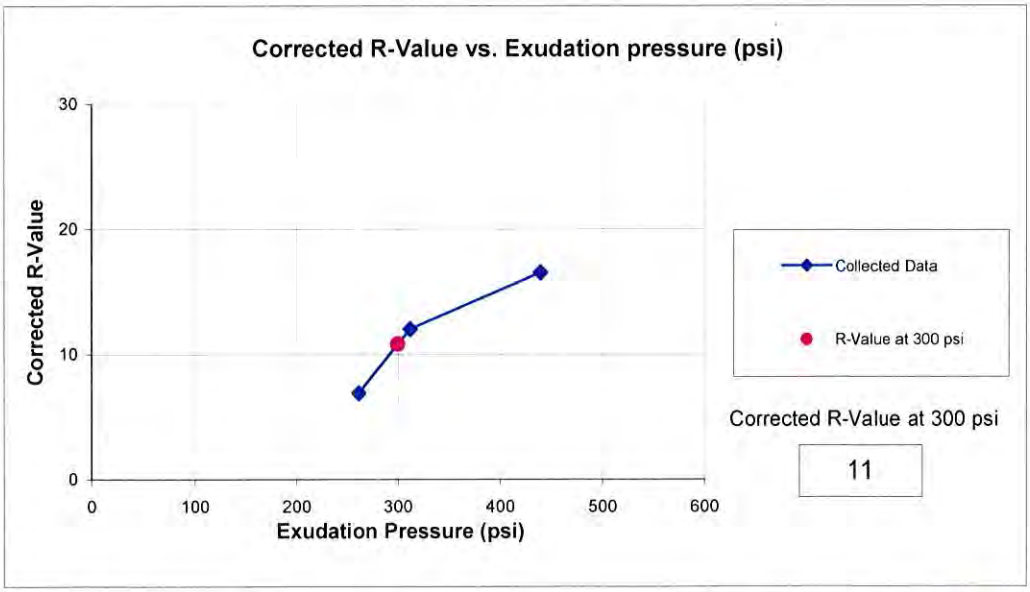
Sample:	1	2	3
Weight of Wet Soil & Dish (g):	1133.54	1087.12	1015.31
Weight of Dry Soil & Dish (g):	939.08	921.40	829.24
Weight of Water Lost (g):	194.46	165.72	186.07
Weight of Dish (g):	15.56	15.63	15.55
Weight of Dry Soil (g):	923.52	905.77	813.69
Moisture Content:	21.06%	18.30%	22.87%

Density Information

Weight of Soil & Mold (g):	3249.4	3188.1	3121.5
Weight of Mold (g):	2115.2	2102.3	2100.7
Weight of Wet Soil (g):	1134.2	1085.8	1020.8
Sample Height (in):	2.70	2.52	2.50
Wet Density (pcf):	127.3	130.6	123.8
Dry Density (pcf):	105.2	110.4	100.7

R-Value Information

Exudation Pressure (lbs):	3919	5520	3283
Exudation Pressure (psi):	312	439.3	261.3
2000 lbs. Dial Reading (psi):	135	125	144
Displacement Turns:	3.58	3.54	3.77
Uncorrected R-Value:	11	17	7
Corrected R-Value:	12	17	7



Data Entered: 3/4/16 By: NN
File Name: 2203_82_rvalue-ASTMD2844-R5_2.xls

Data Checked By: VR
Date: 3/4/16

ADVANCED TERRA TESTING

R-Value
ASTM D 2844

Client: Kumar and Associates
Job No.: 2203-82
Project: Bennett Pavements
Location: --
Project No.: 16-3-104

Boring No.: P31-P35
Depth: 1-3'
Sample No.: 6020
Date Tested: 2/22/2016 By: BDF

Moisture Information

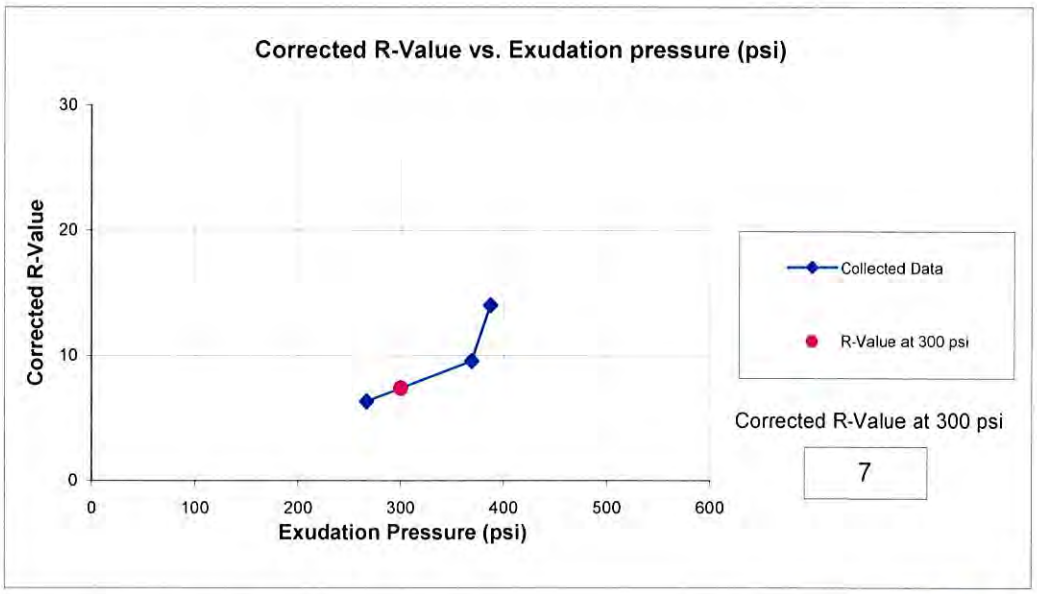
Sample:	1	2	3
Weight of Wet Soil & Dish (g):	1106.64	1041.13	1046.98
Weight of Dry Soil & Dish (g):	941.24	859.44	876.79
Weight of Water Lost (g):	165.40	181.69	170.19
Weight of Dish (g):	15.54	15.54	14.07
Weight of Dry Soil (g):	925.70	843.90	862.72
Moisture Content:	17.87%	21.53%	19.73%

Density Information

Weight of Soil & Mold (g):	3217.1	3155.8	3155.1
Weight of Mold (g):	2115.1	2102.3	2100.7
Weight of Wet Soil (g):	1102.0	1053.5	1054.4
Sample Height (in):	2.57	2.52	2.49
Wet Density (pcf):	130.0	126.7	128.4
Dry Density (pcf):	110.3	104.3	107.2

R-Value Information

Exudation Pressure (lbs):	4865	3352	4635
Exudation Pressure (psi):	387	266.7	368.8
2000 lbs. Dial Reading (psi):	134	143	138
Displacement Turns:	3.17	4.42	3.78
Uncorrected R-Value:	13	6	10
Corrected R-Value:	14	6	10



Corrected R-Value at 300 psi: 7

Data Entered: 3/4/16 By: NN
File Name: 2203_82_rvalue-ASTMD2844-R5_3.xls

Data Checked By: KR
Date: 3/4/16

ADVANCED TERRA TESTING

TOWN of BENNETT

CONSTRUCTION PLANS

STREET IMPROVEMENT PROJECT

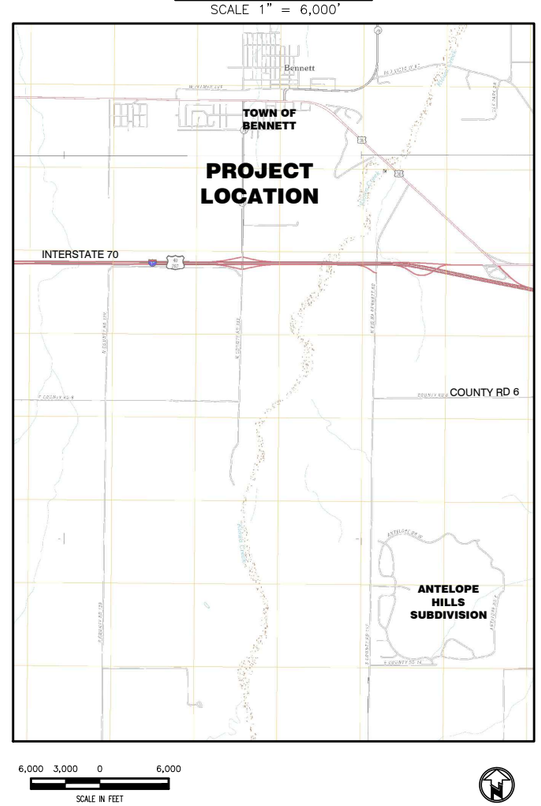
BENNETT, COLORADO

MARCH 2016

PROPERTY OWNER: Town of Bennett
355 4th St.
Bennett, CO 80102

CIVIL ENGINEER: Terramax, Inc.
4220 Golf Vista Drive
Loveland, Colorado 80537
(303) 929-3194

VICINITY MAP
SCALE 1" = 6,000'



SHEET INDEX

C1. Cover Sheet
C2. General Notes and Specifications
C3. "Core Town" Area
C4. Centennial Addition
C5. Brothers Four
C6 Cordella Subdivision
C7 Antelope Hills Subdivision
C8 Kiowa-Bennett Road
C9 Details
C10 Details

APRIL 18, 2016 - ADDENDUM 3 UPDATE

ISSUED FOR BID
MARCH 22, 2016

UNCC
UTILITY NOTIFICATION CENTER OF COLORADO
3 Days Before You Dig:
Call: 1-800-922-1987
Click: www.UNCC.org

TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 Golf Vista Drive
Loveland, Colorado 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
PROJECT SCOPE - PAVEMENT EXTENTS
"CORE TOWN" AREA

Project No.	725
Date	04/15/16
By	LD
Scale	1" = 600'
Sheet	1

Plot Date: 04/19/16-1:59pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Cover Sheet.dwg

GENERAL NOTES:

1. SPECIFICATIONS. THE PROJECT SPECIFICATIONS SHALL BE THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" LATEST EDITION, LATEST REVISIONS, LATEST SPECIAL PROVISIONS, AND INCLUDING DIVISION 100, GENERAL PROVISIONS. THE STANDARD SPECIFICATIONS ARE AVAILABLE DIRECTLY FROM CDOT.

2. QUALITY ASSURANCE (QA) / QUALITY CONTROL (QC): FOR QA-QC PER THE SPECIFICATIONS, THE SELECTED CONTRACTOR IS REQUIRED TO PROVIDE QUALITY CONTROL FOR THE PROJECT, AND THE LOCAL AGENCY (TOWN OF BENNETT, PROJECT OWNER) IS REQUIRED TO PROVIDE QUALITY ASSURANCE.

3. RIGHT-OF-WAY LIMITS. PROJECT PROPERTY AND ROAD RIGHTS-OF-WAY AS SHOWN ON THESE PLANS ARE UNDER THE OWNERSHIP AND CONTROL OF THE TOWN OF BENNETT. EXISTING FENCE IS NOT TO BE DISTURBED BY THIS PROJECT WORK. ANY DISTURBANCE OR DAMAGE TO EXISTING FENCING ADJACENT TO THE PROJECT BY THE CONTRACTOR SHALL BE REPAIRED OR REPLACED BY THE CONTRACTOR IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS AT HIS SOLE EXPENSE. PROJECT WORK AND ACTIVITIES ARE NOT ALLOWED OUTSIDE KNOWN TOWN OF BENNETT PROPERTY OR RIGHT-OF-WAY CONTROLLED AREAS, AS SHOWN ON THESE PLANS.

4. CONSTRUCTION EASEMENT. THE TOWN OF BENNETT HAS NOT OBTAINED ADDITIONAL CONSTRUCTION EASEMENT FOR THIS PROJECT WORK, TEMPORARY OR PERMANENT. THE CONTRACTOR SHALL CONFINE ALL PROJECT WORK AND RELATED ACTIVITIES TO THE TOWN OF BENNETT PROPERTY AND RIGHT-OF-WAY UNLESS THE CONTRACTOR MAKES HIS OWN ARRANGEMENTS DIRECTLY WITH AFFECTED ADJACENT PROPERTY OWNERS. IN SUCH CASE, THE CONTRACTOR SHALL PROVIDE THE TOWN OF BENNETT WRITTEN, SIGNED COPIES OF ANY AGREED CONSTRUCTION AGREEMENT ARRANGEMENT.

5. CONTROL OF WORK AREA. THE PROJECT WORK AREA SHALL BE UNDER THE CONTRACTOR'S CONTROL FOR THE DURATION OF THE PROJECT THROUGH SUBSTANTIAL COMPLETION. DURING THAT TIME, THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL ACTIVITIES AND WORK WITHIN THIS AREA, INCLUDING CONSTRUCTION MEANS AND METHODS, ACCESS, SAFETY, SECURITY, SOIL DISTURBANCE, PROTECTION OF UTILITIES AND IMPROVEMENTS. THE CONTRACTOR IS RESPONSIBLE FOR PROJECT WORK AREA COMPLIANCE WITH ALL FEDERAL AND STATE LAWS, CODES, PERMITS AND REQUIREMENTS. THE CONTRACTOR SHALL GRANT ACCESS FOR REVIEW, OBSERVATION AND INSPECTION OF THE SITE AND WORK TO THE TOWN OF BENNETT AS WELL AS OTHER AGENCIES HAVING RIGHTFUL JURISDICTION.

6. INDEMNIFICATION. THE CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; THAT THESE REQUIREMENTS SHALL APPLY CONTINUOUSLY AND SHALL NOT BE LIMITED TO WORKING HOURS; AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE TOWN OF BENNETT AND TERRAMAX, INC. THE PROJECT ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPT FOR LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE TOWN OF BENNETT OR THE PROJECT ENGINEER.

7. APPROVED PLANS. CONTRACTOR SHALL WORK FROM AN APPROVED CONSTRUCTION PLAN SET, ISSUED "FOR CONSTRUCTION", SEALED, SIGNED, AND DATED BY THE PROJECT ENGINEER OF RECORD, DANIEL P. GIROUX, P.E. CONTRACTOR SHALL MAINTAIN AT LEAST ONE SET OF THE SIGNED, APPROVED PLANS ON-SITE AT ALL TIMES THROUGHOUT THE PROJECT EXECUTION.

8. NOTIFICATIONS. THE CONTRACTOR SHALL NOTIFY THE TOWN OF BENNETT, A MINIMUM OF THREE FULL BUSINESS DAYS PRIOR TO THE COMMENCEMENT OF PROJECT WORK ON SITE, AND A MINIMUM OF TWO FULL BUSINESS DAYS PRIOR TO REQUIRED TESTING OR INSPECTIONS. THE CONTRACTOR SHALL PROVIDE THE TOWN OF BENNETT A MINIMUM OF THREE BUSINESS DAYS' NOTICE FOR ANY UTILITY OUTAGES.

9. TESTING AND INSPECTIONS. INSPECTIONS BY THE TOWN OF BENNETT WILL BE REQUIRED AT MINIMUM FOR CULVERT EXTENSIONS, CULVERT BACKFILL, RIPRAP, BASE PROOF-ROLL, ASPHALT PILE DRIVING, CONCRETE FORMS, REBAR AS APPLICABLE, AND CONCRETE POURS. TESTING WILL BE IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.

10. DEBRIS AND WASTE MATERIALS. ALL DEBRIS AND WASTE MATERIALS CREATED BY THE PROJECT WORK SHALL BE THE PROPERTY AND RESPONSIBILITY OF THE CONTRACTOR, TO BE REMOVED FROM THE PROJECT SITE AND APPROPRIATELY AND LEGALLY DISPOSED OF, AT THE CONTRACTOR'S SOLE EXPENSE.

11. PROJECT SITE APPEARANCE AND CONDITION. GENERAL CLEANUP OF THE PROJECT AREA SHALL BE MAINTAINED THROUGHOUT THE DURATION OF THE PROJECT. WHEN STREET-CLEANING IS REQUIRED, THE ENTIRE WIDTH OF THE ROAD SHALL BE CLEANED.

12. PROJECT SITE RESTORATION. ALL PAVEMENTS, UTILITIES, FENCING, LANDSCAPING AND OTHER STRUCTURES OR SURFACES AFFECTED BY THE PROJECT CONSTRUCTION SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN BEFORE COMMENCEMENT OF THE WORK, TO THE SATISFACTION OF THE TOWN OF BENNETT.

13. UTILITY LOCATES. THESE DRAWINGS DO NOT PURPORT TO PROVIDE A RECORD OF ALL EXISTING UTILITY LOCATIONS ON THE PROJECT SITE. THE CONTRACTOR SHALL FIELD-VERIFY ALL UTILITY LOCATIONS IN THE FIELD, INCLUDING THROUGH TIMELY NOTIFICATION TO THE UTILITY NOTIFICATION CENTER OF COLORADO (UNCC OR "ONE-CALL"), AMONGST OTHER MEASURES, BEFORE COMMENCING PROJECT WORK.

TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
GENERAL NOTES AND SPECIFICATIONS

Project No.	725
Date	04/15/16
By	LD
Scale	n/a
Sheet	2

Plot Date: 04/19/16-2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road General Notes.dwg

EXPLANATION

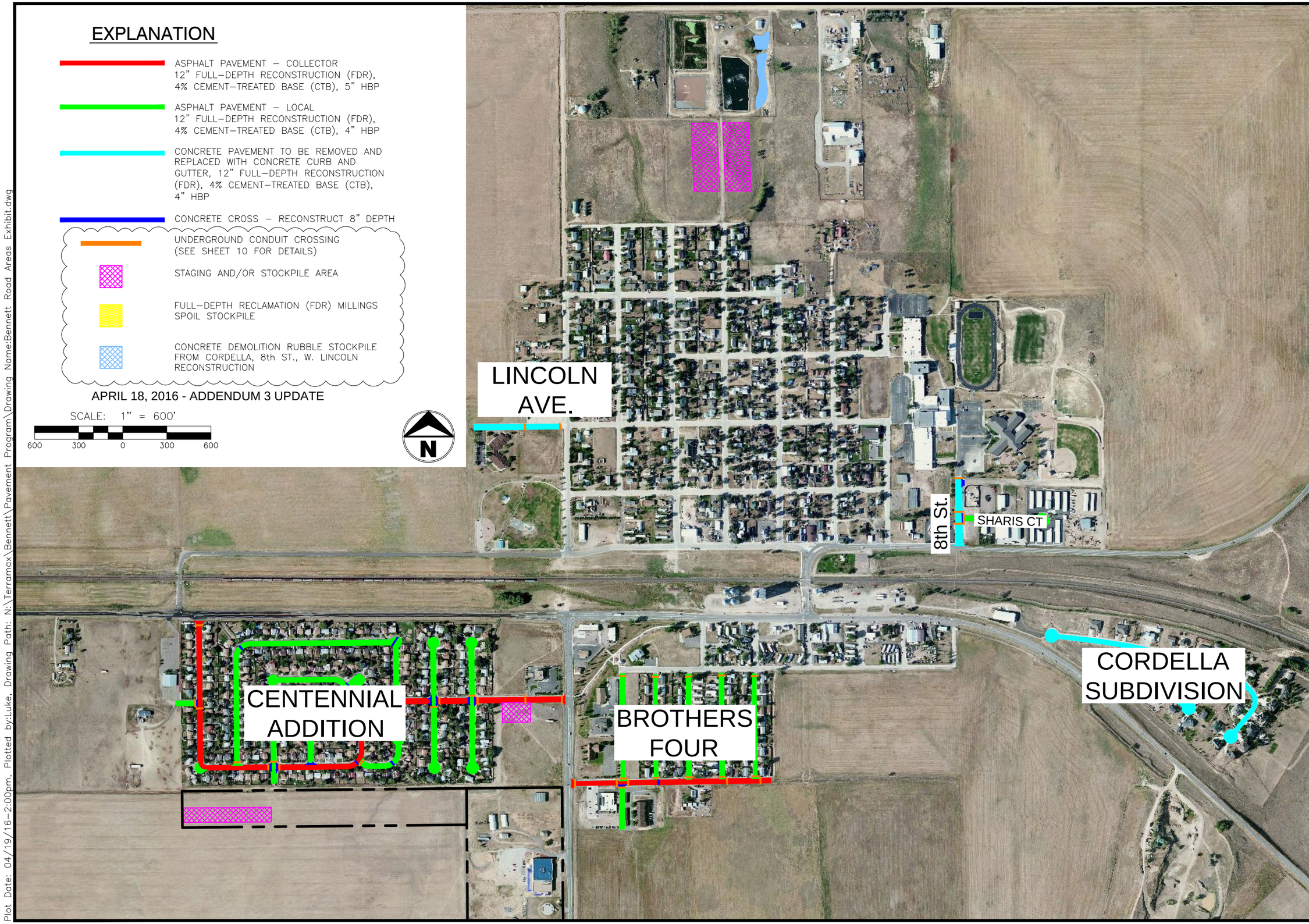
- ASPHALT PAVEMENT – COLLECTOR
  12" FULL–DEPTH RECONSTRUCTION (FDR),
  4% CEMENT–TREATED BASE (CTB), 5" HBP
- ASPHALT PAVEMENT – LOCAL
  12" FULL–DEPTH RECONSTRUCTION (FDR),
  4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE PAVEMENT TO BE REMOVED AND REPLACED WITH CONCRETE CURB AND GUTTER, 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE CROSS – RECONSTRUCT 8" DEPTH
- UNDERGROUND CONDUIT CROSSING (SEE SHEET 10 FOR DETAILS)
- STAGING AND/OR STOCKPILE AREA
- FULL–DEPTH RECLAMATION (FDR) MILLINGS SPOIL STOCKPILE
- CONCRETE DEMOLITION RUBBLE STOCKPILE FROM CORDELLA, 8th ST., W. LINCOLN RECONSTRUCTION

APRIL 18, 2016 - ADDENDUM 3 UPDATE

SCALE: 1" = 600'

600 300 0 300 600

N



TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
PROJECT SCOPE - PAVEMENT EXTENTS
"CORE TOWN" AREA

Project No.	725
Date	04/15/16
By	LD
Scale	1" = 600'
Sheet	3

Plot Date: 04/19/16–2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Areas Exhibit.dwg

EXPLANATION

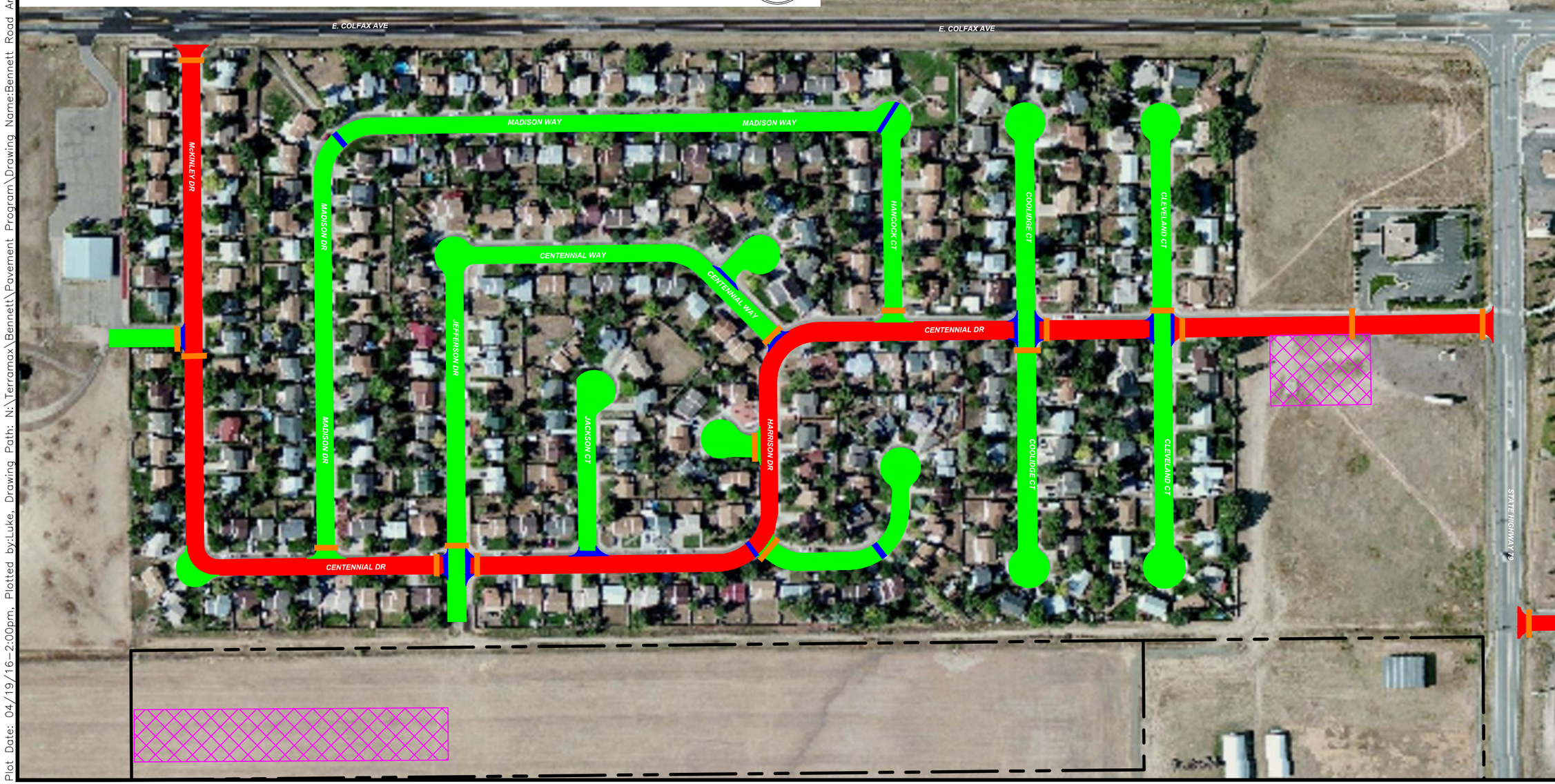
- ASPHALT PAVEMENT – COLLECTOR 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 5" HBP
- ASPHALT PAVEMENT – LOCAL 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE PAVEMENT TO BE REMOVED AND REPLACED WITH CONCRETE CURB AND GUTTER, 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE CROSS – RECONSTRUCT 8" DEPTH
- UNDERGROUND CONDUIT CROSSING (SEE SHEET 10 FOR DETAILS)
- FULL–DEPTH RECLAMATION (FDR) MILLINGS SPOIL STOCKPILE, MAX. HEIGHT 20 FEET
- FULL–DEPTH RECLAMATION (FDR) MILLINGS SPOIL – PLACE TO 6–INCH DEPTH FOR "GRAVEL" PARKING LOT OR ROAD USAGE
- CONCRETE DEMOLITION RUBBLE STOCKPILE FROM CORDELLA, 8th ST., W. LINCOLN RECONSTRUCTION

APRIL 18, 2016 - ADDENDUM 3 UPDATE

SCALE: 1" = 200'

200 100 0 100 200

N



TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
PROJECT SCOPE - PAVEMENT EXTENTS
CENTENNIAL ADDITION

Project No.	725
Date	04/15/16
By	LD
Scale	1" = 200'
Sheet	4

Plot Date: 04/19/16–2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Areas Exhibit.dwg

EXPLANATION

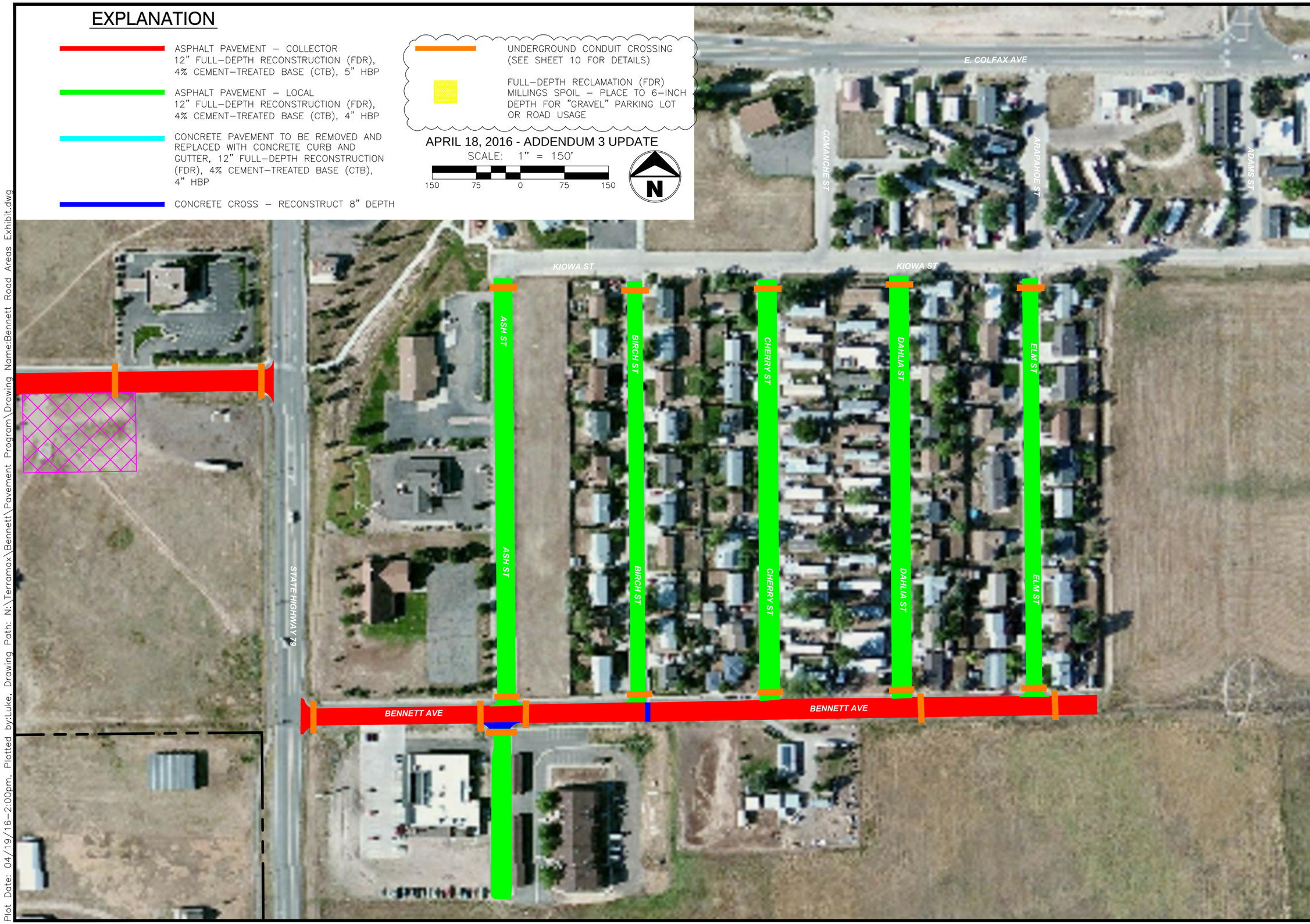
- ASPHALT PAVEMENT – COLLECTOR 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 5" HBP
- ASPHALT PAVEMENT – LOCAL 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE PAVEMENT TO BE REMOVED AND REPLACED WITH CONCRETE CURB AND GUTTER, 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE CROSS – RECONSTRUCT 8" DEPTH
- UNDERGROUND CONDUIT CROSSING (SEE SHEET 10 FOR DETAILS)
- FULL–DEPTH RECLAMATION (FDR) MILLINGS SPOIL – PLACE TO 6–INCH DEPTH FOR "GRAVEL" PARKING LOT OR ROAD USAGE

APRIL 18, 2016 - ADDENDUM 3 UPDATE

SCALE: 1" = 150'

150 75 0 75 150

N



TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
PROJECT SCOPE - PAVEMENT EXTENTS
BROTHERS FOUR

Project No.	725
Date	04/15/16
By	LD
Scale	1" = 150'
Sheet	5

Plot Date: 04/19/16–2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Areas Exhibit.dwg

EXPLANATION

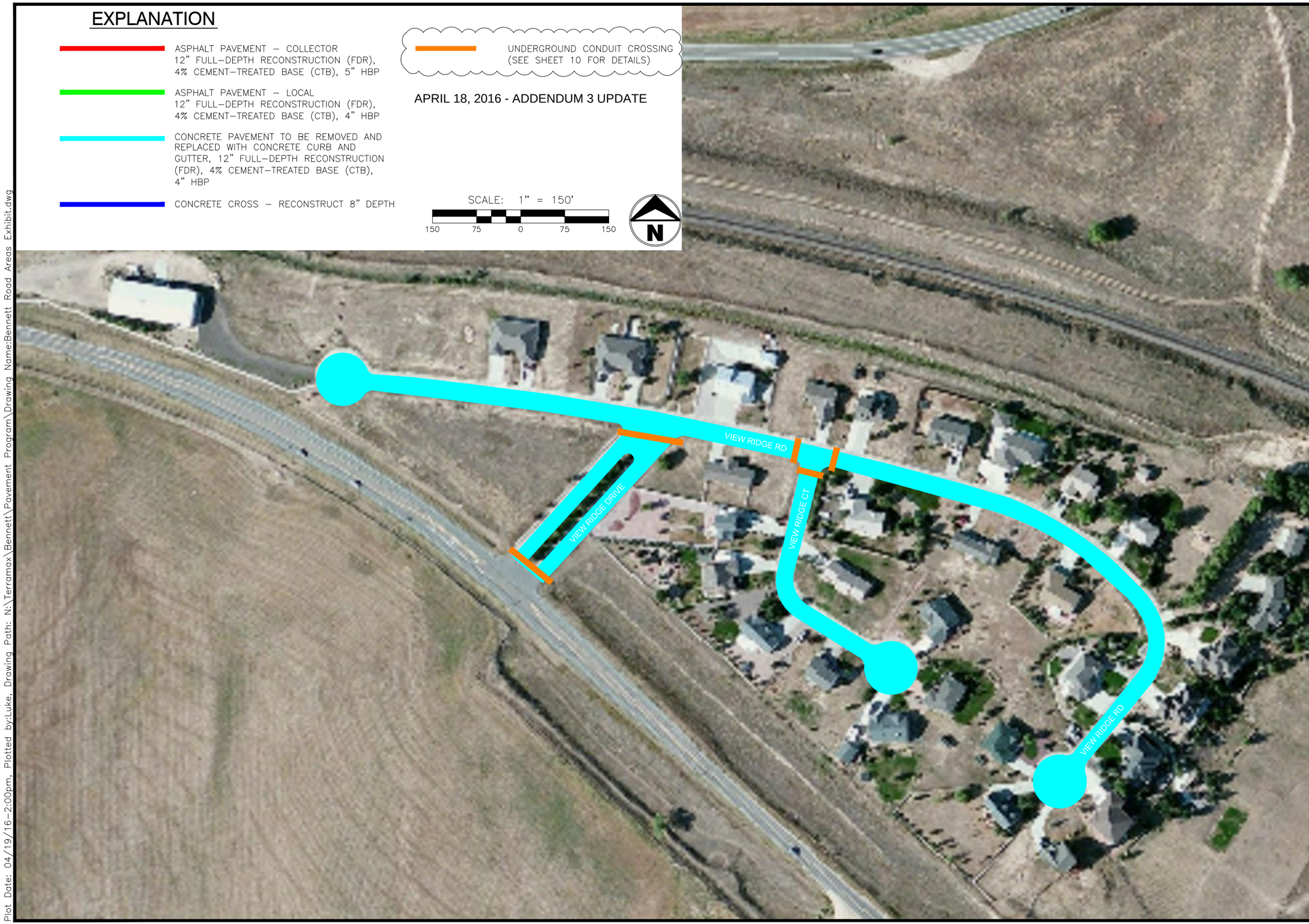
- ASPHALT PAVEMENT – COLLECTOR 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 5" HBP
- ASPHALT PAVEMENT – LOCAL 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE PAVEMENT TO BE REMOVED AND REPLACED WITH CONCRETE CURB AND GUTTER, 12" FULL–DEPTH RECONSTRUCTION (FDR), 4% CEMENT–TREATED BASE (CTB), 4" HBP
- CONCRETE CROSS – RECONSTRUCT 8" DEPTH
- UNDERGROUND CONDUIT CROSSING (SEE SHEET 10 FOR DETAILS)

APRIL 18, 2016 - ADDENDUM 3 UPDATE

SCALE: 1" = 150'

150 75 0 75 150

N

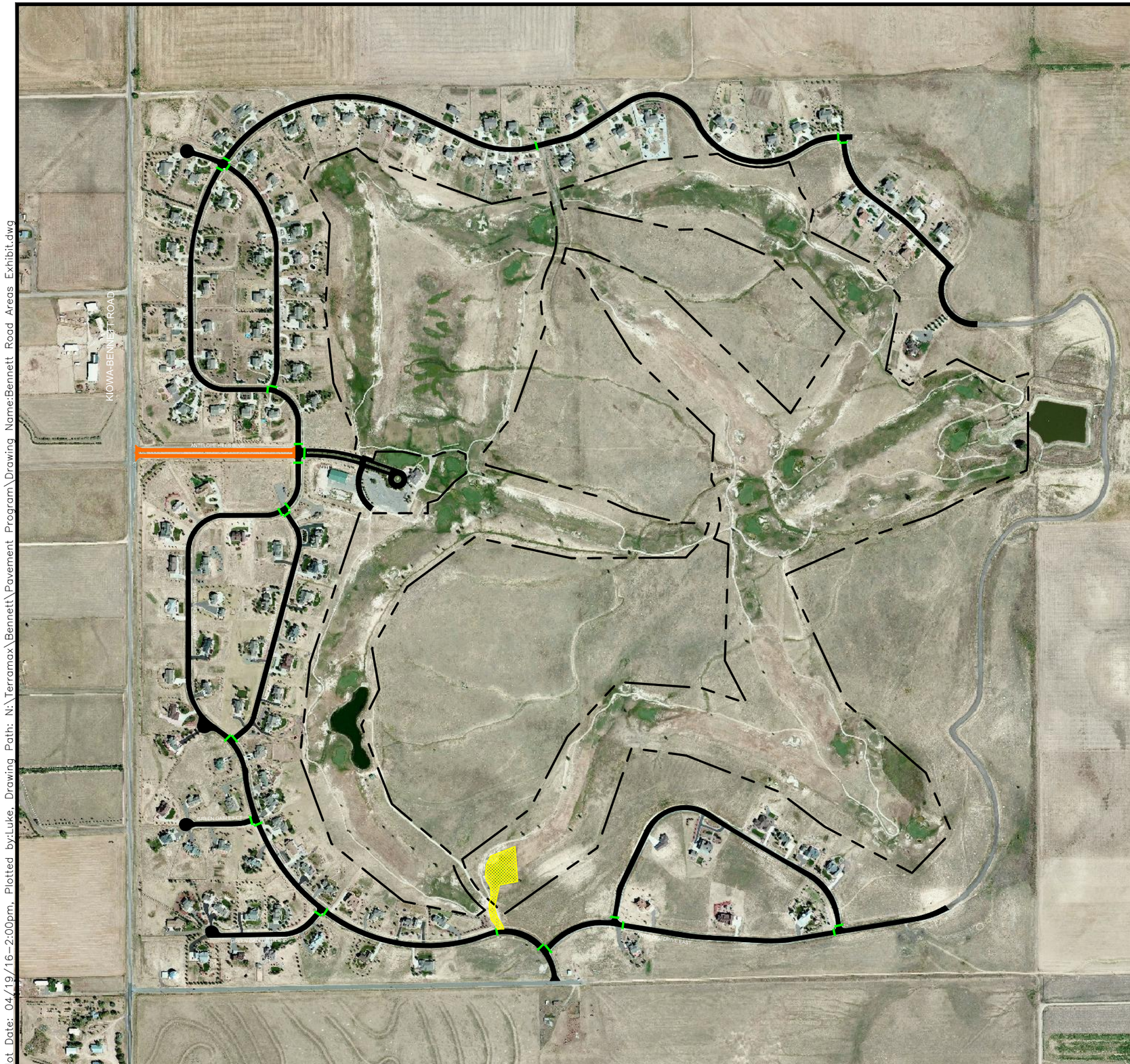


TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
PROJECT SCOPE - PAVEMENT EXTENTS
CORDELLA SUBDIVISION

Project No.	725
Date	04/15/16
By	LD
Scale	1" = 150'
Sheet	6

Plot Date: 04/19/16–2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Areas Exhibit.dwg



EXPLANATION

ASPHALT PAVEMENT – COLLECTOR
14" FULL–DEPTH RECONSTRUCTION (FDR),
5" HBP

ASPHALT PAVEMENT – LOCAL
14" FULL–DEPTH RECONSTRUCTION (FDR),
4" HBP

UNDERGROUND CONDUIT CROSSING
(SEE SHEET 10 FOR DETAILS)

FULL–DEPTH RECLAMATION (FDR) MILLINGS
SPOIL STOCKPILE, MAX. HEIGHT 20 FEET

FULL–DEPTH RECLAMATION (FDR) MILLINGS
SPOIL – PLACE TO 6–INCH DEPTH FOR
"GRAVEL" PARKING LOT OR ROAD USAGE

CONCRETE DEMOLITION RUBBLE STOCKPILE
FROM CORDELLA, 8th ST., W. LINCOLN
RECONSTRUCTION

APRIL 18, 2016 - ADDENDUM 3 UPDATE

SCALE: 1" = 600'

600 300 0 300 600

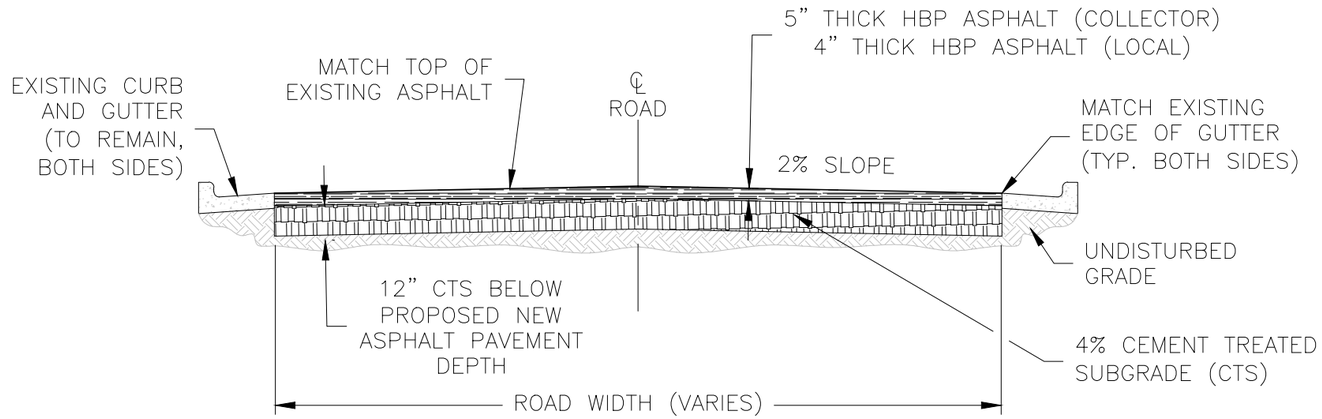
N

TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
PROJECT SCOPE - PAVEMENT EXTENTS
ANTELOPE HILLS SUBDIVISION

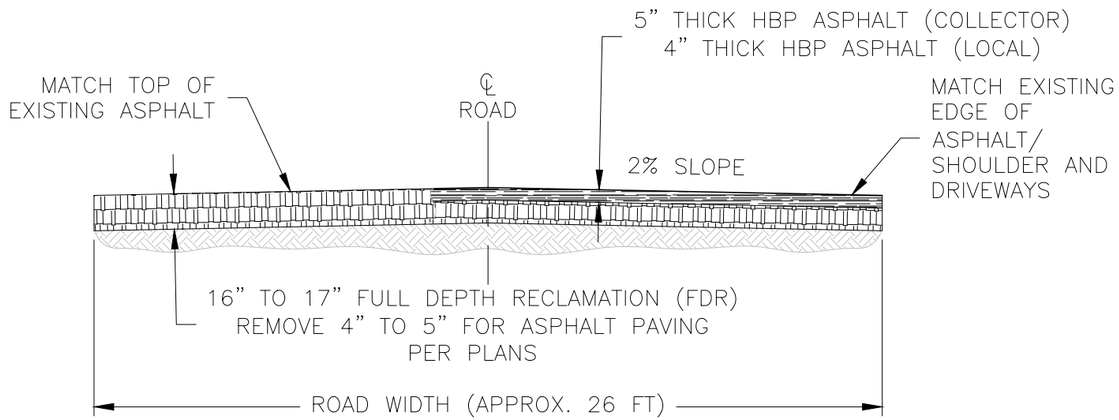
Project No.	725
Date	04/15/16
By	LD
Scale	1" = 600'
Sheet	7

Plot Date: 04/19/16–2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Areas Exhibit.dwg



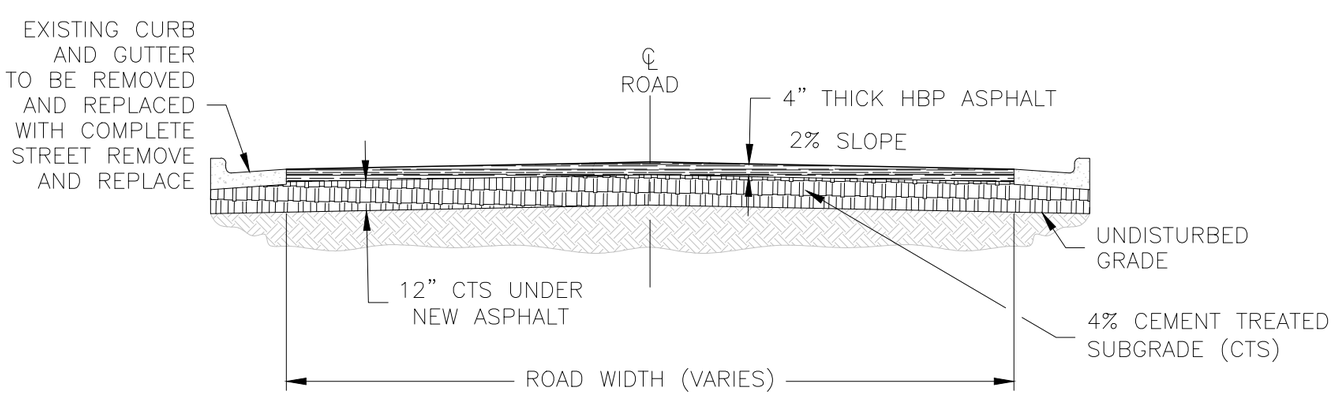
CENTENNIAL AND FOUR BROTHERS ROAD CROSS-SECTION

SCALE 1" = 5'



ANTELOPE HILLS TYPICAL ROAD CROSS-SECTION

SCALE 1" = 5'



CORDELLA, 8th, AND WEST LINCOLN TYPICAL ROAD CROSS-SECTION

SCALE 1" = 5'

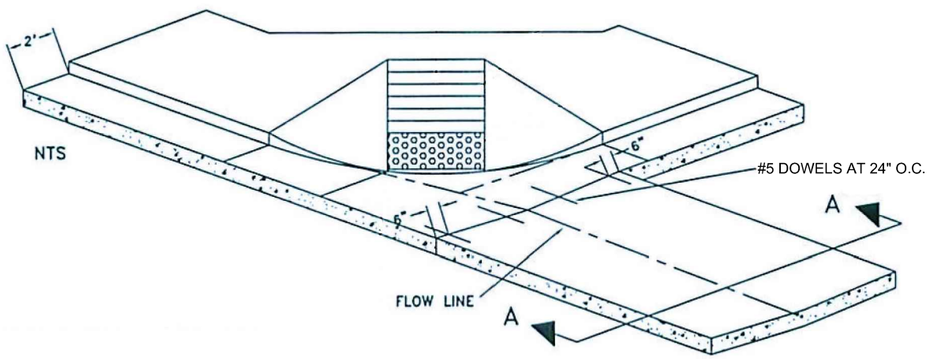
APRIL 18, 2016 - ADDENDUM 3 UPDATE

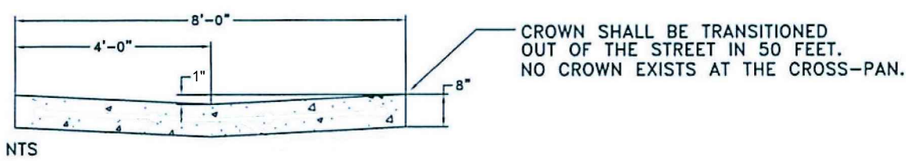
TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
DETAILS

Project No.	725
Date	04/15/16
By	LD
Scale	As Noted
Sheet	8

Plot Date: 04/19/16-2:48pm, Plotted by:Luke, Drawing Path: N:\Swap\AcPublish_10868\Drawing Name:Bennett Road Details.dwg



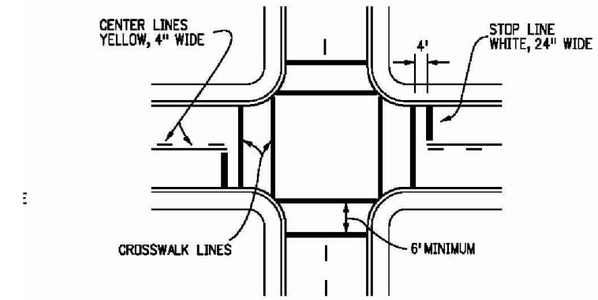


SECTION A–A

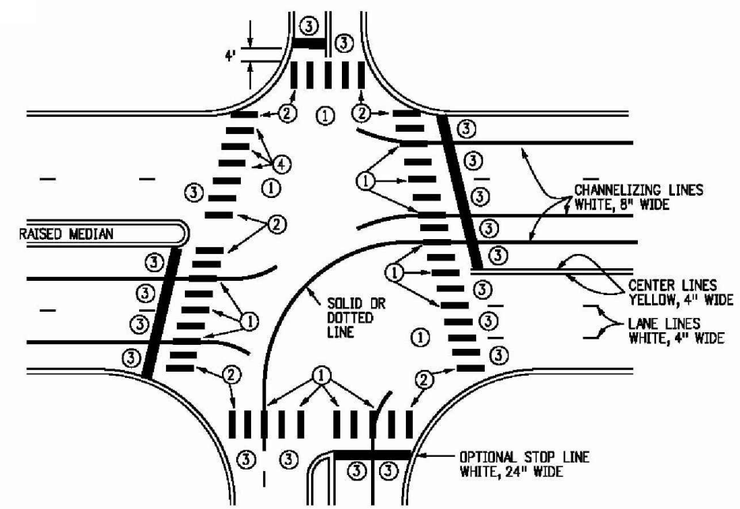
NOTE:
THIS PARTICULAR DETAIL IS GENERALIZED. ANY PARTICULAR INSTALLATION MAY INCLUDE ALL OR PART OF THE DETAIL ELEMENTS AS PART OF THE CONSTRUCTION. ANY GIVEN INSTALLATION MAY INCLUDE REQUIREMENTS OF OTHER DETAILS. EXISTING CONDITIONS AND AND CONFIGURATIONS OF LOCATION WILL AFFECT ACTUAL CONSTRUCTION OF RAMPS.

CONCRETE CROSS-PAN DETAIL

NOT TO SCALE

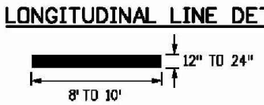


TYPICAL TRANSVERSE LINE CROSSWALK MARKINGS



TYPICAL CONTINENTAL CROSSWALK MARKINGS

LONGITUDINAL LINE DETAIL



CROSSWALK NOTES

CENTER CROSSWALKS ON CURB RAMPS. IF SUCH RAMPS ARE NOT PROVIDED CENTER ON SIGNAL POLES WHEREVER PRACTICAL.

1. CENTER ON LANE, CENTER OR CHANNELIZING LINE.
2. CENTER OR EXTENDED FLOW LINE.
3. CENTER BETWEEN ADJACENT LINES.
4. LINES AND SPACES TO APPROXIMATE ADJACENT PATTERN.

TYPICAL CROSSWALK MARKING

CDOT S-627-1, SHEET 3 OF 5

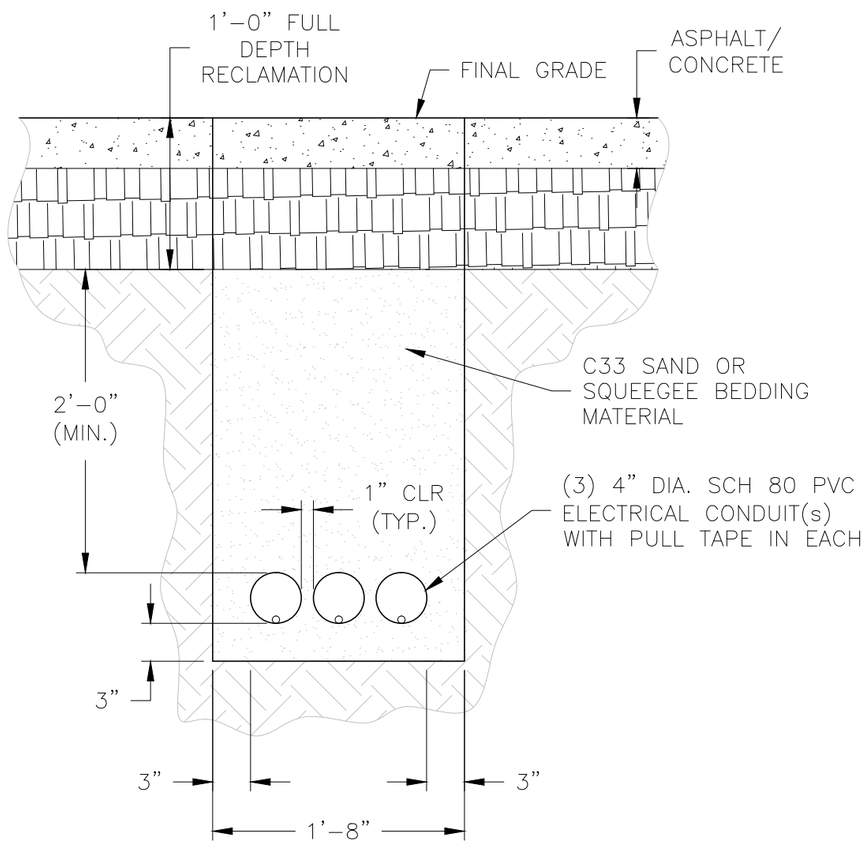
TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
DETAILS

Project No.	725
Date	04/15/16
By	LD
Scale	As Noted
Sheet	9

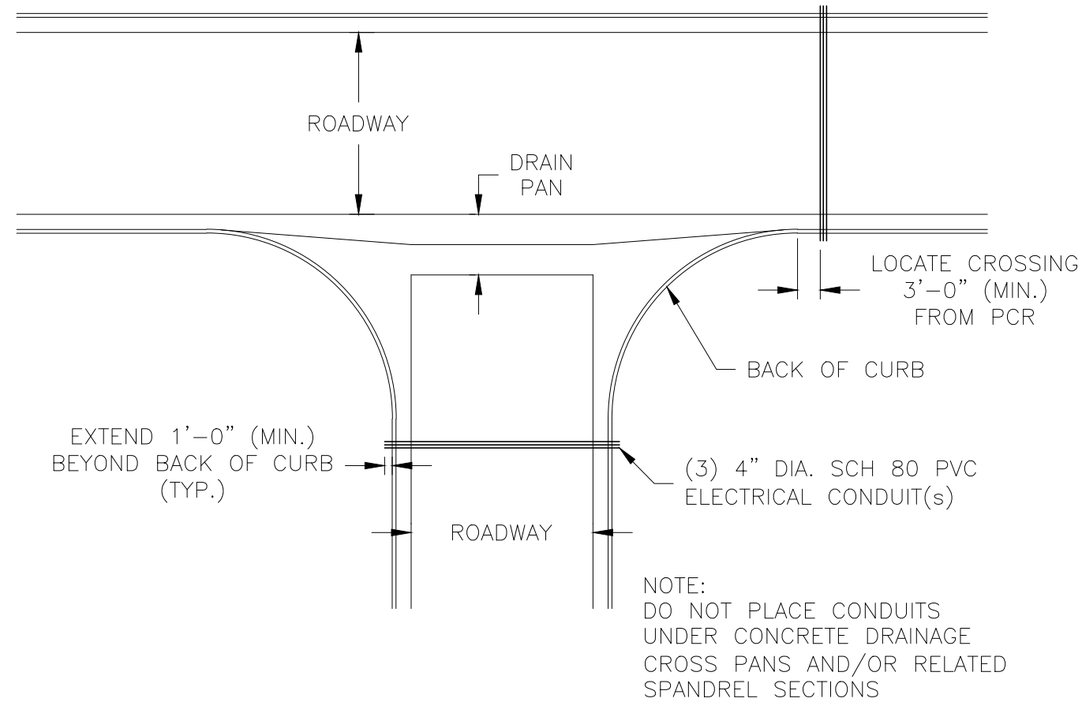
Plot Date: 04/19/16-2:00pm, Plotted by:Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Details.dwg

APRIL 18, 2016 - ADDENDUM 3 UPDATE



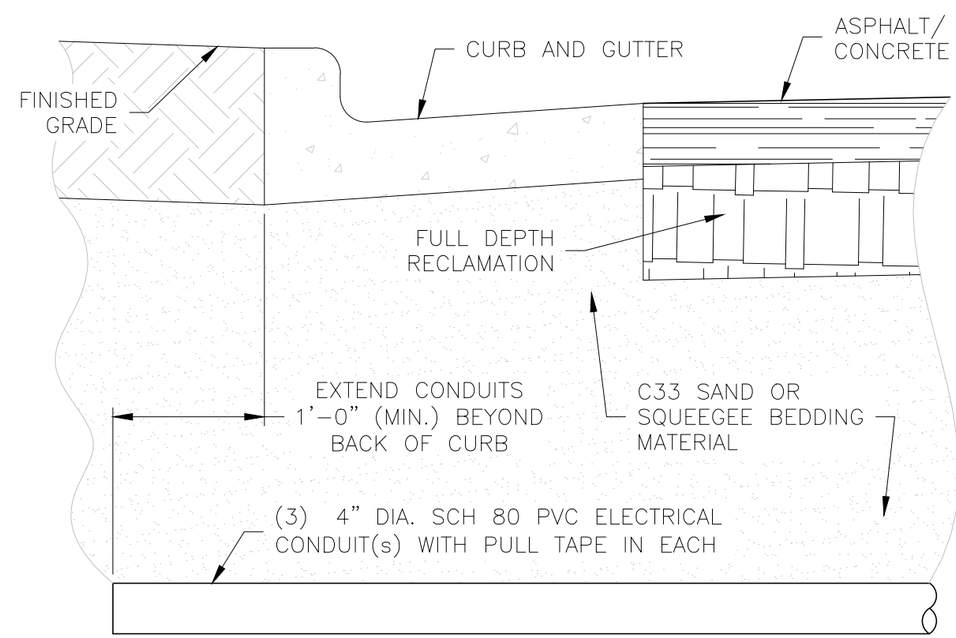
SECTION

SCALE 1" = 1'-0"



PLAN

SCALE 1" = 20'-0"



PROFILE

SCALE 1" = 1'-0"

TERRAMAX, INC.
CONSULTING ◊ ENGINEERING
4220 GOLF VISTA DRIVE
LOVELAND, COLORADO 80537
DANGIROUX@TERRAMAX.US
(303) 929-3194

TOWN of BENNETT
STREET IMPROVEMENT PROJECT
UNDERGROUND CONDUIT CROSSING DETAILS

Project No.	725
Date	04/15/16
By	LD
Scale	As Noted
Sheet	10

Plot Date: 04/19/16 2:00pm, Plotted by Luke, Drawing Path: N:\Terramax\Bennett\Pavement Program\Drawing Name:Bennett Road Details.dwg