

# Empire Laboratories, Inc.

GEOTECHNICAL ENGINEERING & MATERIALS TESTING

September 22, 1989

CORPORATE OFFICE  
P.O. Box 503 • 301 No. Howes  
Fort Collins, Colorado 80522  
(303) 484-0359  
FAX No. (303) 484-0454

Mr. Bill Tiley  
University Realty, Inc.  
2039 South College Avenue  
Fort Collins, Colorado 80525

Re: Bighorn Drive Pavement Design  
Fox Meadows Business Park #2  
Fort Collins, Colorado  
ELI Project No. 7414-88

Dear Mr. Tiley:

We are pleased to submit an addendum to our "Report of a Pavement Design" for a portion of Fox Meadows Business Park, Fort Collins, Colorado. The original report was prepared for the widening of Timberline Road adjacent to the west edge of the Fox Meadows Business Park by Empire Laboratories, Inc. dated March 11, 1988. The purpose of this addendum is to provide subsurface information for the pavement design for the extension of Bighorn Drive from Timberline Road to the existing Bighorn Drive.

The additional field investigation, carried out on September 13, 1989, consisted of drilling one additional boring. The boring was located from existing streets using conventional chaining methods. The location of the test boring is shown on the Test Boring Location Plan included in Appendix A. A boring log prepared from the field log is shown in Appendix A. The log shows soils encountered, location of sampling and ground water at the time of the exploration. The boring was advanced with a four-inch diameter, continuous-type, power-flight auger drill. During the drilling operations, a geotechnical engineer from Empire Laboratories, Inc. was present and made continuous observation of the soils encountered.

Bighorn Drive is located east of Timberline Road approximately 1000 feet south of Horsetooth Road in southeast Fort Collins, Colorado. More particularly, the site is described as a tract of land situate in the Northwest 1/4 of Section 32, Township 7 North, Range 69 West of the Sixth P.M., City of Fort Collins, Larimer County, Colorado. The site consists of pasture land located east of Timberline Road. Existing farm buildings are located to the north and south. A residential area is located to the east. The property is relatively flat and has minor drainage to the southeast. The site is currently vegetated with grass and weeds.



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P.O. Box 1135  
Longmont, CO 80502  
(303) 776-3921

P.O. Box 1744  
Greeley, CO 80632  
(303) 351-0460

P.O. Box 5659  
Cheyenne, WY 82003  
(307) 632-9224

Member of Consulting Engineers Council

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Samples from the test boring were subjected to testing in the laboratory to provide a sound basis for evaluating the physical properties of the soils encountered. Moisture contents and Atterberg limits were determined. The results of these tests are included in Appendix A of this letter.

The soil profile of the additional test boring at the site consists of strata of materials arranged in different combinations. In order of increasing depths, they are as follows:

- (1) Silty Topsoil: The additional area tested is overlain by a six (6) inch layer of silty topsoil. The topsoil has been penetrated by root growth and organic matter and should not be used as a bearing soil or as a fill and/or backfill material.
- (2) Silty Clay: A layer of brown silty clay underlies the topsoil and extends a depth of nine (9) feet below the surface. The silty clay is plastic, contains varying amounts of silt, and is damp to moist in situ. The silty clay stratum exhibits poor subgrade characteristics.
- (3) Sandy Silty Clay: A layer of tan sandy silty clay underlies the upper clays at a depth of nine (9) feet and extends beyond the depths explored. The lower silty clay is plastic, contains varying amounts of sand and is damp to moist.
- (4) Ground Water: At the time of the investigation, no free ground water was encountered at the site to the depths explored. Water levels in this area are subject to change due to seasonal variations and irrigation demands on and/or adjacent to the site.

It is our understanding that Bighorn Drive is to be extended to the west to Timberline Road. The street has been classified as an industrial commercial street by the City of Fort Collins. It is recommended that all site grading and utilities be constructed in accordance with the recommendations set forth in our original report prepared for the site.

It is our opinion that flexible pavement is suitable for the proposed street construction at the site. A flexible pavement alternate should consist of asphalt concrete underlain by crushed aggregate base course or asphalt concrete underlain by plant mix bituminous base course. The design criteria described below was utilized in determining the pavement thicknesses at the site.

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City of Fort Collins "Design Criteria and Standards for Streets"  
dated July 1986  
"R" value - 8  
Regional Factor - 1.0  
Serviceability Index - 2.5  
20-Year Design Life  
18 kip Equivalent Daily Load Application - 15 as provided by the  
City of Fort Collins  
Weighted Structural Number - 2.80

Asphalt Concrete	4"
Crushed Aggregate Base Course	<u>9"</u>
Total Pavement Thickness	13"
Asphalt Concrete	2"
Plant Mix Bituminous Base Course	<u>5½"</u>
Total Pavement Thickness	7½"

The crushed aggregate base course should meet City of Fort Collins Class 5 or 6 specifications. The subgrade below the proposed asphalt pavement should be prepared in accordance with the recommendations discussed in our original report. Upon proper preparation of the subgrade, the subbase and base course should be placed and compacted at optimum moisture to at least ninety-five percent (95%) of Standard Proctor Density ASTM D 698-78.

It is recommended that the asphalt concrete and/or plant mix bituminous base course be placed in two (2) to three (3) inch lifts. All plant mix bituminous base course and asphalt concrete shall meet City of Fort Collins specifications and should be placed in accordance with these specifications. All subbase material shall have an "R" value between 50 and 69, the crushed aggregate base course shall have an "R" value between 70 and 77, the plant mix bituminous base course shall have an Rt value of 90 or greater, and the asphalt concrete shall have an Rt value of 95 or greater. The "R" value of the pavement materials used should be verified by laboratory tests. Field density tests should be taken in the aggregate base course, bituminous base course, and asphalt concrete under the direction of the geotechnical engineer.

A feasible pavement alternate at the site would be rigid pavement. Using the eighteen (18) kip equivalent daily load application described above, a modulus of subgrade reaction of one hundred (100) pounds per square

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inch per inch based on an "R" value of 8, a design life of twenty (20) years, and concrete designed with a modulus of rupture of six hundred (600) pounds per square inch, five (5) inches of nonreinforce concrete is recommended.

Subgrade below the proposed street should be prepared in accordance with the recommendations discussed in our original report. Concrete pavement should be placed directly on the subgrade that has been uniformly and properly prepared in accordance with the above recommendations. All concrete used in the paving shall meet ASTM specifications, and all aggregate shall conform to ASTM C-33 specifications. The concrete should be designed with a minimum modulus of rupture of six hundred (600) pounds per square inch in twenty-eight (28) days. It is recommended that laboratory mix designs be done to determine the proper proportions of aggregates, cement, and water necessary to meet these requirements. It is essential that the concrete have a low water-cement ratio, an adequate cement factor, and sufficient quantities of entrained air. Joints should be carefully designed and constructed in accordance with the City of Fort Collins "Design Criteria and Standards for Streets" to ensure good performance of the pavement. It is recommended that all concrete pavement be placed in accordance with City of Fort Collins specifications. If paving is done during cold weather, acceptable cold weather procedures as outlined in the City specifications should be utilized. The concrete pavement should be properly cured and protected in accordance with the above specifications. Concrete injured by frost should be removed and replaced. It is recommended that the pavement not be opened to traffic until a flexural strength of four hundred (400) pounds per square inch is obtained or a minimum of fourteen (14) days after the concrete has been placed.

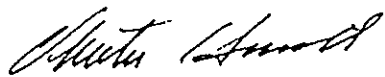
If you have any questions regarding our recommendations in this addendum, please do not hesitate to contact us.

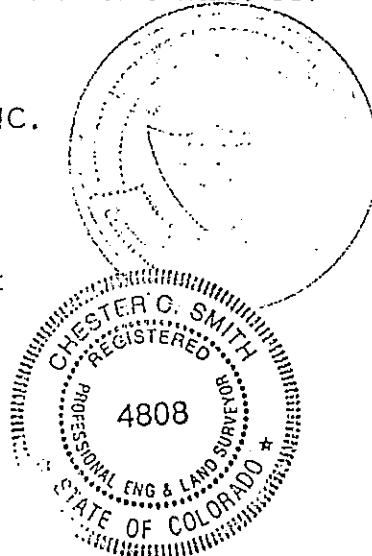
Very truly yours,

EMPIRE LABORATORIES, INC.

  
Neil R. Sherrod  
Senior Engineering Geologist

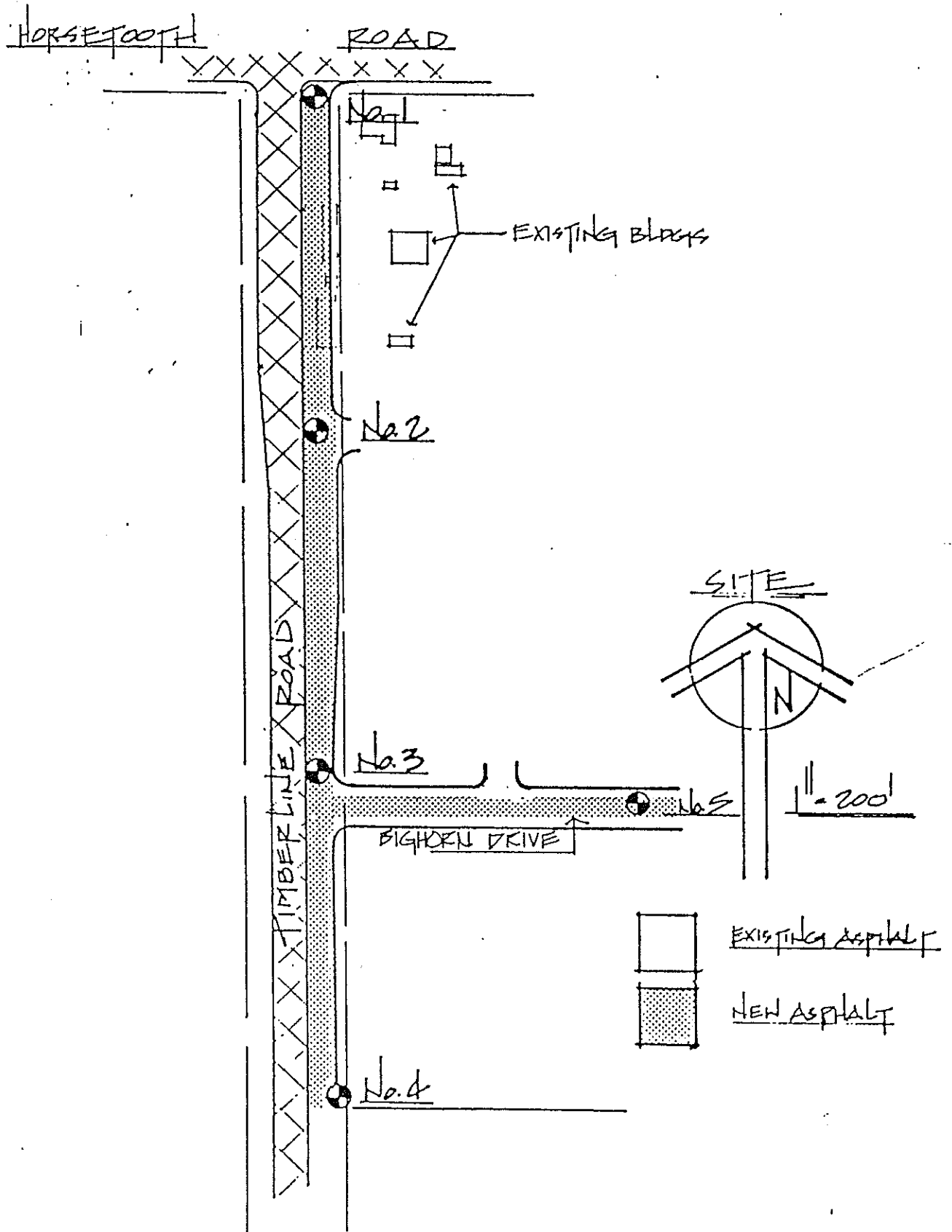
Reviewed by:

  
Chester C. Smith, P.E.  
President




























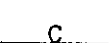


APPENDIX A.

TEST BORING LOCATION PLAN



# KEY TO BORING LOGS

	
TOPSOIL	GRAVEL
	
FILL	SAND & GRAVEL
	
SILT	SILTY SAND & GRAVEL
	
CLAYEY SILT	COBBLES
	
SANDY SILT	SAND, GRAVEL & COBBLES
	
CLAY	WEATHERED BEDROCK
	
SILTY CLAY	SILTSTONE BEDROCK
	
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SANDY SILTY CLAY	
	
SHELBY TUBE SAMPLER	
	
STANDARD PENETRATION DRIVE SAMPLER	
	
WATER TABLE 0 HRS. AFTER DRILLING	
	
HOLE CAVED	

5/12 Indicates that 5 blows of a 140 pound hammer falling 30 inches was required to penetrate 12 inches.

# LOG OF BORINGS

DEPTH

No. 5

0

4/12

12/12

5

5/12

10

4/12

15



SUMMARY OF TEST RESULTS

Boring No.	Depth (Ft.)	Moisture (%)	Dry Density (PCF)	Compressive Strength (PSF)	Swell Pressure (PSF)	Soluble Sulfates (%)	pH	Liquid Limit (%)	Plasticity Index (%)	Group Index	Classification AASHTO USCS	Resistivity (OHM-CM)	Penetration Blows/In.
5	0.0-1.0	22.3											4/12
	1.0-2.0												12/12
	4.0-5.0	21.3											5/12
	9.0-10.0	20.9											4/12
Composite Sample	0.5-4.0							40.8	20.0	12.0	A-7-6(12); CL		

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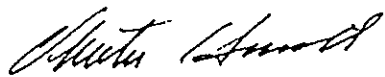
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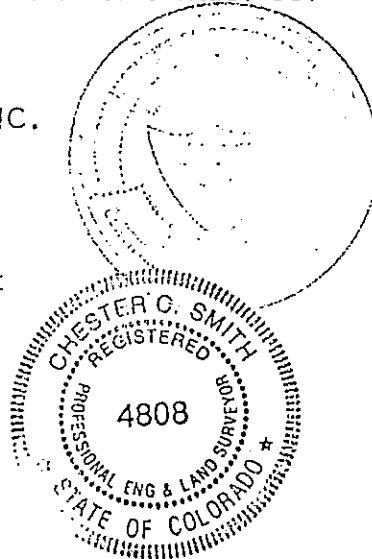
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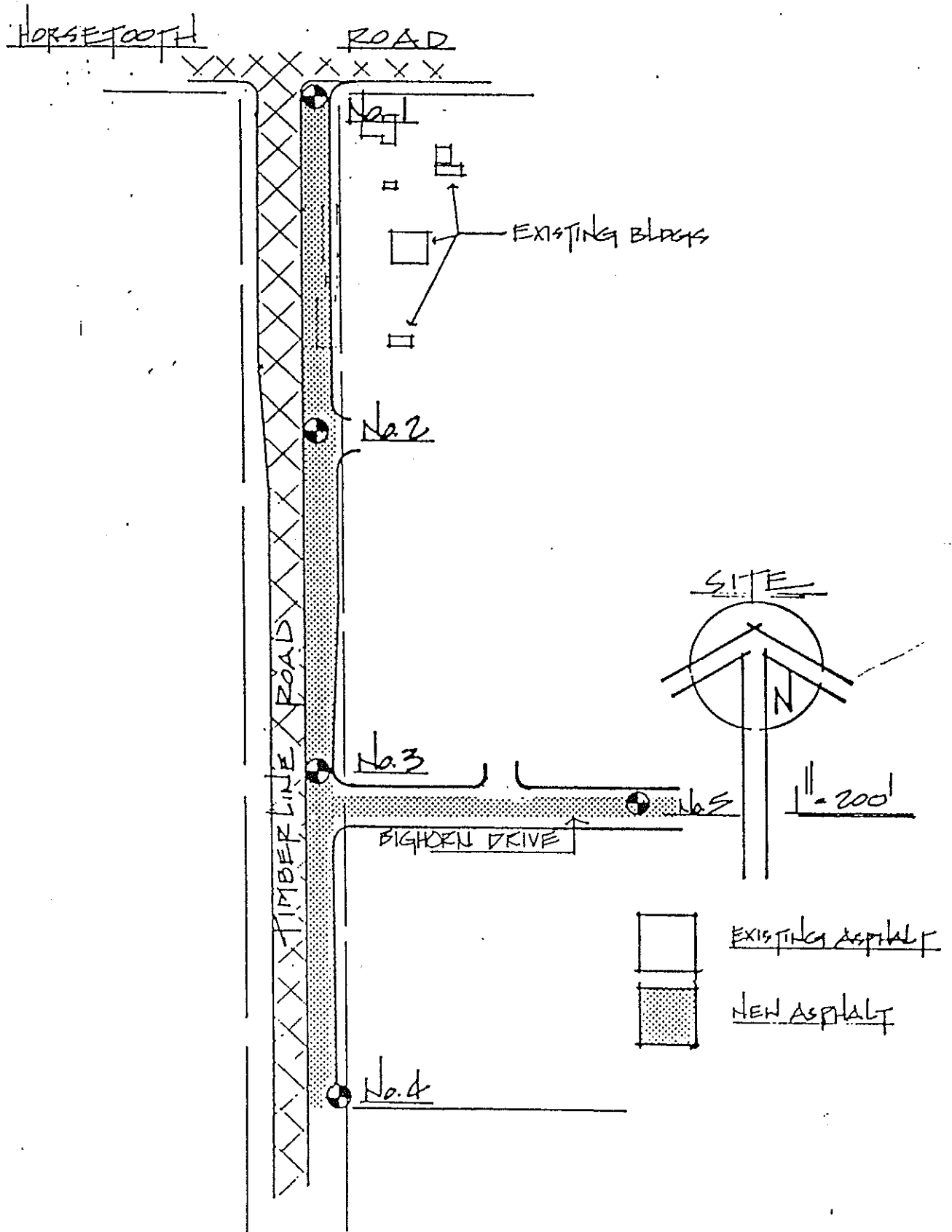
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









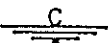


APPENDIX A.

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	1.0-2.0												12/12
	4.0-5.0	21.3											5/12
	9.0-10.0	20.9											4/12
Composite Sample	0.5-4.0							40.8	20.0	12.0	A-7-6(12); CL		