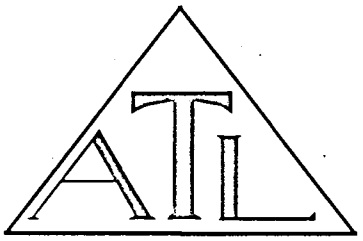


ATL, INC.

CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

PALADIN ROAD BOX CULVERT
WEST INTERCEPTOR DRAINAGE CHANNEL
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ATL JOB NO. 197026

A470.940

PALADIN ROAD BOX CULVERT
WEST INTERCEPTOR DRAINAGE CHANNEL
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ATL JOB NO. 197026

ATL Job No. 197026 May 30, 1997

GEOTECHNICAL INVESTIGATION

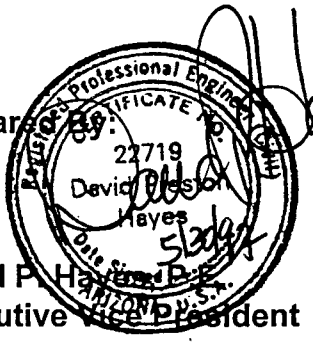
REPORT FOR

SFC ENGINEERING CO.

PROJECT

PALADIN ROAD BOX CULVERT
WEST INTERCEPTOR DRAINAGE CHANNEL
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ATL JOB NO. 197026

Prepared By:



David P. Hayes, P.E.
Executive Vice President

ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

May 30, 1997

Thomas M. KoeneKamp. P.E.
SFC Engineering Co.
7776 Pointe Parkway West, Suite 290
Phoenix, Arizona 85044

Re: Geotechnical Investigation Report
Paladin Road Box Culvert
West Interceptor Drainage Channel
Flood Control District of Maricopa County
ATL Job No. 197026

Dear Mr. KoeneKamp:

This final report presents the results of a geotechnical investigation for the proposed construction of a box culvert for the West Interceptor Drainage Channel under Paladin Road. This work is also part of the Phase 2 plan development for the Roosevelt Irrigation District (RID) Overchute Project, Contract No. FCD-97-01. ATL's work was completed in accordance with ATL Proposal No. P97060 dated February 17, 1997 to SFC Engineering Co.

The investigation consisted of drilling one (1) boring thirteen (13) feet deep, sampling for laboratory analysis and reporting physical properties relative to the material's suitability for use as support for the structure and general backfill quality. Generally, as depth increased, the material changed from a silty SAND, to a clayey SAND to a sandy CLAY, with a trace of cementation. The material was very dense, with SPT values of 63 blows per foot near the invert elevation. As per our discussion, 12 inches of native material should be over-excavated below the culvert slab and refilled with compacted aggregate base course compacted as specified in this Report.

ATL has appreciated the opportunity to be of service to the SFC Engineering Co. on this project and looks forward to our continued association on future projects. Should any questions arise, please do not hesitate to contact us at your earliest convenience.

Very truly yours,

Registered Professional Engineer (Civil) CERTIFICATE NO. 22719 David Preston Hayes 5/30/97

David P. Hayes, P.E.
Executive Vice President

DPH/brc

2912 W. CLARENDON
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1400½ N. BROAD
GLOBE, AZ 85502
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FAX (520) 425-9597

1855 W. KAIBAB LANE SUITE 6
FLAGSTAFF, AZ 86001
TELEPHONE (520) 773-9614
FAX (520) 773-9522

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GEOTECHNICAL INVESTIGATION

REPORT FOR

SFC ENGINEERING CO.

PROJECT

PALADIN ROAD BOX CULVERT
WEST INTERCEPTOR DRAINAGE CHANNEL
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ATL JOB NO. 197026

1.0 PROJECT DESCRIPTION

As part of the Phase 2 design for the Roosevelt Irrigation District Overchute Project, a box culvert will be constructed under Paladin Road just south of its intersection with the Indian School Road Bypass near Litchfield Park, Arizona. The box is 82 feet long under the roadway with another 30 feet of concrete lining transition channel on either end. A triple barrel box is planned with each cell opening 7 feet high by 6 feet wide.

The Flood Control District of Maricopa County will finance the project under Contract No. FCD-97-01. The interceptor earth channel is approximately 1200 feet long and varies in section, depending on whether it is the Plaza Circle channel or the West Interceptor Channel.

2.0 LOCATION AND SITE DESCRIPTION

The project site is located south of Litchfield Park, parallel and south of the Indian School Road By-Pass. The channel passes under Paladin Circle Road. The site consists of desert (arid) plants, growing in a topography of "farmland and roadways". There is mixed construction consisting of residential and one-story commercial buildings with a new mall just completed west of Litchfield Road and north of I-10. Several developments are currently under construction.

3.0 SCOPE OF WORK

ATL's responsibility was to provide information on the quality of subgrade materials encountered and their suitability for re-use on this project. To accomplish these tasks, the following drilling, testing and reporting sequence was initiated:

A) Field Investigation:

A Mobil B-50 drill rig was used to drill one(1) hole, approximately thirteen (13) feet deep. At the bottom of the boring, a SPT (Standard Peentration Test) was conducted by driving a split-spoon sampler 18 inches, recording blow counts to drive the sampler every 6 inches in depth. In addition to the SPT samples, bulk samples of the auger cuttings were obtained for laboratory determination of index properties. All borings were back - filled at the completion of drilling.

B) Laboratory Analysis:

Upon receipt of the bulk samples at ATL's Phoenix laboratory, the logs were edited and tests assigned as follows:

- Sieve Analysis
- Plasticity Index
- Moisture Content

All tests were performed in accordance with the current AASHTO/ASTM Standards.

C) **Office Engineering:**

This report was produced using information developed from the field investigation and laboratory testing and addresses the following issues:

1. **Index Properties and Classification of the Subgrade Soil.**
2. **Recommendations for Reuse of Excavated Material.**

4.0 DRILLING AND SAMPLING PROCEDURES

Only one (1) borehole was required for this project. The borehole was placed in Paladin Road and advanced to a depth of thirteen (13) feet below existing grade.

A Mobile B-50 drill rig with an eight (8) inch outside diameter hollow-stem continuous flight auger was utilized to penetrate the subsoil and sample the material. Beginning at three-feet below grade, Standard Penetration Test (SPT) values were obtained at each layer interval but no more than 5-feet apart using a split-spoon sampler, driven 18 inches with a 140-pound hammer. Sampling of the subsurface material was accomplished using a standard split spoon-sampler driven with a 140-pound hammer falling thirty inches, in accordance with ASTM Standard D-1586. Bulk samples of the existing native material were selectively sampled off the auger flights and returned to the laboratory for analysis. The borehole was returned to its original state by backfilling with excess cuttings and compacting the top 12 inches.

The boring location is shown on a site plant in Plate 4. The edited boring log is presented in Appendix A.

5.0 LABORATORY TESTING

Index tests, consisting of sieve analysis and Atterburg limits, along with in-situ moisture content determinations, were determined throughout the boring profile.

The following table lists the types and quantities of tests performed to provide the project design information:

TEST	NUMBER OF TESTS PERFORMED
Sieve Analysis	1
Atterberg Limit	1
Moisture Content	1

All laboratory tests were conducted in accordance with ASTM/AASHTO published Standards, and are summarized in Appendix B, "Laboratory Test Results". The soil shown on the edited boring logs was classified using the Unified Soils Classification System (USCS).

Please note that the soil samples will be stored for 60 days after the issuance of this report before they are discarded. Therefore, questions concerning the soil samples should be discussed within that time frame.

6.0 SUMMARY OF EXISTING CONDITIONS

Three (3) soil strata were encountered in the one (1) boring drilled for this project. The top 4 feet consisted of a **light, brown silty SAND (SM)** in a damp condition. Between 4 and 5½ feet below grade, a **light brown, clayey SAND (SC)** with a trace of cementation was encountered. From 5½ feet to the bottom of the boring at 13 feet, a **light brown sandy lean CLAY (CL)** with a trace of cementation was encountered. SPT "N" values increased as depth increased, from 29 blows/foot to 50 blows in six inches. This indicates a "Hard" and "Very Dense" material.

Laboratory results for material sampled in the 5½ to 11½ depth range, revealed a fine material with 59% passing the No. 200 screen and a plasticity index of 14. The in-situ moisture content was 25.9%.

7.0 DISCUSSIONS AND RECOMMENDATIONS

In the construction of this 3-barrel box culvert, the contractor will encounter a sandy CLAY (SC) at the proposed invert depth. This material could be near saturation and because of this condition as well as the poor structural quality of a CL material, it will require over-excavation of 12 inches below the proposed bottom of slab. The clayey SAND (SC) and silty SAND (SM) material that will be encountered in the initial 5-feet of excavation may be reused as backfill behind the box culvert walls.

The following soil parameters may be used for the box culvert slab assuming that the construction procedures recommended in Section 8.0 of this report are adhered to:

Net Allowable Bearing Capacity: ..... 2,500 psf

Estimated Total Settlement: ..... Less than 0.5"

Bearing Material ..... 12" of Engineered ABC

For the excavated soil used to backfill behind the box culvert walls, the following equivalent pressures may be used assuming a unit rate of 110 pcf:

Active: ..... 40 psf

Passive: ..... 305 psf

Coefficient of Friction: 0.40

8.0 CONSTRUCTION RECOMMENDATIONS

ATL recommends that the Phoenix supplement of MAG Standards be used as a guideline for the contractor. The following sub-sections provide specific references to MAG with additional recommendations.

8.1 Excavation

Section 206 of MAG should be followed during construction. Except for the Lean Clay material encountered below 5½ feet, the native material may be reused and compacted in accordance with Section 8.2.

8.2 Compaction

MAG Section's 211 and 215 may be followed as appropriate, using either AASHTO T-99 or ASTM D698. In-place densities for the native material below the over-excavation limits, as well as the aggregate base course should be compacted to within 95% of the maximum laboratory dry density and within ± 2% of the optimum moisture content.

Water settling, as a means of compacting material, is **not** acceptable for this project.

8.3 Borrow

If imported borrow is used for backfill, the following criteria should be followed for acceptance:

Sieve Size	Percent Passing
3"	100
3/4"	55 - 80
No. 4	35 - 60
No. 40	5 - 20
No. 200	0 - 12

Plasticity Index ≤ 10.

In addition, the borrow shall contain no "chunks" of clay, organic matter, tree limbs, excess moisture and stones larger than 3 inches.

8.4 Aggregate Base Course

The aggregate base course (ABC) material used under pavement sections should conform to Section 702 of MAG as follows:

Sieve Size	Percent Passing
1 1/8	100
No. 4	38 - 65
No. 8	25 - 60
No. 30	10 - 40
No. 200	3 - 12

9.0 ADDITIONAL SERVICES

ATL is prepared to provide materials testing services during construction for this project. Our staff of experienced technicians and field engineers can provide competent and reliable testing services. In addition, geotechnical expertise and knowledge of the site, is readily available in - house, reducing "learning curve" time.

Questions concerning the development of the Report's recommendations should be directed to the author.

PLATES

GUIDELINES IN THE USE AND INTERPRETATION

OF THIS GEOTECHNICAL REPORT

ATL Job No.197026

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

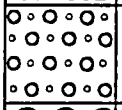
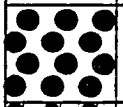
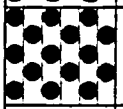
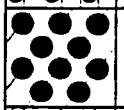
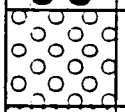
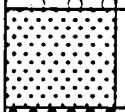
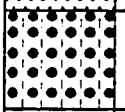
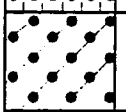
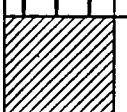
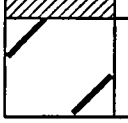
The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

SOIL CLASSIFICATION & TERMINOLOGY

GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
	GW	Well graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GP	Poorly graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GM	Silty gravels, gravel - sand - silt mixtures.
	GC	Clayey gravels, gravel - sand - clay mixtures.
	SW	Well graded sands, gravelly sands.
	SP	Poorly graded sands, gravelly sands.
	SM	Silty sands, sand - silt mixtures
	SC	Clayey sands, sand - clay mixtures
	ML	Inorganic silts, clayey silts with slight plasticity
	MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand - gravel mixtures,

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
50	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0 - 4	Very soft	Easily penetrated several inches with fist.
3 - 4	Soft	Easily penetrated several inches with thumb.
5 - 8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9 - 15	Stiff	Readily indented with thumb but penetrated only with great effort.
16 - 30	Very stiff	Readily indented with thumbnail.
30 +	Hard	Indented only with difficulty by thumbnail.

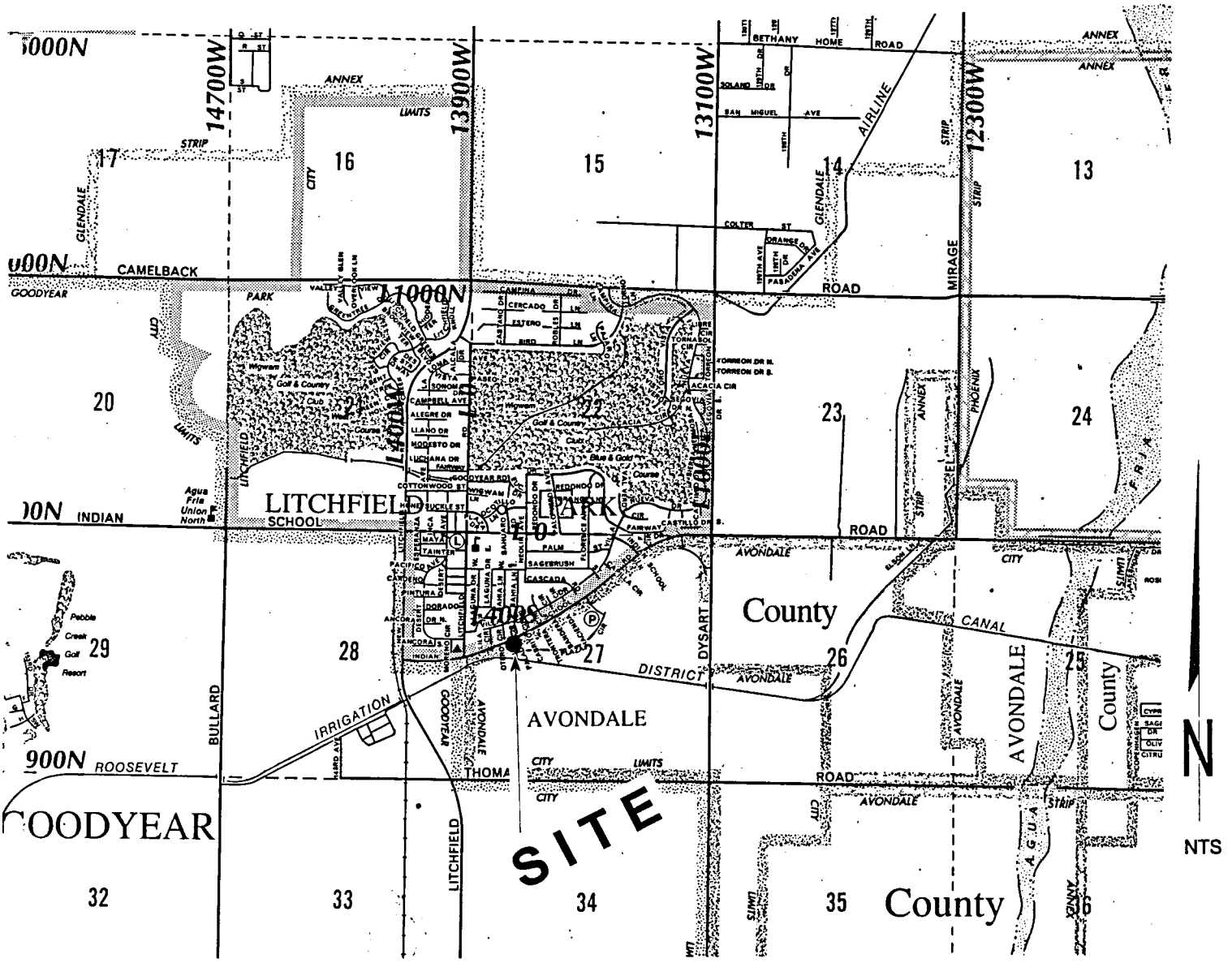
3. Relative Firmness. Terms for description of partially saturated and / or cemented soils which commonly occur in the Southwest including clays, cemented granular materials silts and silty and clayey granular soils.

N	Relative Firmness
0 - 4	Very soft
5 - 8	Soft
9 - 15	Moderately firm
16 - 30	Firm
31 - 50	Very firm
50 +	Hard

4. Standard Penetration Tests (SPT) = 

DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 inches
Gravel	3 inches to No. 4 sieve
Coarse gravel	3 inches to 3/4 inch
Fine gravel	3/4 inch to No. 4 sieve
Sand	No. 4 sieve to No. 200
Coarse	No. 4 sieve to No. 10
Medium	No. 10 sieve to No. 40
Fine	No. 40 sieve to No. 200
Fines (silt or clay)	Below No. 200 sieve

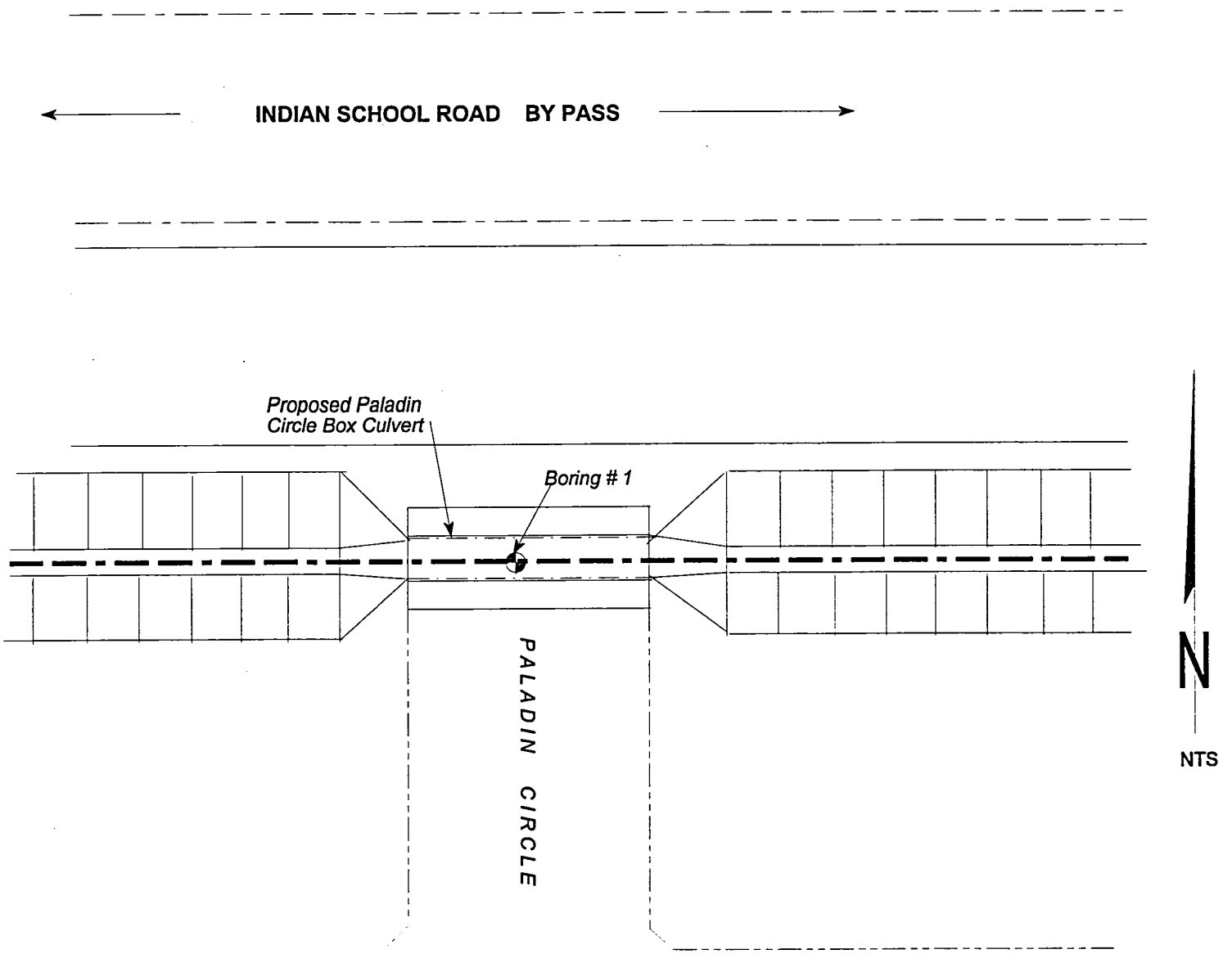


VICINITY MAP

BOX CULVERT ON PALADIN ROAD
West Interceptor Damage Channel

ATL JOB NO. 197026

PLATE 3



BORING LOCATIONS

BOX CULVERT ON PALADIN ROAD
West Interceptor Damage Channel

ATL JOB NO. 197026

PLATE 4

APPENDIX A

BORING LOGS

BOX CULVERT ON PALADIN ROAD
West Interceptor Damage Channel

ATL Job No. *197026*
Boring No. *1*

Boring Location: *Centerline of Paladin Circle, 115 feet South Centerline Indian School bypass*

Boring Equipment: *Mobil B-50 with 8 - inch diameter hollow Stem auger*

Date of Boring: *4/18/97* **Elevation of Boring:** *Existing* **Driller:** *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A.Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	Water Content %	Dry Density (pcf)
		Light brown, silty SAND(SM), Damp				
		Light brown, clayey SAND(SC), Damp	29			
	5	*Trace of cementation*			10.0	
		Light brown, sandy CLAY(CL), Damp	38			
		Trace of cementation	50 / 5"			
	10		63			
			50 / 6"			
		(Bottom of boring at 13 feet)				
	15					
	20					
	25					

Boring Stopped at 13 Feet Below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A1

APPENDIX B

LABORATORY TEST RESULTS

SUMMARY OF LABORATORY ANALYSIS

CLIENT: SFC ENGINEERING DATE: 05/19/97

PROJECT: BOX CULVERT ON PALADIN ROAD

LOCATION: WEST INTERCEPTOR DRAINAGE CHANNEL MARICOPA COUNTY

MATERIAL: See Below SAMPLING DATE: 04/18/97

REQUESTED BY: David Hayes ATL JOB NO: 197026

BORING No.	DEPTH (FT)	MOIST (%)	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING											
						200	100	50	40	30	16	10	4	3/8	3/4	1.5	3
1	5.5 - 11.5	25.9	CL	32	14	59.3	68	78	83	87	94	97	100				

Project Number = 197026 Client: SFC Engineering Co.
Location = Box Culvert on Paladin Road
Date = 4/24/97
Tested By = D. Johnson
Boring Number = 1
Depth = 5 1/2 ft - 11 1/2 ft
Sample Number = 97-0243
Description = Lt. brown, sandy lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	20.00	2.00	2.00	98.00
#10	2.000	10.00	1.00	3.00	97.00
#16	1.180	30.00	3.00	6.00	94.00
#30	0.600	70.00	7.00	13.00	87.00
#40	0.425	40.00	4.00	17.00	83.00
#50	0.300	50.00	5.00	22.00	78.00
#100	0.150	100.00	10.00	32.00	68.00
#200	0.075	90.00	9.00	41.00	59.00
Pan	0.000	0.00	0.00	41.00	59.00