ENCAPCO Emulsified Treated Base

Project Owner: CALTRANS
General Contractor: DeSilva/Gates Construction
Emulsion Development & Design: Reed & Graham, Inc.
Environmental Permitting & Compliance: Levine-Fricke

November 3, 1995

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I. PROJECT OVERVIEW

This demonstration project was a cooperative effort of Encapco, Caltrans, DeSilva Gates Construction (DGC) and DeSilva/Myers (a joint venture). DGC was under contract with Caltrans for the construction of two projects along the I-80 Corridor.

The first project, a DGC/Myers joint venture in Emeryville, involved the widening and construction of the roadway sections on Interstate Route 80 in Contra Costa County beginning at the Port of Oakland Overcrossing and continuing northward past the Powell Street Undercrossing. The work includes widening and reconstructing the connector ramps from 32nd Street and Route 580 to northbound Route 80. The second project, in Richmond and Pinole, involved the construction of an interchange at Richmond Parkway and I-80, widening of north and southbound I-80 and the construction of a "Park and Ride" lot.

There were approximately 11,000 cubic tons of contaminated soils at the Emeryville site with heavy concentrations of lead and cadmium from previous steel mill and fill operations. The soils were identified and segregated at the Emeryville site to be hauled to Richmond for processing. Samples had been previously evaluated and a site-specific mix design for asphaltic based emulsion was delivered to the job site in Richmond. Once the soil was delivered, it was screened and then mixed with the emulsion. The treated material, as Encapco ETB (Emulsified Treated Base), was then placed as a replacement for Class III aggregate baserock in several different areas of this project. However, the resultant structural characteristics would have allowed for the material to be used for several higher grade construction materials as well. (See the attached map which depicts the Encapco ETB placement locations.)

This project helps prove the effectiveness and feasibility of the process in converting contaminated soils into a viable, reusable construction material.

ENCAPCO

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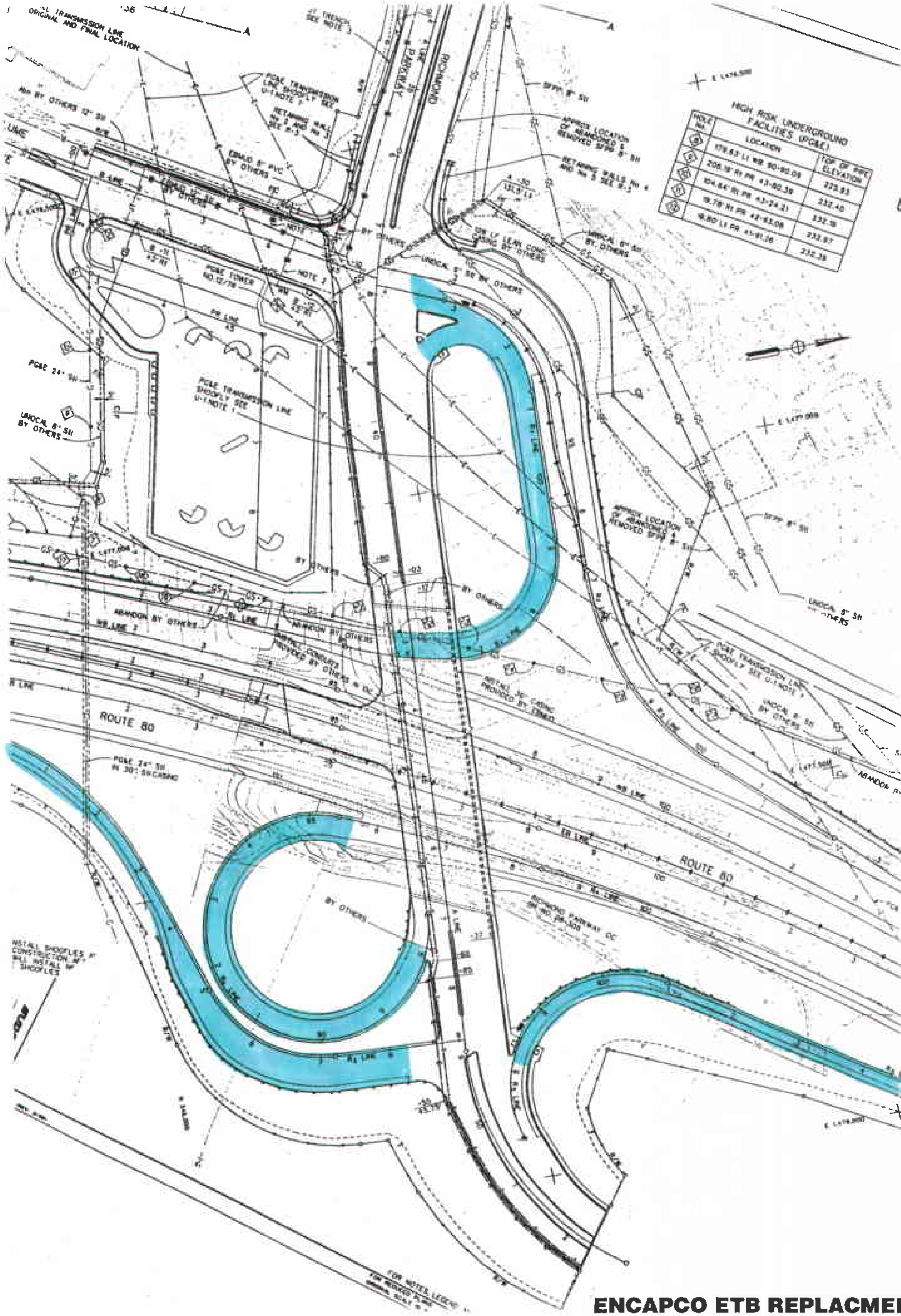


ENCAPCO ETB REPLACMENT LOCATIONS

II. OBJECTIVES

The purpose of conducting the asphalt stabilization project was to demonstrate a proven method by which an environmental liability can be transformed into an asset (useable end product) that meets regulatory requirements at a reasonable cost and in an acceptable time period using the Encapco process. As many site owners have learned, the costs of restoring contaminated sites that are restricted from productive use can become unacceptable, unless the site can be quickly returned to beneficial use.

Specifically, utilizing the Encapco ETB process will:

- provide a practical, cost-effective substitution for a commercial roadway construction product that meets industry standards;
- transform a hazardous waste to a non-hazardous, conventional construction material for road bases, landfill caps, berms and dikes, while mitigating a concern over the fate of encapsulated contaminants;
- assure local, state and federal environmental regulatory agencies of complete encapsulation of contaminants in the emulsified asphalt matrix by certified test results; and
- provide agencies and owners with an acceptable project alternative to other soil remediation options with the added benefit of Encapco ETB as a useable product.

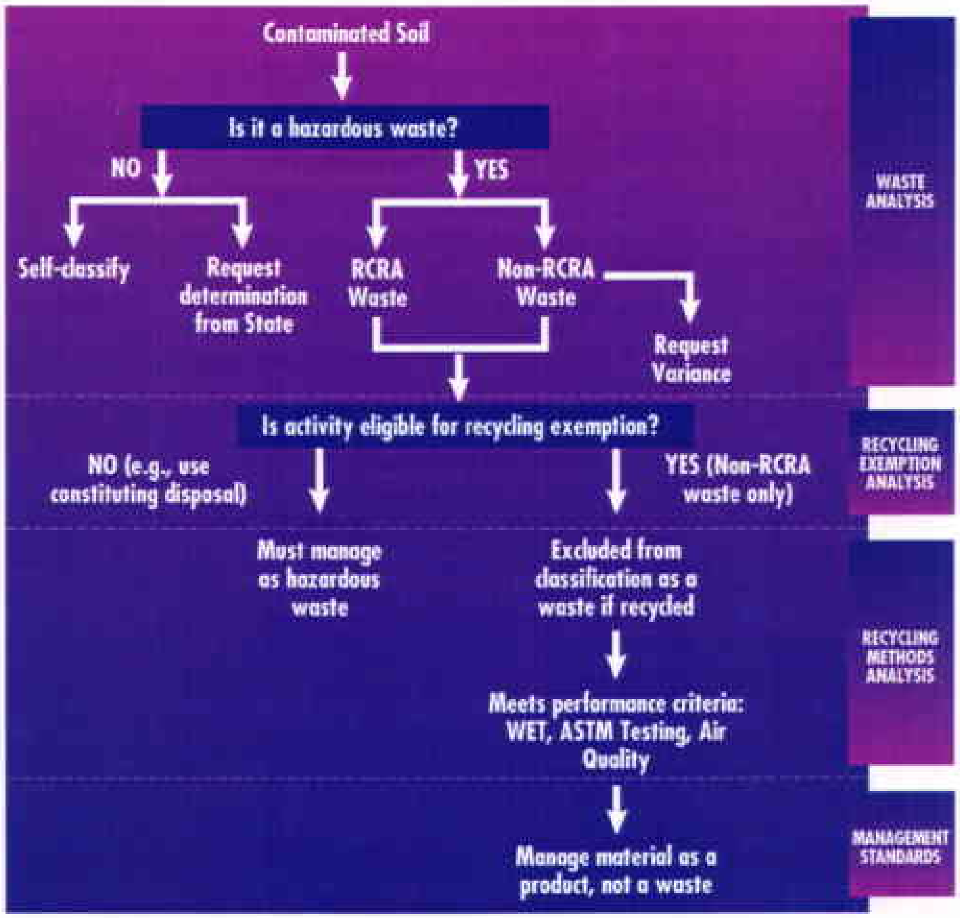
III. GENERAL CONSIDERATIONS

With any project there are a number of considerations which need to be addressed. On the following pages we have identified some of the general topics as they pertain to our process.

A. ENVIRONMENTAL

Transportation and disposal of contaminated soil to landfills is costly and does not limit the liability of a hazardous waste generator. Recycling of contaminated soil using asphaltic emulsion, however, is an effective method as long as the contaminants meet certain criteria. If a contaminated soil is hazardous, recycling is a possible alternative if the soil and asphalt emulsion mixture meet certain regulatory requirements. Before beginning on any soils remediation project, several considerations should be made to evaluate whether recycling contaminated soil into Encapco ETB is a viable alternative.

The graphic below depicts that process:



Evaluation of site characterization information with regard to contaminant type and concentration, soil type, and volume of soil potentially available for recycling is important when considering recycling as a remediation alternative.

Planning for the use of the recycled construction material needs to be addressed in the early stages of project planning.

B. ASPHALT AND CONSTRUCTION OVERVIEW

Asphalt from Petroleum

Almost all asphalt used in the United States is refined from petroleum. Such asphalt is produced in a variety of types and grades ranging from hard brittle solids to almost water thin liquids.

Asphalt Emulsion

Asphalt emulsion consists of three basic ingredients: Asphalt, water and an emulsifying agent. On some occasions the emulsifying agent may contain a stabilizer. It is well known that water and asphalt will not mix except under carefully controlled conditions using highly specialized equipment and chemical additives. The blending of asphalt emulsion and water is somewhat like a mechanic trying to wash grease from his hands with only water. It is not until a detergent or soapy agent of some type is used that grease can be successfully removed. The soap particles surround the globules of grease, breaking the surface tension that holds them, allowing them to be washed away. Some of the same physical and chemical principles apply in the formulation, production, and use of asphalt emulsion.

The objective is to make a dispersion of the asphalt emulsion in water, stable enough for pumping, prolonged storage, and mixing. Furthermore, the emulsion should break down quickly after contact with the contaminated soil in a mixer. Upon curing, the residual asphalt retains all of the adhesive, durability, and water-resistant properties of the asphalt from which it was produced. Emulsion can either be anionic or cationic.

Terms Associated with Asphalt Emulsion

Breaking - The asphalt droplets coalesce and produce a continuous film of asphalt on the aggregate or pavement. For dense mixture, more time is needed to allow for mixing and laydown. Asphalt coalescence is commonly referred to as breaking or setting. The rate at which the asphalt globules separate from the water phase is referred to as breaking time or setting time. RS: Rapid Set; MS: Medium Set; SS: Slow Set

Curing - For paving uses, asphalt emulsions depend on the evaporation of water for development of their curing and adhesion characteristics. Water displacement can be fairly rapid under favorable weather conditions.

Emulsified Treated Base (ETB) - Basic Overview

Encapco ETB is recycled material made from contaminated soil and emulsion, using no additional aggregate. This recycled material meets design specifications for aggregate roadbase and sub-base in normal construction projects.

Contaminated soil which would be a candidate for this form of recycling is soil impacted by the following:

- Organics
- Heavy hydrocarbons: Hydrocarbons that are normally too heavy for thermal treatment
- Metal bearing: Soils containing metals such as lead, copper, zinc
- PNAs
- A number of other contaminates which we are capable of treating and have ongoing R & D efforts to further verify

The Encapco Process Involves Three Fundamental Steps:

1. Site Specific Mix Design - Site sample taken to lab for:
   - Chemical/toxicity analysis for contaminant encapsulation
   - Structural analysis for construction purposes
   - Formulation of mix design satisfying environmental criteria and construction industry specification

2. Mixing On-Site (Micro Encapsulation) - Contaminated stockpile
   - Screen to remove deleterious material
   - Feed to a rotary pugmill
   - Mill mixes emulsion with soil, "coating" individual particles (no additional aggregate is added)
   - Conveyor delivers Encapco ETB to trucks for placement

3. Placement (Macro Encapsulation) - Encapco ETB is placed using sequential construction techniques:
   - Grading
   - Compacting
   - Curing

   Encapco ETB cures to form a monolithic structure meeting design and regulatory specifications.

IV. THE ENCAPCO PROCESS

A. SITE SPECIFIC SAMPLES AND MIX DESIGN

Material Sample and Mix Design - A representative set of samples was taken from the site and evaluated. The samples consisted of 300 pounds of material. Strict testing protocols were followed to ensure thorough characterization of the material. This phase is critical for the formulation of an exact mix design of asphalt emulsions to permanently encapsulate and thus recycle the specific soil matrix being dealt with.

Criteria - All treated soil materials are to be physically encapsulated in an asphaltic mixture with no materials exceeding established limits for STLC, TTLC or other California limits for toxic chemicals in quantities exceeding concentrations set forth in Section 66699 Title 22, of the State of California Code of Regulations (CCR).

B. TESTING & APPROVALS

Bench Scale Testing - Test pellets were subjected to extensive bench scale testing to ensure performance requirements are met or exceeded. These included limits established for STLC, TTLC, TCLP and other tests for toxic substances required by different agencies. Comprehensive structural testing was done at this stage.

Agency Approvals - When the mix design and bench scale testing were complete, we reviewed the data with each agency required to secure the proper approvals and permits.

Table I - SOIL CHARACTERISTICS OF THIS PROJECT PRIOR TO TREATMENT

STRUCTURAL CHARACTERISTICS		**ANALYTICAL**		
I. Sieve Size	% Passing	Tests	Composite	Lot 4
1"	100	TTLC Lead mg/kg	1800	2300
#4	59.1	STLC Lead mg/l	20	135
#200	12.9	TPH	110	160
II. Sand Equivalent	32			
III. Plasticity Index	N/P			
IV. Maximum Density	142.2 @ 7.6%			

C. PRODUCTION

The contaminated soil was excavated and stockpiled at the Emeryville site. It was then screened to a sieve size of 1" or less. The soils were mixed by weight and moisture conditioned as required, using no additional aggregate. They were then hauled and stockpiled in Richmond to facilitate a faster construction schedule. The asphaltic emulsion was then mixed with the soils in a pugmill and proportioned by batch weight. A metering device was used to introduce the emulsion in specified proportions. The quantity of water was adjusted to meet optimum moisture content. This was done on site at ambient temperature with no Volatiles emitted.

Encapco ETB was delivered to the roadbed from the pugmill. It was spread to the required thickness within specified tolerances. This insured uniformity of the mixture while utilizing standard construction practices. Subsequent layers of other structural sections were not placed until the underlying lifts were stable.

D. QUALITY CONTROL & POST-PRODUCTION ANALYSES

Throughout the process careful QC sampling and testing were administered to verify field performance. Following completion of the production phase, the in-place product was cored to verify performance. Testing protocol included quantitative extraction of residual binder within the mixture, stability, flow, density, softening point, and penetration.

Table II - ENCAPCO ETB POST-PRODUCTION CHARACTERISTICS

STRUCTURAL INTEGRITY		**ANALYTICAL**				
I. R-Value (Cured)	95	Tests	1	2	3	4
II. Cohesion Value	769	STLC Lead mg/l	.45	.33	ND	ND
III. Moisture/Density	131 lbs @ 10.8% moisture	TPH	N/A	N/A	N/A	N/A
IV. Marshall Stability	@ 15% 2617					

Note: Original values are listed in Table I

V. BENEFITS & COMPARATIVE COST

A. BENEFITS

This project demonstrated the commercial viability of Encapco ETB, both from the standpoint of remediating hazardous materials and recycling those materials into a high value construction material.

Some of the benefits of Encapco ETB realized on this project were:

- successful elimination of the liability of a contaminated material by transforming it into a commercial construction product at a reduced cost;
- use of Encapco ETB emulsion and the contaminated soils with no additional aggregate material being added;
- the Encapco ETB provided structural strengths well above those required by the Caltrans Specifications; and
- this emulsion has characteristics with an affinity for many metals in the soils; for example, it is highly effective in encapsulating soluble lead.

Additional benefits to the process are:

- the material has the workability of a cold-mix asphalt product, with all of the structural characteristics of a hot-mix asphalt (i.e. it handles like a 80 PEN and sets up with values in the 30 to 40 range;
- Encapco ETB is processed on site at ambient temperatures with conventional construction techniques;
- the process encapsulates the contaminates in a highly impervious material achieving permeability rates on the order of 10 to -8cm/sec; this allows for its use as liners, cut-off walls, caps, etc.;
- saves time over other processes; and
- is less expensive than landfill alternative.

B. COMPARATIVE COST

The following tables show the potential cost and time savings from utilizing Encapco ETB as compared to other alternatives.

TABLE III: TYPICAL PROJECT REMEDIATION COMPARATIVE COST ANALYSIS OF CAL-ONLY, CLASS I WASTE "*" Indicates Process is Effective Only With Certain Organic Compounds

REMEDIATION COST EVALUATION	Unit	ENCAPCO ETB Stabilization	Haul to Landfill	*Bio-Remediation	*Incineration	Soil Washing
Volume of Material to be Treated	Tons	20,000	20,000	20,000	20,000	20,000
Estimated Cost of Excavation	$	80,000	80,000	80,000	80,000	80,000
Testing, Design, Permitting & Mgmt	$	65,000	65,000	120,000	150,000	150,000
Estimated Soil Remediation Unit Cost	/ Ton	$45	$50	$40	$45	$80
Total Estimated Soil Remediation Cost	$	900,000	1,000,000	800,000	900,000	1,600,000
New Product Value @ $10/Ton	$	(200,000)				
NET TOTAL COST NET UNIT COST	$ $	$845,000 $42.25	$1,145,000 $57.25	$1,000,000 $50.00	$1,130,000 $56.60	$1,830,000 $91.50

TABLE IV: TYPICAL PROJECT REMEDIATION COMPARATIVE TIME ANALYSIS OF CAL-ONLY, CLASS I WASTE "*" Indicates Process is Effective Only With Certain Organic Compounds

REMEDIATION COST EVALUATION	Unit	ENCAPCO ETB Stabilization	Haul to Landfill	*Bio-Remediation	*Incineration	Soil Washing
Volume of Material to be Treated	Tons	20,000	20,000	20,000	20,000	20,000
Excavation	Days	20	30	20	20	20
Remediation	Days	15	15	180	100	200
Design and Permitting	Days	60	60	100	100	100
TOTAL DURATION	Days	95	105	300	220	320

ENCAPCO ETB NET COST SAVINGS	$		$(300,000)	$(155,000)	$(285,000)	$(985,000)
ENCAPCO ETB NET TIME SAVINGS	Days		10	205	125	225

APPENDIX A

DYNAFLECT ANALYSIS

BY

TESTING ENGINEERS

Testing Engineers, Inc.

Quality Assurance Services
Materials Consulting
Since 1954

RECEIVED
OCT 2 6 1995

George Nemie
Project Manager
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Sept. 27, 1995

SUBJECT: Preliminary Analysis of the Engineering Properties of Encapco Emulsion Treated Base (ETB) on the Richmond Parkway Interchange

On Sept. 15, Dynaflect deflection measurements were made on both lanes of an approximately 800' section of the Richmond Parkway Interchange over the emulsion treated base layer (ETB). The bottom lift of ETB was placed on 8/25/95 and the top lift was placed on 9/5/95.

The purpose of the deflection study was to provide an assessment of the pavement strength of the yet to be completed pavement section and a preliminary evaluation of the gravel factor of the emulsion treated base used on the project. The following two structural sections were utilized on the project:

Sta. 95+73 to Sta. 100+40
(Section 1)

0.8' emulsion treated base
1.0' aggregate subbase

Sta. 100+40 to Sta. 103+50
(Section 2)

0.8' emulsion treated base
0.37' aggregate subbase
0.6' CL. 3 Permeable material

Pavement Strength Evaluation

A total of 60 individual deflection measurements using all 5 Dynaflect sensors were made at 25' intervals.

The following is a summary of the sensors (maximum) deflection levels.

Location	80th Percentile Deflection Level*	Median Deflection Level*
Section 1 - Lane 1	0.010"	0.010"
Section 1 - Lane 2	0.011"	0.010"
Section 2 - Lane 1	0.012"	0.009"

Location	80th Percentile Deflection Level*	Median Deflection Level*
Section 2 - Lane 2	0.014"	0.012"

*Equivalent 18 Kip deflectometer deflection

Based upon the pavement fatigue criteria in California Test 356, the "tolerable" deflection level for the completed pavement consisting of a 0.6' dense grade asphalt concrete surfacing level at a traffic index of 10.0 would be approximately 0.011". Thus, taking into consideration the deflection attenuation resulting from placement of A.C. surfacing, there is no possibility of premature fatigue cracking on the subject pavement assumming the surfacing is of, at least, average quality.

<u>A Preliminary Evaluation of ETB Gravel Factor</u>

For the purposes of this evaluation, the writer selected the back-calculation procedure developed jointly by the University of Washington and the Washington Department of Transportation, "Evercalc", while a number of back calculation programs are available, "Evercalc" can be adopted to the Dynaflect, the NDT device used by Testing Engineers on this project.

One of the major changes resulting from the 1986 revision of the AASHTO Pavement Design Guidelines (1) was the substitution of resilient modulus (M_r) for the soil support value as the basic property to characterize the response of pavement to load and thus, pavement performance. This revision was made in consideration of the fact that resilient modulus represents a basic property which can be used in the mechanistic analysis of multilayered systems to quantify the primary pavement responses of stress, strain and displacement which can be used to predict fatigue cracking, rutting, faulting, etc.

Backcalculation to determine M_r involves selection of ranges of moduli for each element of the structural section with an initial or "seed" value to be used for the first iteration. By elastic layer analysis, the program executes several iterations to compute a deflection basin which most nearly matches that measured by the 5 Dynaflect sensors in the field. The quality of

(1) AASHTO Guide for the Design of Pavement Structures, American Association of State Highway and Transportation Officials, Washington, D.C., 1986

the output can be evaluated by the deviation from the measured basin of that computed. For the purpose of this analysis, the writer utilized the measured median deflection basin from each of the 4 test sections. The results are summarized below.

Location	ETB	M_r ASB	Pemeable Base	Subgrade
Section 1-lane 1	120,000	70,000		21,016
Section 1-lane 2	104,636	60,000		22,649
Section 2-lane 1	114,111	54,204	70,000	15,000
Section 2-lane 2	70,000	37,121	70,000	10,293

The above results are considered to have acceptable levels of deviation between measured and computed deflection. Subgrade moduli, ranging from 10,293 to 22,649 are relatively consistant. This is also the case with the ETB M_r values with the exception of that from Section 2-Lane 2. It should be pointed out that back calculated M_r values of asphalt treated materials are particular sensitive to variations in thickness. The fact that design rather than measured thickness was used in the analysis is a probable reason for the ETB M_r deviation noted.

To convert ETB M_r values to an AASHTO layer coefficient, an analytical procedure presented by Rada et al (2) was used.

The following equation is considered appropriate for pavement materials other than asphalt concrete.

$$A_i \quad A_s \quad \left[\frac{E_i \; (1-U_s^2)}{E_s \; (1-U_i^2)}\right]^{1/3}$$

where A_i = layer coefficient of ith layer material
A_s = " " " standard material
E_i = elastic modulus of ith layer material
E_s = " " " standard material
U_i = Poisson's ration of ith layer material
U_s = " " " standard material

For this computation the standard material was a crushed stone base with the following properties:

A_s = 0.14 (AASHTO Layer Coefficient)
E = 30,000
U = 0.35

(2) "Comparison of AASHTO Structural Evaluation Techniques Using Non Destructive Deflection Testing", G.R. Ruda, M.W. Witezak, and S.D. Rabinow, Transportation Research Record No. 1207, PP134-144, 1988.

ETB was assumed to have a modulus of 100,000 and a poisson's ratio of 0.35. The result was an AASHTO layer coefficient of a_2= 0.21 which would correspond, approximately, to a Caltrans gravel factor of 1.5, slightly higher than assummed for asphalt treated permeable base (1.4).

It is important to note that this finding was the result of a test of an extremely limited nature. The hazards of extrapolating it too freely without additional tests under a variety of subgrade and environmental conditions is obvious. Future tests should include deflection measurements before and after ETB placement and on the completed pavement. It should also be pointed out that the ETB will stiffen as the asphalt ages thus increasing the M_r.

However the assummed ETB M_r of 100,000 based upon the results of back calculation appears to meet the test of "reasonableness" since past research on emulsion treated bases reveals a range of M_r ranging from 40,000 to 300,000 for this material.*

If I can provide any further information, please let me know.

Sincerely,
TESTING ENGINEERS, INC.

Raymond A. Forsyth
Calif. Geotechnical Engineer No. 320

*National Cooperative Research Program Report 128 "Evaluation of AASHTO Interim Guides for Design of Pavement Structures" Pg. 30 Highway Research Board, 1972

APPENDIX B

PRODUCTION SPECIFICATION

1.0 Production Specification

1.1 Processing of Material

All treated soil materials to be physically encapsulated in an asphaltic mixture with no materials exceeding established limits for STLC, TTLC or other California limits for toxic chemicals in quantities exceeding concentrations set forth in Section 66699 Title 22, of the State of California Code of Regulation (CCR).

1.2 Central Plant Mixing

Soil and emulsion shall be mixed in a pugmill with an adjustable gate to control the amount of soil entering the mixer. The asphaltic emulsion shall be introduced through a meter that will control the emulsion to 13% (±1.5%).

The job mix formula of residual binder from this mixture shall be 8.3% (±1%).

The liquid emulsion shall be delivered to the jobsite at a temperature not to exceed 120°F and will be proportioned at a temperature between 90°F and 120°F. The liquid emulsion will be proportioned into the mixture at a rate of 13%. Changes in emulsion content shall not be made unless permitted by the Engineer.

Water may be proportioned by weight or volume. The quantity of water added to the mixture shall be adjusted to produce optimum moisture content. The addition of water shall be made under conditions which shall permit an accurate determination of the quantity of water utilized.

2.0 Spreading and Compacting

Emulsion Treated Base will be delivered to the roadbed as a uniform mixture. The mixture will be deposited on the roadbed at a quantity per linear foot, which will provide the compacted thickness for the width being spread without resorting to spotting, picking up or otherwise shifting the mixture. The mixture will then be spread to the required thickness within the specified tolerances by means that will maintain the uniformity of the mixture.

Spreading may be accomplished with a Motor Grader that has been equipped with end wings on the blade, has the blade fixed in a position normal to the direction of travel, and is equipped with cross slope and automatic grade controls. At the option of the contractor, spreading may accomplished with a paving machine.

Where the required thickness is more than 0.40 foot or less, the mixture will be spread and compacted in one layer. Where the required thickness is more than 0.40 foot, the mixture will be placed in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 0.40 foot. Subsequent layers of mixture or other structural section materials will not be placed until the underlying lifts have cured for a minimum of 72 hours and are stable.

Compaction of the spread mixture will be accomplished by two passes providing full coverage with pneumatic tired roller. A forward and backward pass will be considered as two passes. Traffic shall be routed during placement such that travel across or on the spread mixture will be the minimum amount required for placement of the material. Care shall be exercised to insure that overworking of the material does not occur. Final dressing of the uppermost lift, if necessary, will be accomplished with a static steel-wheeled roller to remove minor surface irregularities. If more significant rutting occurs during placement, the motor grader may trim the ETB after four hours cure prior to static wheeled roller.

Grade Tolerance shall be in accordance with Section 19-1.02 "Grade Tolerance" of the Standard Specifications.

After compaction of the spread material, traffic will not be allowed on the material for a minimum of 72 hours. Then, only traffic required to place subsequent layers or material will be allowed on the Emulsion Treated Base, as provided for traffic on treated bases in Section-1.02 "Weight Limitations" of the Standard Specifications.

The subsequent layer shall be ½" or ½" medium asphalt concrete. It shall be placed to a plane 0.10' above the theoretical top of ETB Grade. It shall be placed and compacted in accordance with section 39 "Asphalt Concrete" of the Standard Specifications and the requirements of Section 10-1.42 "Asphalt Concrete" of the Project Special Provisions.

3.0 Quality Control in the Field

3.1 Sampling: Prior to the start of production, contractor shall provide suitable sampling of the stockpiled material to establish the preconditioned moisture content.

3.2 Analytical: One grab sample per day will be taken and retained for the purpose of STLC testing (Lead). At the direction of Caltrans, some of these samples may be subjected to testing.

3.3 Structural: Once during every 500 tons of production, a sample will be taken from the grade and then split with one half of the material going to Caltrans and the other half of the material going to Encapco. The sampled material will be subjected to Extraction Testing (Method B) (California Test Method 310) to determine that ETB was produced within the specified job mix formula range for residual binder.

4.0 Post Testing

Core the in-place ETB for the following: Quantitative extraction of residual binder within the ETB mixture: AASHTO T164, ASTM D 2172, Unit Weight California 308.

APPENDIX C

MATERIAL TEST RESULTS

BY

REED & GRAHAM, INC.

AND

BERLOGAR GEOTECHNICAL ENGINEERS

1.0 EXCERPTS FROM REED & GRAHAM, INC.TECHNICAL REPORT # 395, DATED JUNE 16, 1995:

Listed in Table 1 below are the results from further testing of the emulsion treated soil (ETS) for the Emeryville Flyover Project. The procedures to obtain the results were more formalized to reflect field conditions and ease of specimen preparation. The conditions for moisture content at compaction and test are listed in Table 2, and for curing conditions see Table 3.

Table 1. Physical Properties of the ETS for the Emeryville Flyover Project; 9.6% Binder (15.0% emulsion at 64% residual binder content) by dry weight of soil (DWS). All specimens compacted with California Kneading Compactor.

TEST METHOD	TEST DESCRIPTION	SPECIMEN[1]	RESULT
Cal Test 306	C_1, Initial Cohesion Value, 72±8°	CVI	352
Cal Test 306	C_F, Initial Cohesion Value, 72±8°	CVF	409
Cal Test 307	Moisture Vapor Susceptibility, 72±8°F	MVS	78
Cal Test 305	Swell Test	SW-1	0.000 in
Cal Test 301 (modified)	Initial R_I - Value	RVI-1	57
Cal Test 301 (modified)	Final R_F - Value	RVF	69
	$R_{tI} = R_I + 0.05C_I$		75
	$R_{tF} = R_F + 0.05C_F$		90
Cal Trans	Capiliary Absorption 72±8°F, %	CAT	0.328
	Cohesion Value, 72±8°F		635

[1] Values stated are a mean of two specimens, except R VI-1 which is a single data point; due to RVI-2 being out of moisture content range at test (RVI-2 = 82 at 1.72% moisture content).

Table 2. ETS Specimen Moisture Conditons at Compaction and Test.

SPECIMEN	MOISTURE CONTENT COMPACTION, %	MOISTURE CONTENT AT TEST, %	EXUDATION COMPACTION MOISTURE, g	DESIRED EXUDATION COMPACTION MOISTURE RANGE, g
CVI	4.10	3.88	3	2-10
CVF	4.10	2.40	2	2-10
MVS	4.10	2.77	3	2-10
SW-1	4.10	2.77	3	2-10
RVI-1	4.27	3.91	2	2-10
RVF	4.19	2.61	2	2-10
CAT	4.02	3.02	2	2-10

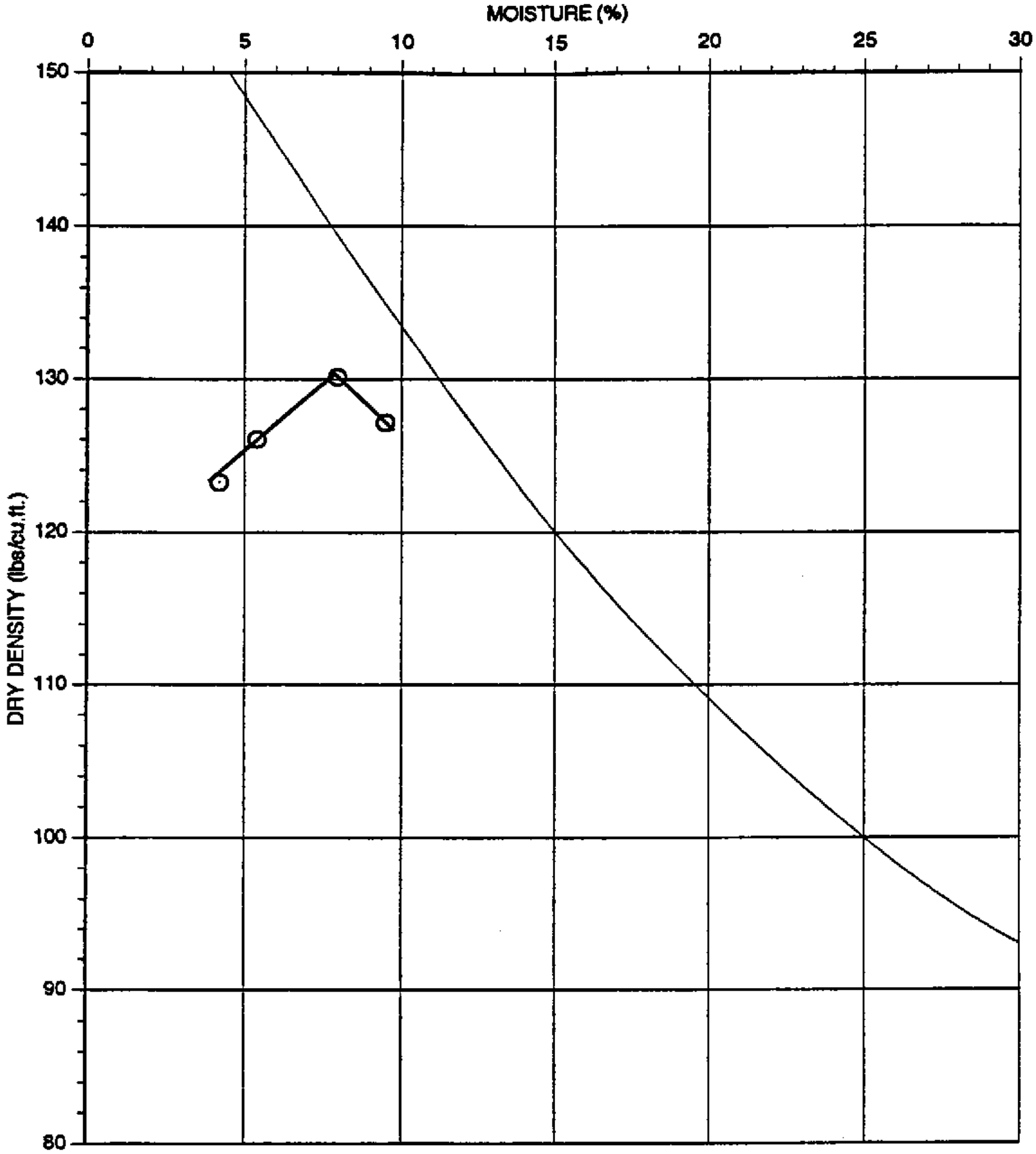
Table 3. Curing Conditions for ETS Specimens Prior to Testing.

SPECIMEN	COMPACTED; CURED 24 HRS 72±8°F	COMPACTED; CURED 24 HRS 140±5°F	CURED 24 HRS 72±8°F	COMPACTED;: CURED 72 HRS 140±5°F
CVI	X			
CVF				X
MVS				X
SW-1				X
RVI-1	X			
RVF				X
CAT		X	X	

The essential design of the experiments were to establish the compaction moisture content, which would yield an exudation of moisture of 2-10g. This was done to simulate the amount of moisture needed to compact the mixture in a field application. These compacted specimens would then represent the initial ETS physical condition, and all relevant physical data would be related to an uncured state of the ETS compacted mixture. Certain specimens were then cured for 72 hours in a 140°F force draft oven, and all relevant data would then represent a cured state of the ETS compacted mixture.

2.0 EXCERPTS FROM BERLOGAR GEOTECHNICAL ENGINEERS ANALYSIS OF COMPACTION AND DRY DENSITY AGGREGATE

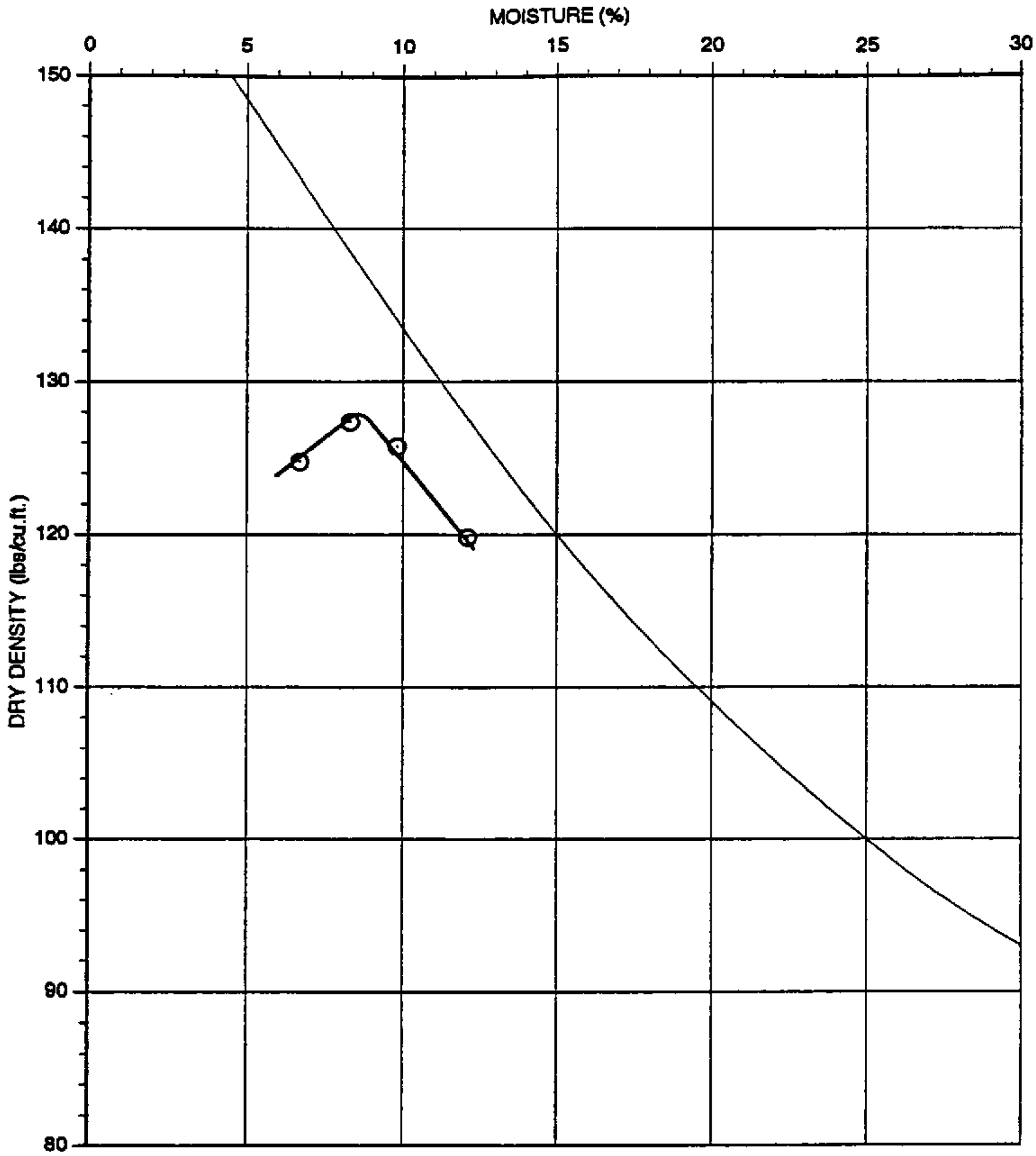
JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	LOCATION	DESCRIPTION	OPTIMUM MOISTURE CONTENT (%)	MAX. DRY DENSITY (pcf)
⊙	Test Strip	SAND and GRAVEL treated with emulsion	8.0	130.1

COMPACTION TEST DATA

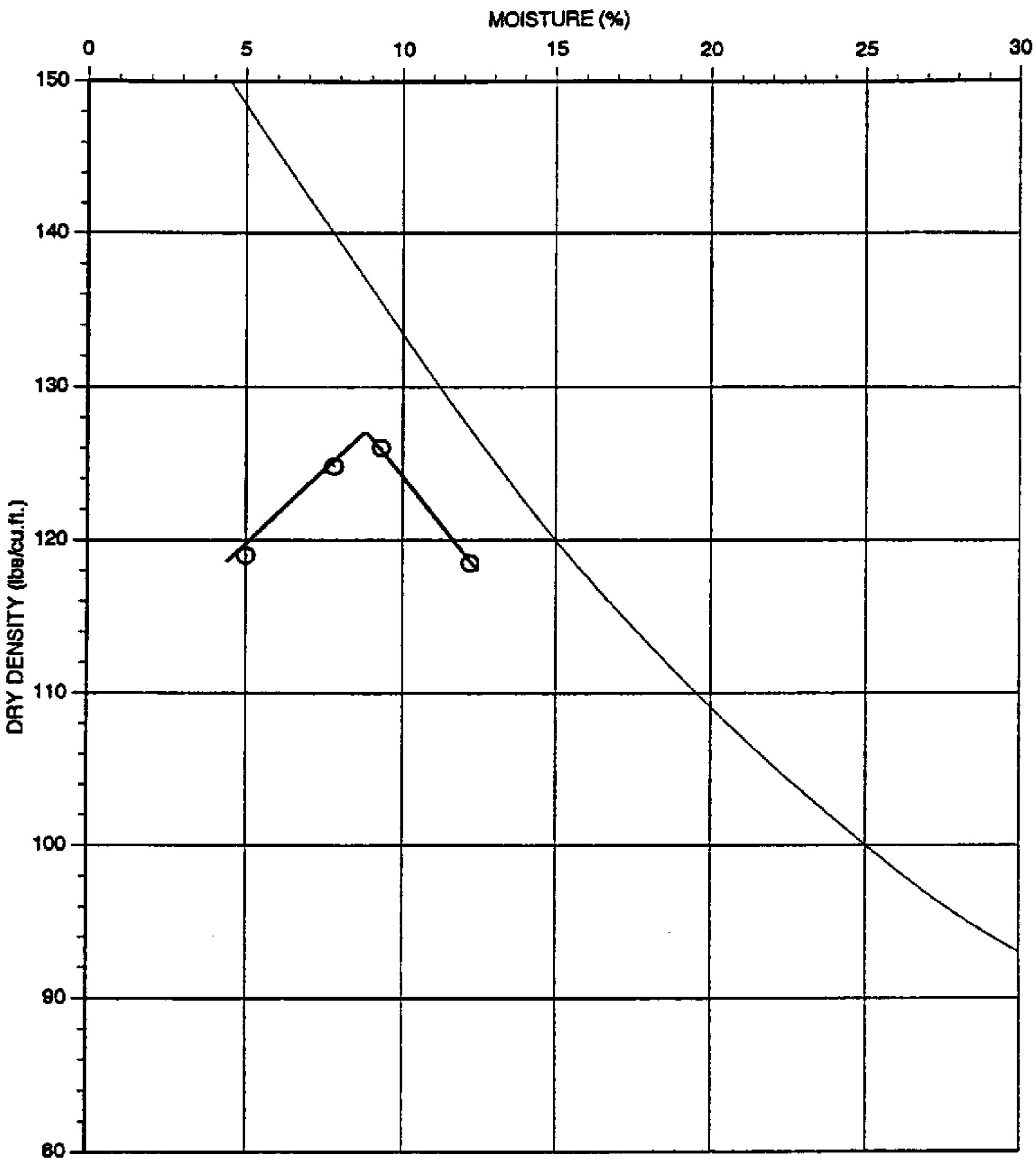
JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	LOCATION	DESCRIPTION	OPTIMUM MOISTURE CONTENT (%)	MAX. DRY DENSITY (pcf)
⊙	Ramp Strip	SAND and GRAVEL treated with polymer modified emulsion	7.9	128.3

COMPACTION TEST DATA

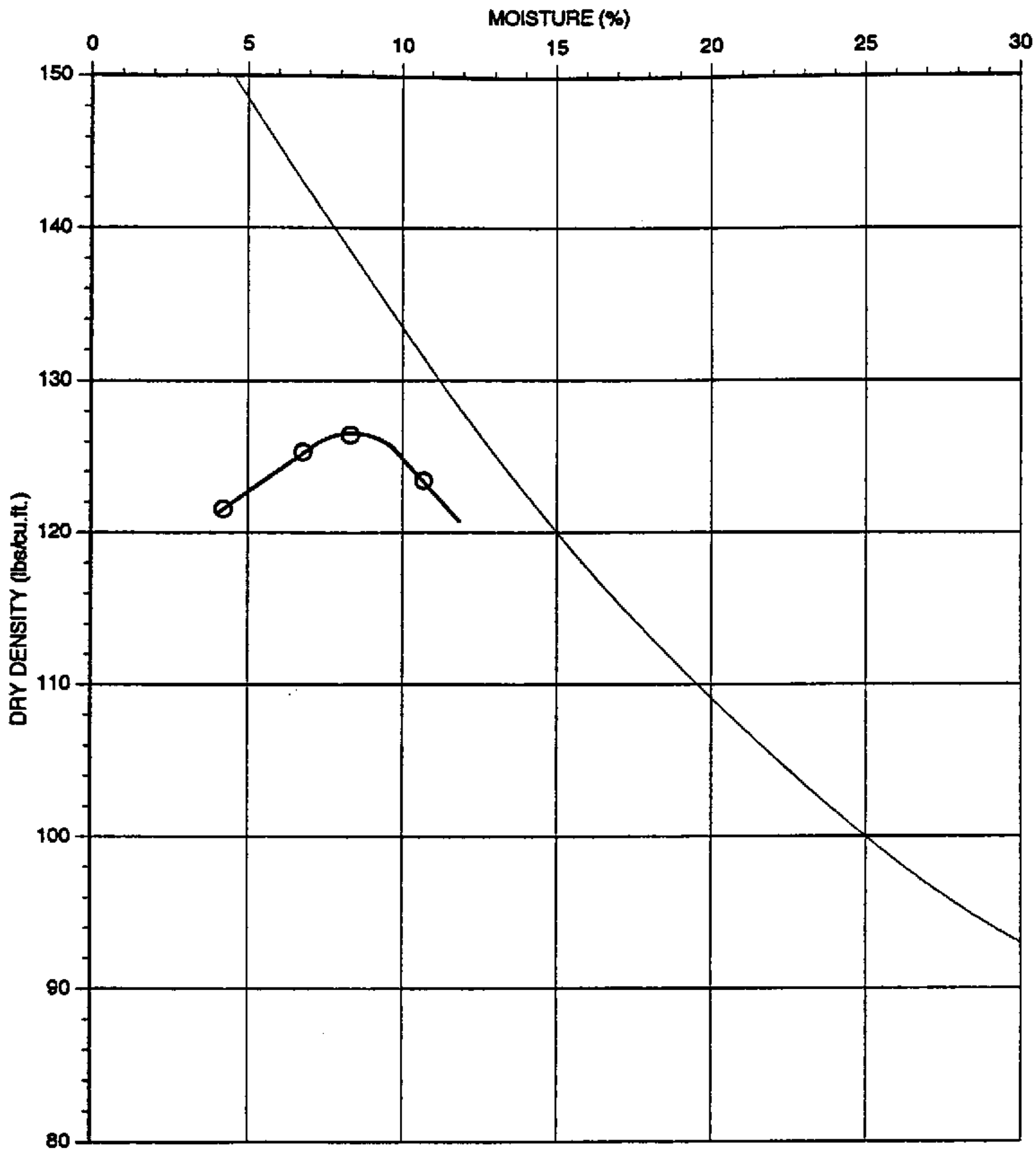
JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	LOCATION	DESCRIPTION	OPTIMUM MOISTURE CONTENT (%)	MAX. DRY DENSITY (pcf)
⊙	South Test Strip (placed on 7-21-95)	SAND and GRAVEL treated with emulsion	8.7	126.8

COMPACTION TEST DATA

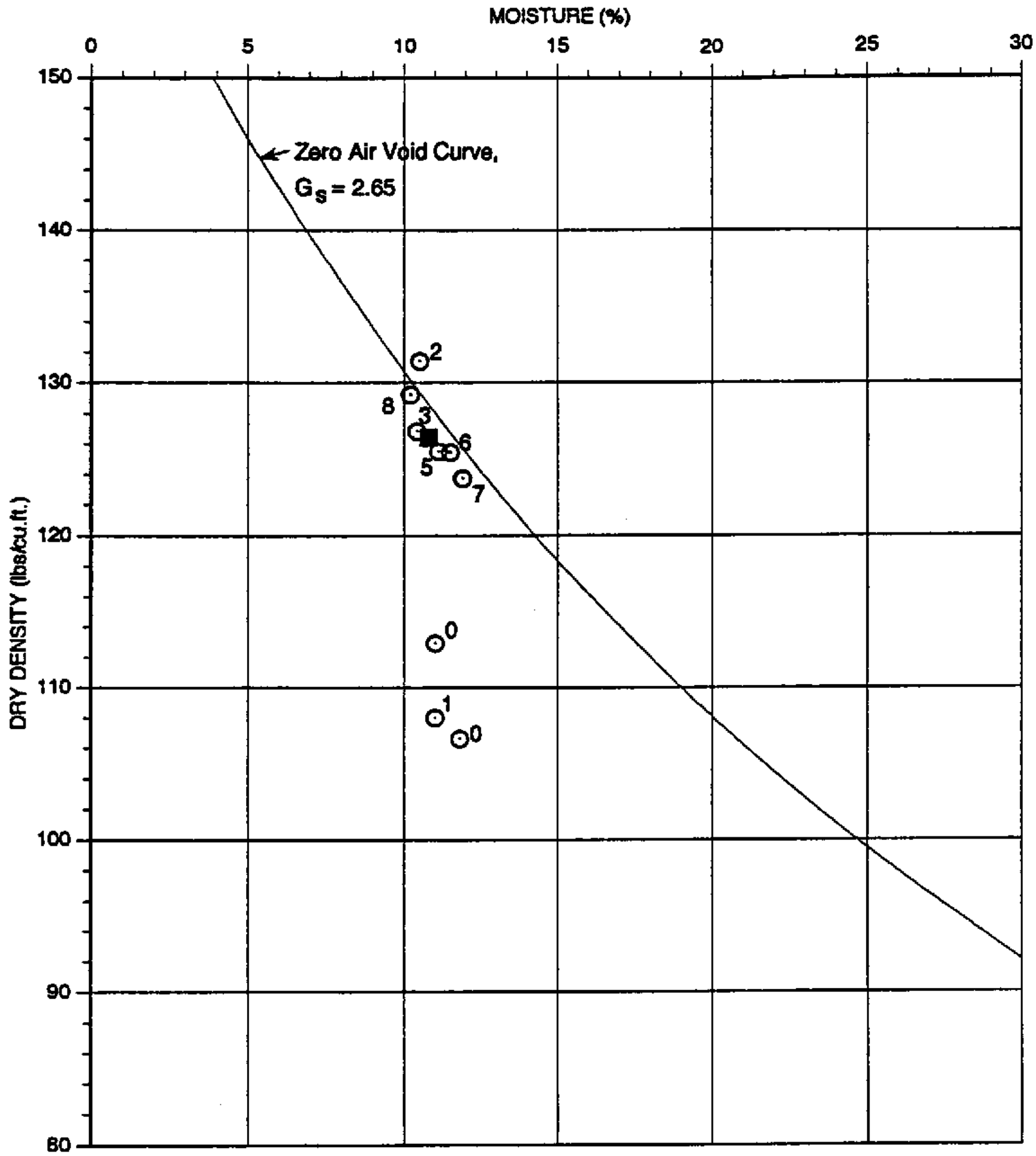
JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	LOCATION	DESCRIPTION	OPTIMUM MOISTURE CONTENT (%)	MAX. DRY DENSITY (pcf)
⊙	South Test Strip (placed on 7-24-95)	SAND and GRAVEL treated with polymer modified emulsion	8.3	126.4

COMPACTION TEST DATA

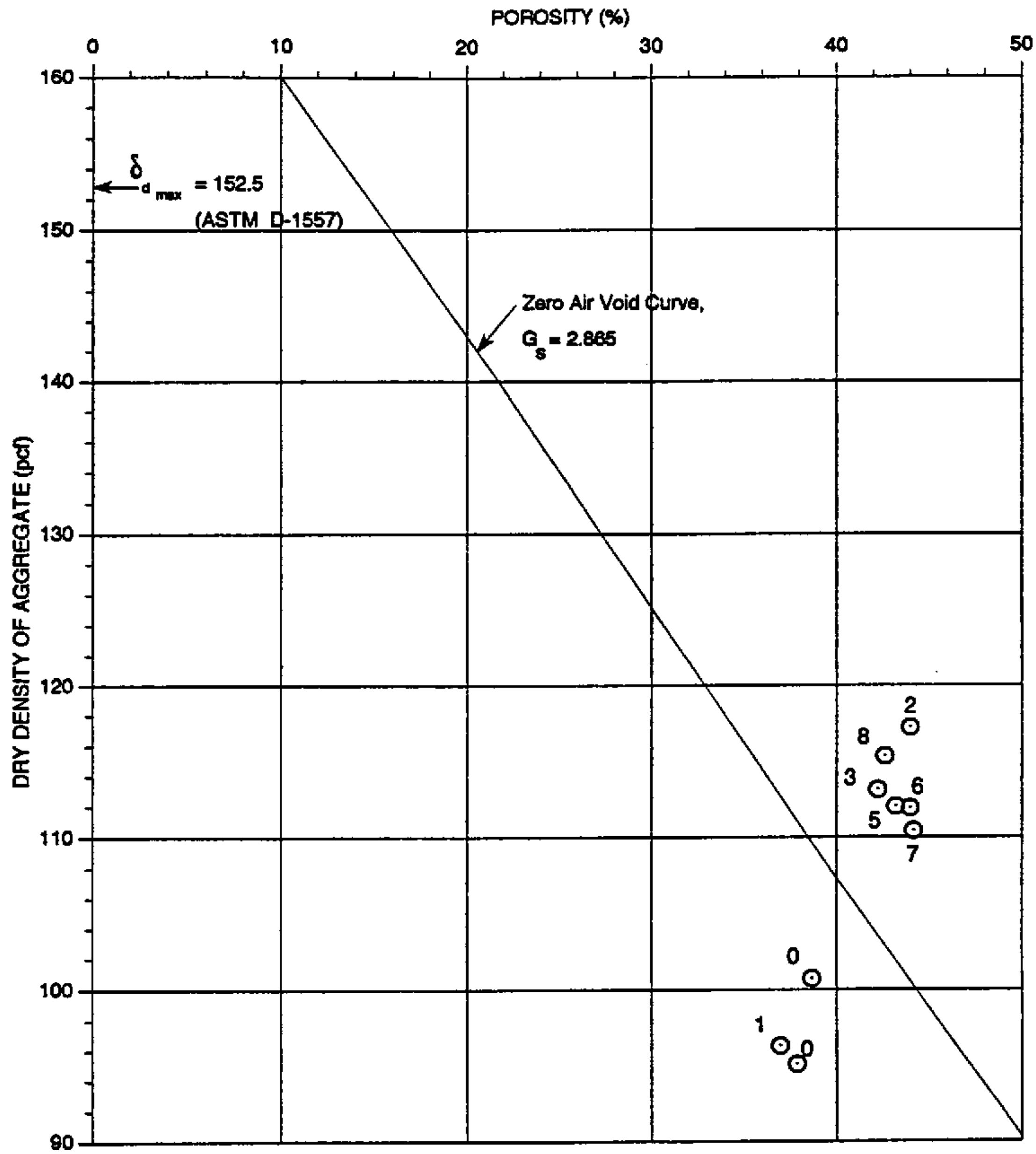
JOB NUMBER: 2048.000 DATE: 10-30-95 BY: DMH



SYMBOL	MIX IDENTIFICATION	DESCRIPTION
⊙	8-11-95 Mix	Field density test results using nuclear gauge (ASTM D-2922) with oven-dried moisture content; Number indicates passes of rolling by a rubber tire roller prior to testing
■		Single Point Compaction (ASTM D-1557) on as-mixed material

FIELD COMPACTION TEST DATA

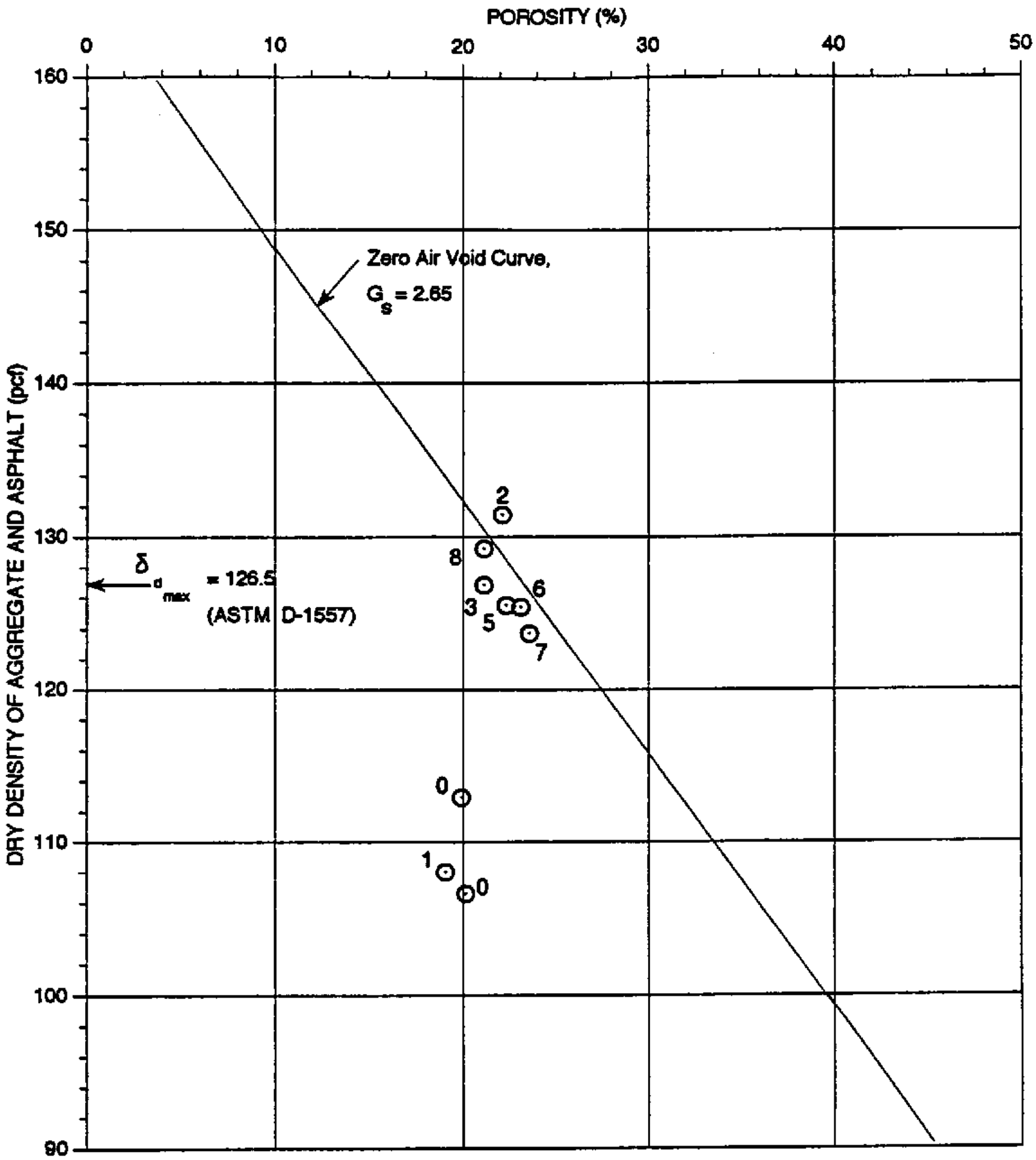
JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	MIX IDENTIFICATION	DESCRIPTION
⊙	8-11-95 Mix	Field density test results using nuclear gauge (ASTM D-2922) with oven-dried moisture content; number indicates passes of rolling prior to testing

FIELD COMPACTION TEST DATA

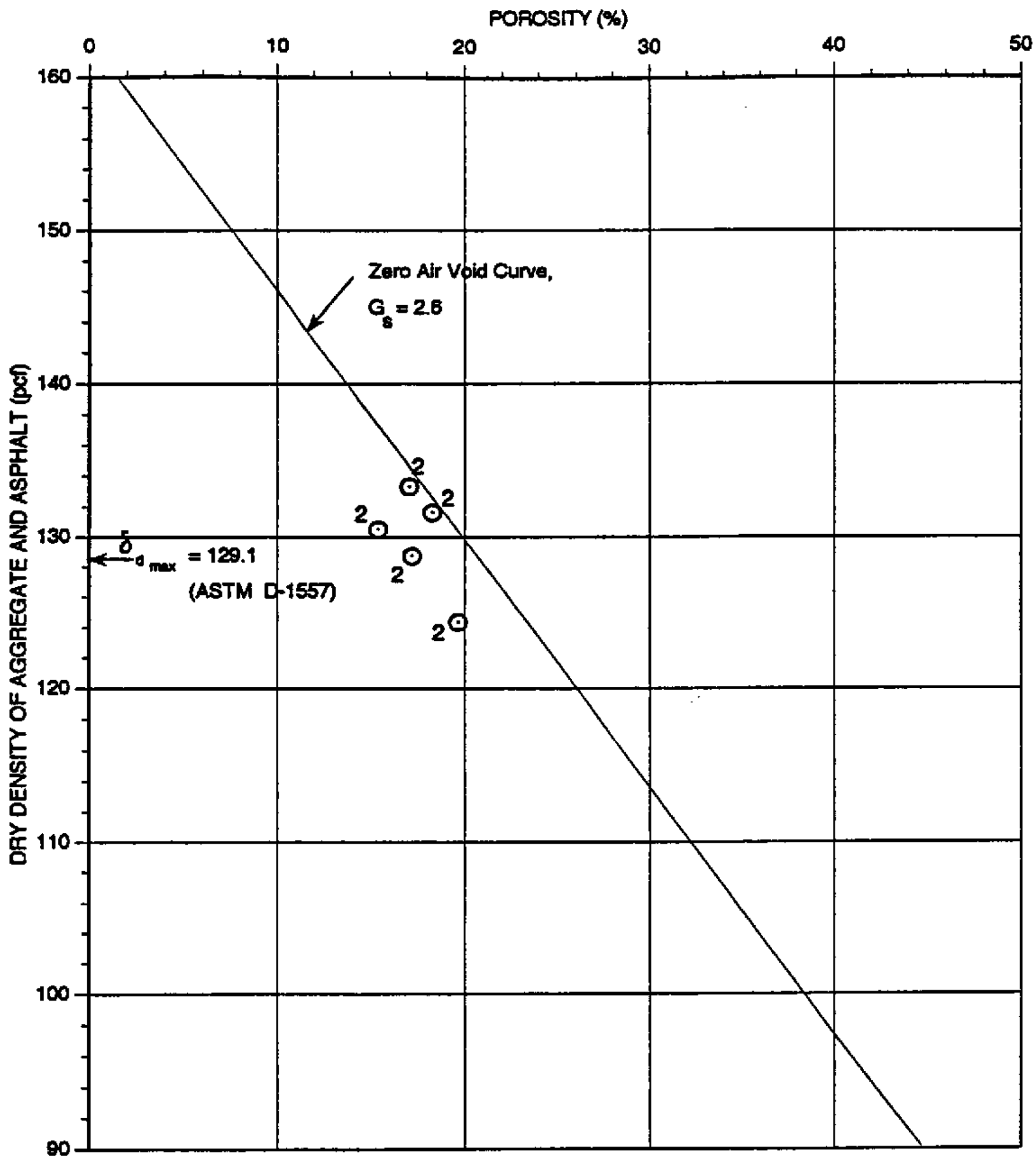
JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	MIX IDENTIFICATION	DESCRIPTION
⊙	8-11-95 Mix	Field density test results using nuclear gauge (ASTM D-2922) with oven-dried moisture content; number indicates passes of rolling prior to testing

FIELD COMPACTION TEST DATA

JOB NUMBER: 2046.000 DATE: 10-30-95 BY: DMH



SYMBOL	MIX IDENTIFICATION	DESCRIPTION
⊙	8-11-95 Mix	Field density test results using sand cone method (ASTM D-1556) with oven-dried moisture content; number indicates passes of rolling prior to testing

FIELD COMPACTION TEST DATA

APPENDIX D

ENCAPCO REPORT

OF

ANALYTICAL TESTING

ENCAPCO REPORT OF ANALYTICAL TESTING - SUPERIOR LAB/EMERYVILLE JOB#9515

DATE RPTD	DATE SMPLD	TIME SMPLD	SMPL BY	SMPL ID	LAB ID	TESTS	ELMNT	RESULTS SOIL	RESULTS ETB	UNIT	TESTED PURPOSE / REMARKS
04/11/95	04/11/95	01:10	SB	SVC-1	81171	TTLC	Pb	1800		mg/k	Initial soil composite from Emeryville of all sampled
		01:20		SVC-4			Pb	2300		mg/k	sections and a composite from Section 4.
							Zn	5400		mg/k	
				SVC-1		STLC	Pb	20		mg/l	
							Zn	260		mg/l	
				SVC-4			Pb	135		mg/l	
							Zn	350		mg/l	
				SVC-2		TRPH		100		mg/k	
				SVC-4				160		mg/k	
05/04/95	04/28/95	01:20	SB	SVC-2	81398	TTLC	Pb	380		mg/k	Second composite sample of all sections and
		01:20		SVC-2		STLC	Pb	1.7		mg/l	samples from individual sampling areas.
		01:30		SV3-4			Pb	38		mg/l	
		01:35		SV4-1A			Pb	120		mg/l	
05/10/95	05/08/95	08:30	SB	SVP-3	81480	STLC	Pb		0.45	mg/l	4 pellets made of different emulsion ingredients and
				SVP-4		STLC	Pb		0.33	mg/l	percents of emulsion.
				SVP-5		STLC	Pb		ND		
				SVP-6		STLC	Pb		ND		
05/26/95	05/24/95	02:00	SB	SVC-3	81681	TCLP RCRA	8 Mtls	ND			Composite sample of total job site for TCLP anlsys.
07/06/95	07/03/95	09:40	SB	PRL-1	82037	STLC	Pb		ND		Pellet made from ETB processed at Park & Ride Lot
							Cd		ND		test strip.
07/10/95	07/05/95	12:05	SB	SVC-12	82041	STLC	Cd	0.6		mg/l	Composite sample of total job site soil for STLC
							Pb	38		mg/l	analysis.
07/18/95	07/12/95	03:00	SB	PRL-2	82071	STLC	Cd		ND	mg/l	Sample of dried ETB processed material
							Pb		0.36	mg/l	(uncompacted).
09/14/95	08/29/95	01:30	SB	PRLS-4	20046	STLC	Pb	34			Soil sample from feeder belt during 08/29/95
							Cd	0.7			processing run.
10/06/95	09/08/95	1:15	SB	PRLP-5	20197	STLC	Pb		ND	mg/l	Pellets made from processed material per day's run,
							Cd		0.053	mg/l	encapsulation verification.
10/06/95	09/20/95	9:40	SB	PRLP-6	20197	STLC	Pb		ND	mg/l	Pellets made from processed material per day's run,
							Cd		ND	mg/l	encapsulation verification.
10/06/95	09/21/95	11:15	SB	PRLP-7	20197	STLC	Pb		ND	mg/l	Pellets made from processed material per day's run,
							Cd		ND	mg/l	encapsulation verification.