

## 7.5. PROJECT COST ESTIMATE

### 7.5.1. UNIT CONSTRUCTION COST ANALYSIS

#### (1) Market Price of Major Construction Materials

The market prices of the major construction materials are basically collected from the publication of "Costos Nueva Sede de la Biblioteca Nacional May 2006".

The following exchange rates of US\$, Peruvian Sol, and Japanese Yen in May 2006 are adopted:

- a) US\$ 1.0 = Soles 3.25
- b) US\$ 1.0 = Yen 116.35

The market prices of the major construction materials are shown in Table 7.5-1.

Table 7.5-1 List of Mayor Construction Material Market Price

Major Construction Materials	Sub-Items	Classification	Unit	(Unit: Price in May 2006)	
				Market Price (Soles)	(US\$)
Soil	Common Soil		m3	19.50	6.00
	Sand				
	River Sand		m3	12.28	3.78
	Sea Sand		m3	20.17	6.21
	Gravel	D=5 cm	m3	40.00	12.31
	Crushed Stone	D=20mm	m3	47.42	14.59
	Cobble Stone	D=150mm	m3	31.26	9.62
Cement	Poltrand Cement		30kg	11.70	3.60
Cement Concrete	Readymixed	175kg/m2, in site	m3	188.10	57.88
		210kg/m2, in site	m3	231.00	71.08
Asphalt	Hot Asphalt Mixture	in Plant	m3	183.00	56.31
	Asphalt		litter	1.19	0.37
Steel	Reinforced Bar	D=9mm	Ton	2114.00	650.46
		D=19mm	Ton	2114.00	650.46
		D=32mm	Ton	2114.00	650.46
	H-Steel	Ton	2360.00	726.15	
	Plate	e=10mm	Ton	1950.00	600.00
Fabrication	Cement Concrete Block	120*190*390	Piece	1.10	0.34
		150*190*390	Piece	1.24	0.38
		190*190*390	Piece	1.42	0.44
		100*200 T=60mm	m2	22.80	7.02
Drainage	Cement Concrete Pipe	D=200mm	m	13.20	4.06
		D=500mm	m	68.60	21.11
		D=600mm	m	111.53	34.32
	Steel Pipe	D=100mm	6m	78.38	24.12
		D=200mm	m	108.77	33.47
	Water Supply Pipe	D=200mm	5m	450.00	138.46
PVC D=300mm		5m	980.82	301.79	
Others	Road Lighting	Type-3, H=7m	Vol.	241.00	74.15
		Type-4, H=5m	Vol.	226.00	69.54
	Electric Pole	Concrete H=8m	Vol.	211.00	64.92
		Steel H=5m	Vol.	500.00	153.85
	Plantaion	Tree	Vol.	25.00	7.69
		Grass	m2	12.00	3.69
	Telephon Line	4-way	Piece	17.50	5.38
Electric Line	4-way	Piece	17.50	5.38	
				0.00	
Labore Cost	Supervisor		Day	91.28	28.09
	Skilled		Day	81.81	25.17
	Un-skilled		Day	73.84	22.72
				0.00	
Machine Cost	Buldozer	110-135HP	Hr.	164.44	50.60
	Tamping Roller	101-135HP	Hr.	101.19	31.14
	Vibrator	4-HP	Hr.	134.22	41.30
	Remarks:				
	1) US\$ 1.0=S./ 3.25				
	2) Excluding IGV				
	3) Data are mainly obtained from " Publicacion Mensual Del Grupo S 10 COSTOS"				

## **(2) Unit Cost Analysis for Major Construction Working Items**

The unit cost analysis for the major construction working items are conducted based on the following conditions.

- 1) The components of labor cost, material cost, and construction equipment cost are examined with reference to the following data and information.
  - a) Programa de Transporte Urbano de Lima Metropolitana, Estudio De Factibilidad in 2003.
  - b) Detailed Design Report of COSAC project in 2004.
  - c) Detailed Design Reports of Av. Venezuela in 1997.
  - d) Detailed Design Reports of Intersection Improvement in 1993 to 1997.
  - e) Unit cost analysis of similar construction project in 2006.
  - f) Unit cost analysis prepared by a contractor in 2006.
- 2) The unit cost analysis for major construction working items is adopted from the figures contained in Table 7.5-2.
- 3) The results of unit cost analysis for the major construction working items are shown in Table 7.5-3.

Table 7.5-2 List of Unit Construction Cost Analysis

Working Items	Sub-items	Classification	Unit	(Unit: US\$ in May 2006)			Total Cost
				Labour Cost	Material Cost	Equipment Cost	
Demolishing Works	Guardrail	Steel	%	40.3	0.0	59.7	100.0
			m	2.5	0.0	3.7	6.2
	Site Clearing	Tree	%	15.7	0.0	84.3	100.0
			ha	2.3	0.0	14.4	16.7
	Pavement	Asphalt Concrete	%	10.5	0.0	89.5	100.0
			m3	2.7	0.0	22.9	26.5
		Cement Concrete	%	18.5	0.0	71.5	100.0
			m3	9.3	0.0	35.6	49.8
		Side Walk	%	45.4	0.0	54.6	100.0
		m3	6.2	0.0	7.4	13.6	
	Concrete Structure	Concrete Block	%	27.5	0.0	72.5	100.0
			m3	5.0	0.0	13.2	18.2
	Central Reservation	W=1.0m	%	27.5	0.0	72.5	100.0
			m	0.5	0.0	1.2	1.7
		W=5.0m	%	27.5	0.0	72.5	100.0
		m	0.5	0.0	1.4	1.9	
	Electric Pole	Concrete	%	27.5	0.0	72.5	100.0
			Vol.	27.5	0.0	72.5	100.0
	Sewage		%	27.5	0.0	72.5	100.0
			m	4.1	0.0	10.9	15.0
Excavation Works	by Hand	%	95.0	0.0	5.0	100.0	
		m3	6.5	0.0	0.3	6.8	
		By Machine	%	16.0	0.0	84.0	100.0
	m3	0.4	0.0	1.9	2.3		
Enbankment Works	Road	Common soil	%	2.9	63.0	34.1	100.0
			m3	0.3	5.2	2.9	8.4
	Structure	%	43.0	3.7	53.3	100.0	
		m3	4.8	0.4	6.0	11.2	
Wasted Soil	10km Transport	%	20.0	0.0	80.0	100.0	
		M3	1.0	0.0	4.1	5.1	
Pavement Works	Asphalt Concrete (Carriageway)	Sub-base(T=25cm)	%	4.4	68.4	27.2	100.0
			m3	0.7	11.3	4.5	16.5
		Base(T=20cm)	%	4.3	64.8	30.9	100.0
			m3	0.8	12.2	5.8	18.8
		Asphalt Concrete (T=5cm)	%	2.0	62.4	35.6	100.0
			m2	0.1	3.4	2.0	5.5
		Asphalt Concrete (T=10cm)	%	2.0	69.9	28.1	100.0
			m2	0.2	6.8	2.7	9.7
		Asphalt Sheel	%	14.4	29.9	55.7	100.0
			m2	0.1	0.2	0.3	0.6
	Cement Concrete (Carriageway)	Sub-base(T=20cm)	%	4.4	68.4	27.2	100.0
			m3	0.7	11.3	4.5	16.5
		Base(T=20cm)	%	4.3	64.8	30.9	100.0
			m3	0.8	12.2	5.8	18.8
		Reinforced Bar	%	20.0	70.0	10.0	100.0
			m2	1.8	6.3	1.0	9.1
		Concrete(T=10cm)	%	26.3	71.0	3.7	100.0
			m2	2.7	7.2	0.4	10.3
	Concrete(T=20cm)	%	25.0	73.0	2.0	100.0	
		m2	4.6	13.5	0.4	18.5	
	Asphalt Concrete Overlay(Carriageway)	Levelling	%	10.0	0.0	90.0	100.0
			m2	0.1	0.0	0.8	0.9
		Asphalt (Conection)	%	4.1	64.2	31.7	100.0
			m2	0.1	0.5	0.2	0.8
		Asphalt Concrete (T=5cm)	%	2.0	62.4	35.6	100.0
			m2	0.1	3.4	2.0	5.5
		Asphalt Concrete (T=10cm)	%	2.0	69.9	28.1	100.0
			m2	0.2	6.8	2.7	9.7
		Asphalt Sheel	%	14.4	29.9	55.7	100.0
			m2	0.1	0.2	0.3	0.6
Asphalt Concrete (Side Walks)	Sub-Base (T=15cm)	%	4.4	68.4	27.2	100.0	
		m3	0.7	11.3	4.5	16.5	
	Base(T=10cm)	%	4.3	64.8	30.9	100.0	
		m3	0.8	12.2	5.8	18.8	
	Asphalt Concrete (T=5cm)	%	2.0	62.4	35.6	100.0	
		m2	0.1	3.4	2.0	5.5	
Cement Concrete (Side Walks)	Sub-base(T=10cm)	%	4.4	68.4	27.2	100.0	
		m3	0.7	11.3	4.5	16.5	
	Base(T=5cm)	%	4.3	64.8	30.9	100.0	
		m3	0.8	12.2	5.8	18.8	
Reinforced Bar	%	20.0	70.0	10.0	100.0		
	m2	1.0	3.5	0.5	5.0		

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		Cement Concrete (T=5cm)	%	26.3	71.0	3.7	100.0
			m2	1.6	4.2	0.2	6.0
Concrete Works	Central Reservation	(0.3*0.15*1.0)*2	%	30.6	66.2	3.2	100.0
			m	3.5	7.6	0.4	11.5
	Outer Reservation	(0.3*0.15*1.0)*2	%	30.6	66.2	3.2	100.0
			m	3.5	7.6	0.4	11.5
	Block for Side Walk	0.3*0.15*1.0	%	30.6	66.2	3.2	100.0
			m	1.9	4.0	0.2	6.1
Utilities Works	Sewage	Concrete Pipe D=0.5m,	%	10.0	70.0	20.0	100.0
			m	3.0	21.1	6.0	30.1
	Water Supply	Steel Pipe	%	10.0	70.0	20.0	100.0
			m	19.8	138.5	39.5	197.8
	Tel. & Electric Line	Concrete Box 0.5*0.5*1.0	%	10.0	80.0	10.0	100.0
			m	2.3	18.4	2.3	23.0
	Manhole	D=0.6m, H=1.5m	%	10.0	80.0	10.0	100.0
			Vol.	12.8	102.2	12.8	127.8
Traffic Facilities	Traffic Signal	For Vehicle	%	10.0	80.0	10.0	100.0
			Unit	1,118.5	8,948.0	1,118.5	11,185.0
		For Pedestrian	%	10.0	80.0	10.0	100.0
			Unit	894.0	7,157.6	895.0	8,947.0
	Traffic Board		%	50.0	39.0	11.0	100.0
			Unit	50.5	39.4	11.1	101.0
	Information Board		%	50.0	39.0	11.0	100.0
			Unit	50.5	39.4	11.1	101.0
	Lane Mark		%	43.0	52.3	4.7	100.0
			m	0.7	0.8	0.1	1.6
	Lighting	Concrete Pole	%	10.0	70.0	20.0	100.0
			Unit	10.4	72.8	20.8	104.0
Others	Gurdrail	Steel H=0.5m	%	3.3	96.6	0.1	100.0
			m	1.0	28.5	0.1	29.6
	Plantation of Road	Tree	%	33.3	56.8	9.9	100.0
			Unit	4.6	7.7	1.3	13.6
		Grass	%	21.3	77.6	0.1	100.0
			m2	1.5	5.5	0.1	7.1
Bus Stop	2-booth (L=50m,W=3.5m)	Concrete (50*3.5=175m2)	%	11.9	87.4	0.7	100.0
			Unit	372.7	2,738.2	21.9	3,133.0
		Fence(L=50m)	%	47.9	47.1	5.0	100.0
			Unit	296.0	291.0	31.0	618.0
		Roof (50*3.5=175m2)	%	40.0	50.0	10.0	100.0
			Unit	700.0	875.0	175.0	1,750.0
		Wall (50*3=150m2)	%	40.0	50.0	10.0	100.0
			Unit	700.0	875.0	175.0	1,750.0
		Ticket Office 1.5*2=3.0m2	%	40.0	50.0	10.0	100.0
			Unit	200.0	250.0	50.0	500.0
		Bench(L=20m)	%	40.0	50.0	10.0	100.0
			Unit	120.0	150.0	30.0	300.0
		Lighting	%	40.0	50.0	10.0	100.0
			Vol.	200.0	250.0	50.0	500.0
	Sub-total		Unit				8,551.0
Bus Terminal (210*74=15,540m2)	Pavement	Asphalt(S=5,000m2)	%	5.0	65.0	30.0	100.0
			Unit	5,960.0	77,480.0	35,760.0	119,200.0
	Bus Platform	Bus Booth(6-Unit.) S=(100*20)*2	%	5.0	65.0	30.0	100.0
			Unit	7,200.0	93,600.0	43,200.0	144,000.0
	Office Building	Office(600m2)	%	15.0	40.0	45.0	100.0
			Unit	45,000.0	120,000.0	135,000.0	300,000.0
	Fence	Hence(L=600m)	%	40.0	50.0	10.0	100.0
			Unit	2,966.4	3,708.0	741.6	7,416.0
	Gasolin Stand	Gasolin Stand	%	10.0	30.0	60.0	100.0
			Unit	500.0	1,500.0	3,000.0	5,000.0
	Passenger Building	Passenger Waiting Room(800m2)	%	15.0	40.0	45.0	100.0
			Unit	60,000.0	160,000.0	180,000.0	400,000.0
	Information Board	Information System	%	45.0	45.0	10.0	100.0
			Unit	4,500.0	4,500.0	1,000.0	10,000.0
	Parking Area	50*35=1,750m2	%	5.0	65.0	30.0	100.0
			Unit	1,303.8	16,948.8	7,822.4	26,075.0
	Utilities	Utility System	%	35.0	40.0	25.0	100.0
			Unit	17,500.0	20,000.0	12,500.0	50,000.0
	Others	Marking,Plantation, etc.	%	35.0	40.0	25.0	100.0
			Unit	17,500.0	20,000.0	12,500.0	50,000.0
	sub-total		Unit				1,085,616.0

Remarks:

1) 1.0 US\$ = S./ 3.25

2) Excluding IGV(19%)

3) Direct Unit Construction Cost

Table 7.5-3 Unit cost of Major construction Working Items

Working Items	Sub-items	Classification	Unit	Unit Cost (US\$)	
<b>A Administration</b>					
A-01	Working Office and Warehouse in Site		m2	20.00	
A-02	Administration Office in Site		m2	25.00	
A-03	Wall and Fence of Site		Unit	10,000.00	
A-04	Water & Electrical Supply of Site		Unit	5,000.00	
A-05	Safety Control in Site		Unit	5,000.00	
<b>B Preparation and Mobilization</b>					
B-01	Mobilization of Machine and Material To Site		Unit	40,000.00	
B-02	Site Clearing	Vacant Area and Road side	Ha	10.00	
B-03	Traffic Control Management	During Under Construction Period	Unit	10,000.00	
<b>C Construction Works (Direct Cost)</b>					
C-01	Demolishing Works	Guardrail	m	6.20	
		Plantation	m2	16.70	
		Asphalt Concrete Pavement	m3	26.50	
		Cement Concrete Pavement	m3	49.80	
		Side Walk Pavement	m3	13.60	
		Central Reservation	W=5m	1.90	
		Outer Separation	W=1m	1.70	
		Concrete Block(Side of Side Walks 15*30*100	m	1.70	
		Sewage Pipe and Water Supply Pipe	m	15.00	
		Electric Power Pole & Lanes	vol.	32.00	
		Concrete Structure	Building	49.80	
		Concrete Wall	H=3.0m	3.30	
C-02	Soil Works	Excavation	By hand	m3	6.80
		Excavation	By Machine	m3	2.30
		Embankment of Structure	In Site	m3	11.20
		Embankment of Road	In Site	m3	8.40
		Compaction of Soil		m3	8.00
		Wasted Soil	L=10km	m3	5.10
C-03	Concrete Works	Ready-mixed Concrete	210kg/m2	m3	85.00
		Ready-mixed Concrete	100kg/m2	m3	65.00
		Hot-mixed Asphalt		m3	80.00
C-04	Pavement Works for Carriageways and Exclusive Trunk Bus way	Asphalt Concrete Pavement	Sub-base (25cm)	m3	16.50
			Base(20cm)	m3	18.80
			Water Protection	m2	0.60
			Asphalt (10cm)	m2	9.70
			Asphalt (5cm)	m2	5.50
		Cement Concrete Pavement	Sub-base (20cm)	m3	16.50
			Base(20cm)	m3	18.80
			Frame(0.2cm*4)	m2	8.10
			Reinforced(10kg)	m2	9.10
			Concrete(10cm)	m2	10.30
			Concrete(20cm)	m2	18.50
		Asphalt Concrete Overlay	Leveling	m2	0.90
			Connection (Asphalt)	m2	0.80
			Asphalt (10cm)	m2	9.70
			Asphalt (5cm)	m2	5.50
			Asphalt(3cm)	m2	3.50
	Pavement Works for Side Walks	Asphalt Concrete Pavement	Sub-base (15cm)	m3	16.50
			Base(10cm)	m3	18.80
			Asphalt(5cm)	m2	5.50
		Cement Concrete Pavement	Concrete(5cm)	m2	6.00
			Frame(0.05cm*4)	m2	1.90
			Reinforced(3kg)	m2	5.00
			Sub-base (15cm)	m3	16.50
			Base(5cm)	m3	18.80
C-05	Concrete Works	I-type Gutter Concrete Block	15*30cm	m	6.10
		Central Reservation(I-type*2)	(15*30cm)*2	m	11.50
		Outer Separation(I-type*2)	(15*30cm)*2	m	11.50

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C-06	Utility Works	Sewage(D=450)	Concrete Pipe	m	30.10
		Water Supply(D=150)	Steel Pipe	m	100.00
		Electric & Telephon(0.5m*0.5m*0.5	Concrete Box	m	23.00
		Manhole	Improvement	Vol.	23.00
C-07	Traffic and Facilities	Lane Marking		m	1.60
		Traffic Marking		m	1.60
		Traffic Board		Unit	101.00
		Information Board		Unit	101.00
		Traffic Signal for Vehicle		Unit	11,185.00
		Traffic Signal for Pedestrian		Unit	8,947.00
C-08	Safety and Environmental Facilities	Gurdrail		m	29.60
		Lighting (30m Interval)		30m	104.00
		Plantation (20m Interval)	Tree(H=3.0m)	20m	13.60
		Plantation	Grass	m2	7.10
C-09	Bus Stop	1-Bus Booth	L=25m,W=3.5m	vol.	4,275.00
		2-Bus Booth	L=50m,W=3.5m	vol.	8,551.00
C-10	Bus Terminal		S=15,540 Ha	vol.	1,085,616.00
C-11	Social Environmental	Under-construction		unit	300,000.00
		After-construction		unit	200,000.00
D	Sub-total (A to C)=Direct Cost				
E	Overhead	Direct Cost (D) * 15%			
F	Profit	Direct Cost (D) * 10%			
G	Sub-total (A to E)				
H	Land Acquisition Cost				
I	Compensation				
J	Total Construction Cost (A to E)				
K	Engineering Cost	Total Construction Cost (J) * 10%			
L	Administrartion Cost	Total Construction Cost (J) * 10%			
M	Contiengency	Total Construction Cost (J) * 15%			
N	Sub-total (A to L)				
O	IGV	N * 19%			
P	Grand Total				

## 7.5.2. PROJECT COST ESTIMATE

### (1) Conditions of Project Cost

- 1) The project cost includes the following items.
  - a) Construction cost
  - b) Land acquisition cost and compensation
  - c) Engineering cost
  - d) Contingency
  - e) Administrative cost
  - f) IGV
- 2) The construction cost includes the following items.
  - a) Direct construction cost of trunk busway, the improvement of existing road, and bus stops and bus terminals.
  - b) Indirect construction cost of trunk busway, the improvement of existing road, and bus stops and bus terminals.
  - c) Constructor's profit
- 3) Land acquisition cost and compensation includes the following items
  - a) Land acquisition cost
  - b) Compensation for buildings
- 4) The project cost is estimated based on the May, 2006 price. The exchange rates are as follows.
  - a) US\$ 1.0 = Soles 3.25
  - b) US\$ 1.0 = Japanese Yen 116.35

### (2) Construction Cost Estimate

Based on the major construction working item unit cost analysis and construction quantities estimate, the construction cost is estimated. The total construction cost is shown in Table 7.5-4. The detailed construction cost of Av. Venezuela and Av. Arica is shown in Table 7.5-5, and Av. Ayllon and Carretera Central is shown in Table 7.5-6.

In addition to the above, the construction cost for improvement of bus stop facilities (3 bus stops) on Av. Grau is shown in Table 7.5-7.

Table 7.5-4 Total Construction Cost for Trunk Busway

Road Segment	Construction Cost (US\$ 1,000)	Remarks
Av. Venezuela –Av. Arica	15,086	See Table 7.5-5
Av. Ayllon—Carr. Central	13,330	See Table 7.5-6
Improvement of Bus Stop on Av. Grau	529	See Table 7.5-7
Total	28,945	

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Table 7.5-5 Construction Cost on Av. Venezuela and Av. Arica

Items	Unit	Unit Cost (US\$)	Ovalo Saloom - Av. Arica ( 8,550m )									
			Av. Elmer Faucett - Av. Venezuela (2,360m)		Av. Universitaria - Av. Venezuela (1,980m)		Av. Arica - Av. Venezuela (2,370m)		Av. Venezuela - Av. Arica (1,840m)		Total (L=8,550m)	
			Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	
<b>A Administration</b>												
Working Office and Warehouse in Site	m <sup>2</sup>	20.0	500.0	10,000	0.0	0	0.0	0	0.0	0	500.0	10,000
Administration Office in Site	m <sup>2</sup>	25.0	500.0	12,500	0.0	0	0.0	0	0.0	0	500.0	12,500
Wall and Fence of Site	Unit	10,000	1.0	10,000	0.0	0	0.0	0	0.0	0	1.0	10,000
Water & Electrical Supply of Site	Unit	10,000	1.0	10,000	0.0	0	0.0	0	0.0	0	1.0	10,000
Safety Control in Site	Unit	5,000	1.0	5,000	0.0	0	0.0	0	0.0	0	1.0	5,000
<b>B Preparation and Mobilization</b>												
Mobilization of Machine and Material	Unit	40,000	1.0	40,000	0.0	0	0.0	0	0.0	0	1.0	40,000
Site Clearing	Unit	10,000.0	1.0	10,000	0.0	0	0.0	0	0.0	0	1.0	10,000
Traffic Control Management	Unit	10,000	1.0	10,000	0.0	0	0.0	0	0.0	0	1.0	10,000
<b>C. Direct Cost</b>												
<b>1.Site Clearing and Demolition</b>												
Sidewalk	m <sup>3</sup>	33.2	630.0	20,941	127.5	4,238	639.0	21,240	1,228.5	40,835	2625.0	87,255
Median Plantation 2.5	m <sup>2</sup>	13.4	630.0	8,423	50.0	669	2,566.0	34,307	150.0	2,006	3396.0	45,405
Light Pole	vol	44.0	206.0	9,063	8.0	353	103.0	4,533	50.0	2,200	367.0	16,149
Electric Pole	vol	35.0	17.0	595	4.0	140	46.0	1,609	93.3	3,267	160.3	5,611
Traffic Signal	vol	44.0	14.0	616	2.0	88	8.0	352	8.0	352	32.0	1,408
Traffic Sign	vol	22.0	5.0	110	7.0	154	3.0	66	3.0	66	18.0	396
Bus stop facilities	vol	1,300.0	5.0	6,500	2.0	2,600	1.0	1,300	0.0	0	8.0	10,400
Pedestrian Bridge	vol	27,000.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Tree Small 10cm<t<20cm(Moving)	vol	24.5	1,030.0	25,256	50.0	1,226	16.0	392	160.0	3,923	1256.0	30,797
Tree Big 30cm<t (Moving)	vol	35.0	3.0	105	29.0	1,015	6.0	210	0.0	0	38.0	1,330
Concrete Structure	m <sup>3</sup>	5.5	4.0	22	6.0	33	0.0	0	3.0	16	13.0	71
Other Structure(Wall)	m	6.6	2,950.0	19,588	1,600.0	10,624	1,400.0	9,296	0.0	0	5950.0	39,508
<b>2.Excavation</b>												
Asphalt ( 5cm )	m <sup>2</sup>	0.8	22,795.0	18,236	4,925.0	3,940	14,160.0	11,328	5,675.0	4,540	47555.0	38,044
Concrete (20cm )	m <sup>2</sup>	1.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Soil (Waste)	m <sup>3</sup>	5.1	3,539.5	17,874	423.8	2,140	4,621.0	23,336	1,662.3	8,394	10246.5	51,745
Exc./ Fill	m <sup>3</sup>	5.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Soil Transport	m <sup>3</sup> /km	10.7	4,247.4	45,447	522.9	5,595	5,545.2	59,334	1,994.7	21,343	12310.2	131,720
<b>3.Pavement</b>												
Asphalt Overlay t = 5cm	m <sup>2</sup>	7.2	47,295.0	340,524	11,510.0	82,872	24,470.0	176,184	32,000.0	230,400	115275.0	829,980
<b>Trunk busway / Arterial</b>												
Asphalt t = 10cm	m <sup>2</sup>	10.3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Base course t = 20cm	m <sup>2</sup>	3.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Sub-base course t = 30cm	m <sup>2</sup>	3.4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
<b>Trunk busway / Arterial</b>												
a. Asphalt t = 15cm	m <sup>2</sup>	15.1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
b. Base course t = 25cm (Carre. Centar	m <sup>2</sup>	3.6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
a. Sub-base course t = 35cm	m <sup>2</sup>	3.4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Vene-Asphalt t = 5cm	m <sup>2</sup>	7.2	20,900.0	150,480	34,800.0	250,560	29,750.0	214,200	6,980.0	50,256	92430.0	665,496
Vene-Cement Conc. t = 20cm	m <sup>2</sup>	18.5	21,870.0	404,595	35,850.0	663,225	31,070.0	574,795	7,940.0	146,890	96730.0	1,789,505
Vene-Base course t = 30cm	m <sup>2</sup>	1.1	21,870.0	24,057	35,850.0	39,435	31,070.0	34,177	7,940.0	8,734	96730.0	106,403
<b>Frontage Lane</b>												
Asphalt t = 5cm	m <sup>2</sup>	6.1	8,000.0	48,800	16,800.0	102,480	16,800.0	102,480	0.0	0	41600.0	253,760
Base course t = 20	m <sup>2</sup>	3.2	8,760.0	28,032	17,380.0	55,616	17,400.0	55,680	0.0	0	43540.0	139,328
Sub-base course t = 30	m <sup>2</sup>	3.4	8,760.0	29,784	17,380.0	59,092	17,400.0	59,160	0.0	0	43540.0	148,036
<b>Sidewalk</b>												
Cement Concrete t=10cm	m <sup>2</sup>	10.2	19,200.0	195,840	12,440.0	126,888	14,000.0	142,800	9,675.0	98,685	55315.0	564,213
Base course t = 10cm	m <sup>2</sup>	1.9	19,680.0	36,998	13,140.0	24,703	14,880.0	27,974	10,315.0	19,392	58015.0	109,068
Plantation	vol	13.6	480.0	6,533	290.0	3,947	204.0	2,776	140.0	1,905	1114.0	15,161
<b>4.Drainage</b>												
Manhole (5cm levee raising)	vol	37.2	84.0	3,125	70.0	2,604	84.0	3,125	71.0	2,641	309.0	11,495
<b>5.Additional</b>												
Chapter Bar	m	20.0	500.0	10,000	1,000.0	20,000	400.0	8,000	3,200.0	64,000	5100.0	102,000
<b>6.Facilities</b>												
Median 1.0m, 2.0m	m	15.0	19,200.0	288,000	11,600.0	174,000	0.0	0	1,600.0	24,000	32400.0	486,000
Median Plantation 2.0m	m	8.0	960.0	7,680	580.0	4,640	12,800.0	102,400	0.0	0	14340.0	114,720
Guard Rail	m	29.0	4,720.0	136,880	3,960.0	114,840	4,740.0	137,460	3,680.0	106,720	17100.0	495,900
Lighting	vol	74.2	240.0	17,796	96.0	7,116	133.3	9,887	50.0	3,708	519.3	38,506
Lane Marking	m	1.6	12,000.0	19,200	7,850.0	12,560	8,800.0	14,080	3,200.0	5,120	31850.0	50,960
Traffic Signs	vol	101.0	5.0	505	3.0	303	5.0	505	3.0	303	16.0	1,616
Traffic Signal	Unit	50,000.0	3.0	150,000	2.0	100,000	3.0	150,000	3.0	150,000	11.0	550,000
Box Culvert	m	45.0	4,800.0	216,000	2,900.0	130,500	4,000.0	180,000	3,000.0	135,000	14700.0	661,500
<b>7.Intersection</b>												
At-grade signalized	vol	80,530.0	3.0	241,590	2.0	161,060	3.0	241,590	2.0	161,060	10.0	805,300
At-grade non signalized	vol	35,790.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
<b>8.Bridge</b>												
Pedestrian Bridge	vol	90,000.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
9 Bus Stop	vol	37,508.0	6.0	225,048	4.0	150,032	6.0	225,048	6.0	225,048	22.0	825,176
<b>10 .Bus Terminal</b>												
Social Environmental - Under	Unit	2,237,875.0	1.0	2,237,875	0.0	0	0.0	0	0.0	0	1.0	2,237,875
Social Environmental - After	Unit	300,000.0	1.0	300,000	0.0	0	0.0	0	0.0	0	1.0	300,000
<b>D. Sub-total (A to C)</b>												
				5,599,618		2,319,288		2,629,625		1,520,805		12,069,336
<b>E. Overhead Direct Cost (D)*15%</b>												
				839,943		347,893		394,444		228,121		1,810,400
<b>F. Profit Dierct Cost (D)*10%</b>												
				559,962		231,929		262,962		152,081		1,206,934
<b>G. Total (A to F)</b>												
				6,999,522		2,899,110		3,287,031		1,901,006		15,086,670



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Table 7.5-6 Construction Cost on Av. Ayllon and Carretera Central

Items	Unit	Unit Cost (US\$)	Av. Grau - Via de Evitamiento (4,950m)										Total (L = 9,080 m)	
			Av. Circunvalación - Carretera Central (1,920)		Av. Nicolás Avellan Carretera Central (1,160)		Via de Evitamiento - Carretera Central (1,870 m)		Av. Asturias - Carretera Central (3,390 m)		Av. Separadora Industrial - Carretera Central (740 m)			
			Quantity		Quantity		Quantity		Quantity		Quantity		Quantity	
Unit : US\$														
<b>A. Administration</b>														
Working Office and Warehouse in Site	m <sup>2</sup>	20.0	500.0	10,000					0.0	0			500.0	10000
Administration Office in Site	m <sup>2</sup>	25.0	500.0	12,500					0.0	0			500.0	12500
Wall and Fence of Site	Unit	10,000	1.0	10,000					0.0	0			1.0	10000
Water & Electrical Supply of Site	Unit	10,000	1.0	10,000					0.0	0			1.0	10000
Safety Control in Site	Unit	5,000	1.0	5,000					0.0	0			1.0	5000
<b>B. Preparation and Mobilization</b>														
Mobilization of Machine and Material to Site	Unit	40,000	1.0	40,000					0.0	0			1.0	40000
Site Clearing	Unit	10,000.0	1.0	10,000					0.0	0			1.0	10000
Traffic Control Management	Unit	10,000	1.0	10,000					0.0	0			1.0	10000
<b>C. Direct Cost</b>														
<b>1. Site Clearing and Demolition</b>														
Sidewalk	m <sup>2</sup>	33.2	514.5	17,102	330.0	10,969	480.0	15,955	840.0	27,922	105.0	3,490	2269.5	75438.18
Median Plantation 2.5	m <sup>3</sup>	13.4	3,640.0	48,667	100.0	1,337	528.0	7,059	1,072.0	14,333	300.0	4,011	5640.0	75406.8
Light Pole	Vol.	44.0	88.0	3,873	66.0	2,903	40.0	1,760	162.5	7,150	35.0	1,540	391.5	17226
Electric Pole	Vol.	35.0	46.0	1,610	50.0	1,750	80.0	2,800	310.0	10,850	52.5	1,838	538.5	18847.5
Traffic Signal	Vol.	44.0	4.0	176	4.0	176	6.0	264	12.0	528	2.0	88	28.0	1232
Traffic Sign	Vol.	22.0	0.0	0	0.0	0	0.0	0	5.0	110	1.0	22	6.0	132
Bus stop facilities	Vol.	1,300.0	0.0	0	0.0	0	1.0	1,300	6.0	7,800	1.0	1,300	8.0	10400
Pedestrian Bridge	Vol.	27,000.0	0.0	0	0.0	0	3.0	81,000	0.0	0	0.0	0	3.0	81000
Small Tree 10 cm. < t < 20 cm. (Moving)	Vol.	24.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Big Tree 30 cm. < t (Moving)	Vol.	35.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Concrete Structure	m <sup>3</sup>	5.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Other Structure (Wall)	m	6.6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
<b>2. Excavation</b>														
Asphalt (5 cm.)	m <sup>2</sup>	0.8	0.0	0	7,370.0	5,896	9,480.0	7,584	0.0	0	4,270.0	3,416	21120.0	16896
Concrete (20 cm.)	m <sup>3</sup>	1.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Soil (Waste)	m <sup>3</sup>	5.1	4,154.5	20,980	798.5	4,032	1,482.0	7,484	1,912.0	9,656	832.0	4,202	9179.0	46353.95
Exc/ Fill	m <sup>3</sup>	5.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Soil Transport	m <sup>3</sup> /km	10.7	4,985.4	53,344	958.2	10,253	1,778.4	19,029	2,294.4	24,550	998.4	10,683	11014.8	117858.36
<b>3. Pavement</b>														
Asphalt Overlay t = 10 cm.	m <sup>2</sup>	7.2	33,520.0	241,344	24,200.0	174,240	41,700.0	300,240	60,900.0	438,480	24,200.0	174,240	184520.0	1328544
Trunk / Arterial busway														
Asphalt t = 10 cm.	m <sup>2</sup>	10.3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Base course t = 20 cm.	m <sup>2</sup>	3.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Sub-base course t = 30 cm.	m <sup>2</sup>	3.4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Trunk / Arterial busway														
a. Asphalt t = 15 cm.	m <sup>2</sup>	15.1	10,280.0	155,228	1,500.0	22,650	23,500.0	354,850	40,500.0	611,550	6,300.0	95,130	82080.0	1239408
a. Base course t = 25 cm.	m <sup>2</sup>	3.6	11,040.0	39,744	1,700.0	6,120	24,220.0	87,192	42,360.0	152,496	6,720.0	24,192	86040.0	309744
c. Sub-base course t = 35 cm.	m <sup>2</sup>	3.4	11,040.0	37,536	1,700.0	5,780	24,220.0	82,348	42,360.0	144,024	6,720.0	22,848	86040.0	292536
Vene-Asphalt t = 5 cm.	m <sup>2</sup>	7.2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Vene-Cement Conc. t = 20 cm.	m <sup>2</sup>	18.5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Vene-Base course t = 30 cm.	m <sup>2</sup>	1.1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Frontage Lane														
Asphalt t = 5 cm.	m <sup>2</sup>	6.1	0.0	0	0.0	0	0.0	0	0.0	0	4,550.0	27,755	4550.0	27755
Base course t = 20	m <sup>2</sup>	3.2	0.0	0	0.0	0	0.0	0	0.0	0	4,690.0	15,008	4690.0	15008
Sub-base course t = 30	m <sup>2</sup>	3.4	0.0	0	0.0	0	0.0	0	0.0	0	4,690.0	15,946	4690.0	15946
Sidewalk														
Cement Concrete t = 5 cm.	m <sup>2</sup>	10.2	3,210.0	32,742	6,600.0	67,320	8,360.0	85,272	27,150.0	276,930	4,970.0	50,694	50290.0	512958
Base course t = 10 cm.	m <sup>2</sup>	1.9	3,610.0	6,787	7,000.0	13,160	9,080.0	17,070	28,390.0	53,373	5,250.0	9,870	53330.0	100260.4
Plantation	Vol.	13.6	0.0	0	100.0	1,361	180.0	2,450	0.0	0	70.0	953	350.0	4763.5
<b>4. Drainage</b>														
Manhole (5 cm. levee raising)	Vol.	37.2	80.0	2,976	62.0	2,306	20.0	744	50.0	1,860	13.0	484	225.0	8370
<b>5. Additional</b>														
Chapter Bar	m	20.0	3,600.0	72,000	200.0	4,000	400.0	8,000	700.0	14,000	200.0	4,000	5100.0	102000
<b>6. Facilities</b>														
Median 1.0 m. 2.0 m	m	15.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Median Plantation 2.0 m	m	8.0	0.0	0	1,800.0	14,400	3,600.0	28,800	6,200.0	49,600	1,400.0	11,200	13000.0	104000
Guard Rail	m	29.0	3,840.0	111,360	2,320.0	67,280	3,740.0	108,460	6,780.0	196,620	1,480.0	42,920	18160.0	526640
Lighting	Vol.	74.2	106.0	7,857	60.0	4,449	120.0	8,898	206.0	15,272	46.7	3,460	538.6	39937.19
Lane Marking	m	1.6	3,600.0	5,760	3,000.0	4,800	7,200.0	11,520	15,500.0	24,800	3,500.0	5,600	32800.0	52480
Traffic Signs	Vol.	101.0	3.0	303	0.0	0	0.0	0	5.0	505	2.0	202	10.0	1010
Traffic Signal	Vol.	50,000.0	2.0	100,000	2.0	100,000	2.0	100,000	3.0	150,000	0.0	0	9.0	450000
Box Culvert	m	45.0	0.0	0	1,800.0	81,000	3,600.0	162,000	6,200.0	279,000	1,400.0	63,000	13000.0	585000
<b>7. Intersection</b>														
At-grade signalized	Vol.	80,530.0	3.0	241,590	1.0	80,530	2.0	161,060	5.0	402,650	1.0	80,530	12.0	966360
At-grade non signalized	Vol.	35,790.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
<b>8. Bridge</b>														
Pedestrian Bridge	Vol.	90,000.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Bus Stop	Vol.	37,508.0	4.0	150,032	4.0	150,032	4.0	150,032	4.0	150,032	2.0	75,016	18.0	675144
<b>9. Bus Terminal</b>														
Social Environmental - Under	Unit	2,237,875.0	0.0	0	0.0	0	0.0	0	0.0	0	1.0	2,237,875	1.0	2237875
Social Environmental - After	Unit	300,000.0	1.0	300,000	0.0	0	0.0	0	0.0	0	0.0	0	1.0	300000
<b>D. Sub-total (A to C)</b>														
E. Overhead Direct Cost (D)*15%				1,958,511		836,744		1,813,172		3,064,091		2,991,512		10,664,030
F. Profit Direct Cost (D)*10%				293,777		125,512		271,976		459,614		448,727		1,599,604
<b>F. Profit Direct Cost (D)*10%</b>														
<b>G. Total (A to F)</b>														
			2,448,139		1,045,930		2,085,148		3,830,113		3,739,390		13,330,037	

Table 7.5-7 Construction Cost for Improvement of Bus Stops on Av. Grau

Working Items	Sub-items	Classification	Unit	Unit Cost	Quantity	Cost (US\$)
A. Administration	Working Office	150m2	m2	20	150	3,000
	Wall & Fence		unit	5,000	1	5,000
	Safety Control		unit	5,000	1	5,000
B. Preparation & Mobilization	Machine & Materials		unit	10,000	1	10,000
	Site Clearance		unit	5,000	1	5,000
	Traffic Control		unit	5,000	1	5,000
C. Demolishing	Plantation		unit	2,000.0	1	2,000
	Central Reservation		m	1.9	510	969
	Curb		m	1.7	1,020	1,734
	Fence		m	6.2	510	3,162
	Bus Platform	Concrete Slab	m2	5	720	3,600
	Roof		m2	4	480	1,920
	Bench		unit	100	12	1,200
	Lighting		unit	1,000	3	3,000
	Pavement	Asphalt	m2	26.7	1,530	40,851
	Step or Slope	Steel	unit	5,500	10	55,000
D. New Construction	Pavement	Asphalt	m2	15.1	765	11,552
		Base Course	m2	3.6	765	2,754
		Sub-Base Course	m2	3.4	765	2,601
	Guardrail		m	29	720	20,880
	Curb	Concrete H=20cm	m2	10	720	7,200
	Bus Platform	(H=90cm)				
		Concrete Wall H=1.5m	m	100	351	35,100
		Platform Slab W=3.5m	m2	175	55.5	9,713
		Approach Section	m2	39	60	2,310
		Roof	m2	175	60	10,500
		Ticket Office	unit	2,000	3	6,000
		Wall, fence	m	200	60	12,000
		Bench	unit	300	3	900
		Information Board	unit	1,000	3	3,000
		Gate Equipment	unit	5,000	3	15,000
		Lighting	unit	1,000	3	3,000
	Others	unit	5,000	3	15,000	
	Step or Slope	Re-moved	unit	20,000	6	120,000
Sub-Total (Direct Cost)						423,945
Overhead	Direct Cost * 15%					63,592
Profits	Direct Cost * 10%					42,395
Total(A)						529,931

### (3) Land Acquisition Cost and Compensation Estimate

#### 1) Land Acquisition Cost and Compensation for Trunk Busway construction

Additional land acquisitions are required at the road segments between station No. 1 to No.7 and station No. 13 to No. 29 along the Av. Venezuela. However, additional land acquisitions are not required along the Av. Arica, Av. Ayllon and Carr. Central section.

The results of calculation of land acquisition cost and compensation of the Av. Venezuela section are summarized in Table 7.5-8 and Table 7.5-9.

Table 7.5-8 Land Acquisition Cost for Trunk Busway Construction

Sites	Location	Area (m2)	Unit Cost (US\$)	Cost (US\$)
(1) A-Site	Av. Venezuela No. 890	7,857.20	113	887,864
(2) B-Site	Av. Venezuela No. 990	4,832.27	113	546,047
(3) C-Site	Av. Venezuela No. 1700	3,347.38	113	378,254
(4) D-Site	Av. Insurgentes No. 1075	1,643.59	113	185,726
(5) E-Site	Av. Venezuela S/N	5,097.60	113	576,029
(6) F-Site	Av. Venezuela S/N	1,274.40	113	144,007
(7) G-Site	Av. Venezuela S/N	3,313.44	113	374,419
(8) H-Site	Av. Venezuela S/N	1,380.60	113	156,008
(9) I-Site	Av. Venezuela No. 4641	1,539.90	113	174,009
(10) J-Site	Av. Venezuela No. 2595	2,520.13	113	284,774
(11) K-Site	Av. Venezuela No. 2695	2,124.00	113	240,012
(12) L-Site	Av. Venezuela S/N	3,373.06	113	381,156
(13) M-Site	Av. Venezuela S/N	8,627.69	113	974,929
Total				5,303,232

Table 7.5-9 Compensation Cost for Trunk Busway Construction

Items	Area (m2)	Unit Cost (US\$)	Total (US\$)
A-Building	750.61	250	187,653
B-Building	80.92	250	20,230
C-Building	418.12	250	104,530
D-Building	11.00	250	2,750
Total	1,260.65		315,163

## 2) Land Acquisition Cost and Compensation for Trunk Bus Terminal

Trunk bus terminal sites are being evaluated, close to the Ovalo Saloom intersection in Callao city and in Santa Anita in Lima city. However, the negotiation activities regarding the land acquisition between the Peruvian counterparts in the Study and individual land owners have not yet been completed. Assuming the smooth definition of the bus terminal location sites, two (2) bus terminals (Alternative plan-A, and Alternative plan-B) in Callao and two (2) bus terminals (Alternative plan-A and Alternative plan-B) in Santa Anita are identified as the proposed bus terminals. Therefore, the additional land acquisition cost of the trunk bus terminals is estimated based on the proposed trunk bus terminal as shown in Table 7.5-10. The compensation for the trunk bus terminal is not required, because, in the proposed bus terminal, there are no houses and no buildings.

Table 7.5-10 Land Acquisition Cost For Trunk Bus Terminal

Terminal	Location	Area (m2)	Unit Cost (US\$)	Total (US\$)
A-Terminal	Callao	15,540	124	1,926,960
B-Terminal	Santa Anita, Lima	15,540	113	1,756,020
Total		31,080		3,682,980

#### (4) Project Cost Estimate for Infrastructure

##### 1) Project Cost for the Infrastructure of the Trunk Busway Construction

The project cost for the infrastructure of the East-West trunk busway includes the construction cost, land acquisition and compensation, engineering cost, administration cost, contingency, and IGV. The total project cost is estimated at about US\$ 61 million, as shown in Table 7.5-11.

Table 7.5-11 List of Project Cost

Items	Unit (US\$ 1,000)			
	Av. Venezuela Av. Arica	Av. Ayllon Carr. Central	Improvement of Bus Stop on Av. Grau	Total
(1) Construction Cost	15,086	13,330	529	28,945
(2) Land Acquisition and Compensation	7,545	1,756	0	9,301
(3) Sub-total (A)	22,631	15,086	529	38,246
(4) Engineering Cost (A*10%)	2,263	1,509	53	3,825
(5) Administration Cost (A*10%)	2,263	1,509	53	3,825
(6) Contingency (A*15%)	3,395	2,263	79	5,737
(7) Sub-total (B)	30,552	20,366	714	51,632
(8) IGV (B*19%)	5,805	3,870	136	9,810
(9) Total	36,357	24,236	850	61,442

#### (5) Foreign and Local Components of Project Cost

The foreign currency and local currency components in the project cost are adopted at 76 % and 24%, respectively, based on a similar trunk bus construction project, such as the COSAC-1 project. The detailed foreign currency and local currency components of the East-West trunk busway project are shown in Table 7.5-12.

Table 7.5-12 Foreign Currency and Local Currency

Items	Unit: (US\$1,000)					
	Total Cost	%	Foreign Currency	%	Local Currency	%
(1) Construction Cost	28,945	100	21,998	76	6,947	24
(2) Land Acquisition and Compensation	9,301	100	0	0	9,301	100
(3) Engineering Cost	3,825	100	2,907	76	918	24
(4) Administration Cost	3,825	100	0	0	3,825	100
(5) Contingency	5,737	100	4,360	76	1,377	24
(6) IGV	9,810	100	0	0	9,810	100
(7) Total	61,443	100	29,265	48	32,178	52

#### (6) Bus Fleet Purchase Cost

Based on the future bus passenger projection in 2010, the number of articulated buses required for the exclusive trunk busway and single buses required for the feeder bus are estimated as shown in Table 7.5-13.

Table 7.5-13 List of Bus Fleet Purchase Cost

Type of Bus System	No. of Bus Fleet Required (Vehicle)	Cost per Fleet (US\$1,000)	Cost (US\$1,000)	Remarks
Trunk Bus	100	220	22,000	Articulated Bus
Feeder Bus	300	100	30,000	Single Bus
Total			52,000	

**(7) Annual Operation and Maintenance Cost**

As mentioned in the previous section (6.9) of this report, the annual operation and maintenance (OM) cost for the trunk bus operation system is estimated at US\$ 16,997 million, and the annual maintenance cost for the East-West trunk busway facilities, including general traffic lanes, is estimated at US\$ 3,072 million. This is about 5.0 % of the total project cost.

## **A.1. Alternative Case Design Conducted (Risk Analysis)**

### **A.1.1 General**

As previously mentioned, the preliminary design of the East-West trunk busway is conducted in accordance with Municipal Ordinance No.-0018-05 of October 1995. As the result of preliminary design, some areas of land acquisition and compensation on the existing Av. Venezuela are required. At present, this land belongs to the private companies and a government authority (navy school). The Lima and Callao municipalities should carry out negotiations with these private companies and the navy school, and the land acquisition problem should be definitely resolved as soon as possible.

If the negotiation of the land acquisition problem between the municipalities and the private companies or the navy school takes too long, it is recommended that the East-West trunk busway be constructed without additional land acquisition and compensation in accordance with Alternative Case preliminary design, so as to achieve the smooth and rapid execution of the East-West trunk busway project. The result of plan and profile design and cross section design based on the Alternative Case design is presented in the Appendix "Drawings".

### **A.1.2 Alternative Case Design**

#### **A.1.2.1 Plan and Profile Design**

The plan and profile design of the Alternative Case is adopted as the same design of the original preliminary design, as previously mentioned in 7.3.3.

#### **A.1.2.2 Cross Section Design**

The Alternative Case design is conducted based on the existing right of way without any requirement of additional land acquisitions and compensation or re-settlement. The Alternative Case design is conducted based only on the existing Av. Venezuela. The existing Av. Arica, Av. Ayllon, and Carretera Central are not required, because the road width between the existing Av. Arica, Av. Ayllon, and Carretera Central, frozen in 1995, is the same. The principal cross section design features of the Alternative Case are as follows.

- 1) A road segment of approximately 650 m at stations No. 1 to No. 4 on Av. Venezuela (existing right of way is about 32.5 m) is adopted at the typical cross section Type-D (right of way is 32.0 m) of the exclusive trunk busway without any additional land acquisition and compensation.
- 2) A road segment of approximately 200 m at stations No. 7 to 8 on Av. Venezuela (existing right of way is about 32.3 m) is adopted at the typical cross section Type-C (right of way is 36.0 m) of the exclusive trunk busway without any additional land acquisition and compensation.
- 3) A road segment of approximately 900 m at stations No. 14 to No. 17 on Av. Venezuela (existing right of way is about 25.0 m) is adopted at the typical cross section Type-E (right of way is 25.0 m) of the exclusive trunk busway.

The results of preliminary engineering drawings of the Alternative Case are summarized in the Appendix "Drawings".

### A.1.3 Project Cost Estimate

The project cost of the Alternative Case is estimated in the same manner as the original preliminary design.

#### A.1.3.1 Construction Cost Estimate

The construction cost is estimated in the same manner as the original preliminary design. The construction cost of Av. Venezuela is estimated based on the Alternative Case preliminary engineering drawings, and the detailed calculation of the construction cost is presented in Table A.1.3- 1. The construction cost of Av. Ayllon and Carretera Central does not vary compared to the original preliminary design. The total construction cost of Alternative Case (Av. Venezuela and Av. Arica) is estimated at US\$ 27.67 million as shown in Table A.1.3- 1.

Table A.1.3- 1 Construction Cost of Alternative Case

Road Segment	Construction Cost (US\$ 1,000)	Remarks
Av. Venezuela –Av. Arica	13,811	See Table A.1.3-4
Av. Ayllon—Carr. Central	13,330	See Table 7.5-6
Improvement of Bus Stop on Av. Grau	529	See Table 7.5-7
Total	27,670	

#### A.1.3.2 Land Acquisition Cost

The additional land of the trunk bus terminals (at Callao city and Santa Anita in Lima) is required in the Alternative Case. The land acquisition cost of two (2) bus terminals is shown in Table A.1.3- 2.

Table A.1.3- 2 Land Acquisition Cost

Terminal	Location	Area (m2)	Unit Cost (US\$)	Total (US\$)
A-Terminal	Callao	15,540	124	1,926,960
B-Terminal	Santa Anita in Lima	15,540	113	1,756,020
Total		31,080		3,682,980

#### A.1.3.3 Project Cost Estimate

The total project cost including Av. Venezuela, Av. Arica, Av. Grau improvement of bus stops, Av. Ayllon, and Carretera Central is shown in Table A.1.3- 3. The total construction cost is estimated at US\$ 50,365 million.

Table A.1.3- 3 Project Cost of Alternative Case

Items	Unit: (US\$ 1,000)			
	Av. Venezuela Av. Arica	Av. Ayllon Carr. Central	Improvement of Bus Stop on Av. Grau	Total
(1) Construction Cost	13,811	13,330	529	27,670
(2) Land Acquisition and Compensation	1,926	1,756	0	3,682
(3) Sub-total (A)	15,737	15,086	529	31,352
(4) Engineering Cost (A*10%)	1,573	1,509	53	3,135
(5) Administration Cost (A*10%)	1,573	1,509	53	3,135
(6) Contingency (A*15%)	2,360	2,263	79	4,702
(7) Sub-total (B)	21,243	20,366	714	42,323
(8) IGV (B*19%)	4,036	3,870	136	8,042
(9) Total	25,279	24,236	850	50,365

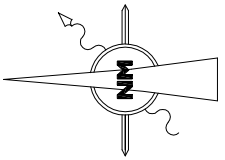
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Final Report

Table A.1.3- 4 Construction Cost of Av. Venezuela and Av. Arica (Alternative Case)

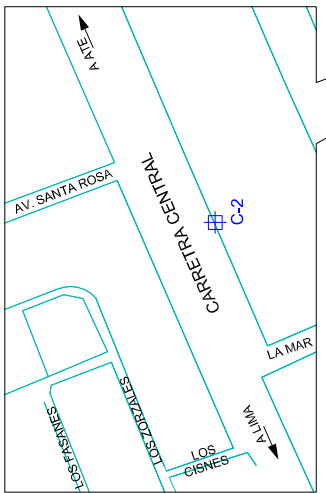
Items	Unit	Unit Cost (US\$)	Ovalo Saloom - Av. Arica ( 8,550m )								Total (L=8550m)	
			Av. Elmer Faucett - Av. Venezuela ( 2,360m )		Av. Universitaria - Av. Venezuela ( 1,980m )		Av. Arica - Av. Venezuela ( 2,370m )		Av. Venezuela - Av. Arica ( 1,840m )		Quantity	Quantity
			Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
<b>A Administration</b>												
Working Office and Warehouse in Site	m <sup>2</sup>	20,0	500,0	10.000					0,0	0	500,0	10.000
Administration Office in Site	m <sup>2</sup>	25,0	500,0	12.500					0,0	0	500,0	12.500
Wall and Fence of Site	Unit	10.000	1,0	10.000					0,0	0	1,0	10.000
Water & Electrical Supply of Site	Unit	5.000	1,0	5.000					0,0	0	1,0	5.000
Safety Control in Site	Unit	5.000	1,0	5.000					0,0	0	1,0	5.000
<b>B Preparation and Mobilization</b>												
Mobilization of Machine and Matery to Site	Unit	40.000	1,0	40.000					0,0	0	1,0	40.000
Site Clearing	Unit	10.000,0	1,0	10.000					0,0	0	1,0	10.000
Traffic Control Management	Unit	10.000	1,0	10.000					0,0	0	1,0	10.000
<b>C. Direct Cost</b>												
<b>1 Site Clearing and Demolition</b>												
Sidewalk	m <sup>3</sup>	33,2	630,0	20.941	127,5	4.238	639,0	21.240	1.228,5	40.835	2625,0	87.255
Median Plantation 2.5	m <sup>3</sup>	13,4	630,0	8.423	50,0	669	2.566,0	34.307	150,0	2.006	3396,0	45.405
Light Pole	vol	44,0	206,0	9.063	8,0	353	103,0	4.533	50,0	2.200	367,0	16.149
Electric Pole	vol	35,0	17,0	595	4,0	140	46,0	1.609	93,3	3.267	160,3	5.611
Traffic Signal	vol	44,0	14,0	616	7,0	308	8,0	352	8,0	352	37,0	1.628
Traffic Sign	vol	22,0	5,0	110	2,0	44	3,0	66	3,0	66	13,0	286
Bus stop facilities	vol	1.300,0	5,0	6.500	2,0	2.600	1,0	1.300	0,0	0	8,0	10.400
Pedestrian Bridge	vol	27.000,0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Tree Small 10cm<t<20cm(Moving)	vol	24,5	1.030,0	25.256	50,0	1.226	16,0	392	160,0	3.923	1256,0	30.797
Tree Big 30cm<t (Moving)	vol	35,0	3,0	105	29,0	1.015	6,0	210	0,0	0	38,0	1.330
Concrete Structure	m <sup>3</sup>	5,5	4,0	22	6,0	33	0,0	0	3,0	16	13,0	71
Other Structure(Wall)	m	6,6	950,0	6.308	0,0	0	0,0	0	0,0	0	950,0	6.308
<b>2 Excavation</b>												
Asphalt ( 5cm )	m <sup>2</sup>	0,8	22.795,0	18.236	1.525,0	1.220	7.340,0	5.872	5.675,0	4.540	37335,0	29.868
Concrete ( 20cm )	m <sup>2</sup>	1,5	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Soil (Waste)	m <sup>3</sup>	5,1	3.539,5	17.874	253,8	1.281	3.939,0	19.892	1.662,3	8.394	9394,5	47.442
Exc/ Fill	m <sup>3</sup>	5,0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Soil Transport	m <sup>3</sup> /km	10,7	4.247,4	45.447	318,9	3.413	4.726,8	50.577	1.994,7	21.343	11287,8	120.780
<b>3.Pavement</b>												
Overlay												
Asphalt t = 5cm	m <sup>2</sup>	7,2	41.814,0	301.061	16.510,0	118.872	16.300,0	117.360	32.000,0	230.400	106624,0	767.693
Trunk busway / Arterial												
Asphalt t = 10cm	m <sup>2</sup>	10,3	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Base course t = 20cm	m <sup>2</sup>	3,5	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Sub-base course t = 30cm	m <sup>2</sup>	3,4	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Trunk busway / Arterial												
a. Asphalt t = 15cm	m <sup>2</sup>	15,1	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
a. Base course t = 25cm	m <sup>2</sup>	3,6	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
a. Sub-base course t = 35cm	m <sup>2</sup>	3,4	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
Vene-Asphalt t = 5cm	m <sup>2</sup>	7,2	20.790,0	149.688	28.885,0	207.972	43.300,0	311.760	6.980,0	50.256	99955,0	719.676
Vene-Cement Conc. t = 20cm	m <sup>2</sup>	18,5	21.508,0	397.898	29.655,0	548.618	44.560,0	824.360	7.940,0	146.890	103663,0	1.917.766
Vene-Base course t = 30cm	m <sup>2</sup>	1,1	21.508,0	23.659	29.655,0	32.621	44.560,0	49.016	7.940,0	8.734	103663,0	114.029
Frontage Lane												
Asphalt t = 5cm	m <sup>2</sup>	6,1	3.120,0	19.032	0,0	0	0,0	0	0,0	0	3120,0	19.032
Base course t = 20	m <sup>2</sup>	3,2	3.600,0	11.520	0,0	0	0,0	0	0,0	0	3600,0	11.520
Sub-base course t = 30	m <sup>2</sup>	3,4	3.600,0	12.240	0,0	0	0,0	0	0,0	0	3600,0	12.240
Sidewalk												
Cement Concrete t=10cm	m <sup>2</sup>	10,2	19.812,5	202.088	10.100,0	103.020	14.500,0	147.900	9.675,0	98.685	54087,5	551.693
Base course t = 10cm	m <sup>2</sup>	1,9	20.292,5	38.150	10.800,0	20.304	15.380,0	28.914	10.315,0	19.392	56787,5	106.761
Plantation	vol	13,6	480,0	6.533	170,0	2.314	204,0	2.776	140,0	1.905	994,0	13.528
<b>4 Drainage</b>												
Manhole (5cm levee raising)	vol	37,2	84,0	3.125	70,0	2.604	84,0	3.125	71,0	2.641	309,0	11.495
<b>5. Additional</b>												
Chapter Bar	m	20,0	2.000,0	40.000	2.300,0	46.000	400,0	8.000	3.200,0	64.000	7900,0	158.000
<b>6. Facilities</b>												
Median 1.0m, 2.0m	m	15,0	1.000,0	15.000	200,0	3.000	0,0	0	1.600,0	24.000	2800,0	42.000
Median Plantation 2.0m	m	8,0	5.600,0	44.800	1.200,0	9.600	4.000,0	32.000	0,0	0	10800,0	86.400
Guard Rail	m	29,0	4.720,0	136.880	3.960,0	114.840	4.740,0	137.460	3.680,0	106.720	17100,0	495.900
Lighting	vol	74,2	190,0	14.089	72,0	5.339	133,3	9.887	50,0	3.708	445,3	33.021
Lane Marking	m	1,6	7.200,0	11.520	3.200,0	5.120	8.800,0	14.080	3.200,0	5.120	22400,0	35.840
Traffic Signs	vol	101,0	5,0	505	3,0	303	5,0	505	3,0	303	16,0	1.616
Traffic Signal	vol	50.000,0	3,0	150.000	2,0	100.000	3,0	150.000	3,0	150.000	11,0	550.000
Box Culvert	m	45,0	4.800,0	216.000	1.700,0	76.500	4.000,0	180.000	3.000,0	135.000	13500,0	607.500
<b>7. Intersection</b>												
At-grade signalized	vol	80.530,0	3,0	241.590	1,0	80.530	3,0	241.590	2,0	161.060	9,0	724.770
At-grade non signalized	vol	35.790,0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
<b>8. Bridge</b>												
Pedestrian Bridge	vol	90.000,0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0
9 Bus Stop	vol	37.508,0	6,0	225.048	4,0	150.032	6,0	225.048	6,0	225.048	22,0	825.176
9 Bus Terminal	Unit	2.237.875,0	1,0	2.237.875	0,0	0	0,0	0	0,0	0	1,0	2.237.875
10. Social Environmental - Under	Unit	300.000,0	1,0	300.000	0,0	0	0,0	0	0,0	0	1,0	300.000
Social Environmental - After	Unit	200.000,0	1,0	200.000	0,0	0	0,0	0	0,0	0	1,0	200.000
<b>D. Sub-total ( A to C )</b>												
			5.260.295		1.644.127		2.624.132		1.520.805		11.049.359	
<b>E. Overhead Direct Cost (D)*15%</b>			789.044		246.619		393.620		228.121		1.657.404	
<b>F. Profit Diect Cost (D)*10%</b>			526.029		164.413		262.413		152.081		1.104.936	
<b>G. Sub-Total ( A to E )</b>			6.575.369		2.055.159		3.280.165		1.901.006		13.811.699	



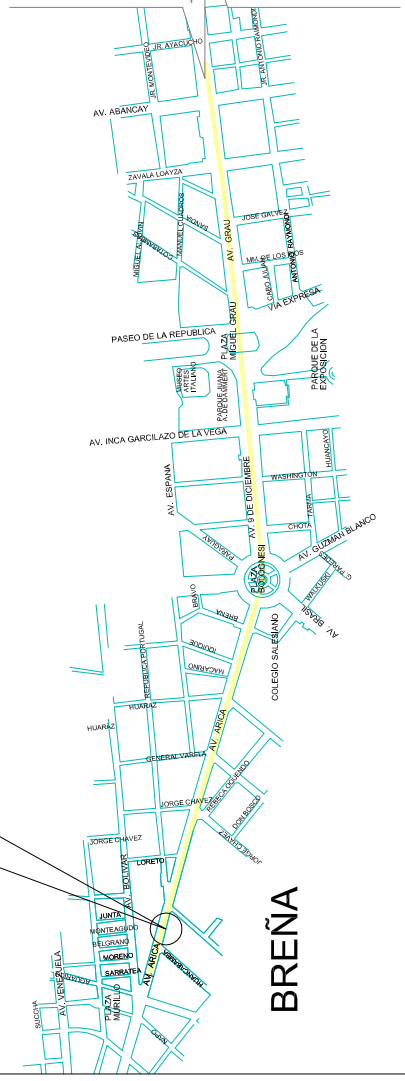
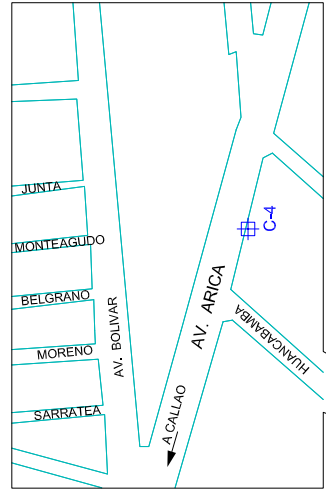
## **A.2 Soil Investigation Data Conducted by JICA Study Team**



CALICATA C-2  
CARRETERA CENTRAL N° 3228



CALICATA C-4  
AV. ARICA N° 857

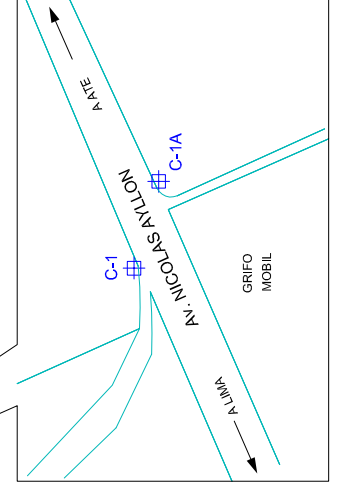
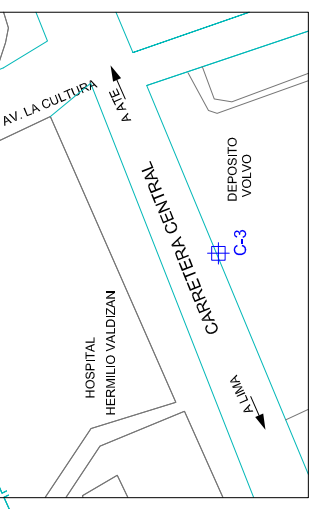


BREÑA



ATE

CALICATA C-3  
CARRETERA CENTRAL N° 3500



CALICATAS C-1 Y C-1A  
AV. NICOLAS AYLLON N° 112

LEYENDA

# Calicata



ARQUICUST S.R.L.  
AV. NICOLAS AYLLON / CARRETERA CENTRAL Y AV. ARICA - LIMA  
INVESTIGACIÓN DE SUELOS CON FINES DE PAVIMENTACIÓN  
UBICACIÓN DE CALICATAS

PROYECTADO :	M.M.M	E.P.V.	LAMINA N°	M2493-1
ESCALA :	1 / 20,000	FECHA :	Julio 2006	

Sondaje: **C-1** Tipo: **Calicata** Proyecto: **INVESTIGACIÓN DE SUELOS CON FINES DE PAVIMENTACIÓN AV. NICOLAS AYLLÓN, SANTA ANITA - LIMA**  
 Cota del Terreno: **—** Registrado: **S.S.P.** Revisado: **M.M.M.**  
 Cota del Agua Subterránea: **—** Fecha: **Mayo 2006**

Profund. (m)	Muestra	Símbolo	Descripción
			Carpeta asfáltica.
			Relleno. Grava arenosa, ligeramente limosa, mal graduada, medianamente densa, seca, beige; con gravas angulares de 1 ½ de tamaño máximo. Restos de basura.
			Losa de concreto.
0.5			Arena fina a media, gravosa, arcillosa, limosa, suelta a medianamente densa, ligeramente húmeda, marrón con oxidaciones. Finos de plasticidad baja. (SC)
1.0			Grava arenosa, arcillosa, limosa, suelta a medianamente densa, ligeramente húmeda, gris; con gravas redondeadas de 2 ½ pulg de tamaño máximo. Finos de plasticidad baja. (GC-GM)
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			

- Muestra Alterada
- Muestra Inalterada
- Muestra en Bloque
- Muestra de Agua

OBSERVACIONES:

Sondaje: **C-1A** Tipo: **Calicata** Proyecto: **INVESTIGACIÓN DE SUELOS CON FINES DE PAVIMENTACIÓN AV. NICOLAS AYLLÓN, ATE - LIMA**  
 Cota del Terreno: **—** Registrado: **S.S.P.** Revisado: **M.M.M.**  
 Cota del Agua Subterránea: **—** Fecha: **Mayo 2006**

Profund. (m)	Muestra	Símbolo	Descripción
			Carpeta asfáltica.
			Relleno afirmado. Grava arenosa, ligeramente limosa, mal graduada, de plasticidad baja, medianamente densa, seca, beige; con gravas de 1 ½ de tamaño máximo. Finos de plasticidad baja. Hacia el otro extremo se aprecia un cable y una red de teléfono que atraviesa la calicata.
0.5			Arena fina a media, gravosa, arcillosa, limosa, medianamente densa, ligeramente húmeda, marrón claro. Finos de plasticidad. (SC)
1.0			Grava arenosa, arcillosa, limosa, suelta a medianamente densa, ligeramente húmeda, marrón; con gravas y piedras redondeadas de 4 pulg de tamaño máximo. Finos de plasticidad baja. (GC-GM)
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			

- Muestra Alterada
- Muestra Inalterada
- Muestra en Bloque
- Muestra de Agua

OBSERVACIONES:

Sondaje: **C-2** Tipo: **Calicata** Proyecto: **INVESTIGACIÓN DE SUELOS CON FINES DE PAVIMENTACIÓN AV. NICOLAS AYLLÓN, ATE - LIMA**  
 Cota del Terreno: **—** Registrado: **S.S.P.** Revisado: **M.M.M.**  
 Cota del Agua Subterránea: **—** Fecha: **Mayo 2006**

Profund. (m)	Muestra	Símbolo	Descripción
			Carpeta asfáltica.
			Relleno afirmado. Grava arenosa, limosa, medianamente densa, seca, beige; con gravas angulares de 1 ½ pulg de tamaño máximo. Finos de plasticidad baja.
0.5			Relleno. Arena fina a media, limosa, suelta a medianamente densa, ligeramente húmeda, marrón. Finos de plasticidad baja. Restos de desmonte y basura (trozos de ladrillos, bolsas y fierros).
			Arena fina a media, mal graduada, densa, ligeramente húmeda, marrón claro. (SP)
1.0			Grava arenosa, ligeramente limosa, mal graduada, densa, ligeramente húmeda, marrón claro; co piedras y bolones angulares de 10 pulg de tamaño máximo. Finos de plasticidad baja. (GP-GM)
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			

- Muestra Alterada
- Muestra Inalterada
- Muestra en Bloque
- Muestra de Agua

OBSERVACIONES:

Sondaje: **C-3** Tipo: **Calicata** Proyecto: **INVESTIGACIÓN DE SUELOS CON FINES DE PAVIMENTACIÓN AV. NICOLAS AYLLÓN, ATE - LIMA**  
 Cota del Terreno: **—** Registrado: **S.S.P.** Revisado: **M.M.M.**  
 Cota del Agua Subterránea: **—** Fecha: **Mayo 2006**

Profund. (m)	Muestra	Símbolo	Descripción
			Carpeta asfáltica.
			Relleno afirmado. Grava arenosa, ligeramente limosa, mal graduada, medianamente densa, seca, beige; con gravas angulares de 1 ½ pulg de tamaño máximo. Finos no plásticos.
0.5			Relleno. Arena fina, limosa, medianamente densa, seca, marrón claro. Finos de plasticidad baja. Restos de desmonte y basura (trozos de ladrillos, bolsas, etc).
1.0			Grava arenosa, mal graduada, medianamente densa, seca, gris; con gravas redondeadas de 1 pulg de tamaño máximo. (GP)
1.5			Arena fina a media, arcillosa, limosa, densa, seca, marrón claro; con gravas redondeadas aisladas de 1 pulg de tamaño máximo. Finos de plasticidad baja. (SC-SM)
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			

- Muestra Alterada
- Muestra Inalterada
- Muestra en Bloque
- Muestra de Agua

OBSERVACIONES:

Sondaje: **C-4** Tipo: **Calicata** Proyecto: **INVESTIGACIÓN DE SUELOS CON FINES DE PAVIMENTACIÓN AV. ARICA, BREÑA - LIMA**  
 Cota del Terreno: **—** Registrado: **S.S.P.** Revisado: **M.M.M.**  
 Cota del Agua Subterránea: **—** Fecha: **Mayo 2006**

Profund. (m)	Muestra	Símbolo	Descripción
			Carpeta asfáltica.
			Losa de concreto.
0.5			Relleno. Arena fina, limosa, suelta a medianamente densa, ligeramente húmeda, marrón; con gravas aisladas de 2 pulg de tamaño máximo. Finos no plásticos. Restos de desmonte y basura (fragmentos de concreto, ladrillos, bolsas, etc).
1.0			Arcilla limosa, arenosa, de plasticidad baja, medianamente compacta, húmeda, marrón; con gravas aisladas de 2 pulg de tamaño máximo. (CL)
1.5			Grava arenosa, bien graduada, suelta a medianamente densa, ligeramente húmeda, marrón claro; con gravas y piedras redondeadas de 4 pulg de tamaño máximo. (GW)
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			

- Muestra Alterada
- Muestra Inalterada
- Muestra en Bloque
- Muestra de Agua

OBSERVACIONES:

**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-7

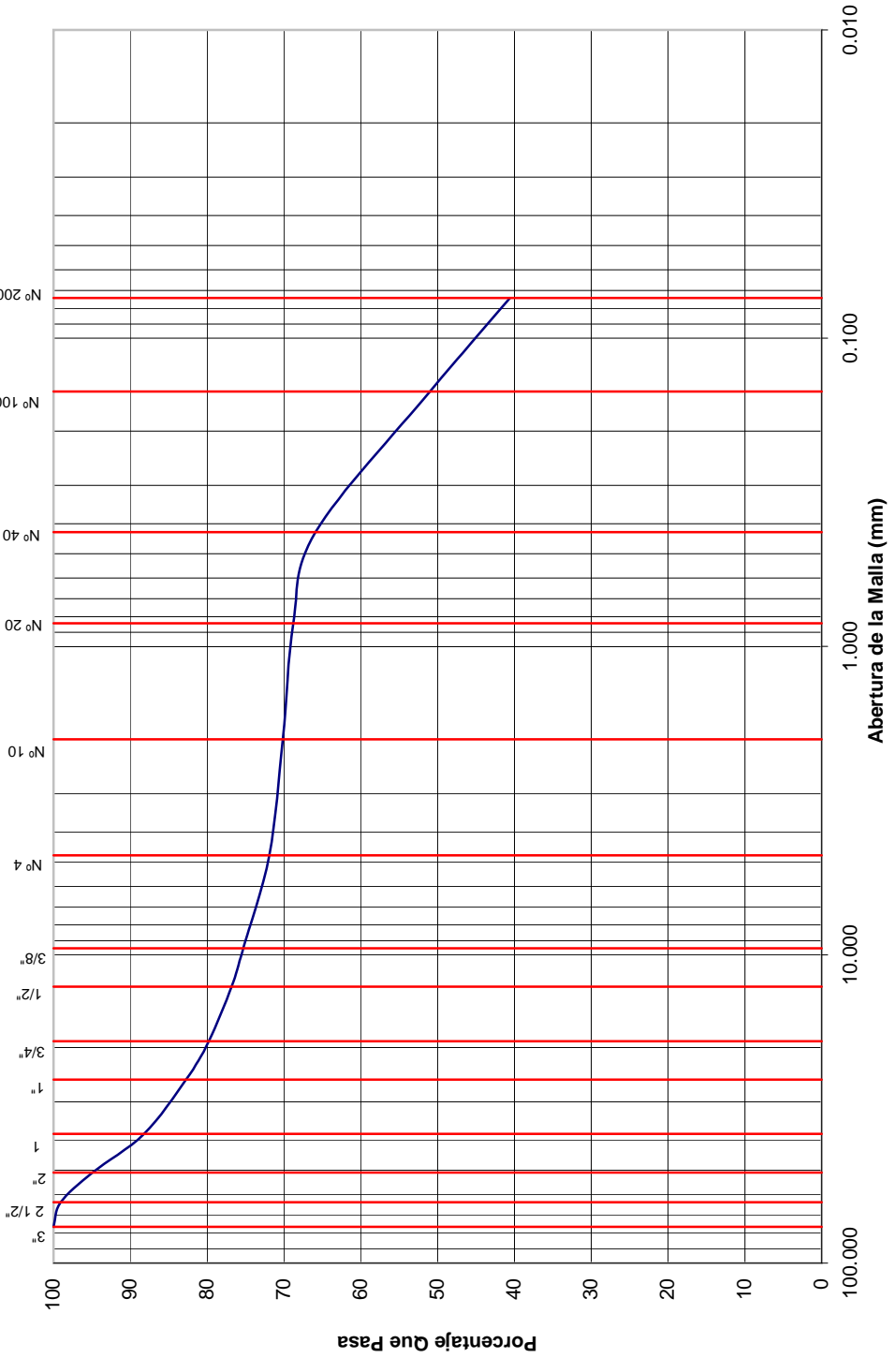
PROYECTO: INVESTIGACION DE SUELOS CON FINES DE

UBICACIÓN: AV. ARICA Y NICOLÁS AYLLON - LIMA

SONDAJE: C-1A

PROFUNDIDAD: 0.30 - 0.80 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA		GRUESA	GRUESA	MEDIA	FINA
GRUESA	FINA				



Cu= --

Cc= --

LL= 26

LP= 16

IP= 10

SUCS= SC



**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-8

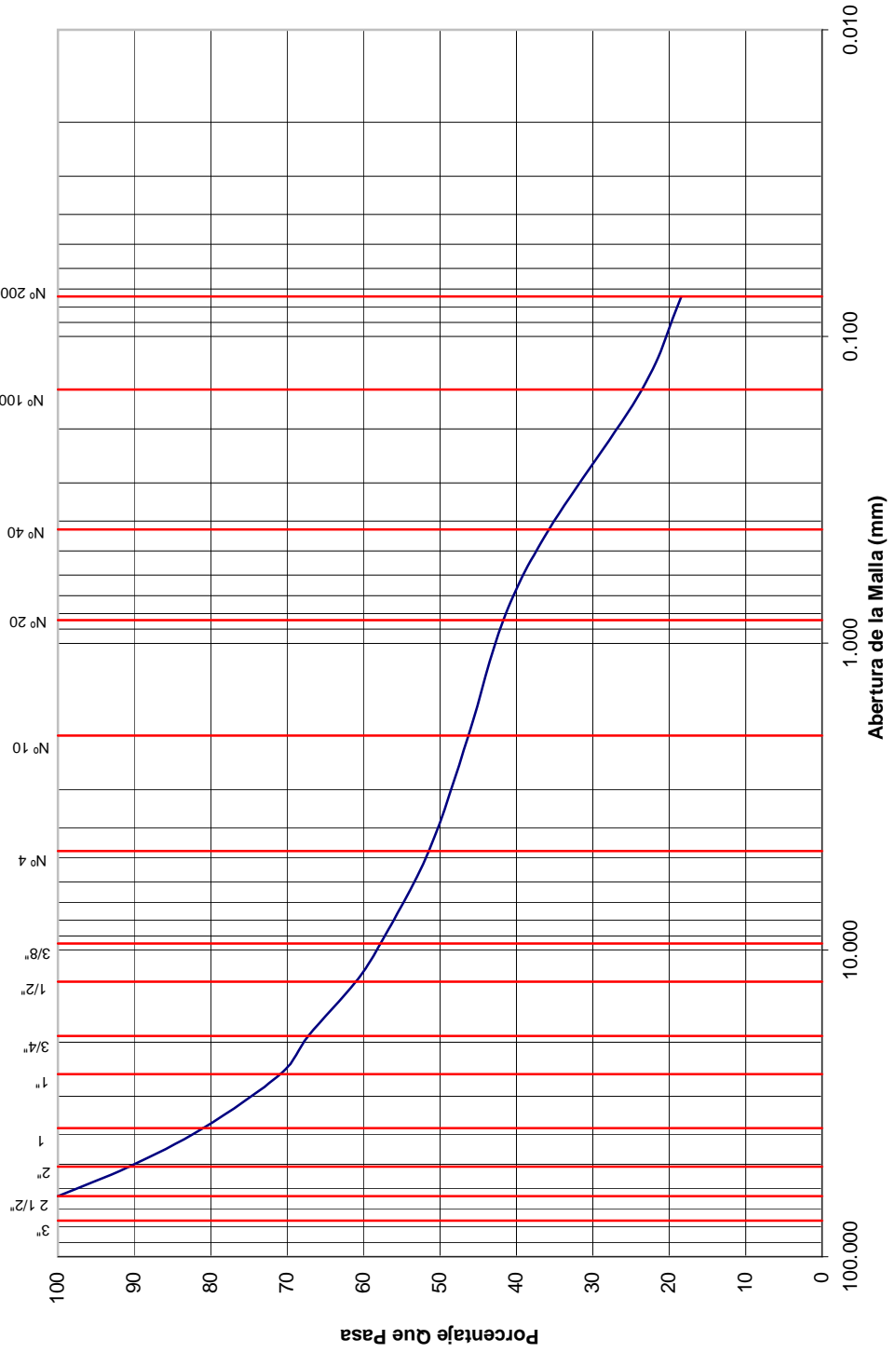
PROYECTO: INVESTIGACION DE SUELOS CON FINES DE

UBICACIÓN: AV. ARICA Y NICOLÁS AYLLÓN - LIMA

SONDAJE: C-1A

PROFUNDIDAD: 1.10 - 1.30 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA		MEDIA			
GRUESA	FINA	GRUESA	FINA		



Cu= --

Cc= --

LL= 21

LP= 15

IP= 6

SUCS= GC-GM

**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-9

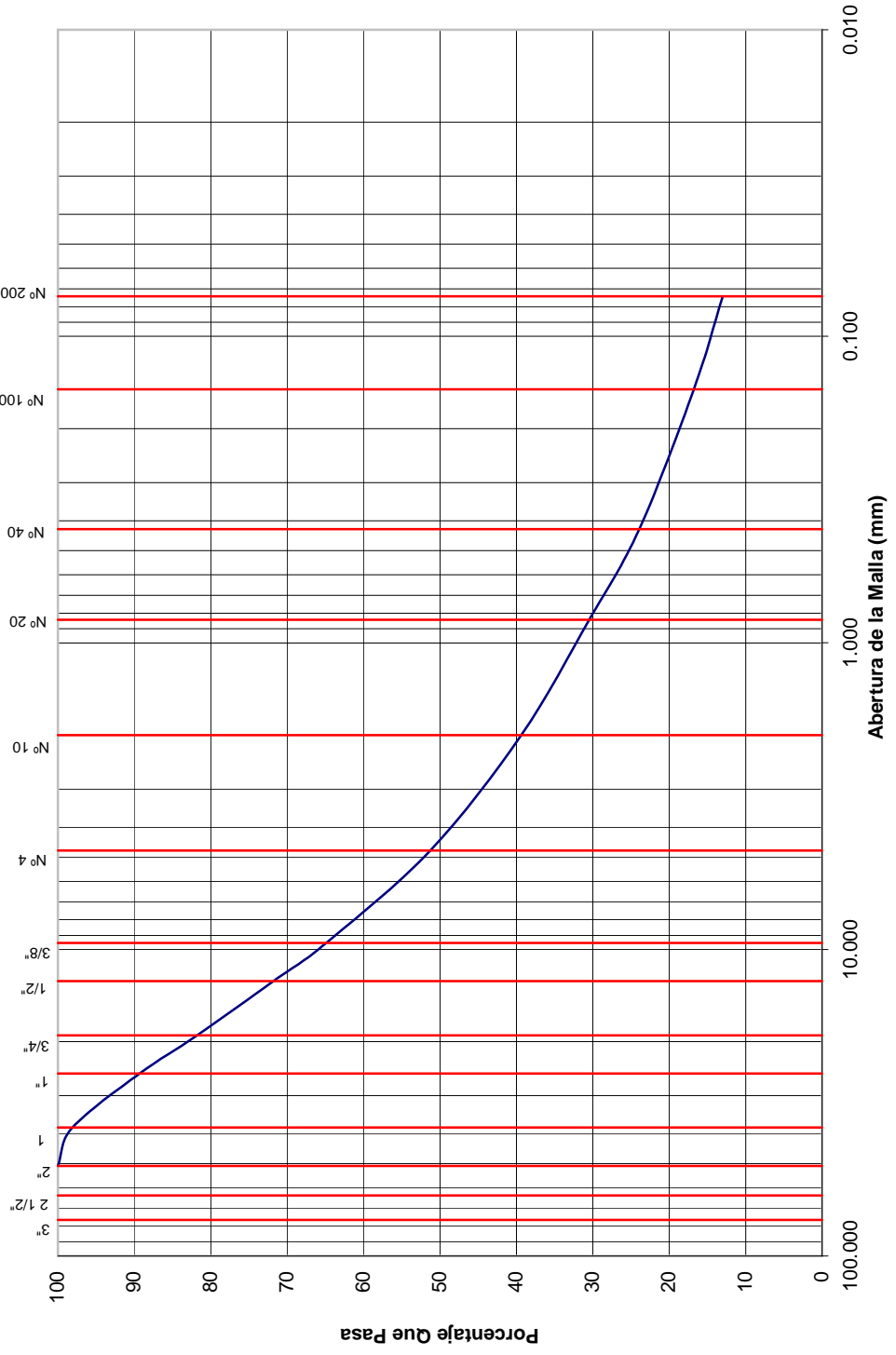
PROYECTO: INVESTIGACION DE SUELOS CON FINES DE

UBICACIÓN: AV. ARICA Y NICOLÁS AYLLON - LIMA

SONDAJE: C-2

PROFUNDIDAD: 0.05 - 0.23 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA		MEDIA		FINA	
GRUESA	FINA	GRUESA	GRUESA	GRUESA	FINA



Cu= --

Cc= --

LL= 20

LP= 17

IP= 3

SUCS= GM

**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-10

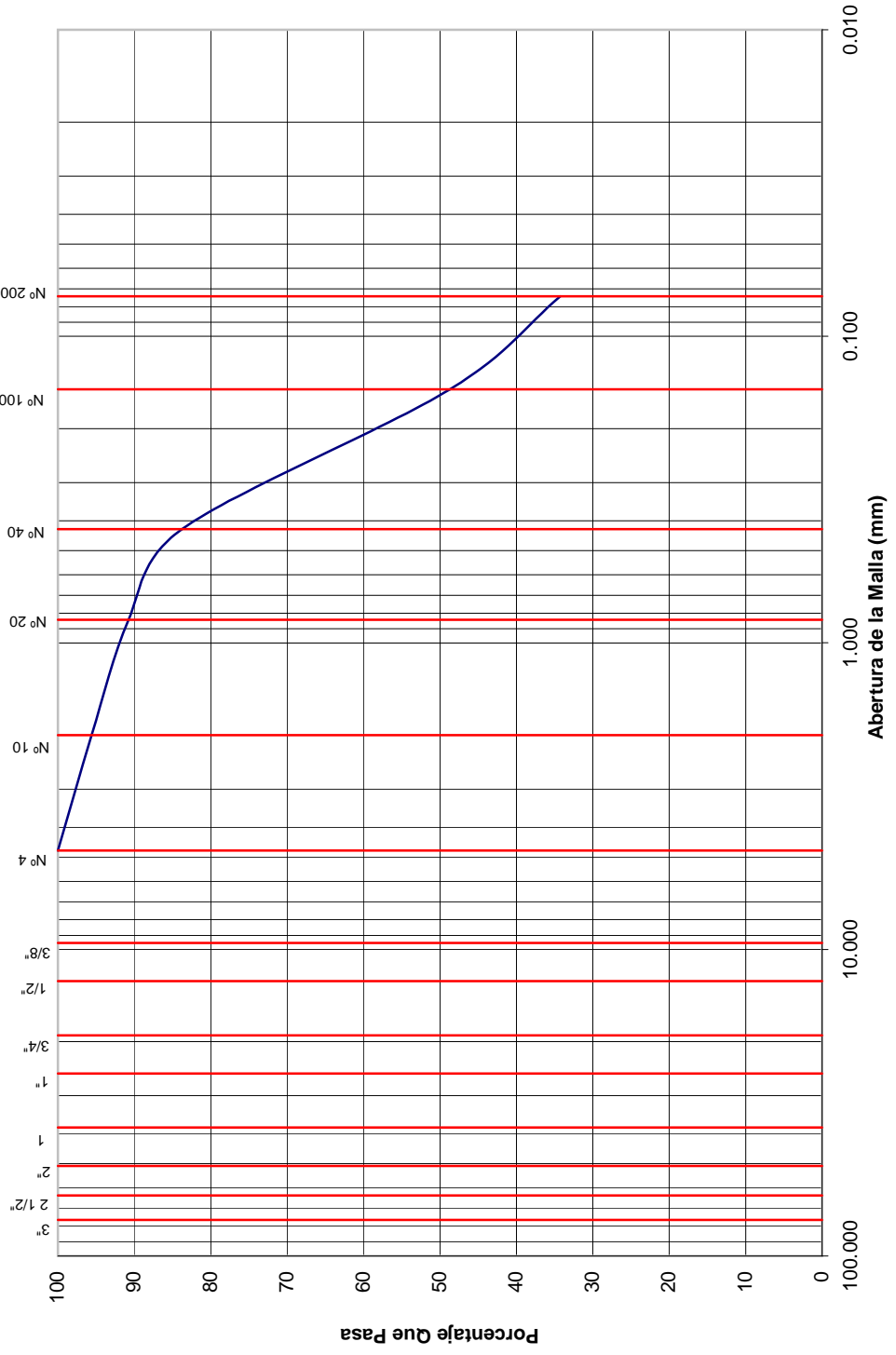
PROYECTO: INVESTIGACION DE SUELOS CON FINES DE

UBICACIÓN: AV. ARICA Y NICOLÁS AYLLON - LIMA

SONDAJE: C-2

PROFUNDIDAD: 0.23 - 0.70 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA		GRUESA	MEDIA	FINA	
GRUESA	FINA	GRUESA	MEDIA	FINA	



Cu= --

Cc= --

LL= 18

LP= 16

IP= 2

SUCS= SM

**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-11

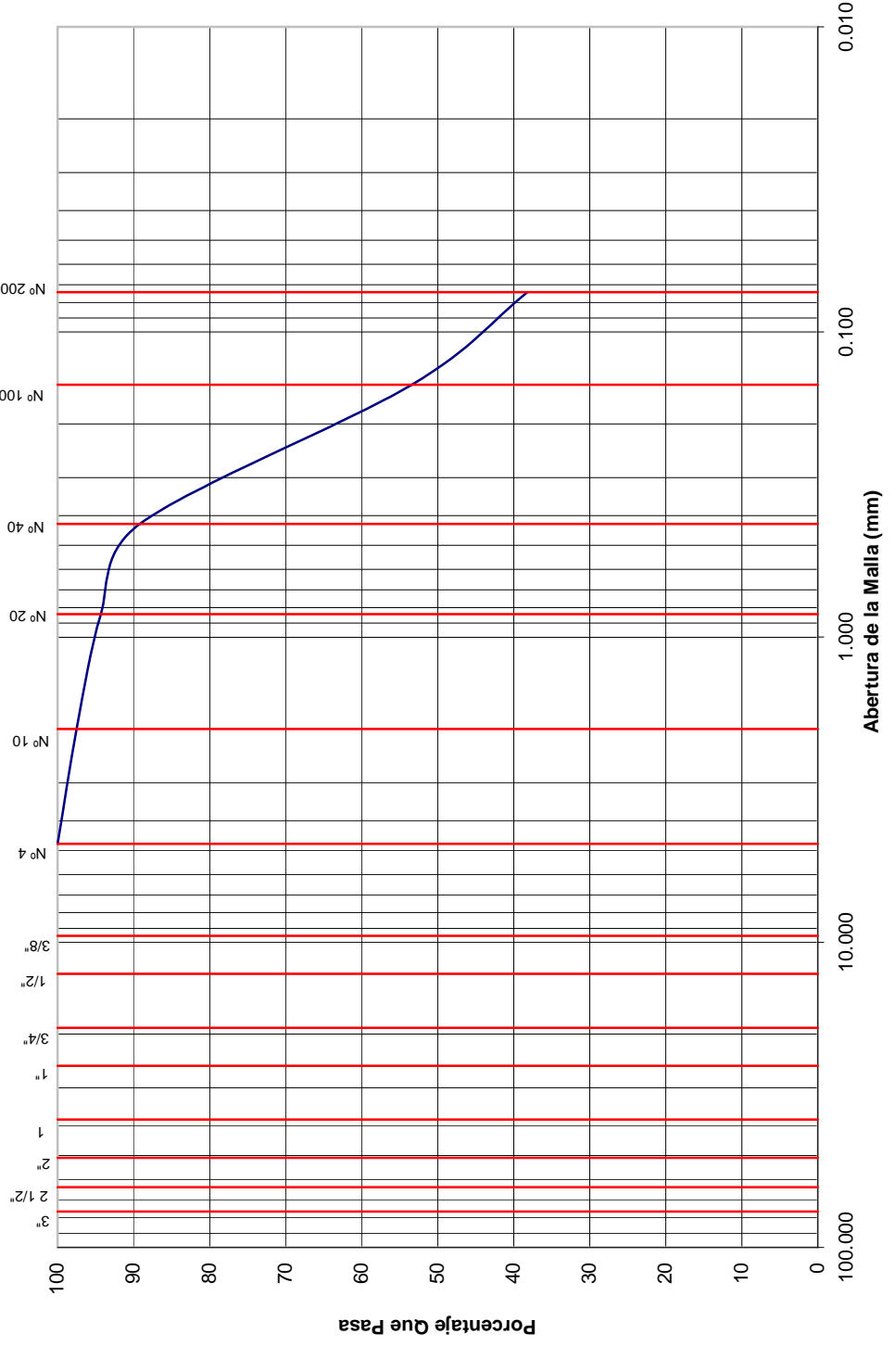
PROYECTO: INVESTIGACION DE SUELOS CON FINES DE PAVIMENTACIÓN

UBICACIÓN: AV. ARICA Y NICOLÁS AYLLON - LIMA

SONDAJE: C-3

PROFUNDIDAD: 0.90 - 1.50 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA		GRUESA	MEDIA	FINA	
GRUESA	FINA				



Cu= --

Cc= --

LL= 20

LP= 13

IP= 7

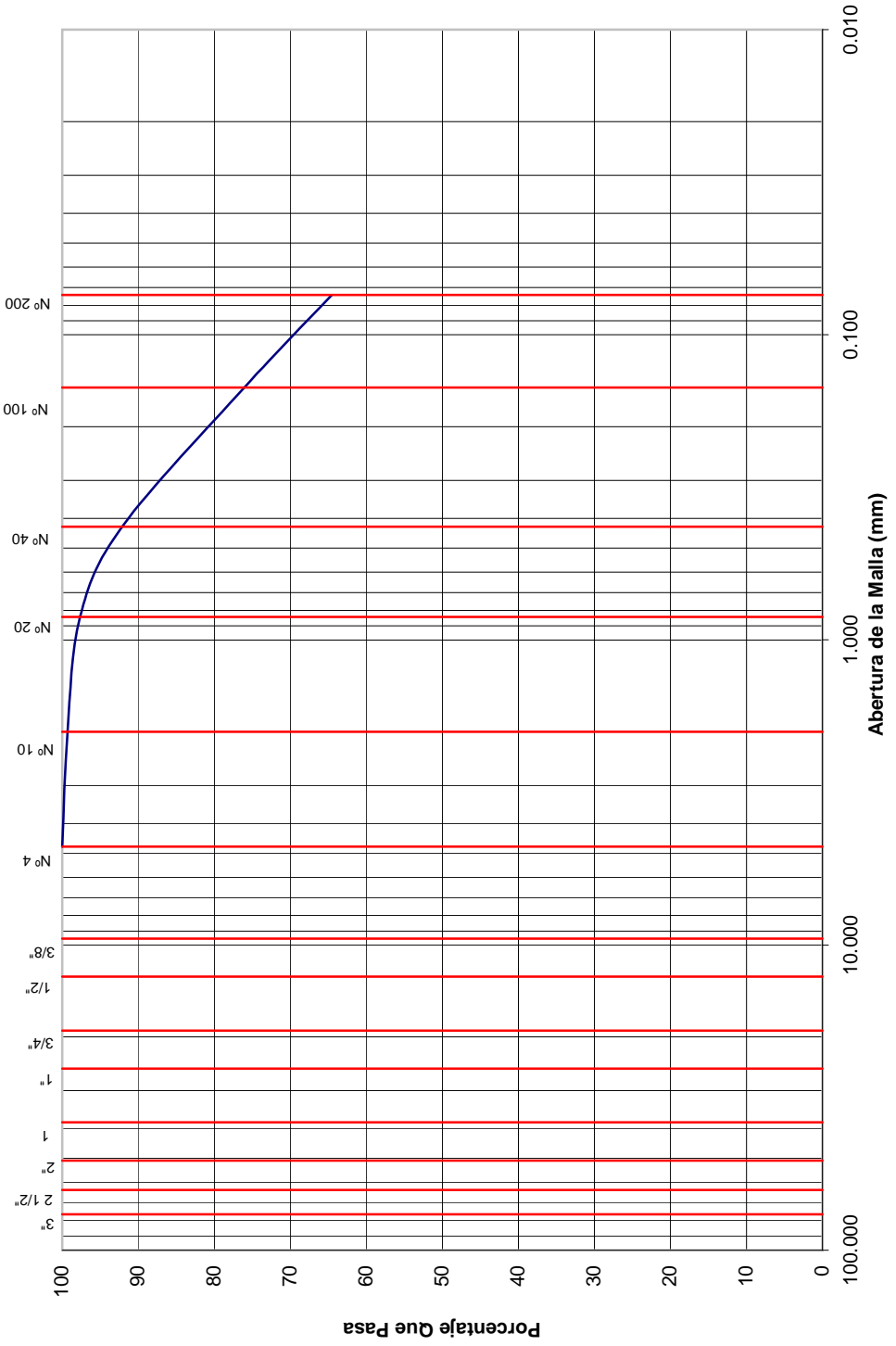
SUCS= SC-SM

**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-12

PROYECTO: INVESTIGACION DE SUELOS CON FINES DE PAVIMENTACIÓN      UBICACIÓN: AV. ARICA Y NICOLÁS AYLLON - LIMA  
 SONDAJE: C-4      PROFUNDIDAD: 0.60 - 1.00 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA					
GRUESA	FINA	GRUESA	MEDIA	FINA	

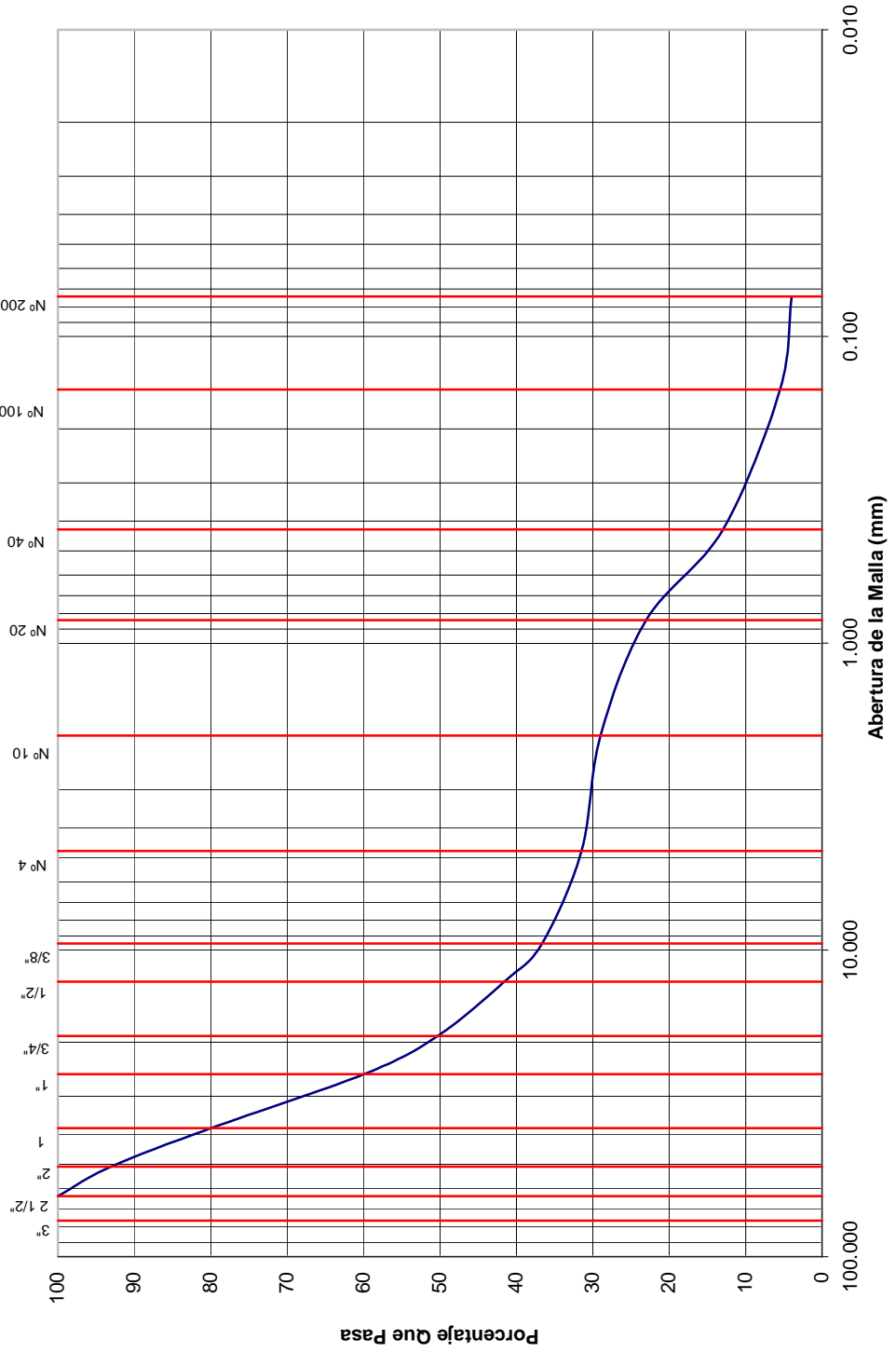


**ANALISIS GRANULOMETRICO POR TAMIZADO**

LAMINA Nº M2493-13

PROYECTO: INVESTIGACION DE SUELOS CON FINES DE PAVIMENTACIÓN      UBICACIÓN: AV. ARICA Y NICOLÁS AYLLON - LIMA  
 SONDAJE: C-4      PROFUNDIDAD: 1.20 - 1.40 m

BOLONERIA		ARENA			LIMO Y ARCILLA
GRAVA					
GRUESA	FINA	GRUESA	MEDIA	FINA	



Cu= 109.57

Cc= 1.55

LL= --

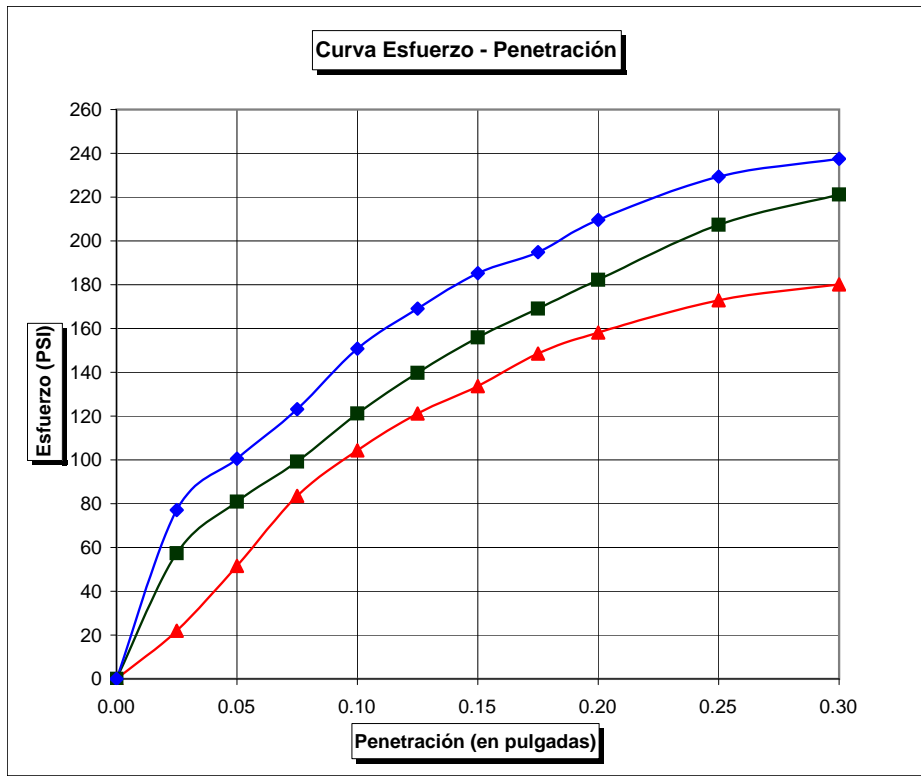
LP= --

IP= --

SUCS= GW

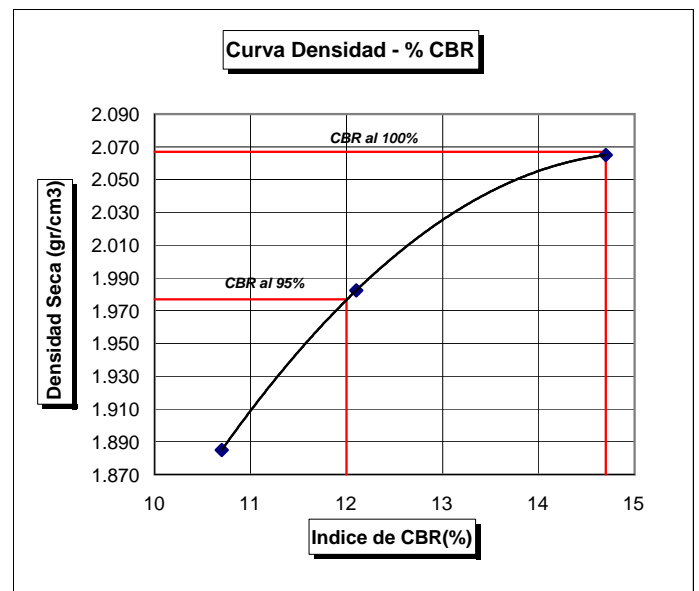
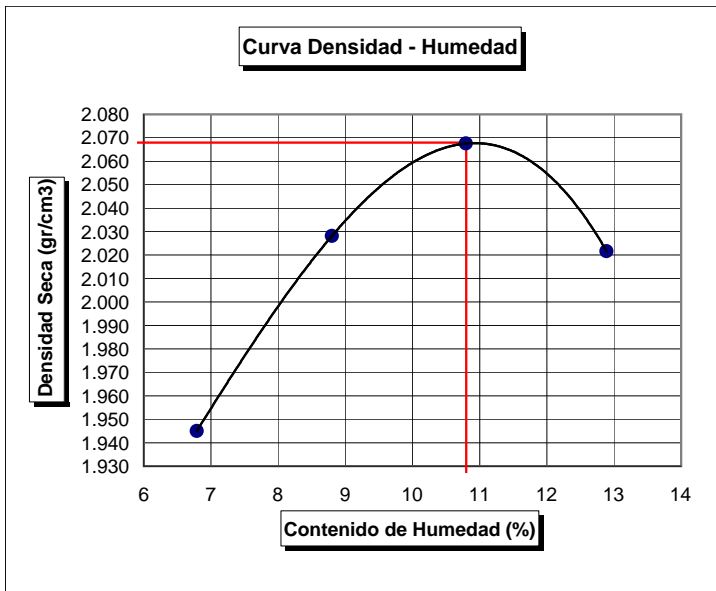
**ENSAYO DE CBR ASTM D - 1883**

**PROYECTO:** INVESTIGACION DE SUELOS  
**UBICACIÓN:** AV. ARICA Y NICOLAS AYLLON  
**SONDAJE:** C - 2  
**PROFUNDIDAD:** 0.23 - 0.70 m



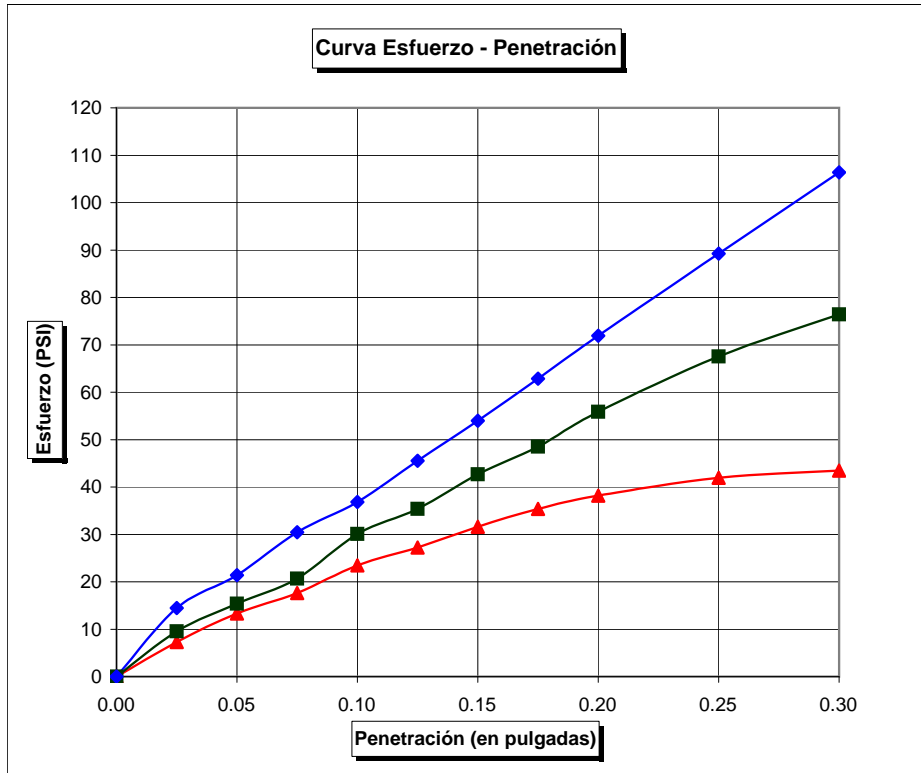
<b>MAXIMA DENSIDAD SECA :</b>	2.07
<b>HUMEDAD OPTIMA:</b>	10.8%
<b>CBR al 95% de la MDS(0.1" de penetración):</b>	12
<b>CBR al 100% de la MDS(0.1" de penetración):</b>	15

	MOLDE 1	MOLDE 2	MOLDE 3
<b>DENSIDAD SECA</b>	2.06	1.98	1.88
<b>CBR</b>	15	12	11
<b>GOLPES</b>	56	25	12
<b>% DE EXPANSION</b>	0.26	0.32	0.39



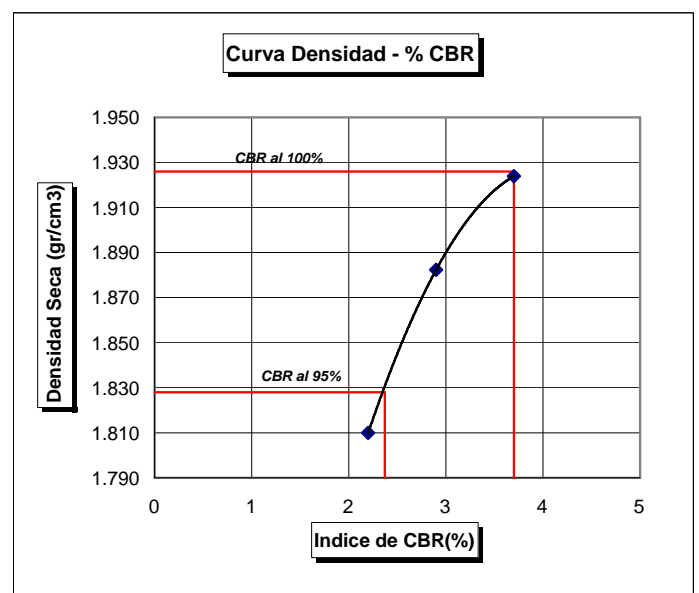
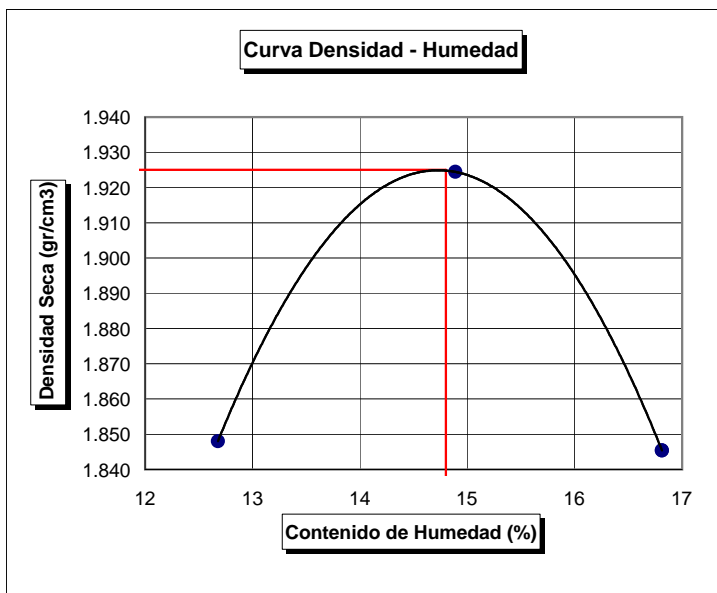
**ENSAYO DE CBR ASTM D - 1883**

**PROYECTO:** INVESTIGACION DE SUELOS  
**UBICACIÓN:** AV. ARICA Y NICOLAS AYLLON  
**SONDAJE:** C - 4  
**PROFUNDIDAD:** 0.60 - 1.00 m



<b>MAXIMA DENSIDAD SECA :</b>	1.93
<b>HUMEDAD OPTIMA:</b>	14.8%
<b>CBR al 95% de la MDS(0.1" de penetración):</b>	2
<b>CBR al 100% de la MDS(0.1" de penetración):</b>	4

	MOLDE 1	MOLDE 2	MOLDE 3
<b>DENSIDAD SECA</b>	1.92	1.88	1.81
<b>CBR</b>	4	3	2
<b>GOLPES</b>	56	25	12
<b>% DE EXPANSION</b>	1.20	1.40	1.60





## **CUADROS**



**CUADRO N°M2493-1**

**INVESTIGACIÓN DE SUELOS PARA FINES DE PAVIMENTACIÓN, AV. AYLÓN - AV. ARICA, LIMA**  
**ANÁLISIS GRANULOMÉTRICO POR TAMIZADO, LÍMITES DE ATTERBERG Y CLASIFICACIÓN UNIFICADA**

MUESTRA		ANÁLISIS GRANULOMÉTRICO POR TAMIZADO														LÍMITES DE ATTERBERG			SUCS	
Calicata	Profundidad (m)	% QUE PASA LA MALLA N°														L.L	L.P	I.P		
		4"	3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	N°4	N°10	N°20	N°40	N°100					N°200
C-1A	0.30 - 0.80	100	100	99	95	88	83	80	77	75	72	70	69	66	51	41	26	16	10	SC
C-1A	1.10 - 1.30			100	91	81	7	67	61	58	51	46	42	36	24	18	21	15	6	GC-GM
C-2	0.05 - 0.23				100	98	89	82	72	65	51	39	30	24	17	13	20	17	3	GM
C-2	0.23 - 0.70										100	96	91	84	49	34	18	16	2	SM
C-3	0.90 - 1.50										100	98	94	89	53	38	20	13	7	SC-SM
C-4	0.60 - 1.00			100	93	80	60	50	42	37	31	29	23	13	6	65	25	15	10	CL
C-4	1.20 - 1.40														4	4	--	--	--	GW

# CHAPTER 8

## Environmental Study