Economic operating expenses

Results of analysis:

EIRR	9.67 % > 8.0 %
B/C ratio	1.15 (with discount rate of 8 %) > 1.0
NPV	US$ 5,717,000 (ditto) > 0

e. Sensitivity Analysis

Without agricultural project, the Project will be infeasible financially and economically.

(9) Conclusion

Through this Study, several alternatives for the Project were established and studied. Each alternative was evaluated and an optimum plan was selected for a verification of the feasibility. The selected optimum plan was proved to be feasible.

10.2 Recommendation

The southern part of Lima city consists of a built-up area which comprises, among others, the commercial districts of San Juan de Miraflores and Surquillo, high-class residential districts of San Borja and La Molina, and Pueblos Jóvenes of Villa Maria del Triunfo and Villa el Salvador.

In the built-up area, the coverage of the sewers is almost 100 per cent, but the raw sewage from Surco Outfall is being directly discharged without any treatment into the Pacific Ocean.

Pueblos Jóvenes is an easily commutable area since it is located inside the urban region as a satellite town of Lima, and is favored with a good climate and natural features. Because of this, the population is increasing and residential districts are expanding rapidly. To cope with the situation, urban development or redevelopment projects are continuously being carried out in this region. However, some public facilities, the

sewerage system among them, still desperately lag behind the requirement of the expanding urban area. In the built-up area, therefore, overpopulation is resulting to the worsening of the condition of the living environment in the hygienic sense and is increasing the rate of the incidence of infectious diseases because of inadequate water supply and sewerage system, as compared with other districts.

As stated above, the sewage originating from this built-up area and Pueblos Jóvenes is directly discharged to the Surco beach without any treatment. This is the major and very cause of the water pollution of the Surco beach, which has made the preservation of the sea water quality a subject of great importance to the citizens of Lima who are using the beach as the sole recreation resort in the area. In order to solve the problem, the Republic of Peru has made an urgent request with the Japanese government for an examination of the possibility of implementing a sewerage system improvement project in the southern part of Lima.

For the purpose of smooth, effective, and successful implementation of the prospective Project in the aspects of design, construction, and administration of the operation and maintenance, the following recommendations are hereby made:

(1) Effective Usage of City Water by Taking Measures Against Water Leakage

Based on the result of 24 hour measurement of the rate of the discharge from the Surco outfall, it was found that the total volume discharged during night time is extremely larger than that at day time. This is presumed to be caused by leakage of water owing to inadequate conditions of water supply and sanitary wares. If this situation is corrected, about 1.0 m^3/s of water may be saved. (Water leakage aggregates to about 4.0 m^3/s all over Lima.)

(2) Urgency of Development of Sewerage System in Districts Along Surco Beach (from Playa de La Chira to Barranco)

Even if this Lima Project is implemented and the sewage discharged at the Surco outfall is cut, sewage coming from other districts will continue to pollute the sea, as long as the development of the sewerage system in

the above districts along the Surco beach is neglected or its implementation is deferred.

In this case, the completed sewerage system may therefore hardly produce the intended effect of sea water quality improvement at the Surco beach, which will then bring great disappointment to the people, especially during the recreation season. Moreover, the inadequate sanitary conditions in these coastal districts may directly affect the sea-bathers which may lead them to rate of the sewerage projects even lower.

(3) Fulfillment of Development of Sewerage System throughout Pueblos Jóvenes District

Sub-facilities other than the mains such as branch sewers and the like, are not included in this Project. However, for the sake of the more effective operation of the facilities planned in this Project, i.e., in order that its ability can be fully put to use, it is recommended that the government of Peru carry out the prior construction of sub-facilities in accordance with the development plan in districts that are not provided with such sub-facilities.

(4) Execution of Training

Once this Project is authorized for adoption, the technology transfer will be conducted during the designing and installation periods with respect to the administration of the operation to be carried out after completion of the plant.

However, the training periods are rather short and hardly enough for satisfactory results. Under the circumstance, it is desirable that the engineer should be trained in the advanced countries in the field of sewerage technology for adequate operation and maintenance of the facilities before the completion of this Project. Participation in a group study and training course conducted by JICA, for example, will be one of such training measures.

(5) Coordinative Arrangement with Agricultural Project in San Bartolo

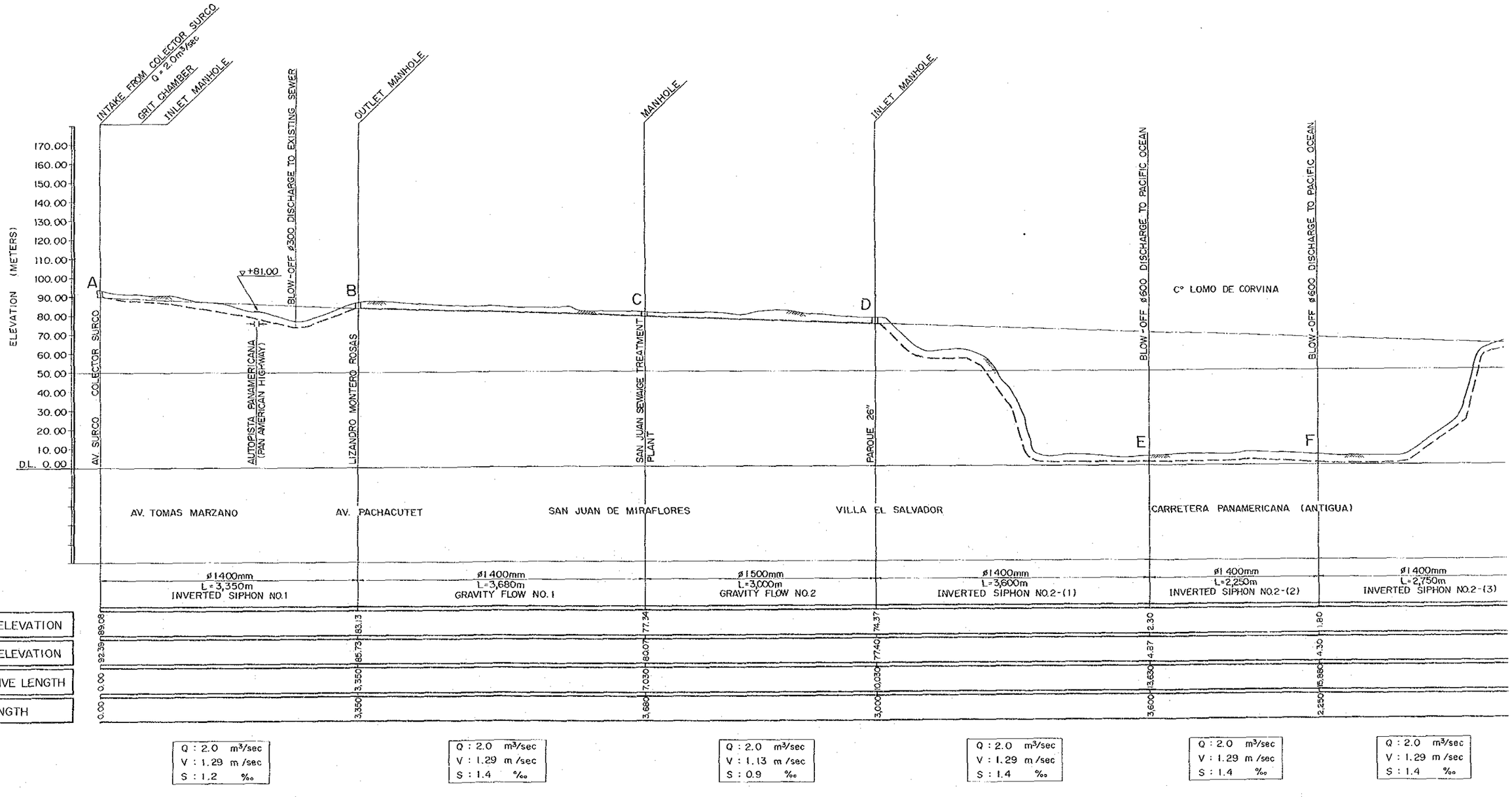
In the Republic of Peru, the recycling of the sewage water is already widely practiced, and in fact, more than 30 installations for this purpose are presently in operation. Likewise in San Bartolo where the sewage treatment plant is to be installed, the recycling of sewage water may take place in due time. A large-scale agricultural project is already under way in San Bartolo, wherein the recycled water may be used for irrigation or for maintaining the greens. In order to make this Project successful, the concurrent completion of the sewerage project and the agricultural project are inevitable.

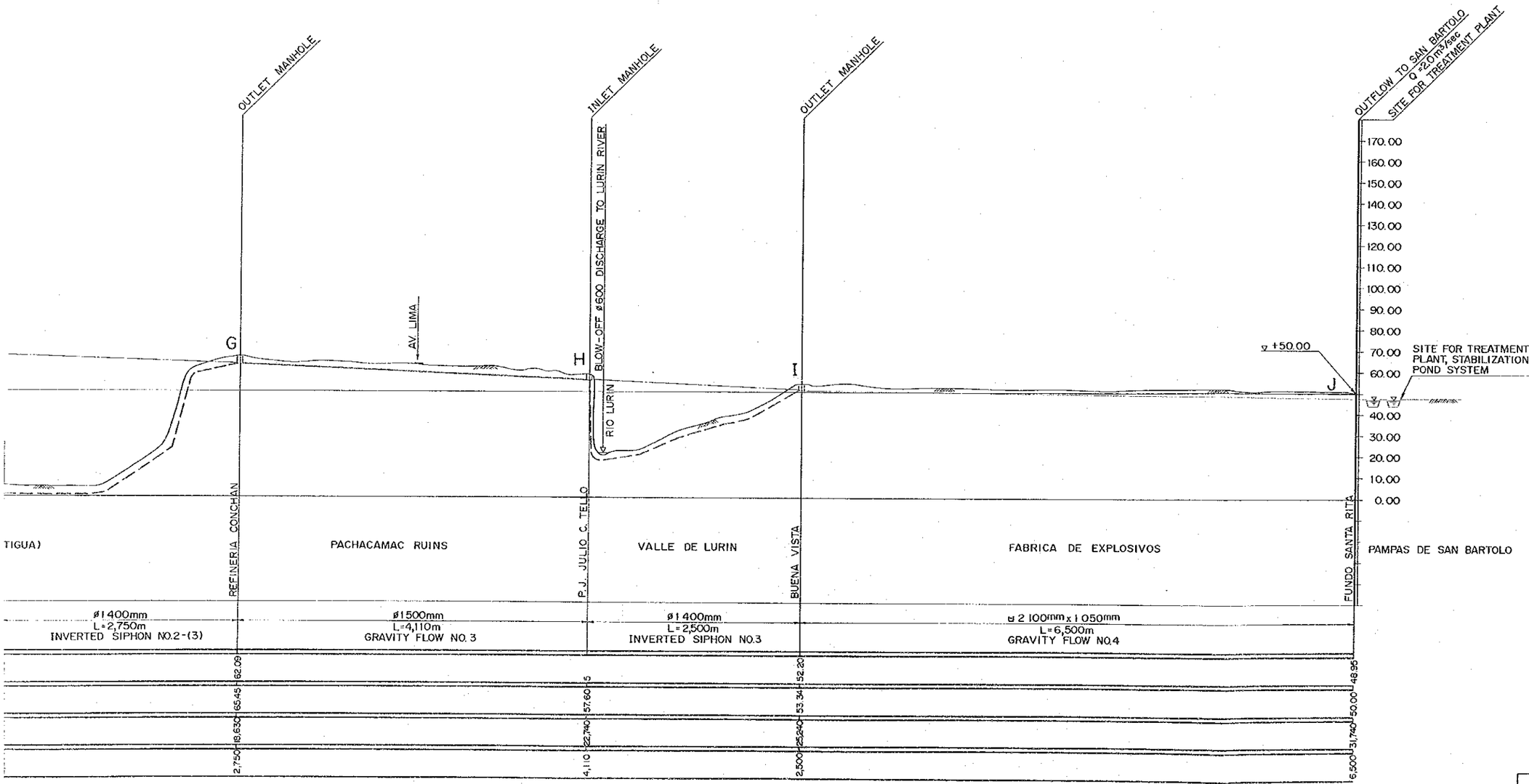
(6) Further Study on Inverted Siphon

The alternatives using inverted siphon are effective, but at the time of detailed design of the Project, it is necessary to analyze especially the characteristics of sewage in order to assure the durability and effective operation and maintenance.

(7) Enlargement of Transmission Line in Phase I

The planned sewage flow to be transmitted to San Bartolo in Phase I was decided at 1.5 m^3/s in consideration of present available sewage flow at the intake points. However, in case the intake of 2 m^3/s becomes possible, the plan with a sewage flow of 2 m^3/s will be technically feasible in that Phase.


INTAKE FROM COLECTOR SURCO
Q = 2.0m³/sec
GRIT CHAMBER
INLET MANHOLE
BLOW-OFF ø300 DISCHARGE TO EXISTING SEWER
OUTLET MANHOLE
MANHOLE
INLET MANHOLE
BLOW-OFF ø600 DISCHARGE TO PACIFIC OCEAN
BLOW-OFF ø600 DISCHARGE TO PACIFIC OCEAN
C° LOMO DE CORVINA
ELEVATION (METERS)
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
D.L. 0.00
▽+81.00
A
B
C
D
E
F
AV. SURCO COLECTOR SURCO
AUTOPISTA PANAMERICANA (PAN AMERICAN HIGHWAY)
LIZANDRO MONTERO ROSAS
SAN JUAN SEWAIGE TREATMENT PLANT
PARQUE 26"
AV. TOMAS MARZANO
AV. PACHACUTET
SAN JUAN DE MIRAFLORES
VILLA EL SALVADOR
CARRETERA PANAMERICANA (ANTIGUA)
ø1400mm
L=3,350m
INVERTED SIPHON NO.1
ø1400mm
L=3,680m
GRAVITY FLOW NO.1
ø1500mm
L=3,000m
GRAVITY FLOW NO.2
ø1400mm
L=3,600m
INVERTED SIPHON NO.2-(1)
ø1400mm
L=2,250m
INVERTED SIPHON NO.2-(2)
ø1400mm
L=2,750m
INVERTED SIPHON NO.2-(3)
INVERT ELEVATION
GROUND ELEVATION
CUMULATIVE LENGTH
LENGTH
89.08
92.39
0.00
0.00
83.13
85.73
3,350
3,350
77.34
80.07
7,030
3,680
74.37
77.40
10,030
3,000
72.30
74.87
13,630
3,600
71.80
74.30
15,880
2,250
Q : 2.0 m³/sec
V : 1.29 m/sec
S : 1.2 ‰
Q : 2.0 m³/sec
V : 1.29 m/sec
S : 1.4 ‰
Q : 2.0 m³/sec
V : 1.13 m/sec
S : 0.9 ‰
Q : 2.0 m³/sec
V : 1.29 m/sec
S : 1.4 ‰
Q : 2.0 m³/sec
V : 1.29 m/sec
S : 1.4 ‰
Q : 2.0 m³/sec
V : 1.29 m/sec
S : 1.4 ‰



LEGEND

INVERTED SIPHON	
GRAVITY FLOW	
SPECIAL MANHOLE	
HYDRAULIC GRADIENT	
DIAMETER	ø
OPEN CHANNEL	⊔
LENGTH	L =
QUANTITY	Q :
VELOCITY	V :
SLOPE	S :

SCALE V = 1 : 2,000
H = 1 : 50,000

Servicio de Agua Potable y Alcantarillado de Lima
SEDAPAL

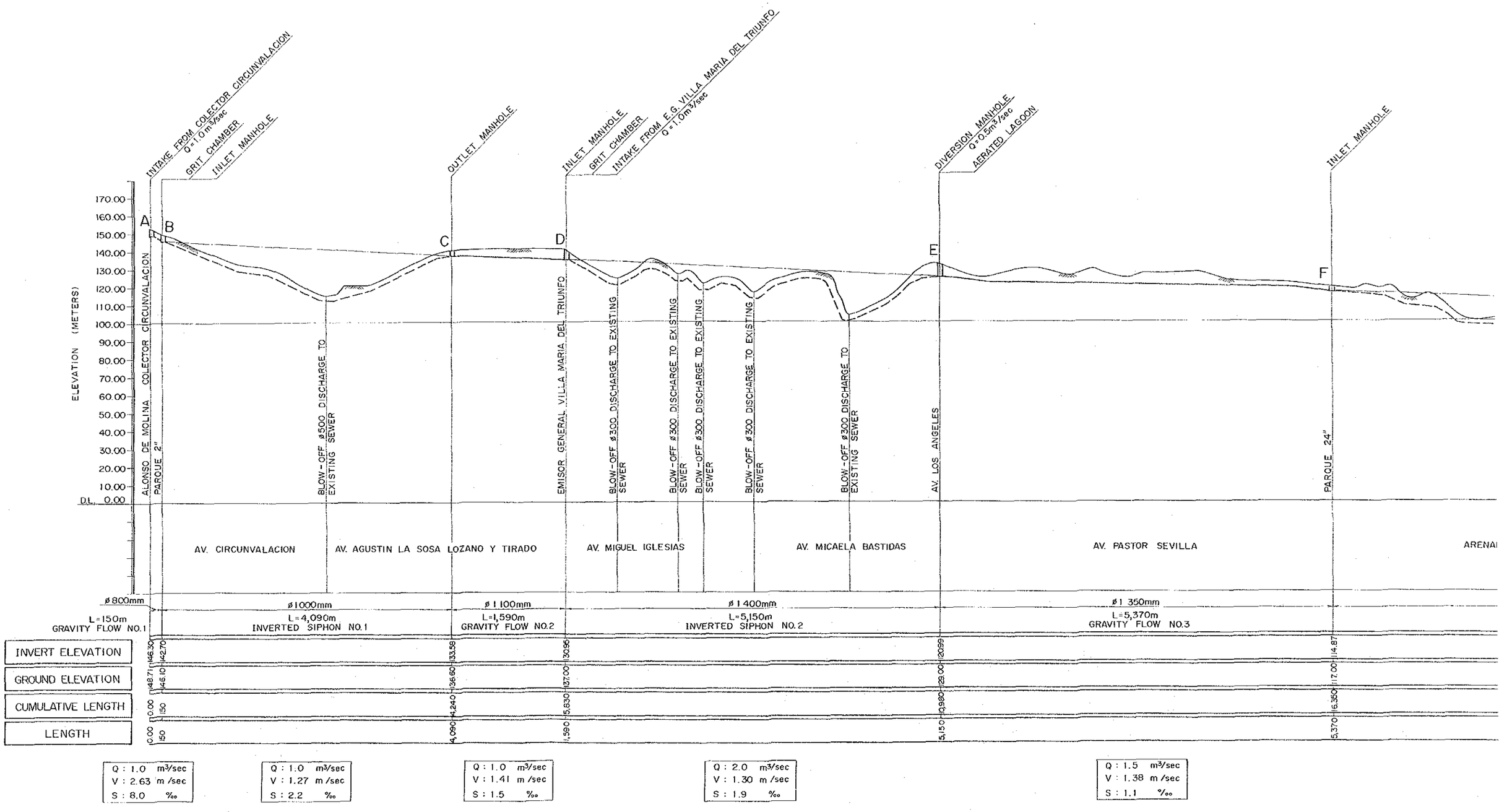
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

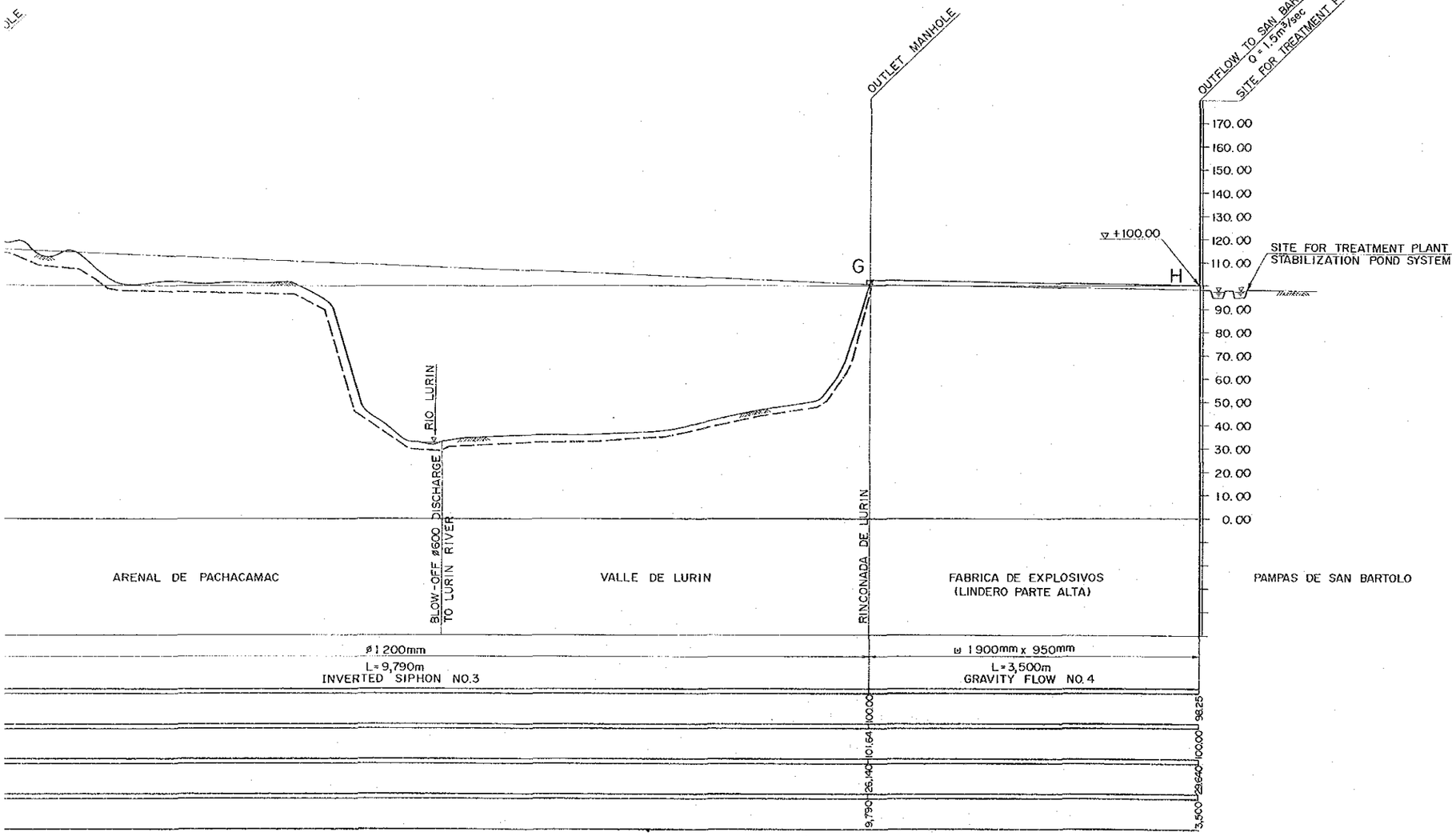
TITLE: LONGITUDINAL PROFILE OF RECOMMENDED SYSTEM PHASE II

SCALE: AS SHOWN	DATE: - -'90	DRAWING No.: 3/3

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 7-28


ELEVATION (METERS)
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
D.L. 0.00
A
B
C
D
E
F
INTAKE FROM COLECTOR CIRCUNVALACION
Q = 1.0 m3/sec
GRIT CHAMBER
INLET MANHOLE
OUTLET MANHOLE
INLET MANHOLE
GRIT CHAMBER
INTAKE FROM E.G. VILLA MARIA DEL TRIUNFO
Q = 1.0m3/sec
DIVERSION MANHOLE
Q=0.5m3/sec
AERATED LAGOON
INLET MANHOLE
ALONSO DE MOLINA COLECTOR CIRCUNVALACION
PARQUE 2"
BLOW-OFF ø500 DISCHARGE TO EXISTING SEWER
EMISOR GENERAL VILLA MARIA DEL TRIUNFO
BLOW-OFF ø300 DISCHARGE TO EXISTING SEWER
BLOW-OFF ø300 DISCHARGE TO EXISTING SEWER
BLOW-OFF ø300 DISCHARGE TO EXISTING SEWER
BLOW-OFF ø300 DISCHARGE TO EXISTING SEWER
AV. LOS ANGELES
PARQUE 24"
AV. CIRCUNVALACION
AV. AGUSTIN LA SOSA LOZANO Y TIRADO
AV. MIGUEL IGLESIAS
AV. MICAELA BASTIDAS
AV. PASTOR SEVILLA
ARENAL
ø800mm
L=150m
GRAVITY FLOW NO.1
ø1000mm
L=4,090m
INVERTED SIPHON NO.1
ø1100mm
L=1,590m
GRAVITY FLOW NO.2
ø1400mm
L=5,150m
INVERTED SIPHON NO.2
ø1350mm
L=5,370m
GRAVITY FLOW NO.3
INVERT ELEVATION
GROUND ELEVATION
CUMULATIVE LENGTH
LENGTH
146.30
142.70
133.58
130.96
120.89
114.87
148.71
146.10
136.60
137.00
128.00
117.00
0.00
150
4,240
5,830
10,980
16,350
0.00
150
4,090
1,590
5,150
5,370
Q : 1.0 m3/sec
V : 2.63 m/sec
S : 8.0 ‰
Q : 1.0 m3/sec
V : 1.27 m/sec
S : 2.2 ‰
Q : 1.0 m3/sec
V : 1.41 m/sec
S : 1.5 ‰
Q : 2.0 m3/sec
V : 1.30 m/sec
S : 1.9 ‰
Q : 1.5 m3/sec
V : 1.38 m/sec
S : 1.1 ‰



LEGEND

INVERTED SIPHON	
GRAVITY FLOW	
SPECIAL MANHOLE	
HYDRAULIC GRADIENT	
DIAMETER	ø
OPEN CHANNEL	⊔
LENGTH	L =
QUANTITY	Q :
VELOCITY	V :
SLOPE	S :

SCALE V = 1 :
H = 1 :

Servicio de Agua Potable y Alcantarillado de Lima
SEDAPAL

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: LONGITUDINAL PROFILE OF RECOMMENDED SYSTEM PHASE I

SCALE: AS SHOWN | DATE: - -'90 | DRAWING No.: 2/3

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 7-27

COLE. STA. ANITA
COLE. VITARTE
COLE. BACKUS Y JHONSONS
COLE. LA MOLINA
COLE. LA MOLINA VIEJA
COLE. CIRCUNVALACION
COLE. MENDOZA
COLE. No.10
COLE. JAVIER PRADO
COLE. SAN BORJA ESTE
COLE. No.22
SEDAPAL
COLE. SURCO
COLE. ALIVIADERO DEL COSTANERO
COLE. No.4
COLE. No.25
COLE. BALNEARIOS DEL SUR
COLE. SAN JUAN

INTAKE AT CIRCUNVALACON
Q = 1.0 m³/s
148.71
146.30
146.10
142.10
GRIT CHAMBER INLET MANHOLE
ø1400mm
A
B
ø1300mm
S=8.0‰
L=150m
ø=800mm
ø=1000mm
BLOW-OFF ø500mm
S=2.2% L=4,090m
C
136.60
133.58
ø=1 100m
S=1.5‰
L=1,590m
D
137.00
130.95
140.91
138.40
OUTLET MANHOLE
INLET MANHOLE
GRIT CHAMBER
INTAKE AT E.G. VILLA MARIA DEL TRIUNFO
Q = 1.0m³/s
EMISOR GENERAL VILLA MARIA DEL TRIUNFO
ø1000mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
DIVERSION MANHOLE
Q = 0.5m³/s
92.39
89.08
INTAKE AT SURCO
Q = 2.0m³/s
ø=1.400mm
S=1.2‰
L=3,350m
GRIT CHAMBER
INLET MANHOLE
BLOW-OFF ø300mm
ø900mm
OUTLET MANHOLE
ø1400mm
85.73
83.13
ø=400mm
S=1.4‰ L=3,680m
B
C
80.07
77.34
ø=1400mm
S=1.9‰
L=5,150m
BLOW-OFF ø300mm
129.69
120.99
ø=1500mm
S=0.9‰
L=3,900m
MANHOLE
ø700mm
E
PHASE - I
ELEVATION TRANSMISSION LINE
INLET MANHOLE
117.00
114.67
ø=1350mm S=1.1‰ L=5,370m
P-24
F
EMISOR VILLIA EL SALVADOR
P-26
77.40
74.37
D
INLET MANHOLE
ø1400mm
S=1.4‰
Aerated Lagoon (0.5m³/s)
S.T.P. SAN JUAN
Stabilization Pond System
PHASE - II
LOW ELEVATION TRANSMISSION LINE
65.45
62.09
G
OUTLET
ø=1400mm
S=1.4‰
L=250m
F
ø=1400mm S=1.4‰ L=2,750m

SITE FOR TREATMENT PLANT

OUTLET MANHOLE

100.00
98.25

OUTFLOW TO SAN BARTOLO
ELEVATION 100m

Q=1.5 m³/s

Stabilization Pond System
(0.25m³/s / block)

T-NO.1 | T-NO.2 | T-NO.3
T-NO.4 | T-NO.5 | T-NO.6

ø1900mm
ø950mm
S=0.5‰
L=3,500m

ø1.64
100.00

H

G

50.00
48.95

OUTFLOW TO SAN BARTOLO
ELEVATION 50m

T-NO.1 | T-NO.2 | T-NO.3 | T-NO.4
T-NO.5 | T-NO.6 | T-NO.7 | T-NO.8

Q=2.0m³/s

Stabilization Pond System
(0.25m³/s / block)

ø600mm

BLOW-OFF ø600mm

L=9,790m

S=1.5‰

ø1200mm

S=0.5‰ L=6,500m

53.34
52.20

ø1400mm S=1.5‰ L=2,500m

57.60
56.07

ø1400mm
ø1050mm
ø760 x 1460mm

FABRICA DE EXPLOSIVOS

LURIN

INLET MANHOLE

OUTLET MANHOLE

BLOW-OFF ø600mm

INLET MANHOLE

L=5,170m

S=0.9‰

PACHACAMAC RUINS

PAMPA SAN BARTORO

17.00
14.87

P-24

F

65.46
62.09

ø1500mm

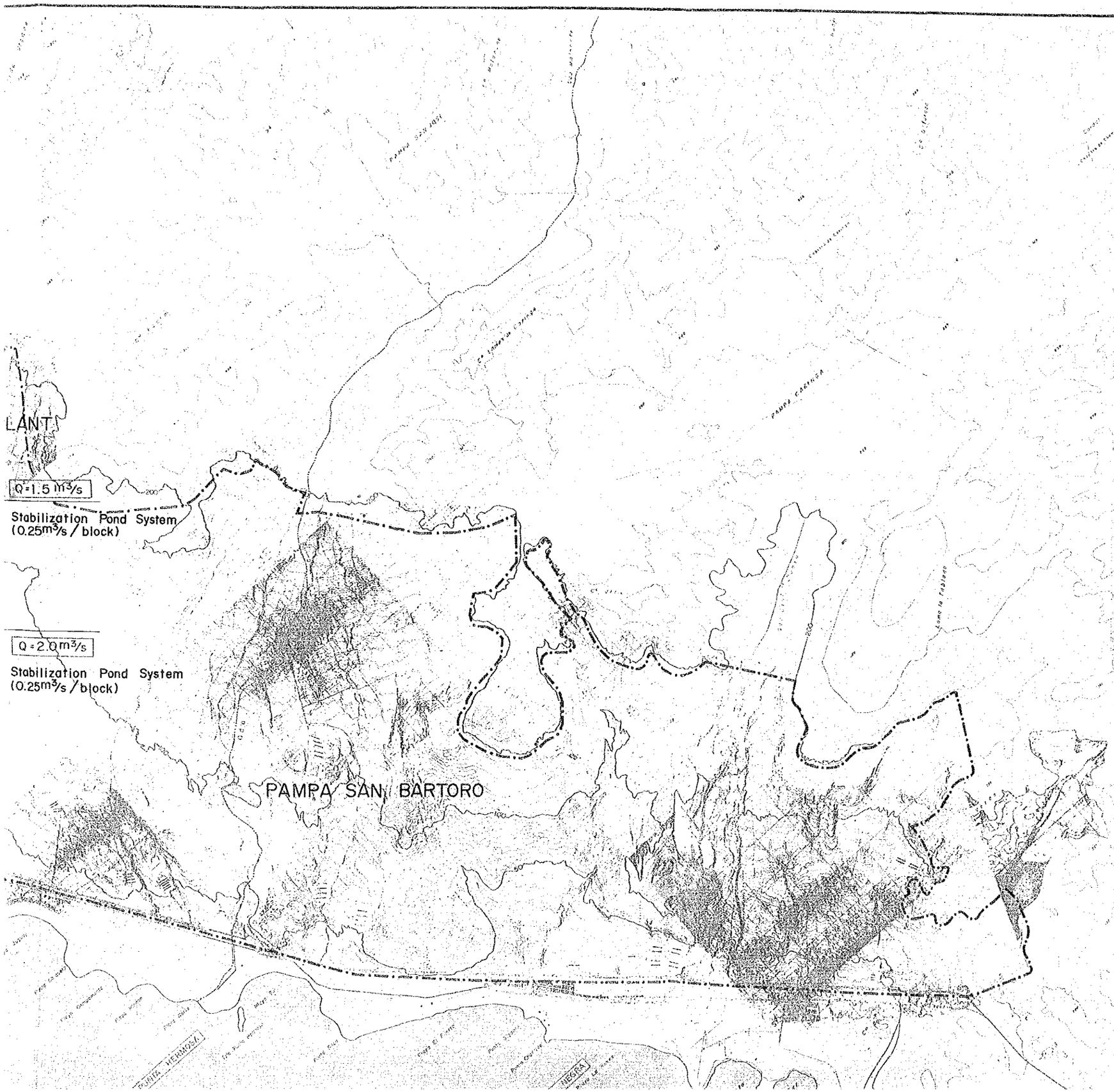
G

OUTLET MANHOLE

ø1400mm S=1.4‰ L=2,750m

ø600mm

PUNTA HERMOSA



LEGEND

PHASE I PROJECT (COLORED IN RED)

PHASE II PROJECT (COLORED IN GREEN)

FLOW DIRECTION

GRAVITY FLOW

INVERTED SIPHON

OPEN CHANNEL

INTAKE STRUCTURE

GRIT CHAMBER

SPECIAL MANHOLE

BLOW-OFF
(DISCHARGE TO EXISTING SEWER)

BLOW-OFF
(DISCHARGE TO SEA OR RIVER)

PROPOSED SEWAGE TREATMENT PLANT
T

OTHERS

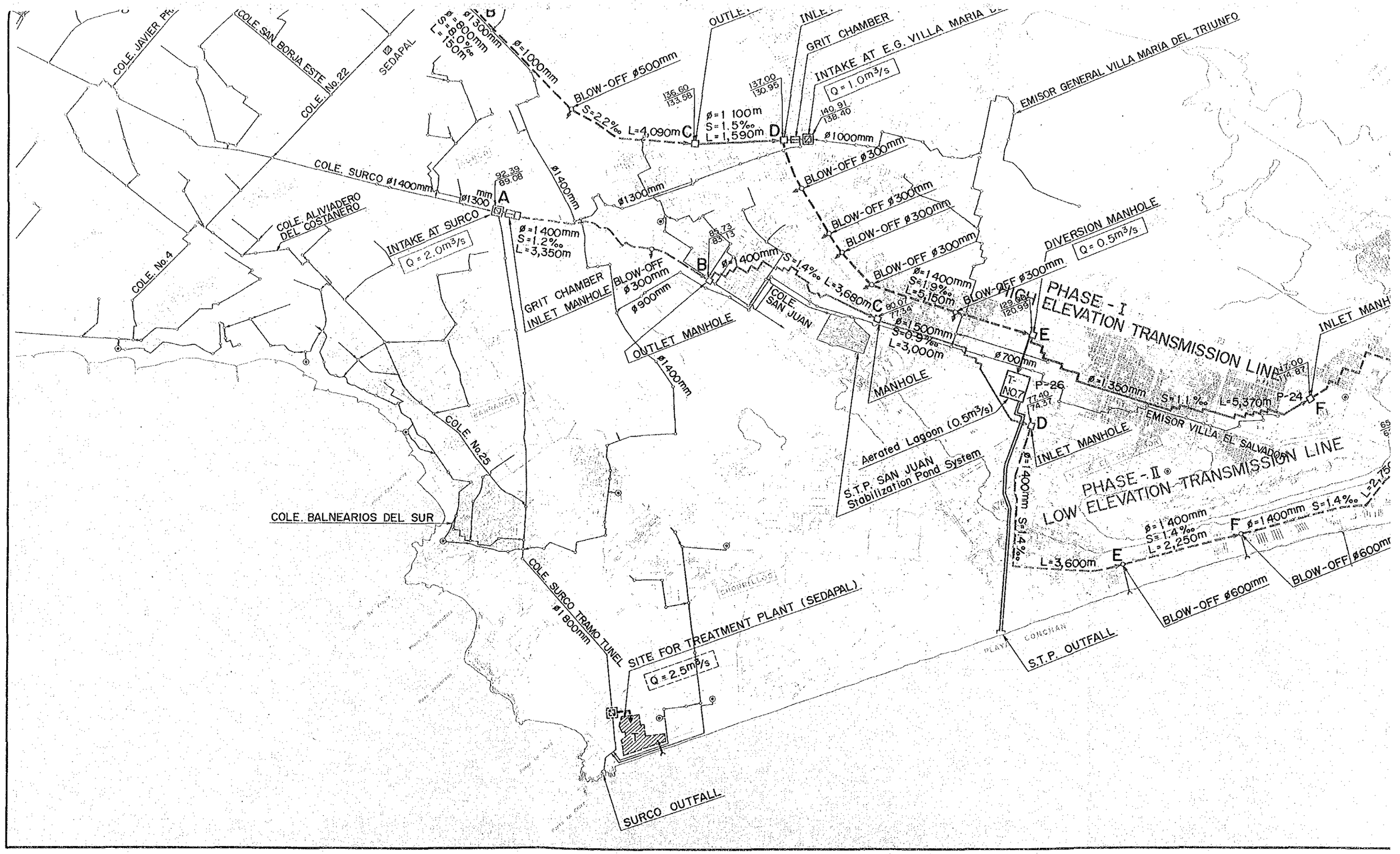
GROUND ELEVATION / INVERT ELEVATION — 100.00 / 98.25

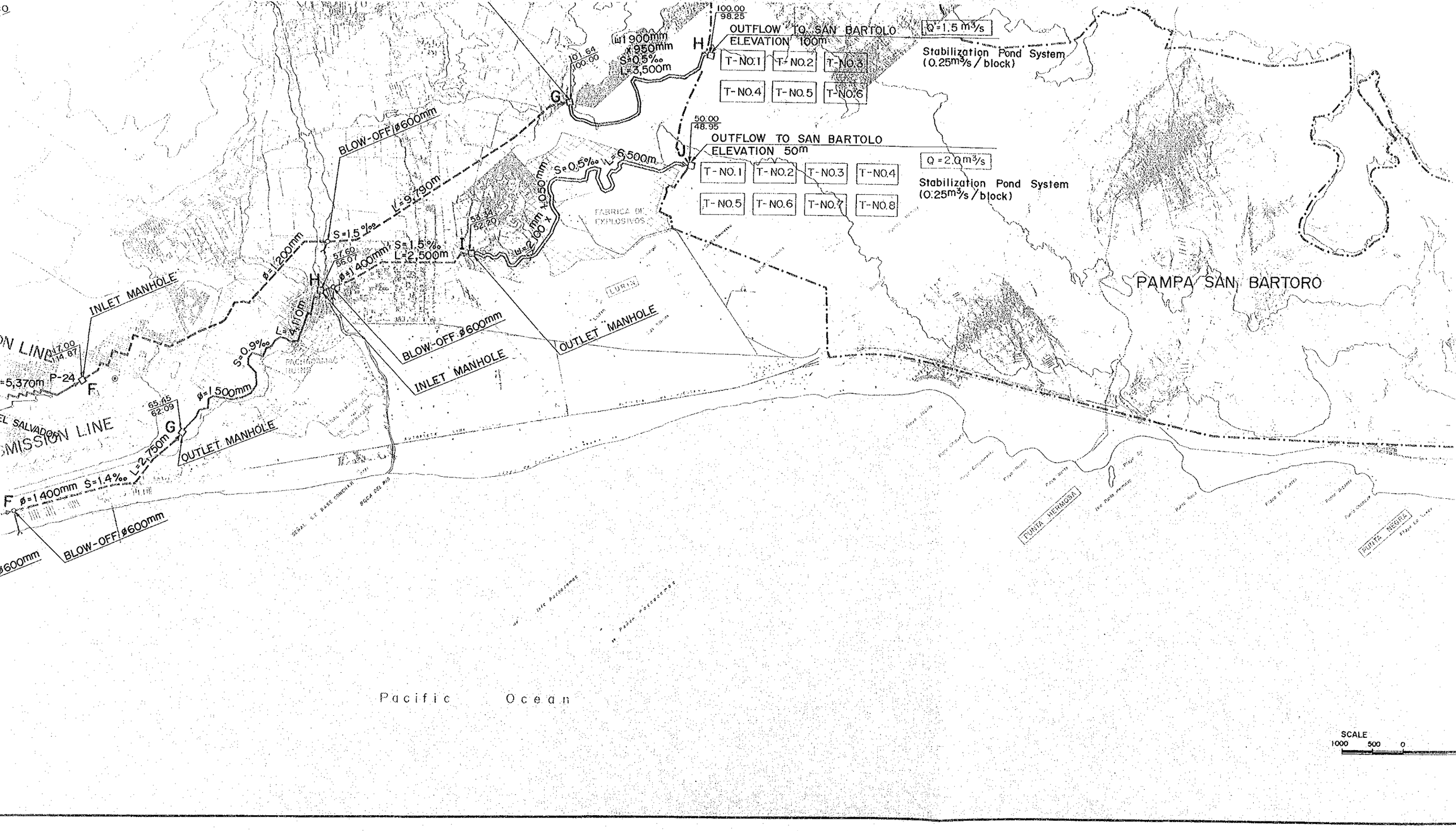
DIAMETER ø
OPEN CHANNEL ⊔
LENGTH L =
QUANTITY Q =
VELOCITY V =
SLOPE S =

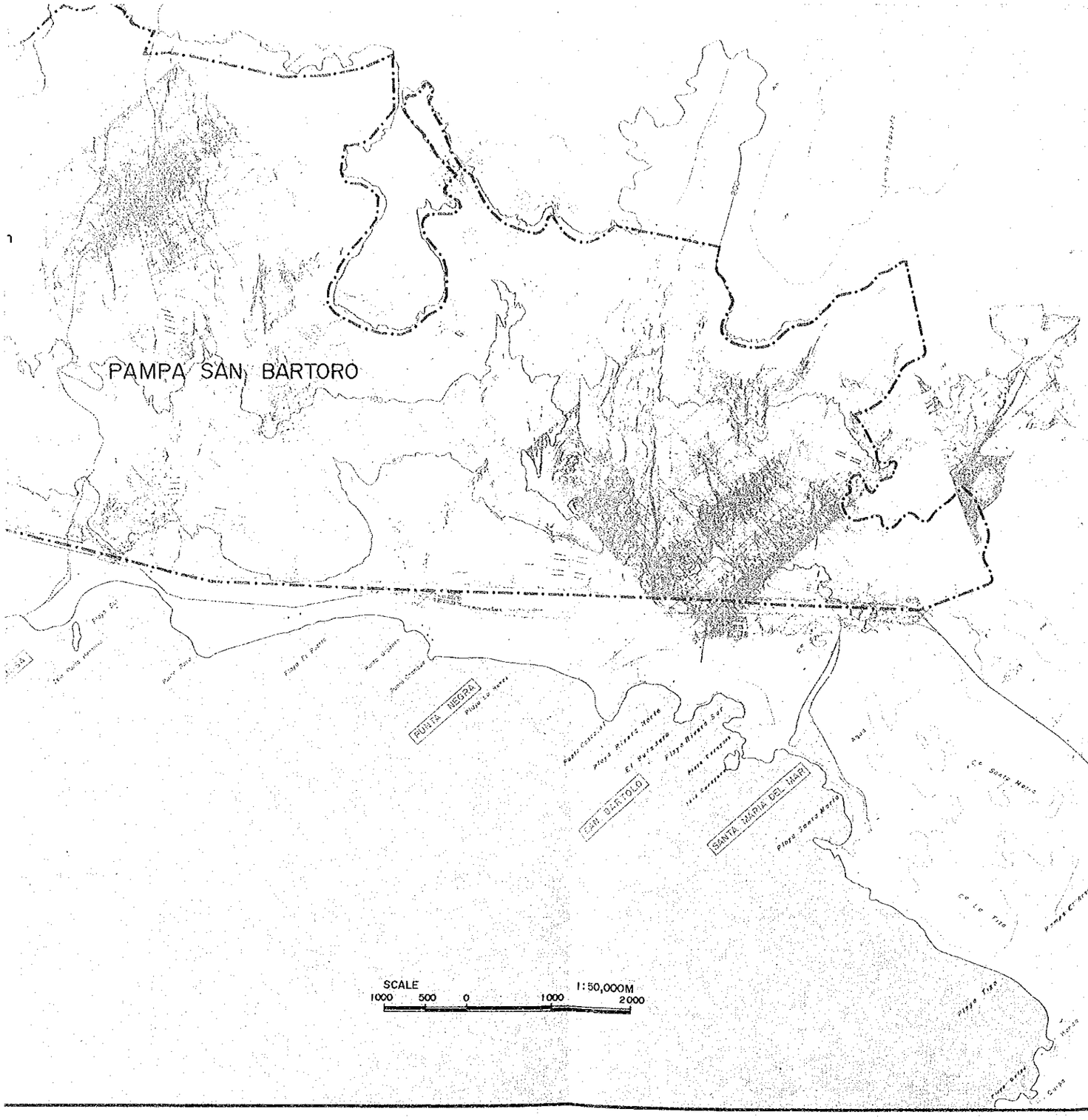
EXISTING MAIN SEWER

EXISTING PUMPING STATION

EXISTING SEWAGE TREATMENT PLANT


COLE. JAVIER Pte.
COLE. SAN BORJA ESTE No.22
COLE. No.22
SEDAPAL
ø=800mm S=80‰ L=150m
ø1300mm
ø=1000mm
BLOW-OFF ø500mm
S=2.2‰ L=4,090m C
136.60 133.58
ø=1 100m S=1.5‰ L=1,590m D
137.00 130.95
OUTLE
INLE
GRIT CHAMBER
INTAKE AT E.G. VILLA MARIA D
Q = 1.0m³/s
140.91 138.40
EMISOR GENERAL VILLA MARIA DEL TRIUNFO
ø1000mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
DIVERSION MANHOLE
Q = 0.5m³/s
COLE. SURCO ø1400mm
92.39 89.08
mm ø1300
A
ø1400mm
ø1300mm
COLE. ALIVIADERO DEL COSTANERO
INTAKE AT SURCO
Q = 2.0m³/s
ø=1400mm S=1.2‰ L=3,350m
85.73 83.13
B
ø=400mm
S=1.4‰ L=3,680m C
80.07 77.34
ø=1400mm S=1.9‰ L=5,150m
129.60 120.99
G
PHASE - I
ELEVATION TRANSMISSION LINE
INLET MANH
COLE. No.4
GRIT CHAMBER INLET MANHOLE
BLOW-OFF ø300mm
ø900mm
OUTLET MANHOLE
ø1400mm
COLE. SAN JUAN
ø=1500mm S=0.9‰ L=3,000m
MANHOLE
ø700mm
T-NO.7
P-26
77.40 74.37
E
ø=1350mm S=1.1‰ L=5,370m P-24
137.00 134.87
F
EMISOR VILLA EL SALVADOR
D
INLET MANHOLE
Aerated Lagoon (0.5m³/s)
S.T.P. SAN JUAN
Stabilization Pond System
ø=1400mm S=1.4‰
PHASE - II
LOW ELEVATION TRANSMISSION LINE
ø=1400mm S=1.4‰ L=2,250m
F ø=1400mm S=1.4‰ L=2,75
L=3,600m E
BLOW-OFF ø600mm
BLOW-OFF ø600mm
COLE. BALNEARIOS DEL SUR
COLE. No.25
COLE. SURCO TRAMO TUNEL ø1800mm
SITE FOR TREATMENT PLANT (SEDAPAL)
Q = 2.5m³/s
CONCHAN
PLAYA
S.T.P. OUTFALL
SURCO OUTFALL


OUTFLOW TO SAN BARTOLO
ELEVATION 100m
Q=1.5 m³/s
T-NO.1
T-NO.2
T-NO.3
T-NO.4
T-NO.5
T-NO.6
Stabilization Pond System
(0.25m³/s / block)
100.00
98.25
101.64
100.00
ø1900mm x 950mm
S=0.5‰
L=3,500m
OUTFLOW TO SAN BARTOLO
ELEVATION 50m
Q=2.0m³/s
50.00
48.95
T-NO.1
T-NO.2
T-NO.3
T-NO.4
T-NO.5
T-NO.6
T-NO.7
T-NO.8
Stabilization Pond System
(0.25m³/s / block)
S=0.5‰ L=6,500m
ø1400mm x 1050mm x 2 lines
53.34
52.20
L=9,790m
BLOW-OFF ø600mm
S=1.5‰
ø1200mm
INLET MANHOLE
57.60
56.07
ø1400mm S=1.5‰
L=2,500m
BLOW-OFF ø600mm
INLET MANHOLE
OUTLET MANHOLE
FABRICA DE EXPLOSIVOS
LURIN
PAMPA SAN BARTORO
S=0.9‰
L=4,110m
ø1500mm
65.45
62.09
L=2,750m
OUTLET MANHOLE
ø1400mm S=1.4‰
BLOW-OFF ø600mm
ø600mm
INLET MANHOLE
L=5,370m P-24
17.00
14.67
F
G
H
I
J
SERAL S.E. BASE CONCHAN
BECA DEL RIO
PUNTA HERMOSA
PUNTA NEGRA
Pacific Ocean
SCALE
1000 500 0



GRIT CHAMBER

SPECIAL MANHOLE

BLOW-OFF
(DISCHARGE TO EXISTING SEWER)

BLOW-OFF
(DISCHARGE TO SEA OR RIVER)

PROPOSED SEWAGE TREATMENT PLANT
T

OTHERS

GROUND ELEVATION / INVERT ELEVATION	100.00 / 98.25
DIAMETER	ø
OPEN CHANNEL	⊔
LENGTH	L =
QUANTITY	Q =
VELOCITY	V =
SLOPE	S =

EXISTING MAIN SEWER

EXISTING PUMPING STATION

EXISTING SEWAGE TREATMENT PLANT

SEWAGE TREATMENT PLANT IN THE FUTURE

FIGURE 7-26

Servicio de Agua Potable y Alcantarillado de Lima
SEDAPAL

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHEPN PART OF LIMA

TITLE: LAYOUT PLAN OF THE RECOMMENDED SYSTEM

SCALE = 1:50,000 | DATE: - - 90 | DRAWING NO. 1/3

JAPAN INTERNATIONAL COOPERATION AGENCY