S.7.3 Grit Chambers and Pumping Facility

S.7.3.1 Grit Chambers

These are located at the intake point and upstream of inverted siphon, transmission pump or treatment plant to prevent inorganic solids and coarse matters from getting into the system.

FIGURE S-13 shows an outline of a grit chamber structure, plug-flow rectangular type. The following criteria shall be used in the design of the structure:

Water surface load: S = Approx. 1,800 $m^3/m^2/day$
Average velocity : V = Approx. 0.30 m/sec
Detention time : T = 30 to 60 sec

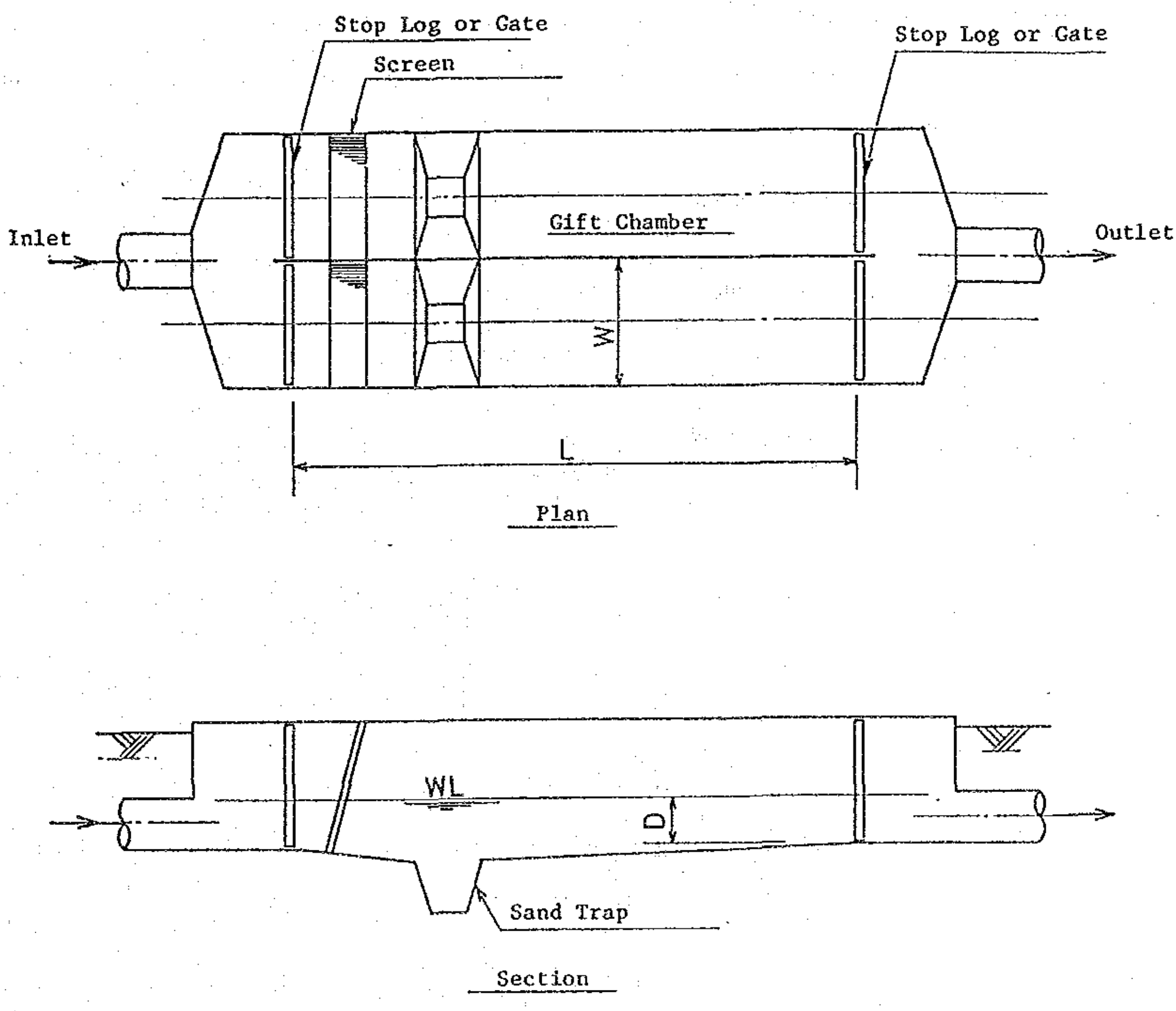


FIGURE S-13 Outline of Grit Chamber Structure

S.7.3.2 Pumping Facility

In the design of pumping facility, it is desirable to have as few pumps as possible, with each pump having a uniform capacity and performance for easier operation and maintenance.

Optimum arrangements in the number of pumps to be installed are prescribed by the "Guidelines and Explanation for Design of Sewage Facilities" (Japan Sewerage Works Association, 1984) as follows:

Design Flow (m^3/sec)	Number of Pumps (set)
under 0.5	3 (including 1 stand-by)
0.5 to 1.5	3 to 5 (including 1 stand-by)
above 1.5	4 to 6 (including 1 standy-by)

Pumps shall be of the vertical shaft centrifugal type for less space requirement and suitability to design flow and total head.

Because provision must be made for power cuts, bypass should be considered.

S.7.4 Sewage Treatment Plant

Items considered in the selection of treatment method includes: quantity and quality of sewage and their variation, conditions in the areas of discharge and water use, scale of treatment plant, location and environment of treatment plant, operation and maintenance organization and operation and maintenance cost.

The discharge from Colector Surco was projected to be 6.5 m^3/sec for the year 2000. The design flow of sewage treatment plant proposed for each alternative in Chapter S.6 are summarized in TABLE S-16. Target treated water quality is as follows:

Site	Treatment Level	BOD_5 (mg/l)	Fecal Coliform (MPN/100 ml)
West bank of Rio Lurin	3	35	1,000
San Bartolo	2	45	10,000

TABLE S-16 Design Flow of Sewage Treatment Plant in Each Proposed Site

(unit : m^3/s)

Proposed Site		a. San Juan STP		b. San Juan		c. Villa El Salvador		e. & f. San Bartolo	
Alternatives		Ph-I	Ph-II	Ph-I	Ph-II	Ph-I	Ph-II	Ph-I	Ph-II
A	A_1	-	-	-	-	0.5	-	3.5	-
	A_2	-	-	-	-	0.5	-	1.5	2.0
	A_3	-	-	-	-	0.5	-	0.5	3.0
B	B_1	-	-	-	-	0.5	-	3.5	-
	B_2	-	-	-	-	0.5	-	1.5	2.0
	B_3	-	-	-	-	0.5	-	0.5	3.0
C	C_1	0.5*1	-	1.0	-	0.83	-	-	1.67
	C_2	-	-	1.0	-	0.83	-	-	2.17
	C_3	-	-	-	0.5	0.83	-	-	2.67
	C_3'	-	-	-	0.5	1.0	-	-	2.5
D	D_1	0.5*1	-	1.0	-	-	-	-	2.5
	D_2	-	-	1.0	-	-	-	-	3.0
E	E_1	-	-	-	-	0.5	-	1.5	2.0
	E_2	-	-	-	0.5	-	-	1.0	2.5

*1 0.5 m^3/s is the increase in quantity by reconstruction.

The proposed treatment methods shall be aerated lagoon (AL) for San Juan STP, San Juan and Villa El Salvador and Waste Stabilization Pond (WSP) for San Bartolo. Design criteria on waste stabilization pond and aerated lagoon are given in TABLEs S-17 and S-18.

TABLE S-17 Design Criteria of Waste Stabilization Pond

Parameter	Symbol	Unit	Formula or Value	Application
Primary Facultative Pond				
. Water Temperature	Tw	°C	Tw = 8.49 + 0.82 Ta	Ta = 15 °C Tw = 8.49 + 0.82 x 15 = 20.8 °C
. BOD_5 Areal Loading	Li1	kg-BOD/ha/d	under 400 $Li1 = 357.4 \times 1.085^{(Tw-20)}$	$Li1 = 357.4 \times 1.085^{(20.8-20)}$ = 382
. Water Depth	D1	m	1.3 - 1.6	1.5
. BOD_5 Removal Rate	R1	%	65 - 75	70
Secondary Facultative Pond				
. BOD_5 Areal Loading	Li2	kg-BOD/ha/d	40 - 210	200
. Water Depth	D2	m	1.3 - 1.6	1.5
. BOD_5 Removal Rate	R2	%	30 - 40	35

TABLE S-18 Design Criteria for Aerated Lagoon (Dual Power Aeration System)

Parameter	Symbol	Unit	Formula or Value	Application
Complete Mixing Aerated Lagoon				
. Detention Time	t*c	day	1.5 - 2.0	2.0
. Water Depth	Dc	m	3.0 - 4.0	3.0
. Number of Lagoon	Nc	-	1	1
. Oxygen Requirement	Ro	kg/hr	$Ro=6.24 \times 10^{-5} \times Q.Li$	Same as left
. Power Requirement for Mixing	pc	w/m^3	$pc>=6w/m^3$	$6w/m^3$
Facultative Aerated Lagoon				
. Detention Time for One-Cell	t*f	day	0.5 - 1.0	0.67
. Water Depth	Df	m	3.0 - 4.0	3.0
. Power Requirement for Partially Mixing	pf	w/m^3	$pf >=1 w/m^3$	$1.0-1.5w/m^3$
. Number of Lagoon	nf	-	1 - 3 (series)	3 cells
Sedimentation Ponds				
. Detention Time	t*s	day	1 - 2	1

S.7.5 Evaluation of Alternatives

S.7.5.1 Construction Cost

Estimated construction costs and unit cost per cubic meter of each alternative are summarized in TABLE S-19. Thirty percent of direct construction cost were added as overhead expenses.

S.7.5.2 Operation and Maintenance Cost

The operation and maintenance cost and unit cost per cubic meter of each alternative are summarized in TABLE S-20.

TABLE S-19 Comparison of Construction Cost

PLAN		CONST. COST C (1,000US$)	UNIT COST C/Q (US$/m^3)	RATIO (%)	RANKING	REMARKS
A	A_1	88,971	257	100	2	***
	A_2	111,537	323	125	10	*
	A_3	103,447	299	116	7	*
B	B_1	77,704	225	87	1	***
	B_2	97,314	282	109	5	**
	B_3	94,780	274	107	3	***
C	C_1	124,770	361	140	14	*
	C_2	122,442	354	138	12	*
	C_3	105,739	306	119	8	*
	C_3'	122,539	355	138	12	*
D	D_1	118,832	344	134	11	*
	D_2	108,077	313	121	9	*
E	E_1	98,301	284	110	6	**
	E_2	95,905	278	108	4	**

NOTE:
1) Ratios are shown in comparison to the C/Q of plan A_1 as 100%.
2) *** Superior, ** Intermediate, * Inferior
3) Q: 4 m^3/s x 86,400 s/day = 345,600 m^3/day

TABLE S-20 Comparison of Operation and Maintenance Cost

PLAN		O&M COST Cm (US$/year)	UNIT COST Cm/Q (10^{-3}US$/m^3)	RATIO (%)	RANKING	REMARKS
A	A_1	562,250	4.46	100	11	*
	A_2	594,115	4.71	106	12	*
	A_3	616,752	4.89	110	14	*
B	B_1	140,345	1.11	25	1	***
	B_2	155,669	1.23	28	3	**
	B_3	144,477	1.15	26	2	***
C	C_1	598,050	4.74	106	13	*
	C_2	437,063	3.46	78	9	*
	C_3	293,577	2.33	52	7	*
	C_3'	326,781	2.59	58	8	*
D	D_1	446,782	3.54	79	10	*
	D_2	282,520	2.24	50	6	*
E	E_1	154,185	1.22	27	3	**
	E_2	152,923	1.21	27	3	**

NOTE:
1) O&M cost is estimated for direct cost only.
2) Ratios are shown in comparison to the Cm/Q of plan A_1 as 100%.
3) Q: 4m^3/s x 86,400 s/day x 365 days/year = 126,144,000 m^3/year

S.7.5.3 Technical Evaluation

(1) Alternative A (Pumping and Gravity Flow)

This plan is not recommendable because of high O & M (power and repair) and replacement cost.

(2) Alternative B (Gravity Flow)

It is hard to adopt this plan because of the dim possibility of getting approval for passage through the Pachacamac ruins.

(3) Alternative C (Gravity Flow and Pumping)

Plans C_1 and C_2 are inadequate because a pumping facility is necessary and it gives the same disadvantages as plan A has. Plan C_3 is not recommendable because of the need for passage through the Pachacamac Ruins. In plan C_3', transmission of the treated sewage to the destination by gravity without a pumping facility is possible because of the high potential of proposed STP at the site of c).

(4) Alternative D (Gravity Flow and Pumping)

Advantages and disadvantages of alternative D are almost the same as that of plans C_1 and C_2 because of the need for passage through the Pachacamac Ruins and necessity of pumping facilities.

(5) Alternative E (Gravity Flow)

The sewage can be transmitted to the destination without pumps. However, adoption of inverted siphon cannot be avoided. In case of accident, damage will be less than that which may be incurred under alternative A.

(6) Conclusion of Technical Evaluation

Comparison of technical evaluation of each alternative is shown in TABLE S-21. Based on this Table, alternative E is judged to be superior.

S.7.5.4 Selection of Optimum Plans

Construction cost, operation and maintenance cost and technical evaluation of each alternative are summarized in TABLE S-22.

The alternatives with pumping facilities are not recommendable because of high operations, maintenance and replacement costs. The alternatives in which the transmission line will pass through the Pachacamac Ruins is not recommendable for Phase I, until detailed investigations prove otherwise. On the overall, Plan E1 is selected a optimum plan for further study.

TABLE S-21 Comparison of Technical Evaluation

PLAN		PHASE I PLANNED SEWAGE QUANTITY (m^3/s)	TECHNICAL EVALUATION	REMARKS
A	A_1	4.0	*	Devaluation due to necessity of Pumping Facility.
	A_2	2.0	*	
	A_3	1.0	*	
B	B_1	4.0	*	Devaluation due to dim possibility of approval for passing of transmission line.
	B_2	2.0	*	
	B_3	1.0	*	
C	C_1	2.33	*	Same as Alternative A and B.
	C_2	1.83	*	- ditto -
	C_3	0.83	*	- ditto -
	C_3'	1.0	*	Devaluation due to long siphon.
D	D_1	1.5	*	Devaluation due to necessity of Pumping Facility.
	D_2	1.0	*	
E	E_1	2.0	***	
	E_2	1.0	***	

Legend : *** Superior ** Intermediate * Inferior

TABLE S-22 Comparison of Evaluation

PLAN		PHASE I PLANNED SEWAGE Q'TY (M^3/S)	CONSTRUCTION COST	O&M COST	TECHNICAL EVALUATION	COMPREHENSIVE EVALUATION
A	A_1	4.0	***	*	*	
	A_2	2.0	*	*	*	
	A_3	1.0	**	*	*	
B	B_1	4.0	***	***	*	
	B_2	2.0	**	**	*	
	B_3	1.0	***	***	*	
C	C_1	2.33	*	*	*	
	C_2	1.83	*	*	*	
	C_3	0.83	*	*	*	
	C_3'	1.0	*	*	*	
D	D_1	1.5	*	*	*	
	D_2	1.0	*	*	*	
E	E_1	2.0	**	**	***	***
	E_2	1.0	**	**	***	**

Legend: *** Superior ** Intermediate * Inferior

CHAPTER 8

POLLUTION ANALYSIS FOR THE COAST OF CHIRA

CHAPTER S.8 POLLUTION ANALYSIS FOR THE COAST OF CHIRA

S.8.1 Introduction

The Direction T?cnica de Salud Ambienta (DITESA) started survey and research project on the pollution problems in 1984 in view of the severe sea water pollution along the coastal areas of Metropolitan Lima. The objective of the project was to protect and preserve the environment of coastal areas by carrying out measures to be taken against pollution. This was done using computer-aided simulation models. In this Study, same model was adopted for pollution analysis caused by the discharge from Surco Outfall.

S.8.2 Present Sea Water Pollution Condition

S.8.2.1 Bacteria

Analyses in bacteriological items were conducted during the Study period by SEDAPAL at designated sampling stations shown in FIGURE S-14. Results of the analyses are summarized in TABLE S-23. The concentration of coliform bacteria in the sea water varies widely with the location point and date of sampling. Salmonella bacteria were found at points where many commercial fishing boats converge.

CEPIS also conducted in 1986 and 1987 study in total and fecal coliform along the coast of Lima at the Pacific Ocean. Results show that fecal coliform concentrations near sampling points exceed the water quality standard.

Coliform numbers in the sewage were measured at three main sewers: Colector Surco, Colector Circunvalacion and Colector Balnearios del Sur. Results of analyses are given in TABLE S-24. The average concentration was computed considering the variation in coliform concentration at specific times.

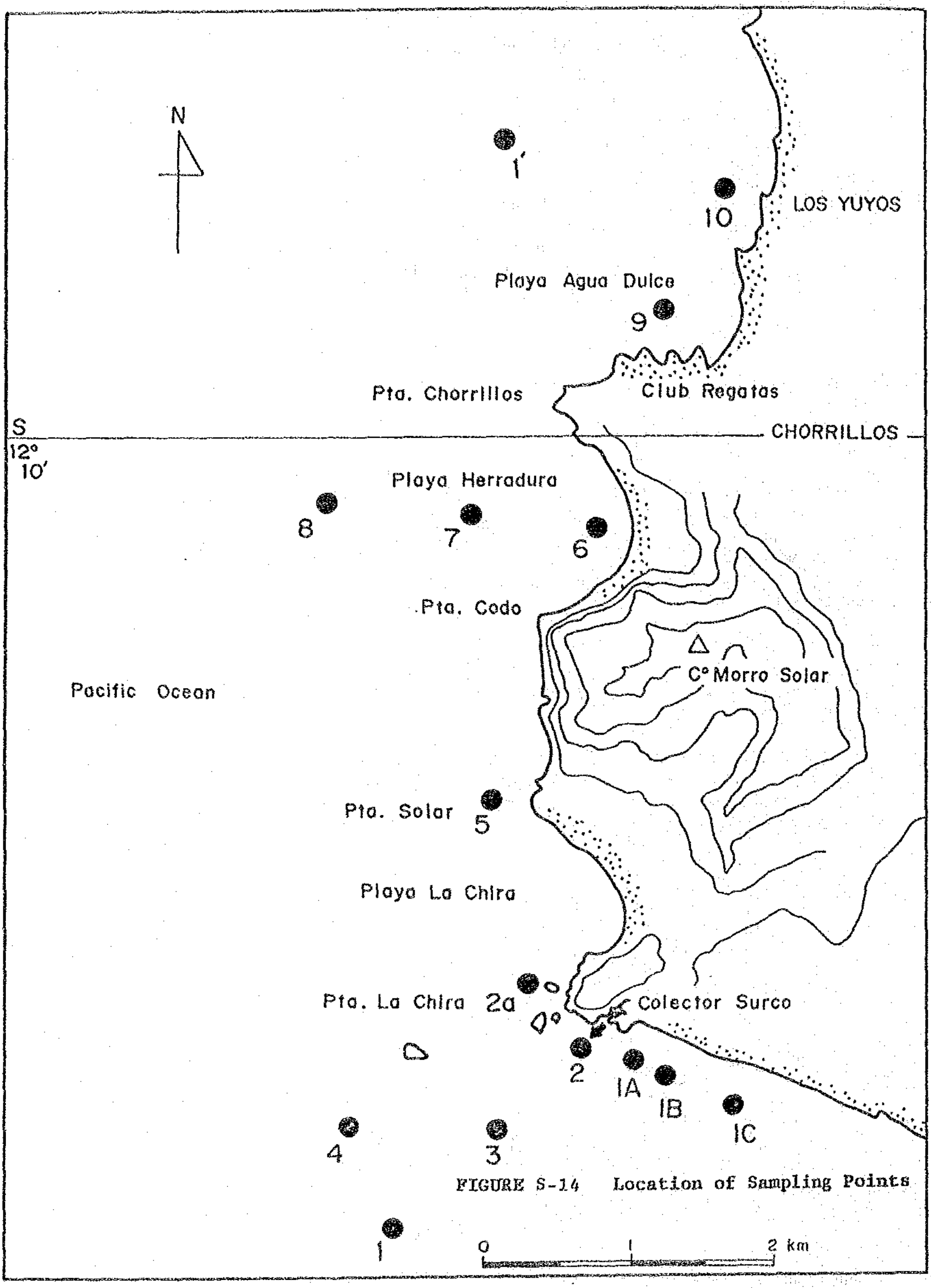


FIGURE S-14 Location of Sampling Points

TABLE S-23 Quality of Sea Water

Analysed Items, Date (1989)	Sampling Point No.																
	1	1'	1A	1B	1C	2-0m	2-3m	2-5m	2a	3	4	5	6	7	8	9	10
Total Coliform																	
5/15	—	—	—	—	—	7.5×10^{7}	—	—	1.5×10^{3}	—	—	2.1×10^{4}	< 1	—	—	2.1×10^{2}	—
5/23	—	—	—	—	—	1.1×10^{7}	1.5×10^{5}	$<2.4\times10^{3}$	—	—	—	7 x10	2.3x10	—	—	—	9
5/29	—	4.3x10	—	—	—	2.4×10^{7}	—	—	—	2.4×10^{7}	$<2.4\times10^{3}$	2.4×10^{4}	2.3x10	$>2.4\times10^{3}$	$>2.4\times10^{3}$	9	15
6/5	3.9x10	—	—	—	—	2.4×10^{7}	—	—	—	2.4×10^{5}	4	2.4×10^{4}	2.4×10^{2}	4 x10	2.4×10^{2}	2.4×10^{3}	4.3x10
6/12	—	—	—	—	—	1.1×10^{7}	—	—	—	9.3×10^{5}	1.5x10	2.4×10^{3}	2.3x10	4 x10	7	—	2.3×10^{2}
10/16	—	—	—	—	—	2.3×10^{6}	—	—	—	1.1×10^{6}	1.1×10^{4}	$>2.4\times10^{4}$	4.6×10^{2}	4.6×10^{2}	4.3x10	9	2.4x10
10/23	—	—	—	—	—	9.3×10^{6}	—	—	—	4×10^{4}	4×10^{2}	2.3×10^{4}	1.1×10^{3}	1.1×10^{3}	1.1×10^{3}	2.4×10^{2}	2.3x10
10/30	—	—	4.6×10^{4}	4	< 1	4.3×10^{6}	—	—	—	4×10^{2}	—	9.3×10^{3}	4.6×10^{2}	7.5x10	1.1×10^{4}	—	—
Fecal Coliform																	
5/23	—	—	—	—	—	4.6×10^{6}	1.2×10^{5}	$<2.4\times10^{2}$	—	—	—	7 x10	2.3x10	—	—	—	9
5/29	—	2.3x10	—	—	—	1.1×10^{7}	—	—	—	4.6×10^{5}	$<2.4\times10^{3}$	2.4×10^{4}	< 1	$>2.4\times10^{3}$	$>2.4\times10^{3}$	4	9
6/5	2.3x10	—	—	—	—	2.4×10^{6}	—	—	—	2.4×10^{5}	4	4.6×10^{3}	< 1	4 x10	2.4×10^{2}	2.4×10^{2}	9
6/12	—	—	—	—	—	2.4×10^{6}	—	—	—	2.4×10^{4}	4	2.4×10^{3}	< 1	4 x10	4	—	2.3x10
10/16	—	—	—	—	—	2.3×10^{6}	—	—	—	1.5×10^{5}	1.1×10^{4}	1.1×10^{4}	2.4×10^{2}	4.6×10^{2}	4.3x10	< 1	4
10/23	—	—	—	—	—	4.3×10^{6}	—	—	—	4×10^{4}	4×10^{2}	2.3×10^{4}	4.6×10^{2}	1.1×10^{3}	1.1×10^{3}	4.3x10	< 1
10/30	—	—	4.6×10^{4}	< 1	< 1	9×10^{5}	—	—	—	4×10^{2}	—	9.3×10^{3}	4.6×10^{2}	2.3x10	9.3×10^{2}	—	—
Salmonella Bacteria																	
6/12	—	—	—	—	—	2.4×10^{2}	—	—	—	< 1	—	< 1	—	—	—	—	—
10/16	—	—	—	—	—	9.3	—	—	—	1	< 1	—	—	—	—	—	—
10/30	—	—	2.1	< 1	< 1	—	—	—	—	—	—	—	—	—	—	—	—

TABLE S-24 Coliform Number and Sewage Flow

(May 31 - June 1)

		Main Sewer Surco	Circun.	B. Sur	Total
Sewage Flow (m^3/sec)	Maximum	4.929	1.454	0.305	6.569
	Minimum	2.769	0.839	0.082	3.756
	Average	4.058	1.134	0.178	5.370
Fecal Coliform (MPN/100ml)	Maximum	$4.6x10^7$	$4.6x10^7$	$2.4x10^7$	$4.5x10^7$
	Minimum	$2.4x10^7$	$2.4x10^7$	$2.4x10^7$	$2.4x10^7$
	Average	$3.7x10^7$	$3.4x10^7$	$2.4x10^7$	$3.6x10^7$

(June 19 - June 20)

		Main Sewer Surco	Circun.	B. Sur	Total
Sewage Flow* (m^3/sec)	Maximum	4.929	1.454	0.305	6.569
	Minimum	2.769	0.839	0.082	3.756
	Average	4.058	1.134	0.178	5.370
Fecal Coliform (MPN/100ml)	Maximum	$1.1x10^8$	$4.6x10^7$	$1.1x10^8$	$9.7x10^7$
	Minimum	$4.3x10^6$	$9.3x10^6$	$2.4x10^7$	$6.3x10^6$
	Average	$4.5x10^7$	$3.9x10^7$	$5.1x10^7$	$4.4x10^7$

*: Sewage flow measured on May 31 to June 1 was applied.

(Oct. 19 - Oct. 20)

		Main Sewer Surco	Circun.	B. Sur	Total
Sewage Flow (m^3/sec)	Maximum	4.477	1.612	0.296	6.324
	Minimum	2.313	0.841	0.076	3.240
	Average	3.625	1.157	0.181	4.963
Fecal Coliform (MPN/100ml)	Maximum	$2.4x10^8$	$2.4x10^8$	$4.3x10^7$	$1.9x10^8$
	Minimum	$9.0x10^6$	$4.0x10^6$	$4.0x10^6$	$7.5x10^6$
	Average	$7.5x10^7$	$9.6x10^7$	$3.2x10^7$	$7.8x10^7$

S.8.2.2 Heavy Metals

UNEP engineers in cooperation with CEPIS analyzed heavy metal concentrations in shellfish at Agua Dulce beach from 1985 to 1988. Findings in study were: Mercury (Hg) and Copper (Cu) were lower than permissible limits of 500 µg/kg and 100 mg/kg, respectively. Cadmium (Cd) exceeded the 0.05 mg/kg limit, possibly influenced by the sewage from Colector Surco including industrial waste water.

Copper and cadmium concentrations in seawater at Callao Port were measured from 1974 to 1986 by IMARPE. Results were 9.7 - 26.7 μg/l and 1.58 - 5.1 μg/l, respectively.

It can be concluded that heavy metals are in great concentrations in the surrounding water. Decrease could be expected with the reduction of sewage discharge from Colector Surco.

S.8.3 Computer Simulation and Results

Fecal coliform bacteria was adopted as parameter being one of the major parameters for water quality standard in Peru, and is directly related to the water pollution caused by sewage. The Box Mixing Model developed by DITESA in the year 1984 was used in the simulation process.

The Box Mixing Model used in the analysis assumes that parameter does not vary with time but only spatial distribution. There were no vertical differences in temperature; hence, bacteria was assumed to be distributed horizontally only. The survey area was divided into 77 segments with smaller segments near the Surco Outfall. The sewage flow at Colector Surco was added to the total at that segment.

Based on the computational results, contamination caused by the raw sewage discharge from Surco Outfall spreads northward and the contour line which can be perceived as the boundary of area affected by pollution reaches up to the Club Regattas at present discharge condition.

TABLE S-25 gives the projected average discharge from the Surco Outfall. Figure for 1992 assumes completion of Phase I facilities. The project is targeted for completion in 2000.

TABLE S-25 Project Sewage Discharge Quantity

(Unit: m^3/sec)

Year	1990	91	92	93	94	95	96	97	98	99	2000
Sewage Discharge	5.00	5.15	5.30	5.45	5.60	5.75	5.90	6.05	6.20	6.35	6.50
Interception	-	-	2.00	2.00	2.00	4.00	4.00	4.00	4.00	4.00	4.00
Net Discharge	5.00	5.15	3.30	3.45	3.60	1.75	1.90	2.05	4.20	2.35	2.50

Simulation results in both cases of discharge conditions (with and without the project are shown in FIGURE S-15 for different phases of the project.

S.8.4 Conclusion

The present sewage discharge of 5.0 m^3/s shows coliform distribution has exceeded the limit (set by Peruvian law) in the swimming areas of La Chira, Herradura and Club Regatas. Even with a 4.0 m^3/s reduction from a projected sewage flow of 6.5 m^3/s in the year 2000, La Chira will remain unsuitable for swimming but Herradura, Club Regatas and Agua Dulce can be recovered as good swimming areas.

If the project is implemented on schedule, the sea water pollution condition in the area north of Club Regatas will not exceed the present level for many years after the year 2000; otherwise, the sea water pollution will spread farther to the north.

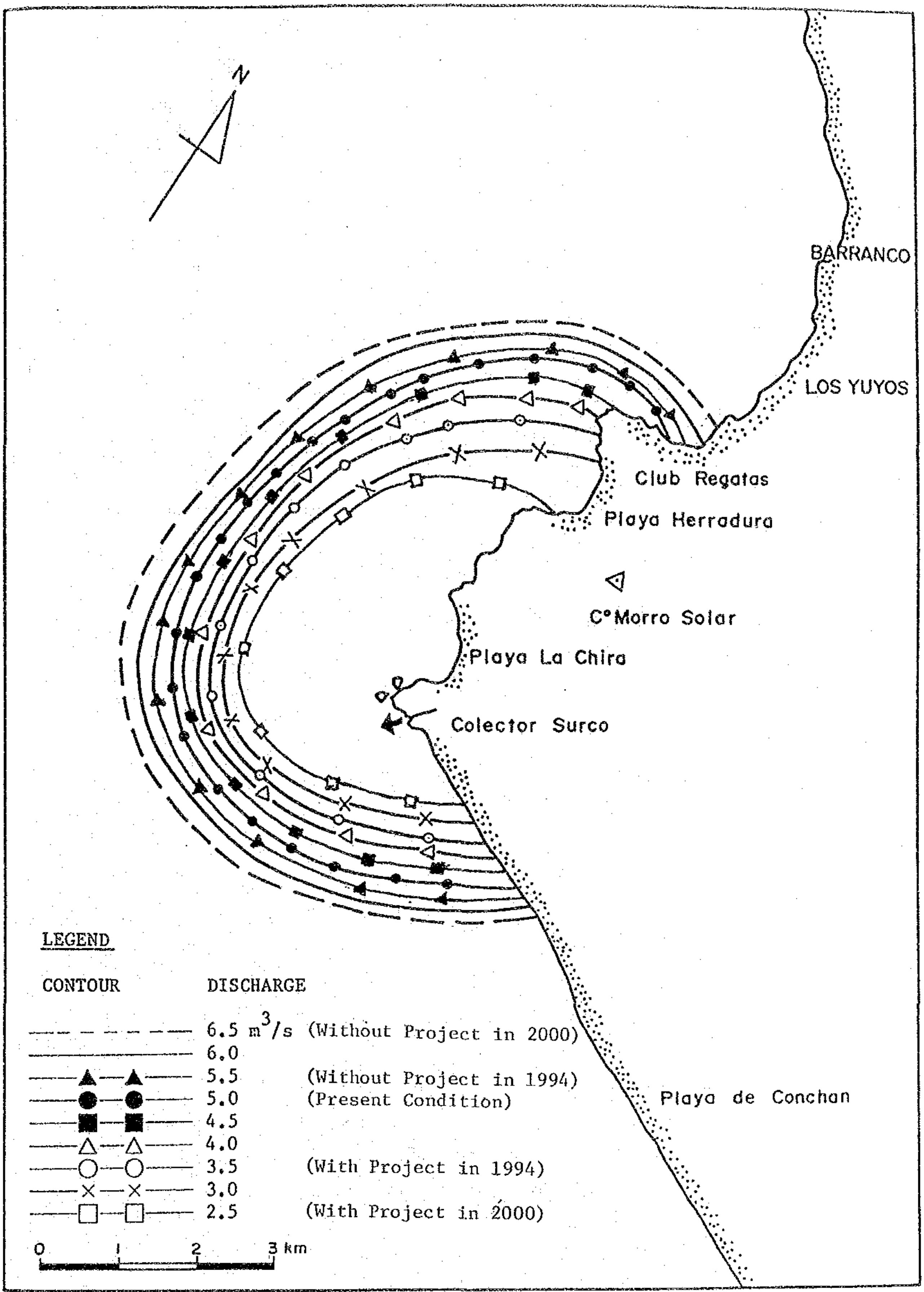


FIGURE S-15 Simulated Contour Line of Fecal Coliforms

CHAPTER 9

PROJECT EVALUATION

CHAPTER S.9 PROJECT EVALUATION

S.9.1 Implementation Program

S.9.1.1 Implementation Plan

With due regard to the size of investment and technical problems, the Project is programmed to be implemented in two stages, Phase I which is targeted for completion in 1992 and Phase II which is expected to be completed in 1995. Assumptions and conditions in the formulation of the implementation plan are, i) each phase will entail one year for detailed design and two years for construction, ii) detailed design includes period of financial procurement like loan application with lending agency, and iii) construction stage includes tendering and construction supervision. The implementation plan is divided into the construction of intake facilities, conduit system and sewage treatment plants components. (refer to FIGURE S-16)

S.9.1.2 Capital Investment Schedule

The Project is estimated to entail a total outlay of US$ 105,759,000, broken down into US$ 49,816,000 foreign currency component and US$ 55,943,000 local currency component. This cost includes engineering fee for detailed design and construction supervision and contingency. Local currency component includes cost of labor and materials actually paid in the local currency. Cost of imported materials and equipment to be paid in foreign currency comprises the foreign currency component. Details of Project Cost are given in TABLE S-26.

TABLE S-26 Summary of Project Cost

(Unit : Dollar 1,000)

Items	Total Value	Foreign Currency Portion	Local Currency Portion
1. Intake Facilities	620	312	308
2. Conduit System	71,661	37,480	34,181
3. Treatment Plants	19,892	5,708	14,184
4. Plantation	61	0	61
Sub Total	92,234	43,500	48,734
5. Engineering Services			
D/D	3,640	2,366	1,274
C/S	2,427	1,577	849
6. Contingency	7,458	2,372	5,086
Total	105,759	49,816	55,943

Note : D/D is Detailed Design
C/S is Construction Supervision

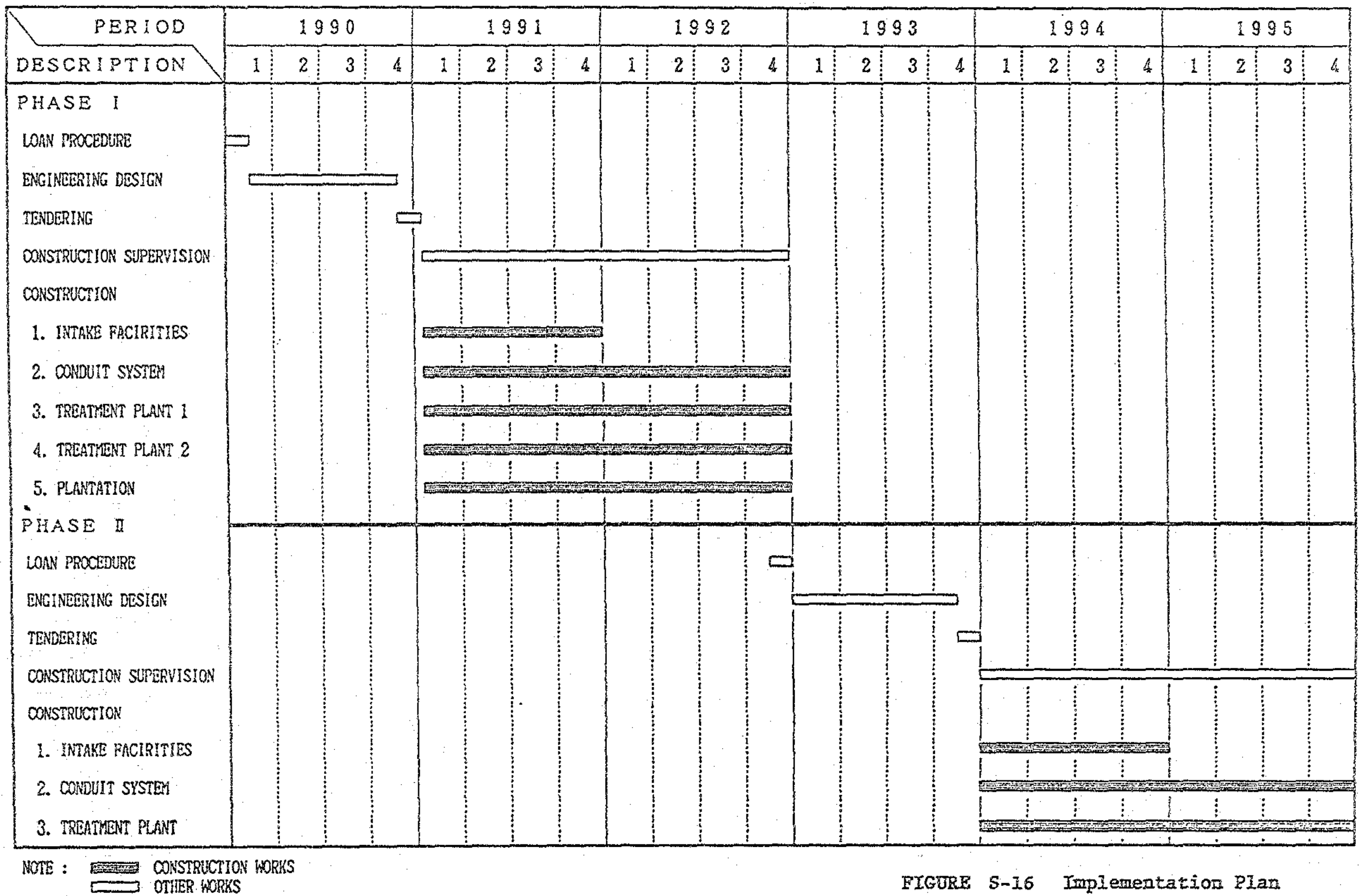


FIGURE S-16 Implementation Plan

S.9.2 Organizational and Managerial Aspect

After a review of the existing related administrative organizations, there was found the need to establish a new local sewerage office to manage the affairs of the Project. The new office will be under the SEDAPAL and shall be known as the Southern Lima Sewerage System Office. The proposed organization consists of the Treatment Plant Division and the Sewer Division which will both be under the overall administration of an Office Manager. Each division will be headed by a Division Chief and shall be responsible for the operation and maintenance of their respective sewerage system component.

S.9.3 Financial Analysis

A financial plan study for the Project was carried out to guide SEDAPAL in its viable implementation in consideration of existing financial practices, and potential funding sources to meet the estimated capital costs for construction and recurrent costs for operation and maintenance.

S.9.3.1 Present Financial Situation

The present financial situation of the SEDAPAL, being the agency which will undertake the financial management of the Project, was reviewed as a requirement of the financial plan study.

SEDAPAL is independent from the national government administratively, technically, economically and financially. It derives its income from fees charged for water supply and sewerage services and associated activities. Budget for expenses, including that for operation and maintenance, are prepared and disbursed according to guidelines and are covered with SEDAPAL's own resources. In 1988, SEDAPAL realized a net income of I/.6,912,442,000 from its various services. However, in the same year, it suffered a loss of I/.16,425,126,000.

S.9.3.2 Funding Arrangements

Major fund requirements of the Project are categorized into the construction capital cost and recurrent cost for annual operation and maintenance of the system, including debt services and depreciation.

S.9.3.3 Alternative Financing Plan

The following four alternative funding arrangements were considered and assessed as to their financial impact on SEDAPAL as well as on the individual consumer.

Alternative 1: Entire Project cost to be financed by a multilateral loan

Alternative 2: Foreign currency and local currency components to be financed by bilateral and multilateral loans, respectively.

Alternative 3: Foreign currency component to be financed by multilateral loan, and balance to be shared by bilateral loan and government subsidy.

Alternative 4: Entire foreign currency component and part of local currency component totaling about 70 percent of the Project cost to be financed by bilateral loan, and balance to be financed by government subsidy.

Loan conditions assumed in the study of alternative plans are the following:

Multilateral Loan: (IBRD)	20-year repayment period including 6-year grace period, 8 percent interest.
Bilateral Loan :	30-year repayment period including 10-year grace period, 2.5 percent interest.

In terms of the funding burden imposed on SEDAPAL, Alternative 3 and Alternative 4 appear to be the most favorable among the alternatives. Alternative 4, however, has a slight edge during the construction stage and operation period, hence is the most recommendable arrangement. Project cost, disbursement schedule and funding allocation for the selected alternative are summarized in TABLE S-27.

TABLE S-27 Disbursement Schedule of Optimum Plan

a. Project Cost and Disbursement Schedule

(Unit : Dollar x 1,000)

Year	Foreign Portion	Local Portion	Total
1990	1,147	617	1,764
1991	11,750	12,205	23,910
1992	11,532	12,002	23,534
1993	1,220	657	1,876
1994	10,990	12,756	23,746
1995	10,851	12,620	23,471
Total	47,444	50,857	98,301

b. Funding allocation

(Unit : Dollar x 1,000)

Year	Bilateral Loan	Government Subsidy	Total
1990	1,638	126	1,764
1991	16,722	7,188	23,910
1992	16,475	7,059	23,534
1993	1,742	134	1,876
1994	15,699	8,047	23,746
1995	15,501	7,970	23,471
Total	67,777	30,524	98,301

S.9.3.4 Revenue Plan

As mentioned previously, SEDAPAL's sewerage tariff system is expressed as surcharge on water rate. If consumer does not have water supply connection to the SEDAPAL system, independent sewerage rate is adopted.

The projected incomes for sewerage charge are given in TABLE S-28 together with assumptions and conditions for estimation.

Additional revenue in the amount of US$ 3.28 million per year is expected to be realized from fees to be collected from farmers for the use of treated water for irrigation and development of agricultural land in San Bartolo plain. SEDAPAL's share of this water sale revenue which amounts to US$ 2.19 million per year is credited as a financial benefit to the Project.

TABLE S-28 Income from Sewerage Charge

(Unit : Dollar x 1000)

Year	Domestic	Others	Total
1990	4,305	2,658	6,963
1991	4,504	2,677	7,181
1992	4,712	2,697	7,409
1993	4,929	2,715	7,644
1994	5,152	2,734	7,886
1995	5,383	2,735	8,136
1996	5,623	2,773	8,396
1997	5,872	2,793	8,665
1998	6,129	2,813	8,942
1999	6,396	2,833	9,229
2000	6,672	2,853	9,525

conditions and assumptions:

(1) Surcharge rate of domestic sewerage charge is 35% of average domestic water tariff.

(2) Other wastewater charge is 35% of commercial water tariff, i.e., 131.5 Intis/m^3/month x 0.35 = 46 Intis/m^3/month.

(3) Industrial sewage charge is 57.5 Intis/m^3/month.

(4) Above sewerage charges and surcharge rate will remain unchanged until year 2010.

(5) Subject population is restricted within the Surco Drainage Area.

(6) Exchange rate is I/.500 to US$.

S.9.3.5 Administrative Expenses of the Project

The administrative expenses of the Project is estimated to be around 12 percent of the total for SEDAPAL. This is based on the 34 to 35 percent Project coverage of the total population served by SEDAPAL and the sewerage surcharge rate of 35 percent of average water tariffs.

S.9.3.6 Cash Flow Statement

The cash flow statement indicates net annual revenue surplus are predicted to be large enough to cover total expenditures related to Phase I and II, which demonstrates in simple terms the financial feasibility of the Project.

Average unit cost of sewerage from 1990 to 2010 is US$ 0.03 per cu.m.

S.9.4 Economic Analysis

In the economic analysis, financial prices are adjusted to economic values by eliminating direct transfer payments, the largest among which in this Project are direct government subsidies and credit transactions.

S.9.4.1 Economic Benefits of the Project

Health benefits that will accrue to the community from the sewerage system are: i) reduction of the burden on local and national government agencies concerned with disease prevention and patient treatment activities because of the preventive effect of the Project, and ii) reduction of the incidence of diseases on the part of individuals due to the elimination of the opportunities of contact with infected matters.

The Project is also anticipated to contribute to the local economy in the form of, i) appreciation of land value and related properties in the area, ii) intensification of land use, iii) added government revenue due to the increase in tax of appreciated land and other property values, iv) provision of employment opportunities to the local people, v) increased sales of local materials and equipment, and vi) increased income of the tourism industry. In particular, half of the increase in land value of the areas to be developed as agricultural land through the use of treated wastewater for irrigation is assumed attributable to the Project. Total area to be developed for agricultural purposes is 4,800 hectares at a developed cost of US$ 6,000 per hectare. Also, the tourism industry is expected to realize an additional income of US$ 3,390,800 annually.

Economic benefits are summarized in TABLE S-29. Based on calculation of quantifiable benefits, the monetary gains in 15 years after the completion of the Project would be equal to US$ 101 million, which at present worth is US$ 41 million.

TABLE S-29 Summary of Economic Benefits

(Unit : Dollar x 1000)

Year	Health Benefit	Land Value	Tourism Income	Economic Water Value	Total Economic Benefit
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	0
1993	242	0	1,696	0	1,938
1994	252	4,320	1,696	0	6,268
1995	262	540	1,696	806	3,304
1996	272	540	3,391	806	5,009
1997	283	6,540	3,391	806	11,020
1998	294	1,290	3,391	1,681	6,656
1999	306	750	3,391	1,681	6,128
2000	318	750	3,391	1,681	6,140
2001	318	750	3,391	1,681	6,140
2002	318	0	3,391	1,681	5,390
2003	318	0	3,391	1,681	5,390
2004	318	0	3,391	1,681	5,390
2005	318	0	3,391	1,681	5,390
2006	318	0	3,391	1,681	5,390
2007	318	0	3,391	1,681	5,390
2008	318	0	3,391	1,681	5,390
2009	318	0	3,391	1,681	5,390
2010	318	0	3,391	1,681	5,390

S.9.4.2 Economic Costs of the Project

Financial Project costs were converted to economic costs through the use of shadow pricing factors. Modifications that were adopted in this regard were, i) import duties and domestic consumer taxes are assumed to be US$ 26,320,000 for foreign currency component and US$ 4,202,000 for local currency component of Project cost, and ii) shadow exchange rate factor of 1.3 was applied to the local currency component while a premium factor of 0.5 was applied to the percentage of unskilled labor, which is about 20 percent of local current component of the Project cost.

S.9.4.3 Economic Analysis

The feasibility of the Project was determined by the Economic Internal Rate of Return (EIRR) which parameter and indicators include:

B : Present value of benefits
C : Present value of costs
B/C: Ratio of benefits to costs
NPV: Net present value or B-C

Discount rate used to transform all economic costs and benefits to their present value was 8 percent, which is considered to represent the pertinent opportunity cost of capital. Under such condition, a B/C > 1, or an NPV > 0 at 8 percent discount rate, indicate the feasibility of a project. Calculations shown in TABLE S-30 indicate an EIRR of 9.67 percent, NPV of US$ 5,717 thousand, and B/C ratio of 1.15. Since the EIRR exceeds the opportunity cost of capital of 8 percent as well as interest rate of international lending agencies, and the B/C and NPV also exceed the economic feasibility criteria, the Project is economically feasible and is therefore strongly recommended for implementation.

S.9.5 Sensitivity Analysis

A sensitivity study was conducted to determine the effect of different funding schemes and the capital investment for Project construction considering, i) capital contribution of the government, ii) sewerage charge, iii) interest of foreign loan and fund allocation, and iv) without or delay of agricultural project. Except for one case of the sensitivity study where the financing plan is Alternative 4, the charge is unchanged until year 2010, government subsidy is not applied, and agricultural project is omitted, all other cases tend to show that the Project is economically feasible.

TABLE S-30 Economic Benefit and Cost

(Unit : Dollar x 1000)

year	Land Value	Health Benefit	Tourism Income	Water Value	Total Income	Capital Invest.	Operat. Exp.	Total Exp.	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	0	0	0	0	0	906	0	906	-906	0	906	-906
1991	0	0	0	0	0	13,117	0	13,117	-13,117	0	12,145	-12,145
1992	0	0	0	0	0	12,909	0	12,909	-12,909	0	11,067	-11,067
1993	0	242	1,696	0	1,938	985	94	1,079	859	1,538	856	682
1994	4,320	252	1,696	0	6,268	13,368	94	13,462	-7,194	4,607	9,895	-5,288
1995	540	262	1,696	806	3,304	13,217	94	13,311	-10,007	2,248	9,059	-6,811
1996	540	272	3,391	806	5,009	0	118	118	4,891	3,157	75	3,082
1997	6,540	283	3,391	806	11,020	0	118	118	10,902	6,430	69	6,361
1998	1,290	294	3,391	1,681	6,656	0	118	118	6,538	3,596	64	3,532
1999	750	306	3,391	1,681	6,128	0	118	118	6,010	3,066	59	3,006
2000	750	318	3,391	1,681	6,140	0	118	118	6,022	2,844	55	2,789
2001	750	318	3,391	1,681	6,140	0	118	118	6,022	2,633	51	2,583
2002	0	318	3,391	1,681	5,390	0	118	118	5,272	2,140	47	2,093
2003	0	318	3,391	1,681	5,390	0	118	118	5,272	1,982	44	1,938
2004	0	318	3,391	1,681	5,390	0	118	118	5,272	1,835	40	1,795
2005	0	318	3,391	1,681	5,390	0	118	118	5,272	1,699	37	1,662
2006	0	318	3,391	1,681	5,390	0	118	118	5,272	1,573	35	1,539
2007	0	318	3,391	1,681	5,390	0	118	118	5,272	1,457	32	1,425
2008	0	318	3,391	1,681	5,390	0	118	118	5,272	1,349	30	1,319
2009	0	318	3,391	1,681	5,390	0	118	118	5,272	1,249	27	1,221
2010	0	318	3,391	1,681	5,390	0	118	-26,809	32,199	1,156	-5,752	6,908
Salvage Value								(-26,927)				
								Present Value		44,559	38,842	5,717

B.C.Ratio is 1.15 IRR is 9.67%

S.9.6 Justification of the Project

Projects relating to public utilities such as transportation, power plant, waterworks, etc., provide a quantitative evaluation of the benefits with respect to productivity. On the other hand, on such unproductive infrastructure projects as the sewerage system, evaluation of the benefit is difficult if only such measurable variables like cost are to be used. Nevertheless, the development of a sewerage system for Lima has become an urgent necessity to protect the sea water from severe contamination due to discharge of sewage without treatment. The government of Peru has already designated the resorts as restricted area for swimming. Once this sewerage project is completed, improvement of the sea water pollution condition will be attained. People in the lower income brackets can again avail safety of the leisure and comfort of popular coastal resort.

The sewage collection system in Lima is almost complete but raw sewage is being directly discharged without treatment into the Pacific Ocean through the Surco Outfall. With the increasing population, the worsening of the sewage problem has increased the outbreak of infectious diseases due to the water system.

The technical and financial aspects of the proposed sewerage project have been fully and carefully studied, results of which are included in this report. Considering the project cost and benefits that could be derived, it can be concluded that the project is financially feasible.

Along with the construction of the sewerage system, the agricultural program to develop large areas of farmland is envisioned. It is planned that treated sewage shall be directed to this area to provide water for agricultural needs. The economic impact when this is realized cannot be overemphasized considering the employment to be generated, trade and commerce, and the emergence of a new and healthy community.

The recycling of sewage water has been started in Peru with over 30 installations already in operation. The implementation of this project with the treatment plant in San Bartolo will greatly enhance the use of recycled water to include agricultural farms in the area.

CHAPTER 10

CONCLUSION AND RECOMMENDATION

CHAPTER S.10 CONCLUSION AND RECOMMENDATION

S.10.1 Conclusion

Outline and results of analysis of recommended plan are summarized as follows:

(1) Target Year

The target year for the Project in this Study is year 2000.

(2) Planned Population

Present and future population in Metropolitan Lima and the Study Area are as follows:

Year	Metropolitan Lima	Surco Drainage Area
1989	6,000,000	1,700,000
2000	7,600,000	2,700,000

(3) Planned Sewage Quantity (Daily Average)

1989: 5.0 m^3/s

Domestic sewage	3.619 m^3/s
Industrial wastewater + Other	1.381 m^3/s
Total	5.0 m^3/s

2000 : 6.5 m^3/s

Item	Unit	Domestic Sewage			Industrial & Other Wastewater	Total
		D/S.H	D/S.L	I.D		
Population	person	899,290	1,507,860	279,950		2,687,100
Unit Q.	lpcd	210	180	110		
Sewage Flow	m^3/s	2.186	3.142	0.356	0.355 + 0.467	6.506 say 6.5

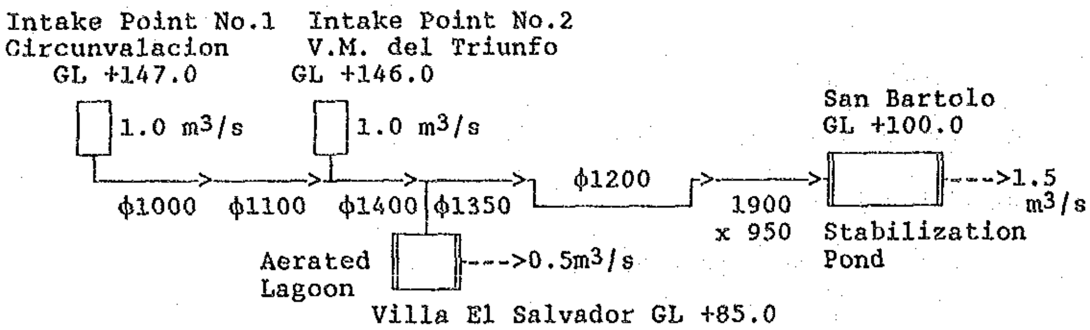
(4) Planned Sewage Quality

Item	Inflow	Treated Water	Removal Rate
BOD5	250 mg/l	49 mg/l (Stabilization Pond)	80 %
		30 mg/l (Aerated Lagoon)	88 %
SS	250 mg/l	- mg/l (Stabilization Pond)	- %
		60 mg/l (Aerated Lagoon)	76 %

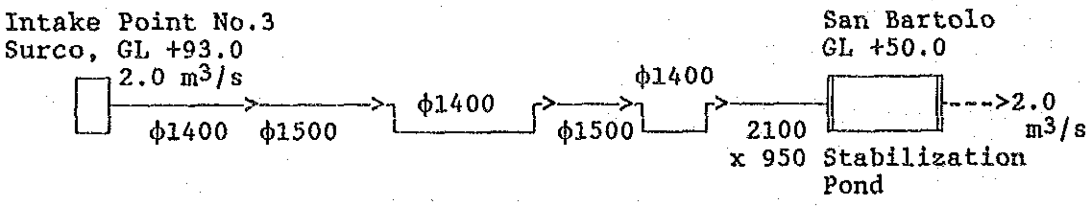
(5) Optimum Plan

a. Outline of plan

Phase I



Phase II



b. Outline of facilities

- Intake facilities:
  Control Gates, Screens, Grit Chambers, and Flow Meters will be provided.

- Transmission facilities
  Sewage will be transmitted by gravity. Gravity flow sections will be made of concrete pipes and open channel. Inverted siphon sections will be made of prestressed concrete pipes and ductile cast iron pipes. Air valves and blow-off valves will be provided at places where necessary.

- Sewage treatment facilities:

  1) Aerated Lagoon System for Villa El Salvador site

  Mechanical aerators will be provided on aerated lagoons. Detention time is set at 4 days for aerated lagoons and 1 day for sedimentation ponds. Required site area is estimated at 15 ha.

  2) Stabilization Pond System for San Bartolo site

  This treatment method does not require any power supply. Total detention time for No.1 and No.2 facultative ponds is set at 15 days. Required site area is estimated at 450 ha.

c. Construction Cost

Estimated construction cost of the Project is summarized as follows:

Phase	Direct Cost					Indirect Cost			Total
	Intake Facility	Conduit	Treatment Facility		Sub Total	Overhead	Others	Sub Total	
			C & A	Equip.					
Phase I	283	27,201	5,494	4,831	37,809	11,338	61	11,399	49,208
Phase II	226	31,563	5,976	-	37,765	11,328	-	11,328	49,093
Total	509	58,764	11,470	4,831	75,574	22,666	61	22,727	98,301

C & A: Construction cost for Civil and Architectural works.
Equip.: Cost for Mechanical and Electrical equipment.
Others: Cost for plantation.
The base date of cost estimation is October 26, 1989.
Exchange Rate: I/. 6,050.75 = US$ 1.00

d. Operation and maintenance cost

Estimated operation and maintenance cost of the project is summarized as follows:

(unit: US$/year)

Phase	Conduit	Treatment Facility		Total
		Labor	Power	
Phase I	1,888	31,200	89,261	122,349
Phase II	1,884	29,952	-	31,836
Total	3,772	61,152	89,261	154,185

(6) Project Evaluation

a. Improvement of water pollution at Surco

Currently, the sea area along the coasts stretching from Pta. La Chira to the Club Regatas is designated by the Ministry of Health as a restricted area unsuitable for swimming (refer to FIGURE S-15).

In year 2000, the polluted sea area will recede by 3.0 km. Thus, the sea area in north of Playa Herradura will be improved as a pleasant recreational area.

b. Greening of desert into agricultural land

The expected area to be converted by the Project at the time of completion is as follows:

Name of Place	Sewage Amount	Reclaimation Area	No. of Employment
Villa El Salvador	0.5 m^3/s	500 ha	1,000
San Bartolo	3.5 m^3/s	4,300 ha	9,000
Total	4.0 m^3/s	4,800 ha	10,000

c. Financial analysis

Financing assumption:

around 70 % (US$ 67,777,000) - bilateral loan

around 30 % (US$ 30,524,000) - government subsidy

Results of analysis:

B/C ratio	1.20 (with discount rate of 8 %) > 1.0
NPV	US$ 30,660,000 (ditto) > 0

d. Economic analysis

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.

(7) 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.

S.10.2 Recommendation

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 use of potable water by taking measures against water

leakage, probably from inadequate sanitary and kitchen equipment.

2) Urgency of development of a sewerage system in districts along Surco Beach (from Playa de Chira to Barranco).

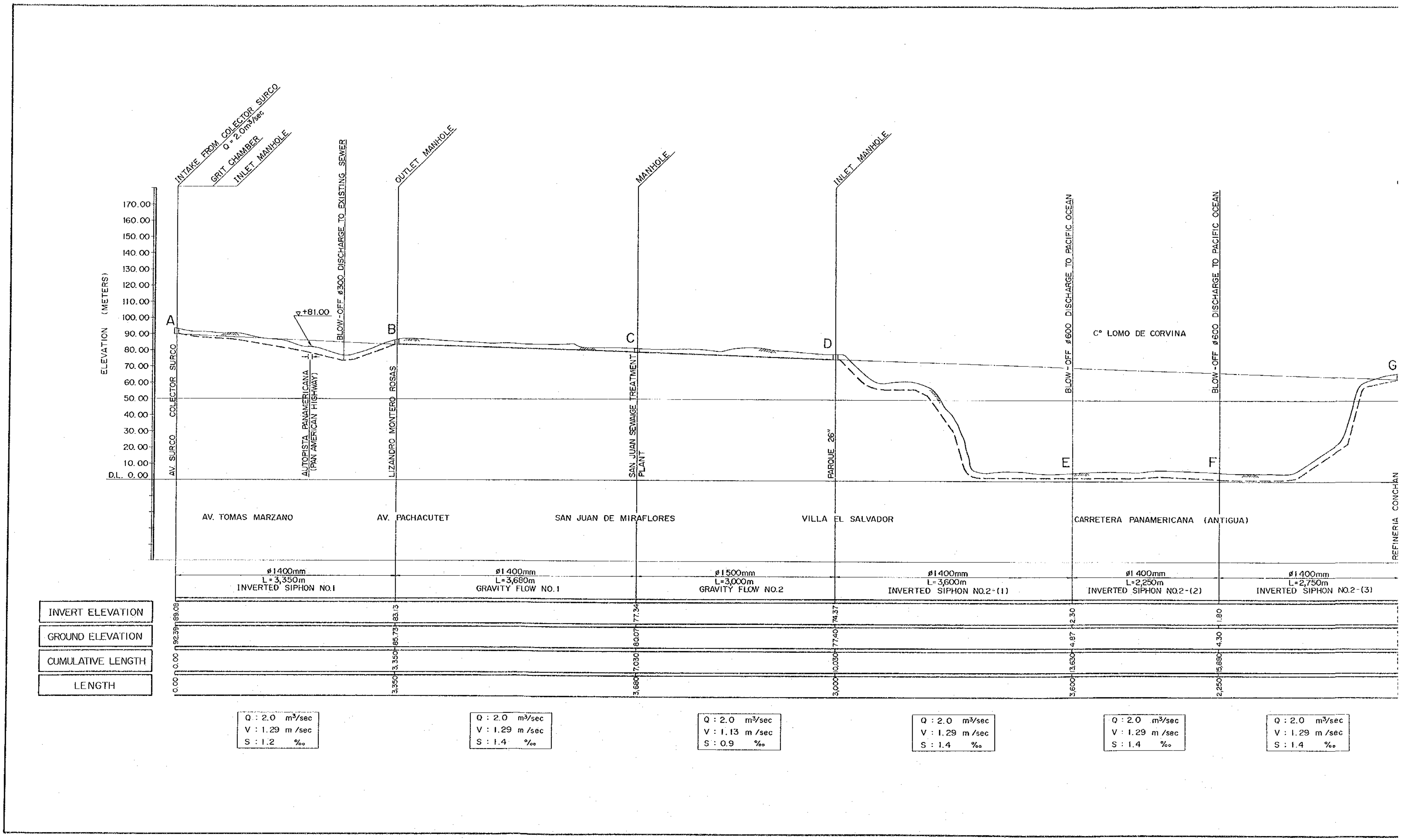
3) Fulfillment of development of sewerage system throughout Pueblos Jóvenes district. Sub-facilities as branch sewers and connections were not included in this proposed Project.

4) Execution of training prior to completion of the Project. This will take place during the design and installation periods.

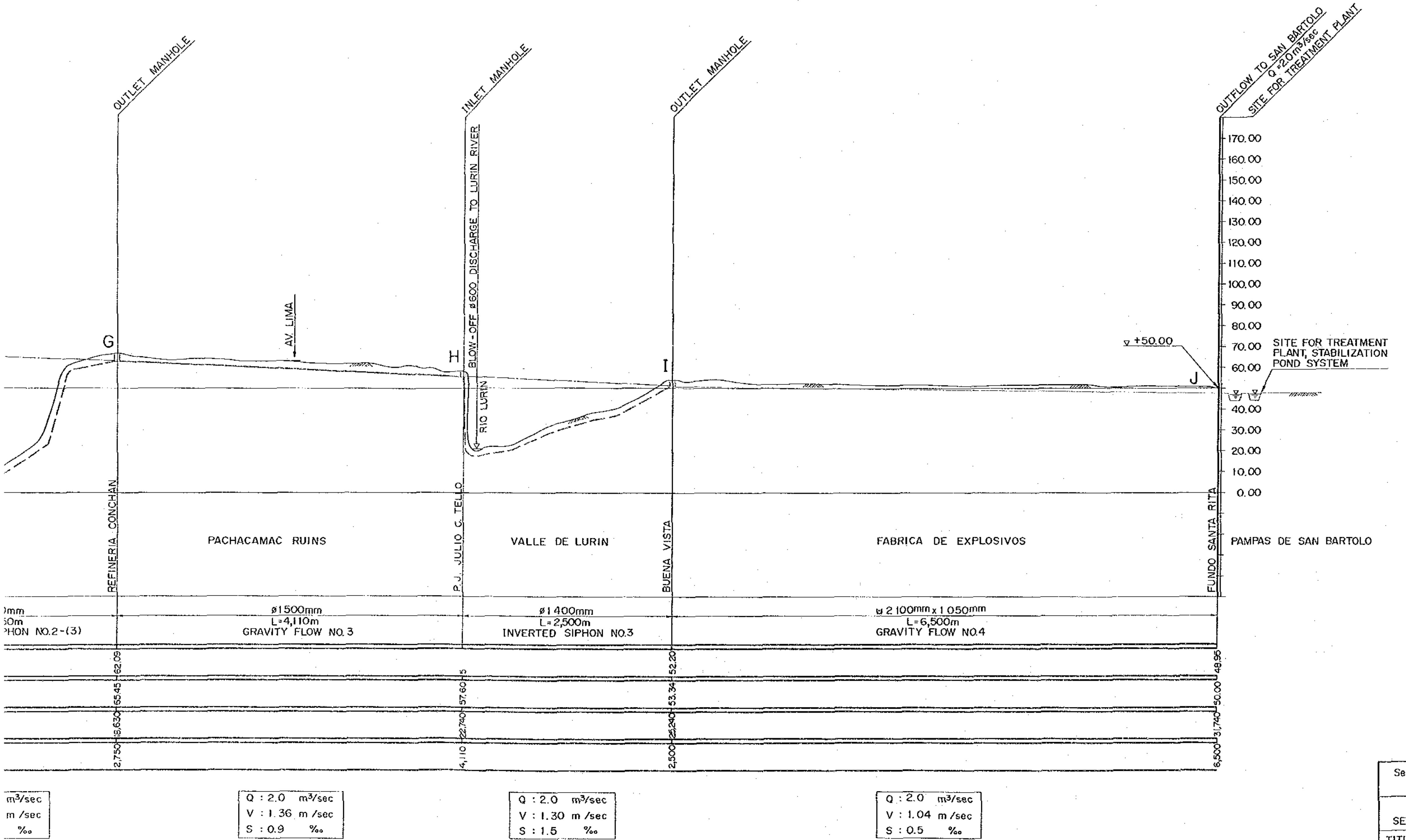
5) Coordinate/arrange for the agricultural project in San Bartolo to make use of the treated sewage water.

6) Further Study on Inverted Siphon for durability and effective Operation and maintenance.

7) in case the intake of 2.0m^3/s becomes possible, enlargement of transmission line in Phase I will be technical feasible.



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
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
G
+81.00
C° LOMO DE CORVINA
AV. SURCO COLECTOR SURCO
AUTOPISTA PANAMERICANA (PAN AMERICAN HIGHWAY)
LIZANDRO MONTERO ROSAS
SAN JUAN SEWAIGE TREATMENT PLANT
PARQUE 26"
REFINERIA CONCHAN
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: 89.08, 83.13, 77.34, 74.37, 2.30, 1.80
GROUND ELEVATION: 92.39, 85.73, 80.07, 77.40, 4.87, 4.30
CUMULATIVE LENGTH: 0.00, 3,350, 7,030, 0,030, 3,630, 5,880
LENGTH: 0.00, 3,350, 3,680, 3,000, 3,600, 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

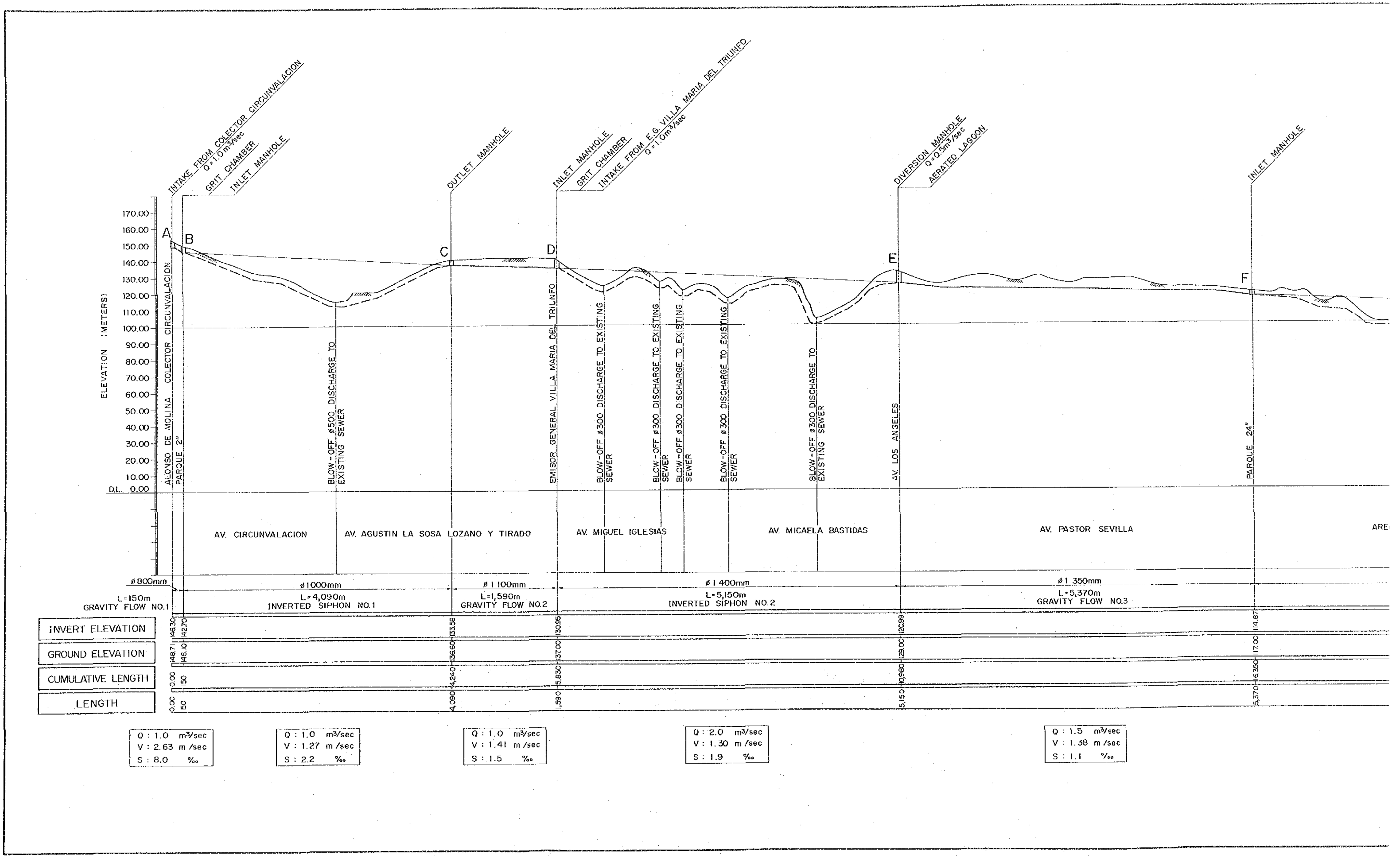
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

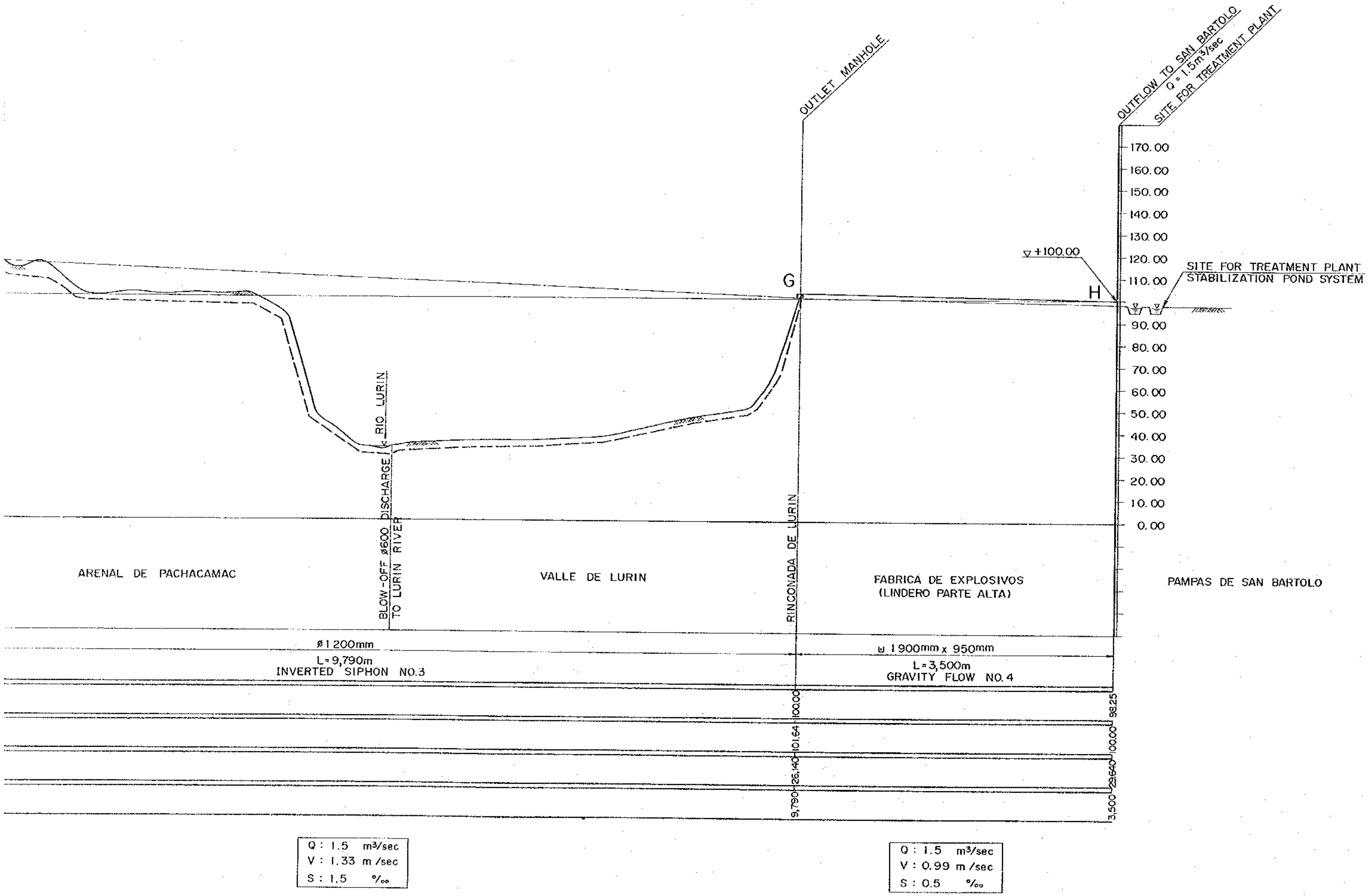
TITLE: LONGITUDINAL PROFILE OF RECOMMENDED SYSTEM PHASE II

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

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 7-28


INTAKE FROM COLECTOR CIRCUNVALACION
Q=1.0m³/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
ELEVATION (METERS)
A
B
C
D
E
F
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
AV. LOS ANGELES
PARQUE 24"
D.L. 0.00
AV. CIRCUNVALACION
AV. AGUSTIN LA SOSA LOZANO Y TIRADO
AV. MIGUEL IGLESIAS
AV. MICAELA BASTIDAS
AV. PASTOR SEVILLA
ø800mm
L=150m
GRAVITY FLOW NO.1
ø1000mm
L=4,090m
INVERTED SIPHON NO.1
ø1 100mm
L=1,590m
GRAVITY FLOW NO.2
ø1 400mm
L=5,150m
INVERTED SIPHON NO.2
ø1 350mm
L=5,370m
GRAVITY FLOW NO.3
INVERT ELEVATION
GROUND ELEVATION
CUMULATIVE LENGTH
LENGTH
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

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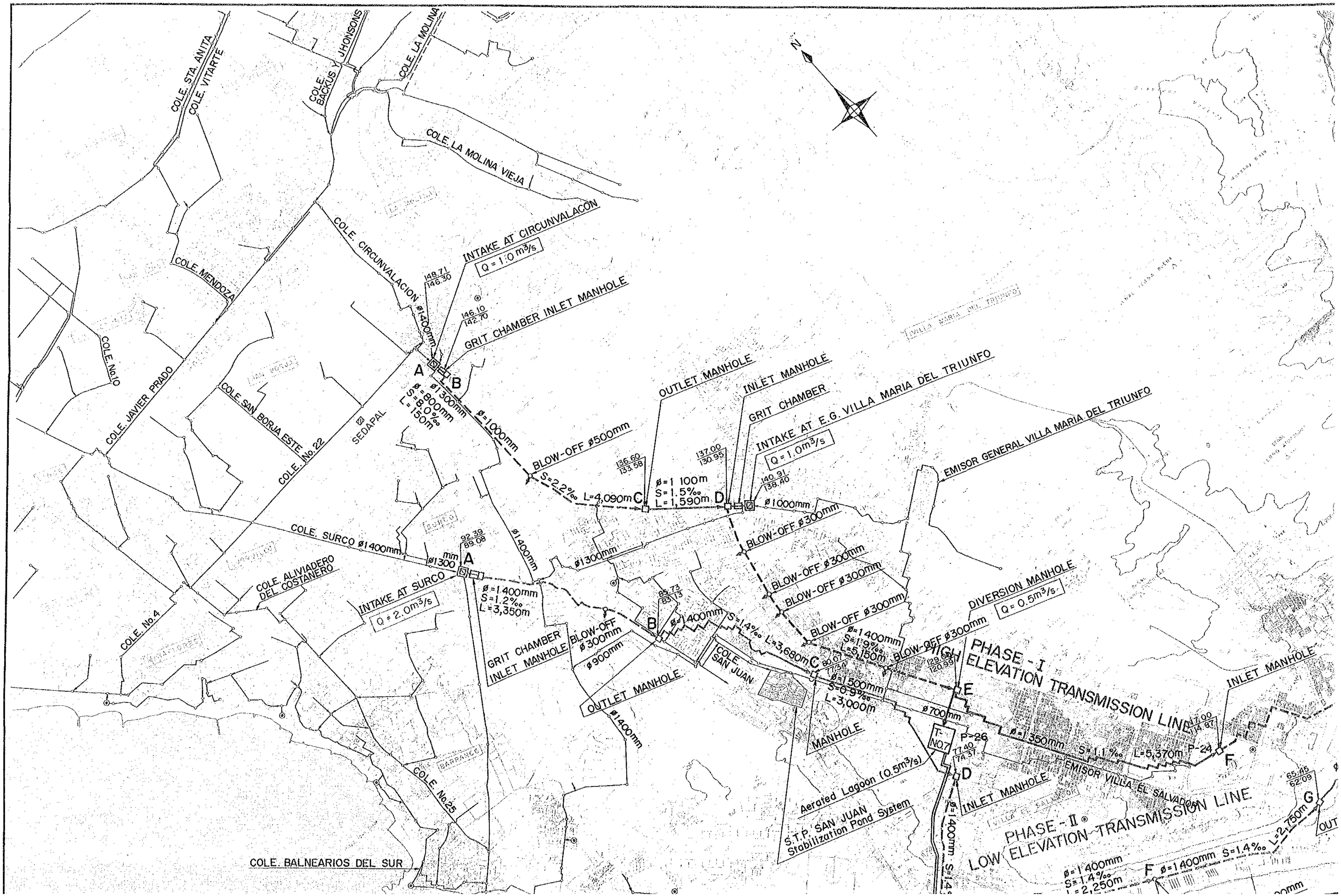
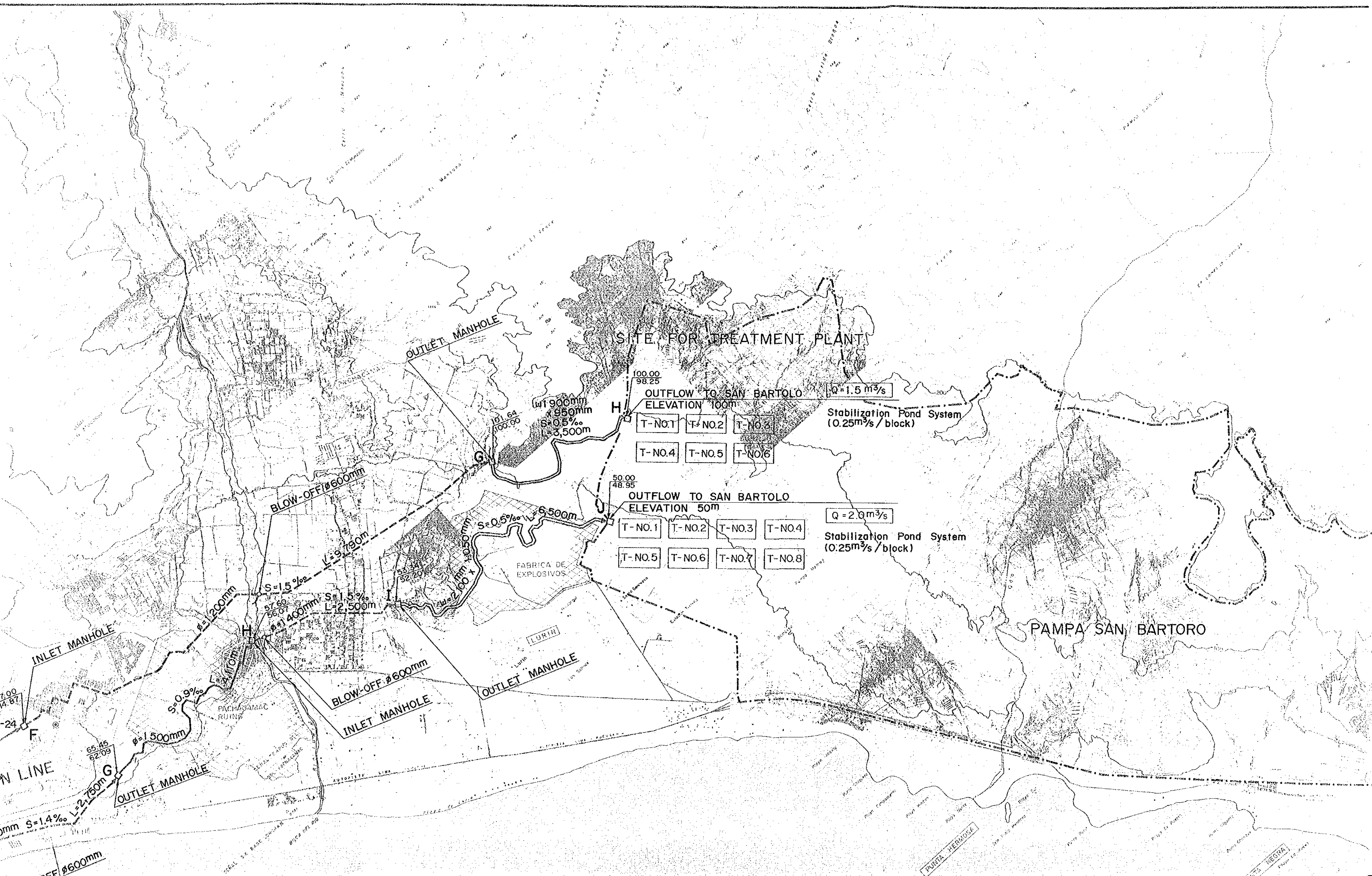
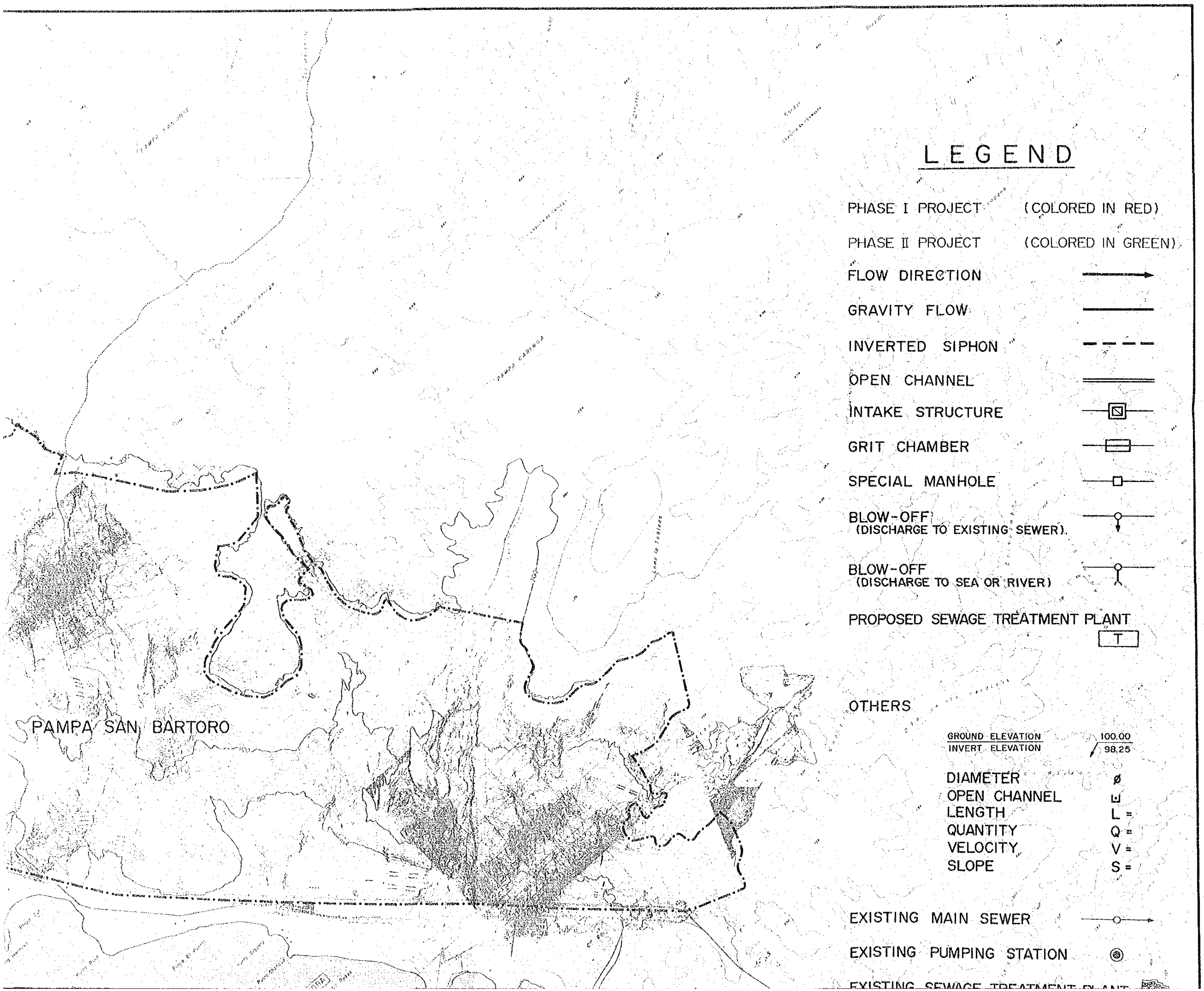
FIGURE 7-27

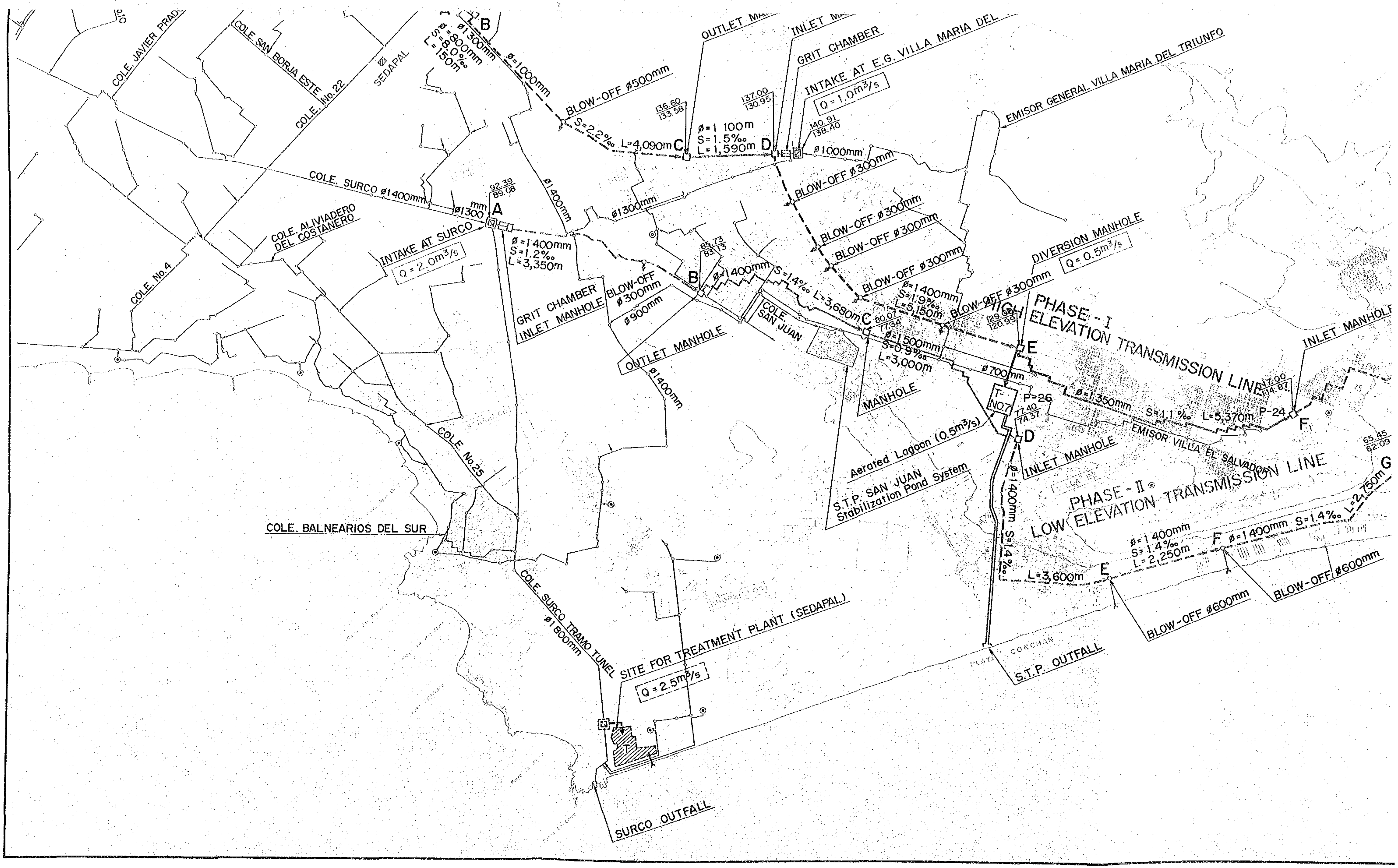


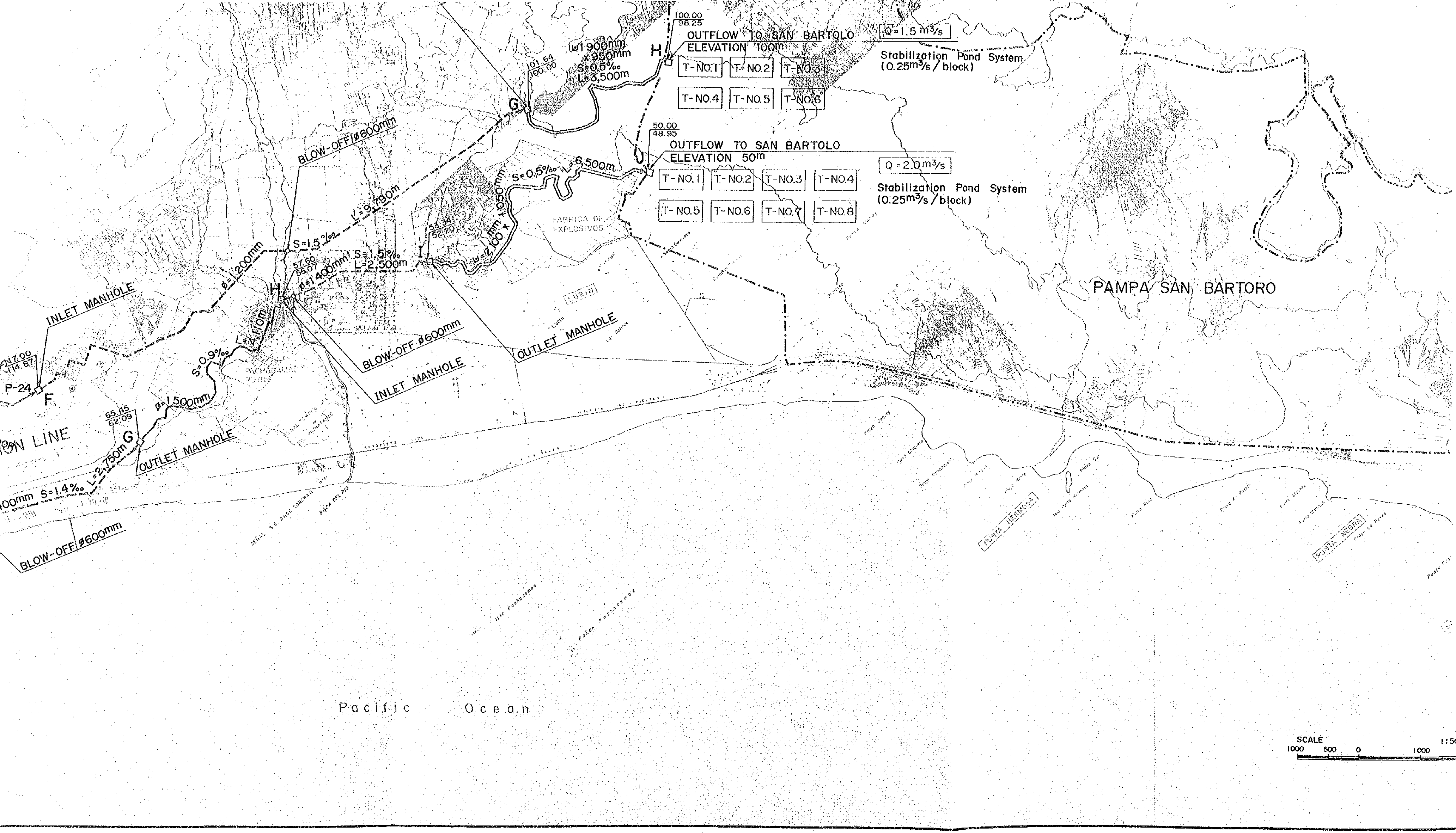
N
COLE. STA. ANITA
COLE. VITARTE
COLE. BACKUS Y JHONSONS
COLE. LA MOLINA
COLE. LA MOLINA VIEJA
COLE. MENDOZA
COLE. No.10
COLE. CIRCUNVALACION
INTAKE AT CIRCUNVALACON
Q = 1.0 m³/s
GRIT CHAMBER INLET MANHOLE
COLE. JAVIER PRADO
COLE SAN BORJA ESTE
COLE. No. 22
SEDAPAL
OUTLET MANHOLE
INLET MANHOLE
GRIT CHAMBER
INTAKE AT E.G. VILLA MARIA DEL TRIUNFO
Q = 1.0 m³/s
EMISOR GENERAL VILLA MARIA DEL TRIUNFO
BLOW-OFF ø500mm
S=2.2‰ L=4,090m
ø=1 100m S=1.5‰ L=1,590m
ø1000mm
COLE. SURCO ø1400mm
INTAKE AT SURCO
Q = 2.0 m³/s
ø=1.400mm S=1.2‰ L=3,350m
COLE. ALIVIADERO DEL COSTANERO
COLE. No.4
GRIT CHAMBER INLET MANHOLE
BLOW-OFF ø300mm
OUTLET MANHOLE
COLE. SAN JUAN
S=1.4‰ L=3,680m
DIVERSION MANHOLE
Q = 0.5 m³/s
PHASE - I HIGH ELEVATION TRANSMISSION LINE
ø=1.400mm S=1.9‰ L=5,150m
ø=1500mm S=0.9‰ L=3,000m
ø=1 350mm S=1.1‰ L=5,370m
INLET MANHOLE
MANHOLE
Aerated Lagoon (0.5m³/s)
S.T.P. SAN JUAN Stabilization Pond System
EMISOR VILLA EL SALVADOR
PHASE - II LOW ELEVATION TRANSMISSION LINE
ø=1 400mm S=1.4‰ L=2,250m
ø=1400mm S=1.4‰ L=2,750m
COLE. No.25
COLE. BALNEARIOS DEL SUR



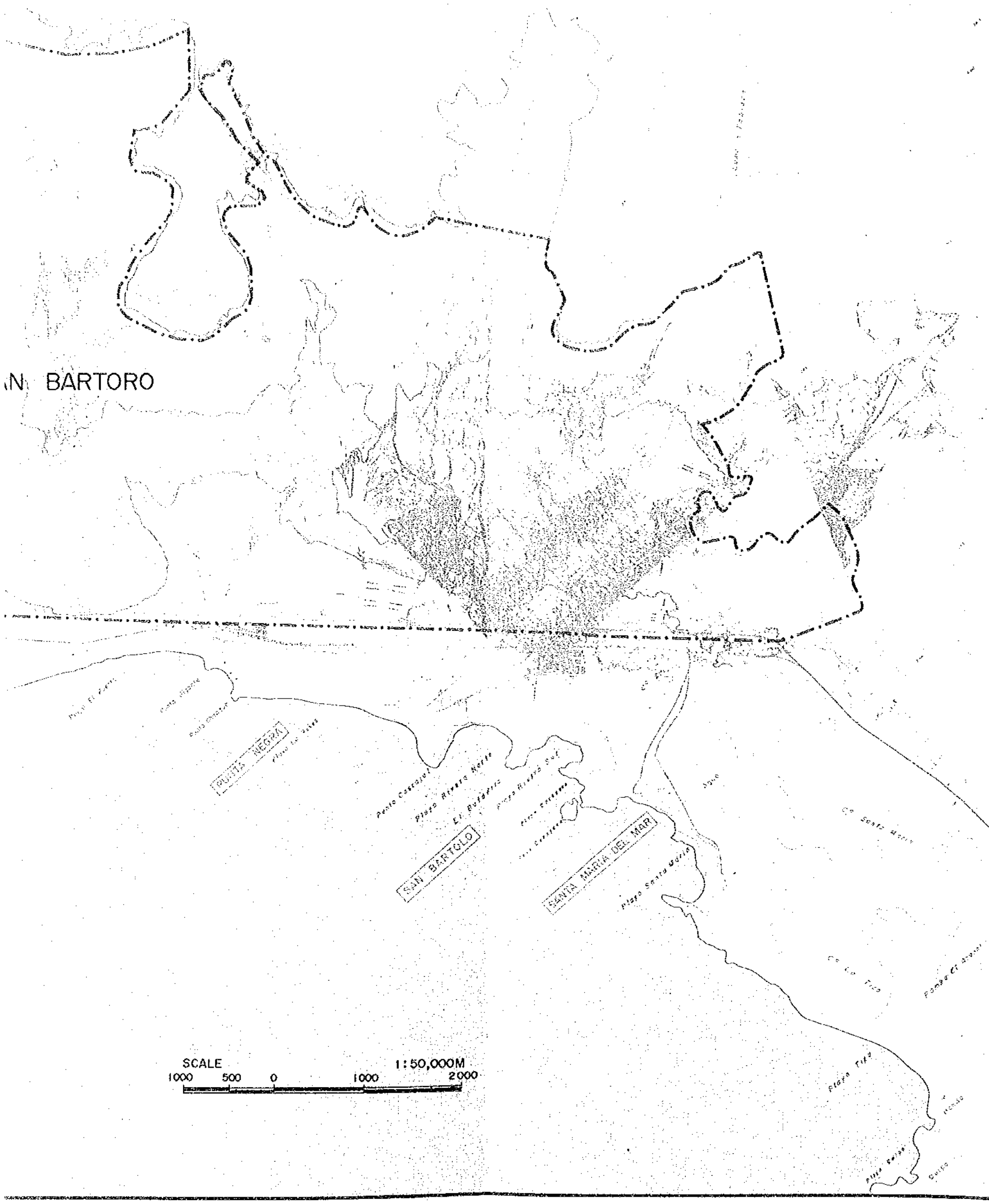
SITE FOR TREATMENT PLANT
100.00
98.25
OUTFLOW TO SAN BARTOLO
ELEVATION 100m
Q=1.5 m3/s
Stabilization Pond System
(0.25m3/s / block)
T-NO.1
T-NO.2
T-NO.3
T-NO.4
T-NO.5
T-NO.6
50.00
48.95
OUTFLOW TO SAN BARTOLO
ELEVATION 50m
Q=2.0m3/s
Stabilization Pond System
(0.25m3/s / block)
T-NO.1
T-NO.2
T-NO.3
T-NO.4
T-NO.5
T-NO.6
T-NO.7
T-NO.8
OUTLET MANHOLE
ω1900mm
x950mm
S=0.5‰
L=3,500m
101.64
100.00
G
H
J
S=0.5‰
L=6,500m
FABRICA DE EXPLOSIVOS
BLOW-OFF ø600mm
V=9,790m
S=1.5‰
ø=1,200mm
S=1.5‰
L=2,500m
57.60
56.07
ø=1,400mm
53.34
52.20
I
LURIN
OUTLET MANHOLE
BLOW-OFF ø600mm
INLET MANHOLE
INLET MANHOLE
PACHACAMAC RUINS
S=0.9‰
ø=1,500mm
65.45
62.09
G
F
OUTLET MANHOLE
L=2,750m
S=1.4‰
PAMPA SAN BARTORO
PUNTA HERMOSA


PAMPA SAN BARTORO
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


COLE. JAVIER PRADO
COLE. SAN BORJA ESTE
COLE. No.22
SEDAPAL
B
ø=1300mm
S=0.0‰
L=800mm
150m
ø=1000mm
BLOW-OFF ø500mm
S=2.2‰
L=4,090m
C
OUTLET MANHOLE
136.60
133.58
ø=1 100m
S=1.5‰
L=1,590m
D
INLET MANHOLE
GRIT CHAMBER
137.00
130.95
INTAKE AT E.G. VILLA MARIA DEL TRIUNFO
Q=1.0m³/s
140.91
138.40
ø1000mm
EMISOR GENERAL VILLA MARIA DEL TRIUNFO
COLE. SURCO ø1400mm
92.39
89.08
ø1300mm
A
INTAKE AT SURCO
Q=2.0m³/s
ø1400mm
ø1300mm
COLE. ALIVIADERO DEL COSTANERO
ø=1400mm
S=1.2‰
L=3,350m
GRIT CHAMBER
INLET MANHOLE
BLOW-OFF ø300mm
ø900mm
OUTLET MANHOLE
85.73
83.13
B
ø=1400mm
S=1.4‰
L=3,680m
BLOW-OFF ø300mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
BLOW-OFF ø300mm
COLE. SAN JUAN
COLE. No.4
C
80.07
77.34
ø=1400mm
S=1.9‰
L=5,150m
ø=1500mm
S=0.9‰
L=3,000m
BLOW-OFF ø300mm
DIVERSION MANHOLE
Q=0.5m³/s
129.96
120.93
PHASE - I
HIGH ELEVATION TRANSMISSION LINE
E
ø700mm
MANHOLE
T-NO7
P-26
77.40
74.37
D
ø=1350mm
S=1.1‰
L=5,370m
P-24
17.00
14.87
F
INLET MANHOLE
EMISOR VILLA EL SALVADOR
INLET MANHOLE
Aerated Lagoon (0.5m³/s)
S.T.P. SAN JUAN
Stabilization Pond System
COLE. No.25
ø1400mm
ø=1400mm
S=1.4‰
L=3,600m
PHASE - II
LOW ELEVATION TRANSMISSION LINE
65.45
62.09
G
ø=1400mm
S=1.4‰
L=2,250m
E
F
ø=1400mm
S=1.4‰
L=2,750m
BLOW-OFF ø600mm
BLOW-OFF ø600mm
COLE. BALNEARIOS DEL SUR
COLE. SURCO TRAMO TUNEL
ø1800mm
SITE FOR TREATMENT PLANT (SEDAPAL)
Q=2.5m³/s
PLAYA CONCHAN
S.T.P. OUTFALL
SURCO OUTFALL



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
H
ω1900mm x 950mm
S=0.5‰
L=3,500m
101.64
100.00
G
50.00
48.95
OUTFLOW TO SAN BARTOLO
ELEVATION 50m
Q=2.0m³/s
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)
J
S=0.5‰
L=6,500m
ω=2,100 x 1,050mm
53.34
52.20
I
FABRICA DE EXPLOSIVOS
BLOW-OFF ø600mm
L=9,790m
S=1.5‰
57.60
56.07
ø=1,400mm
S=1.5‰
L=2,500m
H
ø=1,200mm
INLET MANHOLE
BLOW-OFF ø600mm
OUTLET MANHOLE
LURIN
INLET MANHOLE
PAMPA SAN BARTORO
117.00
114.87
P-24
F
S=0.9‰
L=4,110m
PACHACAMAC RUINS
ø=1,500mm
65.45
62.09
G
ON LINE
OUTLET MANHOLE
L=2,750m
00mm S=1.4‰
BLOW-OFF ø600mm
PUNTA HERMOSA
PUNTA NEGRA
Pacific Ocean
SCALE
1000 500 0 1000



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

SEWAGE TREATMENT PLANT IN THE FUTURE

T

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

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