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Table 1.4-1 Members of the Study Team and Advisory Panel

Study Team

Name	Designation
Yoshiharu MATSUMOTO	Leader
Keiji SASABE	Asst. Leader/ Water Resources Development Planner
Susumu HONDA	Sabo/ Turbid Water Specialist
Sachio TAKAHASHI	Industrial Wastewater Specialist
Atsushi MURAMATSU	Sewage Specialist
Akiko MUKADE	Water Quality Specialist
Shoichi IMADO	Water Purification Specialist (March-July, 1996)
Shuji ARAKAWA	Water Purification Specialist (Nov., '96 - March, '97)
Valerio GUTIERREZ	Legal and Institutional Specialist
Naomichi ISHIBASHI	Economist
Andrew DORMAN	Structure Design Engineer
Kazuyoshi KAGEYAMA	Environmental Specialist
Masashi SUZUKI	Geodetic Engineer
Tomoko SUZUKI	Coordinator
Hiroaki OSHIMA	Dam Planner
Akira FUJINO	Geologist

Advisory Panel

Name	Designation
Shuuhei KAZUSA	Chairman/ River Environmental Management (January, '96 - September, '97)
Yoshiaki MORIKITA	Chairman/ River Environmental Management (November, '96 - July, '97)
Taizo YAMADA	Environmental Economics
Shuichi OCHI	Water Pollution Control

Table 2.1-1 Factory and Employee Numbers in Cities

CIV	City	Celala Te-w	El Consejo	Las Termitas	Quaya	Qui	Panajuelo	San Diego de los Andes	San José de los Andes	Chancay	Perdaya	Occaso del Tío	San Francisco de Yare	Total
		Yare	San Félix River	Santa Mercedes	Santa Mercedes	Urdueña	Quinsipuro	Quinsipuro	Quinsipuro	Quinsipuro	Quinsipuro	Quinsipuro	Quinsipuro	
31100	Food product factory excl. soft drinks						1(203)			1(691)			1(26)	3(920)
31111	Abattoirs for cattle, pigs, sheep, horses and rabbits			1(45)	1(90)					1(33)				3(168)
31112	Farms of chicken and other animals		1(40)	1(324)	1(324)									2(108)
31113	Preparation and manufacture of meat conserves	1(54)		2(261)						1(56)				4(371)
31121	Milk pasteurization and bottling					1(14)								1(14)
31123	Biscuits, shortcake and noodles									1(390)			1(266)	2(676)
31221	Production of animal food			1(39)	1(39)									2(78)
31311	Distillery		1(575)									1(430)		2(1013)
31341	Production of soft drinks												1(18)	1(18)
31342	Boiling and gasification of natural mineral waters								1(49)					1(49)
	Subtotal of food related factories-B32	1(54)	2(653)	3(345)	3(457)	1(14)	1(203)	0	1(49)	4(1179)	0	1(400)	3(350)	21(3715)
32111	Manufacturers of textile fibers					1(23)								1(23)
32112	Spinning, weaving and finishing of wool and mixed fibers					1(11)						1(37)		2(48)
32113	Spinning, weaving and finishing of cotton, artificial, synthetic and mixed fibers			3(859)		2(120)				5(376)	1(160)	1(51)		12(1576)
32311	Tannery and finishing of leather						1(41)							1(41)
32321	Industry to prepare tanning leather						2(65)							2(65)
35131	Synthetic resins, plastic materials and artificial fibers					1(28)								1(28)
35135	Synthetic resins, plastic materials and artificial fibers, except glass			1(117)		1(28)				1(700)		1(37)		4(882)
35211	Manufacturers of paint and varnishes			1(11)		1(65)				3(821)			1(16)	6(914)
35231	Manufacturers of soaps and cleaning products			1(48)	1(236)		1(59)			1(210)			3(288)	7(821)
35234	Manufacturers of perfumes and cosmetics													0
35291	Manufacturers of polishing products, waxes and polishes			2(92)										2(92)
35292	Manufacture of adhesive, glue and priming for textile factory									1(45)				1(45)
35295	Manufacture of adhesive materials, glues, gelatin and gums									1(18)				1(18)
36200	Pottery and porcelain miter												1(80)	1(80)
36201	Production of fiberglass					1(15)	1(72)							2(87)
36991	Manufacturers of floor tiles					1(300)							1(1039)	2(1339)
36992	Manufacture of other non-metallic products										1(42)			1(42)
37102	Manufacture of iron and steel, excl. pig iron and without rolling					1(12)	1(24)			1(550)				3(386)
37201	Production of non-ferrous metals and alloys			1(180)		3(218)					1(41)		1(85)	6(324)
38191	Manufacture of metallic products, excl. machinery			1(22)			2(130)						1(55)	4(205)
38195	Metal plating		1(25)	2(346)		1(25)	1(53)			2(321)		2(141)		9(911)
38431	Car parts factory			1(295)										1(295)
38435	Automobile spare parts factory					2(414)		1(212)		1(170)		1(26)		5(822)
29011	Sand quarry			1(7)		2(19)	2(19)						2(16)	8(65)
	Subtotal of non-food related factories	0	0	14(2127)	1(236)	18(1279)	11(443)	1(212)	0	15(2311)	4(943)	8(318)	9(1568)	82(9313)
	Total	1(54)	5676	18(2323)	4(693)	19(1295)	12(646)	1(212)	1(49)	19(3481)	4(943)	9(758)	12(1899)	105(13028)

Note: Employee numbers in parentheses

Table 2.1-2 (1/5) Inventory of Representative Factories in the Study Area

code	Name	Category (C11U)	Location	Municipality	Registration	Treatment system	Type of treatment system	Water source	Volume of water using (ton/day)	Volume of wastewater (l/day)	Water body receiving wastewater	Kind of Products	Total production (ton/year)	Employees	Work h/day	Work d/week
F-1	Ron Santa Teresa	Alcohol Production (31311)	Hacienda Santa Teresa El Consejo Edo. Aragua	Jose Felix Ribas	Yes	Yes	UASB	5 wells	243	288	Cano Tiquiritio	Rum and alcoholic beverages	12x10 ³	500	9	5
F-2	La Monseratina	Sausage (31113)	Andres Bello St.No.4 Las Tejerias Industrial Zone	Santos Michelena	Yes	No	-	1 well	25	25	Servers	Sausage, ham, blood pudding	Sausage: 960, Ham:240, Blood-pudding: 384	60	8	5
F-3	Proagro	Fowl Processing (31112)	Guayas Industrial Zone Curiepe road	Santos Michelena	Yes	Yes	Biological System	8 wells	1800	1800	Tuy River	Poultry	60,000 per day	339	8	6
F-4	Industrias Savoy	Snack Factory P-P7 (31173)	Charallave - Ocumare Road, KM 1, Pitahaya Flache	Cristobal Rojas	Yes	Yes	Biological System	Mains	200	200	Qda. El Dividive	Corn Flour	-	390	8	5
F-5	Beneficiadora Aureli	Slaughter-house (31111)	La Bonanza Sector, Old Road, Charallave - Caracas	Guaticapurro	Yes	No	-	Mains Cistern	80	80	Qda. Charallave	Pork Meat	2,200	33	6	5
F-6	Industrias Savoy	Snack Factory P-P7 (31173)	Ocumare - Yare Road, KM 6	Simon Bolivar	Yes	No	-	1 well & mains	167	83	Tuy River	Salad Snacks	200-300	286	20	6
F-7	Pepsi Cola	Soft Drink Plant (31341)	Ocumare - San Francisco de Yare Road	Simon Bolivar	Yes	Yes	Irrigation	Mains	22.5	15	Infiltration	Soft drink	2,100	18	8.8	5
F-8	Ilamaca	Milky Factory (31121)	Ramon Rodriguez Street, Marin J. Industrial Zone, CUA, Miranda ST.	Urdaneta	Yes	Yes	Grease removal, Biological reactor, sedimentation	Mains	31.9	32	Tuy River	Butter, Cheese	Butter 0.4ton/d, Cheese 0.3ton/d	14	9	5
F-9	Industrias Pampero	Alcoholic Beverages (31311)	Ocumare - Yare Road, Aponic Sector	Lander	Yes	Yes	Biological sedimental, drying beds	Mains	6,500	320	Tuy River	Alcoholic Drink	14,365	236	8	5

Table 2.1-2 (2/5) Inventory of Representative Factories in the Study Area

code	Name	Category (CIIU)	Location	Municipality	Registration	Treatment system	Type of treatment system	Water source	Volume of using water	Volume of wastewater (l/day)	Water body receiving wastewater	Kind of Products	Total production (ton/year)	Employees	Work h/day	Work d/wk.
F-10	Avicola La Mora	Poultry slaughtering (31112)	Hacienda Tiquire Esperanza	Jose Felix Ribas	Yes	Yes	Activated sludge	1 well	201	201	Qda. Tiquirito	Packed Chicken	Packed chicken 3600000/m	80	8.2	5
F-11	Provegran	Meat & bone processing (31152)	Las Tejerias, Canote Sector	Santos Michelena	Yes	Yes	9 Steps - chlorination chamber	1 well	500	202	Qda. Guayas	Processing/ sub products	23,400	85	24	6
F-19	Castelo Blanco Industrias	Ham & Sausage factory (31113)	Charallave, Alvarenga Hilllocks	Cristbal Rojas	Yes	No	Septic Tank	Mains	6	6	No	Ham Sausages	2,080	60	8	5
N-10	Grupo Manufacturero Unidad (Tannery)	Leather coloring factory (32321)	Paracotos	Guacaipuro	Yes	No	Sediments dried and transported to la Bonaza Landfill	1 well	0.6	0.6	Stored in 3 tanks, treated and discharge into Qua.	Leather Colored	1500-1600 per month	11	9	5
N-11	La Union Concordia Tannery	Leather finishing (32321)	Paracotos KM2, Tacata Road	Guacaipuro	Yes	Yes	Physical - Chemical	1 well	60	60	Qda. Maitana	Leather for Shoes	300,000 ft ²	42	9	5
N-12	Arenera Paracotos	Sand Production (2901)	Paracotos Main Avenue	Guacaipuro	Yes	No	Septic Tank for domestic waste	1 well	2000	2000	Sedimentato r to Qda. Maitana	Sand	Sand, 600m ³ /m	11	8	5
N-13	Alfombras y Fietros Iberia	Carpet factory (32112)	Las Tejerias	Santos Michelena	Yes	Yes	3 Storage tank Treatment tank Sed.tanks, Drying beds	Mains	100	40	Sewer Net, Tuy River	Carpet	Carpet 100,000m ² /month	36	9	5
N-14	Pinturas Manpica	Paint factory (32211)	Tejerias Industrial Zone, end of "Elias Rodriguez" Street	Santos Michelena	Yes	No	-	1 well	2	0.25	Sewer Net, Tuy River	Water Paint (90%), Oil Paint	1356	15	8	5
N-15	Textilana	Textile finishing (32113)	Tejerias Industrial Zone, "Andres Bello" Avenue	Santos Michelena	Yes	No	-	1 well	922	748.8	Sewer Net, Tuy River	Textiles	440,000 linear meters	230	16	5.5

Table 2.1-2 (3/5) Inventory of Representative Factories in the Study Area

code	Name	Category (C11U)	Location	Municipality	Registration	Treatment system	Type of treatment System	Water source	Volume of using water	Volume of wastewater (l/day)	Water body receiving wastewater	Kind of Products	Total production (ton/year)	Employees	Work h/day	Work d/wk.
N-16	Vengraf	Metal mechanics (37201)	Tejeras Industrial Zone, "Andres Bello" Avenue	Santos Michelena	Yes	Yes	Physical - Chemical Treatment	1 well	42	42	Sewer Net, Tuy River	Brass Tubes & Pipes	Brass Tubes & Pipes	180	9	5
N-17	Industrias Vargas	Cosmetics factory (35232)	Las Guayas Industrial Zone, Cadafe Street, Guayas	Santos Michelena	Yes	No	-	2 wells	9	9	Sewers, Tuy River	Shampoo	50,000kg/week 26000ton/y	100	8	5
N-18	Maek de Venezuela	Truck assembling (38431)	Las Tejeras	Santos Michelena	Yes	Yes	Physical Chemical System	1 well	15	15	Sewers, Tuy River	Trucks	8 per day	-	9	5
N-21	Terminados de Aluminio Alumbr	Metal mechanics (37201)	Alvarenga Industrial Urbanization, Tricentenaria Av.	Cristobal Rojas	Yes	Yes	Physical Chemical System	Mains	29	28.8	Sewers, Tuy River	Aluminum sections	3 ton/day	20	16	5
N-22	Multiprens	Car parts factory (38433)	Charallave - Cua Road, KM 2, Corpoindustria Industrial	Cristobal Rojas	Yes	No	-	Mains	59	34.8	Sewers	Car parts	-	170	8.8	5
N-23	Aplanchados Rey David	Indigo Industrial Pre-Washed (32112)	Tuy River Industrial Urbanization	Cristobal Rojas	Yes	No	-	Mains	15	12	Sewers	Jeans	1200 Jeans/day	13	9	5
N-24	Aicsa	Electric Panels (3699)	Charallave - Ocumare Road, KM6	Cristobal Rojas	Yes	No	Domestic = Septic Tank	Mains	-	-	Qda. Charallave	Electric Panels	-	42	9	5
N-25	Petrosima Quimica	Petro Chemical Industry (35135)	Charallave - Ocumare Road, Pitahaya Sector	Cristobal Rojas	Yes	Yes	Industry = ?; Domestic = Yes	Mains	60	Industry = 10, Domestic = 30 - 50	All wastes recovered	Plastic products	-	700	24	7
N-26	Madosa	Cooker Assembling (37101)	Alvarenga Industrial Urbanization, Charallave	Cristobal Rojas	Yes	Yes	Electrical Chemical Treatment System	Mains	100	100	Qda. El Mamon	Cooker	500 U/m	350	9	5
N-27	Manufactura de Algodon Inca	Medical Cotton & Carpet factory (32113)	Charallave - Ocumare del Tuy Old Road, Pitahaya Sector	Cristobal Rojas	Yes	Yes	Crude Water Reception Tank	Mains	30	30	Qda. Dividive	Carpets Cotton	-	160	9	5

Table 2.1-2 (4/5) Inventory of Representative Factories in the Study Area

code	Name	Category (CIIU)	Location	Municipality	Registration	Treatment system	Type of treatment system	Water source	Volume of using water (ton/day)	Volume of wastewater (t/day)	Water body receiving wastewater	Kind of Products	Yield production (ton/year)	Employees	Work h/day	Work d/wk.
N-28	Hilanderas Hicril	Spinning Mill (35135)	Tuy City Industrial Zone, Shed #56,57	Lander	Yes	No	-	Mains & Cistern	30	30	Sewers - Tuy River	Yarn (Acril 100%)	30000 - 40000Kg/month	100	16	6
N-29	Quimicas Polyesin	Elastomers & Polyester Production (35135)	Bolivar Avenue, El Cerrito Route	Lander	Yes	No	Domestic Septic Tank	1 well	115	3	Storage tanks	Elastomers, Polyester	1.560	88	24	20
N-31	Industrias Ferrogalvan de Venezuela	Foundry (37201)	Maia Sector, 1st Parcel of Land, #384	Lander	Yes	No	-	Mains	10.5	0	No discharge	Electric & Phone adapters	2.5ton/m	41	24	5
N-32	Balgres	Ceramic Floor Tile factory (36911)	Yare - Santa Teresa Road	Simon Bolivar	Yes	Yes	Storage Tank	Mains, Lagoons, Rain-fall	950	300	Recycled	Floor Tiles	15000 m ² /day	1039	8	6
N-33	Detergentes Yare	Detergent factory (35231)	Santa Teresa - San Foo. de Yare Road, Pararavos Sector	Simon Bolivar	Yes	Yes	Recycle System	Mains	20	Recycled	Recycled	Detergens	3600 ton/year	50	16	5
N-34	Aspa Brown Boveri	Metal mechanics (37201)	Santa Teresa - San Foo. de Yare Road, KM 6	Simon Bolivar	Yes	Yes	Physical Chemical System	Mains	500	300	Tuy River	Transmission, Lane Tower Structures	7000-8000 ton/year	85	9	5
N-35	Textiles La Fila	Textile factory (Tanning) (32113)	La Fila Sector, La Laguna Street	Urdaneta	Yes	Yes	Sedimentator & Solids Separator	Mains	200	200	Sewers	Nylon, Cotton, Polyester Cloths	50	109	7	5
N-36	Fabrica de Aires Acondicionador	Car Parts Factory (38433)	Cua Perimetral Avenue, Marin J. Industrial Urb.	Urdaneta	Yes	No	-	Mains	70	70	Qda. Aparay, Tuy River	Vehicle, Air Conditioner, Evaporators	100,000	300	9	5
N-37	Dexamum	Aluminium sections finishing factory (37201)	Paracaima Interprise Center, El Canal Avenue, Shed #2, Marin	Urdaneta	Yes	No	Directly to Sewer Net	Mains	203	2.5	Tuy River	Aluminium sections	25000-30000 Metersly	14	8	5

Table 2.1-2 (5/5) Inventory of Representative Factories in the Study Area

code	Name	Category (C11U)	Location	Municipality	Registration	Treatment system	Type of treatment system	Water source	Volume of water using (ton/day)	Volume of wastewater (l/day)	Water body receiving wastewater	Kind of Products	Total production (ton/year)	Employees	Work h/day	Work d/wk.
N-38	Corporación Industrial Americeer	Ceramic Floor Tile factory (36911)	Marin J. Industrial Zone	Urdaneta	Yes	Yes	Solid Decantation	Mains, Well	90	Clarified water reused	Domestic w/water Qda. Aparay	Ceramic Floor Tile	2.5×10^6 m ²	300	24	7
N-39	Metal Mecanica Tuy	Foundry (37201)	Marin J. Industrial URB	Urdaneta	Yes	No	-	Mains	from 10 to 12	0.3	Tuy River	Metal casting	5500 pieces/m	44	9	5
N-40	Infra División Aluminio, S.A. (Industria Nacional Fabrica de Retenedores)	Metal Mechamies (37201)	Marin J. Industrial URB	Urdaneta	Yes	Yes	Biological Treatment System	Mains	50	40	Tuy River	Aluminum Radiators	150000 unit / year	160	8	5
N-41	Estampados Textiles Como, C.A.	Industrial Dyeing (32113)	Charallave - Ocumaredel Tuy Road, Las Juajitos Sector	Cristbal Rojas	Yes	Yes	Physical - Chemical Process	4 wells	200	200	Qda. Charallave	Dye and Finishing Clothes	500000	45	16	5.5

Table 2.1-3(1/2) Inventory of Piggeries

Upper Basin

No.	Name	Location	Animal numbers	Treatment system	Water source	#Volume of water used (tons/day)	Water body receiving waste water	Working hours (h/day)	Working days (d/week)	Working days (d/year)	Number of workers
1	Funchal	Las Tejerias	4,289	3 ponds	Qda. El Limon	6	Not discharged	8	7	365	6
2	Guayas	Las Tejerias	3,000	2 ponds, poor function	Deep well	20	Qda. Guayyas	8	7	365	4
3	Had. San Jorge	Morocopo	3,603	None exist	Deep well	40	Qda. Morocopo	8	7	365	7
4	Graiteca	Morocopo	54	3 ponds, good	Spring water	10	Not discharged	8	7	365	3
5	San Martin de Porres	Morocopo	5,500	3 ponds, poor function	Qda. El Limon	60	Qda. Morocopo	8	7	365	4
6	Ganacer	Morocopo	2,650	4 ponds	Qda. El Rosario	16	Qda. Morocopo	9	7	365	3
7	Dartin	Morocopo	837	2 ponds, poor function	Qda. El Limon	5	Qda. Morocopo	8	7	365	2
8	Valle Alto	Morocopo	900	2 ponds, poor function	Qda. El Limon	6	Qda. Morocopo	12	7	365	4
9	La Milagrosa	Morocopo	1,856	3 ponds	Spring water	10	Qda. Morocopo	8	7	365	1
10	Hnos. Rodoriguez, C.A	Morocopo	7,000	4 ponds, good	Qda. Agua Buena	40	Qda. Morocopo, but not discharged	8	7	365	6
11	Agropecuaria Namarda	Morocopo	4,700	2 ponds	Qda. El Limon and deep well	20	Qda. Morocopo	10	7	365	7
12	Morocopo	Morocopo	4,920	4 ponds, good	Qda. El Rosario	5	Qda. Morocopo, but not discharged	8		365	6
13	Multiflo	Morocopo	1,500	Tanks	Qda. El Limon	10	Qda. Morocopo	8		365	3
14	Gramilea	Guacaipuro	2,318	3 ponds	Deep well	25	Tuy River	8	7	365	1
15	El Sacrificio	Guacaipuro	134	5 septic tanks	Deep well	1	Qda. Guayas	10	7	365	3
16	Las Mercedes	Guacaipuro	255	2 ponds, good	Spring water	6	Qda. Guayas, but not discharged	8	7	365	8
17	Agropecuaria 67	Boca de Cagua	1,400	9 tanks and 3 ponds, poor function	Spring water and deep well	5	Tuy River	8	7	365	3
18	Santa Maria o Fatima	Boca de Cagua	2,400	2 ponds, very poor function	Deep well	30	Tuy River	8	7	365	3
19	Agropecuaria Retamal	Retamal	768	-	-	6	Qda. Guayas	8	7	365	4
20	Agropecuaria la Fronoa	Qda. Guayas	350	-	Deep well	3	Qda. Guayas	8	6	365	6

Volume of wastewater was reported as same as using water volume.

Table 2.1-3(2/2) Inventory of Piggeries

Middle Basin

No	Name	Location	Animal numbers	Treatment system	Water source	Volume of using water (tons/dav)	Volume of wastewater (tons/dav)	Water body receiving ww	Working hours (h/d)	Working days (d/week)	Working days (d/year)	Number of workers
21	El Marques	Tacata	7,000	2 ponds poor function	2 wells	70	50	Tuy River	8	6.5	338	11
22	Guacaipuro	Cua	300	3 ponds	-	-	-	Qda. Apamate	8	7	365	2
23	Rancho Grande	Ocumare del Tuy	2,000	Ponds	Well	10	7	Not discharged	8	7	365	3
24	Langreana	Ocumare del Tuy	3,000	Ponds	Well	10.5	9	Not discharged	10	7	365	2
25	San Bernardo	Ocumare del Tuy	1,800	3 ponds	Well	15	10	For irrigation	8	7	355	5
26	Aveirese	Ocumare del Tuy	1,500	3 ponds	Tuy River	40	30	Tuy River	8	6	312	1
27	Nichita	Ocumare del Tuy	-	3 ponds	-	-	-	Tuy River	-	7	365	-
28	Canose	Ocumare del Tuy	3,000	3 ponds	1 well	15	10	Tuy River	8	7	365	4
29	Cabrales	Ocumare del Tuy	80	2 ponds	Municipal water supply	4	3	Not discharged	8	7	365	1
30	La Chicharra	Charallave	-	None exist	-	-	-	*Qda. Cantarrana	8	7	365	-
31	Las Gondolas	Charallave	4,000	None exist	Well, delivered	35	20	*Qda. Cantarrana	8	7	365	6
32	La Cooperativa	Charallave	113	None exist	Delivered by tanker	3	3	Not discharged	8	7	365	3
33	La Mata	Charallave	275	2 ponds	Delivered by tanker	8	8	Not discharged	8	7	365	2

*Wastewater does not flow into Quebrada Charallave in the dry season

Table 2.1-4 Numbers of Piggeries and Pigs, and Water Bodies receiving Wastewater

Water body and location	Treatment condition	Piggeries	Head of pigs	No discharging of wastes (tons/day)	Well treated wastes (tons/day)	None or poor treatment (tons/day)
Tuy River and Boca de Cagua	Well treated	1	2.318	-	25	-
	None or poor treatment	2	3.800	-	-	35
	No discharge of wastes	0	0	0	-	-
	Subtotal	3	6	0	25	35
Qda. Morocopo	Well treated	4	10.700	-	66	-
	None or poor treatment	4	10.800	-	-	71
	No discharge of wastes	3	12.000	85	-	-
	Subtotal	11	33.500	85	66	71
Qda. Guayas	Well treated	4	4.251	-	1	-
	None or poor treatment	0	0	-	-	29
	No discharge of wastes	2	4.544	12	-	-
	Subtotal	6	8.795	12	1	29
Subtotal in the upper basin		20	48.413	97	92	135
Tacata (Tuy River)	Well treated	0	0	-	0	-
	None or poor treatment	1	7.000	-	-	50
	No discharge of wastes	0	0	0	-	-
	Subtotal	1	7.000	0	0	50
Cua (Tarma River)	Well treated	1	300	-	?	-
	None or poor treatment	0	0	-	-	0
	No discharge of wastes	0	0	0	-	-
	Subtotal	1	300	0	?	0
Ocumare del Tuy (Tuy River)	Well treated	2+1*	4.500	-	55	-
	None or poor treatment	0	0	-	-	0
	No discharge of wastes	4	6.880	0	-	-
	Subtotal	7	11.380	0	55	0
Charallave (Qda. Cantarran)	Well treated	0	0	-	0	-
	None or poor treatment	0	0	-	-	0
	No discharge of wastes	3*1*	4.388	31	-	-
	Subtotal	4	4.388	31	0	0
Subtotal in the middle basin		13	23.068	31	55	50
Total in the basin		33	71.481	128	147	185

* 3 ponds exist in this piggery, but no information of pig numbers or treatment condition

Note: No information of good or poor about treatment efficiency, therefore in case the treatment exist it was dealt with good treatment efficiency.

Table 2.1-5 Comparison of Numbers of Piggeries and Pigs between 1988 and 1996

		Upper basin	Middle basin	Subtotal	Total
1988*	Piggery	No treatment	16	14	30
		With treatment	12	4	16
		Subtotal	28	18	46
	Pigs	38,000	32,000		70,000
1996	Piggery	None or poor treatment	6	1	7
		Well treated	9	4	13
		No discharging ww	5	8	13
		Subtotal	20	13	33
	Pigs	None or poor treatment	14,600	7,000	21,600
		Well treated	17,269	4,800	22,069
		No discharging ww	16,544	11,268	27,812
		Subtotal	48,413	23,068	

*: After "Diagnostico de las Fuentes de Contaminacion en la Cuenca del Rio Tuy",
E. R. Gunwald. A. (1989)

Table 2.1-6 Population and Households in Cities and Towns in the Study Area

City or Town	Population	Area (km ²)	Population density (P/km ²)	Households	Persons per household
Colonia Tovar	3,373	14.3	236	935	3.6
El Consejo	13,171	2.9	4,542	2,875	4.6
Sabaneta	14,498	6.3	2,301	3,005	4.8
Sto. Domingo and La Concepcion	2,670	2.2	1,214	613	4.4
Las Tejerias	23,819	30.4	784	5,217	4.6
Paracotos	6,068	10	607	1,490	4.1
Tacata	1,198	1.9	631	337	3.6
Cua and Las Mercedes	62,836	63.0	997	15,594	4.0
Charallave	59,939	144.1	416	14,000	4.3
Ocumare del Tuy and Colonia Mendoza	76,880	83.9	916	17,396	4.4
San Fran. de Yare and San Ant. de Yare	18,902	91.3	207	4,604	4.1
				Mean	4.2

Note: Population of most of the cities and towns include the population of surrounding rural areas (OCEI-1990).

Table 2.1-7 Population and Population Density in Sub-basin (1995)

No.	Area name	Population	Area (km ²)	Population density (P/km ²)
1	Toval and other	5,281	240.7	22
2	El Consejo, Cano Tiquirito and others	27,450	46.0	597
3	Las Tejerias, Qda. Morocopo and others	41,887	132.8	315
4	Qda. Guayas and others	4,836	106.9	45
5	Paracotos, Qda. Maitana and others	29,091	284.8	102
6	Guare River (including Tacata)	1,783	181.8	10
7	Tacata-Tazon (Sabaneta)	754	55.8	14
8	Tarma River, part of Cua and others	16,193	218.0	74
9	Charallave, part of Cua and others	143,185	357.4	401
10	Ocumare del Tuy, S. F. de Yare and other	95,399	226.8	421
	Total	365,859	1,851.0	

Table 2.1-8 Sanitary Condition

Miranda State

Population range										
	<1000	1000-2499	2500-4999	5000-9999	10000-19999	20000-49999	50000-99999	100000-499999	>500000	
Total households (x100)	4049	165	84	68	175	120	479	1232	1726	-
Type of sanitation	No. of households with sanitary service (X100)									
Flush toilet to sewer system	3168	15	16	33	50	54	366	1030	1605	-
Flush toilet to septic tank	460	52	43	21	88	37	73	97	49	-
Latrine	138	23	9	8	19	12	10	41	17	-
None exists	225	71	13	5	16	15	23	49	32	-
Not declared	58	4	3	1	2	2	7	15	23	-

Type of sanitation	% of households with sanitary service									
Flush toilet to sewer system	78	9	19	49	29	45	76	84	93	-
Flush toilet to septic tank	11	32	51	31	50	31	15	8	3	-
Latrine	3	14	11	12	11	10	2	3	1	-
None exists	6	43	15	7	9	13	5	4	2	-
Not declared	1	2	4	1	1	2	1	1	1	-

Aragua State

Population range										
	<1000	1000-2499	2500-4999	5000-9999	10000-19999	20000-49999	50000-99999	100000-499999	>500000	
Total households (x100)	2219	84	41	38	46	149	106	404	-	1350
Type of sanitation	No. of households with sanitary service (X100)									
Flush toilet to sewer system	1654	8	8	12	27	69	58	351	-	1120
Flush toilet to septic tank	331	34	22	17	10	44	26	20	-	158
Latrine	117	13	5	4	5	24	13	18	-	34
None exists	87	27	6	4	4	10	8	9	-	21
Not declared	30	2	0.6	1	0.2	1	1	4	-	17

Type of sanitation	% of households with sanitary service									
Flush toilet to sewer system	75	10	20	32	59	46	55	87	-	83
Flush toilet to septic tank	15	40	54	45	22	30	25	5	-	12
Latrine	5	15	12	10	11	16	12	4	-	3
None exists	4	32	14	10	9	7	8	2	-	2
Not declared	1	2	1	3	0	1	1	1	-	1

Note: Data is from OCEI-1990

Table 2.1-9 Percent of Households with Sanitary Service in Cities

Miranda State

City	Paracotos	San Fran. de Yare	Charallave	Ocumare del Tuy	Cua
Total households	1490	4604	14009	17396	15594
Type of sanitation	% of households with sanitary service				
Flush toilet to sewer system	29	45	60*	60*	88*
Flush toilet to septic tank	50	31	-	-	-
Latrine	11	10	-	-	-
None exists	9	13	-	-	-
Not declared	1	1	25	25	1

Aragua State

City	Colonia Tovar	Tacata	Guacama ya	Santo Domingo	Las Tejerias	El Consejo	Sabaneta
Total households	935	337	931	613	5217	2825	3005
Type of sanitation	% of households with sanitary service						
Flush toilet to sewer system	0	20	32	32	55	82*	84*
Flush toilet to septic tank	100*#	54	45	45	25	-	-
Latrine	-	12	10	10	12	-	-
None exists	-	14	10	10	7	-	-
Not declared	-	1	3	3	1	1	1

*: After "Updating of Environmental Investigating Project in Tuy River basin and its Influencing Area", Efrén Guedez (1994)

#: All flush toilets are connected to septic tanks or cesspool.

Table 2.2-1 Water Quality Standard in Decree No.883

Parameter	Type Sub-type	Type 1		Type 2		Discharged Water	
		1-A	1-B	2-A	2-B	to River e.i.c.	to Sewer Net
DO	(mg/l)	4.0 <	4.0 <	-	-	-	-
pH		6.0-8.5	6.0-8.5	-	-	6.0-9.0	6.0-9.0
Coloc (U;P;Co)		50>	150>	-	-	500	-
Turbidity	(NTU)	25>	250>	-	-	-	-
Fluoride	(mg/l)	1.7>	1.7>	-	-	5.0	-
Phenolic Compounds	(mg/l)	-	0.002	-	-	0.5	0.5
Total Coliforms	(MNP/100ml)	2000>	10000>	1000>	5000>	-	-
Focal Coliforms	(MNP/100ml)	-	-	100>	1000>	-	-
BOD	(mg/l)	-	-	-	-	60	350
COD	(mg/l)	-	-	-	-	350	900
Total Suspended Solids	(mg/l)	-	-	-	-	-	1600
Suspended Solids	(mg/l)	-	-	-	-	80	400
Total Dissolved Solids	(mg/l)	1500	-	3000	-	-	-
Mineral oil	(mg/l)	0.3	-	-	-	20	20
Mineral oil and hydrocarbon	(mg/l)	-	-	-	-	20	150
Oils and greases from veg/animals	(mg/l)	-	-	-	-	20	150
Alkyl Mercury	(mg/l)	-	-	-	-	Undetec.	Undetec.
Aldehydes	(mg/l)	-	-	-	-	2.0	-
Total Aluminum	(mg/l)	0.2	-	1.0	-	5.0	5.0
Total Arsenic	(mg/l)	0.05	-	0.05	-	0.5	0.5
Total Barium	(mg/l)	1.0	-	1.0	-	5.0	5.0
Boron	(mg/l)	-	-	0.75	-	5.0	-
Total Cadmium	(mg/l)	0.01	-	0.005	-	0.2	0.2
Total Cyanide	(mg/l)	0.1	-	0.2	-	0.2	0.2
Chloride	(mg/l)	600	-	-	-	1,000	-
Total Cobalt	(mg/l)	-	-	-	-	0.5	0.5
Total Copper	(mg/l)	1.0	-	0.2	-	1.0	1.0
Total Chrome	(mg/l)	0.05	-	0.05	-	2.0	2.0
Detergents	(mg/l)	1.0	-	-	-	2.0	8.0
Dispersives	(mg/l)	1.0	-	-	-	2.0	8.0
Hardness (as CaCO3)	(mg/l)	500	-	-	-	-	-
Tin	(mg/l)	-	-	-	-	5.0	10.0
Extract of carbon at chloroform	(mg/l)	0.15	-	-	-	-	-
Total phosphorus (as P)	(mg/l)	-	-	-	-	10	10
Total Iron	(mg/l)	1.0	-	1.0	-	10	25
Total Manganese	(mg/l)	0.1	-	0.5	-	2.0	10
Total Mercury	(mg/l)	0.01	-	0.01	-	0.01	0.01
Total Nickel	(mg/l)	-	-	0.5	-	-	2.0
T-N(without NO ₂ ,NO ₃)	(mg/l)	-	-	-	-	40	40
Nitrites+Nitrates	(mg/l)	10.0	-	-	-	10	-
Total Silver	(mg/l)	0.05	-	0.05	-	0.1	0.1
Total Lead	(mg/l)	0.05	-	0.05	-	0.5	0.5
Selenium	(mg/l)	0.01	-	0.01	-	0.05	0.2
Sodium	(mg/l)	200	-	-	-	-	-
Sulfates	(mg/l)	400	-	-	-	1000	400
Sulfites	(mg/l)	-	-	-	-	2.0	-
Sulfides	(mg/l)	-	-	-	-	0.5	2.0
Vanadium	(mg/l)	-	-	10.0	-	-	5.0
Zinc	(mg/l)	5.0	-	5.0	-	5.0	5.0
Temperature	(°C)	-	-	-	-	-	40
Biocides							
- Organophosphates and carbamates	(mg/l)	0.1	-	0.1	-	0.25	0.25
- Organochlorates	(mg/l)	0.2	-	0.2	-	0.05	0.05
Radioactivity							
- Alpha activity	(Bq/l)	0.1	-	0.1	-	0.1	0.1
- Beta activity	(Bq/l)	1.0	-	1.0	-	1.0	1.0

Table 2.2-2 (1/2) Number of Sampling Sites for Water Quality Analyses during the Study Period

Parameter	Tuy River	Tributary	Sand quarry flushing water	Total
Water Discharge	10	14	-	24
Odor	10	14	-	24
Color	10	14	-	24
Water Temperature	10	14	-	24
pH	10	14	-	24
EC	10	14	-	24
DO	10	14	-	24
BOD	10	14	-	24
COD	10	14	-	24
TOC	10	14	-	24
SS	10	14	-	24
Turbidity	10	14	-	24
TN	10	14	-	24
TP	10	14	-	24
NH4	10	14	-	24
NO2+3	10	14	-	24
PO4	10	14	-	24
N-Hexane Extract	10	14	-	24
Hg	10	-	-	10
As	10	-	-	10
Cd	10	-	-	10
Pb	10	14	-	24
Se	10	-	-	10
Cr	10	14	-	24
Cu	10	14	-	24
Zn	10	14	-	24
Ni	10	14	-	24
TS	10	14	-	24
VS	10	14	-	24
VSS	10	14	-	24
Total Coliform	10	14	-	24
Fecal Coliform	10	14	-	24
Cl	10	14	-	24
Sedimentation test	12	6	1	19

Table 2.2-2 (2/2) Number of Sampling Sites for Water Quality Analyses during the Study Period

Parameter	Industrial Wastewater			Livestock Wastewater	Domestic Wastewater	Total
	Non-food	Industrial Area	Food			
Water Discharge	26	4	17	13	10	70
Odor	26	4	17	13	10	70
Color	26	4	17	13	10	70
Water temperature	26	4	17	13	10	70
pH	26	4	17	13	10	70
EC	26	4	17	13	10	70
BOD	26	4	17	13	10	70
COD	26	4	17	13	10	70
TOC	26	4	17	13	10	70
SS	26	4	17	13	10	70
Turbidity	26	4	17	13	10	70
TN	26	4	17	13	10	70
TP	26	4	17	13	10	70
NH ₄	26	4	17	13	10	70
NO ₂₊₃	26	4	17	13	10	70
PO ₄	26	4	17	13	10	70
N-Hexane Extract	26	4	17	13	-	60
Hg	26	4	-	-	-	30
As	26	4	-	-	-	30
Cd	26	4	-	-	-	30
Pb	26	4	-	-	-	30
Se	26	4	-	-	-	30
Cr	26	4	-	-	-	30
Cu	26	4	-	13	-	43
Zn	26	4	-	13	-	43
Ni	26	4	-	-	-	30

Table 2.2-3 Previously Obtained Heavy Metals in the Tuy River Water

Sampling Spot	Year	Cd($\mu\text{g/l}$)	Cr($\mu\text{g/l}$)	Pb($\mu\text{g/l}$)
Colonia Tovar	12-1987	20>	20>	20>
Las Caballerizas	05-1985	9, 11	-	-
Guayas	05-1985	8	57	-
	07-1985	-	140	-
	08-1985	-	100	-
	09-1985	-	100	-
Boca de Cagua	08-1990	20> (3 results)	20> (3 results)	50 > (3 results)
	09-1990	20> (4 results)	20> (4 results)	50> (4 results)
	10-1990	20> (5 results)	63, 94, 20> (3 results)	50> (5 results)
	02-1992	70-110 (7 results)	20> (7 results)	500-1800 (5 results)
Los Cujes	07-1985	-	96	-
	08-1985	-	100	-
	09-1985	-	100	-
	02-1992	60, 100, 100	68, 20>(2 results)	600, 800, 1800
Pinango	05-1985	9, 19	-	-
Cua	05-1985	9	-	-
Ocumare del Tuy	05-1985	15	-	-
	02-1992	110, 100	90, 20>	600, 4000
San Fco. de Yare	12-1987	20>	40	20>
San Antonio	05-1985	9	-	-
	07-1985	-	117	-
	08-1985	10 (6 results)	133-203(7 results)	100> (5 results)
	09-1985	-	100-128(6 results)	100> (3 results)
	08-1990	20> (3 results)	50, 55, 187	50> (3 results)
	09-1990	20> (4 results)	566, 20> (3 results)	50> (4 results)
	10-1990	20> (5 results)	50, 220, 20>(3 results)	50> (5 results)
	11-1990	20> (2 results)	120, 220	50> (2 results)
02-1992	60-90 (9 results)	20> (9 results)	400-1700 (9 results)	
Water Quality Standard		10	50	50

Table 2.3-1 Inventory of Hydrometeorological Stations

Climatological Station

Serial	Location	Type	Organization	Latitude ° - ' N	Longitudé ° - ' W	Altitude EL. m	Time in operation
0682	Colonia Tovar	CL	SM	10-25	67-18	1,435	1931-
0673	Agua Fria	PR	MA	10-24	67-11	1,741	1948-
0465	El Consejo	PC	AC	10-15	67-16	570	
0671	Las Tejerias	PR	MA	10-16	67-10		
0672	Insti. Pignatelli	PR	MA	10-22	67-02	1,240	1958-
0676	Paracotos	PR	MA	10-16	66-58	620	1961-
0675	Rio Arriba	PR	MA	10-09	67-01	395	1959-
0455	Macaguaita	PR	MA	10-07	66-56	480	1961-
0182	Cua-Tovar	CL	MA	10-09	66-52	230	1951-
0579	Palmira	PR	MA	10-05	66-51	440	1991-
0661	Charallave	PR	MA	10-16	66-51	400	1946-
0460	La Veraniega	PR	MA	10-09	66-46	170	1969-
0299	Santa Teresa	PR	MA	10-13	66-39	158	1954-

Note: PR= Pluviograph, PC=Pluviometer, CL=Climatological Station, SM=Aeronautical Meteorological St
MA=MARNR, AC=Tuy River Agency

Hydrometric Station

Serial	River	Location	Latitude ° - ' N	Longitude ° - ' W	Altitude	C.A. km ²	Time in operation
0682	Tuy	Colonia Tovar	10-25	67-17	1,635	2	1948-79
0579	Tuy	Las caballerias	10-16	67-15	575	122	1986-
0455	Tuy	Hda. Barrios	10-15	67-16	552	213	1941-77
0460	Tuy	Hda. Tazon	10-09	66-55	415	1,143	1941-78
0182	Tuy	Ocumare	10-08	66-46		1,711	1992-
0675	Tuy	Hda. San Antonio	10-13	66-43	134	1,843	1967-
0299	Tuy	Pte. Sta. Teresa	10-13	66-39		2,348	1943-47
0661	Agua Fria	Agua Fria	10-25	67-11		9	1951-64, 1974
0671	Guare	Rio Arriba	10-09	67-01	395	92	1958-75, 1993
0676	Guare	Tacata	10-12	67-00	297	185	1961-77
0672	Ocumarito	Desecho	10-06	66-48	189	123	1959-76, 1980
0673	Sucuta	La Cochinera	10-06	66-44	204	65	1951-64, 1974
0674	Talma	Hda. Sousa	10-08	66-53	239	78	1972-75, 1981

Note: C.A.: Catchment Area

Table 2.3-2 Features by Sub-Basin

Basin	River		Catchment			River	Name of the Major Twon
			Area		Max. Height	Length	
			(Km ²)	(%)	(EL m)	(km)	
Upper	1	Tuy	165.0	8.9	2,420	21.5	Colonia Tovar
	1-1	Lagunetas	73.0	3.9	2,340	20.0	
	2	Qda. El Socorro	105.0	5.7	1,520	5.0	El Consejo
	2-1	Qda. Morocopo	35.0	1.9	1,500	8.0	
	3	Qda. Guayas	140.0	7.5	1,640	13.5	Las Tejerias
	4	Cagua	82.0	4.4	1,360	11.5	
	5	Qda. Maitana	203.0	10.9	1,460	27.0	
	6	Guare	195.0	10.5	1,380	22.0	Tacata
		Sub-total	998.0	53.8	2,420	55.0	
Middle	7	Qda. de Sacua	83.0	4.5	1,020	9.0	Cua
	8	Qda. Aniagua	92.0	5.0	1,320	11.5	Paracotos
	8-1	Tarma	98.0	5.3	1,600	18.0	
	9	Ocumarito	146.0	7.9	1,420	21.0	
	10	Qda. de Mume	67.0	3.6	1,020	12.0	
	11	Qda. Charallave	145.0	7.8	1,100	33.0	Charallave
	12	Sucuta	152.0	8.2	1,160	22.5	Ocumare del Tuy
	13	Qda. Seca	75.0	4.0	660	7.5	San Francisco de Yare
		Sub-total	858.0	46.2	1,600	50.0	
	Total	1,856.0	100.0				

Table 2.3-3 (1/2) Monthly Average Discharge of the Tuy River

Hd. Barrios, Tuy River (C.A.=248 km²)

Unit: m³/s

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1958	0.47	0.27	0.25	0.13	0.90	2.01	1.70	1.47	1.08	1.05	0.61	0.31	0.85
1959	0.26	0.36	0.51	0.25	1.06	0.70	0.64	0.68	0.77	0.86	0.63	0.11	0.57
1960	0.32	0.15	0.18	0.60	0.63	0.99	1.09	1.39	1.55	1.08	1.13	0.83	0.83
1961	0.17	0.12	0.18	0.14	0.07	0.11	0.77	1.19	1.05	0.83	0.83	0.31	0.48
1962	0.13	0.09	0.15	0.10	0.21	0.63	0.78	1.59	1.19	0.73	0.43	0.10	0.51
1963	0.07	0.05	0.05	0.21	1.44	2.10	0.95	0.65	1.64	0.82	0.91	0.21	0.76
1964	0.12	0.08	0.08	0.13	0.24	0.52	1.07	1.14	1.24	1.20	0.14	0.18	0.51
1965	0.18	0.11	0.08	0.12	0.59	1.40	1.07	1.48	0.79	1.10	1.06	0.39	0.70
1966	0.12	0.08	0.06	0.09	0.30	1.59	2.19	1.99	1.34	1.53	1.75	1.49	1.04
1967	0.71	0.45	0.28	0.38	0.44	0.73	0.61	1.25	0.82	0.95	0.70	0.50	0.65
1968	0.25	0.21	0.15	0.40	0.87	1.07	0.85	1.06	0.81	0.23	0.34	0.12	0.53
1969	0.13	0.10	0.09	0.88	1.14	2.31	1.85	2.17	1.54	2.15	2.43	0.74	1.29
1970	0.38	0.26	0.43	0.21	0.36	1.93	2.00	1.63	1.85	1.17	0.76	0.89	0.99
1971	0.28	0.18	0.15	0.49	0.75	0.54	0.42	0.58	0.69	0.69	0.53	0.14	0.45
1972	0.21	0.13	0.24	0.33	1.02	0.40	0.35	0.30	0.28	0.40	0.42	0.37	0.37
1973	0.20	0.18	0.27	0.44	0.27	0.15	0.29	0.25	0.32	0.54	1.10	0.16	0.35
1974	0.19	0.19	0.17	0.10	0.22	0.09	0.22	0.64	1.61	2.33	1.23	0.40	0.62
1975	0.55	0.51	0.52	0.32	0.45	0.48	0.16	0.55	1.39	-	2.04	1.98	-
1976	0.90	0.50	0.10	0.70	0.30	0.10	0.50	0.60	0.50	1.20	0.20	0.20	0.48
1977	0.01	0.01	0.01	0.01	0.02	0.08	-	-	0.08	0.18	0.03	0.01	-
Max.	0.90	0.51	0.52	0.88	1.44	2.31	2.19	2.17	1.85	2.33	2.43	1.98	1.29
Min.	0.01	0.01	0.01	0.01	0.02	0.08	0.16	0.25	0.08	0.18	0.03	0.01	0.35
Ave.	0.28	0.20	0.20	0.30	0.56	0.90	0.92	1.08	1.03	1.00	0.86	0.47	0.67

Hd. Tazon, Tuy River (C.A.=1,180 km²)

Unit: m³/s

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1958	1.61	1.17	0.87	0.94	2.44	9.00	16.10	10.60	11.90	7.22	4.51	2.85	5.77
1959	2.16	1.62	1.21	0.72	2.24	3.73	2.93	5.02	4.09	5.52	5.46	2.27	3.08
1960	1.28	0.92	0.57	1.36	3.01	8.03	10.40	18.80	12.20	6.55	6.56	6.65	6.36
1961	2.77	2.06	1.61	1.31	0.82	1.66	7.70	6.44	8.48	6.66	6.66	3.82	4.17
1962	2.22	2.10	1.82	0.78	1.80	4.61	5.41	6.77	4.96	5.76	4.13	1.91	3.52
1963	1.44	0.89	0.79	1.84	9.10	13.20	9.54	6.92	12.30	7.67	5.27	3.47	6.04
1964	2.23	1.71	1.10	0.95	1.17	2.79	5.78	10.80	8.60	5.99	3.27	2.24	3.89
1965	1.69	1.60	0.90	0.57	1.89	10.50	15.10	14.50	9.68	12.20	11.20	5.19	7.08
1966	3.95	2.37	1.54	1.55	1.95	13.30	13.00	16.00	10.90	14.20	12.80	8.64	8.35
1967	5.55	3.78	2.37	3.78	2.59	3.28	4.74	7.14	3.69	3.99	2.97	3.13	3.92
1968	1.87	1.23	0.74	1.17	4.12	10.91	11.96	12.10	11.98	8.54	4.62	2.86	6.01
1969	4.31	4.01	4.03	3.79	4.54	20.02	-	31.83	18.19	17.11	11.78	11.24	-
1970	4.76	3.30	2.90	1.65	2.45	9.22	14.01	18.58	13.47	10.07	6.61	8.89	7.99
1971	7.05	3.05	1.15	2.86	1.84	1.48	2.59	6.83	8.07	6.93	4.91	2.28	4.09
1972	4.33	2.33	2.09	1.94	6.09	1.58	3.75	6.29	5.51	4.83	2.35	1.82	3.58
1973	1.65	1.09	0.77	0.96	0.70	0.55	0.55	1.14	3.91	5.83	6.52	2.69	2.20
1974	1.68	0.84	0.51	0.31	0.80	0.20	0.57	2.28	2.31	4.71	1.51	0.88	1.38
1975	0.68	0.52	0.28	0.17	0.21	0.41	0.12	2.50	2.18	12.77	4.14	2.40	2.20
1976	1.70	1.30	1.30	1.30	1.10	1.20	8.40	3.70	1.60	14.00	4.70	3.40	3.64
1977	2.23	1.07	0.68	0.27	0.64	5.06	3.45	6.49	6.20	3.90	9.43	3.33	3.56
Max.	7.05	4.01	4.03	3.79	9.10	20.02	16.10	31.83	18.19	17.11	12.80	11.24	8.35
Min.	0.68	0.52	0.28	0.17	0.21	0.20	0.12	1.14	1.60	3.90	1.51	0.88	1.38
Ave.	2.76	1.85	1.36	1.41	2.48	6.04	7.16	9.74	8.01	8.22	5.97	4.00	4.57

Table 2.3-3 (2/2) Monthly Average Discharge of the Tuy River

Toma de Agua, Tuy River (C.A.=1,856 km²) Unit: m³/s

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1958	2.53	1.84	1.37	1.48	3.84	14.16	25.32	16.67	18.72	11.36	7.09	4.48	9.08
1959	3.40	2.55	1.90	1.13	3.52	5.87	4.61	7.90	6.43	8.68	8.59	3.57	4.84
1960	2.01	1.45	0.90	2.14	4.73	12.63	16.36	29.57	19.19	10.30	10.32	10.46	10.00
1961	4.36	3.24	2.53	2.06	1.29	2.61	12.11	10.13	13.34	10.48	10.48	6.01	6.56
1962	3.49	3.30	2.86	1.23	2.83	7.25	8.51	10.65	7.80	9.06	6.50	3.00	5.54
1963	2.26	1.40	1.24	2.89	14.31	20.76	15.01	10.88	19.35	12.06	8.29	5.46	9.50
1964	3.51	2.69	1.73	1.49	1.84	4.39	9.09	16.99	13.53	9.42	5.14	3.52	6.12
1965	2.66	2.52	1.42	0.90	2.97	16.52	23.75	22.81	15.23	19.19	17.62	8.16	11.14
1966	6.21	3.73	2.42	2.44	3.07	20.92	20.45	25.17	17.14	22.33	20.13	13.59	13.13
1967	8.73	5.95	3.73	5.95	4.07	5.16	7.46	11.23	5.80	6.28	4.67	4.92	6.17
1968	2.94	1.93	1.16	1.84	6.48	17.16	18.81	19.03	18.84	13.43	7.27	4.50	9.45
1969	6.78	6.31	6.34	5.96	7.14	31.49	-	50.06	28.61	26.91	18.53	17.68	-
1970	7.49	5.19	4.56	2.60	3.85	14.50	22.04	29.22	21.19	15.84	10.40	13.98	12.57
1971	11.09	4.80	1.81	4.50	2.89	2.33	4.07	10.74	12.69	10.90	7.72	3.59	6.43
1972	6.81	3.66	3.29	3.05	9.58	2.49	5.90	9.89	8.67	7.60	3.70	2.86	5.63
1973	2.60	1.71	1.21	1.51	1.10	0.87	0.87	1.79	6.15	9.17	10.26	4.23	3.46
1974	2.64	1.32	0.80	0.49	1.26	0.31	0.90	3.59	3.63	7.41	2.38	1.38	2.17
1975	1.07	0.82	0.44	0.27	0.33	0.64	0.19	3.93	3.43	20.09	6.51	3.77	3.46
1976	2.67	2.04	2.04	2.04	1.73	1.89	13.21	5.82	2.52	22.02	7.39	5.35	5.73
1977	3.51	1.68	1.07	0.42	1.01	7.96	5.43	10.21	9.75	6.13	14.83	5.24	5.60
Max.	11.09	6.31	6.34	5.96	14.31	31.49	25.32	50.06	28.61	26.91	20.13	17.68	13.13
Min.	1.07	0.82	0.44	0.27	0.33	0.31	0.19	1.79	2.52	6.13	2.38	1.38	2.17
Ave.	4.34	2.91	2.14	2.22	3.89	9.49	11.27	15.31	12.60	12.93	9.39	6.29	7.19

Table 2.3-4 Monthly Average Discharge of the Ocumarito River

El Desecho, Ocumarito River (C.A.=122.7 km²) Unit: m³/s

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1960	0.26	0.12	0.06	0.12	0.34	1.78	2.25	4.81	2.80	1.52	1.54	1.18	1.40
1961	0.78	0.53	0.39	0.25	0.16	0.51	2.47	5.33	3.13	1.43	1.65	1.13	1.49
1962	0.79	0.49	0.45	0.23	0.32	1.83	3.31	4.29	3.68	1.79	0.95	0.64	1.57
1963	0.47	0.31	0.37	0.38	2.17	3.33	2.72	2.27	3.51	2.09	1.26	0.85	1.65
1964	0.62	0.47	0.35	0.29	0.31	0.66	1.46	2.07	1.72	1.16	0.75	0.51	0.87
1965	0.55	0.85	0.37	0.26	0.29	1.81	3.89	5.18	4.18	3.51	2.10	1.59	2.06
1966	1.14	0.73	0.50	0.35	0.30	1.42	4.24	4.29	4.16	3.18	2.85	4.06	2.28
1967	2.08	1.35	0.84	0.64	0.50	0.60	1.35	2.03	0.99	0.91	0.81	1.39	1.13
Max.	2.08	1.35	0.84	0.64	2.17	3.33	4.24	5.33	4.18	3.51	2.85	4.06	2.28
Min.	0.26	0.12	0.06	0.12	0.16	0.51	1.35	2.03	0.99	0.91	0.75	0.51	0.87
Ave.	0.84	0.61	0.42	0.31	0.55	1.49	2.71	3.78	3.02	1.95	1.49	1.42	1.56

Table 2.5-1 Pollution Flowrate for Industrial Wastewater

(1)

CIU	Pollution flowrate of BOD (kg/day/employee)
31173	0.08
31342	0.01
32111	1.28
35131	1.08
35135	1.08
35234	0.54
35295	0.42
36991	0.03
3699	0.03
37102	0.05
37201	0.05
38191	0.03
38193	0.03
38431	0.27
38433	0.27

(2)

CIU	Pollution flowrate of BOD (kg/day/employee)
32112	1.35
32113	1.21
32311	2.00
32321	2.00
36200	4.00
36201	4.00

Table 2.6-1 (1/2) Major Features of the Existing Reservoirs

Item	Ocumarito	Lagartijo	Taguacita	Camatagua
Dam				
Start operation	1969	1962	1986	1968
Name of river	Ocumarito	Lagartijo	Taguacita	Guárico
Location:				
Longitude (W)	10°04'38"	10°10'21"	10°11'27"	09°48'32"
Latitude (N)	66°49'43"	66°41'53"	66°33'30"	66°55'08"
Purpose	U	U, F, R	U, F	U, I, F, R
Type	Concrete arch	Rockfill		Rockfill
Height				
Crest length				
Design discharge (m ³ /s)				
Maximum	-	9.0	9.0	19.0
Normal	-	3.8	-	-
Spillway (m ³ /s)				
Normal	860	1,200		
Emergency	1,000			
Operation	Hidrocapital	Hidrocapital	Hidrocapital	MARNR
Reservoir				
Capacity (million m ³)				
Surcharge	3.90	33.00		172.11
Effective	6.00	70.00	119.10	1,532.09
Dead		10.00	3.30	41.80
Gross	10.85	113.00	122.40	1,746.00
Water level (EL m)				
High	248.30	192.85		304.00
Normal	245.50	189.75	172.40	301.66
Low	232.80		104.00	261.00
Operation Rule				

Purpose: U: Urban I: Irrigation F: Flood control R: Recreation

Table 2.6-1 (2/2) Major Features of the Existing Reservoirs

Item	Qda. Seca	La Mariposa	La Pereza	Agua Fría
Dam				
Start operation	1961	1949	1969	1949
Name of river	Qda. Seca	Valle	La Pereza	Jarillo
Location:				
Longitude (W)	10°14'43"	10°25'21"	10°26'43"	10°20'43"
Latitude (N)	66°43'47"	66°56'29"	66°43'47"	67°09'51"
Purpose	U	U	U	U
Type				
Height				
Crest length				
Design discharge (m ³ /s)				
Maximum	-	-		
Normal	4.0	5.0	8.0	1.75
Spillway (m ³ /s)				
Normal		725		380
Emergency				500
Operation	Hidrocapital	Hidrocapital	Hidrocapital	Hidrocapital
Reservoir				
Capacity (million m ³)				
Surcharge	1.25	1.00		0.60
Effective	6.50	7.00		5.75
Dead	0.75			0.05
Gross	8.50	9.00	8.00	6.40
Water level (EL m)				
High	170.40	984.20	1,068.50	1,718.00
Normal	169.50	981.00		1,716.50
Low				
Operation Rule				

Purpose: U: Urban I: Irrigation F: Flood control R: Recreation

Table 2.6-2 Major Features of the Water Source

River	Cagua	Guare	Aniagua
Location		Tácata	
Catchment Area (km ²)	53	183	62
Discharge (m ³ /s)			
Average monthly	0.25	0.75	0.25
Dam			
Studied	No	Yes	No
Type	-	Rockfill	-
Height (m)	-	61	-
Ave. regulated Q (m ³ /s)	-	1.5	-
Cost	-		

River	Tarma	Sucuta
Location		
Catchment Area (km ²)	57	71
Discharge (m ³ /s)		
Average monthly	0.23	0.29
Dam		
Studied	No	No
Type	-	-
Height	-	-
Ave. regulated Q (m ³ /s)	-	-
Cost	-	-

Table 2.7-1 Capable Analytical Parameters and Methods in the Laboratory

No	Parameter	Method
1	Oil and grease	Extraction by organic solvent
2	Aluminium	Atomic absorption spectrometry
3	Alkalinity	Volumetric method
4	Bromine (Br)	Disco Hellige
5	Calcium (Ca)	ISE method
6	Cyanide (CN ⁻)	ISE method
7	Chlorine (Cl ⁻)	Polarography
8	Residual Chlorine (Cl ₂)	Orthotridine
9	Copper (Cu)	Atomic absorption spectrometry
10	Conductivity	Potentiometer
11	Chromium (Cr)	Atomic absorption spectrometry
12	MBAS	Methylene Blue
13	BOD	Electric measuring method
14	COD	Potassium Dichromite titration
15	Total Hardness	EDTA titration
16	Calcium Hardness	EDTA titration
17	Phenol	Direct extraction by Chloroform
18	Total Phosphate	Ascorbic Acid
19	Fluorine (F)	ISE method
20	Specific Gravity	Gravimetric method
21	Iron (Fe)	Atomic absorption spectrometry
22	Langumuar Index	Electrochromic method
23	Manganese (Mn)	Atomic absorption spectrometry
24	Nickel (Ni)	Atomic absorption spectrometry
25	Total Nitrogen	Kjeldahl method
26	Nitrate	Blucine spectrophotometric or ISE method
27	Nitrite	Colorimetric (NEDA)
28	Ammonium Nitrogen	Nester titration or ISE
29	pH	Potenciometric
30	Agro-chemicals	Gaschromatography
31	Silver (Ag)	ISE method
32	Lead (Pb)	Atomic absorption spectrometry
33	Potassium (K)	ISE method
34	Silicate (SiO ₂)	Molibden-silicate
35	Total Solid	Gravimetric method
36	Dissolved Solid	Gravimetric method
37	Total Suspended Solid	Gravimetric method
38	Sedimentable Solid	Volumetric method
39	Sodium (Na)	ISE method
40	Sulfate-ion	Gravimetric method
41	Sulfite-ion	ISE method
42	Turbidity	Turbidity meter
43	Zinc (Zn)	Atomic absorption spectrometry

Table 2.8-1 History and Future of Metropolitan Caracas Water Supply System

YEAR	WATER RESOURCE	SYSTEM	SUPPLY CAPACITY m ³ /sec	SERVICE POPULATION
1950	La Mariposa (Yalle River) Macarao, Filla Norte Wells		1.63	704,567
1965	Tuy River	Tuy I	4.33	1,780,000
1968	Tuy River Lagartijo Reservoir	Tuy I Tuy II Camatuy	9.50	2,050,000
1980	Tuy River Lagartijo Reservoir Qda, Seca Reservoir Camatagua Reservoir	Tuy I Tuy II Tuy III (line No. 1)	13.00	3,000,000
1983	"	Tuy I Tuy II Tuy III (line No. 2)	16.00	3,200,000
1992	Tuy River Lagartijo Reservoir Qda, Seca Reservoir Camatagua Reservoir Taguacita Reservoir	Tuy I Tuy II Tuy III (line No. 5)	16.00	3,400,000
1994	"	Tuy I Tuy II Tuy III (line No. 3)	19.50	3,500,000
1996	"	Tuy I Tuy II Tuy III	22.00	3,600,000
2000	Tuy River, Lagartijo Reservoir Taguacita Reservoir Qda, Seca Reservoir Camatagua Reservoir Taguaza Reservoir	Tuy IV	26.50	4,200,000

Table 2.8-2 Outline of the Water Supply System

System	Tuy I	Tuy II	Tuy III
Actual Capacity (1995)	Maximum : 3.75 m ³ /sec Average : 2.71 m ³ /sec	Maximum : 7.20 m ³ /sec Average : 5.69 m ³ /sec	Maximum : 8.60 m ³ /sec Average : 7.18 m ³ /sec
Water Resource	Tuy River Lagartijo Reservoir Quebrada Seca Reservoir Camatagua Reservoir	Tuy River Lagartijo Reservoir Quebrada Seca Reservoir Taguacita Reservoir	Camatagua Reservoir
Pumping Station	No.11 Station 1.0 m ³ /sec × 272 m × 3,720 kw - 5 units No.12 Station 1.0 m ³ /sec × 287 m × 3,850 kw - 4 units No.13 Station 1.0 m ³ /sec × 287 m × 3,850 kw - 4 units No.14 Station 1.0 m ³ /sec × 287 m × 3,850 kw - 4 units	No.21 Station 1.5 m ³ /sec × 150 m × 5,950 kw - 4 units No.22 Station 1.5 m ³ /sec × 364 m × 8,000 kw - 4 units No.23 Station 1.5 m ³ /sec × 364 m × 8,000 kw - 4 units	No.31 Station 2.3 m ³ /sec × 217 m × 8,000 kw - 5 units No.32 Station 3.0 m ³ /sec × 420 m × 15,000 kw - 5 units No.33 Station 3.0 m ³ /sec × 420 m × 15,000 kw - 5 units
Total Pump Head	1,074.38 m	963.30 m	1,028.40 m
Distance to Caracas from Water Resource	32.0 km	36.5 km	80.3 km
Treatment Plant	La Mariposa	La Guairita	Caujarito

Table 2.8-3 Causes of Suspension of Water Intake at Toma de Agua (1995)

Month	Suspension		Causes					
	Time	Total Hour	color	odor	chlorine demand	turbidity	detergent	other chemical
Jan	4	33	3	2	2	0	1	0
Feb.	2	11	0	2	1	0	2	0
Mar.	2	17	0	0	2	2	2	0
Apr.	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0
Jun.	4	26	2	2	1	2	0	0
Jul.	3	15	0	3	0	0	0	0
Aug.	2	11	0	1	0	0	0	1
Sep.	2	15	0	1	1	0	0	1
Oct.	6	63	3	5	0	1	3	0
Nov.	0	0	0	0	0	0	0	0
Dec.	0	0	0	0	0	0	0	0
Total	25	191	8	16	7	5	8	2
Dry	8	44	3	4	4	2	4	0
Rain	17	67	5	12	3	3	4	2

Table 2.9-1 (1/2) Population of the Study Area

Town		Population				
No.	Name	1981	Age:0-17	Age:18-64	Age:65-	1990
1	La Mora	10,624	5,085	5,193	346	11,599
2	El Consejo	10,914	5,127	5363	424	12,196
3	Sabaneta-Los Cerritos	11,289	5,873	5,075	341	13,527
4	La Guruta-La Concepcion	43	21	20	2	2,670
5	El Conde	273	135	115	23	399
6	Tovar	2,675	1,132	1,406	137	3,373
7	Jarillo	1,104	525	539	40	1,034
8	Curiepe	1,783	951	776	56	2,490
9	Las Tejerias	14,461	7,156	6,844	461	20,246
10	Morocopo	354	180	165	9	608
11	La Esperanza	160	56	99	5	455
12	Boqueron (La Penita)	721	347	350	24	968
13	San Daniel	293	159	113	21	299
14	Aniagua	379	205	158	16	521
15	Los Chaguaramos	769	390	353	26	967
16	La Providencia	402	205	182	15	477
17	Tacata	1,002	460	481	61	1,198
18	Palo Negro	370	184	174	12	498
19	Lagunetica	177	75	95	7	258
20	Carrizal	21,012	9,794	10,715	503	30,423
21	San Diego	1,215	477	682	56	1,634
22	Paracotos	4,540	1,892	2,424	224	6,038
23	Parques del Sur	92	39	49	4	200
24	Sabaneta	271	144	120	7	633
25	Los Amarillos	535	289	234	12	779
26	Cortada de Maturin-Maitana	69	34	33	2	361
27	Agua Fria	570	293	266	11	769
28	Cua	23,590	11,557	11,259	774	50,520
29	Las Mercedes de Cua	2,794	1,373	1,323	98	5,969

Source: OCEI

Table 2.9-1 (2/2) Population of the Study Area

Town		Population				
No.	Name	1981	Age:0-17	Age:18-64	Age: 65-	1990
30	La Siempre Viva	847	377	441	29	1,822
31	Quebrada Honda	436	217	206	13	550
32	La Palmita	102	55	44	3	128
33	Colonia Mendoza	1,020	488	484	48	1,538
34	Piloncito (La Cabrera)	2,711	1,376	1,288	47	4,075
35	Ocumare del Tuy	40,666	19,302	19,967	1,397	61,043
36	Los Cajones	504	251	241	12	769
37	Las Yaguas	147	85	55	7	251
38	Sucuta	1,238	665	537	36	1,845
39	San Francisco de Yare	5,152	2,369	2,577	206	9,905
40	Parcelamiento de Yare	535	260	255	20	1,021
41	Pinango	541	310	218	13	338
42	San Jose de Los Altos	1,171	395	728	48	1,571
43	Charallave	29,410	13,822	14,744	844	51,807
44	Santa Barbara	497	284	191	22	1,691
45	(Tuy River Upper Basin)	85,355	40,640	41,890	2,825	113,393
46	(Tuy River Middle Basin)	112,103	53,774	54,692	3,637	196,070
47	(Tuy River Basin)	197,458	94,414	96,582	6,462	309,463
48	(Caracas)	2,577,127	908,222	1,576,028	92,877	3,124,171

Source: OCEI

Table 2.9-2 (1/2) Number of Household Samples by Income Group

Town		No Income	<Bs 200000	Bs 200000-	>Bs1000000	Total
No.	Name		/month	1000000/month	/month	Inhabitants
1	La Mora	n.a.	n.a.	n.a.	n.a.	n.a.
2	El Consejo	3,793	2,735	256	276	7,060
3	Sabaneta-Los Cerritos	3,740	2,526	127	337	6,730
4	La Gruta-La Concepcion	13	12	1	2	28
5	El Conde	103	58	1	13	175
6	Tovar	806	876	67	81	1,830
7	Jarillo	318	386	7	26	737
8	Curiepe	646	398	17	53	1,114
9	Las Tejerias	5,058	3,636	286	348	9,328
10	Morocopo	101	110	7	2	220
11	La Esperanza	55	45	2	2	104
12	Boqueron (La Penita)	2	186	14	20	222
13	San Daniel	96	67	0	6	169
14	Aniagua	135	5	0	7	147
15	Los Chaguaramos	279	39	1	29	348
16	La Providencia	176	69	1	5	251
17	Tacata	357	262	21	15	655
18	Palo Negro	94	123	8	2	227
19	Lagunetica	54	61	1	4	120
20	Carrizal	6,883	5,832	776	354	13,845
21	San Diego	446	388	52	13	899
22	Paracotos	1,355	1,608	149	57	3,169
23	Parques del Sur	29	34	2	1	66
24	Sabaneta	75	69	2	1	147
25	Los Amarillos	207	125	4	8	344
26	Cortada de Maturin-Maitana	23	20	1	0	44
27	Agua Fria	209	129	6	10	354
28	Cua	7,632	6,082	645	481	14,840
29	Las Mercedes de Cua	907	632	57	66	1,662

Source: Based on 1981 data prepared by OCEI.

Table 2.9-2 (2/2) Number of Household Samples by Income Group

Town		No Income	<Bs 200000 /month	Bs 200000- 1000000/month	>Bs1000000 /month	Total Inhabitants
No.	Name					
30	La Siempre Viva	279	187	6	44	516
31	Quebrada Honda	183	53	7	3	246
32	La Palmita	42	2	0	3	47
33	Colonia Mendoza	364	275	21	14	674
34	Piloncito (La Cabrera)	851	698	46	97	1,692
35	Ocumare del Tuy	13,671	10,868	1,283	864	26,686
36	Los Cajones	155	133	4	25	317
37	Las Yaguas	52	24	1	0	77
38	Sucuta	407	258	20	25	710
39	San Francisco de Yare	1,651	1,290	301	144	3,386
40	Parcelamiento de Yare	194	148	9	7	358
41	Pinango	164	115	5	9	293
42	San José de Los Altos	490	241	157	25	913
43	Charallave	9,426	8,196	1,049	640	19,311
44	Santa Barbara	159	96	2	27	284
45	(Tuy River Upper Basin)	24,849	19,824	1,960	1,654	48,287
46	(Tuy River Middle Basin)	36,831	29,273	3,462	2,492	72,058
47	(Tuy River Basin)	61,680	49,097	5,422	4,146	120,345
48	(Caracas)	19,456	725,403	335,392	5,604	1,085,855

Source: Based on 1981 data prepared by OCEI.

Table 2.9-3 (1/2) Employment Structure (1981)

No.	Town Name	Sector			Total Employees
		Agriculture	Industry	Services	
1	La Mora	n.a.	n.a.	n.a.	n.a.
2	El Consejo	81	1,649	1226	2956
3	Sabaneta-Los Cerritos	178	1,411	984	2,573
4	La Guruta-La Concepcion	2	10	2	14
5	El Conde	32	8	20	60
6	Tovar	383	126	471	980
7	Jarillo	329	28	54	411
8	Curiepe	50	235	155	440
9	Las Tejerias	236	2,048	1,610	3,894
10	Morocopo	101	8	16	125
11	La Esperanza	16	6	30	52
12	Boqueron (La Penita)	23	43	136	202
13	San Daniel	56	0	9	65
14	Aniagua	7	1	2	10
15	Los Chaguaramos	31	20	21	72
16	La Providencia	25	30	19	74
17	Tacata	35	86	153	274
18	Palo Negro	27	32	71	130
19	Lagunetica	7	21	26	54
20	Carrizal	181	2,847	3,587	6,615
21	San Diego	52	148	231	431
22	Paracotos	88	762	880	1,730
23	Parques del Sur	5	23	7	35
24	Sabaneta	2	44	27	73
25	Los Amarillos	8	49	55	112
26	Cortada de Maturin-Maitana	6	10	6	22
27	Agua Fria	18	35	78	131
28	Cua	129	3,244	3,214	6,587
29	Las Mercedes de Cua	53	358	259	670

Source: OCEI

Table 2.9-3 (2/2) Employment Structure (1981)

Town		Sector			Total
No.	Name	Agriculture	Industry	Services	Employees
30	La Siempre Viva	24	113	62	199
31	Quebrada Honda	21	25	15	61
32	La Palmita	4	2	2	8
33	Colonia Mendoza	71	125	100	296
34	Piloncito (La Cabrera)	18	423	291	732
35	Ocumare del Tuy	409	5,327	6,230	11,966
36	Los Cajones	134	11	9	154
37	Las Yaguas	12	9	10	31
38	Sucuta	61	143	75	279
39	San Francisco de Yare	41	812	745	1,598
40	Parcelamiento de Yare	19	83	54	156
41	Pinango	8	86	30	124
42	San Jose de Los Altos	34	94	266	394
43	Charallave	158	4,053	4,708	8,919
44	Santa Barbara	43	20	35	98
45	(Tuy River Upper Basin)	1,943	9,656	10,066	21,665
46	(Tuy River Middle Basin)	1,275	14,952	15,915	32,142
47	(Tuy River Basin)	3,218	24,608	25,981	53,807
48	(Caracas)	10,297	268,224	670,358	948,879

Source: OCEI

Table 2.10-1 Personnel of Tuy River Agency

Admin. Unit	Secretary	Adminis- tration	Environ- ment	Chief Operative Unit	Manager	Adviser	Total
General Manager	2	-	6	-	2	3	13
Adomin. and Budget	2	13	-	-	1	-	16
Man. Educ./Participat.	1	-	3	-	1	-	5
Man. Planning/Project	1	-	4	-	-	-	5
Man. Protection Zone	5	-	11	2	1	1	20
Man. Federal District	8	6	34	2	1	-	51
Man. Miranda	11	5	30	4	1	-	51
TOTAL:	30	24	88	8	7	4	161

Sources: a) *Plan de Entrenamiento y Desarrollo de Personal, Soc. Fanny Parilli, Caracas, June, 1995*
 b) Tuy River Agency

Table 2.10-2 Personnel of Miranda Management Office

Category	Territorial Manage- ment	Administra- tion/ Budget	Los Teques /High Tuy	Middle Tuy/ Ocumare	Rio Grande/ Guatire	Low Tuy Barlo- vento	Total
Professional	6	1	5	3	1	3	19
Technician	1	3	4	7	2	1	16
Administration	3	3	3	2	-	3	16
TOTAL	10	7	12	12	3	7	51

Sources: a) *Plan de Entrenamiento y Desarrollo de Personal, Soc. Fanny Parilli, Caracas, June, 1995*
 b) Tuy River Agency, Miranda Office.

Table 2.10-3 Number of Personnel by Profession in Tuy River Basin Agency

Profession	Number
Hydrometeorologist Technician	9
Agronomist Technician	1
Draftsman	5
Forest Technician	7
Agriculture Technician	2
Surveyor	1
Geology and Mines Technician	1
Social Worker	1
Assistant Engineer and Planning	7
Superior Tech. of Publicity	1
Superior Tech. Civil Constructions	1
Superior Tech. Agriculture	1
Superior Tech. Marketing	1
Bachelor in Education	1
Lawyer	6
Agronomist Engineer	14
Agriculture Engineer	1
Hydrometeorologist Engineer	1
Hydraulic Engineer	2
Hydrologist Engineer	1
Civil Engineer	5
Chemist Engineer	2
Geologist	1
Forest Engineer	7
Bachelor in Geography	7
Urban Expert	2
Biologist	6
Architect	5
Sociologist	4
Bachelor in Chemistry	1
Secretaries and Clerks	30
Medium Tech. Administration	21
Univ. Sup. Computation	3
Bachelor Administration	1
University Sup. Tech. Social Work	1
Total	161

Sources: a) *Plan de Entrenamiento y Desarrollo de Personal, Soc. Fanny Parilli, Caracas, June, 1995*
 b) Tuy River Agency

Table 2.10-4 Budget of the Tuy River Basin Agency for 1996

CONCEPT	BUDGET		
	Bolibares	US\$ *	%
REVENUES			
Contribution National Government	311,720,000	670,366	95
Contribution Federal District	5,000,000	10,753	2
Own Revenues	4,000,000	8,602	1
Fiscal Stamp **	6,000,000	12,903	2
TOTAL	326,720,000	702,624	100
EXPENSES			
Personnel Expenses	224,758,253	483,351	69
Materials and Supplies	27,140,000	58,366	8
Non Personnel Services	27,273,000	58,366	8
Real Assets	9,150,000	19,677	3
Services of Debt and Dim. of Passives	38,038,747	81,804	12
Transference	360,000	774	-
TOTAL	326,720,000	702,624	100

Source: Office of Administration and Budget, Tuy River Agency

* As of 13/05/1996 exchange rate: US\$ 1=Bs. 465

** According to a Resolution of the Treasury Ministry of May 29, 1995, it authorize to the Agency of Tuy River Basin to use 75% of the revenues due to Fiscal Stamp.

Table 2.10-5 Budget Estimated for Project "Integral Sanitation of Tuy River Basin"

WORKS/YEAR	1996	1997	1998	1999	Total US\$ million
Sanitation lagoons, Low Tuy	20				20
Treatment Plants		50			50
Collectors and Urban Networks			20		20
Hydraulic River Infrastructure				30	30
TOTAL					120

Source: Proyecto: Saneamiento Integral Cuenca del Rio Tuy, Tuy River Agency, MRNR, Caracas, February, 1996.

Table 2.10-6 Classification of Personnel of Hidrocapital

Category	Number
Management	22
Corporate	163
Metropolitan System	194
Litoral System	82
Panamerican System	79
Losada-Ocumare System	83
Fajardo System	44
Barlovento System	41
Contracts	8
TOTAL:	716

Source: Office of Human Resources, HIDROCAPITAL

Table 2.10-7 Budget of Hidrocapital During the Period 1993-1995

Unit: US\$

CONCEPT	1995	1994	1993
REVENUES:			
Selling of Water	27,280,326	20,984,866	6,392,676
TOTAL:	27,280,326	20,984,866	6,392,676
EXPENSES:			
Production & Distribution of Water	51,739,881	39,799,908	2,876,704
Admon. & Commercialization	596,745	459,034	3,835,606
Personnel	1,260,539	969,645	-
Operation	7,820,444	6,015,726	-
Depreciation & Amortization	113,787	87,528	-
TOTAL:	61,531,395	47,331,842	6,712,310
DEFICIT:	34,251,069	26,346,976	319,634

Table 2.10-8 Budget of HIDROCAPITAL for 1995 (estimated)

CONCEPT	Bolivares	US\$	%
REVENUES			
Selling of Water	12,685,351,779	27,280,326	100
TOTAL	12,685,351,779	27,280,326	100
EXPENSES			
Cost of Production-Distribution	24,059,044,621	51,739,881	84
Admon. and Commercialization	277,486,254	596,745	1
Personnel	586,150,461	1,260,539	2
Operation	3,636,506,594	7,820,444	13
Depreciation and amortization	52,910,847	113,787	0
TOTAL	28,612,098,777	61,531,395	100

Source: MEMORIA Y CUENTA, HIDROCAPITAL, MARNR, 1995

Table 2.10-9 (1/2) The System of Charge for Water Use

Type of Charge	Minimum Monthly Charge per 15 m ³ (Bs.)	Monthly Payment per Consumption of 120m ³ (Bs.)
(a) Residentially		
Type 1	112.50	1,662.50
Type 2	140.75	2,078.25
Type 3	168.75	2,493.75
Type 4	197.00	2,909.50
Type 5	225.00	3,325.00
Type 6	281.25	4,156.25
(b) Social		
Type 1	56.25	1,497.00
Type 2	56.25	1,822.00
Type 3	56.25	2,147.00
Type 4	56.25	2,297.00
Type 5	56.25	2,797.00
Type 6	56.25	3,447.00
(c) Commercial	Consumption up to 30 m ³ /month(Bs/m ³)	Excess (Bs/m ³)
Type 1	15.00	25.00
Type 2	18.75	31.25
Type 3	22.50	37.50
Type 4	26.25	43.75
Type 5	30.00	50.00
Type 6	37.50	62.50
(d) Industrial A	Consumption up to 50 m ³ /month (Bs/m ³)	Excess (Bs/m ³)
Type 1	20.50	32.50
Type 2	25.60	40.60
Type 3	30.75	48.75
Type 4	35.90	56.90
Type 5	41.00	65.00
Type 6	51.25	81.25
(e) Industrial B	Consumption up to 40 m ³ /month (Bs/m ³)	Excess(Bs/m ³)
Type 1	17.00	27.00
Type 2	21.25	33.75
Type 3	25.50	40.50
Type 4	29.75	47.25
Type 5	34.00	54.00
Type 6	42.50	67.50

Source: Gaceta Oficial No. 35,161 of March 1, 1993, Prices of Water Supply.

Table 2.10-9 (2/2) The System of Charge for Water Use

Any adjustment of these charges will be executed according to the following equation:

$$Pmra = Pmri(axS/Si + bxE/Ei + cxQ/Qi + dxC/Ci)$$

Where: Pmra= Mean adjusted referential price, Pmri= Mean initial referential price, a= rate of personnel costs to the total, b= rate of costs of electricity to the total, c= rate of costs of chemical substances to the total, d= rate of costs of maintenance to the total

The summation of these factors should be 1.0.

$$\text{Total Cost} = \text{Personnel Expenses} + \text{Electricity Charges} + \text{Chemical Substances Costs} + \text{Maintenance Expenses}$$

Where: S= Current minimum salary, Si=Initial minimum salary, E= Expected mean price of electricity (Bs/kwh), Ei=Initial mean price of electricity (Bs/kWh), Q=Expected average price of chemical substances, Qi=Initial average price of chemical substances, C= Current price index for wholesalers of construction products, Ci= Initial price index for wholesalers of construction products

Values for Pmri used in the current price list were as follows:

Tariff	Pmri (Bs/m ³)
Social-Residential use	7.50
Type 1	10.00
Type 2	12.50
Type 3	15.00
Type 4	17.50
Type 5	20.00
Type 6	25.00

Source: *Gaceta Oficial* No. 35,161 of March 1, 1993, Prices of Water Supply.

Table 2.10-10 (1/2) Legal Statements on Environment in Venezuela

Classification	Title	Date	Feature and Main Purpose
Environment	Law of Environment	16-6-1976	The main principles for the conservation, defense and improvement of environment on behalf of the quality of life.
	Forestry Law of Soils and Water	26-1-1966, 28-4-1977, 6-10-1989	Regulates the conservation, promotion and exploitation of the natural resources and their products.
	Law of Protection of the Wild Fauna	16-6-1976	Regulates the protection and rational exploitation of the wild faunas and their products.
	Decree no.1302	10-10-86	Establishment of incentives for the persons who make investments in equipment, civil works and facilities for the conservation, defense and improvement of the environment(derogated).
	Decree no.1221	2-11-1990	Regulation of the Environmental Corps (Reglamento sobre Guarderia Ambiental) and the organization, operation, assignments and coordination of the institutions and officials to work in the corps.
	Penal Law of Environment	3-1-1992	Classification of the environmental crimes which violates the regulations related to conservation, defense and improvement of the environment and establishment of the corresponding penal sanctions.
	Decree no.2213	27-4-1992	Partial by-laws of Organic Law of Environment on the environment impact assessments.
Water	Decree no. 2831	20-10-1978	Partial by-laws no.4 of the Organic Law of Environment on classification of waters (Derogated by Decree no.883).
	Resolution no.31	28-5-85	Standards on liquid effluents
	Decree no.238	29-1-92	Sanitation standards of drinking water quality
	Decree no.883	18-12-95	Establishment of the standards of the classification and quality control of the water bodies and liquid residues or effluents
	Decree no.1,400	10-7-1996	Regulation and control of the exploitation of hydric resources and watersheds

Table 2.10-10 (2/2) Legal Statements on Environment in Venezuela

Human Activities	Decree no. 635	25-1-1990	Regulation of piggery activities at the national territory, according to the principles of conservation, protection and better option regarding the uses of resources such as mentioned in the state's and regional plans of territorial ordination
	Law of Mines and its by-laws	18-1-1945	Regulates the exploration and exploitation of mines
	Decree no.2216	27-4-1992	Standards of the management of solid residues from domestic, commercial, industrial or any other nature which is not harmful
	Decree no.2219	27-4-1992	Standards to regulate the influence of the natural renewable resources, associated to the exploration and exploitation of minerals.
	Decree no.2220	27-4-1992	Standards to regulate the activities which can produce changes of flow, obstruction of river beds and problems of sedimentation.
	Decree no.2224	27-4-1992	Standards to regulate the discharges of liquid residues to water bodies(derogated by Decree no.883).
	Law of Urban Ordination	16-12-1987	The ordination of the urban development in all states in order to make a smooth development of the populated centers.
Human Activities	Decree no.125	22-4-94	Complementary standards for the phased improvement of activities which produce liquid pollutants affecting environmental quality (derogated by Decree no.883).
	Decree no.2211	27-4-1992	Standards of the control of generation and management of toxic residues
Administration	Law of Central Administration	28-12-1976	defining the duties of the MARNR
	Resolution	27-2-81	price list of services of aqueducts and sewer
	Law of Territory Ordination	11-8-1983	States the regulations which will rule the process of ordination of the territory in accordance with the economical and social strategies of the nation
	Resolution 304/28	1-3-93	Price list of the services of aqueducts, collection, treatment and disposal of residual waters.

Table 2.10-11 Legal Statements Regarding the Tuy River Basin

Classification	Title	Date	Features
Conservation	Decree no.1010	20-7-72	Declaration of specially affected zone by the construction of a new urban center in the valley of Tuy with the area of approximately 4120 ha.
	Decree no.1046	20-7-72	Declaration of zone protective of soils, forest and water in the territory around the metropolitan Caracas.
	Decree no.2299	18-1-93	Ordination plan and by-laws of the use of the protective zone of the metropolitan Caracas.
	Decree no.2306	29-3-93	Declaration of critical area with priority of treatment on the Tuy River basin.
	Decree no.2308	26-3-93	Plan of ordination and regulation on the use of the critical area with priority of treatment on the Tuy River basin; Purpose: the improvement, recuperation and ordination of the basin, establishing the guidelines for the administration and orientation of the permitted land use and activities..
Development	Decree no.1039	20-7-72	Permission of a new urban center in the valleys of Tuy, City of Diego de Losada.
Administration	Resolution no.318	20-11-81	Regulations for the use of the sector of El Jarillo (Upper Tuy) for agricultural uses.
	Decree no.2307	12-4-93	Foundation of the Unique Authority of Area Agency of Tuy River Basin and the North Region of the Littoral Ridge of the Federal District and Miranda State.
	Decree no.3240	16-12-1993	Reform of Decree 2307; Incorporating the administration of the office of Protection of the Metropolitan Caracas.

Table 2.10-12 Penalties Established in Different Laws

Law / Activity	Penalty		
	Prison (years)	Fine	Others
Law of Forest, Soils and Waters (26-1-1966)			
Setting fire to forests	1 - 6		
Illegal exploitation of forest products, or destroy vegetation		1,000-50,000 Bs	
Organic Law of Environment (7-6-1976)			
For the enforcement of the law	10 (max)	1,000,000 Bs (max)	-Temporary, total or partial occupation of the polluting sources (not exceed 6month) -Temporary or permanent closure of the factories -Temporary or permanent closure of the activity -Modification or demolishing of buildings -Any other measure to correct/repair damages
Organic Law of Territory Ordination (11-8-1983)			
Activities contrary to the present law, to the plans of territory ordering and to the administrative authorizations.		1,000 - 500,000 Bs. /1, /2	- 2 years disability to obtain authorizations - Confiscation equipment - Demolition installations - Repair of the damages
Penal Law of Environment (3-1-1992)			
Discharge of non-biodegradable materials, biological/chemical agents, effluents/waste waters without treatment, to water bodies, river sides, beds or basins	1/4 - 1	300 - 1,000 DSM*	
Produce change of flow or sedimentation in the rivers	1/4 - 3/4	300 - 900 DSM	
Exploitation of granular materials	1/3 2/3	400 - 800	
Pollution of underground water	1 - 2 month	1,000 - 2,000 DSM	
Setting fire to plantations, pasture, forests, etc.	1/2 - 6	600-6,000 DSM	
Generation/use of toxic/dangerous substances. Transforming of toxic or dangerous residues which can be transported to other receptive mean. Mixing/operation/discharge of toxic materials with domestic or industrial waste to unauthorized sites, etc.	1 - 3	1,000-3,000 DSM	

* DSM (*Dias Salario Minimo*)=Minimum Salary per Day~1 US Dollar as of Feb/97.

Table 3.3-1 Baseline Pollution Projection for BOD

Effluent Load (BOD: kg/day)

		1990	1995	Standard			High			Low		
				2000	2005	2010	2000	2005	2010	2000	2005	2010
	Tovar	159	187	210	239	277	228	282	358	191	197	205
R-2	El consejo	9,077	9,275	27,113	53,636	93,814	29,216	69,184	139,453	21,571	34,744	50,003
R-4	Las Tejerias	7,234	7,496	9,028	11,196	14,351	9,437	13,014	18,885	8,350	9,381	10,552
R-5	Q. Guayas	1,764	1,800	2,138	2,627	3,350	2,201	2,979	4,294	2,022	2,253	2,518
X-4	Q. Maitana	1,820	2,027	2,536	3,195	4,085	2,615	3,523	4,933	2,174	2,435	2,727
	Upstream	20,055	20,784	41,026	70,892	115,876	43,697	88,982	167,922	34,309	49,011	66,005
R-6	Q. Guare	1,235	1,255	1,263	1,271	1,279	1,267	1,279	1,293	1,236	1,236	1,237
R-8	Cua	761	947	1,281	1,727	2,333	1,320	1,846	2,592	1,146	1,378	1,655
R-9	Charallave	9,614	11,518	15,586	21,291	29,389	16,075	23,390	34,666	14,088	17,071	20,667
R-10	Ocumare	5,876	6,970	9,352	12,639	17,203	9,672	14,071	20,893	8,342	9,866	11,614
	Middle	17,487	20,690	27,483	36,928	50,204	28,334	40,586	59,443	24,812	29,551	35,173
	Total	37,542	41,474	68,508	107,820	166,080	72,031	129,568	227,365	59,121	78,562	101,178

Water Quality (BOD: mg/l)

		1990	1995	Standard			High			Low		
				2000	2005	2010	2000	2005	2010	2000	2005	2010
R-2	El Consejo	-	686	1,843	3,345	5,335	1,874	3,815	6,523	1,641	2,525	3,468
R-4	Las Tejerias	-	563	1,091	1,731	2,518	1,090	1,885	2,886	1,012	1,406	1,814
R-5	Q. Guayas	-	598	1,101	1,706	2,440	1,097	1,845	2,776	1,031	1,406	1,794
X-4	Q. Maitana	-	34	61	95	138	62	107	165	57	78	100
R-6	R. Guare	-	32	48	69	97	49	77	119	45	57	70
R-8	Cua	-	30	42	57	76	42	62	90	39	48	58
R-9	Charallave	-	8	11	15	19	11	16	22	10	12	14
R-10	Ocumare	-	7	9	12	14	9	12	16	9	10	11

Table 4.1-1 (1/2) Summary of Key Issues for Water Quality

Major Problem

Organic Pollution	Toxicant	Turbidity
<ul style="list-style-type: none"> - Destruction of original function (place of aquatic life) of the river - Problem on water supply <ul style="list-style-type: none"> - Suspension of intake - Use of much chlorine (effect to human health) - High treatment cost for color, odor, etc. 	<ul style="list-style-type: none"> - Potential damage to human health - Problem on water supply <ul style="list-style-type: none"> - Suspension of intake - Effect to human health 	<ul style="list-style-type: none"> - Destruction of esthetic environment of the river - Problem on water supply <ul style="list-style-type: none"> - Suspension of intake - High pre-treatment cost to remove sediment

Indicator

Organic Pollution	Toxicant	Turbidity
<ul style="list-style-type: none"> - BOD (coliform is represented by BOD) 	<ul style="list-style-type: none"> - Heavy metals (Pb, Cr, Cu, Zn) 	<ul style="list-style-type: none"> - SS

Pollution Source

Organic Pollution	Toxicant	Turbidity
Factory: Alcohol, Food, Textile, Others Piggery Residence	Factory: Metal plating, Tannery, Others	Factory: Sand quarry, organic pollution Basin: Basin erosion

Ongoing Pollution Control Efforts (Technical Measure)

Organic Pollution	Toxicant	Turbidity
<u>Factories and Piggeries</u> <ul style="list-style-type: none"> - Most of the factories have plans to install treatment plants prepared with the assistance of a consultant - There are also studies by GTZ for the installation of treatment plants of several representative factories and for improvement in production process <u>Domestic Wastewater</u> <ul style="list-style-type: none"> - Sewerage networks (could be used in the future) have been established in major urban centers 	<u>Factories</u> <ul style="list-style-type: none"> - Treatment is basically conducted 	<u>Factory (Sand Quarry)</u> <ul style="list-style-type: none"> - Some are installed with sand settling ponds, and in these factories, turbidity of effluent is less <u>Other Factories</u> <ul style="list-style-type: none"> - Same with the items in the column of factories for organic pollution <u>Countermeasure for use</u> <ul style="list-style-type: none"> - Hidrocapital uses pre-treatment for removal of turbidity <u>Basins erosion</u> <ul style="list-style-type: none"> - No countermeasures are conducted

Present Problems (Technical Aspect)

Organic Pollution	Toxicant	Turbidity
<u>Factories and Piggeries</u> <ul style="list-style-type: none"> - Only 50% of the factories have treatment plant and actual installation of treatment plants is not progressing well due to lack of funds - In addition, necessity of treatment to meet the water 	<u>Factory</u> <ul style="list-style-type: none"> - Due to bad maintenance, toxicant flows from some factories. - Factories lack in technical staff for maintaining treatment plants and O&M is not properly conducted - Necessity of treatment to 	<u>Factory (Sand Quarry)</u> <ul style="list-style-type: none"> - Actual installation of the plants is not in good progress due to lack of funds - Necessity of treatment to meet the water quality standard is not well recognized by owners, thus education is necessary <u>Other Factories</u>

(to be continued)

Table 4.1-1 (2/2) Summary of Key Issues for Water Quality

(continued from the previous page)

<p>quality standards is not well recognized by owners, thus education is necessary</p> <ul style="list-style-type: none"> - Factories lack in technical staff for maintaining treatment plants and O&M is not properly conducted <p><u>Domestic Wastewater</u></p> <ul style="list-style-type: none"> - Treatment plants are either not installed or inoperable except in some residential complexes and the overall treatment rate is very low 	<p>meet the water quality standard is not well recognized by owners, thus education is necessary</p>	<ul style="list-style-type: none"> - The same with the items in the column of factories and piggeries for organic pollution <p><u>Countermeasure for use</u></p> <ul style="list-style-type: none"> - Cost for pre-treatment is high for the removal of sediment <p><u>Basins erosion</u></p> <ul style="list-style-type: none"> - No countermeasures are being conducted
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Institutional Measures already Undertaken and Present Problems

Organic Pollution	Toxicant	Turbidity
<p style="text-align: center;"><u>Laws and Regulations</u></p> <p style="text-align: center;">Laws and regulations are sufficient to a large extent.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>Current water quality standards Decree No.883 do not include a limit for BOD; it should be included</p> </div> <ul style="list-style-type: none"> - Installation of treatment plants by factories is not progressing well; provision of necessary laws and regulations for a support system is needed 		
<p style="text-align: center;"><u>Enforcement of Laws</u></p> <ul style="list-style-type: none"> - Enforcement of these laws and regulations are not adequately conducted. - Application of punitive action is necessary in combination with a strong support system. - Monitoring is conducted with the assistance of GTZ; strengthening of the monitoring system is necessary for the enforcement of the laws. 		
<p style="text-align: center;"><u>Organization and Operational Management</u></p> <ul style="list-style-type: none"> - Training in environmental aspect is needed for the technical personnel of ACRT - Strengthening of function of ACRT is needed - Budget of ACRT is not sufficient 		
<p style="text-align: center;"><u>Public Awareness of the Environment</u></p> <ul style="list-style-type: none"> - Environmental education is performed by ACRT; it should be strengthened - Seminars focusing on manufacturers have been conducted by the program of GTZ; it should be strengthened - Appropriate countermeasures should be taken for forest fire that cause devastation of the basin and resultant erosion and sediment discharge 		

**Table 4.1-2 BOD Production and Effluent Load by Sub-basin and by
Pollution Source (1995)**

Production load

Basin	Industrial (kg/day)	Livestock (kg/day)	Domestic (kg/day)	Total (kg/day)	Ratio (%)
Upper	58,812	8,554	5,958	73,324	74.3
(%)	80.2	11.7	8.1	100.0	
Middle	7,859	3,758	13,799	25,417	25.7
(%)	30.9	14.8	54.3	100.0	
Total	66,672	12,312	19,756	98,740	100.0
(%)	67.5	12.5	20.0	100.0	

Effluent load

Basin	Industrial (kg/day)	Livestock (kg/day)	Domestic (kg/day)	Total (kg/day)	Ratio (%)
Upper	11,817	3,222	5,840	20,880	50.3
(%)	56.6	15.4	28.0	100.0	
Middle	5,046	1,878	13,670	20,594	49.7
(%)	24.5	9.1	66.4	100.0	
Total	16,864	5,100	19,510	41,474	100.0
(%)	40.7	12.3	47.0	100.0	

Table 4.1-3 BOD Production and Effluent Load by Sub-basin (1995)

Area Name	Category	Production			Discharge			Area (km ²)
		Load (kg/day)	Rate(1) (%)	Rate(2) (%)	Load (kg/day)	Rate(1) (%)	Rate(2) (%)	
Tovar and other	Industrial	38	11.7	0.3	19	10.1	0.4	240.7
	Livestock	0	0.0		0	0.0		
	Domestic	285	88.3		168	89.9		
	Sub total	323	100.0		187	100.0		
El Consejo C. Tiquirito and other	Industrial	51,949	97.2	54.1	7,792	84.0	22.4	46.0
	Livestock	0	0.0		0	0.0		
	Domestic	1,482	2.8		1,482	16.0		
	Sub total	53,431	100.0		9,275	100.0		
Las Tejerias Q. Morocopo and other	Industrial	5,083	37.7	13.7	2,948	39.3	18.1	132.8
	Livestock	6,140	45.5		2,286	30.5		
	Domestic	2,262	16.8		2,262	30.2		
	Sub total	13,485	100.0		7,496	100.0		
Q. Guayas and other	Industrial	1,173	30.5	3.9	603	33.5	4.3	106.9
	Livestock	2,414	62.7		936	52.0		
	Domestic	261	6.8		261	14.5		
	Sub total	3,848	100.0		1,800	100.0		
Paracotos Q. Maitana and other	Industrial	570	26.6	2.2	456	22.5	4.9	284.8
	Livestock	0	0.0		0	0.0		
	Domestic	1,571	73.4		1,571	77.5		
	Sub total	2,141	100.0		2,027	100.0		
R. Guare (including Tacata)	Industrial	0	0.0	0.1	0	0.0	0.2	181.6
	Livestock	0	0.0		0	0.0		
	Domestic	96	100.0		96	100.0		
	Sub total	96	100.0		96	100.0		
Tacata-Tazon (Sabaneta)	Industrial	0	0.0	1.2	0	0.0	2.8	55.8
	Livestock	1,134	96.5		1,134	97.9		
	Domestic	41	3.5		24	2.1		
	Sub total	1,175	100.0		1,158	100.0		
R. Tarma part of Cua and other	Industrial	74	7.5	1.0	59	6.2	2.3	218.0
	Livestock	49	4.9		15	1.5		
	Domestic	874	87.7		874	92.3		
	Sub total	997	100.0		947	100.0		
Charallave, part of Cua and other	Industrial	4,572	33.2	13.9	3,135	27.2	27.8	357.4
	Livestock	1,458	10.6		729	6.3		
	Domestic	7,732	56.2		7,654	66.4		
	Sub total	13,762	100.0		11,518	100.0		
Ocumare del Tuy S.F de Yare and other	Industrial	3,213	33.9	9.6	1,853	26.6	16.8	226.8
	Livestock	1,118	11.8		0	0.0		
	Domestic	5,152	54.3		5,117	73.4		
	Sub total	9,483	100.0		6,970	100.0		
TOTAL		98,740	-	100.0	41,474	-	100.0	1,850.8

Note : Rate(1) is against each areas
Rate(2) is against whole areas

Table 4.1-4 Present Removal Rate by Pollution Source

<i>Factory</i>		<i>(mg/l)</i>								
Category		BOD			COD			SS		
		before	after	rate (%)	before	after	rate (%)	before	after	rate (%)
Food	F-1	67,200	2,220	96.7	110,361	11,496	89.6	14,700	2,453	83.3
	F-3	4,320	14	99.7	2,131	73	96.6	1,630	3	99.8
	F-4	1,920	34	98.2	4,133	32	99.2	1,063	216	79.7
	F-8	300	14	95.3	376	143	62.0	288	188	34.7
	F-9	288	5	98.3	413	58	86.0	256	228	10.9
	F-10	315	185	41.3	765	335	56.2	179	68	62.0
	Ave			88.2			81.6			61.7
Non-Food	N-26	10	4	60.0	58	10	82.8	214	92	57.0
	N-18	20	20	0.0	166	100	39.8	190	316	-66.3
	N-41		192		4,035	3,242	19.7	456	324	28.9
	N-42				184	376	-104.3	192	224	-16.7
	N-27	150			428	317	25.9	92	280	-204.3
	N-34	16	2	87.5	754	6,110	-710.3	522	1,768	-238.7
	N-35	635	177	72.1	714	547	23.4	40	224	-460.0
	N-40	42	54	0.0	120	280	-133.3	8	8	0.0
Ave			43.9			-94.6			-112.5	

<i>Piggery</i>		<i>(mg/l)</i>								
		BOD			COD			SS		
		before	after	rate (%)	before	after	rate (%)	before	after	rate (%)
	P-8	8,976	47	99.5	20,800	640	96.9	22,625	81	99.6
	P-5	3,100	116	96.3	13,705	896	93.5	5,870	146	97.5
	P-13	14,500	1,170	91.9	11,049	1,832	83.4	5,900	333	94.4
	Ave			95.9			91.3			97.2

<i>Household</i>		<i>(mg/l)</i>								
		BOD			COD			SS		
		before	after	rate (%)	before	after	rate (%)	before	after	rate (%)
	D-7	101	56	44.6	60	119	-98.3	48	32	33.3

Table 4.1-5 Removal Rate of Heavy Metals at Factories

($\mu\text{g/l}$)

Category		Pb (SD=50)			Cr (SD=50)			Cu (SD=1000)		
		before	after	rate	before	after	rate	before	after	rate
Non-Food	N-26	<250	<250	-	333	<50	15	168	64	38
	N-18	<250	<250	-	<50	<50	-	63	<50	79
	N-41	<250	<250	-	200	<50	25	<50	100	200
	N-42	<250	<250	-	150	150	100	<50	100	200
	N-27	<250	<250	-	<50	90	180	100	80	80
	N-34	7270	3450	47	1100	2100	191	3900	1100	28
	N-35	<250	<250	-	<50	400	800	70	<50	71
	N-40	<250	<250	-	<50	177	354	<50	<50	-
Ave				53			-138			0
Category		Zn (SD=5000)			Ni			Hg (SD=5)		
		before	after	rate	before	after	rate	before	after	rate
Non-Food	N-26	83	65	22	465	<50	89	1.7	1.4	18
	N-18	1915	90	95	20837	255	99	3.8	3.3	13
	N-41	248	83	67	80	98	-23	2.5	2.5	-12
	N-42	40	2228	-5470	139	100	28	2.7	2.6	4
	N-27	48	48	0	<50	<50	-	1	5	-400
	N-34	2543	229	91	697	1230	-76	9.9	2	80
	N-35	200	7300	-3550	<50	<50	-	1.9	-	-
	N-40	500	400	20	<50	<50	-	2.9	-	-
Ave				-1091			23			-50
Category		As (SD=50)			Cd (SD=10)			Se (SD=10)		
		before	after	rate	before	after	rate	before	after	rate
Non-Food	N-26	BLD	BLD	-	BLD	BLD	-	BLD	BLD	-
	N-18	BLD	10	-	BLD	BLD	-	BLD	BLD	-
	N-41	BLD	BLD	-	BLD	BLD	-	BLD	0.5	-
	N-42	11	BLD	-	ND	BLD	-	BLD	BLD	-
	N-27	11	BLD	-	BLD	BLD	-	BLD	BLD	-
	N-34	29	13	45	BLD	BLD	-	BLD	BLD	-
	N-35	BLD	10	-	BLD	41	-	BLD	BLD	-
	N-40	11	BLD	-	BLD	BLD	-	BLD	BLD	-
Ave				55			0			0

(SD=): Standard for effluent to river

Table 6.1-1 Installation Cost of Treatment Plants for Existing Factories and Piggeries

Industrial Category	Areas	Production Wastewater Volume m3/day	Waste Water Volume to be Treated		Cost* \$1,000
			(1) m3/day without T.P.	(2) m3/day with T.P.	
Food Factories	El. Consejo	929	306	158	492
	Las Tejerias	2,034	671	346	878
	Qda.Guayas	681	225	116	361
	Paracotos	48	16	8	25
	Cua	6	2	1	3
	Charallave	2,949	973	501	1,263
	Ocumare	427	141	73	226
	S.F.de Yare	70	23	12	37
	Total	7,142	2,357	1,214	2,786
Non-food Factory	El. Consejo	0	0	0	0
	Las Tejerias	2,770	1,274	305	2,800
	Qda.Guayas	9	4	1	9
	Paracotos	286	131	31	289
	Cua	192	88	21	194
	Charallave	4,301	1,978	473	3,348
	Ocumare	357	164	39	361
	S.F.de Yare	1,490	685	164	1,506
	Total	9,404	4,326	1,034	8,507
Piggeries	El. Consejo	0	0	0	0
	Las Tejerias	409	123	205	341
	Qda.Guayas	161	48	81	154
	Paracotos	0	0	0	0
	Qda.Guare	76	23	38	73
	Cua	3	1	2	3
	Charallave	98	29	49	87
	Ocumare	49	15	25	47
	S.F.de Yare	0	0	0	0
Total	796	239	398	705	
Total				11,998	

Note: *Cost=(1)x(Unit cost) + (2)x(Unit cost)x0.5

Unit cost of Food factory : 1,277 (US\$/m3/day)

Unit cost of Non-food factory 1,963(US\$/m3/day)

Unit cost of Piggery : 1,739(US\$/m3/day)

Table 6.1-2 Installation Cost of Treatment Plants for Newly Built by 2003

Industrial Category	Areas	Production Wastewater Volume m3/day	Wastewater Volume to be treated (1) m3/day	Cost* \$1,000
Food Factories	El. Consejo	527	527	673
	Las Tejerias	904	904	1,155
	Qda. Guayas	298	298	380
	Paracotos	28	28	36
	Cua	2	2	3
	Charallave	1,288	1,288	1,646
	Ocumare	254	254	324
	S.F.de Yare	33	33	42
	Total	3,335	3,335	4,260
Non-food Factory	El. Consejo	0	0	0
	Las Tejerias	986	986	1,936
	Qda. Guayas	6	6	13
	Paracotos	180	180	354
	Cua	70	70	138
	Charallave	1,507	1,507	2,958
	Ocumare	116	116	228
	S.F.de Yare	461	461	905
	Total	3,327	3,327	6,531
Piggeries	El. Consejo	-	-	-
	Las Tejerias	-	-	-
	Qda. Guayas	-	-	-
	Paracotos	-	-	-
	Qda. Guare	-	-	-
	Cua	-	-	-
	Charallave	-	-	-
	Ocumare	-	-	-
	S.F.de Yare	-	-	-
	Total	-	-	-
	Total			

Note :

Unit cost of Food factory : 1,277 (US\$/m3/day)

Unit cost of Non-food factory : 1,963(US\$/m3/day)

Piggery will not increase in the future.

Table 6.1-3 Installation Cost of Treatment Plants for Newly Built from 2003 to 2010

Industrial Category	Areas	Production Wastewater Volume m3/day	Wastewater Volume to be treated (l) m3/day	Cost* \$1,000
Food Factories	El. Consejo	909	909	1,161
	Las Tejerias	1,559	1,559	1,991
	Qda.Guayas	513	513	656
	Paracotos	49	49	62
	Cua	4	4	5
	Charallave	2,221	2,221	2,838
	Ocumare	438	438	559
	S.F.de Yare	57	57	73
	Total	5,751	5,751	7,346
Non-food Factory	El. Consejo	0	0	0
	Las Tejerias	1,700	1,700	3,338
	Qda.Guayas	11	11	22
	Paracotos	311	311	610
	Cua	121	121	238
	Charallave	2,598	2,598	5,100
	Ocumare	200	200	393
	S.F.de Yare	794	794	1,560
	Total	5,736	5,736	11,260
Piggeries	El. Consejo	-	-	-
	Las Tejerias	-	-	-
	Qda.Guayas	-	-	-
	Paracotos	-	-	-
	Qda.Guare	-	-	-
	Cua	-	-	-
	Charallave	-	-	-
	Ocumare	-	-	-
	S.F.de Yare	-	-	-
	Total	-	-	-
Total				18,606

Note :

Unit cost of Food factory : 1,277 (US\$/m3/day)

Unit cost of Non-food factory : 1,963(US\$/m3/day)

Piggery will not increase in the future

Table 6.1-4 Cost of Institution of Treatment Plants to Reduce Odor and color
for Existing Factories

Item	Industrial Category	Discharge which have to be treated by new treatment plant (m3/day)		(3) Unit cost	Treatment cost*
		(1) with T.P.	(2) without T.P.	\$/m3/day	\$1000
Toxicant	Tannery and Metal plating	166	40	1,963	365
Odor and color	Distillery	474	220	1,277	746
	Synthetic resin	430	104	1,963	946
Total		---	---	---	2,057

note: *Treatment Cost=(1)x(3)+(2)x(3)x0.5

T.P. is Treatment plants

Table 6.1-5 Cost Comparison Among Integrated Sewage System

Case	Integrated System	Cost(US\$ Million)			
		Land Acquisition	Treatment Plant	Drainage Pipe between Urban Centers	Total
1	One Integrated System	2.4	27.3	29.83	59.55
2	Two Integrated System	2.66	30.35	18.75	51.76
3	Several Integrated System	2.98	34	15.45	52.43
4	Individual System	3.51	40.02	0	43.53

Table 6.1-6 Relation between Cost and Effectiveness (Sewage System)

Areas	(1) Effectiveness (ton/day)	(2) Cost (US\$ thousands)	(1)/(2) (US\$ thousand /ton/day)	Economic Priority
El Consejo	2.30*	1,741	757	2
Las Tejerias	4.07*	1,716	422	1
Cua	0.27**	3,081	11,500	6
Charallave	0.21**	2,283	11,100	5
Ocumare del Tuy	2.70**	3,601	1,333	3
S. F. de Yare	0.55**	1,892	3,440	4

* Effectiveness is evaluated at Boca de Cagua

** Effectiveness is evaluated at Toma de Agua

Table 6.1-7 Valuation of Suspended Solid Volume by Reforestation

Sub-Basin		Area (km ²) (A)	Actual	Reforestation			
No.	Name		SS(m ³ /year) (1)	(km ²) (B)	SS(m ³ /year) (2)	Effect(m ³ /year/km ((1)-(2))/B)	Effect Rate ((1)-(2))/Total(1)
1	TUY RIVER	238	81229	90	50735	339	5.4%
2	Qda. EL SOCORRO	139	43910	72	24609	268	3.4%
3	Qda. GUAYAS	136	51767	16	41910	616	1.7%
4	CAGUA RIVER	84	43474	46	16839	579	4.7%
5	Qda. MAITANA	205	85629	40	58737	672	4.8%
6	GUARE RIVER	194	69753	92	38786	337	5.5%
UPPER TUY RIVER		996	375761	356	231168	406	25.6%
7	Qda. de SACUA	83	25965	34	14274	344	2.1%
8	Qda. ANIAGUA	188	46221	64	36209	156	1.8%
9	OCUMARITO RIVER	150	54016	88	31982	250	3.9%
10	Qda. de MUME	67	4344	39	3651	18	0.1%
11	Qda. CHARALLAVE	141	23112	13	19338	290	0.7%
12	SUCUTA RIVER	155	32528	119	19861	106	2.2%
13	Qda. SECA	77	2825	31	2340	16	0.1%
MIDDLE TUY RIVER		861	189012	388	127655	158	10.9%
Total		1857	564773	744	358823	277	36.5%

Table 6.1-7 Valuation of Suspended Solid Volume by Reforestation

Sub-Basin		Area (km ²) (A)	Actual SS(m ³ /year) (1)	Reforestation			
No.	Name			(km ²) (B)	SS(m ³ /year) (2)	Effect(m ³ /year/km ²) ((1)-(2))/(B)	Effect Rate ((1)-(2))/Total(1)
1	TUY RIVER	238	81229	90	50735	339	5.4%
2	Qda. EL SOCORRO	139	43910	72	24609	268	3.4%
3	Qda. GUAYAS	136	51767	16	41910	616	1.7%
4	CAGUA RIVER	84	43474	46	16839	579	4.7%
5	Qda. MAITANA	205	85629	40	58737	672	4.8%
6	GUARE RIVER	194	69753	92	38786	337	5.5%
UPPER TUY RIVER		996	375761	356	231168	406	25.6%
7	Qda. de SACUA	83	25965	34	14274	344	2.1%
8	Qda. ANIAGUA	188	46221	64	36209	156	1.8%
9	OCUMARITO RIVER	150	54016	88	31982	250	3.9%
10	Qda. de MUME	67	4344	39	3651	18	0.1%
11	Qda. CHARALLAVE	141	23112	13	19338	290	0.7%
12	SUCUTA RIVER	155	32528	119	19861	106	2.2%
13	Qda. SECA	77	2825	31	2340	16	0.1%
MIDDLE TUY RIVER		861	189012	388	127655	158	10.9%
Total		1857	564773	744	358823	277	36.5%

Table 6.1-8 Capacity and Cost of Sand Settling Pond

Case 1	Discharge Cut Rate	Sed. V (m ³ /year)	Cut Sed. V (t)	Dimension W×D×L & Volume (m ³) of Pond	Intal+O/M Cost (US\$/year)(2)	Unit Cost (US\$)(2)/(1)
Tuy-Hda. Barrios (213km ²)	70%	81,229	40,105	100×2.10×225	597,352	14.9
			49% cut	36,000		
Cagua (84km ²)	70%	43,474	24,815	70×1.80×225	451,751	18.2
			57% cut	22,400		
Maitana (205km ²)	70%	85,629	41,911	100×2.10×225	601,060	14.3
			49% cut	38,000		
Guare (194km ²)	70%	69,753	34,684	100×1.80×225	555,186	16.0
			50% cut	30,000		
Total (1857km ²)		563,109	141,515	126,400		
			25% cut			

Case 2	Discharge Cut Rate	Sed. V (m ³ /year)	Cut Sed. V (t)	Dimension W×D×L & Volume (m ³) of Pond	Intal+O/M Cost (US\$/year)(2)	Unit Cost (US\$)(2)/(1)	Priority
Tuy-Hda. Barrios (213km ²)	60%	81,229	34,503	100×1.80×200	501,304	14.6	2
			42% cut	36,000			
Cagua (84km ²)	60%	43,474	21,350	70×1.60×200	386,993	18.1	4
			49% cut	22,400			
Maitana (205km ²)	60%	85,629	36,055	100×1.90×200	514,719	14.3	1
			42% cut	38,000			
Guare (194km ²)	60%	69,753	29,838	100×1.50×200	464,854	15.6	3
			43% cut	30,000			
Total (1857km ²)		563,109	121,746	126,400			
			22% cut				

Case 3	Cut Rate	Sed. V (m ³ /year)	Cut Sed. V (t)	Dimension W×D×L & Volume (m ³) of Pond	Intal+O/M Cost (US\$/year)(2)	Unit Cost (US\$)(2)/(1)
Tuy-Hda. Barrios (213km ²)	50%	81,229	29,055	100×1.70×175	452,055	15.6
			36% cut	29,750		
Cagua (84km ²)	50%	43,474	17,985	70×1.50×175	357,235	19.9
			41% cut	18,375		
Maitana (205km ²)	50%	85,629	30,193	100×1.80×175	461,630	15.3
			35% cut	31,500		
Guare (194km ²)	50%	69,753	24,986	100×1.50×175	423,810	17.0
			36% cut	26,250		
Total (1857km ²)		563,109	102,219	105,875		
			18% cut			

Table 6.1-8 Capacity and Cost of Sand Settling Pond

Case 1	Discharge Cut Rate	Sed. V (m ³ /year)	Cut Sed. V (1)	Dimension W×D×L & Volume (m ³) of Pond	Intal+O/M Cost (US\$/year)(2)	Unit Cost (US\$)(2)(1)
Tuy-Hda. Barrios (213km ²)	70%	81,229	40,105	100×2.10×225	597,352	14.9
			49% cut	36,000		
Cagua (84km ²)	70%	43,474	24,815	70×1.80×225	451,751	18.2
			57% cut	22,400		
Maitana (205km ²)	70%	85,629	41,911	100×2.10×225	601,060	14.3
			49% cut	38,000		
Guare (194km ²)	70%	69,753	34,684	100×1.80×225	555,186	16.0
			50% cut	30,000		
Total (1857km ²)		563,109	141,515	126,400		
			25% cut			

Case 2	Discharge Cut Rate	Sed. V (m ³ /year)	Cut Sed. V (1)	Dimension W×D×L & Volume (m ³) of Pond	Intal+O/M Cost (US\$/year)(2)	Unit Cost (US\$)(2)(1)	Priority
Tuy-Hda. Barrios (213km ²)	60%	81,229	34,503	100×1.80×200	501,304	14.5	2
			42% cut	36,000			
Cagua (84km ²)	60%	43,474	21,350	70×1.60×200	386,993	18.1	4
			49% cut	22,400			
Maitana (205km ²)	60%	85,629	36,055	100×1.90×200	514,719	14.3	1
			42% cut	38,000			
Guare (194km ²)	60%	69,753	29,838	100×1.50×200	464,854	15.6	3
			43% cut	30,000			
Total (1857km ²)		563,109	121,746	126,400			
			22% cut				

Case 3	Cut Rate	Sed. V (m ³ /year)	Cut Sed. V (1)	Dimension W×D×L & Volume (m ³) of Pond	Intal+O/M Cost (US\$/year)(2)	Unit Cost (US\$)(2)(1)
Tuy-Hda. Barrios (213km ²)	50%	81,229	29,055	100×1.70×175	452,055	15.6
			36% cut	29,750		
Cagua (84km ²)	50%	43,474	17,985	70×1.50×175	357,235	19.9
			41% cut	18,375		
Maitana (205km ²)	50%	85,629	30,193	100×1.80×175	461,630	15.3
			35% cut	31,500		
Guare (194km ²)	50%	69,753	24,986	100×1.50×175	423,810	17.0
			36% cut	26,250		
Total (1857km ²)		563,109	102,219	105,875		
			18% cut			

Table 6.1-9 Sediment Volume in Pre-treatment Pond for 1 Year

Pond No.	Date of Cleaning Pond		Sediment		Total V (m ³)
	Start	End	Depth (m)	Volum (m ³)	
1	1995/11/20	1995/11/23	1.15	2263	22730
1	1995/12/28	1995/12/29	1.00	1968	
1	1996/6/17	1996/6/19	1.00	1968	
1	1996/7/15	1996/7/16	1.80	3542	
1	1996/8/8	1996/8/12	1.50	2952	
1	1996/9/18	1996/9/19	1.50	2952	
1	1996/10/7	1996/10/10	1.30	2558	
1	1996/10/28	1995/10/29	1.10	2165	
1	1996/11/18	1996/11/21	1.20	2362	
2	1995/11/22	1995/11/22	1.00	1968	24009.6
2	1996/1/2	1996/1/3	1.10	2165	
2	1996/6/20	1996/6/21	1.00	1968	
2	1996/7/17	1996/7/18	2.00	3936	
2	1996/8/23	1996/8/28	2.50	4920	
2	1996/9/20	1996/9/23	1.00	1968	
2	1996/10/9	1996/10/11	1.20	2362	
2	1996/10/30	1996/10/31	1.20	2362	
2	1996/11/22	1996/11/23	1.20	2362	
3	1995/11/24	1995/11/27	1.10	2165	17318.4
3	1996/7/8	1996/7/11	1.50	2952	
3	1996/7/19	1996/7/23	1.60	3149	
3	1996/8/29	1996/9/4	2.50	4920	
3	1996/9/25	1996/9/27	1.00	1968	
3	1996/11/1	1996/11/1	1.10	2165	
4	1995/11/10	1995/11/125	1.00	1968	18696
4	1996/1/4	1996/1/5	1.00	1968	
4	1996/7/1	1996/7/3	1.20	2362	
4	1996/7/30	1996/7/31	2.00	3936	
4	1996/9/5	1996/9/11	2.00	3936	
4	1996/9/24	1996/9/25	1.00	1968	
4	1996/11/5	1996/11/7	1.30	2558	
5	1995/11/16	1995/11/17	1.50	2952	14760
5	1996/6/27	1996/6/28	1.00	1968	
5	1996/8/6	1996/8/7	1.80	3542	
5	1996/9/30	1996/10/1	1.00	1968	
5	1996/10/22	1996/10/24	1.20	2362	
5	1996/11/8	1996/11/8	1.00	1968	
6	1995/11/20	1995/11/20	1.20	2362	19483
6	1996/6/11	1996/6/13	1.00	1968	
6	1996/8/1	1996/8/6	2.40	4723	
6	1996/9/12	1996/9/18	2.00	3936	
6	1996/10/2	1996/10/4	1.10	2165	
6	1996/10/24	1996/10/25	1.10	2165	
6	1996/11/11	1996/11/11	1.10	2165	
Total (Average intake volume = 3.27m ³ /s)					116998

Table 6.1-10 Benefit and Cost of Countermeasure for Turbidity

Case	Size	Reduction Volume of SS (mg/l) (1)	Benefit (US\$/year)		Cost (US\$/year)				B-C (2)-(3)	B/C (2)/(3)			
			Unit Cost (US\$/m ³)	Intake	Alumini	Total(2)	Initial Cost	OM Cost			Pre-treat Unit Cost	Total(3)	Unit cost (3)/(1)
Reforestation			Effect (hr/day)	0.327	0.0062								
Case 1 (SS= 4.8% cut)	4000ha	46	4.7 m ³ /s x 1.4 days	62,179	9,854	72,032	330,000	20,000	2,092	352,092	7,641	-280,059	0.20
Case 2 (SS= 6.5% cut)	5600ha	62	4.8 m ³ /s x 1.7 days	76,728	13,560	90,287	462,000	28,000	2,591	492,581	7,894	-402,294	0.18
Case 3 (SS= 11.2% cut)	10200ha	108	5.0 m ³ /s x 2.4 days	114,044	24,396	138,440	841,500	51,000	3,836	896,336	8,336	-757,896	0.15
Case 4 (SS= 16.7% cut)	19400ha	160	5.3 m ³ /s x 3.0 days	148,370	38,175	186,545	1,600,500	97,000	4,991	1,702,491	10,619	-1,515,946	0.11
Sand Settling Pond for Tributaries								5.0					
Case 1 (SS= 6.4% cut)	Malaria(e)	61	4.8 m ³ /s x 1.7 days	76,658	13,345	90,003	331,865	180,275	2,579	514,719	8,373.9	-424,716	0.17
Case 2 (SS= 12.5% cut)	(a)Hda, Barbas(b)	120	5.1 m ³ /s x 2.4 days	114,454	27,619	142,074	659,383	352,790	3,850	1,016,023	8,446.5	-873,949	0.14
Case 3 (SS= 17.8% cut)	(b)Cuacua(c)	171	5.3 m ³ /s x 3.0 days	149,805	41,150	190,955	973,857	501,980	5,039	1,480,877	8,652.1	-1,289,922	0.13
Case 4 (SS= 21.6% cut)	(c)Capua(d)	208	5.5 m ³ /s x 3.5 days	180,396	51,506	231,902	1,253,072	608,730	6,068	1,867,870	8,999.4	-1,635,968	0.12
Case 5 (SS= 25.6% cut)	(d)Guaya	246	5.7 m ³ /s x 4.0 days	212,948	63,043	275,991	1,554,504	720,855	7,163	2,282,522	9,280.2	-2,006,532	0.12
Sand Settling Pond Intake for Treatment								22.4					
Case 1 (SS= 47.4% cut)	40x130m	455	6.6 m ³ /s x 5.4 days	335,447	136,857	472,305	401,046	58,248	11,284	470,577	1,034.1	1,728	1.00
Case 2 (SS= 45.5% cut)	40x100m	437	6.5 m ³ /s x 5.1 days	316,941	129,678	446,619	343,500	44,806	10,662	398,968	913.4	47,652	1.12
Case 3 (SS= 42.9% cut)	40x70m	412	6.4 m ³ /s x 4.8 days	293,110	120,083	413,193	287,178	31,364	9,860	328,402	797.4	84,791	1.26
Sand Settling Pond Before Intake for Oda Saca			Setting Sediment Volume (m ³ /year)										
			Initial Cost	3,730	680,520	684,250	587,710	18,900	-	605,610	1,316.4	77,640	1.13
Case 1 (SS= 48.0% cut)	3000m ²	461	113420	4,660	996,360	1,001,020	687,010	16,600	-	703,610	1,032.3	297,410	1.42
Case 2 (SS= 71.0% cut)	5000m ²	682	166060	6,060	1,115,560	1,121,620	-	-	-	-	-	-	-
Case 3 (SS= 79.0% cut)	7000m ²	758	185930										

Table 6.1-10 Benefit and Cost of Countermeasure for Turbidity

Case	Size	Reduction of SS Volume (mg/l) (1)	Benefit (US\$/year)		Cost (US\$/year)			B-C (2)-(3)	B/C (2)/(3)				
			Unit Cost (us\$/m ³) Effect (8hr/day)	Intake 0.327	Alumini 0.0062	Total(2)	Initial Cost			OM Cost	Pre-treat OM cost	Total(3)	Unit cost (3)/(1)
Reforestation													
Case 1 (SS= 4.8% cut)	4000ha	46	4.7 m ³ /s x 1.4 days	62,179	9,854	72,032	330,000	20,000	2,092	352,092	7,641	-280,059	0.20
Case 2 (SS= 6.5% cut)	5600ha	62	4.8 m ³ /s x 1.7 days	76,728	13,560	90,287	462,000	28,000	2,581	492,581	7,894	-402,294	0.18
Case 3 (SS= 11.2% cut)	10200ha	108	5.0 m ³ /s x 2.4 days	114,044	24,396	138,440	841,500	51,000	3,835	896,336	8,336	-757,896	0.15
Case 4 (SS= 16.7% cut)	19400ha	160	5.3 m ³ /s x 3.0 days	148,370	38,175	186,545	1,600,500	97,000	4,991	1,702,491	10,619	-1,515,946	0.11
Sand Settling Pond on 4 tributaries													
Case 1 (SS= 6.4% cut)	Matanzas(a)	61	4.8 m ³ /s x 1.7 days	76,658	13,345	90,003	331,865	180,275	2,579	514,719	8,373.9	-424,716	0.17
Case 2 (SS= 12.9% cut)	(a)+(da. Barros)(b)	120	5.1 m ³ /s x 2.4 days	114,454	27,619	142,074	659,383	352,790	3,850	1,016,023	8,446.5	-873,949	0.14
Case 3 (SS= 17.8% cut)	(b)+(Guare)(c)	171	5.3 m ³ /s x 3.0 days	149,805	41,150	190,955	973,857	501,990	5,039	1,480,877	8,652.1	-1,289,922	0.13
Case 4 (SS= 21.6% cut)	(c)+(Cagua)=(d)	208	5.5 m ³ /s x 3.5 days	180,396	51,506	231,902	1,253,072	608,730	6,068	1,867,870	8,999.4	-1,635,968	0.12
Case 5 (SS= 25.6% cut)	(d)+(Guayas)	246	5.7 m ³ /s x 4.0 days	212,948	63,043	275,991	1,554,504	720,855	7,163	2,282,522	9,280.2	-2,006,532	0.12
Sand Settling Pond at intake for Pretreatment													
Case 1 (SS= 47.4% cut)	40x130m	455	6.6 m ³ /s x 5.4 days	335,447	136,857	472,305	401,046	58,248	11,284	470,577	1,034.1	1,728	1.00
Case 2 (SS= 45.5% cut)	40x100m	437	6.5 m ³ /s x 5.1 days	316,941	129,678	446,619	343,500	44,806	10,662	398,968	913.4	47,652	1.12
Case 3 (SS= 42.9% cut)	40x70m	412	6.4 m ³ /s x 4.8 days	293,110	120,083	413,193	287,178	31,364	9,860	328,402	797.4	84,791	1.26
Sand Settling Pond Before Intake for Oda Seca													
			Settling Sediment Volume (m ³ /year)	Initial Cost	OM Cost 2\$/m ³	Total(2)	Initial Cost	Sedimentation Pond before Intake	OM Cost	Total(3)	Unit cost (3)/(1)	(2)-(3)	(2)/(3)
Case 1 (SS= 48.0% cut)	3000m ²	451	1,13420	3,730	680,520	684,250	587,710	18,900	-	606,610	1,316.4	77,640	1.13
Case 2 (SS= 71.0% cut)	5000m ²	682	166060	4,660	996,360	1,001,020	687,010	16,600	-	703,610	1,032.3	297,410	1.42
Case 3 (SS= 79.0% cut)	7000m ²	758	185930	6,060	1,115,560	1,121,620	-	-	-	-	-	-	-

Table 6.1-11 Cost for Monitoring System

(Unit: US\$ thousand)

Category	Item	Cost
Initial Cost	Monitoring Facilities and Equipment	946
	Laboratory Equipment	671
	Office Equipment	10
	Transportation Facilities	25
	(Total)	1,652
O&M Cost	Monitoring	23
	Laboratory	30
	Transportation	3
	Office	1
	Personnel Expense	35
	(Total)	92

Table 6.3-1 Economic Priority

Category	Measures	Site/area	Effectiveness	Annual cost*1 (US\$ thousand)	Cost- effectiveness*2	Economic priority
Improvement of Water quality	Treatment plant (factory & piggery)	Whole area	2.32ton/day	6,395	US\$2756/ton/day	4
	Sewage system	El Consejo*3	2.30ton/day	1,741	US\$757/ton/day	2
		Las Tejerias*3	4.07ton/day	1,716	US\$422/ton/day	1
		Ocumare del Tuy	2.70ton/day	3,601	US\$1333/ton/day	3
		S.F. de Yare	0.55ton/day	1,892	US\$3440/ton/day	5
	Afforestation	for 3 Tributaries*4	115mg/l	916	US\$8/mg/l	1
Sand settling pond in tributaries	for 4 Tributaries*5	225mg/l	1,880	US\$8.4/mg/l	2	
Securement of Water	Pumping and Dam	O-Tuy III system and Guare dam	Approx. (2.0m3/s)	12,579	US\$6290/m3/s	1
	Lessening color/odor	Whole area	0.75mcm/yr (0.02m3/s)	316	US\$13739/m3/s	2
	Sand settling pond	Toma de Agua	0.72mcm/yr (0.02m3/s)	348	US\$14500/m3/s	3

*1 Annual Cost = Initial Cost x Annuity Factor + O&M Cost

*2 Cost-Effectiveness = Annual cost / Effectiveness

*3 Effectiveness is evaluated to Boca de Cagua (not Toma de Agua)

*4 Maitana, Guayas and Cagua river basins

*5 Maitana, Hda.Barrios, Guare and Cagua

Table 6.5-1 (1/2) SUMMARY OF MASTER PLAN

Stage	Category	Objective	Project	Outcome	Procedure	Timing	Responsible agency #1	Effectiveness #2 (US\$/ton/day)	Economic priority	Financial cost (US\$1,000)	Method of cost recovery	Report reference
Short Term Program	Technical measure	Water quality improvement	Installation of treatment plant to existing factories and piggeries	Reduction of BOD pollution of 0.49 kg/day Reduction of SS pollution Reduction of toxicant	Installation of treatment plant to factories with support of institutional measures	2000-2003	(1) Factory and piggersy owners (2) ACRT	\$3,864 /ton/day	4	\$11,998	Factory and piggersy owners pay the cost	6.1.1 (Vol. 2)
			Installation of treatment plant to factories (newly constructed)	Reduction of BOD pollution of 0.67 ton/day, SS and Toxicant	Installation with support of institutional measures	2000-2003	(1) Factory owners (2) ACRT	\$2,473/ton/day	3	\$10,791	-do-	6.1.1 (Vol. 2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 2.70 ton/day	Installation of sewage treatment plant in the area of Ocumare del Tuy	1997-2003	(1) ACRT (2) State Gov.	\$1,333/ton/day	2	\$28,020	Charge to households and factories	6.1.1 (Vol. 2)
			Reforestation	Reduction of BOD pollution of 4.07 ton/day*5 Reduction of Turbidity of 35 mg/l	Installation in the area of Las Teñigas	2000-2003	(1) ACRT (2) State Gov.	\$422 /ton/day	1	\$12,700	- do -	
			Securement of water quantity	Securement of water quantity by construction of Cuare dam newly developed water of 2.0 m ³	Reforestation in Matiana basin	1997-2003	(1) ACRT (2) State Gov.	\$9.1/mg/l	1	\$2,520	Government pay the cost	6.1.1 (Vol. 2)
			Installation of sand settling pond and operation	Securement of water quantity of 0.023 m ³ /s	Construction of pump and dam	1997-2003	(1) Hydrocepial	\$6,290/m ³ /s	1	\$85,980	Charge to households in CMA	6.1.2 (Vol. 2)
			Installation of treatment plant to factories	Securement of water quantity of 0.024 m ³ /s	Installation of sand settling pond at Torre de Agua	1997-2003	(1) Hydrocepial (2) ACRT	\$15,130/m ³ /s	3	\$2,610	-do-	6.1.1 (Vol. 2)
			Provision of law and regulation and operation	Strengthening of control of factory effluent	Approval from higher authority	1997-2003	(1) MARNR (2) CORDIPLAN	N.A.	N.A.	N.A.	N.A.	6.1.3 (Vol. 2)
			Strengthening of the function of organization and operation	Strengthening of enforcement for necessity action taken by agency concerned	Approval from higher authority	1997-2003	(1) ACRT (2) MARNR	N.A.	N.A.	N.A.	N.A.	6.1.3 (Vol. 2)
			Establishment/operation monitoring system	Collection of basic information	Confirmation of budgetary allocation	1997-2003	(1) ACRT (2) MARNR	N.A.	N.A.	1,652	Government pay the cost	6.1.3 (Vol. 2)
Institutional measure	Assurance of water quantity and water quality improvement		Establishment of environmental fund and operation	Assistance for necessary works for environment improvement	Establishment of new law	1997-2003	(1) ACRT (2) FONCORE/CORP-INDUSTRIA	N.A.	N.A.	24,846	Repayment by borrowers	6.1.3 (Vol. 2)
			Establishment/operation pollution charge	Promotion of installation of treatment plant for factories/piggeries	Establishment of new law	1997-2003	(1) ACRT	N.A.	N.A.	N.A.	N.A.	
			Establishment/operation public education system	Awareness by public on significance of environment problem	Approval from higher authority	1997-2003	(1) ACRT (2) State Gov., private sector	N.A.	N.A.	50	Government pay the cost	6.1.3 (Vol. 2)

*1 (1): Implementing Agency/Body (2): Related Agency/Body
 *2 Cost Effectiveness = Annual Cost / Outcome (Annual Cost = Initial Cost x annuity factor(0.11 to 0.13) + O&M Cost)
 *3 Priority is confirmed through the pre-feasibility study
 *4 The cost shows that establish the Environmental Fund including loan amortizations for factories and piggeries
 *5 Outcome at the Doce de Cagua
 N.A.: not applicable

Table 6.5-1 (2/2) SUMMARY OF MASTER PLAN

Stage	Category	Objective	Project	Outcome	Procedure	Timing	Related agency *1	Effectiveness *2 (US\$1,000)	Economic priority	Financial cost (US\$1,000)	Method of cost recovery	Report reference
Mid Term Program	Technical measure	Water quality improvement and Securement of water Quantity	Installation of treatment plant to factories (newly constructed)	Reduction of BOD pollution of 1.17 ton/day	Installation of treatment plant to factories with support of institutional measure	2004-2010	(1) Factory	\$2,441/ton/day	2	\$18,606	Factory owners pay the cost	6.1.1 (Vol.2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 0.55 ton/day	Installation of sewage system in the area of S.F. de Ynre	2004-2010	(1) ACRT (2) State Gov.	\$3,440/ton/day	4	\$14,100	Charge to households and factories	6.1.1 (Vol.2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 0.27 ton/day	Extension of sewage system in the area of Ocumare del Tuy	2004-2010	(1) ACRT (2) State Gov.	\$2,640/ton/day	3	\$4,914	Charge to households and factories	6.1.1 (Vol.2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 2.30 ton/day	Installation of sewage system in the EL Consueño	2007-2010	(1) ACRT (2) State Gov.	\$757/ton/day	1	\$13,100	Charge to households and factories	6.1.1 (Vol.2)
			Reforestation	Reduction of turbidity of 70 mg/l	Reforestation in two tributaries (Oda Guayas and Caguan)	2004-2010	(1) ACRT (2) State Gov.	\$8.5/mg/l	1	\$5,120	Government pay the cost	6.1.1 (Vol.2)
			Sand setting pond in tributaries	Reduction of turbidity of 725 mg/l	Construction in 4 tributaries	2004-2010	(1) ACRT	\$8.4/mg/l	2	\$11,391	Government pay the cost	6.1.1 (Vol.2)
			Sustainable enforcement of monitoring	Sustainable enforcement of basic information	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	Continuation of Short Term	Government pay the cost	6.1.4 (Vol.2)
			Sustainable enforcement of strengthening of control	Strengthening of enforcement for necessity action taken by agency concerned	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	Continuation of Short Term	Government pay the cost	6.1.3 (Vol.2)
			Sustainable enforcement of public education	Education for school, manufacturers and inhabitants	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	Continuation of Short Term	Government pay the cost	6.1.3 (Vol.2)
			Sustainable enforcement of application of environmental fund	Assistance for necessary works for environment improvement	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	US\$18,606	Repayment by borrowers	6.1.3 (Vol.2)
			Sustainable enforcement of application of pollution charge	Promotion of installation of treatment plant for factories and pigeries	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	N.A.	6.1.3 (Vol.2)	

*1 (1): Responsible Agency/Body (2): Related Agency/Body *2 Cost Effectiveness = Annual Cost / Outcomes (Annual Cost = Initial Cost x 0.11 + O&M Cost) N.A.: not applicable