TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 105 SHEET NO.: 5/6

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 1-29-07 WORK FINISHED: 1-29-07

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: --- TYPE & SIZE BIT: ---

GROUND WATER: DATE AND DEPTH: 1-29-07; -119.0 FT.(ELEV.= 92.73 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 155051.0285 "Y" COORDINATE: 217951.7258 ELEVATION: 129.00 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	OBSEVATION WELL [b	Td
141								
142								
143			White to yellowish marly limestone with inclusions of hard re-crystallized limestone					
144								
145	84.80	55/4"	-145.0'	55/4"	12.7	---		
146								
147								
148								
149								
150		50/3"		50/3"	16.4	---		
151								
152								
153								
154								
155		28 – 53		53	16.1	---		
156								
157								
158			Yellowish -- brown soft gravelly (fragmented) and weathered limestone embedded in clay material moist becoming more clayey (plastic) with depth					B
159								
160		55/2"		55/2"	15.1	---		
161								
162								
163								
164								
165		60/6"		60/6"	16.3	---		
166								
167								
168								
169								
170	77.18	68/6"	-170.0'	68/6"	18.8	---		
171								
172								
173			Brown to yellowish dense clayey material intermixed with weathered calcareous rock fragments (residual highly weathered calcareous moist rock)					
174								
175		44 – 55		55	19.8	---		

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE
[a = DESCRIPTION MADE BY MR. MARIO SORIANO RESSY, GEOLOGIST
[b = SEE ATTACHED WELL DETAILS

TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32196
PONCE, PR 00732-2196

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 105 SHEET NO.: 6/6

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 1-29-07 WORK FINISHED: 1-29-07

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: —— TYPE & SIZE BIT: ——

GROUND WATER: DATE AND DEPTH: 1-29-07; -119.0 FT.(ELEV.= 92.73 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 155051.0285 "Y" COORDINATE: 217951.7258 ELEVATION: 129.00 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	OBSEVATION WELL [b	Td
176								
177								
178								
179								
180		32 – 30	Brown to yellowish dense clayey material intermixed with weathered calcareous rock fragments (residual highly weathered calcareous moist rock)	72	20.3	—		B
181		42						
182								
183								
184								
185	68.06	60/6"	-184.5'	60/6"	16.8	—		
186			END OF BORING					
187								
188								
189								
190								
191								
192								
193								
194								
195								
196								
197								
198								
199								
200								
201								
202								
203								
204								
205								
206								
207								
208								
209								
210								

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

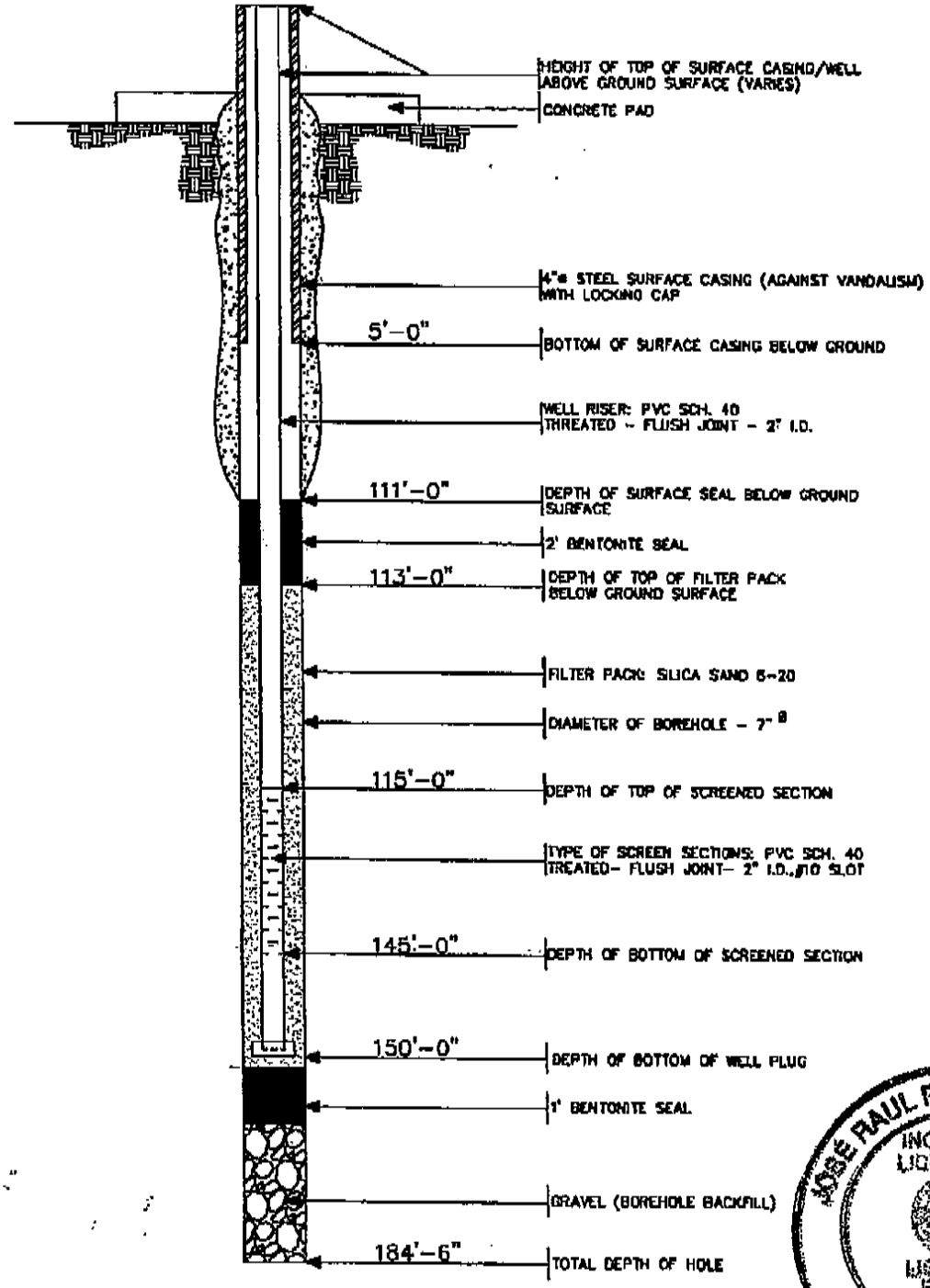
W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE
[a = DESCRIPTION MADE BY MR. MARIO SORIANO RESSY, GEOLOGIST
[b = SEE ATTACHED WELL DETAILS

LATERAL EXPANSION
MUNICIPAL LANDFILL

BARINAS WARD, YAUCO, P.R.

LM WASTE SERVICES, INC



JOSÉ RAUL RIVERA NAZARIO
INGENIERO
LICENCIADO
LIC. 13526
EXPIRA
13 NOV. 2007
PUERTO RICO

MONITORING WELL # 105
CONSTRUCTION DETAILS

NOT TO SCALE

TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 106 SHEET NO.: 1/4

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 11-28-06 WORK FINISHED: 11-28-06

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ---- TYPE & SIZE BIT: ----

GROUND WATER: DATE AND DEPTH: 11-28-06; -72.0 FT (ELEV.=119.42 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 155007.2430 "Y" COORDINATE: 218420.8879 ELEVATION: 141.37 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	OBSEVATION WELL [b	Td
1		2 – 4	Top soil intermixed with limestone fragments brown / reddish yellow -2.0'	11	33.5	---		A
2	140.76	7 – 6						
3		6 – 6	Pink weathered limestone -4.0'	13	9.7	---		
4	140.15	7 – 12						
5		17 – 26	White, hard limestone brittle – fragmented by sampling process – re-crystallized limestone	49	2.3	---		B
6		23 – 68						
7		60/6"		60/6"	2.8	---		
8								
9								
10		50/4"		50/4"	2.4	—		
11								
12								
13								
14								
15		50/0"		50/0"	1.5	—		
16								
17								
18								
19								
20		50/0"		50/0"	1.4	---		
21								
22								
23								
24								
25		50/0"		50/0"	—	---		
26								
27								
28	132.84		-28.0'					
29			Cavity -30.5'					
30	132.07	4 – 70		70/6"	3.3	---		
31			White, hard limestone brittle – fragmented by sampling process – re-crystallized limestone					
32								
33								
34								
35		50/0"		50/0"	—	---		

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE
[a = DESCRIPTION MADE BY MR. MARIO SORIANO RESSY, GEOLOGIST
[b = SEE ATTACHED WELL DETAILS

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FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 106 SHEET NO.: 2/4

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 11-28-06 WORK FINISHED: 11-28-06

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ----- TYPE & SIZE BIT: -----

GROUND WATER: DATE AND DEPTH: 11-28-06; -72.0 FT (ELEV.=119.42 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 166007.2430 "Y" COORDINATE: 218420.8879 ELEVATION: 141.37 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	OBSEVATION WELL [b	Td
36								
37								
38			White, hard limestone brittle – fragmented by sampling process					
39								
40		50/0"		50/0"	---	---		
41	128.87		-41.0'					B
42								
43								
44								
45		6 – 50		50/6"	15.0	—		
46								
47								
48								
49								
50		8 – 15		41	16.6	---		
51		26						
52								
53								A
54								
55		16 – 21	Limestone fragments intermixed with plastic clay and sandy silt	39	17.0	---		
56		18						
57								
58								
59								
60		20 –23		73	14.5	---		
61		50						
62								
63								
64								B
65		11 – 50		50/3"	30.0	---		
66								
67								
68								
69								
70		31 – 40 – 40		80	19.5	---		

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
LL = LIQUID LIMIT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
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Td = TYPE OF DRILLING
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(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50
[a = DESCRIPTION MADE BY MR. MARIO SORIANO RESSY, GEOLOGIST
[b = SEE ATTACHED WELL DETAILS

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FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 106 SHEET NO.: 3/4

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 11-28-06 WORK FINISHED: 11-28-06

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ------ TYPE & SIZE BIT: ----

GROUND WATER: DATE AND DEPTH: 11-28-06; -72.0 FT (ELEV.=119.42 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 155007.2430 "Y" COORDINATE: 218420.8879 ELEVATION: 141.37 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	OBSEVATION WELL [b	Td
71								
72								
73			Limestone fragments intermixed with plastic clay and sandy silt. Hard limestone lens at 75.0– 76.0 feet					
74								
75		50/1"		50/1"	10.8	—		
76								
77	117.90		-77.0'					
78								
79								
80		75/6"		75/6"	22.5	---		
81								
82								
83								
84								
85		50/3"		50/3"	15.0	—		
86								
87								
88								B
89								
90		75/5"	Yellowish – highly weathered limestone intermixed with clay – wet calcareous saprolitic natural	75/5"	16.0	---		
91								
92								
93								
94								
95		75/5"		75/5"	18.2	—		
96								
97								
98								
99								
100		75/3"		75/3"	17.0	—		
101								
102								
103								
104								
105		50/2"		50/2"	15.7	---		

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
LL = LIQUID LIMIT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
PI = PLASTICITY INDEX
Td = TYPE OF DRILLING
% = PERCENT FINER THAN NO. 200 SIEVE
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50
[a = DESCRIPTION MADE BY MR. MARIO SORIANO REGGY, GEOLOGIST
[b = SEE ATTACHED WELL DETAILS

TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 106 SHEET NO.: 4/4

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 11-28-06 WORK FINISHED: 11-28-06

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ------ TYPE & SIZE BIT: -----

GROUND WATER: DATE AND DEPTH: 11-28-06; -72.0 FT (ELEV.=119.42 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 155007.2430 "Y" COORDINATE: 218420.8879 ELEVATION: 141.37 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	OBSEVATION WELL [b	Td
106								
107								
108								
109								
110		50/2"		50/2"	12.5	---		
111								
112								
113								
114			Yellowish – highly weathered limestone intermixed with clay – wet calcareous saprolitic natural lenses of brown sandy natural and volcanic rock fragments					
115		50/4"		50/4"	20.9	---		
116								
117								
118								
119								
120		14 – 18		56	33.1	—		
121		38						
122								
123	153.88		-123.0'					B
124								
125		50/4"		50/4"	14.3	---		
126								
127								
128								
129								
130		37 – 75		75/6"	24.0	---		
131								
132			Mudstone – dark gray hard with shell fragments becoming sandy with depth					
133								
134								
135		42 – 42		50/3"	19.7	---		
136		50/3"						
137								
138								
139								
140	98.70	30 – 50/3"	-140.0'	50/3"	21.3	---		
141			END OF BORING					

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

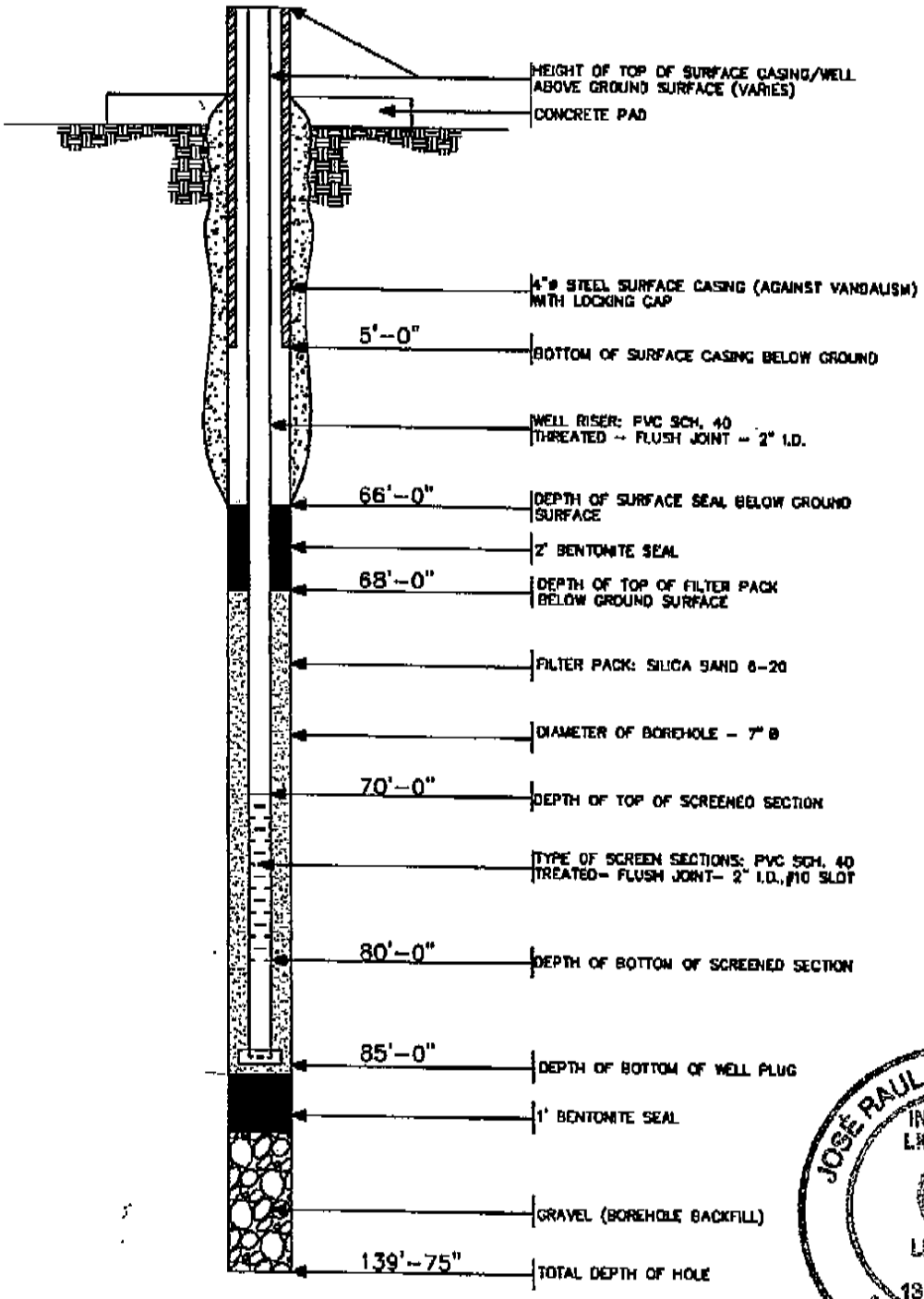
W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE
[a = DESCRIPTION MADE BY MR. MARIO SORIANO RESSY, GEOLOGIST
[b = SEE ATTACHED WELL DETAILS

LATERAL EXPANSION
MUNICIPAL LANDFILL

BARINAS WARD, YAUCO, P.R.

LM WASTE SERVICES, INC



JOSÉ RAUL RIVERA NAZARIO
INGENIERO LICENCIADO
LIC. 13625
EXPIRA 13 NOV. 2007
PUERTO RICO

MONITORING WELL # 106
CONSTRUCTION DETAILS

NOT TO SCALE

TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 107 SHEET NO.: 1/3

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 3-13-07 WORK FINISHED: 3-15-07

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ---- TYPE & SIZE BIT: ----

GROUND WATER: DATE AND DEPTH: 3-13-07; -75.0 FT. (ELEV.= 97.29 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 154546.8531 "Y" COORDINATE: 218492.4008 ELEVATION: 120.15 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	PIEZOMETER [b	Td
1		6 – 6	Yellowish marly material with hard limestone fragments	6	14	---		
2		20 – 11	(Fill)					
3		3 – 4	Dry	11	17	---		
4		7 – 13						
5		3 – 3		7	21	---		
6		4 – 7						
7		6 – 4		9	22	---		
8		5						
9								
10		4 – 5		23	16	---		
11		18						
12			Yellowish brown – semi consolidated. Sandy silt with					
13			some clay dry (Fill?) and limestone rock fragments.					A
14			Becoming more clayey and hard with depth					
15		8 – 12		28	26	---		
16		16						
17								
18								
19								
20		10 – 18		39	24	---		
21		21						
22								
23								
24	112.83		-24.0'					
25		10 – 22		56	22	---		B
26		34						
27			Yellowish brown silty clay mottled with marly –					
28			calcareous material – semi-consolidated					
29			Dry					
30	111.00	13 – 20	-30.0'	49	25	---		A
31		29						
32			Brown hard to semi-consolidated sandy silt – becoming					
33			sandier and friable at depth and with some rounded					
34			gravel fragments. Dry					
35		18 – 54		54/6"	18	---		B

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ¼ FT/SEC.

W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE

[a Description made by Mr. Mario Soriano Rassy, Geologist
[b = SEE ATTACHED PIEZOMETER DETAILS

TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32196
PONCE, PR 00732-2196

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 107 SHEET NO.: 2/3

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 3-13-07 WORK FINISHED: 3-15-07

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ----- TYPE & SIZE BIT: -----

GROUND WATER: DATE AND DEPTH: 3-13-07; -75.0 FT. (ELEV.= 67.29 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 154548.8531 "Y" COORDINATE: 218492.4008 ELEVATION: 120.15 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	PIEZOMETER [b	Td
36								
37								
38								
39								
40		34 – 50/6"		50/6"	8	—		
41								
42			Brown hard to semi-consolidated sandy silt – becoming sandier and friable at depth and with some rounded gravel fragments. Dry					
43								
44								
45		42 – 60		60/6"	14	—		
46								
47								
48								
49								
50	104.91	15 – 26	-50.0'	50/2"	28	—		
51		50/2"						
52								
53								B
54								
55		18 – 28	Brown hard to semi-consolidated sandy silt – becoming sandier and friable at depth and with some rounded gravel fragments. Dry with lenses or seams of sandy clay interbbeded in the about. With rock fragments	75	28	—		
56		47						
57								
58								
59								
60		50/6"		50/6"	22	—		
61								
62	101.25		-62.0'					
63								
64								
65		50/3"		50/3"	11	—		
66			Dark – brown weathered conglomerate lense of highly weathered rock inter-mixed with sandy loose material, occasional clay seams. Moist to wet at 79'					
67								
68								
69								
70		8 – 25 – 32		57	22	—		

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 60
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE

[a Description made by Mr. Mario Soriano Rosay, Geologist
[b = SEE ATTACHED PIEZOMETER DETAILS

TEL. 787-259-1410
FAX: 787-259-1604

VICTOR E. RIVERA & ASSOCIATES
GEOTECHNICAL ENGINEERS

PO BOX 32198
PONCE, PR 00732-2198

PROJECT: Municipal Landfill Lateral Expansion BORING NO.: 107 SHEET NO.: 3/3

LOCATION: Barinas Ward, Yauco, Puerto Rico CLIENT: LM Waste Service Corp.

INSPECTOR: J. Nazario DRILLER: E. Vargas WORK STARTED: 3-13-07 WORK FINISHED: 3-15-07

POWER DRIVEN HOLLOW STEM AUGER; SAMPLE-TYPES & SIZES 1 3/8" I.D. SPLIT SPOON HAMMER WGT: 140 POUNDS

HAMMER DROP: 30" DRILLING FLUID: NONE CORE DATA-TYPE BARREL: ---- TYPE & SIZE BIT: ----

GROUND WATER: DATE AND DEPTH: 3-13-07; -75.0 FT. (ELEV.= 97.29 M) DRILL MANUFACTURER TYPE & NO. CME – 55

"X" COORDINATE: 154546.8531 "Y" COORDINATE: 218492.4008 ELEVATION: 120.15 M JOB NO.: 06-2749

DEPTH (FT.)	ELEV. (M)	S.P.T. "N" VALUES	GEOLOGIC DESCRIPTION OF MATERIALS [a	N	W_N	Qu	PIEZOMETER [b	Td
71								
72								
73								
74								
75	▼	15 – 32		80	25	---		
76		48	Dark – brown weathered conglomerate lense of highly weathered rock inter-mixed with sandy loose material, occasional clay seams. Moist to wet at 79'					
77								
78								
79								
80		50/2"		50/2"	21	—		
81								
82								
83	94.84		-83.0'					
84								
85		29 – 42		42/6"	20	---		
86								
87								
88								B
89								
90		50/3"		50/3"	15	—		
91								
92								
93			Brown – sandy silt with some clay and weathered rock fragments embedded – (saprolitic material of a conglomeratic layer. Moist to wet saturated at 99' at it becomes more sandy and friable					
94								
95		50/3"		52/3"	21	---		
96								
97								
98								
99								
100		50/4"		50/4"	31	---		
101								
102								
103								
104	88.14	50/5"	-104.4'	50/5"	18	—		
105			END OF BORING					

* = INDICATED AS NEEDED (1) NO. OF BLOWS REQUIRED TO DRIVE SAMPLER 0"-6", 6"-12", 12"-18"
(2) FORCE TO CAUSE THIN WALLED SAMPLER TO PENETRATE AT RATE ½ FT/SEC.

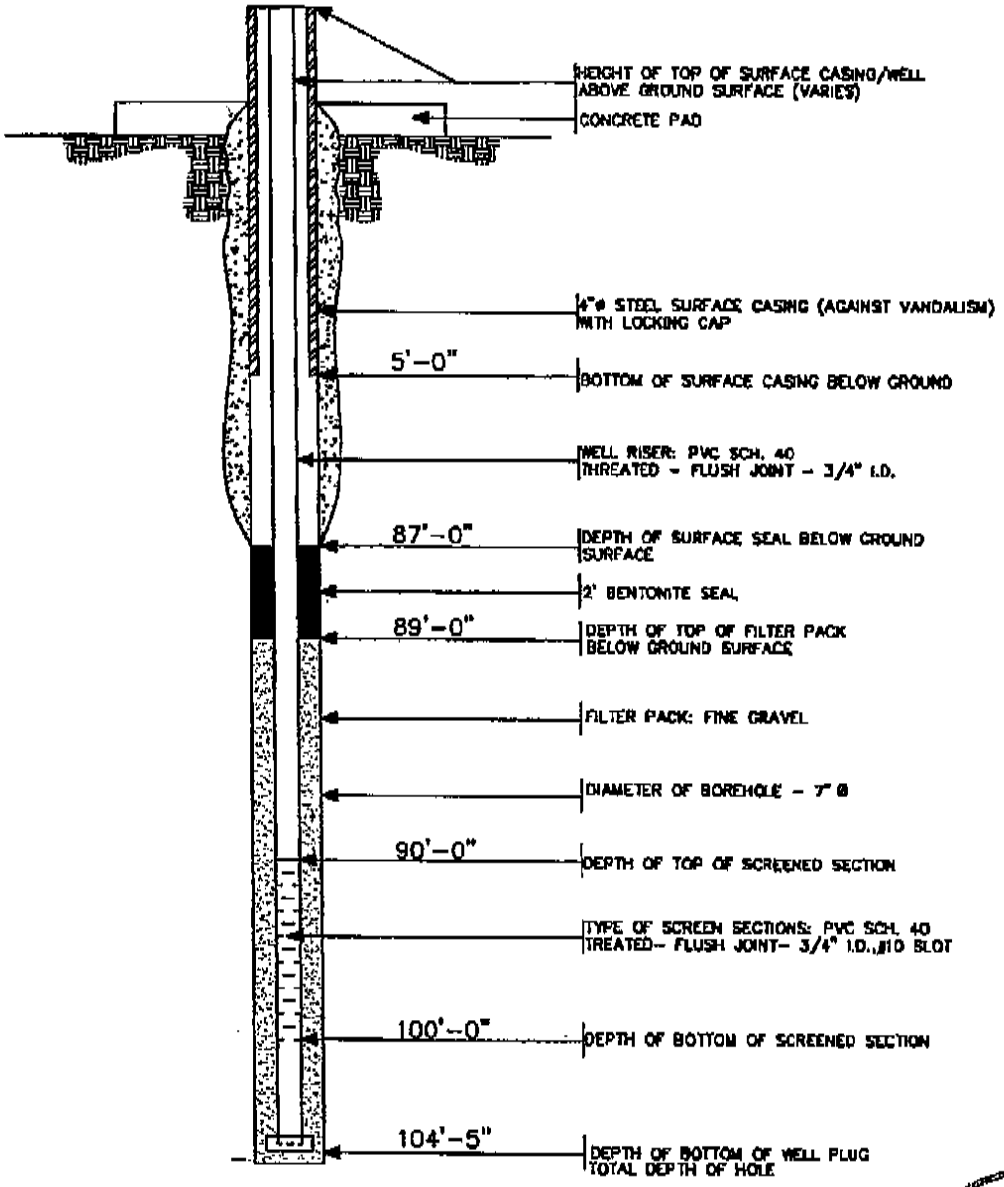
W_N = NATURAL MOISTURE CONTENT IN % OF DRY WEIGHT
Qu = UNCONFINED COMPRESSIVE STRENGTH IN TONS PER SQ. FT.
Td = TYPE OF DRILLING
(A) = STANDARD BORING IN SOILS SHOWING "N" VALUES BELOW 50
(B) = ROTARY DRILLING USING ALLOY DRAG BIT AND/OR IN SOILS SHOWING "N" VALUES ABOVE 50

N = SUM OF THE LAST 12" OF SAMPLER PENETRATION
LL = LIQUID LIMIT
PI = PLASTICITY INDEX
% = PERCENT FINER THAN NO. 200 SIEVE
[a = DESCRIPTION MADE BY MR. MARIO SORIANO RESSY, GEOLOGIST
[b = SEE ATTACHED PIEZOMETER DETAILS

LATERAL EXPANSION MUNICIPAL LANDFILL

BARINAS WARD, YAUCO, P.R.

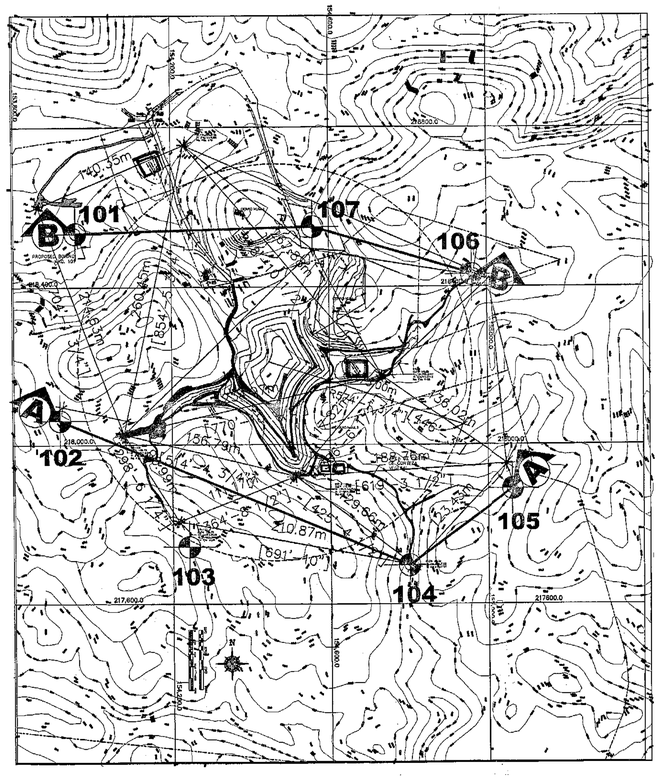
LM WASTE SERVICES, INC



PIEZOMETER # 107 CONSTRUCTION DETAILS

NOT TO SCALE

JOSÉ RAUL RIVERA NAZARIO
INGENIERO LICENCIADO
LIC.# 13525
EXPIRA 13 NOV. 20
PUERTO RICO



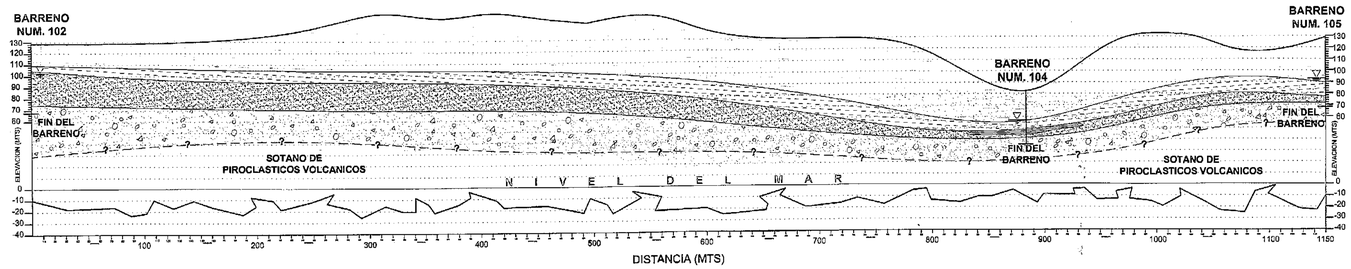
LOCALIZACION DE BARRENOS Y ALINEAMIENTO DE SECCIONES

NO A ESCALA

LEYENDA:

= LOCALIZACION DE BARRENOS (I01 AL 107)

= ALINEAMIENTO DE SECCIONES A A Y B B



LEYENDA:

= MARGAS CALCAREAS Y CALIZAS

= ARCILLA - DENSA - EXPANSIVA

= LODOLITA - DENSA - ORGANICA

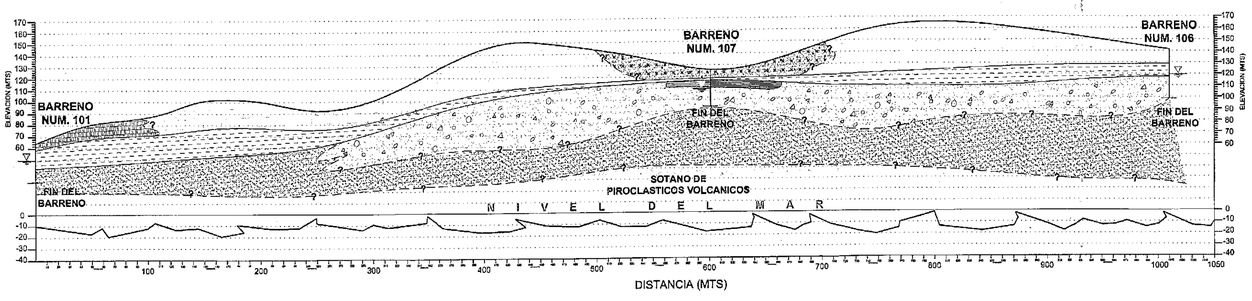
= CONGLOMERADO

= LENTE DE CALIZA ALTERADO Y ARCILLA

= NIVEL FREATICO

PERFIL ESTRATIGRAFICO A A

ESCALA HORIZONTAL = 1:2500
ESCALA VERTICAL = 1:2500



LEYENDA:

= MARGAS CALCAREAS Y CALIZAS

= ARCILLA - DENSA - EXPANSIVA

= LODOLITA - DENSA - ORGANICA

= CONGLOMERADO

= LENTE DE CALIZA ALTERADO Y ARCILLA

= COLLUVIAL

= RELLENO Y MATERIAL COLLUVIAL

= NIVEL FREATICO

PERFIL ESTRATIGRAFICO B B

ESCALA HORIZONTAL = 1:2500
ESCALA VERTICAL = 1:2500

JOSE RAUL RIVERA NAZARIO
INGENIERO LICENCIADO
LIC. 13525
EXPIRA 13 NOV. 2007
PUERTO RICO

PERFILES ESTRATIGRAFICOS

GEOLOGIA POR:

MARIO SORIANO RESSY
INGENIERO GEOLOGICO
LIC. 4131

NOTAS GENERALES

VERA Job No. 06-2749	HOJA NUM.: 1/1
FECHA: 5/14/07	DIBUJADO POR: C. Morales
ESCALA: 1:2500	APROBADO POR: J. Rivera

EXHIBIT "A"

EXPANSION LATERAL DEL VERTEDERO MUNICIPAL

BARRIO BARINAS
YAUCO, PUERTO RICO

LM Waste Service Corp.

MARIO SORIANO RESSY
GEOLOGICAL ENGINEERING AND ENVIROMENTAL SERVICES
(787) 723-4831

20TH ANNIVERSARY 1987 - 2007
GEOTECHNICAL ENGINEERS

VICTOR E. RIVERA ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS
SOIL AND CONCRETE TESTING LABORATORIES
ROAD NO. 2 KM. 221.8, EL TUQUE, PONCE, PR
P. O. BOX 32198,PONCE, PR 00732-2198
TELS.(787) 259-1410/259-1411
843-6538- FAX: 259-1604
e-mail: verivera@prtc.net

Apéndice 6:

Log of Exploratory Boring-AGES

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 06/25/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data TOTAL DEPTH = 50' BACKFILLED WITH NATIVE SOIL

Boring No. B-1 Sheet 1 of 2

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/ft.	WATER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		48	-	Split Spoon	sm	Calcarenite, fine-grained, 10YR 7/1 light gray, dense, slightly moist, subrounded pebbles and cobbles.
6						
7						
8						
9						
10		100/6"	-	Split Spoon	ls	Limestone, 10YR 7/1 light gray, moderately hard, mud supported.
11						
12						
13						
14						
15		50/6"	-	Split Spoon	ls	Limestone, 5Y 8/1 white, moderately hard, slightly moist, moderately consolidated, mud supported.
16						
17						
18						
19						
20		100/3"	-	Split Spoon	sp	Calcarenite, fine-to coarse-grained sand, very dense, slightly moist, moderately to poorly consolidated.
21						
22						
23						
24						
25		100/12"	-	Split Spoon	sm	Silty Sand, fine-to coarse-grained, 2.5Y 3/3 light olive brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite, and mudstone).
26						
27						
28						
29						
30		100/10"	-	Split Spoon	sp	Calcarenite, medium-to coarse-grained, 2.5Y 5/6 light olive brown, very dense, slightly moist, poorly consolidated.
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 06/25/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Boring No. B-1 Sheet 2 of 2

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"

Well Installation Data

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		100/8"	-	Split Spoon	sm	Silty Sand, fine-to medium-grained, 2.5Y 4/3 olive brown, very dense, slightly moist.
36						
37						
38						
39						
40		60/12"	-	Split Spoon	sm	Silty Sand, fine-grained, 10YR 4/3 brown, very dense, slightly moist, subrounded pebbles and cobbles (andesite, mudstone, and serpentinite).
41						
42						
43						
44						
45		100/12"	-	Split Spoon	sc	Clayey Silt, 10YR 5/1 gray, very dense, slightly moist, subrounded pebbles and cobbles (andesite, mudstone and serpentinite).
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 06/29/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57
HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data TOTAL DEPTH = 50'
BACKFILLED WITH NATIVE SOIL

Boring No. B-2
Sheet 1 of 2

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/ft	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		50	-	Split Spoon	sc	Calcareous Siltstone, 5YR 8/2 pinkish white, very dense, slightly moist, poorly consolidated, subrounded pebbles and cobbles (limestone).
6						
7						
8						
9						
10		52/12"	-	Split Spoon	sc	Calcareous Siltstone, 7.5YR 4/4 brown, very dense, slightly moist, subrounded pebbles and cobbles (limestone, mudstone, and serpentinite).
11						
12						
13						
14						
15		73/12"	-	Split Spoon	sm	Calcarenite, fine-grained sand, 2.5Y 4/2 dark grayish brown, very dense, slightly moist, poorly consolidated.
16						
17						
18						
19						
20		42/12"	-	Split Spoon	sm	Calcarenite, fine-to coarse-grained, 10YR 5/4 yellowish brown, very dense, slightly moist, poorly consolidated.
21						
22						
23						
24						
25		51/12"	-	Split Spoon	sm	Calcarenite, fine-grained, 10YR 5/4 yellowish brown, very dense, slightly moist, poorly consolidated, subrounded pebbles and cobbles (limestone, mudstone and serpentinite).
26						
27						
28						
29						
30		60/12"	-	Split Spoon	sp	Sand, medium-to coarse-grained, 7.5YR 5/2 grayish brown, very dense, slightly moist, subrounded pebbles and cobbles (andesite, mudstone, and serpentinite).
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-141-01 Date 06/29/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged by C. RODRIGUEZ Drilling Company AGES

Boring No. B-2
Sheet 2 of 2

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"

Well Installation Date

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/ft	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		80/12"	-	Split Spoon	gm	Silty Gravel. 2.5YR 5/4 light olive brown, very dense, slightly moist, contains angular to well rounded volcanic clasts.
36						
37						
38						
39						
40		100/5"	-	Split Spoon	gm	Silty Gravel. 2.5YR 5/4 light olive brown, very dense, slightly moist, contains angular to well rounded volcanic clasts.
41						
42						
43						
44						
45		5"	-	Split Spoon	gm	Silty Gravel. 2.5YR 5/4 light olive brown, very dense, slightly moist, contains angular to well rounded volcanic clasts.
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project / 93-147-01 Date 06/29/93
Client MUNICIPIO DE TAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES

Boring No. B-3
Sheet 1 of 2

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"

Well Installation Date TOTAL DEPTH = 50' BACKFILLED WITH NATIVE SOIL

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		65	-	Split Spoon	sp	Calcarenite, fine-to medium-grained sand, 5YR 4/4 reddish brown, very dense, slightly moist, poorly consolidated, subrounded pebbles and cobbles (limestone).
6						
7						
8						
9						
10		65	-	Split Spoon	sp	Calcarenite, fine-to medium-grained, 5YR 4/4 reddish brown, very dense, slightly moist, subrounded pebbles and cobbles (andesite, serpentinite and mudstone).
11						
12						
13						
14						
15		100/12"	-	Split Spoon	sm	Calcarenite, 7.5YR 4/4 brown, very dense, slightly moist, poorly consolidated, subrounded pebbles and cobbles (andesite clasts)
16						
17						
18		100	-	Split Spoon	gw	Gravel, coarse-grained, very dense, slightly moist, poorly sorted, subrounded to rounded.
19						
20						
21						
22		100/12"	-	Split Spoon	sm	Calcareous Silty Clay, 10YR 6/6 brownish yellow to 5Y 6-1 grayish gray, very dense, slightly moist, paleosoils.
23						
24						
25		100/12"	-	Split Spoon	ls	Argillaceous Limestone, 10YR 8/1 white, very dense, slightly moist, poorly consolidated.
26						
27						
28						
29						
30		100/9"	-	Split Spoon	ls	Argillaceous Limestone, 5YR 6/3 light reddish brown, very dense, slightly moist, subrounded pebbles and cobbles (mudstone and siltstone).
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-141-01 Date 06/29/93
Client MUNICIPIO DE TAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DR. LNG CO. MODEL B-57
HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data

Boring No. B-3
Sheet 2 of 2

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/ft.	MOTOR READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33		1001 2 1/2"	-	Split Spoon	ml	Calcareous Silt. 7.5YR 5/8 strong brown, very dense, moist, poorly consolidated, subrounded (mudstone).
34						
35						
36						
37						
38						
39						
40		1001 3"	-	Split Spoon	ml	Calcareous Silt. 7.5YR 5/8 strong brown, very dense, moist, poorly consolidated, subrounded (mudstone).
41						
42						
43						
44						
45		-	-	-	-	Calcareous Silt. 7.5YR 5/8 strong brown, very dense, moist, poorly consolidated, subrounded (mudstone).
46						
47						
48						
49						
50		-	-	-	-	Calcareous Silt. 7.5YR 5/8 strong brown, very dense, moist, poorly consolidated, subrounded (mudstone).
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 06/29/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged by C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57
HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data TOTAL DEPTH = 50'
BACKFILLED WITH NATIVE SOIL

Boring No. B-4
Sheet 1 of 2

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		1001 8"	-	Split Spoon	sm	Calcarenite, fine-to medium-grained sand, 7.5YR 5/4 brown, very dense, slightly moist, subrounded pebbles and cobbles (mudstone, siltstone, and limestone).
6						
7						
8						
9						
10		1001 12"	-	Split Spoon	sm	Calcarenite, fine-grained sand, 7.5YR 5/8 strong brown, very dense, slightly moist, subrounded pebbles and cobbles (mudstone, siltstone, andesite).
11						
12						
13						
14						
15		1001 12"	-	Split Spoon	sm	Calcarenite, fine-grained sand, 7.5YR 5/8 strong brown, very dense, slightly moist, subrounded pebbles and cobbles (mudstone, siltstone, andesite).
16						
17						
18						
19						
20		1001 12"	-	Split Spoon	ml	Sandy Silt, fine-grained sand, 5YR 5/8 yellowish brown, very dense, slightly moist.
21						
22						
23						
24						
25		1001 10"	-	Split Spoon	sm	Sandy Silt, fine-grained sand, 5YR 5/2 olive gray, very dense, slightly moist.
26						
27						
28						
29						
30		1001 9 1/2"	-	Split Spoon	sp	Sand, fine-grained, 2.5YR 5/3 light olive brown, very dense, slightly moist.
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 06/23/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES

Boring No. B-4
Sheet 2 of 2

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"

Well Installation Date

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		100	-	Split Spoon	sp	Sand, fine-grained, 5Y 5/2 olive gray, very dense, slightly moist.
36						
37						
38						
39						
40		100/6"	-	Split Spoon	sl	Sandy Silt, fine-grained sand, 5Y 3/2 olive gray, very dense, slightly moist.
41						
42						
43						
44						
45		100/12"	-	Split Spoon	sp	Sandstone, fine-to medium-grained, 2.5Y 5/3 light olive brown, very dense, slightly moist, poorly consolidated.
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 07/7/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57
HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data TOTAL DEPTH 50'-0"
BACKFILLED WITH NATIVE SOIL.

Boring No. B-5
Sheet 1 of 1

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/6"	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		100/9"	-	Split Spoon	sm	Calcarenite, fine-to medium-grained sand, 15YR 5/4 brown, very dense, slightly moist, subrounded pebbles and cobbles (andesite and mudstone).
6						
7						
8						
9						
10		100/6"	-	Split Spoon	sm	Sand, fine-to coarse-grained, 15YR 5/4 brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite and mudstone).
11						
12						
13						
14						
15		100/9"	-	Split Spoon	sm	Calcarenite, fine-grained sand, 15YR 5/6 strong brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite and mudstone).
16						
17						
18						
19						
20		100/9"	-	Split Spoon	ml	Sandy Silt, fine-grained sand, 15YR 5/6 strong brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite andesite and mudstone).
21						
22						
23						
24						
25		100/9"	-	Split Spoon	sm	Gravely Silty Sand, fine-grained sand, 10YR 5/6 yellowish brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite and mudstone).
26						
27						
28						
29						
30		100/9"	-	Split Spoon	sm	Gravely Silty Sand, fine-to medium-grained, 10YR 5/4 yellowish brown, very dense, subrounded pebbles and cobbles (serpentinite, andesite and mudstone).
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 07/2/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged by C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data

Boring No. B-5 Sheet 2 of 2

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		100/10"	-	Split Spoon	la	Argillaceous Limestone, fine-grained, 2.5Y 5/2 grayish brown, very dense, slightly moist, poorly consolidated
36						
37						
38						
39						
40		100/12"	-	Split Spoon	sm	Calcareous Silty Sand, fine-grained, 10YR 4/2 dark brown, very dense, slightly moist, poorly consolidated.
41						
42						
43						
44						
45		100/3"	-	Split Spoon	sm	Calcareous Silty Sand, fine-grained, 10YR 4/2 dark brown, very dense, slightly moist, poorly consolidated
46						
47						
48						
49						
50						
51						
52						
53						
54						
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56						
57						
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59						
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AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 7/06/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Boring No. B-6 Sheet 1 of 2

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57
HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Data TOTAL DEPTH = 50'
BACKFILLED WITH NATIVE SOIL.

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOWS/ft.	MOTTER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		6/18"	-	Split Spoon	ml	Calcareous Clayey Silt, 2.5Y 6/4 light yellowish brown, loose, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite, mudstone).
6						
7						
8						
9						
10		22/18"	-	Split Spoon	ml	Calcareous Clayey Silt, 10YR 4/4 dark yellowish brown, medium dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite and mudstone).
11						
12						
13						
14						
15		32	-	Split Spoon	cl	Calcareous Silty Clay, 5Y 8/1 white, medium dense, slightly moist, paleosoils.
16						
17						
18						
19						
20		100/12"	-	Split Spoon	ml	Calcareous Clayey Silt, 2.5Y 6/8 yellow, very dense, slightly moist, subrounded pebbles and cobbles (limestone).
21						
22						
23						
24						
25		100/3"	-	Split Spoon	ml	Calcareous Silty, 10YR 5/6 yellowish brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite and mudstone).
26						
27						
28						
29						
30		15/6"	-	Split Spoon	sm	Calcarenite, fine-grained, 2.5Y 5/4 light olive brown, very dense, slightly moist, subrounded pebbles and cobbles (serpentinite, andesite, and mudstone).
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 01/6/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"

Boring No. B-6 Sheet 2 of 2

FIELD LOCATION OF BORING:

Well Installation Data

Water Level			
Time			
Date			

DEPTH (feet)	LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		50/8"	-	Split Spoon	sm	Silty Sand, fine-grained 10YR 5/6 yellowish brown, very dense, slightly moist, pebbles and cobbles (serpentinite, andesite and mudstone)
36						
37						
38						
39						
40		50/12"	-	Split Spoon	sm	Silty Sand, fine-grained 10YR 5/6 yellowish brown, very dense, slightly moist, pebbles and cobbles (serpentinite, andesite and mudstone)
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
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56						
57						
58						
59						
60						
61						
62						
63						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 01/6/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Boring No. B-7 Sheet 1 of 1

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"

Well Installation Data TOTAL DEPTH = 50' BACKFILLED WITH NATIVE SOIL.

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		100/10"	-	Split Spoon	sm	Calcareous Silty Sand fine-grained, 7.5YR 5/6 strong brown, very dense, slightly moist, subrounded pebbles and cobbles (limestone)
6						
7						
8						
9						
10		-	-	-	-	Calcareous Silty Sand fine-grained, 7.5YR 5/6 strong brown, very dense, slightly moist, subrounded pebbles and cobbles (limestone)
11						
12						
13						
14						
15		50/12"	-	Split Spoon	sm	Calcarenite, 5GY 7/1 light greenish gray to 10YR yellowish brown, very dense, slightly moist, poorly consolidated, subrounded pebbles and cobbles (limestone)
16						
17						
18						
19						
20		50/6"	-	Split Spoon	ls	Argillaceous Limestone, 10YR 7/6 yellow, very dense, slightly moist, poorly consolidated, subrounded pebbles and cobbles (limestone)
21						
22						
23						
24						
25		50/8"	-	Split Spoon	ls	Argillaceous Limestone, 10YR 6/6 brownish yellow, very dense, moist, poorly consolidated, subrounded pebbles and cobbles (limestone)
26						
27						
28						
29						
30		50/8"	-	Split Spoon	sl	Calcareous Siltstone, 10YR 6/6 brownish yellow, very dense, slightly moist, poorly to moderately consolidated
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 07/6/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES

Boring No. B-7
Sheet 2 of 2

FIELD LOCATION OF BORING:

Drilling Method MOBILE DRILLING CO. MODEL B-57
HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Date

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/FT.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		50/1"	-	Split Spoon	sc	Calcareous Claystone, 10YR 5/8 yellowish brown, slightly moist, moderately hard.
36						
37						
38						
39						
40		50/3"	-	Split Spoon	sm	Calcareous Siltstone, 10YR 5/3 brown, moderately hard, slightly moist.
41						
42						
43						
44						
45		50/11"	-	Split Spoon	sp	Sand, fine-grained, 10YR 4/4 dark yellowish brown, very dense, slightly moist.
46						
47						
48						
49						
50						
51						
52						
53						
54						
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57						
58						
59						
60						
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62						
63						
64						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 07/7/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged by C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"
Well Installation Date TOTAL DEPTH = 50' BACKFILLED WITH NATIVE SOIL.

Boring No. B-6 Sheet 1 of 1

FIELD LOCATION OF BORING:

Water Level				
Time				
Date				

DEPTH (feet)	GRAPHIC LOG	BLOW/ft.	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
1						
2						
3						
4						
5		50/4"	-	Split Spoon	gm	Calcareous Silt, 7.5YR 7/8 reddish brown poorly consolidated, subrounded pebbles and cobbles (limestone), chalky powder.
6						
7						
8						
9						
10		50/1"	-	Split Spoon	gc	Calcareous Clay, 7.5YR 8/1 white, slightly moist, subrounded pebbles and cobbles.
11						
12						
13						
14						
15		50/6"	-	Split Spoon	ls	Argillaceous Limestone, 7.5YR 7/4 pink, very dense, slightly moist, poorly consolidated, fossiliferous.
16						
17						
18						
19						
20		50/12"	-	Split Spoon	ls	Argillaceous Limestone, 7.5YR 7/4 pink, very dense, slightly moist, poorly consolidated, fossiliferous.
21						
22						
23						
24						
25		50/2"	-	Split Spoon	ls	Chalk, 10YR 8/1 white, with mudstone and calcarenite clasts.
26						
27						
28						
29						
30		50/2"	-	Split Spoon	ls	Chalk, 10YR 8/1 white, with mudstone and calcarenite clasts.
31						
32						

AGES APPLIED GEOSCIENCES & ENVIRONMENTAL SERVICES, INC.

LOG OF EXPLORATORY BORING

Project # 93-147-01 Date 01/1/93
Client MUNICIPIO DE YAUCO
Location VERTEDERO MUNICIPAL
Logged By C. RODRIGUEZ Drilling Company AGES
Drilling Method MOBILE DRILLING CO. MODEL B-57 HOLLOW STEM AUGER Hole Dia. 8"
Boring No. B-8 Sheet 2 of 2

FIELD LOCATION OF BORING:

Well Installation Data:

Water Level				
Time				
Date				

DEPTH (feet)	LOG	BLOW/ft	METER READING	SAMPLE TYPE & DEPTH	U.S.C.S. SYMBOL	LITHOLOGIC DESCRIPTION
33						
34						
35		50/3"	-	Split Spoon	gw	Conglomerate with clasts of mudstone and andesite. 5R 1/4 pink, very dense, slightly moist.
36						
37						
38						
39						
40		50/1"	-	Split Spoon	ml	Calcareous Silt, 2.5Y 6/8 olive yellow, very dense, slightly moist.
41						
42						
43						
44						
45		50/6"	-	Split Spoon	ls	Argillaceous Limestone, 2.5Y 6/6 olive yellow, very dense, slightly moist, limestone clasts.
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						

Apéndice 7:

Condición Hidrológica en el Área del Vertedero Municipal de Yauco

CONDICIÓN HIDROLÓGICA EN EL ÁREA DEL VERTEDERO MUNICIPAL DE YAUCO

por

Carlos Conde-Costas
Hidrólogo - Limnólogo

Mayo 2007

TABLA DE CONTENIDO

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ANEJOS

CONDICIÓN HIDROLÓGICA EN EL ÁREA DEL VERTEDERO MUNICIPAL DE YAUCO

por

Carlos Conde-Costas
Hidrólogo – Limnólogo

Mayo 2007

INTRODUCCIÓN

El **Municipio de Yauco** se propone expandir lateralmente las facilidades del vertedero municipal, localizado en el **Barrio Barinas** a la altura del **kilómetro 3.8, carretera estatal PR-335** (**Figura 1**). De las **593** cuerdas que componen la finca el proyecto contempla la utilización de unas **60** cuerdas.

La disposición de desperdicios sólidos mediante el método de ***relleno sanitario*** es considerada una operación con el potencial de impactar el recurso agua, aún cuando se lleve a cabo a tenor con las normas y reglamentación establecidas. Por tal razón, reconocer el alcance de un evento de contaminación y predecir su interacción con sistemas hidrológicos resulta de vital importancia para establecer planes de contingencia e iniciar medidas de mitigación. A tales efectos se requiere un conocimiento óptimo de la estructura y dinámica de los sistemas suceptibles a impacto.

Como parte del proceso evaluativo en torno al referido proyecto se realizó un estudio de los sistemas hidrológicos contenidos en dichos terrenos. A tenor con los requisitos de información expresados por el **Departamento de Recursos Naturales y Ambientales de Puerto Rico** la investigación se enmarcó en los siguientes aspectos:

- Caracterización de la estructura y comportamiento hidrológico de los sistemas de drenaje superficial y subterráneo contenidos en los terrenos del vertedero.

- Determinación de la relación e interacción de los sistemas de interés con las cuencas de drenaje del **Río Yauco** y **Río Loco**.

- Caracterización de las particularidades del sistema de drenaje subterráneo, propiedades hidráulicas del acuífero y potencial de abasto.

- Determinación del efecto del uso propuesto en la condición hidrológica actual.

Descripción del Área

Las condiciones climáticas en el área donde ubica el ***Vertedero Municipal de Yauco*** (VMY) lo situan en la zona de vida de ***bosque subtropical seco*** (*Ewel & Whitmore, 1973*). El área se caracteriza por una temperatura promedio anual de **25.3 *grados Celsius*** (°C), registrando un mínimo de **24** °C durante el mes de enero y un máximo de **27** °C durante agosto y septiembre. Con una precipitación anual promedio de unos **784** milímetros (mm) y una evapotranspiración de **2,020** mm el área presenta un balance de agua negativo, donde el periodo húmedo ocurre entre los meses de agosto a noviembre mientras que el seco entre enero y marzo (***Figura 2***) (*Fuente: National Weather Service - National Climate Data Center*).

El **Río Yauco** y el **Río Loco** son los sistemas de drenaje superficial principales, flanqueando al **Este** y al **Oeste**, respectivamente, la localidad de estudio. Dichos ríos obtienen la mayoría del caudal en la porción superior de su cuenca (*McClymonds,* 1967; *Crooks,* 1968) pues en la porción inferior (costera) la ocurrencia de corrientes de agua en cauces de ***primer*** y ***segundo orden*** resulta un evento extraordinario. Bajo la

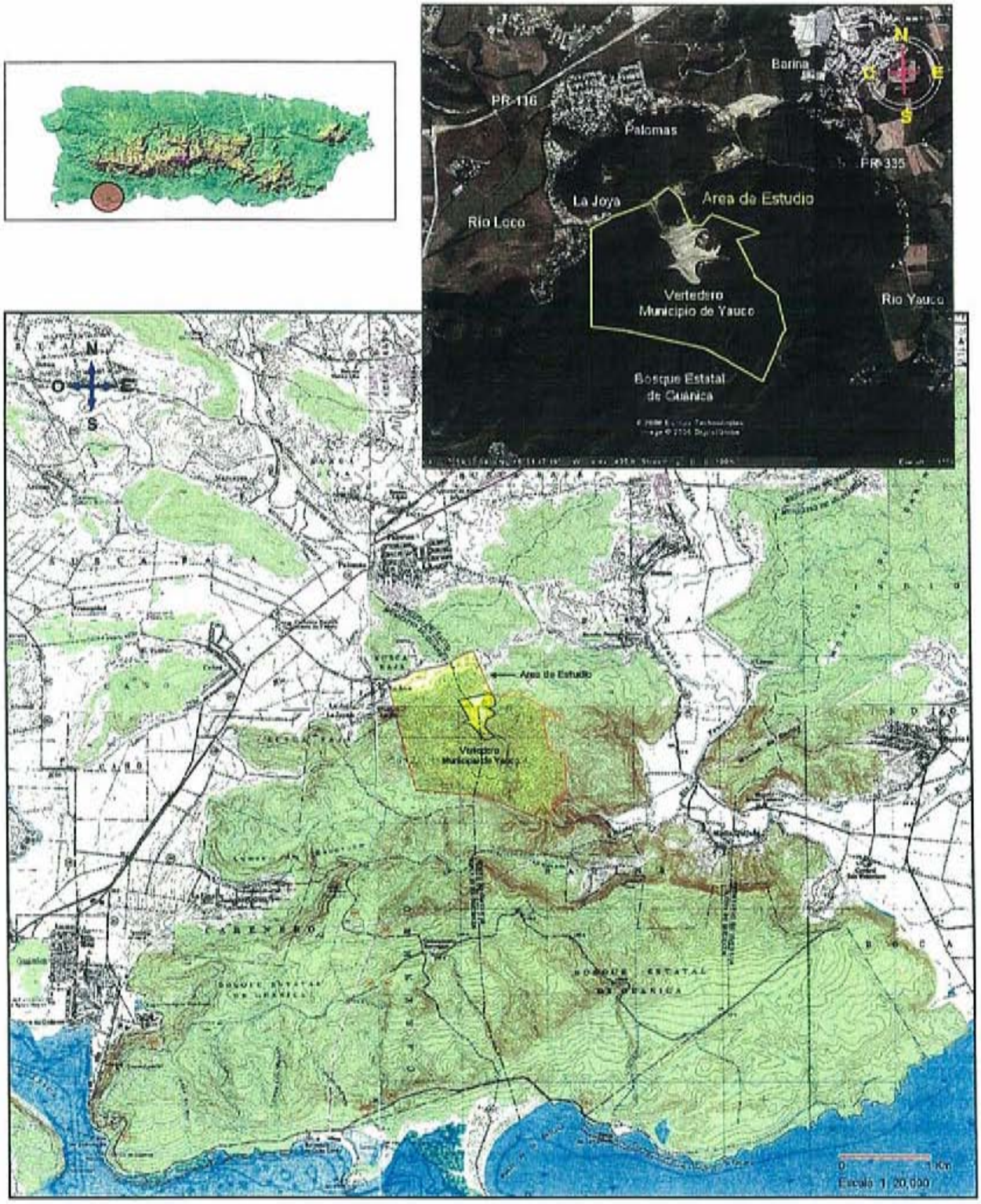

Figura 1. Localización del área de estudio: finca del Vertedero de Yauco, Barrio Barinas, Municipio de Yauco, Puerto Rico

condición climática imperante el régimen de precipitación típico de la zona no es suficiente para generar y sostener flujos de drenaje pues la evapotranspiración retorna a la atmósfera la mayor parte de las aguas meteóricas y escorrentía residual.

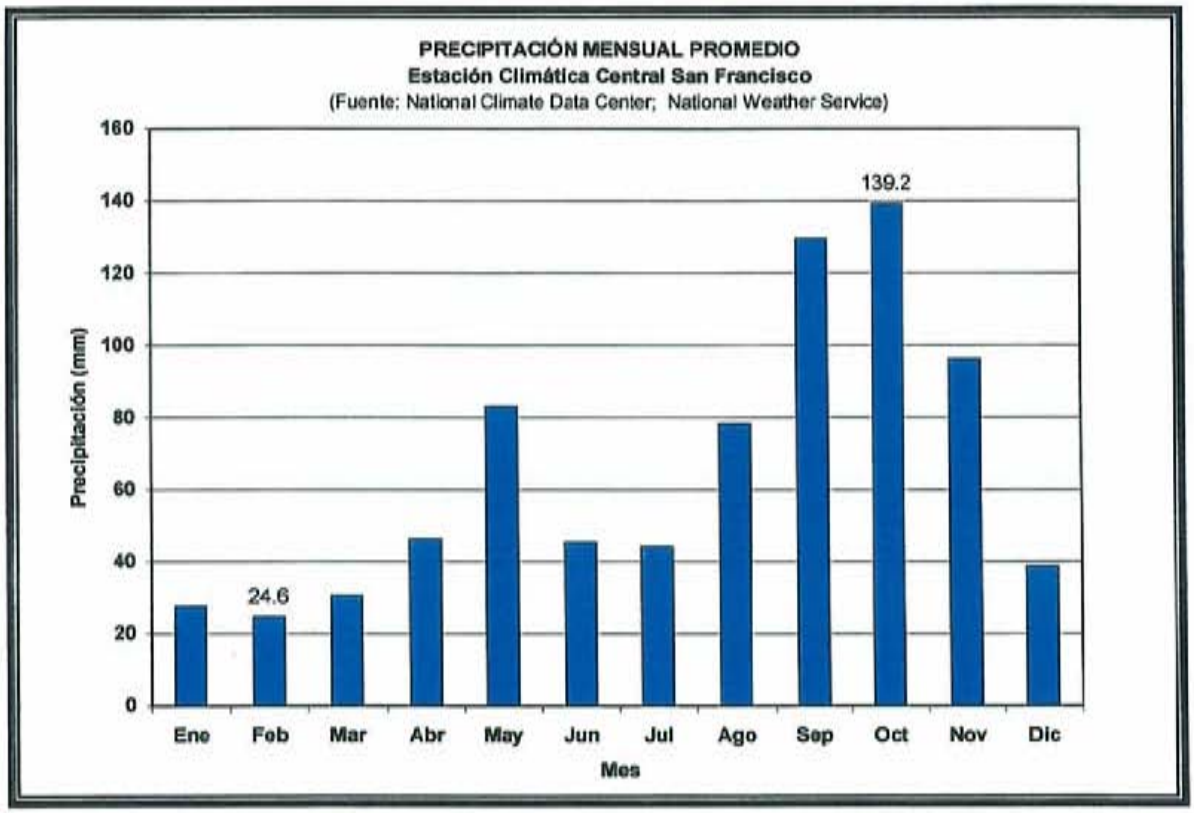

Figura 2. Régimen representativo de la precipitación mensual promedio para la localidad del Vertedero Municipal de Yauco (registrado a unos 4 km al sureste).

En los terrenos del vertedero, ubicados a unos **3** km del litoral costero y a una elevación que fluctua entre los **70** y **180** metros (m) sobre el nivel del mar, aflora la **Formación Juana Díaz**, depositada bajo el mar durante del **Periodo Terciario** (*Krushensky & Monroe,* 1978). La mayor parte del ***relleno sanitario*** descansa sobre su ***unidad basal***, compuesta por rocas sedimentarias volcánicas (lodolitas y conglomerados) y depósitos lenticulares de arena, grava y caliza entre capas de cienos

y arcillas. La ***unidad caliza***, compuesta por estratos finos y gruesos de caliza recristalizada de gran pureza, compone la mayoría de los terrenos y áreas de bosque, colindantes al Sur con el **Bosque Estatal de Guánica**.

Por su naturaleza geológica la **Formación Juana Díaz** no constituye una fuente de agua subterránea importante. La baja permeabilidad de los estratos impide la obtención de agua en cantidades economicamente aprovechables. En adición al bajo rendimiento, la mayoría de las aguas subterráneas contenidas en la formación clasifican como salinas (concentración de solidos disueltos > **1,000** miligramos por litro; Hem, 1989). Se entiende que la alta mineralización de las aguas es producto del ambiente deposicional marino y una pobre capacidad de drenaje (*McClymonds,* 1967).

En la localidad la ocurrencia de aguas subterráneas ***"aprovechables"*** esta practicamente limitada a los valles aluviales del **Río Yauco** y **Río Loco** (*McClymonds,* 1967; *Crooks,* 1968; *Quiñones-Aponte,* 1986 y *Ramos-Gines,* 1986). El acuífero aluvial del **Río Loco** es la principal fuente de abasto público del **Municipio de Guánica** y contribuye significativamente a satisfacer la demanda agrícola. El acuífero aluvial del **Río Yauco** es utilizado en menor escala, principalmente para irrigación.

CARACTERIZACIÓN DE SISTEMAS HIDROLÓGICOS

El estudio se concentró en la documentación de los sistemas hidrológicos superficial y subterráneo contenidos en la finca del ***Vertedero Municipal de Yauco.*** La recopilación de datos se llevó a cabo mediante observaciones de campo, hincado de barrenos exploratorios y pozos de monitoreo, realización de pruebas hidráulicas, examen de mapas (topográfico, geológico, entre otros), planos de la facilidad y fotos aéreas, y la revisión de publicaciones, estudios y otros documentos pertinentes provistos por la firma operadora del vertedero, ***LM Waste Service Corp.***

El hincado de barrenos exploratorios y construcción de pozos de monitoreo (detalles en **Tabla 1**) fue realizado por los ingenieros geotécnicos ***Victor E. Rivera Associates***, a tenor con la metodología y especificaciones aceptadas. La distribución y ubicación de siete (**7**) barrenos exploratorios y seis (**6**) pozos de monitoreo se configuró a los fines de garantizar resultados representativos de la condición hidrogeológica existente. La profundidad de los barrenos exploratorios fluctuó entre los **35** y **60** m, siendo determinada en función de la ubicación y espesor de la unidad acuífera y la detección del subyacente estrato de lodolita o conglomerado, límites estratigráficos de la formación. El examen de las muestras geológicas (obtenidas a intervalos de **1.5** m) fue realizado por el geólogo-ingeniero ***Mario Soriano Ressi,*** quien describió y caracterizó la condición litológica y estratigrafía de la localidad de estudio.

La construcción de los pozos de monitoreo se llevó a cabo a tenor con la información hidrogeológica obtenida de los barrenos exploratorios: ubicación y espesor de la unidad acuífera, nivel de agua, condición hidrostática y calidad mineral de las aguas. Los pozos fueron terminados bajo la unidad acuífera con camisilla de plástico **PVC** de dos (**2**) pulgadas de diámetro y perforada a través del espesor saturado de la unidad.

Mediante una "***corrida de niveles y calidad***" (realizada el 29 de marzo de 2007 y que incluyó los tres (3) pozos de monitoreo existentes) se preparó un mapa potenciométrico con el **método de triangulación** *(Driscoll,* 1989) y se determinó la dirección del flujo y salinidad de las aguas. Las propiedades hidráulicas se obtuvieron de pruebas realizadas en pozos seleccionados utilizando el **método de porrazo** (slug) y de **extricación** (bailer method). Los valores se computaron a partir de curvas de recuperación y la aplicación de modelos analíticos correspondientes (ver **Anejos**).

Tabla 1. Localización geográfica y datos de construcción relevantes a los pozos de monitoreo instalados en el Vertedero Municipal de Yauco.

Pozo	Coordenadas		Elevación (m) (SNM)	Barreno Exploratorio		Pozo de Monitoreo	
	X	Y		Profundidad (m) (BLS)	Nivel de Agua	Profundidad (m) (BLS)	Intervalo Rejillado
MW-101	153862.14	218601.21	63.93	35.05	14.48	21.31	13.7 - 19.8
MW-102	154077.62	218026.10	128.78	60.96	25.60	28.94	21.3 - 27.4
MW-103	154215.95	217805.99	109.70	15.80	nd	no completado	
MW-104	154808.31	217695.97	82.34	47.24	25.90	30.46	25.9 - 29.0
MW-105	155051.03	217951.73	129.00	56.39	36.27	47.22	44.2- 45.7
MW-106	155007.24	218420.89	141.37	42.67	21.94	25.88	21.3 - 24.4
MW-107	154546.85	218492.40	120.15	25.00	22.86	32.00	27.4 - 30.5
MW-1 *	154232.52	218753.94	74.63	53.34	45.72	25.60	16.4 - 25.6
MW-2 *	152512.68	217919.28	110.90	76.20	25.60	32.00	22.8 - 32.0
MW-3 *	154732.34	218174.37	116.08	15.24	10.30	15.24	6.0 -15.2

* Pozos existentes - datos de construcción según bitácora de contratista, provista por LM Corp.

Aguas Superficiales

Ocurrencia

Debido a que el potencial de evapotranspiración (**2,020** mm) en las colinas y llanos costeros de las cuencas hidrográficas del **Río Yauco** y el **Río Loco** duplica la recarga de agua provista por la precipitación (**780** mm), la ocurrencia de corrientes de agua superficial en los cauces de drenaje que sirven la localidad de estudio resulta un evento extraordinario. Como factor agravante, de la porción residual una parte se infiltrará al subsuelo y otra será almacenada en la vegetación de las áreas de bosque. Lo cierto es, que solo bajo eventos de precipitación de gran intensidad y duración se podría generar suficiente escorrentía para sostener un flujo a través de las hondonadas de drenaje capaz de accesar el cauce principal de dichos ríos.

En adición a los factores mencionados, el surgimiento de corrientes en los cauces de drenaje que sirven los terrenos del vertedero está restringido por la limitada extensión del área de captación correspondiente a dichos cauces. Por otra parte, la condición geológica y topográfica de los terrenos no permite aportaciones de caudal provenientes de sistemas de drenaje subterráneo, factor que típicamente sostiene el flujo básico de sistemas superficiales lóticos. Lo cierto es, que las aguas subterráneas en la **Formación Juana Díaz** están contenidas en una unidad cuya posición litológica, entre otros factores, impide el afloramiento de estas al sistema de drenaje superficial.

Patrón de Drenaje

La dinámica del drenaje superficial es función de las condiciones climáticas, topográficas, geológicas, suelos y usos del terreno que presenta un área en particular. El drenaje inicia con la **escorrentía** (*flujo de agua sobre el terreno*) que se genera cuando el caudal de precipitación excede la tasa de infiltración, lo que ocurre por lo

general durante períodos de lluvias intensas y terrenos saturados. El movimiento de las aguas terrestres responde a la fuerza de gravedad, por lo que el flujo de escorrentía habrá de ocurrir a través de un gradiente altitudinal, esto es, hacia el punto de menor elevación.

La mayor parte de los terrenos donde ubica el vertedero pertenecen a la cuenca de drenaje del **Río Yauco** mientras que una porción de la margen norte está contenida en la cuenca del **Río Loco** (**Figura 3**). Se entiende que el origen de los cauces de ***primer*** y ***segundo orden*** que sirven la localidad fue promovido estructuralmente, esto es, por actividad tectónica que facilitó el surgimiento de rutas de menor resistencia.

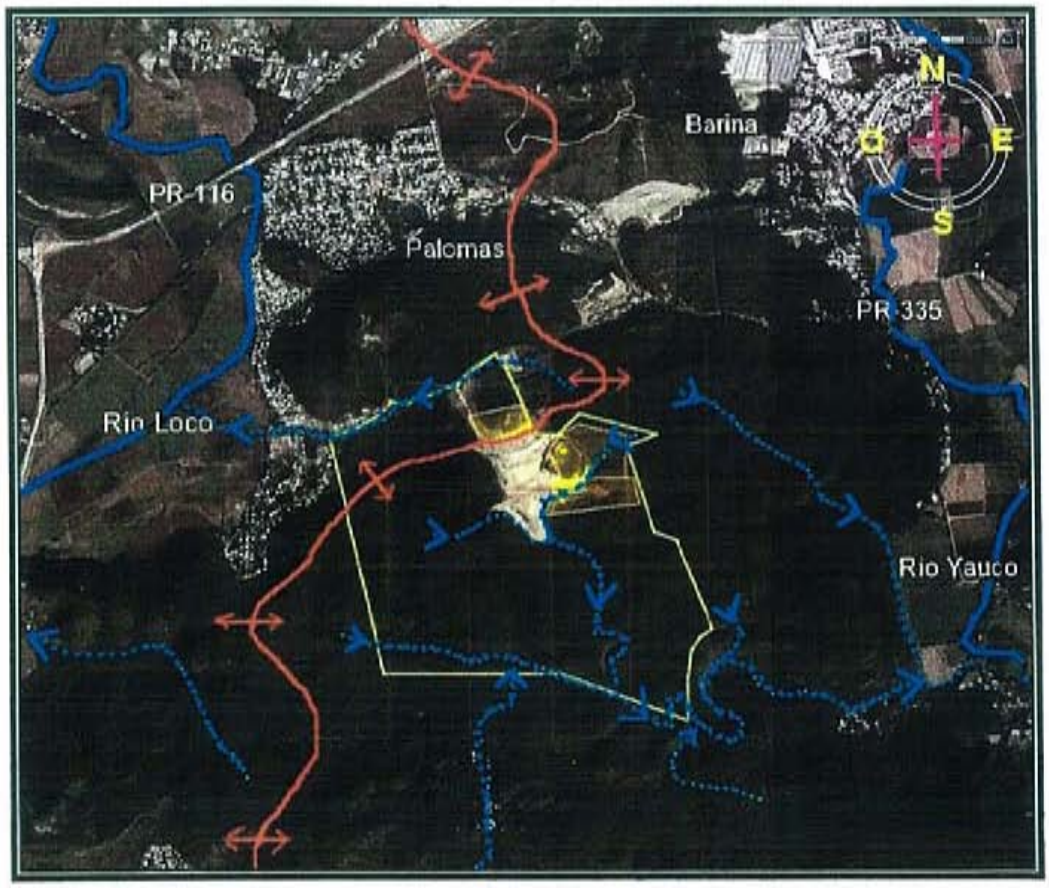

Figura 3. Divisoria de cuencas del Río Yauco y Río Loco y cauces de primer y segundo orden en la localidad del Vertedero Municipal de Yauco.

El área donde aflora la unidad basal de la **Formación Juana Díaz** está cubierta principalmente por suelos de la asociación ***Descalabrado-Jácana-San Germán***, que exhiben una permeabilidad moderada (**0.6** a **2.0** plg/hr} (*Gierbolini, 1975*). Se entiende que por su alto contenido de arcilla, la razón de infiltración de estos suelos disminuye según aumenta la húmedad, por lo que en áreas de pendientes pronunciadas se generará una escorrentía rápida.

Por otra parte, en las áreas donde aflora la unidad caliza se espera el surgimiento de un caudal de escorrentía menor, pues la carencia de suelos y el desarrollo de porosidad secundaria en la roca caliza promoverá una razón de infiltración mayor. Finalmente es menester indicar que la escorrentía generada sobre las áreas de relleno sanitario, así como también el afloramiento de lixiviados drenarán a las charcas de retención correspondientes. Solo cuando la capacidad de almacenamiento de las charcas sea excedida tendrán estas aguas el potencial de accesar los cauces de drenaje principales. En la **Figura 4** se presenta una conceptualización del patrón de drenaje en las inmedicaciones del vertedero.

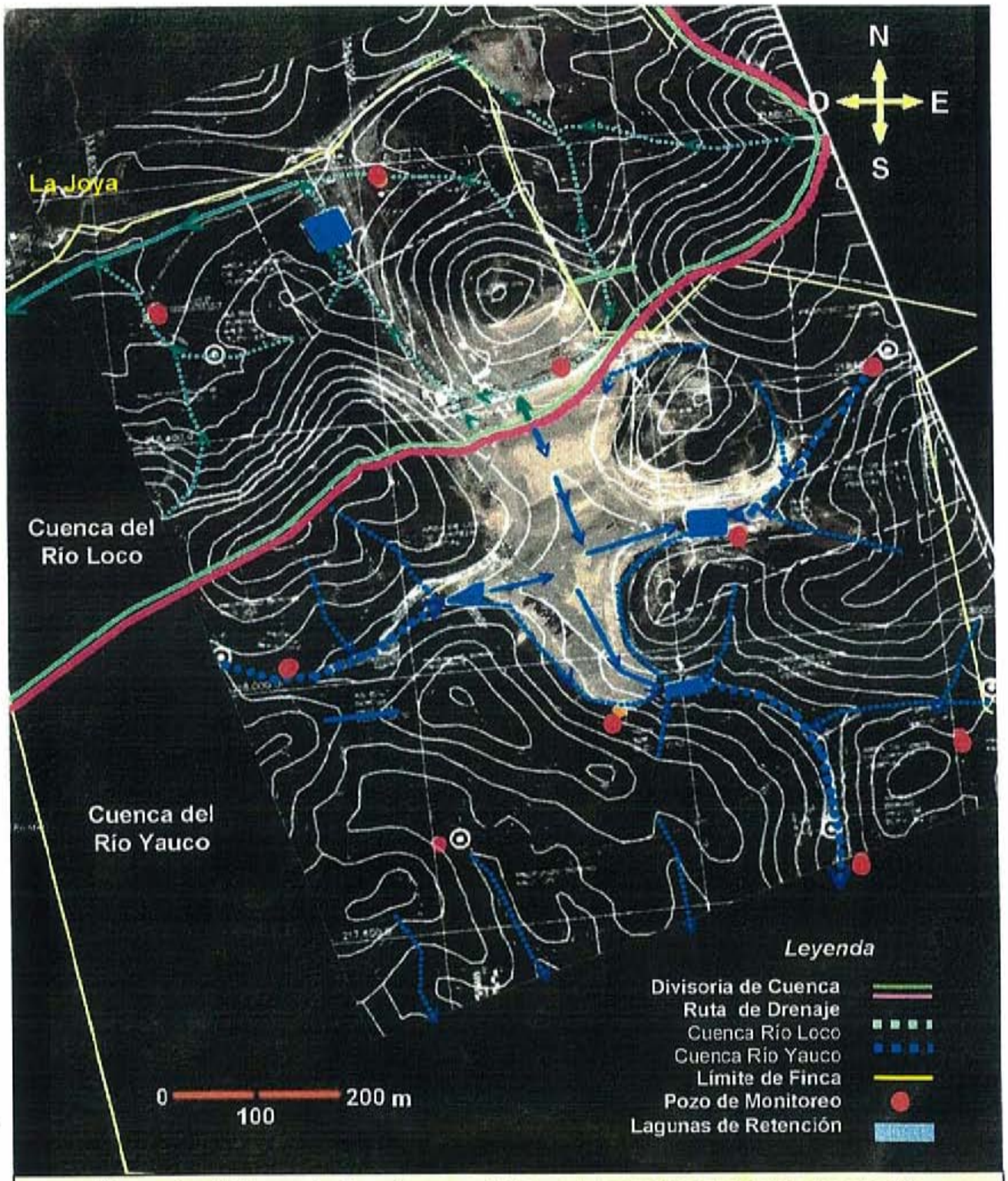

Figura 4. Sistema de drenaje superficial y rutas preferenciales de escorrentía en la finca del Vertedero Municipal de Yauco.

Aguas Subterráneas

Ocurrencia

En la localidad de estudio las aguas subterráneas están contenidas en un estrato cuya baja permeabilidad y pobre conductividad hidráulica impide el aprovechamiento de estas como fuente de abasto (condición contraria al concepto que típicamente define a un "**acuífero**"). No obstante, la capacidad de dicho estrato para transmitir agua resulta suficiente para permitír la caracterización del sistema de drenaje subterráneo, condición que lo cualifica como "**acuitardo**". Por otra parte, en una secuencia estratigráfica la clasificación de estratos como acuíferos o acuitardos es una determinación relativa que responderá al grado de conductividad hidráulica o permeabilidad que presenten *(Freeze & Cherry, 1979)*. Por ejemplo, en una secuencia de arena y cienos, los cienos se consideran acuitardos, mientras que en una secuencia de cieno y arcilla serían acuífera.

Considerando la naturaleza impermeable de la secuencia de estratos mayores que componen la **unidad basal** de la **Formación Juana Díaz** (margas calcáreas - arcilla densa - lodolita – conglomerado) (ver **Anejo**) y la no detección de otras zonas saturadas (perchadas), resulta procedente tratar el referido estrato saturado como la unidad acuífera de la localidad de estudio. Dicha unidad se detectó entre el estrato de arcilla densa (de unos **10** a **20** m de espesor) y en las áreas fronterizas superior e inferior, extendiendose en el plano horizontal sin interrupción aparente. La unidad, cuyo espesor fluctuó entre unos dos (**2**) a cuatro (**4**) m, exhibió variación areal en sus componentes. Secuencias de ***arena-cieno*** y ***cieno-arena*** predominan en la localidad de los pozos **MW-101** y **MW-102**, mientras que la localidad de los pozos **MW-104, MW-105** y **MW-106** presenta una matriz de fragmentos de roca caliza, arena y cieno.

Los datos de nivel de agua obtenidos durante el hincado de los barrenos exploratorios indican que las aguas se encuentran bajo condiciones de confinamiento. En todos los barrenos el nivel de agua registrado se elevó por encima de la unidad saturada. Dicho comportamiento está en armonía con el ambiente geológico donde ocurren las aguas subterráneas, esto es, flanqueadas por estratos impermeables.

Patrón de Drenaje

Al igual que las aguas superficiales el movimiento y dirección de las aguas subterráneas responde a la fuerza de gravedad, por lo que la orientación del drenaje habrá de ocurrir a través de un gradiente altitudinal hacia el punto de menor elevación, en otras palabras, del área de recarga a la de descarga. El sistema presenta un potencial de recarga muy limitado dependiente del caudal de aguas meteóricas que pueda infiltrarse, condición a ocurrír preferencialmente en el afloramiento de la unidad caliza. Aún cuando los valles aluviales del **Río Yauco** y el **Río Loco** constituyen áreas de descarga potenciales, la pobre capacidad de transmición del sistema limita grandemente aportaciones al acuífero aluvial. De hecho, las colindancias del sistema se consideran fronteras de no flujo o impermeables. Debido a que la extracción de agua de la **Formación Juana Díaz** es mínima (si alguna) se puede establecer que el sistema esta en equilibrio dinámico donde la recarga es igual al volumen de recarga.

El mapa potenciométrico (**Figura 5**) muestra el patrón y dirección del drenaje que caracteriza al sistema. Las lineas de contorno concéntricos indican la presencia de un área de recarga preferencial en las partes altas del afloramiento de la **Formación Juana Díaz.** La misma actua como divisoria del flujo de aguas subterráneas en la localidad de estudio. A tenor con los gradientes una porción del flujo discurre hacia la cuenca del Río Yauco y otra hacia el Río Loco. Determinaciones en el plano vertical evidenciaron un gradiente hidráulico mínimo lo que junto al poco espesor de la unidad acuífera resulta poco relevante su influencia en la dinámica del drenaje subterráneo.

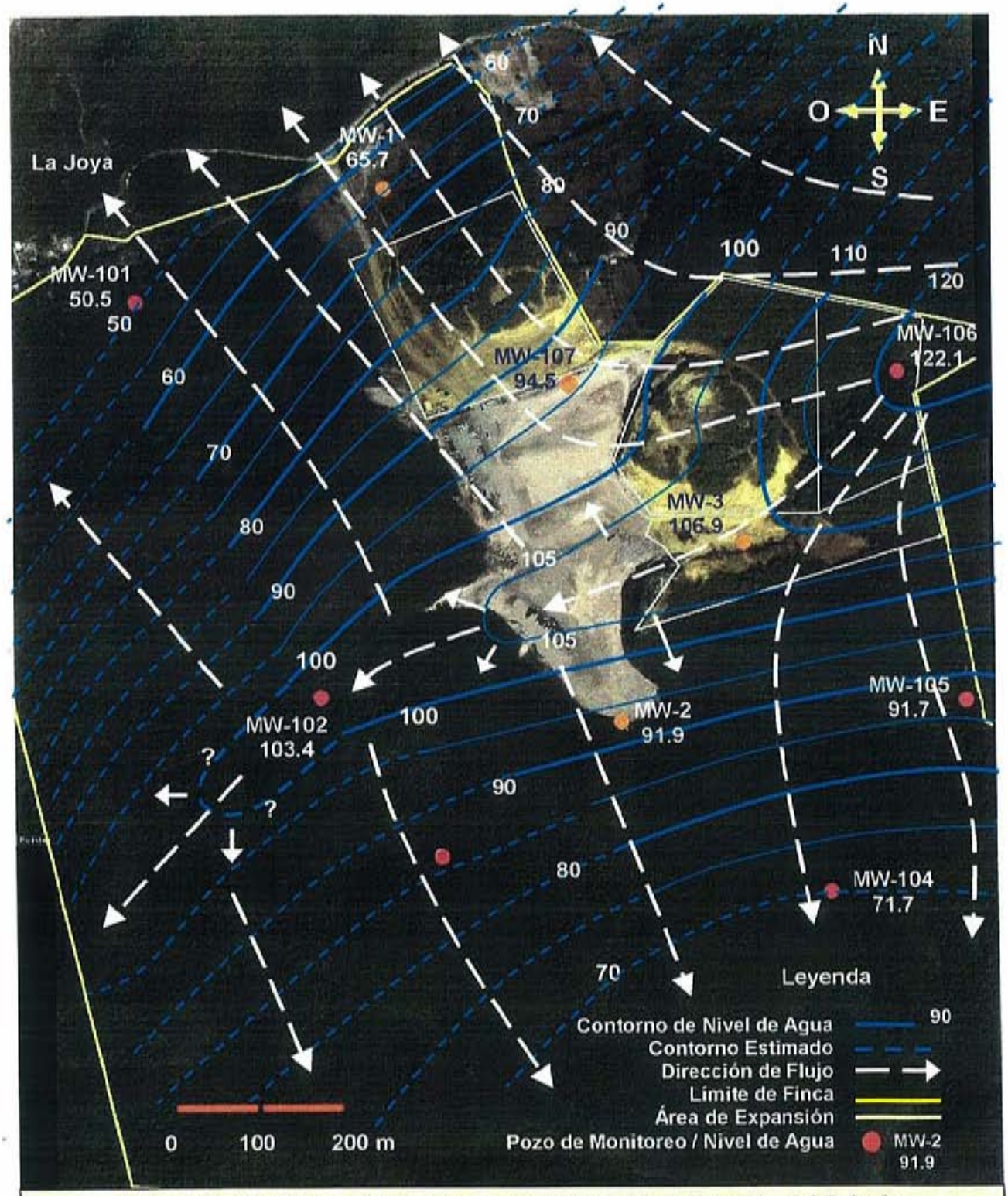

Figura 5. Configuración del nivel potenciométrico y dirección del flujo de aguas subterráneas en el área del Vertedero de Yauco al 29 de marzo de 2007. (Elevación en metros sobre el nivel del mar)

Propiedades Hidráulicas

La capacidad de transmición y almacenaje que exhibe la unidad acuífera esta dada por la **transmisividad** (T) y el **coeficiente de almacenamiento** (S), respectivamente. El estado de confinamiento y la cobertura total del espesor de la unidad permitieron la obtención de resultados confiables y representativos (**Tabla 2**) (**Figura 6**). Los valores de transmisividad correlacionan con la naturaleza heterogénea de la unidad acuífera y con la **conductividad hidráulica** (K) esperada para unidades de naturaleza impermeable. La conductividad hidráulica exhibe variación areal (condición **heterogénea**) (ver **Anejo**) y con toda seguridad en el plano horizontal y vertical (condición **anisotrópica**).

Los valores del coeficiente de almacenamiento correlacionan con los esperados para unidades acuíferas confinadas, donde típicamente fluctuan entre $\mathbf{10^{-5}}$ a $\mathbf{10^{-3}}$ (0.00001 a 0.001) (*Lohman, 1979, Driscol, 1989*). Para acuiferos **freáticos** el *coeficiente* es equivalente al rendimiento específico, fluctuando entre **0.1** a **0.30** donde **0.20** es un valor representativo para la gran mayoría de los escenarios.

El estimado de la *velocidad promedio* entre rutas seleccionadas reflejo diferencias significativas entre estas (**Tabla 3**). Se entiende que dicha condición es producto de la variabilidad areal en permeabilidad y conductividad hidráulica que exhibe la unidad acuífera. Basandonos en los datos obtenidos se estimó que un contaminante generado en el área del **MW-106** tardaría unos **14** años en llegar al área del pozo **MW-104**, **25** años al **MW-101** y **70** años al **MW-102.** La ruta entre **MW-102** y **MW- 101** tardaria unos **550** años. Se enfatiza que ante un evento contaminante real se debe considerar que la mas rápida razón de movimiento excedará varias veces el valor promedio aquí computado.

Tabla 2. Propiedades hidrogeológicas de la unidad acuífera en el área de pozos de prueba seleccionados en el Vertedero Municipal de Yauco.

Area	Condición Hidrostática	Composición de Matriz Geológica	Transmisividad			Coeficiente de Almacenamiento
			cm^2/sec	p^2/dia	gpd/p	
MW-101	Confinado	Secuencia de arena-cieno y cieno-arenoso de unos 3 m de espesor en estrato de arcilla. Entre 49.6 y 46.5 m sobre el nivel del mar (SNM)	0.002	0.15	1.09	5.5E-02
MW-102	Confinado	Secuencia de arena-cieno y cieno-arenoso de unos 3 m de espesor en contacto del estrato de arcilla y la lodolita. Entre 104 y 101.5 m SNM	0.002	0.19	1.43	3.3E-05
MW-104	Confinado	Fragmentos de roca caliza y arena de unos 4 m de espesor en lente de caliza y arcilla. Entre 54.5 y 50.3 m SNM.	0.004	0.40	2.33	1.0E-04
MW-106	Confinado	Fragmentos calizos y cieno arenoso con lente de roca caliza dura (0.3 m) de unos 1.5 m de espesor en estrato de caliza y arcilla. Entre 119 y 117.5 m SNM.	0.24	22	167	2.1E-03

Tabla 3. Estimado de la velocidad promedio del flujo de aguas subterráneas entre rutas seleccionadas del Vertedero Municipal de Yauco.

Ruta Seleccionada		Distancia	Velocidad Promedio	
de	a	(pies)	pies por día	metros por día
MW-102	MW-101	2011	**0.01**	**0.003**
MW-102	MW-104	2625	**0.01**	**0.003**
MW-106	MW-101	3937	**0.44**	**0.13**
MW-106	MW-104	2953	**0.58**	**0.18**
MW-106	MW-102	3347	**0.13**	**0.03**

Figura 6. Transmisividad (T), Coeficiente de Almacenamiento (S) y Velocidad Promedio (V) en área de pozos de prueba seleccionados en Vertedero Municipal de Yauco. (Elevación en metros sobre el nivel del mar)

Calidad de Agua

La corrida de calidad realizada el 29 de marzo de 2007 evidenció gran variabilidad areal en el contenido mineral o salinidad de las muestras coleccionadas a un (1) metro bajo el nivel del agua en los pozos de monitoreo (**Tabla 4**) (**Figura 7**). A tenor con la clasificación consultada (Hem, 1989) en el área del pozo **MW-101** las aguas clasifican como "**muy salinas**" (concentración de solidos disueltos (TDS) entre 10,000 y 35,000 mg/L), en el área del pozo **MW-2** como "**moderadamente salinas**" (TDS: 3,000 – 10,000 mg/L) y como "**levemente salinas**" (TDS: 1,000 –3,000 mg/L) en el área del pozo **MW-1**.. En las áreas restantes las aguas subterráneas clasificaron como "**frescas**" (TDS < 1,000 mg/L).

Es menester destacar que la condición de salinidad en el área del pozo **MW-101** es similar a la que presenta el agua de mar. No obstante, por su distancia al litoral costero, ubicación topográfica y litológica se descarta que la mineralización de las aguas sea producto de una interacción con la cuña de agua salada. Se entiende que la condición actual es reflejo del ambiente marino donde se originó la **Formación Juana Díaz** y de la pobre capacidad de "**lavado**" que presenta la localidad de dicho pozo.

La variabilidad areal en salinidad aparenta estar asociada a la correspondiente variabilidad en permeabilidad y conductividad hidráulica que presenta arealmente la unidad acuífera. Por otra parte, la presencia de aguas subterráneas frescas correlaciona con las áreas preferenciales de recarga donde aflora la unidad caliza y se entiende que ocurre la mayor razón de infiltración.

CONSIDERACIONES SOBRE EL USO PROPUESTO

A tenor con la evidencia recopilada y el análisis realizado se entiende que la utilización del área contemplada (unas **60** cuerdas) para expandir lateralmente las facilidades del **Vertedero Municipal de Yauco** no tendrá impacto detrimental alguno en la dinámica y condición actual de los sistemas hidrológicos presentes en la localidad, considerando que dicha actividad se llevará a cabo a tenor con las normas y criterios operacionales requeridos.

El grado de aislamiento hidrológico que exhiben los sistemas de drenaje superficial y subterráneo contenidos en la localidad de estudio impide que el referido proyecto constituya un factor de riesgo para las fuentes de abasto en el área, limitadas mayormente a las aguas subterráneas contenidas en los acuíferos aluviales del **Río Yauco** y **Río Loco**. Lo cierto es, que la relación e interacción hidrológica de dichos sistemas con las cuencas de drenaje correspondientes es prácticamente irrelevante.

Por otra parte, la impermeabilidad y pobre conductividad hidráulica de los estratos que componen la **Formación Juana Díaz** constituye una "barrera" natural que limita significativamente el acceso de contaminantes a la unidad saturada, así como también su transporte en el plano horizontal. Es menester indicar que el área de expansión contemplada esta limitada mayormente a terrenos con un bajo potencial de infiltración. Lo cierto es, que la localidad de estudio presenta unas características hidrológicas favorables para el uso de terreno actual.

Finalmente indicamos que el presente estudio ha contemplado los aspectos hidrológicos que permiten reconocer el alcance de un evento de contaminación y predecir su interacción con los sistemas hidrológicos de interés. Dicho conocimiento permite establecer planes de contingencia e iniciar medidas de mitigación efectivas.

Tabla 4. Calidad de las aguas subterráneas y nivel potenciométrico en los pozos de monitoreo del Vertedero Municipal de Yauco al 29 de marzo de 2007.

Pozo	Hora	Nivel de Agua (m) (SNM)	Tem (°C)	pH	SK (uS/cm)	TDS (mg/L)	SAL (ppm)	NO_3 (mg/L)
MW-101	1330	50.47	28	6.9	45,300	29,000	29.83	nd
MW-102	1430	103.44	27	7.6	820	530	0.41	nd
MW-104	1520	71.74	26	7.3	1,120	710	0.56	0.72
MW-105	1500	91.73	27	7.8	670	430	0.33	3.25
MW-106	1350	122.11	26	7.3	960	610	0.48	nd
MW-1	1330	65.68	nd	7.7	3,540	2,300	1.88	4.18
MW-2	1450	91.99	30	7.4	7,550	4,800	4.22	6.70
MW-3	1420	106.92	28	7.5	1,300	840	0.66	nd

Relevancia y Potencial

Desde una perspectiva hidrológica la relación e interacción de los sistemas de drenaje del **Vertedero Municipal de Yauco** con las cuencas del **Río Yauco** y **Río Loco** es por demás limitado y prácticamente irrelevante. De igual manera calificamos su importancia en términos del potencial de aprovechamiento. Lo cierto es, que el grado de aislamiento hidrológico que exhiben y su incapacidad para satisfacer demandas de uso son el resultado de diversos factores de estado, entendiendo como primarios: *el balance de agua negativo que caracteriza la zona* y *la formación geológica que compone los terrenos.*

Como argumento a favor del sistema superficial que sirve los predios se puede postular que bajo eventos de precipitación extraordinarios se podrá generar un flujo a través de los cauces de drenaje capaz de accesar el canal principal de la cuenca y ejercer funciones típicas de ecosistemas lóticos. No obstante, reconociendo que la probabilidad de ocurrencia anual de tales eventos es muy baja y que su intérvalo de recurrencia anual es muy largo, resulta fundamentado reafirmar que la presencia de dicho sistema en el área es prácticamente irrelevante.

En la localidad de estudio el sistema hidrológico subterráneo no tiene el potencial para servir como fuente de abasto pues carece de una unidad geológica capaz de transmitir agua en cantidades aprovechables. La naturaleza impermeable de la **Formación Juana Díaz** se evidencia al comparar la pobre transmisividad registrada para el estrato saturado (**170** galones/día/pie) (gpd/p) con el valor mínimo utilizado (**100,000** gpd/p) para declarar como productiva una unidad acuífera (*Freeze & Cherry, 1979)* y con los valores de transmisividad del productivo acuífero aluvial del **Río Loco**, que fluctuan entre **300,000** a **600,000** gpd/p (McClymonds, 1967).

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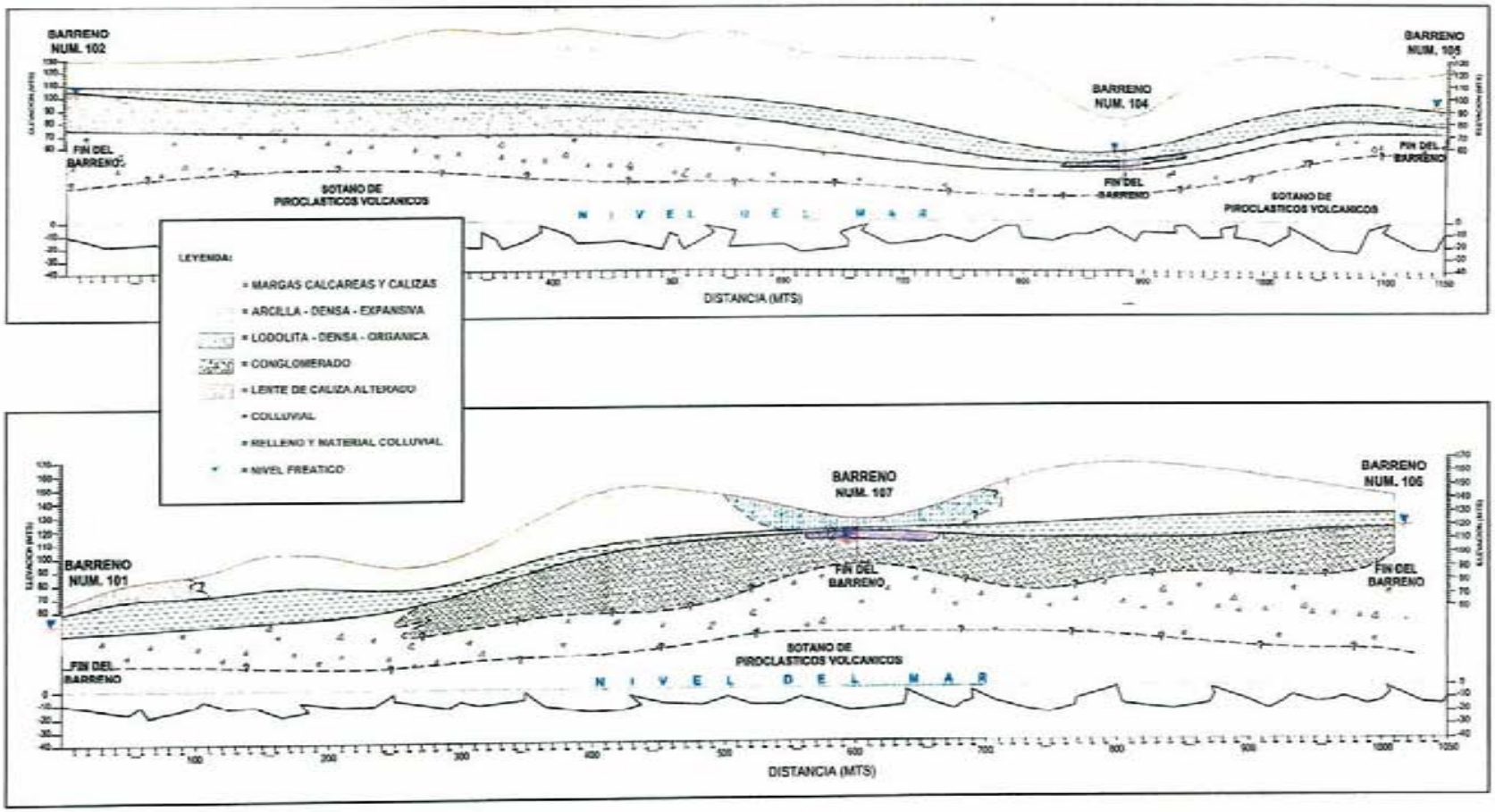
ANEJOS

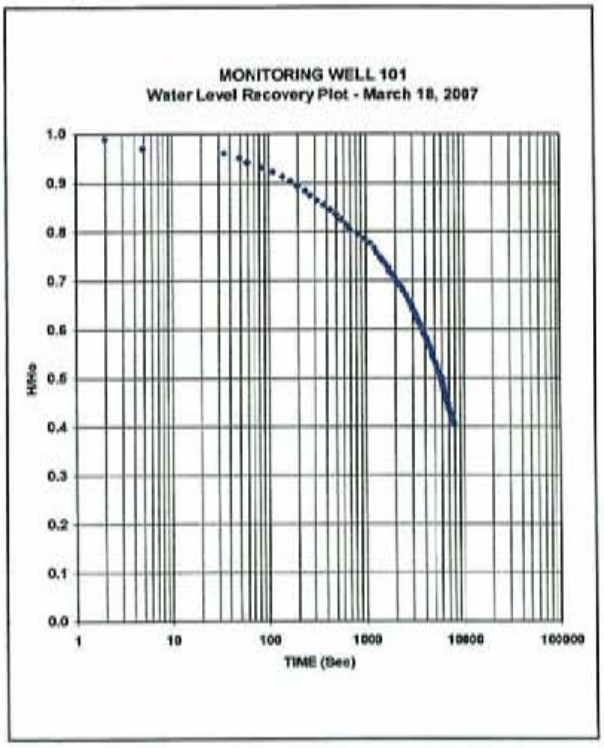
PERFIL ESTRATIGRAFICO: AREA DEL VERTEDERO DE YAUCO

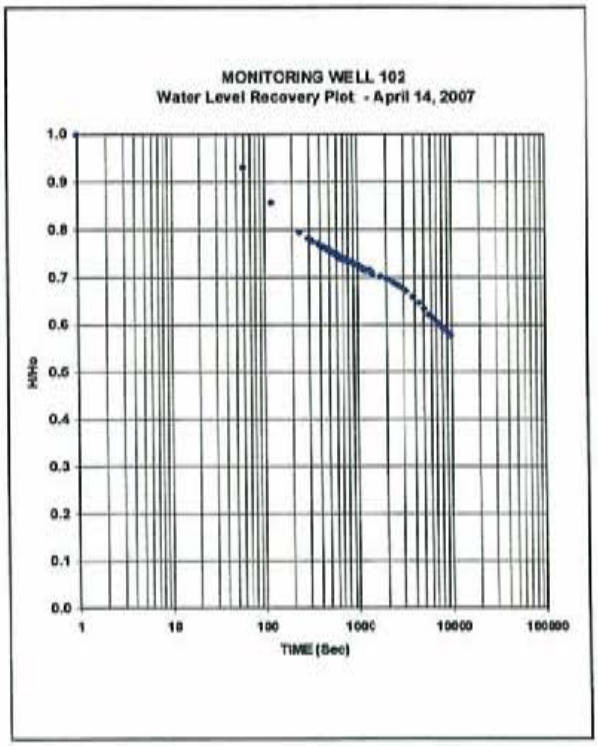
Fuente: Victor Rivera Associates, Inc.

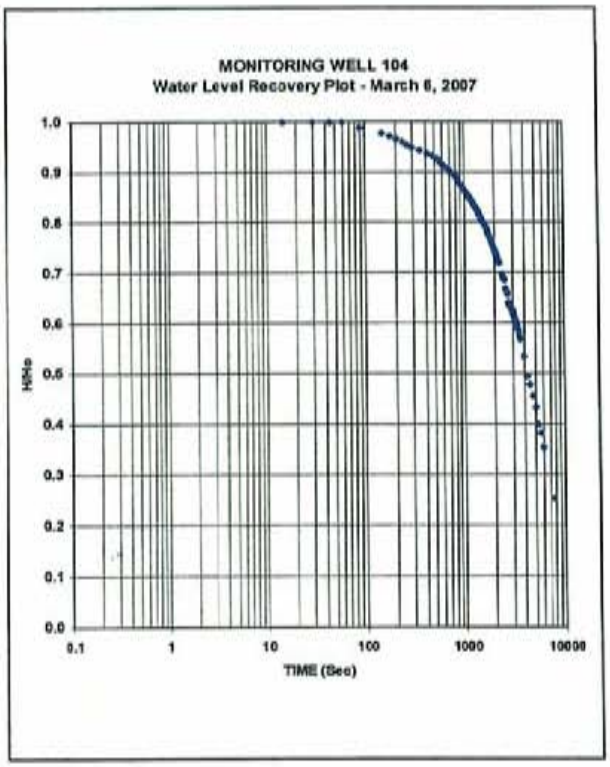
Mario Soriano Ressi -Geólogo

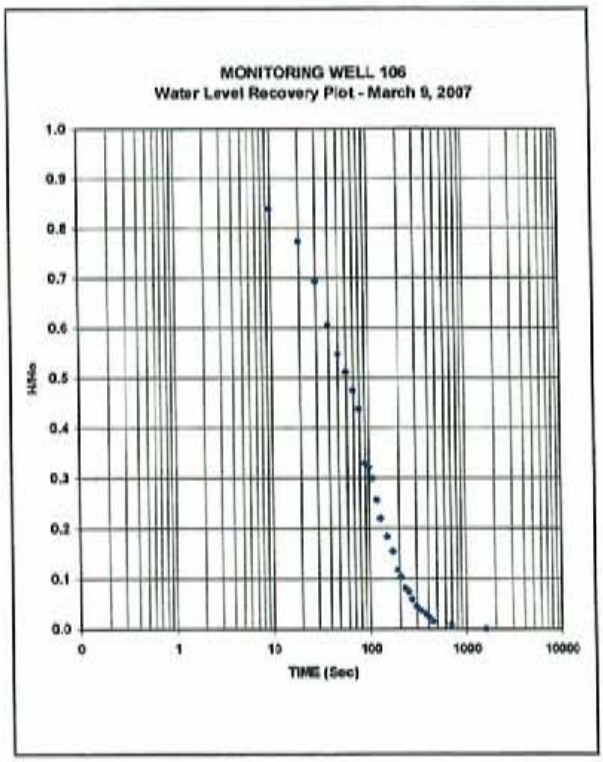


Curvas de recuperación de nivel de agua obtenidas en pozos de monitoreo seleccionados, Vertedero de Yauco, Puerto Rico.









TABLAS DE DATOS

Computo de Transmisividad

Area	Slug	Ts	Bailer	Tb	Range		T	
	Method	cm^2/sec	Method	cm^2/sec	From	To	Units	Average
MW101	Curve 1	0.001	Equation A	0.002	**0.001**	**0.003**	cm^2/sec	**0.002**
	Curve 2	0.001	Equation B	0.003	0.057	0.235	ft^2/day	**0.15**
	Average	**0.001**	Average	**0.003**	**0.423**	**1.75**	gpd/ft	**1.09**
MW102	Curve 1	0.001	Equation A	0.003	**0.001**	**0.004**	cm^2/sec	**0.002**
	Curve 2	0.001	Equation B	0.004	0.057	**0.326**	ft^2/day	**0.19**
	Average	**0.001**	Average	**0.004**	**0.423**	**2.44**	gpd/ft	**1.43**
MW104	Curve 1	0.004	Equation A	0.002	**0.005**	**0.004**	cm^2/sec	**0.004**
	Curve 2	0.006	Equation B	n/a	0.465	0.326	ft^2/day	**0.40**
	Average	**0.005**	Average	**0.002**	**1.19**	**3.48**	gpd/ft	**2.33**
MW106	Curve 1	0.21	Equation A	0.31	**0.23**	**0.25**	cm^2/sec	**0.24**
	Curve 2	0.25	Equation B	0.18	**21.39004**	**23.25005**	ft^2/day	**22.32**
	Average	**0.23**	Average	**0.25**	**160.00**	**173.91**	gpd/ft	**166.95**

Computo de Velocidad Promedio del Flujo

Ruta		Distancia (pies)	*K*	dh/dl	Θ	**Velocidad Promedio**
de	a		p/d	p		(pies por día)
MW102	MW101	2011	0.03	0.09	0.40	**0.01**
MW102	MW104	2625	0.05	0.04	0.31	**0.01**
MW106	MW101	3937	2.28	0.06	0.31	**0.44**
MW106	MW104	2953	2.30	0.06	0.22	**0.58**
MW106	MW102	3347	2.29	0.02	0.31	**0.13**

INSTRUMENTOS ANALITICOS

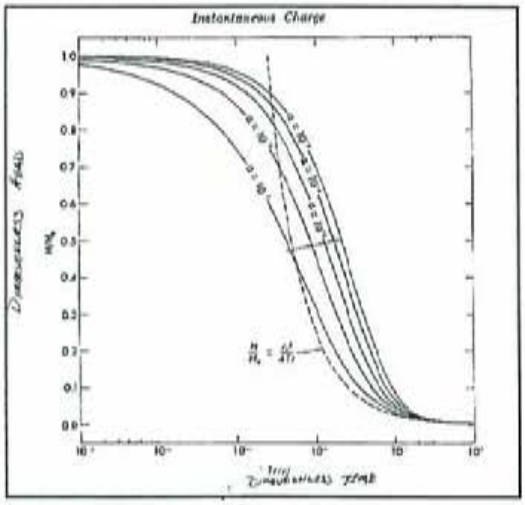
Transmisividad (T)

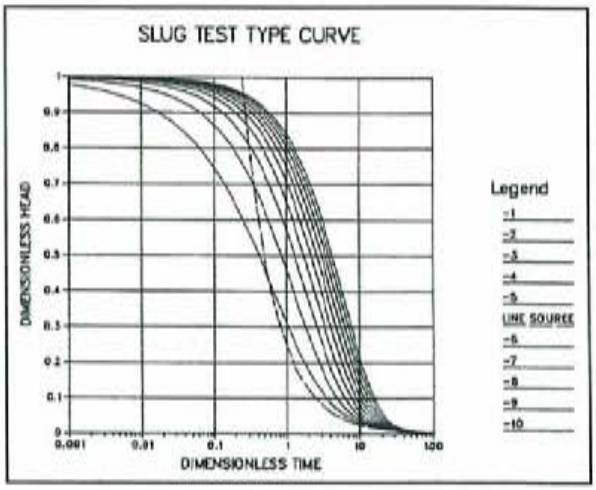
Método de Porrazo (Slug Test) - Solución de Cooper (Lohman, 1979)

$$T = \frac{1.0\,(r_c^2)}{t}$$

T - transmisividad
$Tt\ /\ (r_c^2) = 1.0$ (punto de correlación)
r_c^2 - radio de camisilla
t – tiempo

Curvas Tipo





Método de Extricación (Bailer Test) - Solución de Skibitzke (Lohman, 1979)

$T = \dfrac{V}{4\,(\Pi)\,(s')\,(t)}$	$T = \dfrac{1}{4\,(\Pi)\,(s')}\,[V_1/t_1 + \ldots V_n/t_n]$	$T = \dfrac{V}{4\,(\Pi)\,(s')}\,[1/t_1 + \ldots 1/t_n]$
Un ciclo	Multiples ciclos – *V* variada	Multiples ciclos – *V* constante

V - volumen de agua removido en una extracción, s' - abatimiento residual
t - tiempo en segundos terminada la extracción, Π - pi

Coeficiente de Almacenamiento (S)

Método de Porrazo (Slug Test) - Solución de Cooper (Lohman, 1979)

$$S = \frac{r_c^2}{r_s^2} \alpha$$

S - coeficiente de almacenamiento
r_s^2 - radio de rejilla
r_c^2 - radio de camisilla
α – curva tipo

Velocidad Promedio *(Lohman, 1979)*

$$V = \frac{K\ (dh / dl)}{\Theta}$$

K – conductividad hidráulica
dh /dl – gradiente hidráulico
Θ - porosidad efectiva

DATOS DE RECUPERACION DE NIVEL

MW-104 – 6 DE MARZO DE 2007

T (sec)	Head (bls)	m	H	H/Ho
-1	37.52	11.436	na	na
0	39.3	11.979	0.543	0.999
15	39.3	11.979	0.543	0.999
30	39.3	11.979	0.543	0.999
45	39.3	11.979	0.543	0.999
60	39.3	11.979	0.543	0.999
90	39.28	11.973	0.537	0.988
150	39.26	11.966	0.530	0.977
180	39.25	11.963	0.527	0.971
210	39.24	11.960	0.524	0.966
240	39.23	11.957	0.521	0.960
270	39.22	11.954	0.518	0.954
300	39.21	11.951	0.515	0.949
360	39.20	11.948	0.512	0.943
420	39.19	11.945	0.509	0.938
480	39.18	11.942	0.506	0.932
540	39.17	11.939	0.503	0.926
570	39.16	11.936	0.500	0.921
600	39.15	11.933	0.497	0.915
650	39.14	11.930	0.494	0.910
700	39.13	11.927	0.491	0.904
740	39.12	11.924	0.488	0.898
800	39.11	11.921	0.485	0.893
840	39.10	11.918	0.482	0.887
870	39.09	11.915	0.479	0.881
900	39.08	11.912	0.476	0.876
960	39.07	11.909	0.473	0.870
990	39.06	11.905	0.469	0.865
1050	39.05	11.902	0.466	0.859
1110	39.04	11.899	0.463	0.853
1140	39.03	11.896	0.460	0.848
1200	39.02	11.893	0.457	0.842
1230	39.01	11.890	0.454	0.837
1290	39.00	11.887	0.451	0.831
1350	38.99	11.884	0.448	0.825
1380	38.98	11.881	0.445	0.820
1410	38.97	11.878	0.442	0.814
1470	38.96	11.875	0.439	0.808
1500	38.95	11.872	0.436	0.803
1560	38.94	11.869	0.433	0.797
1620	38.93	11.866	0.430	0.792
1680	38.92	11.863	0.427	0.786
1710	38.91	11.860	0.424	0.780
1740	38.90	11.857	0.421	0.775
1800	38.89	11.854	0.418	0.769
1860	38.88	11.851	0.415	0.764
1890	38.87	11.848	0.412	0.758
1950	38.86	11.845	0.409	0.752
1980	38.85	11.841	0.405	0.747
2010	38.85	11.841	0.405	0.747
2040	38.84	11.838	0.402	0.741
2100	38.83	11.835	0.399	0.736
2130	38.82	11.832	0.396	0.730
2190	38.81	11.829	0.393	0.724
2250	38.80	11.826	0.390	0.719
2400	38.76	11.814	0.378	0.696
2460	38.75	11.811	0.375	0.691
2520	38.74	11.808	0.372	0.685
2580	38.71	11.799	0.363	0.668
2640	38.70	11.796	0.360	0.663
2700	38.69	11.793	0.357	0.657
2760	38.66	11.784	0.348	0.640
2820	38.65	11.781	0.345	0.634
2940	38.84	11.777	0.341	0.629
3000	38.63	11.774	0.338	0.623
3060	38.62	11.771	0.335	0.618
3120	38.61	11.768	0.332	0.612
3180	38.60	11.765	0.329	0.606
3240	38.59	11.762	0.326	0.601
3300	38.58	11.759	0.323	0.595

MW-106 – 9 DE MARZO DE 2007

T (sec)	min	Head (bls)	m	H
-1	-1	65.55	19.980	na
0	0.00	66.92	20.398	0.418
10	0.17	66.70	20.331	0.351
20	0.33	66.61	20.303	0.323
30	0.50	66.50	20.270	0.290
40	0.67	66.38	20.233	0.253
50	0.83	66.30	20.209	0.229
60	**1.00**	66.25	20.194	0.214
70	1.10	66.20	20.178	0.198
80	1.20	66.15	20.163	0.183
90	1.30	66.00	20.117	0.137
100	1.40	65.99	20.114	0.134
110	1.50	65.96	20.105	0.125
120	2.00	65.90	20.087	0.107
130	2.10	65.85	20.072	0.092
150	2.30	65.80	20.056	0.076
170	2.50	65.76	20.044	0.064
190	3.10	65.71	20.029	0.049
210	3.30	65.69	20.023	0.043
230	3.50	65.66	20.014	0.034
250	4.10	65.65	20.011	0.031
270	4.30	65.63	20.005	0.025
300	5.00	65.61	19.999	0.019
330	5.30	65.60	19.996	0.016
375	6.15	65.59	19.992	0.012
420	7.00	65.58	19.989	0.009
450	7.30	65.57	19.986	0.006
690	11.30	65.56	19.983	0.003
1570	26.10	65.55	19.980	0.000

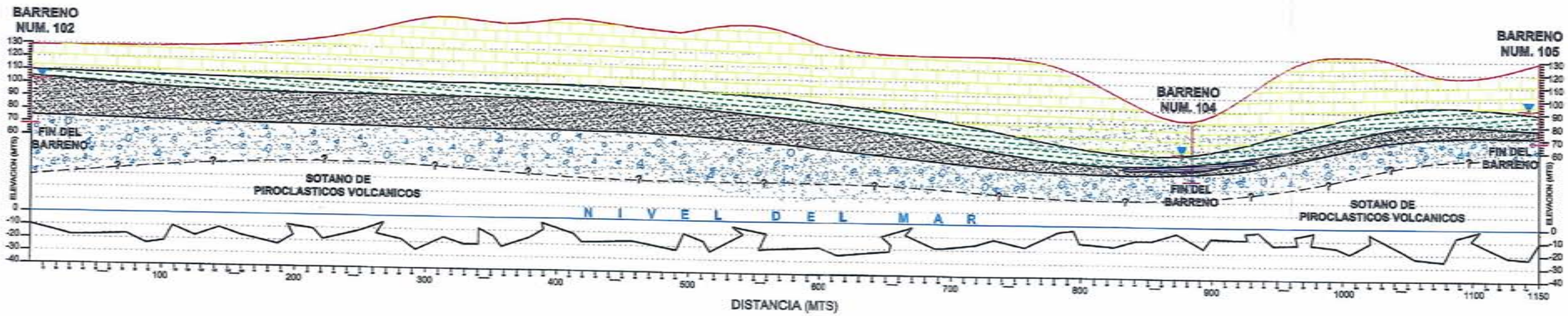
DATOS DE RECUPERACION DE NIVEL

MW-101 – 18 DE MARZO DE 2007

sec	min	WL	H		0.314
-1	-1	48.5	na	m	H/Ho
0	0	49.53	1.03	0.314	1.000
2	0.001	49.52	1.02	0.311	0.990
5	0.08	49.50	1.00	0.305	0.971
35	0.58	49.49	0.99	0.302	0.961
50	0.83	49.48	0.98	0.299	0.951
60	1.00	49.47	0.97	0.296	0.942
85	1.42	49.46	0.96	0.293	0.932
110	1.83	49.45	0.95	0.290	0.922
140	2.33	49.44	0.94	0.287	0.912
170	2.83	49.43	0.93	0.283	0.903
200	3.33	49.42	0.92	0.280	0.893
240	4.00	49.41	0.91	0.277	0.883
270	4.50	49.40	0.90	0.274	0.874
320	5.33	49.39	0.89	0.271	0.864
380	6.33	49.38	0.88	0.268	0.854
440	7.33	49.37	0.87	0.265	0.845
500	8.33	49.36	0.86	0.262	0.835
555	9.25	49.35	0.85	0.259	0.825
635	10.58	49.34	0.84	0.256	0.815
695	11.58	49.33	0.83	0.253	0.806
840	14.00	49.32	0.82	0.250	0.796
980	16.33	49.31	0.81	0.247	0.786
1100	18.33	49.30	0.80	0.244	0.777
1230	20.50	49.29	0.79	0.241	0.767
1290	21.50	49.28	0.78	0.238	0.757
1440	24.00	49.27	0.77	0.235	0.747
1560	26.00	49.26	0.76	0.232	0.738
1700	28.33	49.25	0.75	0.229	0.728
1780	29.67	49.24	0.74	0.226	0.718
1950	32.50	49.23	0.73	0.223	0.709
2070	34.50	49.22	0.72	0.219	0.699
2235	37.25	49.21	0.71	0.216	0.689
2425	40.42	49.20	0.70	0.213	0.680
2595	43.25	49.19	0.69	0.210	0.670
2750	45.83	49.18	0.68	0.207	0.660
2940	49.00	49.17	0.67	0.204	0.650
3090	51.50	49.16	0.66	0.201	0.641
3250	54.17	49.15	0.65	0.198	0.631
3370	56.17	49.14	0.64	0.195	0.621
3565	59.42	49.13	0.63	0.192	0.612
3735	62.25	49.12	0.62	0.189	0.602
3885	64.75	49.11	0.61	0.186	0.592
4150	69.17	49.10	0.60	0.183	0.582
4285	71.42	49.09	0.59	0.180	0.573
4530	75.50	49.08	0.58	0.177	0.563
4650	77.50	49.07	0.57	0.174	0.553
4820	80.33	49.06	0.56	0.171	0.544
5105	85.08	49.05	0.55	0.168	0.534
5310	88.50	49.04	0.54	0.165	0.524
5550	92.50	49.03	0.53	0.162	0.514
5790	96.50	49.02	0.52	0.159	0.505
6030	100.50	49.01	0.51	0.155	0.495
6150	102.50	49.00	0.50	0.152	0.485
6300	105.00	48.99	0.49	0.149	0.476
6495	108.25	48.98	0.48	0.146	0.466
6660	111.00	48.97	0.47	0.143	0.456
7000	116.67	48.96	0.46	0.140	0.447
7140	119.00	48.95	0.45	0.137	0.437
7395	123.25	48.94	0.44	0.134	0.427
7650	127.50	48.93	0.43	0.131	0.417
7935	132.25	48.92	0.42	0.128	0.408

MW-102 – 14 DE ABRILDE 2007

sec	min	WL	H		0.491
-1	-1	85.25	na	m	H/Ho
1	0	86.86	1.61	0.491	0.999
60	1.00	86.75	1.50	0.457	0.931
120	**2.00**	**86.63**	1.38	0.421	0.857
240	4.00	86.53	1.28	0.390	0.795
300	5.00	86.51	1.26	0.384	0.782
330	5.50	86.50	1.25	0.381	0.776
390	6.50	86.49	1.24	0.378	0.770
420	7.00	86.48	1.23	0.375	0.764
450	7.50	86.48	1.23	0.375	0.764
480	8.00	86.47	1.22	0.372	0.757
510	8.50	86.47	1.22	0.372	0.757
540	9.00	86.46	1.21	0.369	0.751
570	9.50	86.46	1.21	0.369	0.751
600	10.00	86.45	1.20	0.366	0.745
630	10.50	86.45	1.20	0.366	0.745
660	11.00	86.44	1.19	0.363	0.739
690	11.50	86.44	1.19	0.363	0.739
750	12.50	86.44	1.19	0.363	0.739
810	13.50	86.43	1.18	0.360	0.733
870	14.50	86.43	1.18	0.360	0.733
930	15.50	86.42	1.17	0.357	0.726
990	16.50	86.42	1.17	0.357	0.726
1050	17.50	86.41	1.16	0.354	0.720
1110	18.50	86.41	1.16	0.354	0.720
1170	19.50	86.40	1.15	0.351	0.714
1230	20.50	86.40	1.15	0.351	0.714
1290	21.50	86.40	1.15	0.351	0.714
1350	22.50	86.40	1.15	0.351	0.714
1410	23.50	86.39	1.14	0.347	0.708
1470	24.50	86.39	1.14	0.347	0.708
1770	29.50	86.38	1.13	0.344	0.701
2070	34.50	86.37	1.12	0.341	0.695
2370	39.50	86.36	1.11	0.338	0.689
2670	44.50	86.35	1.10	0.335	0.683
2970	49.50	86.34	1.09	0.332	0.677
3270	54.50	86.33	1.08	0.329	0.670
3870	64.50	86.31	1.06	0.323	0.658
4470	74.50	86.29	1.04	0.317	0.646
5070	84.50	86.27	1.02	0.311	0.633
5670	94.50	86.25	1.00	0.305	0.621
6270	104.50	86.24	0.99	0.302	0.615
6870	114.50	86.23	0.98	0.299	0.608
7440	124.00	86.22	0.97	0.296	0.802
8040	134.00	86.21	0.96	0.293	0.596
8640	144.00	86.20	0.95	0.290	0.590
9240	154.00	86.19	0.94	0.287	0.584
9840	164.00	86.18	0.93	0.283	0.577



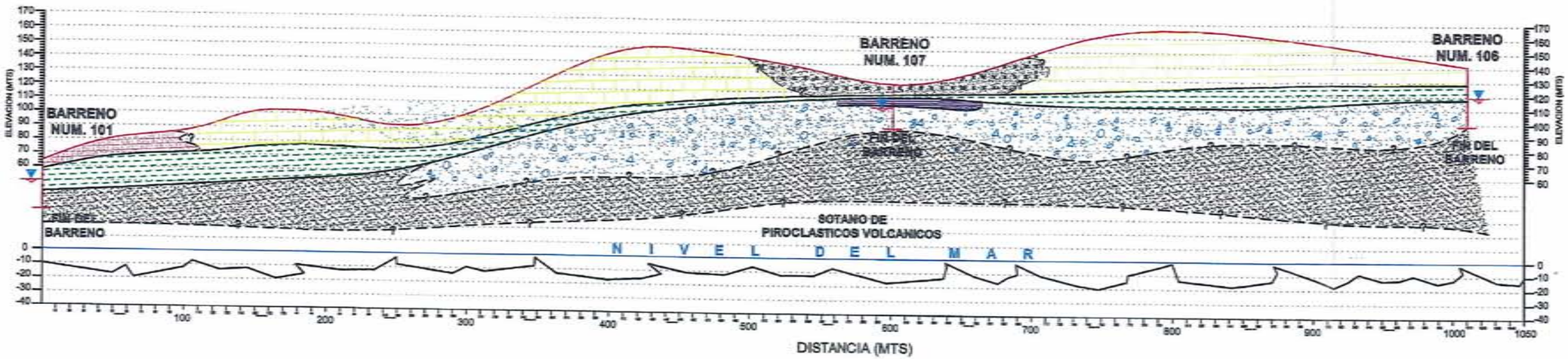
LEYENDA:

- = MARGAS CALCAREAS Y CALIZAS
- = ARCILLA - DENSA - EXPANSIVA
- = LODOLITA - DENSA - ORGANICA
- = CONGLOMERADO
- = LENTE DE CALIZA ALTERADO Y ARCILLA
- = NIVEL FREATICO

PERFIL ESTRATIGRAFICO A A

ESCALA HORIZONTAL = 1:3000
ESCALA VERTICAL = 1:3000

FIGURA NUM. 3



LEYENDA:

- = MARGAS CALCAREAS Y CALIZAS
- = ARCILLA - DENSA - EXPANSIVA
- = LODOLITA - DENSA - ORGANICA
- = CONGLOMERADO
- = LENTE DE CALIZA ALTERADO Y ARCILLA
- = COLLUVIAL
- = RELLENO Y MATERIAL COLLUVIAL
- = NIVEL FREATICO

PERFIL ESTRATIGRAFICO B B

ESCALA HORIZONTAL = 1:3000
ESCALA VERTICAL = 1:3000

FIGURA NUM. 4

Apéndice 8:

Estudio de Ruido

EVALUACION DE IMPACTOS DEBIDO AL RUIDO

EXPANSION LATERAL DE VERTEDERO DE RELLENO SANITARIO

YAUCO, PUERTO RICO

PREPARADO PARA:
LM WASTE SERVICE CORP.

PREPARADO POR:

MORENO ASSOCIATES
ENVIRONMENTAL AND ENGINEERING CONSULTANTS

FEBRERO 2008

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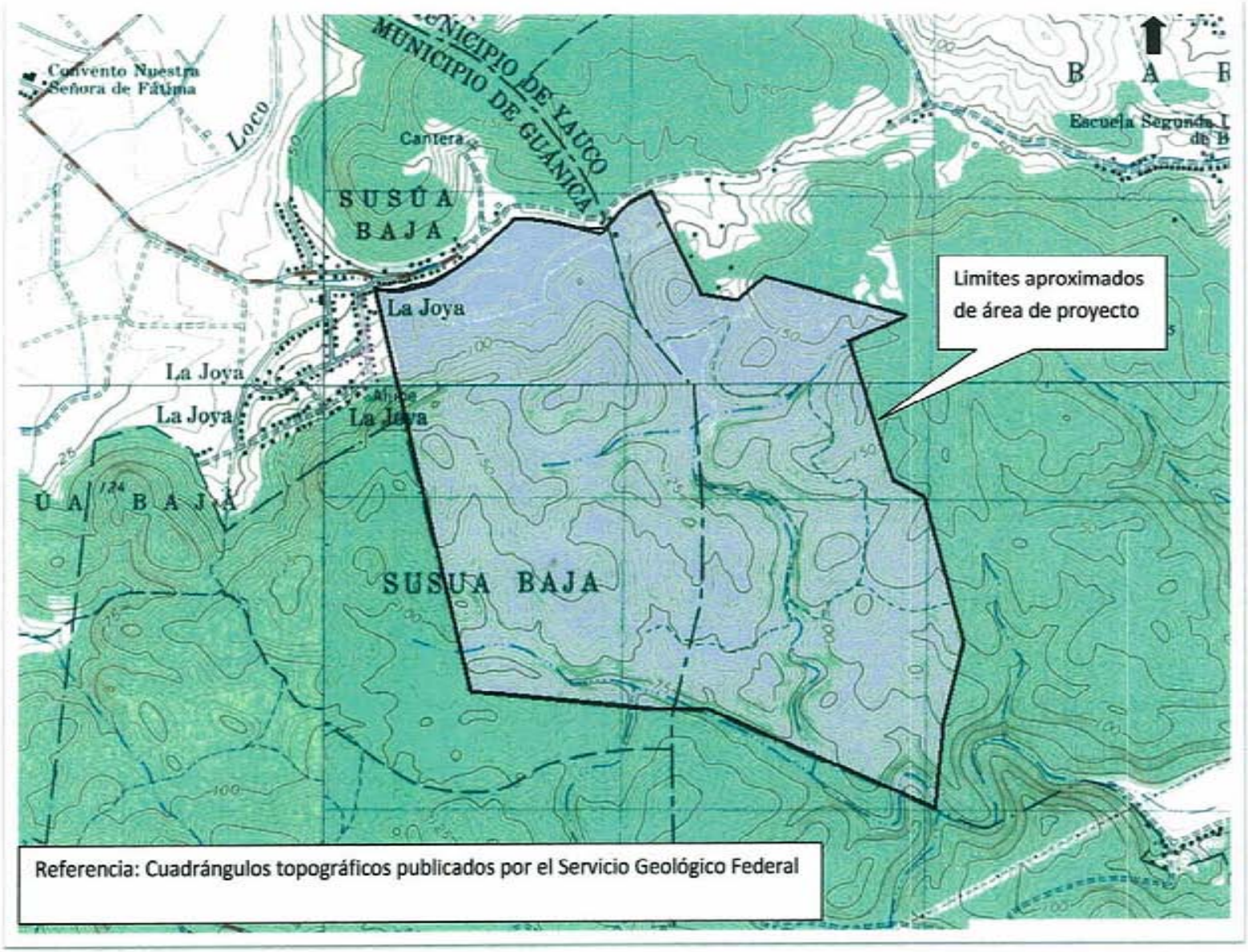

Figura 1: Mapa de localización (escala aproximada 1:20,000)

ESTUDIO DE RUIDO

EVALUACION DE IMPACTOS DEBIDO AL RUIDO

PARA

EXPANSION LATERAL DE VERTEDERO DE RELLENO SANITARIO

YAUCO, PUERTO RICO

FEBRERO 2008

TABLA DE CONTENIDO

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3.0 RESULTADOS DE LA MEDICION DE NIVELES DE RUIDO 8

4.0 ANALISIS DE DATOS 14

5.0 CONCLUSIONES Y/O RECOMENDACIONES 17

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1 FOTOS DEL AREA DEL PROYECTO Y PUNTOS DE MONITORIA RUIDO

2 COPIA DE MANUAL DE SONOMETRO Y CERTIFICADO DE CALIBRACION DE EQUIPO

1.0 Introducción

La compañía **LM Waste Service Corp.** (**LM**), opera un **Vertedero de Relleno Sanitario** (**VRS**) localizado en los municipios de Yauco y Guánica. Este **VRS** recibe desperdicios sólidos no-peligrosos, los cuales luego de ser debidamente compactados, se cubren con material de relleno selecto de acuerdo a las condiciones del **Plan de Operación** para la facilidad aprobado por la **Junta de Calidad Ambiental** (**JCA**). Es decir, que la facilidad opera utilizando el sistema de celdas. La facilidad en cuestión, se encuentra localizada en el Barrio Barina del Municipio de Yauco y el Barrio Susúa Baja de Guánica. El acceso a esta facilidad se realiza pricipalmente a través de un camino municipal que llega hasta la carretera estatal **PR-389** (ver **figura 1** para localización del área del proyecto). No obstante, también se puede utilizar para llegar hasta la facilidad el acceso a través de la carretera estatal **PR-322** y luego tomando la **PR-116** hasta llegar al camino municipal que llega hasta el **VRS**. Esta ruta es menos utilizada que la que se mencionara en primera instancia. Las operaciones de la facilidad abarcan un periodo de más de 10 años. Al presente se planifica la expansión lateral del vertedero hacia el norte y este con respecto a la localización del área activa. Esta propiedad, de la cual actualmente se obtiene material de relleno, tiene una cabida superficial total estimada de 593.0066 cuerdas, que incluyen las 30 cuerdas en donde se ubica el área actualmente en operación (es decir, el área activa). Bajo la propuesta expansión (que se planifica realizar en varias etapas) se han estimado los siguientes requisitos de áreas.

Distribución de áreas	
USO	AREA (en cuerdas)
Area activa en operación	30.0
Expansiones laterales #1, #2, #3 y #4 (las cuales requieren 15.0 cuerdas cada una.)	60.0
Area para Oficinas Administrativas y facilidades de apoyo	15.0
Area para reciclaje de Municipio de Yauco	5.0
Remanente de finca principal y 50 cuerdas reservadas para el desarrollo de nuevas tecnologías	157.0066
Area de amortiguamiento reservada para protección de Bosque Seco de Guánica	326
TOTAL	593.0066 cuerdas

Basados en el Plano de Mensura preparado para la finca, se pueden identificar los siguientes colindantes:

Colindancia	**Colindantes**
Norte	Quebrada Barinas y carretera estatal **PR-389** en una parte
Sur	Bosque Seco de Guánica
Este	Varios vecinos
Oeste	Comunidad La Joya, Autoridad de Tierras, Hacienda Santa Rita

De la revisión del Plano de Mensura provisto, así como de la observación del área en cuestión, resalta el hecho de que no hay vecinos de tipo residencial inmediatos en las áreas en las cuales se llevan a cabo actualmente las operaciones, ni en las cercanías de las áreas para expansión lateral propuestas. Tomando en consideración la escala gráfica del plano se puede estimar que la distancia menor entre las áreas de expansión propuestas y las residencias más cercanas existentes en el lugar es de aproximdamente 500 metros. Las residencias más cercanas al lugar se encuentran en las inmediaciones de la colindancia norte de la propiedad, hacia la Comunidad La Joya. Es de destacarse el hecho de que el área activa se localiza hacia el centro de la finca.

Los datos antes mencionados, fueron utilizados para identificar lugares en los cuales se tomarían lecturas de los niveles de ruido existentes, de forma tal que se pueda documentar el ambiente sonoro existente. Estos lugares se podrían considerar como receptores críticos para efectos de niveles de ruido. Como nota aclaratoria, es de esperarse que los niveles de ruido que generará la operación del **VRS** se mantengan muy similares a los niveles actuales debido a que se continuarán utilizando los mismos equipos pesados. Estos niveles de ruido se midieron a varias distancias desde el área activa para observar la relación entre distancia y el ruido.

Es importante indicar, que como medida de protección para el Bosque Seco, se está manteniendo una franja de conservación. De esta manera, se puede indicar que el proyecto de expansión no afectará directamente este sistema natural de reconocida importancia.

La información obtenida de la realización de este estudio, será utilizada en la redacción de la **Declaración de Impacto Ambiental** (**DIA**) que deberá ser preparada y circulada entre las agencias con pertinencia en el proyecto.

Es importante indicar que en Puerto Rico la **Junta de Calidad Ambiental** (**JCA**) es la agencia que por mandato de ley tiene la facultad para promulgar los reglamentos que estime necesarios para salvaguardar la calidad del ambiente. Para cumplir con este propósito, la agencia reglamenta la contaminación debido al ruido ambiental mediante la aplicación del **Reglamento para el Control de la Contaminación por Ruidos** (**RCCCR**), así como otros reglamentos sobre aspectos ambientales tales como contaminación atmosférica, contaminación de terrenos, y contaminación de aguas. Nos obstante, en este caso particular, nos circunscribiremos a la reglamentación aplicable al aspecto de contaminación debido al ruido. El **RCCR** establece límites numéricos para los niveles de ruido que se permiten entre lo que se designan como fuente emisora y zona receptora. De esta manera, se establecen criterios específicos que se basan en la naturaleza de las actividades que se llevan a cabo en el predio originador del ruido (fuente emisora) y del predio que recibe los ruidos generados por la operación (zona receptora). Es decir, que se definió el uso de los procedimientos y tipo de información ha ser obtenido de manera que los mismos sean consistentes y compatibles con los que establece la **JCA** en su **RCCA**.

De esta determinación resulta necesario comenzar por definir que el período de medición de los niveles de ruido que deberán ser utilizados para recopilar la información no puede ser menor de 30 minutos según definido en el **RCCR**. También se definió, que el nivel de ruido a utilizarse es el nivel de ruido L_{10}, el cual se expresa en decibeles medidos en la escala **A**. En la siguiente sección, se abundará un poco más con respecto a estas unidades.

La comparación entre los niveles medidos y los niveles máximos permitidos por la **JCA** para una zona de tipo residencial, ayudarán a una mejor planificación del proyecto. Es decir, que el objetivo final de este estudio es establecer las bases para una evaluación científica de la situación existente, de acuerdo con la reglamentación ambiental aplicable.

2.0 Discusión de aspectos reglamentarios

2.1 Reglamentación Local

Según se indicó anterioriormente, la **Junta de Calidad Ambiental** de Puerto Rico (**JCA**), ha promulgado el **Reglamento para el Control de la Contaminación por Ruidos** (**RCCR**). Este reglamento, tiene como propósito el establecimiento de normas y requisitos para el control, disminución, o eliminación de ruidos nocivos a la salud y el bienestar público. A tales efectos, la **JCA** ha establecido en el artículo **IV** de su reglamento, los niveles de emisiones de ruido que se permiten (identificados como **Tabla I** en el **RCCR**). Estos niveles, se han establecido en función de la fuente de emisión y la zona receptora. La fuente de emisión se define como cualquier objeto o artefacto

originador de onda sonora, ya bien sea de tipo estacionario, móvil o portátil. El reglamento define los siguientes tres (3) tipos de zonas de fuente emisora. Estas son: zona residencial (Zona I), zona comercial (Zona II), y zona industrial (Zona III). En la tabla 2-1, se presentan los niveles de emisiones de ruido que se permiten entre las diferentes zonas (según definido en la tabla I del **RCCR**).

Tabla 2-1: Niveles de ruido entre zonas establecidos por JCA en su RCCR

Fuente emisora								
	60	50	65	55	70	60	50	45
	65	50	70	60	75	65	50	45
	65	50	70	65	75	75	50	45

Se aclara que la zona identificada como Zona IV, corresponde a una zona de tranquilidad, la cual se define en el reglamento, como aquellas que incluyen, peor no se limitan a: Hospitales, Clínicas, Hospitales de Salud Mental y Tribunales de Justicia.
Es también importante aclarar, que los niveles de emisiones contenidos en esta tabla, se refieren a niveles de sonido L_{10}. Este se define, como aquel nivel de sonido, en la escala **A** (**dBA**) que es excedido en un diez por ciento (10%) del tiempo para un período bajo consideración.

En este momento, es pertinente introducir varios conceptos o definiciones que es necesario entender para atender la discusión que sigue. En primer lugar, la unidad utilizada para expresar la intensidad del sonido es un decibel (cuyas siglas son **dB**. Se define un decibel como la unidad de medición de ruido, igual a 20 veces el logaritmo a la base 10 de la razón de la presión del sonido, medido a la presión de referencia, la cual es 20 micropascales. Se utiliza la escala de medición de ruido A, debido a que es la que más se asemeja a la respuesta del oído humano al sonido.

El período de medición mínimo para tomar datos de ruido se ha establecido en 30 minutos de acuerdo al **artículo 2.1.3** del **RCCR**.

Es importante notar el hecho de que el reglamento, establece dos niveles de ruido, que se describen a continuación:

Diurno: Periodo comprendido entre las 7:01 A.M. hasta las 10:00 P.M.

Nocturno: Periodo comprendido entre las 10:00 P.M. hasta las 7:00 A.M.

También, se desea introducir el concepto de Ruido de Ambiente (Background Noise). Este se define como todos los ruidos asociados con un ambiente dado, compuesto usualmente por sonidos de varias fuentes cercanas y lejanas.

Finalmente, de acuerdo a la tabla antes mencionada, se puede establecer que no habiendo ajustes por ruido ambiental, los niveles de emisión de ruido aplicables en el límite de propiedad serán los que siguen:

Periodo diurno: 65 dBA (L_{10})
Periodo nocturno: 50 dBA (L_{10})

El **RCCR** también establece en su Artículo V, lo siguiente:

- **Parte 5.1.1**, Prohibiciones Generales que reglamentan los niveles máximos de ruido para vehículos de motor que transitan por las vías públicas del país. Este artículo establece de manera específica que ninguna persona operará o permitirá la operación de vehículos de motor, motocicleta o cualquier otro en una vía pública en cualquier momento de tal forma que los niveles de presión de sonido emitidos por tal vehículo excedan los niveles máximos permisibles establecidos en la Tabla II. Estos niveles se establecen en función de una distancia de 50 pies (medidos desde el centro de la vía pública) y de la velocidad especificada. Así pues, en la Tabla II de este reglamento se establece los siguientes niveles.

Tipo de vehículo	35 MPH o menos	Sobre 35 MPH	Estacionado (motor encendido)
Vehículos de motor de 10,000 lbs. o más (peso bruto)	86 dB(A)	90 dB9A)	88 dB(A)
Motocicletas (cualesquiera)	80 dB(A)	84 dB(A)	88 dB(A)
Otros (cualesquiera otro o combinación)	76 dB(A)	80 dB(A)	88 dB(A)

- **Parte 5.1.2** establece que ninguna persona operará o permitirá la operación de un vehículo de motor o motocicleta en la vía pública en cualquier momento que no esté equipado por un sistema, aparato o artefacto amortiguador de sonido que opere eficientemente.

- **Parte 5.1.3** establece que ninguna persona dejará operando o permitirá la operación de cualquier vehículo de motor o cualquier equipo auxiliar de arrastre estacionado en una vía pública o predio de estacionamiento público o privado a una distancia no menor de 150 pies de la zona designada como residencial o zona de tranquilidad durante el periodo nocturno. Esta prohibición abarca equipo adicional, tales como (pero no limitados) a: equipo de refrigeración, generadores portátiles de electricidad o equipo similar.

- **Parte 5.2** establece que ninguna persona venderá o permitirá la venta de vehículos de motor nuevos (o motocicletas nuevas), de tal forma que el ruido que el vehículo emita no exceda los niveles máximos permitidos durante una prueba de aceleración, según establecido en la Tabla III. En aquellos casos donde los niveles de ruido emitidos estén bajo la reglamentación de la Agencia Federal de Protección Ambiental, a través de su control sobre la manufactura de nuevos productos, dichas normas apolicarán en Puerto Rico en vez de los límites establecidos en la Tabla III, la cual lee como sigue:

Tipo de vehículo	Nivel Máximo Permisible (en dB(A))
Vehículo de motor con un peso bruto de 10,000 lbs. o más fabricado entre los años 1975 y 1977	86
Vehículo de motor con un peso bruto de 10,000 lbs. o más fabricado entre los años 1978 y 1983	83
Vehículo de motor con un peso bruto de 10,000 lbs. o más fabricado entre los años 1983 y 1985	80
Vehículo de motor con un peso bruto menor de 10,000 lbs. fabricado después de 1975	80
Motocicletas manufacturadas entre los años 1975 y 1986	83
Motocicletas manufacturadas después del año 1986	80
Motocicletas de pedal y motor (Tipo "moped") manufacturadas después del año 1983	70
Motocicletas "Off Road" A- Desplazamiento de 170 cc y menor, manufacturadas entre los años 1983 y 1986 Manufacturadas después del año	 83 80

1986	
B- Desplazamiento de más de 170 cc y manufacturadas entre los años 1983 y 1986	86
Manufacturadas después de 1986	82

2.2 Reglamentación Federal

La **Agencia Federal de Protección Ambiental (APA)**, ha promulgado reglamentación que aplica a los manufactureros de vehículos de motor. Dicha reglamentación se encuentra en el **Código de Reglamentos Federales** (**CFR** por sus siglas en inglés), **Título 40**, **Parte 205** y aplica a vehículos de motor con un peso de 10,000 lbs. o más. Este reglamento, establece el nivel máximo de ruido en 80 dB(A), medidos a la distancia especificada de 50 pies.

La existencia de este reglamento es relevante para el proyecto en cuestión, puesto que la gran mayoría de los camiones utilizados exceden el peso de 10,000 lbs. y por lo tanto, y según establecido en el **RCCA** de la **JCA** (**artículo 5.2**) prevalece el reglamento federal para controlar la emisión de ruido para el tipo de camiones usados para el acarreo de basura hasta el **VRS**. No obstante, si examinamos ambos reglamentos, es evidente el hecho de que los valores máximos permitidos para vehículos manufacturados después del año 1983 es de 80 dB(A) en ambos reglamentos. Es decir, que en términos prácticos aunque la **JCA** establece unos límites que están explícitamente limitados a los que establezca la **APA**, los valores numericos de ambos reglamentos son los mismos.

3.0 Resultados de la medición de niveles de ruido

Se realizaron mediciones de los niveles de ruido en los límites de la propiedad en la cual se propone la expansión del **VRS**. Estos datos se tomaron el día 23 de enero de 2008. De los tres (3) puntos de monitoría de ruido selccionados, dos (2) se localizaron en la colindancia entre el área del proyecto con zonas en donde las áreas residenciales se encontraban más próximas. El tercer punto se localizó en la colindancia este, fuera de interferencias directas y constituye tal vez un descriptor de la situación de la propiedad sin desarrollarse. La localización de todos ellos se ilustra en la **figura 2**. En esta figura también se ilustra la distribución de áreas en las cuales se planifica realizar la expansión lateral del **VRS**.

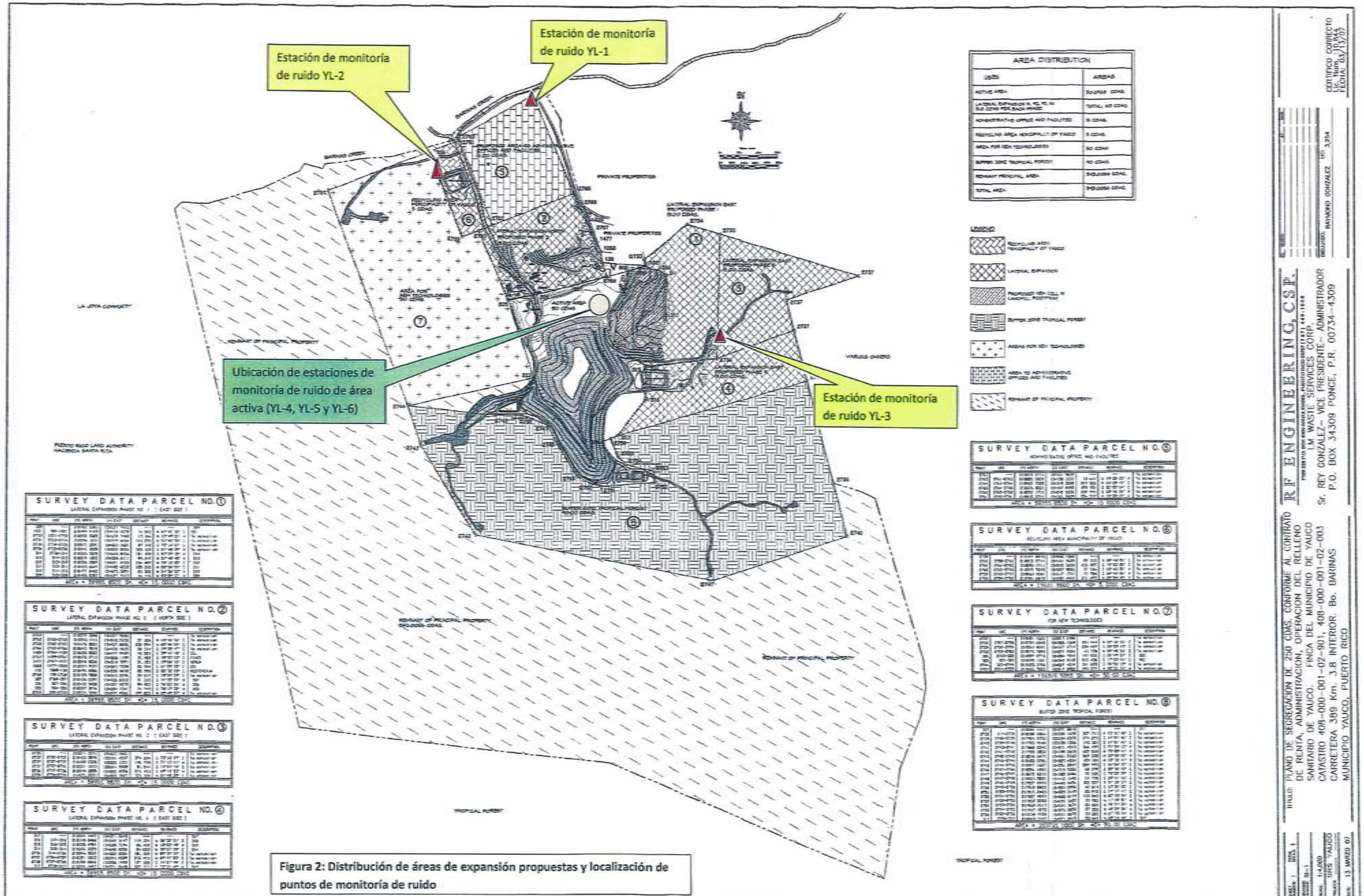

Figura 2: Distribución de áreas de expansión propuestas y localización de puntos de monitoría de ruido

A continuación, se presenta una breve descripción de cada uno de los puntos de monitoría de ruido utilizados, y también las estaciones de monitoría de ruido interna (cercanas al área activa del **VRS** de Yauco actualmentye en operación).

Identificación de Punto	Comentarios
YL-1	Este receptor se localizó en la parte más oriental de la colindancia norte de la finca en la que se propone la expansióbn de **VRS**. Se encuentra ubicado a una distancia aproximada de 15 metros del camino de acceso del **VRS**. Esta vía constituye el acceso principal de la facilidad según se pudo apreciar de la cantidad de camiones de acarreo que utilizaron la misma durante el periodo de medición. El punto se encuentra a un nivel algo más bajo que el del camino de acceso. Es importante notar el hecho de que el flujo vehicular observado es sumamente limitado. Dada su localización, en este lugar se percibe el ruido generado por el tráfico vehicular que discurre por el camino del acceso al vertedero. Se tomaron lecturas de los niveles de ruido en este receptor entre las 4:40 A.M y 5:10 A.M. para el periodo nocturno y entre las 10:55 A.M. y 11:25 A.M. para el periodo diurno.
YL-2	Este receptor se localizó a una distancia de aproximadamente 40 metros de colindancia norte en dirección hacia la Comunidad La Joya. Se localizó de manera más precisa cerca del borde

noroeste de la laguna de retención de aguas de escorrentía que se observa a la entrada del **VRS** de Yauco. Este punto sirve para monitorear el nivel de ruido que se percibe de la operación del **VRS** hacia esta colindancia que es la que más cercana se encuentra a zonas residenciales. También se recoge en este punto el ruido causado or el tráfico de camiones que entran a la facilidad actualmente en operación. Se tomaron lecturas de los niveles de ruido en este receptor entre las 5:20 A.M. y las 5:50 A.M para el periodo nocturno y entre 10:15 A.M. y las 10:45 A.M. para el periodo diurno.

YL-3

Este receptor se localizó en la colindancia este de la propiedad. Justo a medio camino hacia el pozo de monitoría 106. Es un lugar apartado de la zona de operación actual y sirve para observar el nivel de sonido en la propiedad en su estado actual. No se observan posibles receptores residenciales ni de ningún otro tipo cerca de esta colindancia. Se tomaron las lecturas de ruido entre las 7:10 A.M. y 7:40 A.M.

Estación Interna YL-4

Esta estación, se localizó a una distancia de aproximadamente 80 metros del área de tiro activa al momento de realizar el estudio (se identifica con un círculo de color marrón claro en la figura 2). Durante el momento de la toma de datos se estaba utilizando una

excavadora D-8 y una D-4 con camiones que llegaban y salían. La excavadora D-4 se estaba utilizando para manejar el material de relleno del vertedero mientras que la D-8 se utilizaba para agrupar y compactar la basura depositada. Los datos de ruido se tomaron entre las 8:10 A.M. y las 8:40 A.M..

Estación Interna YL-5

Esta estación se estableció a una distancia de 25 metros (80 pies) detrás de la estación identificada como YL-4. Su propósito era obtener información sobre la atenuación del ruido en función de la distancia. Esta distancia se midió utilizando una cinta.

Estación Interna YL-6

Esta estación se estableció a una distancia de 10 metros (30 pies) medidos desde la estación YL-5. La intención en su establecimiento es la de establecer la correlación entre reducción de ruido y distancia. Esta distancia se midió utilizando una cinta.

Para fines ilustrativos, se incluyen fotos de cada una de las estaciones de medición antes mencionadas en el **Apéndice 1**. Las mediciones en las estaciones **YL-1** y **YL-2** se llevaron a cabo tanto durante el periodo diurno como el nocturno, con la finalidad de utilizarlos y compararlos con los niveles correspondientes definidos por la **JCA**. La estación **YL-3** se tomó para documentar la condición de ruido en la porción de la propiedad en su condición sin desarrollar. Aunque no se tomó durante el periodo nocturno, debido a la ausencia de factores externos en el lugar se entiende que los niveles deben ser esnecialmente los mismos durante el mencioando periodo, o tal vez un poco mayores debido a la presencia de insectos nocturnos cuyo canto es altamente perceptible. Por otra parte, los datos en las estaciones YL-4, YL-5 y YL-6 se tomaron durante el periodo diurno a los fines de tener referencias con respecto a los niveles de ruido existentes (y que serán básicamente los mismos que se generen en la operación de la expansión propuesta).

Previo a la medición de los niveles de ruido, se calibró el sonómetro de acuerdo con las especificaciones del manufacturero. Se verificó constantemente la condición de las baterías para mantener el sonómetro en óptimas condiciones de operación. El instrumento se colocó sobre un trípode para facilitar la toma de lecturas. El sonómetro utilizado fue un sonómetro marca Quest, Modelo 2900 con integrador de datos. En el **Apéndice 2** se incluye copia del manual del equipo, y el certificado de calibración vigente. La metodología de medición consistía de poner en funcionamiento el sonómetro por un periodo mínimo de 30 minutos, al cabo de los cuales de anotaba la información recolectada.

Con el propósito de facilitar la comprensión de los datos obtenidos, se han resumido los mismos en las tablas **3-1** y **3-2**. En la primera de ellas, se resumen los resultados de la medición en los puntos tomados en las colindancias del área del proyecto, mientras que en la segunda, se resumen los resultados obtenidos en el periodo de medición de ruido en las cercanías del área de tiro del **VRS**. De esta manera, es más sencillo presentar y comparar los resultados obtenidos.

Tabla 3-1: Resultados de medición de niveles de ruido en dBA en colindancias con comunidad

RECEPTOR	PERIODO DIURNO		PERIODO NOCTURNO	
	Nivel Medido	Estándar	Nivel Medido	Estándar
YL-1				
L_{10}	55.2	65	46.8	50
L_{Max}	85.1	N/A	79.4	
L_{Min}	31.6	N/A	37.8	
YL-2				
L_{10}	50.0	65	44.1	50
L_{Max}	75.9	N/A	56.4	
L_{Min}	34.0	N/A	30.8	
YL-3				
L_{10}	33.0	65	N/A	50
L_{Max}	56.9	N/A	N/A	
L_{Min}	25.9	N/A	N/A	

Tabla 3-2: Resultados de medición de niveles de ruido en dBA en cercanías de área de tiro

RECEPTOR	PERIODO DIURNO	
	Nivel Medido	Estándar
Estación YL-4 (a 80 metros)		
L_{10}	69.5	65
L_{Max}	82.9	N/A
L_{Min}	51.6	N/A
Estación YL-5 (a 105 metros)		
L_{10}	68.1	65
L_{Max}	78.5	N/A
L_{Min}	41.6	N/A
Estación YL-6 (a 115 metros)		
L_{10}	63.0	65
L_{Max}	75.9	N/A
L_{Min}	49.3	N/A

4.0 Análisis de datos

4.1 Ajuste por ruido ambiental

Al comenzar con el análisis de los datos recopilados, se desea aclarar que se utilizaron los datos obtenidos durante la medición de los niveles de ruido en las localidades **YL-1** y **YL-2** para establecer si es necesario o no realizar ajustes a los niveles de ruido de acuerdo a lo establecido en la sección 4.1.1 del Artículo IV del **RCCR**. Es decir, que entendemos que debido a que en estas ubicaciones no se percibía el ruido de la operación de las facilidades del vertedero, su condición actual permite su uso como indicadores del nivel de ruido de ambiental. Es importante indicar que durante el periodo nocturno el nivel de ruido producido por los insectos y animales de vida nocturna (grillos y coquíes) era altamente notable. De la misma manera, en las cercanías del camino de acceso al **VRS** se podía percibir el efecto del tráfico vehicular sobre el ambiente sonoro. Ante estas consideraciones, y de acuerdo a los ajustes por ruido ambiental que se especifican en el artículo 4.1.1 del **RCCR** de la **JCA**, entendemos que los niveles de referencia para efectuar comparaciones deben ser los mismos que establece la Tabla I del mencionado reglamento, sin necesidad de realizar ajustes. Este artículo estable que:

- Si el ruido ambiental es menor que el nivel establecido en la Tabla I por más de 5 dB(A), aplicarán los límites establecidos en le Tabla I.

- Si el ruido ambiental es menor que el nivel establecido en la Tabla I por menos de 5 dB(A), se le añadirán 3 dB(A) a los límites de la Tabla I.

- Si el ruido ambiental es mayor que el nivel establecido en la Tabla I, se le añadirán 5 dB(A) a los niveles de la Tabla I.

Para el periodo nocturno, se observa que en los receptores **YL-1 y** YL-**2** no se excedieron los niveles de la Tabla I. Es importante observar el hecho de que entre los receptores antes mencionados y al área de tiro activa del **VRS** de Yauco existen áreas montañosas que físicamente las separan entre sí y que por consiguiente constituyen barreras naturales de atenuación de ruido. Por tal motivo, y si no se alteran estas condiciones, los niveles de ruido detectables en estos lugares corresponden a factores ajenos a la operación del **VRS** tales como el tráfico vehicular a través del camino de acceso a la facilidad. Se aclara sin embrago, que gran parte del tráfico del camino, corresponde a los camiones que entran y salen de la facilidad. La observación hecha aplica únicamente a los trabajos de operación dentro del vertedero como tal.

4.2 Comparación de niveles de JCA con resultados de medición

A los fines de presentar de forma clara, el análisis de la comparación entre los niveles medidos y los estándares aplicables, se discutirán separadamente las discusiones relativas al periodo diurno y al periodo nocturno.

Periodo diurno

El nivel de ruido máximo en la colindancia con la finca en la cual se propone realizar la expansión se observó en el receptor YL-**1**, mientras que el más bajo se observó en el punto **YL-3**. En ambos casos la realizadad física del lugar se correlaciona muy bien con los resulatdos obtenidos. De esta manera, en el punto **YL-1**, que se encuentra cercano al camino de acceso al vertedero y a través del cual transitan la amyoría de los camiones de acarreo denotó un nivel L_{10} de 55.2 dBA, mientras que en el punto **YL-3**, el nivel medido fue de 33.0 dBA. El nivel L_{10} medido en **YL-2** fue de 50.0 dBA, más bajo que el nivel de ruido medido

en **YL-1**. En este lugar también se percibió el ruido causado por el tráfico vehicular de los camiones que entraban al **VRS** y de otros vehículos privados que pasaban por el camino. En ninguno de los casos se obtuvieron lecturas de los niveles de ruido que excedieran los límites máximos establecidos por la **JCA** en su **RCCR**.

Periodo Nocturno

Durante el periodo nocturno, el nivel máximo de ruido L_{10} se registró en el receptor **YL-1** con un nivel de 46.8 dBA. A este le siguió el nivel registrado en el receptor **YL-2**, en el cual se registró un nivel de ruido de 44.1 dBA. Es interesante notar el hecho de que en ambos receptores se observó una influencia debido al tráfico vehicular, en adición a la influencia del ruido causado por los insectos de vida nocturna que normalmente se encuentran en las zonas rurales de la Isla. No obstante, se observó (y consistente con los datos obtenidos) que el impacto relativo al tráfico vehicular en el punto **YL-1** fue mayor. Se entiende que esto es el resultado de dos (2) aspectos importantes:

- Mayor afluencia de tráfico vehicular en este tramo del camino de acceso, tanto de vehículos de camiones que se dirigen o salen del **VRS** como de vehículos privados.
- Mayor cercanía de este punto con respecto al camino.

Con estos resultados se puede observar que en ninguno de los casos se excedieron los niveles de ruido L_{10} que establece el **RCCR** para el periodo nocturno.

Operación de tiro de basura en vertedero

La medición del nivel de ruido generado por la operación de tiro de basura y su posterior compactación en el **VRS** fue realizada a varias distancias. En su medición más cercana, que se realizó a un a distancia aproximada de 80 metros, se registró un nivel L_{10} de 69.5 dBA (Estación **YL-4**). Este nivel excede al máximo permitido por la **JCA** en 4.5 dBA. Sin embargo, se aclara que este nivel se verifica internamente denrto de la facilidad y no en sus colindancias. En el próximo punto, que se tomó a 105 metros desde el área de tiro (en la localidad que se identificó como estación **YL-5**) el nivel L_{10} medido fue de 68.1 dBA. Es decir que todavía se excedia el nivel máximo establecido en el **RCCR** por 3.1 dBA. En el último de los puntos de medición que se localizó a una distancia de 115 metros del área de tiro el nivel de ruido L_{10} medido fue de 63 dBA. Este dato implica que a esta distancia, el nivel de ruido estaba en cumplimiento con los niveles máximos permitidos por la **JCA** en su **RCCR** para una zona

receptora residencial (debido a que en este lugar no se excedió el máximo nivel permito por la **JCA** para este tipo de usos). Se aclara que existen otros factores que pueden incidir sobre estos resultados y que bien pueden afectar estas observaciones tales como el paso de camiones en ruta hacia otros puntos dentro del **VRS**, el uso de equipo pesado diferente al usado al momento de realizar las mediciones, la presencia de vegetación y/o elementos que atenúen la propagación de las ondas de sonido, etc. No obstante, se entiende que estos resultados medidos reflejan con bastante certeza los niveles de ruido típicos que resultan de la operación de una facilidad de este tipo.

5.0 Conclusiones y/o recomendaciones

Luego de analizados los datos sobre niveles de ruido recopilados en el área del proyecto, se puede presentar a las siguientes conclusiones:

- Para el periodo diurno, la operación del **VRS** está en cumplimiento con los niveles L_{10} de 65 dB(A) aplicables de acuerdo a los resultados de la medición de los niveles de ruido en los puntos **YL-1** y **YL-2**. Por tal razón, se entiende que si se mantienen separaciones adecuadas con respecto hacia las colindancias hacia zonas de uso residencial como resultado de la expansión propuesta, no deberían registrarse incidentes de exposición a niveles altos de ruido en estas zonas sensitivas. Es importante, sin embargo, resaltar el hecho de que se recomienda preservar en la medida posible, los pequeños montes que separan físicamente a la comunidad del área de operación como tal. En su defecto, si se tienen que cortar estas partes altas, se deben mantener aquellas porciones hacia el lado de la comunidad que sirvan para separar físicamente las operaciones de los vecinos.

- En la medida en que sea posible, las operaciones dentro del vertedero deben ajustarse al periodo diurno que establece el **RCCR** de la **JCA** en lo que respecta a las operaciones de tiro de basura. Es decir, que la operación se recomienda en el horario de 7:01 A.M. a 10:00 P.M., pero si se hace necesario el depósito de basura se recomienda que el uso de los equipos pesados para su manejo y compactación dentro de la celda se realicen dentro del horario diurno. Es decir, que aunque se reciba basura durante el periodo nocturno, su compactación dentro del área activa debería realizarse durante el periodo diurno. Esta recomendación es particularmente válida, dado el caso de que el **RCCR** penaliza el horario nocturno con niveles de ruido que son entre 10 y 15 dBA más bajos que los aplicables para el periodo diurno. Esto sin considerar que la operación continúa siendo la misma en el **VRS** sin importar que sea de día o de noche.

- Los datos sobre los niveles de ruido recopilados, permiten aseverar que a una distancia de aproximadamente 115 metros del área de tiro los niveles de ruido generados por la operación, se encuentran en cumplimiento con el nivel de ruido L_{10} de 65 dBA especificado por la **JCA**. Este detalle sugiere que en distancias mayores a esta (sin la intervención de elementos atenuantes tales como vegetación, protuberancias del terreno) los niveles que se perciban en el perímetro de la colindancia deben estar en cumplimiento con el **RCCR** de la **JCA**.

- Para ayudar en la mejor comprensión de este tema, también se consultó la publicación **Roadway Construction Noise Model** de la **Administración Federal de Carreteras** (**FHWA** por sus siglas en inglés). Este documento publicado en enero del 2006, sirve para ayudar en la predicción de los impactos por ruido que generan los trabajos de construcción de carreteras. De hecho, también incluye un modelo computadorizado (**RCNM**) que permite estimar los niveles de ruido que son percibidos a distancias especificadas, en equipos de construcción tales como excavadoras, camiones, generadores de emergencia, etc. Estos equipos son para fines prácticos, los mismos que se utilizan en las operaciones diarias de un vertedero. Por tal razón, se utilizó el modelo considerando que se utilizaban simultáneamente dos (2) excavadoras y un camión. Se definió una distancia de 200 metros hasta un receptor residencial, y el resultado obtenido para un nivel de ruido L_{10} fue de 62.2 dBA. Este nivel es menor del límite establecido por la **JCA** para una zona emisora industrial y una zona receptora residencial. Basados en estos resultados, y los datos empíricos obtenidos, se entiende que distancias en estos rangos o mayores constituyen elementos de minimización de impactos debido al ruido generado por la operación del **VRS** que puedan ser recibidos por receptores cercanos al área del proyecto. En este caso en particular, la presencia de una cubierta de vegetación densa servirá de atenuante adicional para la emisión de los niveles de ruido, lo que implica que a distancias menores sería posible obtener niveles de ruido menores a los que la **JCA** establece en su **RCCR**.

- Adicionalmente a los puntos antes mencionados, se desea aclarar que la propagación del sonido es y ha sido objeto de estudio por diversas entidades. Por tal razón, existe literatura que documenta el efecto de la distancia en la propagación y atenuación del sonido. Es un hecho conocido que a mayor distancia entre la fuente emisora y el receptor, menor el nivel de ruido percibido por el receptor, debido a la atenuación que se da debido a la atmósfera y a la condición del trayecto de recorrido del ruido entre la fuente emisora y el receptor. El sonido necesita de un medio para su propagación, es decir, que en la atmósfera se puede propagar, no siendo así en un vacío. En sus estudios sobre este tema la **FHWA**, en su publicación **FHWA Noise Barrier Design Handbook**, establece que la intensidad del ruido disminuye con el cuadrado de la

distancia. En esta referencia, se establece que el nivel de sonido medido a una distancia conocida (L_1) disminuye en función de la distancia de acuerdo a la siguiente ecuación.

$$L_2 = L_1 + 20^* \text{Log}_{10} (d_1/d_2)$$

En donde:

L_2 = nivel de sonido en dB(A) a la distancia d_2

Es decir, que conociendo el valor de un nivel de ruido a una distancia en particular, es posible estimar matemáticamente su valor a otra distancia específica. Debe aclararse sin embargo, que esta fórmula no toma en consideración elementos que se constituyan en atenuantes del ruido en su trayecto entre la fuente de emisión y el receptor. Es también interesante observar que la literatura que acompaña al modelo **RCNM** (que se mencionara en el punto anterior) se indica que en su algoritmo se consideró esta ecuación.

- Para el periodo nocturno, los niveles de ruido L_{10} no exceden el nivel de nocturno especificado en el **RCCR**.

- Con respecto a tránsito de vehículos pesados desde y hacia la facilidad del **VRS**, se debe mencionar que el nivel de ruido emitido por los camiones está reglamentado a nivel del manufacturero de los mismos según requerido por la **Agencia de Protección Ambiental Federal** (**EPA**). Es decir que siempre y cuando los equipos de amortiguación de ruido instalados en los camiones por el manufacturero se mantengan en buenas condiciones, no existe impedimento reglamentario tanto de la **JCA** como de la **EPA** (con respecto a ruido) para su desplazamiento a través de las vías públicas.

- En cuanto al artículo **5.1.3** del **RCCR**, y basado en los detalles de la expansión propuesta del **VRS**, se entiende que no se violará esta sección reglamentaria, dado el caso de que no se estacionará o dejará operando vehículos de motor a una distancia menor de 150 pies de zonas designadas como residencial durante el periodo nocturno.

- Durante los trabajos de construcción de la expansión del **VRS**, se utilizarán equipos pesados que generarán niveles de ruido altos. Se entiende que estos impactos tendrán carácter temporero pero deberán discutirse en la **DIA** que se prepare sobre el proyecto. Para ayudar en la preparación de este documento, incluimos un listado de los niveles de ruido generados por diversos tipos de equipos de construcción y que fueran obtenidos de un manual técnico preparado por la **FHWA**. Estos

niveles fueron medidos a una distancia de 50 pies de la fuente y la lectura real depende de la cantidad de equipos usados, su condición, momento de operación en particular, etc. No obstante, es información comúnmente

Niveles de Ruido de Equipos de Construcción (en dBA, medidos a una distancia de 15 metros)	
Tipo de Equipo	**Niveles de Ruido**
Raspadora	89 - 95
Niveladora	77 - 87
Arrasadora	87 - 89
Rolo, "sheepsfoot"	72 - 80
Rolo, vibrador	85 - 90
Cargadora de cuchara	80 - 81
Cargadora "terex"	96
"Backhoe"	79 - 85
"Backhoe", grande	91
Grúa	80 -85
Grúa, mal ejemplo	95
Camión, fuera de la carretera	81 - 96
Camión, asfalto	69 - 82
Camión, hormigón	71 - 82
Camión, cemento	91
Pavimentadora	82 - 92
Barrenadora de roca(montada)	91
Sierra de hormigón	87
Bomba de agua	79
Bomba de hormigón	76
Generador	69 - 75
Planta de hormigón	93

Referencia: Manual técnico de la Administración Federal de Carreteras.

utilizada en la preparación de la sección de impactos por ruido durante la etapa de construcción que normalmente se incluye en las **DIA's**.

6.0 Certificación

Certifico que la información presentada en este estudio es cierta, correcta y completa a mi mejor entender y saber. También se certifica que los resultados fueron obtenidos utilizando los criterios de práctica usual y aceptada para este tipo de estudios. Para la evaluación del proyecto se utilizaron los planos de distribución provistos por el dueño. Cualquier cambio en las condiciones aquí descritas, resultarán en la necesidad de revisar los hallazgos.

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APENDICES

APENDICE 1

FOTOS DEL AREA DEL PROYECTO Y PUNTOS DE MONITORIA DE RUIDO

APENDICE 2

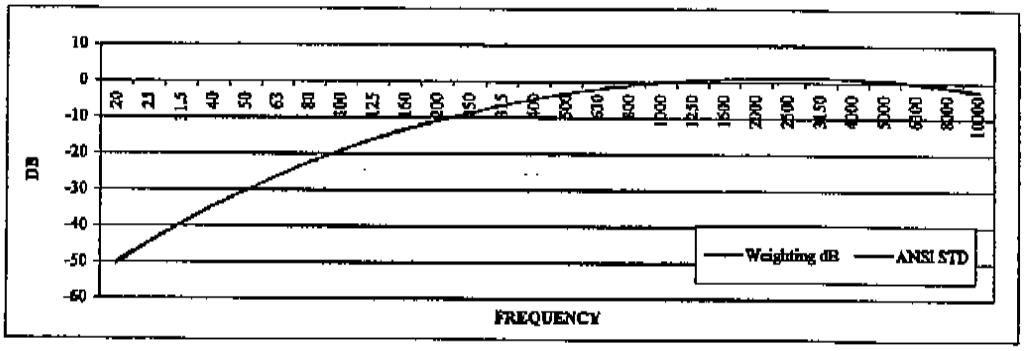
COPIA DE SECCIONES DEL MANUAL DEL EQUIPO Y CERTIFICADO DE CALIBRACION

CERTIFICATE OF CALIBRATION

SOUND LEVEL METER

Manufacturer:	Quest	**Calibration Date:**	September 11, 2007
Model Number:	2900	**Date Due:**	September 11, 2008
Serial Number:	CDA080024	**Temperature:**	70.2 °F
Service Order:	3099	**Relative Humidity:**	54.2 %
Reference Number:	3099-2900-CDA080024	**Barometric Pressure:**	30.01

Frequency (HZ)	Meter Actual Display (dB)	Meter Weighting dB	ANSI STD	Tolerance	Relative Diff
20	64.1	-49.9	-50.5	± 3	0.6
25	69.4	-44.6	-44.7	± 3	0.1
31.5	74.7	-39.3	-39.4	± 3	0.1
40	79.6	-34.4	-34.6	± 2	0.2
50	83.8	-30.2	-30.2	± 2	0.0
63	87.8	-26.2	-26.2	± 2	0.0
80	91.6	-22.4	-22.5	± 2	0.1
100	94.8	-19.2	-19.1	± 1.5	-0.1
125	98.1	-15.9	-16.1	± 1.5	0.2
160	100.9	-13.1	-13.4	± 1.5	0.3
200	103.2	-10.8	-10.9	± 1.5	0.1
250	105.3	-8.7	-8.6	± 1.5	-0.1
315	107.4	-6.6	-6.6	± 1.5	0.0
400	109.2	-4.8	-4.8	± 1.5	0.0
500	110.7	-3.3	-3.2	± 1.5	-0.1
630	112.1	-1.9	-1.9	± 1.5	0.0
800	113.2	-0.8	-0.8	± 1.5	0.0
1000	114.0	0.0	0.0	± 1.5	0.0
1250	114.6	0.6	0.6	± 1.5	0.0
1600	115.0	1.0	1.0	± 2	0.0
2000	115.2	1.2	1.2	± 2	0.0
2500	115.3	1.3	1.3	± 2.5	0.0
3150	115.3	1.3	1.2	± 2.5	0.1
4000	115.1	1.1	1.0	± 3	0.1
5000	114.7	0.7	0.5	± 3.5	0.2
6300	114.1	0.1	-0.1	± 4.5	0.2
8000	113.1	-0.9	-1.1	± 5	0.2
10000	111.8	-2.2	-2.5	+ 5 to -µ	0.3



CIHE Calibration Laboratory certifies that the instrument specified above meets the manufacturer's specifications and was calibrated using standards and instruments also listed below where the accuracy is traceable to National Institute of Standards and Technology (NIST), and the calibration systems and records are in compliance to ANSI S1.4-1983

STANDARDS USED

Manufacturer	Description	Model No.	Serial No.	Certificate No.	Due Date
Gras	Pistonphone	42AA	16295	16219-1	4/30/2008
Stanford Research	Function Generator	DS360	33001	022307	3/16/2008
Instek	Oscilloscope	GDS-820C	EG131287	934163	4/17/2008
Larson Davis	Real-Time Analyzer	3100 RTA	1227	2003-53517	10/9/2007
Krohn Hite	Distortion Analyzer	6800A	350	0310094	10/14/2007

Calibrated By: _____ Date: 09/11/07

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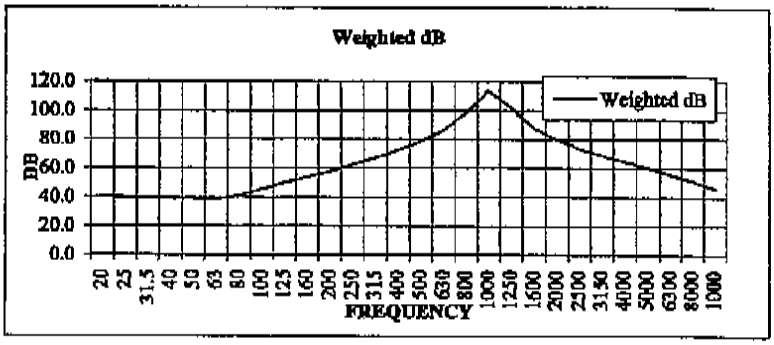
CERTIFICATE OF CALIBRATION

ACOUSTICAL CALIBRATOR

Manufacturer:	Quest	**Calibration Date:**	September 11, 2007
Model Number:	QC-10	**Date Due:**	September 11, 2008
Serial Number:	QIA080187	**Temperature:**	70.5 °F
Service Order:	3099	**Relative Humidity:**	54.0 %
Reference Number:	3099-QC10-QIA080187	**Barometric Pressure:**	29.99

Frequency (HZ)	Weighting dB
20	40.4
25	39.7
31.5	39.2
40	38.9
50	38.8
63	38.4
80	40.6
100	45.5
125	49.9
160	53.7
200	57.9
250	62.6
315	67.1
400	72.5
500	78.7
630	86.3
800	98.5
1000	114.0
1250	102.0
1600	87.7
2000	80.1
2500	73.6
3150	69.1
4000	64.9
5000	60.5
6300	55.8
8000	51.5
10000	46.2



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STANDARDS USED

Manufacturer	Description	Model No.	Serial No.	Certificate No.	Due Date
Gras	Pistonphone	42AA	16295	16219-1	4/30/2008
Stanford Research	Function Generator	DS360	33001	022307	3/16/2008
Instek	Oscilloscope	GDS-820C	EG131287	934163	4/17/2008
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Calibrated By: _____ Date: 09/11/07

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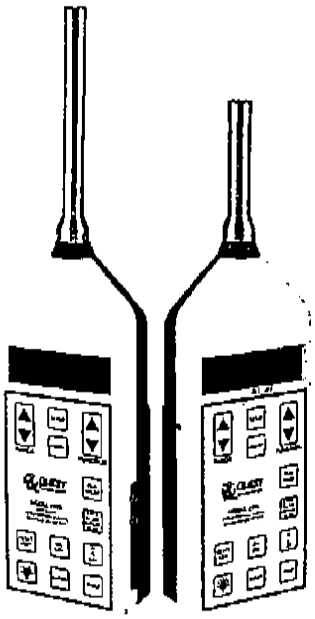
instructions for

Models 1900 and 2900

Integrating and Logging Sound Level Meter



QUEST TECHNOLOGIES

56-352
Rev. H
8/99

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WITH THE OB-100/OB-300

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1. INTRODUCTION TO THE MODELS 1900/2900

The Quest Models 1900 and 2900 are advanced sound level meters which perform a wide variety of acoustical measurements. Both exponential averaged and time integrated measurements may be made, with the capability of either internal or external data logging. The output of an independently weighted peak detector may also be displayed or logged. Applications include laboratory, industrial, community and audiometric measurement and analysis.

The models 1900 and 2900 provide a numerical readout of measurements as well as a moving bar graph indication. The results of individual sound studies may be stored in internal memory for future reference. Meter operation is controlled from either the membrane keypad or through the communications port. AC and DC output jacks are provided for connecting to external devices such as audio recorders, chart recorders, oscilloscopes, etc. Data may be sent to a parallel printer by using a special interface cable. The meters are housed in a tough injection molded plastic case with internal shielding to protect against external electrical interference, such as that from motors or portable radios.

The Model 1900 delivers Type 1 accuracy for critical measurements, while the model 2900 is a Type 2 instrument for general field survey work. The model 2900 uses a 0.52 inch electret microphone, while the 1900 accommodates a variety of microphones to meet even the most unconventional applications. As both meters are operationally identical, this manual will refer only to the model 1900 except where appropriate.

Options include expanded logging memory and a second RMS detector to allow simultaneous measurement of C-A frequency weighted LEQ or LAVG.

Plug in the Model OB-300 combination 1/3 - 1/1 Octave Filter Set and create a 1/3 or 1/1 octave band analyzer covering 33 bands from 12.5 Hz to 20 kHz. The addition of the Model OB-100 Octave Filter Set will create an octave band analyzer covering 10 bands from 31.5 Hz to 16 kHz.

If sound measurements need to be made from a distance, simply remove the microphone/pre-amplifier and insert either an ICM-10 (10 foot) or an ICM-50 (50 foot) extension cable. Distances of up to 100 feet can be accommodated by adding two ICM-50 extension cables in series.

With the microphone and preamplifier removed, the meter can accept other input devices such as the Quest Model VI-90 Vibration Integrator. The VA-508C Vibration Assembly, combined with the Models 1900 or 2900, provides a quick and precise method of measuring and analyzing many types of industrial vibration.

1.1 Assembling the Meter

The microphone and preamplifier must be assembled prior to making any measurements.

Microphone Handling and Storage

The microphones used with the model 1900 will provide years of reliable use, but certain precautions should be followed with regard to handling and storage.

1. Never remove the microphone grid. This will expose the diaphragm, making it susceptible to physical damage. When removing a microphone from the preamplifier be careful not to unscrew only the grid.

2. Never touch the diaphragm.

3. Electret (prepolarized) microphones should never be stored at high temperatures, as long term degradation of the polarization charge may occur. This results in a decrease in microphone sensitivity.

4. An electret microphone should be stored in its protective box when not in use for long periods of time.

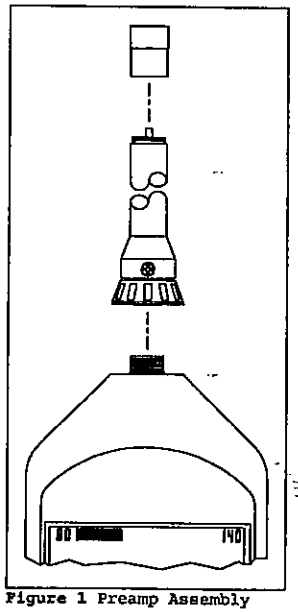

Figure 1 Preamp Assembly

To attach the microphone to the preamplifier, screw the microphone onto the threaded end of the preamplifier. Attach the preamplifier to the meter by placing the connector ends together and rotating the preamplifier until it drops onto the meter. Finger tighten the black locking ring by screwing it onto the meter.

MODEL 1900 ONLY:Microphone Polarization Voltage - 200VDC

Check that the microphone polarization voltage switch is set properly. This switch is located inside the battery compartment on the rear of the meter. To locate this switch, remove the battery door with a phillips head screwdriver and pull the 9 volt batteries out of the compartment. Electret, or prepolarized microphones such as the QE4146 or QE224 should be operated with the 200 Volt microphone polarization voltage turned OFF. Condenser microphones must be operated with the 200 Volts turned ON.

CAUTION: Be careful not to turn on the 200 volt polarization switch if a prepolarized (electret) microphone is attached. The microphone may be damaged.

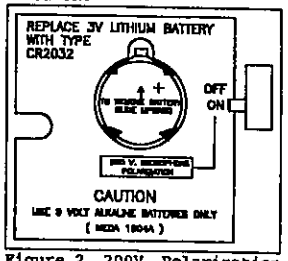

Figure 2 200V Polarization Switch

1.2 Initial Turn On and Check

Before taking measurements with the Model 1900, there is a series of quick checks that should be performed. Turn the unit on by pressing the ON/OFF key. The display will indicate that a brief warmup is taking place. Check for the BAT indicator in the display. If it indicates a low battery condition, replace the batteries.

A measurement display such as SPL or LEQ will appear in the display. Pressing the FUNCTION key will select a different display. Press FUNCTION to review the possible measurements. When you have done this, set the display to read SPL. The meter is now displaying current Sound Pressure Level. Press the A/C/LIN key to change the frequency weighting. Press the FAST/SLOW/PEAK/IMPULSE key to change the response time of the reading.

To perform an Acoustic Study, press RUN/PAUSE. Allow the meter to run for a while and press RUN/PAUSE again to end the study. The FUNCTION key may now be used to review the results.

Although the Model 1900 will maintain accurate calibration over a long period of time, the calibration should be checked and the meter slightly adjusted, if necessary, before each use. To check the calibration of the Model 1900, perform the following procedure using a Quest Calibrator.

1. Turn the Calibrator ON. If optional, set the frequency to 1 kHz. Note the SPL of the calibrator.

3. Insert the microphone fully into the calibrator adapter ring, if required for the size microphone in use.

4. Slowly place the Calibrator onto the adapter/microphone.

5. Using the FUNCTION key, set the Model 1900 to read SPL and set the weighting, response and range as appropriate. Note: SPL must be one of the display options enabled in the Setup Menu.

6. Use a screwdriver to adjust the calibration control, located through the small hole on the left side of the meter, until the display matches the calibration level.

Storing the Calibration Value

The model 1900 can store the time, date and SPL of a calibration, which will be included in the printout and in downloaded data for each study. Enter the PARA Setup Menu and go to CAL by pressing the following keys:

SETUP,
▲ or ▼ to " PARA ",
ENTER,
▲ or ▼ to " CAL "

The meter will display current SPL. Perform a calibration as directed in the previous section. Range and weighting keys will be operational, but the response time will be set to FAST. When the reading on the display is correct, press ENTER to store. The display will briefly read " CAL$_{OK}$ " and return to the "PARA" menu display. The calibration SPL, time and date are now stored. Press SETUP to return to the measurement displays, such as SPL.

2. ABOUT THE METER

2.1 The Display

The LCD display provides the user with the selected measurement and the current measurement parameters. The measurement range, as well as instrument status such as low battery (BAT), RUN (▶), PAUSE (▮▮), and OVERLOAD (OL) is also displayed. The numeric display normally updates every second, while the bargraph provides a continuous indication of the sound level.

The bar indicator portion of the display always indicates the current SPL (Sound Pressure Level). The range of the bar indicator is the same as that of the instrument and is indicated by the numbers on either side of the bargraph. Each segment of the bargraph represents 2 dB.

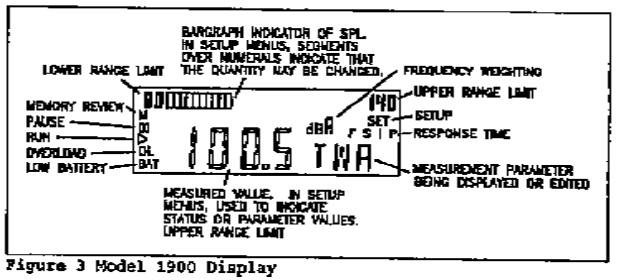

Figure 3 Model 1900 Display

2.2 Keypad Functions

Press this key to turn the meter on. After a warmup period of several seconds, the meter is ready to use. Pressing and holding this key for five seconds until " OFF_{OFF} " is displayed, and then releasing, will turn the meter off.

Momentarily pressing this key turns the LCD backlight on for several seconds. Pressing and holding for 3 seconds will turn the backlight on until the switch is again pressed to turn it off.

Note: Leaving the backlight on for extended periods will reduce battery life.

Press this key to begin a study, which automatically increments the memory location counter by 1. The number of the location appears on the display briefly after pressing RUN. Pressing RUN/PAUSE again ends the study and stores the data in that memory location.

Press the ▲ or ▼ to increase or decrease the 60dB measuring range in 10dB steps. Pressing this key while in RUN ends the current study and begins a new study. When this happens, the memory location will momentarily appear on the screen so that the operator may make note of his time and location for that study. (Key locked out while in Session mode and RUN.)

While inside the SETUP menus, the RANGE key may be used as UP and DOWN arrows for incrementing or decrementing numeric values.

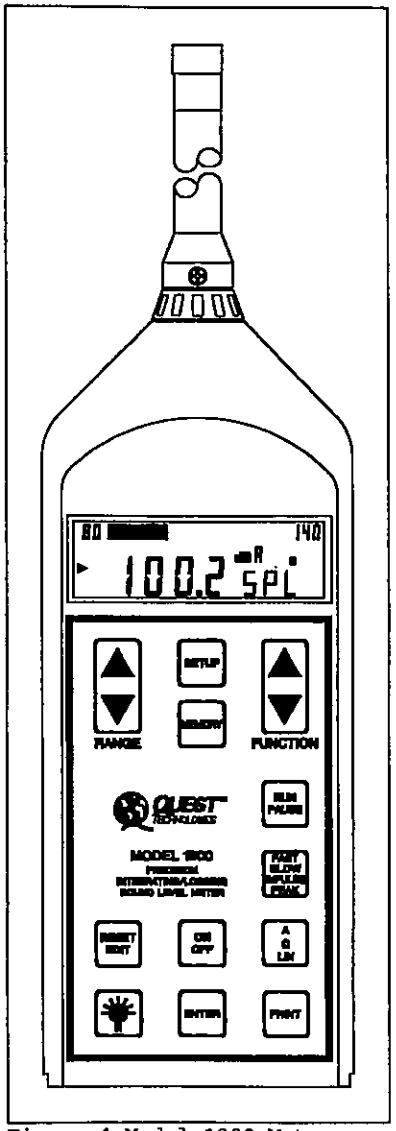

Figure 4 Model 1900 Meter

Press this key to select the time averaging from the four choices of FAST, SLOW, IMPULSE or PEAK. A display annunciator indicates the response by displaying " F ", " S ", " I " or " P ". Pressing this key while in RUN mode will end the current study and begin a new study. (Key locked out while in Session mode and RUN.) Refer to section 6.8 for details on time averaging.

Press this key to cycle the frequency weighting through the choices of A, C or Linear. The choice is shown by a letter following 'dB' in the display (A, C or L). Pressing this key while in RUN mode will end the current study and begin a new study. (Key is locked out while in Session mode and RUN.)

Press FUNCTION ▲ or ▼ to select any of the following displays that have been selected via the SETUP key:

SPL, LEQ (LAVG), TWA, LMAX, LMIN, LN1, LN2, LN3, LN4, LDN, CNEL, % OL time, exposure in Pa2S or Pa2H, LPK, SEL, elapsed TIME (min/sec), elapsed TIME (hour/min), LLOG (LAVG or LEQ last logged - this value updates every logging interval), BATT, or TAKM. If the C-A option is installed, C-A Leq or Lavg may also be displayed. Refer to section 3.1, Measured Quantities.

While in RUN mode, the display shows the current value for the study. While in PAUSE mode the final value for the previous study is displayed. SPL will always show the current 1 second MAX according to the response selected (F/S/I/P). While in PAUSE, if selecting quantities such as LMAX, LEQ, etc. after the meter has been RESET (had it's memory cleared) the display will show "----". FUNCTION is also used while in the setup mode as an up/down arrow key for selecting menus or parameters.

While in PAUSE mode, press SETUP to access one of five Setup Menus which allow the user to define the operation of the meter. There are many quantities that may be displayed, logged or printed, and most users will not be interested in all of them. SETUP allows the user to select only the items of interest, for example SPL, LAV and L10, excluding all others. The five menus are:

COMM	Communications Parameters
PARA	Measurement Parameters
PRNT	Data to be Printed
LOG	Data to be Logged
DISP	Data to be Displayed

Refer to section 3.3 for details on meter SETUP.

This key is used to group studies stored in memory into a File for printout, and to review individual studies stored in memory. While in PAUSE, press MEMORY to display " FILE ". Press ENTER to group the previously stored

studies into a File . Pressing FUNCTION ▲ or ▼ causes " XX_{LOC} " to be displayed, where XX is the number of the last study (as in memory LOCation #XX). Press ENTER to display a measured quantity such as LAV. The FUNCTION key may be used to display other quantities (LMAX, SEL, etc.). Press ENTER again to return to the " XX_{LOC} " display. The function key may be used to increment or decrement memory locations. If incrementing past the last location the display will read " 1 LOC ", or the first study. If 10,000 or more studies have been performed, the display will read " XXXX_{XLOC} ". Press MEMORY again to exit study review. (Refer to section 3.2 for more details)

Pressing MEMORY while in RUN briefly displays the number of the current memory location (study number and session number).

PRINT — Press this key while in PAUSE to print all studies in memory to a parallel printer or computer. Press this key while in Memory Review to print only the study currently under review. To interrupt a printout, press again.

ENTER — The ENTER key is used in SETUP to enter or exit any of the five setup menus. When changing a numeric value in the PARA menu, it will store that value and turn off the bar graph segments above that parameter.

RESET EDIT — This key has two functions. While in SETUP, it is used to turn on or off display, logging or print choices, or to cycle through certain parameter selections (3>4>5>6>3..dB exchange rate for example). When not in setup (i.e. in PAUSE), pressing and holding RESET/EDIT will clear the internal memory.

2.3 Output Jacks

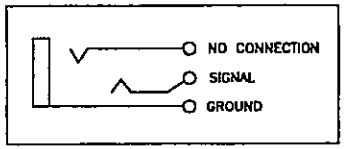

Figure 5. Output Jack Connections

DC - The Sound Pressure Level (SPL) over the 60 dB range selected is linearly represented by a 0 to 1 volt DC output. Zero volts is equal to the bottom of the range and 1 volt is equal to full scale. This output is provided for connecting to a 0 to 1 volt input data acquisition system or chart recorder. See section 4.4 "Chart Recording" for details.

AC - This jack provides an amplified, weighted AC signal. Full scale output (SPL) equals 3.16VAC.

COMM - The COMM jack is used for direct connection to an RS-232 compatible device such as a personal computer via the supplied cable. An optional Parallel Interface Module is used to connect to a parallel printer.

3. OPERATING PROCEDURE

Pressing the ON/OFF key will turn the meter on. The initial display is " 1900_{128K} " where 128k bytes is the amount of memory installed. The next display, " $X.X_{REV}$ " shows the revision of the installed firmware. A 5 second warmup will follow, and the display will read " 5_{WMUP} " counting down to " 1_{WMUP} ". If the logging memory has been filled, the display will read " $FULL_{MEM}$ " for those 5 seconds. If this occurs, reset the unit before performing any studies.

3.1 Measured Quantities

The FUNCTION switch steps through the following possible measurements performed by the model 1900. This list may be shortened as desired via the DISP Setup Menu. Refer to section 3.3 "Setup Menus" for details.

SPL - Sound Pressure Level will be displayed, with the selected weighting and response characteristics. The value displayed is the maximum SPL during the previous second. (SPL is also always shown in the display bar indicator.)

LEQ - The average integrated sound level accumulated while in the RUN mode is shown in the numeric display. LEQ indicates that a 3dB exchange rate was used for the measurements.

LAVG - The same type of measurement as LEQ, except that a 4, 5 or 6dB exchange rate was used. The display will be correct for the exchange rate selected.

TWA - Time Weighted Average. The average level accumulated during a study, but calculated with an eight hour integration time.

LMAX - The Maximum SPL obtained while in the RUN mode is shown in the numeric display. With PEAK response selected, this functions as a Peak Hold.

LMIN - The Minimum Sound Pressure Level obtained while in the RUN mode is shown in the numeric display.

LN - The SPL exceeded for N% of the time during a study. Four user selectable values are calculated. The default values are L5, L10, L50 and L90. The values may be changed in the PARA Setup Menu.

LDN - Day/Night Sound Level. The average sound pressure over a 24 hour study, with additional factors for time of day. Sound pressures between the hours of 10 pm and 7 am are increased by 10dB prior to being averaged. A 3dB exchange rate should be used and is generally assumed. If an exchange rate other than 3dB is selected via the Setup Menu, LDN will not be calculated and " $----_{LDN}$ " will be displayed.

CNEL - Community Noise Exposure Level. The average sound pressure over a 24 hour study, with additional factors for time of day. Sound pressures between the hours of 7 pm and 10 pm are increased by 5dB prior to being averaged. Sound pressures between the hours of 10 pm and 7 am are increased by 10dB prior to being averaged. A 3dB exchange rate should be used and is generally assumed. If an exchange rate other than 3dB is selected via the Setup Menu, CNEL will not be calculated and the display will show " $----_{CNEL}$ ".

%OL - Percentage of time during the study that an overload (OL) condition occurred. Overload indicates that the signal has exceeded the measuring range.

PA2S - PA2H Sound Exposure in Pascal-squared seconds or Pascal -squared hours, switching from Pa2S to Pa2H at 3600 Pa2S. The display will show " $----_{PA2}$ " if the exchange rate is not 3dB.

SEL - The Sound Exposure Level is the constant sound level which, if lasting for one second, would deliver the same amount of acoustical energy as that accumulated over the entire study.

RTMS or RTHM - The total RUN time will be displayed. Time may be displayed in MIN:SEC and HRS:MIN. The MIN:SEC display for a study that lasts over one hour will wrap around to 00:00. The HRS:MIN display will count to 99:59 and then wrap around to 00:00 but the actual time will be stored in memory.

LPK - The Peak Level. The output of a second peak detector may be viewed as LPK or logged. The frequency weighting is independent of the main RMS detector and may be set in the PARA setup menu as 2PK. The selection of whether or not to log peaks is made in the LOG Setup Menu. The weighting selection (A, C or LIN) is made in the PARA Setup Menu. While viewing LPK the weighting of the second peak detector is displayed, and the Weighting and Response keys are disabled.

LLOG - The LEQ (or LAVG) last logged during a study. Data is logged at a user defined interval. This feature may be used to display a timed LEQ for the previous logging interval. This display updates at the end of each logging interval. The display will show " $----_{LLOG}$ " if LEQ is not being logged.

TAKM The time integration of individual Taktmaximal values. Taktmaximal is the maximum level (L_{MAX}) encountered over either a 3 or 5 second interval. 3 or 5 second Taktmaximal is selected in the PARA Setup Menu. Individual Taktmaximal (L_{MAX}) values may be logged by setting the logging interval to 3 or 5 seconds in the LOG Setup Menu. Taktmaximal measurements are required by some countries' noise regulations. A Taktmaximal measurement calculates a higher average level for highly impulsive sounds than does a LEQ measurement. TAKM is affected by the Exchange Rate and should be run with an Exchange Rate of 3dB.

BATT Displays the voltage of the weaker of the two 9 volt batteries to give an indication of remaining life. The low battery indication (BAT) on the display occurs at approximately 6.8 volts.

LC-A An optional second RMS detector may be used to provide a simultaneous C-A weighted LEQ or LAVG of the measured sound. Refer to section 3.6 "C-A Option".

Acoustic Study Options

An acoustic **Study** is a set of measurements performed over a user defined period of time, referred to as the **Run Time**. The study begins at the **Start Time** and ends at the **Stop Time**. Each study is stored in a consecutively numbered **Memory Location** which is displayed briefly at the beginning of each study. Consecutive studies may be grouped into a **File**. When printing data, each File will have its own individual header, which makes it easier to locate related groups of data in the printout. Alternately, place the meter in **Session Mode** to create a cummulative summary of the data from consecutive studies with identical measuring parameters.

Up to five quantities may be logged at user defined time intervals. Final summary data for all measured quantities is also stored for each study.

The study may be initiated and ended in several ways (refer to Figure 6):

Manual Study - Press RUN/PAUSE to begin a study, causing the RUN indicator to light. " X_{LOC} " will be displayed briefly, where X is the number of the current memory location. Press RUN/PAUSE again to end the study, causing the PAUSE indicator to light.

NOTE: During a study, pressing a key to change a parameter such as weighting, range or response time will stop the current study and, after a brief settling time, begin a new study.

Manual Timed Study - Press RUN/PAUSE to begin a study. If a Programmed Run Time duration has been set and enabled in the Parameter (PARA) setup menu, the study will run for this time duration and automatically stop. The study may be interrupted by pressing the PAUSE key.

Auto Timed Study - An Auto ON time and date must be set and enabled in the setup menu and the meter must be turned OFF. When the internal clock/calendar reaches this time and date, the meter will turn on and begin a study. The duration of the study will be that of the Programmed Run Time stored via the setup menu. At the end of the study, the unit will PAUSE and turn itself OFF. The study may be interrupted by depressing the PAUSE key.

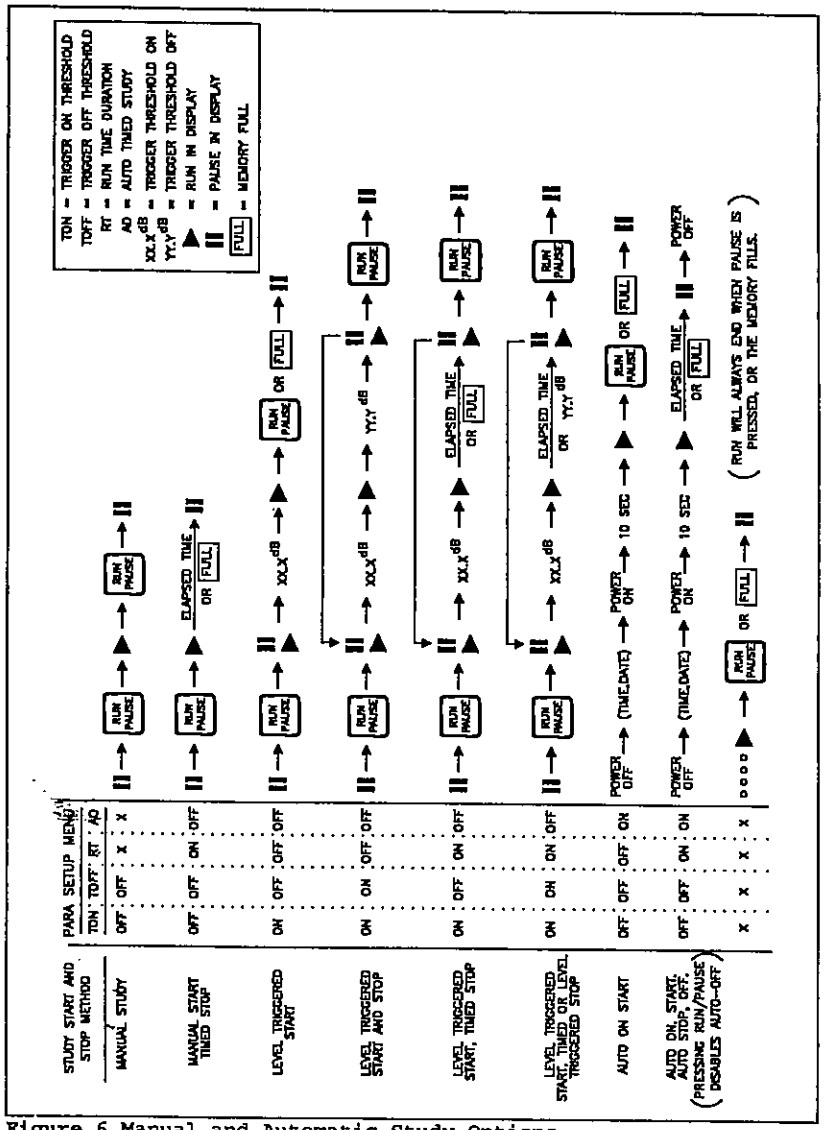

Figure 6 Manual and Automatic Study Options

Threshold Triggered Study - A Trigger Threshold ON level in dB must be set and enabled in the setup menu. While in PAUSE mode, press RUN to arm the meter. If the SPL reaches the desired level a study will begin. The study will end in one of three ways. If a Trigger Threshold OFF level in dB is set, the study will end when the SPL falls to this level. (Note: This level cannot be greater than the Trigger Threshold ON level.) If a Programmed Run Time duration is enabled, the study will last for the specified length of time unless the OFF level is reached. If the SPL is still above the ON level a new study will begin. The study may be interrupted by pressing PAUSE.

NOTE: Both Threshold Triggered and Auto Timed studies may not be enabled simultaneously. While in the Setup Menu, one may not be enabled without first disabling the other.

Filter Controlled Study - Each time the filter band on the optional bandpass filters (OB-100 or OB-300) is changed, either manually or automatically, the current study is ended and, after a brief settling time, a new study will begin.

NOTE: For long term unattended measurements where the possibility of power interruption exists, it is recommended that the meter be set up to run shorter term consecutive studies, such as one hour threshold-triggered studies with a Trigger Threshold ON level sufficiently low to always retrigger at the end of the hour. If power is interrupted during a RUN, all data for that study will be lost. The data from previous studies will be retained.

File Creation (Grouping Studies)

It may be desirable to separate a group of studies into a File. For example, if several studies were performed at a single site using various weightings, response times or filters, you might wish to separate the printout of these studies from that of a similar group of studies performed at a different site. Grouping consecutive studies into a File accomplishes this. A File is created after performing the last study to be grouped, and prior to beginning the first study of the next group.

To create a File, press MEMORY while in Pause mode. " FILE " will appear in the display. Press ENTER. This will group all studies performed since the last File was created into a new File. When printing data, each File will have a Header section to separate it from the previous File. Refer to Figure 7.

File creation is not available if the meter is set to run in session mode. Refer to the next section.

Session Mode (Combined Studies)

To obtain a cumulative measurement of consecutive studies (which must have identical measurement parameters), enable Session mode in the Parameters Setup Menu. (The meter must first have its memory cleared by performing a RESET.) A Session consists of individual studies stored in their memory locations with the addition of an overall summary of all of those studies. Any number of consecutive studies may be grouped into a Session. For example Session 1 might consist of studies 1 through 5, session 2 might consist of studies 6 through 9 and session 3 might consist of studies 10 through 31.

Pressing RUN after performing a RESET begins Session 1 and Study 1 (memory location 1). A session is closed in one of four ways:

1) Press MEMORY , then RESET
2) Change a measurement parameter such as weighting or exchange rate while in PAUSE (Weighting, Response and Range keys are locked out while in RUN only in Session mode)
3) Change the state of an optional bandpass filter. This may be done in either RUN or PAUSE.
4) Turn the meter off. This session cannot be reopened.

After closing a session, the next time RUN is pressed will begin the next session and study. Measurements for individual studies cannot be viewed while measuring Session mode. The displayed data is for the overall session. Individual studies can be viewed by reviewing data in memory. (Refer to section 3.2)

Viewing Measured Results

While performing a study (unit is in RUN mode) the FUNCTION key may be used to view the various measurements as they are occurring. Only measurements selected via the DISP Setup Menu will be available for viewing. If the meter is in Session mode, the value displayed will be the overall summary for the entire session. The displayed value will be updated each second, except for LLOG which is updated each logging interval as selected in the Setup menu. Pressing the MEMORY key during a study will briefly display " XX_{LOC} ", where XX is the current memory location. If the meter is in Session mode, pressing MEMORY will briefly display " XX_{SESS} "" followed by " XX_{LOC} "" to indicate the current session and memory location.

While the unit is in PAUSE mode, the FUNCTION key may be used to view the results of the previous study, or the results of the current session if the meter is in Session mode. The exceptions to this are SPL, which always shows the current SPL updated once per second, and LLOG, the value of which is not displayed. Again, only measurements selected via the Setup Menu will be available for viewing.

While in PAUSE mode, any change to range, weighting or response will make the data from the previous study or session available only by reviewing its memory location. Turning on the optional bandpass filter or changing its frequency will also cause this to happen.

3.2 Reviewing Memory Locations

The results of all currently stored studies are available by pressing the MEMORY key. The memory review process is slightly different depending upon whether or not Session mode was used to create the data in memory.

If Session mode was not enabled, pressing MEMORY will cause " FILE " to appear in the display (refer to File Creation). Press the FUNCTION ▵ or ▿ key. This will display the memory location of the last study performed. For example " 19_{LOC} " would indicate that the last study was the 19th study stored in memory. The ▵ or ▿ keys are used to select other memory locations. Pressing ▿ would select " 18_{LOC} ", but pressing ▵ would wrap around to the first study and select " 1_{LOC} ". Refer to Figure 7.

If Session mode is enabled, pressing MEMORY will display " XX_{SESS} ", which is the last session completed (a currently open session cannot be viewed in memory). The FUNCTION arrow keys select the desired session. The RANGE arrow keys select either individual memory locations of studies within that session or the overall session data.

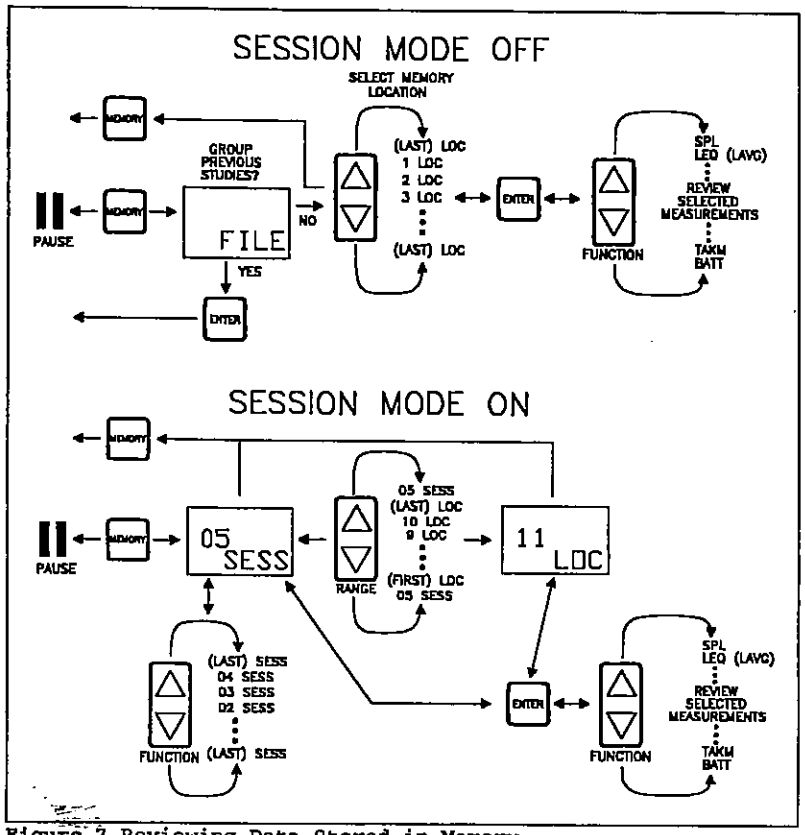

Figure 7 Reviewing Data Stored in Memory

Once the memory location of the desired study is selected, press ENTER to view the measurement results. The measurement parameters such as range , weighting and response will be shown in the display and the " M " indicator will be lit. If an optional bandpass filter was used during the study, the frequency will be briefly displayed. Use the FUNCTION key to select the measurements of interest. Only measurements currently selected via the Setup menu will be available for viewing, but these can be changed at any time by going back to the Setup menu. Pressing ENTER will return to the memory location or session number display. Pressing MEMORY returns to Pause mode.

The data in the memory location being reviewed may be printed using the PRINT key. Refer to section 4.4, "Printing Data". Data logged during a study may be viewed by printing the Time History portion of the printout.

Memory Capacity

The number of studies (memory locations) that can be created is limited by the amount of memory. The amount of data that is logged, if any, during a study will also fill the available memory. Logging data every second will fill memory faster than logging every minute. Session mode will also use more memory due to the extra summary information that must be stored. If the memory fills during a study, the unit will PAUSE and display " FULL ".

In addition to the problem of filling the memory, the total amount of energy accumulated during a study can cause the unit to overflow, causing calculation errors. This is dependent upon the range setting and how high the SPLs are during the study. This can be determined from the value of SEL at various exchange rates as follows:

Exchange Rate	Maximum SEL Without Overflow
3 dB	150 dB + Range
4 dB	200 dB + Range
5 dB	250 dB + Range
6 dB	301 dB + Range

For example, with an exchange rate of 3dB on the 60 - 120 dB range, the maximum SEL without overflow would be 150 dB + 60 dB = 210dB.

The following chart shows approximate time available versus logging rate and number of items logged for the standard 128Kbyte memory.

Maximum number of studies with no data logged: 796 for 128k memory.

Logging Rate	Number of items logged				
	1	2	3	4	5
1 second	21 hr	10.5 hr	7 hr	5 hr	4 hr
3 seconds	2.6 dy	1.3 dy	21 hr	15 hr	12.5 hr
5 seconds	4.4 dy	2.2 dy	1.4 dy	1.1 dy	21 hr
10 seconds	8.7 dy	4.4 dy	2.8 dy	2.2 dy	1.7 dy
15 seconds	13.3 dy	6.5 dy	4.4 dy	3.3 dy	2.6 dy
30 seconds	26 dy	13.2 dy	8.7 dy	6.6 dy	5.3 dy
1 minute	53 dy	26 dy	17.6 dy	13.3 dy	10.5 dy
3 minutes	159 dy	79 dy	53 dy	39 dy	31 dy
5 minutes	265 dy	132 dy	88 dy	66 dy	53 dy
10 minutes	1.3 yr	265 dy	176 dy	132 dy	106 dy
15 minutes	2.2 yr	1 yr	265 dy	198 dy	159 dy
30 minutes	4.3 yr	2.2 yr	1.3 yr	1 yr	318 dy
1 hour	8.6 yr	4.3 yr	2.9 yr	2.2 yr	1.7 yr
2 hours	17 yr	8.6 yr	5.7 yr	4.3 yr	3.4 yr
4 hours	34 yr	17 yr	11.6 yr	8.6 yr	6.9 yr
8 hours	69 yr	34 yr	23 yr	17 yr	13.9 yr
24 hours	209 yr	104 yr	69 yr	52 yr	41 yr

If the 512K memory option is installed, the above times would increase by a factor of 4.

The total number of logged items (LEQ, LMAX, LPK, L10 or L90) possible can be calculated by the following formula:

# of logged items = 2/3 [M - (144 x # of studies) - (3072 x # of studies with stats logged)]

where M = 114687 w/ 128k memory or 507903 w/ 512k memory. The total run time is calcuated by multiplying the number of logged items by the logging rate divided by the number of items logged.

Erasing Stored Data

To erase the data in the memory locations, the meter must be in the Pause mode. Press and hold the RESET/EDIT key for five seconds. The display will read " 5_{RST} " , count down from 5 to 1, and " $----_{RST}$ " will be displayed. The memory is now cleared and the next study will be stored in memory location 1.

3.3 Setup Menus

The operation of the model 1900 may be customized through the Setup menus. While in PAUSE mode, pressing the SETUP key lights the SET annunciator in the display and allows access to the various menus. Pressing the FUNCTION ▵ or ▿ keys selects from among the five Setup menus. Once the desired menu is displayed, pressing the ENTER key enters that menu and displays the first item that may be modified. Refer to figures 8 - 11. The five menus are:

DISP - Displayed Data, or the measurements that may be viewed by pressing FUNCTION while in RUN or PAUSE.

LOG - Logged Data and Logging parameters, or which measurements are logged, where the data is stored and how often the data is stored.

PRNT - Printout format, or printout data presentation.

PARA - Measurement Parameters, or variables affecting the way a measurement is performed. These include thresholds, percentage values for LN, peak detector weighting, etc. as well as clock/calendar setting and calibration value storage.

COMM - Communications parameters for using the COMM port.

The key sequence to exit a Setup Menu is the reverse of the one used to enter the menu.

DISP Setup Menu (Displayed data) Refer to Figure 8

Press SETUP and the FUNCTION ▵ or ▿ keys until "DISP" is displayed. Pressing ENTER gets you into the Display Setup Menu and will, for example, display " on_{SPL} ". You may now choose whether or not SPL will be among the active displays by pressing RESET/EDIT, which toggles between " on_{SPL} " and " oFF_{SPL} ". Pressing FUNCTION ▿ cycles to the next selection, " on_{LAV} " which may be turned on or off with the RESET/EDIT key. The displayed quantities that are selected in this manner are:

SPL (Sound Pressure Level), LEQ or LAVG (Equivalent Level), TWA (Time Weighted Average), LMAX (Maximun Level), LMIN (Minimum Level), LN1, LN2, LN3, LN4 (% Exceedance Levels), LDN (Day Night Level) , CNEL (Community Noise Exposure Level), %OL (Percent Overload Time), PA2S or Pa2H (Exposure), LPK (Peak Level) , SEL (Sound Exposure Level), RTMS (Run Time MIN:SEC), RTHM (Run Time HR:MIN), LLOG (Last LEQ Logged), BATT (Battery Voltage), TAKM (Taktmaximal) and/or LEQ (LAVG) C-A if the C-A option is installed. (TAKM and LC-A cannot both be enabled.)

Press ENTER to exit the DISP Setup Menu, displaying "DISP". The FUNCTION ▵ or ▿ keys may now be used to select another Setup menu.

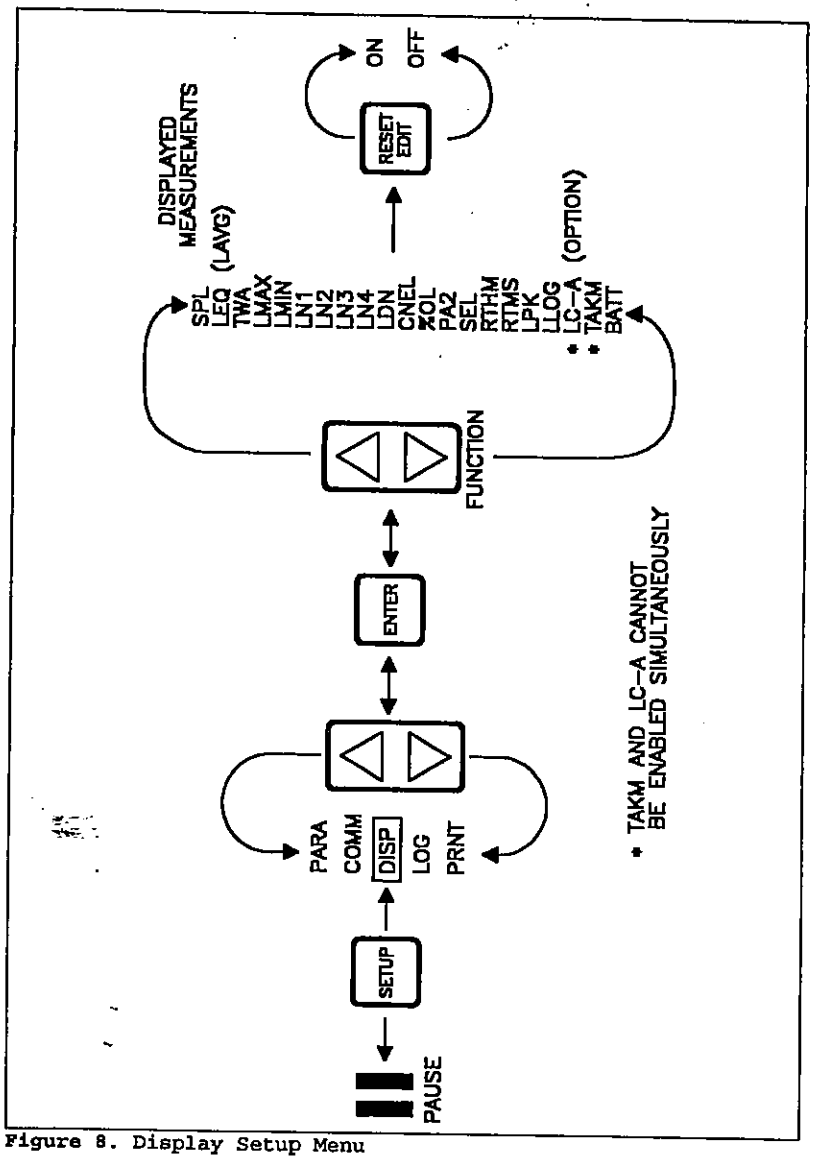

Figure 8. Display Setup Menu

LOG Setup Menu (Data to be logged) Refer to Figure 9

After pressing SETUP, the ▲ or ▼ keys may be pressed until "LOG" is displayed. Pressing ENTER gets you into the Logging Setup Menu and will, for example, display " on_{LEQ} ". You may now choose whether or not LEQ will be among the data that will be periodically logged. Press RESET/EDIT to toggle between " on_{LEQ} " and " oFF_{LEQ} ". Pressing FUNCTION cycles to the next selection, " on_{LPEAK} ", which is turned on or off in the same way. The measured quantities available for logging are:

LAV(or LEQ), Peak, LMAX, L10, L90.

Note that the Peak value that is logged has independently selectable weighting from that of the main measurement. This is set in the PARA Setup Menu.

In addition, whether or not to log to internal memory, whether or not to log to the COMM port, and the time interval (logging rate) may be selected. Saving statistics tables (STAT on or off) for each study may also be selected. The statistics tables provide useful information when downloaded to the optional PC support software, but are not available to the user directly from the meter.

At each of the five measured quantities, press RESET/EDIT to turn that quantity on or off. Do the same for STAT.

To select the destination for logged data, depress FUNCTION to display " on_{COMM} " or " on_{MEM} " which sends logged data to the COMM jack or internal memory respectively. Use the RESET/EDIT key to turn these options on or off.

To select the **logging interval**, press EDIT/RESET which will light the bargraph over the time interval shown on the display. Use the UP or DOWN arrow key to select the desired time interval. The choices are:

1, 3, 5, 10, 15 or 30 seconds
1, 3, 5, 10, 15 or 30 minutes
1, 2, 4, 8 or 24 hours

When the desired interval is displayed, press ENTER to store your selection.

Press ENTER again to exit the LOG Setup menu.

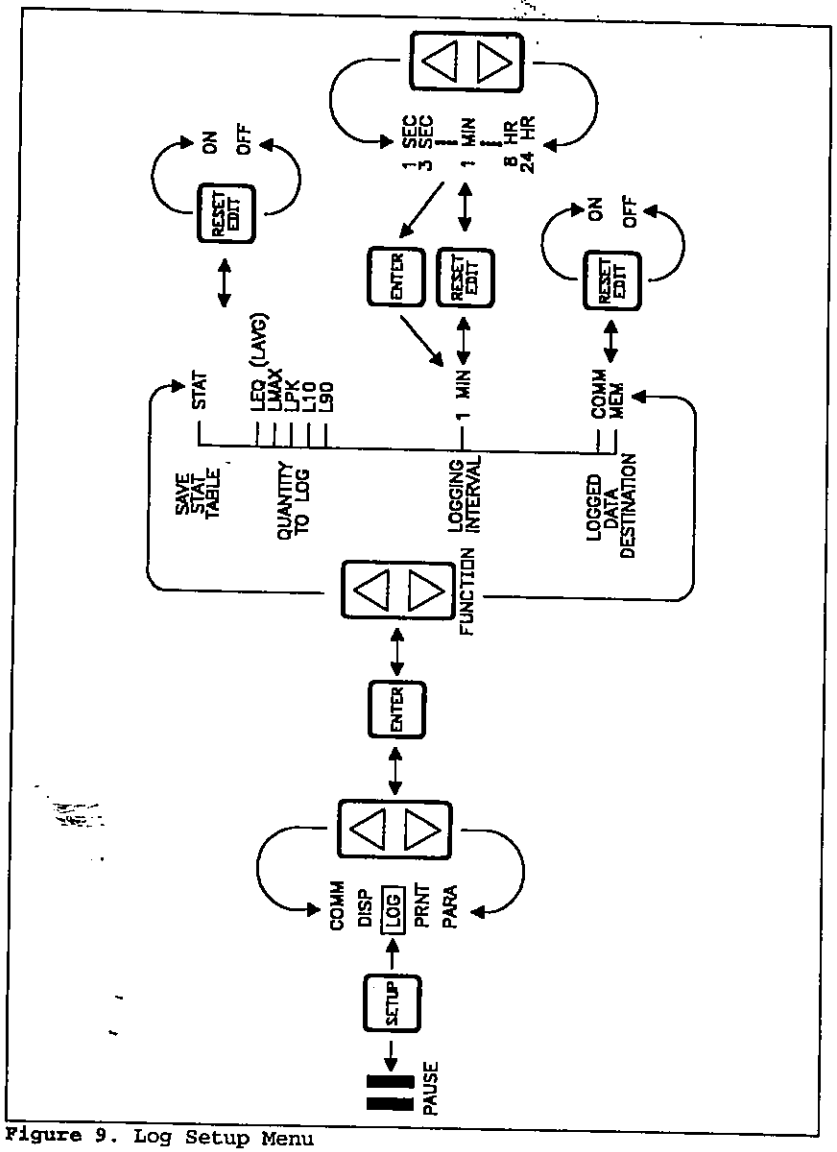

Figure 9. Log Setup Menu

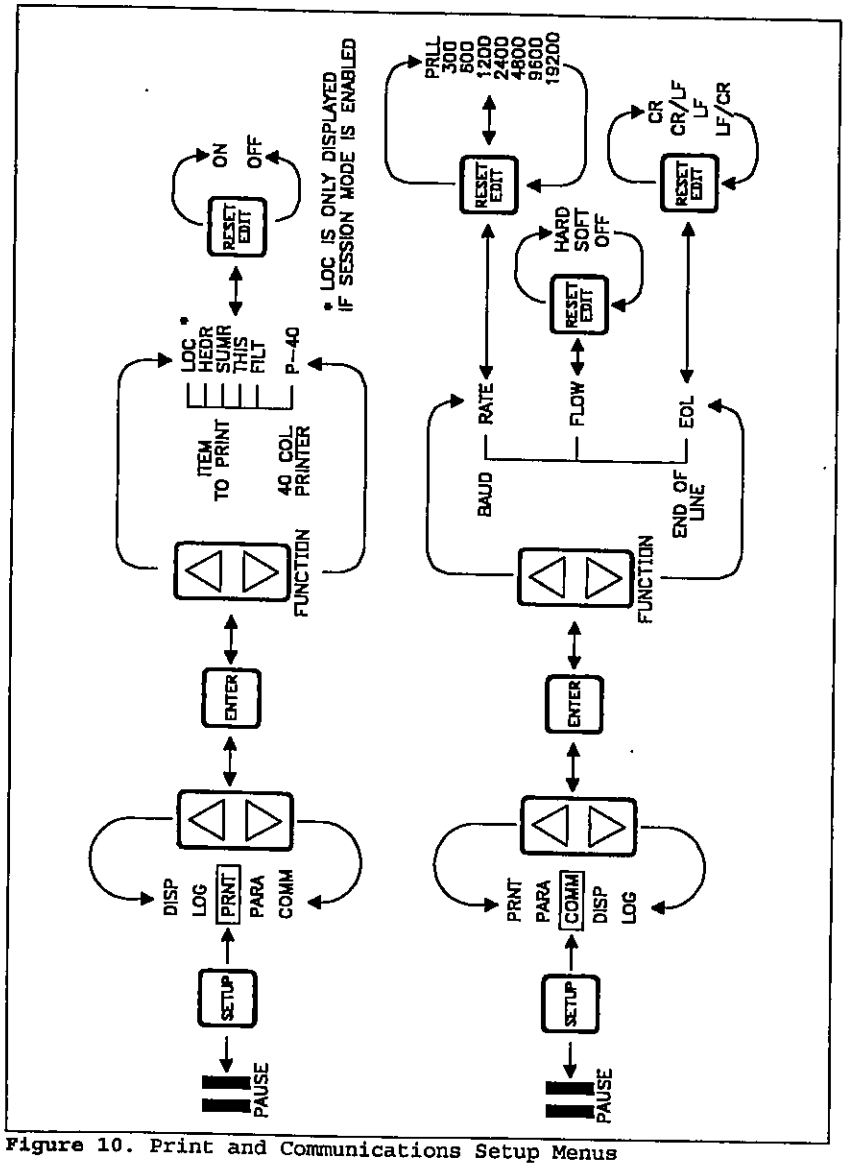

Figure 10. Print and Communications Setup Menus

PRNT Setup Menu (Data to be printed) Refer to Figure 10

After pressing SETUP, the ▲ or ▼ arrow keys may be pressed until PRNT is displayed. The data presentation for the printout may be selected in the Print setup menu. Pressing ENTER gets you into the menu and will, for example, display " on_{HDR} ". You may now choose whether or not the header is included in the printout. Pressing EDIT/RESET toggles between " on_{HDR} " and " oFF_{HDR} ". Pressing FUNCTION cycles to the next selection, " on_{SUMR} ", which is turned on or off in the same way. The printout options are:

HEDR -	Header, on or off
SUMR -	Summary of all measurements, on or off
THIS -	Numeric Time History, on or off
FILT -	Filter Data Grouping, on or off. Data collected using an optional bandpass filter may be grouped under a common header (ON) or printed as an individual study (OFF).
P-40 -	Compressed print mode. This will fit the printout onto a small 40 column printer.
LOC -	Print individual memory locations along with session data (Session mode only)

A sample printout is shown in Section 4.4, "Printing Data".

COMM Setup Menu (Communications parameters) Refer to Figure 10

While in SETUP, press the FUNCTION key to display "COMM". Press ENTER to access the Communications Setup Menu where the following selections involving data communications are made:

BAUD -	Baud Rate. Choice of 300, 600, 1200, 2400, 4800, 9600, 19200 baud or parallel printer output (PRLL).
FLOW -	Flow control or handshaking. Select HARDware, SOFTware or OFF. This is important for transfers of large amounts of data to prevent lost data.
EOL -	End of Line Characters. Choice of : Cr (carriage return) CrLF (carriage return and line feed) LF (line feed) LFCr (line feed and carriage return)

Cycle through these parameters by pressing the ▲ and ▼ keys. Press the RESET/EDIT key to change the values. Pressing ENTER returns to the "COMM" display. Refer to section 4, Communications, for more information.

PARA Setup Menu (Measurement parameters) Refer to Figure 11

After pressing SETUP, the ▲ or ▼ keys may be pressed until PARA is displayed. Pressing ENTER gets you into the Measurement Parameter setup menu, where the following parameters may be set:

ER - Exchange Rate selection of 3, 4, 5 or 6dB. Changing this parameter from 3dB changes LEQ to LAVG for all displays.

TH - Threshold level for averaging (set dB level from 0 to 180, or turn off). If the threshold is enabled, the meter will not integrate SPL below the threshold.

LNX - Four selectable exceedance (LN) values (X = 1 through 4). For each LNX, set N from 1 to 99 in 1% increments.

Ton - Threshold Trigger ON level (set dB level from 0 to 180 or turn off). Sets Threshold triggered study initiation level.

ToFF - Threshold Trigger OFF level (set dB level < or = Threshold Trigger ON level). Sets Threshold triggered study termination level (this is overridden if Programmed Run Time Duration is enabled).

RTHM or RTMS - Programmed Run Time Duration in Hours/Minutes or Minutes/Seconds (set hours/minutes/seconds, or turn off). Sets study length for manual, threshold, or Auto-On initiated study. 99 hour, 59 minute 59 second maximum. Setting to 00:00:00 will default to OFF.

AOMD, AOHM or AOMS - Auto-On Time in Month/Day, Hours/Minutes or Minutes/Seconds (Set Month, Day, Time, or turn off). Sets time to automatically turn on unit and begin study. 24 hour military time format is used for Hours/Minutes.

YEAR, MODY or HRMN - Clock/Calendar (Set year, month/day, hours/minutes). 24 hour military time format is used.

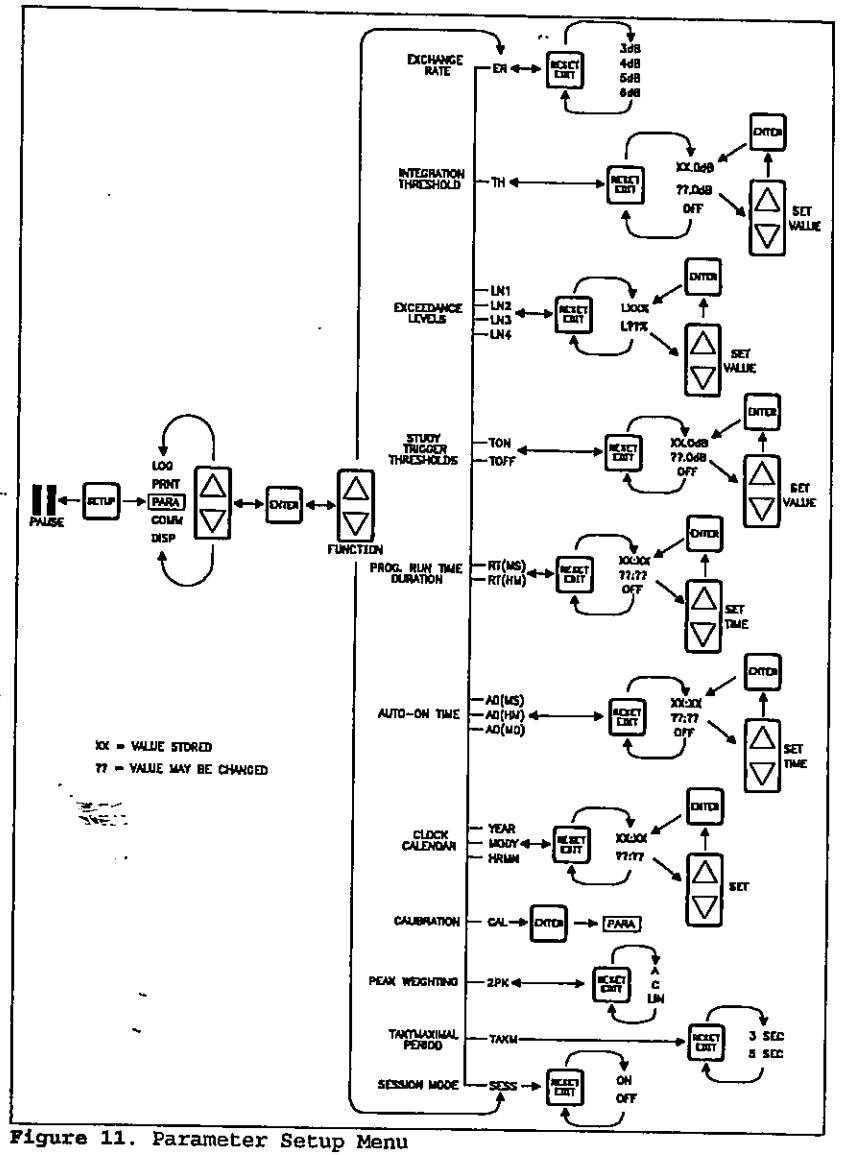

Figure 11. Parameter Setup Menu

- Calibration Value. Stores calibration value for SPL and peak detector. SPL calibration value and time and date of calibration will appear on the printout. The instrument's range settings may be adjusted to compensate for microphones that differ in sensitivity from the standard mics. Refer to section 5.1 "Calibration" for details.

2PK - Select Weighting of Second Peak Detector (A, C, LIN) used for LPK display or for logging data.

TAKM - 3 or 5 second L_{MAX} for Taktmaximal measurements.

SESS - Session mode ON or OFF. ON combines consecutive studies into a cumulative summary. See section 3.2 for details. If there is data in memory, this cannot be changed without first resetting the unit.

The user cycles through these parameters by pressing the ▲ and ▼ keys. Pressing the EDIT/RESET key allows the user to change the values or enable/disable the parameter. When setting numeric values the bargraph sections above the quantity to be changed will be lit. The ▲ and ▼ keys are used to change numeric values. Pressing ENTER stores the value. Pressing ENTER again returns to the "PARA" display.

Typical Setups

OSHA NOISE COMPLIANCE

Threshold = 90dB
Weighting = A
Exchange Rate = 5dB
Response = Slow

OSHA HEARING CONSERVATION

Same as above except with Threshold = 80dB

DEPARTMENT OF DEFENSE NOISE COMPLIANCE

Threshold = 80dB
Weighting = A
Exchange Rate = 4dB
Response = Slow

IEC NOISE MONITORING

Threshold = OFF
Weighting = A
Exchange Rate = 3dB
Response = Slow

TAKTMAXIMAL

Weighting = A
Response = Fast
TAKM = 3 or 5 Seconds as desired, with Logging Interval set to 3 or 5 seconds to log TAPts as LMAX values if LMAX is enabled in LOG Setup Menu

3.4 Overload Detection

While viewing SPL the overload indicator (OL) is displayed whenever the incoming signal saturates (overloads) the circuitry. If the OL indicator is on, increase the RANGE until the OL condition is removed. If an OL condition occurs while in the RUN mode, the OL indicator will light and remain on for the duration of the study.

The percentage overload time is a display option that may be enabled via the DISP setup menu and then selected using the FUNCTION key. The overload time will also be printed on the hard copy printout. While reviewing a study stored in memory, the OL indicator will remain on if an overload occurred during that study. Percentage overload time may be useful in determining the validity of a study during which overload occurred. A small percentage indicates that the data is fairly accurate, while a larger percentage indicates that significant errors occurred.

An overload will also be indicated while logging to the serial port or printing a time history of a study. For each logging interval that contained an overload condition, OL will print at the end of that line of data.

3.5 Battery Replacement

The BAT indicator in the display means that one or both 9V batteries is weak and should be replaced. Make sure the meter is turned off when replacing the batteries. Use a phillips head screwdriver to remove the battery cover on the rear of the unit. Remove the old batteries and replace with fresh alkaline batteries.

A lithium coin cell (type CR2032) is accessible through the battery compartment. This battery maintains the data memory, clock/calendar and setup information when the meter is turned off. A dead lithium cell will cause the meter to lose information stored in the setup menus, the serial number and any data. As long as the meter is turned on, this information will not be lost. If the meter is to be turned off while changing the lithium cell, retrieve any data stored in the meter and make note of setup parameters as these will be erased. Refer to figure 2.

1. Remove the 9 volt batteries from the battery compartment. Using a fingernail or other thin non-metallic object, push the bottom edge of the battery toward the top (microphone end) of the meter until it comes out of the holder.

2. Insert the new lithium cell, edge first and + side up, into the top of the holder. Press the bottom edge of the battery toward the top of the meter until it snaps into the holder.

FOTO DE ENTRADA HACIA VERTEDERO

FOTO ILUSTRANDO CAMINO DE ACCESO HACIA VERTEDERO (TRAMO CERCANO)

FOTO TOMADA CERCA DE AREA ACTIVA HACIA COLINDANCIA ESTE DE PROPIEDAD

FOTO TOMADA DESDE AREA ACTIVA HACIA COLINDANCIA NORTE DE PROPIEDAD

FOTO ILUSTRANDO ESTACION DE MONITORIA DE RUIDO YL-1

FOTO ILUSTRANDO ESTACION DE MONITORIA DE RUIDO YL-2

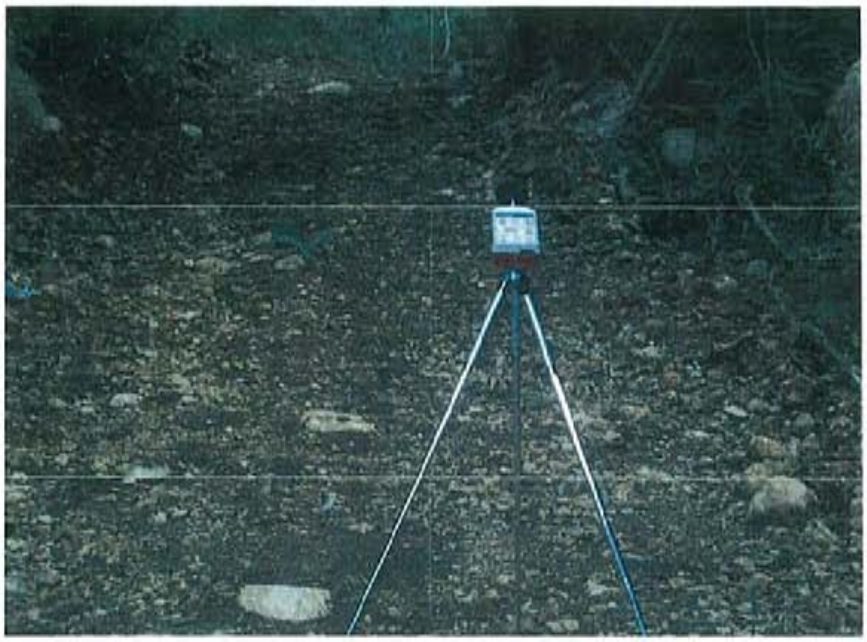

FOTO ILUSTRANDO ESTACION DE MONITORIA DE RUIDO YL-3

FOTO ILUSTRANDO LECTURA DE SONOMETRO EN ESTACION YL-3

FOTO ILUSTRANDO ESTACION DE MONITORIA DE RUIDO YL-4

FOTO ILUSTRANDO ESTACION DE MONITORIA DE RUIDO YL-5

FOTO ILUSTRANDO ESTACION DE MONITORIA DE RUIDO YL-6

FOTO ILUSTRANDO AREA DE TIRO DEL VERTEDERO (ACTIVA)

Apéndice 9:

Estudio de Tránsito

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Estudio de Tránsito
Expansión Relleno Sanitario de Yauco
Yauco, PR

Preparado para:
L & M Waste System
Febrero 2008

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1 INTRODUCCIÓN

La Autoridad de Carreteras y Transportación en su documento titulado "Guías para la Preparación de Estudios Operacionales de Acceso y de Tránsito para Puerto Rico" establece la necesidad y ámbito de los estudios relacionados al tema del tránsito según el tamaño del desarrollo. El documento establece dos (2) tipos de estudios para determinar el efecto que un desarrollo tendrá en su área de influencia; Estudio de Acceso y el Estudio de Tránsito. El primero se define como aquel recomendable para proyectos pequeños, los cuales podrán tener un impacto significativo en las intersecciones formadas por los accesos propuestos y no, necesariamente , en el sistema vial. El segundo es aquel que incluye la evaluación operacional de las intersecciones formadas por los accesos propuestos y por las intersecciones más importantes que están localizadas cerca del desarrollo. Según establecido en el mencionado documento, un desarrollo con menos unidades de vivienda, número de habitaciones o pies cuadrados de área comercial u oficinas que el valor mínimo de la tabla I, página 5, de las guías no requerirá la preparación de estudio operacional alguno.

El desarrollo sujeto de este informe consiste en la expansión del vertedero existente con 60 cuerdas adicionales divididas en cuatro celdas de 15 cuerdas cada una, lo que le prolongará la vida útil por 30 años mas. Aunque en las guías de la ACT no se requiere estudio de tránsito para este tipo de proyecto, el proponente del mismo decidió preparar el mismo como parte del proceso ambiental.

El siguiente informe presenta el estudio de tránsito asociado al proyecto denominado "Expansión Relleno Sanitario de Yauco". El mismo evalúa las condiciones del tránsito en las intersecciones que servirán de conexión para el mencionado desarrollo a la red vial junto a las intersecciones adyacentes de mayor

importancia. Se modelará el funcionamiento de las mencionadas intersecciones mediante el uso del programa de computadoras para el análisis de intersecciones "Signalised & unsignalised Intersection Design & Research Aid".

2 Localización y descripción de la acción propuesta

El proyecto consiste en una expansión de 60 cuerdas en el lado sur del vertedero de Yauco. El mismo esta localizado en el barrio Barina de dicho municipio. Esta expansión permite añadirle 30 años a la vida útil del vertedero. Aunque este tipo de expansión no implica directamente un aumento en el tránsito, el mismo ocurriría debido a que varios vertedero tendrían que cerrar operaciones en los próximos años. Algunos de los municipios que actualmente depositan en esos vertederos podrían contratar al municipio de Yauco para el depósito de sus desperdicios. La siguiente figura muestra un mapa de localización del proyecto..

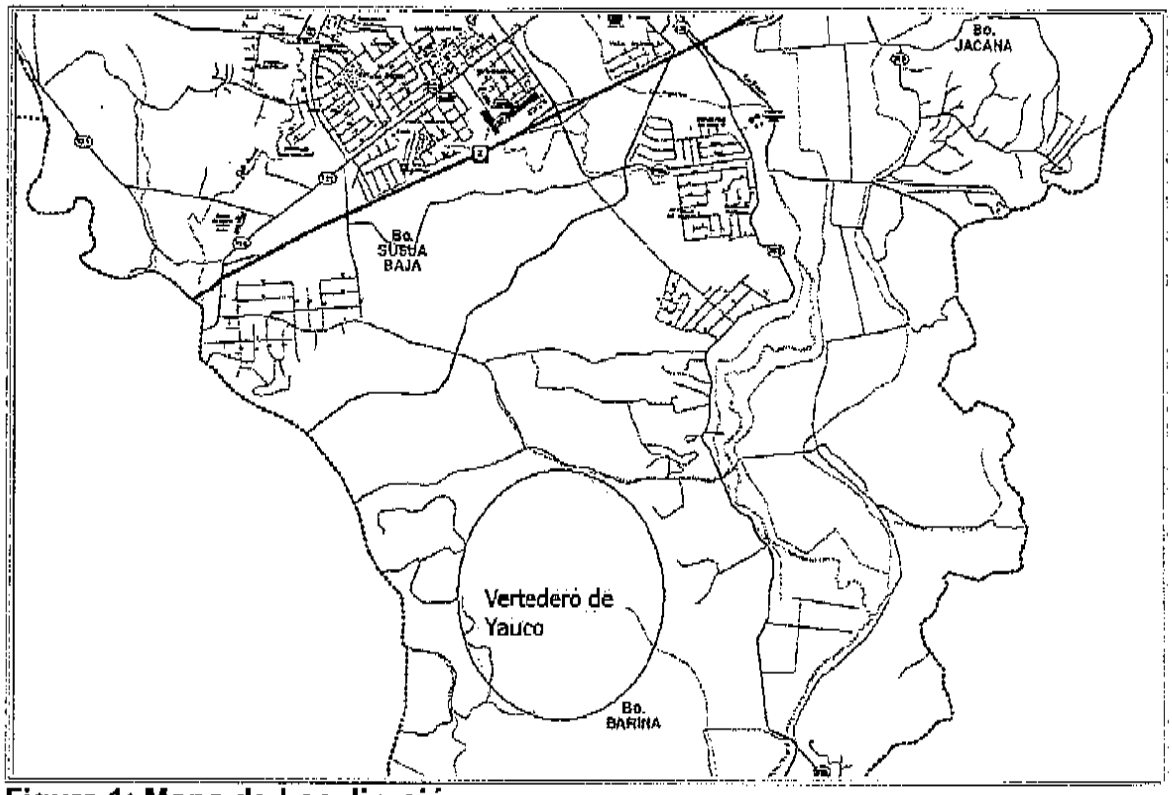

Figura 1: Mapa de Localización

3 METODOLOGÍA PARA LA EVALUACIÓN DEL IMPACTO EN EL TRÁNSITO DEBIDO A LA ACCIÓN PROPUESTA

a. El jueves 13 de diciembre de 2007 se realizaron conteos de vehículos en el área de estudio durante las 12 horas de mayor afluencia vehicular. Los horarios de conteos realizados fueron de 6:00 AM a 6:00 PM. Estos conteos se realizaron para determinar el número de vehículos que utilizan las vías de tránsito cercanas al área del proyecto. Las intersecciones medidas fueron:

   (a) PR-128 y PR-127
   (b) PR-127 y calle 16
   (c) Calle 16 y calle A
   (d) PR-116 y PR-116R

b. Dado que el proyecto no estará completado hasta aproximadamente el año 2010, los flujos del año 2007 fueron expandidos a ese año usando un factor de crecimiento anual. Debido al tamaño de este proyecto, se requiere el análisis de un escenario adicional cinco años más tarde por lo que los flujos también fueron expandidos al año 2015.

c. Utilizando como referencia el calendario de cierre de vertederos de Puerto Rico se estimó el número de viajes que se generarían desde y hacia el proyecto propuesto.

d. Con todos los datos recopilados se procedió a analizar las intersecciones en cuestión. Para realizar este análisis se utilizó el programa de computadoras SIDRA Intersection 3.2. Las situaciones estudiadas fueron los períodos pico de la mañana y de la tarde con los flujos existentes, y las mismas situaciones al añadirse el crecimiento anual esperado y los flujos generados por el proyecto. Las intersecciones estudiadas son las mencionadas anteriormente.

4 Teoría

4.1 Evaluación sobre el Nivel de Servicio (LOS) para una intersección:

El nivel de servicio es la metodología más conocida utilizada para la evaluación de una facilidad. El nivel de servicio representa las condiciones de operación de las intersecciones: el nivel de servicio "A" representa las condiciones excelentes de tránsito y el nivel "F", las peores condiciones. Tanto las intersecciones semaforizadas como las no semaforizadas pueden ser categorizadas utilizando esta metodología. Estos niveles de servicio a su vez se encuentran basados en las demoras promedio que tienen los vehículos en las intersecciones. A continuación se definen las categorías para cada nivel de servicio.

LOS A: Excelente

Esta es una condición de flujo libre, acompañada por bajos volúmenes de tránsito y altas velocidades. Hay poca o ninguna restricción en maniobrabilidad del conductor y los conductores pueden mantener sus deseadas velocidades con poco o ningún retraso.

LOS B: Muy Buena

En esta condición, las velocidades de operación comienzan a estar restringidas un tanto por las condiciones del tránsito. Los conductores aún tienen una libertad considerable para seleccionar su velocidad y carril de operación.

LOS C: Buena

Las velocidades y maniobrabilidad se vuelven más controladas por volúmenes de tránsito más altos. La mayoría de los conductores están restringidos en su libertad para seleccionar su propia velocidad, cambiar de carril o pasar.

LOS D: Aceptable

Este nivel de servicio se acerca a un flujo inestable, con velocidades operacionales tolerables siendo mantenidas, aunque considerablemente afectadas por los cambios en las condiciones operacionales. Los conductores tienen poca libertad para maniobrar y la comodidad y conveniencia son bajas.

LOS E: Capacidad

El flujo de tránsito se vuelve inestable y podría haber paradas momentáneas.

LOS F: Mala

En esta condición, la velocidad operacional podría bajar a cero y resultar en colas de tránsito.

4.2 Relación entre demoras y Nivel de Servicio

La tabla #1, muestra las diferentes relaciones entre el nivel de servicio y las demoras promedio por cada vehículo en las intersecciones controladas ya sea por semáforo, señales de PARE o CEDA, o en rotondas. (Manual de SIDRA). Estas demoras tienen como componentes la demora de viajar a través de la intersección mas la demora de la detención como consecuencia de la intersección.

Tabla 1 Criterio del Nivel de Servicio para intersecciones

NIVEL DE SERVICIO	DEMORA DE VEHÍCULOS (SEG.)	
	Semáforo y Rotonda	PARE y CEDA
A	$d \leq 10$	$d \leq 10$
B	$10 < d \leq 20$	$10 < d \leq 15$
C	$20 < d \leq 35$	$15 < d \leq 25$
D	$35 < d \leq 55$	$25 < d \leq 35$
E	$55 < d \leq 80$	$35 < d \leq 50$
F	$80 < d$	$50 < d$

4.3 Glosario

A continuación se presenta una lista de términos comunes en la práctica de la ingeniería de tránsito, según definidos por la Autoridad de Carreteras y Transportación.

- **Acceso (intersección)** – está caracterizado por un grupo de carriles en una dirección de la intersección, incluyendo los movimientos a la izquierda, recto y a la derecha.

- **ADT** – "Average Daily Traffic", tránsito promedio diario en una facilidad de una carretera.

- **Área de estudio** – área geográfica que contiene las intersecciones y segmentos más críticos de una carretera, los cuales se esperan sean afectados por el tránsito a ser generado por el desarrollo.

- **Ciclo** – el período de tiempo requerido para una secuencia completa de indicaciones del semáforo.

- **Desarrollo** – proyectos residenciales, comerciales, de oficinas, de hospederías e industriales, entre otros, que serán construidos en un predio de terreno sin desarrollar o que forman parte de una reconstrucción o expansión de una edificación existente.

- **Día típico** – un martes, miércoles o jueves durante los días de clase entre los meses de enero a mayo y de agosto a diciembre. Para los usos comerciales, el sábado podrá incluirse entre los días típicos.

- **Estudio operacional** – el análisis del impacto potencial al tránsito causado por un desarrollo propuesto. Este tipo de estudio dependerá del tipo y tamaño del proyecto. Para propósitos de este documento, un

estudio operacional consistirá de un estudio de accesos o un estudio de tránsito.

- **Factor de hora pico** – una medida de la fluctuación en la demanda vehicular dentro de la hora pico.

- **Fase** – una parte del ciclo asignado a un movimiento de tránsito que tenga el derecho de paso o a una combinación de movimientos de tránsito que tengan simultáneamente el derecho de paso durante uno o más intervalos.

- **Hora pico** – un período de una hora durante la mañana (AM) o durante la tarde (PM) que representa el volumen de tránsito más alto en el sistema, resultado de la suma de los volúmenes de cuatro (4) períodos de quince (15) minutos consecutivos.

- **Modelos de micro simulación** – modelos que simulan el movimiento individual de vehículos, basados en teorías de cambio de carril, dirección de los vehículos y forma de conducir.

- **Nivel de servicio ("Level of Service" - LOS)** – una medida cualitativa que describe las condiciones operacionales de un componente del sistema de transportación. Generalmente descrito por los siguientes factores: velocidad, tiempo de viaje, demora, interrupciones en el tránsito y seguridad.

- **Semáforo actuado** – un tipo de sistema de semáforos mediante el cual se varían los intervalos de tiempo de acuerdo con las demandas del tránsito registradas por la actuación de los detectores localizados en el pavimento de rodaje.

- **Semáforo semiactuado** – un tipo de sistema de semáforos donde los detectores son colocados en los accesos de menor flujo vehicular para permitirle prioridad de verde a los accesos principales.

- **Semáforo de tiempo fijo** – un tipo de sistema de semáforos que opera con programas predeterminados de ciclos en intervalos.

- **Volumen** – el número de personas o vehículos pasando por un punto de un carril o un segmento de carretera durante cierto intervalo de tiempo.

5 Análisis de Tránsito

5.1 Afluencia vehicular

A modo de determinar el patrón de viajes actuales del sector se realizaron conteos manuales en seis (6) intersecciones cercanas al proyecto. Dichos conteos se realizaron en periodos de quince (15) minutos de 6:00 AM a 6:00 PM el día 13 de diciembre de 2007. Las intersecciones contadas fueron las siguientes:

1. PR-128 y PR-127
2. PR-127 y calle 16
3. Calle 16 y calle A
4. PR-116 y PR-116R

Las tablas en el apéndice 1 ilustran el flujo vehicular obtenido mediante dichos conteos manuales. Para determinar la hora pico se buscaron los cuatro períodos consecutivos de 15 minutos con más flujo. Una vez se encontraba esta hora en los períodos AM y PM, se buscaba el período de 15 minutos con mayor flujo, y este valor multiplicado por cuatro era el que se utilizaba para la modelación. Dado que ya se está usando el valor del período de 15 minutos más alto, el factor de hora pico a utilizarse es 1.0.

Los flujos mostrados están identificados por dos letras separadas por un guión. La primera representa el acceso de procedencia del movimiento en inglés: North, South, East & West. La segunda letra representa el tipo de movimiento: Left, Thru & Right. Las siguientes tablas muestran los flujos vehiculares por acceso de las intersecciones estudiadas.

Tabla 2 Flujos PR-128 y PR-127 (Condición Presente)

2007	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	312	896	92	76	116	88	188	1056	412	352	592	516	4696
Pico PM	280	616	152	180	208	68	488	916	96	300	408	452	4164

Tabla 3 Flujos PR-127 y calle 16 (Condición Presente)

2007	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	12	--	104	104	552	--	--	--	--	--	920	16	1708
Pico PM	4	--	196	196	600	--	--	--	--	--	728	16	1740

Tabla 4 Flujos Calle 16 y calle A (Condición Presente)

2007	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	--	--	--	--	40	64	40	--	0	24	32	--	200
Pico PM	--	--	--	--	48	72	40	--	20	20	32	--	232

Tabla 5 Flujos PR-116 y PR-116R (Condición Presente)

2007	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	28	508	260	0	68	256	164	400	68	152	116	40	2060
Pico PM	60	492	316	0	60	252	196	592	116	68	84	40	2276

5.2 Crecimiento Anual

Los flujos obtenidos en diciembre de 2007 fueron expandidos al año 2010, cuando el desarrollador entiende que la expansión estará operando. Los flujos de la zona fueron expandidos utilizando un factor de crecimiento que nos fue brindado por la Oficina de Recopilación de Datos y Análisis de Tránsito de la Autoridad de Carreteras y Transportación. Debido al tamaño del proyecto, el mismo también tiene que ser analizado para un escenario cinco años luego de su fecha de

operación. Para las carreteras PR-128 y PR-127 el factor de 20 años provisto por la ACT fue de 1.25, lo que equivale a 1.03 para el año 2010, y 1.09 para el año 2015. Para la carretera 116 el factor de 20 años provisto por la ACT fue de 1.42, lo que equivale a 1.04 para el año 2010, y 1.15 para el año 2015.

5.3 Generación de viajes del proyecto

El proyecto bajo estudio propone la expansión en tamaño al vertedero existente en Yauco. Esta expansión tiene como propósito el expandir la vida útil del vertedero, lo que no implica necesariamente un aumento en la cantidad de viajes que se realizan al vertedero diariamente. Sin embargo, la realidad es que durante el tiempo de vida útil del vertedero de Yauco se estarán cerrando otros vertederos, causando que los viajes que se realizan a ellos se tengan que redistribuir entre los vertederos que queden operando. Para propósitos de estimados de generación de viajes, presumimos que los viajes de los vertederos que vayan cerrando se dividirían equitativamente entre los seis vertederos con mayor vida útil, uno de los cuales sería Yauco. Para el año 2010 estarían cerrando los vertederos de: Aguadilla, Arroyo, Barranquitas, Juncos, Toa Baja, Vega Baja y Yabucoa. En la actualidad estos vertederos reciben 662 viajes diarios que tendrían que ser atendidos por los restantes vertederos. Para nuestros estimados presumimos que una sexta parte de estos viajes se relocalizarían a Yauco. Para el año 2015 se estarían añadiendo a la lista de cierres los vertederos de los siguientes municipios: Añasco, Cayey, Fajardo, Isabela, Juana Díaz y Santa Isabel. Entonces el total de viajes que tendrían que ser reasignados aumentaría a 923 viajes diarios. En adición a la información de viajes diarios, es importante poder determinar los viajes que ocurrirían durante las horas pico de las carreteras aledañas. De acuerdo a

información que recibimos del operador del vertedero de Yauco, pudimos estimar que durante la hora pico de llegada de camiones al vertedero, para el día con el pico mas alto, el volumen más alto era de casi 20% del volumen total del día. Presumimos el peor escenario, y utilizamos ese valor de 20$ para el período pico de la mañana y el de la tarde. Además presumimos que la misma cantidad de viajes que llegan, saldrían en el mismo período. La siguiente tabla muestra los resultados obtenidos de la generación de viajes.

Tabla 6: Generación de Viajes

				ADT			Pico AM			Pico PM		
Uso	Categoría	Tamaño	Unidad	Total	Entra	Sale	Total	Entra	Sale	Total	Entra	Sale
Vertedero (2010)				221	110	111	44	22	22	44	22	22
Vertedero (2015)				308	154	154	62	31	31	62	31	31

5.4 Distribución de Viajes

Para realizar la distribución de los viajes que generará el proyecto bajo estudio, presumimos que todos los viajes saldrían a través de la calle 16 desde el vertedero. Una llegan a la intersección con la carretera PR127, 60% de los viajes se dirigirían hacia el Oeste en dirección a la carretera PR-116, y 40% se dirigiría hacia el Este en dirección a la carretera PR-128. El 60% de la carretera PR-116 a su vez se dividiría en 50% hacia la PR-2 y 10% seguiría por la PR-116 hacia otros municipios. El 40% de la PR-128 se dividiría en 10% hacia el Norte de la PR-128, 5% hacia el Este de la PR-127, y el restante 25% hacia el Sur de la PR-128. Este 25% se divide a su vez en 15% hacia el Este de la PR-2 y 10% hacia el Sur de la PR-128. Las rutas de llegada al vertedero serían el inverso de la descripción anterior.

5.5 Tránsito Futuro

Para la modelación de la situación futura se tomaron los flujos de la situación base, se multiplicaron por el factor de crecimiento anual y se le añadieron los flujos que se obtuvieron en la etapa de generación de viajes, repartidos de acuerdo a la distribución que se explicó anteriormente. Las siguientes tablas muestran los flujos modelados.

Tabla 7 Flujos PR-128 y PR-127 (Condición Futura 2010)

2010	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	326	918	94	78	120	90	193	1082	424	363	608	535	4831
Pico PM	293	631	156	185	214	70	500	939	100	310	419	469	4286

Tabla 8 Flujos PR-127 y calle 16 (Condición Futura 2010)

2010	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	25	--	116	116	566	--	--	--	--	--	943	29	1795
Pico PM	17	--	210	210	615	--	--	--	--	--	746	29	1827

Tabla 9 Flujos Calle 16 y calle A (Condición Futura 2010)

2010	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	--	--	--	--	42	89	64	--	0	25	33	--	253
Pico PM	--	--	--	--	50	97	64	--	21	21	33	--	286

Tabla 10 Flujos PR-116 y PR-116R (Condición Futura 2010)

2010	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	29	529	273	2	71	278	182	417	71	158	121	42	2173
Pico PM	63	513	331	2	63	274	215	617	121	71	88	42	2400

Tabla 11 Flujos PR-128 y PR-127 (Condición Futura 2015)

2015	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	347	974	100	83	128	96	204	1148	451	386	646	569	5132
Pico PM	313	670	165	196	228	74	531	996	107	329	446	500	4555

Tabla 12 Flujos PR-127 y calle 16 (Condición Futura 2015)

2015	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	32	--	125	125	600	--	--	--	--	--	1001	36	1919
Pico PM	23	--	225	225	653	--	--	--	--	--	792	36	1954

Tabla 13 Flujos Calle 16 y calle A (Condición Futura 2015)

2015	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	--	--	--	--	46	104	77	--	0	28	37	--	292
Pico PM	--	--	--	--	55	114	77	--	23	23	37	--	329

Tabla 14 Flujos PR-116 y PR-116R (Condición Futura 2015)

2015	Sur			Este			Norte			Oeste			Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	Hora
Pico AM	32	583	301	3	78	310	204	459	78	174	133	46	2401
Pico PM	69	564	365	3	69	305	241	679	133	78	96	46	2648

5.6 Modelación de Tránsito

Para la evaluación de las intersecciones seleccionadas se utilizó el programa SIDRA Intersection v. 3.2. Este modelo permite la evaluación de intersecciones semaforizadas y de prioridad, además de la optimización de las de semáforo, y es el preferido debido a su capacidad de predicción, aún en situaciones de sobresaturación. Se realizaron modelaciones para los períodos pico de la mañana y de la tarde para la situación actual y las situaciones futuras.

5.6.1 Intersección PR-128 y PR-127

Esta intersección tiene una configuración tipo "cruz" operada con semáforo. Los accesos norte y sur corresponden a la carretera PR-128 y ambos están formados por dos carriles ingresando a la intersección, un carril corto de viraje a la derecha y un carril saliendo de la intersección. Los accesos este y oeste corresponden a la carretera PR-127. El acceso este cuenta con dos carriles compartidos entrando a la intersección, de 3.35m y 3.2m de ancho; y un carril saliendo de 3.1m de ancho. El acceso oeste cuenta con un carril compartido, un carril recto y un carril corto de viraje a la derecha entrando a la intersección. Saliendo de la intersección cuenta con un carril. La siguiente figura muestra la geometría existente.

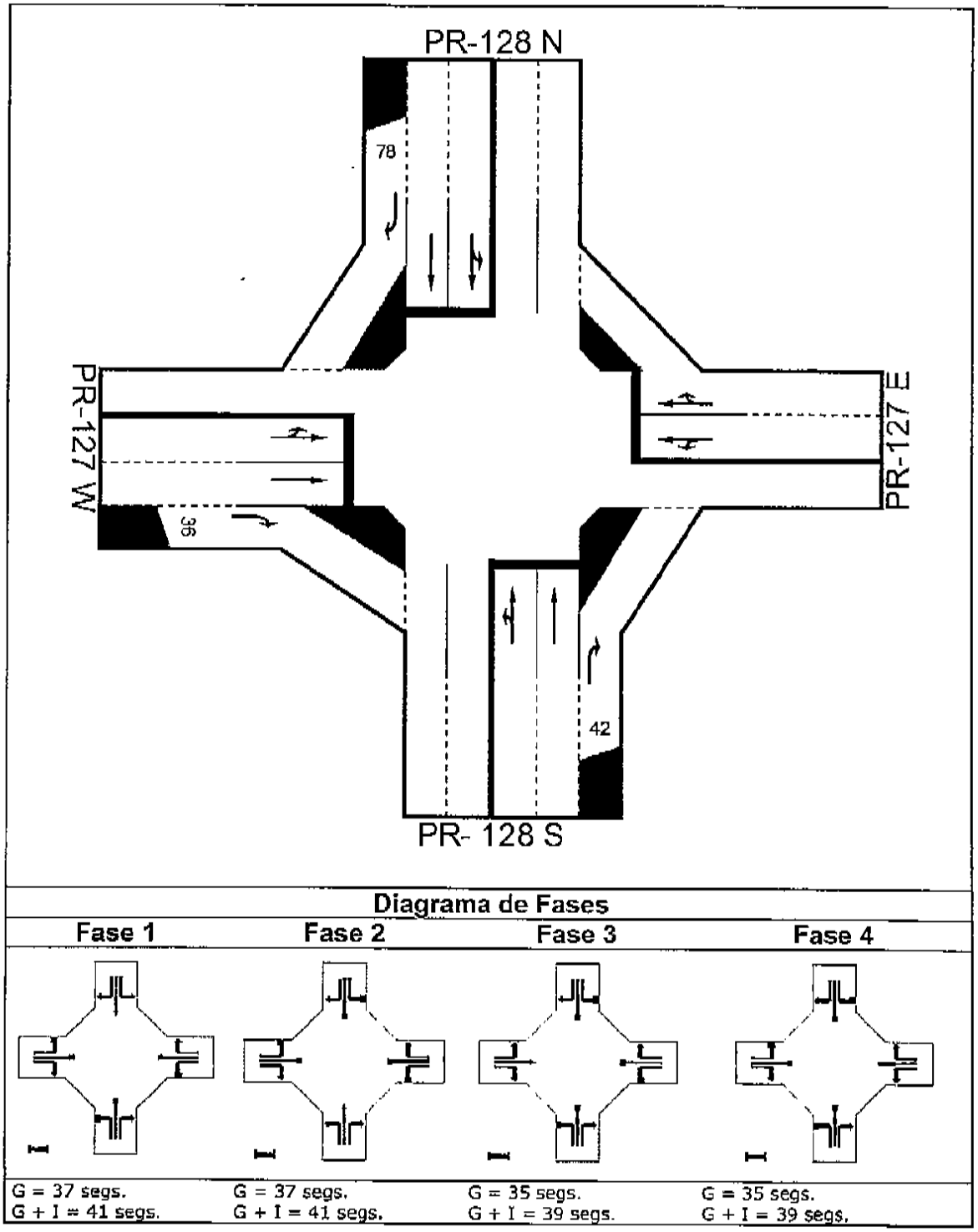

Figura 2 Croquis y Diagrama de Fases Int. PR- 128 y PR-127

La siguiente tabla muestra los resultados obtenidos para las distintas situaciones modeladas.

Tabla 15 Resultados modelación PR-128 y PR-127

		Demora Promedio por Vehículo [seg.], Nivel de Servicio (LOS) y Cola Máxima [metros]												
		Acceso Sur PR-128			Acceso Este PR-127			Acceso Norte PR-128			Acceso Oeste PR-127			Demora y LOS Total Int.
		Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	
Base 2007														**Control= Semáforo**
AM	Izquierda	395.2	F	327	80.5	F	68	305.9	F	374	172.3	F	185	231.1 F
	Recto	388.8	F	549	72.4	E	68	296.5	F	441	268.4	F	378	
	Derecha	7.7	A	1	8.0	A	1	7.8	A	5	8.0	A	6	
	Acceso	363.3	F	549	54.3	D	68	225.8	F	441	153.2	F	378	
PM	Izquierda	156.0	F	190	210.7	F	190	462.9	F	439	71.3	E	96	219.8 F
	Recto	151.1	F	251	161.3	F	190	451.0	F	634	91.6	F	165	
	Derecha	7.7	A	1	53.7	D	31	7.7	A	1	7.9	A	5	
	Acceso	131.6	F	251	164.8	F	190	426.5	F	634	53.8	D	165	
Futuro 2010														**Control= Semáforo**
AM	Izquierda	133.0	F	216	61.3	E	17	140.8	F	228	81.8	F	100	101.1 F
	Recto	131.4	F	227	51.0	D	44	132.4	F	236	135.2	F	266	
	Derecha	16.1	B	8	58.8	E	44	11.7	B	28	15.0	B	36	
	Acceso	123.7	F	227	56.2	E	44	103.2	F	236	87.3	F	266	
PM	Izquierda	125.5	F	153	121.1	F	60	115.2	F	234	117.3	F	101	88.2 F
	Recto	123.8	F	161	63.8	E	67	106.5	F	247	34.6	C	97	
	Derecha	21.3	C	18	71.7	E	67	11.8	B	6	16.9	B	36	
	Acceso	109.4	F	161	87.6	F	67	103.1	F	247	50.3	D	101	
														Control= Semáforo
AM	Izquierda	145.4	F	252	82.3	F	22	135.7	F	250	157.2	F	155	105.6 F
	Recto	143.8	F	264	63.7	E	56	127.3	F	259	129.4	F	249	
	Derecha	13.8	B	7	71.6	E	56	12.6	B	36	8.1	A	9	
	Acceso	135.0	F	264	71.2	E	56	99.6	F	259	93.0	F	249	
PM	Izquierda	179.5	F	187	216.5	F	85	173.2	F	290	207.6	F	139	126.4 F
	Recto	177.9	F	197	44.8	D	55	164.7	F	305	24.9	C	66	
	Derecha	19.2	B	16	52.7	D	55	11.4	B	6	8.1	A	8	
	Acceso	155.6	F	197	113.6	F	85	157.4	F	305	65.5	E	139	

Como podemos notar, esta intersección opera de manera deficiente en la actualidad. Sin embargo hay que notar que el proyecto bajo estudio no empeorará la demora. De hecho en el futuro la demora puede ser disminuida significativamente mediante la optimización de los tiempos del semáforo.

5.6.2 Intersección PR-127 y Calle 16

Esta intersección es de tipo "T" y esta controlada por un Pare. Los accesos este y oeste corresponden a la carretera PR-127 con un carril por dirección de flujo. El acceso sur corresponde a la calle 16 y cuenta con un carril por dirección de flujo. La siguiente figura muestra lo antes descrito.

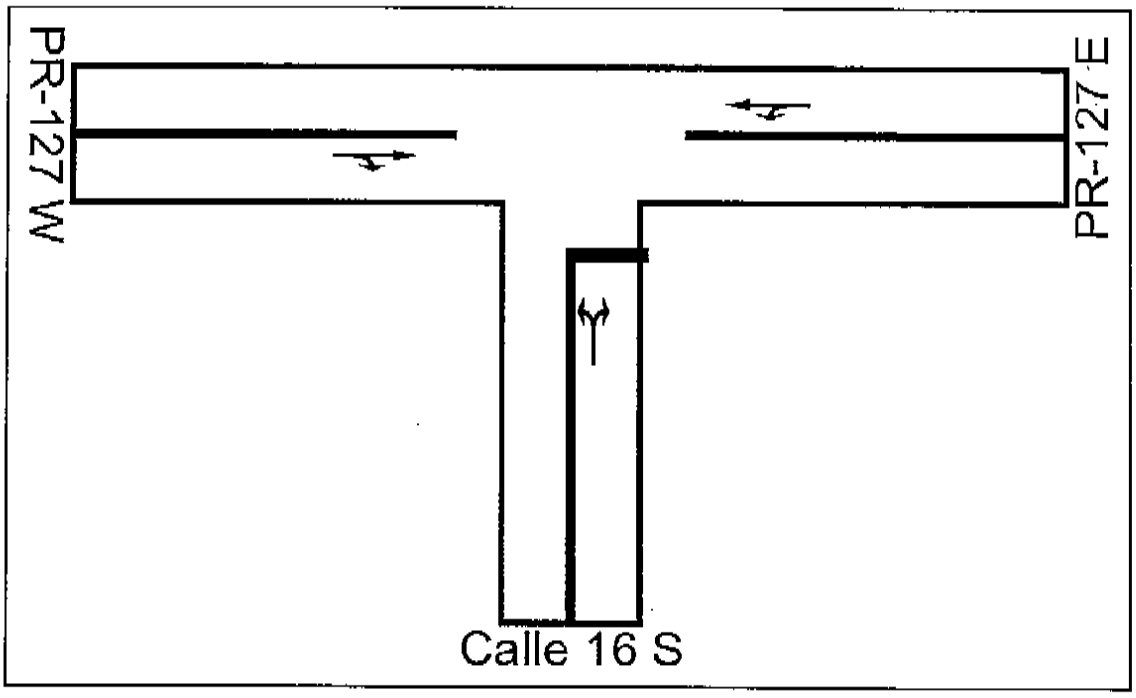

Figura 3: Diagrama esquemático geometría PR-127 y calle 16

La siguiente tabla muestra los resultados obtenidos para las distintas situaciones modeladas.

Tabla 16 Resultados modelación PR-127 y Calle 16

		Demora Promedio por Vehículo [seg.], Nivel de Servicio (LOS) y Cola Máxima [metros]												
		Acceso Sur Calle 16			Acceso Este PR-127			Acceso Norte			Acceso Oeste PR-127			Demora y LOS Total Int.
		Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	
Base 2007														**Control= Pare**
AM	Izquierda	30.9	D	6	30.2	D	26	--	--	--	--	--	--	11.0
	Recto	--	--	--	21.7	C	26	--	--	--	0.0	A	0	
	Derecha	31.0	D	6	--	--	--	--	--	--	8.2	A	0	
	Acceso	31.0	D	6	23.0	C	26	--	--	--	0.1	A	0	
PM	Izquierda	22.2	C	7	25.4	D	30	--	--	--	--	--	--	11.3
	Recto	--	--	--	16.9	C	30	--	--	--	0.0	A	0	
	Derecha	22.4	C	7	--	--		--	--	--	8.2	A	0	
	Acceso	22.4	C	7	19.0	C	30	--	--	--	0.2	A	0	
Futuro 2010														**Control= Pare**
AM	Izquierda	43.1	E	10	36.0	E	30	--	--	--	--	--	--	14.5
	Recto	--	--	--	27.5	D	30	--	--	--	0.0	A	0	
	Derecha	43.3	E	10	--	--	--	--	--	--	8.2	A	0	
	Acceso	43.2	E	--	28.9	D	30	--	--	--	0.2	A	0	
PM	Izquierda	29.0	D	12	29.5	D	34	--	--	--	--	--	--	14.2
	Recto	--	--	--	21.1	C	34	--	--	--	0.0	A	0	
	Derecha	29.1	D	12	--	--	--	--	--	--	8.2	A	0	
	Acceso	29.1	D	12	23.2	C	34	--	--	--	0.3	A	0	
Futuro 2015														**Control= Pare**
AM	Izquierda	91.7	F	24	51.9	F	37	--	--	--	--	--	--	24.6
	Recto	--	--	--	43.4	E	37	--	--	--	0.0	A	0	
	Derecha	91.8	F	24	--	--	--	--	--	--	8.2	A	0	
	Acceso	91.8	F	24	44.9	E	37	--	--	--	0.3	A	0	
PM	Izquierda	41.2	E	19	41.0	E	42	--	--	--	--	--	--	21.0
	Recto	--	--	--	32.5	D	42	--	--	--	0.0	A	0	
	Derecha	41.3	E	19	--	--	--	--	--	--	8.2	A	0	
	Acceso	41.3	E	19	34.7	D	42	--	--	--	0.4	A	0	

Como se puede notar en la tabla anterior, esta intersección operará sin ningún problema de capacidad.

5.6.3 Intersección Calle16 y Calle A

Esta intersección es de tipo "T" y esta controlada por un Pare. Los accesos este y oeste corresponden a la Calle A y el acceso norte corresponde a la Calle 16. Todos los accesos cuentan con un carril por dirección de flujo. La siguiente figura muestra lo antes descrito.

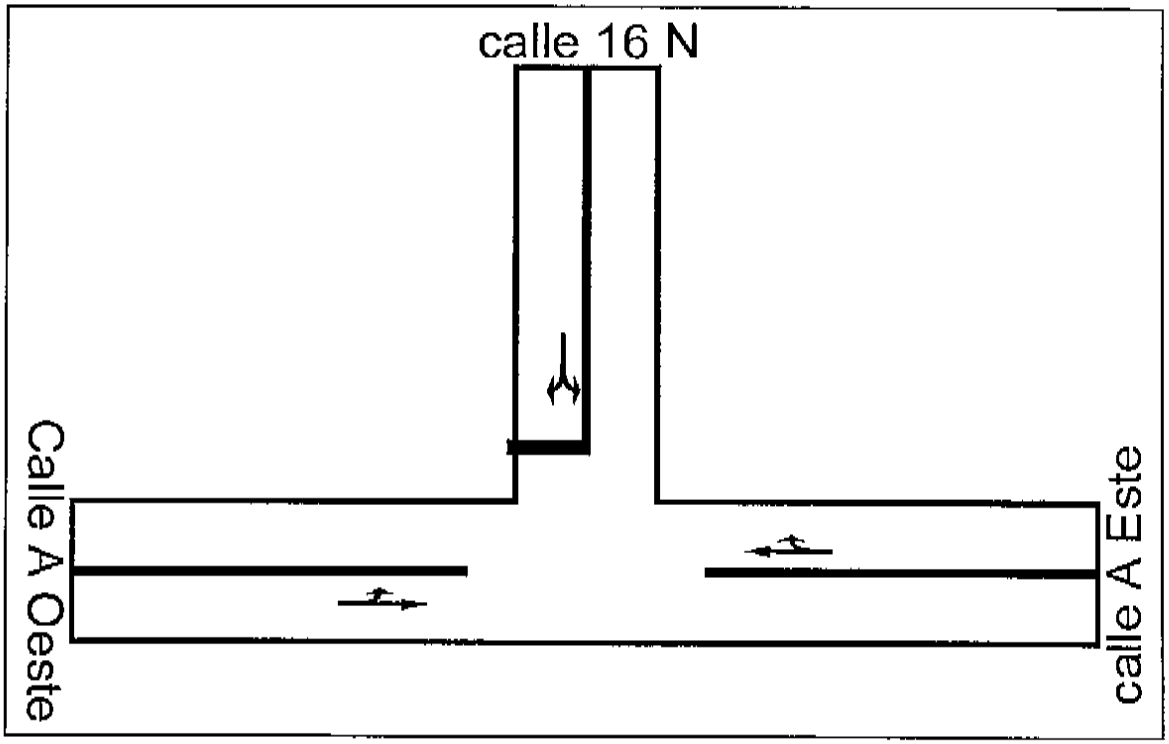

Figura 4: Diagrama esquemático geometría Calle16 y Calle A

La siguiente tabla muestra los resultados obtenidos para las distintas situaciones modeladas.

Tabla 17 Resultados modelación Calle 16 y Calle A

		Demora Promedio por Vehículo [seg.], Nivel de Servicio (LOS) y Cola Máxima [metros]												
		Acceso Sur N/A			Acceso Este Calle A			Acceso Norte Calle 16			Acceso Oeste Calle A			Demora y LOS Total Int.
		Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	
Base 2007														**Control= Pare**
AM	Izquierda	--	--	--	--	--	--	12.8	B	1	9.4	A	0	6.7
	Recto	--	--	--	0.0	A	0	--	--	--	0.4	A	0	
	Derecha	--	--	--	9.1	A	0	11.3	B	1	--	--	--	
	Acceso	--	--	--	5.6	A	0	--	--	1	4.3	A	0	
PM	Izquierda	--	--	--	--	--	--	12.7	B	1	9.4	A	0	6.9
	Recto	--	--	--	0.0	A	0	--	--	--	0.5	A	0	
	Derecha	--	--	--	9.1	A	0	11.3	B	1	--	--	--	
	Acceso	--	--	--	5.5	A	0	12.2	B	1	3.9	A	0	
Futuro 2010														**Control= Pare**
AM	Izquierda	--	--	--	--	--	--	12.9	B	1	9.5	A	1	7.5
	Recto	--	--	--	0.0	A	0	--	--	--	0.6	A	1	
	Derecha	--	--	--	9.1	A	0	11.5	B	1	--	--	--	
	Acceso	--	--	--	6.2	A	0	12.9	B	1	4.4	A	1	
PM	Izquierda	--	--	--	--	--	--	12.9	B	1	9.6	A	0	7.6
	Recto	--	--	--	0.0	A	0	--	--	--	0.6	A	0	
	Derecha	--	--	--	9.1	A	0	11.4	B	1	--	--	--	
	Acceso	--	--	--	6.0	A	0	12.5	B	1	4.1	A	0	
Futuro 2015														**Control= Pare**
AM	Izquierda	--	--	--	--	--	--	13.1	B	1	9.6	A	1	7.7
	Recto	--	--	--	0.0	A	0	--	--	--	0.7	A	1	
	Derecha	--	--	--	9.1	A	0	11.6	B	1	--	--	--	
	Acceso	--	--	--	6.3	A	0	13.1	B	1	4.5	A	1	
PM	Izquierda	--	--	--	--	--	--	13.0	B	1	9.7	A	1	7.8
	Recto	--	--	--	0.0	A	0	--	--	--	0.7	A	1	
	Derecha	--	--	--	9.1	A	0	11.6	B	1	--	--	--	
	Acceso	--	--	--	6.1	A	0	12.7	B	1	4.2	A	1	

Como se puede notar, esta intersección tiene capacidad para manejar el aumento en tránsito esperado.

5.6.4 Intersección PR-116 y PR-116R

Esta intersección tiene una configuración tipo "cruz" operada con semáforo. Los accesos norte y sur corresponden a la carretera PR-116 y los accesos este y oeste corresponden a la carretera PR-116R. El acceso sur cuenta con un carril corto de viraje a la derecha, dos carriles para seguir recto y un carril corto de viraje a la izquierda llegando a la intersección. Saliendo de la intersección tiene dos carriles normales y uno corto. Los accesos este y oeste cuentan con dos carriles normales entrando a la intersección. Por el acceso este sale un carril y por el oeste salen dos carriles. Por el acceso norte entran dos carriles cortos uno de viraje a la izquierda y uno de viraje a la derecha y dos carriles para seguir directo. Salen de la intersección dos carriles. La siguiente figura muestra la geometría existente.

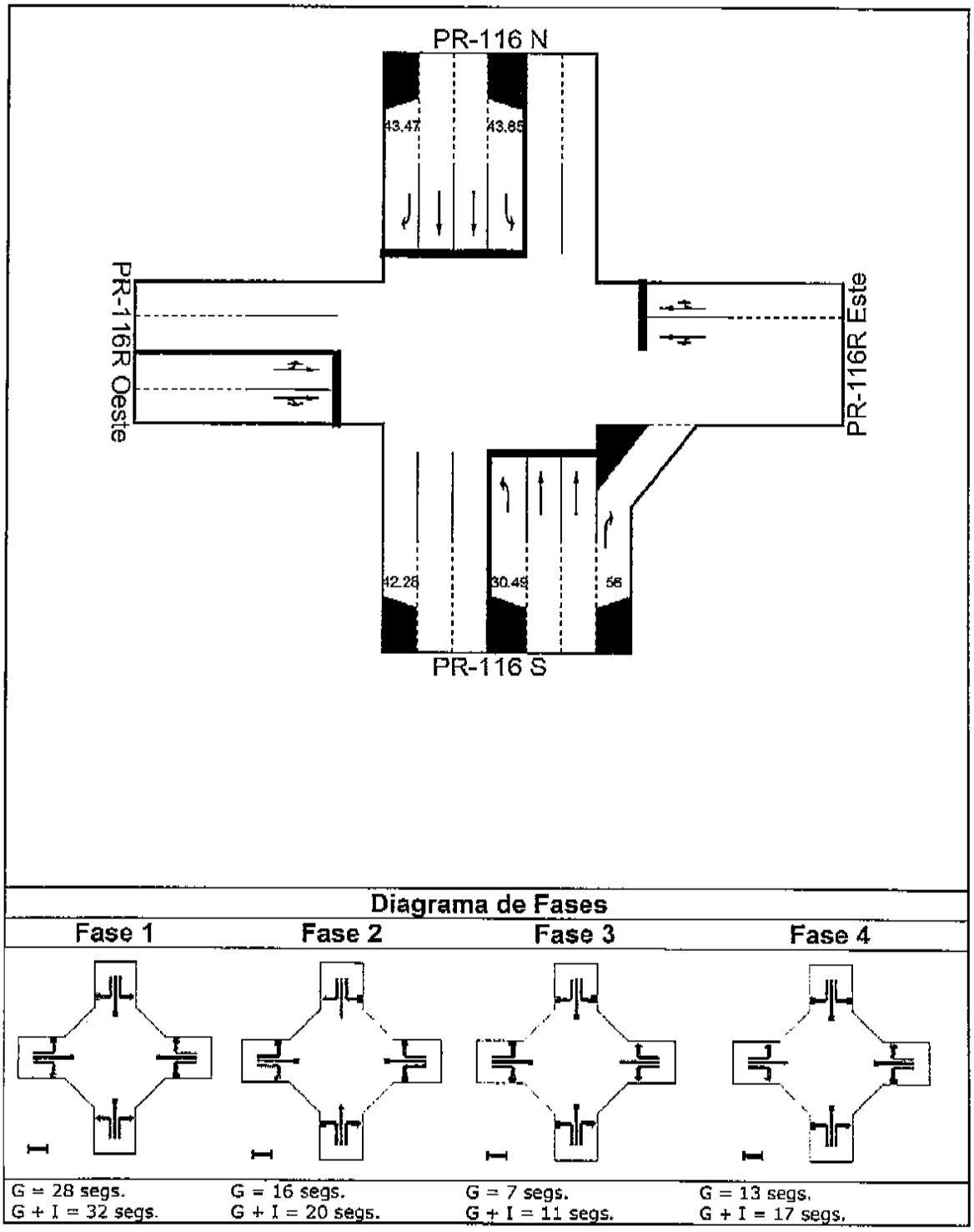

Figura 5 Croquis y Diagrama de Fases Int. PR- 116 y PR-116R

La siguiente tabla muestra los resultados obtenidos para las distintas situaciones modeladas.

Tabla 18 Resultados modelación PR-116 y PR-116R

		Demora Promedio por Vehículo [seg.], Nivel de Servicio (LOS) y Cola Máxima [metros]												
		Acceso Sur PR-116			Acceso Este PR-116R			Acceso Norte PR-116			Acceso Oeste PR-116R			Demora y LOS Total Int.
		Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	Demora y LOS		Cola	
Base 2007														**Control= Semáforo**
AM	Izquierda	27.1	C	3	47.6	D	12	31.0	C	23	47.6	D	44	27.8 C
	Recto	32.9	C	41	39.5	D	12	35.4	D	54	35.2	D	44	
	Derecha	7.8	A	3	11.8	B	14	8.6	A	1	24.8	C	6	
	Acceso	24.5	C	41	17.7	B	14	31.4	C	54	39.9	D	44	
PM	Izquierda	26.0	C	6	48.8	D	10	30.2	C	27	59.7	E	31	26.7 C
	Recto	27.2	C	35	40.8	D	10	37.9	D	89	51.8	D	31	
	Derecha	7.8	A	3	10.4	B	10	8.7	A	2	11.7	B	2	
	Acceso	20.1	C	35	16.3	B	10	32.5	C	89	46.2	D	31	
Futuro 2010														**Control= Semáforo**
AM	Izquierda	24.8	C	2	31.3	C	8	28.2	C	19	45.6	D	36	23.4 C
	Recto	24.2	C	30	23.3	C	8	30.5	C	44	31.2	C	36	
	Derecha	8.0	A	3	11.6	B	12	8.7	A	1	18.2	B	4	
	Acceso	18.9	B	30	14.1	B	12	27.5	C	44	36.6	D	36	
PM	Izquierda	26.1	C	7	49.0	D	11	30.8	C	31	65.7	E	34	28.3 C
	Recto	27.4	C	37	40.9	D	11	42.3	D	99	57.8	E	34	
	Derecha	7.8	A	3	10.4	B	12	8.7	A	2	12.1	B	2	
	Acceso	20.2	C	37	16.3	B	12	35.4	D	99	51.0	D	34	
Futuro 2015														**Control= Semáforo**
AM	Izquierda	26.0	C	3	43.4	D	12	30.6	C	27	55.4	E	53	28.6 C
	Recto	31.2	C	44	35.4	D	12	38.2	D	63	40.6	D	53	
	Derecha	7.9	A	3	12.6	B	19	8.6	A	1	22.0	C	6	
	Acceso	23.4	C	44	17.4	B	19	33.0	C	63	45.5	D	53	
PM	Izquierda	26.9	C	8	49.2	D	12	35.0	C	39	90.0	F	45	32.1 C
	Recto	26.9	C	41	41.1	D	12	49.6	D	121	82.1	F	45	
	Derecha	7.8	A	4	11.1	B	15	8.8	A	3	12.8	B	3	
	Acceso	19.9	B	41	16.9	B	15	41.1	D	121	70.4	E	45	

Como podemos notar, la operación de esta intersección no se verá afectada por la construcción del proyecto bajo estudio. Es importante señalar que los resultados que se muestran en los escenarios futuros fueron obtenidos luego de optimizar los tiempos del semáforo.

En el apéndice 3 se muestran fotografías de las intersecciones analizadas, seguido por el apéndice 4, donde se muestran los resultados de las modelaciones de las intersecciones. La versión electrónica de dichas modelaciones está disponible para la revisión de las agencias gubernamentales concernientes comunicándose a nuestra oficina vía telefónica o a la dirección de correo electrónico: info@tecpr.com.

6 Conclusiones y Recomendaciones

Luego de analizar las intersecciones de interés al proyecto que nos ocupa podemos llegar a la conclusión que desde el punto de vista de la Ingeniería de Tránsito no existe impedimento para su desarrollo. Las modelaciones de estas intersecciones nos demuestran que las mismas poseen la capacidad para manejar adecuadamente el incremento en tránsito que el proyecto bajo estudio, y el incremento anual esperado pudiera representar. Sin embargo, es importante señalar que es necesario el que se optimicen los tiempos de los semáforos del área, lo que debe ser un proceso continuo de la Autoridad de Carreteras y Transportación.

Además recomendamos el que se establezca como política de operación del vertedero de Yauco el que todos los vehículos provenientes del lado Este de la carretera salgan de esta carretera a través de la rampa de la carretera PR-116, y no de la carretera PR-128.

7 Certificación

Certifico que la información presentada en este estudio es cierta, correcta y completa, y que fue obtenida utilizando los criterios de la practica usual y aceptada de la ingeniería de tránsito

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8 REFERENCIAS

1. Trip Generation Manual, Institute of Transportation Engineers, 7th edition, 2003
2. Trip Generation Handbook: An ITE Recommended Practice, Institute of Transportation Engineers, March 2001
3. "Signalised & unsignalised Intersection Design & Research Aid". SIDRA
4. Guías para la Preparación de Estudios Operacionales de Accesos y de Tránsito para Puerto Rico, Versión 1.0, 22 de diciembre de 2004, Autoridad de Carreteras y Transportación

9 Apéndices

9.1 Apéndice 1: Flujos Obtenidos Mediante Conteos

Conteos PR-128 y PR-127

Comienzo Periodo	Movimiento												Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	
6:00	57	47	11	11	9	8	12	132	24	20	42	26	399
6:15	69	62	20	12	12	23	27	150	41	27	44	28	515
6:30	64	205	25	12	25	22	14	213	39	31	54	74	778
6:45	64	213	24	15	18	28	16	274	51	82	110	101	996
7:00	68	221	28	13	26	24	21	288	76	65	132	80	1042
7:15	78	224	23	19	29	22	47	264	103	88	148	129	1174
7:30	80	191	27	27	43	23	27	308	83	50	142	92	1093
7:45	79	174	30	27	27	31	21	282	103	72	126	94	1066
8:00	77	161	25	35	53	17	49	274	110	40	125	107	1073
8:15	71	135	15	34	46	21	29	267	111	20	121	73	943
8:30	52	107	29	35	39	24	45	269	84	54	116	47	901
8:45	50	132	31	43	35	15	29	244	68	37	114	68	866
9:00	46	128	24	45	45	13	38	222	71	41	103	79	855
9:15	43	123	27	44	48	15	40	212	55	39	93	60	799
9:30	73	132	28	43	45	16	42	197	54	40	94	62	826
9:45	60	132	22	41	35	21	42	206	52	44	103	56	814
10:00	48	121	24	35	59	11	43	189	57	42	99	64	792
10:15	45	107	25	42	53	24	44	179	34	57	98	66	774
10:30	43	112	32	35	49	31	47	212	45	52	94	62	814
10:45	51	115	27	43	53	32	48	227	32	56	93	61	838
11:00	63	197	56	72	70	48	52	187	42	55	94	62	998
11:15	53	126	45	39	43	32	60	198	39	44	100	59	838
11:30	61	130	54	39	46	20	94	221	36	48	102	64	915
11:45	61	118	39	28	34	14	109	210	32	59	107	67	878
12:00	64	110	42	32	24	15	105	237	41	46	61	74	851
12:15	76	80	31	20	33	12	102	208	40	60	73	74	809
12:30	76	98	49	24	35	7	106	193	24	51	105	82	850
12:45	80	137	38	39	39	15	98	170	20	64	110	81	891
13:00	81	156	35	38	31	11	93	168	13	51	106	81	864
13:15	83	148	41	31	27	12	83	157	12	68	94	94	850
13:30	85	129	27	24	28	11	102	176	23	66	83	83	837
13:45	83	133	32	26	22	21	106	183	22	66	68	102	864
14:00	78	128	32	33	24	13	107	175	13	68	74	98	843
14:15	81	133	36	35	22	15	103	187	16	64	66	106	864
14:30	81	128	32	31	31	13	101	189	17	60	75	106	864
14:45	79	145	30	35	28	15	98	195	21	57	87	111	901
15:00	74	154	22	34	28	15	89	206	19	72	89	119	921
15:15	70	154	38	45	52	17	122	229	24	75	102	113	1041
15:30	63	163	44	36	32	26	86	222	20	64	87	75	918
15:45	57	176	43	27	46	13	89	228	22	57	42	89	889
16:00	61	169	32	38	38	19	94	195	25	33	44	51	799
16:15	62	149	28	41	46	19	63	174	11	51	44	92	780
16:30	60	129	26	34	43	12	68	178	17	72	58	72	769
16:45	71	141	27	33	38	12	91	195	25	47	79	56	815
17:00	70	131	34	41	41	18	105	185	14	30	66	37	772
17:15	71	131	26	35	51	14	81	164	29	66	37	59	764
17:30	56	146	45	36	52	20	84	155	15	52	57	89	807
17:45	59	119	24	16	45	9	57	157	9	44	39	78	656

Conteos PR-127 y calle 16

Comienzo Periodo	Movimiento												Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	
6:00	1		8	8	89						100	1	207
6:15	2		11	11	105						111	1	241
6:30	2		10	10	100						105	1	228
6:45	4		15	15	103						100	2	239
7:00	6		19	19	109						115	2	270
7:15	3		20	20	120						139	3	305
7:30	2		24	24	104						146	7	307
7:45	3		33	33	113						181	2	365
8:00	3		26	26	138						230	4	427
8:15	1		39	39	163						141	4	387
8:30	1		21	21	150						154	8	356
8:45	1		16	16	163						134	4	334
9:00	1		12	12	168						157	5	355
9:15	2		17	17	144						132	3	315
9:30	0		11	11	140						162	5	329
9:45	2		19	19	158						152	2	352
10:00	1		14	14	144						136	2	311
10:15	1		15	15	140						125	2	298
10:30	1		12	12	122						114	2	263
10:45	1		11	11	132						115	2	272
11:00	2		15	15	134						127	8	301
11:15	6		30	30	144						158	2	370
11:30	2		23	23	165						138	4	355
11:45	0		27	27	161						162	4	381
12:00	1		23	23	167						148	3	365
12:15	4		14	14	84						149	2	267
12:30	3		28	28	147						145	6	357
12:45	4		39	39	167						132	3	384
13:00	2		35	35	144						133	2	351
13:15	1		36	36	98						120	1	292
13:30	2		33	33	89						133	3	293
13:45	3		40	40	88						145	2	318
14:00	2		33	33	130						156	2	356
14:15	1		49	49	150						182	4	435
14:30	2		28	28	158						172	5	393
14:45	2		27	27	178						153	1	388
15:00	4		40	40	157						138	4	383
15:15	2		40	40	162						162	4	410
15:30	4		43	43	134						145	2	371
15:45	1		39	39	162						186	3	430
16:00	1		25	25	151						172	4	378
16:15	4		38	38	150						185	3	418
16:30	5		25	25	158						131	3	347
16:45	3		35	35	145						177	3	398
17:00	1		33	33	145						154	2	368
17:15	1		25	25	133						144	2	330
17:30	2		20	20	128						139	2	311
17:45	3		20	20	122						154	1	320

Conteos PR-116 y Calle A

Comienzo Periodo	Movimiento												Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	
6:00					2	5	4		0	0	1		12
6:15					4	7	4		0	1	0		16
6:30					2	8	5		0	1	1		17
6:45					6	10	7		0	1	1		25
7:00					4	11	9		0	2	1		27
7:15					4	13	10		1	6	5		39
7:30					10	16	10		0	6	8		50
7:45					7	16	6		3	7	9		48
8:00					9	7	7		1	6	6		36
8:15					7	12	14		5	6	3		47
8:30					3	9	16		6	3	9		46
8:45					5	12	9		3	4	2		35
9:00					9	5	7		1	0	5		27
9:15					2	7	10		4	2	2		27
9:30					7	1	9		1	5	3		26
9:45					4	12	7		3	1	4		31
10:00					2	8	6		1	1	1		19
10:15					3	7	5		1	1	2		19
10:30					4	5	7		1	1	1		19
10:45					2	6	8		1	1	2		20
11:00					4	8	6		2	2	3		25
11:15					1	10	13		6	4	1		35
11:30					3	10	9		5	3	0		30
11:45					3	7	11		6	4	3		34
12:00					1	9	9		3	6	5		33
12:15					8	15	9		3	4	4		43
12:30					5	7	8		5	8	1		34
12:45					7	10	10		1	4	5		37
13:00					7	7	11		1	2	1		29
13:15					8	8	8		1	1	1		27
13:30					5	10	7		2	2	2		28
13:45					8	8	9		1	2	3		31
14:00					8	9	9		1	1	2		30
14:15					5	8	8		7	6	2		36
14:30					6	13	12		6	2	9		48
14:45					6	13	10		2	5	5		41
15:00					16	15	8		6	7	4		56
15:15					12	18	10		5	5	8		58
15:30					6	12	14		8	3	4		47
15:45					7	10	16		4	6	7		50
16:00					4	5	15		7	0	9		40
16:15					8	9	12		5	7	8		49
16:30					9	15	14		4	3	8		53
16:45					6	11	12		8	7	6		48
17:00					5	9	10		5	2	4		35
17:15					7	10	8		6	3	4		38
17:30					6	8	9		2	1	3		29
17:45					5	8	9		4	1	2		29

Conteos PR-116 y PR-116R

Comienzo Periodo	Movimiento												Total
	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	
6:00	1	92	22	1	1	14	4	40	2	20	8	8	213
6:15	2	100	31	0	0	22	4	55	2	22	9	7	254
6:30	3	104	34	3	2	32	5	66	4	29	10	11	303
6:45	4	84	48	0	0	26	7	57	5	30	19	10	290
7:00	8	126	62	1	5	27	14	45	5	21	17	12	343
7:15	6	124	57	0	10	50	27	86	11	27	13	11	422
7:30	7	133	70	0	10	54	21	85	13	27	39	21	480
7:45	7	127	65	0	17	64	41	100	17	38	29	10	515
8:00	16	95	52	0	21	47	18	68	11	29	20	13	390
8:15	7	122	56	0	8	34	16	70	7	19	27	16	382
8:30	11	119	45	0	10	42	19	72	3	22	15	9	367
8:45	8	112	57	0	5	33	22	58	5	23	17	14	354
9:00	2	104	55	1	4	28	22	51	2	8	15	9	301
9:15	5	84	47	0	2	33	25	54	4	9	17	8	288
9:30	8	78	40	1	1	32	24	59	8	12	15	12	290
9:45	7	99	43	0	2	35	20	60	8	11	19	11	315
10:00	9	68	45	0	3	33	20	49	9	14	21	14	285
10:15	8	75	47	0	2	30	24	55	5	14	22	12	294
10:30	6	78	52	1	1	28	21	48	2	12	20	11	280
10:45	10	75	50	0	5	30	20	69	8	11	20	12	310
11:00	8	86	54	0	8	35	24	85	7	15	22	12	356
11:15	15	78	61	1	11	45	23	89	17	11	23	18	392
11:30	14	73	57	0	18	41	36	113	23	8	12	14	409
11:45	11	99	57	0	20	42	36	103	12	12	16	17	425
12:00	19	82	71	0	28	55	41	100	20	11	17	18	462
12:15	14	73	57	0	15	52	52	105	17	28	25	17	455
12:30	13	93	59	0	13	44	36	103	28	22	24	13	448
12:45	21	86	62	0	13	45	41	106	25	16	21	27	463
13:00	20	82	43	1	10	45	38	100	15	13	22	19	408
13:15	18	85	52	2	8	44	31	98	20	12	20	18	408
13:30	14	78	50	0	9	46	32	99	11	14	24	11	388
13:45	11	76	44	1	10	52	39	105	19	11	22	19	409
14:00	15	77	39	0	8	44	42	110	18	10	26	10	399
14:15	19	68	45	1	5	54	44	100	17	18	35	12	418
14:30	20	66	42	1	4	52	45	95	20	12	34	14	405
14:45	15	64	45	0	5	57	40	108	22	11	33	11	411
15:00	17	67	48	0	30	53	46	128	28	17	31	13	478
15:15	20	95	69	0	24	60	70	121	41	17	16	9	542
15:30	12	88	73	1	13	55	55	98	21	11	27	10	464
15:45	13	114	63	1	23	46	47	99	28	9	13	12	468
16:00	15	123	79	0	15	63	49	148	29	17	21	10	569
16:15	10	90	70	1	29	49	42	113	26	9	23	16	478
16:30	17	77	63	0	14	50	50	97	21	8	20	8	425
16:45	16	68	56	0	12	39	47	91	16	9	21	9	384
17:00	14	74	55	0	8	33	33	88	14	8	20	5	352
17:15	11	77	52	1	9	35	39	87	12	5	14	4	346
17:30	8	68	50	0	7	32	28	66	11	4	11	5	290
17:45	8	62	44	0	8	33	25	62	8	3	10	2	265

9.2 Apéndice 2: Listado de Archivos de Modelaciones

Archivo	Lugar	Periodo
Yauco-Vertedero.aap	03 PR-128 y PR-127	Pico AM Base
Yauco-Vertedero.aap	03 PR-128 y PR-127	Pico PM Base
Yauco-Vertedero futuro 2010.aap	03 PR-128 y PR-127	Pico AM Futuro 2010
Yauco-Vertedero futuro 2015.aap	03 PR-128 y PR-127	Pico AM Futuro 2015
Yauco-Vertedero futuro 2010.aap	03 PR-128 y PR-127	Pico PM Futuro 2010
Yauco-Vertedero futuro 2015.aap	03 PR-128 y PR-127	Pico PM Futuro 2015
Yauco-Vertedero.aap	04 PR-127 y calle 16	Pico AM Base
Yauco-Vertedero.aap	04 PR-127 y calle 16	Pico PM Base
Yauco-Vertedero futuro 2010.aap	04 PR-127 y calle 16	Pico AM Futuro 2010
futuro 2015.aap	04 PR-127 y calle 16	Pico AM Futuro 2015
futuro 2010.aap	04 PR-127 y calle 16	Pico PM Futuro 2010
futuro 2015.aap	04 PR-127 y calle 16	Pico PM Futuro 2015
Yauco-Vertedero.aap	05 calle 16 y calle A	Pico AM Base
Yauco-Vertedero.aap	05 calle 16 y calle A	Pico PM Base
Yauco-Vertedero futuro 2010.aap	05 calle 16 y calle A	Pico AM Futuro 2010
futuro 2015.aap	05 calle 16 y calle A	Pico AM Futuro 2015
futuro 2010.aap	05 calle 16 y calle A	Pico PM Futuro 2010
futuro 2015.aap	05 calle 16 y calle A	Pico PM Futuro 2015
Yauco-Vertedero.aap	06 PR-116 y PR-116R	Pico AM Base
Yauco-Vertedero.aap	06 PR-116 y PR-116R	Pico PM Base
futuro 2010.aap	06 PR-116 y PR-116R	Pico AM Futuro 2010
futuro 2015.aap	06 PR-116 y PR-116R	Pico AM Futuro 2015
futuro 2010.aap	06 PR-116 y PR-116R	Pico PM Futuro 2010
futuro 2015.aap	06 PR-116 y PR-116R	Pico PM Futuro 2015

9.3 Apéndice 3: Fotografías de las intersecciones

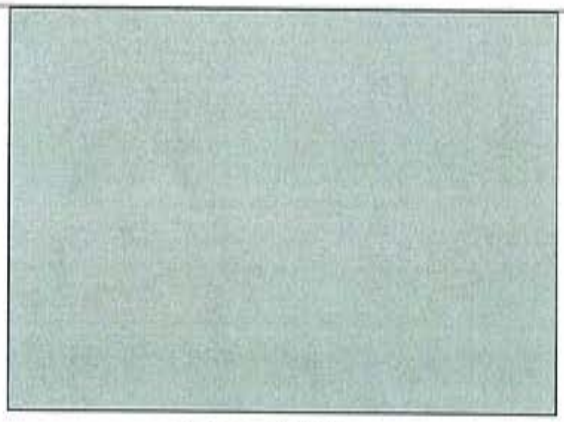
Acceso Norte

Acceso Oeste

Acceso Este

Acceso Sur

Figura 6 Fotografías Accesos Int. PR-128 y PR-127



Acceso Norte

Acceso Oeste

Acceso Este

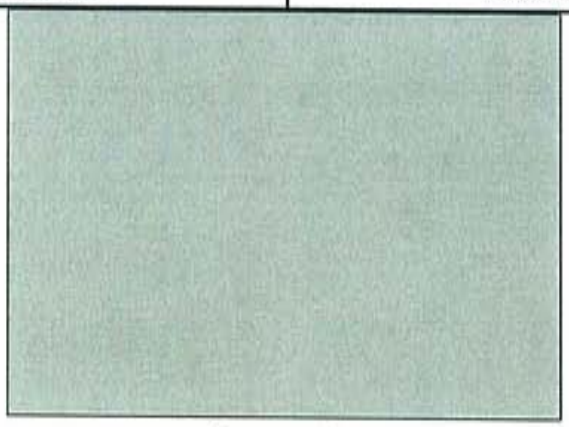
Acceso Sur

Figura 7 Fotografías Accesos Int. PR-127 y Calle 16

Acceso Norte

Acceso Oeste

Acceso Este

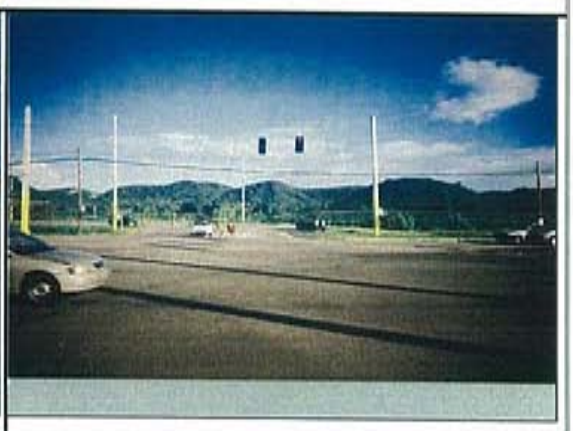


Acceso Sur

Figura 8 Fotografías Accesos Int. Calle 16 y Calle A

Acceso Norte

Acceso Oeste



Acceso Este

Acceso Sur

Figura 9 Fotografías Accesos Int. PR-116 y PR-116R

9.3 Apéndice 4: Resultados modelaciones

Output Tables
Output Tables
03 PR-128 y PR-127
Pico AM Base

Run Information
Cycle Time = 160 (Sum of User-given Phase Times)

* Basic Parameters:
Intersection Type: Signalised - Fixed Time
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

* Iteration Data:
No. of Main (Timing-Capacity) Iterations = 1
Comparison of last two iterations:
Difference in intersection degree of satn = 0.0 %
Largest difference in eff. green times = 0 secs
(max. value for stopping = 0 secs)

* Cycle time is at maximum and short lanes exist.
A shorter cycle time may give better results.

Table 5.1 - Movement Phase and Timing Parameters
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Mov Typ	PHASE MATRIX First Green Fr	To	Op Pr	Second Green Fr	To	Op Pr	Lost Tim 1st Grn	2nd Grn	Req.Mov.Time 1st Grn	2nd Grn	Eff. Grn 1st Grn	2nd Grn
South: PR- 128 S													
1 L	B	C	Y					5		71.1		36	
2 T	*B	C						4		72.0		37	
3 R (Slp)	B	C			C	B		4	4	10.0Min	30.0Min	37	115
East: PR-127 E													
4 L	*D	A	Y					5		35.5		34	
5 T	D	A						4		35.4		35	
6 R (Slp)	A	D			D	A		4	4	30.0Min	10.0Min	117	35
North: PR-128 N													
7 L	A	B	Y					4		64.2		37	
8 T	*A	B						4		64.2		37	
9 R (Slp)	A	B			B	A		4	4	22.3	30.0Min	37	115
West: PR-127 W													
10 L	C	D	Y					4		48.9		35	
11 T	*C	D						4		58.5		35	
12 R (Slp)	C	D			D	C		4	4	38.1	36.6	35	117

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

* Critical Movement/Green Period

Movement Types:
Slp Slip Lane Movement
Ped Pedestrian
Dum Dummy

Under heading 'Op':
Y If opposed turn

Table 5.2 - Movement Capacity Parameters
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Dem Flow (veh /h)	MV (%)	Satn Flow 1st Grn	2nd Grn	Flow Ratio 1st Grn	2nd Grn	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x

South: PR- 128 S											
1	L	312	1.9	839		0.372		189	0.90	-46	100	1.653*
2	T	896	0.0	2344		0.382		542	0.90	-46	100	1.653*
3	R	92	0.0	1534<	1433<	0.034	0.028	1385	0.90	1255	100	0.066
East: PR-127 E												
4	L	76	0.0	443		0.172		94	0.90	11	100	0.807
5	T	116	1.7	656		0.177		144	0.90	11	22	0.808
6	R	88	0.0	518	551	0.084	0.081	499	0.90	411	22	0.176
North: PR-128 N												
7	L	188	0.0	555		0.339		128	0.90	-39	100	1.465
8	T	1056	0.0	3116		0.339		721	0.90	-39	100	1.465
9	R	412	1.9	1722<	1608<	0.126	0.121	1554	0.90	239	100	0.265
West: PR-127 W												
10	L	352	2.0	1393		0.253		305	0.90	-22	100	1.155
11	T	592	2.0	1930		0.307		422	0.90	-36	100	1.402
12	R	516	1.9	1426<	1323<	0.192	0.184	1279	0.90	123	100	0.403

< Reduced saturation flow due to a short lane effect

Table S.3 - Intersection Parameters
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Critical Movements: 8, 2, 11, 4

L= 17 Y= 1.199 U= 1.333 T= 230.2

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	160*	****	160

(Phase times user specified, cycle time = sum of phase times)

* Cmax increased to match sum of phase times

**** Y and U values are too large ****

Cycle time is at maximum and short lanes exist.
A shorter cycle time may give better results.

Intersection Level of Service	=	F
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	231.1
Largest average movement delay (s)	=	395.2
Largest back of queue, mean (m)	=	549
Performance Index	=	717.33
Degree of saturation (highest)	=	1.653
Practical Spare Capacity (lowest)	=	-46 %
Effective intersection capacity, (veh/h)	=	2841
Total vehicle flow (veh/h)	=	4696
Total person flow (pers/h)	=	7044
Total vehicle delay (veh-h/h)	=	301.41
Total person delay (pers-h/h)	=	452.12
Total effective vehicle stops (veh/h)	=	6654
Total effective person stops (pers/h)	=	9981
Total vehicle travel (veh-km/h)	=	2853.2
Total cost ($/h)	=	10231.02
Total fuel (L/h)	=	769.3
Total CO2 (kg/h)	=	1923.90

Table S.4 - Phase Information
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Phase Change Times: 0, 41, 82, 121
Phase Green Times: 37, 37, 35, 35

(Phase times specified by the user)
Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

Table S.5 - Movement Performance

Mov ID		Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Aver. (vehs)	Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S										
1	L	34.25	51.37	395.2	1.00	1.72	46.2	327	72.92	5.1
2	T	96.76	145.14	388.8	1.00	1.88	78.5	549	207.21	5.1
3	R	0.20	0.29	7.7	0.06	0.61	0.1	1	1.57	49.5
East: PR-127 E										
4	L	1.70	2.55	80.5	1.00	0.94	9.6	68	6.65	18.7
5	T	2.33	3.50	72.4	1.00	0.94	9.6	68	9.89	20.1
6	R	0.19	0.29	8.0	0.06	0.64	0.1	1	1.51	49.1
North: PR-128 N										
7	L	15.98	23.96	305.9	1.00	1.68	53.4	374	37.28	6.4
8	T	86.98	130.47	296.5	1.00	1.72	63.0	441	206.46	6.6
9	R	0.89	1.33	7.8	0.07	0.61	0.6	5	7.15	49.4
West: PR-127 W										
10	L	16.85	25.28	172.3	1.00	1.31	26.0	185	48.96	10.5
11	T	44.14	66.22	268.4	1.00	1.65	53.1	378	108.63	7.2
12	R	1.14	1.71	8.0	0.17	0.63	0.9	6	9.10	48.9

Table S.6 - Intersection Performance
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1300	1.653	131.20	196.80	363.3	0.93	1.75	549	281.70	5.4
East: PR-127 E									
280	0.808	4.23	6.34	54.3	0.70	0.85	68	18.06	24.1
North: PR-128 N									
1656	1.465	103.85	155.77	225.8	0.77	1.44	441	250.89	8.3
West: PR-127 W									
1460	1.402	62.14	93.20	153.2	0.71	1.21	378	166.69	11.5
ALL VEHICLES:									
4696	1.653	301.41	452.12	231.1	0.79	1.42	549	717.33	8.2
INTERSECTION (persons):									
7044	1.653		452.12	231.1	0.79	1.42		717.33	8.2

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR- 128 S												
1 LT	123	37	0	0	443	268	1.653	394.8	1.72	46.2	327.1	500.0
2 T	123	37	0	0	765	463	1.653	387.9	1.90	78.5	549.2	500.0
3 R	4	37	4	115	92	1385	0.066	7.7	0.61	0.1	0.8	42.0T
East: PR-127 E												
1 LT	125	35	0	0	192	238	0.808	75.6	0.94	9.6	67.6	500.0
2 R	4	117	4	35	88	499	0.176	8.0	0.64	0.1	0.8	500.0
North: PR-128 N												
1 LT	123	37	0	0	568	388	1.466	300.4	1.68	53.4	373.5	500.0
2 T	123	37	0	0	676	461	1.466	295.8	1.73	63.0	441.2	500.0
3 R	4	37	4	115	412	1554	0.265	7.8	0.61	0.6	4.5	78.0T
West: PR-127 W												
1 L	125	35	0	0	352	305	1.155	172.3	1.31	26.0	185.1	500.0
2 T	125	35	0	0	592	422	1.403	268.4	1.65	53.1	378.1	500.0
3 R	4	35	4	117	516	1279	0.403	8.0	0.63	0.9	6.1	36.0T

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR- 128 S												
1 LT	312	131	0	443	3.30	1950	1159	0	42	268	1.653	100
2 T	0	765	0	765	3.81	2001	2001	0	0	463	1.653	100
3 R	0	0	92	92	3.81	2001	1534<	1433<	0	1385	0.066	100
East: PR-127 E												
1 LT	76	116	0	192	3.35	1955	1087	0	33	238	0.808	100
2 R	0	0	88	88	3.20	1940	121	1878	0	499	0.176	22P
North: PR-128 N												
1 LT	188	380	0	568	3.33	1953	1677	0	31	388	1.466	100
2 T	0	676	0	676	3.73	1993	1993	0	0	461	1.466	100
3 R	0	0	412	412	3.73	1993	1722<	1608<	0	1554	0.265	100
West: PR-127 W												
1 L	352	0	0	352	2.97	1917	1393	0	49	305	1.155	100
2 T	0	592	0	592	3.35	1955	1930	0	0	422	1.403	100
3 R	0	0	516	516	3.35	1955	1426<	1323<	0	1279	0.403	100

< Reduced saturation flow due to a short lane effect
P Lane under-utilisation found by the "Program". This includes cases where the value of lane under-utilisation due to downstream effects has been modified by the program during lane flow calculations (e.g. a de facto exclusive lane has been found).

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR- 128 S											
1 L		312	189	100	1.653*	36		395.2	1.72	46.2	72.92
2 T		896	542	100	1.653*	37*		388.8	1.88	78.5	207.21

3 R	(Slp)	92	1385<	100	0.066	37	115	7.7	0.61	0.1	1.57
East: PR-127 E												
4 L		76	94	100	0.807	34*		80.5	0.94	9.6	6.65
5 T		116	144	22	0.808	35		72.4	0.94	9.6	9.89
6 R	(Slp)	88	499	22	0.176	117	35	8.0	0.64	0.1	1.51
North: PR-128 N												
7 L		188	128	100	1.465	37		305.9	1.68	53.4	37.28
8 T		1056	721	100	1.465	37*		296.5	1.72	63.0	206.46
9 R	(Slp)	412	1554<	100	0.265	37	115	7.8	0.61	0.6	7.15
West: PR-127 W												
10 L		352	305	100	1.155	35		172.3	1.31	26.0	48.96
11 T		592	422	100	1.402	35*		268.4	1.65	53.1	108.63
12 R	(Slp)	516	1279<	100	0.403	35	117	8.0	0.63	0.9	9.10

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table 5.14 - Summary of Input and Output Data
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: PR- 128 S												
1 LT	312	131		443	1	1950	37		1.653	394.8	327	500
2 T		765		765	0	1982	37		1.653	387.9	549	500
3 R			92	92	0	2001	37	115	0.066	7.7	1	42
	312	896	92	1300	0				1.653	363.3	549	
East: PR-127 E												
1 LT	76	116		192	1	1955	35		0.808	75.6	68	500
2 R			88	88	0	1950	117	35	0.176	8.0	1	500
	76	116	88	280	1				0.808	54.3	68	
North: PR-128 N												
1 LT	188	380		568	0	1953	37		1.466	300.4	374	500
2 T		676		676	0	1975	37		1.466	295.8	441	500
3 R			412	412	2	1993	37	115	0.265	7.8	5	78
	188	1056	412	1656	0				1.466	225.8	441	
West: PR-127 W												
1 L	352			352	2	1916	35		1.155	172.3	185	500
2 T		592		592	2	1955	35		1.403	268.4	378	500
3 R			516	516	2	1955	35	117	0.403	8.0	6	36
	352	592	516	1460	2				1.403	153.2	378	

ALL VEHICLES	Total Flow	% HV	Cycle Time	Max X	Aver. Delay	Max Queue
	4696	1	160	1.653	231.1	549

Peak flow period = 15 minutes.

Queue values in this table are mean back of queue (metres).

Note: Basic Saturation Flows (in through car units) have been adjusted for grade, lane widths, parking manoeuvres and bus stops.

Table 5.15 - Capacity and Level of Service
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Mov Typ	Green Ratio 1st grn	Time (g/C) 2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR- 128 S										
1 L		0.225		312	189	1.653*	395.2	F	46.2	327
2 T		0.231*		896	542	1.653*	388.8	F	78.5	549
3 R	(Slp)	0.231	0.719	92	1385<	0.066	7.7	A	0.1	1
East: PR-127 E										
4 L		0.213*		76	94	0.807	80.5	F	9.6	68
5 T		0.219		116	144	0.808	72.4	E	9.6	68
6 R	(Slp)	0.731	0.219	88	499	0.176	8.0	A	0.1	1
North: PR-128 N										
7 L		0.231		188	128	1.465	305.9	F	53.4	374
8 T		0.231*		1056	721	1.465	296.5	F	63.0	441
9 R	(Slp)	0.231	0.719	412	1554<	0.265	7.8	A	0.6	5
West: PR-127 W										
10 L		0.219		352	305	1.155	172.3	F	26.0	185
11 T		0.219*		592	422	1.402	268.4	F	53.1	378
12 R	(Slp)	0.219	0.731	516	1279<	0.403	8.0	A	0.9	6
ALL VEHICLES:				4696		1.653	231.1	F	78.5	549
INTERSECTION (persons):				7044			231.1		78.5	549

Level of Service calculations are based on average control delay including geometric delay (HCM criteria), independent of the current delay definition used. For the criteria, refer to the "Level of Service" topic in the SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table D.5 - Progression Factors and Actuated Signal Parameters
03 PR-128 y PR-127
Pico AM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR- 128 S									
1 L	FT	No	3	1.000	1.000	6	NA		
2 T	FT	No	3	1.000	1.000	6	NA		
3 R	FT	No	3	1.000	1.000	6	NA	6	NA
East: PR-127 E									
4 L	FT	No	3	1.000	1.000	6	NA		
5 T	FT	No	3	1.000	1.000	6	NA		
6 R	FT	No	3	1.000	1.000	6	NA	6	NA
North: PR-128 N									
7 L	FT	No	3	1.000	1.000	6	NA		
8 T	FT	No	3	1.000	1.000	6	NA		
9 R	FT	No	3	1.000	1.000	6	NA	6	NA
West: PR-127 W									
10 L	FT	No	3	1.000	1.000	6	NA		
11 T	FT	No	3	1.000	1.000	6	NA		
12 R	FT	No	3	1.000	1.000	6	NA	6	NA

Site: 03 PR-128 y PR-127 BA
C:\Documents and Settings\Carlos M
Contreras\Desktop\Yauco-Vertedero-Dic2007\corridas
Yauco-Vertedero\Yauco-Vertedero.sap
Processed Feb 01, 2008 02:38:27PM

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Output Tables
Output Tables
03 PR-128 y PR-127
Pico PM Base

Run Information
Cycle Time = 160 (Sum of User-given Phase Times)

* Basic Parameters:
  Intersection Type: Signalised - Fixed Time
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Model Defaults: Standard Right TEC - Customised Model
  Peak Flow Period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes.
  Delay definition: Control delay
                Geometric delay included
  SIDRA Standard Delay model used
  SIDRA Standard Queue model used
  Level of Service based on: Delay (HCM method)
  Queue definition: Back of queue, Average

* Iteration Data:
  No. of Main (Timing-Capacity) Iterations = 1
  Comparison of last two iterations:
    Difference in intersection degree of satn = 0.0 %
    Largest difference in eff. green times = 0 secs
    (max. value for stopping = 0 secs)

* Cycle time is at maximum and short lanes exist.
  A shorter cycle time may give better results.

Table S.1 - Movement Phase and Timing Parameters
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Mov Typ	PHASE MATRIX First Green Fr	To	Op Pr	Second Green Fr	To	Op Pr	Lost Tim 1st Grn	2nd Grn	Req.Mov.Time 1st Grn	2nd Grn	Eff. Grn 1st Grn	2nd Grn
South: PR- 128 S													
1 L	B	C	Y					4		50.0		37	
2 T	*B	C						4		50.0		37	

3 R	(Slp)	B	C		C	B		4	4	10.0Min	30.0Min	37 115
East: PR-127 E												
4 L		D	A	Y				5		51.9		34
5 T		*D	A					4		52.3		35
6 R	(Slp)	A	D		D	A		4	4	44.3	12.8	117 35
North: PR-128 N												
7 L		*A	B	Y				4		70.3		37
8 T		A	B					4		78.3		37
9 R	(Slp)	A	B		B	A		4	4	10.0Min	30.0Min	37 115
West: PR-127 W												
10 L		C	D	Y				4		32.5		35
11 T		*C	D					4		41.6		35
12 R	(Slp)	C	D		D	C		4	4	33.8	32.6	35 117

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

* Critical Movement/Green Period

Movement Types:
Slp Slip Lane Movement
Ped Pedestrian
Dum Dummy

Under heading 'Op':
Y If opposed turn

Table S.2 - Movement Capacity Parameters
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Dem Flow (veh	HV	Satn Flow 1st	Satn Flow 2nd	Flow Ratio 1st	Flow Ratio 2nd	Total Cap. (veh	Prac. Deg. Satn	Prac. Spare Cap.	Lane Util	Deg. Satn
South: PR- 128 S											
1 L	280	2.1	1083		0.259		250	0.90	-20	100	1.118
2 T	616	0.0	2382		0.259		551	0.90	-20	100	1.118
3 R	152	0.0	1533<	1432<	0.052	0.050	1384	0.90	719	100	0.110
East: PR-127 E											
4 L	180	0.0	682		0.264		145	0.90	-28	100	1.242
5 T	208	1.9	766		0.272		168	0.90	-27	20	1.241
6 R	68	0.0	101	915	0.227	0.049	274	0.90	263	20	0.248
North: PR-128 N											
7 L	488	0.0	1168		0.418		270	0.90	-50	100	1.807*
8 T	916	0.0	2193		0.418		507	0.90	-50	100	1.806
9 R	96	2.1	1723<	1609<	0.034	0.024	1555	0.90	1358	100	0.062
West: PR-127 W											
10 L	300	2.0	1872		0.160		410	0.90	23	100	0.733
11 T	408	2.0	1930		0.211		422	0.90	-7	100	0.966
12 R	452	2.0	1425<	1323<	0.168	0.161	1279	0.90	155	100	0.353

< Reduced saturation flow due to a short lane effect

Table S.3 - Intersection Parameters
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Critical Movements: 7, 2, 11, 5

L= 16 Y= 1.159 U= 1.288 T= 222.1

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	160*	****	160

(Phase times user specified, cycle time = sum of phase times)

* Cmax increased to match sum of phase times

**** Y and U values are too large ****

Cycle time is at maximum and short lanes exist.
A shorter cycle time may give better results.

Intersection Level of Service	=	F
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	219.8
Largest average movement delay (s)	=	462.9
Largest back of queue, mean (m)	=	634
Performance Index	=	612.52
Degree of saturation (highest)	=	1.807
Practical Spare Capacity (lowest)	=	-50 %
Effective intersection capacity, (veh/h)	=	2305
Total vehicle flow (veh/h)	=	4164

Total person flow (pers/h)	=	6246
Total vehicle delay (veh-h/h)	=	254.24
Total person delay (pers-h/h)	=	381.36
Total effective vehicle stops (veh/h)	=	5592
Total effective person stops (pers/h)	=	8388
Total vehicle travel (veh-km/h)	=	2527.9
Total cost ($/h)	=	8689.22
Total fuel (L/h)	=	656.6
Total CO2 (kg/h)	=	1641.81

Table S.4 - Phase Information
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Phase Change Times: 0, 41, 82, 121
Phase Green Times: 37, 37, 35, 35

(Phase times specified by the user)
Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Aver. (vehs)	Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1 L	12.14	18.20	156.0	1.00	1.28	26.8	190	36.81	11.4
2 T	25.86	38.79	151.1	1.00	1.31	35.9	251	79.42	11.6
3 R	0.32	0.49	7.7	0.06	0.61	0.2	1	2.60	49.5
East: PR-127 E									
4 L	10.54	15.80	210.7	1.00	1.39	26.9	190	28.29	8.8
5 T	9.32	13.98	161.3	0.95	1.19	26.9	190	27.16	11.0
6 R	1.01	1.52	53.7	0.82	0.78	4.4	31	4.45	24.3
North: PR-128 N									
7 L	62.76	94.13	462.9	1.00	1.86	62.8	439	126.33	4.4
8 T	114.76	172.15	451.0	1.00	2.00	90.5	634	233.89	4.5
9 R	0.21	0.31	7.7	0.06	0.61	0.1	1	1.64	49.5
West: PR-127 W									
10 L	5.94	8.92	71.3	0.99	0.86	13.5	96	23.86	20.3
11 T	10.38	15.58	91.6	1.00	1.09	23.2	165	40.15	17.1
12 R	0.99	1.49	7.9	0.14	0.62	0.7	5	7.92	49.0

Table S.6 - Intersection Performance
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1048	1.118	38.32	57.48	131.6	0.86	1.20	251	118.82	13.0
East: PR-127 E									
456	1.242	20.87	31.31	164.8	0.95	1.21	190	59.90	10.9
North: PR-128 N									
1500	1.807	177.73	266.59	426.5	0.94	1.87	634	361.86	4.7
West: PR-127 W									
1160	0.966	17.32	25.98	53.8	0.66	0.85	165	71.93	24.3
ALL VEHICLES:									
4164	1.807	254.24	381.36	219.8	0.84	1.34	634	612.52	8.5
INTERSECTION (persons):									
6246	1.807		381.36	219.8	0.84	1.34		612.52	8.5

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Back (m)	Lane Length (m)
South: PR- 128 S												
1 LT	123	37	0	0	378	338	1.118	155.7	1.28	26.8	190.3	500.0
2 T	123	37	0	0	518	463	1.118	150.4	1.31	35.9	251.5	500.0
3 R	4	37	4	115	152	1383	0.110	7.7	0.61	0.2	1.4	42.0T
East: PR-127 E												
1 LT	125	35	0	0	333	268	1.241	207.0	1.39	26.9	190.0	500.0
2 TR	4	8	113	35	123	494	0.248	50.2	0.72	4.4	31.1	500.0
North: PR-128 N												
1 LT	123	37	0	0	572	316	1.806	461.8	1.86	62.8	439.5	500.0
2 T	123	37	0	0	832	461	1.806	450.7	2.01	90.5	633.6	500.0
3 R	4	37	4	115	96	1555	0.062	7.7	0.61	0.1	0.9	78.0T
West: PR-127 W												
1 L	125	35	0	0	300	409	0.733	71.3	0.86	13.5	95.8	500.0
2 T	125	35	0	0	408	422	0.966	91.6	1.09	23.2	165.0	500.0
3 R	4	35	4	117	452	1279	0.353	7.9	0.62	0.7	5.1	36.0T

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR- 128 S												
1 LT	280	98	0	378	3.30	1950	1463	0	42	338	1.118	100
2 T	0	518	0	518	3.81	2001	2001	0	0	463	1.118	100
3 R	0	0	152	152	3.81	2001	1533<	1432<	0	1383	0.110	100
East: PR-127 E												
1 LT	180	153	0	333	3.35	1955	1227	0	37	268	1.241	100
2 TR	0	55	68	123	3.20	1940	1676	1877	0	494	0.248	20D
North: PR-128 N												
1 LT	488	84	0	572	3.33	1953	1368	0	46	316	1.806	100
2 T	0	832	0	832	3.73	1993	1993	0	0	461	1.806	100
3 R	0	0	96	96	3.73	1993	1723<	1609<	0	1555	0.062	100
West: PR-127 W												
1 L	300	0	0	300	2.97	1917	1872	0	49	409	0.733	100
2 T	0	408	0	408	3.35	1955	1930	0	0	422	0.966	100
3 R	0	0	452	452	3.35	1955	1425<	1323<	0	1279	0.353	100

< Reduced saturation flow due to a short lane effect
D Lane under-utilisation due to downstream effects

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR- 128 S											
1 L		280	250	100	1.118	37		156.0	1.28	26.8	36.81
2 T		616	551	100	1.118	37*		151.1	1.31	35.9	79.42
3 R	(Slp)	152	1384<	100	0.110	37	115	7.7	0.61	0.2	2.60
East: PR-127 E											
4 L		180	145	100	1.242	34		210.7	1.39	26.9	28.29
5 T		208	168	20	1.241	35*		161.3	1.19	26.9	27.16
6 R	(Slp)	68	274	20	0.248	117	35	53.7	0.78	4.4	4.45
North: PR-128 N											
7 L		488	270	100	1.807*	37*		462.9	1.86	62.8	126.33
8 T		916	507	100	1.806	37		451.0	2.00	90.5	233.89
9 R	(Slp)	96	1555<	100	0.062	37	115	7.7	0.61	0.1	1.64
West: PR-127 W											
10 L		300	410	100	0.733	35		71.3	0.86	13.5	23.86
11 T		408	422	100	0.966	35*		91.6	1.09	23.2	40.15
12 R	(Slp)	452	1279<	100	0.353	35	117	7.9	0.62	0.7	7.92

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.14 - Summary of Input and Output Data
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Timo = 160 (Sum of User-given Phase Times)

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: PR- 128 S												
1 LT	280	98		378	2	1950	37		1.118	155.7	190	500
2 T		518		518	0	1979	37		1.118	150.4	251	500
3 R			152	152	0	2001	37	115	0.110	7.7	1	42
	280	616	152	1048	1				1.118	131.6	251	
East: PR-127 E												
1 LT	180	153		333	1	1955	35		1.241	207.0	190	500
2 TR		55	68	123	1	1951	8	35	0.248	50.2	31	500U
	180	208	68	456	1				1.241	164.8	190	
North: PR-128 N												
1 LT	488	84		572	0	1953	37		1.806	461.8	439	500
2 T		832		832	0	1977	37		1.806	450.7	634	500
3 R			96	96	2	1993	37	115	0.062	7.7	1	78
	488	916	96	1500	0				1.806	426.5	634	
West: PR-127 W												
1 L	300			300	2	1916	35		0.733	71.3	96	500
2 T		408		408	2	1955	35		0.966	91.6	165	500
3 R			452	452	2	1955	35	117	0.353	7.9	5	36
	300	408	452	1160	2				0.966	53.8	165	

ALL VEHICLES	Total Flow	% HV	Cycle Time	Max X	Aver. Delay	Max Queue

	4164	1	160	1.807	219.8	634

Peak flow period = 15 minutes.

Queue values in this table are mean back of queue (metres).

Note: Basic Saturation Flows (in through car units) have been adjusted for grade, lane widths, parking manoeuvres and bus stops.

U Lane under-utilisation specified by the "User"

Table S.15 - Capacity and Level of Service
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR- 128 S										
1 L		0.231		280	250	1.118	156.0	F	26.8	190
2 T		0.231*		616	551	1.118	151.1	F	35.9	251
3 R	(Slp)	0.231	0.719	152	1384<	0.110	7.7	A	0.2	1
East: PR-127 E										
4 L		0.213		180	145	1.242	210.7	F	26.9	190
5 T		0.219*		208	168	1.241	161.3	F	26.9	190
6 R	(Slp)	0.731	0.219	68	274	0.248	53.7	D	4.4	31
North: PR-128 N										
7 L		0.231*		488	270	1.807*	462.9	F	62.8	439
8 T		0.231		916	507	1.806	451.0	F	90.5	634
9 R	(Slp)	0.231	0.719	96	1555<	0.062	7.7	A	0.1	1
West: PR-127 W										
10 L		0.219		300	410	0.733	71.3	E	13.5	96
11 T		0.219*		408	422	0.966	91.6	F	23.2	165
12 R	(Slp)	0.219	0.731	452	1279<	0.353	7.9	A	0.7	5
ALL VEHICLES:				4164		1.807	219.8	F	90.5	634
INTERSECTION (persons):				6246			219.8		90.5	634

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table D.5 - Progression Factors and Actuated Signal Parameters
03 PR-128 y PR-127
Pico PM Base
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 160 (Sum of User-given Phase Times)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Disp. Grn. Settings 1st Grn Gmin	Gmax	2nd Grn Gmin	Gmax
South: PR- 128 S									
1 L	FT	No	3	1.000	1.000	6	NA		
2 T	FT	No	3	1.000	1.000	6	NA		
3 R	FT	No	3	1.000	1.000	6	NA	6	NA
East: PR-127 E									
4 L	FT	No	3	1.000	1.000	6	NA		
5 T	FT	No	3	1.000	1.000	6	NA		
6 R	FT	No	3	1.000	1.000	6	NA	6	NA
North: PR-128 N									
7 L	FT	No	3	1.000	1.000	6	NA		
8 T	FT	No	3	1.000	1.000	6	NA		
9 R	FT	No	3	1.000	1.000	6	NA	6	NA
West: PR-127 W									
10 L	FT	No	3	1.000	1.000	6	NA		
11 T	FT	No	3	1.000	1.000	6	NA		
12 R	FT	No	3	1.000	1.000	6	NA	6	NA

Site: 03 PR-128 y PR-127 BP
C:\Documents and Settings\Carlos M
Contreras\Desktop\Yauco-Vertedero-Dic2007\corridas
Yauco-Vertedero\Yauco-Vertedero.aap
Processed Feb 01, 2008 02:45:28PM

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Output Tables
Output Tables
03 PR-128 y PR-127
Pico AM Futuro 2010

Run Information
Cycle Time = 90 (Optimum Cycle Time)

* Basic Parameters:
Intersection Type: Signalised - Fixed Time
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Specified performance measure for "best" cycle time in variable run - Delay
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

* Iteration Data:
No. of Main (Timing-Capacity) Iterations = 3
Comparison of last two iterations:
Difference in intersection degree of satn = 0.0 %
Largest difference in eff. green times = 1 secs
(max. value for stopping = 1 secs)
Information on Previous Iteration:
Cycle Time = 90
Phase Times: 0, 29, 58, 79
Critical Movements: 9(1st), 2, 11

* If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table S.1 - Movement Phase and Timing Parameters
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Mov Typ	PHASE MATRIX First Green Fr	To	Op Pr	Second Green Fr	To	Op Pr	Lost Tim 1st Grn	2nd Grn	Req.Mov.Time 1st Grn	2nd Grn	Eff. Grn 1st	2nd
South: PR- 128 S													
1 L		E	F							4		36.0	25
2 T		*E	F							4		36.0	25
3 R	(Slp)	E	F		F	E	Y			4	35	18.9	38.8 25 26
East: PR-127 E													
4 L		D	C	Y						6		10.0Min	4
5 T		D	C							4		10.0Min	6
6 R	(Slp)	E	D	Y	D	E				44	4	46.5	41.1 7 35
North: PR-128 N													
7 L		C	E							4		36.5	25
8 T		C	E							4		36.6	25
9 R	(Slp)	*C	E		E	C	Y			4	21	36.6	33.1 25 40
West: PR-127 W													
10 L		F	D							4		24.2	18
11 TR		*F	C							4		40.7	28
12 R	(Slp)	C	F	Y	F	C	Y			29	4	69.8	20.0Min 29 28

Current Phase Sequence: Split Phasing
Input phase sequence: C E F D
Output phase sequence: C E F D

* Critical Movement/Green Period

Movement Types:
Slp Slip Lane Movement
Ped Pedestrian
Dum Dummy

Under heading 'Op':
Y If opposed turn

Table S.2 - Movement Capacity Parameters
03 PR-128 y PR-127

Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Dem Flow (veh /h)	HV (%)	Satn Flow 1st Grn	Satn Flow 2nd Grn	Flow Ratio 1st Grn	Flow Ratio 2nd Grn	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x
South: PR- 128 S											
1 L	326	2.1	1018		0.320		283	0.90	-22	100	1.153
2 T	918	0.0	2866		0.320		796	0.90	-22	100	1.153
3 R	94	0.0	414<	837<	0.149	0.038	357	0.90	242	100	0.263
East: PR-127 E											
4 L	78	0.0	2146		0.036		95	0.90	10	100	0.818
5 T	120	1.7	2264		0.053		151	0.90	13	100	0.795
6 R	90	0.0	365	218	0.025	0.371	113	0.90	13	100	0.795
North: PR-128 N											
7 L	193	0.0	593		0.325		165	0.90	-23	100	1.172
8 T	1082	0.0	3324		0.326		923	0.90	-23	100	1.172
9 R	424	1.9	874<	1149<	0.326	0.121	753	0.90	60	100	0.563
West: PR-127 W											
10 L	363	1.9	1801		0.202		360	0.90	-11	100	1.008
11 TR	704E	1.7	1917		0.367		596	0.90	-24	100	1.180*
12 R	439	2.5	879<	502<	0.453	0.083	439	0.90	-10	100	1.000

E "Excess" flow from the short lane of an adjacent movement added to normal flow
< Reduced saturation flow due to a short lane effect

Table S.3 - Intersection Parameters
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Critical Movements: 9(1st), 2, 11

L= 12 Y= 1.013 U= 1.125 T= 113.3

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	****	90

(Program-determined Optimum Cycle Time)

**** Y and U values are too large ****

Intersection Level of Service	=	F
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	101.1
Largest average movement delay (s)	=	140.8
Largest back of queue, mean (m)	=	266
Performance Index	=	420.46
Degree of saturation (highest)	=	1.180
Practical Spare Capacity (lowest)	=	-24 %
Effective intersection capacity, (veh/h)	=	4094
Total vehicle flow (veh/h)	=	4831
Total person flow (pers/h)	=	7247
Total vehicle delay (veh-h/h)	=	135.68
Total person delay (pers-h/h)	=	203.52
Total effective vehicle stops (veh/h)	=	6560
Total effective person stops (pers/h)	=	9841
Total vehicle travel (veh-km/h)	=	2934.4
Total cost ($/h)	=	5674.94
Total fuel (L/h)	=	544.4
Total CO2 (kg/h)	=	1361.56

Table S.4 - Phase Information
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Phase Change Times: 0, 29, 58, 80
Phase Green Times: 25, 25, 18, 6

Current Phase Sequence: Split Phasing
Input phase sequence: C E F D
Output phase sequence: C E F D

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Aver. (vehs)	Longest Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1 L	12.05	18.07	133.0	1.00	1.55	30.6	216	34.68	12.9
2 T	33.50	50.26	131.4	1.00	1.56	32.4	227	97.10	13.0
3 R	0.42	0.63	16.1	0.50	0.70	1.1	8	2.88	41.7
East: PR-127 E									
4 L	1.33	1.99	61.3	1.00	0.87	2.4	17	4.87	22.3
5 T	1.70	2.55	51.0	1.00	1.07	6.3	44	7.20	25.0
6 R	1.47	2.21	58.8	1.00	1.07	6.3	44	5.60	23.0
North: PR-128 N									
7 L	7.55	11.32	140.8	1.00	1.59	32.6	228	21.26	12.3
8 T	39.78	59.67	132.4	1.00	1.60	33.7	236	116.64	12.9
9 R	1.37	2.06	11.7	0.43	0.72	4.0	28	11.36	45.5
West: PR-127 W									
10 L	8.24	12.37	81.8	1.00	1.21	14.0	100	28.37	18.5
11 TR	26.43	39.64	135.2	1.00	1.65	37.3	266	77.30	12.7
12 R	1.84	2.75	15.0	0.56	0.74	5.1	36	13.22	42.5

Table S.6 - Intersection Performance
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1338	1.153	45.97	68.95	123.7	0.96	1.50	227	134.65	13.6
East: PR-127 E									
288	0.818	4.50	6.75	56.2	1.00	1.01	44	17.67	23.6
North: PR-128 N									
1699	1.172	48.70	73.06	103.2	0.86	1.38	236	149.25	15.7
West: PR-127 W									
1506	1.180	36.51	54.76	87.3	0.87	1.28	266	118.89	17.7
ALL VEHICLES:									
4831	1.180	135.68	203.52	101.1	0.90	1.36	266	420.46	15.9
INTERSECTION (persons):									
7247	1.180		203.52	101.1	0.90	1.36		420.46	15.9

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR- 128 S												
1 LT	65	25	0	0	603	523	1.153	132.5	1.55	30.6	216.1	500.0
2 T	65	25	0	0	641	556	1.153	131.2	1.56	32.4	226.6	500.0
3 R	4	25	35	26	94	357	0.264	16.1	0.70	1.1	7.9	42.0T
East: PR-127 E												
1 L	86	4	0	0	78	95	0.818	61.3	0.87	2.4	16.6	500.0
2 TR	68	7	4	11	210	264	0.795	54.3	1.07	6.3	44.2	500.0
North: PR-128 N												
1 LT	65	25	0	0	626	534	1.172	135.1	1.59	32.6	228.4	500.0
2 T	65	25	0	0	649	554	1.172	132.2	1.60	33.7	236.2	500.0
3 R	4	25	21	40	424	754	0.563	11.7	0.72	4.0	28.1	78.0T
West: PR-127 W												
1 L	72	18	0	0	363	360	1.008	81.8	1.21	14.0	99.8	500.0
2 TR	62	28	0	0	704	596	1.180	135.2	1.27	37.3	265.6	500.0
3 R	29	29	4	28	439	439	1.000	15.0r	0.74	5.1	36.1<	36.0T

< Short lane capacity is reached and there is excess flow into an adjacent lane
r Delay, stops and queue length for this lane have been cut down to fit in the queuing space. The amount cut may not be accounted for fully in the adjacent lane performance statistics. You may wish to change the short lane to a full lane to investigate the extent of this effect.
T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR- 128 S												
1 LT	326	277	0	603	3.30	1950	1883	0	0	523	1.153	100
2 T	0	641	0	641	3.81	2001	2001	0	0	556	1.153	100
3 R	0	0	94	94	3.81	2001	414<	837<	40	357	0.264	100
East: PR-127 E												
1 L	78	0	0	78	3.35	1955	2146	0	88	95	0.818	100
2 TR	0	120	90	210	3.20	1940	621	1766	40	264	0.795	100
North: PR-128 N												
1 LT	193	433	0	626	3.33	1953	1923	0	0	534	1.172	100
2 T	0	649	0	649	3.73	1993	1993	0	0	554	1.172	100
3 R	0	0	424	424	3.73	1993	874<	1149<	40	754	0.563	100
West: PR-127 W												
1 L	363	0	0	363	2.97	1917	1801	0	0	360	1.008	100
2 TR	0	608	96E	704	3.35	1955	1917	0	0	596	1.180	100
3 R	0	0	439	439	3.35	1955	879<	502<	80	439	1.000	100

E "Excess" flow from back of an adjacent short lane
< Reduced saturation flow due to a short lane effect

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR- 128 S											
1 L		326	283	100	1.153	25		133.0	1.55	30.6	34.68
2 T		918	796	100	1.153	25*		131.4	1.56	32.4	97.10
3 R	(Slp)	94	357<	100	0.263	25	26	16.1	0.70	1.1	2.88
East: PR-127 E											
4 L		78	95	100	0.818	4		61.3	0.87	2.4	4.87
5 T		120	151	100	0.795	6		51.0	1.07	6.3	7.20
6 R	(Slp)	90	113	100	0.795	7	35	58.8	1.07	6.3	5.60
North: PR-128 N											
7 L		193	165	100	1.172	25		140.8	1.59	32.6	21.26
8 T		1082	923	100	1.172	25		132.4	1.60	33.7	116.64
9 R	(Slp)	424	753<	100	0.563	25*	40	11.7	0.72	4.0	11.36
West: PR-127 W											
10 L		363	360	100	1.008	18		81.8	1.21	14.0	28.37
11 TR		704E	596	100	1.180*	28*		135.2	1.65	37.3	77.30
12 R	(Slp)	439	439<	100	1.000	29	28	15.0	0.74	5.1	13.22

E "Excess" flow from the short lane of an adjacent movement added to normal flow
< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.14 - Summary of Input and Output Data
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: PR- 128 S												
1 LT	326	277		603	1	1950	25		1.153	132.5	216	500
2 T		641		641	0	1976	25		1.153	131.2	227	500
3 R			94	94	0	2001	25	26	0.264	16.1	8	42
	326	918	94	1338	1				1.153	123.7	227	
East: PR-127 E												
1 L	78			78	0	1955	4		0.818	61.3	17	500
2 TR		120	90	210	1	1939	7	11	0.795	54.3	44	500
	78	120	90	288	1				0.818	56.2	44	
North: PR-128 N												
1 LT	193	433		626	0	1953	25		1.172	135.1	228	500
2 T		649		649	0	1973	25		1.172	132.2	236	500
3 R			424	424	2	1993	25	40	0.563	11.7	28	78
	193	1082	424	1699	0				1.172	103.2	236	
West: PR-127 W												
1 L	363			363	2	1916	18		1.008	81.8	100	500
2 R		608	96	704	2	1955	28		1.180	15.0	36	500
3 R			439	439	2	1955	29	28	1.000	15.0r	36	36
	363	608	535	1506	2				1.180	87.3	266	

ALL VEHICLES	Total Flow	% HV	Cycle Time	Max X	Aver. Delay	Max Queue
	4831	1	90	1.180	101.1	266

Peak flow period = 15 minutes.

Queue values in this table are mean back of queue (metres).

Note: Basic Saturation Flows (in through car units) have been adjusted for grade, lane widths, parking manoeuvres and bus stops.

r Delay, stops and queue length for this lane have been cut down to fit in the queuing space. The amount cut may not be accounted for fully in the adjacent lane performance statistics. You may wish to change the short lane to a full lane to investigate the extent of this effect.

Table S.15 - Capacity and Level of Service
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Queue Aver. (vehs)	Back (m)
South: PR- 128 S										
1 L		0.278		326	283	1.153	133.0	F	30.6	216
2 T		0.278*		918	796	1.153	131.4	F	32.4	227
3 R	(Slp)	0.278	0.289	94	357<	0.263	16.1	B	1.1	8
East: PR-127 E										
4 L		0.044		78	95	0.818	61.3	E	2.4	17
5 T		0.067		120	151	0.795	51.0	D	6.3	44
6 R	(Slp)	0.078	0.389	90	113	0.795	58.8	E	6.3	44
North: PR-128 N										
7 L		0.278		193	165	1.172	140.8	F	32.6	228
8 T		0.278		1082	923	1.172	132.4	F	33.7	236
9 R	(Slp)	0.278*	0.444	424	753<	0.563	11.7	B	4.0	28
West: PR-127 W										
10 L		0.200		363	360	1.008	81.8	F	14.0	100
11 TR		0.311*		704E	596	1.180*	135.2	F	37.3	266

12	R	(Slp)	0.322	0.311	439	439<	1.000	15.0	B	5.1	36
ALL VEHICLES:					4831		1.180	101.1	F	37.3	266
INTERSECTION (persons):					7247			101.1		37.3	266

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)
E "Excess" flow from the short lane of an adjacent movement added to normal flow

Table S.21 - Optimum Cycle Time Results
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Performance Measure	Smallest Value	Cycle Time
Degree of Satn	1.180	90
Average Delay	101.1	90
Stop Rate	1.27	150
Max. Queue for Any Movement	32.2	80
Perf. Index	412.2	80
Cost	5674.9	90

Performance Measure	Largest Value	Cycle Time
Eff. Inters. Cap.	4094	90
Prac. Spare Cap.	-24	90

If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table D.5 - Progression Factors and Actuated Signal Parameters
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Prog. Factor	Prog. Factor	1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR- 128 S									
1 L	FT	No	3	1.000	1.000	6	NA		
2 T	FT	No	3	1.000	1.000	6	NA		
3 R	FT	No	3	1.000	1.000	6	NA	6	NA
East: PR-127 E									
4 L	FT	No	3	1.000	1.000	6	NA		
5 T	FT	No	3	1.000	1.000	6	NA		
6 R	FT	No	3	1.000	1.000	6	NA	6	NA
North: PR-128 N									
7 L	FT	No	3	1.000	1.000	6	NA		
8 T	FT	No	3	1.000	1.000	6	NA		
9 R	FT	No	3	1.000	1.000	6	NA	6	NA
West: PR-127 W									
10 L	FT	No	3	1.000	1.000	6	NA		
11 T	FT	No	3	1.000	1.000	6	NA		
12 R	FT	No	3	1.000	1.000	6	NA	6	NA

Table V.21 - Intersection Summary for Optimum Cycle Time
03 PR-128 y PR-127
Pico AM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Cycle Time (sec)	Eff. Int. Cap.	Intersn Deg. of Satn	Prac. Spare Cap.	Aver. Delay (sec)	Stop Rate	Longest Queue (veh)	Perf. Index	Cost Total $/h	Unsatt
40	2226	2.170	-59	306.5	2.15	53.0	754.9	13329.1	
50	3016	1.602	-44	172.4	1.83	41.6	530.1	8348.8	
60	3519	1.373	-34	127.8	1.60	35.9	449.2	6682.5	
70	3767	1.283	-30	107.5	1.46	32.6	415.2	5918.4	
00	4081	1.184	-24	101.5	1.40	32.2	412.2	5692.8	
90	4094	1.180	-24	101.1	1.36	37.3	420.5	5674.9	
100	4072	1.186	-24	105.6	1.34	40.5	439.9	5842.3	
110	4077	1.185	-24	108.9	1.32	45.7	457.4	5966.1	
120	4081	1.184	-24	113.0	1.30	47.9	475.7	6118.3	
130	4084	1.183	-24	116.7	1.29	53.0	494.1	6256.1	
140	4094	1.180	-24	121.7	1.28	56.6	515.0	6442.0	
150	4057	1.191	-24	126.1	1.27	59.2	534.3	6604.4	

Site: 03 PR-128 y PR-127 FA 2010
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Output Tables
Output Tables
03 PR-128 y PR-127
Pico AM Future 2015

Run Information
Cycle Time = 100 (Optimum Cycle Time)

* Basic Parameters:
Intersection Type: Signalised - Fixed Time
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Specified performance measure for "best" cycle time in variable run - Delay
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

* Iteration Data:
No. of Main (Timing-Capacity) Iterations = 3
Comparison of last two iterations:
Difference in intersection degree of satn = 0.0 %
Largest difference in eff. green times = 1 secs
(max. value for stopping = 1 secs)
Information on Previous Iteration:
Cycle Time = 100
Phase Times: 0, 33, 66, 88
Critical Movements: 9(1st), 1, 11

* If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Degree of saturation of non-critical movement 10 is greater than the critical movement degrees of saturation because of rounding of a small green time.

* Opposed turn in movement 4 has high x.
Its capacity is mainly due to end departures. Consider increasing the number of end departures, and/or specifying this as an undetected movement, since it may be affecting the timing results adversely.

Table 5.1 - Movement Phase and Timing Parameters
03 PR-128 y PR-127
Pico AM Future 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Mov ID	Mov Typ	PHASE MATRIX First Green Fr	To	Op Pr	Second Green Fr	To	Op Pr	Lost Tim 1st Grn	2nd Grn	Req.Mov.Time 1st Grn	2nd Grn	Eff. Grn 1st Grn	2nd Grn
South: PR- 128 S													
1 L	*B	C						4		41.8		29	
2 T	B	C						4		41.8		29	
3 R	(Slp) B	C			C	B	Y	4	33	19.1	36.4	29	34
East: PR-127 E													
4 L	D	A	Y					6		11.4		5	
5 T	D	A						4		10.8		7	
6 R	(Slp) B	D	Y		D	B		48	4	51.1	50.7	7	41
North: PR-128 N													
7 L	A	B						4		42.4		30	
8 T	A	B						4		42.4		30	
9 R	(Slp) *A	B			B	A	Y	4	24	42.4	42.1	30	42
West: PR-127 W													
10 L	C	D						4		27.8		18	
11 T	*C	A						4		41.2		29	
12 R	(Slp) A	C	Y		C	A	Y	4	4	42.0	26.7	63	29

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

* Critical Movement/Green Period

Movement Types:
Slp Slip Lane Movement

Under heading 'Op':
Y If opposed turn

Ped Pedestrian
Dum Dummy

Table S.2 - Movement Capacity Parameters
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Mov ID	Dem Flow (veh /h)	HV (%)	Satn Flow 1st Grn	2nd Grn	Flow Ratio 1st Grn	2nd Grn	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x
South: PR- 128 S											
1 L	347	2.0	1020		0.340		296	0.90	-23	100	1.173
2 T	974	0.0	2866		0.340		831	0.90	-23	100	1.173
3 R	100	0.0	527<	912<	0.136	0.031	463	0.90	317	100	0.216
East: PR-127 E											
4 L	83	0.0	1699		0.049		85	0.90	-8	100	0.977
5 T	128	2.3	2088		0.061		146	0.90	3	100	0.876
6 R	96	0.0	373	204	0.026	0.420	110	0.90	3	100	0.875
North: PR-128 N											
7 L	204	0.0	591		0.345		177	0.90	-22	100	1.151
8 T	1148	0.0	3326		0.345		998	0.90	-22	100	1.151
9 R	451	2.0	790<	1095<	0.345	0.163	697	0.90	39	100	0.647
West: PR-127 W											
10 L	386	2.1	1799		0.215		324	0.90	-24	100	1.192*
11 T	646	2.0	1930		0.335		560	0.90	-22	100	1.154
12 R	569	1.9	1015<	1086<	0.342	0.204	954	0.90	51	100	0.596

< Reduced saturation flow due to a short lane effect

Degree of saturation of non-critical movement 10 is greater than the critical movement degrees of saturation because of rounding of a small green time.

Opposed turn in movement 4 has high x.
Its capacity is mainly due to end departures. Consider increasing the number of end departures, and/or specifying this as an undetected movement, since it may be affecting the timing results adversely.

Table S.3 - Intersection Parameters
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Critical Movements: 9(1st), 1, 11

L= 12 Y= 1.020 U= 1.133 T= 125.3

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	****	100

(Program-determined Optimum Cycle Time)

**** Y and U values are too large ****

Intersection Level of Service	=	F
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	105.6
Largest average movement delay (s)	=	157.2
Largest back of queue, mean (m)	=	264
Performance Index	=	461.53
Degree of saturation (highest)	=	1.192
Practical Spare Capacity (lowest)	=	-24 %
Effective intersection capacity, (veh/h)	=	4305
Total vehicle flow (veh/h)	=	5132
Total person flow (pers/h)	=	7698
Total vehicle delay (veh-h/h)	=	150.58
Total person delay (pers-h/h)	=	225.87
Total effective vehicle stops (veh/h)	=	6816
Total effective person stops (pers/h)	=	10224
Total vehicle travel (veh-km/h)	=	3118.2
Total cost ($/h)	=	6207.69
Total fuel (L/h)	=	586.8
Total CO2 (kg/h)	=	1467.61

Table S.4 - Phase Information
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Phase Change Times: 0, 34, 67, 89
Phase Green Times: 30, 29, 18, 7

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Aver. (vehs)	Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1 L	14.02	21.02	145.4	1.00	1.57	35.6	252	39.83	12.0
2 T	38.90	58.35	143.8	1.00	1.58	37.7	264	111.21	12.1
3 R	0.38	0.58	13.8	0.41	0.68	1.0	7	2.82	43.5
East: PR-127 E									
4 L	1.90	2.84	82.3	1.00	0.99	3.2	22	6.39	18.4
5 T	2.27	3.40	63.7	1.00	1.13	7.9	56	8.90	21.8
6 R	1.91	2.86	71.6	1.00	1.13	7.9	56	6.89	20.3
North: PR-128 N									
7 L	7.69	11.54	135.7	1.00	1.54	35.8	250	22.47	12.6
8 T	40.60	60.90	127.3	1.00	1.54	37.0	259	123.76	13.3
9 R	1.57	2.36	12.6	0.45	0.72	5.0	36	13.04	44.7
West: PR-127 W									
10 L	16.85	25.28	157.2	1.00	1.47	21.7	155	45.61	11.3
11 T	23.22	34.82	129.4	1.00	1.54	34.9	249	70.19	13.2
12 R	1.28	1.92	8.1	0.23	0.64	1.3	9	10.40	48.5

Table S.6 - Intersection Performance
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1421	1.173	53.30	79.95	135.0	0.96	1.51	264	153.87	12.7
East: PR-127 E									
307	0.977	6.07	9.11	71.2	1.00	1.10	56	22.18	20.3
North: PR-128 N									
1803	1.151	49.87	74.80	99.6	0.86	1.34	259	159.28	16.1
West: PR-127 W									
1601	1.192	41.35	62.02	93.0	0.73	1.20	249	126.20	16.9
ALL VEHICLES:									
5132	1.192	150.58	225.87	105.6	0.85	1.33	264	461.53	15.4
INTERSECTION (persons):									
7698	1.192		225.87	105.6	0.85	1.33		461.53	15.4

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)

South: PR- 128 S												
1 LT	71	29	0	0	640	546	1.173	144.9	1.57	35.6	251.5	500.0
2 T	71	29	0	0	681	580	1.173	143.6	1.58	37.7	263.8	500.0
3 R	4	29	33	34	100	463	0.216	13.8	0.68	1.0	7.2	42.0T
East: PR-127 E												
1 L	95	5	0	0	83	85	0.977	82.3	0.99	3.2	22.4	500.0
2 TR	77	7	4	12	224	256	0.876	67.1	1.13	7.9	56.2	500.0
North: PR-128 N												
1 LT	70	30	0	0	664	577	1.151	130.1	1.54	35.8	250.3	500.0
2 T	70	30	0	0	688	598	1.151	127.2	1.54	37.0	258.8	500.0
3 R	4	30	24	42	451	697	0.647	12.6	0.72	5.0	35.8	78.0T
West: PR-127 W												
1 L	82	18	0	0	386	324	1.192	157.2	1.47	21.7	154.7	500.0
2 T	71	29	0	0	646	560	1.154	129.4	1.54	34.9	248.7	500.0
3 R	4	63	4	29	569	954	0.596	8.1	0.64	1.3	9.0	36.0T

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR- 128 S												
1 LT	347	293	0	640	3.30	1950	1884	0	0	546	1.173	100
2 T	0	681	0	681	3.81	2001	2001	0	0	580	1.173	100
3 R	0	0	100	100	3.81	2001	527<	912<	36	463	0.216	100
East: PR-127 E												
1 L	83	0	0	83	3.35	1955	1699	0	79	85	0.977	100
2 TR	0	128	96	224	3.20	1940	613	1774	36	256	0.876	100
North: PR-128 N												
1 LT	204	460	0	664	3.33	1953	1923	0	0	577	1.151	100
2 T	0	688	0	688	3.73	1993	1993	0	0	598	1.151	100
3 R	0	0	451	451	3.73	1993	790<	1095<	36	697	0.647	100
West: PR-127 W												
1 L	386	0	0	386	2.97	1917	1799	0	0	324	1.192	100
2 T	0	646	0	646	3.35	1955	1930	0	0	560	1.154	100
3 R	0	0	569	569	3.35	1955	1015<	1086<	72	954	0.596	100

< Reduced saturation flow due to a short lane effect

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR- 128 S											
1 L		347	296	100	1.173	29*		145.4	1.57	35.6	39.83
2 T		974	831	100	1.173	29		143.8	1.58	37.7	111.21
3 R	(Slp)	100	463<	100	0.216	29	34	13.8	0.68	1.0	2.82
East: PR-127 E											
4 L		83	85	100	0.977	5		82.3	0.99	3.2	6.39
5 T		128	146	100	0.876	7		63.7	1.13	7.9	8.90
6 R	(Slp)	96	110	100	0.875	7	41	71.6	1.13	7.9	6.89
North: PR-128 N											
7 L		204	177	100	1.151	30		135.7	1.54	35.8	22.47
8 T		1148	998	100	1.151	30		127.3	1.54	37.0	123.76
9 R	(Slp)	451	697<	100	0.647	30*	42	12.6	0.72	5.0	13.04
West: PR-127 W											
10 L		386	324	100	1.192*	18		157.2	1.47	21.7	45.61
11 T		646	560	100	1.154	29*		129.4	1.54	34.9	70.19
12 R	(Slp)	569	954<	100	0.596	63	29	8.1	0.64	1.3	10.40

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.14 - Summary of Input and Output Data
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: PR- 128 S												
1 LT	347	293		640	1	1950	29		1.173	144.9	252	500
2 T		681		681	0	1976	29		1.173	143.6	264	500
3 R			100	100	0	2001	29	34	0.216	13.8	7	42
	347	974	100	1421	0				1.173	135.0	264	
East: PR-127 E												
1 L	83			83	0	1955	5		0.977	82.3	22	500
2 TR		128	96	224	1	1939	7	12	0.876	67.1	56	500

	83	128	96	307	1				0.977	71.2	56	
North: PR-128 N												
1 LT	204	460		664	0	1953	30		1.151	130.1	250	500
2 T		688		688	0	1973	30		1.151	127.2	259	500
3 R			451	451	2	1993	30	42	0.647	12.6	36	78
	204	1148	451	1803	0				1.151	99.6	259	
West: PR-127 W												
1 L	386			386	2	1916	18		1.192	157.2	155	500
2 T		646		646	2	1955	29		1.154	129.4	249	500
3 R			569	569	2	1955	63	29	0.596	8.1	9	36
	386	646	569	1601	2				1.192	93.0	249	

ALL VEHICLES	Total Flow	% HV	Cycle Time	Max X	Aver. Delay	Max Queue
	5132	1	100	1.192	105.6	264

Peak flow period = 15 minutes.

Queue values in this table are mean back of queue (metres).

Note: Basic Saturation Flows (in through car units) have been adjusted for grade, lane widths, parking manoeuvres and bus stops.

Table S.15 - Capacity and Level of Service
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Mov ID	Mov Typ	Green Ratio (g/C) 1st grn	Green Ratio (g/C) 2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR- 128 S										
1 L		0.290*		347	296	1.173	145.4	F	35.6	252
2 T		0.290		974	831	1.173	143.8	F	37.7	264
3 R	(Slp)	0.290	0.340	100	463<	0.216	13.8	B	1.0	7
East: PR-127 E										
4 L		0.050		83	85	0.977	82.3	F	3.2	22
5 T		0.070		128	146	0.876	63.7	E	7.9	56
6 R	(Slp)	0.070	0.410	96	110	0.875	71.6	E	7.9	56
North: PR-128 N										
7 L		0.300		204	177	1.151	135.7	F	35.8	250
8 T		0.300		1148	998	1.151	127.3	F	37.0	259
9 R	(Slp)	0.300*	0.420	451	697<	0.647	12.6	B	5.0	36
West: PR-127 W										
10 L		0.180		386	324	1.192*	157.2	F	21.7	155
11 T		0.290*		646	560	1.154	129.4	F	34.9	249
12 R	(Slp)	0.630	0.290	569	954<	0.596	8.1	A	1.3	9
ALL VEHICLES:				5132		1.192	105.6	F	37.7	264
INTERSECTION (persons):				7698			105.6		37.7	264

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.
< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table S.21 - Optimum Cycle Time Results
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Performance Measure	Smallest Value	Cycle Time
Degree of Satn	1.181	130
Average Delay	105.6	100
Stop Rate	1.22	150
Max. Queue for Any Movement	37.1	90
Perf. Index	457.8	90
Cost	6207.7	100

Performance Measure	Largest Value	Cycle Time
Eff. Inters. Cap.	4346	130
Frac. Spare Cap.	-24	130

If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table D.5 - Progression Factors and Actuated Signal Parameters
03 PR-120 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Mov	Arrival	Delay Prog.	Queue Prog.	Disp. Grn. 1st Grn	Settings 2nd Grn

ID	Control	Coord.	Type	Factor	Factor	Gmin	Gmax	Gmin	Gmax
South: PR- 128 S									
1 L	FT	No	3	1.000	1.000	6	NA		
2 T	FT	No	3	1.000	1.000	6	NA		
3 R	FT	No	3	1.000	1.000	6	NA	6	NA
East: PR-127 E									
4 L	FT	No	3	1.000	1.000	6	NA		
5 T	FT	No	3	1.000	1.000	6	NA		
6 R	FT	No	3	1.000	1.000	6	NA	6	NA
North: PR-128 N									
7 L	FT	No	3	1.000	1.000	6	NA		
8 T	FT	No	3	1.000	1.000	6	NA		
9 R	FT	No	3	1.000	1.000	6	NA	6	NA
West: PR-127 W									
10 L	FT	No	3	1.000	1.000	6	NA		
11 T	FT	No	3	1.000	1.000	6	NA		
12 R	FT	No	3	1.000	1.000	6	NA	6	NA

Table V.21 - Intersection Summary for Optimum Cycle Time
03 PR-128 y PR-127
Pico AM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 100 (Optimum Cycle Time)

Cycle Time (sec)	Eff. Int. Cap.	Intersn Deg. of Satn	Prac. Spare Cap.	Aver. Delay (sec)	Stop Rate	Longest Queue (veh)	Perf. Index	Cost Total $/h	Unsett
40	2230	2.301	-61	340.1	2.23	58.4	862.3	15497.3	
50	3017	1.701	-47	197.9	1.91	47.2	614.2	9891.6	
60	3520	1.458	-38	151.2	1.70	41.5	527.8	8039.7	
70	3759	1.365	-34	127.8	1.55	38.2	485.9	7105.5	
80	4089	1.255	-28	115.6	1.45	37.8	466.9	6615.5	
90	4252	1.207	-25	107.9	1.38	37.1	457.8	6300.6	
100	4305	1.192	-24	105.6	1.33	37.7	461.5	6207.7	
110	4325	1.187	-24	108.8	1.30	41.1	478.0	6329.3	
120	4336	1.183	-24	110.3	1.27	43.1	490.9	6387.9	
130	4346	1.181	-24	112.2	1.25	45.1	504.5	6461.3	
140	4333	1.105	-24	114.6	1.23	47.2	519.4	6550.7	
150	4226	1.214	-26	119.0	1.22	49.2	538.8	6726.3	

Site: 03 PR-128 y PR-127 FA 2015
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Contreras\Desktop\Yauco-Vertedero-Dic2007\corridas
Yauco-Vertedero\Yauco-Vertedero futuro 2015.sap
Processed Feb 01, 2008 02:22:21PM

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Output Tables
Output Tables
03 PR-128 y PR-127
Pico PM Futuro 2010

Run Information
Cycle Time = 90 (Optimum Cycle Time)

* Basic Parameters:
  Intersection Type: Signalised - Fixed Time
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Model Defaults: Standard Right TEC - Customised Model
  Peak Flow Period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes.
  Specified performance measure for "best" cycle time in variable run - Delay
  Delay definition: Control delay
  Geometric delay included
  SIDRA Standard Delay model used
  SIDRA Standard Queue model used
  Level of Service based on: Delay (HCM method)
  Queue definition: Back of queue, Average

* Iteration Data:
  No. of Main (Timing-Capacity) Iterations = 2
  Comparison of last two iterations:
    Difference in intersection degree of satn = 0.0 %
    Largest difference in eff. green times = 0 secs
    (max. value for stopping = 0 secs)

* If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

* Movement 12 has large x because of short lanes.
  The degree of saturation of adjacent movement 11 is less than sp, hence this solution may be satisfactory.
  See Table S.7 for queue length, delay etc.

Table S.1 - Movement Phase and Timing Parameters
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Mov Typ	PHASE MATRIX First Green	PHASE MATRIX Second Green	Lost Tim 1st	Lost Tim 2nd	Req.Mov.Time 1st	Req.Mov.Time 2nd	Eff. Grn 1st	Eff. Grn 2nd
South: PR- 128 S									
1	L	*B	C			4		27.9	19
2	T	B	C			4		27.9	19
3	R (Slp)	B	C	C	B	Y	4	42	27.7	49.1	19	25
East: PR-127 E									
4	L	*D	A	Y			4		17.6	11
5	T	D	A				4		15.3	11
6	R (Slp)	B	D	Y	D	B	34	4	38.2	57.5	7	45
North: PR-128 N									
7	L	A	B				4		41.1	30
8	T	*A	B				4		41.1	30
9	R (Slp)	A	B	B	A	Y	4	25	10.0Min	30.0Min	30	31
West: PR-127 W									
10	L	*C	D				4		21.2	14
11	TR	C	A				4		30.2	29
12	R (Slp)	A	C	Y	C	A	Y	34	6	59.6	36.0	23	27

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

* Critical Movement/Green Period

Movement Types:
Slp Slip Lane Movement
Ped Pedestrian
Dum Dummy

Under heading 'Op':
Y If opposed turn

Table S.2 - Movement Capacity Parameters

03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Dem Flow (veh /h)	HV (%)	Satn Flow 1st Grn	Satn Flow 2nd Grn	Flow Ratio 1st Grn	Flow Ratio 2nd Grn	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x
South: PR- 128 S											
1 L	293	2.0	1227		0.239		259	0.90	-20	100	1.131*
2 T	631	0.0	2644		0.239		558	0.90	-20	100	1.130
3 R	156	0.0	405<	853	0.237	0.071	322	0.90	86	100	0.484
East: PR-127 E											
4 L	185	0.0	1365		0.136		167	0.90	-19	100	1.109
5 T	214	1.9	1895		0.113		232	0.90	-3	100	0.924
6 R	70	0.0	265	110	0.042	0.535	76	0.90	-3	100	0.926
North: PR-128 N											
7 L	500	0.0	1348		0.371		449	0.90	-19	100	1.113
8 T	939	0.0	2531		0.371		844	0.90	-19	100	1.113
9 R	100	2.0	812<	1294<	0.043	0.050	716	0.90	545	100	0.140
West: PR-127 W											
10 L	310	1.9	1801		0.172		280	0.90	-19	100	1.107
11 TR	502E	1.6	1915		0.262		617	0.90	11	100	0.813
12 R	386	2.3	957<	472<	0.256	0.300	386	0.90	-10	100	1.000

E "Excess" flow from the short lane of an adjacent movement added to normal flow
< Reduced saturation flow due to a short lane effect

Movement 12 has large x because of short lanes.
The degree of saturation of adjacent movement 11 is less than xp, hence this solution may be satisfactory.
See Table S.7 for queue length, delay etc.

Table S.3 - Intersection Parameters
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Critical Movements: 8, 1, 10, 4

L= 16 Y= 0.917 U= 1.019 T= 107.7

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	****	90

(Program-determined Optimum Cycle Time)

**** Y and U values are too large ****

Intersection Level of Service	=	F
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	88.2
Largest average movement delay (s)	=	125.5
Largest back of queue, mean (m)	=	247
Performance Index	=	346.35
Degree of saturation (highest)	=	1.131
Practical Spare Capacity (lowest)	=	-20 %
Effective intersection capacity, (veh/h)	=	3789
Total vehicle flow (veh/h)	=	4286
Total person flow (pers/h)	=	6429
Total vehicle delay (veh-h/h)	=	105.06
Total person delay (pers-h/h)	=	157.60
Total effective vehicle stops (veh/h)	=	5442
Total effective person stops (pers/h)	=	8163
Total vehicle travel (veh-km/h)	=	2601.4
Total cost ($/h)	=	4588.10
Total fuel (L/h)	=	454.3
Total CO2 (kg/h)	=	1135.97

Table S.4 - Phase Information
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Phase Change Times: 0, 34, 57, 75
Phase Green Times: 30, 19, 14, 11

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Aver. (vehs)	Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1 L	10.21	15.32	125.5	1.00	1.44	21.6	153	29.68	13.5
2 T	21.70	32.54	123.8	1.00	1.45	23.0	161	63.52	13.6
3 R	0.92	1.39	21.3	0.66	0.76	2.5	18	5.72	37.9
East: PR-127 E									
4 L	6.22	9.33	121.1	1.00	1.25	8.6	60	18.00	13.8
5 T	3.79	5.69	63.8	1.00	1.19	9.5	67	14.51	21.8
6 R	1.39	2.09	71.7	1.00	1.19	9.5	67	4.90	20.3
North: PR-128 N									
7 L	15.99	23.99	115.2	1.00	1.51	33.5	234	49.16	14.4
8 T	27.77	41.65	106.5	1.00	1.52	35.3	247	89.98	15.3
9 R	0.33	0.49	11.8	0.36	0.67	0.8	6	2.54	45.4
West: PR-127 W									

10 L	10.10	15.15	117.3	1.00	1.33	14.2	101	29.77	14.2
11 TR	4.82	7.23	34.6	0.98	0.94	13.6	97	26.10	30.8
12 R	1.81	2.71	16.9	0.60	0.75	5.1	36	12.46	41.1

Table S.6 - Intersection Performance
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1080	1.131	32.83	49.25	109.4	0.95	1.35	161	98.91	15.0
East: PR-127 E									
469	1.109	11.41	17.11	87.6	1.00	1.21	67	37.41	17.6
North: PR-128 N									
1539	1.113	44.09	66.14	103.1	0.96	1.46	247	141.69	15.6
West: PR-127 W									
1198	1.107	16.73	25.10	50.3	0.87	0.98	101	68.33	25.2
ALL VEHICLES:									
4286	1.131	105.06	157.60	88.2	0.94	1.27	247	346.35	17.5
INTERSECTION (persons):									
6429	1.131		157.60	88.2	0.94	1.27		346.35	17.5

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR- 128 S												
1 LT	71	19	0	0	446	395	1.131	125.1	1.44	21.6	152.8	500.0
2 T	71	19	0	0	478	422	1.131	123.6	1.45	23.0	161.0	500.0
3 R	4	19	42	25	156	322	0.484	21.3	0.76	2.5	17.8	42.0T
East: PR-127 E												
1 L	79	11	0	0	185	167	1.109	121.1	1.25	8.6	60.4	500.0
2 TR	66	5	6	13	284	307	0.924	65.8	1.19	9.5	67.2	500.0
North: PR-128 N												
1 LT	60	30	0	0	700	629	1.113	112.8	1.51	33.5	234.5	500.0
2 T	60	30	0	0	739	664	1.113	106.3	1.52	35.3	246.8	500.0
3 R	4	30	25	31	100	717	0.140	11.8	0.67	0.8	5.8	78.0T
West: PR-127 W												
1 L	76	14	0	0	310	280	1.107	117.3	1.33	14.2	101.4	500.0
2 TR	61	29	0	0	502	617	0.813	34.6	0.85	13.6	96.6	500.0
3 R	34	23	6	27	386	386	1.000	16.9r	0.75	5.1	36.1<	36.0T

< Short lane capacity is reached and there is excess flow into an adjacent lane
r Delay, stops and queue length for this lane have been cut down to fit in the queuing space. The amount cut may not be accounted for fully in the adjacent lane performance statistics. You may wish to change the short lane to a full lane to investigate the extent of this effect.
T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR- 128 S												
1 LT	293	153	0	446	3.30	1950	1870	0	0	395	1.131	100
2 T	0	478	0	478	3.81	2001	2001	0	0	422	1.131	100
3 R	0	0	156	156	3.81	2001	405<	853	40	322	0.484	100
East: PR-127 E												
1 L	185	0	0	185	3.35	1955	1365	0	88	167	1.109	100
2 TR	0	214	70	284	3.20	1940	648	1879	40	307	0.924	100
North: PR-128 N												
1 LT	500	200	0	700	3.33	1953	1886	0	0	629	1.113	100
2 T	0	739	0	739	3.73	1993	1993	0	0	664	1.113	100
3 R	0	0	100	100	3.73	1993	812<	1294<	40	717	0.140	100
West: PR-127 W												
1 L	310	0	0	310	2.97	1917	1801	0	0	280	1.107	100
2 TR	0	419	83E	502	3.35	1955	1915	0	0	617	0.813	100
3 R	0	0	386	386	3.35	1955	957<	472<	80	386	1.000	100

E "Excess" flow from back of an adjacent short lane
< Reduced saturation flow due to a short lane effect

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR- 128 S											
1 L		293	259	100	1.131*	19*		125.5	1.44	21.6	29.68
2 T		631	558	100	1.130	19		123.8	1.45	23.0	63.52
3 R	(Slp)	156	322<	100	0.484	19	25	21.3	0.76	2.5	5.72
East: PR-127 E											
4 L		185	167	100	1.109	11*		121.1	1.25	8.6	18.00
5 T		214	232	100	0.924	11		63.8	1.19	9.5	14.51
6 R	(Slp)	70	76	100	0.926	7	45	71.7	1.19	9.5	4.90
North: PR-128 N											
7 L		500	449	100	1.113	30		115.2	1.51	33.5	49.16
8 T		939	844	100	1.113	30*		106.5	1.52	35.3	89.98
9 R	(Slp)	100	716<	100	0.140	30	31	11.8	0.67	0.8	2.54
West: PR-127 W											
10 L		310	280	100	1.107	14*		117.3	1.33	14.2	29.77
11 TR		502E	617	100	0.813	29		34.6	0.94	13.6	26.10
12 R	(Slp)	386	386<	100	1.000	23	27	16.9	0.75	5.1	12.46

E "Excess" flow from the short lane of an adjacent movement added to normal flow
< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.14 - Summary of Input and Output Data
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: PR- 128 S												
1 LT	293	153		446	1	1950	19		1.131	125.1	153	500
2 T		478		478	0	1976	19		1.131	123.6	161	500
3 R			156	156	0	2001	19	25	0.484	21.3	18	42
	293	631	156	1080	1				1.131	109.4	161	
East: PR-127 E												
1 L	185			185	0	1955	11		1.109	121.1	60	500
2 TR		214	70	284	1	1939	5	13	0.924	65.8	67	500
	185	214	70	469	1				1.109	87.6	67	
North: PR-128 N												
1 LT	500	200		700	0	1953	30		1.113	112.8	234	500
2 T		739		739	0	1973	30		1.113	106.3	247	500
3 R			100	100	2	1993	30	31	0.140	11.8	6	78
	500	939	100	1539	0				1.113	103.1	247	
West: PR-127 W												
1 L	310			310	2	1916	14		1.107	117.3	101	500
2 R		419	83	502	2	1955	29		0.813	16.9	36	500
3 R			386	386	2	1955	23	27	1.000	16.9r	36	36
	310	419	469	1198	2				1.107	50.3	101	

ALL VEHICLES	Total Flow	% HV	Cycle Time	Max X	Aver. Delay	Max Queue
	4286	1	90	1.131	88.2	247

Peak flow period = 15 minutes.

Queue values in this table are mean back of queue (metres).

Note: Basic Saturation Flows (in through car units) have been adjusted for grade, lane widths, parking manoeuvres and bus stops.

r Delay, stops and queue length for this lane have been cut down to fit in the queuing space. The amount cut may not be accounted for fully in the adjacent lane performance statistics. You may wish to change the short lane to a full lane to investigate the extent of this effect.

Table S.15 - Capacity and Level of Service
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Mov Typ	Green Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR- 128 S										
1 L		0.211*		293	259	1.131*	125.5	F	21.6	153
2 T		0.211		631	558	1.130	123.8	F	23.0	161
3 R	(Slp)	0.211	0.278	156	322<	0.484	21.3	C	2.5	18
East: PR-127 E										
4 L		0.122*		185	167	1.109	121.1	F	8.6	60
5 T		0.122		214	232	0.924	63.8	E	9.5	67
6 R	(Slp)	0.078	0.500	70	76	0.926	71.7	E	9.5	67
North: PR-128 N										
7 L		0.333		500	449	1.113	115.2	F	33.5	234

8	T		0.333*		939	844	1.113	106.5	F	35.3	247
9	R	(Slp)	0.333	0.344	100	716<	0.140	11.8	B	0.8	6
West: PR-127 W											
10	L		0.156*		310	280	1.107	117.3	F	14.2	101
11	TR		0.322		502E	617	0.813	34.6	C	13.6	97
12	R	(Slp)	0.256	0.300	386	386<	1.000	16.9	B	5.1	36
ALL VEHICLES:					4286		1.131	88.2	F	35.3	247
INTERSECTION (persons):					6429			88.2		35.3	247

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)
E "Excess" flow from the short lane of an adjacent movement added to normal flow

Table S.21 - Optimum Cycle Time Results
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Performance Measure	Smallest Value	Cycle Time
Degree of Satn	1.091	150
Average Delay	88.2	90
Stop Rate	1.17	150
Max. Queue for Any Movement	34.3	70
Perf. Index	338.7	80
Cost	4588.1	90

Performance Measure	Largest Value	Cycle Time
Eff. Inters. Cap.	3928	150
Prac. Spare Cap.	-18	150

If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table D.5 - Progression Factors and Actuated Signal Parameters
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR- 128 S									
1 L	FT	No	3	1.000	1.000	6	NA		
2 T	FT	No	3	1.000	1.000	6	NA		
3 R	FT	No	3	1.000	1.000	6	NA	6	NA
East: PR-127 E									
4 L	FT	No	3	1.000	1.000	6	NA		
5 T	FT	No	3	1.000	1.000	6	NA		
6 R	FT	No	3	1.000	1.000	6	NA	6	NA
North: PR-128 N									
7 L	FT	No	3	1.000	1.000	6	NA		
8 T	FT	No	3	1.000	1.000	6	NA		
9 R	FT	No	3	1.000	1.000	6	NA	6	NA
West: PR-127 W									
10 L	FT	No	3	1.000	1.000	6	NA		
11 T	FT	No	3	1.000	1.000	6	NA		
12 R	FT	No	3	1.000	1.000	6	NA	6	NA

Table V.21 - Intersection Summary for Optimum Cycle Time
03 PR-128 y PR-127
Pico PM Futuro 2010
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 90 (Optimum Cycle Time)

Cycle Time (sec)	Eff. Int. Cap.	Intersn Deg. of Satn	Prac. Spare Cap.	Aver. Delay (sec)	Stop Rate	Longest Queue (veh)	Perf. Index	Cost Total $/h	Unsatt
40	1733	2.473	-64	310.5	2.12	65.6	670.1	11948.1	
50	2988	1.434	-37	141.8	1.72	41.4	416.5	6384.4	
60	3320	1.291	-30	103.6	1.49	34.8	352.4	5109.3	
70	3590	1.194	-25	95.3	1.39	34.3	343.3	4829.7	
80	3735	1.148	-22	88.8	1.31	34.5	338.7	4610.1	
90	3789	1.131	-20	88.2	1.27	35.3	346.3	4588.1	
100	3812	1.124	-20	88.9	1.24	38.3	356.3	4609.2	
110	3848	1.114	-19	91.9	1.22	39.4	371.5	4704.2	
120	3843	1.115	-19	93.9	1.20	42.3	384.6	4771.4	
130	3831	1.119	-20	99.2	1.19	43.6	404.5	4944.8	
140	3878	1.105	-19	101.5	1.18	46.5	418.3	5018.9	
150	3928	1.091	-18	104.2	1.17	47.9	433.5	5108.6	

Site: 03 PR-128 y PR-127 PP 2010
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Contreras\Desktop\Yauco-Vertedero-Dic2007\corridas
Yauco-Vertedero\Yauco-Vertedero futuro 2010.sap
Processed Feb 01, 2008 02:11:17PM

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Output Tables
Output Tables
03 PR-128 y PR-127
Pico PM Futuro 2015

Run Information
Cycle Time = 80 (Optimum Cycle Time)

* Basic Parameters:
  Intersection Type: Signalised - Fixed Time
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Model Defaults: Standard Right TIC - Customised Model
  Peak Flow Period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes.
  Specified performance measure for "best" cycle time in variable run - Delay
  Delay definition: Control delay
  Geometric delay included
  SIDRA Standard Delay model used
  SIDRA Standard Queue model used
  Level of Service based on: Delay (HCM method)
  Queue definition: Back of queue, Average

* Iteration Data:
  No. of Main (Timing-Capacity) Iterations = 3
  Comparison of last two iterations:
    Difference in intersection degree of satn = 2.1 %
    Largest difference in eff. green times = 1 secs
    (max. value for stopping = 2 secs)
  Information on Previous Iteration:
    Cycle Time = 80
    Phase Times: 0, 28, 48, 64
    Critical Movements: 8, 2, 10, 4

* If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table S.1 - Movement Phase and Timing Parameters
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Mov ID	Mov Typ	PHASE MATRIX First Green Fr	To	Op Pr	Second Green Fr	To	Op Pr	Lost Tim 1st Grn	2nd Grn	Req.Mov.Time 1st Grn	2nd Grn	Eff. Grn 1st	2nd

```
Grn  Grn
 ------------------------------------------------------------------------------
---------
 South: PR- 128 S
    1 L        B      C                                  4        26.6
16
    2 T       *B      C                                  4        26.6
16
    3 R  (Slp) B      C            C      B      Y       4   36   24.4     40.2
16   24
 ------------------------------------------------------------------------------
---------
 East: PR-127 E
    4 L       *D      A      Y                           4        21.9
12
    5 T        D      A                                  4        14.9
12
    6 R  (Slp) B      D      Y      D      B             28    4   31.3     47.7
7   41
 ------------------------------------------------------------------------------
---------
 North: PR-128 N
    7 L        A      B                                  4        39.0
25
    8 T       *A      B                                  4        39.0
25
    9 R  (Slp) A      B            B      A      Y       4   22   10.0Min  30.0Min
25   29
 ------------------------------------------------------------------------------
---------
 West: PR-127 W
   10 L       *C      D                                  4        20.3
11
   11 T        C      A                                  4        24.5
27
   12 R  (Slp) A      C      Y      C      A      Y       4    5   29.3     25.0
45   26
 ------------------------------------------------------------------------------
---------
 ------------------------------------------------------------------------------
---------
   Current Phase Sequence: Two-phase
   Input phase sequence: A B C D
   Output phase sequence: A B C D
 ------------------------------------------------------------------------------
---------
   *  Critical Movement/Green Period

 Movement Types:                          Under heading 'Op':
   Slp  Slip Lane Movement                  Y   If opposed turn
   Ped  Pedestrian
   Dum  Dummy
```

Table 5.2 - Movement Capacity Parameters
03 PR-128 y PR-127

Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Mov ID	Dem Flow (veh /h)	HV (%)	Satn Flow 1st Grn	Satn Flow 2nd Grn	Flow Ratio 1st Grn	Flow Ratio 2nd Grn	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x
South: PR- 128 S											
1 L	313	1.9	1233		0.254		247	0.90	-29	100	1.269
2 T	670	0.0	2639		0.254		528	0.90	-29	100	1.269
3 R	165	0.0	546<	836	0.229	0.048	360	0.90	96	100	0.458
East: PR-127 E											
4 L	196	0.0	975		0.201		146	0.90	-33	100	1.340*
5 T	228	2.2	1856		0.123		278	0.90	10	100	0.819
6 R	74	0.0	271	130	0.037	0.491	90	0.90	10	100	0.819
North: PR-128 N											
7 L	531	0.0	1349		0.394		422	0.90	-29	100	1.260
8 T	996	0.0	2530		0.394		791	0.90	-29	100	1.260
9 R	107	1.9	947<	1320	0.080	0.081	774	0.90	551	100	0.138
West: PR-127 W											
10 L	329	2.1	1798		0.183		247	0.90	-32	100	1.331
11 T	446	2.0	1930		0.231		651	0.90	31	100	0.685
12 R	500	2.0	942<	1031<	0.284	0.225	865	0.90	56	100	0.578

< Reduced saturation flow due to a short lane effect

Table 5.3 - Intersection Parameters
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

```
 ------------------------------------------------------
   Critical Movements: 8, 2, 10, 4

   L=   16  Y=  1.032  U=  1.146  T=    107.7

   Cycle Time:
     Minimum   Maximum   Practical   Chosen
        40       150       ****        80
     (Program-determined Optimum Cycle Time)


     **** Y and U values are too large ****

   Intersection Level of Service              =        F
   Worst movement Level of Service            =        F
   Average intersection delay (s/pers)        =    126.4
   Largest average movement delay (s)         =    216.5
   Largest back of queue, mean (m)            =      305
   Performance Index                          =   435.19
   Degree of saturation (highest)             =    1.340
```

Practical Spare Capacity (lowest)	=	-33 %
Effective intersection capacity, (veh/h)	=	3399
Total vehicle flow (veh/h)	=	4555
Total person flow (pers/h)	=	6833
Total vehicle delay (veh-h/h)	=	159.96
Total person delay (pers-h/h)	=	239.94
Total effective vehicle stops (veh/h)	=	6594
Total effective person stops (pers/h)	=	9891
Total vehicle travel (veh-km/h)	=	2765.4
Total cost ($/h)	=	6235.90
Total fuel (L/h)	=	554.3
Total CO2 (kg/h)	=	1386.27

Table S.4 - Phase Information
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Phase Change Times: 0, 29, 49, 64
Phase Green Times: 25, 16, 11, 12

Current Phase Sequence: Two-phase
Input phase sequence: A B C D
Output phase sequence: A B C D

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Aver. (vehs)	Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1 L	15.61	23.41	179.5	1.00	1.71	26.4	187	39.13	10.1
2 T	33.12	49.67	177.9	1.00	1.72	28.1	197	83.40	10.1
3 R	0.88	1.32	19.2	0.65	0.76	2.4	16	5.62	39.3
East: PR-127 E									
4 L	11.79	17.68	216.5	1.00	1.53	12.1	85	27.51	8.6
5 T	2.84	4.26	44.8	1.00	1.09	7.8	55	12.38	26.9
6 R	1.08	1.62	52.7	1.00	1.09	7.8	55	4.18	24.6
North: PR-128 N									
7 L	25.55	38.33	173.2	1.00	1.86	41.4	290	65.98	10.4
8 T	45.56	68.34	164.7	1.00	1.88	43.6	305	121.38	10.9
9 R	0.34	0.51	11.4	0.37	0.68	0.8	6	2.62	45.8
West: PR-127 W									
10 L	18.97	28.46	207.6	1.00	1.66	19.5	139	44.86	8.9
11 T	3.09	4.64	24.9	0.92	0.80	9.3	66	18.91	35.6
12 R	1.13	1.70	8.1	0.22	0.64	1.2	8	9.22	48.6

Table S.6 - Intersection Performance
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR- 128 S									
1148	1.269	49.61	74.41	155.6	0.95	1.58	197	128.15	11.4
East: PR-127 E									
498	1.340	15.71	23.56	113.6	1.00	1.26	85	44.07	14.6
North: PR-128 N									
1634	1.260	71.45	107.18	157.4	0.96	1.79	305	189.98	11.3
West: PR-127 W									
1275	1.331	23.20	34.79	65.5	0.67	0.96	139	72.99	21.5
ALL VEHICLES:									
4555	1.340	159.96	239.94	126.4	0.88	1.45	305	435.19	13.4
INTERSECTION (persons):									
6833	1.340		239.94	126.4	0.88	1.45		435.19	13.4

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR- 128 S												
1 LT	64	16	0	0	475	374	1.269	179.1	1.71	26.4	186.7	500.0
2 T	64	16	0	0	508	400	1.269	177.8	1.73	28.1	197.0	500.0
3 R	4	16	36	24	165	360	0.458	19.2	0.76	2.4	16.5	42.0T
East: PR-127 E												
1 L	68	12	0	0	196	146	1.341	216.5	1.53	12.1	84.6	500.0
2 TR	55	5	6	14	302	369	0.819	46.8	1.09	7.8	55.1	500.0
North: PR-128 N												
1 LT	55	25	0	0	742	589	1.260	170.9	1.86	41.4	289.5	500.0
2 T	55	25	0	0	785	623	1.260	164.6	1.88	43.6	305.2	500.0
3 R	4	25	22	29	107	774	0.138	11.4	0.68	0.8	5.5	78.0T
West: PR-127 W												
1 L	69	11	0	0	329	247	1.331	207.6	1.66	19.5	139.3	500.0
2 T	53	27	0	0	446	651	0.685	24.9	0.80	9.3	66.4	500.0

3 R	4	45	5	26	500	865	0.578	8.1	0.64	1.2	8.4	36.0T

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR- 128 S												
1 LT	313	162	0	475	3.30	1950	1871	0	0	374	1.269	100
2 T	0	508	0	508	3.81	2001	2001	0	0	400	1.269	100
3 R	0	0	165	165	3.81	2001	546<	836	45	360	0.458	100
East: PR-127 E												
1 L	196	0	0	196	3.35	1955	975	0	99	146	1.341	100
2 TR	0	228	74	302	3.20	1940	648	1876	45	369	0.819	100
North: PR-128 N												
1 LT	531	211	0	742	3.33	1953	1886	0	0	589	1.260	100
2 T	0	785	0	785	3.73	1993	1993	0	0	623	1.260	100
3 R	0	0	107	107	3.73	1993	947<	1320	45	774	0.138	100
West: PR-127 W												
1 L	329	0	0	329	2.97	1917	1798	0	0	247	1.331	100
2 T	0	446	0	446	3.35	1955	1930	0	0	651	0.685	100
3 R	0	0	500	500	3.35	1955	942<	1031<	90	865	0.578	100

< Reduced saturation flow due to a short lane effect

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR- 128 S											
1 L		313	247	100	1.269	16		179.5	1.71	26.4	39.13
2 T		670	528	100	1.269	16*		177.9	1.72	28.1	83.40
3 R	(Slp)	165	360<	100	0.458	16	24	19.2	0.76	2.4	5.62
East: PR-127 E											
4 L		196	146	100	1.340*	12*		216.5	1.53	12.1	27.51
5 T		228	278	100	0.819	12		44.8	1.09	7.8	12.38
6 R	(Slp)	74	90	100	0.819	7	41	52.7	1.09	7.8	4.18
North: PR-128 N											
7 L		531	422	100	1.260	25		173.2	1.86	41.4	65.98
8 T		996	791	100	1.260	25*		164.7	1.88	43.6	121.38
9 R	(Slp)	107	774<	100	0.138	25	29	11.4	0.68	0.8	2.62
West: PR-127 W											
10 L		329	247	100	1.331	11*		207.6	1.66	19.5	44.86
11 T		446	651	100	0.685	27		24.9	0.80	9.3	18.91
12 R	(Slp)	500	865<	100	0.578	45	26	8.1	0.64	1.2	9.22

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.14 - Summary of Input and Output Data
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: PR- 128 S												
1 LT	313	162		475	1	1950	16		1.269	179.1	187	500
2 T		508		508	0	1976	16		1.269	177.8	197	500
3 R			165	165	0	2001	16	24	0.458	19.2	16	42
	313	670	165	1148	1				1.269	155.6	197	
East: PR-127 E												
1 L	196			196	0	1955	12		1.341	216.5	85	500
2 TR		228	74	302	2	1939	5	14	0.819	46.8	55	500
	196	228	74	498	1				1.341	113.6	85	
North: PR-128 N												
1 LT	531	211		742	0	1953	25		1.260	170.9	290	500
2 T		785		785	0	1973	25		1.260	164.6	305	500
3 R			107	107	2	1993	25	29	0.138	11.4	6	78
	531	996	107	1634	0				1.260	157.4	305	
West: PR-127 W												
1 L	329			329	2	1916	11		1.331	207.6	139	500
2 T		446		446	2	1955	27		0.685	24.9	66	500
3 R			500	500	2	1955	45	26	0.578	8.1	8	36
	329	446	500	1275	2				1.331	65.5	139	

ALL VEHICLES	Total	%	Cyclo	Max	Aver.	Max

Flow	HV	Time	X	Delay	Queue
4555	1	80	1.340	126.4	305

Peak flow period = 15 minutes.

Queue values in this table are mean back of queue (metres).

Note: Basic Saturation Flows (in through car units) have been adjusted for grade, lane widths, parking manoeuvres and bus stops.

Table S.15 - Capacity and Level of Service
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Mov ID	Mov Typ	Green Ratio (g/C) 1st grn	Green Ratio (g/C) 2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR- 128 S										
1 L		0.200		313	247	1.269	179.5	F	26.4	187
2 T		0.200*		670	528	1.269	177.9	F	28.1	197
3 R	(Slp)	0.200	0.300	165	360<	0.458	19.2	B	2.4	16
East: PR-127 E										
4 L		0.150*		196	146	1.340*	216.5	F	12.1	85
5 T		0.150		228	278	0.819	44.8	D	7.8	55
6 R	(Slp)	0.087	0.512	74	90	0.819	52.7	D	7.8	55
North: PR-128 N										
7 L		0.312		531	422	1.260	173.2	F	41.4	290
8 T		0.312*		996	791	1.260	164.7	F	43.6	305
9 R	(Slp)	0.312	0.363	107	774<	0.138	11.4	B	0.8	6
West: PR-127 W										
10 L		0.138*		329	247	1.331	207.6	F	19.5	139
11 T		0.338		446	651	0.685	24.9	C	9.3	66
12 R	(Slp)	0.562	0.325	500	865<	0.578	8.1	A	1.2	8
ALL VEHICLES:				4555		1.340	126.4	F	43.6	305
INTERSECTION (persons):				6833			126.4		43.6	305

Level of Service calculations are based on average control delay including geometric delay (HCM criteria), independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table S.21 - Optimum Cycle Time Results
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Performance Measure	Smallest Value	Cycle Time
Degree of Satn	1.282	140
Average Delay	126.4	80
Stop Rate	1.28	150
Max. Queue for Any Movement	41.2	60
Perf. Index	431.2	70
Cost	6235.9	80

Performance Measure	Largest Value	Cycle Time
Eff. Inters. Cap.	3554	140
Prac. Spare Cap.	-30	140

If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table D.5 - Progression Factors and Actuated Signal Parameters
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR- 128 S									
1 L	FT	No	3	1.000	1.000	6	NA		
2 T	FT	No	3	1.000	1.000	6	NA		
3 R	FT	No	3	1.000	1.000	6	NA	6	NA
East: PR-127 E									
4 L	FT	No	3	1.000	1.000	6	NA		
5 T	FT	No	3	1.000	1.000	6	NA		
6 R	FT	No	3	1.000	1.000	6	NA	6	NA
North: PR-128 N									
7 L	FT	No	3	1.000	1.000	6	NA		
8 T	FT	No	3	1.000	1.000	6	NA		
9 R	FT	No	3	1.000	1.000	6	NA	6	NA
West: PR-127 W									

10 L	FT	No	3	1.000	1.000	6	NA		
11 T	FT	No	3	1.000	1.000	6	NA		
12 R	FT	No	3	1.000	1.000	6	NA	6	NA

Table V.21 - Intersection Summary for Optimum Cycle Time
03 PR-128 y PR-127
Pico PM Futuro 2015
Intersection ID: 03
Fixed-Time Signals, Cycle Time = 80 (Optimum Cycle Time)

Cycle Time (sec)	Eff. Int. Cap.	Intersn Deg. of Satn	Prac. Spare Cap.	Aver. Delay (sec)	Stop Rate	Longest Queue (veh)	Perf. Index	Cost Total $/h	Unsett
40	1736	2.625	-66	345.3	2.20	71.8	768.4	13923.0	
50	2987	1.525	-41	167.0	1.83	47.8	490.7	7681.1	
60	3289	1.385	-35	136.9	1.63	41.2	441.2	6615.1	
70	3471	1.312	-31	128.1	1.52	43.8	431.2	6300.7	
80	3399	1.340	-33	126.4	1.45	43.6	435.2	6235.9	
90	3471	1.312	-31	134.2	1.43	48.9	458.9	6507.3	
100	3479	1.309	-31	133.7	1.38	49.3	466.2	6486.1	
110	3509	1.298	-31	136.1	1.35	52.0	479.6	6569.3	
120	3481	1.308	-31	136.7	1.32	54.7	489.4	6589.0	
130	3551	1.283	-30	143.6	1.31	57.3	511.9	6831.9	
140	3554	1.282	-30	148.3	1.30	59.9	530.3	6995.7	
150	3548	1.284	-30	151.1	1.28	62.4	544.6	7092.3	

Site: 03 PR-128 y PR-127 FP 2015
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Contreras\Desktop\Yauco-Vertedero-Dic2007\corridas
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Output Tables
Output Tables
04 PR-127 y calle 16
Pico AM Base

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
04 PR-127 y calle 16
Pico AM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	D
Average intersection delay (s/pers)	=	11.0
Largest average movement delay (s)	=	31.0
Largest back of queue, mean (m)	=	26
Performance Index	=	28.48
Degree of saturation (highest)	=	0.558
Practical Spare Capacity (lowest)	=	43 %
Effective intersection capacity, (veh/h)	=	3063
Total vehicle flow (veh/h)	=	1708
Total person flow (pers/h)	=	2562
Total vehicle delay (veh-h/h)	=	5.23
Total person delay (pers-h/h)	=	7.85
Total effective vehicle stops (veh/h)	=	262
Total effective person stops (pers/h)	=	394
Total vehicle travel (veh-km/h)	=	1034.9
Total cost ($/h)	=	750.97
Total fuel (L/h)	=	102.8
Total CO2 (kg/h)	=	257.26

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (veh)	Back (m)	Index	Speed (km/h)
South: Calle 16 S									
1 L	0.10	0.15	30.9	0.88	1.08	0.8	6	0.37	33.5
3 R	0.90	1.34	31.0	0.88	1.09	0.8	6	3.25	33.7
East: PR-127 E									
4 L	0.87	1.31	30.2	1.00	1.20	3.8	26	3.21	32.7
5 T	3.33	4.99	21.7	1.00	0.00	3.8	26	12.09	37.5
West: PR-127 W									
11 T	0.00	0.00	0.0	0.00	0.00	0.0	0	9.30	60.0
12 R	0.04	0.05	8.2	0.00	0.67	0.0	0	0.26	49.0

Table S.6 - Intersection Performance
04 PR-127 y calle 16
Pico AM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
116	0.464	1.00	1.50	31.0	0.88	1.09	6	3.62	33.7
East: PR-127 E									
656	0.558	4.20	6.29	23.0	1.00	0.19	26	15.29	36.7
West: PR-127 W									
936	0.485	0.04	0.05	0.1	0.00	0.01	0	9.56	59.8
ALL VEHICLES:									
1708	0.558	5.23	7.85	11.0	0.44	0.15	26	28.48	46.2
INTERSECTION (persons):									
2562	0.558		7.85	11.0	0.44	0.15		28.48	46.2

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
04 PR-127 y calle 16
Pico AM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (veh)	Queue Back (m)	Lane Length (m)
South: Calle 16 S								
1 LR	116	250	0.464	31.0	1.09	0.8	6.0	500.0
East: PR-127 E								
1 LT	656	1177	0.557	23.0	0.19	3.8	26.5	500.0
West: PR-127 W								
1 TR	936	1948	0.480	0.1	0.01	0.0	0.0	500.0

Table S.8 - Lane Flow and Capacity Information
04 PR-127 y calle 16
Pico AM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: Calle 16 S								
1 LR	12	0	104	116	68	250	0.464	100
East: PR-127 E								
1 LT	104	552	0	656	656	1177	0.557	100
West: PR-127 W								
1 TR	0	920	16	936	936	1948	0.480	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
04 PR-127 y calle 16
Pico AM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: Calle 16 S									
1 L		12	26	100	0.462	30.9	1.08	0.8	0.37
3 R		104	224	100	0.464	31.0	1.09	0.8	3.25
East: PR-127 E									
4 L		104	187	100	0.556	30.2	1.20	3.8	3.21
5 T		552	990	100	0.558*	21.7	0.00	3.8	12.09
West: PR-127 W									
11 T		920	1915	100	0.480	0.0	0.00	0.0	9.30

12 R	16	33	100	0.485	8.2	0.67	0.0	0.26

* Maximum degree of saturation

Table S.15 - Capacity and Level of Service
04 PR-127 y calle 16
Pico AM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Queue Aver. (vehs)	Back (m)
South: Calle 16 S								
1	L	12	26	0.462	30.9	D	0.8	6
3	R	104	224	0.464	31.0	D	0.8	6
East: PR-127 E								
4	L	104	187	0.556	30.2	D	3.8	26
5	T	552	990	0.558*	21.7	C	3.8	26
West: PR-127 W								
11	T	920	1915	0.480	0.0	A	0.0	0
12	R	16	33	0.485	8.2	A	0.0	0
ALL VEHICLES:		1708		0.558	11.0	NA	3.8	26

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 04 PR-127 y calle 16 BA
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Output Tables
Output Tables
04 PR-127 y calle 16
Pico PM Base

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
04 PR-127 y calle 16
Pico PM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	D
Average intersection delay (s/pers)	=	11.3
Largest average movement delay (s)	=	25.4
Largest back of queue, mean (m)	=	30
Performance Index	=	30.99
Degree of saturation (highest)	=	0.659
Practical Spare Capacity (lowest)	=	21 %
Effective intersection capacity, (veh/h)	=	2642
Total vehicle flow (veh/h)	=	1740
Total person flow (pers/h)	=	2610
Total vehicle delay (veh-h/h)	=	5.48
Total person delay (pers-h/h)	=	8.22
Total effective vehicle stops (veh/h)	=	484
Total effective person stops (pers/h)	=	726
Total vehicle travel (veh-km/h)	=	1053.6
Total cost ($/h)	=	782.74
Total fuel (L/h)	=	112.5
Total CO2 (kg/h)	=	281.67

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.
See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (vehs)	Back (m)	Index	Speed (km/h)
South: Calle 16 S									
1 L	0.02	0.04	22.2	0.78	1.09	0.9	7	0.11	38.6
3 R	1.22	1.83	22.4	0.78	1.11	0.9	7	5.30	38.8
East: PR-127 E									
4 L	1.38	2.07	25.4	1.00	1.28	4.3	30	5.81	35.2
5 T	2.82	4.23	16.9	1.00	0.00	4.3	30	12.16	41.0
West: PR-127 W									
11 T	0.00	0.00	0.0	0.00	0.00	0.0	0	7.36	60.0
12 R	0.04	0.05	8.2	0.00	0.67	0.0	0	0.26	49.0

Table S.6 - Intersection Performance
04 PR-127 y calle 16
Pico PM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
200	0.466	1.24	1.86	22.4	0.78	1.11	7	5.40	38.8
East: PR-127 E									
796	0.659	4.20	6.30	19.0	1.00	0.32	30	17.97	39.4
West: PR-127 W									
744	0.382	0.04	0.05	0.2	0.00	0.01	0	7.62	59.7
ALL VEHICLES:									
1740	0.659	5.48	8.22	11.3	0.55	0.28	30	30.99	46.0
INTERSECTION (persons):									
2610	0.659		8.22	11.3	0.55	0.28		30.99	46.0

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
04 PR-127 y calle 16
Pico PM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: Calle 16 S								
1 LR	200	430	0.465	22.4	1.11	0.9	7.2	500.0
East: PR-127 E								
1 LT	796	1209	0.658	19.0	0.32	4.3	30.4	500.0
West: PR-127 W								
1 TR	744	1948	0.382	0.2	0.01	0.0	0.0	500.0

Table S.8 - Lane Flow and Capacity Information
04 PR-127 y calle 16
Pico PM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: Calle 16 S								
1 LR	4	0	196	200	60	430	0.465	100
East: PR-127 E								
1 LT	196	600	0	796	796	1209	0.658	100
West: PR-127 W								
1 TR	0	728	16	744	744	1948	0.382	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
04 PR-127 y calle 16
Pico PM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: Calle 16 S									
1 L		4	9	100	0.444	22.2	1.09	0.9	0.11
3 R		196	421	100	0.466	22.4	1.11	0.9	5.30
East: PR-127 E									
4 L		196	298	100	0.658	25.4	1.28	4.3	5.81
5 T		600	911	100	0.659*	16.9	0.00	4.3	12.16
West: PR-127 W									
11 T		728	1906	100	0.382	0.0	0.00	0.0	7.36

12 R	16	42	100	0.381	8.2	0.67	0.0	0.26

* Maximum degree of saturation

Table S.15 - Capacity and Level of Service
04 PR-127 y calle 16
Pico PM Base
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: Calle 16 S								
1	L	4	9	0.444	22.2	C	0.9	7
3	R	196	421	0.466	22.4	C	0.9	7
East: PR-127 E								
4	L	196	298	0.658	25.4	D	4.3	30
5	T	600	911	0.659*	16.9	C	4.3	30
West: PR-127 W								
11	T	728	1906	0.382	0.0	A	0.0	0
12	R	16	42	0.381	8.2	A	0.0	0
ALL VEHICLES:		1740		0.659	11.3	NA	4.3	30

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 04 PR-127 y calle 16 BP
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Magdamari\Yauco-Vertedero-Dic2007\corridas Yauco-Vertedero\Yauco-Vertedero.aap
Processed Jan 17, 2008 02:00:32PM

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Output Tables
Output Tables
04 PR-127 y calle 16
Pico AM Futuro 2010

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
04 PR-127 y calle 16
Pico AM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	E
Average intersection delay (s/pers)	=	14.5
Largest average movement delay (s)	=	43.3
Largest back of queue, mean (m)	=	30
Performance Index	=	32.73
Degree of saturation (highest)	=	0.682
Practical Spare Capacity (lowest)	=	17 %
Effective intersection capacity, (veh/h)	=	2631
Total vehicle flow (veh/h)	=	1795
Total person flow (pers/h)	=	2693
Total vehicle delay (veh-h/h)	=	7.24
Total person delay (pers-h/h)	=	10.86
Total effective vehicle stops (veh/h)	=	331
Total effective person stops (pers/h)	=	497
Total vehicle travel (veh-km/h)	=	1087.4
Total cost ($/h)	=	839.67
Total fuel (L/h)	=	111.7
Total CO2 (kg/h)	=	279.46

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.
See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (vehs)	Back (m)	Index	Speed (km/h)
South: Calle 16 S									
1 L	0.30	0.45	43.1	0.93	1.17	1.3	10	0.94	28.2
3 R	1.39	2.09	43.3	0.93	1.19	1.3	10	4.38	28.4
East: PR-127 E									
4 L	1.16	1.74	36.0	1.00	1.24	4.2	30	3.84	30.0
5 T	4.32	6.49	27.5	1.00	0.00	4.2	30	13.57	34.2
West: PR-127 W									
11 T	0.00	0.00	0.0	0.00	0.00	0.0	0	9.53	60.0
12 R	0.07	0.10	8.2	0.00	0.67	0.0	0	0.47	49.0

Table S.6 - Intersection Performance
04 PR-127 y calle 16
Pico AM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
141	0.682	1.69	2.54	43.2	0.93	1.19	10	5.32	28.3
East: PR-127 E									
682	0.624	5.48	8.22	28.9	1.00	0.21	30	17.41	33.4
West: PR-127 W									
972	0.500	0.07	0.10	0.2	0.00	0.02	0	10.00	59.6
ALL VEHICLES:									
1795	0.682	7.24	10.86	14.5	0.45	0.18	30	32.73	43.1
INTERSECTION (persons):									
2693	0.682		10.86	14.5	0.45	0.18		32.73	43.1

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
04 PR-127 y calle 16
Pico AM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: Calle 16 S								
1 LR	141	207	0.682	43.2	1.19	1.3	10.1	500.0
East: PR-127 E								
1 LT	682	1095	0.623	28.9	0.21	4.2	29.7	500.0
West: PR-127 W								
1 TR	972	1947	0.499	0.2	0.02	0.0	0.0	500.0

Table S.8 - Lane Flow and Capacity Information
04 PR-127 y calle 16
Pico AM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: Calle 16 S								
1 LR	25	0	116	141	60	207	0.682	100
East: PR-127 E								
1 LT	116	566	0	682	682	1095	0.623	100
West: PR-127 W								
1 TR	0	943	29	972	972	1947	0.499	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
04 PR-127 y calle 16
Pico AM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: Calle 16 S									
1 L		25	37	100	0.676	43.1	1.17	1.3	0.94
3 R		116	170	100	0.682[a]	43.3	1.19	1.3	4.38
East: PR-127 E									
4 L		116	186	100	0.624	36.0	1.24	4.2	3.84
5 T		566	908	100	0.623	27.5	0.00	4.2	13.57
West: PR-127 W									
11 T		943	1889	100	0.499	0.0	0.00	0.0	9.53

12 R	29	58	100	0.500	8.2	0.67	0.0	0.47

* Maximum degree of saturation

Table 5.15 - Capacity and Level of Service
04 PR-127 y calle 16
Pico AM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: Calle 16 S								
1	L	25	37	0.676	43.1	E	1.3	10
3	R	116	170	0.682*	43.3	E	1.3	10
East: PR-127 E								
4	L	116	186	0.624	36.0	E	4.2	30
5	T	566	908	0.623	27.5	D	4.2	30
West: PR-127 W								
11	T	943	1889	0.499	0.0	A	0.0	0
12	R	29	58	0.500	8.2	A	0.0	0
ALL VEHICLES:		1795		0.682	14.5	NA	4.2	30

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 04 PR-127 y calle 16 PA 2010
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Processed Jan 17, 2008 10:08:50AM

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Output Tables
Output Tables
04 PR-127 y calle 16
Pico AM Futuro 2015

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
04 PR-127 y calle 16
Pico AM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	24.6
Largest average movement delay (s)	=	91.8
Largest back of queue, mean (m)	=	37
Performance Index	=	43.22
Degree of saturation (highest)	=	0.977
Practical Spare Capacity (lowest)	=	-18 %
Effective intersection capacity, (veh/h)	=	1965
Total vehicle flow (veh/h)	=	1919
Total person flow (pers/h)	=	2879
Total vehicle delay (veh-h/h)	=	13.12
Total person delay (pers-h/h)	=	19.69
Total effective vehicle stops (veh/h)	=	432
Total effective person stops (pers/h)	=	647
Total vehicle travel (veh-km/h)	=	1162.5
Total cost ($/h)	=	1048.70
Total fuel (L/h)	=	127.6
Total CO2 (kg/h)	=	319.35

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (veh)	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
1 L	0.81	1.22	91.7	0.99	1.50	3.0	24	2.01	17.3
3 R	3.19	4.78	91.8	0.99	1.55	3.0	24	7.91	17.4
East: PR-127 E									
4 L	1.80	2.70	51.9	1.00	1.33	5.3	37	4.89	24.6
5 T	7.24	10.86	43.4	1.00	0.00	5.3	37	17.71	27.4
West: PR-127 W									
11 T	0.00	0.00	0.0	0.00	0.00	0.0	0	10.12	60.0
12 R	0.08	0.12	8.2	0.00	0.67	0.0	0	0.58	49.0

Table S.6 - Intersection Performance
04 PR-127 y calle 16
Pico AM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
157	0.977	4.00	6.00	91.8	0.99	1.54	24	9.92	17.4
East: PR-127 E									
725	0.731	9.04	13.56	44.9	1.00	0.23	37	22.61	26.8
West: PR-127 W									
1037	0.533	0.08	0.12	0.3	0.00	0.02	0	10.70	59.5
ALL VEHICLES:									
1919	0.977	13.12	19.69	24.6	0.46	0.22	37	43.22	35.9
INTERSECTION (persons):									
2879	0.977		19.69	24.6	0.46	0.22		43.22	35.9

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
04 PR-127 y calle 16
Pico AM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (veh)	Queue Back (m)	Lane Length (m)
South: Calle 16 S								

1 LR	157	160	0.980	91.8	1.54	3.0	23.7	500.0
East: PR-127 E								
1 LT	725	994	0.729	44.9	0.23	5.3	37.3	500.0
West: PR-127 W								
1 TR	1037	1947	0.533	0.3	0.02	0.0	0.0	500.0

Table S.8 - Lane Flow and Capacity Information
04 PR-127 y calle 16
Pico AM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: Calle 16 S								
1 LR	32	0	125	157	60	160	0.980	100
East: PR-127 E								
1 LT	125	600	0	725	725	994	0.729	100
West: PR-127 W								
1 TR	0	1001	36	1037	1037	1947	0.533	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
04 PR-127 y calle 16
Pico AM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: Calle 16 S									
1	L	32	33	100	0.970	91.7	1.50	3.0	2.01
3	R	125	128	100	0.977*	91.8	1.55	3.0	7.91
East: PR-127 E									
4	L	125	171	100	0.731	51.9	1.33	5.3	4.89
5	T	600	823	100	0.729	43.4	0.00	5.3	17.71
West: PR-127 W									
11	T	1001	1879	100	0.533	0.0	0.00	0.0	10.12
12	R	36	68	100	0.529	8.2	0.67	0.0	0.58

* Maximum degree of saturation

Table S.15 - Capacity and Level of Service
04 PR-127 y calle 16
Pico AM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: Calle 16 S								
1	L	32	33	0.970	91.7	F	3.0	24
3	R	125	128	0.977*	91.8	F	3.0	24
East: PR-127 E								
4	L	125	171	0.731	51.9	F	5.3	37
5	T	600	823	0.729	43.4	E	5.3	37
West: PR-127 W								
11	T	1001	1879	0.533	0.0	A	0.0	0
12	R	36	68	0.529	8.2	A	0.0	0
ALL VEHICLES:		1919		0.977	24.6	NA	5.3	37

Level of Service calculations are based on average control delay including geometric delay (HCM criteria), independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 04 PR-127 y calle 16 FA 2015
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Processed Jan 18, 2008 09:18:05AM

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Output Tables
Output Tables
04 PR-127 y calle 16
Pico PM Futuro 2010

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
04 PR-127 y calle 16
Pico PM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	D
Average intersection delay (s/pers)	=	14.2
Largest average movement delay (s)	=	29.5
Largest back of queue, mean (m)	=	34
Performance Index	=	35.15
Degree of saturation (highest)	=	0.714
Practical Spare Capacity (lowest)	=	12 %
Effective intersection capacity, (veh/h)	=	2558
Total vehicle flow (veh/h)	=	1827
Total person flow (pers/h)	=	2741
Total vehicle delay (veh-h/h)	=	7.22
Total person delay (pers-h/h)	=	10.84
Total effective vehicle stops (veh/h)	=	576
Total effective person stops (pers/h)	=	865
Total vehicle travel (veh-km/h)	=	1106.1
Total cost ($/h)	=	854.67
Total fuel (L/h)	=	121.3
Total CO2 (kg/h)	=	303.71

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (vehs)	Back (m)	Index	Speed (km/h)
South: Calle 16 S									
1 L	0.14	0.21	29.0	0.86	1.18	1.5	12	0.53	34.5
3 R	1.70	2.55	29.1	0.86	1.22	1.5	12	6.58	34.7
East: PR-127 E									
4 L	1.72	2.58	29.5	1.00	1.34	4.8	34	6.62	33.0
5 T	3.60	5.40	21.1	1.00	0.00	4.8	34	13.42	38.0
West: PR-127 W									
11 T	0.00	0.00	0.0	0.00	0.00	0.0	0	7.54	60.0
12 R	0.07	0.10	8.2	0.00	0.67	0.0	0	0.47	49.0

Table S.6 - Intersection Performance
04 PR-127 y calle 16
Pico PM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
227	0.654	1.83	2.75	29.1	0.86	1.21	12	7.11	34.7
East: PR-127 E									
825	0.714	5.32	7.99	23.2	1.00	0.34	34	20.03	36.6
West: PR-127 W									
775	0.398	0.07	0.10	0.3	0.00	0.02	0	8.01	59.5
ALL VEHICLES:									
1827	0.714	7.22	10.84	14.2	0.56	0.32	34	35.15	43.4
INTERSECTION (persons):									
2741	0.714		10.84	14.2	0.56	0.32		35.15	43.4

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
04 PR-127 y calle 16
Pico PM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: Calle 16 S								
1 LR	227	353	0.643	29.1	1.21	1.5	11.5	500.0
East: PR-127 E								
1 LT	825	1157	0.713	23.2	0.34	4.8	33.8	500.0
West: PR-127 W								
1 TR	775	1946	0.398	0.3	0.02	0.0	0.0	500.0

Table S.8 - Lane Flow and Capacity Information
04 PR-127 y calle 16
Pico PM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: Calle 16 S								
1 LR	17	0	210	227	60	353	0.643	100
East: PR-127 E								
1 LT	210	615	0	825	825	1157	0.713	100
West: PR-127 W								
1 TR	0	746	29	775	775	1946	0.398	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
04 PR-127 y calle 16
Pico PM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: Calle 16 S									
1 L		17	26	100	0.654	29.0	1.18	1.5	0.53
3 R		210	326	100	0.644	29.1	1.22	1.5	6.58
East: PR-127 E									
4 L		210	294	100	0.714*	29.5	1.34	4.8	6.62
5 T		615	862	100	0.713	21.1	0.00	4.8	13.42
West: PR-127 W									
11 T		746	1874	100	0.398	0.0	0.00	0.0	7.54

12 R	29	73	100	0.397	8.2	0.67	0.0	0.47

* Maximum degree of saturation

Table 5.15 - Capacity and Level of Service
04 PR-127 y calle 16
Pico PM Futuro 2010
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: Calle 16 S								
1	L	17	26	0.654	29.0	D	1.5	12
3	R	210	326	0.644	29.1	D	1.5	12
East: PR-127 E								
4	L	210	294	0.714*	29.5	D	4.8	34
5	T	615	862	0.713	21.1	C	4.8	34
West: PR-127 W								
11	T	746	1874	0.398	0.0	A	0.0	0
12	R	29	73	0.397	8.2	A	0.0	0
ALL VEHICLES:		1827		0.714	14.2	NA	4.8	34

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 04 PR-127 y calle 16 FP 2010
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futuro 2010.sap
Processed Jan 17, 2008 10:08:52AM

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Output Tables
Output Tables
04 PR-127 y calle 16
Pico PM Futuro 2015

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
04 PR-127 y calle 16
Pico PM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	E
Average intersection delay (s/pers)	=	21.0
Largest average movement delay (s)	=	41.3
Largest back of queue, mean (m)	=	42
Performance Index	=	43.44
Degree of saturation (highest)	=	0.821
Practical Spare Capacity (lowest)	=	-3 %
Effective intersection capacity, (veh/h)	=	2379
Total vehicle flow (veh/h)	=	1954
Total person flow (pers/h)	=	2931
Total vehicle delay (veh-h/h)	=	11.39
Total person delay (pers-h/h)	=	17.08
Total effective vehicle stops (veh/h)	=	706
Total effective person stops (pers/h)	=	1059
Total vehicle travel (veh-km/h)	=	1182.9
Total cost ($/h)	=	1028.10
Total fuel (L/h)	=	135.5
Total CO2 (kg/h)	=	339.26

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov ID	Total Flow (veh/h)	Total Delay (veh-h/h)	Aver. Delay (pers-h/h)	Prop. Queued (sec)	Eff. Stop Rate	Longest Queue (vehs)	Aver. Back (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
1 L	0.26	0.39	41.2	0.92	1.34	2.3	19	0.88	28.9
3 R	2.58	3.87	41.3	0.92	1.42	2.3	19	8.75	29.1
East: PR-127 E									
4 L	2.56	3.84	41.0	1.00	1.48	6.1	42	8.22	28.1
5 T	5.90	8.85	32.5	1.00	0.00	6.1	42	17.01	31.7
West: PR-127 W									
11 T	0.00	0.00	0.0	0.00	0.00	0.0	0	8.01	60.0
12 R	0.08	0.12	8.2	0.00	0.67	0.0	0	0.58	49.0

Table S.6 - Intersection Performance
04 PR-127 y calle 16
Pico PM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: Calle 16 S									
248	0.821	2.84	4.27	41.3	0.92	1.41	19	9.63	29.1
East: PR-127 E									
878	0.807	8.46	12.69	34.7	1.00	0.38	42	25.23	30.7
West: PR-127 W									
828	0.426	0.08	0.12	0.4	0.00	0.03	0	8.58	59.4
ALL VEHICLES:									
1954	0.821	11.39	17.08	21.0	0.57	0.36	42	43.44	38.3
INTERSECTION (persons):									
2931	0.821		17.08	21.0	0.57	0.36		43.44	38.3

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
04 PR-127 y calle 16
Pico PM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: Calle 16 S								

1 LR	248	303	0.820	41.3	1.41	2.3	18.5	500.0
East: PR-127 E								
1 LT	878	1088	0.807	34.7	0.38	6.1	42.5	500.0
West: PR-127 W								
1 TR	828	1946	0.426	0.4	0.03	0.0	0.0	500.0

Table S.8 - Lane Flow and Capacity Information
04 PR-127 y calle 16
Pico PM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: Calle 16 S								
1 LR	23	0	225	248	60	303	0.820	100
East: PR-127 E								
1 LT	225	653	0	878	878	1088	0.807	100
West: PR-127 W								
1 TR	0	792	36	828	828	1946	0.426	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
04 PR-127 y calle 16
Pico PM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: Calle 16 S									
1	L	23	28	100	0.821*	41.2	1.34	2.3	0.88
3	R	225	274	100	0.821*	41.3	1.42	2.3	8.75
East: PR-127 E									
4	L	225	279	100	0.806	41.0	1.48	6.1	8.22
5	T	653	809	100	0.807	32.5	0.00	6.1	17.01
West: PR-127 W									
11	T	792	1861	100	0.426	0.0	0.00	0.0	8.01
12	R	36	85	100	0.424	8.2	0.67	0.0	0.58

* Maximum degree of saturation

Table S.15 - Capacity and Level of Service
04 PR-127 y calle 16
Pico PM Futuro 2015
Intersection ID: 04
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Queue Aver. (vehs)	Back (m)
South: Calle 16 S								
1	L	23	28	0.821*	41.2	E	2.3	19
3	R	225	274	0.821*	41.3	E	2.3	19
East: PR-127 E								
4	L	225	279	0.806	41.0	E	6.1	42
5	T	653	809	0.807	32.5	D	6.1	42
West: PR-127 W								
11	T	792	1861	0.426	0.0	A	0.0	0
12	R	36	85	0.424	8.2	A	0.0	0
ALL VEHICLES:		1954		0.821	21.0	NA	6.1	42

Level of Service calculations are based on average control delay including geometric delay (HCM criteria), independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
\~ Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 04 PR-127 y calle 16 PP 2015
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Processed Jan 18, 2008 09:18:07AM

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Output Tables
Output Tables
05 calle 16 y calle A
Pico AM Base

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table 5.3 - Intersection Parameters
05 calle 16 y calle A
Pico AM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay (s/pers)	=	6.7
Largest average movement delay (s)	=	12.8
Largest back of queue, mean (m)	=	1
Performance Index	=	3.05
Degree of saturation (highest)	=	0.061
Practical Spare Capacity (lowest)	=	1208 %
Effective intersection capacity, (veh/h)	=	3286
Total vehicle flow (veh/h)	=	201
Total person flow (pers/h)	=	302
Total vehicle delay (veh-h/h)	=	0.37
Total person delay (pers-h/h)	=	0.56
Total effective vehicle stops (veh/h)	=	94
Total effective person stops (pers/h)	=	142
Total vehicle travel (veh-km/h)	=	121.4
Total cost ($/h)	=	92.78
Total fuel (L/h)	=	17.3
Total CO2 (kg/h)	=	43.64

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table 5.15 or Movement Displays for individual movement LOS values.

Table 5.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (veh)	Back (m)	Index	Speed (km/h)
East: calle A Este									
5 T	0.00	0.00	0.0	0.00	0.00	0.0	0	0.40	60.0
6 R	0.16	0.24	9.1	0.00	0.67	0.0	0	1.04	49.0
North: calle 16 N									
7 L	0.14	0.21	12.8	0.25	0.87	0.1	1	0.80	46.0
9 R	0.00	0.00	11.3	0.25	0.84	0.1	1	0.02	46.2
West: Calle A Oeste									
10 L	0.06	0.09	9.4	0.22	0.66	0.1	0	0.42	47.3
11 T	0.00	0.01	0.4	0.22	0.00	0.1	0	0.37	57.0

Table 5.6 - Intersection Performance
05 calle 16 y calle A
Pico AM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
104	0.061	0.16	0.24	5.6	0.00	0.41	0	1.45	52.7
North: calle 16 N									
41	0.040	0.15	0.22	12.8	0.25	0.87	1	0.82	46.0
West: Calle A Oeste									
56	0.035	0.07	0.10	4.3	0.22	0.28	0	0.79	52.4
ALL VEHICLES:									
201	0.061	0.37	0.56	6.7	0.11	0.47	1	3.05	51.1
INTERSECTION (persons):									
302	0.061		0.56	6.7	0.11	0.47		3.05	51.1

Queue values in this table are mean back of queue (metres).

Table 5.7 - Lane Performance
05 calle 16 y calle A
Pico AM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
East: calle A Este								
1 TR	104	1701	0.061	5.6	0.41	0.0	0.0	500.0
North: calle 16 N								
1 LR	41	1043	0.039	12.8	0.87	0.1	0.5	500.0
West: Calle A Oeste								
1 LT	56	1601	0.035	4.3	0.28	0.1	0.5	500.0

Table 5.8 - Lane Flow and Capacity Information
05 calle 16 y calle A
Pico AM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
East: calle A Este								
1 TR	0	40	64	104	104	1701	0.061	100
North: calle 16 N								
1 LR	40	0	1	41	41	1043	0.039	100
West: Calle A Oeste								
1 LT	24	32	0	56	56	1601	0.035	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table 5.10 - Movement Capacity and Performance Summary
05 calle 16 y calle A
Pico AM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
East: calle A Este									
5 T		40	654	100	0.061*	0.0	0.00	0.0	0.40
6 R		64	1047	100	0.061*	9.1	0.67	0.0	1.04
North: calle 16 N									
7 L		40	1018	100	0.039	12.8	0.87	0.1	0.80
9 R		1	25	100	0.040	11.3	0.84	0.1	0.02
West: Calle A Oeste									
10 L		24	686	100	0.035	9.4	0.66	0.1	0.42

11 T	32	915	100	0.035	0.4	0.00	0.1	0.37

* Maximum degree of saturation

Table S.15 - Capacity and Level of Service
05 calle 16 y calle A
Pico AM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
East: calle A Este								
5 T		40	654	0.061*	0.0	A	0.0	0
6 R		64	1047	0.061*	9.1	A	0.0	0
North: calle 16 N								
7 L		40	1018	0.039	12.8	B	0.1	1
9 R		1	25	0.040	11.3	B	0.1	1
West: Calle A Oeste								
10 L		24	686	0.035	9.4	A	0.1	0
11 T		32	915	0.035	0.4	A	0.1	0
ALL VEHICLES:		201		0.061	6.7	NA	0.1	1

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods

Site: 05 calle 16 y calle A BA
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Processed Jan 31, 2008 09:58:53AM

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Output Tables
Output Tables
05 calle 16 y calle A
Pico PM Base

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
05 calle 16 y calle A
Pico PM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay (s/pers)	=	6.9
Largest average movement delay (s)	=	12.7
Largest back of queue, mean (m)	=	1
Performance Index	=	3.56
Degree of saturation (highest)	=	0.070
Practical Spare Capacity (lowest)	=	1038 %
Effective intersection capacity, (veh/h)	=	3300
Total vehicle flow (veh/h)	=	232
Total person flow (pers/h)	=	348
Total vehicle delay (veh-h/h)	=	0.44
Total person delay (pers-h/h)	=	0.66
Total effective vehicle stops (veh/h)	=	114
Total effective person stops (pers/h)	=	171
Total vehicle travel (veh-km/h)	=	140.2
Total cost ($/h)	=	106.65
Total fuel (L/h)	=	19.7
Total CO2 (kg/h)	=	49.53

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.
See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (veh)	Back (m)	Index	Speed (km/h)
East: calle A Este									
5 T	0.00	0.00	0.0	0.00	0.00	0.0	0	0.49	60.0
6 R	0.18	0.27	9.1	0.00	0.67	0.0	0	1.17	49.0
North: calle 16 N									
7 L	0.14	0.21	12.7	0.24	0.89	0.1	1	0.80	46.1
9 R	0.06	0.09	11.3	0.24	0.86	0.1	1	0.39	46.3
West: Calle A W									
10 L	0.05	0.08	9.4	0.24	0.66	0.1	0	0.35	47.2
11 T	0.00	0.01	0.5	0.24	0.00	0.1	0	0.37	56.8

Table 5.6 - Intersection Performance
05 calle 16 y calle A
Pico PM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
120	0.070	0.18	0.27	5.5	0.00	0.40	0	1.66	52.9
North: calle 16 N									
60	0.054	0.20	0.31	12.2	0.24	0.88	1	1.19	46.1
West: Calle A W									
52	0.032	0.06	0.09	3.9	0.24	0.25	0	0.72	52.7
ALL VEHICLES:									
232	0.070	0.44	0.66	6.9	0.12	0.49	1	3.56	50.9
INTERSECTION (persons):									
348	0.070		0.66	6.9	0.12	0.49		3.56	50.9

Queue values in this table are mean back of queue (metres).

Table 5.7 - Lane Performance
05 calle 16 y calle A
Pico PM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (veh)	Queue Back (m)	Lane Length (m)
East: calle A Este								
1 TR	120	1707	0.070	5.5	0.40	0.0	0.0	500.0
North: calle 16 N								
1 LR	60	1110	0.054	12.2	0.88	0.1	0.7	500.0
West: Calle A W								
1 LT	52	1617	0.032	3.9	0.25	0.1	0.5	500.0

Table 5.8 - Lane Flow and Capacity Information
05 calle 16 y calle A
Pico PM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
East: calle A Este								
1 TR	0	48	72	120	120	1707	0.070	100
North: calle 16 N								
1 LR	40	0	20	60	60	1110	0.054	100
West: Calle A W								
1 LT	20	32	0	52	52	1617	0.032	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table 5.10 - Movement Capacity and Performance Summary
05 calle 16 y calle A
Pico PM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
East: calle A Este									
5 T		48	683	100	0.070*	0.0	0.00	0.0	0.49
6 R		72	1024	100	0.070*	9.1	0.67	0.0	1.17
North: calle 16 N									
7 L		40	740	100	0.054	12.7	0.89	0.1	0.80
9 R		20	370	100	0.054	11.3	0.86	0.1	0.39
West: Calle A W									
10 L		20	622	100	0.032	9.4	0.66	0.1	0.35

11 T	32	995	100	0.032	0.5	0.00	0.1	0.37

* Maximum degree of saturation

Table 5.15 - Capacity and Level of Service
05 calle 16 y calle A
Pico PM Base
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (veh)	Queue Back (m)
East: calle A Este								
5	T	48	683	0.070*	9.0	A	0.0	0
6	R	72	1024	0.070*	9.1	A	0.0	0
North: calle 16 N								
7	L	40	740	0.054	12.7	B	0.1	1
9	R	20	370	0.054	11.3	B	0.1	1
West: Calle A W								
10	L	20	622	0.032	9.4	A	0.1	0
11	T	32	995	0.032	0.5	A	0.1	0
ALL VEHICLES:		232		0.070	6.9	NA	0.1	1

Level of Service calculations are based on
average control delay including geometric delay [HCM criteria],
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods

Site: 05 calle 16 y calle A BP
C:\Documents and Settings\Magdamari\My Documents\Proyectos
Magdamari\Yauco-Vertedero-Dic2007\corridas Yauco-Vertedero\Yauco-Vertedero.sap
Processed Jan 17, 2008 01:59:52PM

M0276, Traffic Consulting Group, Larga Office
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Output Tables
Output Tables
05 calle 16 y calle A
Pico AM Futuro 2010

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table 5.3 - Intersection Parameters
05 calle 16 y calle A
Pico AM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay (s/pers)	=	7.5
Largest average movement delay (s)	=	12.9
Largest back of queue, mean (m)	=	1
Performance Index	=	4.00
Degree of saturation (highest)	=	0.078
Practical Spare Capacity (lowest)	=	927 %
Effective intersection capacity, (veh/h)	=	3259
Total vehicle flow (veh/h)	=	254
Total person flow (pers/h)	=	381
Total vehicle delay (veh-h/h)	=	0.53
Total person delay (pers-h/h)	=	0.79
Total effective vehicle stops (veh/h)	=	133
Total effective person stops (pers/h)	=	199
Total vehicle travel (veh-km/h)	=	153.4
Total cost ($/h)	=	121.45
Total fuel (L/h)	=	23.4
Total CO2 (kg/h)	=	58.99

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.
See Table 5.15 or Movement Displays for individual movement LOS values.

Table 5.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (veh)	Back (m)	Index	Speed (km/h)
East: calle A Este									
5 T	0.00	0.00	0.0	0.00	0.00	0.0	0	0.42	60.0
6 R	0.23	0.34	9.1	0.00	0.67	0.0	0	1.45	49.0
North: calle 16 N									
7 L	0.23	0.35	12.9	0.28	0.87	0.1	1	1.28	45.9
9 R	0.00	0.00	11.5	0.28	0.84	0.1	1	0.02	46.1
West: Calle A W									
10 L	0.07	0.10	9.5	0.26	0.67	0.1	1	0.44	47.2
11 T	0.01	0.01	0.6	0.26	0.00	0.1	1	0.38	56.6

Table S.6 - Intersection Performance
05 calle 16 y calle A
Pico AM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
131	0.078	0.23	0.34	6.2	0.00	0.45	0	1.88	52.0
North: calle 16 N									
65	0.064	0.23	0.35	12.9	0.28	0.87	1	1.30	45.9
West: Calle A W									
50	0.037	0.07	0.11	4.4	0.26	0.29	1	0.82	52.1
ALL VEHICLES:									
254	0.078	0.53	0.79	7.5	0.13	0.52	1	4.00	50.4
INTERSECTION (persons):									
381	0.078		0.79	7.5	0.13	0.52		4.00	50.4

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
05 calle 16 y calle A
Pico AM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (veh)	Queue Back (m)	Lane Length (m)
East: calle A Este								
1 TR	131	1681	0.078	6.2	0.45	0.0	0.0	500.0
North: calle 16 N								
1 LR	65	1019	0.064	12.9	0.87	0.1	0.9	500.0
West: Calle A W								
1 LT	58	1572	0.037	4.4	0.29	0.1	0.5	500.0

Table S.8 - Lane Flow and Capacity Information
05 calle 16 y calle A
Pico AM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
East: calle A Este								
1 TR	0	42	89	131	131	1681	0.078	100
North: calle 16 N								
1 LR	64	0	1	65	60	1019	0.064	100
West: Calle A W								
1 LT	25	33	0	58	58	1572	0.037	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
05 calle 16 y calle A
Pico AM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
East: calle A Este									
5 T		42	539	100	0.078*	0.0	0.00	0.0	0.42
6 R		89	1142	100	0.078*	9.1	0.67	0.0	1.45
North: calle 16 N									
7 L		64	1003	100	0.064	12.9	0.87	0.1	1.28
9 R		1	16	100	0.062	11.5	0.04	0.1	0.02
West: Calle A W									
10 L		25	678	100	0.037	9.5	0.67	0.1	0.44

11 T	33	894	100	0.037	0.6	0.00	0.1	0.38

* Maximum degree of saturation

Table 5.15 - Capacity and Level of Service
05 calle 16 y calle A
Pico AM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
East: calle A Este								
5	T	42	539	0.078*	0.0	A	0.0	0
6	R	89	1142	0.078*	9.1	A	0.0	0
North: calle 16 N								
7	L	64	1003	0.064	12.9	B	0.1	1
9	R	1	16	0.062	11.5	B	0.1	1
West: Calle A W								
10	L	25	678	0.037	9.5	A	0.1	1
11	T	33	894	0.037	9.6	A	0.1	1
ALL VEHICLES:		254		0.078	7.5	NA	0.1	1

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 05 calle 16 y calle A EA 2010
C:\Documents and Settings\Carlos M
Contreras\Desktop\Yauco-Vertedero-Dic2007\corridas
Yauco-Vertedero\Yauco-Vertedero Futuro 2010.sap
Processed Jan 17, 2008 10:08:51AM

H0276, Traffic Consulting Group, Large Office
Produced by SIDRA Intersection 3.2.0.1855
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Output Tables
Output Tables
05 calle 16 y calle A
Pico AM Futuro 2015

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
05 calle 16 y calle A
Pico AM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay (s/pers)	=	7.7
Largest average movement delay (s)	=	13.1
Largest back of queue, mean (m)	=	1
Performance Index	=	4.65
Degree of saturation (highest)	=	0.090
Practical Spare Capacity (lowest)	=	792 %
Effective intersection capacity, (veh/h)	=	3268
Total vehicle flow (veh/h)	=	293
Total person flow (pers/h)	=	440
Total vehicle delay (veh-h/h)	=	0.63
Total person delay (pers-h/h)	=	0.94
Total effective vehicle stops (veh/h)	=	156
Total effective person stops (pers/h)	=	234
Total vehicle travel (veh-km/h)	=	176.9
Total cost ($/h)	=	141.15
Total fuel (L/h)	=	27.4
Total CO2 (kg/h)	=	68.92

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (vehs)	Back (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
5 T	0.00	0.00	0.0	0.00	0.00	0.0	0	0.46	60.0
6 R	0.26	0.39	9.1	0.00	0.67	0.0	0	1.70	49.0
North: calle 16 N									
7 L	0.28	0.42	13.1	0.30	0.87	0.1	1	1.55	45.9
9 R	0.00	0.00	11.6	0.30	0.83	0.1	1	0.02	46.1
West: Calle A W									
10 L	0.07	0.11	9.6	0.28	0.67	0.1	1	0.50	47.1
11 T	0.01	0.01	0.7	0.28	0.00	0.1	1	0.43	56.3

Table S.6 - Intersection Performance
05 calle 16 y calle A
Pico AM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
150	0.090	0.26	0.39	6.3	0.00	0.46	0	2.16	51.9
North: calle 16 N									
78	0.078	0.28	0.42	13.1	0.30	0.87	1	1.57	45.9
West: Calle A W									
65	0.042	0.08	0.12	4.5	0.28	0.29	1	0.92	52.0
ALL VEHICLES:									
293	0.090	0.63	0.94	7.7	0.14	0.53	1	4.65	50.2
INTERSECTION (persons):									
440	0.090		0.94	7.7	0.14	0.53		4.65	50.2

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
05 calle 16 y calle A
Pico AM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
East: calle A Este								

1 TR	150	1674	0.090	5.3	0.46	0.0	0.0	500.0
North: calle 16 N								
1 LR	78	998	0.078	13.1	0.87	0.1	1.1	500.0
West: Calle A W								
1 LT	65	1553	0.042	4.5	0.29	0.1	0.6	500.0

Table 5.8 - Lane Flow and Capacity Information
05 calle 16 y calle A
Pico AM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
East: calle A Este								
1 TR	0	46	104	150	150	1674	0.090	100
North: calle 16 N								
1 LR	77	0	1	78	60	998	0.078	100
West: Calle A W								
1 LT	28	37	0	65	65	1553	0.042	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table 5.10 - Movement Capacity and Performance Summary
05 calle 16 y calle A
Pico AM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
East: calle A Este									
5 T		46	513	100	0.090*	0.0	0.00	0.0	0.46
6 R		104	1161	100	0.090*	9.1	0.67	0.0	1.70
North: calle 16 N									
7 L		77	985	100	0.078	13.1	0.87	0.1	1.55
9 R		1	13	100	0.077	11.6	0.83	0.1	0.02
West: Calle A W									
10 L		28	669	100	0.042	9.6	0.67	0.1	0.50
11 T		37	884	100	0.042	0.7	0.00	0.1	0.43

* Maximum degree of saturation

Table 5.15 - Capacity and Level of Service
05 calle 16 y calle A
Pico AM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
East: calle A Este								
5 T		46	513	0.090*	0.0	A	0.0	0
6 R		104	1161	0.090*	9.1	A	0.0	0
North: calle 16 N								
7 L		77	985	0.078	13.1	B	0.1	1
9 R		1	13	0.077	11.6	B	0.1	1
West: Calle A W								
10 L		28	669	0.042	9.6	A	0.1	1
11 T		37	884	0.042	0.7	A	0.1	1
ALL VEHICLES:		293		0.090	7.7	NA	0.1	1

Level of Service calculations are based on average control delay including geometric delay (HCM criteria), independent of the current delay definition used. For the criteria, refer to the "Level of Service" topic in the SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Site: 05 calle 16 y calle A FA 2015
C:\Documents and Settings\Magdamari\My Documents\Proyectos Magdamari\Yauco-Vertedero-Dic2007\corridas Yauco-Vertedero\Yauco-Vertedero futuro 2015.sap
Processed Jan 18, 2008 09:18:06AM

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Output Tables
Output Tables
05 calle 16 y calle A
Pico PM Futuro 2010

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
05 calle 16 y calle A
Pico PM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay (s/pers)	=	7.6
Largest average movement delay (s)	=	12.9
Largest back of queue, mean (m)	=	1
Performance Index	=	4.53
Degree of saturation (highest)	=	0.087
Practical Spare Capacity (lowest)	=	818 %
Effective intersection capacity, (veh/h)	=	3283
Total vehicle flow (veh/h)	=	286
Total person flow (pers/h)	=	429
Total vehicle delay (veh-h/h)	=	0.60
Total person delay (pers-h/h)	=	0.90
Total effective vehicle stops (veh/h)	=	153
Total effective person stops (pers/h)	=	230
Total vehicle travel (veh-km/h)	=	172.7
Total cost ($/h)	=	135.79
Total fuel (L/h)	=	25.8
Total CO2 (kg/h)	=	65.04

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (vehs)	Back (m)	Index	Speed (km/h)
East: calle A Este									
5 T	0.00	0.00	0.0	0.00	0.00	0.0	0	0.51	60.0
6 R	0.25	0.37	9.1	0.00	0.67	0.0	0	1.58	49.0
North: calle 16 N									
7 L	0.23	0.34	12.9	0.27	0.88	0.1	1	1.28	46.0
9 R	0.07	0.10	11.4	0.27	0.85	0.1	1	0.41	46.2
West: Calle A W									
10 L	0.06	0.08	9.6	0.27	0.67	0.1	0	0.37	47.1
11 T	0.01	0.01	0.6	0.27	0.00	0.1	0	0.38	56.4

Table S.6 - Intersection Performance
05 calle 16 y calle A
Pico PM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
147	0.087	0.25	0.37	6.0	0.00	0.44	0	2.09	52.2
North: calle 16 N									
85	0.080	0.30	0.44	12.5	0.27	0.87	1	1.69	46.0
West: Calle A W									
54	0.034	0.06	0.09	4.1	0.27	0.26	0	0.75	52.4
ALL VEHICLES:									
286	0.087	0.60	0.90	7.6	0.13	0.54	1	4.53	50.3
INTERSECTION (persons):									
429	0.087		0.90	7.6	0.13	0.54		4.53	50.3

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
05 calle 16 y calle A
Pico PM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
East: calle A Este								
1 TR	147	1688	0.087	6.0	0.44	0.0	0.0	500.0
North: calle 16 N								
1 LR	85	1065	0.080	12.5	0.87	0.1	1.1	500.0
West: Calle A W								
1 LT	54	1588	0.034	4.1	0.26	0.1	0.5	500.0

Table S.8 - Lane Flow and Capacity Information
05 calle 16 y calle A
Pico PM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
East: calle A Este								
1 TR	0	50	97	147	147	1688	0.087	100
North: calle 16 N								
1 LR	64	0	21	85	60	1065	0.080	100
West: Calle A W								
1 LT	21	33	0	54	54	1588	0.034	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
05 calle 16 y calle A
Pico PM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
East: calle A Este									
5 T		50	574	100	0.087*	0.0	0.00	0.0	0.51
6 R		97	1114	100	0.087*	9.1	0.67	0.0	1.58
North: calle 16 N									
7 L		64	802	100	0.080	12.9	0.88	0.1	1.28
9 R		21	263	100	0.080	11.4	0.85	0.1	0.41
West: Calle A W									
10 L		21	618	100	0.034	9.6	0.67	0.1	0.37

11 T	33	971	100	0.034	0.6	0.00	0.1	0.38

* Maximum degree of saturation

Table S.15 - Capacity and Level of Service
05 calle 16 y calle A
Pico PM Futuro 2010
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
East: calle A Este								
5 T		50	574	0.087*	0.0	A	0.0	0
6 R		97	1114	0.087*	9.1	A	0.0	0
North: calle 16 N								
7 L		64	802	0.080	12.9	B	0.1	1
9 R		21	263	0.080	11.4	B	0.1	1
West: Calle A W								
10 L		21	618	0.034	9.6	A	0.1	0
11 T		33	971	0.034	0.6	A	0.1	0
ALL VEHICLES:		286		0.087	7.6	NA	0.1	1

Level of Service calculations are based on average control delay including geometric delay (HCM criteria), independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods

Site: 05 calle 16 y calle A PP 2010
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Output Tables
Output Tables
05 calle 16 y calle A
Pico PM Futuro 2015

Run Information
* Basic Parameters:
Intersection Type: Unsignalised - Two-Way Stop Control
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

Table S.3 - Intersection Parameters
05 calle 16 y calle A
Pico PM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay [s/pers]	=	7.8
Largest average movement delay [s]	=	13.0
Largest back of queue, mean [m]	=	1
Performance Index	=	5.25
Degree of saturation [highest]	=	0.100
Practical Spare Capacity [lowest]	=	697 %
Effective intersection capacity, [veh/h]	=	3278
Total vehicle flow [veh/h]	=	329
Total person flow [pers/h]	=	494
Total vehicle delay [veh-h/h]	=	0.71
Total person delay [pers-h/h]	=	1.07
Total effective vehicle stops [veh/h]	=	179
Total effective person stops [pers/h]	=	269
Total vehicle travel [veh-km/h]	=	198.7
Total cost [$/h]	=	157.38
Total fuel [L/h]	=	30.1
Total CO2 [kg/h]	=	75.05

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections.
See Table S.15 or Movement Displays for individual movement LOS values.

Table S.5 - Movement Performance

Mov	Total	Total	Aver.	Prop.	Eff.	Longest Queue	Perf.	Aver.

ID	Delay (veh-h/h)	Delay (pers-h/h)	Delay (sec)	Queued	Stop Rate	Aver. (veh)	Back (m)	Index	Speed (km/h)
East: calle A Este									
5 T	0.00	0.00	0.0	0.00	0.00	0.0	0	0.56	60.0
6 R	0.29	0.43	9.1	0.00	0.67	0.0	0	1.86	49.0
North: calle 16 N									
7 L	0.28	0.42	13.0	0.30	0.88	0.2	1	1.55	45.9
9 R	0.07	0.11	11.6	0.30	0.85	0.2	1	0.45	46.1
West: Calle A W									
10 L	0.06	0.09	9.7	0.30	0.67	0.1	1	0.41	47.1
11 T	0.01	0.01	0.7	0.30	0.00	0.1	1	0.43	56.1

Table S.6 - Intersection Performance
05 calle 16 y calle A
Pico PM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
East: calle A Este									
169	0.100	0.29	0.43	6.1	0.00	0.45	0	2.42	52.1
North: calle 16 N									
100	0.096	0.35	0.53	12.7	0.30	0.87	1	2.00	45.9
West: Calle A W									
60	0.038	0.07	0.10	4.2	0.30	0.26	1	0.84	52.2
ALL VEHICLES:									
329	0.100	0.71	1.07	7.8	0.14	0.54	1	5.25	50.1
INTERSECTION (persons):									
494	0.100		1.07	7.8	0.14	0.54		5.25	50.1

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
05 calle 16 y calle A
Pico PM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (veh)	Queue Back (m)	Lane Length (m)
East: calle A Este								
1 TR	169	1684	0.100	6.1	0.45	0.0	0.0	500.0
North: calle 16 N								
1 LR	100	1040	0.096	12.7	0.87	0.2	1.3	500.0
West: Calle A W								
1 LT	60	1572	0.038	4.2	0.26	0.1	0.6	500.0

Table S.8 - Lane Flow and Capacity Information
05 calle 16 y calle A
Pico PM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
East: calle A Este								
1 TR	0	55	114	169	169	1684	0.100	100
North: calle 16 N								
1 LR	77	0	23	100	60	1040	0.096	100
West: Calle A W								
1 LT	23	37	0	60	60	1572	0.038	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
05 calle 16 y calle A
Pico PM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
East: calle A Este									
5 T		55	548	100	0.100*	0.0	0.00	0.0	0.56
6 R		114	1136	100	0.100*	9.1	0.67	0.0	1.86
North: calle 16 N									
7 L		77	801	100	0.096	13.0	0.88	0.2	1.55
9 R		23	239	100	0.096	11.6	0.85	0.2	0.45
West: Calle A W									
10 L		23	603	100	0.038	9.7	0.67	0.1	0.41

11	T	37	969	100	0.038	0.7	0.00	0.1	0.43

* Maximum degree of saturation

Table 5.15 - Capacity and Level of Service
05 calle 16 y calle A
Pico PM Futuro 2015
Intersection ID: 05
Stop Sign Controlled Intersection

Mov ID	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. [vehs]	Queue Back (m)
East: calle A Este								
5	T	55	548	0.100*	0.0	A	0.0	0
6	R	114	1136	0.100*	9.1	A	0.0	0
North: calle 16 N								
7	L	77	801	0.096	13.0	B	0.2	1
9	R	23	239	0.096	11.6	B	0.2	1
West: Calle A W								
10	L	23	603	0.038	9.7	A	0.1	1
11	T	37	969	0.038	0.7	A	0.1	1
ALL VEHICLES:		329		0.100	7.8	NA	0.2	1

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at
two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods

Site: 05 calle 16 y calle A FP 2015
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Output Tables
Output Tables
06 PR-116 y PR-116R
Pico AM Base

Run Information
Cycle Time = 80 (User-given Cycle Time)

* Basic Parameters:
Intersection Type: Signalised - Actuated Isolated
For actuated signal timings, cycle increment is set to 1 second
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

* Iteration Data:
No. of Main (Timing-Capacity) Iterations = 2
Comparison of last two iterations:
Difference in intersection degree of satn = 0.0 %
Largest difference in off. green times = 0 secs
(max. value for stopping = 0 secs)

Table 5.3 - Intersection Parameters
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Critical Movements: 7, 8, 6(1st), 11

L= 22 Y= 0.497 U= 0.642 T= 73.3

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	62	80

(Cycle time specified by the user)

Intersection Level of Service	=	C
Worst movement Level of Service	=	D
Average intersection delay (s/pers)	=	27.8
Largest average movement delay (s)	=	47.6
Largest back of queue, mean (m)	=	54
Performance Index	=	82.00
Degree of saturation (highest)	=	0.795
Practical Spare Capacity (lowest)	=	13 %
Effective intersection capacity, [veh/h]	=	2598

Total vehicle flow (veh/h)	=	2065
Total person flow (pers/h)	=	3098
Total vehicle delay (veh-h/h)	=	15.97
Total person delay (pers-h/h)	=	23.96
Total effective vehicle stops (veh/h)	=	1642
Total effective person stops (pers/h)	=	2463
Total vehicle travel (veh-km/h)	=	1253.9
Total cost ($/h)	=	1226.65
Total fuel (L/h)	=	163.5
Total CO2 (kg/h)	=	409.03

Table S.4 - Phase Information
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Phase Change Times: 0, 32, 52, 63
Phase Green Times: 28, 16, 7, 13

Current Phase Sequence: Existente
Input phase sequence: G H I J
Output phase sequence: G H I J

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Aver. (vehs)	Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
1 L	0.21	0.32	27.1	0.67	0.70	0.4	3	1.04	34.4
2 T	4.64	6.96	32.9	0.97	0.82	5.8	41	23.67	31.5
3 R	0.57	0.85	7.8	0.12	0.62	0.4	3	4.51	49.1
East: PR-116R Este									
4 L	0.01	0.02	47.6	0.98	0.75	1.7	12	0.05	26.0
5 T	0.75	1.12	39.5	0.98	0.74	1.7	12	3.35	28.8
6 R	0.84	1.26	11.8	0.40	0.74	1.9	14	6.37	45.4
North: PR-116 N									
7 L	1.45	2.17	31.0	0.78	0.79	3.1	23	7.01	32.5
8 T	3.93	5.90	35.4	0.97	0.88	7.7	54	19.53	30.4
9 R	0.16	0.24	8.6	0.14	0.68	0.1	1	1.23	48.3
West: PR-116R Oeste									
10 L	2.01	3.01	47.6	1.00	0.93	6.3	44	8.23	26.1
11 T	1.13	1.70	35.2	0.97	0.88	6.3	44	5.59	30.5
12 R	0.28	0.41	24.8	0.83	0.75	0.9	6	1.42	35.7

Table S.6 - Intersection Performance
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
796	0.645	5.42	8.12	24.5	0.68	0.75	41	29.22	35.9
East: PR-116R Este									
325	0.455	1.60	2.40	17.7	0.52	0.74	14	9.77	40.4
North: PR-116 N									
636	0.791	5.54	8.31	31.4	0.83	0.83	54	27.78	32.2
West: PR-116R Oeste									
308	0.795	3.42	5.13	39.9	0.97	0.89	44	15.24	28.6
ALL VEHICLES:									
2065	0.795	15.97	23.96	27.8	0.75	0.80	54	82.00	34.0
INTERSECTION (persons):									
3098	0.795		23.96	27.8	0.75	0.80		82.00	34.0

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Effective Red and Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Back (m)	Lane Length (m)
6outh: PR-116 S												
1 L	52	28	0	0	28	243	0.115	27.1	0.70	0.4	3.1	30.5T
2 T	64	16	0	0	254	393	0.645	32.9	0.82	5.8	40.5	500.0
3 T	64	16	0	0	254	395	0.645	32.9	0.82	5.8	40.6	500.0
4 R	4	16	4	56	260	1443	0.180	7.8	0.62	0.4	2.6	56.0T
East: PR-116R Este												
1 LT	73	7	0	0	69	174	0.397	39.6	0.74	1.7	11.6	500.0
2 R	4	7	19	50	256	563	0.455	11.8	0.74	1.9	14.2	500.0
North: PR-116 N												
1 L	52	28	0	0	168	281	0.598	31.0	0.79	3.1	23.3	43.8T
2 T	64	16	0	0	306	386	0.791	37.2	0.94	7.7	53.7	500.0
3 T	64	16	0	0	94	400	0.236	29.5	0.69	1.9	13.5	500.0
4 R	4	16	6	54	68	859	0.079	8.6	0.68	0.1	0.9	43.5T
West: PR-116R Oeste												
1 LT	67	13	0	0	246	309	0.795	44.5	0.93	6.3	44.0	500.0
2 TR	16	6	45	13	62	392	0.159	21.8	0.71	0.9	6.2	500.0

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR-116 S												
1 L	28	0	0	28	2.44	1864	694<	0	0	243	0.115	100
2 T	0	254	0	254	3.46	1966	1966	0	0	393	0.645	100
3 T	0	254	0	254	3.53	1973	1973	0	0	395	0.645	100
4 R	0	0	260	260	3.30	1950	1803<	1546<	0	1443	0.180	100
East: PR-116R Este												
1 LT	1	68	0	69	3.70	1990	1988	0	0	174	0.397	87P
2 R	0	0	256	256	3.70	1990	5304	158	44	563	0.455	100
North: PR-116 N												
1 L	168	0	0	168	2.40	1860	803<	0	96	281	0.598	100
2 T	0	306	0	306	3.12	1932	1932	0	0	386	0.791	100
3 T	0	94	0	94	3.78	1998	1998	0	0	400	0.236	30D
4 R	0	0	68	68	3.56	1976	1074<	955<	45	859	0.079	100
West: PR-116R Oeste												
1 LT	152	94	0	246	3.40	1960	1901	0	0	309	0.795	100
2 TR	0	22	40	62	3.61	1981	1071	1920	45	392	0.159	20D

< Reduced saturation flow due to a short lane effect
P Lane under-utilisation found by the "Program". This includes cases where the value of lane under-utilisation due to downstream effects has been modified by the program during lane flow calculations (e.g. a de facto exclusive lane has been found).
D Lane under-utilisation due to downstream effects

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR-116 S											
1 L		28	243<	100	0.115	28		27.1	0.70	0.4	1.04
2 T		508	788	100	0.645	16		32.9	0.82	5.8	23.67
3 R	(Slp)	260	1443<	100	0.180	16	56	7.8	0.62	0.4	4.51
East: PR-116R Este											
4 L		1	3	87	0.394	7		47.6	0.75	1.7	0.05
5 T		68	172	87	0.397	7		39.5	0.74	1.7	3.35
6 R		256	563	100	0.455	7*	50	11.8	0.74	1.9	6.37
North: PR-116 N											
7 L		168	281<	100	0.598	28*		31.0	0.79	3.1	7.01
8 T		400	506	30	0.791	16*		35.4	0.88	7.7	19.53
9 R		68	859<	100	0.079	16	54	8.6	0.68	0.1	1.23
West: PR-116R Oeste											
10 L		152	191	100	0.795*	13		47.6	0.93	6.3	8.23
11 T		116	146	20	0.795*	13*		35.2	0.88	6.3	5.59
12 R		40	252	20	0.159	47	13	24.8	0.75	0.9	1.42

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.15 - Capacity and Level of Service
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR-116 S										
1 L		0.350		28	243<	0.115	27.1	C	0.4	3
2 T		0.200		508	788	0.645	32.9	C	5.8	41
3 R	(Slp)	0.200	0.700	260	1443<	0.180	7.8	A	0.4	3
East: PR-116R Este										
4 L		0.087		1	3	0.394	47.6	D	1.7	12
5 T		0.087		68	172	0.397	39.5	D	1.7	12
6 R		0.087*	0.625	256	563	0.455	11.8	B	1.9	14
North: PR-116 N										
7 L		0.350*		168	281<	0.598	31.0	C	3.1	23
8 T		0.200*		400	506	0.791	35.4	D	7.7	54
9 R		0.200	0.675	68	859<	0.079	8.6	A	0.1	1
West: PR-116R Oeste										
10 L		0.162		152	191	0.795*	47.6	D	6.3	44
11 T		0.162*		116	146	0.795*	35.2	D	6.3	44
12 R		0.587	0.162	40	252	0.159	24.8	C	0.9	6
ALL VEHICLES:				2065		0.795	27.8	C	7.7	54

INTERSECTION (persons):	3098	27.8	7.7	54

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table D.5 - Progression Factors and Actuated Signal Parameters
06 PR-116 y PR-116R
Pico AM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Gap Settings es	Gap Settings eh	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR-116 S											
1 L	VA	No	3	1.000	1.000	2.0	2.6	6	20		
2 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
3 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
East: PR-116R Este											
4 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
5 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
6 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
North: PR-116 N											
7 L	VA	No	3	1.000	1.000	2.5	3.1	6	50		
8 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
9 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
West: PR-116R Oeste											
10 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
11 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
12 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA

Site: 06 PR-116 y PR-116R BA
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Output Tables
Output Tables
06 PR-116 y PR-116R
Pico PM Base

Run Information
Cycle Time = 80 (User-given Cycle Time)

* Basic Parameters:
Intersection Type: Signalised - Actuated Isolated
For actuated signal timings, cycle increment is set to 1 second
Driving on the right-hand side of the road
Input data specified in Metric units
Model Defaults: Standard Right TEC - Customised Model
Peak Flow Period (for performance): 15 minutes
Unit time (for volumes): 60 minutes.
Delay definition: Control delay
Geometric delay included
SIDRA Standard Delay model used
SIDRA Standard Queue model used
Level of Service based on: Delay (HCM method)
Queue definition: Back of queue, Average

* Iteration Data:
No. of Main (Timing-Capacity) Iterations = 2
Comparison of last two iterations:
Difference in intersection degree of satn = 0.0 %
Largest difference in eff. green times = 0 secs
(max. value for stopping = 0 secs)

Table S.3 - Intersection Parameters
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Critical Movements: 7, 8, 6(1st), 10

L= 22 Y= 0.573 Q= 0.711 Y= 78.9

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	77	80

(Cycle time specified by the user)

Intersection Level of Service	=	C
Worst movement Level of Service	=	E
Average intersection delay (s/pcu)	=	26.7
Largest average movement delay (s)	=	59.7
Largest back of queue, mean (m)	=	89
Performance Index	=	88.42
Degree of saturation (highest)	=	0.918
Practical Spare Capacity (lowest)	=	-2 %
Effective intersection capacity, (veh/h)	=	2482
Total vehicle flow (veh/h)	=	2277
Total person flow (pers/h)	=	3416
Total vehicle delay (veh-h/h)	=	16.89
Total person delay (pers-h/h)	=	25.34
Total effective vehicle stops (veh/h)	=	1825
Total effective person stops (pers/h)	=	2737
Total vehicle travel (veh-km/h)	=	1382.7
Total cost ($/h)	=	1331.76
Total fuel (L/h)	=	178.3
Total CO2 (kg/h)	=	446.16

Table S.4 - Phase Information
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Phase Change Times: 0, 34, 59, 69
Phase Green Times: 30, 21, 6, 7

Current Phase Sequence: Existente
Input phase sequence: G H I J
Output phase sequence: G H I J

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Aver. (veh)	Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
1 L	0.43	0.65	26.0	0.66	0.72	0.9	6	2.21	35.0
2 T	3.72	5.59	27.2	0.89	0.74	5.1	35	20.83	34.3
3 R	0.69	1.03	7.8	0.13	0.62	0.5	3	5.49	49.1
East: PR-116R Este									
4 L	0.01	0.02	48.8	0.99	0.75	1.5	10	0.05	25.6
5 T	0.68	1.02	40.8	0.99	0.74	1.5	10	3.00	28.3
6 R	0.73	1.09	10.4	0.31	0.72	1.4	10	5.66	46.8
North: PR-116 N									
7 L	1.65	2.47	30.2	0.78	0.80	3.7	27	8.16	32.9
8 T	6.24	9.36	37.9	0.96	0.97	12.7	89	30.75	29.4
9 R	0.28	0.42	8.7	0.16	0.69	0.3	2	2.17	48.2
West: PR-116R Oeste									
10 L	1.13	1.69	59.7	1.00	1.01	4.4	31	4.18	22.8
11 T	1.21	1.81	51.8	1.00	1.01	4.4	31	4.97	24.8
12 R	0.13	0.20	11.7	0.35	0.69	0.3	2	0.97	45.2

Table S.6 - Intersection Performance
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06

Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
868	0.476	4.85	7.27	20.1	0.60	0.70	35	28.52	38.6
East: PR-116R Este									
313	0.466	1.42	2.13	16.3	0.45	0.73	10	8.72	41.5
North: PR-116 N									
904	0.892	8.16	12.24	32.5	0.82	0.90	89	41.07	31.7
West: PR-116R Oeste									
192	0.918	2.47	3.70	46.2	0.87	0.95	31	10.11	26.4
ALL VEHICLES:									
2277	0.918	16.89	25.34	26.7	0.69	0.80	89	88.42	34.6
INTERSECTION (persons):									
3416	0.918		25.34	26.7	0.69	0.80		88.42	34.6

Queue values in this table are mean back of queue (metres).

Table 5.7 - Lane Performance
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Effective Red and Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR-116 S												
1 L	50	30	0	0	60	251	0.239	26.0	0.72	0.9	6.5	30.5T
2 T	59	21	0	0	246	516	0.476	27.2	0.74	5.0	35.3	500.0
3 T	59	21	0	0	246	518	0.476	27.2	0.74	5.1	35.4	500.0
4 R	4	21	4	51	316	1446	0.219	7.8	0.62	0.5	3.3	56.0T
East: PR-116R Este												
1 LT	74	6	0	0	61	149	0.409	40.9	0.74	1.5	10.5	500.0
2 R	4	6	14	56	252	541	0.466	10.4	0.72	1.4	10.4	500.0
North: PR-116 N												
1 L	50	30	0	0	196	284	0.691	30.2	0.80	3.7	27.4	43.8T
2 T	59	21	0	0	453	507	0.892	41.8	1.06	12.7	88.7	500.0
3 T	59	21	0	0	139	525	0.266	25.5	0.67	2.7	18.7	500.0
4 R	4	21	7	48	116	812	0.143	8.7	0.69	0.3	1.9	43.5T
West: PR-116R Oeste												
1 LT	73	7	0	0	152	166	0.917	55.3	1.01	4.4	30.9	500.0
2 R	22	47	4	7	40	203	0.197	11.7	0.69	0.3	1.9	500.0

T Short lane due to specification of Turn Slot

Table 5.8 - Lane Flow and Capacity Information
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR-116 S												
1 L	60	0	0	60	2.44	1864	669<	0	0	251	0.239	100
2 T	0	246	0	246	3.46	1966	1966	0	0	516	0.476	100
3 T	0	246	0	246	3.53	1973	1973	0	0	518	0.476	100
4 R	0	0	316	316	3.30	1950	1722<	1560<	0	1446	0.219	100
East: PR-116R Este												
1 LT	1	60	0	61	3.70	1990	1988	0	0	149	0.409	88P
2 R	0	0	252	252	3.70	1990	6125	116	44	541	0.466	100
North: PR-116 N												
1 L	196	0	0	196	2.40	1860	757<	0	96	284	0.691	100
2 T	0	453	0	453	3.12	1932	1932	0	0	507	0.892	100
3 T	0	139	0	139	3.78	1998	1998	0	0	525	0.266	30D
4 R	0	0	116	116	3.56	1976	967<	930<	45	812	0.143	100
West: PR-116R Oeste												
1 LT	68	84	0	152	3.40	1960	1894	0	0	166	0.917	100
2 R	0	0	40	40	3.61	1981	56	1940	45	203	0.197	21P

< Reduced saturation flow due to a short lane effect
P Lane under-utilisation found by the "Program". This includes cases where the value of lane under-utilisation due to downstream effects has been modified by the program during lane flow calculations (e.g. a de facto exclusive lane has been found).
D Lane under-utilisation due to downstream effects

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table 5.10 - Movement Capacity and Performance Summary
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index

South: PR-116 S											
1	L		60	251<	100	0.239	30		26.0	0.72	0.9	2.21
2	T		492	1034	100	0.476	21		27.2	0.74	5.1	20.83
3	R	(Slp)	316	1447<	100	0.218	21	51	7.8	0.62	0.5	5.49
East: PR-116R Este												
4	L		1	2	88	0.404	6		48.8	0.75	1.5	0.05
5	T		60	147	88	0.409	6		40.8	0.74	1.5	3.00
6	R		252	540	100	0.466	6*	56	10.4	0.72	1.4	5.66
North: PR-116 N												
7	L		196	284<	100	0.690	30*		30.2	0.80	3.7	8.16
8	T		592	664	30	0.892	21*		37.9	0.97	12.7	30.75
9	R		116	812<	100	0.143	21	48	8.7	0.69	0.3	2.17
West: PR-116R Oeste												
10	L		68	74	100	0.918*	7*		59.7	1.01	4.4	4.18
11	T		84	92	21	0.917	7		51.8	1.01	4.4	4.97
12	R		40	203	21	0.197	47	7	11.7	0.69	0.3	0.97

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.15 - Capacity and Level of Service
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR-116 S										
1 L		0.375		60	251<	0.239	26.0	C	0.9	6
2 T		0.262		492	1034	0.476	27.2	C	5.1	35
3 R	(Slp)	0.262	0.637	316	1447<	0.218	7.8	A	0.5	3
East: PR-116R Este										
4 L		0.075		1	2	0.404	48.8	D	1.5	10
5 T		0.075		60	147	0.409	40.8	D	1.5	10
6 R		0.075*	0.700	252	540	0.466	10.4	B	1.4	10
North: PR-116 N										
7 L		0.375*		196	284<	0.690	30.2	C	3.7	27
8 T		0.262*		592	664	0.892	37.9	D	12.7	89
9 R		0.262	0.600	116	812<	0.143	8.7	A	0.3	2
West: PR-116R Oeste										
10 L		0.087*		68	74	0.918*	59.7	E	4.4	31
11 T		0.087		84	92	0.917	51.8	D	4.4	31
12 R		0.587	0.087	40	203	0.197	11.7	B	0.3	2
ALL VEHICLES:				2277		0.918	26.7	C	12.7	89

INTERSECTION (persons):	3416	26.7	12.7	89

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.
< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table D.5 - Progression Factors and Actuated Signal Parameters
06 PR-116 y PR-116R
Pico PM Base
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Gap Settings es	eh	Disp. Grn. Settings 1st Grn Gmin	Gmax	2nd Grn Gmin	Gmax
South: PR-116 S											
1 L	VA	No	3	1.000	1.000	2.0	2.6	6	20		
2 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
3 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
East: PR-116R Este											
4 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
5 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
6 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
North: PR-116 N											
7 L	VA	No	3	1.000	1.000	2.5	3.1	6	50		
8 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
9 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
West: PR-116R Oeste											
10 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
11 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
12 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA

Site: 06 PR-116 y PR-116R BP
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Output Tables
Output Tables
06 FR-116 y FR-116R
Pico AM Futuro 2010

Run Information
Cycle Time = 50 (Optimum Cycle Time)

* Basic Parameters:
  Intersection Type: Signalised - Actuated Isolated
  For actuated signal timings, cycle increment is set to 1 second
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Model Defaults: Standard Right TEC - Customised Model
  Peak Flow Period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes.
  Specified performance measure for "best" cycle time in variable run - Delay
  Delay definition: Control delay
  Geometric delay included
  SIDRA Standard Delay model used
  SIDRA Standard Queue model used
  Level of Service based on: Delay (HCM method)
  Queue definition: Back of queue, Average

* Iteration Data:
  No. of Main (Timing-Capacity) Iterations = 2
  Comparison of last two iterations:
  Difference in intersection degree of satn = 0.0 %
  Largest difference in off. green times = 0 secs
  (max. value for stopping = 0 secs)

* If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table 5.3 - Intersection Parameters
06 FR-116 y FR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Critical Movements: 7, 8, 6(1st), 10

L= 22 Y= 0.427 U= 0.599 T= 51.9

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	55	50

(Program-determined Optimum Cycle Time)

Intersection Level of Service = C
Worst movement Level of Service = D

Average intersection delay (s/pers)	=	23.4
Largest average movement delay (s)	=	45.6
Largest back of queue, mean (m)	=	44
Performance Index	=	74.45
Degree of saturation (highest)	=	0.942
Practical Spare Capacity (lowest)	=	-4 %
Effective intersection capacity, (veh/h)	=	2307
Total vehicle flow (veh/h)	=	2173
Total person flow (pers/h)	=	3260
Total vehicle delay (veh-h/h)	=	14.12
Total person delay (pers-h/h)	=	21.17
Total effective vehicle stops (veh/h)	=	1891
Total effective person stops (pers/h)	=	2837
Total vehicle travel (veh-km/h)	=	1319.5
Total cost ($/h)	=	1221.81
Total fuel (L/h)	=	170.1
Total CO2 (kg/h)	=	425.59

Table S.4 - Phase Information
06 PR-116 y PR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Phase Change Times: 0, 16, 29, 39
Phase Green Times: 12, 9, 6, 7

Current Phase Sequence: Existente
Input phase sequence: G H I J
Output phase sequence: G H I J

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Aver. (vehs)	Longest Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
1 L	0.20	0.30	24.8	0.78	0.71	0.3	2	0.95	35.6
2 T	3.55	5.33	24.2	1.00	0.92	4.2	30	20.04	36.1
3 R	0.61	0.91	8.0	0.20	0.64	0.4	3	4.78	48.7
East: PR-116R Este									
4 L	0.02	0.03	31.3	0.95	0.75	1.1	8	0.08	32.2
5 T	0.46	0.69	23.3	0.95	0.72	1.1	8	2.50	36.6
6 R	0.90	1.34	11.6	0.49	0.76	1.6	12	6.46	45.6
North: PR-116 N									
7 L	1.42	2.14	28.2	0.90	0.80	2.5	19	6.62	34.0
8 T	3.53	5.30	30.5	0.98	1.01	6.2	44	17.67	32.6
9 R	0.17	0.26	8.7	0.20	0.69	0.1	1	1.27	48.1
West: PR-116R Oeste									
10 L	2.00	3.00	45.6	1.00	1.13	5.1	36	7.82	26.7
11 T	1.05	1.57	31.2	0.96	1.01	5.1	36	5.09	32.3
12 R	0.21	0.32	18.2	0.83	0.75	0.6	4	1.17	40.0

Table S.6 - Intersection Performance
06 PR-116 y PR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
831	0.746	4.36	6.54	18.9	0.73	0.82	30	25.78	39.4
East: PR-116R Este									
351	0.339	1.37	2.06	14.1	0.59	0.75	12	9.04	43.3
North: PR-116 N									
670	0.916	5.13	7.69	27.5	0.87	0.92	44	25.56	34.2
West: PR-116R Oeste									
321	0.942	3.26	4.89	36.6	0.96	1.03	36	14.08	29.9
ALL VEHICLES:									
2173	0.942	14.12	21.17	23.4	0.78	0.87	44	74.45	36.5
INTERSECTION (persons):									
3260	0.942		21.17	23.4	0.78	0.87		74.45	36.5

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
06 PR-116 y PR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Lane No.	Effective Red and Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR-116 S												
1 L	38	12	0	0	29	308	0.094	24.8	0.71	0.3	2.4	30.5T
2 T	41	9	0	0	264	354	0.746	24.2	0.92	4.2	29.5	500.0
3 T	41	9	0	0	265	355	0.746	24.2	0.92	4.2	29.6	500.0
4 R	4	9	4	33	273	1383	0.197	8.0	0.64	0.4	2.9	56.0T
East: PR-116R Este												
1 LT	44	6	0	0	73	238	0.306	23.5	0.72	1.1	7.5	500.0
2 R	4	6	14	26	278	819	0.339	11.6	0.76	1.6	11.9	500.0
North: PR-116 N												
1 L	38	12	0	0	182	335	0.542	28.2	0.80	2.5	19.1	43.8T

West: PR-116R Oeste										
10	L	0.140*		158	168	0.942*	45.6	D	5.1	36
11	T	0.140		121	129	0.941	31.2	C	5.1	36
12	R	0.540	0.140	42	223	0.188	18.2	B	0.6	4
ALL VEHICLES:				2173		0.942	23.4	C	6.2	44
INTERSECTION (persons):				3260			23.4		6.2	44

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table S.21 - Optimum Cycle Time Results
06 PR-116 y PR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Performance Measure	Smallest Value	Cycle Time
Degree of Satn	0.821	120
Average Delay	23.4	50
Stop Rate	0.74	150
Max. Queue for Any Movement	6.2	50
Perf. Index	74.4	50
Cost	1221.8	50

Performance Measure	Largest Value	Cycle Time
Eff. Inters. Cap.	2647	120
Prac. Spare Cap.	10	120

If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table D.5 - Progression Factors and Actuated Signal Parameters
06 PR-116 y PR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Gap Settings es	Gap Settings eh	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR-116 S											
1 L	VA	No	3	1.000	1.000	2.0	2.6	6	20		
2 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
3 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
East: PR-116R Este											
4 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
5 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
6 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
North: PR-116 N											
7 L	VA	No	3	1.000	1.000	2.5	3.1	6	50		
8 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
9 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
West: PR-116R Oeste											
10 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
11 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
12 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA

Table V.21 - Intersection Summary for Optimum Cycle Time
06 PR-116 y PR-116R
Pico AM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 50 (Optimum Cycle Time)

Cycle Time (sec)	Eff. Int. Cap.	Intersn Deg. of Satn	Prac. Spare Cap.	Aver. Delay (sec)	Stop Rate	Longest Queue (veh)	Perf. Index	Cost Total $/h	Unsett
40	1976	1.100	-18	28.5	0.96	9.0	78.4	1311.9	
50	2307	0.942	-4	23.4	0.87	6.2	74.4	1221.8	
60	2415	0.900	0	25.0	0.85	7.1	78.8	1248.2	
70	2447	0.888	1	27.2	0.84	7.9	83.9	1283.2	
80	2624	0.828	9	28.4	0.81	8.3	87.3	1300.7	
90	2635	0.825	9	30.5	0.80	9.2	92.5	1335.6	
100	2635	0.825	9	32.7	0.80	10.1	97.5	1372.3	
110	2620	0.830	8	35.3	0.80	11.0	103.3	1415.4	
120	2647	0.821	10	36.2	0.78	11.2	106.2	1427.9	
130	2374	0.915	-2	37.8	0.76	11.4	110.2	1453.3	
140	2172	1.000	-10	38.5	0.75	11.9	112.7	1463.8	
150	2175	0.999	-10	39.6	0.74	12.9	116.2	1480.0	

Site: 06 PR-116 y PR-116R FA 2010
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Average intersection delay (s/pers)	=	28.6
Largest average movement delay (s)	=	55.4
Largest back of queue, mean (m)	=	63
Performance Index	=	95.58
Degree of saturation (highest)	=	0.938
Practical Spare Capacity (lowest)	=	-4 %
Effective intersection capacity, (veh/h)	=	2561
Total vehicle flow (veh/h)	=	2401
Total person flow (pers/h)	=	3602
Total vehicle delay (veh-h/h)	=	19.08
Total person delay (pers-h/h)	=	28.62
Total effective vehicle stops (veh/h)	=	2062
Total effective person stops (pers/h)	=	3092
Total vehicle travel (veh-km/h)	=	1457.9
Total cost ($/h)	=	1445.62
Total fuel (L/h)	=	192.7
Total CO2 (kg/h)	=	482.09

Table S.4 - Phase Information
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Phase Change Times: 0, 27, 45, 55
Phase Green Times: 23, 14, 6, 11

Current Phase Sequence: Existente
Input phase sequence: G H I J
Output phase sequence: G H I J

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Aver. (vehs)	Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
1 L	0.23	0.35	26.0	0.69	0.71	0.5	3	1.14	35.0
2 T	5.06	7.59	31.2	0.99	0.90	6.2	44	26.31	32.3
3 R	0.66	0.99	7.9	0.15	0.63	0.4	3	5.24	49.0
East: PR-116R Este									
4 L	0.04	0.05	43.4	0.99	0.76	1.7	12	0.14	27.3
5 T	0.77	1.15	35.4	0.99	0.76	1.7	12	3.56	30.4
6 R	1.08	1.62	12.6	0.48	0.75	2.5	19	7.98	44.7
North: PR-116 N									
7 L	1.73	2.60	30.6	0.84	0.81	3.6	27	8.31	32.7
8 T	4.87	7.31	38.2	0.97	0.99	9.0	63	23.02	29.3
9 R	0.19	0.28	8.6	0.16	0.69	0.2	1	1.42	48.2
West: PR-116R Oeste									
10 L	2.68	4.01	55.4	1.00	1.10	7.6	53	10.20	23.9
11 T	1.50	2.25	40.6	0.97	1.01	7.6	53	6.77	28.4
12 R	0.28	0.42	22.0	0.83	0.75	0.9	6	1.49	37.3

Table S.6 - Intersection Performance
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
916	0.740	5.95	8.92	23.4	0.70	0.80	44	32.69	36.5
East: PR-116R Este									
391	0.519	1.89	2.83	17.4	0.59	0.75	19	11.68	40.7
North: PR-116 N									
741	0.908	6.79	10.19	33.0	0.85	0.91	63	32.75	31.5
West: PR-116R Oeste									
353	0.938	4.46	6.69	45.5	0.96	1.02	53	18.46	26.7
ALL VEHICLES:									
2401	0.938	19.08	28.62	28.6	0.77	0.86	63	95.58	33.6
INTERSECTION (persons):									
3602	0.938		28.62	28.6	0.77	0.86		95.58	33.6

Queue values in this table are mean back of queue (metros).

Table S.7 - Lane Performance
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Lane No.	Effective Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR-116 S												
1 L	47	23	0	0	32	263	0.122	26.0	0.71	0.5	3.2	30.5T
2 T	56	14	0	0	291	393	0.740	31.2	0.90	6.2	43.5	500.0
3 T	56	14	0	0	292	395	0.740	31.2	0.90	6.2	43.6	500.0
4 R	4	14	4	48	301	1450	0.208	7.9	0.63	0.4	3.1	56.0T
East: PR-116R Este												
1 LT	64	6	0	0	81	170	0.476	35.7	0.76	1.7	12.2	500.0
2 R	4	6	19	41	310	597	0.519	12.6	0.75	2.5	18.5	500.0
North: PR-116 N												
1 L	47	23	0	0	204	300	0.680	30.6	0.81	3.6	26.9	43.8T

2 T	56	14	0	0	351	386	0.908	41.9	1.08	9.0	63.1	500.0
3 T	56	14	0	0	108	400	0.271	26.2	0.70	2.0	13.8	500.0
4 R	4	14	6	46	78	853	0.091	8.6	0.69	0.2	1.1	43.5T
West: PR-116R Oeste												
1 LT	59	11	0	0	280	299	0.937	52.4	1.10	7.6	52.9	500.0
2 TR	16	6	37	11	73	389	0.187	19.0	0.71	0.9	6.1	500.0

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR-116 S												
1 L	32	0	0	32	2.44	1864	801<	0	0	263	0.122	100
2 T	0	291	0	291	3.46	1966	1966	0	0	393	0.740	100
3 T	0	292	0	292	3.53	1973	1973	0	0	395	0.740	100
4 R	0	0	301	301	3.30	1950	1857	1574<	0	1450	0.208	100
East: PR-116R Este												
1 LT	3	78	0	81	3.70	1990	1986	0	0	170	0.476	92P
2 R	0	0	310	310	3.70	1990	5835	166	50	597	0.519	100
North: PR-116 N												
1 L	204	0	0	204	2.40	1860	913<	0	110	300	0.680	100
2 T	0	351	0	351	3.12	1932	1932	0	0	386	0.908	100
3 T	0	108	0	108	3.78	1998	1998	0	0	400	0.271	30D
4 R	0	0	78	78	3.56	1976	1097<	964<	51	853	0.091	100
West: PR-116R Oeste												
1 LT	174	106	0	280	3.40	1960	1901	0	0	299	0.937	100
2 TR	0	27	46	73	3.61	1981	1019	1921	51	309	0.187	20D

< Reduced saturation flow due to a short lane effect
P Lane under-utilisation found by the "Program". This includes cases where the value of lane under-utilisation due to downstream effects has been modified by the program during lane flow calculations (e.g. a de facto exclusive lane has been found).
D Lane under-utilisation due to downstream effects

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR-116 S											
1 L		32	263<	100	0.122	23		26.0	0.71	0.5	1.14
2 T		583	788	100	0.740	14		31.2	0.90	6.2	26.31
3 R	(Slp)	301	1451<	100	0.207	14	48	7.9	0.63	0.4	5.24
East: PR-116R Este											
4 L		3	6	92	0.473	6		43.4	0.76	1.7	0.14
5 T		78	164	92	0.476	6		35.4	0.76	1.7	3.56
6 R		310	597	100	0.519	6*	41	12.6	0.75	2.5	7.98
North: PR-116 N											
7 L		204	300<	100	0.680	23*		30.6	0.81	3.6	8.31
8 T		459	506	30	0.908	14*		38.2	0.99	9.0	23.02
9 R		78	853<	100	0.091	14	46	8.6	0.69	0.2	1.42
West: PR-116R Oeste											
10 L		174	186	100	0.938*	11*		55.4	1.10	7.6	10.20
11 T		133	142	20	0.937	11		40.6	1.01	7.6	6.77
12 R		46	246	20	0.187	39	11	22.0	0.75	0.9	1.49

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.15 - Capacity and Level of Service
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Mov ID	Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Queue Aver. (vehs)	Back (m)
South: PR-116 S										
1 L		0.329		32	263<	0.122	26.0	C	0.5	3
2 T		0.200		583	788	0.740	31.2	C	6.2	44
3 R	(Slp)	0.200	0.686	301	1451<	0.207	7.9	A	0.4	3
East: PR-116R Este										
4 L		0.086		3	6	0.473	43.4	D	1.7	12
5 T		0.086		78	164	0.476	35.4	D	1.7	12
6 R		0.086*	0.586	310	597	0.519	12.6	B	2.5	19
North: PR-116 N										
7 L		0.329*		204	300<	0.680	30.6	C	3.6	27
8 T		0.200*		459	506	0.908	38.2	D	9.0	63
9 R		0.200	0.657	78	853<	0.091	8.6	A	0.2	1

West: PR-116R Oeste									
10 L	0.157*		174	186	0.938*	55.4	E	7.6	53
11 T	0.157		133	142	0.937	40.6	D	7.6	53
12 R	0.557	0.157	46	246	0.187	22.0	C	0.9	6
ALL VEHICLES:			2401		0.938	28.6	C	9.0	63
INTERSECTION (persons):			3602			28.6		9.0	63

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table S.21 - Optimum Cycle Time Results
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Performance Measure	Smallest Value	Cycle Time
Degree of Satn	0.868	110
Average Delay	28.6	70
Stop Rate	0.75	150
Max. Queue for Any Movement	8.7	50
Perf. Index	91.3	50
Cost	1445.6	70

Performance Measure	Largest Value	Cycle Time
Eff. Inters. Cap.	2765	110
Prac. Spare Cap.	4	110

If an "optimum" cycle time solution is adopted for actuated signal purposes ensure that vehicle-actuated settings reflect this solution in real life. Consider using the "sensitivity analysis" facility to optimise maximum green settings for actuated signals.

Table D.5 - Progression Factors and Actuated Signal Parameters
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Gap Settings es	Gap Settings eh	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR-116 S											
1 L	VA	No	3	1.000	1.000	2.0	2.6	6	20		
2 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
3 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
East: PR-116R Este											
4 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
5 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
6 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
North: PR-116 N											
7 L	VA	No	3	1.000	1.000	2.5	3.1	6	50		
8 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
9 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
West: PR-116R Oeste											
10 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
11 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
12 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA

Table V.21 - Intersection Summary for Optimum Cycle Time
06 PR-116 y PR-116R
Pico AM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 70 (Optimum Cycle Time)

Cycle Time (sec)	Eff. Int. Cap.	Intersn Deg. of Satn	Prac. Spare Cap.	Aver. Delay (sec)	Stop Rate	Longest Queue (veh)	Perf. Index	Cost Total $/h	Unsett
40	1984	1.210	-26	39.7	1.06	13.1	101.8	1659.9	
50	2316	1.037	-13	29.3	0.94	8.7	91.3	1463.5	
60	2424	0.990	-9	29.6	0.90	9.5	94.7	1467.4	
70	2561	0.938	-4	28.6	0.86	9.0	95.6	1445.6	
80	2634	0.911	-1	30.9	0.85	10.1	101.7	1487.9	
90	2645	0.908	-1	32.9	0.84	11.2	107.0	1522.4	
100	2738	0.877	3	36.7	0.83	11.6	115.6	1592.7	
110	2765	0.868	4	36.6	0.82	12.6	117.3	1589.2	
120	2631	0.913	-1	38.6	0.81	13.2	122.4	1625.3	
130	2403	0.999	-10	38.4	0.78	13.3	123.7	1618.3	
140	2401	1.000	-10	38.8	0.76	14.0	126.3	1623.7	
150	2402	0.999	-10	39.8	0.75	15.1	130.1	1639.1	

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Output Tables
Output Tables
06 PR-116 y PR-116R
Pico PM Futuro 2010

Run Information
Cycle Time = 80 (User-given Cycle Time)

* Basic Parameters:
  Intersection Type: Signalised - Actuated Isolated
  For actuated signal timings, cycle increment is set to 1 second
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Model Defaults: Standard Right TEC - Customised Model
  Peak Flow Period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes.
  Delay definition: Control delay
                    Geometric delay included
  SIDRA Standard Delay model used
  SIDRA Standard Queue model used
  Level of Service based on: Delay (HCM method)
  Queue definition: Back of queue, Average

* Iteration Data:
  No. of Main (Timing-Capacity) Iterations = 2
  Comparison of last two iterations:
    Difference in intersection degree of satn = 0.0 %
    Largest difference in eff. green times = 0 secs
    (max. value for stopping = 0 secs)

Table 5.3 - Intersection Parameters
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Critical Movements: 7, 8, 6(1st), 10

L= 22 Y= 0.613 U= 0.743 T= 81.5

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	86	80

(Cycle time specified by the user)

Intersection Level of Service	=	C
Worst movement Level of Service	=	E
Average intersection delay (s/pers)	=	28.3
Largest average movement delay (s)	=	65.7
Largest back of queue, mean (m)	=	99
Performance Index	=	95.85
Degree of saturation (highest)	=	0.959
Practical Spare Capacity (lowest)	=	-6 %
Effective intersection capacity, (veh/h)	=	2502

Total vehicle flow (veh/h)	=	2400
Total person flow (pers/h)	=	3600
Total vehicle delay (veh-h/h)	=	18.85
Total person delay (pers-h/h)	=	28.27
Total effective vehicle stops (veh/h)	=	1964
Total effective person stops (pers/h)	=	2946
Total vehicle travel (veh-km/h)	=	1457.3
Total cost ($/h)	=	1434.34
Total fuel (L/h)	=	190.1
Total CO2 (kg/h)	=	475.63

Table S.4 - Phase Information
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Phase Change Times: 0, 34, 59, 69
Phase Green Times: 30, 21, 6, 7

Current Phase Sequence: Existente
Input phase sequence: G H I J
Output phase sequence: G H I J

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Aver. (vehs)	Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
1 L	0.46	0.68	26.1	0.66	0.73	1.0	7	2.32	34.9
2 T	3.91	5.86	27.4	0.90	0.75	5.3	37	21.83	34.2
3 R	0.72	1.08	7.8	0.13	0.62	0.5	3	5.75	49.1
East: PR-116R Este									
4 L	0.03	0.04	49.0	0.99	0.75	1.6	11	0.10	25.6
5 T	0.72	1.07	40.9	0.99	0.75	1.6	11	3.16	28.2
6 R	0.79	1.19	10.4	0.32	0.73	1.6	12	6.21	46.8
North: PR-116 N									
7 L	1.84	2.76	30.8	0.80	0.81	4.1	31	9.09	32.6
8 T	7.25	10.87	42.3	0.96	1.01	14.2	99	33.91	27.8
9 R	0.29	0.44	8.7	0.16	0.69	0.3	2	2.26	48.2
West: PR-116R Oeste									
10 L	1.30	1.94	65.7	1.00	1.06	4.9	34	4.63	21.4
11 T	1.41	2.12	57.8	1.00	1.06	4.9	34	5.54	23.2
12 R	0.14	0.21	12.1	0.37	0.70	0.3	2	1.03	44.9

Table S.6 - Intersection Performance
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
907	0.496	5.08	7.63	20.2	0.60	0.70	37	29.91	38.6
East: PR-116R Este									
339	0.494	1.54	2.31	16.3	0.45	0.73	12	9.48	41.5
North: PR-116 N									
953	0.930	9.38	14.06	35.4	0.82	0.93	99	45.27	30.4
West: PR-116R Oeste									
201	0.959	2.85	4.28	51.0	0.87	0.98	34	11.19	25.0
ALL VEHICLES:									
2400	0.959	18.85	28.27	28.3	0.69	0.82	99	95.85	33.8
INTERSECTION (persons):									
3600	0.959		28.27	28.3	0.69	0.82		95.85	33.8

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Effective Red and Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Back (m)	Lane Length (m)
South: PR-116 S												
1 L	50	30	0	0	63	251	0.251	26.1	0.73	1.0	6.8	30.5T
2 T	59	21	0	0	256	516	0.496	27.4	0.75	5.3	37.0	500.0
3 T	59	21	0	0	257	518	0.496	27.4	0.75	5.3	37.2	500.0
4 R	4	21	4	51	331	1446	0.229	7.8	0.62	0.5	3.5	56.0T
East: PR-116R Este												
1 LT	74	6	0	0	65	149	0.436	41.2	0.75	1.6	11.2	500.0
2 R	4	6	14	56	274	554	0.494	10.4	0.73	1.6	11.6	500.0
North: PR-116 N												
1 L	50	30	0	0	215	283	0.759	30.8	0.81	4.1	30.8	43.8T
2 T	59	21	0	0	472	507	0.930	47.4	1.11	14.2	99.2	500.0
3 T	59	21	0	0	145	525	0.277	25.6	0.68	2.8	19.6	500.0
4 R	4	21	7	48	121	808	0.150	8.7	0.69	0.3	2.0	43.5T
West: PR-116R Oeste												
1 LT	73	7	0	0	159	166	0.959	61.3	1.06	4.9	34.4	500.0
2 R	23	46	4	7	42	203	0.206	12.1	0.70	0.3	2.1	500.0

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Basic (tcu)	Adj. Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR-116 S												
1 L	63	0	0	63	2.44	1864	668<	0	0	251	0.251	100
2 T	0	256	0	256	3.46	1966	1966	0	0	516	0.496	100
3 T	0	257	0	257	3.53	1973	1973	0	0	518	0.496	100
4 R	0	0	331	331	3.30	1950	1721<	1559<	0	1446	0.229	100
East: PR-116R Este												
1 LT	2	63	0	65	3.70	1990	1986	0	0	149	0.436	88P
2 R	0	0	274	274	3.70	1990	6321	114	44	554	0.494	100
North: PR-116 N												
1 L	215	0	0	215	2.40	1860	755<	0	96	283	0.759	100
2 T	0	472	0	472	3.12	1932	1932	0	0	507	0.930	100
3 T	0	145	0	145	3.78	1998	1998	0	0	525	0.277	30D
4 R	0	0	121	121	3.56	1976	962<	926<	45	808	0.150	100
West: PR-116R Oeste												
1 LT	71	88	0	159	3.40	1960	1895	0	0	166	0.959	100
2 R	0	0	42	42	3.61	1981	59	1940	45	203	0.206	22P

< Reduced saturation flow due to a short lane effect
P Lane under-utilisation found by the "Program". This includes cases where the value of lane under-utilisation due to downstream effects has been modified by the program during lane flow calculations (e.g. a de facto exclusive lane has been found).
D Lane under-utilisation due to downstream effects

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index
South: PR-116 S											
1 L		63	251<	100	0.251	30		26.1	0.73	1.0	2.32
2 T		513	1034	100	0.496	21		27.4	0.75	5.3	21.83
3 R	(Slp)	331	1446<	100	0.229	21	51	7.8	0.62	0.5	5.75
East: PR-116R Este											
4 L		2	5	88	0.437	6		49.0	0.75	1.6	0.10
5 T		63	144	88	0.436	6		40.9	0.75	1.6	3.16
6 R		274	554	100	0.494	6*	56	10.4	0.73	1.6	6.21
North: PR-116 N											
7 L		215	283<	100	0.759	30*		30.8	0.81	4.1	9.09
8 T		617	664	30	0.930	21*		42.3	1.01	14.2	33.91
9 R		121	808<	100	0.150	21	48	8.7	0.69	0.3	2.26
West: PR-116R Oeste											
10 L		71	74	100	0.959*	7*		65.7	1.06	4.9	4.63
11 T		88	92	22	0.959*	7		57.8	1.06	4.9	5.54
12 R		42	203	22	0.207	46	7	12.1	0.70	0.3	1.03

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.15 - Capacity and Level of Service
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR-116 S										
1 L		0.375		63	251<	0.251	26.1	C	1.0	7
2 T		0.262		513	1034	0.496	27.4	C	5.3	37
3 R	(Slp)	0.262	0.637	331	1446<	0.229	7.8	A	0.5	3
East: PR-116R Este										
4 L		0.075		2	5	0.437	49.0	D	1.6	11
5 T		0.075		63	144	0.436	40.9	D	1.6	11
6 R		0.075*	0.700	274	554	0.494	10.4	B	1.6	12
North: PR-116 N										
7 L		0.375*		215	283<	0.759	30.8	C	4.1	31
8 T		0.262*		617	664	0.930	42.3	D	14.2	99
9 R		0.262	0.600	121	808<	0.150	8.7	A	0.3	2
West: PR-116R Oeste										
10 L		0.087*		71	74	0.959*	65.7	E	4.9	34
11 T		0.087		88	92	0.959*	57.8	E	4.9	34
12 R		0.575	0.087	42	203	0.207	12.1	B	0.3	2
ALL VEHICLES:				2400		0.959	28.3	C	14.2	99

INTERSECTION (persons):	3600	28.3	14.2	99

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.

< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c>1.0)

Table D.5 - Progression Factors and Actuated Signal Parameters
06 PR-116 y PR-116R
Pico PM Futuro 2010
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Gap Settings es	Gap Settings ah	Disp. Grn. Settings 1st Grn Gmin	1st Grn Gmax	2nd Grn Gmin	2nd Grn Gmax
South: PR-116 S											
1 L	VA	No	3	1.000	1.000	2.0	2.6	6	20		
2 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
3 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
East: PR-116R Este											
4 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
5 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
6 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
North: PR-116 N											
7 L	VA	No	3	1.000	1.000	2.5	3.1	6	50		
8 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
9 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
West: PR-116R Oeste											
10 L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
11 T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
12 R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA

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Output Tables
Output Tables
06 PR-116 y PR-116R
Pico PM Futuro 2015

Run Information
Cycle Time = 80 (User-given Cycle Time)

* Basic Parameters:
  Intersection Type: Signalised - Actuated Isolated
  For actuated signal timings, cycle increment is set to 1 second
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Model Defaults: Standard Right TEC - Customised Model
  Peak Flow Period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes.
  Delay definition: Control delay
  Geometric delay included
  SIDRA Standard Delay model used
  SIDRA Standard Queue model used
  Level of Service based on: Delay (HCM method)
  Queue definition: Back of queue, Average

* Iteration Data:
  No. of Main (Timing-Capacity) Iterations = 2
  Comparison of last two iterations:
  Difference in intersection degree of satn = 0.0 %
  Largest difference in eff. green times = 0 secs
  (max. value for stopping = 0 secs)

Table S.3 - Intersection Parameters
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Critical Movements: 7, 8, 6(1st), 11

L= 22 Y= 0.677 U= 0.798 Y= 85.9

Cycle Time:

Minimum	Maximum	Practical	Chosen
40	150	110	80

(Cycle time specified by the user)

Intersection Level of Service	=	C
Worst movement Level of Service	=	F
Average intersection delay (s/pers)	=	32.1
Largest average movement delay (s)	=	90.0
Largest back of queue, mean (m)	=	121
Performance Index	=	112.70
Degree of saturation (highest)	=	1.049
Practical Spare Capacity (lowest)	=	-14 %
Effective intersection capacity, (veh/h)	=	2525
Total vehicle flow (veh/h)	=	2648
Total person flow (pers/h)	=	3972
Total vehicle delay (veh-h/h)	=	23.62
Total person delay (pers-h/h)	=	35.43
Total effective vehicle stops (veh/h)	=	2251
Total effective person stops (pers/h)	=	3376
Total vehicle travel (veh-km/h)	=	1607.9
Total cost ($/h)	=	1663.39
Total fuel (L/h)	=	214.6
Total CO2 (kg/h)	=	536.82

Table S.4 - Phase Information
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Phase Change Times: 0, 33, 59, 69
Phase Green Times: 29, 22, 6, 7

Current Phase Sequence: Existente
Input phase sequence: G H I J
Output phase sequence: G H I J

Table S.5 - Movement Performance

Mov ID	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Aver. (veha)	Queue Back (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
1 L	0.52	0.77	26.9	0.68	0.73	1.1	8	2.59	34.5
2 T	4.21	6.31	26.9	0.90	0.76	5.8	41	23.89	34.5
3 R	0.80	1.19	7.8	0.13	0.62	0.6	4	6.36	49.0
East: PR-116R Este									
4 L	0.04	0.06	49.2	1.00	0.76	1.8	12	0.16	25.5
5 T	0.79	1.18	41.1	1.00	0.75	1.8	12	3.48	28.2
6 R	0.94	1.41	11.1	0.37	0.74	2.1	15	7.32	46.1
North: PR-116 N									
7 L	2.34	3.51	35.0	0.85	0.86	5.2	39	11.11	30.7
8 T	9.36	14.04	49.6	0.96	1.08	17.3	121	40.62	25.4
9 R	0.32	0.49	8.8	0.18	0.69	0.4	3	2.54	48.2
West: PR-116R Oeste									
10 L	1.95	2.93	90.0	1.00	1.17	6.4	45	6.13	17.3
11 T	2.19	3.28	82.1	1.00	1.17	6.4	45	7.34	18.4
12 R	0.16	0.24	12.8	0.40	0.70	0.4	3	1.17	44.3

Table S.6 - Intersection Performance
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06

Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: PR-116 S									
998	0.521	5.52	8.28	19.9	0.60	0.71	41	32.84	38.7
East: PR-116R Este									
377	0.543	1.77	2.65	16.9	0.49	0.74	15	10.95	41.0
North: PR-116 N									
1053	0.977	12.03	18.04	41.1	0.84	0.98	121	54.27	28.2
West: PR-116R Oeste									
220	1.049	4.30	6.45	70.4	0.87	1.07	45	14.64	20.4
ALL VEHICLES:									
2648	1.049	23.62	35.43	32.1	0.70	0.85	121	112.70	31.9
INTERSECTION (persons):									
3972	1.049		35.43	32.1	0.70	0.85		112.70	31.9

Queue values in this table are mean back of queue (metres).

Table S.7 - Lane Performance
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Effective Red and Green Times (sec) R1	G1	R2	G2	Dem Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Queue Aver. (vehs)	Queue Back (m)	Lane Length (m)
South: PR-116 S												
1 L	51	29	0	0	69	246	0.280	26.9	0.73	1.1	7.7	30.5T
2 T	58	22	0	0	281	541	0.521	26.9	0.76	5.8	40.6	500.0
3 T	58	22	0	0	283	543	0.521	26.9	0.76	5.8	40.7	500.0
4 R	4	22	4	50	365	1446	0.252	7.8	0.62	0.6	3.9	56.0T
East: PR-116R Este												
1 LT	74	6	0	0	72	149	0.484	41.5	0.75	1.8	12.4	500.0
2 R	4	6	16	54	305	562	0.543	11.1	0.74	2.1	15.4	500.0
North: PR-116 N												
1 L	51	29	0	0	241	276	0.873	35.0	0.86	5.2	38.7	43.8T
2 T	58	22	0	0	519	531	0.977	57.3	1.20	17.3	120.9	500.0
3 T	58	22	0	0	160	550	0.291	24.9	0.68	3.1	21.4	500.0
4 R	4	22	8	46	133	781	0.170	8.8	0.69	0.4	2.5	43.5T
West: PR-116R Oeste												
1 LT	73	7	0	0	174	166	1.049	85.7	1.17	6.4	45.1	500.0
2 R	25	44	4	7	46	204	0.225	12.8	0.70	0.4	2.6	500.0

T Short lane due to specification of Turn Slot

Table S.8 - Lane Flow and Capacity Information
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Lane No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Lane Width (m)	Saturation Flow Adj. Basic (tcu)	Aver 1st (veh)	Aver 2nd (veh)	End Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: PR-116 S												
1 L	69	0	0	69	2.44	1864	679<	0	0	246	0.280	100
2 T	0	281	0	281	3.46	1966	1966	0	0	541	0.521	100
3 T	0	283	0	283	3.53	1973	1973	0	0	543	0.521	100
4 R	0	0	365	365	3.30	1950	1709<	1562<	0	1446	0.252	100
East: PR-116R Este												
1 LT	3	69	0	72	3.70	1990	1985	0	0	149	0.484	89P
2 R	0	0	305	305	3.70	1990	6414	119	44	562	0.543	100
North: PR-116 N												
1 L	241	0	0	241	2.40	1860	762<	0	96	276	0.873	100
2 T	0	519	0	519	3.12	1932	1932	0	0	531	0.977	100
3 T	0	160	0	160	3.78	1998	1998	0	0	550	0.291	30D
4 R	0	0	133	133	3.56	1976	923<	917<	45	781	0.170	100
West: PR-116R Oeste												
1 LT	78	96	0	174	3.40	1960	1895	0	0	166	1.049	100
2 R	0	0	46	46	3.61	1981	63	1939	45	204	0.225	21P

< Reduced saturation flow due to a short lane effect
P Lane under-utilisation found by the "Program". This includes cases where the value of lane under-utilisation due to downstream effects has been modified by the program during lane flow calculations (e.g. a de facto exclusive lane has been found).
D Lane under-utilisation due to downstream effects

Basic Saturation Flow in this table is adjusted for lane width, approach grade, parking manoeuvres and number of buses stopping. Saturation flow scale applies if specified.

Table S.10 - Movement Capacity and Performance Summary
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID	Mov Typ	Dem Flow (veh /h)	Total Cap. (veh /h)	Lane Util (%)	Deg. Satn x	Eff. Grn 1st Grn	Eff. Grn 2nd Grn	Aver. Delay (sec)	Eff. Stop Rate	Average Back Queue (veh)	Perf. Index

South: PR-116 S											
1	L		69	246<	100	0.280	29		26.9	0.73	1.1	2.59
2	T		564	1083	100	0.521	22		26.9	0.76	5.8	23.89
3	R	(Slp)	365	1446<	100	0.252	22	50	7.8	0.62	0.6	6.36
East: PR-116R Este												
4	L		3	6	89	0.482	6		49.2	0.76	1.8	0.16
5	T		69	143	89	0.484	6		41.1	0.75	1.8	3.48
6	R		305	562	100	0.543	6*	54	11.1	0.74	2.1	7.32
North: PR-116 N												
7	L		241	276<	100	0.872	29*		35.0	0.86	5.2	11.11
8	T		679	695	30	0.977	22*		49.6	1.08	17.3	40.62
9	R		133	781<	100	0.170	22	46	8.8	0.69	0.4	2.54
West: PR-116R Oeste												
10	L		78	74	100	1.049*	7		90.0	1.17	6.4	6.13
11	T		96	92	21	1.049*	7*		82.1	1.17	6.4	7.34
12	R		46	204	21	0.225	44	7	12.8	0.70	0.4	1.17

< Reduced capacity due to a short lane effect
* Maximum degree of saturation, or critical green periods

Table S.15 - Capacity and Level of Service
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID		Mov Typ	Green Time Ratio (g/C) 1st grn	2nd grn	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Aver. (vehs)	Queue Back (m)
South: PR-116 S											
1	L		0.363		69	246<	0.280	26.9	C	1.1	8
2	T		0.275		564	1083	0.521	26.9	C	5.8	41
3	R	(Slp)	0.275	0.625	365	1446<	0.252	7.8	A	0.6	4
East: PR-116R Este											
4	L		0.075		3	6	0.482	49.2	D	1.8	12
5	T		0.075		69	143	0.484	41.1	D	1.8	12
6	R		0.075*	0.675	305	562	0.543	11.1	B	2.1	15
North: PR-116 N											
7	L		0.363*		241	276<	0.872	35.0	C	5.2	39
8	T		0.275*		679	695	0.977	49.6	D	17.3	121
9	R		0.275	0.575	133	781<	0.170	8.8	A	0.4	3
West: PR-116R Oeste											
10	L		0.087		78	74	1.049*	90.0	F	6.4	45
11	T		0.087*		96	92	1.049*	82.1	F	6.4	45
12	R		0.550	0.087	46	204	0.225	12.8	B	0.4	3
ALL VEHICLES:					2648		1.049	32.1	C	17.3	121
INTERSECTION (persons):					3972			32.1		17.3	121

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
SIDRA Output Guide or the Output section of the on-line help.
< Reduced capacity due to a short lane effect
* Maximum v/c ratio, or critical green periods
" Movement Level of service has been determined using adjacent lane
v/c ratio rather than short lane v/c ratio (v/c=1.0)

Table D.5 - Progression Factors and Actuated Signal Parameters
06 PR-116 y PR-116R
Pico PM Futuro 2015
Intersection ID: 06
Actuated Isolated Signals, Cycle Time = 80 (User-given Cycle Time)

Mov ID		Control	Coord.	Arrival Type	Delay Prog. Factor	Queue Prog. Factor	Gap Settings as	ah	Disp. Grn. Settings 1st Grn Gmin	Gmax	2nd Grn Gmin	Gmax
South: PR-116 S												
1	L	VA	No	3	1.000	1.000	2.0	2.6	6	20		
2	T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
3	R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
East: PR-116R Este												
4	L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
5	T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
6	R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
North: PR-116 N												
7	L	VA	No	3	1.000	1.000	2.5	3.1	6	50		
8	T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
9	R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA
West: PR-116R Oeste												
10	L	FT	No	3	1.000	1.000	2.0	2.5	6	NA		
11	T	FT	No	3	1.000	1.000	2.5	3.0	6	NA		
12	R	FT	No	3	1.000	1.000	2.5	3.0	6	NA	6	NA

Site: 06 PR-116 y PR-116R FP 2015
C:\Documents and Settings\Magdamari\My Documents\Proyectos
Magdamari\Yauco-Vertedoro-Dic2007\corridas Yauco-Vertedaro\Yauco-Vertedoro
futuro 2015.sap
Processed Jan 18, 2008 09:18:13AM

M0276, Traffic Consulting Group, Large Office
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Apéndice 10:

Evaluación Arqueológica

EVALUACIÓN DE RECURSOS CULTURALES

(Fase 1A)

PROYECTO

EXPANSION LATERAL
VERTEDERO MUNICIPAL DE YAUCO

BARRIO BARINAS
YAUCO, PUERTO RICO

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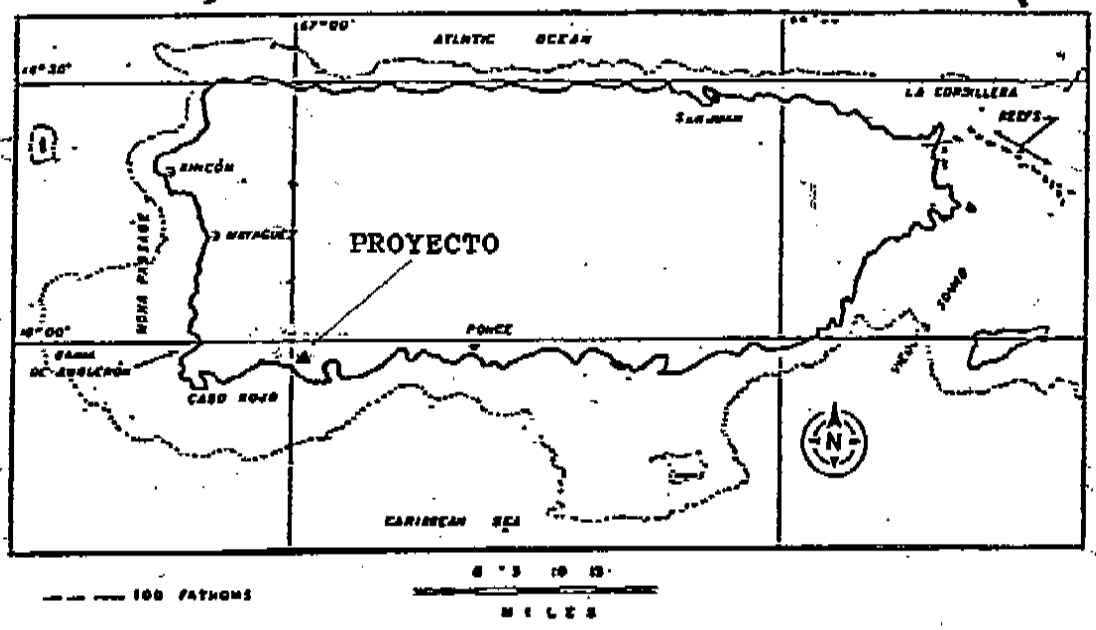
INTRODUCCIÓN

En el último tercio del año de **1992** llevamos a cabo una Evaluación de Recursos Culturales **Fase 1A-1B** para la primera expansión del Vertedero Municipal de Yauco; en esa investigación arqueológica se pudo constar que en los terrenos de la expansión no habían recursos culturales. El Vertedero Municipal eventualmente pasó a ser operado desde el año de 1999 por la compañía LM Waste Services. Ahora se planifica otra expansión lateral del vertedero y la Compañía que administra y opera el mismo nos solicitó una Evaluación de Recursos Culturales **Fase 1A** para los terrenos de la expansión planificada.

El informe será sometido a las Oficinas de Gobierno para el endoso correspondiente.

> "The Stage I survey is designed to determine the presence or absence of cultural resources in the project's potential impact area. The Stage I work must be conducted early during the planning activities for each project. This allows the information derived from this work to be used in developing and screening alternatives to minimize direct and indirect impacts on historic and archaeological properties.
>
> To facilitate planning, the Stage I survey is divided into two logically progressive units of study, Stage 1A and Stage 1B."
> (SHPO, 1992)

La evaluación de recursos culturales en su Fase 1A, consiste en identificar si en las fuentes documentales conocidas existe información que directa o indirectamente pudiera estar relacionada con el área que será intervenida; tomando en consideración los resultados de la investigación documental se procede con un estudio de campo, Fase 1B.



Localización del Proyecto en Relación al Caribe

Las características del sector y su potencial se evalúan en términos arqueológicos, basados en el resultado de la investigación se recomiendan estudios adicionales, sí éstos son necesarios.

Esta evaluación de recursos culturales está conforme con las guías establecidas por el Consejo para la Protección del Patrimonio Arqueológico Terrestre de Puerto Rico y Oficinas afines.

LOCALIZACIÓN DEL AREA BAJO ESTUDIO

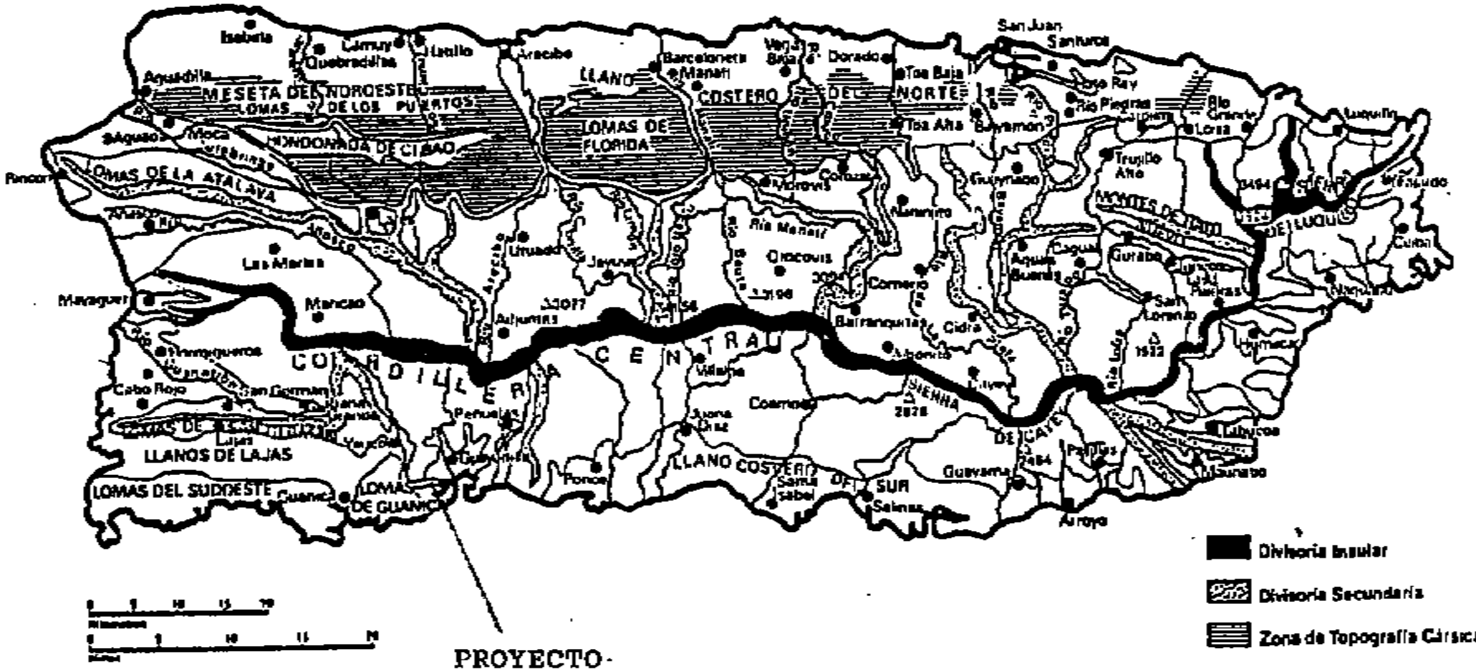
El sector objeto de investigación está localizado en la carretera estatal PR-335 kilómetro 3.8 del barrio Barinas en la municipalidad de Yauco.

La ubicación del predio bajo el sistema de coordenadas Lambert es la siguiente: X= 154460.00 Y= 218.200.00

Las colindancias del área bajo estudio son las siguientes: por el Norte con la carretera PR-335 y terrenos privados; por el Este, Sur y Oeste con terrenos privados no desarrollados.

Los terrenos están localizados dentro de la región geográfica conocida como Las Colinas Semiáridas del Sur.

> "Esta región de colinas esta limitada al norte por las montañas del interior y al sur por el llano costero.
>
> El clima pueda considerarse intermedio, aunque se caracteriza por la semiaridez.
>
> La mayor parte del área esta cubierta de pastos. En los pastos mejorados abunda la yerba de guinea que es muy nutritiva y tolera el pastoreo y los periodos de sequía."
> (Picó, 1980)



Localización del Proyecto en la Zona Geográfica Correspondiente

SUELOS

Los suelos en Puerto Rico son muy variados para una isla relativamente pequeña. Esta variedad se debe en gran parte a la diversidad de las zonas geográficas y al tipo de rocas que en parte originaron los mismos. Se han podido identificar 426 tipos de suelos y 197 series.

> "They closely reflect the rock formation from which they derive and consist basically of two mayor classes based on the geological history: residual in nature that contains the same minerals as the diorite and volcanic supporting bedrock. Transported soils combine these components with andesites and limestone to form sedimentary deposits with usual fluvial materials, while coarse textured upstream regions, fine clays and silts are abundant in the floor plains and near the coasts."
> (Gierbolini, 1979)

Los suelos localizados en el predio que será desarrollado han sido clasificados y llamados por el Departamento de Agricultura como suelos Pozo Blanco cascajoso lómico.

> "Ese suelo se concentra en estrechas franjas en las bases de las colinas de calizas y margas calcáreas que dominan el panorama regional."
> (Soriano Ressy, 2007))

CLIMA

En Puerto Rico el clima es bastante estable debido a su localización en la zona tropical terrestre; no existen variaciones extremas de temperaturas. Dos leves cambios en el clima son sentidos anualmente: la estación invernal desde noviembre hasta febrero en donde la temperatura promedio es desde los 67 grados fahrenheit y la estación de verano desde marzo hasta octubre con una temperatura promedio de 82 grados fahrenheit. Este clima estable y fresco hacen posible una agricultura intensiva con actividades afines todo el año.

Los factores que más influyen en el clima de la Isla son su posición respecto al ecuador, la corriente marina ecuatorial y los vientos alisios que fluyen de este a oeste. En el caso de los vientos alisios, los mismos ayudan a una mayor precipitación, esto es así pues son secos y absorben humedad según se van movimiento y cuando tropiezan con las montañas producen la llamada lluvia orográfica.

La precipitación pluvial anual promedio en la zona bajo estudio oscila entre 30 y 45 pulgadas las cuales se distribuyen en dos periodos: uno corto de abril a junio y uno más extenso entre agosto y noviembre.

El efecto de la precipitación anual tiene un impacto directo en la flora de la región, especialmente en los cultivos; sin embargo el drenaje y las características del suelo también afectan la agricultura aunque no siempre favorablemente.

> "La pendiente del suelo influye pues en tierras llanas, el suelo retiene mejor la humedad que en tierras pendiente. Otro factor a considerarse es el carácter físico del suelo.
>
> Un suelo arenoso o pedregoso resulta muy permeable y es mucho más seco que un suelo arcilloso, aunque los dos reciban la misma cantidad de lluvia."
> (Ibid, 1980)

HIDROLOGIA

Los recursos de agua fresca en/y la vecindad inmediata de los terrenos bajo estudio son inexistentes; no hay manantiales, quebradas ni ríos.

FLORA

La flora en y los alrededores de los terrenos bajo estudio se compone de vegetación que es natural de lugares donde la lluvia es escasa. Pudimos identificar árboles de guásima, quenepa, tea, acacia, almácigo, tachuelo, úcar, pitahaya, algodón y tautúa.

FAUNA

La fauna en la vecindad es muy limitada, se reduce a la presencia de algunas aves y en menor cantidad reptiles: identificamos la reinita, el comeñame, garzas, varias auras tiñosa, un pájaro carpintero, el pitirre y alguno que otro guaraguao volando por los alrededores. La presencia de reptiles se limitan a lagartijos e iguanas.

Descripción del Proyecto: EXTENSION LATERAL VERTEDERO DE YAUCO

El proyecto institucional estará ubicado en un predio de terreno con una extensión de 60.0 cuerdas.

El proyecto consiste en la expansión lateral del vertedero de desperdicios sólidos de Yauco; se utilizará una operación que consiste en depositar y esparcir los desperdicios sólidos sobre el terreno, compactarlos con equipos pesados, cubrir los mismos con suelos arcillosos y volver a compactarlos.

El tipo de desperdicios que continuará recibiendo el vertedero es más bien doméstico, escombros, cienos de plantas de tratamiento, desperdicios orgánicos y aguas de procesos no peligrosas.

Este proyecto por su localización estará a una distancia prudente de áreas urbanas y no impactará adversamente el medio ambiente.

Este proyecto tendrá un impacto muy positivo en la municipalidad de Yauco y pueblos vecinos pues tendrán un área especial que les facilitará el disponer de sus desperdicios en una forma segura y en consonancia con la reglamentación vigente que regula la disposición de desperdicios sólidos en la Isla.

Durante la operación del vertedero se habrá de generar una actividad económica por el pago de cuotas y a la misma vez se crearán empleos directos e indirectos que fortalecerán la economía de la región.

EVALUACION DE RECURSOS CULTURALES
(FASE IA)

PROYECTO

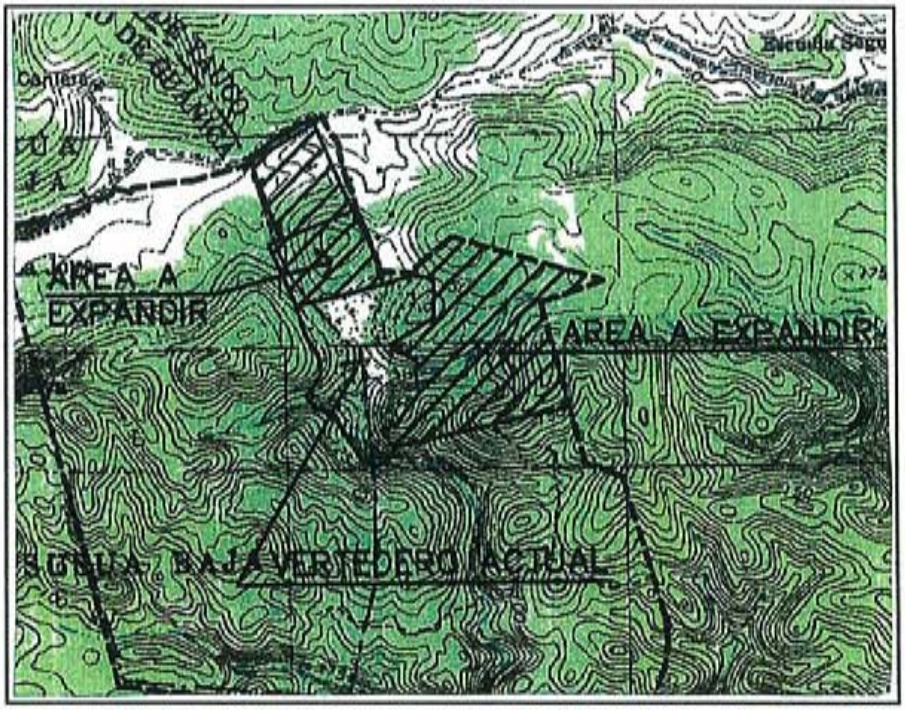
EXPANSION LATERAL VERTEDERO MUNICIPAL DE YAUCO

Sometida a:

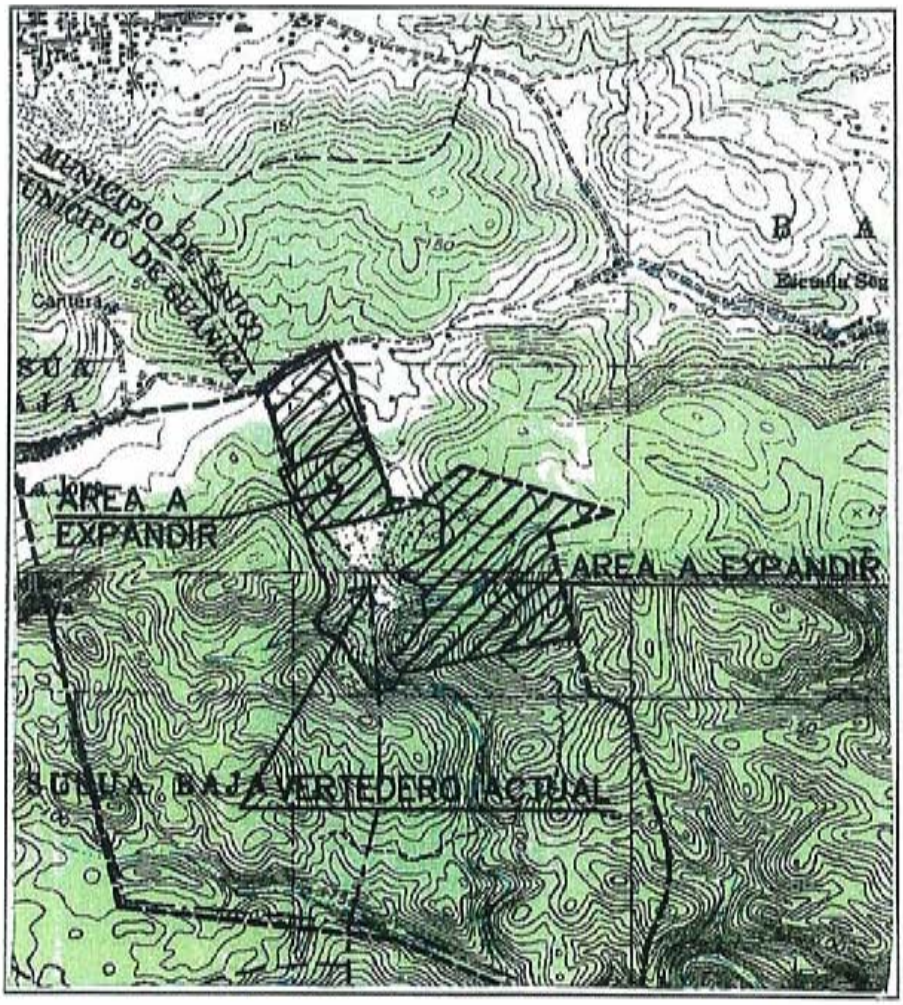
SR. REY GONZALEZ
L M WASTE SERVICE CORP.

Por:

JUAN GONZALEZ COLON
ARQUEOLOGO



BARRIO BARINAS
YAUCO, PUERTO RICO
22 de Mayo de 2008



Localización del predio en el cuadrángulo del U.S.G.S.
Escala 1: 20,000

ESTUDIO FASE 1-A

Esta es la primera parte de una evaluación arqueológica; consiste esencialmente de una investigación documental para localizar información relacionada a sectores con antecedentes precolombinos o históricos.

La investigación documental hace posible un examen de los listados de sitios conocidos en los archivos del Consejo para la Protección del Patrimonio Terrestre de Puerto Rico y de la Oficina Estatal de Preservación Histórica. La información en los archivos de algunas Agencias de Gobierno es de extrema utilidad, así también como el personal especializado de éstas. Se revisan las evaluaciones realizadas por arqueólogos e investigadores afines. Los escritos de historiadores complementan la búsqueda documental. En ocasiones los residentes de la vecindad facilitan información sobre hallazgos previos en o cerca del área bajo estudio.

En el estudio de la **Fase 1-A,** se hace un rastreo/inspección de la superficie de los terrenos que serán intervenidos y de los alrededores inmediatos; en algunas ocasiones la vegetación es un obstáculo para el examen de la superficie.

> "A systematic survey is the logical start to the archaeological investigation of a given region. It attempts to locate as many of the area site as possible to assess their nature and importance through surface examination and collection of associated artifacts."
> (Heitzer, 1968)

Una vez analizada la información documental, la data que se obtiene se utiliza como referencia en el desarrollo de la estrategia del trabajo de campo que se lleva a cabo como parte de la **Fase 1-B.**

Algunos Arqueólogos e investigadores hacen el rastreo/inspección del área bajo estudio durante la **Fase 1B.**

LA PREHISTORIA DE YAUCO: ESTUDIOS PREVIOS

La prehistoria de Yauco y sus áreas vecinas es relativamente conocida; se han documentado algunos de sus sitios.

Como es el caso de la mayoría de los pueblos de la Isla, las primeras noticias relacionadas a su prehistória provienen de reportes sobre el hallazgo fortuito de objetos indígenas que se localizaban durante faenas agrícolas. La mayoría de los "monifatos de indios", como se le conocían antiguamente a los objetos de origen indígena, eventualmente formaban parte de la colección privada del maestro de la escuela o de algún ciudadano de la comunidad.

> "Las antiguedades de los primeros Indios, indígenas de Puerto Rico se hallan reunidos en gran número en la colección del difunto Mr. Látimer, el museo de Artillería de la capital de la Isla y en las numerosas colecciones partículares del Sr. Leopoldo Krug de Mayaguez, del Sr. Carbonell de Cabo Rojo y otros que deben de admirarse del silencio acerca del asunto que guardan los escritos de Fray Iñiho Abbad". (Dumont, 1876)

En varias ocasiones las colecciones de objetos fueron vendidas a instituciones en el extranjero que tenían programas de museos; en varios casos los objetos fueron donados, ejemplo de ello fue la colección Mattei que está en un museo de Francia.

Con el cambio de soberanía ocurrido en Puerto Rico a fines del siglo pasado, se trasladan a la Isla numerosos investigadores de los Estados Unidos Continentales y realizan estudios de antropología, biología, botánica, geología y varias disciplinas afines. La región de Yauco fue visitada por varios arqueólogos

entre los cuales se encontraba el entonces estudiantes de la Universidad de Yale Froelich Rainey.

> "From a finca near Yauco we took horses and rode up to a Barrio called Collores. On a bean field which was littered with potsherds and in a few places by sea shells. Near the center of the plateau was the remnant of a square ball court about 50' x 150'. Many of the stones were still standing."
> (Rainey, 1934)

En el año de 1936, Irving Rouse uno de los pioneros en los estudios sistemáticos de Puerto Rico y el Caribe, visitó y excavó uno de los más importantes sitios de Yauco.

> "Diego Hernandez is reputedly the richest site for stone objects in Puerto Rico and it has been visited many times by people seeking the greenish stone beads and pendants which are plowed out of the soil during the cultivation of sugar cane."(Rouse, 1952)

Después de las investigaciones realizadas por el Dr. Irving Rouse solo se prducían noticias del hallazgo de objetos. Temprano en la década del 1930 el Dr. José L. Montalvo Guenard, investigador que fuera de la prehistoria de Puerto Rico, localizó varios sitios en Yauco; este investigador también era coleccionista y reportó el hallazgo de un singular objeto en concha del sitio de Diego Hernández.

> "This specimen was found in a shell heap near the Rio Duey on the farm of Don Onofre Torres in barrio Diego Hernández, Yauco, Puerto Rico. Several boys picked it out of a small ditch after a rain"...
> (Montalvo, 1949)

En el año de 1979 el que suscribe este reporte realizó un inventario de sitios en la Isla y localizó nuevos sitios para este municipio.

En el año de 1984 el investigador Edgar Máiz et-al hicieron un estudio a lo largo de la cuenca del río Yauco y localizaron sitios precolombinos.

En el año de 1989 el arqueólogo Jesús Figueroa Lugo realiza un trabajo de excavación, Fase II, en el barrio Susua Alta.

Para mediados del año de 2002, el arqueólogo Eduardo Questell y otros investigadores llevan a cabo una investigación Fase III en un sitio cercano al Río Yauco.

Sitios Reportados para el Municipio de Yauco

1- La Escalera
2- La Florida
3- Diego Hernández
4- Mattei
5- Barinas I
6- Barinas II
7- Luchetti
8- Jácanas
9- Media quija
10- Punta Verraco
11- Quebradas
12- Fraternidad
13- El cafetal

INFORMES DE RECURSOS CULTURALES LEIDOS Y ANALIZADOS

Estudios de Recursos Culturales - Fase 11

Ext. Monte Verde

Barrio Susua Alta

1989 – Jesús Figueroa Lugo – No recomendó estudios adicionales

Evaluación Arqueológica – Fase 1A -1B

Haciendas de Yauco

Barrio Almácigo Bajo

1988 – Eduardo Questell et-al - Negativo

Estudio Arqueológico – Fase 1A-1B

Villas del Cafetal

Barrio Susúa Alta

1988 – Antonio Daubón Vidal – Negativo

Estudio Arqueológico – Fase 1A-1B

Quintas del Cafetal

Barrio Susúa Baja

1996 – Jaime Vález – Negativo

Evaluación de Recursos Culturales - Fase 1A-1B

Facilidades Operaciones A.A.A.

Barrio Susúa Baja

1997 – Virginia Rivera – Negativo

Evaluación Arqueológica – Fase 1A-1B

Peb Boys

Barrio Susúa Baja

1999 – Andrés Príncipe - Negativo

Evaluación de Recursos Culturales - Fase 1A-1B

Finca Mariani

Barrio Susúa

2002 – Ethel V. Schlafer - Negativo
Evaluación Arqueológica – Fase 1A-1B

Jardines de Getsemaní

Barrio Susúa Alta

2000 – Eduardo Questell – Negativo

Informe de Evaluación Arqueológica – Fase 1A-1B

Escuela Superior Urbana

Barrio Susúa Baja

2000 – Antonio Daubón Vidal - Negativo

Evaluación de Recursos Culturales - Fase 1A

Mejoras Sistema Alcantarillado

Barrio Jácana

2002 – Rafael del C. Camacho - recomendó estudios adicionales.

Estudios de Recursos Culturales - Fase 1A

Parque de Bombas

Barrio Barinas

2004 – Adalberto Maurás - no recomendó estudios adicionales.

Estudio Arqueológico – Fase 1B

Mejoras al Sistema Alcantarillado

Barrio Jácana

2003 – Marisol Martínez Garayalde - Negativo

Estudio Arqueológico – Fase 1A-1B

Alturas del Susúa

Barrio Susúa

2005 – Harry Alemán Crespo – Negativo

Estudio Arqueológico – Fase 1A-1B

Villas de Yauco

Barrio Susúa Baja

2002 – Aramis Font - Negativo

Evaluación Arqueológica – Fase 1A

Reemplazo Tubería Sanitaria

Barrio Pueblo Sur

2005 – Jesús Figueroa Lugo – No recomendó estudios adicionales.

Evaluación Arqueológica – Fase 1A-1B

Urb. Veredas de Yauco

Barrio Susúa Baja

2003 – Jesús Figueroa Lugo - no recomendó estudios adicionales.

Determinación de Recursos Culturales – Fase 1A-1B

Segregación de Solares

Barrio Susúa Baja

2005- Ethel V. Schlafer – no recomendó estudios adicionales.

Estudio de Recursos Culturales – Fase 1A

Brisas del Cafetal

Barrio Susúa Baja

2005 – Aramis Font – No recomendó estudios adicionales.

NOTAS SOBRE LA HISTORIA DE YAUCO

La fundación oficial de Yauco se efectuó el 29 de febrero del 1756, sin embargo la ocupación de sus tierras data desde tiempos precolombinos.

> "Este territorio fue asiento de la tribu más numerosa de la Isla, en la cuál gobernaba el Cacique más importante, **Agüeybana.** Fue éste el primer territorio visitado por el conquistador Juan Ponce de León"
> (Diez, 1988)

En la región de Yauco ocurrieron importantes incidentes durante los primeros años de la colonización española que han quedado registrado para la histórica: el inicio de la rebelión indígena en el 1511 y la muerte de Cristobal de Sotomayor por parte del Cacique **Güaybana.**

Con la forzada desintegración social de los grupos Indígenas la región pierde su importancia hasta que vecinos del distante pueblo de San Germán deciden establecerse en las riberas del río Yauco. Muy prontamente el grupo de labradores aumenta en tamaño gracias a la fertilidad de las tierras y a la disponibilidad de recursos de agua fresca.

Para el primer tercio del siglo XVIII el núcleo de vecinos de la ribera del río Yauco tenía su Iglesia, la cuál estaba dedicada a la Santísima Virgen del Rosario; prontamente los dedicados labradores deciden que era tiempo para iniciar gestiones y se les reconociera oficialmente como pueblo.

> "Dichos vecinos dieron poder a Don Fernándo Pacheco para que éste solicitara del Gobierno autorización para fundar el pueblo en el asiento situado a medio cambio entre San Germán y Ponce."
> (ibid.)

Durante los primeros años después de la fundación oficial, el desarrollo del poblado fue lento; después del 1815 la Real Cédula de Gracia hizo posible un influjo de inmigrantes hacia Yauco que abonaron progreso prosperidad.

> "Una buena parte de los inmigrantes se dedicaron al cultivo de la caña de azúcar. Otros se ubicaron en el sector montañoso del centro de la Isla para cultivar frutos menores y cafe"
> (Díaz, 1981)

Los inmigrantes mallorquines a la región de Yauco se dedicaron al comercio y a la producción cafetalera; apellidos como Alcover, Alberti, Oliver, Alemañy, Arbona, Mayol todavía mantienen descendencia, algunos continúan dedicados al cultivo del café.

> "Pero lo más significativo desde el punto de vista sociológico es que se fundieron con los nativos, se integraron en la vida social,económica y hasta política de la comunidad de tal manera uqe sin abjurar de su orígen, se convirtieron en autenticos Yaucanos y puertorriqueños."
> (Villar, 1976)

Desde su fundación hasta la década del 1960, la base económica de este municipio fue la agricultura y en segundo plano la ganadería. En el siglo 19 el cultivo del café y su excelente precio en los mercados mundiales trajo mucha prosperidad. El café producido fue tan famoso que se le hacían envios periodicos del mismo al Santo Padre en Roma. En la actualidad se cultiva el aromático grano, frutos menores que en unión a la ganadería y a varias fábricas dedicadas a la manufactura son importantes fuentes de empleos. Son muy frecuentaos los centros comerciales del centro urbano y el de las afueras del municipio.

Este municipio tiene una gran extensión territorial con numerosos barrios: Pueblo, Aguas Blancas, Algarrobo, Almácigo Alto, Almácigo Bajo, Barinas,

Caimito, Collores, Diego Hernández, El Duey, Frailes, La Jácana, Naranjo, Quebradas, Ranchera, Río Prieto, Rubias, Sierra Alta, Susuá Alta, Susua Baja y Vegas.

En este legendario pueblo han nacido un gran múmeros de personalidades que se han destacado en la politica, las artes, las ciencias y en el trabajo social, algunos de ellos todavía activos: Sister Dominga, Modesto Cordero Santiago, Pedro Domingo Mariani, José Enamorado Cuesta, Amelia Agostini del Río, Ruben del Rosario, Leticia del Rosario, Ismael Vélez, Loida Figueroa, Amaury Veray, Magda López de Victoria y Francisco Lluch Mora son algunos ejemplos.

Con estas notas hemos reseñado algunos momentos de la fecunda historia de Yauco, pues una historia con todos sus detalles está más allá de los alcances de este estudio.

Como colofón queremos añadir una observación que se hiciera sobre Yauco en el ano de 1904 por el continental Samuel W. Mavin.

"Como en todos los países productores, hay aquí una región donde el café excede en méritos y esa región es Yauco."

El predio y sus alrededores en el año de 1936.
Foto de la Autoridad de Carreteras
Escala 1: 18,000

El predio y sus alrededores en el año de 2005.
Foto de la Autoridad de Carreteras
Escala 1: 20,000

SENSITIVIDAD ARQUEOLÓGICA

Se revisaron varios informes de arqueólogos que hicieron investigaciones en el Barrio donde ubica el proyecto, los mismos fueron negativos en lo relativo a la presencia de remanentes culturales de origen precolombino o histórico. El que suscribe éste informe también llevó a cabo investigaciones de arqueología por contrato en el Barrio, éstas resultaron negativas de remanentes culturales asociados a etnias precolombinas.

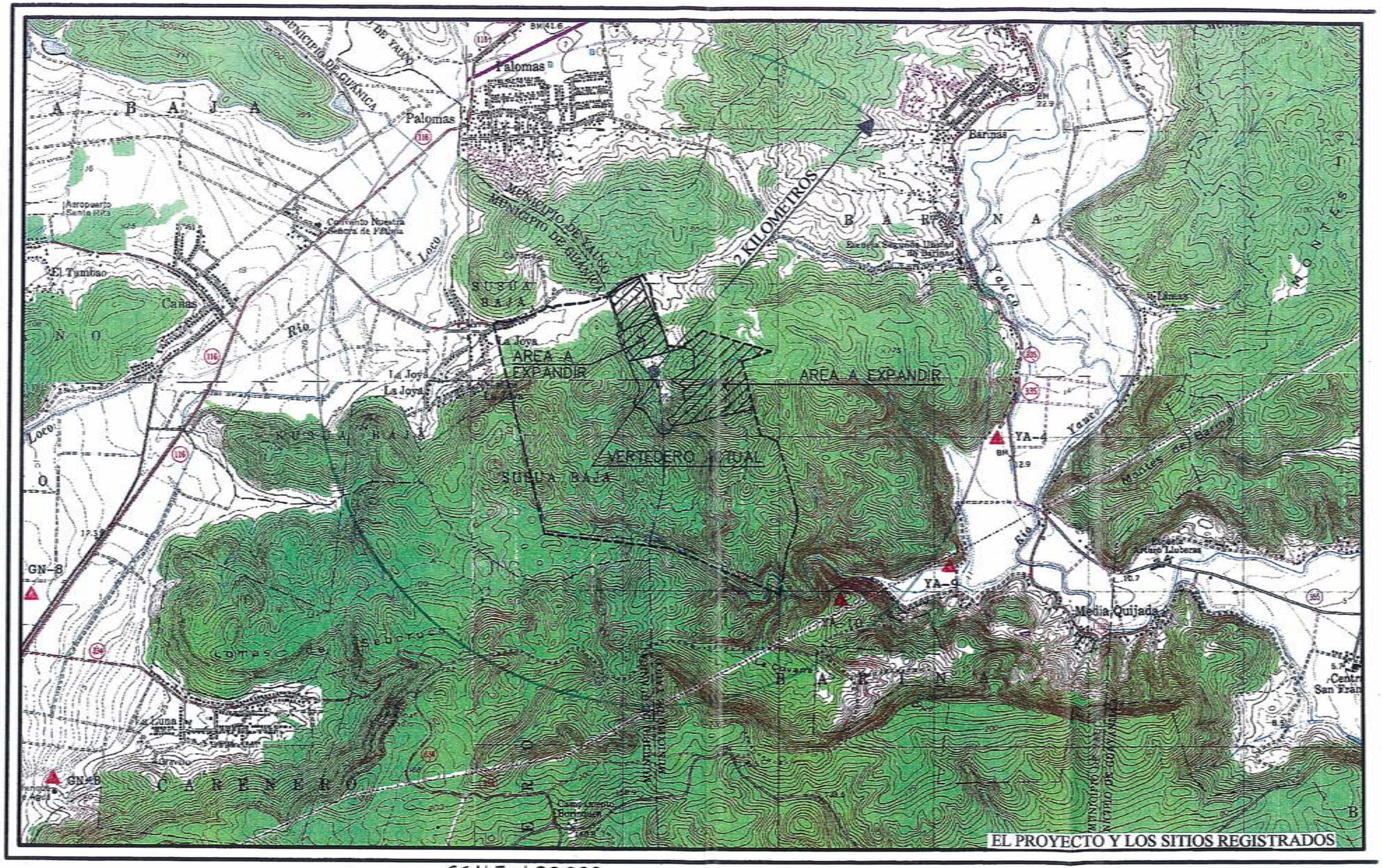
Las consultas con personas que llevan años residiendo en la vecindad, señalan que "he oído que por Collores han sacado cantaras de indios y las tiene el maestro de la escuela de allí."

Según se desprende de los sitios registrados en los cuadrángulos que están archivados en las planeras localizadas en la Oficinal Estatal de Preservación Histórica y del Consejo de Arqueología Terrestre, hay un sitio **(YA-10)** documentado localizado a 1.7 kilómetros al Sureste del vertedero, el mismo no será afectado por las operaciones planificadas. Hay otros sitios reportados pero éstos están a distancias mayores de 2 kilómetros.

Entendemos que por las características de medio ambiente del sector y los suelos pobres para la agricultura, el área bajo estudio es de baja sensitividad arqueológica.

Se debe de entender que porque en un Barrio estén ubicados sitios con materiales precolombinos/históricos, no todos los sectores y/o predios de terrenos del mismo son propensos a tener remanentes culturales.

En el listado del Registro Nacional de Lugares Históricos aparecen unas estructuras que están ubicadas dentro de los límites territoriales de la municipalidad de Yauco, la misma bien distante del área que será intervenida.



SCALE= 1:20,000

RESUMEN DE LA INVESTIGACIÓN DOCUMENTAL

Se revisaron escritos de historiadores y varios informes de arqueólogos que hicieron investigaciones en el Barrio y Barrios colindantes con la zona bajo estudio; en adición se hicieron consultas con personas que conocen el sector, éstos informaron de la no existencia de sitios en el barrio en donde se planifica la ubicación del propuesto proyecto.

Se leyeron y analizaron las evaluaciones de recursos culturales realizadas para terrenos localizados en el barrio Barinas de Yauco. De otros informes leídos solo obtuvimos información de los sitios ya conocidos que están ubicados dentro de la jurisdicción de la municipalidad.

Se examinaron los expedientes con información relacionada a la prehistoria/historia de Puerto Rico que están localizados en los archivos de la Oficina del Consejo para la Protección del Patrimonio Arqueológico Terrestre de Puerto Rico y la Oficina Estatal de Preservación Histórica, en los mismos no aparecen formularios para sitios precolombinos localizados en y/o las cercanías inmediatas a las colindancias de los terrenos que serán intervenidos.

En el listado del Registro Nacional de Lugares Históricos aparecen inscritas estructuras del municipio de **Yauco.**

SÍNTESIS DE LA FASE 1-A

1. En la literatura existente referente a sitios arqueológicos que fue revisada, no hay información sobre la existencia de sitios (que estén registrados) en/o los alrededores inmediatos de la colindancias de los terrenos que serán intervenidos.

2. En los listados del Consejo para la Protección del Patrimonio Arqueológico de Puerto Rico y la Oficina Estatal de Preservación Histórica no hay sitios registrados que estén ubicados en sectores inmediatos a las colindancias.

3. La tradición oral es muy clara en cuanto a que no se conocen áreas con evidencia precolombina, no hay información sobre el hallazgo de objetos de origen indígena dentro de los límites del propuesto proyecto.

4. Se hizo un rastreo/inspección de la superficie de los terrenos expuestos, no se pudo detectar la presencia de recursos precolombinos o históricos.

5. En el listado de propiedades de Puerto Rico incluidas en el Registro Nacional de Lugares Históricos aparecen unas estructuras localizadas dentro de los límites de **Yauco**.

CONCLUSIÓN

En la investigación documental sobre los terrenos que serán intervenidos, se encontró información sobre la no existencia de sitios en la vecindad del predio.

En la inspección/rastreo de los terrenos se pudo constar la ausencia de remanentes de origen precolombino o históricos.

RECOMENDACIONES

Recomendamos que las Agencias de Gobierno correspondientes endosen el proyecto según lo han programado sus proponentes.

No recomendamos más estudios para los terrenos que serán desarrollados; sin embargo queremos enfatizar que los desarrolladores deberán de ejerza cautela cuando se hacen los movimientos de terreno, de aparecer remanentes culturales en el subsuelo, los Proponentes detendrán los trabajos de campo y se comunicarán con la Agencia indicada y el Arqueólogo para determinar la acción a seguir.

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Foto #1 Vista parcial de terrenos de la expansión lateral.

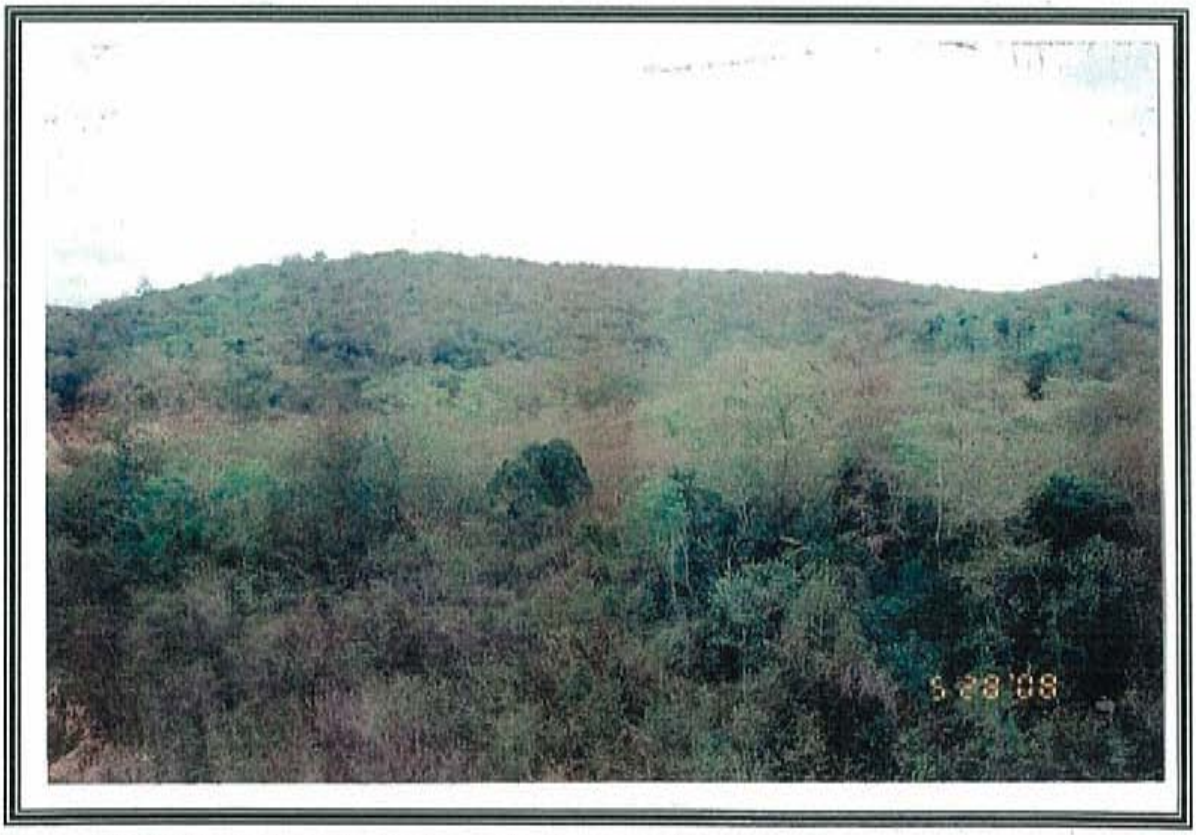

Foto #2 Vista parcial de terrenos de la expansión lateral.

Apéndice 11:

Estudio Hidrológico-Hidráulico

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.
Hydrology • Hydraulics • Sediment Transport

HYDROLOGIC-HYDRAULIC AND SEDIMENTATION ANALYSIS FOR YAUCO LANDFILL YAUCO, PUERTO RICO

PREPARED FOR:

L.M. WASTE SERVICES CORPORATION

PREPARED BY:

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OCTOBER 2008

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GEOMETRY: EXISTING 2-YR

GEOMETRY: EXISTING 100-YR

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13. Water surface profiles for the proposed condition: 2-year flood event for Natural Drainage at sections 9, 10, 11, 12, 13, and 14 (scale as shown).
14. Water surface profiles for the proposed condition: 2-year flood event for Natural Drainage at sections 15, 16, 17, 18 and 19 (scale as shown).

HYDROLOGIC-HYDRAULIC AND SEDIMENTATION ANALYSIS FOR YAUCO LANDFILL YAUCO, PUERTO RICO

Menar Hydrosystems Engineering, PSC
October 2008

I. INTRODUCTION

General

The Yauco landfill is located on the State Road PR-389 Km. 3.8, Barinas ward, within the Municipality of Yauco. Figure 1 shows its location on the USGS topographic maps of Yauco and Punta Verraco, published by the US Geological Survey [1982]. Since the storage capacity of the facility is near the limit it is necessary to be increased. Therefore, additional areas within the property limits will be required for this purpose. An Environmental Impact Statement (EIS) is required to determine the impact on the environment within the project area and vicinity due to the proposed landfill expansion.

For this case, one of the required technical studies which include the EIS is a Hydrologic-Hydraulic and Sedimentation Analysis. The main purpose of this study is the determination of the superficial runoff produced during ordinary and extraordinary rainfall events and the soil erosion potential during those events.

Five retention ponds currently exist within the existing natural drainages and/or creeks within or adjacent to the project property area. The purpose of these ponds is to control the sediments leaving the landfill area.

Flood levels along the creeks or natural drainages will be computed for the 2- and 100-year frequency events since, representative of the ordinary and extraordinary events, respectively. In addition, the sediment yield for the existing and proposed conditions for the 2- and 10-yr events will be determined. Minimum required control structures will be designed for these events. The sediment yield for the 100-year event will be computed for informative purposes only since the resulting minimum required control structures might be too big for their implementation.

The property is not located within flooding zone as indicated in the FEMA's Flood Insurance Rate Maps (FIRM) No. 1615H and 1980H. In spite of that, the project will be treated as a flooding zone and the requirements of the Planning Regulation No. 13 of the PR Planning Board [PRPB, 2005a] will be applied. Figure 2 shows a partial copy of these maps published by the Federal Emergency Management Agency (FEMA).

Authorization

Mr. Ricardo Flores Ortega, P.E., representative of RF Engineering, P.S.C., authorized this study through an agreement with Mr. Miguel Menar Figueroa, P.E., representative of Menar Hydrosystems Engineering, P.S.C.

Scope of Work

The scope of work for the hydrologic-hydraulic study includes the following tasks.

- Site visit to determine the existing hydrologic and hydraulic conditions.
- Hydrologic and hydraulic modeling of the existing and proposed conditions.
- Determination of sediment yields for the existing and proposed conditions for the 2-, 10-, and 100-yr frequency events.
- Determination of the hydraulic profiles for the 2- and 100-year frequency events for the existing and proposed conditions at the existing natural drainages.
- Determine the minimum required change in the existing structures for flow mitigation as required by the Planning Regulation No. 3 of the PRPB. These structures will be designed for the 2- and 100-year peak flow discharges.

This study is divided in three phases: 1) Hydrologic Analysis, 2) Hydraulic Analysis and 2) Sedimentation Analysis. The results will be described below for each phase.

II. HYDROLOGIC AND RETENTION ANALYSES

Methodology

A hydrologic analysis was performed to determine the peak flow discharges corresponding to the 2-year (2-yr), 10-year (10-yr), and 100-year (100-yr) rainfall events within the studied watersheds. This analysis employed the Unit Hydrograph

methodology developed by the U.S. Soil Conservation Service (SCS) and implemented in the April 2008 in the HEC-HMS (Hydrologic Modeling System) computer program (version 3.2) [USACE, 2008].

Peak flow discharges were computed at each sub-basin outlet for two (2) conditions: the ***existing condition*** for the actual condition in the studied area and, the ***proposed condition*** for the proposed changes as part of the expansion of the existing landfill. Figures 3 and 4 show the sub-basins delimitation for the existing and proposed conditions, respectively.

The retention ponds were simulated using the reservoir simulation option included in the HEC-HMS model. This model uses the Elevation-Area and Elevation-Discharge relations to simulate the storage and peak flow discharge within the simulated ponds. For the existing ponds the Elevation-Area relation was developed using the topographic layout plan and the USGS topographic maps of Yauco and Punta Verraco. The Elevation-Discharge relations were determined using the weir flow equation. The existing ponds discharge through weirs structures and by overflow. The Appendix C includes the Elevation-Area and Elevation-Discharge relations calculated for the existing and proposed retention ponds within the studied area.

Watershed Description

Drainage watersheds were delimited using the USGS 1:20,000 topographic maps of Yauco and Punta Verraco, and the existing and proposed topographic layout plans include in Appendix H. Figures 3 and 4 show the drainage watershed for the existing and proposed conditions, respectively.

Existing Condition

For the existing condition a total of ten (10) sub-basins were delimited: ***Basin North*** (***BASN***) and ***Landfill North*** (***LN***) for the areas draining to an existing retention pond named ***Pond North*** located at the north limit of the property. ***Basin West*** (***BASW***) and ***Landfill West*** (***LW***) for drainage areas draining to an existing pond named ***Pond West***. ***Basin East*** (***BASE***) and ***Landfill East*** (***LE***) for drainage areas draining to an existing pond named ***Pond East***. ***Basin South West*** (***BASSW***), ***Basin South East*** (***BASSE***), and ***Landfill South*** (***LS***) for the areas draining to the existing ***Pond South 1***. This, at once, is interconnected with a pond named ***Pond South 2*** which receives runoff from ***Basin South*** (***BASS***).

For the existing condition, the hydrologic model was conceptualized as ***Basin North*** (***BASN***) and basin ***Landfill North*** (***LN***) draining to the existing ***Pond North***. Sub-basins ***Basin West*** (***BASW***) and ***Landfill West*** (***LW***) draining to the existing ***Pond West***. Sub-basins ***Basin East*** (***BASE***) and ***Landfill East*** (***LE***) draining to the existing ***Pond East***. Peak flows from ***Pond West*** and ***Pond East*** were routed using the

Muskingum method. The reaches were named ***RW*** and ***RE***, respectively, and were combined at combination point ***COM***. It was routed through a reach named ***RC***. ***Landfill South*** (***LS***), ***Basin South West*** (***BASSW***) and ***Basin South East*** (***BASSE***) drain into ***Pond South 1*** which drain into the existing ***Pond South 2***. Finally, ***Basin South*** (***BASS***) drains into ***Pond South 2***.

Proposed Condition

For the proposed condition a total of ten (10) sub-basins were delimited. The sub-basins were delimited as described for the existing condition. Only the sub-basins ***Landfill North*** (***LN***), ***Landfill West*** (***LW***), ***Landfill East*** (***LE***), and ***Landfill South*** (***LS***) were rearranged according to the proposed layout plan.

Pond Description

The retention ponds were simulated for the existing and proposed conditions. The Elevation – Area and the Elevation – Discharge relations were determined using the USGS 1:20,000 topographic maps of Yauco and Punta Verraco and, the current topographic survey of the site. Figures 5 and 6 show the retention ponds location for the existing and proposed conditions, respectively.

Existing Condition

As mentioned earlier, for the existing condition five (5) retention ponds were simulated: ***Pond North*** for the existing pond located at north limit of the landfill property, ***Pond***

West for the existing pond at the west limit, ***Pond East*** for the existing pond at the east limit and, ***Pond South 1*** and ***Pond South 2*** for the ponds located at the south limit. For the existing condition the outlet points for ***Pond West*** and ***Pond East*** were determined using the current topographic survey. The effective storage volume for ***Pond West*** and ***Pond East*** are controlled by the pond's dimensions and the topography. That is, when the structures are flooded the surrounding area operates as large storage volumes. These areas were established using the existing topographic survey and the USGS topographic maps. Figure 5 shows the location plan and the storage volume limits for the existing retention ponds.

Proposed Condition

The proposed condition scenario corresponds to the simulation of the minimum required combination of pond storage and outlet structure to avoid flood condition, minimize the sediments discharge and, provide a peak flow discharge equal or lower than the calculated for the existing condition.

Rainfall Data

Average point rainfalls depths for the 2- and 100-year events were taken from the Frequency Data Server available online and developed for NOAA's National Weather Services in NOAA Atlas 14 Volume 3, Version 3.0 [U.S. Department of Commerce, et. al 2006]. This data is included in Appendix B. Frequency based hypothetical storm used by the runoff model for the basin hydrologic response analysis were generated

using the data in Table 1. The total storm is automatically distributed according to the specified depth per duration data for each analyzed exceedance probability (2- and 100-year) for 24 hours duration event. A triangular precipitation distribution (balanced storm) was constructed such that the depth specified for any duration occurs during the central part of the storm.

Table 1. Rainfall depths used in the HEC-1 model.

Duration, hr	0.083	0.25	1	2	3	6	12	24
2-yr, in	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
100-yr, in	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

Time of Concentration

The time of concentration (*Tc*) is defined as the time it takes to the most hydraulically remote drop of water to travel to the basin outlet. Time of Concentration within each sub-basin was estimated using the Kirpich equation,

$$T_c = 0.00013*(L^{0.77}/S^{0.385}) \quad (1)$$

where, T_c is the time of concentration in hours, L is the length of the overland flow in feet, and S is the average overland slope in ft/ft. Appendix A includes the computations for the time of concentration for the studied basins for the existing and proposed conditions.

Soils

The soil types were taken from the new Soil Survey of the San Germán Area, Southwestern Puerto Rico, prepared by the Natural Resources Conservation Service [NRCS, 2007]. This document replaces the Soil Survey of the Lajas Valley Area issued in April 1965. The soils within the project area are mostly composed of hydrologic soil group D. The weighted curve numbers for each sub-basin are included in the Appendix A.

III. HYDROLOGIC AND RETENTION ANALYSES RESULTS

Existing Condition

Peak Discharges

The HEC-HMS modeling was performed using: 1) the rainfall depths; 2) the basin's areas; 3) the curve numbers (CN) and; 4) the basin's lag times ($0.6T_c$). Peak flow discharges for the 2-, 10-, and 100-year events were computed at each sub-basin outlet.

The hydrologic analysis results for the existing condition are shown in Table 2 for the 2-, 10- and 100-year rainfall events. The estimated CN values and peak flow discharges for each sub-basin are shown in this table (for antecedent moisture condition II [AMC II]). The Appendix A includes the CN and time of concentration calculation. The

Appendix D includes the hydrologic simulation results obtained from HEC-HMS model (simulation runs: ***EXISTING 2-YR, EXISTING 10-YR, EXISTING 100-YR***).

Table 2. Hydrologic analysis results for the 2-, 10-, and 100-year rainfall events for the existing condition.

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
2-YR				
BASW	36.89 (0.0576)	82	6	180 (5.10)
LW	1.92 (0.0030)	89	5	12 (0.34)
POND WEST				85 (2.41)
Routing (RW)				83 (2.35)
BASE	70.97 (0.1109)	82	8	318 (9.00)
LE	7.50 (0.0117)	87	5	43 (1.22)
POND EAST				1 (0.03)
Routing (RE)				1 (0.03)
Combination (COM)				84 (2.38)
Routing (RC)				83 (2.38)
LS	6.91 (0.0108)	89	5	42 (1.19)
BASSW	10.85 (0.0170)	82	5	57 (1.61)
BASSE	1.57 (0.0025)	82	5	8 (0.23)
POND SOUTH 1				109 (2.38)
BASS	7.61 (0.0119)	82	5	39 (1.10)
POND SOUTH 2				144 (4.08)
Combination (COMT)				144 (4.08)
LN	17.78 (0.0231)	88	5	88 (2.49)
Routing (RN)				81 (2.29)
BASN	45.45 (0.0710)	84	7	224 (6.34)
POND NORTH				273 (7.73)
10-YR				
BASW	36.89 (0.0576)	82	6	268 (7.59)
LW	1.92 (0.0030)	89	5	16 (0.45)

Table 2. Hydrologic analysis results for the 2-, 10-, and 100-year rainfall events for the existing condition (continued).

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
10-YR				
POND WEST				218 (617)
Routing (RW)				211 (5.97)
BASE	70.97 (0.1109)	82	8	476 (13.48)
LE	7.50 (0.0117)	87	5	61 (17.73)
POND EAST				32 (0.91)
Routing (RE)				32 (0.91)
Combination (COM)				211 (5.97)
Routing (RC)				206 (5.83)
LS	6.91 (0.0108)	89		57 (1.61)
BASSW	10.85 (0.0170)	82	5	84 (2.38)
BASSE	1.57 (0.0025)	82	5	12 (0.34)
POND SOUTH 1				268 (7.59)
BASS	7.61 (0.0119)	82	5	58 (1.64)
POND SOUTH 2				299 (8.47)
Combination (COMT)				299 (8.47)
LN	17.78 (0.0231)	88	5	121 (3.43)
Routing (RN)				111 (3.14)
BASN	45.45 (0.0710)	84	7	327 (9.26)
POND NORTH				396 (11.21)
100-YR				
BASW	36.89 (0.0576)	82	6	371 (10.51)
LW	1.92 (0.0030)	89	5	21 (0.59)
POND WEST				313 (8.86)
Routing (RW)				301 (8.52)
BASE	70.97 (0.1109)	82	8	659 (18.66)
LE	7.50 (0.0117)	87	5	81 (2.29)
POND EAST				264 (7.48)
Routing (RE)				263 (7.45)
Combination (COM)				486 (13.76)

Table 2. Hydrologic analysis results for the 2-, 10-, and 100-year rainfall events for the existing condition (continued).

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
100-YR				
Routing (RC)				480 (13.59)
LS	6.91 (0.0108)	89		75 (2.12)
BASSW	10.85 (0.0170)	82	5	116 (3.28)
BASSE	1.57 (0.0025)	82	5	17 (0.48)
POND SOUTH 1				555 (15.72)
BASS	7.61 (0.0119)	82	5	81 (2.29)
POND SOUTH 2				534 (15.12)
Combination (COMT)				584 (16.54)
LN	17.78 (0.0231)	88	5	160 (4.53)
Routing (RN)				148 (4.19)
BASN	45.45 (0.0710)	84	7	446 (12.63)
POND NORTH				423 (11.98)

Retention Analysis

A flow retention analysis was performed to determine the storage capacity of the existing ponds. The results for this analysis for the existing condition are shown in Table 3.

Results show that for the 2-, 10- and 100-yr events, ponds ***North***, ***South 1*** and ***South 2*** are flooded. For the 2-yr event, ponds ***South 1*** and ***South 2*** are flooded 0.17 meter each one. For the 10-yr event, ponds ***North***, ***South 1*** and ***South 2*** are flooded 0.06, 0.35 and 0.35 meter, respectively. For the 100-yr event, ponds ***North***, ***South 1*** and ***South 2*** are flooded 0.13, 0.60 and 0.60 meter, respectively.

For that reason, these structures should be modified to comply with two purposes: 1) provide the minimum required storage capacity and; 2) to produce an outflow discharge equal or lower than the calculated for the existing condition. As mentioned earlier, these modifications will be performed to comply with the 2- and 100-year design events. Detailed results from the hydrologic modeling of the existing condition are included in Appendix D.

Table 3. Retention analysis for the existing condition.

Structure	Peak Inflow, cfs, (m^3/s)	Peak Outflow, cfs (m^3/s)	Peak Elevation, ft (m)	Top Elevation, ft, (m)	Outlet Structure	Outlet Elevation, ft, (m)
2-YR						
Pond North	283 (8.01)	249 (7.05)	242.6 (73.94)	242.78 (74.00)	Weir	73.00 (239.50)
Pond West	191 (5.41)	85 (2.41)	388.6 (118.44)	393.70 (120.00)	Weir	118.00 (387.14)
Pond East	355 (10.05)	1 (0.03)	385.5 (115.76)	396.98 (121.00)	Weir	119.00 (390.42)
Pond South 1	109 (3.08)	109 (3.08)	318.8 (97.17)	318.24 (97.00)	Weir	97.00 (318.24)
Pond South 2	144 (4.08)	144 (4.08)	318.8 (97.17)	318.24 (97.00)	Weir	97.00 (318.24)
10-YR						
Pond North	406 (11.50)	401 (11.35)	243.0 (74.06)	242.78 (74.00)	Weir	73.00 (239.50)
Pond West	284 (8.04)	218 (6.17)	390.0 (118.87)	393.70 (120.00)	Weir	118.00 (387.14)
Pond East	529 (14.97)	32 (0.91)	391.0 (119.18)	396.98 (121.00)	Weir	119.00 (390.42)
Pond South 1	268 (7.59)	268 (7.59)	319.4 (97.35)	318.24 (97.00)	Weir	97.00 (318.24)
Pond South 2	300 (8.50)	299 (8.47)	319.4 (97.35)	318.24 (97.00)	Weir	97.00 (318.24)
100-YR						
Pond North	551 (15.60)	546 (15.46)	243.2 (74.13)	242.78 (74.00)	Weir	73.00 (239.50)
Pond West	391 (11.07)	313 (8.86)	390.7 (119.09)	393.70 (120.00)	Weir	118.00 (387.14)
Pond East	730 (20.67)	265 (7.50)	394.1 (120.12)	396.98 (121.00)	Weir	119.00 (390.42)
Pond South 1	555 (15.72)	555 (15.72)	320.2 (97.60)	318.24 (97.00)	Weir	97.00 (318.24)
Pond South 2	585 (16.57)	584 (16.54)	320.2 (97.60)	318.24 (97.00)	Weir	97.00 (318.24)

Proposed Condition

Peak Discharges

The hydrologic analysis results for the proposed condition are shown in Table 4 for the 2-, 10-, and 100-year rainfall events, respectively. The estimated CN values and peak flow discharges for each basin are shown in this table (for antecedent moisture condition II [AMC II]). Appendix A includes the CN and lag time calculations. Appendix D includes the hydrologic simulation results obtained from HEC-HMS model (simulation runs: ***PROPOSED 2-YR, PROPOSED 10-YR, PROPOSED 100-YR***).

Table 4. Hydrologic analysis results for the 2-, 10-, and 100-year rainfall events for the proposed condition.

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
2-YR				
BASW	36.89 (0.0576)	82	6	180 (5.10)
LW	1.92 (0.0030)	89	5	12 (0.34)
POND WEST				86 (2.44)
Routing (RW)				85 (2.41)
BASE	58.01 (0.0906)	82	9	304 (8.61)
LE	15.64 (0.0244)	89	5	58 (1.64)
POND EAST				1 (0.03)
Routing (RE)				1 (0.03)
Combination (COM)				85 (2.41)
Routing (RC)				84 (2.38)
LS	6.91 (0.0108)	89	5	43 (1.22)
BASS	7.61 (0.0119)	82	5	39 (1.10)
BASSW	10.85 (0.0170)	82	5	56 (1.59)
BASSE	1.57 (0.0025)	82	5	8 (0.23)
POND SOUTH				102 (2.89)

Table 4. Hydrologic analysis results for the 2-, 10-, and 100-year rainfall event for the proposed condition (continued).

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
2-YR				
Combination (COMT)				102 (2.89)
LN	21.21 (0.0331)	89	5	74 (2.10)
Routing (RN)				68 (1.93)
BASN	43.84 (0.0685)	86	7	206 (5.83)
POND NORTH				5 (0.14)
10-YR				
BASW	36.89 (0.0576)	82	6	269 (7.62)
LW	1.92 (0.0030)	89	5	18 (0.51)
POND WEST				220 (6.23)
Routing (RW)				213 (6.03)
BASE	58.01 (0.0906)	82	9	458 (12.97)
LE	15.64 (0.0244)	89	5	79 (2.24)
POND EAST				37 (1.05)
Routing (RE)				37 (1.05)
Combination (COM)				213 (6.03)
Routing (RC)				210 (5.95)
LS	6.91 (0.0108)	89	5	59 (1.67)
BASS	7.61 (0.0119)	82	5	58 (1.64)
BASSW	10.85 (0.0170)	82	5	83 (2.35)
BASSE	1.57 (0.0025)	82	5	12 (0.34)
POND SOUTH				284 (8.04)
Combination (COMT)				284 (8.04)
LN	21.21 (0.0331)	89	5	101 (2.86)
Routing (RN)				93 (2.63)
BASN	43.84 (0.0685)	86	7	315 (8.92)
POND NORTH				173 (4.90)
100-YR				
BASW	36.89 (0.0576)	82	6	371 (10.51)
LW	1.92 (0.0030)	89	5	24 (0.68)

Table 4. Hydrologic analysis results for the 2-, 10-, and 100-year rainfall event for the proposed condition (continued).

BASIN	AREA, ac (mi^2)	CN	T_c, min	Q, cfs (cms)
100-YR				
POND WEST				316 (8.95)
Routing (RW)				304 (8.61)
BASE	58.01 (0.0906)	82	9	635 17.98)
LE	15.64 (0.0244)	89	5	104 (2.94)
POND EAST				281 (7.96)
Routing (RE)				280 (7.93)
Combination (COM)				497 (14.07)
Routing (RC)				492 (13.93)
LS	6.91 (0.0108)	89	5	77 (2.18)
BASS	7.61 (0.0119)	82	5	81 (2.29)
BASSW	10.85 (0.0170)	82	5	115 (3.26)
BASSE	1.57 (0.0025)	82	5	17 (0.48)
POND SOUTH				570 (16.14)
Combination (COMT)				570 (16.14)
LN	21.21 (0.0331)	89	5	133 (16.14)
Routing (RN)				123 (3.48)
BASN	43.84 (0.0685)	86	7	439 (12.43)
POND NORTH				423 (11.98)

Retention Analysis

For the proposed condition the existing ponds ***North***, ***South 1*** and ***South 2*** were modified to avoid flooding conditions and produce an outflow discharge equal or lower than the calculated for the existing condition for the 2- and 100-yr events.

During the proposed condition, the depth in pond ***North*** was increased 1.0 meter. The ponds ***South 1*** and ***South 2*** were joined in one single pond named ***Pond South***. The

outlet structures for the proposed modified structures are composed weirs. Figure 6 shows a plan view of the proposed retention structures.

The results of the retention pond analysis for the proposed condition are shown in Table 5. For the proposed condition a freeboard of 0.30 and 0.35 meter was calculated for the 100-yr event in ponds ***North*** and ***South***, respectively.

Table 5. Retention analysis for the proposed condition.

Structure	Peak Inflow, cfs, (m^3/s)	Peak Outflow, cfs (m^3/s)	Peak Elevation, ft (m)	Top Elevation, ft, (m)	Outlet Structure	Outlet Elevation, ft, (m)
2-YR						
Pond North	256 (7.25)	5 (0.14)	239.4 (72.97)	242.78 (74.00)	Weir	73.00 (239.50)
Pond West	193 (5.46)	86 (2.43)	388.6 (118.44)	393.70 (120.00)	Weir	118.00 (387.14)
Pond East	354 (10.02)	1 (0.03)	385.9 (117.62)	396.98 (121.00)	Weir	119.00 (390.42)
Pond South	146 (4.13)	102 (2.88)	317.9 (96.90)	321.52 (98.00)	Weir	96.70 (317.26)
10-YR						
Pond North	380 (10.76)	174 (4.92)	240.8 (73.40)	242.78 (74.00)	Weir	73.00 (239.50)
Pond West	286 (8.10)	220 (6.23)	390.0 (118.87)	393.70 (120.00)	Weir	118.00 (387.14)
Pond East	525 (14.87)	37 (1.05)	391.1 (119.20)	396.98 (121.00)	Weir	119.00 (390.42)
Pond South	305 (8.63)	284 (8.04)	318.8 (97.17)	321.52 (98.00)	Weir	96.70 (317.26)
100-YR						
Pond North	525 (14.86)	423 (11.98)	241.8 (73.70)	242.78 (74.00)	Weir	73.00 (239.50)
Pond West	394 (11.16)	316 (8.95)	390.8 (119.11)	393.70 (120.00)	Weir	118.00 (387.14)
Pond East	723 (20.47)	281 (7.96)	394.3 (120.18)	396.98 (121.00)	Weir	119.00 (390.42)
Pond South	597 (16.91)	570 (16.14)	320.4 (97.65)	321.52 (98.00)	Weir	97.00 (318.24)

The proposed ponds will reduce the peak flow discharge at the north and south limits. These flows are reduced from 249 ft^3/s to 5 ft^3/s and from 546 ft^3/s to 423 ft^3/s for the 2-

and 100-yr events, respectively, in the north limit (***Pond North*** outflow). The peak flow is reduced from 149 ft^3/s to 102 ft^3/s and from 584 ft^3/s to 570 ft^3/s for the 2- and 100-yr events, respectively, in the south limit (***Pond South*** outflow). Detailed results from the hydrologic modeling of the proposed condition are included in Appendix D.

The recommended outlet structure for pond ***North*** consists of two weirs located at the north limit. The first weir has a length of 7.0 meters and an invert elevation of 73.00 m (msl). The second weir has a length of 12.0 meters and an invert elevation of 73.60 m (msl). Figure 22 shows the proposed outlet structure for pond ***North***.

The recommended outlet structure for pond ***South*** consists of two weirs located at the north limit. The first weir has a length of 6.5 meters and an invert elevation of 96.70 m (msl). The second weir has a length of 9.0 meters and an invert elevation of 97.70 m (msl). Figure 23 shows the proposed outlet structure for pond ***South***.

IV. FLOOD PROFILE ANALYSIS

A hydraulic analysis was performed for the natural drainages crossing through the property. The purpose of this analysis was to determine the water surface levels for the 2- and 100-year rainfall events. All the peak flow values used at the River Analysis

System (HEC-RAS 4.0) model (existing and proposed) were taken from the HEC-HMS (Hydrologic Modeling System) computer program (version 3.2).

Methodology

The hydraulic analysis was performed using the River Analysis System (HEC-RAS 4.0) model, developed by the U.S. Army Corps of Engineers [USACE, 2008]. Two scenarios were analyzed: 1) Existing and 2) Proposed. These scenarios were computed to determine the water surface elevations along the natural drainage around the landfill area, during the 2- and 100-year flood events. As stated by the Planning Regulation No. 13 of the PRPB [2005a], the 100-year flood levels along the stream should not be increased more than 0.15 meter at any location, as a result from the proposed expansion to the existing landdfill.

Nineteen (19) cross sections were field surveyed (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 and, 19) along the natural drainages under study. These field survey data was submitted by Mr. Ricardo Flores Ortega, P.E., representative of RF Engineering, P.S.C. All these data was used to construct the hydraulic model geometry. A copy of the field surveyed data is included in Appendix H. The cross sections location plan is shown in Figure 7.

Coefficients Values

Manning's roughness coefficients were determined by visual inspection of the site. The values used for the existing condition model were 0.03 in the main channel and 0.04 in the floodplain. Contraction and expansion coefficients of 0.1 and 0.3, respectively, were used for gradual transitions and 0.2 and 0.4 for abrupt transitions.

Existing Condition Model

The existing condition model was developed to simulate the natural drainage conditions based on the submitted field data and the HEC-HMS [version 3.2] peak discharge data.

Computed water levels and velocities at each cross section along the ***Natural Drainage*** for the 2- and 100-year flood events are presented in Table 4. Figures 8, 9, 10, 15, 16 and, 17 shows the water surface profiles for the 2- and 100-year flood events for the ***Natural Drainage*** at ***North***, ***South***, ***East*** and, ***West***. The limits of the 2- and 100-year frequency floodplain, occurring inside and outside of the property limits are shown in Figures 11 and 18, respectively. HEC-RAS input and output data (geometry: ***EXISTING***) is included in Appendix E.

Table 6. Hydraulic modeling results for the existing condition model: 2- and 100-year flood events.

River Sta.	Reach	Profile	Q total (m^3/s)	Min Ch El (m)	W.S. Elev (m)	Vel (m/s)
Natural Drainage						
1	South	2-yr	2.37	90.91	91.17	1.36
2			2.37	92.03	92.34	1.48
3	West		2.40	108.28	108.68	1.64
4			2.40	113.17	113.61	1.75
5			2.40	117.43	117.87	1.70
6			2.40	116.12	118.05	0.15
7			5.42	117.39	117.98	2.08
8			5.42	123.33	123.69	1.55
9	East		0.02	116.74	116.81	0.61
10			0.02	121.39	121.44	0.49
11			0.02	120.32	121.45	0.003
12			0.02	114.27	121.45	0.00004
13			10.06	114.09	121.45	0.02
14			10.06	114.06	121.45	0.02
15	North		7.73	62.57	63.49	2.40
16			7.73	68.60	69.16	1.69
17			8.63	74.56	75.35	1.62
18			8.63	77.38	78.57	2.84
19			8.63	84.18	85.66	2.70

Table 6. Hydraulic modeling results for the existing condition model; 2- and 100-year flood events (continued).

River Sta.	Reach	Profile	Q total (m^3/s)	Min Ch El (m)	W.S. Elev (m)	Vel (m/s)
Natural Drainage						
1	South	100-yr	16.55	90.91	91.63	2.30
2			16.55	92.03	92.87	2.31
3	West		8.87	108.28	109.05	2.26
4			8.87	113.17	114.04	2.40
5			8.87	117.43	118.28	2.43
6			8.87	116.12	118.64	0.38
7			11.09	117.39	118.60	1.56
8			11.09	123.22	123.84	1.85
9	East		7.49	116.74	117.57	2.38
10			7.49	121.39	122.16	2.32
11			7.49	120.32	122.48	0.50
12			7.49	114.27	122.50	0.01
13			20.95	114.09	122.50	0.03
14			20.95	114.06	122.50	0.04
15	North		15.47	62.57	63.85	2.80
16			15.47	68.60	69.34	1.94
17			17.16	74.56	75.50	1.69
18			17.16	77.38	79.08	3.33
19			17.16	84.18	86.12	3.11

The computed maximum velocities produced along the studied natural drainage vary from 0.0004 to 2.84 m/s and from 0.01 to 3.33 m/s for the 2- and 100-year flood events, respectively.

Maximum backwater occurs at different sections. Sections 2, 5 and, 6 have 0.01, 0.01 and, 0.01 meters of backwater, respectively. Therefore, it complies with the Planning Regulation No. 13 of the PR Planning Board.

Proposed Condition Model

The existing condition model was modified to simulate the natural drainage conditions considering the proposed peak discharges computed with the HEC-HMS model. Computed water levels and velocities at each cross section along the ***Natural Drainage*** for the 2- and 100-year flood events are presented in Table 7. Figure 12, 13, 14, 19, 20 and, 21 shows the water surface profiles for the 2- and 100-year flood events for the ***Natural Drainage*** at ***North***, ***East***, ***West*** and, ***South***. HEC-RAS input and output data (geometry: ***PROPOSED***) are included in Appendix E.

Table 7. Hydraulic modeling results for the proposed condition model: 2- and 100-year flood events.

River Sta.	Reach	Profile	Q total	Min Ch El	W.S. Elev	Vel
			(m^3/s)	(m)	(m)	(m/s)
Natural Drainage						
1	South	2-yr	2.42	90.91	91.17	1.36
2			2.42	92.03	92.35	1.49
3	West		2.44	108.28	108.68	1.64
4			2.44	113.17	113.61	1.76
5			2.44	117.43	117.88	1.70
6			2.44	116.12	118.06	0.15
7			5.47	117.39	117.98	2.08
8			5.47	123.33	123.69	1.55
9	East		0.02	116.74	116.81	0.61
10			0.02	121.39	121.44	0.49
11			0.02	120.32	121.45	0.003
12			0.02	114.27	121.45	0.00004
13			10.01	114.09	121.45	0.02
14			10.01	114.06	121.45	0.02
15	North		0.14	62.57	62.74	0.93
16			0.14	68.60	68.71	0.74
17			7.77	74.56	75.33	1.54
18			7.77	77.38	78.50	2.79
19			7.77	84.18	85.60	2.65

Table 7. Hydraulic modeling results for the proposed condition model: 2- and 100-year flood events (continued).

River Sta.	Reach	Profile	Q total (m^3/s)	Min Ch El (m)	W.S. Elev (m)	Vel (m/s)
Natural Drainage						
1	South	100-yr	16.15	90.91	91.62	2.28
2			16.15	92.03	92.86	2.30
3	West		8.95	108.28	109.06	2.26
4			8.95	113.17	114.04	2.41
5			8.95	117.43	118.28	2.44
6			8.95	116.12	118.64	0.38
7			11.19	117.39	118.61	1.56
8			11.19	123.22	123.85	1.85
9	East		7.95	116.74	117.59	2.41
10			7.95	121.39	122.18	2.35
11			7.95	120.32	122.52	0.52
12			7.95	114.27	122.53	0.01
13			20.05	114.09	122.53	0.03
14			20.05	114.06	122.53	0.04
15	North		11.96	62.57	63.70	2.65
16			11.96	68.60	69.27	1.84
17			15.90	74.56	75.54	2.05
18			15.90	77.38	79.02	3.26
19			15.90	84.18	86.07	3.06

The computed maximum velocities produced along the studied natural drainage vary from 0.0004 to 2.79 m/s and 0.01 to 3.06 m/s for the 2- and 100-year flood events, respectively.

Maximum backwater occurs at different sections. Sections 3, 7, 8, 9, 10, 11, 12, 13, 14, 15 and, 17 have 0.01, 0.01, 0.01, 0.02, 0.02, 0.04, 0.03, 0.03, 0.03 and, 0.04 meters of backwater, respectively. Moreover, the computed levels at sections 15 to 19 are lower than the existing. Therefore, it complies with the Planning Regulation No. 13 of the PR Planning Board.

V. SEDIMENTATION ANALYSIS

Methodology

Sediment Yield

The sedimentation analysis was performed to determine the average sediment yield and the sediment load from the studied areas for the 2-, 10-, and 100-yr events. The soil erosion and sediments yield were estimated using the Modified Universal Soil Loss Equation (MUSLE) to calculate the sediment yield of a basin as a result of a specific storm event [Fifield, 2001]. The equation used was the following:

$$A = 95\,(V \times Qp)^{0.56*} \times K \times LS \times C \times P / At \qquad (2)$$

where *A* is the soil erosion calculated in tons/acre, *V* is the volume of runoff in acre-ft, *Qp* is the peak flow in cubic feet per second, *K* is the erosion factor, *LS* is the topographic factor, *C* is the cover and management factor, *P* is the erosion control practice factor, and *At* is the area of the basin.

The *K* factor used for the studied area was obtained from the USDA database for the Caribbean Area available in the RUSLE2 software version 1.26.6.4 (See Appendix F). The *LS* factor was obtained from tables [Fifield, 2001], using the slope and slope length for the analyzed areas for the existing and proposed conditions. The cover factor *C* used for the landfill areas was 1.0 for areas without any cover and 0.004 for areas with grass. The control practice management factor *P* used was 1.0 assuming no erosion management practices.

For the landfill area the erosion factor K was obtained using the soil erodibility nomograph developed by the USDA [2007]. The fill material in the landfill corresponds to AASHTO A-2-4. This material has a maximum of 35 percent of very fine material and an average of 65 sand percent [USDA, 2007]. A zero percent of organic matter was assumed; the soil structure was assumed as very fine granular and; permeability was assumed as very slow. Using these parameters, and the USDA erodibility nomograph, an erosion factor K of 0.36 was estimated for the landfill area (see Appendix F).

The sediment yield and total sediment load were calculated for all analyzed sub-basins described in the hydrologic analysis for the existing and proposed condition.

Pond Sedimentation Analysis

A pond sedimentation analysis was performed to evaluate the storage and sediment trap capacities in the existing and proposed retention ponds. This analysis was developed based on the existing and proposed ponds dimensions, fill material properties and peak flows. The 2-, 10-, and 100-yr rainfall events were evaluated.

As mentioned in the previous section, the fill material assumed for the landfill area was AASHTO A-2-4. The texture classification for this corresponds to sandy loam material. The average size average diameter corresponds to 0.5 to 0.25 mm (fine sand) and a settling velocity of 3.475 centimeters per second (0.03475 m/s) to 20°C [Fifield, 2001]. The sediment trap capacity was evaluated calculating the average upflow velocity within the existing and proposed ponds. The upflow velocity is defined as the flow average velocity from the inlet point to the outlet point within the retention structure. This velocity is directly proportional to the outflow controlled by the outlet structure. The upflow average velocity was calculated using the following equation:

$$v = Q / A \tag{3}$$

where v is the average upflow velocity in the analyzed retention pond, Q is outflow from the pond, and A is the pond surface area. The peak outflows resulting from the retention analysis, shown in Tables 3 and 5, were used in this analysis for the existing and proposed conditions, respectively.

The average upflow velocities were calculated for the existing and proposed retention ponds. These were compared with the settling velocity determined for the fill material (0.03475 m/s). In addition, very fine sands, coarse silt and very fine silts were analyzed. The particles are trapped in the retention pond if the average upflow velocity is lower than its settling velocity. Appendix G includes the sedimentation analysis for the existing and proposed retention ponds.

Sediment Analysis Results

Sediment Yield

Using the MUSLE equation, the sediment yields were calculated for the analyzed basins for the existing and proposed condition for the 2-, 10-, and100-yr rainfall events. Appendix F includes the parameters used in MUSLE equation, the calculated sediment yield and the total sediment load for the existing and proposed conditions for each analyzed event.

Results shows that the sediment load is higher for the proposed condition compared to the existing condition. The sediment load is increased from 13,101 to 15,033 tons

within the studied areas for the 2-yr event, from 24,100 to 27,231 tons for the 10-yr event, from 42,535 to 47,839 tons for the 100-yr for the analyzed basins.

The sediment yields for the existing condition within the landfill area varied from a minimum of 48.29 to a maximum of 403.35 ton/acre for the 2-yr event, a minimum of 91.92 to a maximum of 742.01 ton/acre for the 10-yr event and, a minimum of 165.48 to a maximum of 1,274.93 ton/acre for the 100-yr event. The minimum occurs at ***BASN*** area and the maximum occurs at the landfill area ***LW***.

For the proposed condition the sediment yield varied from a minimum of 45.47 to a maximum of 480.68 ton/acre for the 2-yr event, a minimum of 90.60 to a maximum of 875.08 ton/acre for the 10-yr event, a minimum of 167.51 to a maximum of 1,506.41 ton/acre for the 100-yr event. The minimum occurs at ***BASN*** area and the maximum occurs at the landfill area ***LW***.

Pond Sedimentation Analysis

For the existing condition the results shows that ponds ***South 1*** and ***South 2*** have the capacity to trap particles with a size higher than 0.2 mm (fine sands). Ponds ***North*** and ***West*** trap particles size higher than 0.09 mm (very fine sands) and, pond ***East*** trap particles with a size higher than 0.047 mm (coarse silt).

For the proposed condition the results shows that the ponds ***North***, ***West*** and ***South*** trap particles size higher than 0.09 mm (very fine sands), and pond ***East*** trap particles with a size higher than 0.047 mm (coarse silt).

The calculations for the pond sedimentation analysis are included in the Appendix G for the existing and proposed conditions.

VI. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The results for the 2-, 10- and 100-yr events indicated that the existing ponds ***North***, ***South 1*** and ***South 2*** are flooded. For the 2-yr event ponds ***South 1*** and ***South 2*** are flooded 0.17 meter each one. For the 10-yr event ponds ***North***, ***South 1*** and ***South 2*** are flooded 0.06, 0.35 and 0.35 meter, respectively. For the 100-yr event the ponds ***North***, ***South 1*** and ***South 2*** are flooded 0.13, 0.60 and 0.60 meter, respectively.

2. The effective storage volume for ***Pond West*** and ***Pond East*** are controlled by the pond's dimensions and the topography. That is, when the structures are flooded the surrounding area operates as large storage volumes. These areas were established using the existing topographic survey and the USGS topographic maps. Figure 5

shows the location plan and the storage volume limits for the existing retention ponds.

3. The existing pond ***North***, ***South 1*** and ***South 2*** should be modified to comply with two purposes: 1) provide the minimum required storage capacity and; 2) to produce an outflow discharge equal or lower than the calculated for the existing condition.

4. The proposed ponds will reduce the peak flow discharge at the north and south limits. The peak flows are reduced from 249 ft^3/s to 5 ft^3/s for the 2-yr event and, from 546 ft^3/s to 423 ft^3/s for the 100-yr event, at the north limit (pond ***North***). The peak flow is reduced from 149 ft^3/s to 102 ft^3/s for the 2-yr event and, from 584 ft^3/s to 570 ft^3/s for the 100-yr event, at the south limit (pond ***South***). As noted, for both events the proposed discharge is lower than the existing. Therefore, both ponds complies with the Planning Regulation No. 3 of the PR Planning Board. Specifications of this structure are indicated in Figures 15 and 16.

5. For the landfill area the erosion factor K was obtained using the soil erodibility nomograph developed by the USDA [2007]. The fill material in the landfill corresponds to AASHTO A-2-4. This material has a maximum of 35 percent of very fine material and an average of 65 sand percent [USDA, 2007]. A zero percent of organic matter was assumed, structure was assumed as very fine granular and

permeability as very slow. Using these parameters and the USDA erodibility nomograph, an erosion factor K of 0.36 was estimated for the landfill area.

6. Results shows that the sediment load is higher for the proposed condition compared to the existing condition. The sediment load is increased from 13,101 to 15,033 tons for the 2-yr event, from 24,100 to 27,231 tons for the 10-yr event and, from 42,535 to 47,839 tons for the 100-yr, for the analyzed basins.

7. The sediment yields for the existing condition within the landfill area varied from a minimum of 48.29 to a maximum of 403.35 ton/acre for the 2-yr event, a minimum of 91.92 to a maximum of 742.01 ton/acre for the 10-yr event and, a minimum of 165.48 to a maximum of 1,274.93 ton/acre for the 100-yr event. The minimum value occurs at ***BASN*** area and the maximum occurs at the landfill area ***LW***.

8. For the proposed condition the sediment yield varied from a minimum of 45.47 to a maximum of 480.68 ton/acre for the 2-yr event, a minimum of 90.60 to a maximum of 875.08 ton/acre for the 10-yr event and, a minimum of 167.51 to a maximum of 1,506.41 ton/acre for the 100-yr event. The minimum occurs at the landfill area within the ***BASE*** area and the maximum occurs at the landfill area ***LW***.

9. For the existing condition the results shows that ponds ***South 1*** and ***South 2*** have the capacity to trap particles with a size higher than 0.2 mm (fine sands), pond

North and ***West*** trap particles size higher than 0.09 mm (very fine sands) and, pond ***East*** trap particles with a size higher than 0.047 mm (coarse silt).

10. For the proposed condition the results shows that ponds ***North***, ***West*** and ***South*** trap particles size higher than 0.09 mm (very fine sands) and, pond ***East*** trap particles with a size higher than 0.047 mm (coarse silt).

11. Based on the results of the flood profile analysis it is concluded that no backwater results from the proposed condition compared to the existing condition. Therefore, the proposed expansion to the existing landfill complies with the requirements of the Planning Regulation No. 13 of the PR Planning Board for rural areas (0.30 meter of maximum increase).

Recommendations

1. The recommended outlet structure for pond ***North*** consists of two weirs located at the north limit. The first weir has a length of 7.0 meters and an invert elevation of 73.00 m (msl). The second weir has a length of 12.0 meters and an invert elevation of 73.60 m (msl). Figure 22 shows the proposed outlet structure for pond ***North***.

2. The recommended outlet structure for pond ***South*** consists of two weirs located at the north limit. The first weir has a length of 6.5 meters and an invert elevation of

96.70 m (msl). The second weir has a length of 9.0 meters and an invert elevation of 97.70 m (msl). Figure 23 shows the proposed outlet structure for pond ***South***.

3. For the proposed condition, the depth of pond ***North*** was increased 1.0 meter. The ponds ***South 1*** and ***South 2*** were joined in one single pond named ***Pond South***. The outlet structures for the proposed modified structures are composed weirs. Figure 6 shows the proposed retention structures.

4. The results for the retention pond analysis for the proposed condition are shown in the Table 5. For the proposed condition a freeboard of 0.30 and 0.35 meter was calculated for the 100-yr event at ponds North and South, respectively.

5. The minimum required flow retention structures recommended should be as specified in Figures 15 and 16.

6. Dimensions of the proposed retention structures can be changed to fit the site civil design. However, minimum storage volume, outlet structure and, relative minimum invert elevations should be as recommended.

7. The recommended minimum storage volume includes at least 0.30 meter of freeboard.

8. All recommendations specified herein must be implemented to assure performance in accordance with the hydraulic design. Since the results of this study are based on free flow conditions through the recommended structures, proper cleaning and maintenance is required to assure this condition. The accumulation of debris can severely obstruct flow, producing backwater much higher than presented herein.

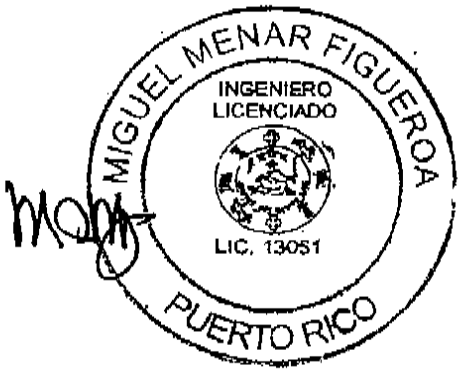
Study Limitations

All recommendations specified herein must be implemented to assure performance in accordance with the design. The results of this study are based on free flow conditions through the recommended hydraulic structures. Proper maintenance is required to assure this condition since, the accumulation of debris can severely obstruct flow, producing backwater much higher than presented herein. This analysis is based on the field data as submitted by Mr. Ricardo Flores Ortega, P.E., representative of RF Engineering, P.S.C. Inaccuracies in this data may total or partially invalidate the results and recommendations contained in this study.

VII. CERTIFICATION

I certify that the hydrologic-hydraulic study presented herein was performed by me and the information is true, correct, and complete as per my knowledge. I know and accept the consequences of include and submit incomplete, unfinished or false information in this document. To state this, I sign the present certification in *Canóvanas, Puerto Rico*, on October 23, 2008.

Respectfully submitted,



Miguel Menar Figueroa, MSCE, PE
PE License #13051

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FIGURES

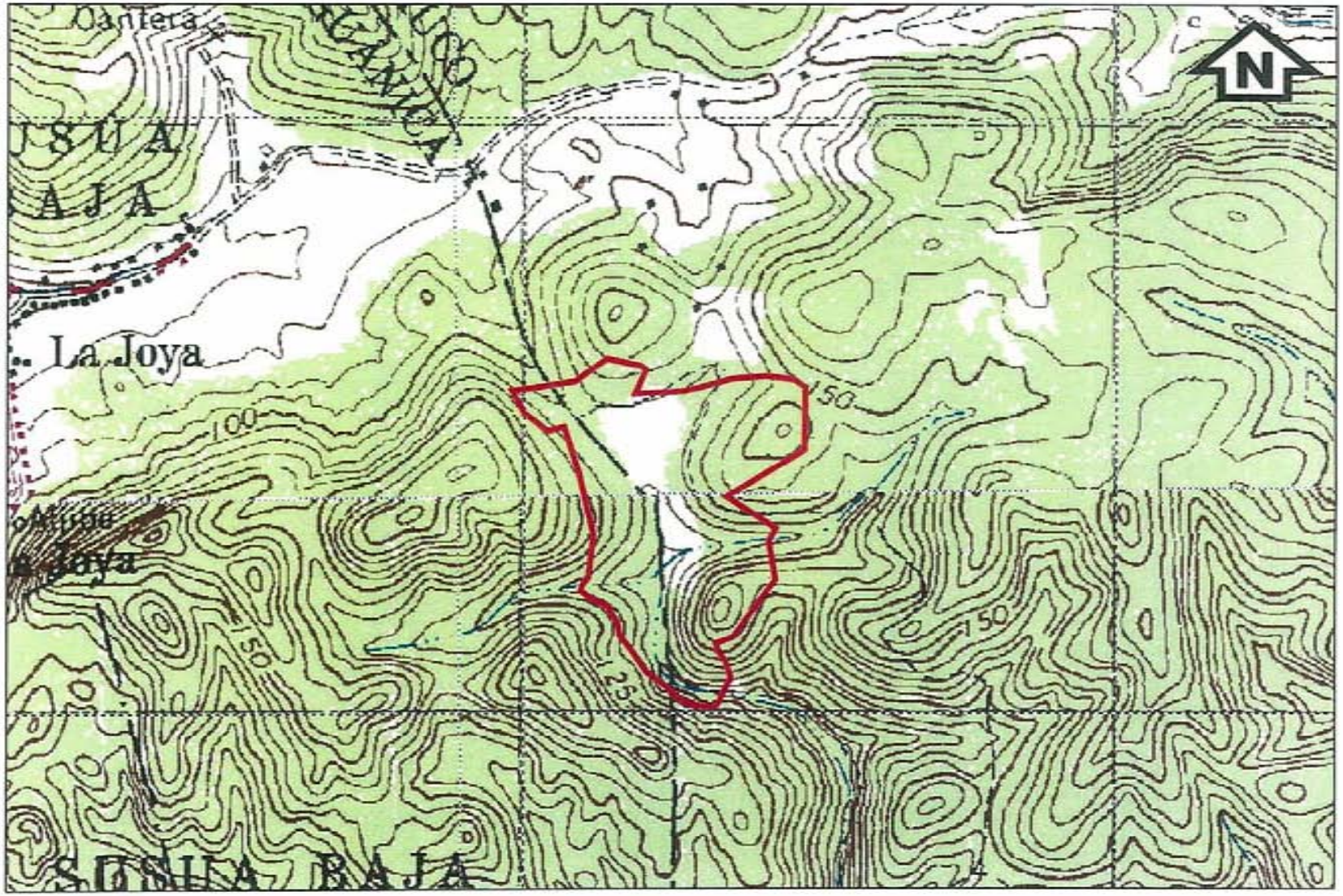

Figure 1. Project location on the USGS topographic maps of Punta Verraco and Yauco (scale 1:10,000).

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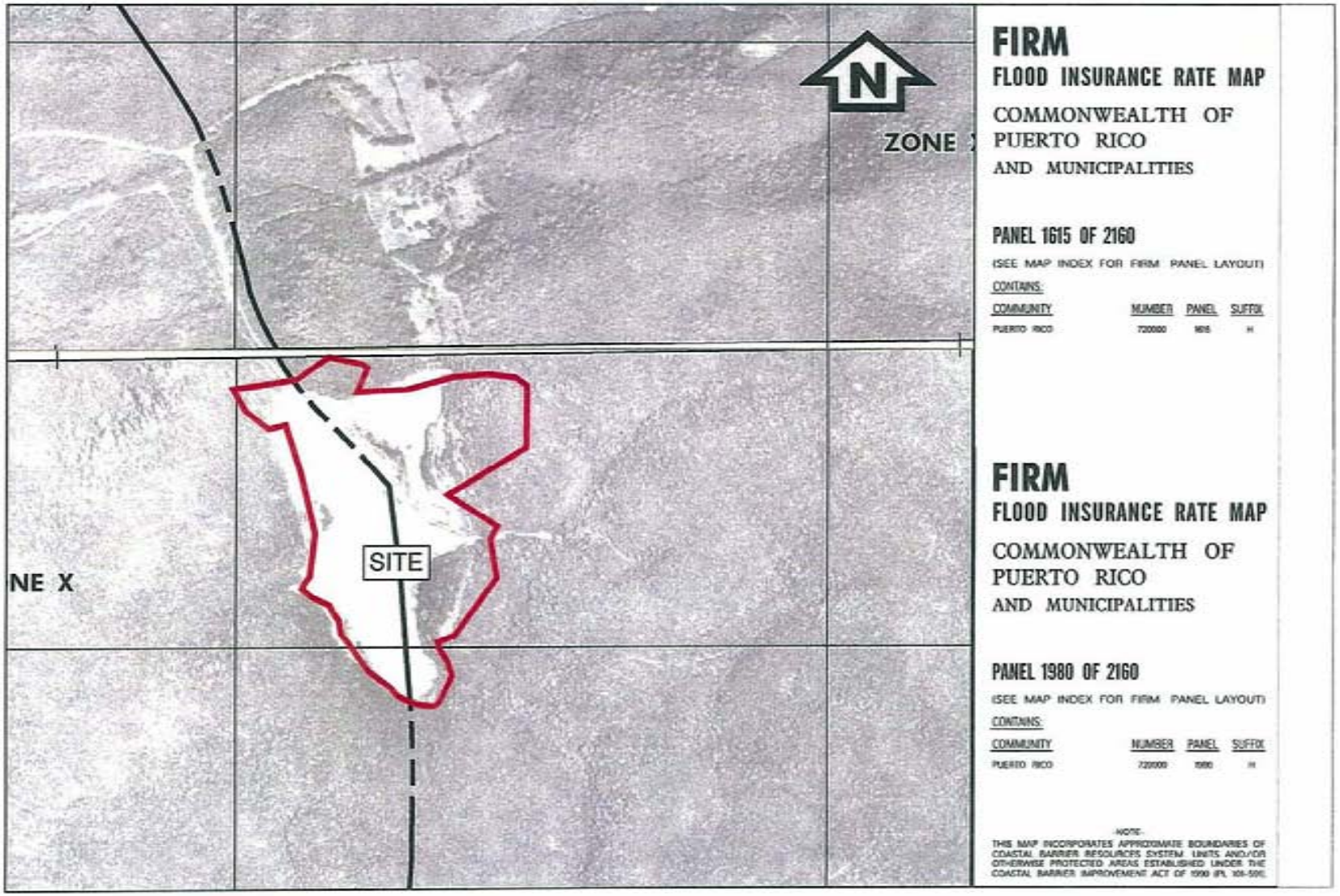

Figure 2. Project location on the partial copy of FEMA Flood Insurance Rate Maps No. 1615H and 1980H (scale 1:10,000).

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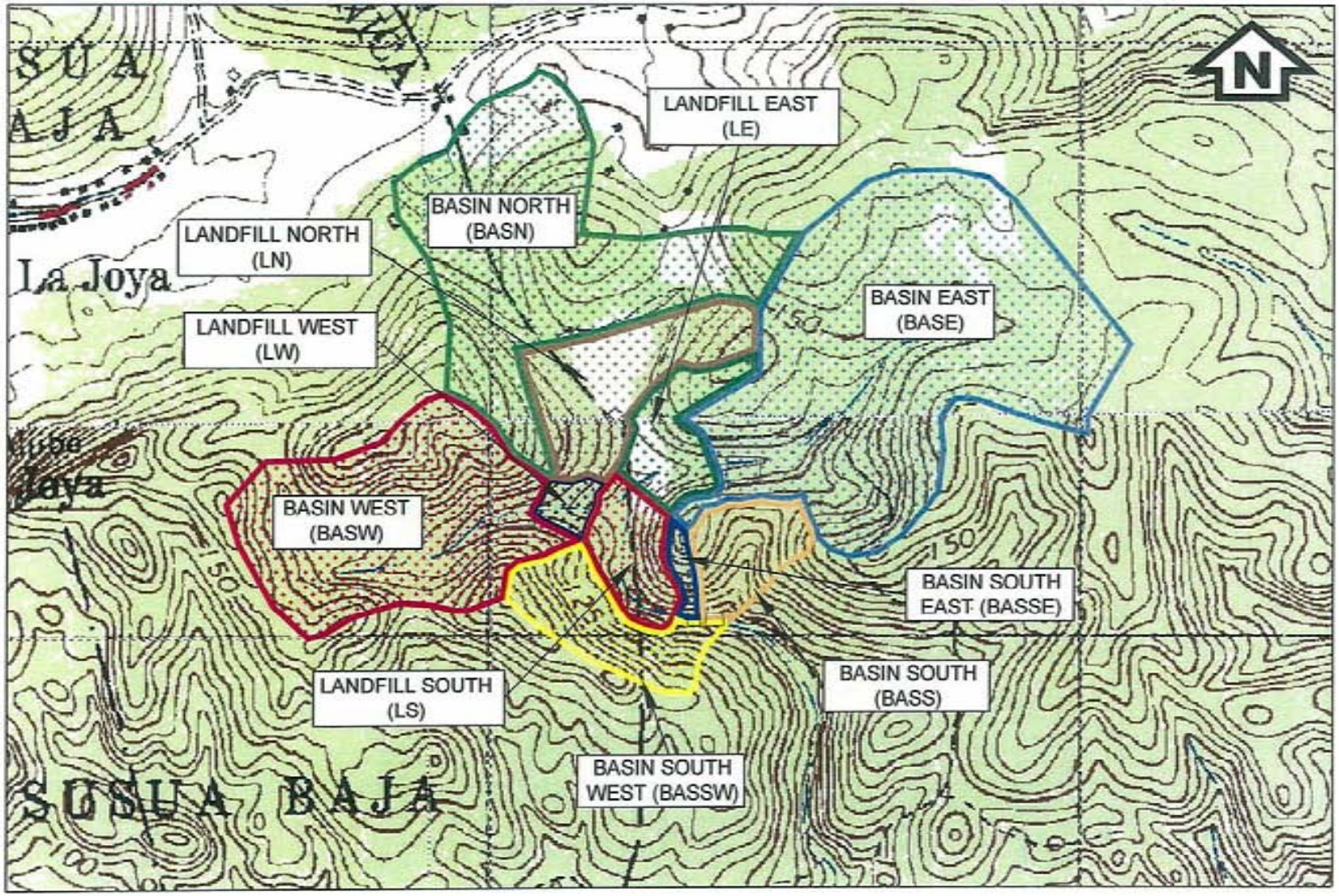

Figure 3. Drainage watershed limits for the existing condition (scale 1:10,000).

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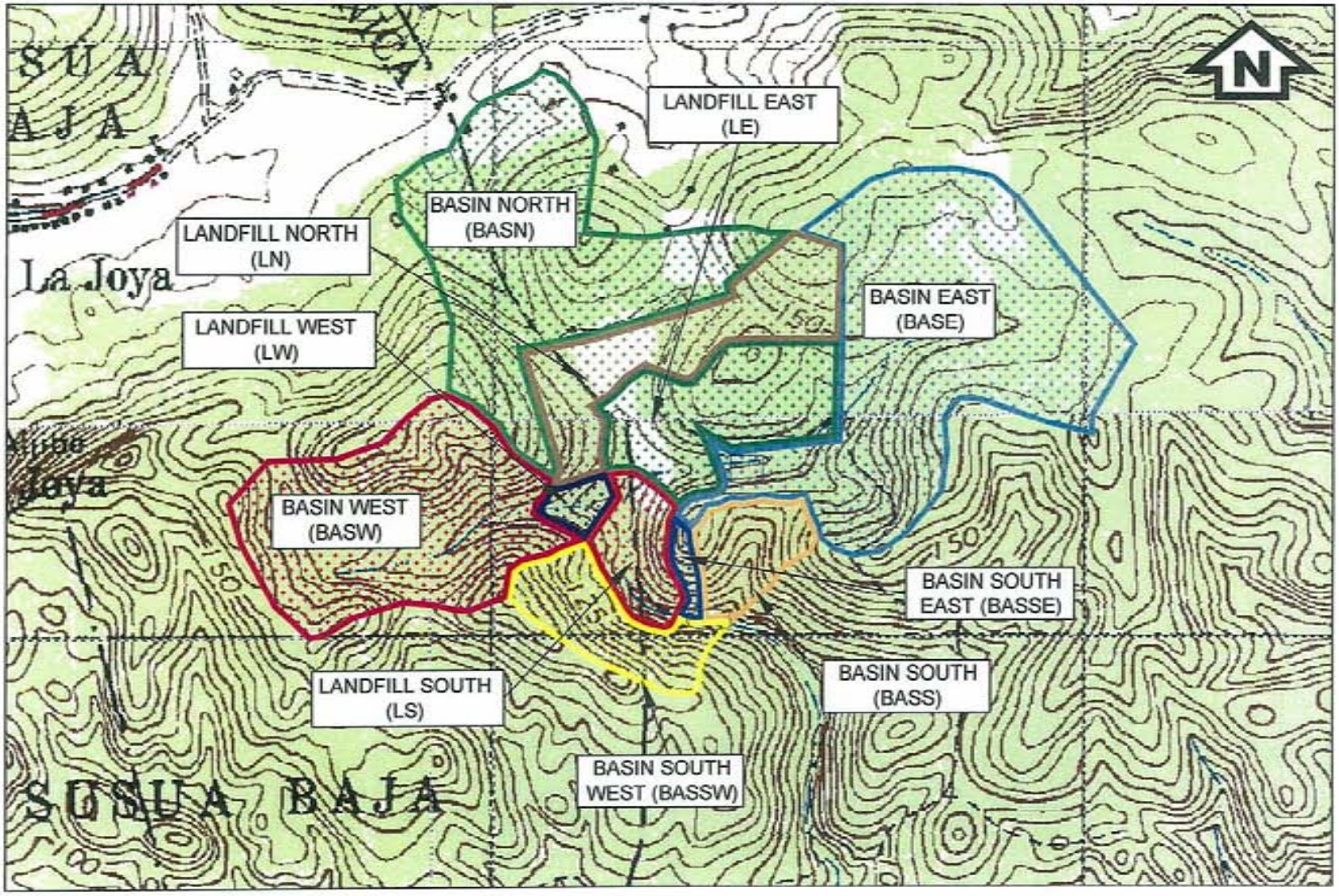

Figure 4. Drainage watershed limits for the proposed condition (scale 1:10,000).

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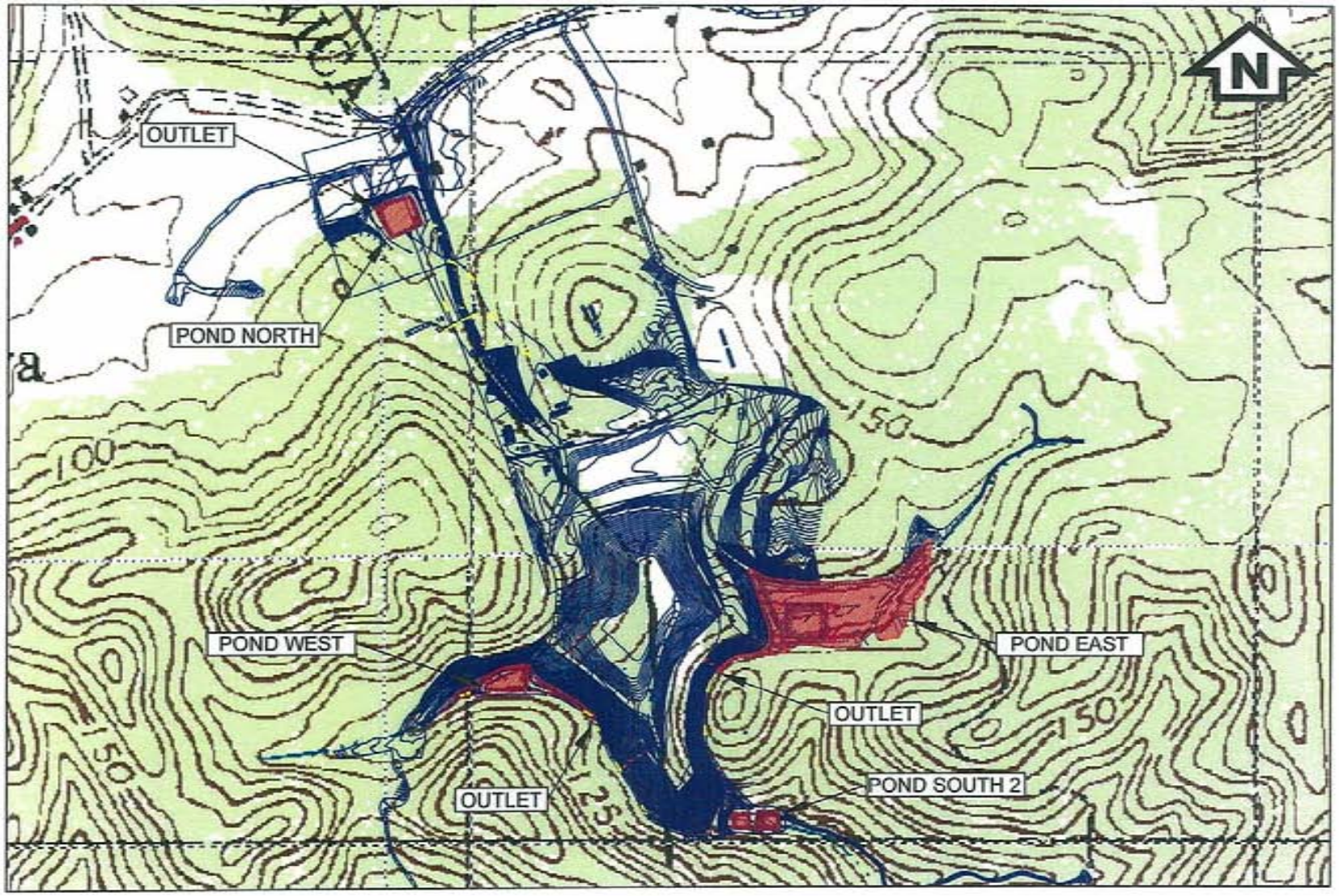

Figure 5. Existing retention ponds location (scale 1:10,000).

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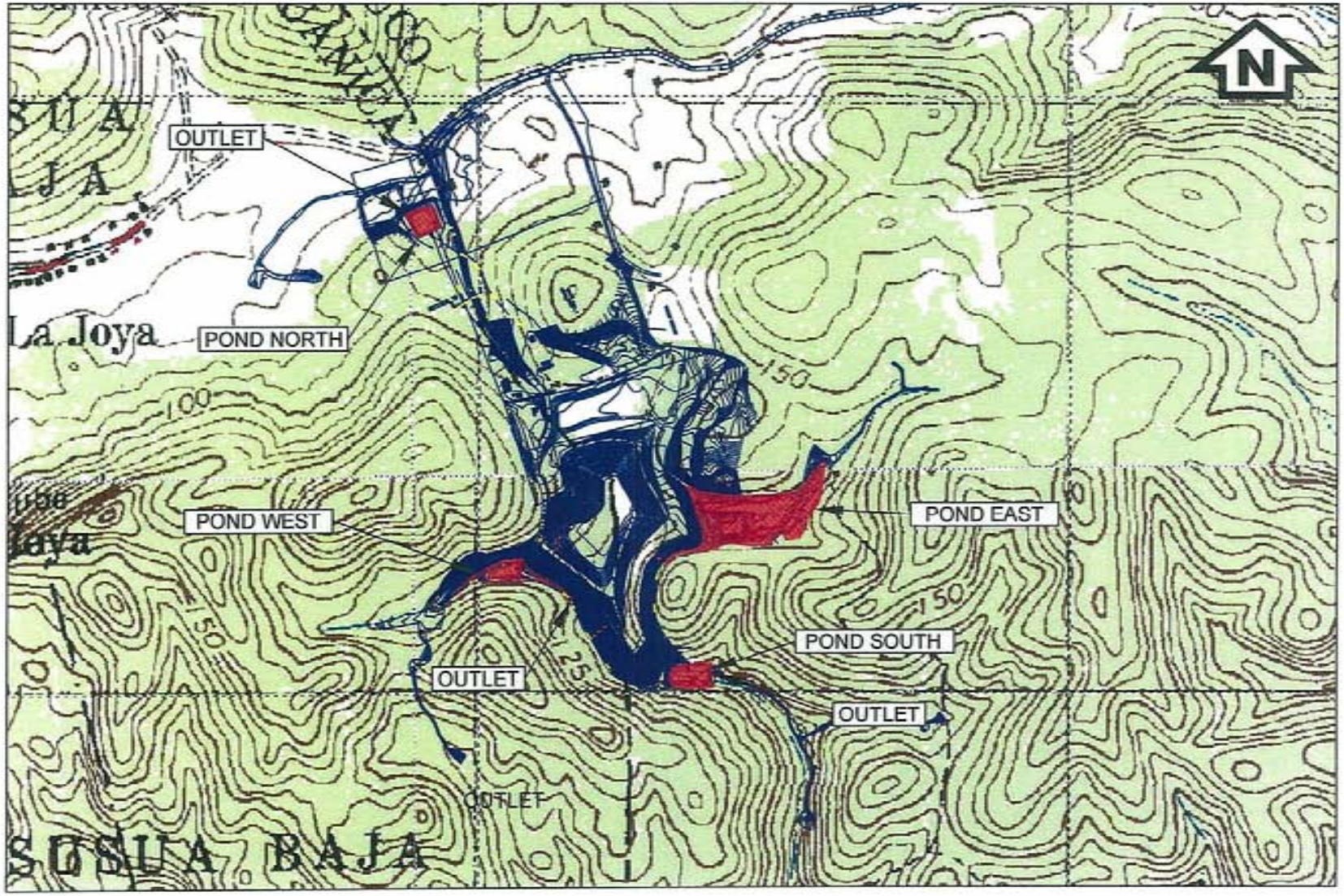

Figure 6. Proposed retention ponds location (scale 1:10,000).

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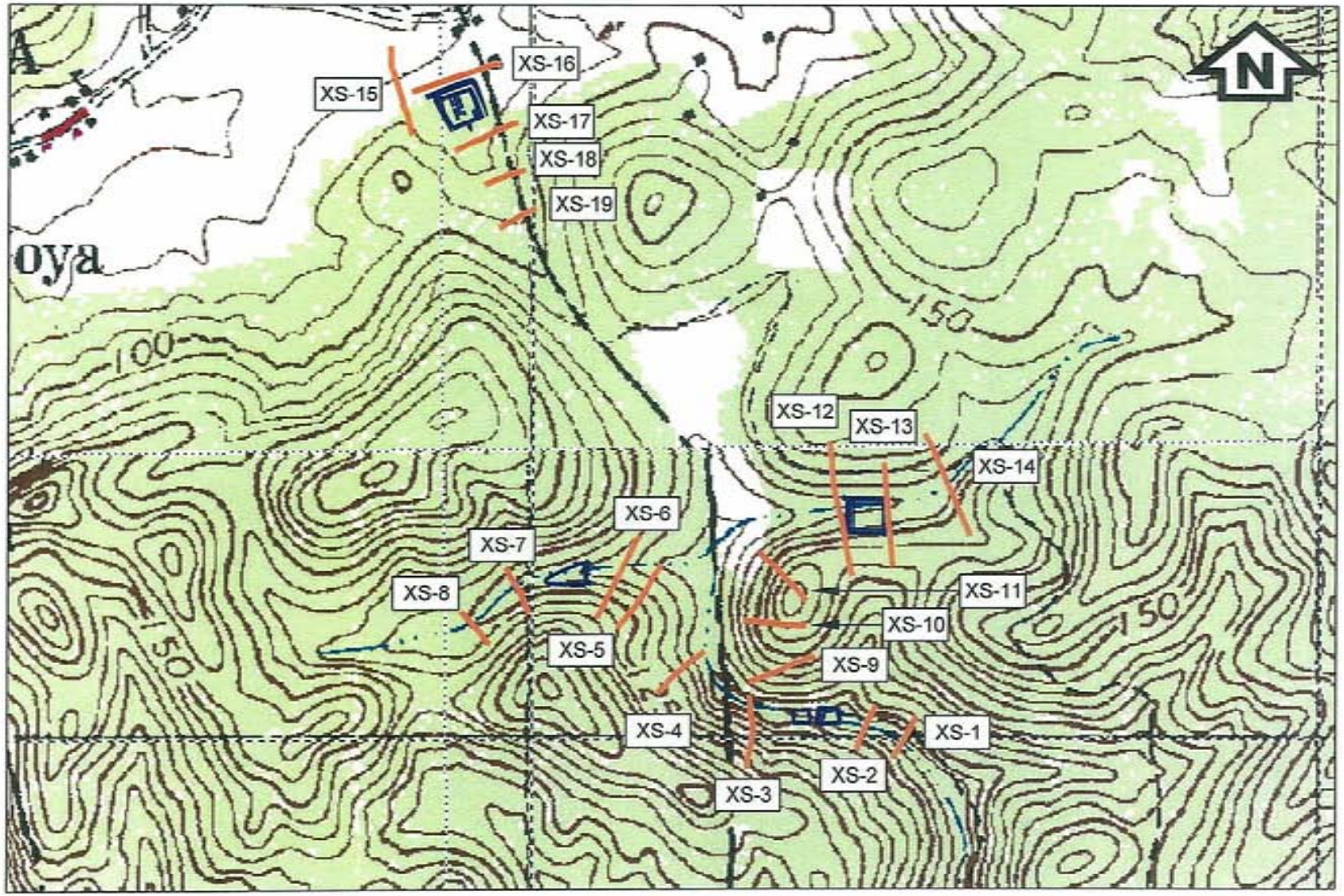

Figure 7. Cross sections location plan for the existing condition model (scale 1:7,500).

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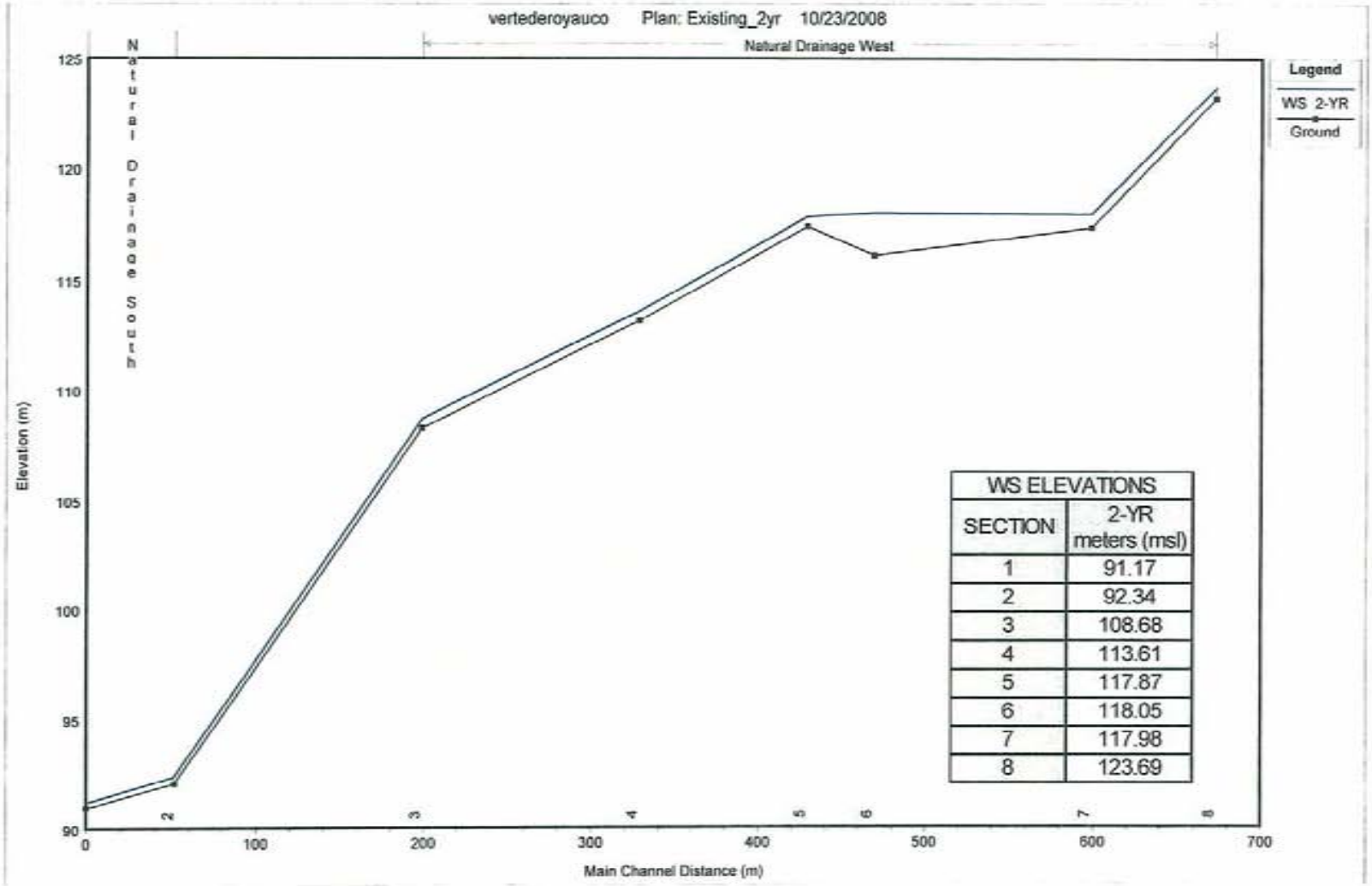

WS ELEVATIONS	
SECTION	2-YR meters (msl)
1	91.17
2	92.34
3	108.68
4	113.61
5	117.87
6	118.05
7	117.98
8	123.69

Figure 8. Water surface profiles for the existing condition: 2-year flood event for Natural Drainage at sections 1, 2, 3, 4, 5, 6, 7 and, 8 (scale as shown).

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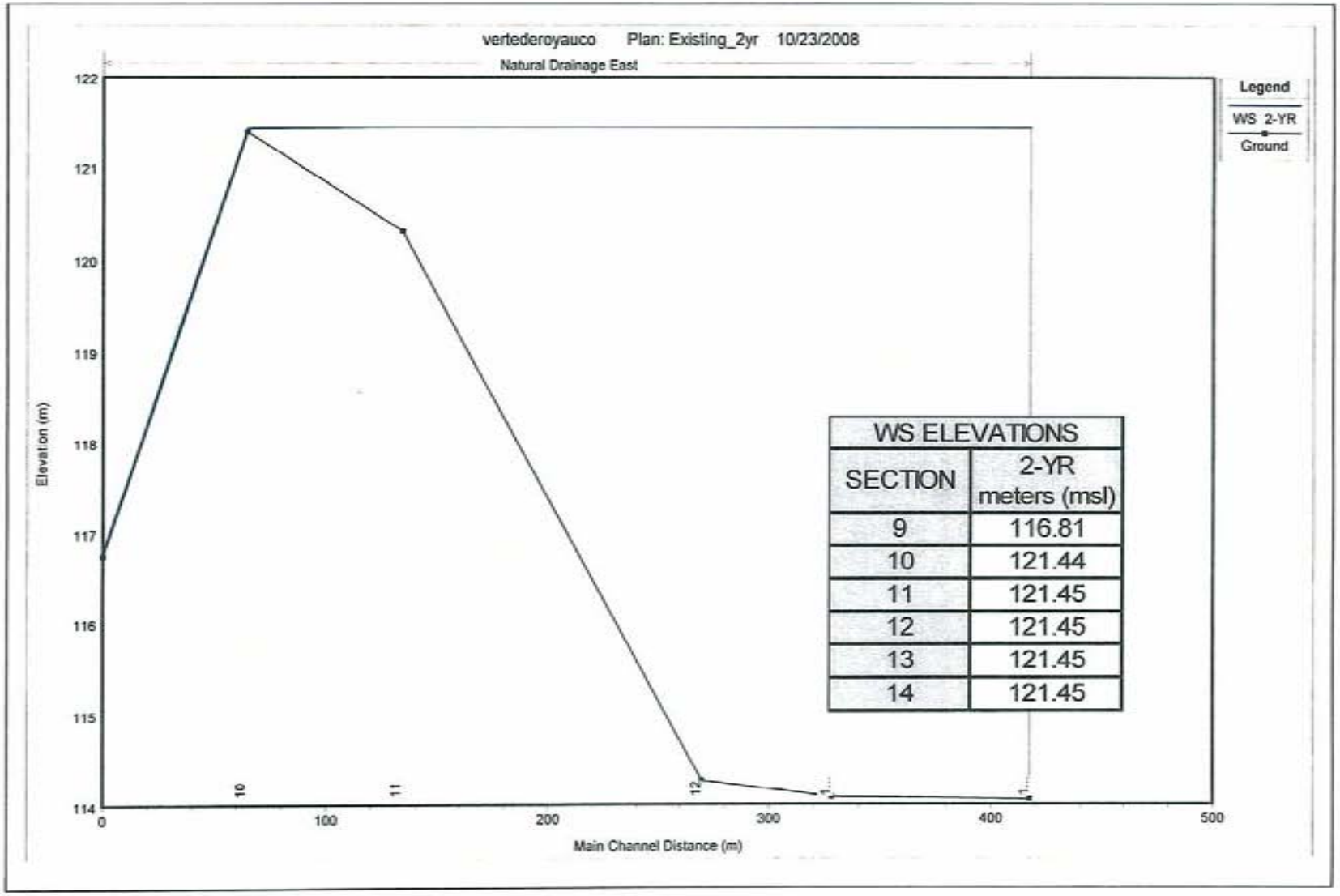

WS ELEVATIONS	
SECTION	2-YR meters (msl)
9	116.81
10	121.44
11	121.45
12	121.45
13	121.45
14	121.45

Figure 9. Water surface profiles for the existing condition: 2-year flood event for Natural Drainage at sections 9, 10, 11, 12, 13 and, 14 (scale as shown).

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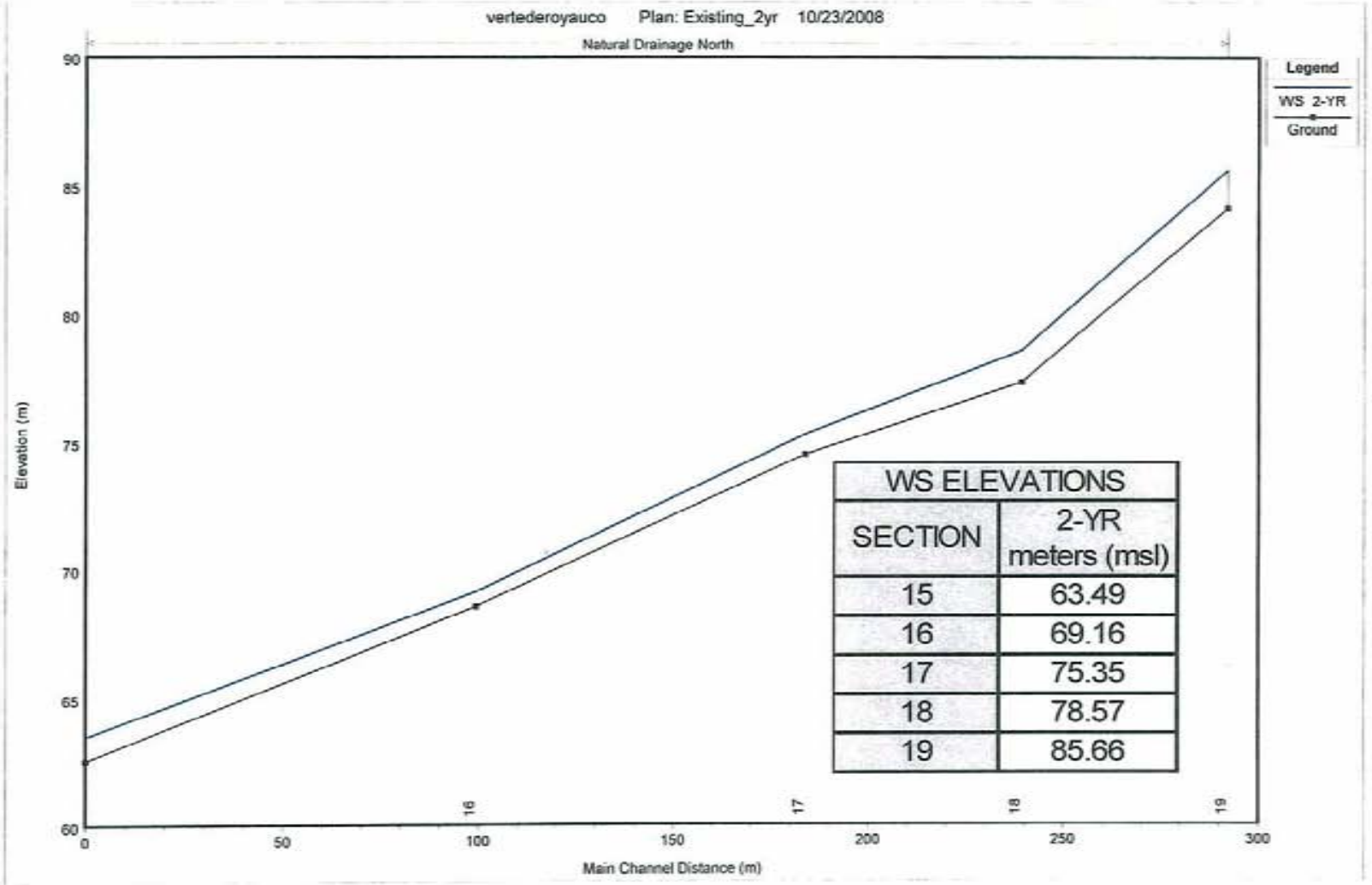

WS ELEVATIONS	
SECTION	2-YR meters (msl)
15	63.49
16	69.16
17	75.35
18	78.57
19	85.66

Figure 10. Water surface profiles for the existing condition: 2-year flood event for Natural Drainage at sections 15, 16, 17, 18 and, 19 (scale as shown).

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Figure 11. 2-year floodplain limits for the existing condition model (scale 1:7,500).

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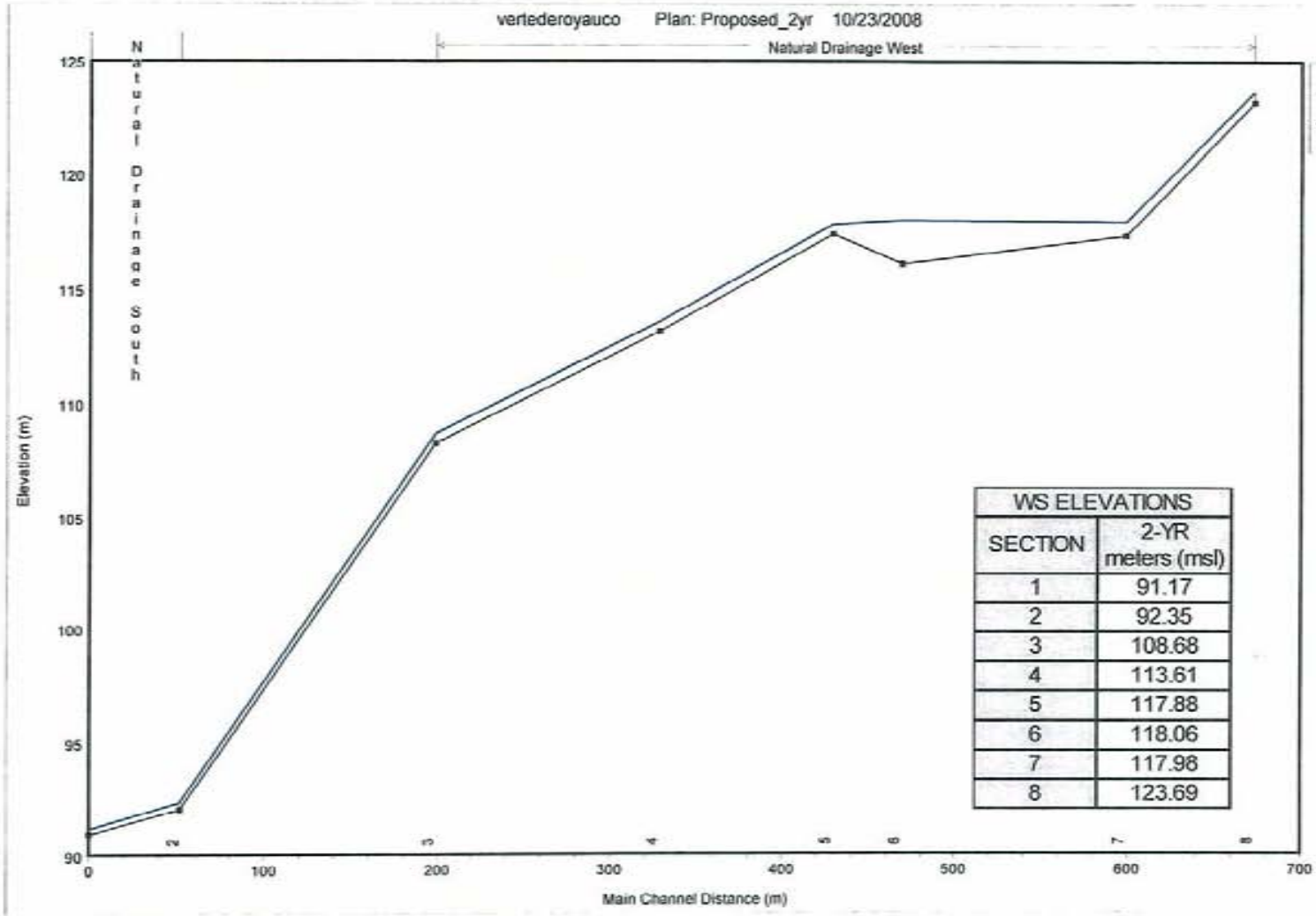

WS ELEVATIONS	
SECTION	2-YR meters (msl)
1	91.17
2	92.35
3	108.68
4	113.61
5	117.88
6	118.06
7	117.98
8	123.69

Figure 12. Water surface profiles for the proposed condition: 2-year flood event for Natural Drainage at sections 1, 2, 3, 4, 5, 6, 7 and, 8 (scale as shown).

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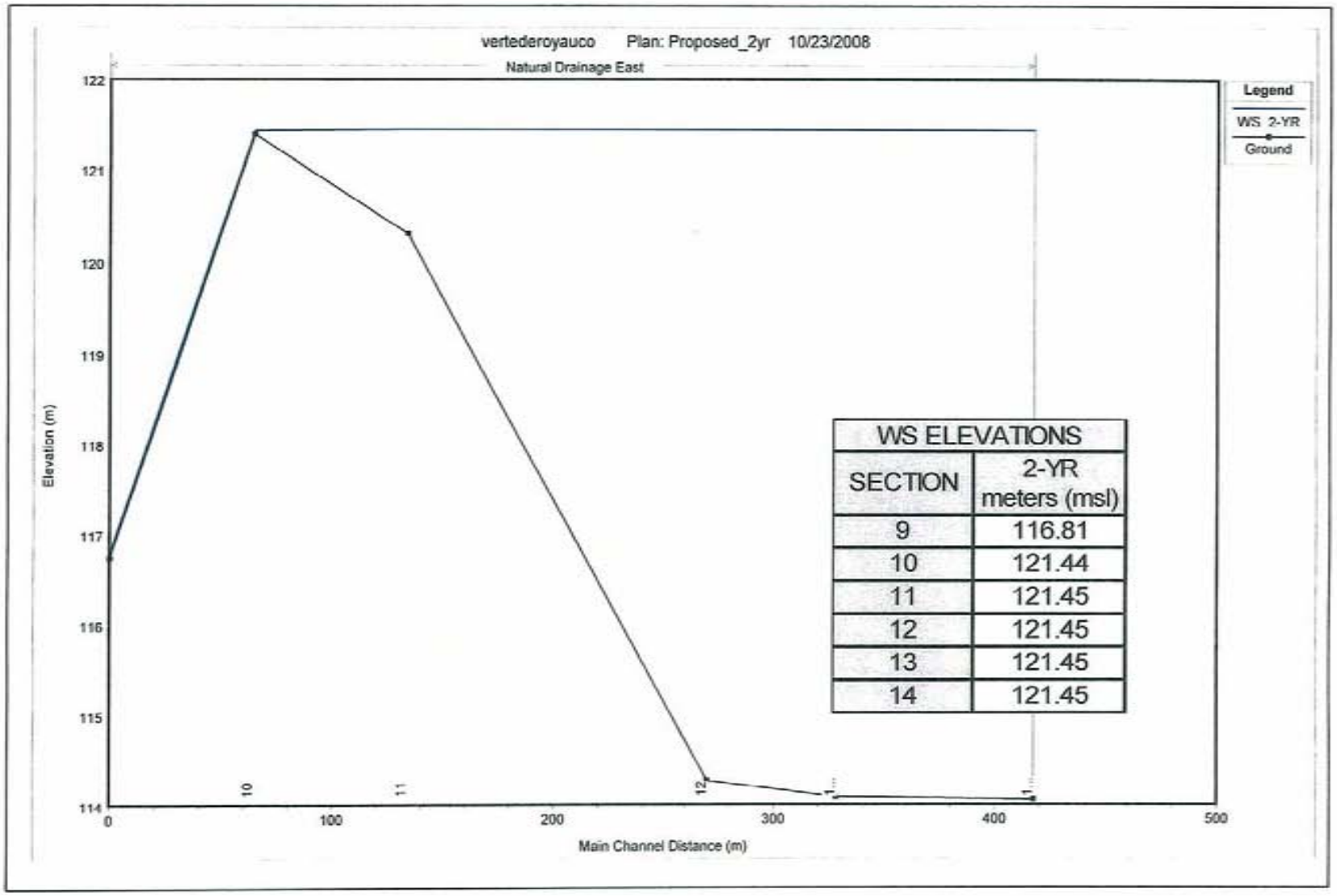

WS ELEVATIONS	
SECTION	2-YR meters (msl)
9	116.81
10	121.44
11	121.45
12	121.45
13	121.45
14	121.45

Figure 13. Water surface profiles for the proposed condition: 2-year flood event for Natural Drainage at sections 9, 10, 11, 12, 13 and, 14 (scale as shown).

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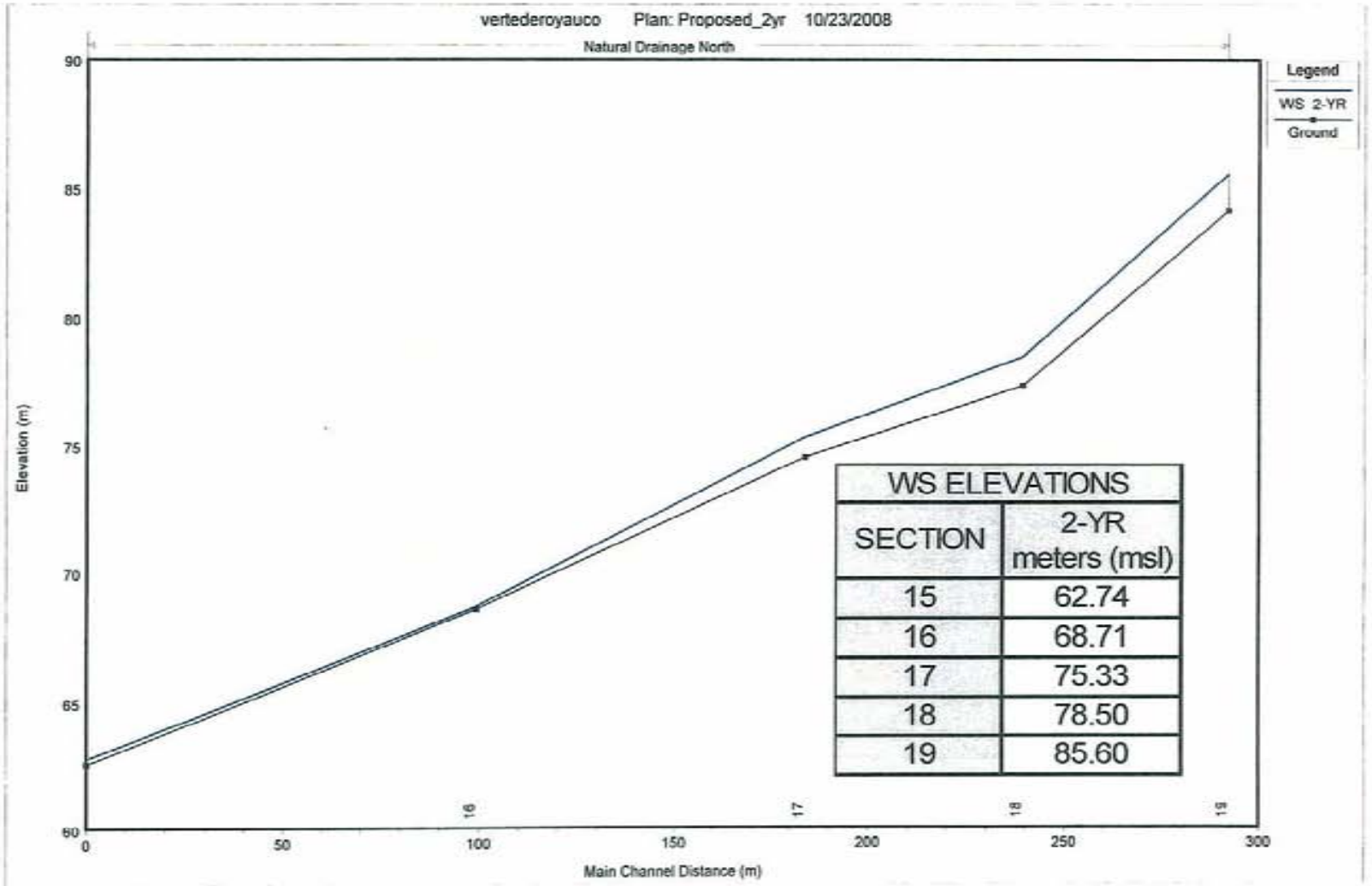

WS ELEVATIONS	
SECTION	2-YR meters (msl)
15	62.74
16	68.71
17	75.33
18	78.50
19	85.60

Figure 14. Water surface profiles for the proposed condition: 2-year flood event for Natural Drainage at sections 15, 16, 17, 18 and, 19 (scale as shown).

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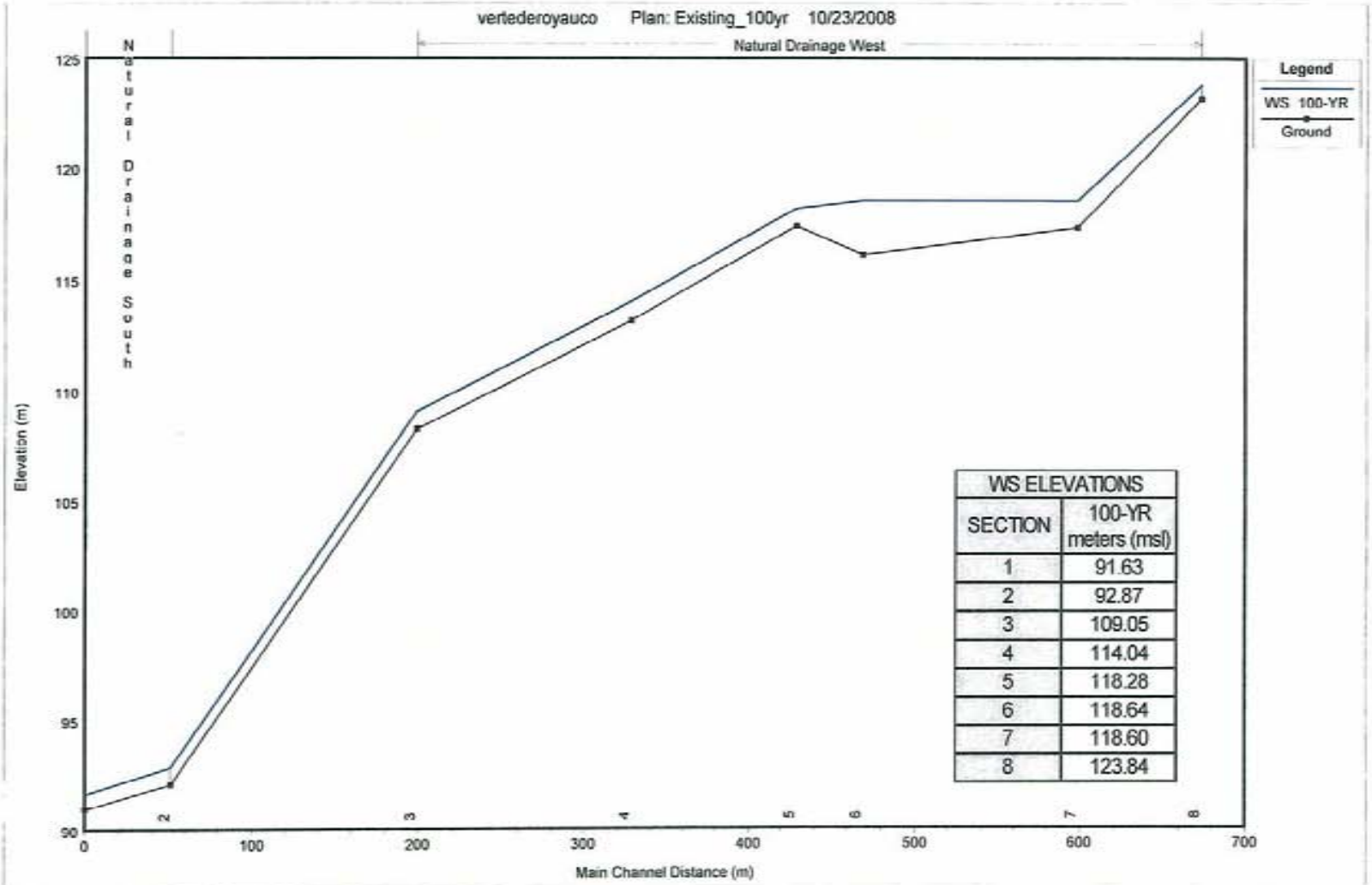

WS ELEVATIONS	
SECTION	100-YR meters (msl)
1	91.63
2	92.87
3	109.05
4	114.04
5	118.28
6	118.64
7	118.60
8	123.84

Figure 15. Water surface profiles for the existing condition: 100-year flood event for Natural Drainage at sections 1, 2, 3, 4, 5, 6, 7 and, 8 (scale as shown).

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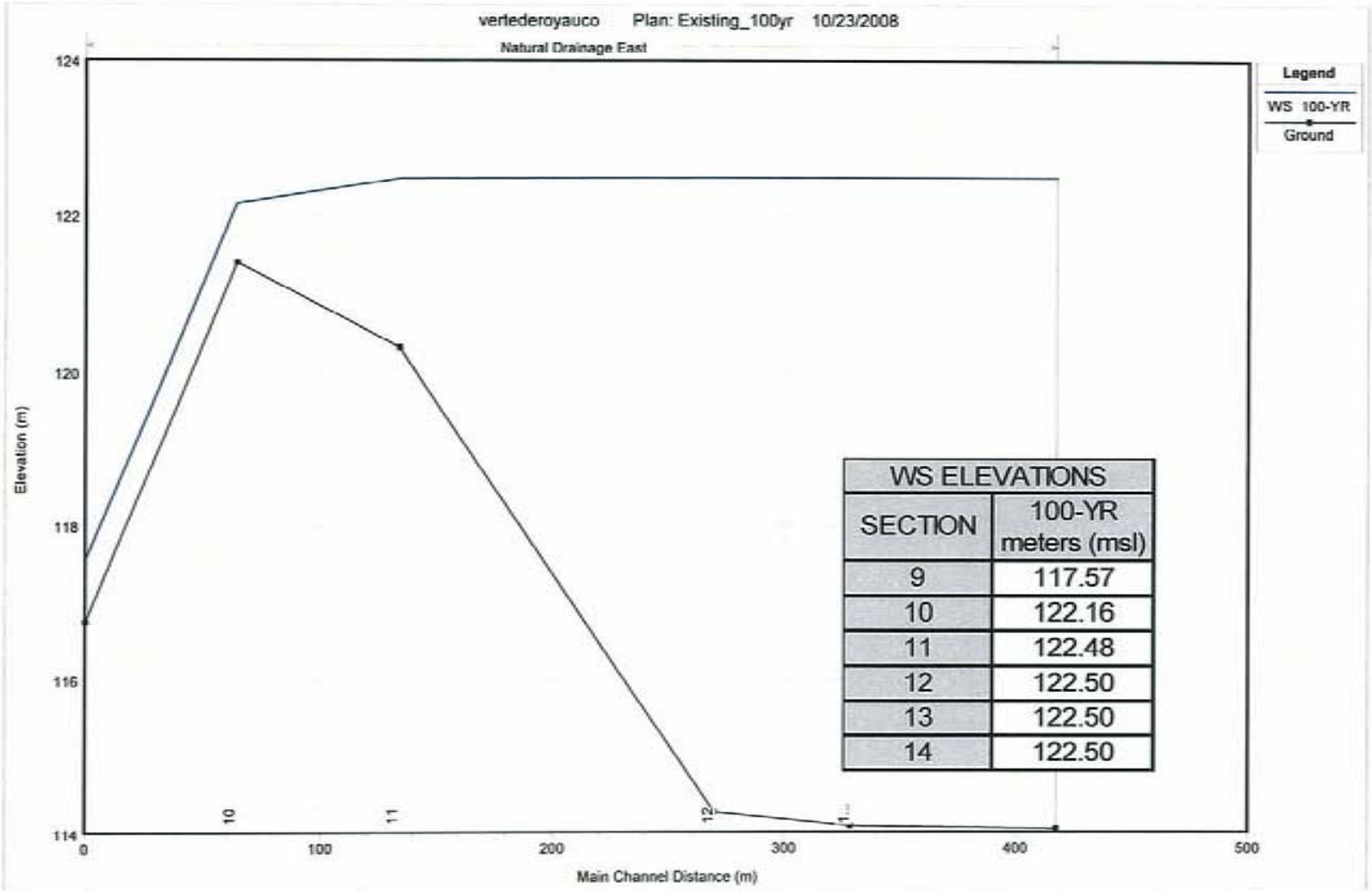

WS ELEVATIONS	
SECTION	100-YR meters (msl)
9	117.57
10	122.16
11	122.48
12	122.50
13	122.50
14	122.50

Figure 16. Water surface profiles for the existing condition: 100-year flood event for Natural Drainage at sections 9, 10, 11, 12, 13 and, 14 (scale as shown).

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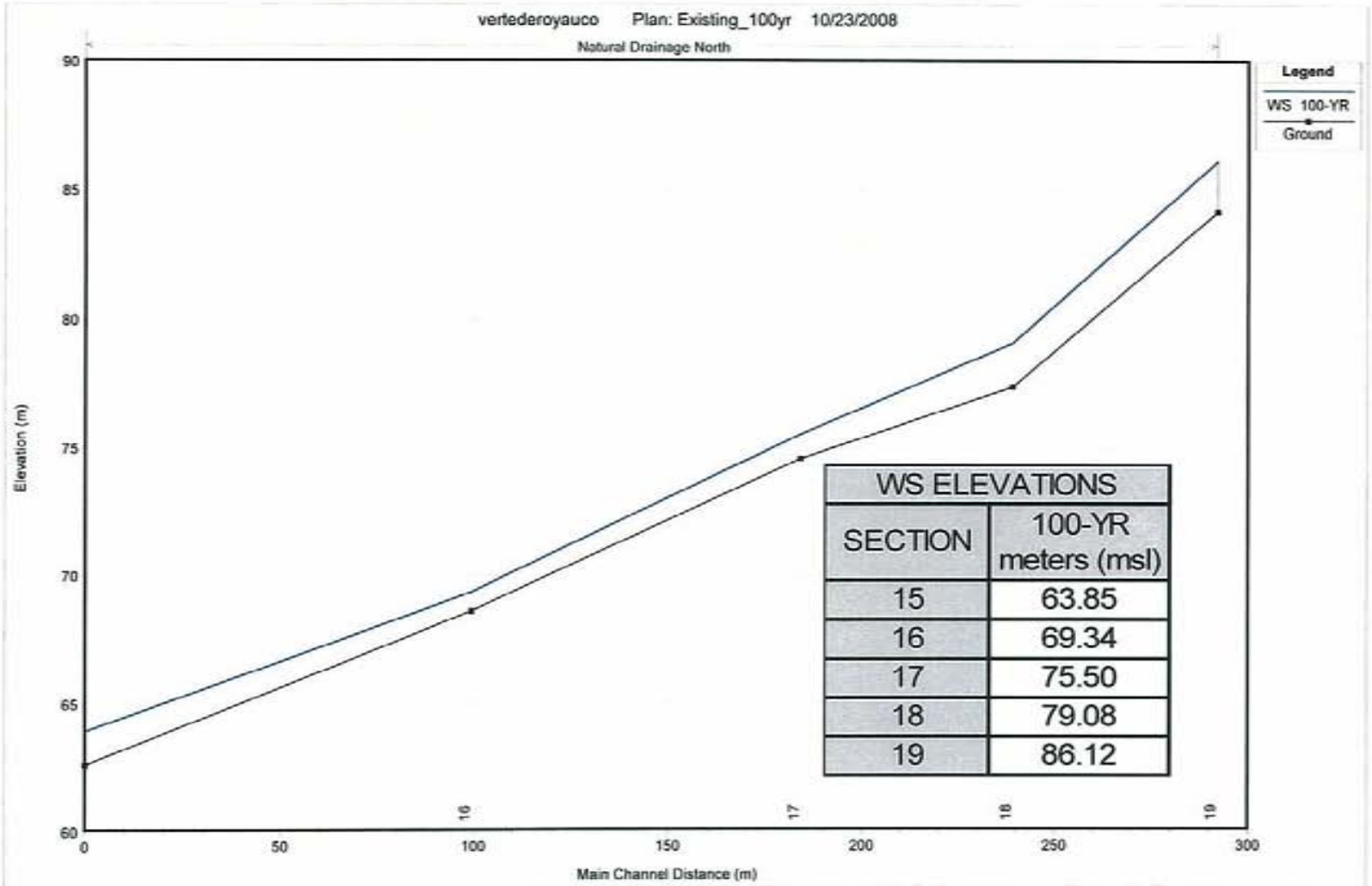

WS ELEVATIONS	
SECTION	100-YR meters (msl)
15	63.85
16	69.34
17	75.50
18	79.08
19	86.12

Figure 17. Water surface profiles for the existing condition: 100-year flood event for Natural Drainage at sections 15, 16, 17, 18 and, 19 (scale as shown).

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Figure 18. 100-year floodplain limits for the existing condition model (scale 1:7,500).

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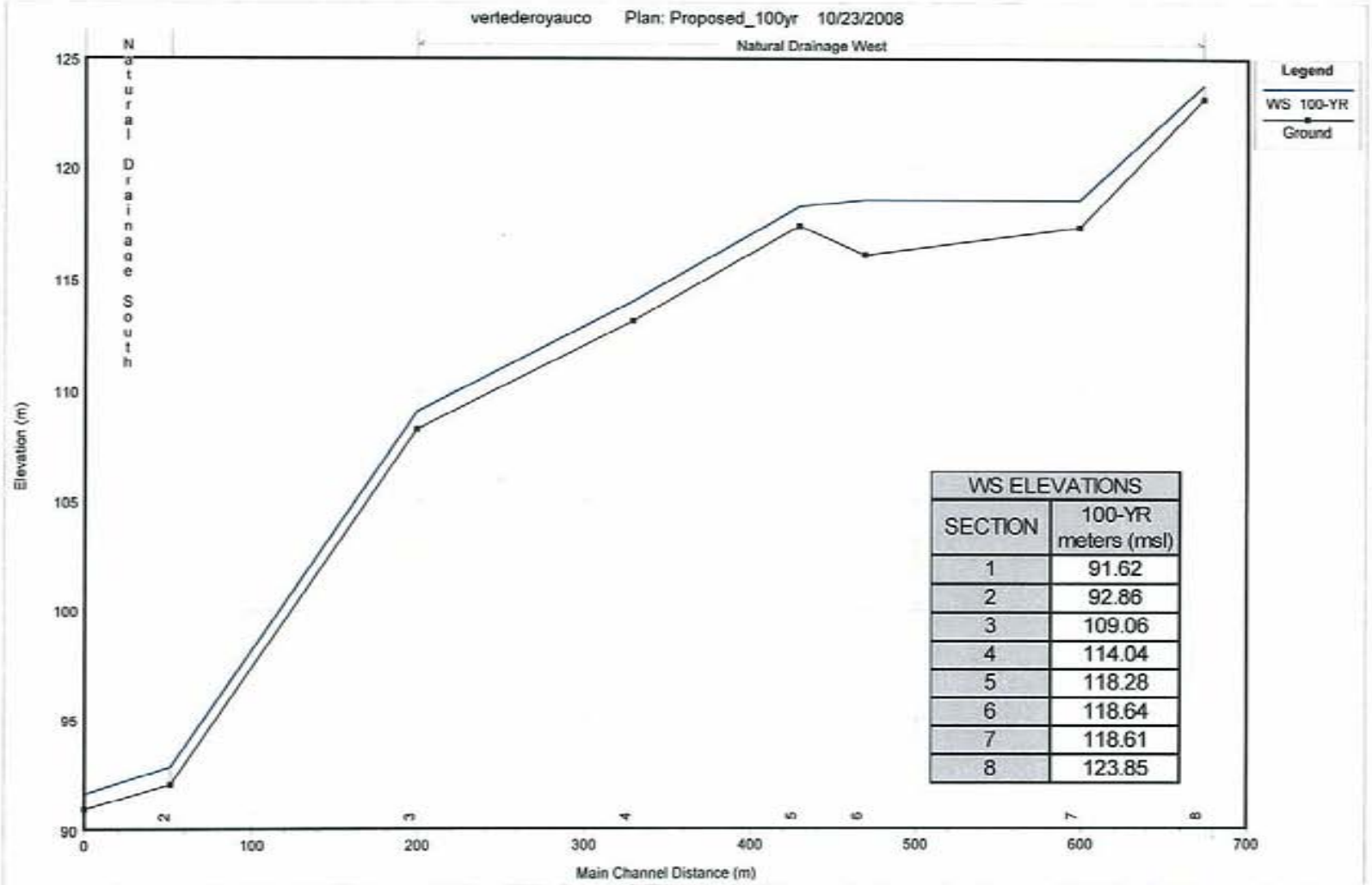

WS ELEVATIONS	
SECTION	100-YR meters (msl)
1	91.62
2	92.86
3	109.06
4	114.04
5	118.28
6	118.64
7	118.61
8	123.85

Figure 19. Water surface profiles for the proposed condition: 100-year flood event for Natural Drainage at sections 1, 2, 3, 4, 5, 6, 7 and, 8 (scale as shown).

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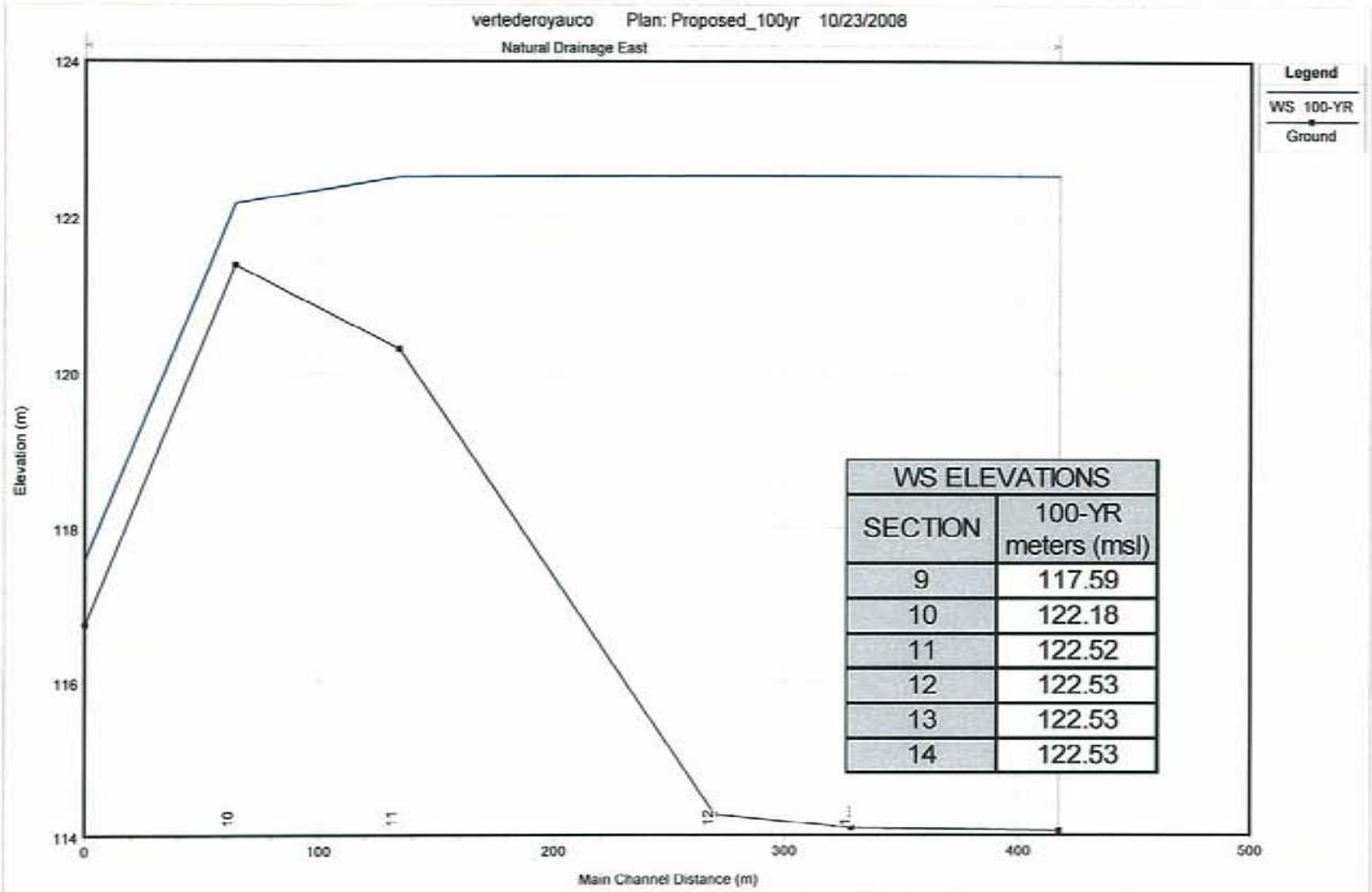

WS ELEVATIONS	
SECTION	100-YR meters (msl)
9	117.59
10	122.18
11	122.52
12	122.53
13	122.53
14	122.53

Figure 20. Water surface profiles for the proposed condition: 100-year flood event for Natural Drainage at sections 9, 10, 11, 12, 13 and, 14 (scale as shown).

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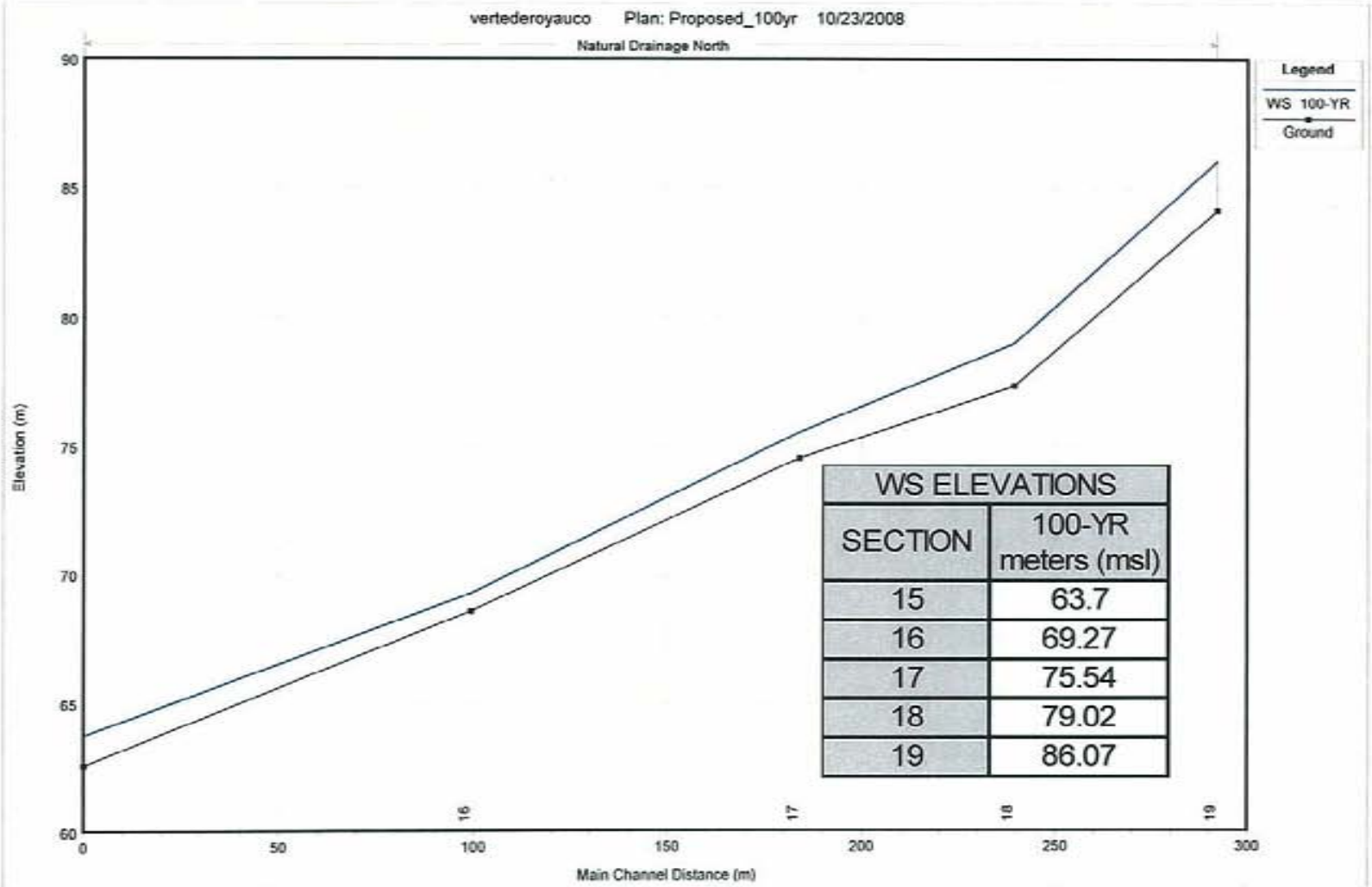

WS ELEVATIONS	
SECTION	100-YR meters (msl)
15	63.7
16	69.27
17	75.54
18	79.02
19	86.07

Figure 21. Water surface profiles for the proposed condition: 100-year flood event for Natural Drainage at sections 15, 16, 17, 18 and, 19 (scale as shown).

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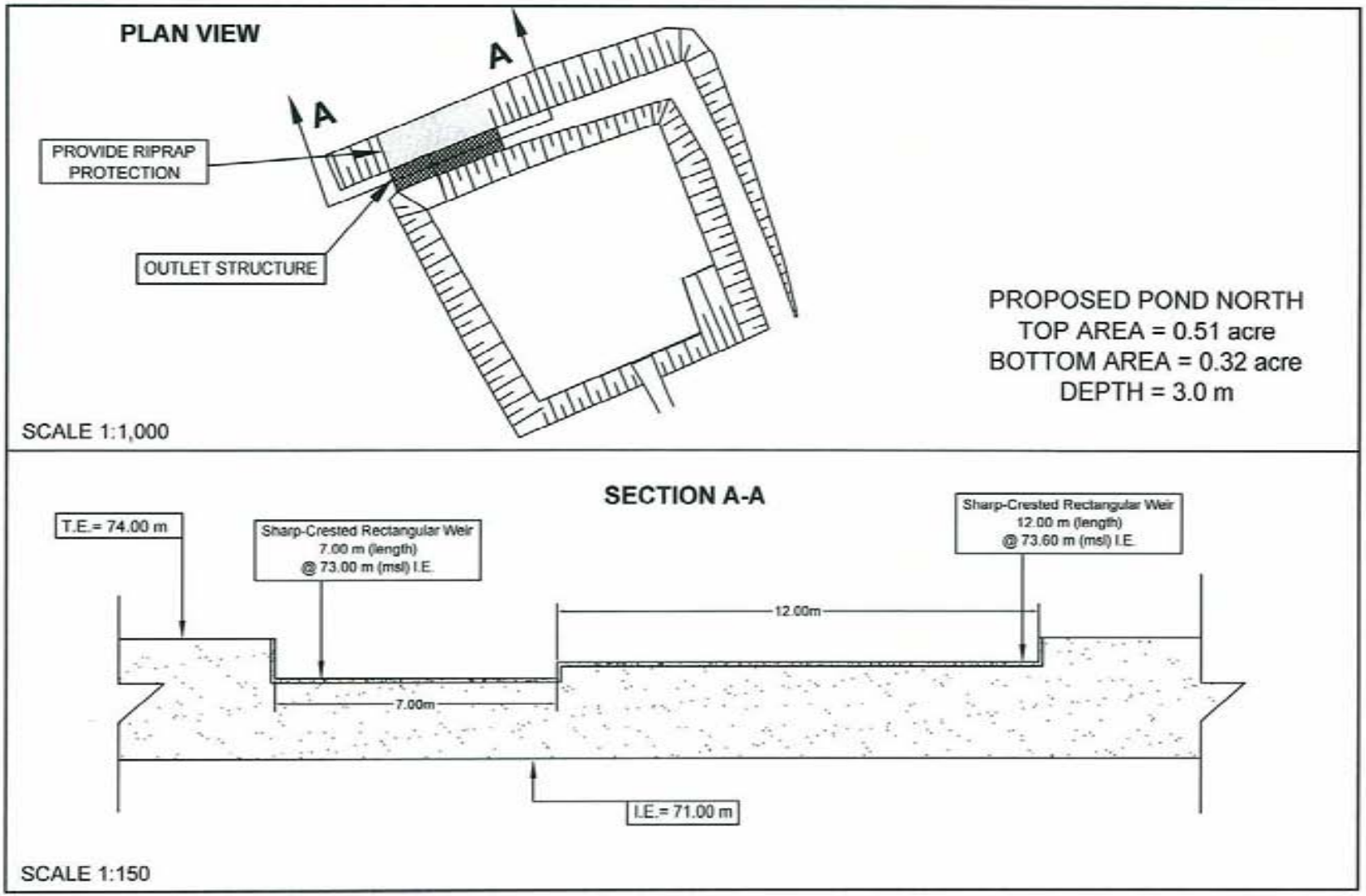

Figure 22. Conceptual scheme of the proposed retention pond: **North** (scale as shown).

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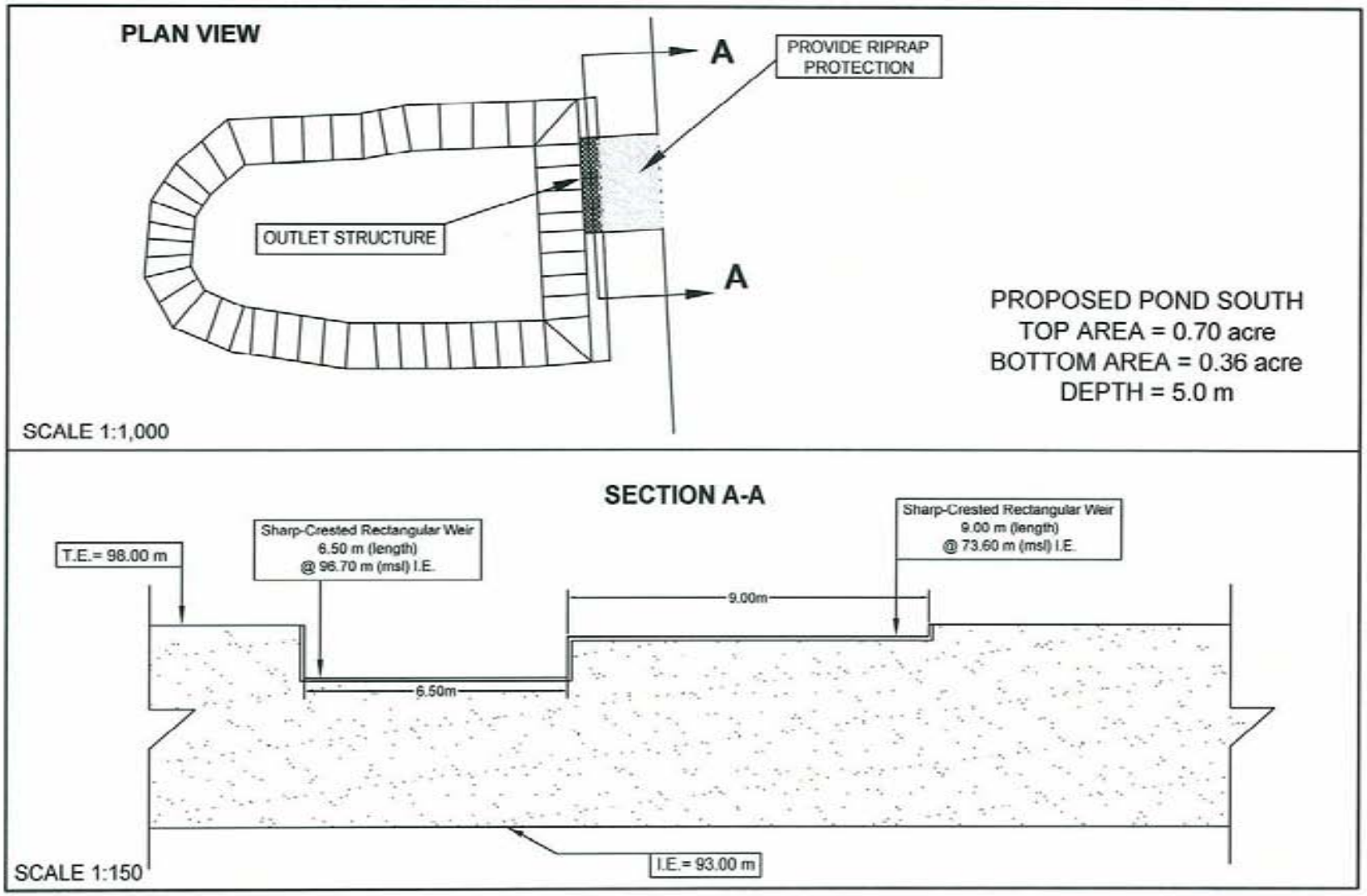

Figure 23. Conceptual scheme of the proposed retention pond: **South** (scale as shown).

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APPENDIX A

HYDROLOGIC DATA

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project: Yauco Landfill By: YACD Date: Sept 24 2008

Location: Yauco, PR Checked: MMF Date: Sept 24 2008

BASIN NAME: **Basin North (BASN)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 45.45

BASIN AREA (mi^2) = 0.0710

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Costa-Pitahay (CuF), D	Grass	82	21.49	1762.18
Costa-Pitahay (CuF), D	Open Spaces	89	9.29	826.81
El Papayo (EpF), D	Grass	82	2.34	191.88
Guayacan (GyC), D	Grass	82	3.14	257.48
Landfill (LfC), D	Open Spaces	89	2.07	184.23
Melones (MnC), D	Grass	82	0.12	9.84
Pithaya-Limestone (PsF), D	Grass	82	7.00	574
				0
		Totals	45.45	3806

CN	84

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Basin West (BASW)** **CONDITION:** **EXIS & PROP**

BASIN AREA (Ac) = 36.89

BASIN AREA (mi^2) = 0.0576

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	0.51	45.39
Pithaya-Limestone (PsF), D	Grass	82	36.38	2983.16
				0
				0
				0
				0
				0
				0
		Totals	36.89	3029

CN	82

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HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Basin East (BASE)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 70.97

BASIN AREA (mi^2) = 0.1109

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	0.29	25.81
Pithaya-Limestone (PsF), D	Grass	82	65.99	5411.18
Pithaya-Limestone (PsF), D	Open Spaces	89	4.69	417.41
				0
				0
				0
				0
				0
		Totals	70.97	5854

CN	82

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Basin South (BASS)** **CONDITION:** **EXIS & PROP**

BASIN AREA (Ac) = 7.61

BASIN AREA (mi^2) = 0.0119

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Pithaya-Limestone (PsF), D	Grass	82	7.61	624.02
				0
				0
				0
				0
				0
				0
				0
		Totals	7.61	624

CN	82

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HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Basin South West (BASSW)** **CONDITION:** **EXIS & PROP**

BASIN AREA (Ac) = 10.85

BASIN AREA (mi^2) = 0.0170

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	1.43	127.27
Pithaya-Limestone (PsF), D	Grass	82	9.42	772.44
				0
				0
				0
				0
				0
				0
		Totals	10.85	900

CN	83

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HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Basin South East (BASSE)** **CONDITION:** **EXIS & PROP**

BASIN AREA (Ac) = 1.57

BASIN AREA (mi^2) = 0.0025

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	0.05	4.45
Pithaya-Limestone (PsF), D	Grass	82	1.52	124.64
				0
				0
				0
				0
				0
				0
		Totals	1.57	129

CN	82

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HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: CURVE NUMBER

Project: Yauco Landfill By: YACD Date: Sept 24 2008

Location: Yauco, PR Checked: MMF Date: Sept 24 2008

BASIN NAME: **Landfill North (LN)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 14.78

BASIN AREA (mi^2) = 0.0231

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Costa-Pitahay (CuF), D	Grass	82	0.51	41.82
Costa-Pitahay (CuF), D	Open Spaces	89	0.57	50.73
Landfill (LfC), D	Open Spaces	89	12.19	1084.91
Pithaya-Limestone (PsF), D	Grass	82	1.51	123.82
				0
				0
				0
				0
		Totals	14.78	1301

CN	88

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WORKSHEET: CURVE NUMBER

Project: Yauco Landfill By: YACD Date: Sept 24 2008

Location: Yauco, PR Checked: MMF Date: Sept 24 2008

BASIN NAME: **Landfill South (LS)** **CONDITION:** **EXIS & PROP**

BASIN AREA (Ac) = 6.91

BASIN AREA (mi^2) = 0.0108

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	6.71	597.19
Pithaya-Limestone (PsF), D	Open Spaces	89	0.20	17.8
				0
				0
				0
				0
				0
				0
		Totals	6.91	615

CN	89

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WORKSHEET: CURVE NUMBER

Project: Yauco Landfill By: YACD Date: Sept 24 2008

Location: Yauco, PR Checked: MMF Date: Sept 24 2008

BASIN NAME: **Landfill East (LE)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 7.50

BASIN AREA (mi^2) = 0.0117

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Grass	82	0.86	70.52
Landfill (LfC), D	Open Spaces	89	5.27	469.03
Pithaya-Limestone (PsF), D	Grass	82	1.10	90.2
Pithaya-Limestone (PsF), D	Open Spaces	89	0.27	24.03
				0
				0
				0
				0
		Totals	7.50	654

CN	87

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WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Landfill West (LW)** **CONDITION:** **EXIS & PROP**

BASIN AREA (Ac) = 1.92

BASIN AREA (mi^2) = 0.0030

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	1.92	170.88
				0
				0
				0
				0
				0
				0
				0
		Totals	1.92	171

CN	89

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WORKSHEET: CURVE NUMBER

Project: Yauco Landfill By: YACD Date: Sept 24 2008

Location: Yauco, PR Checked: MMF Date: Sept 24 2008

BASIN NAME: **Basin North (BASN)** **CONDITION:** **PROPOSED**

BASIN AREA (Ac) = 43.84

BASIN AREA (mi^2) = 0.0685

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Costa-Pitahay (CuF), D	Grass	82	21.07	1727.74
Costa-Pitahay (CuF), D	Open Spaces	89	9.29	826.81
El Papayo (EpF), D	Grass	82	2.34	191.88
Guayacan (GyC), D	Grass	82	3.14	257.48
Landfill (LfC), D	Open Spaces	89	2.07	184.23
Melones (MnC), D	Grass	82	0.12	9.84
Pithaya-Limestone (PsF), D	Grass	82	5.81	574
				0
		Totals	43.84	3772

CN	86

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WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Basin East (BASE)** **CONDITION:** **PROPOSED**

BASIN AREA (Ac) = 58.01

BASIN AREA (mi^2) = 0.0906

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Pithaya-Limestone (PsF), D	Grass	82	54.92	4503.44
Pithaya-Limestone (PsF), D	Open Spaces	89	3.09	275.01
				0
				0
				0
				0
				0
				0
		Totals	58.01	4779

CN	82

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WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Landfill North (LN)** **CONDITION:** **PROPOSED**

BASIN AREA (Ac) = 21.21

BASIN AREA (mi^2) = 0.0331

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	21.21	1887.69
				0
				0
				0
				0
				0
				0
				0
		Totals	21.21	1888

CN	89

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WORKSHEET: CURVE NUMBER

Project:	Yauco Landfill	By:	YACD	Date:	Sept 24 2008
Location:	Yauco, PR	Checked:	MMF	Date:	Sept 24 2008

BASIN NAME: **Landfill East (LE)** **CONDITION:** **PROPOSED**

BASIN AREA (Ac) = 15.64

BASIN AREA (mi^2) = 0.0244

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN	AREA, (Ac)	PRODUCT OF AREA x CN
Landfill (LfC), D	Open Spaces	89	15.64	1391.96
				0
				0
				0
				0
				0
				0
				0
		Totals	15.64	1392

CN	89

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: EXISTING **BASIN NAME: BASN**

L = 793.4 meters x 3.28 = 2,603.02 feet

S = 175.7 (top) – 74.2 (bottom) = 101.50 ÷ 793.4 = 0.1279

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(2603.02)^{0.77}}{(0.1279)^{0.385}}$$

Total = 0.122 x 60 = 7.32 minutes*

Tc = 7 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 17°59'51.99 N **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **BASW**

L = 528.2 meters x 3.28 = 1,732.94 feet

S = 167.0 (top) – 116.5 (bottom) = 50.50 ÷ 528.2 = 0.0956

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(1732.94)^{0.77}}{(0.0956)^{0.385}}$$

Total = 0.100 x 60 = 6 minutes*

Tc = 6 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXISTING** **BASIN NAME:** **BASE**

L = 758.7 meters x 3.28 = 2,489.17 feet

S = 176.6 (top) – 113.5 (bottom) = 63.10 ÷ 758.7 = 0.0832

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(2489.17)^{0.77}}{(0.0832)^{0.385}}$$

Total = 0.140 x 60 = 8.4 minutes*

Tc = 8 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude:** **66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **BASS**

L = 213 meters x 3.28 = 698.82 feet

S = 132.2 (top) – 94.0 (bottom) = 38.20 ÷ 213 = 0.1793

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(698.82)^{0.77}}{(0.1793)^{0.385}}$$

Total = 0.039 x 60 = 2.34 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **BASSE**

L = 152 meters x 3.28 = 498.69 feet

S = 137.8 (top) – 95.0 (bottom) = 42.80 ÷ 152 = 0.2816

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(498.69)^{0.77}}{(0.2816)^{0.385}}$$

Total = 0.025 x 60 = 1.5 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude:** **66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **BASSW**

L = 369 meters x 3.28 = 1,210.63 feet

S = 157.0 (top) – 95.0 (bottom) = 62.00 ÷ 369 = 0.1680

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(1210.63)^{0.77}}{(0.1680)^{0.385}}$$

Total = 0.061 x 60 = 3.66 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude:** **66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: EXISTING **BASIN NAME: LN**

L = 277.8 meters x 3.28 = 911.42 feet

S = 149 (top) – 116 (bottom) = 33.00 ÷ 414 = 0.0797

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(911.42)^{0.77}}{(0.0797)^{0.385}}$$

Total = 0.065 x 60 = 3.9 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 17°59'51.99 N **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **LS**

L = 290.2 meters x 3.28 = 952.10 feet

S = 149 (top) – 106 (bottom) = 43.00 ÷ 290.2 = 0.1482

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(952.10)^{0.77}}{(0.1482)^{0.385}}$$

Total = 0.053 x 60 = 3.18 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude:** **66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: EXISTING **BASIN NAME: LE**

L = 245.4 meters x 3.28 = 805.12 feet

S = 149 (top) – 119. (bottom) = 30.00 ÷ 245.4 = 0.1222

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(805.12)^{0.77}}{(0.1222)^{0.385}}$$

Total = 0.050 x 60 = 3 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 17°59'51.99 N **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **LW**

L = 136.9 meters x 3.28 = 449.15 feet

S = 149 (top) – 116.5 (bottom) = 32.50 ÷ 136.9 = 0.2374

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(449.15)^{0.77}}{(0.12374)^{0.385}}$$

Total = 0.032 x 60 = 1.92 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude:** **66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **PROPOSED** **BASIN NAME:** **BASN**

L = 780.2 meters x 3.28 = 2,559.71 feet

S = 173.2 (top) – 74.2 (bottom) = 99.00 ÷ 780.2 = 0.1269

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(2559.71)^{0.77}}{(0.1269)^{0.385}}$$

Total = 0.121 x 60 = **7**.26 minutes*

Tc = 7 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **PROPOSED** **BASIN NAME:** **BASE**

L = 830 meters x 3.28 = 2,723.10 feet

S = 176.6 (top) – 113.5 (bottom) = 63.10 ÷ 830 = 0.0760

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(2723.10)^{0.77}}{(0.0760)^{0.385}}$$

Total = 0.155 x 60 = 9.3 minutes*

Tc = 9 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

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WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **PROPOSED** **BASIN NAME:** **LN**

L = 456.3 meters x 3.28 = 1,497.05 feet

S = 166 (top) – 116 (bottom) = 50.00 ÷ 456.3 = 0.1096

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(1497.05)^{0.77}}{(0.1096)^{0.385}}$$

Total = 0.085 x 60 = 5.1 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude:** **66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

MENAR HYDROSYSTEMS ENGINEERING, P.S.C.

HYDROLOGY • HYDRAULICS • SEDIMENT TRANSPORT

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **PROPOSED** **BASIN NAME:** **LE**

L = 236 meters x 3.28 = 774.28 feet

S = 159 (top) – 119. (bottom) = 40.00 ÷ 236 = 0.1695

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(774.28)^{0.77}}{(0.16.95)^{0.385}}$$

Total = 0.021 x 60 = 1.26 minutes*

Tc = 5 Minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: **17°59'51.99 N** **Longitude: 66°51'47.03" W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall, in 2-YR	0.64	1.13	2.68	3.37	3.55	4.06	4.47	5.15
Rainfall, in 100-YR	1.03	1.81	4.31	6.19	7.14	9.69	13.34	17.56

APPENDIX B

RAINFALL DATA (NOAA ATLAS 14, VOL 3, VERSION 3.0)

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Puerto Rico 17.9978 N 66.8631 W 377 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 3, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Wed May 7 2008

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | Docs | U.S. Map

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.54	0.73	0.94	1.50	2.23	2.83	2.86	3.17	3.43	3.89	4.68	5.14	5.70	6.24	7.89	9.31	11.31	13.17
2	0.64	0.88	1.13	1.81	2.68	3.37	3.55	4.06	4.47	5.15	6.20	6.81	7.51	8.17	10.19	11.98	14.45	16.80
5	0.73	1.00	1.29	2.06	3.06	4.01	4.31	5.22	6.09	7.37	8.91	9.65	10.48	11.20	13.38	15.43	18.18	20.95
10	0.81	1.10	1.41	2.26	3.36	4.50	4.93	6.17	7.51	9.32	11.32	12.09	12.96	13.67	15.97	18.14	21.07	24.13
25	0.90	1.22	1.57	2.52	3.73	5.17	5.78	7.50	9.62	12.25	14.99	15.69	16.56	17.20	19.59	21.84	24.95	28.36
50	0.97	1.32	1.70	2.71	4.03	5.69	6.46	8.57	11.40	14.78	18.17	18.82	19.59	20.16	22.51	24.75	27.96	31.62
100	1.03	1.41	1.81	2.90	4.31	6.19	7.14	9.69	13.34	17.56	21.70	22.30	22.95	23.40	25.55	27.74	30.99	34.87
200	1.10	1.51	1.94	3.10	4.60	6.71	7.85	10.88	15.47	20.65	25.64	26.18	26.66	26.98	28.94	31.07	34.12	38.21
500	1.19	1.63	2.10	3.35	4.98	7.39	8.82	12.54	18.58	25.21	31.49	31.90	32.29	32.47	33.92	35.90	38.71	42.90
1000	1.26	1.73	2.22	3.55	5.27	7.92	9.57	13.87	21.16	29.03	36.44	36.70	36.98	36.98	37.93	39.71	42.33	46.57

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

*** Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)**

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.56	0.77	0.98	1.57	2.33	2.91	3.09	3.58	3.99	4.54	5.61	6.06	6.64	7.21	8.98	10.51	12.64	14.64
2	0.69	0.95	1.22	1.95	2.89	3.65	3.88	4.58	5.20	6.01	7.42	8.03	8.75	9.45	11.61	13.52	16.14	18.69
5	0.79	1.08	1.39	2.23	3.31	4.35	4.75	5.92	7.13	8.59	10.66	11.35	12.19	12.90	15.22	17.38	20.32	23.32
10	0.87	1.19	1.53	2.45	3.64	4.90	5.45	7.02	8.83	10.84	13.53	14.20	15.04	15.73	18.17	20.46	23.56	26.88
25	0.97	1.33	1.71	2.74	4.06	5.66	6.44	8.60	11.40	14.25	17.92	18.48	19.26	19.84	22.34	24.69	27.93	31.64
50	1.05	1.44	1.84	2.95	4.38	6.24	7.24	9.92	13.64	17.20	21.77	22.23	22.86	23.31	25.73	28.08	31.38	35.36
100	1.13	1.54	1.98	3.17	4.71	6.84	8.07	11.33	16.18	20.49	26.09	26.44	26.86	27.14	29.32	31.57	34.88	39.10
200	1.21	1.65	2.12	3.39	5.03	7.45	8.94	12.88	18.99	24.13	30.98	31.19	31.34	31.44	33.39	35.48	38.54	43.00
500	1.31	1.80	2.31	3.69	5.47	8.28	10.16	15.07	23.23	29.56	38.27	38.28	38.66	39.05	39.27	41.18	43.91	48.46
1000	1.40	1.91	2.45	3.92	5.82	8.93	11.13	16.85	26.81	34.16	44.51	44.95	45.40	45.86	46.32	46.78	48.20	52.78

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.

Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

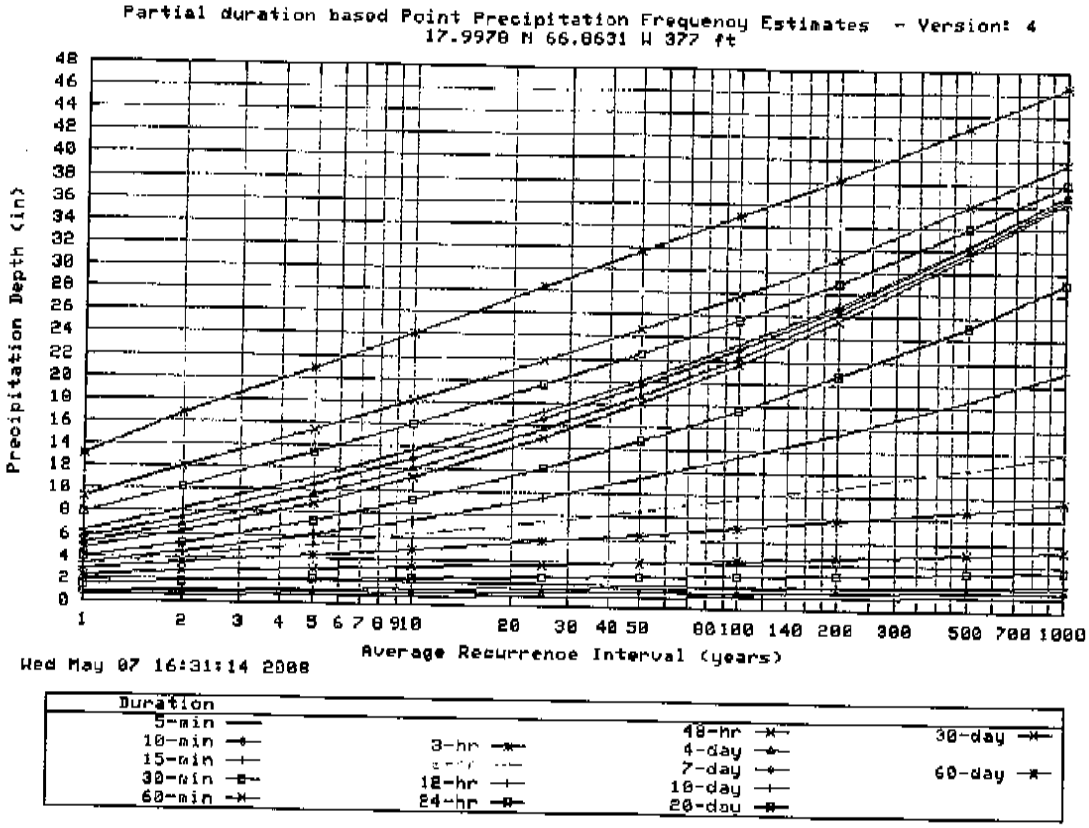
HH, Yauco Landfill, Yauco, Puerto Rico

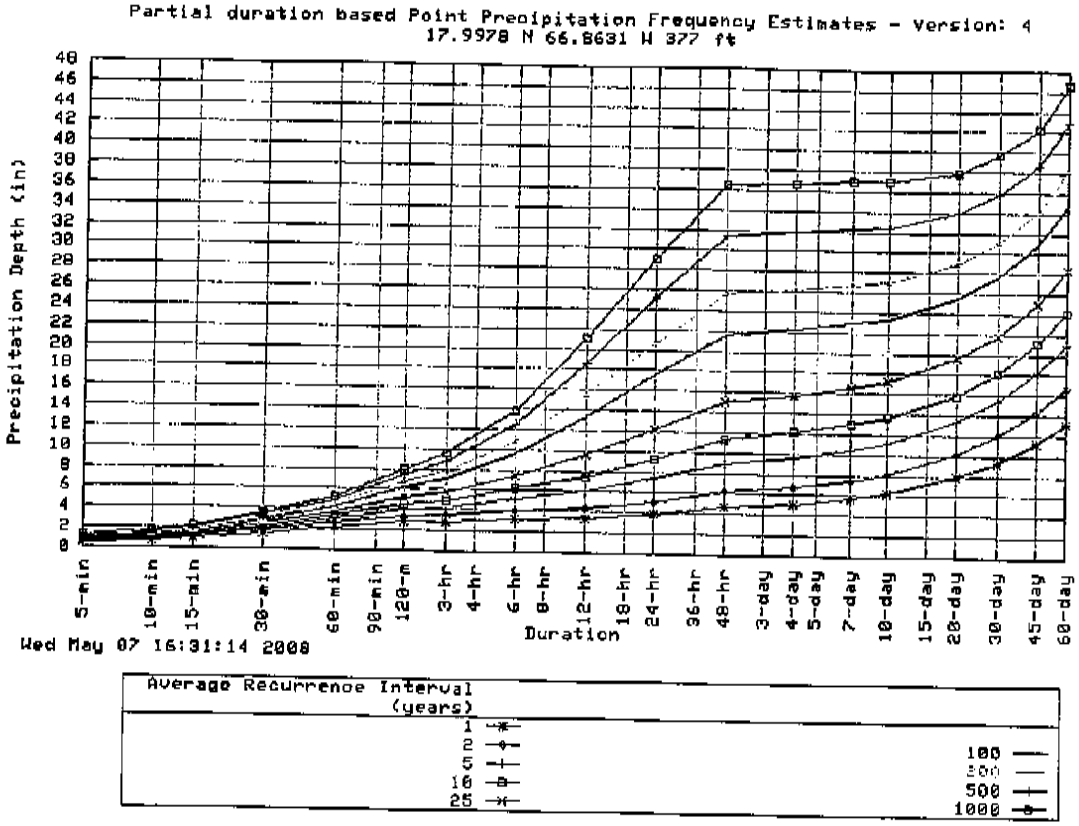
* Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.48	0.66	0.85	1.35	2.01	2.46	2.57	2.83	2.97	3.38	3.96	4.39	4.92	5.43	6.97	8.29	10.14	11.85
2	0.60	0.82	1.05	1.68	2.49	3.09	3.23	3.62	3.88	4.47	5.25	5.81	6.47	7.11	8.99	10.66	12.96	15.09
5	0.68	0.93	1.19	1.91	2.83	3.66	3.90	4.59	5.23	6.36	7.49	8.22	9.02	9.72	11.76	13.68	16.24	18.77
10	0.74	1.01	1.30	2.09	3.10	4.11	4.45	5.39	6.36	7.99	9.44	10.24	11.10	11.82	13.97	16.03	18.77	21.57
25	0.83	1.13	1.45	2.33	3.45	4.71	5.19	6.49	8.00	10.40	12.36	13.14	14.05	14.77	17.02	19.18	22.11	25.21
50	0.89	1.22	1.56	2.50	3.71	5.17	5.75	7.33	9.33	12.44	14.79	15.63	16.49	17.16	19.44	21.63	24.66	28.01
100	0.95	1.30	1.67	2.67	3.96	5.60	6.32	8.18	10.72	14.63	17.43	18.34	19.15	19.77	21.91	24.11	27.21	30.73
200	1.01	1.38	1.78	2.84	4.22	6.06	6.90	9.08	12.23	17.04	20.34	21.29	22.03	22.60	24.64	26.86	29.82	33.55
500	1.09	1.50	1.92	3.07	4.56	6.63	7.67	10.32	14.32	20.53	24.57	25.53	26.30	26.86	28.56	30.75	33.55	37.36
1000	1.16	1.58	2.03	3.25	4.82	7.08	8.28	11.29	16.02	23.42	28.03	29.03	29.80	30.31	31.68	33.77	36.46	40.35

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than.
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

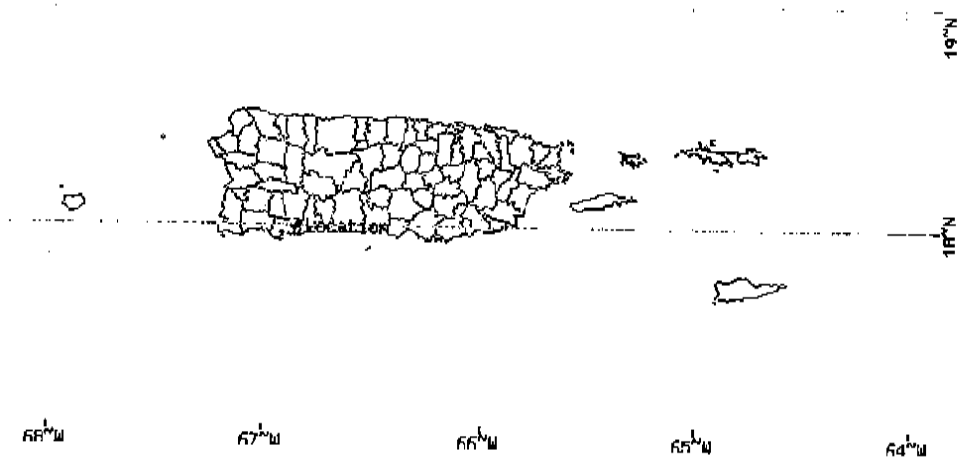
Text version of tables

HH, Yauco Landfill, Yauco, Puerto Rico




Partial duration based Point Precipitation Frequency Estimates - Version: 4
17.9978 N 66.8631 W 377 ft
Precipitation Depth (in)
Duration
5-min
10-min
15-min
30-min
60-min
90-min
120-m
3-hr
4-hr
6-hr
8-hr
12-hr
18-hr
24-hr
36-hr
48-hr
3-day
4-day
5-day
7-day
10-day
15-day
20-day
30-day
45-day
60-day
Wed May 07 16:31:14 2008
Average Recurrence Interval (years)
1
2
5
10
25
100
200
500
1000

Maps -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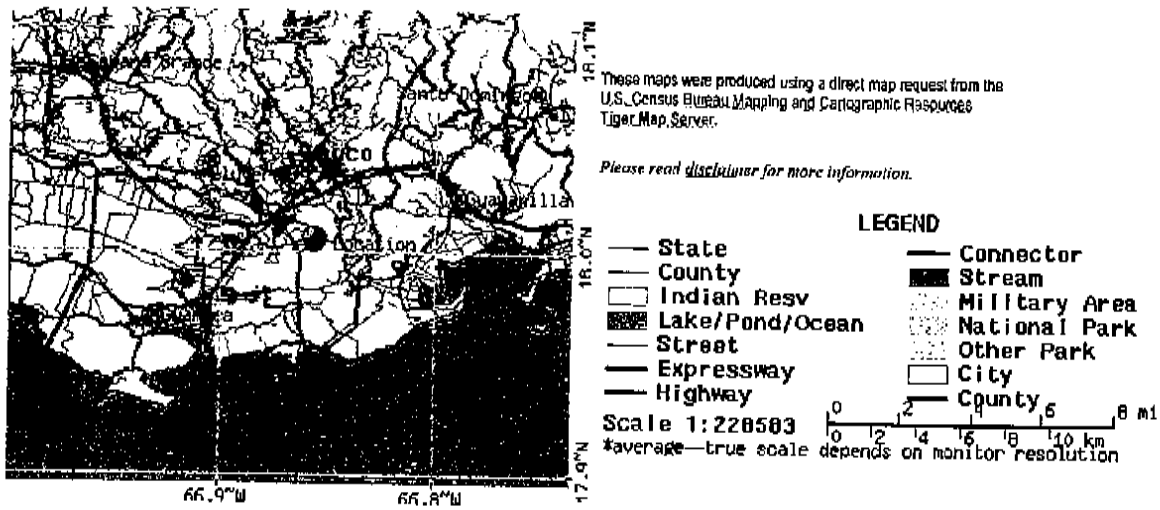
18°N
Location
68°W
67°W
66°W
65°W
64°W



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; USGS **Aerial Photograph** may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to our documentation.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (17.9978/-66.8631). Digital ASCII data can be obtained directly from NCDC.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

Disclaimer

APPENDIX C

POND ELEVATION – AREA AND ELEVATION – OUTFLOW RELATION

EXISTING CONDITION

POND NORTH

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
236.22	72.00	0.00	1292.0	1292.0	0.32
242.78	74.00	2.00	1292.0	2079.0	0.51
243.76	74.30	2.30	1292.0	2079.0	0.51

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	13.71	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	151.18	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(6)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
72.00	236.22	0.00	0	0.00	0	0
73.00	239.50	0.00	0	0.00	0	0
73.05	239.66	0.16	3	0.00	0	3
73.30	240.48	0.98	44	0.00	0	44
73.60	241.47	1.97	124	0.00	0	124
73.90	242.45	2.95	228	0.00	0	228
74.00	242.78	3.28	267	0.00	0	267
74.30	243.76	4.27	396	0.98	484	880

POND WEST

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
377.29	115.00	0.00	680.0	680.0	0.17
380.57	116.00	1.00	680.0	1118.0	0.28
383.85	117.00	2.00	680.0	2060.0	0.51
387.13	118.00	3.00	680.0	2505.0	0.62
390.42	119.00	4.00	680.0	3073.0	0.76
393.70	120.00	5.00	680.0	3559.0	0.88

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	13.71	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	0.00	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(6)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
115.00	377.29	0.00	0	0.00	0	0
118.00	387.13	0.00	0	0.00	0	0
118.03	387.23	0.10	1	0.00	0	1
118.30	388.12	0.98	44	0.00	0	44
118.60	389.10	1.97	124	0.00	0	124
118.90	390.09	2.95	228	0.00	0	228
119.00	390.42	3.28	267	0.00	0	267
120.00	393.70	6.56	756	0.00	0	756

POND EAST

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
374.01	114.00	0.00	1137.0	1137.0	0.28
375.65	114.50	0.50	1137.0	2561.0	0.63
377.29	115.00	1.00	1137.0	9519.0	2.35
390.42	119.00	5.00	1137.0	16422.0	4.06
393.70	120.00	6.00	1137.0	17484.0	4.32
396.98	121.00	7.00	1138.0	18493.0	4.57

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	10.66	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	0.00	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(6)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
114.00	374.01	0.00	0	0.00	0	0
119.00	390.42	0.00	0	0.00	0	0
119.03	390.51	0.10	1	0.00	0	1
120.00	393.70	3.28	208	0.00	0	208

POND SOUTH 1

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
314.96	96.00	0.00	215.0	215.0	0.05
318.24	97.00	1.00	215.0	427.0	0.11
321.52	98.00	2.00	215.0	920.0	0.23

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	56.66	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	0.00	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(8)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
96.00	314.96	0.00	0	0.00	0	0
97.00	318.24	0.00	0	0.00	0	0
97.01	318.27	0.03	1	0.00	0	1
97.30	319.22	0.98	181	0.00	0	181
98.00	321.52	3.28	1104	0.00	0	1104

POND SOUTH 2

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
305.11	93.00	0.00	217.0	217.0	0.05
318.24	97.00	4.00	217.0	704.0	0.17
321.52	98.00	5.00	217.0	1291.0	0.32

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	61.29	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	0.00	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(6)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
93.00	305.11	0.00	0	0.00	0	0
97.00	318.24	0.00	0	0.00	0	0
97.01	318.27	0.03	1	0.00		1
97.55	320.04	1.80	487	0.00	0	487
98.00	321.52	3.28	1195	0.00	0	1195

PROPOSED CONDITION

POND NORTH

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
232.94	71.00	0	1292.0	1292.0	0.32
236.22	72.00	1.00	1292.0	1292.0	0.32
242.78	74.00	3.00	1292.0	2079.0	0.51
243.76	74.30	3.30	1292.0	2079.0	0.51

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	22.97	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	39.37	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(6)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
71.00	232.94	0	0	-1.00	0	0
72.00	236.22	0.00	0	0.00	0	0
73.00	239.50	0.00	0	0.00	0	0
73.05	239.66	0.16	5	0.00	0	5
73.40	240.81	1.31	113	0.00	0	113
73.60	241.47	1.97	208	0.66	69	277
73.90	242.45	2.95	382	1.64	271	654
74.00	242.78	3.28	448	1.97	357	804
74.30	243.76	4.27	664	2.95	655	1319

POND SOUTH

IRREGULAR RETENTION POND: DETERMINATION OF OUTFLOW

Elev, ft	Elev, m	H, m	Base Area, m^2	Top Area, m^2	Top Area, acres
305.11	93.00	0.00	217.0	1438.0	0.36
321.52	98.00	5.00	217.0	2820.0	0.70

WEIR FLOW

Weir		
C = Weir coefficient	3.28	Breadth of crest=1.0 ft
C = Weir coefficient	3.32	than 3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	21.33	
H = Weir head, ft	See Table	

OVERFLOW

Weir		
C = Weir coefficient	3.28	H equal to 1.6 ft; Breadth of crest=1.0 ft
C = Weir coefficient	3.32	3.0 ft; Breadth of crest=1.0 ft
L = Length of weir, ft	29.53	
H = Weir head, ft	See Table	

(1)	(2)	(3)	(4)	(5)	(6)	(6)
Elev, m	Elev, ft	H,ft	Q,ft^3/s	H,ft	Q,ft^3/s	Q,ft^3/s
93.00	305.11	0.00	0	0.00	0	0
96.70	317.25	0.00	0	0.00	0	0
96.72	317.32	0.07	1	0.00	0	1
97.70	320.53	3.28	416	0.00	0	416
97.85	321.03	3.77	513	0.49	24	537
98.00	321.52	4.27	616	0.98	68	684

APPENDIX D

HEC-HMS INPUT AND OUTPUT DATA

BASIN MODEL EXISTING CONDITION:

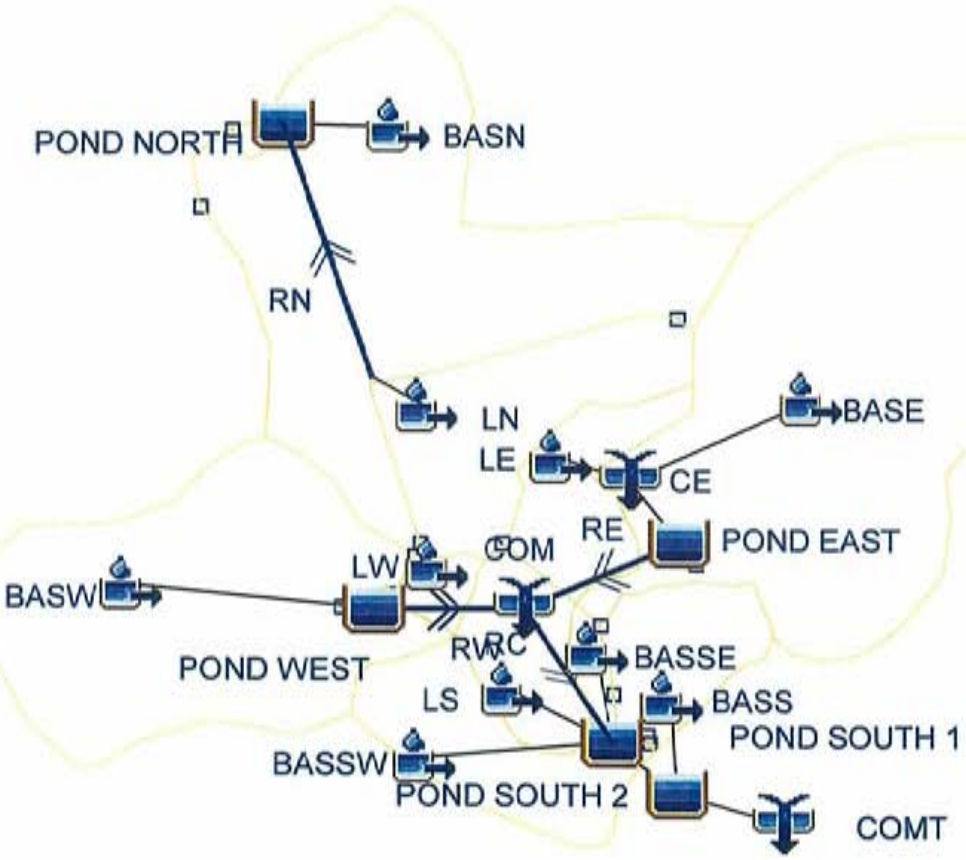
(EXISTING.BASIN)

HEC-HMS

Project : YAUCO

Basin Model : EXISTING

Oct 07 16:22:39 VET 2008



```
Basin: EXISTING
     Description: EXISTING CONDITION
     Last Modified Date: 25 September 2008
     Last Modified Time: 15:56:33
     Version: 3.2
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Allow Blending: No
     Compute Local Flow At Junctions: No

     Sediment Grade Scale: NONE
     Enable Sediment Routing: No
     Fall Velocity Method: UNSPECIFIED
End:

Subbasin: BASW
     Description: West Basin
     Canvas X: -1391.5570321739215
     Canvas Y: -262.07027442299716
     Label X: -64.0
     Label Y: -5.0
     Area: 0.0576
     Downstream: POND WEST

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 82

     Transform: SCS
     Lag: 3.6

     Baseflow: None

     Erosion: None
End:

Reach: RW
     Description: Combination 1
     Canvas X: -838.5619701496952
     Canvas Y: -292.42859667852747
     From Canvas X: -1026.2915888001062
     From Canvas Y: -293.78622112689663
     Label X: -15.0
     Label Y: -16.0
     Downstream: COM

     Route: Muskingum
     Muskingum K: 0.083
     Muskingum X: 0.3
     Muskingum Steps: 4
     Channel Loss: None

     Route Sediment: No
End:

Subbasin: BASE
     Description: East Basin
     Canvas X: -478.25142431385893
```

```
        Canvas Y: -26.276234973889814
        Label X: -3.0
        Label Y: -4.0
        Area: 0.1109
        Downstream: CE

        Canopy: None

        Surface: None

        LossRate: SCS
        Percent Impervious Area: 0.0
        Curve Number: 82

        Transform: SCS
        Lag: 4.8

        Baseflow: None

        Erosion: None
    End:

    Reach: RE
        Description: Combination 1
        Canvas X: -838.5619701496952
        Canvas Y: -292.42859667852747
        From Canvas X: -644.6956503440149
        From Canvas Y: -209.02099397143252
        Label X: -23.0
        Label Y: 18.0
        Downstream: COM

        Route: Muskingum
        Muskingum K: 0.083
        Muskingum X: 0.3
        Muskingum Steps: 4
        Channel Loss: None

        Route Sediment: No
    End:

    Subbasin: BASSW
        Description: South Basin
        Canvas X: -965.4917648303095
        Canvas Y: -481.05354032027265
        Label X: -73.0
        Label Y: -3.0
        Area: 0.0170
        Downstream: POND SOUTH 1

        Canopy: None

        Surface: None

        LossRate: SCS
        Percent Impervious Area: 0.0
        Curve Number: 83

        Transform: SCS
        Lag: 3

        Baseflow: None
```

```
     Erosion: None
End:

Junction: COMT
     Description: Combination 1
     Canvas X: -513.5203113894815
     Canvas Y: -564.9852522907381
     Label X: 13.0
     Label Y: -1.0
End:

Reservoir: POND WEST
     Description: West
     Canvas X: -1026.2915888001062
     Canvas Y: -293.78622112689663
     From Canvas X: -24.12
     From Canvas Y: -8.280000000000001
     Label X: -90.0
     Label Y: -24.0
     Downstream: RW

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 377.29
     Elevation-Area Table: Pond West (EXIS)
     Elevation-Outflow Table: Pond West (EXIS)
     Primary Table: Elevation-Outflow
End:

Reservoir: POND SOUTH 1
     Description: South
     Canvas X: -727.7447561743647
     Canvas Y: -462.43099680861314
     Label X: 30.0
     Label Y: 2.0
     Downstream: POND SOUTH 2

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 314.96
     Elevation-Area Table: Pond South 1 (EXIS)
     Elevation-Outflow Table: Pond South 1 (EXIS)
     Primary Table: Elevation-Outflow
End:

Reservoir: POND EAST
     Description: East
     Canvas X: -644.6956503440149
     Canvas Y: -209.02099397143252
     From Canvas X: -137.88295081967215
     From Canvas Y: -89.65770491803279
     Label X: 1.0
     Label Y: 1.0
     Downstream: RE

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 374.01
     Elevation-Area Table: Pond East (EXIS)
     Elevation-Outflow Table: Pond East (EXIS)
     Primary Table: Elevation-Outflow
End:
```

```
Subbasin: BASN
     Description: South Basin
     Canvas X: -996.3601374333883
     Canvas Y: 316.22147713000356
     From Canvas X: -43.50857142857143
     From Canvas Y: 23.45142857142858
     Label X: 2.0
     Label Y: -4.0
     Area: 0.0710
     Downstream: POND NORTH

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 84

     Transform: SCS
     Lag: 4.2

     Baseflow: None

     Erosion: None
End:

Reservoir: POND NORTH
     Description: West
     Canvas X: -1140.6327475213366
     Canvas Y: 318.4757366626277
     From Canvas X: -72.25714285714287
     From Canvas Y: 2.8285714285714363
     Label X: -111.0
     Label Y: -8.0
     Rating Table Name: Pond North (EXIS)

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 236.22
     Elevation-Area Table: Pond North (EXIS)
     Elevation-Outflow Table: Pond North (EXIS)
     Primary Table: Elevation-Outflow
End:

Reservoir: POND SOUTH 2
     Description: South
     Canvas X: -648.9181304353352
     Canvas Y: -526.2783452338404
     From Canvas X: 15.737142857142857
     From Canvas Y: 2.777142857142863
     Label X: -124.0
     Label Y: -1.0
     Downstream: COMT

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 305.11
     Elevation-Area Table: Pond South 2 (EXIS)
     Elevation-Outflow Table: Pond South 2 (EXIS)
     Primary Table: Elevation-Outflow
End:
```

```
Junction: COM
     Description: Combination 1
     Canvas X: -838.5619701496952
     Canvas Y: -292.42859667852747
     From Canvas X: -50.91428571428571
     From Canvas Y: 23.45142857142858
     Label X: -31.0
     Label Y: 23.0
     Downstream: RC
End:

Reach: RC
     Description: Combination 1
     Canvas X: -727.7447561743647
     Canvas Y: -462.43099680861314
     From Canvas X: -838.5619701496952
     From Canvas Y: -292.42859667852747
     Label X: -48.0
     Label Y: 12.0
     Downstream: POND SOUTH 1

     Route: Muskingum
     Muskingum K: 0.083
     Muskingum X: 0.3
     Muskingum Steps: 4
     Channel Loss: None

     Route Sediment: No
End:

Subbasin: LN
     Description: South Basin
     Canvas X: -960.2010686005145
     Canvas Y: -36.26109069400525
     From Canvas X: 63.603650963870166
     From Canvas Y: -272.8164205991544
     Label X: 6.0
     Label Y: -5.0
     Area: 0.0231
     Downstream: RN

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 88

     Transform: SCS
     Lag: 3

     Baseflow: None

     Erosion: None
End:

Reach: RN
     Description: Combination 1
     Canvas X: -1140.6327475213366
     Canvas Y: 318.4757366626277
     From Canvas X: -1028.5705722552643
     From Canvas Y: 0.20264458852807365
```

```
        Label X: -38.0
        Label Y: -20.0
        Downstream: POND NORTH

        Route: Muskingum
        Muskingum K: 0.083
        Muskingum X: 0.3
        Muskingum Steps: 4
        Channel Loss: None

        Route Sediment: No
    End:

    Subbasin: LE
        Description: East Basin
        Canvas X: -793.4767794972114
        Canvas Y: -100.81653640547142
        From Canvas X: -238.0984145847142
        From Canvas Y: -30.495706816540405
        Label X: -47.0
        Label Y: -1.0
        Area: 0.0117
        Downstream: CE

        Canopy: None

        Surface: None

        LossRate: SCS
        Percent Impervious Area: 0.0
        Curve Number: 87

        Transform: SCS
        Lag: 3

        Baseflow: None

        Erosion: None
    End:

    Subbasin: LS
        Description: South Basin
        Canvas X: -853.619878991484
        Canvas Y: -397.7446891637004
        From Canvas X: -52.41661946864167
        From Canvas Y: 132.1810403991832
        Label X: -50.0
        Label Y: -4.0
        Area: 0.0108
        Downstream: POND SOUTH 1

        Canopy: None

        Surface: None

        LossRate: SCS
        Percent Impervious Area: 0.0
        Curve Number: 89

        Transform: SCS
        Lag: 3

        Baseflow: None
```