Appendix 2

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Brachiaria mutica		FACW	9.		
2. Mimosa casta		OBL	10.		
3. Commelina elegans		UPL	11.		
4. Ipomoea setifera		FACW	12.		
5. Typha domingensis		OBL	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 4/5 = 83.33%

Remarks: Shallow roots in Mimosa casta. FAC-Neutral Test = 4 Wet : 1 Nonwet

HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: 16 (in.)

Depth to Saturated Soil: Surface (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☒ Inundated
- ☒ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☒ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☒ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary soil saturation and shollow waters in adjacent areas.

SOILS

Map Unit Name (Series and Phase): Candelero Loam

Drainage Class: VPD

Field Observations Confirm Mapped Type? ☐Yes ☒No

Taxonomy (Subgroup): Aeric Tropoaqualfs

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-1	A	7.5YR/2.5/1			O
0-7	B	7.5YR/3/1	10YR/6/6	Few, distinct	SM
7-12	B	7.5YR/3/1	10YR/6/6	Common, distinct	SC

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☒ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	☒Yes ☐No (Check)	
Wetland Hydrology Present?	☒Yes ☐No	
Hydric Soils Present?	☒Yes ☐No	
Is this Sampling Point Within a Wetland?	☒Yes ☐No	(Check)

Remarks:

Approved by HQUSACE 3/92

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Brachiaria mutica	H	FACW	9.		
2. Mimosa casta	S	OBL	10.		
3. Commelina elegans	H	UPL	11.		
4. Sida acuta	V	UPL	12.		
5. Tabebuia heterophyla	T	FAC	13.		
6. Cyperus polystachyos	H	FACW	14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 3/6 = 50%

Remarks: Shallow roots in Mimosa casta. FAC-Neutral Test = 3 Wet : 3 Nonwet

HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: <17 (in.)

Depth to Saturated Soil: 2 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☒ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☒ Drift Lines
- ☐ Sediment Deposits
- ☒ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☒ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☒ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary soil saturation and connected and intermitent drainage to a stream area

SOILS

Map Unit Name (Series and Phase): Candelero Loam

Drainage Class: VPD

Field Observations Confirm Mapped Type? ☐Yes ☒No

Taxonomy (Subgroup): Aeric Tropoaqualfs

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-1	A	7.5YR/2.5/1			O
0-7	B	7.5YR/3/2	10YR/6/6	Few, distinct	SM
7-12	B	7.5YR/3/2	10YR/6/6	Few, distinct	SC

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒Yes ☐No (Check)

Wetland Hydrology Present? ☒Yes ☐No

Hydric Soils Present? ☒Yes ☐No

(Check)

Is this Sampling Point Within a Wetland? ☒Yes ☐No

Remarks:

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-3

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Primary criteria is an ordinary highwater mark, vegetation information will be provided as request.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: <18 (in.)

Depth to Saturated Soil: <18 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary ordinary high watermarks, and conncets to an ephemeral streams

SOILS

Map Unit Name (Series and Phase): Cayagua sandy loam

Drainage Class: SED

Field Observations Confirm Mapped Type? ☒ Yes ☒ No

Taxonomy (Subgroup): Aeric Tropoaqualfs

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-1	A	10YR/2.5/1			O
0-4	B	10YR/4/2	7.5YR/5/6	Few, distinct	SM
4-12	B	10YR/6/2	7.5YR/5/6	Few, distinct	MH

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No (Check)

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

(Check)

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

Remarks:

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-4

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Primary criteria is an ordinary highwater mark, vegetation information will be provided as request.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: <18 (in.)

Depth to Saturated Soil: <18 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary ordinary high watermarks, and conncets to an ephemeral streams

SOILS

Map Unit Name (Series and Phase): Cayagua sandy loam

Drainage Class: SED

Field Observations Confirm Mapped Type? ☒Yes ☒ No

Taxonomy (Subgroup): Aeric Tropoaqualfs

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-1	A	10YR/2.5/1			O
0-5	B	10YR/4/2	7.5YR/5/6	Few, distinct	SM
6-16	B	10YR/6/2	7.5YR/5/6	Few, distinct	MH

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐Yes ☒No (Check)

Wetland Hydrology Present? ☒Yes ☐No

Hydric Soils Present? ☒Yes ☐No

(Check)

Is this Sampling Point Within a Wetland? ☒Yes ☐No

Remarks: Jurisdicitional areas was established by ordinary high water marks in the boundaries of drainage patterns that defined an intermitent stream.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-5

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Saccharum spontaneum	H	UPL	9.		
2. Brachiaria mutica	H	FACW	10.		
3. Mimosa casta	S	OBL	11.		
4. Urena lobata	V	FAC	12.		
5. Colocasia esculenta	H	OBL	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 4/5 = 80%

Remarks: Some of the plants are not classified in the list of the national wetland inventory, it was assumed as UPL, but most of them could founded on wetlands areas, over soils that presents redox conditions. FAC-Neutral Test = 4 wet :5 nonwet, its positive

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: <14 (in.)

Depth to Saturated Soil: 1 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☒ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☒ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☒ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): Cayagua sandy loam

Drainage Class: SED

Field Observations Confirm Mapped Type? ☐Yes ☐ No

Taxonomy (Subgroup): Aeric Tropoaqualfs

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-1	A	10YR/2.5/1			O
1-5	B	10YR/3/2	7.5YR/5/6	Few, distinct	SM
5-15	B	10YR/3/2	7.5YR/5/6	Few, distinct	SM

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☒ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒Yes ☐No (Check)

Wetland Hydrology Present? ☒Yes ☐No

Hydric Soils Present? ☒Yes ☐No

(Check)

Is this Sampling Point Within a Wetland? ☒Yes ☐No

Remarks:

Approved by HQUSACE 3/92

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-6

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Primary criteria is an ordinary highwater mark, vegetation information will be provided as request.

HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: 4 (in.)

Depth to Saturated Soil: surface (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☒ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☒ Oxidized Root Channels in Upper 12 Inches
- ☒ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary ordinary high watermarks, stream banks of Los Muertos Creek.

SOILS

Map Unit Name (Series and Phase):	Candelero loam	Drainage Class:	ED
		Field Observations	
Taxonomy (Subgroup):	Aeric Tropoaqualfs	Confirm Mapped Type?	☒Yes ☒ No

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-2	A	Sandy			O
2-8	B	Sandy			S
8-18	B	10YR/6/3	7.5YR/5/6	Few, distinct	SM

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☒ High Organic Content in Surface Layer in Sandy Soils
- ☒ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	☐Yes ☒No (Check)		(Check)
Wetland Hydrology Present?	☒Yes ☐No		
Hydric Soils Present?	☒Yes ☐No	Is this Sampling Point Within a Wetland?	☒Yes ☐No

Remarks: Jurisdicitional area was established by ordinary high water marks in the boundaries of drainage patterns that defined Los Muerto Creek and its tributary.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-7

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Primary criteria is an ordinary highwater mark, vegetation information will be provided as request.

HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: <18 (in.)

Depth to Saturated Soil: <18 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary ordinary high watermarks, and conncets to an ephemeral streams

SOILS

Map Unit Name (Series and Phase):	Candelero loam	Drainage Class:	SED
Taxonomy (Subgroup):	Aeric Tropoaqualfs	Field Observations Confirm Mapped Type?	☒Yes ☒ No

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-1	A	10YR/2.5/1			O
1-8	B	10YR/4/3	7.5YR/5/6	Few, distinct	SM
8-16	B	10YR/6/3	7.5YR/5/6	Few, distinct	MH

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	☒Yes ☐No (Check)		(Check)
Wetland Hydrology Present?	☒Yes ☐No		
Hydric Soils Present?	☒Yes ☐No	Is this Sampling Point Within a Wetland?	☒Yes ☐No

Remarks: Jurisdicitional areas was established by ordinary high water marks in the boundaries of drainage patterns that defined an intermitent stream.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-8

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Primary criteria is an ordinary highwater mark, vegetation information will be provided as request.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: <18 (in.)

Depth to Saturated Soil: <18 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary ordinary high watermarks, and conncets to an ephemeral streams tributary of Los Muertos Creek

SOILS

Map Unit Name (Series and Phase):	Candelero loam	Drainage Class:	SED
Taxonomy (Subgroup):	Aeric Tropoaqualfs	Field Observations Confirm Mapped Type?	☒Yes ☒ No

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-1	A	10YR/2.5/1			O
1-6	B	10YR/4/2	7.5YR/5/6	Few, distinct	SM
6-17	B	10YR/6/2	7.5YR/5/6	Few, distinct	MH

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	☐Yes ☒No (Check)	(Check)
Wetland Hydrology Present?	☒Yes ☐No	
Hydric Soils Present?	☒Yes ☐No	Is this Sampling Point Within a Wetland? ☒Yes ☐No

Remarks: Jurisdicitional areas was established by ordinary high water marks in the boundaries of drainage patterns that defined an intermitent stream.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Estancias de las Artesanos	Date:	March / 9 / 2005
Applicant/Owner:	Interlink Realty International	County:	Las Piedras
Investigator:	Orlando Díaz Díaz	State:	Puerto Rico
Do Normal Circumstances exist on the site?	☒Yes ☐No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☐Yes ☒No	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	☐Yes ☒No	Plot ID:	OP-9

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Primary criteria is an ordinary highwater mark, vegetation information will be provided as request.

HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☒ No Recorded Data Available

Field Observations:

Depth of Surface Water: None (in.)

Depth to Free Water in Pit: 1 (in.)

Depth to Saturated Soil: surface (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☒ Saturated in Upper 12 Inches
- ☒ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☒ Oxidized Root Channels in Upper 12 Inches
- ☒ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Field observation of ordinary ordinary high watermarks, conection between Los Muertos Creek and its tributary.

SOILS

Map Unit Name (Series and Phase): Candelero loam

Drainage Class: ED

Field Observations Confirm Mapped Type? ☒ Yes ☒ No

Taxonomy (Subgroup): Aeric Tropoaqualfs

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0-1	A	Sandy			O
1-10	B	Sandy			S
10-18	B	10YR/6/2	7.5YR/5/6	Few, distinct	SM

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☒ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☒ High Organic Content in Surface Layer in Sandy Soils
- ☒ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No (Check)

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

(Check)

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

Remarks: Jurisdicitional areas was established by ordinary high water marks in the boundaries of drainage patterns that defined Los Muerto Creek and its tributary

Apéndice 8
Mapa de Zonificación

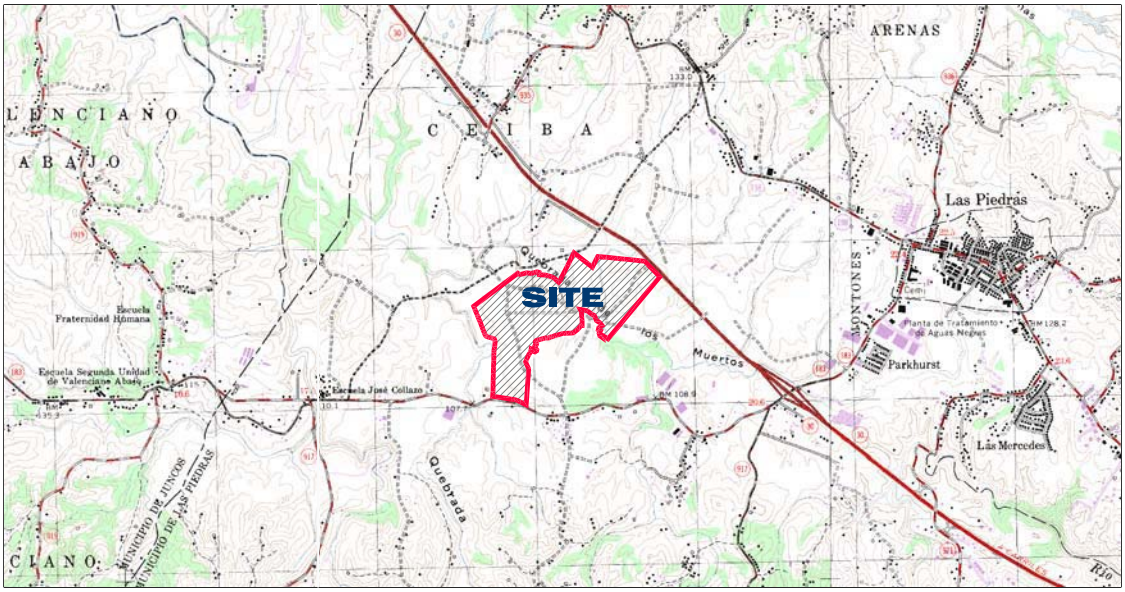
Estancias de los Artesanos
Las Piedras

Zonificación Vigente

Apéndice 9
Estudio Hidrológico-Hidráulico

INTERLINK REALTY INTERNATIONAL
SAN JUAN, PUERTO RICO

HYDROLOGIC-HYDRAULIC STUDY FOR ESTANCIAS DE LOS ARTESANOS LAS PIEDRAS, PUERTO RICO



MARCH, 2006

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HYDROLOGIC-HYDRAULIC STUDY
FOR ESTANCIAS DE LOS ARTESANOS
LAS PIEDRAS, PUERTO RICO

Casiano Ancalle, P.E.

March, 2006

I. INTRODUCTION

Interlink Group plans to undertake a development project located in the Municipality of Las Piedras. The site can be accessed through state roads PR-30 and PR-183. The total project area is approximately 118 acres.

Quebrada Los Muertos crosses the project site. Most of the runoff of the site discharges to this watercourse. A portion at west side of the site drains toward Quebrada Montones. Quebrada Los Muertos discharges into Río Valenciano, which is a tributary of the Río Gurabo.

According to the regulatory flood maps, the project site is not considered floodable for the 100-year rainfall event.

The development of the site is going to increase runoff. This increase has to be mitigated according to the stipulations of the Puerto Rico Planning Board Regulation No. 3.

Purpose of Study

The purpose of the study is to estimate the amount of runoff for existing and proposed condition for the project site, the Quebrada Los Muertos and its unnamed tributary, to evaluate the hydraulic performance of the existing condition, and to recommend span for a crossing bridge over the unnamed tributary. In addition, the study will recommend a detention structure for mitigating the increment in runoff due to the development, in accordance to the Puerto Rico Planning Board Regulation No. 3.

Authorization

Eng. Jorge Aviles on behalf of the owner authorized this study, under a contract signed with Eng. Casiano Ancalle, principal of CA Engineering.

Approach

The following steps have been undertaken throughout the study:

Hydrologic Analysis: The following parameters were determined for the hydrologic analysis: drainage areas, average soil curve number and runoff lag time. Based on these parameters, discharge for 100-years frequency storm was determined for existing and proposed conditions. HEC-1 model was used. Lower frequencies also were estimated.

Hydraulic Analysis: A hydraulic analysis was made in order to estimate the water surface elevations along the course of the watercourses. Existing condition water levels were determined first. Water levels for proposed condition, which included the bridge over the unnamed tributary. Comparison of water elevations for both conditions would fall within the limits established by Regulation No. 13. The US Army Corps of Engineer's HECRAS computer model was used.

Mitigation Analysis: A mitigation analysis was made in order to counteract the impact of the proposed development. This analysis was extended as to reduce the risk of flooding in the downstream area as consequence of this development. HEC-1 model was used for the mitigation analysis. Discharges for 2-, 10-, 25-, 50-, and 100-year frequencies were analyzed for mitigation

Conclusions and recommendations were elaborated.

II. PROJECT BACKGROUND

Location

The project site for Estancias de Los Artesanos is located in Montones ward, in the Municipality of Las Piedras. The project site can be accessed by state roads PR-183 and the PR-30. A future highway PR-204 is planned to be constructed by the Highway & Transportation Authority. The future PR-204 crosses the project site and connects the PR-30 with the PR-183.

The project consists on 488 single family units and 126 walk ups. The total area of the project is approximately 118 acres to be developed in four phases. Figure 1, shows the location of the site in the USGS quadrangle. Figure 3 shows a layout of the proposed project.

Site description and Topography

In existing condition, the project area and its vicinities are covered mainly by pasture and scattered bushes. Most of the site is sloped from 10 up to 60 percent and drains toward the Quebrada Los Muertos and its unnamed tributary. Only a 30.4 acres portion of the site located at the west drains toward Quebrada Montones. The ground elevation of the site varies between 98.0 and 118.0 m. (M.S.L.). Figure 9 shows the topography of the site.

Water Bodies

Quebrada Los Muertos is crossing the project site and runs northward. An unnamed tributary coming from the northeast discharges in Quebrada Los Muertos at the project site. Quebrada Montones runs northward near to the west limit of the project property. These watercourses are tributaries of the Rio Valenciano that subsequently is tributary of the Rio Gurabo.

Flooding

From the regulatory point of view, the project site is not classified as floodable for a 100-year rainfall event. Figure 5 shows sheet 185B from FEMA's flood map.

Field Work

Field data used in this study was taken by drawings provided by Eng. Jorge Aviles. This field information was used for the hydraulic modeling. Results obtained in this study are strictly based on this information. A certified fieldwork is attached in the pocket at the end of this study as Appendix I.

Former Studies

This office found no previous H/H studies for the area under study. So, all the information gathered for the study was through site inspection and interviews of neighboring residents.

Study Level

This study is intended as an aid to the design engineer in the preparation of the construction drawings for the recommended structures. Figures, schematics and drawings must not be used as construction drawings. The design engineer must elaborate the construction drawings in agreements with the recommendations of this study.

III. HYDROLOGIC ANALYSIS

Methodology

The computer program entitled Flood Hydrograph Package (HEC-1) developed by the U.S. Army Corps of Engineers [1990] was used for the hydrologic analysis. Using this program, the Unit Hydrograph method and the Runoff Curve Number (CN) method, both developed by the Soil Conservation Service (SCS), were applied to determine the design hydrograph. This was computed by a process of translating the rainfall excess into a runoff hydrograph known as convolution.

Peak discharges ranging in frequencies from 2-, 10-, 25-, 50- and 100-year were estimated for the existing and proposed condition.

Drainage Areas and Runoff Pattern

At existing condition, four onsite drainage areas were defined. The onsite areas were named: P1 (30.4 acres), P2 (40.6 acres), P3 (18.1 acres) and P4 (28.9 acres). Only Area P1 discharge toward Quebrada Montones, areas P2, P3 and P4 drain to Quebrada Los Muertos.

In addition, for the hydraulic analysis to determine the water levels of Quebrada Los Muertos, two offsite areas were identified: Basin 1 and Basin 2. Basin 1 was subdivided in: Basin 1A (540.6 acres), Basin 1B (710.8 acres) and Basin 1C (60.8 acres). Basin 1C belongs to the property of La Campiña Development currently under construction. Basin 2 (409.8 acres) belongs to the unnamed tributary of Quebrada Los Muertos. Figure 2 shows a portion of the USGS quadrangle of Juncos with the watershed delineation for existing condition including.

In proposed condition, the magnitude of the onsite drainage areas were resized keeping the pattern established in existing condition. The only significant change was the reduction of Area P1 to 24 acres and the consequent increase of Area P2 (47 acres). Figure 3 shows the proposed development layout and the proposed drainage areas.

Table 1 shows a comparison of the magnitude of the drainage areas for existing and proposed condition.

Table 1
Drainage Areas

	Area ID	Area, *Acres*	
		Existing	**Proposed**
PROJECT SITE	P1	30.4	24.0
	P2	40.6	47.0
	P3	18.1	18.1
	P4	28.9	28.9
OFFSITE	Basin 1A	540.6	-
	Basin 1B	710.8	-
	Basin 1C	60.7	-
	Basin 2	409.8	-

Curve Numbers

Curve numbers (CN) were computed using the SCS methodology. For its application the different soil types and land uses were estimated from SCS [1978] and USGS [1982] respectively. Curve numbers were established for Antecedent Moisture Condition II. The soil survey shows five soils type classified as candelero loam, cayagua sandy loam, jagueyes loam, lirios clay loam and pandura loam. Figure 4 shows the portion of the soil map corresponding to the watersheds and project area. Appendix A shows the physiographic characteristics of the watersheds and the CN calculations.

Lag Time

The Lag Time (T_{Lag}) was estimated using the SCS method defined as:

$$T_{Lag} = \frac{L^{0.8}(S+1)^{0.7}}{1900\ Y^{0.5}}$$

where : L = channel length (ft)

S = 1000/CN - 10

Y = average watershed slope

Detailed Lag Time calculation is shown in Appendix A.

Rainfall Data

The variation of rainfall volume with time was required as part of the storm input for the SCS Curve Number method. Therefore, the development of a design storm with a rainfall frequency and duration was necessary to compute the design hydrograph for the watershed. Rainfall data used in this study was obtained from the Technical Paper No. 42 (TP-42) [National Weather Service, 1961. For 0.083 and 0.25 hrs. duration, the precipitation was obtained from a regression analysis. Appendix A includes a spreadsheet with these calculations.

The rainfall event of 2, 10, 25, 50 and 100-years frequency and different durations are shown in Table 2.

Table 2
Rainfall for 2, 10, 25, 50 and 100 years

Duration *Hrs.*	**Precipitation** *Inches*				
	2-yr	***10-yr***	***25-yr***	***50-yr***	***100-yr***
0.083	0.47	0.56	0.60	0.71	0.78
0.25	1.07	1.38	1.52	1.75	1.93
1	2.25	3.35	3.90	4.40	4.80
2	2.80	4.40	5.00	5.60	6.40
3	3.10	4.90	5.70	6.20	7.20
6	3.90	5.90	7.00	7.90	9.00
12	4.50	7.00	8.20	9.80	11.0
24	5.20	8.50	10.0	11.50	13.0

Depth-Area Adjustment

Point rainfall estimates obtained from the TP-42 represent values for areas up to 10 mi^2; therefore, a depth-area adjustment should be applied to the rainfall data when the watershed area is greater. In this case, the largest watershed is approximate 1.11 mi^2. Hence, this adjustment was not applied.

Time Distribution of Rainfall

The triangular type methodology was used to distribute the rainfall depth in time. This method is considered acceptable for small areas.

Rainfall Extraction

Rainfall extraction such as the vegetative interception, the depressional storage, and the infiltration were estimated using the SCS's Runoff Curve Number method. Though this method is used to predict runoff volume directly, the rainfall extraction is incorporated in the model as function of the curve number of the watershed.

Hydrologic Analysis for the Project Site

Following HEC-1 methodology, hydrographs were determined for existing and proposed condition for the project site to evaluate the impact of the development expressed in a runoff increase. Input and output data for the HEC-1 model are included in Appendix B for Existing Condition and Appendix C for Proposed Condition. Table 3 shows the results for these conditions in the next page.

Table 3
Peak Discharges for 2-, 10-, 25-, 50- and 100-yr frequencies

Condition	Description	Area	Peak Discharge, *cfs*				
			2-yr	10-yr	25-yr	50-yr	100-yr
Existing Condition	Discharging to Quebrada Montones	P1	*99*	*151*	*173*	*204*	*228*
	Discharging to Quebrada Los Muertos	P2	135	198	224	264	294
		P3	70	100	113	134	149
		P4	97	146	167	197	219
		COMB (P2+P3+P4)	*288*	*436*	*500*	*587*	*655*
Proposed Condition	Discharging to Quebrada Montones	P1	*99*	*130*	*144*	*167*	*184*
	Discharging to Quebrada Los Muertos	P2	190	253	281	325	357
		P3	80	106	117	136	149
		P4	120	157	174	201	222
		COMB (P2+P3+P4)	*383*	*505*	*560*	*647*	*713*

From the inspection of Table 3, the peak for the combined discharge toward Quebrada Los Muertos in proposed condition is higher than that of the existing condition. The increment in discharge has to be mitigated as required by Puerto Rico Planning Board Regulation No. 3. Discharge from area P1 at proposed condition was maintained similar to the peak of the existing

condition. This indicates that the discharge toward Quebrada Montones do not increase despite of the development. That was ensured with the area reduction of the drainage area for proposed condition.

Hydrologic Analysis for Quebrada Los Muertos

An additional hydrological analysis was performed to determine the peak discharge for Quebrada Los Muertos and its unnamed tributary crossing the project site. This analysis includes the incorporation of the offsite and the onsite areas. Table 4 shows the results of this analysis.

Table 4
Peak Discharges for 100-yr frequency

Description	100-yr peak Discharge, *cfs*
Basin 1 (Quebrada Los Muertos upstream merging point)	4,238
Basin 2 (Unnamed tributary)	1,663
Combined (Quebrada Los Muertos downstream merging point)	5,845

IV. MITIGATION

The development of the site will increase the runoff discharge. The Puerto Rico Planning Board Regulation No. 3 requires a flow mitigation structure wherever an increase in discharge is produced. Therefore, a detention analysis is required in the project.

Methodology

The computer program HEC-1 provides means for modeling detention structures. The purpose of detention is that the proposed condition peak discharge does not exceed the existing condition peak discharge.

Two detention structures will be included in the project. The detention structures will be located in areas P2 (Pond #1) and P4 (Pond #2). Then, a peak reduction is expected in the combined discharge toward Quebrada Los Muertos.

See Figure 6 for schematic layout of the project and the location of the detention ponds.

Depth-Volume Relations

Depth to volume relationships for the detention ponds have been calculated as a function of the bank slope of 1V:2H. Base area of the each pond was set at 2,500 and 1,225 square meters for Area P2 and P4 respectively. Appendix D includes a spreadsheet with the depth-volume relation computations.

Flow – Depth Relations

Pond #1 outlet control structure will consist on a battery of two (2) 42" diameter orifices and a 2.0-meter wide rectangular weir located 2.25 meters above the pond bottom. Pond #2 outlet control structure will consist on a battery of two (2) 33" diameter orifices and a 6.0-meter wider rectangular weir located 2.25 meters over the pond bottom. Flow through the orifices was computed using Torricelli's formula. Appendix D shows the computations and the curve.

Results

The results of the mitigation analysis show that the proposed detention structures provide the appropriate holding for feeding into the downstream the 100-year frequency peak discharge from the combined project site. Mitigation for more recurrent storm events was also found appropriate. Results are shown in Table 5. Input and output data for the HEC-1 model for mitigation are included in Appendix E

Table 5
Mitigation Analysis Results Comparison

Condition	Area	Peak Discharge, *cfs*				
		2-yr	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Existing	P2	135	198	224	264	294
	P3	70	100	113	134	149
	P4	97	146	167	197	219
	COMB (P2+P3+P4)	***288***	***436***	***500***	***587***	***655***
Proposed	P2	190	253	281	325	357
	P3	80	106	117	136	149
	P4	120	157	174	201	222
	COMB (P2+P3+P4)	***383***	***505***	***560***	***647***	***713***
Proposed w/Mitigation	P2 (Mitigated)	*143*	*186*	*206*	*228*	*253*
	P3	80	106	117	136	149
	P4 (Mitigated)	*92*	*118*	*131*	*152*	*179*
	COMB (P2*+P3+P4*)	***288***	***377***	***418***	***464***	***530***

Mitigation Structure Dimensions and Accessories

Final dimensions for the discharge detention ponds will include a minimum free board of 0.30 meters. Figure 7 and 8 show the schematic layout and the schematic sections of the ponds. Consequently, the ponds will have the dimensions shown in Table 6.

Table 6
Detention Ponds Characteristics

POND #1	**Pond Dimensions**	Base Area	2,500 m^2
		Height	2.80 m
		Bank Slope	1V:2H
	Outlet Structure	Orifices @ bottom	2-42”ø
		Rectangular weir @ 2.25	2.0 m
		Emergency Weir Length @ 2.50 over bottom	4.0 m
	Pond Outlet	Concrete Pipes	2-54” ø
POND #2	**Pond Dimensions**	Base Area	1,225 m^2
		Height	2.75 m
		Bank Slope	1V:2H
	Outlet Structure	Orifices @ bottom	2-33”ø
		Rectangular weir @ 2.25	6.0 m
		Emergency Weir Length @ 2.45 over bottom	4.00 m
	Pond Outlet	Concrete Pipe	60” ø

The bottom geometry of the ponds have been considered as square for the mitigation analysis; but another shape can be used as well if the magnitude of the area is maintained.

V. HYDRAULIC ANALYSIS

The hydraulic analysis was made using the mathematical model HEC-RAS developed by the US Corps of Engineers. For this model, the hydraulic regime is steady, uniform, and one-dimensional. The model accepts changes in the geometry of the watercourse, bank-bed-overbank friction coefficient and shapes of hydraulic structures.

The friction coefficient used in the modeling was obtained from visual inspection of the watercourses bed and banks; and crosschecked with the typical values provided by Barnes (1967) and Chow (1959).

Cross sections for the water course were provided by Eng. Jorge Aviles. The field work is included in Appendix I.

Roughness

Manning coefficients estimated for the model are from 0.013 for concrete to 0.055 for the natural watercourse. These values reflect the changes in direction and the irregular shape of the channel bed, and the vegetation present in the courses.

Contraction and Expansion Coefficients

Coefficients of contraction and expansion used are those recommended by the HEC-RAS user's manual. Thus, coefficients of 0.1 and 0.3 respectively were used for gradual transitions.

Hydraulics for Existing Condition

At existing condition, the topography defines the course of Quebrada Los Muertos passing across the project property from south to northwest. The length of this watercourse crossing the property is approximately 800 meters. Ten (10) cross sections were used to model the existing condition. This condition includes the bridge of the new Puerto Rico Highway Authority's PR-30 and PR-183 connector that crosses the project property. In addition, an unnamed tributary

running from northeast to southwest is discharging to Quebrada Los Muertos. Five cross sections more were included to model this watercourse. Figure 9 shows the location of the cross sections and the nomenclature used in the HEC-RAS modeling.

The computer output for this condition is included in Appendix G. The following Table 7 includes the summary of the results.

Table 7
Existing Condition Hydraulics 100-yr flow

River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
15	100-yr	47.12	101.78	104.60	104.22	104.86	0.011684	2.27	20.74	17.90	0.67
14	100-yr	47.12	100.86	104.59		104.62	0.000616	0.72	65.77	36.71	0.17
13	100-yr	47.12	100.32	104.40		104.50	0.004161	1.37	34.38	28.24	0.40
12	100-yr	47.12	99.96	104.25		104.29	0.001378	0.94	50.32	33.67	0.24
11	100-yr	47.12	99.51	104.16		104.20	0.000623	0.89	56.75	31.20	0.17
10	100-yr	120.10	100.25	105.05	103.56	105.15	0.001585	1.44	99.50	83.06	0.29
9	100-yr	120.10	100.16	104.21		104.80	0.012540	3.42	35.10	16.17	0.74
8	100-yr	120.10	99.22	104.06	102.48	104.23	0.002858	1.86	65.90	33.84	0.38
7	100-yr	165.64	99.20	103.88		104.13	0.003330	2.37	84.19	46.73	0.42
6	100-yr	165.64	98.64	103.63		103.94	0.003866	2.57	73.87	39.36	0.44
5.6	100-yr	165.64	98.30	103.51	101.75	103.81	0.003293	2.46	73.09	35.94	0.41
5.5		Bridge									
5.4	100-yr	165.64	98.30	103.39		103.71	0.003731	2.56	69.04	32.07	0.44
5	100-yr	165.64	98.30	103.17		103.55	0.004756	2.77	62.33	28.15	0.49
4	100-yr	165.64	98.14	103.14		103.27	0.001323	1.79	114.87	49.44	0.28
3	100-yr	165.64	97.83	102.84		103.07	0.002559	2.19	84.79	46.12	0.37
2	100-yr	165.64	97.79	102.58		102.80	0.002833	2.09	82.59	34.83	0.39
1	100-yr	165.64	97.62	102.50	100.19	102.59	0.000960	1.46	132.15	52.54	0.24

Hydraulics for Proposed Condition

At proposed condition, a new 15.00-m span bridge will be necessary over the unnamed tributary. This condition included the new structure located between cross sections 14 and 15. Figure 6 shows the layout of the project and the location of the new bridge.

The computer output for this condition is included in Appendix H. The following Table 8 includes the summary of the results

Table 8
Proposed Condition Hydraulics 100-yr flow

River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
15	100-yr	47.12	101.78	104.52	104.22	104.82	0.013901	2.44	19.33	17.07	0.73
14.6	100-yr	47.12	100.86	104.64	102.47	104.66	0.000574	0.70	67.54	37.24	0.17
14.5		Bridge									
14.4	100-yr	47.12	100.86	104.62		104.65	0.000591	0.71	66.81	37.02	0.17
14	100-yr	47.12	100.86	104.59		104.62	0.000616	0.72	65.77	36.71	0.17
13	100-yr	47.12	100.32	104.40		104.50	0.004161	1.37	34.38	28.24	0.40
12	100-yr	47.12	99.96	104.25		104.29	0.001378	0.94	50.32	33.67	0.24
11	100-yr	47.12	99.51	104.16		104.20	0.000623	0.89	56.75	31.20	0.17
10	100-yr	120.10	100.25	105.05	103.56	105.15	0.001585	1.44	99.50	83.06	0.29
9	100-yr	120.10	100.16	104.21		104.80	0.012540	3.42	35.10	16.17	0.74
8	100-yr	120.10	99.22	104.06	102.48	104.23	0.002858	1.86	65.90	33.84	0.38
7	100-yr	165.64	99.20	103.88		104.13	0.003330	2.37	84.19	46.73	0.42
6	100-yr	165.64	98.64	103.63		103.94	0.003866	2.57	73.87	39.36	0.44
5.6	100-yr	165.64	98.30	103.51	101.75	103.81	0.003293	2.46	73.09	35.94	0.41
5.5		Bridge									
5.4	100-yr	165.64	98.30	103.39		103.71	0.003731	2.56	69.04	32.07	0.44
5	100-yr	165.64	98.30	103.17		103.55	0.004756	2.77	62.33	28.15	0.49
4	100-yr	165.64	98.14	103.14		103.27	0.001323	1.79	114.87	49.44	0.28
3	100-yr	165.64	97.83	102.84		103.07	0.002559	2.19	84.79	46.12	0.37
2	100-yr	165.64	97.79	102.58		102.80	0.002833	2.09	82.59	34.83	0.39
1	100-yr	165.64	97.62	102.50	100.19	102.59	0.000960	1.46	132.15	52.54	0.24

Floodplain delineation for Quebrada Los Muertos

The results of the hydraulic analysis were used to delineate the 100-yr floodplain of Quebrada Los Muertos. The proposed development will not impact the natural watercourse and leave unmodified the bed and banks of the existing condition. Figure 9 shows the flood plain delineation for the existing condition.

VI. CONCLUSIONS AND RECOMMENDATIONS

The following are the conclusions of this study:

1. According to the regulatory flood maps, the project site is not considered floodable for the 100-year rainfall event

2. Existing condition runoff peak discharge to Quebrada Los Muertos is lower that that of the proposed condition. Mitigation is needed.

3. The reduction of the onsite Area P1 for proposed condition prevents an increase of the peak discharge due to development of the site toward Quebrada Montones.

4. Mitigation reduces the 100-year discharge for proposed condition from 713 to 530 cfs for the entire project property draining to Quebrada Los Muertos. This value is lower than the existing condition peak flow of 655. Recurrent discharges were also mitigated.

5. Either proposed bridge over the unnamed tributary do not increase the water levels over the allowed by the PR Planning Board Regulation No. 13.

The following are the recommendations of this study:

1. Two detention ponds will be required to mitigate the runoff increase. Mitigation structures will have the dimensions and accessories indicated in Table 6 of this report.

2. Exit headwalls must be provided. Rip-rap shall be placed at the exit of the outlet of the mitigation ponds.

3. It is very important to prepare a long-term maintenance plan, which should include the proposed culvert, the pond outlet structure and the receiving storm system inspection after each significant discharge events. Damages, if any, must be repaired promptly and properly.

Study Limits

All the recommendations specified in this study must be considered to assure the optimum performance of the proposed discharge mitigation pond and the receiving stream. The design engineer will be responsible for elaborating the drawings in conformance with the recommendations of this study.

The results of this study are based on free flow conditions through the hydraulic structures. Proper maintenance must be developed to assure this condition. On the event of the occurrence of any severe obstruction to the flow, the results and recommendations may be impaired. Finally, results and recommendations included in this report must be used only and exclusively by the design engineer for the intended purposes as indicated in this study.

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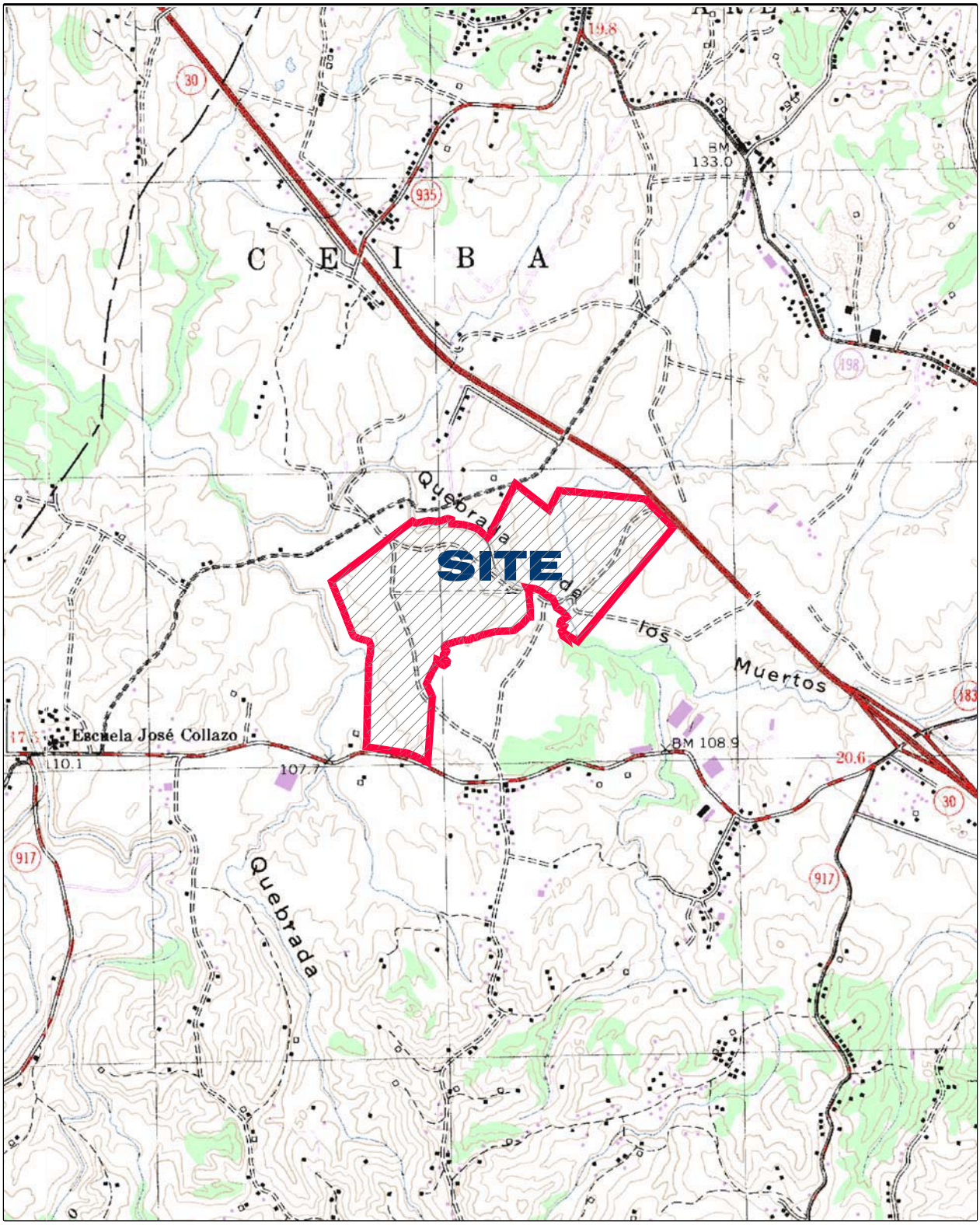
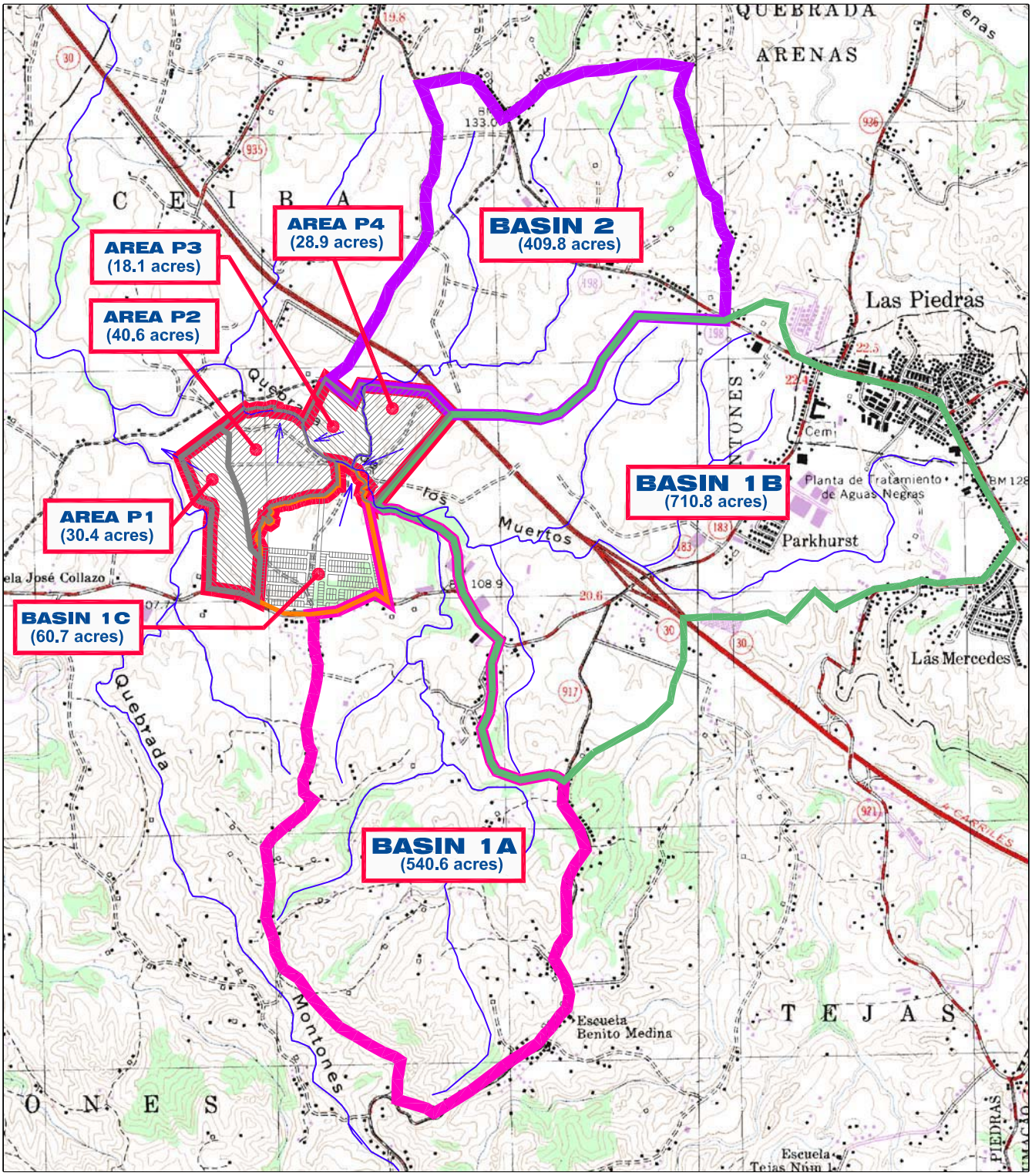
FIGURES



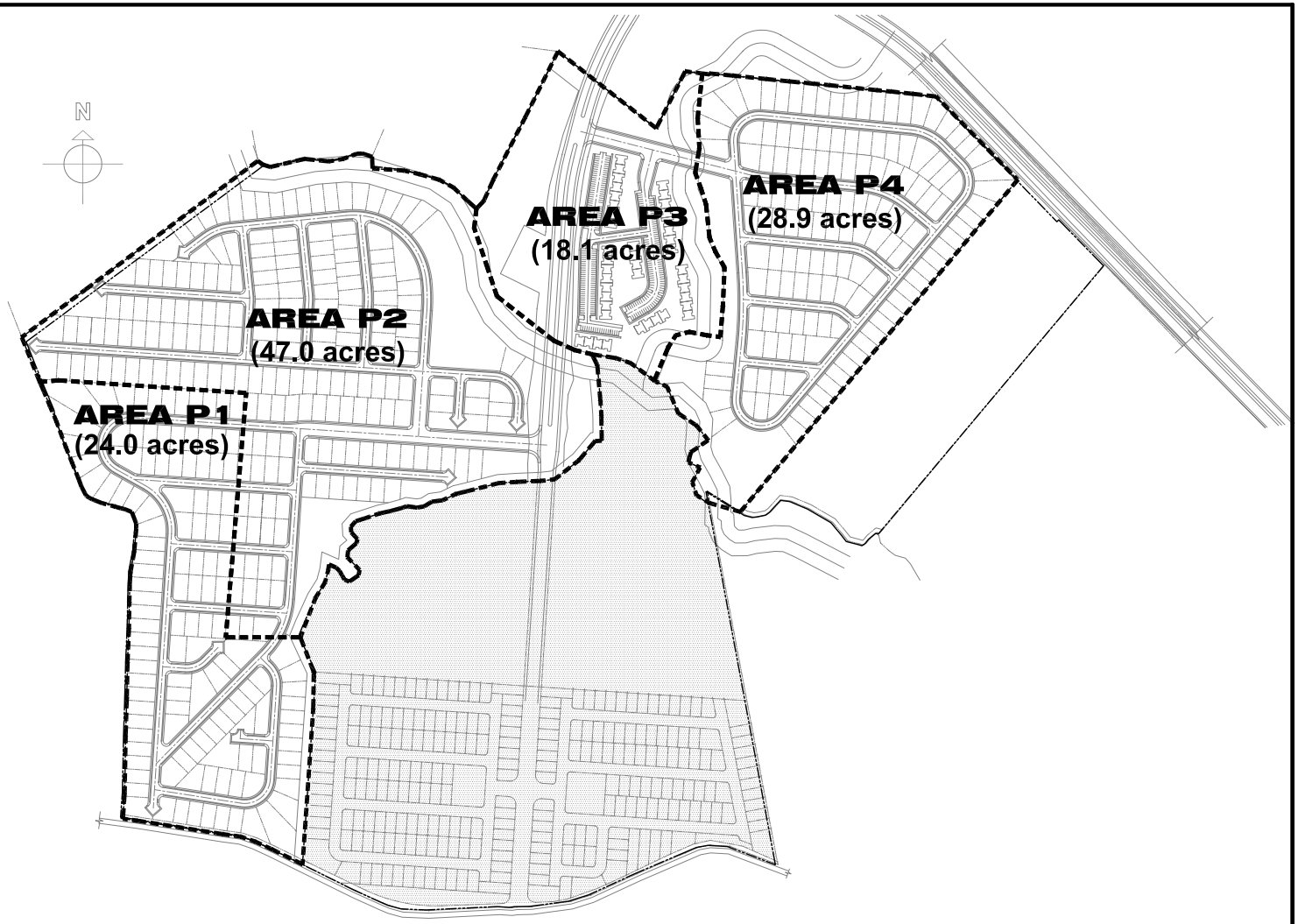
Partial Copy of USGS Quadrangle of Juncos, P.R.

CA Engineering	H/H STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, P.R.	Scale: 1:20,000
	Figure 1 Location Map	



Partial Copy of USGS Quadrangle of Juncos & Humacao, P.R.

CA Engineering	H-H STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, P.R.	Scale: 1:25,000
	Figure 2 Existing Condition Watershed Limit	



CA Engineering

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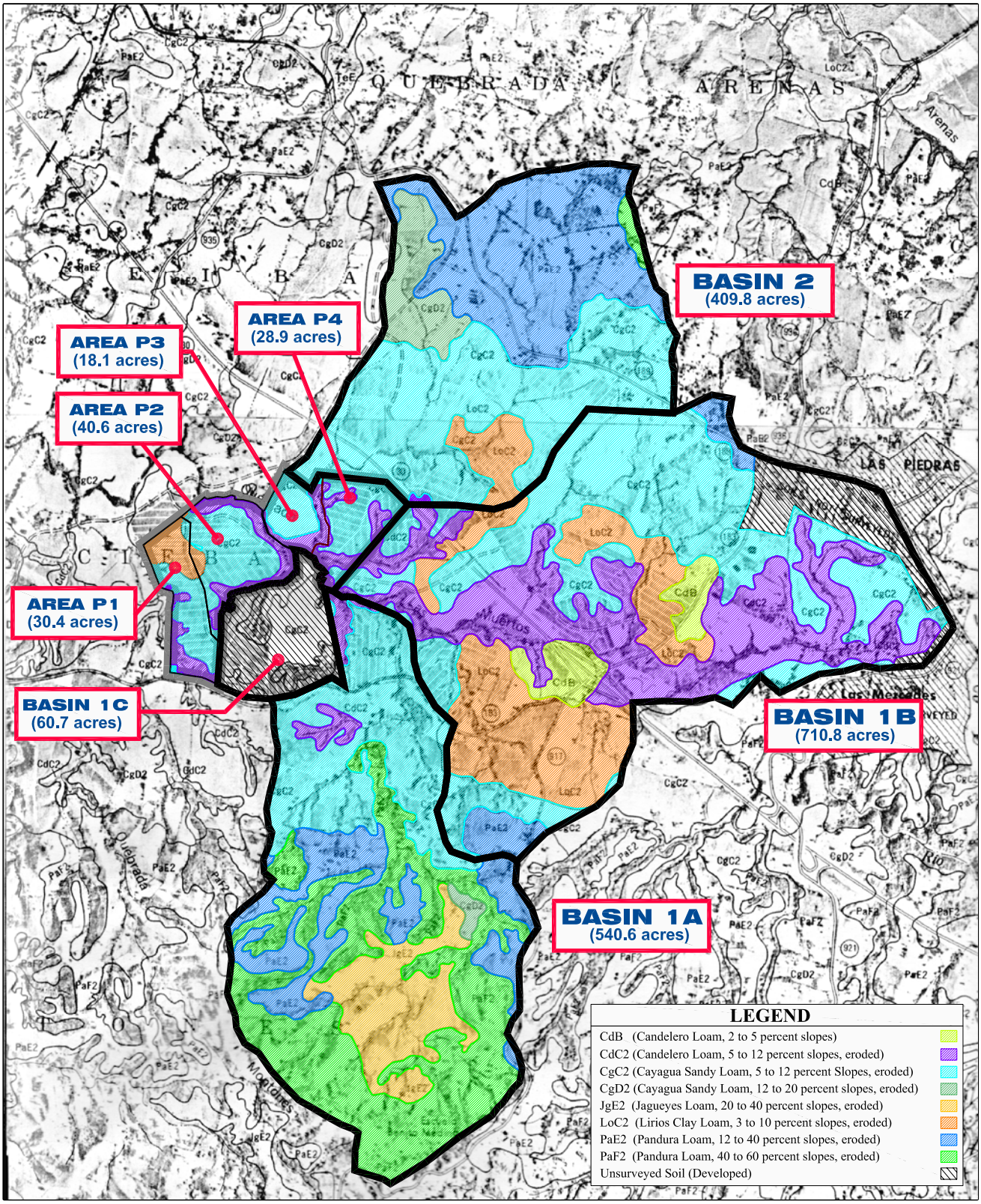
HH STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, PR

Figure 3

Development Layout and Proposed Drainage Areas

FIG.3



Partial Copy of SCS Soil Survey of Humacao Area of Eastern Puerto Rico - Sheets 25 & 29

H/H STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, P.R.

Scale: 1:25,000

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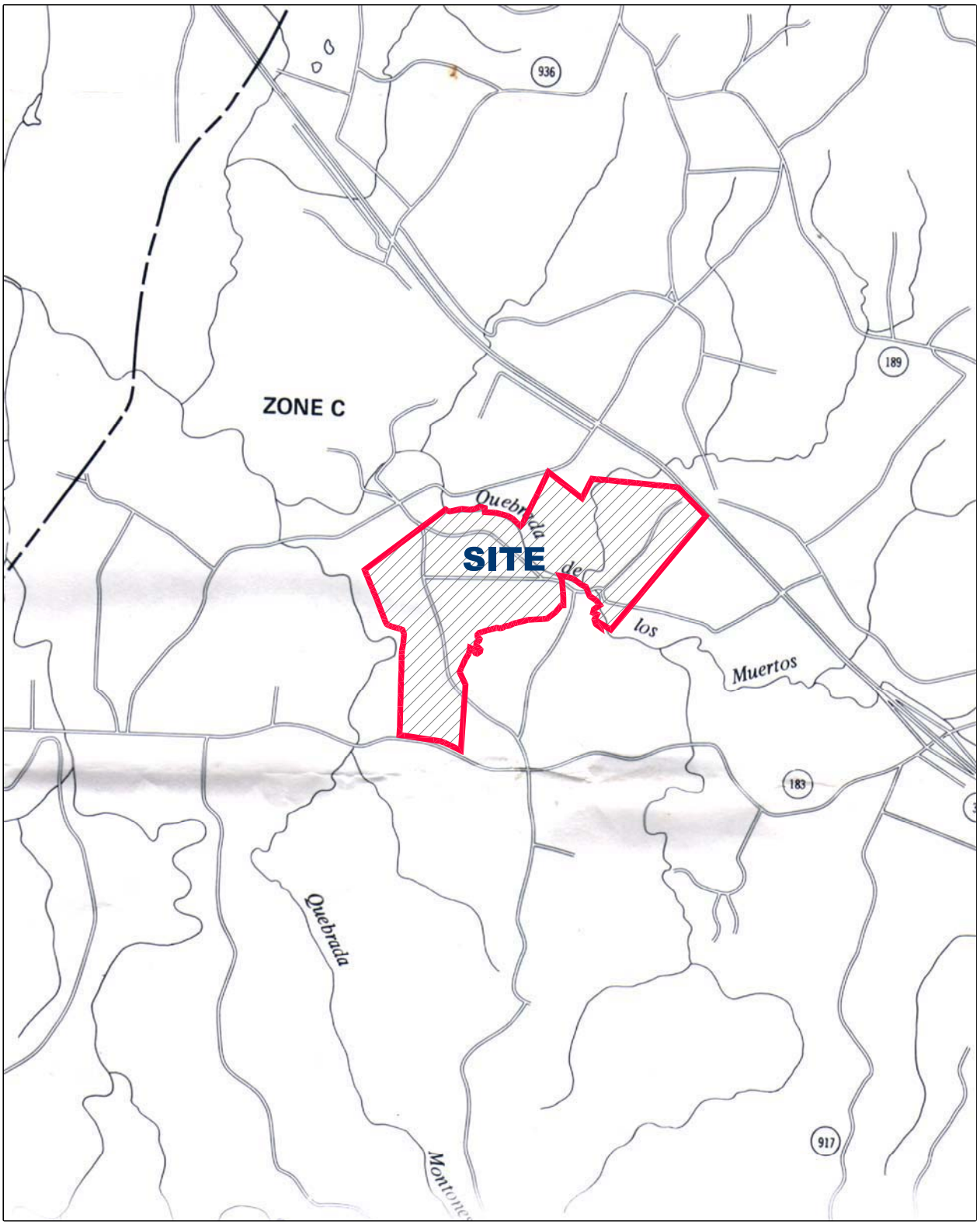
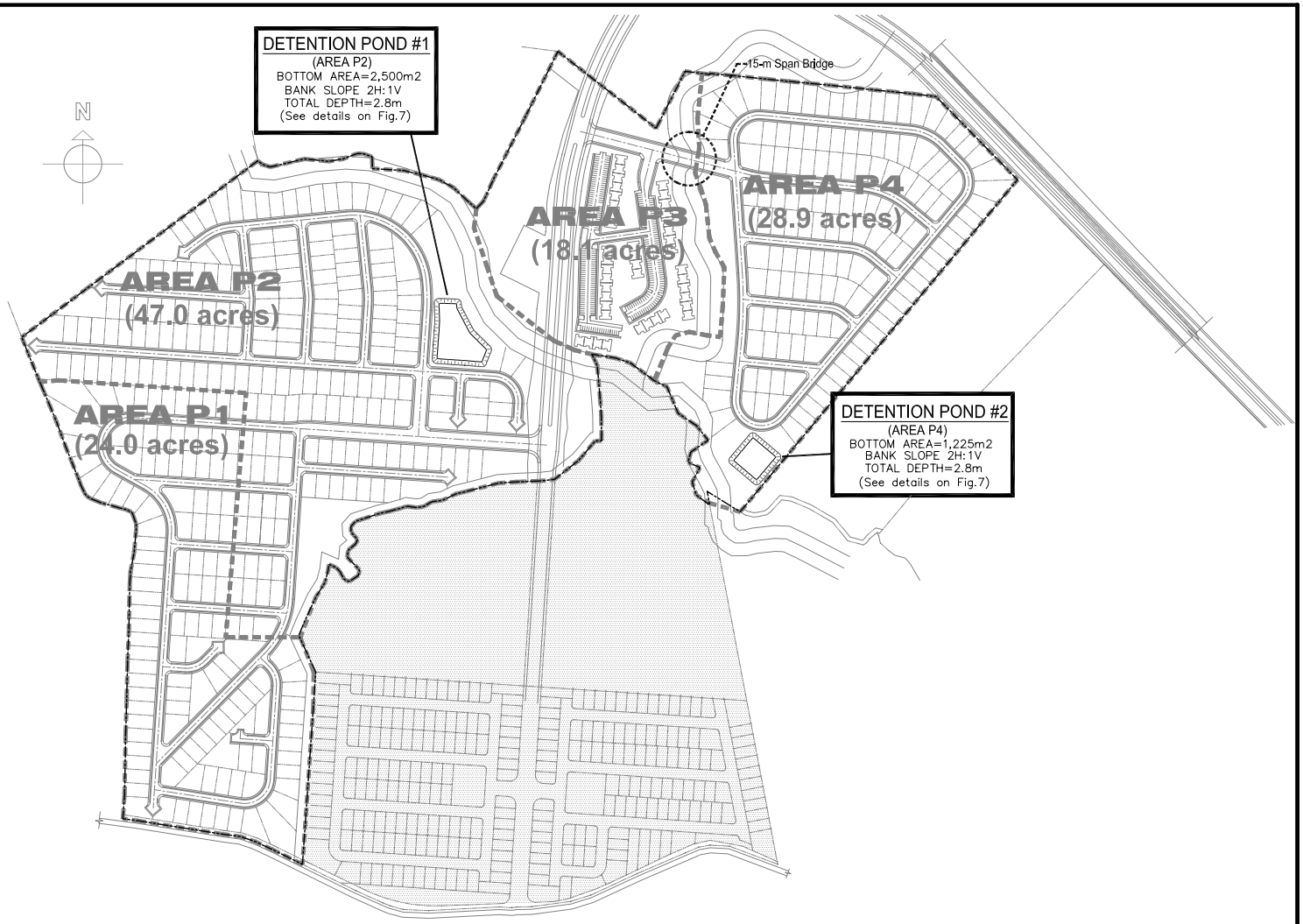
Figure 4

Soils Map



Partial Copy of Firm Insurance Rate Map (FEMA) - Sheet 185

CA Engineering	HH STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, P.R.	Scale: 1:20,000
	Figure 5 FEMA's Flood Insurance Rate Map	



CA Engineering

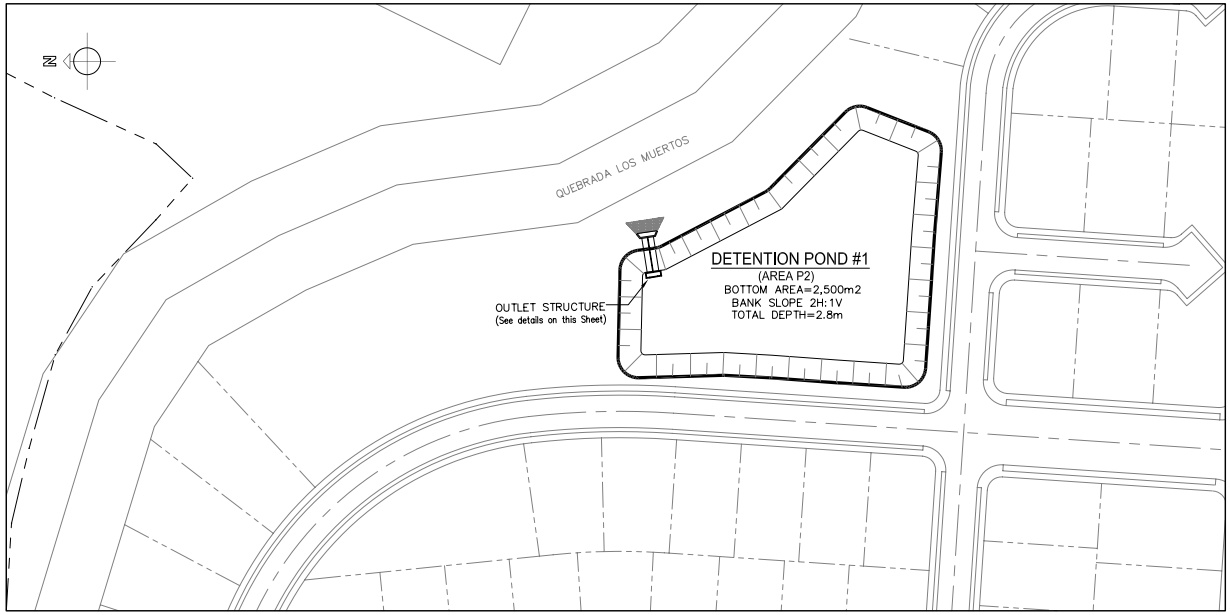
Scale: 1:5,000

HH STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, PR

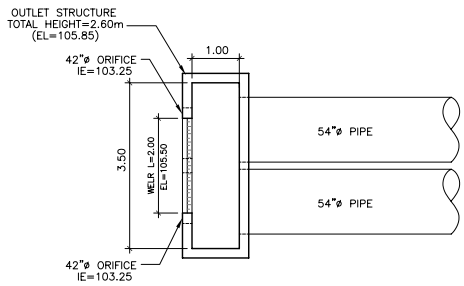
Figure 6

Proposed Structures Layout

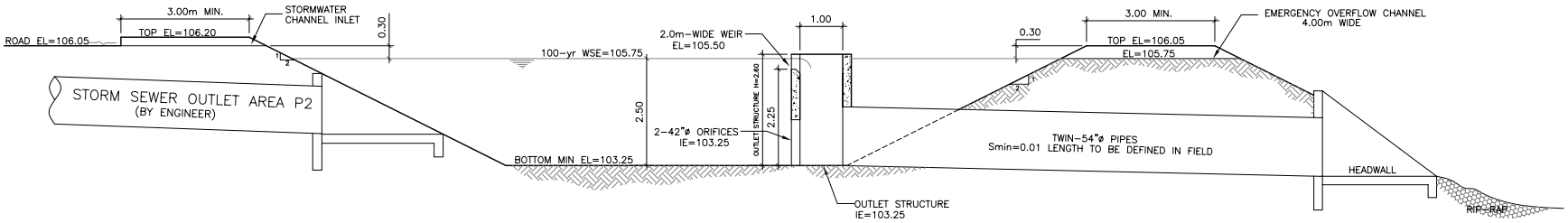
FIG.6



PLAN VIEW



OUTLET STRUCTURE
TOP VIEW
NTS



SCHEMATIC POND SECTION
NTS

CA Engineering

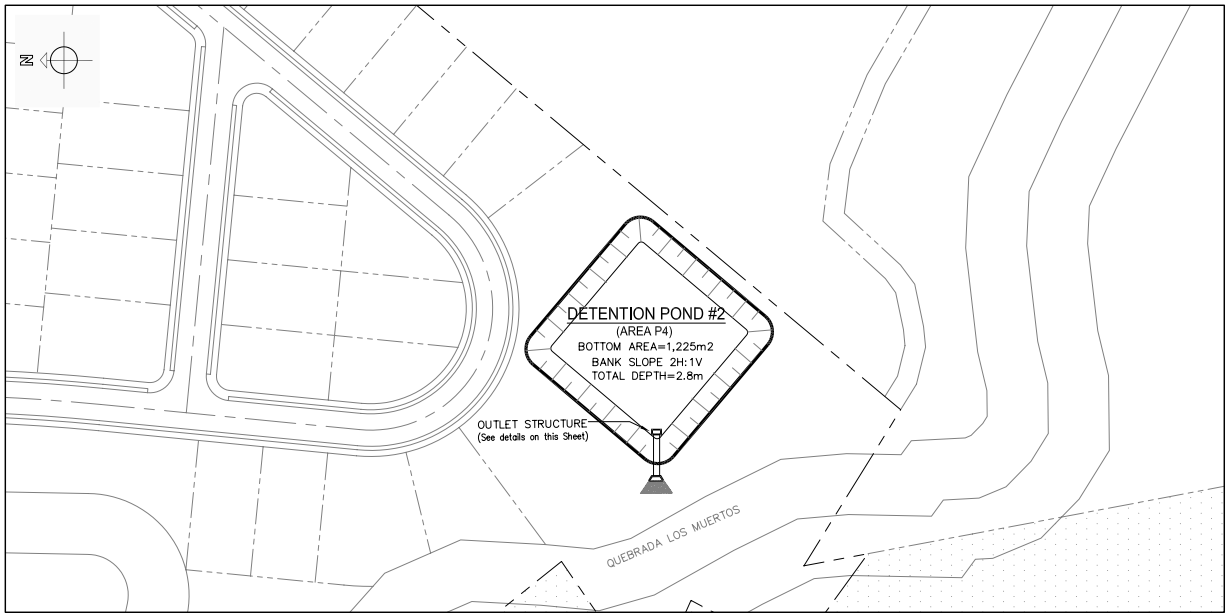
Scale: NTS

HH STUDY - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, PR

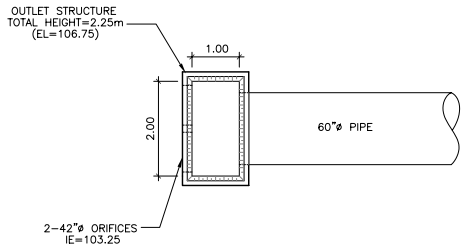
Figure 7

Mitigation Pond Schematics for Area P2

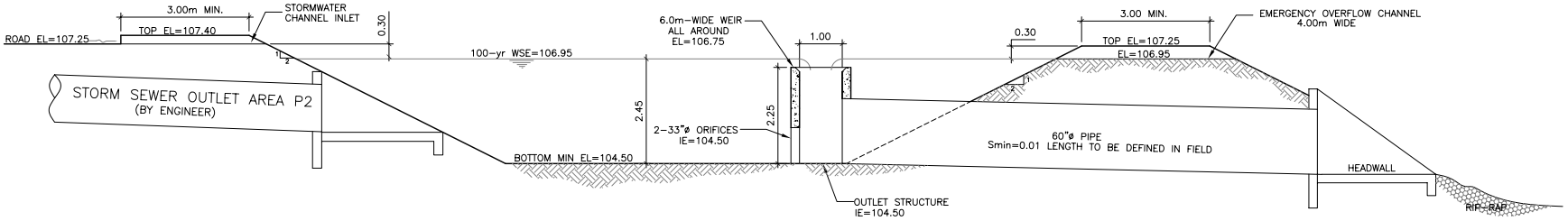
FIG.7



PLAN VIEW



OUTLET STRUCTURE
TOP VIEW
NTS



SCHEMATIC POND SECTION
NTS

CA Engineering

Scale: NTS

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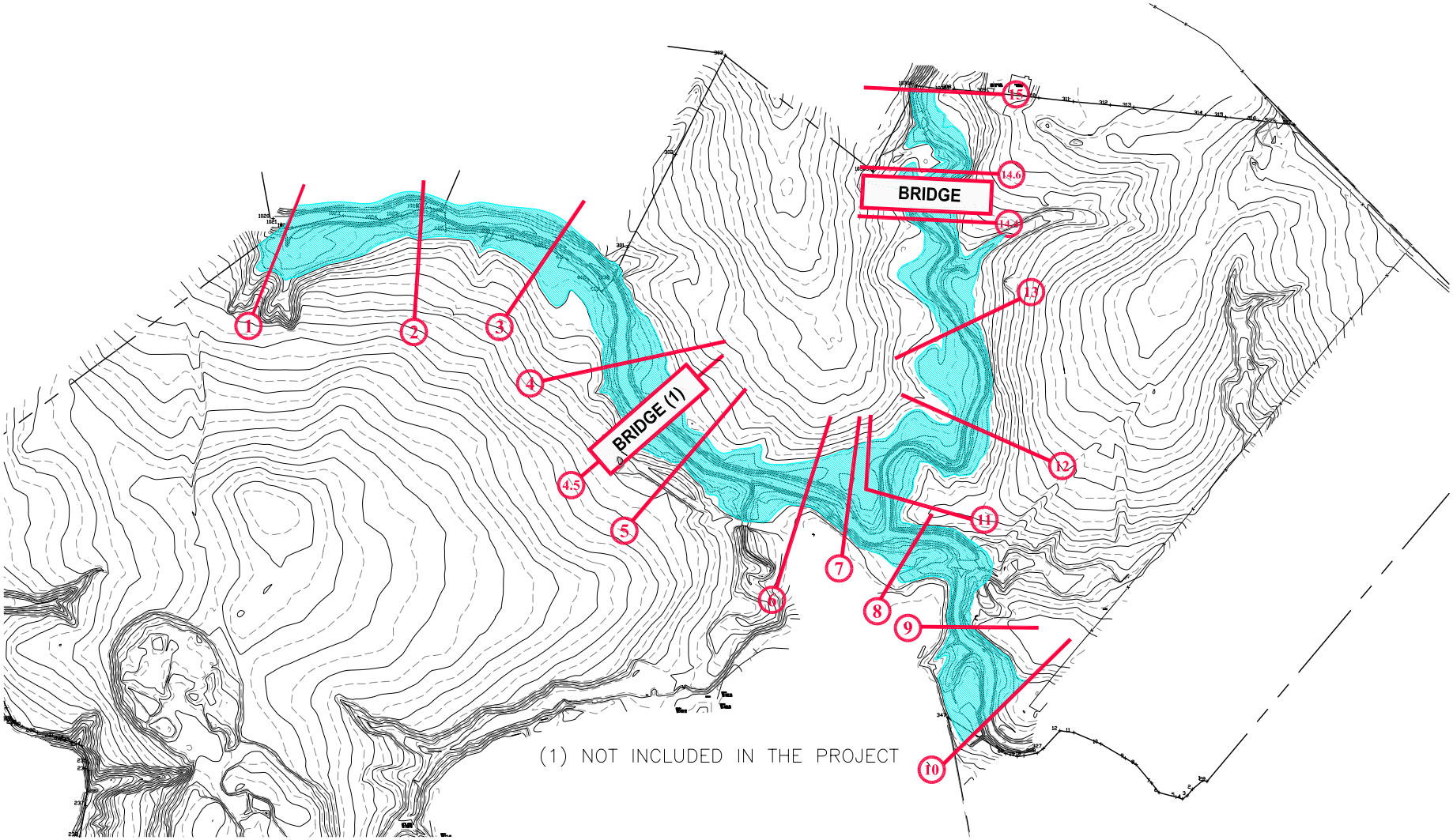
Figure 8

Mitigation Pond Schematics for Area P4

FIG.8



CA Engineering

Scale: 1:3,000

HYDROLOGIC ASPECTS - ESTANCIAS DE LOS ARTESANOS, LAS PIEDRAS, PR

Figure 9

Topography and Cross Sections for Existing Condition

FIG.9