

Haiti Earthquake January 12, 2010

By Eduardo Fierro
BFP Engineers, Inc.
Bertero Fierro Perry

Current Statistics

Human Toll

- **150,000:** Latest estimate of the death toll, from the Haitian Health Ministry. The European Union and the Pan American Health Organization, which are coordinating the health-sector response, have estimated the quake killed 200,000 people.
- **194,000:** Number of injured
- **134:** Estimated number of people rescued by international search teams since the quake

Current Statistics

Effect on people

- **9 million:** Population of Haiti
- **3 million:** Estimated number of people affected by the quake
- **1 million:** Estimated number of displaced people
- **800,000 to 1 million:** People who need temporary shelter
- **235,000:** People who have left Port-au-Prince using free transportation provided by the government. The number who left by private means is undetermined.
- **At least 50:** Aftershocks of magnitude 4.5 or higher that have hit Haiti since the January 12 quake

Current Statistics Effect on Children

- **300,000:** Children younger than 2 who need nutritional support
- **90:** Percentage of schools in Port-au-Prince that have been destroyed
- **363:** Haitian orphans who have been evacuated

Current Statistics Effect on Foreigners

- **12,000:** U.N. workers in the country at the time of the quake
- **53:** U.N. workers still missing
- **At least 82:** U.N. workers dead
- **27:** U.N. workers injured or hospitalized
- **11,500:** Americans and family members who have been evacuated
- **4,800:** Americans unaccounted for

Sources of information for statistical data

- CNN
- *CNN Sources: Office for the Coordination of Humanitarian Affairs, the Red Cross, the United Nations, the U.S. Agency for International Development, the U.S. State Department and the World Food Programme*

Earthquake Data

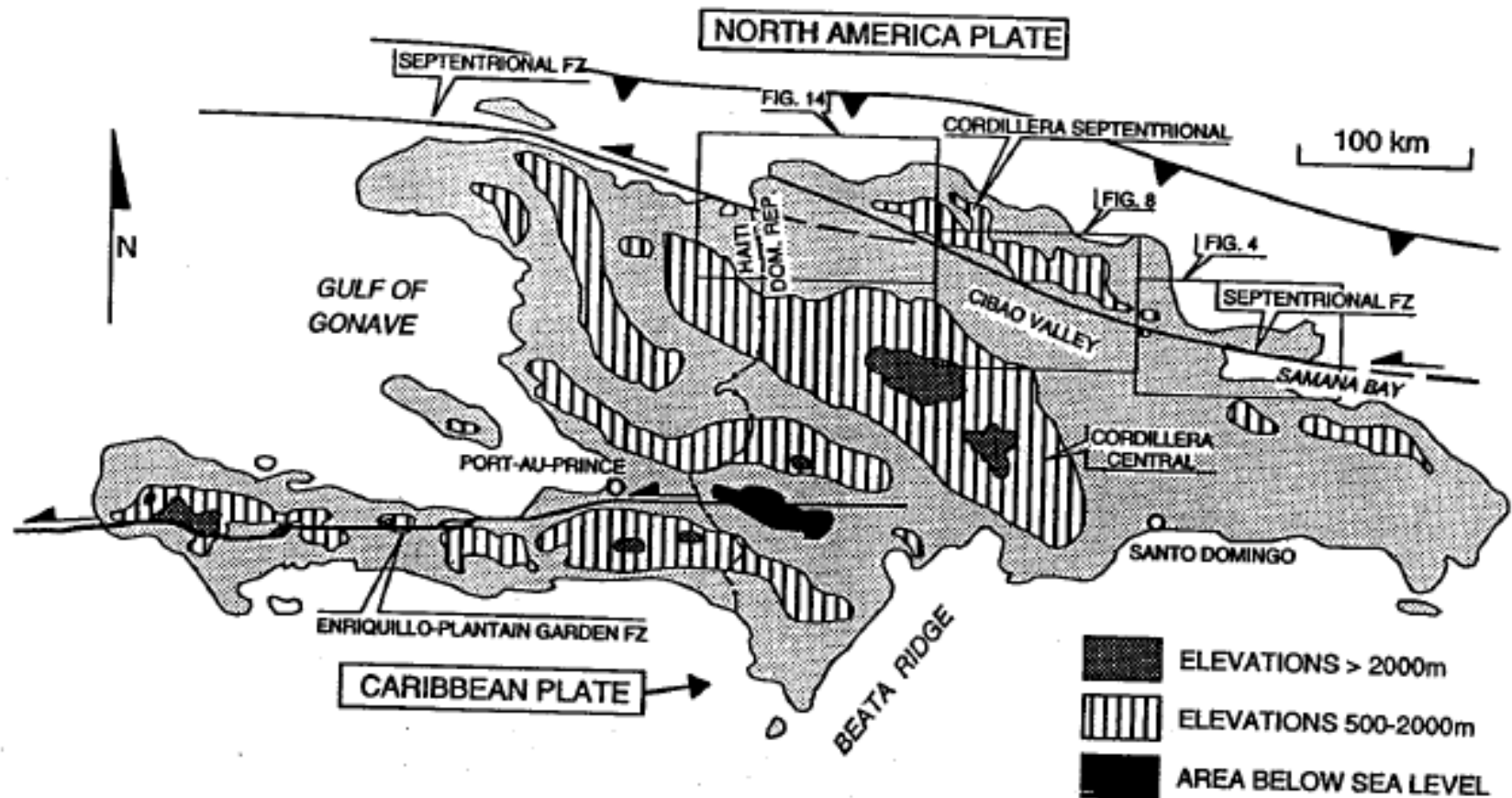
<u>Magnitude</u>	7.0
<u>Date-Time</u>	Tuesday, January 12, 2010 at 21:53:10 UTC Tuesday, January 12, 2010 at 04:53:10 PM at epicenter Time of Earthquake in other Time Zones
<u>Location</u>	18.457°N, 72.533°W
<u>Depth</u>	13 km (8.1 miles) set by location program
<u>Region</u>	HAITI REGION
<u>Distances</u>	25 km (15 miles) WSW of PORT-AU-PRINCE, Haiti 130 km (80 miles) E of Les Cayes, Haiti 150 km (95 miles) S of Cap-Haitien, Haiti 1125 km (700 miles) SE of Miami, Florida
<u>Location Uncertainty</u>	horizontal +/- 3.4 km (2.1 miles); depth fixed by location program
<u>Parameters</u>	NST=312, Nph=312, Dmin=143.7 km, Rmss=0.93 sec, Gp= 25°, M-type=teleseismic moment magnitude (Mw), Version=9
<u>Source</u>	USGS NEIC (WDCS-D)
<u>Event ID</u>	us2010rja6

LOCATION



Tectonic faults Hispaniola

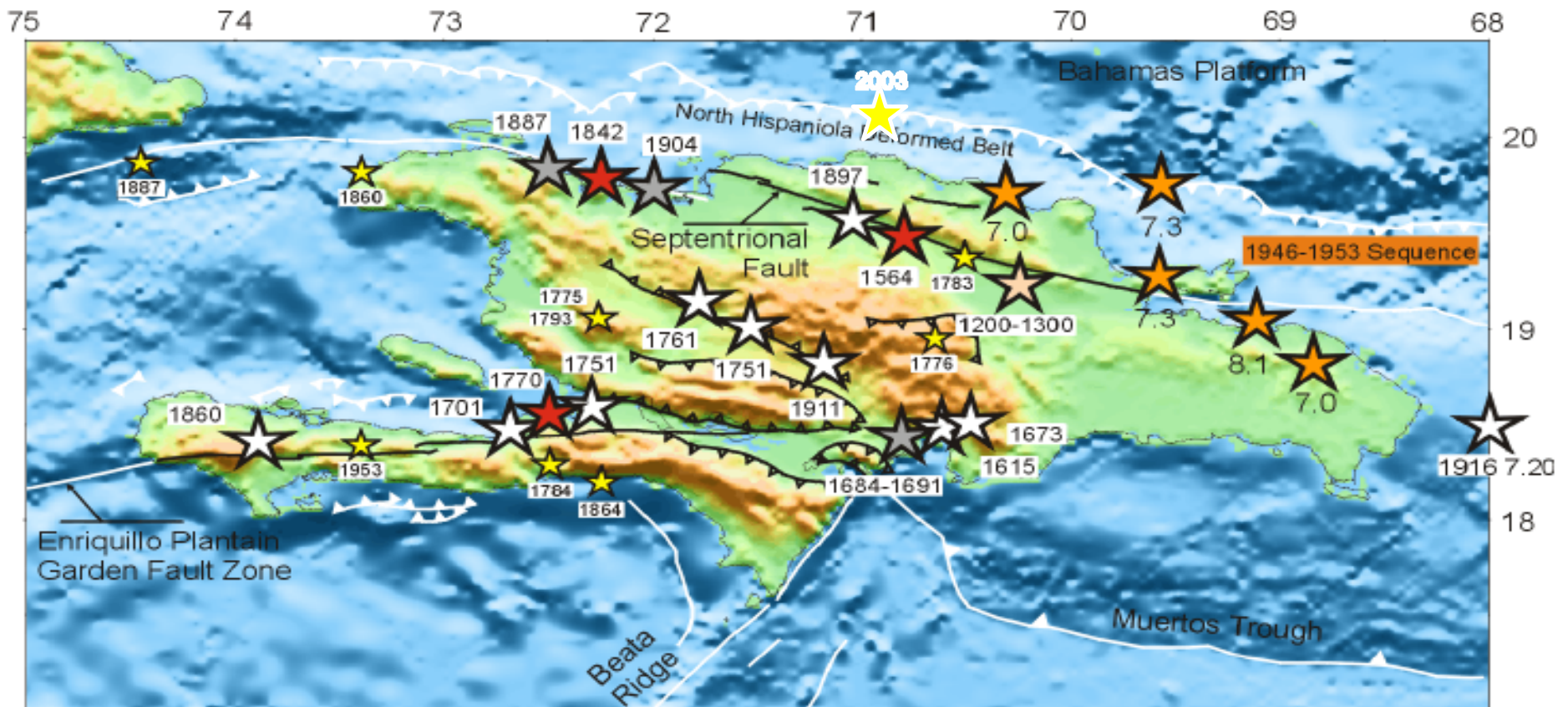
A. MAJOR TECTONIC FEATURES OF HISPANIOLA







Historic Earthquakes in La Hispaniola

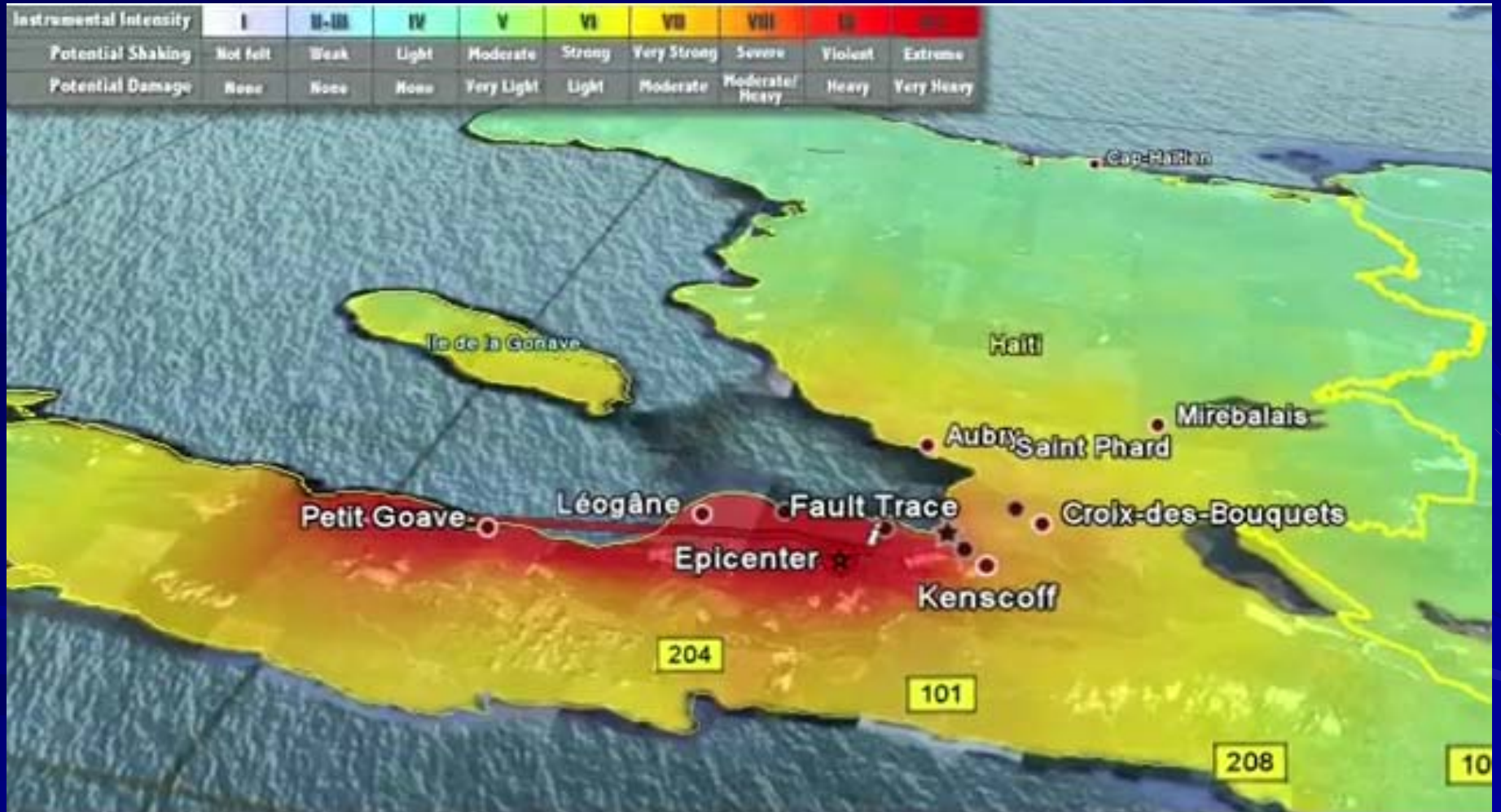
Historical seismicity in Hispaniola (before 1960)

(locations approximate except 46-53 sequence)

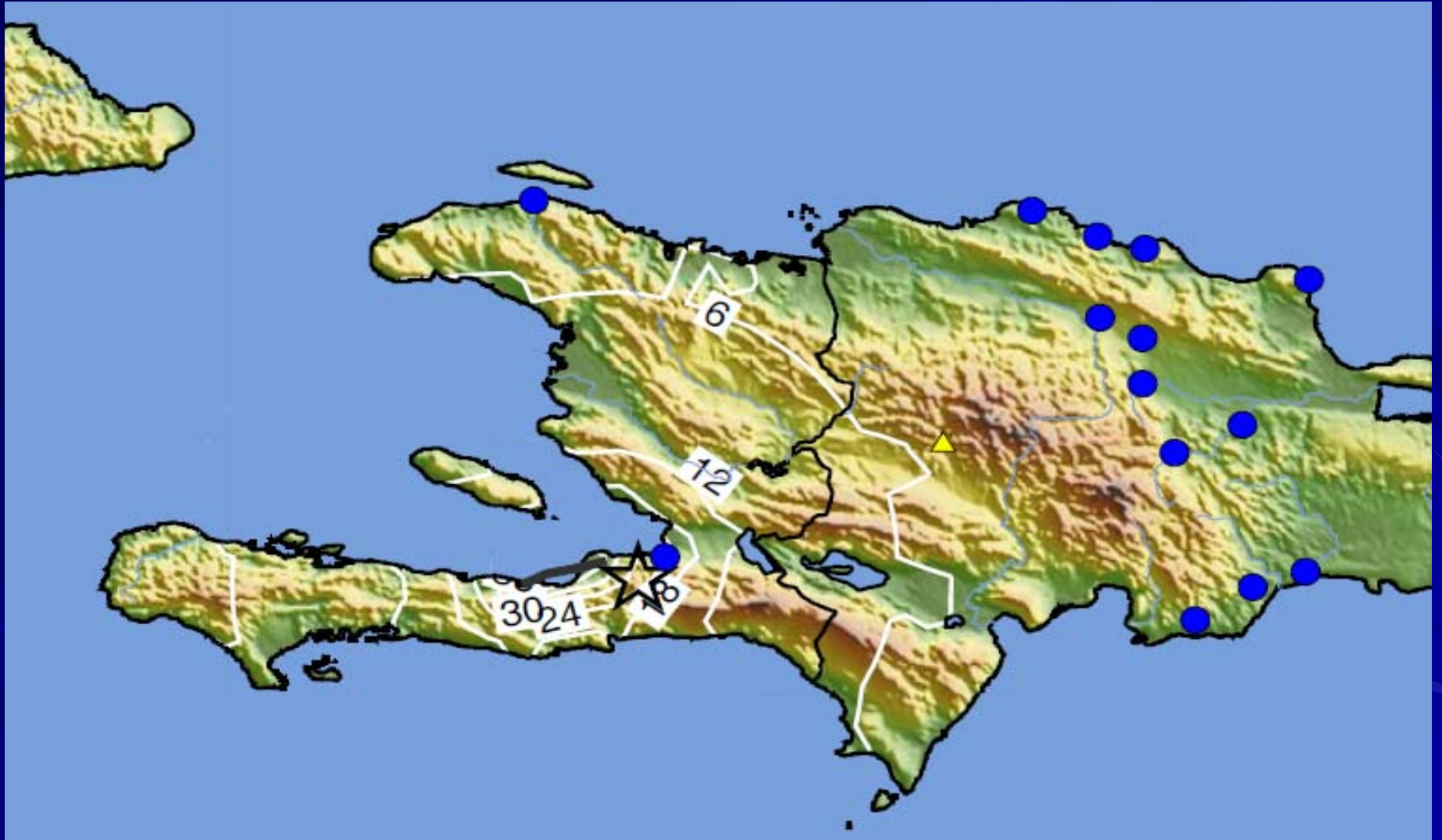


- | | | | | | |
|---|--------------------------|---|---------------|---|-----------------------|
|  | Major earthquakes |  | Other EQ |  | Paleo-earthquakes |
|  | Large EQ, city destroyed |  | 1946 sequence |  | Moderate EQ (NOAA DB) |

INTENSITIES



GROUND ACCELERATIONS AS PER USGS



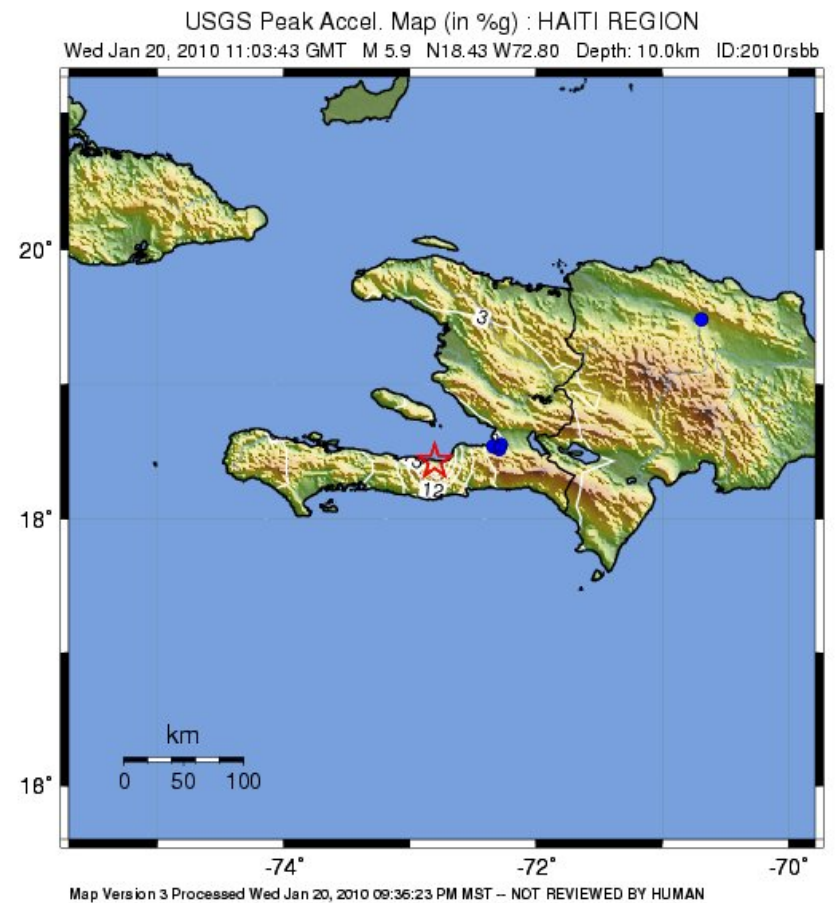
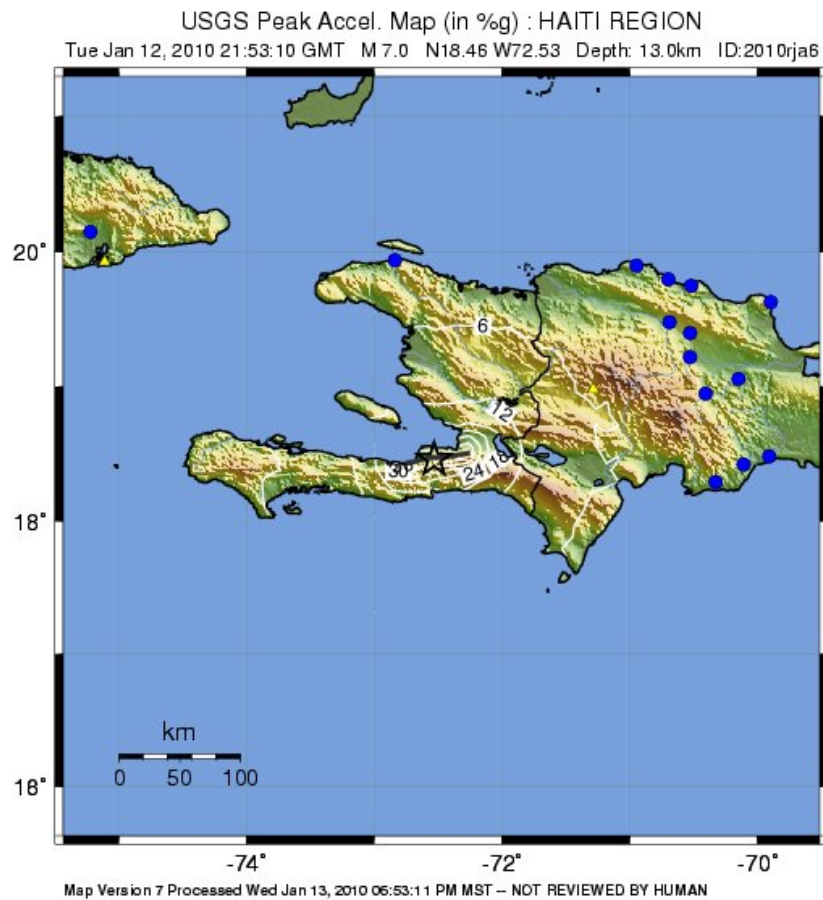
ACCELERATIONS AT A PERIOD OF 0.3 SEC AS PER USGS



PEAK GROUND ACCELERATIONS COMPARISON

12/01/2010

20/01/2010



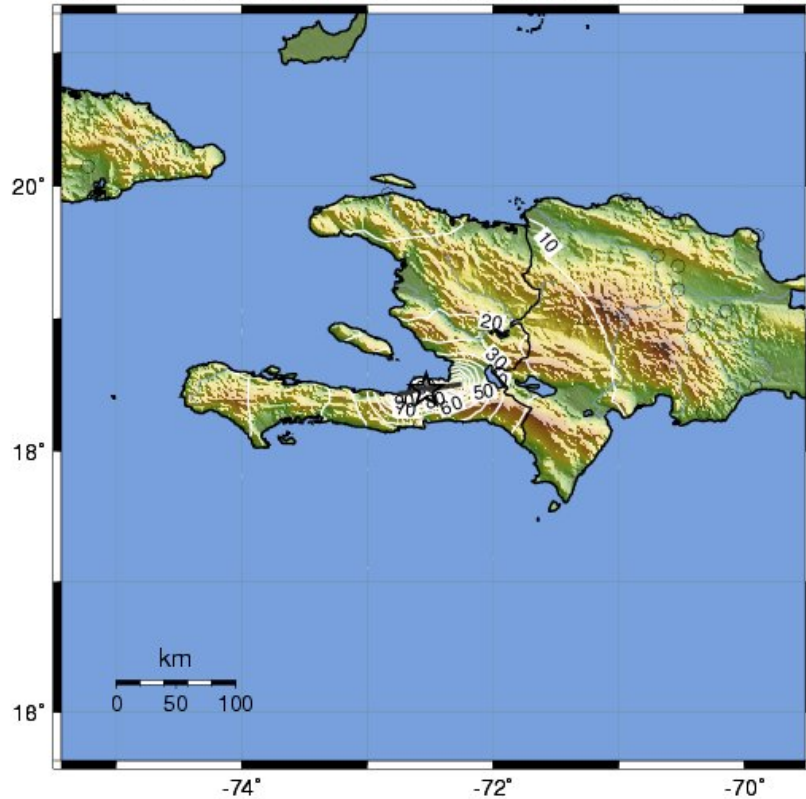
ACCELERATIONS AT 0.3 SEC PERIOD COMPARISON

12/01/2010

12/20/2010

USGS 0.3 s Pseudo-Acceleration Spectra (%g) : HAITI REGION

Tue Jan 12, 2010 21:53:10 GMT M 7.0 N18.46 W72.53 Depth: 13.0km ID:2010rja6

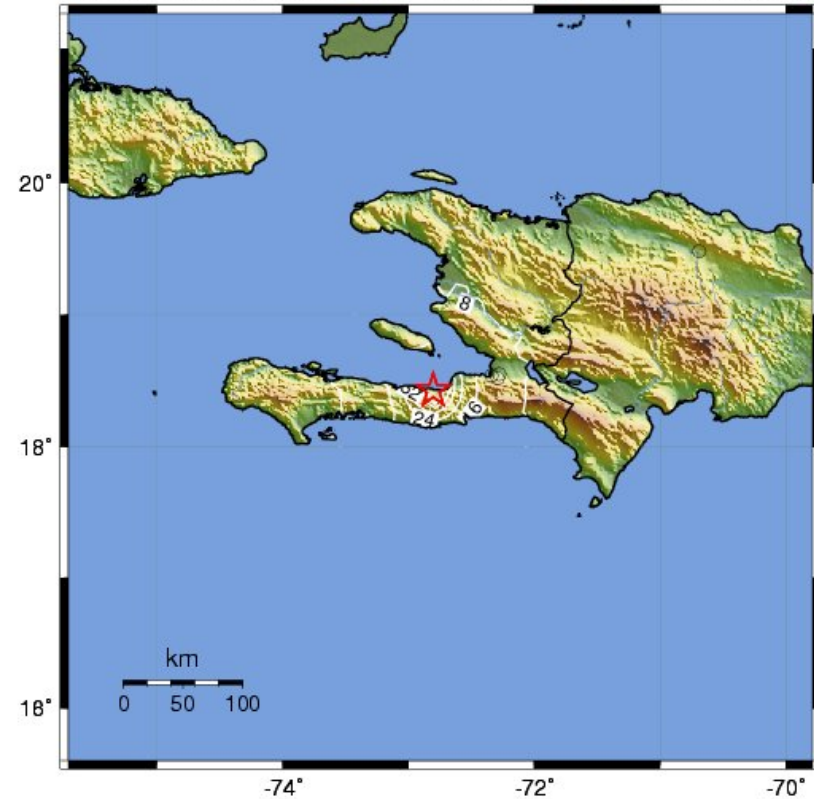


Map Version 7 Processed Wed Jan 13, 2010 06:53:11 PM MST - NOT REVIEWED BY HUMAN

NOTE: These are automated maps based on instrumental response spectra, and may not be appropriate for comparison with design spectral values.

USGS 0.3 s Pseudo-Acceleration Spectra (%g) : HAITI REGION

Wed Jan 20, 2010 11:03:43 GMT M 5.9 N18.43 W72.80 Depth: 10.0km ID:2010rsbb



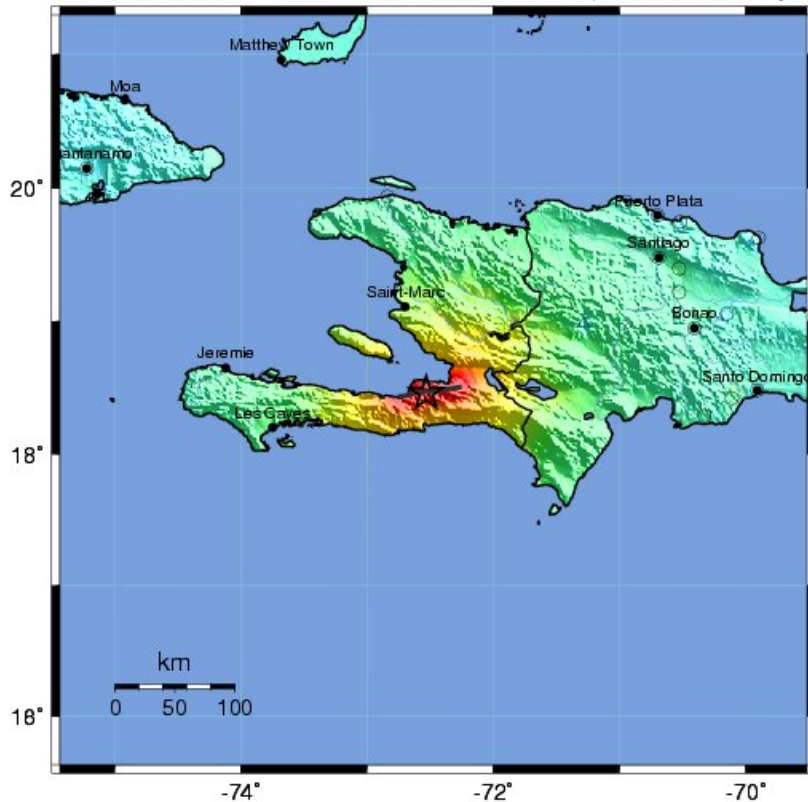
Map Version 3 Processed Wed Jan 20, 2010 09:36:23 PM MST - NOT REVIEWED BY HUMAN

NOTE: These are automated maps based on instrumental response spectra, and may not be appropriate for comparison with design spectral values.

COMPARISON OF INTENSITIES FOR 7.0 OF 12/01/2010 AND 5.9 del 20/01/2010

USGS ShakeMap : HAITI REGION

Tue Jan 12, 2010 21:53:10 GMT M 7.0 N18.46 W72.53 Depth: 13.0km ID:2010rja6

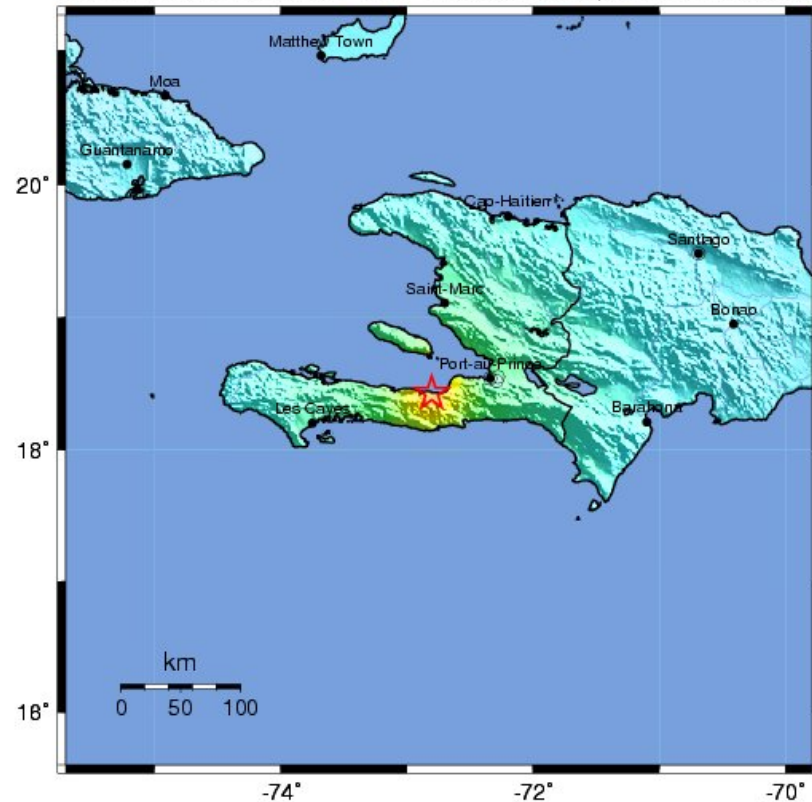


Map Version 7 Processed Wed Jan 13, 2010 06:53:11 PM MST -- NOT REVIEWED BY HUMAN

PERCEIVED SHAKINGS	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

USGS ShakeMap : HAITI REGION

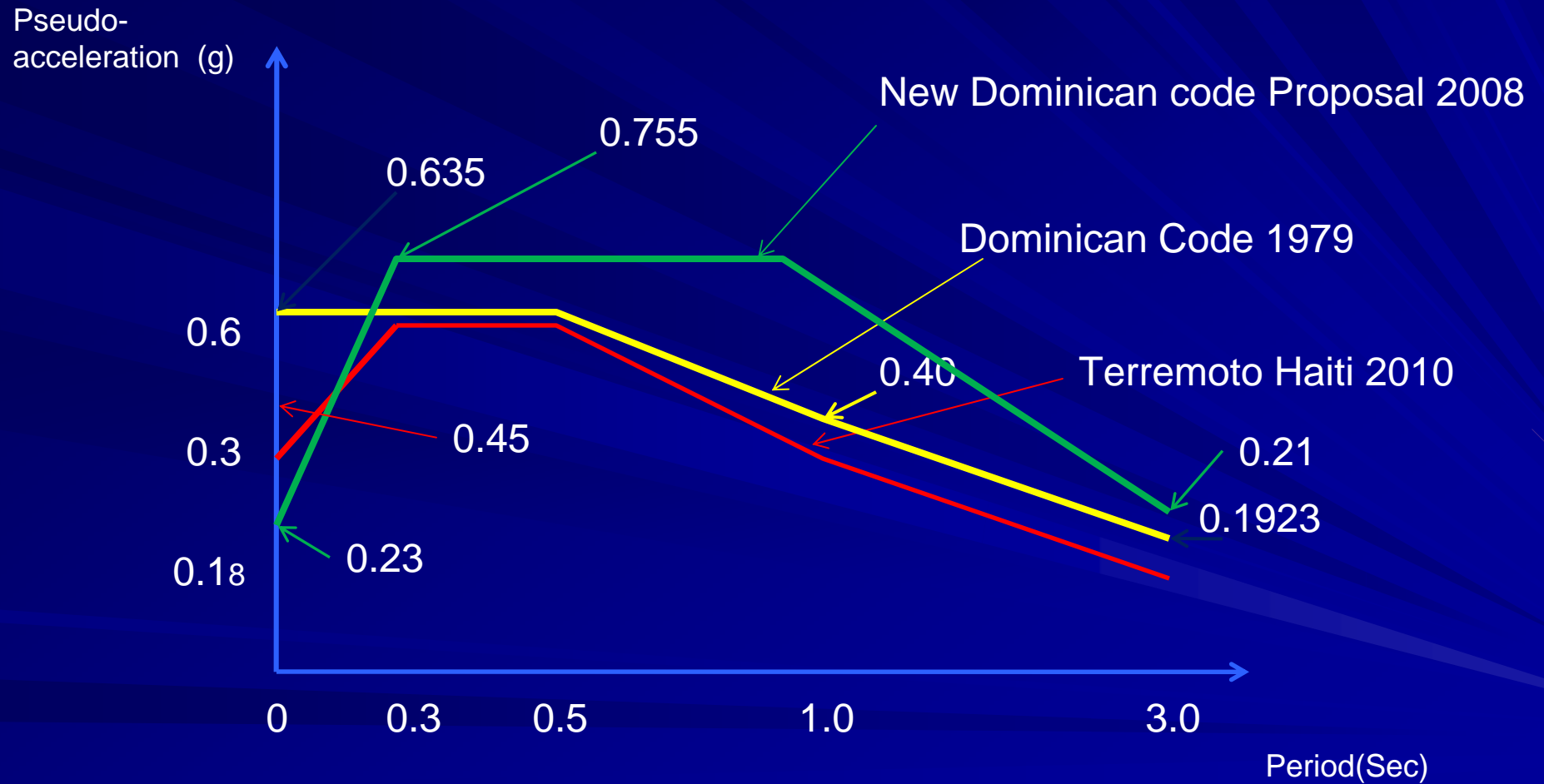
Wed Jan 20, 2010 11:03:43 GMT M 5.9 N18.43 W72.80 Depth: 10.0km ID:2010rsbb



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INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Acceleration Response Spectra HAITI 01/12/2010 red data USGS



LANDSLIDES













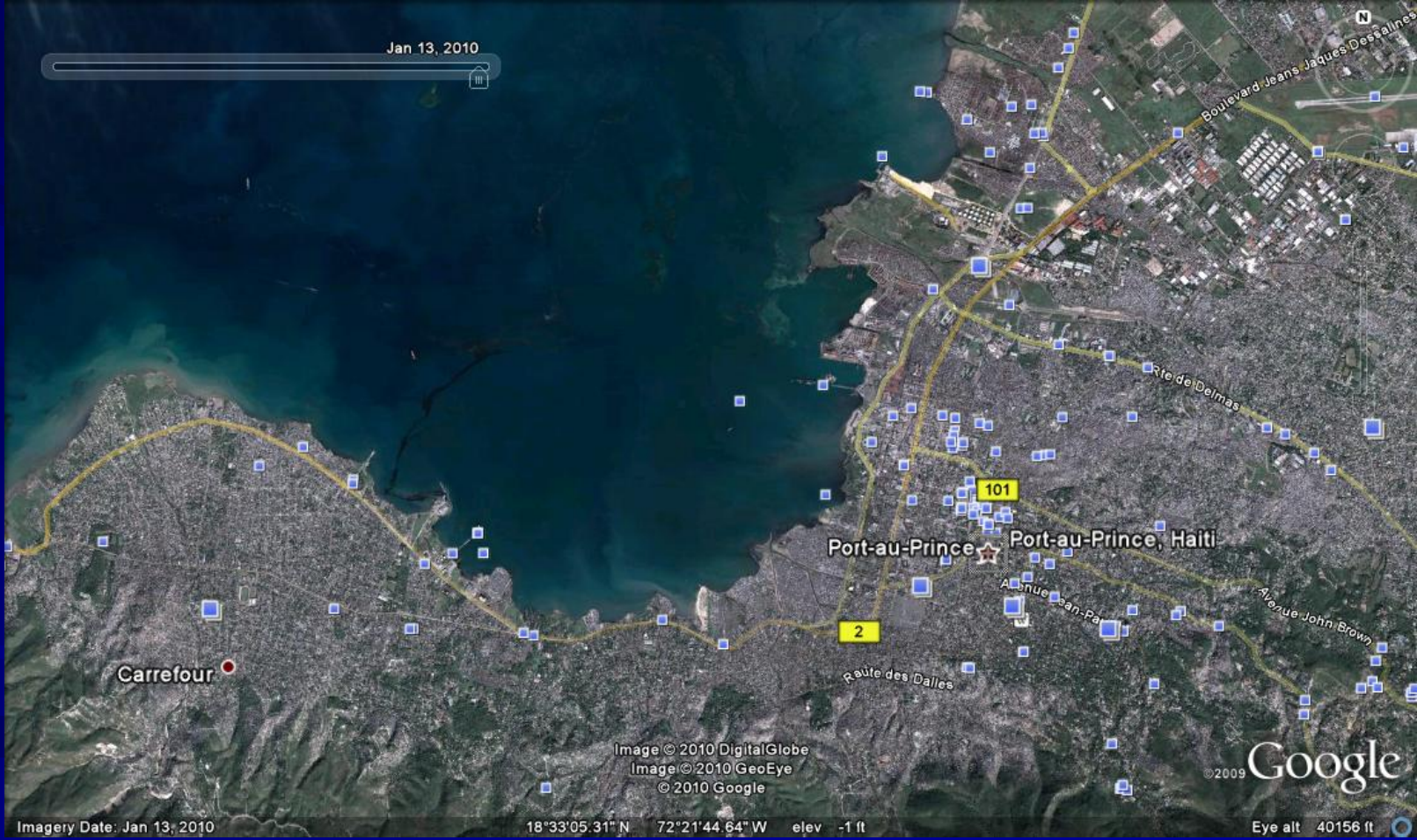


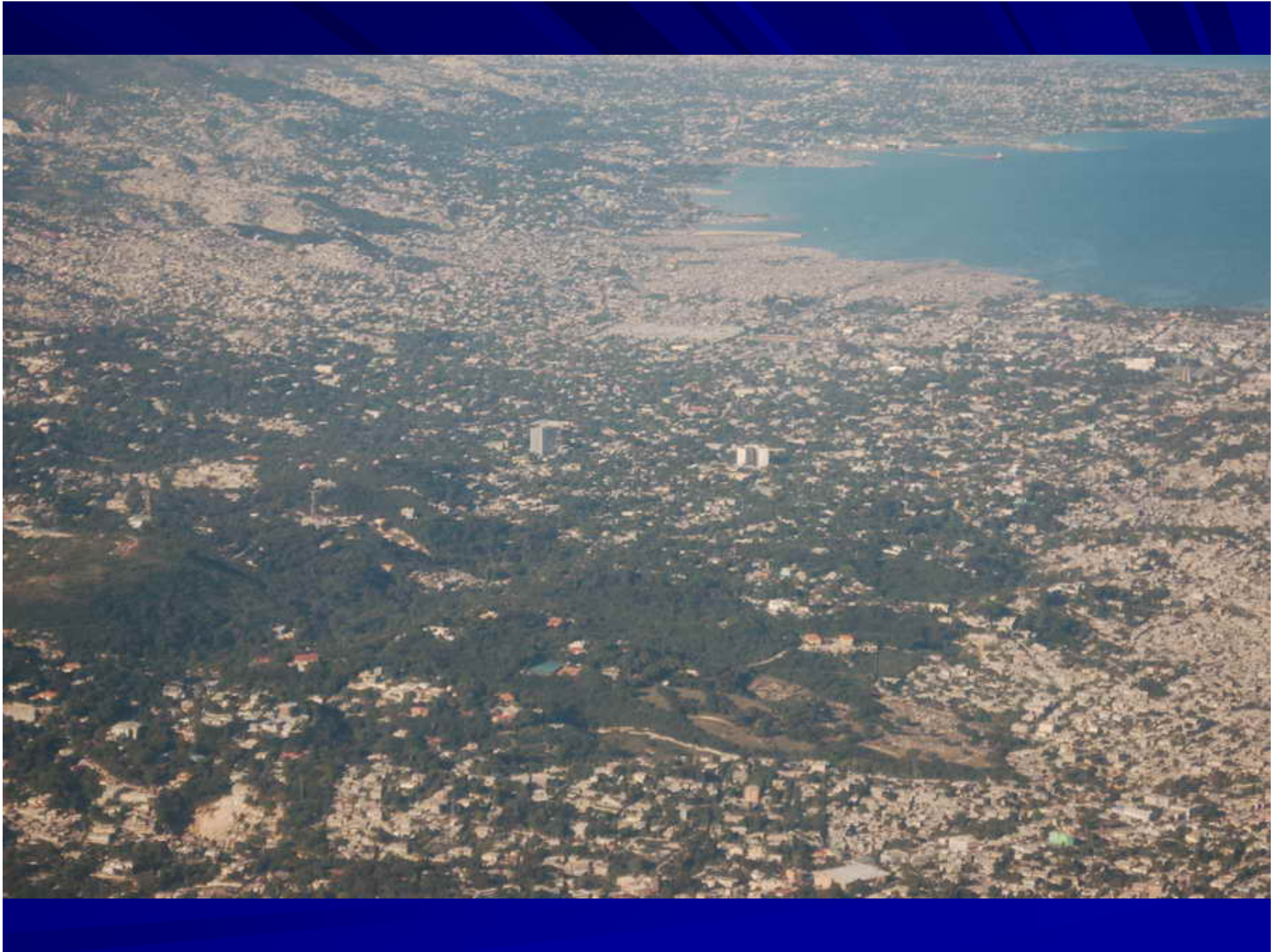






INITIAL IMPRESION













































CAR WASH



gladiator
BOISSON ENERGÉTIQUE

CAR WASH
BAR-RESTO

Sprite

imónac





Typical concrete details





























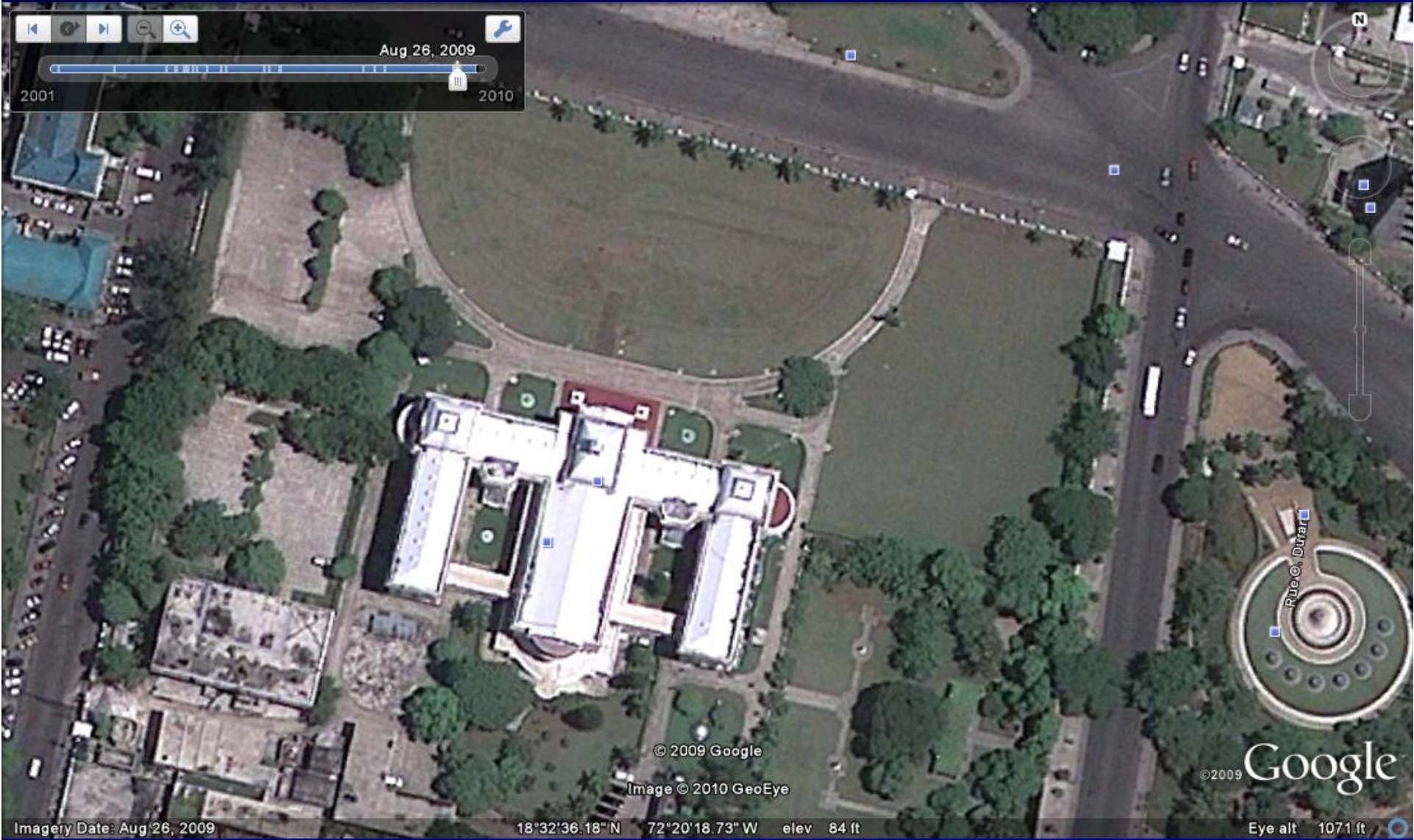






Downtown Port au Prince

Navigation and history controls including back, forward, and search icons. A timeline slider shows the date **Aug 26, 2009** between the years 2001 and 2010.



© 2009 Google

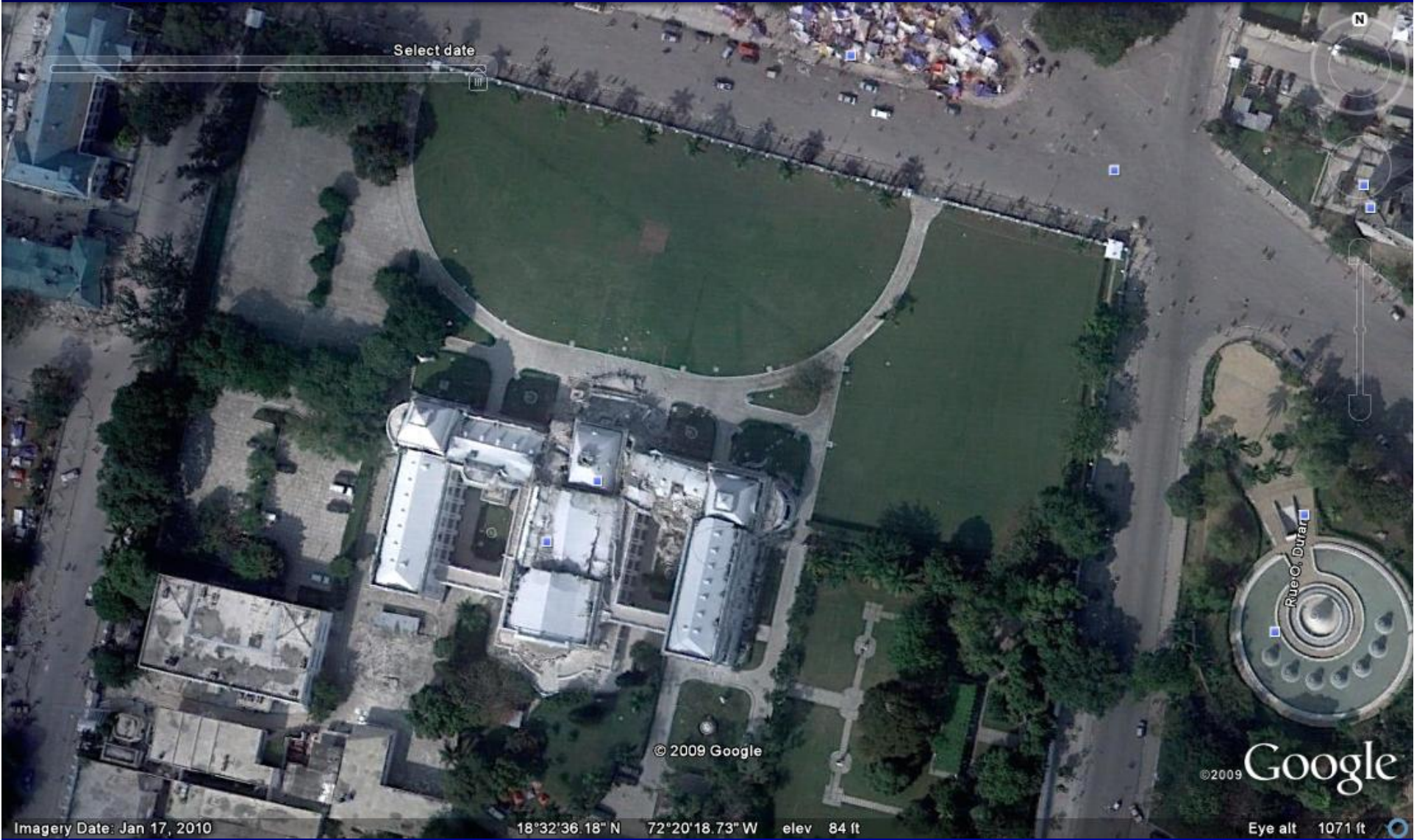
Image © 2010 GeoEye

©2009 Google

Imagery Date: Aug 26, 2009

18°32'36.18" N 72°20'18.73" W elev 84 ft

Eye alt 1071 ft



Select date

© 2009 Google

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Rue O. Duran

Imagery Date: Jan 17, 2010

18°32'36.18" N 72°20'18.73" W elev 84 ft

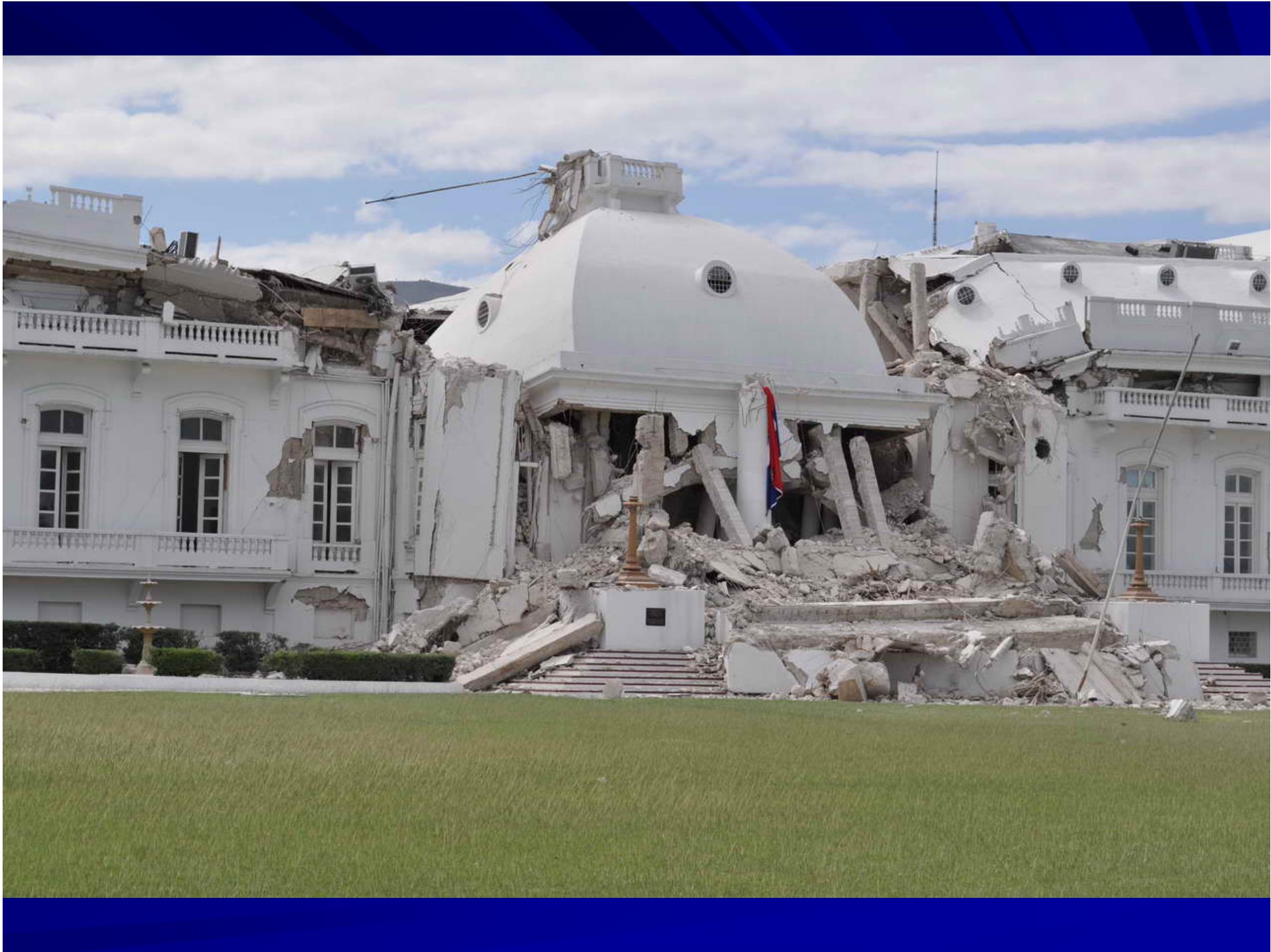
Eye alt 1071 ft













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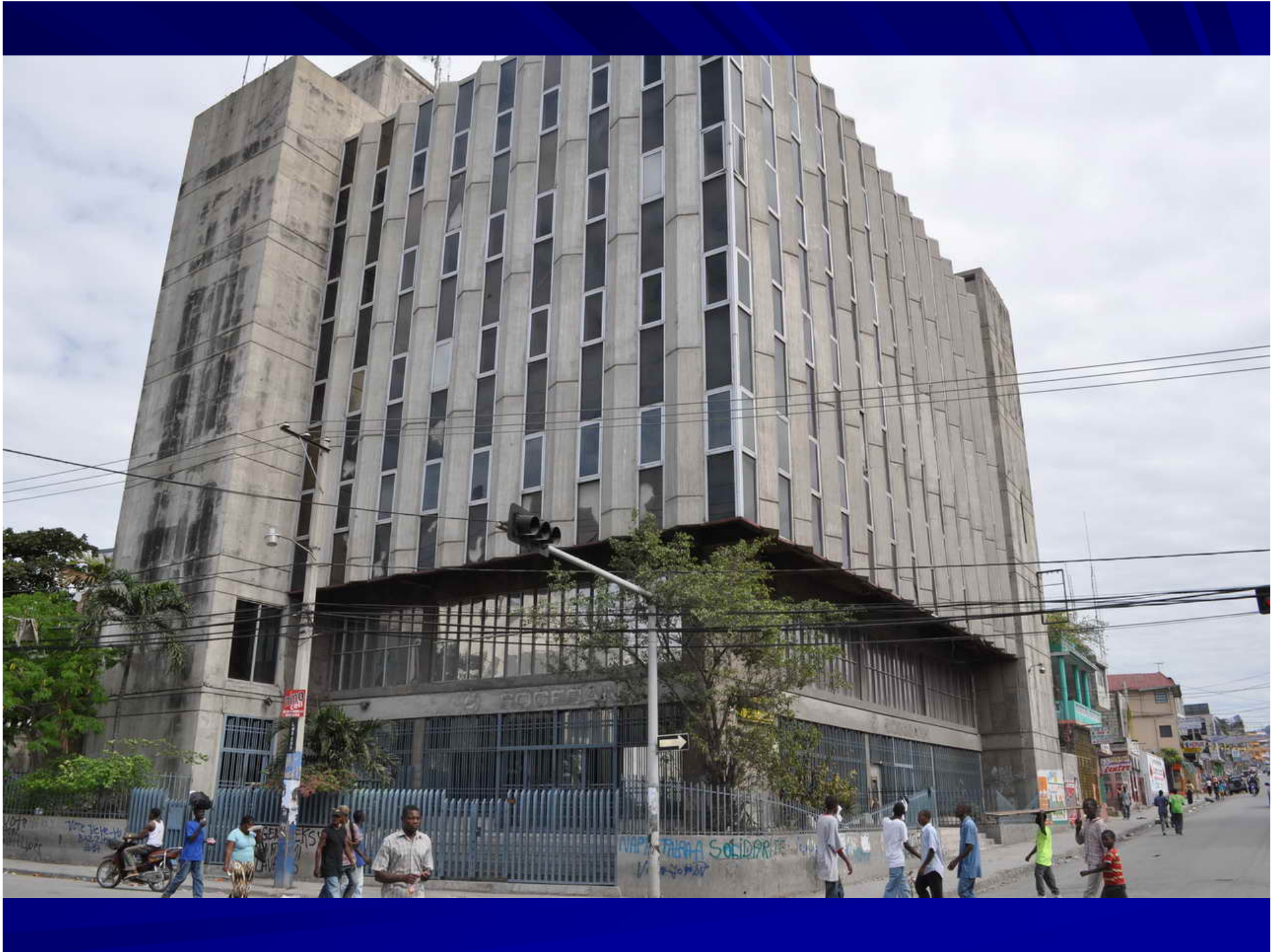




























Downtown Leogane



Jan 13, 2010

Image © 2010 DigitalGlobe
Image © 2010 GeoEye
© 2010 Google
US Dept of State Geographer

18° 36.123' N 72° 24.270' W elev -212 ft

Google

Eye alt 33.78 mi

Imagery Dates: Mar 28, 2009 - Jan 13, 2010















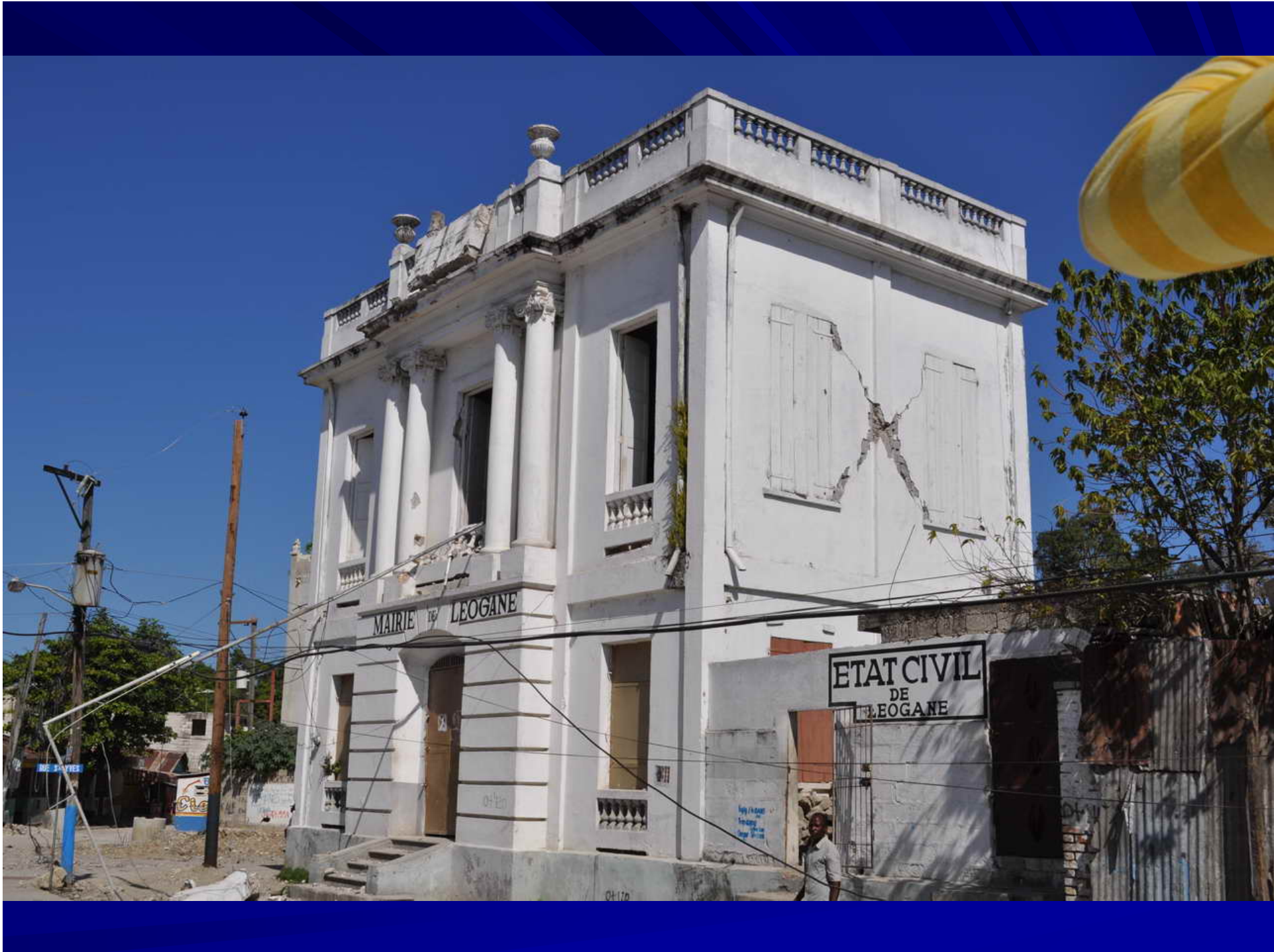




















School Leogane















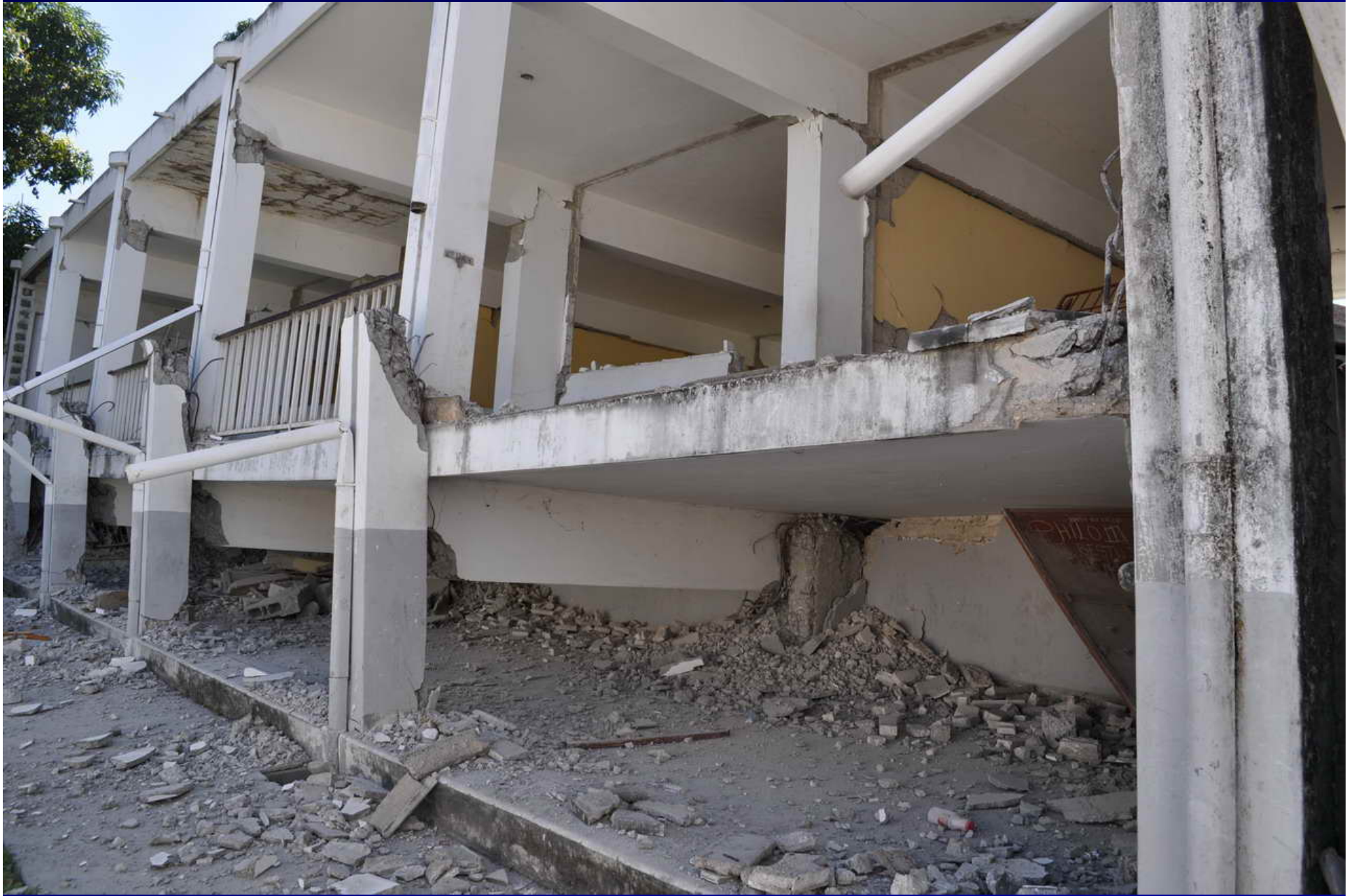


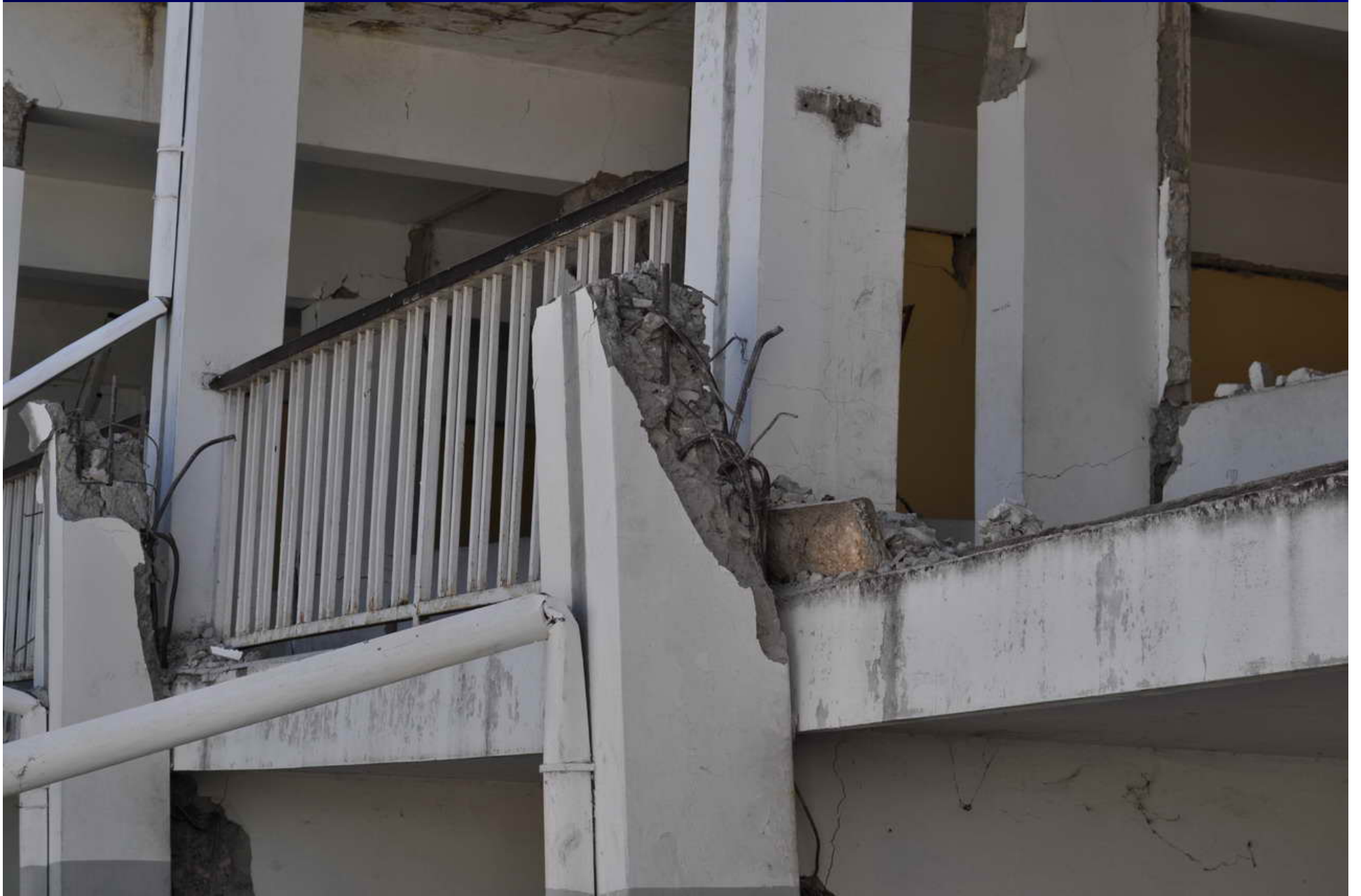






















University Leogane







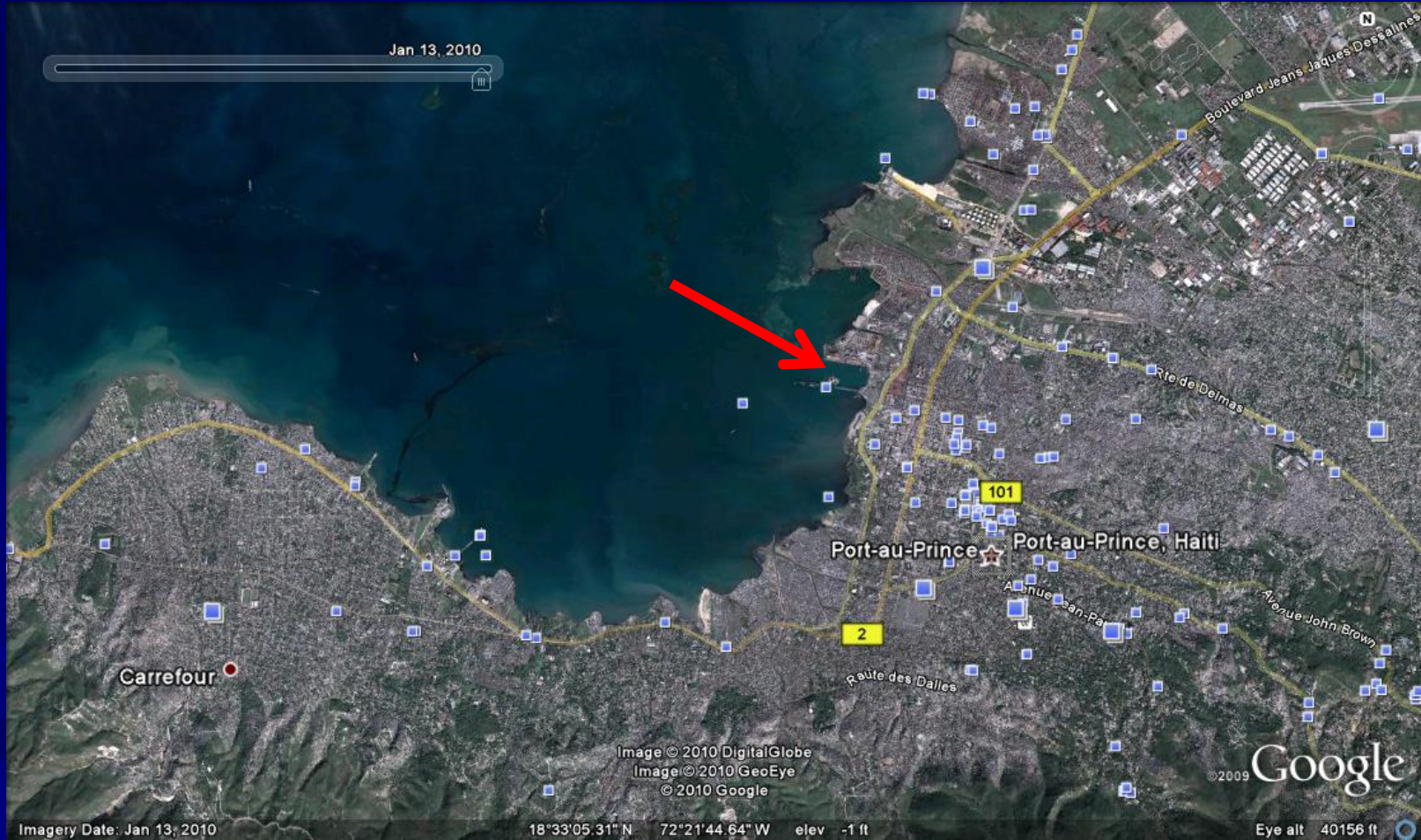








Main Port



Aug 26, 2009



N

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Image © 2010 GeoEye

Google

Imagery Dates: Jul 27, 2009 - Aug 26, 2009

18°33'21.98" N 72°21'02.28" W elev 22 ft

Eye alt 2855 ft.





Select date



N

© 2009 Google

Image © 2010 GeoEye

©2009 Google

Imagery Dates: Jan 13, 2010 - Jan 17, 2010

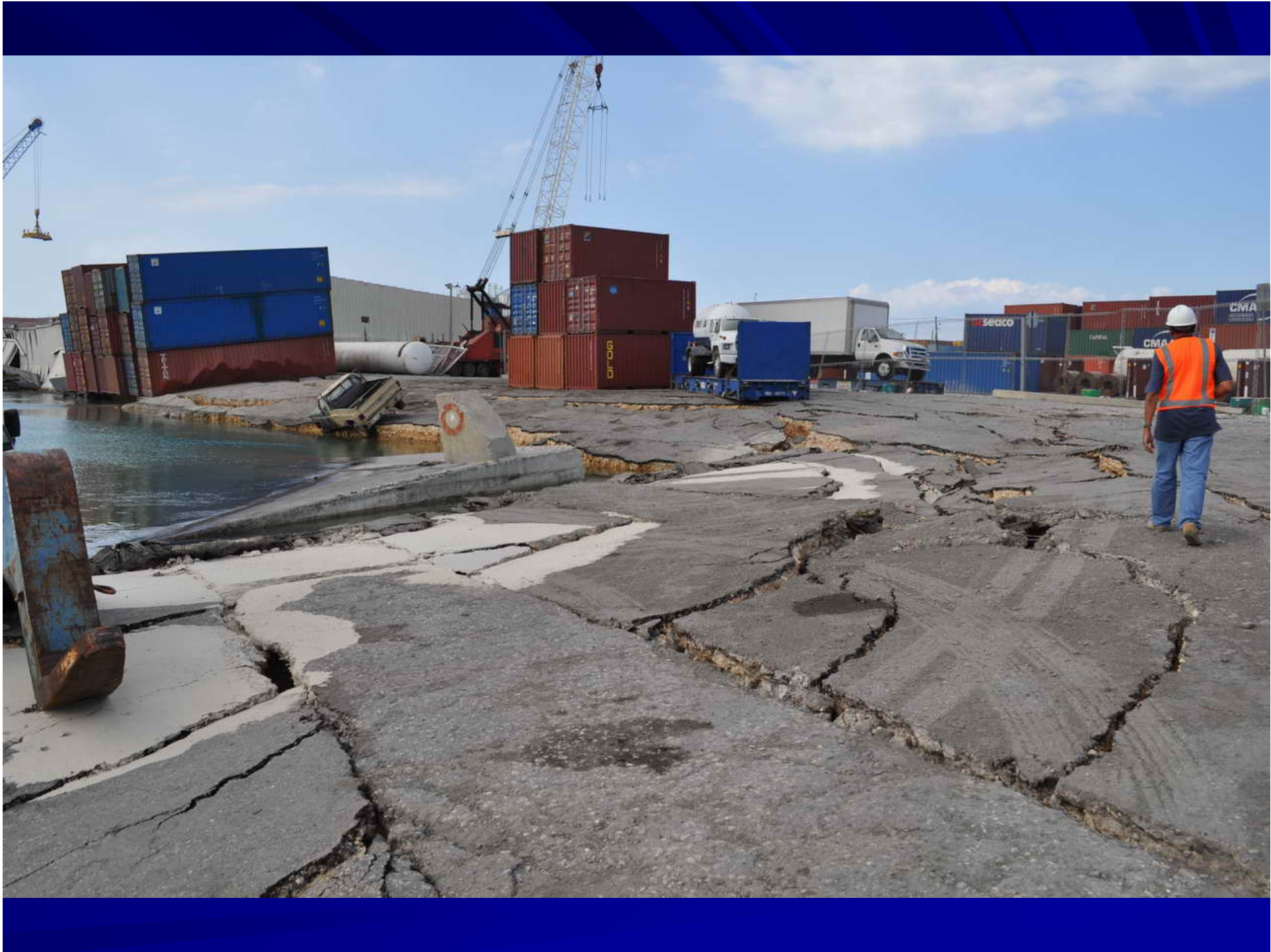
18°33'21.98" N 72°21'02.28" W elev 22 ft

Eye alt 2855 ft





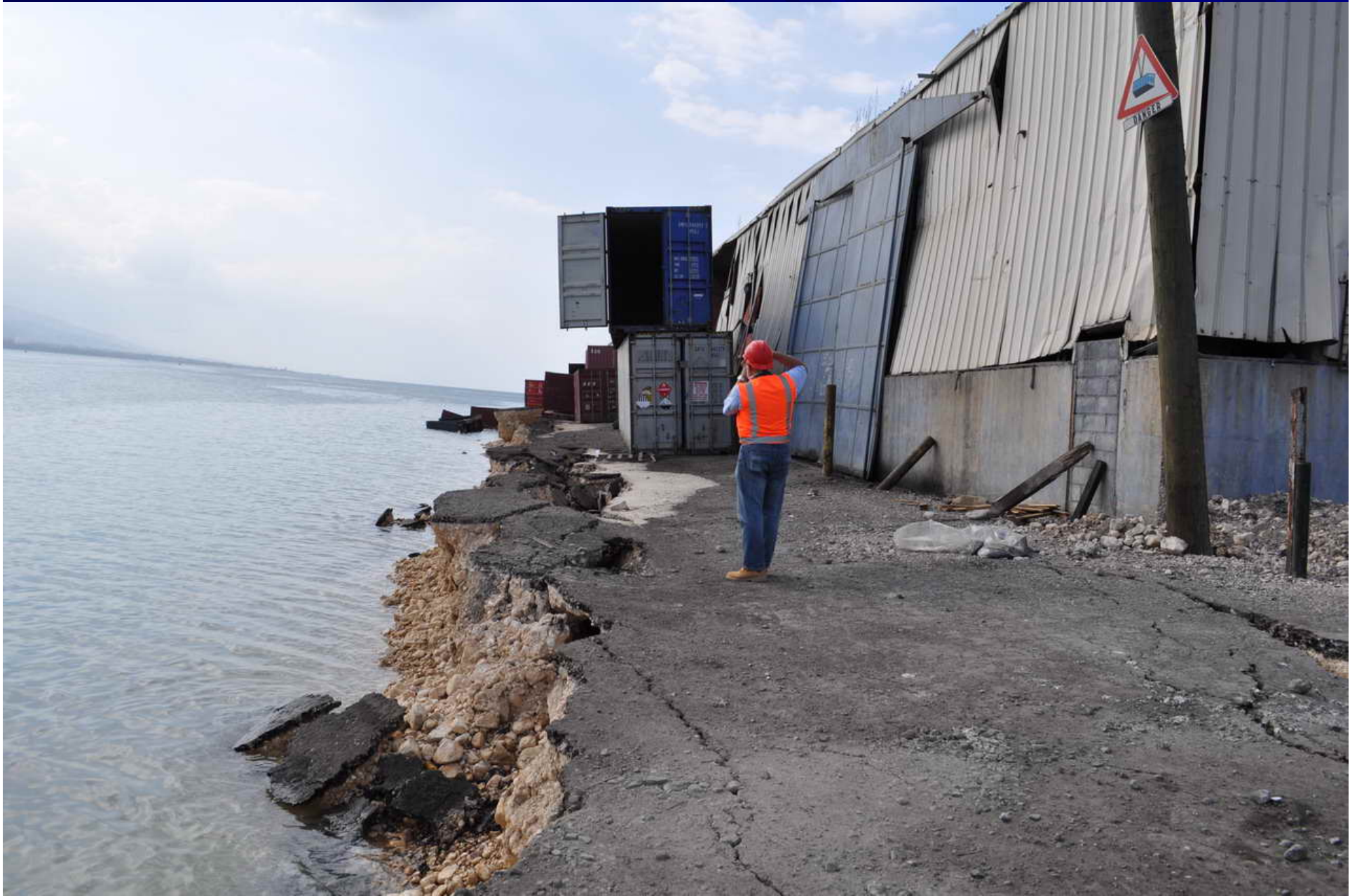








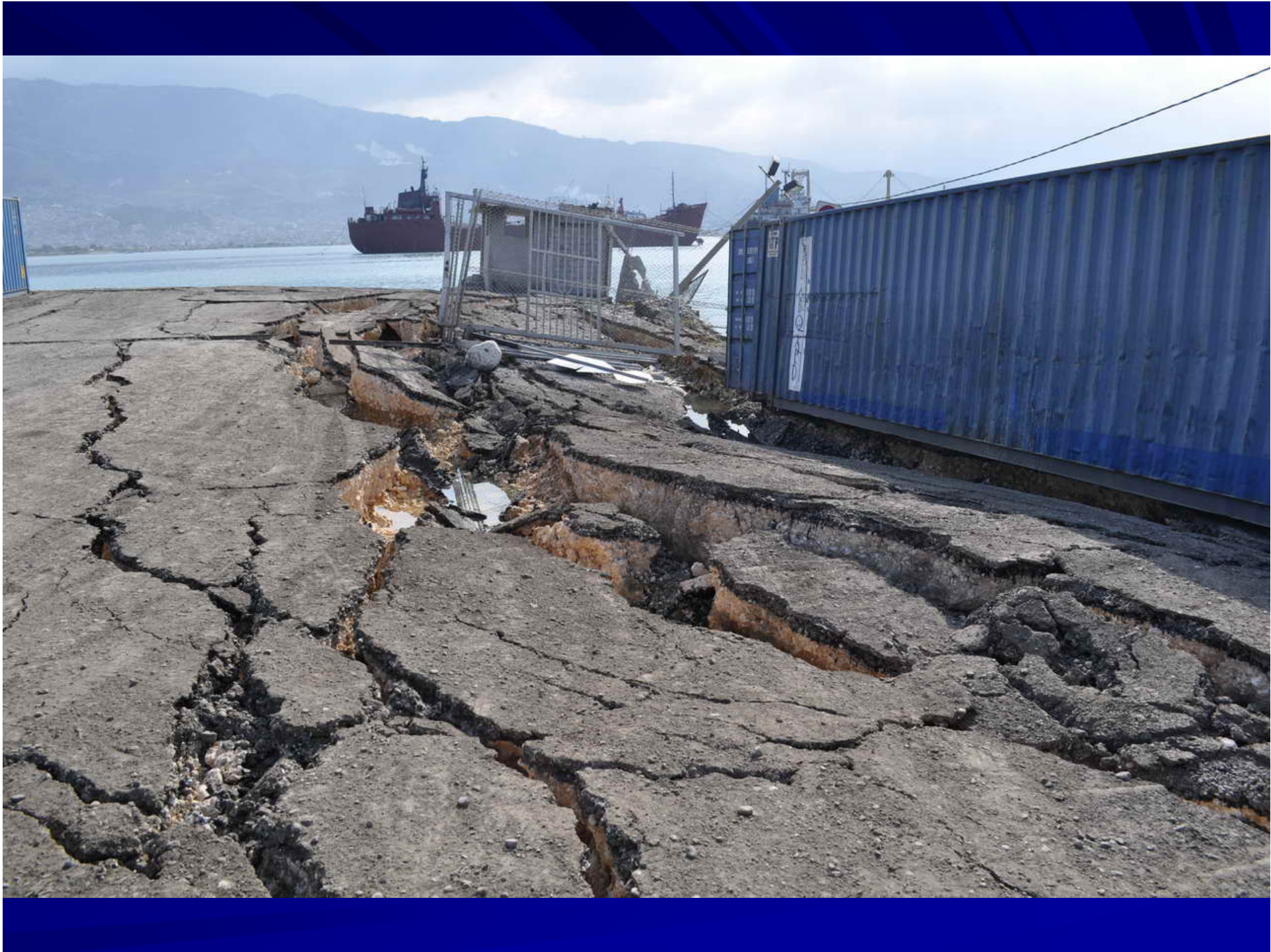


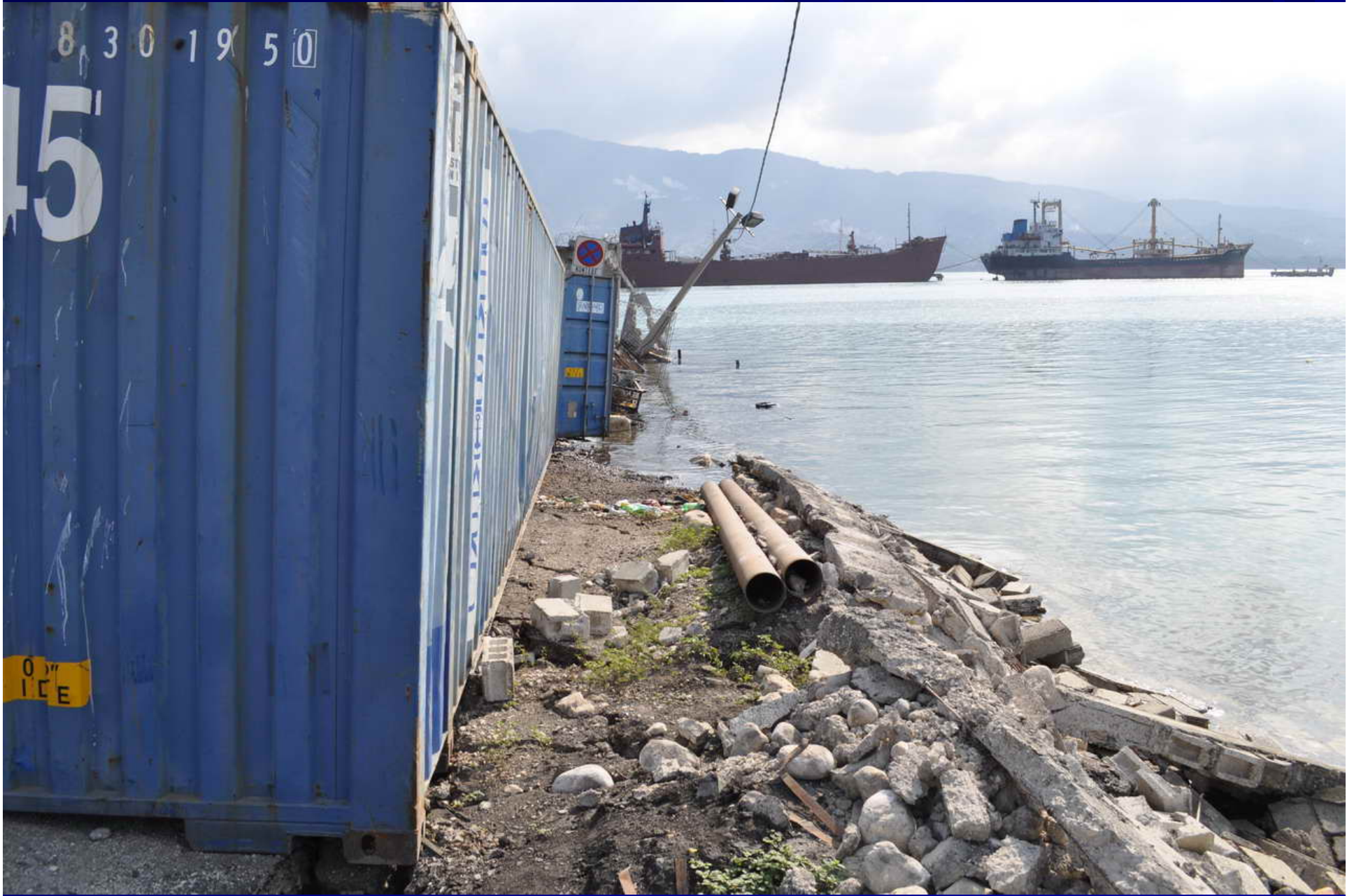








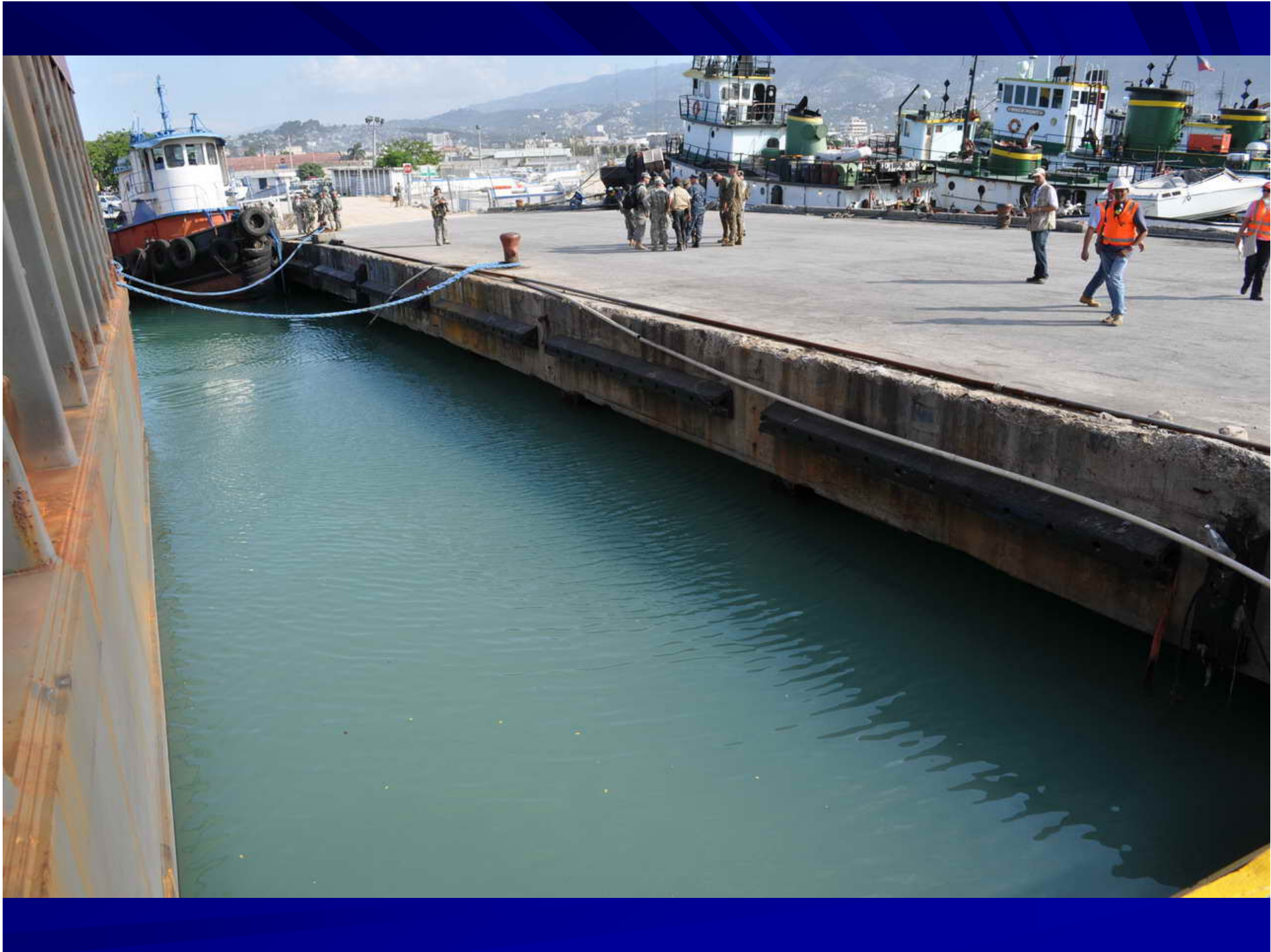














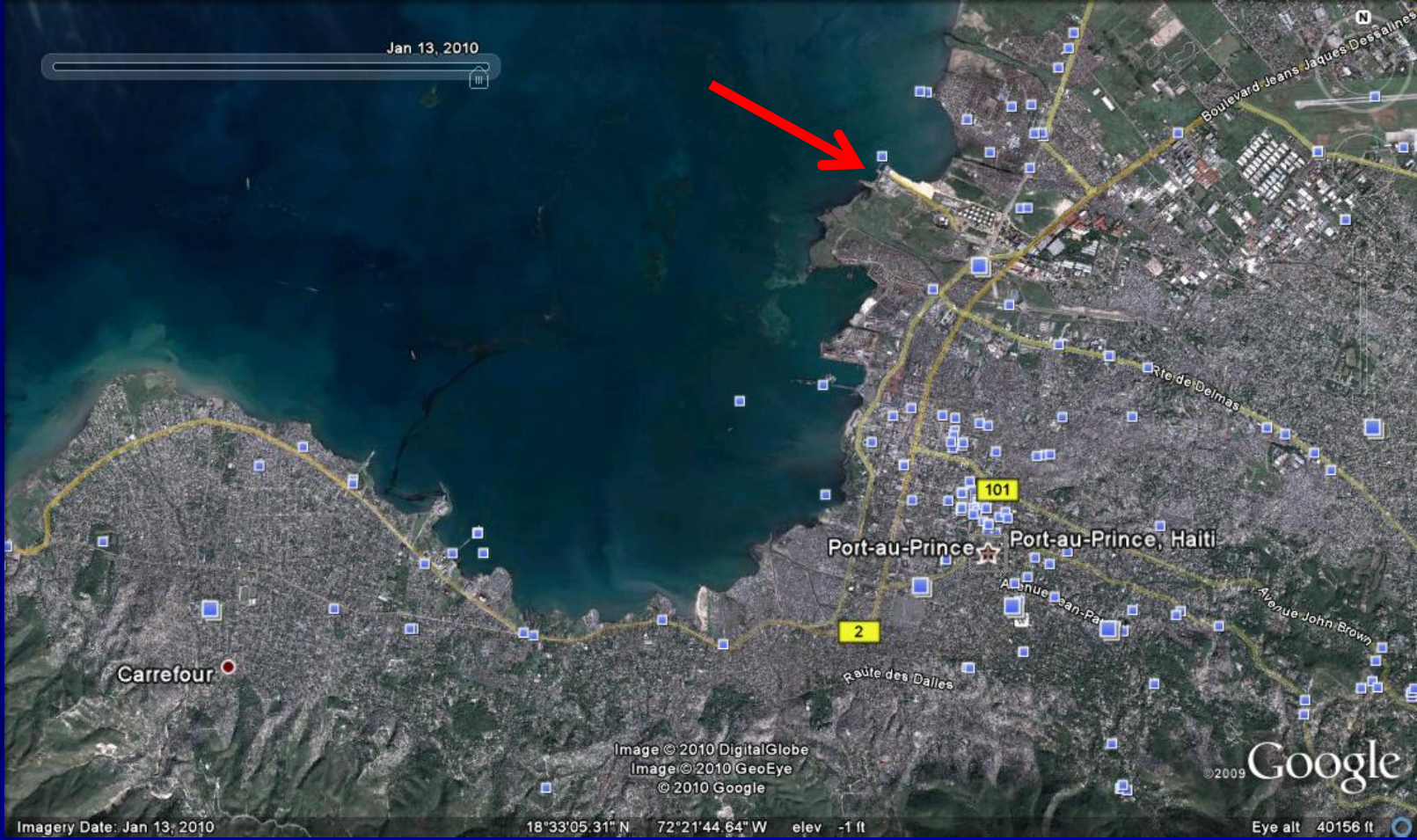








Fuel Port





22 5 2006

Jul 27, 2009



N



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Imagery Date: Jul 27, 2009

18°34'26.57" N 72°20'43.43" W elev 31 ft

Eye alt 1039 ft



Navigation and history controls including a timeline labeled "Select date" with markers for 2001 and 2010, and various navigation icons.

Navigation controls including a compass, zoom in/out buttons, and a vertical slider.

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Image © 2010 GeoEye

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Imagery Dates: Jan 13, 2010 - Jan 17, 2010 18°34'26.57" N 72°20'43.43" W elev 31 ft Eye alt 1039 ft



































































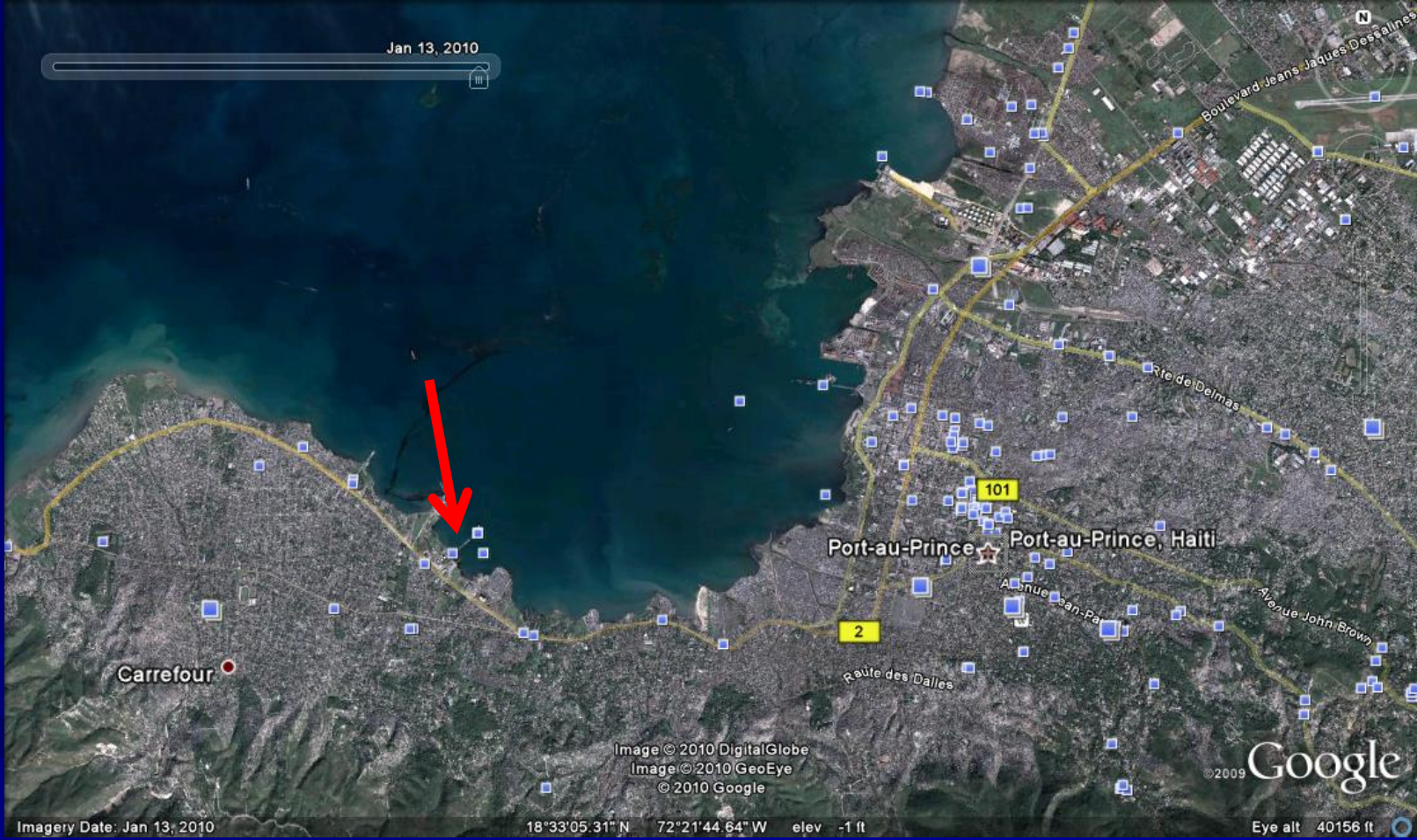


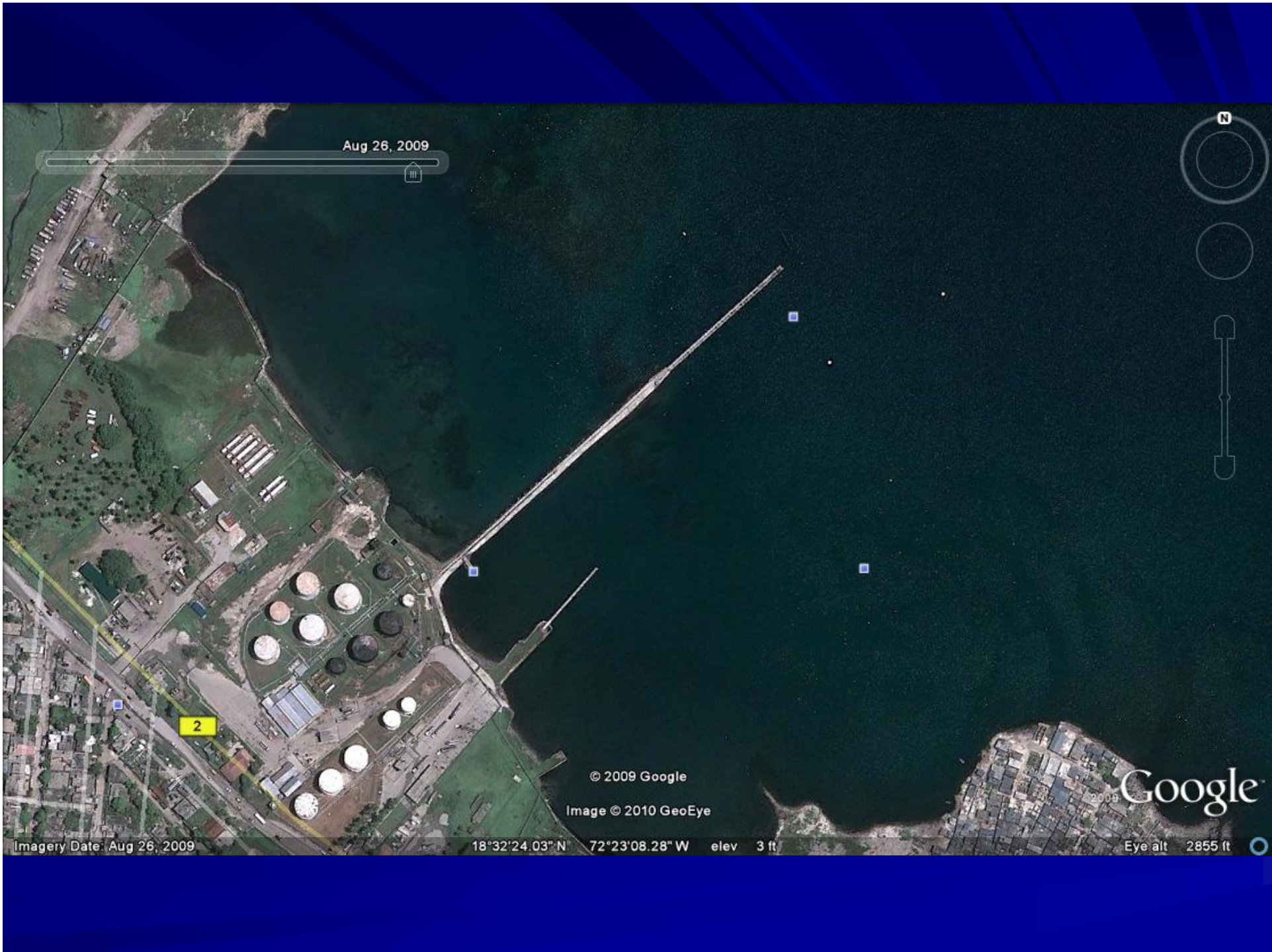






Fuel Port next to Electric Power plants





Aug 26, 2009



N

2

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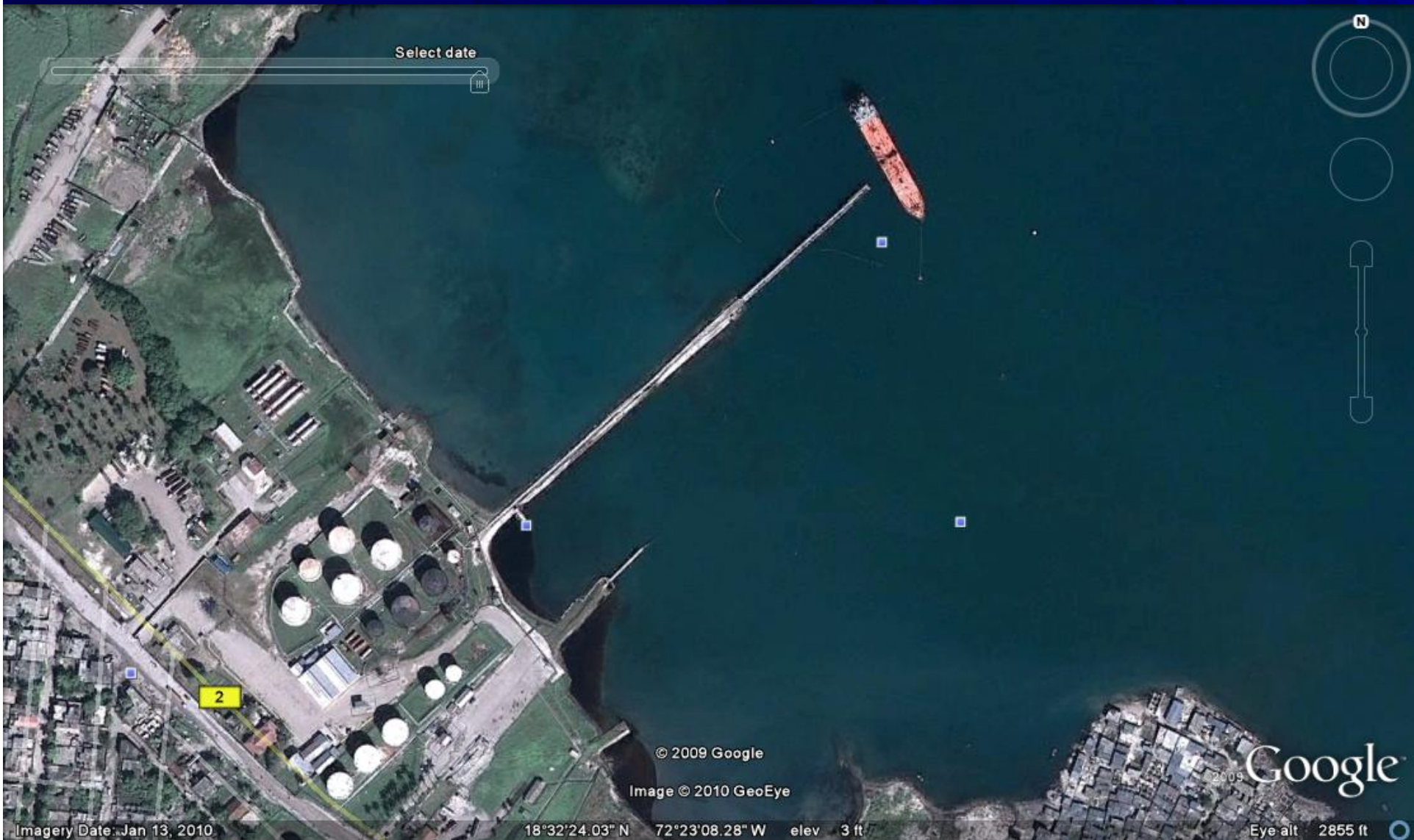
Image © 2010 GeoEye

2009 Google

Imagery Date: Aug 26, 2009

18°32'24.03" N 72°23'08.28" W elev 3 ft

Eye alt 2855 ft



Select date

2

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Image © 2010 GeoEye

Google

Imagery Date: Jan 13, 2010

18°32'24.03" N 72°23'08.28" W elev 3 ft

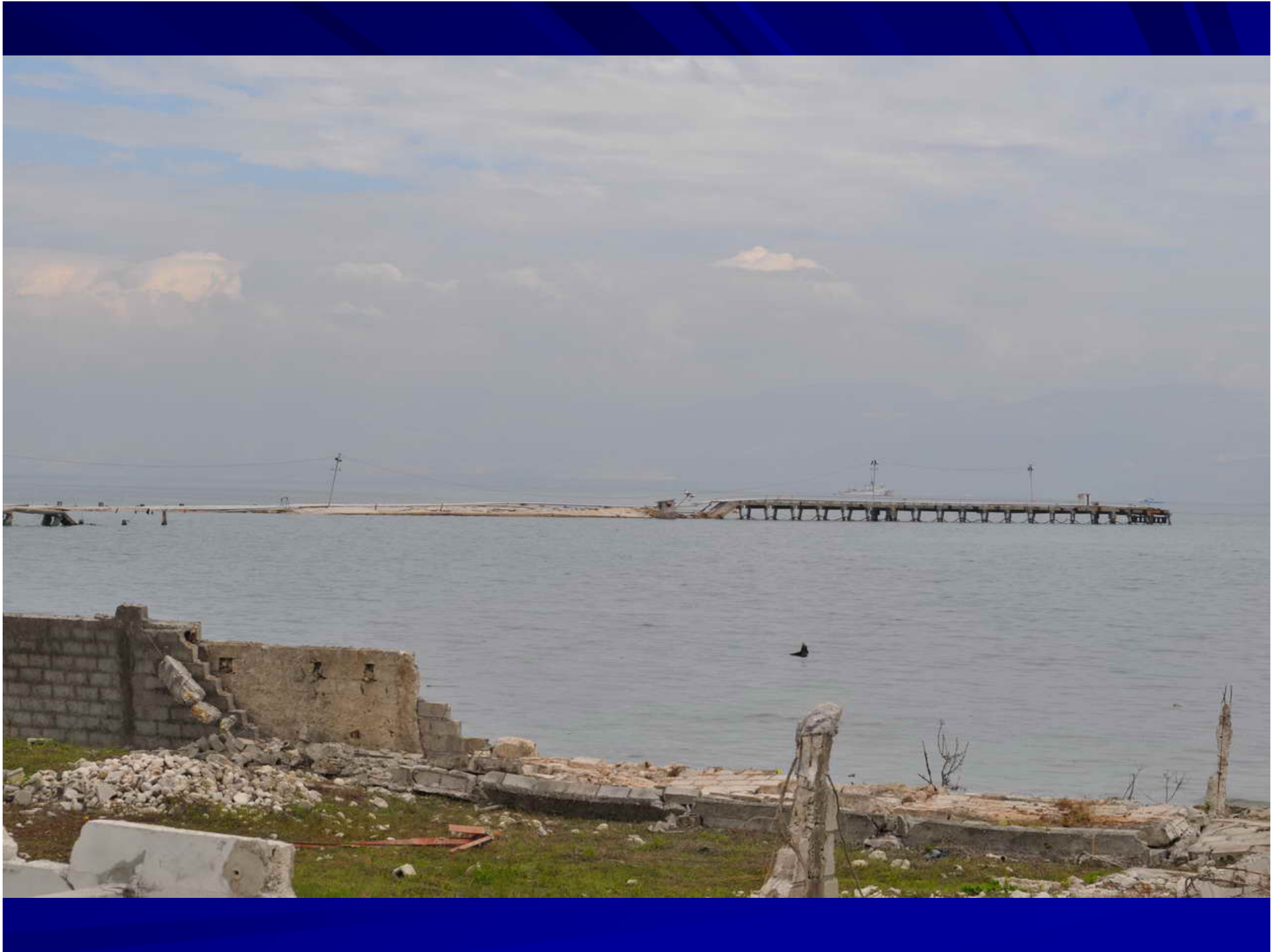
Eye alt 2855 ft











Airport

Navigation controls including back, forward, and zoom buttons. A timeline slider is set to **Apr 12, 2009**, with markers for 2000 and 2010.

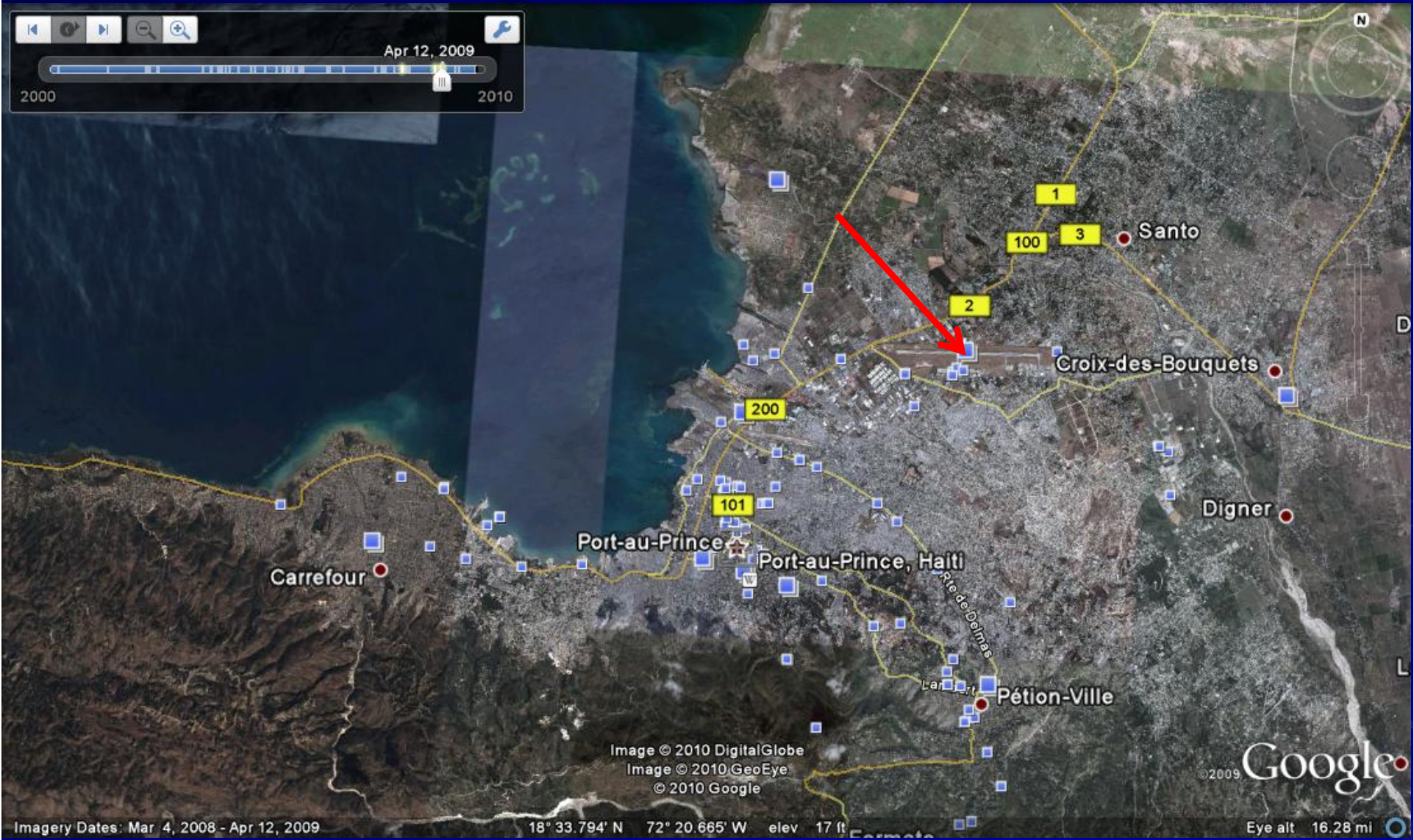


Image © 2010 DigitalGlobe
Image © 2010 GeoEye
© 2010 Google

©2009 Google

Imagery Dates: Mar 4, 2008 - Apr 12, 2009

18° 33.794' N 72° 20.685' W elev 17 ft

Eye alt 16.28 mi









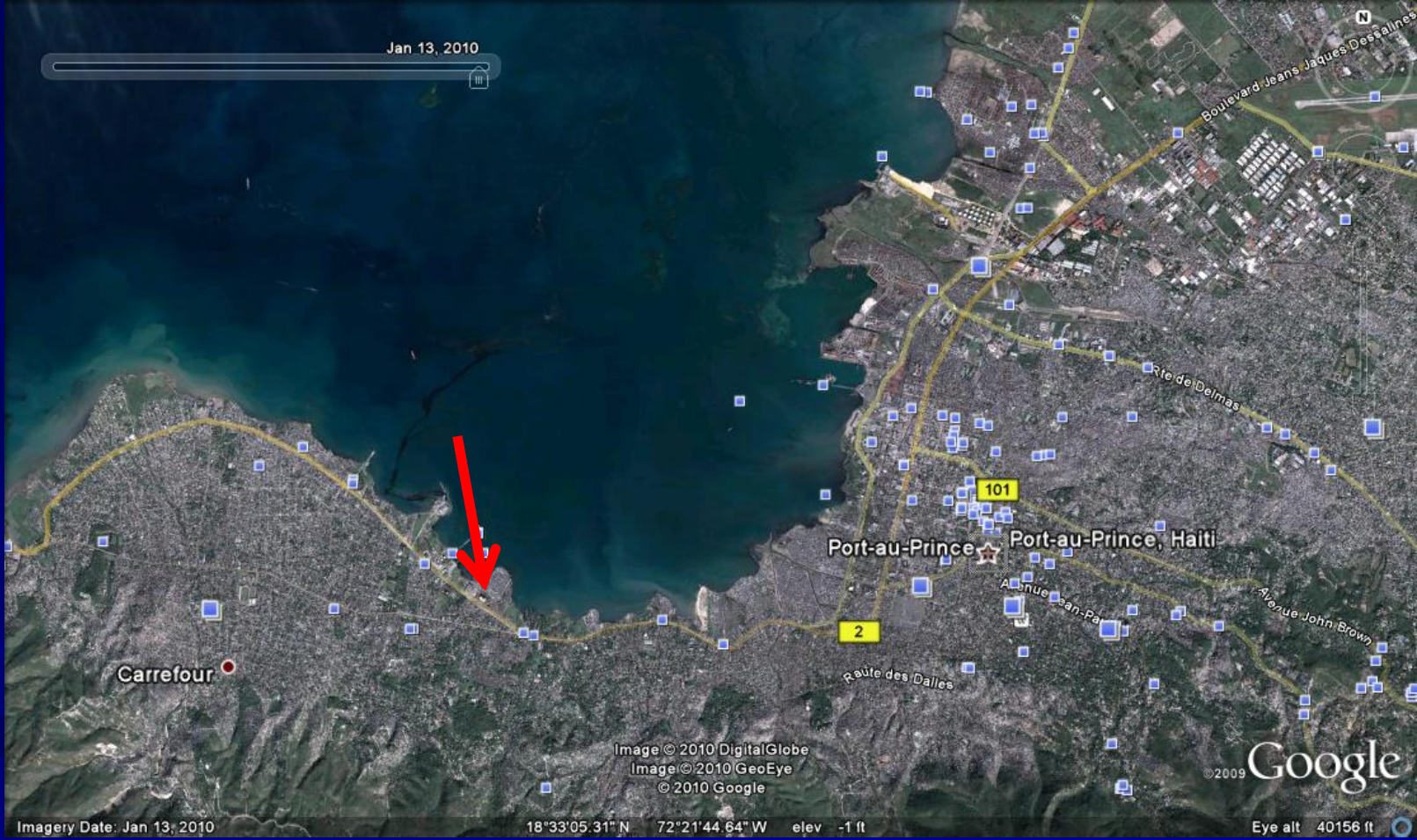




Copa
Airlines



Electric power plant



Jan 13, 2010

Carrefour

Port-au-Prince

Port-au-Prince, Haiti

Google

Imagery Date: Jan 13, 2010

18°33'05.31" N 72°21'44.64" W elev -1 ft

Eye alt 40156 ft



2

Image © 2010 GeoEye
© 2009 Google

©2009 Google

Imagery Date: Jan 13, 2010

18°32'09.64" N 72°23'04.42" W elev 29 ft

Eye alt 2222 ft

















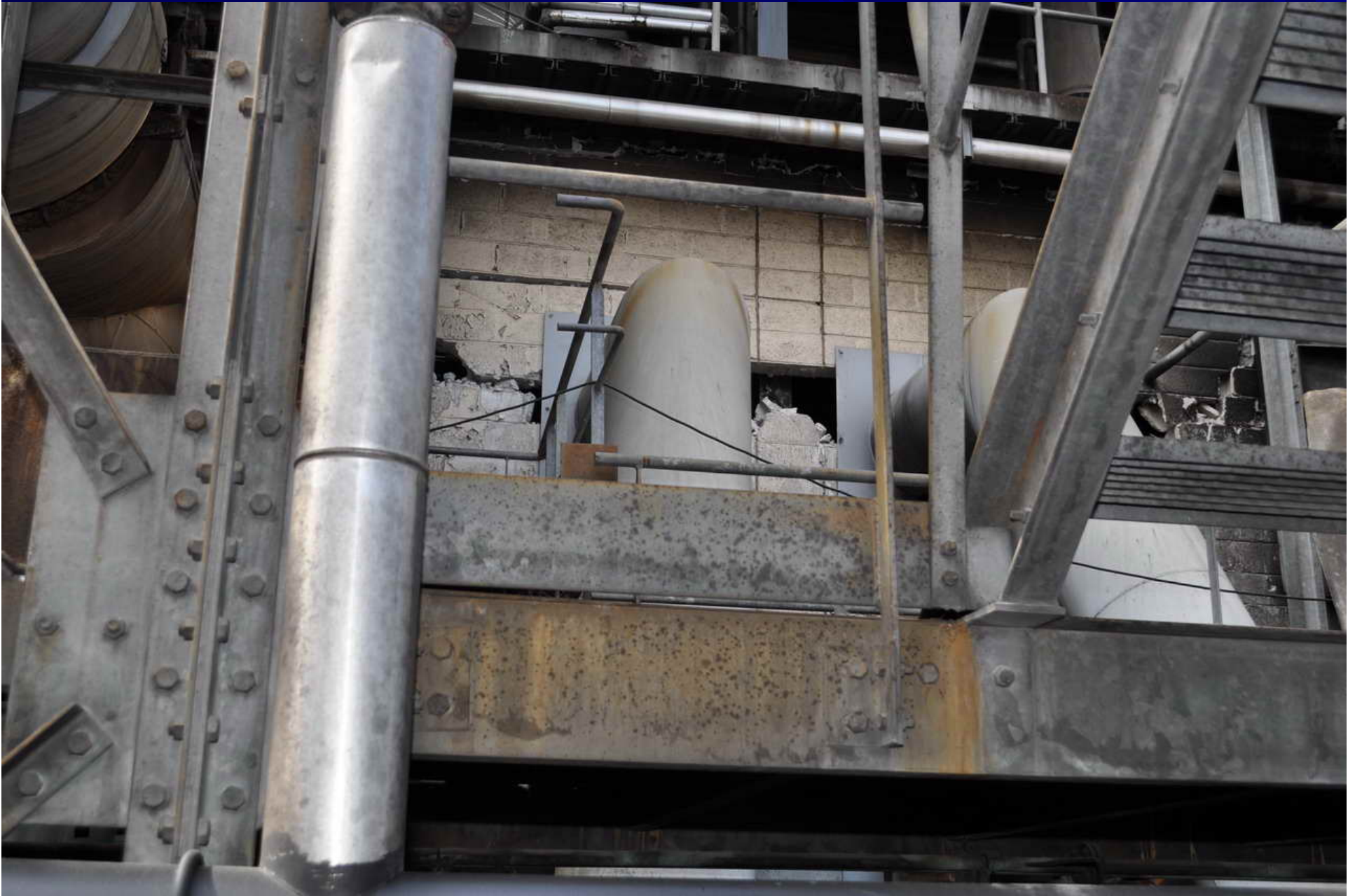












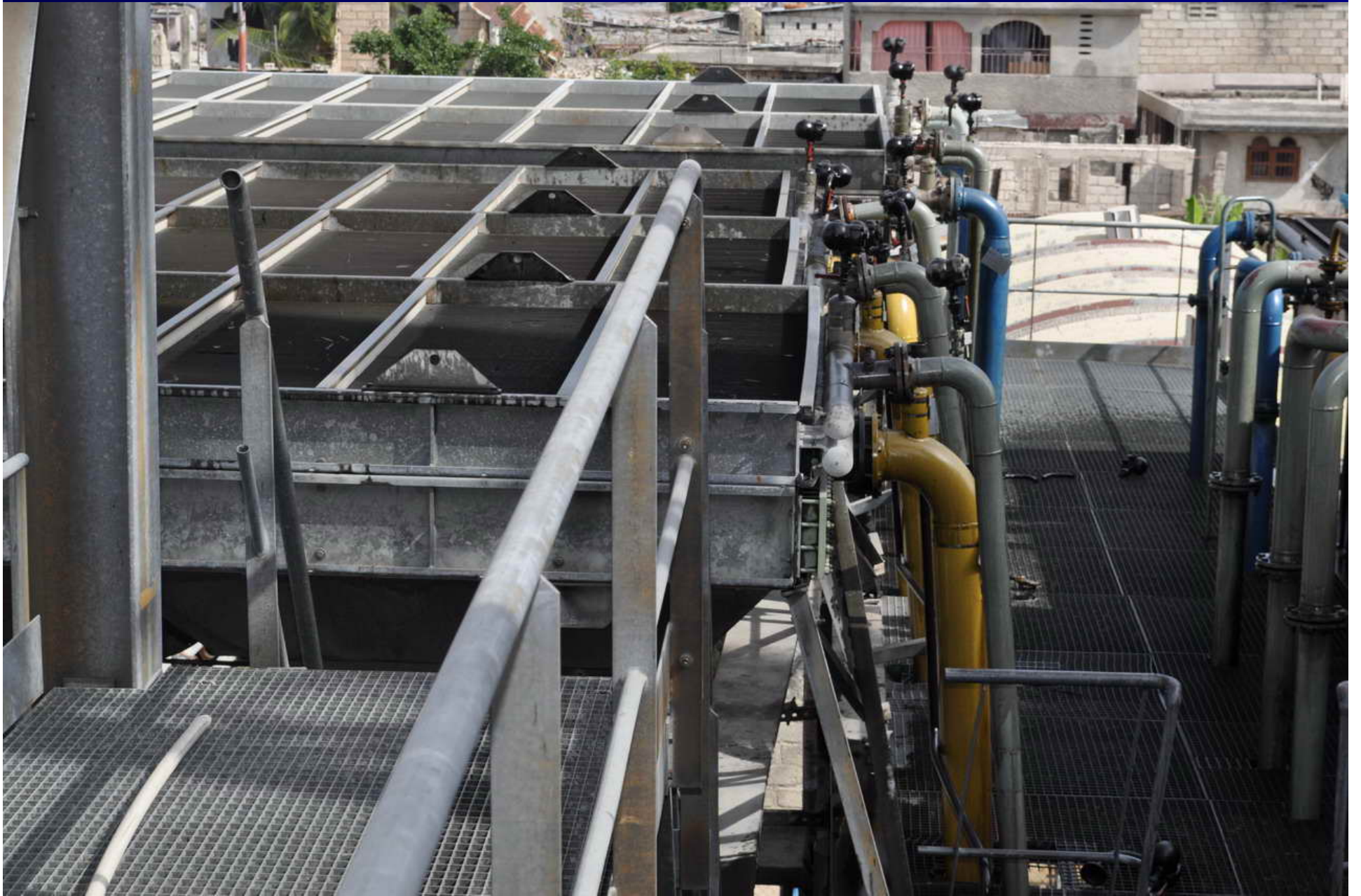


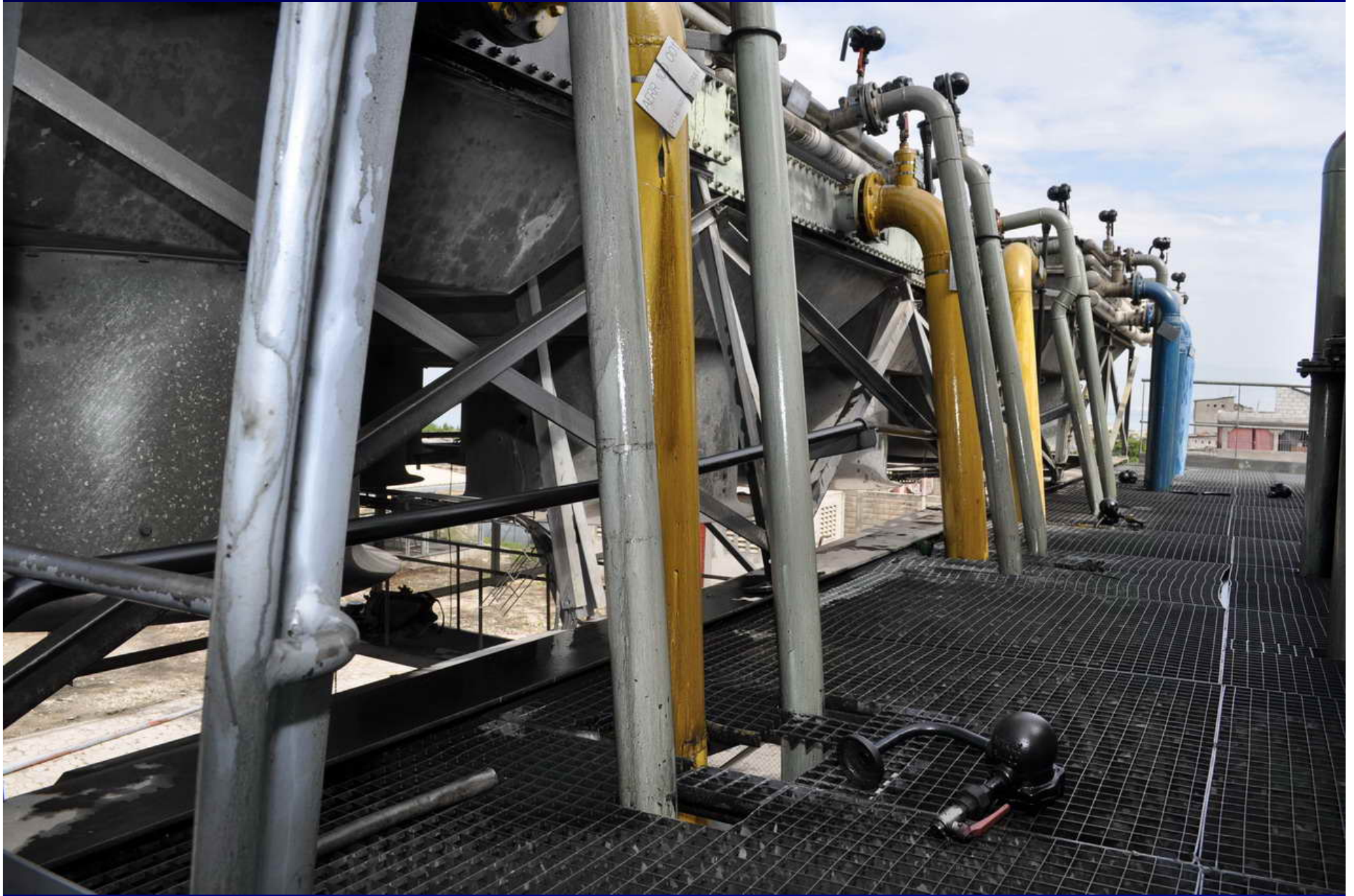


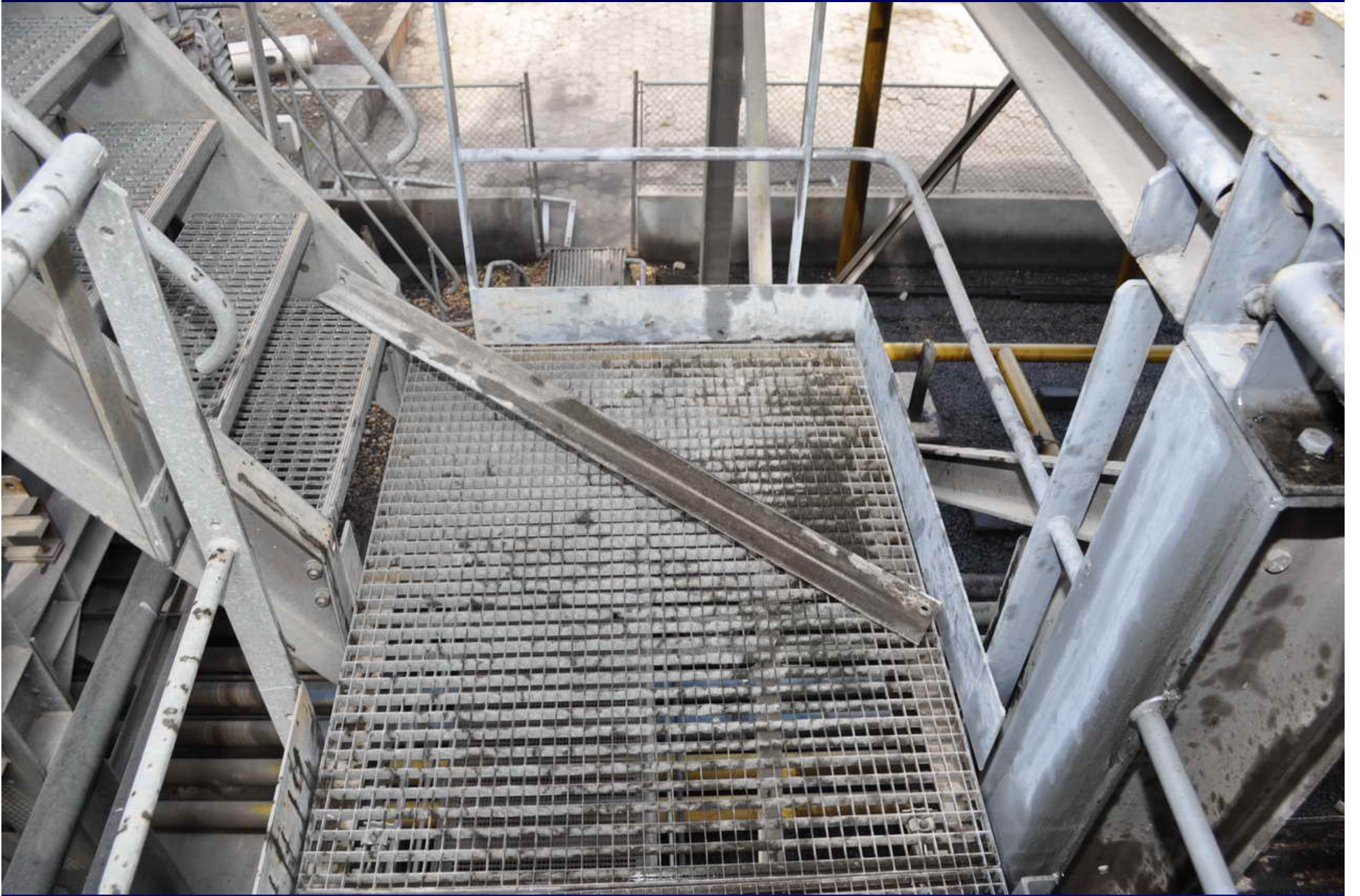






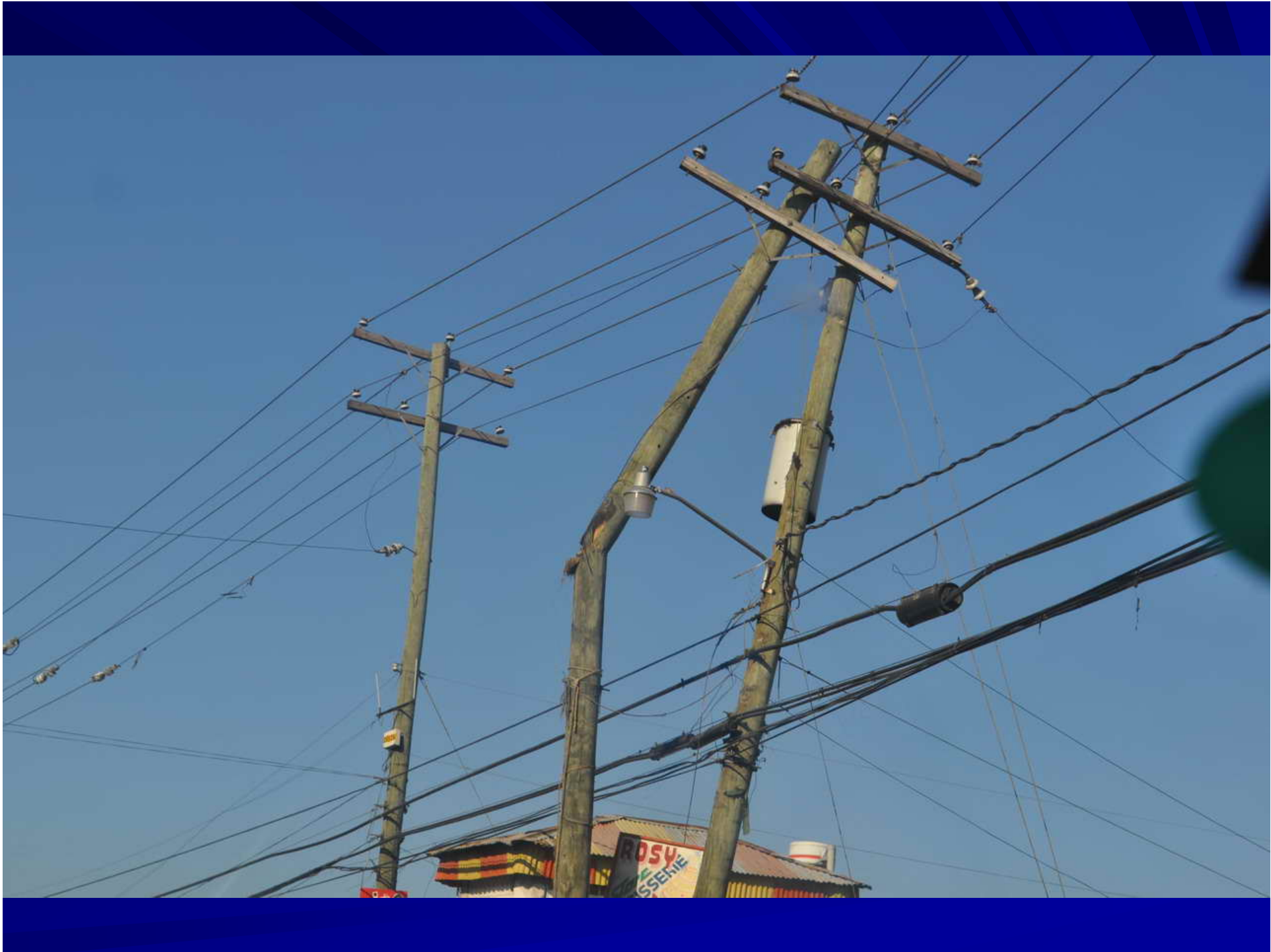




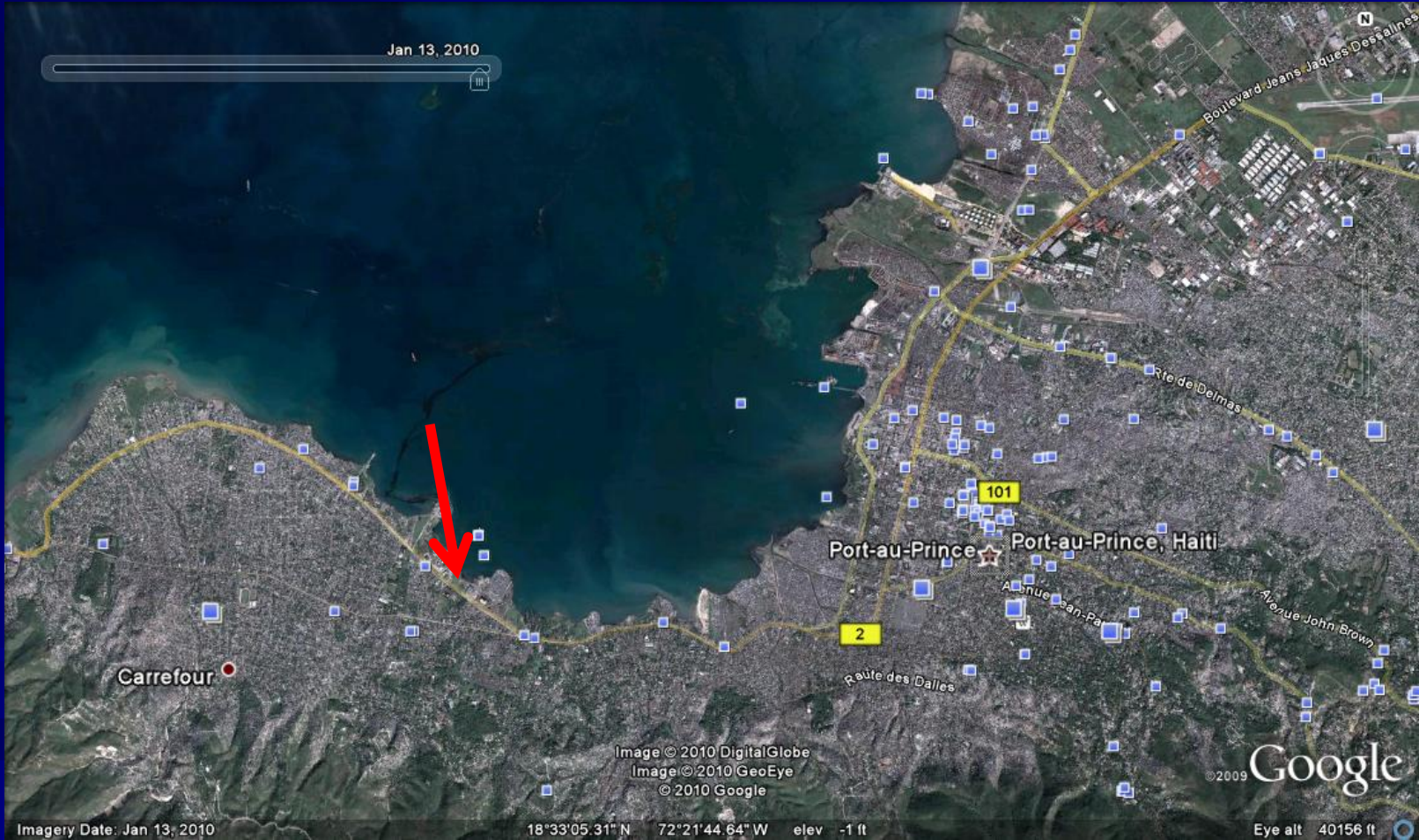








Electric Power Plant Alba





2

Image © 2010 GeoEye
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Imagery Date: Jan 13, 2010

18°32'09.64" N 72°23'04.42" W elev 29 ft

Eye alt 2222 ft











































CAUTION
DANGER TO THE PUBLIC AND TO THE ENVIRONMENT
DO NOT TOUCH OR REMOVE THE COVER
REMOVING COVER MAY BE HAZARDOUS TO LIFE

SUCTION CONNECTION

RETURN CONNECTION

NEMA MOTORS



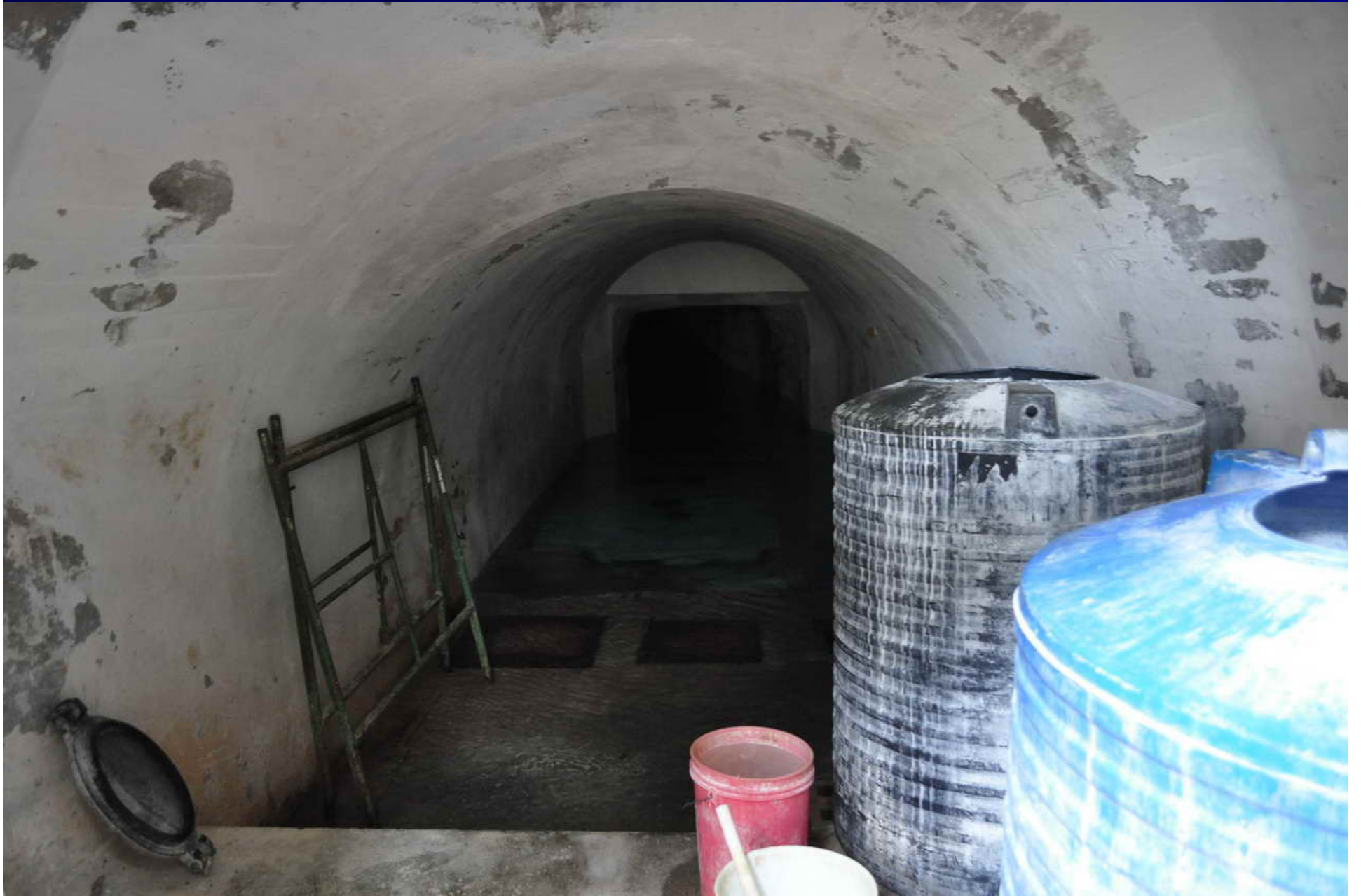








Water Treatment Plant







SYENIS VINCENT
PRESIDENT D'HAÏTI
DEPARTEMENT DES TRAVAUX PUBLICS
J. D. WHITE ENGINEERING CORPORATION
MARS 1940



Water Tank













Fuel Tank Farm





















Steel Factory



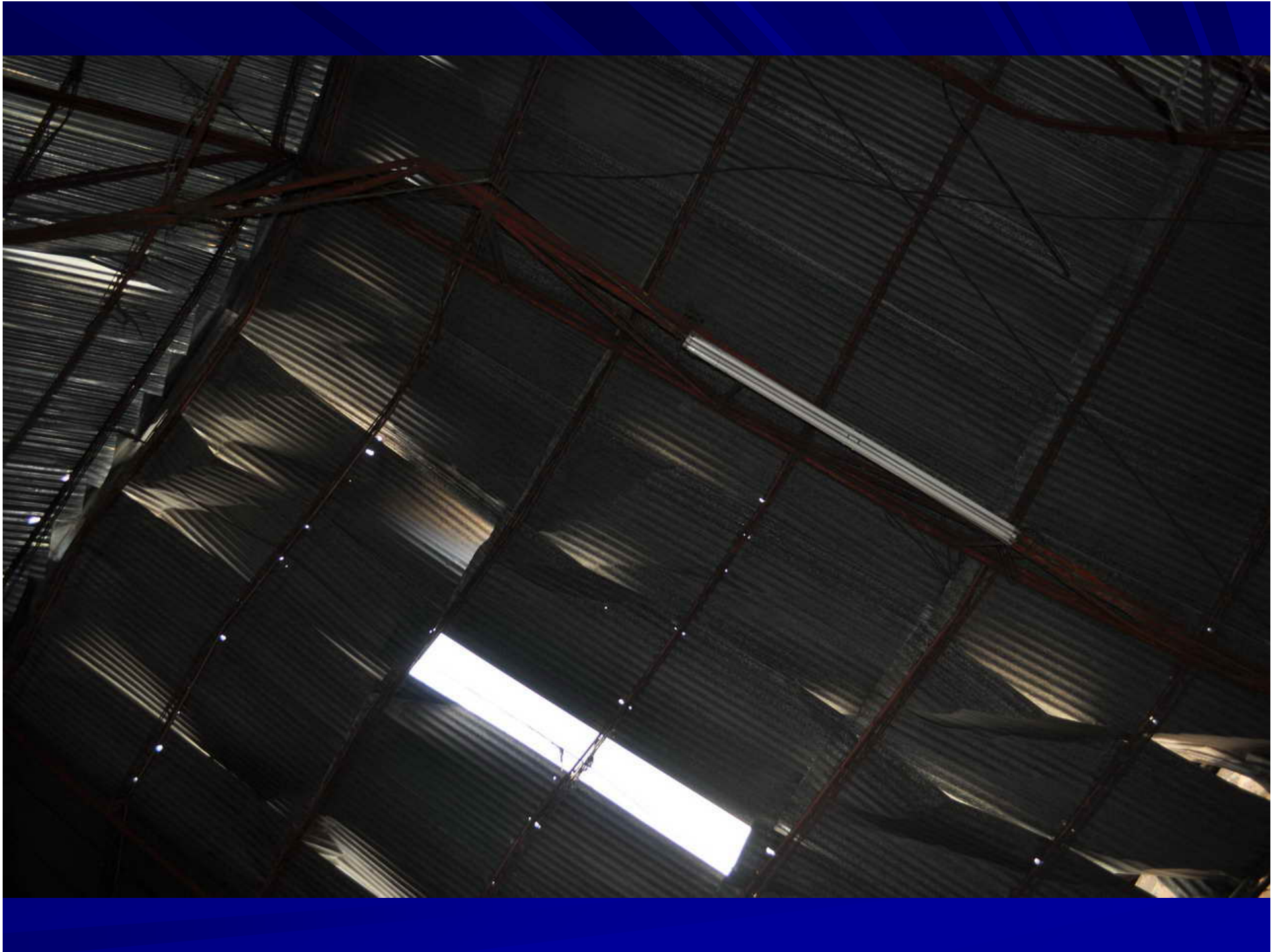








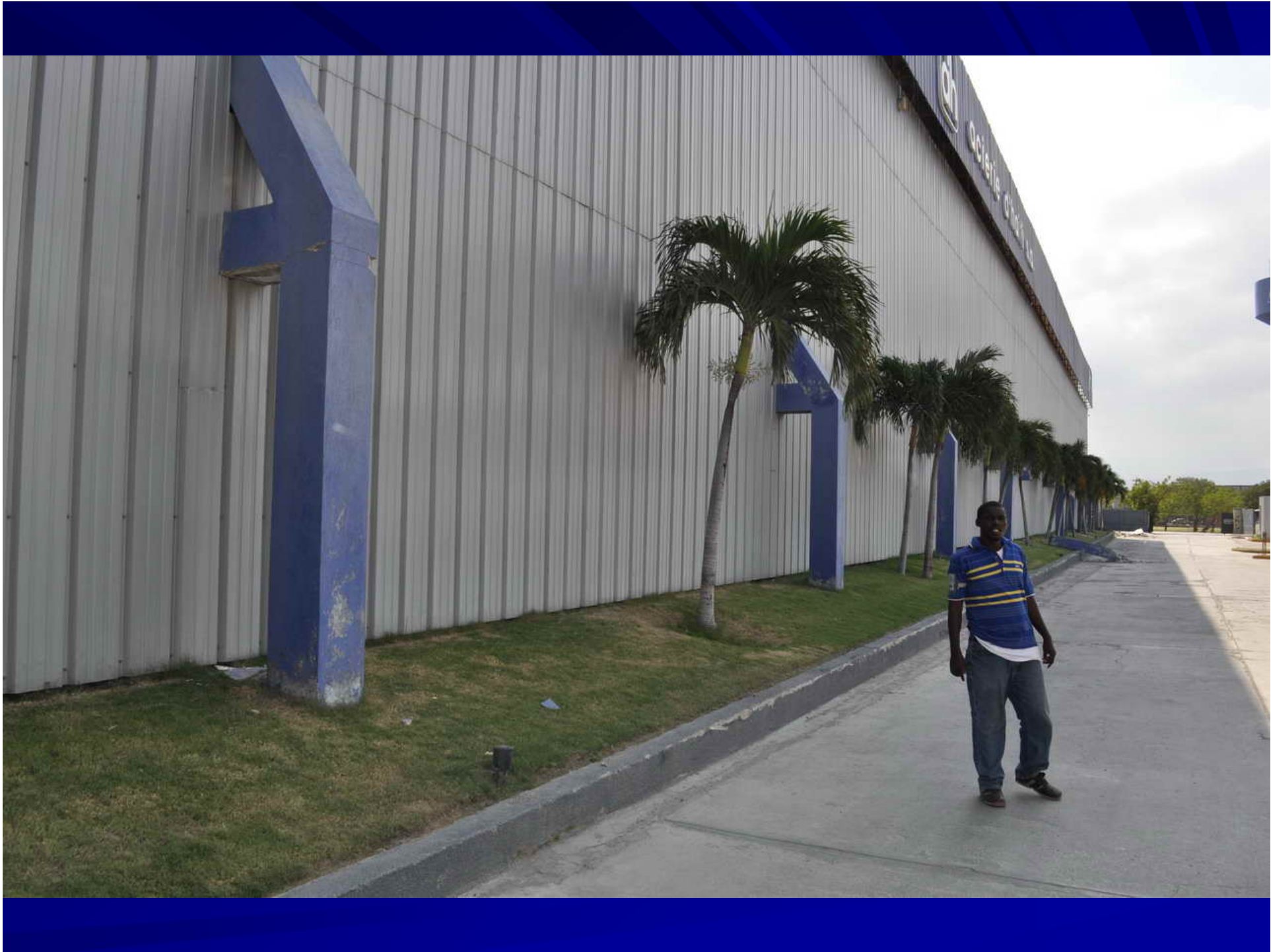


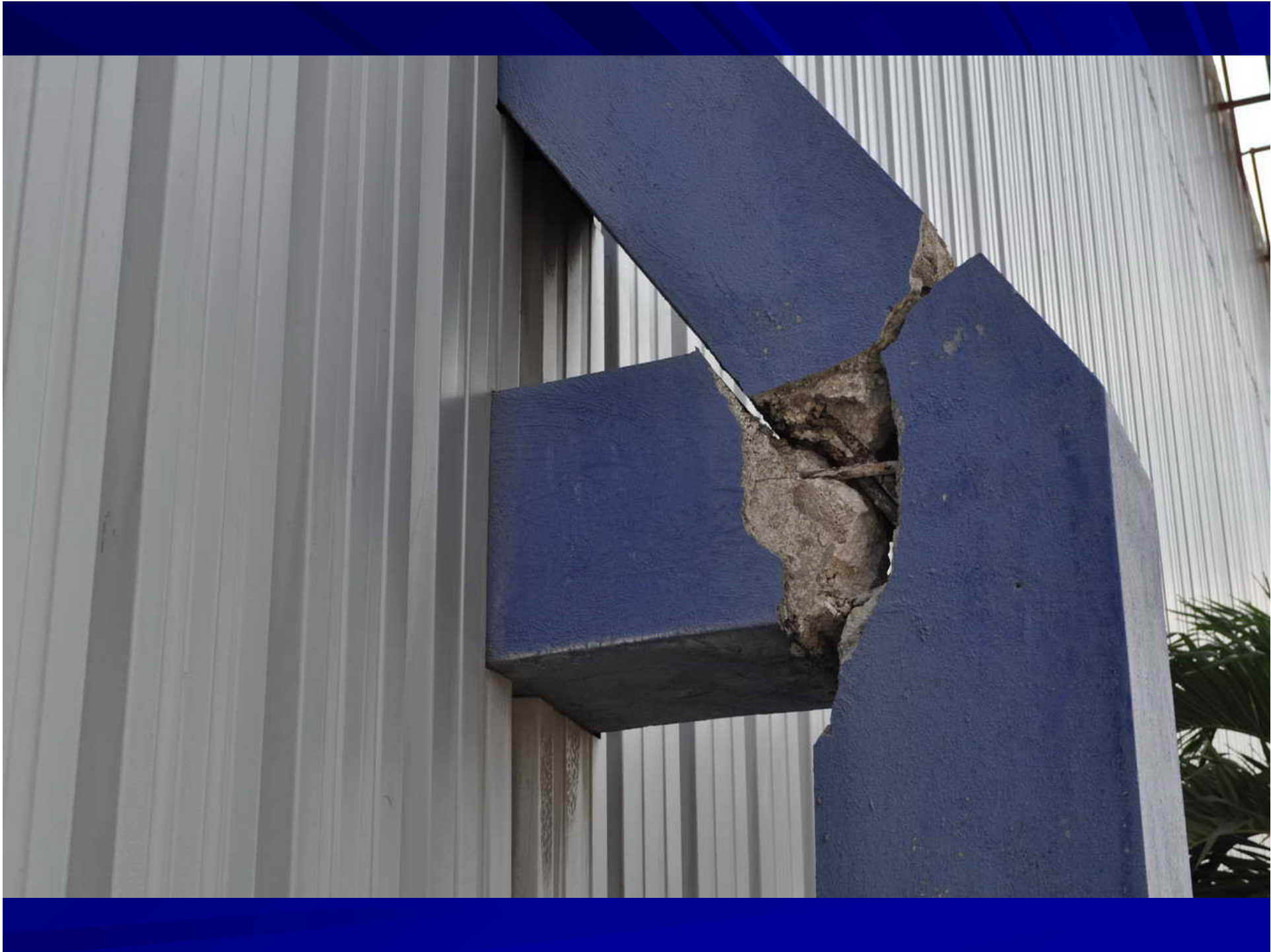




























































Cement Factory



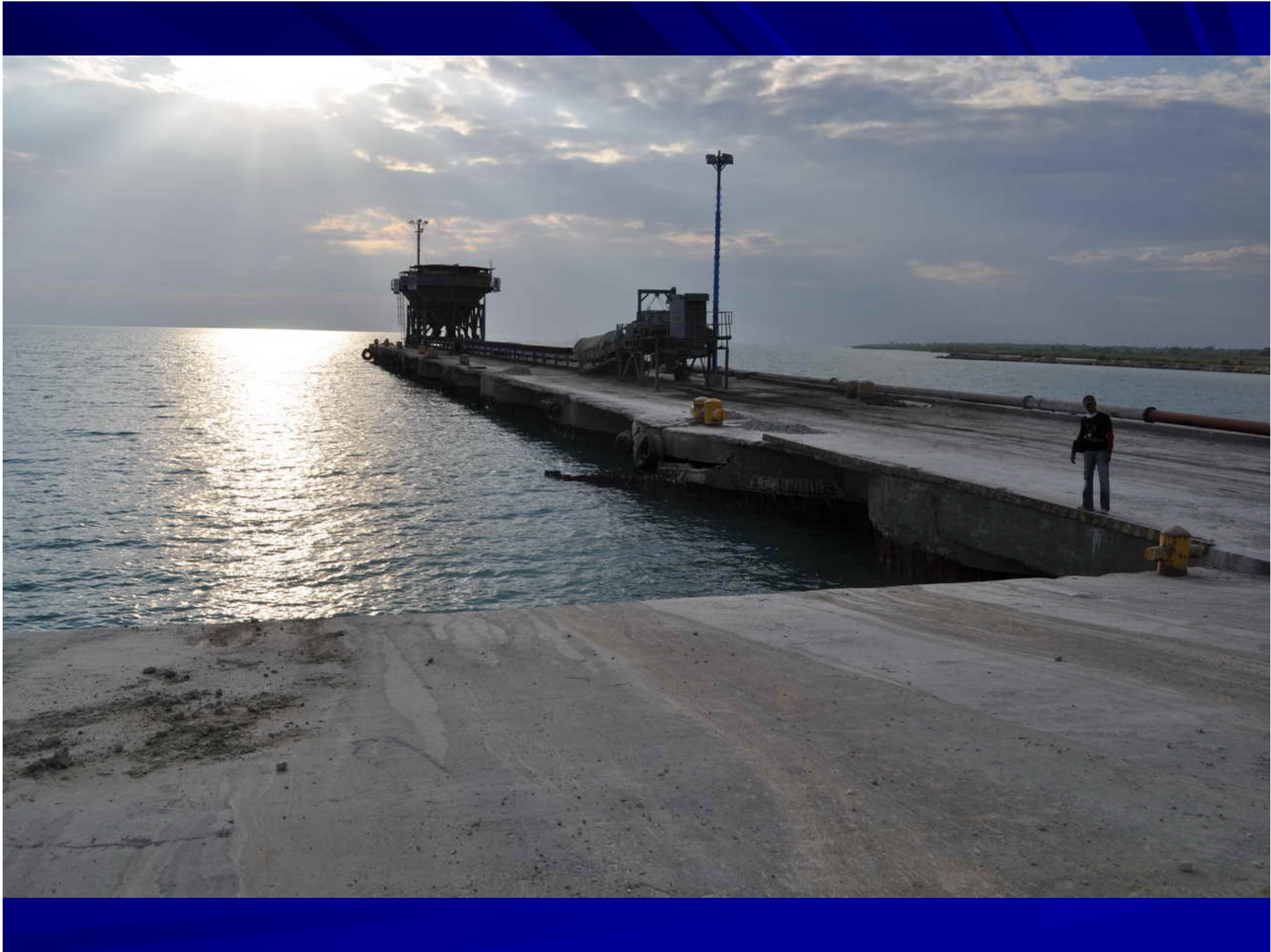
Unit	Area	Area	Area	Area
Unit 100	100	100	100	100
Unit 200	200	200	200	200
Unit 300	300	300	300	300
Unit 400	400	400	400	400
Unit 500	500	500	500	500
Unit 600	600	600	600	600
Unit 700	700	700	700	700
Unit 800	800	800	800	800
Unit 900	900	900	900	900
Unit 1000	1000	1000	1000	1000





































DIESEL
CAPACITY 15000 GIS.
DATE PAINTING NOV 00
IN SERVICE NOV 00
24 PIEDS HAUT

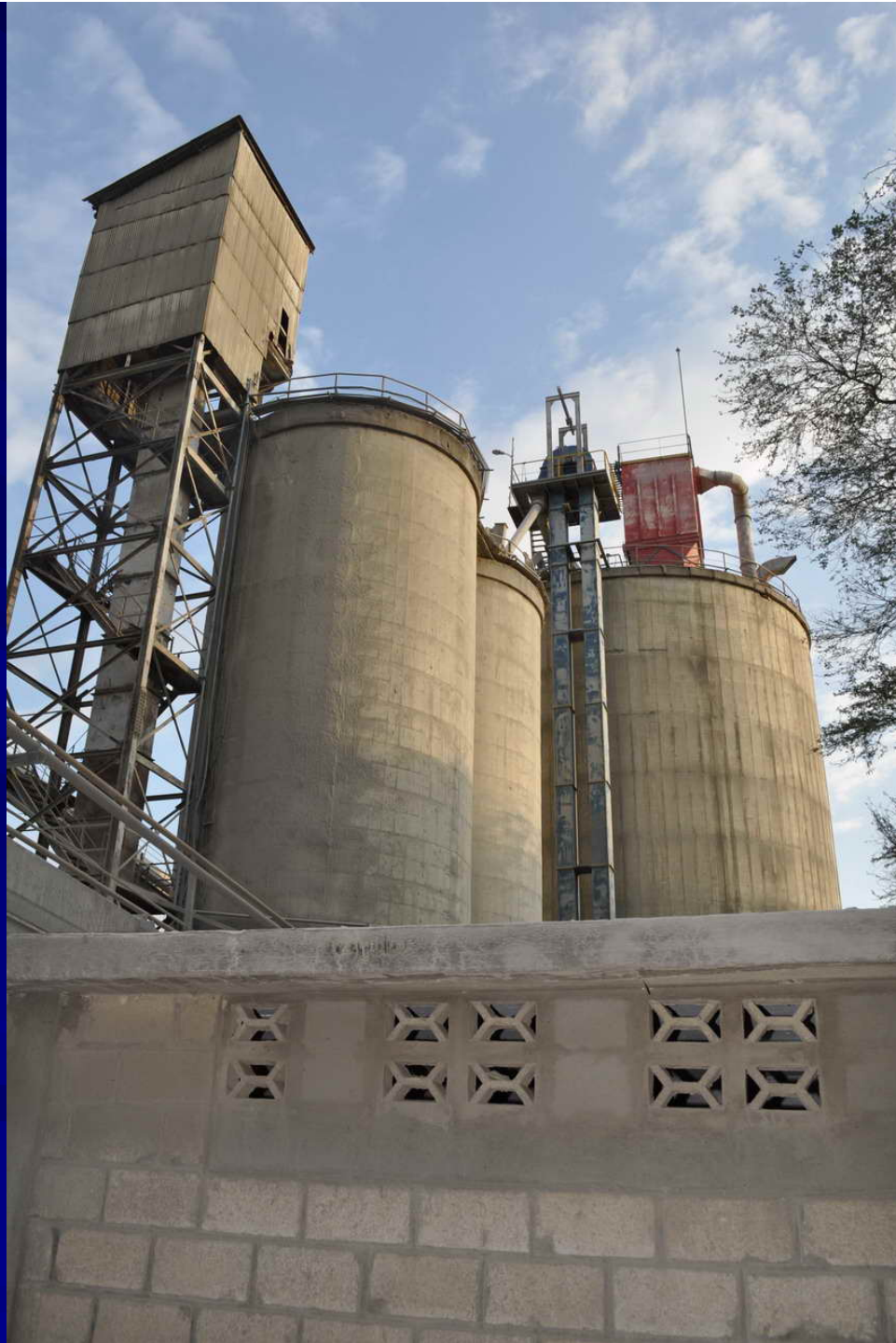






























Bridges





















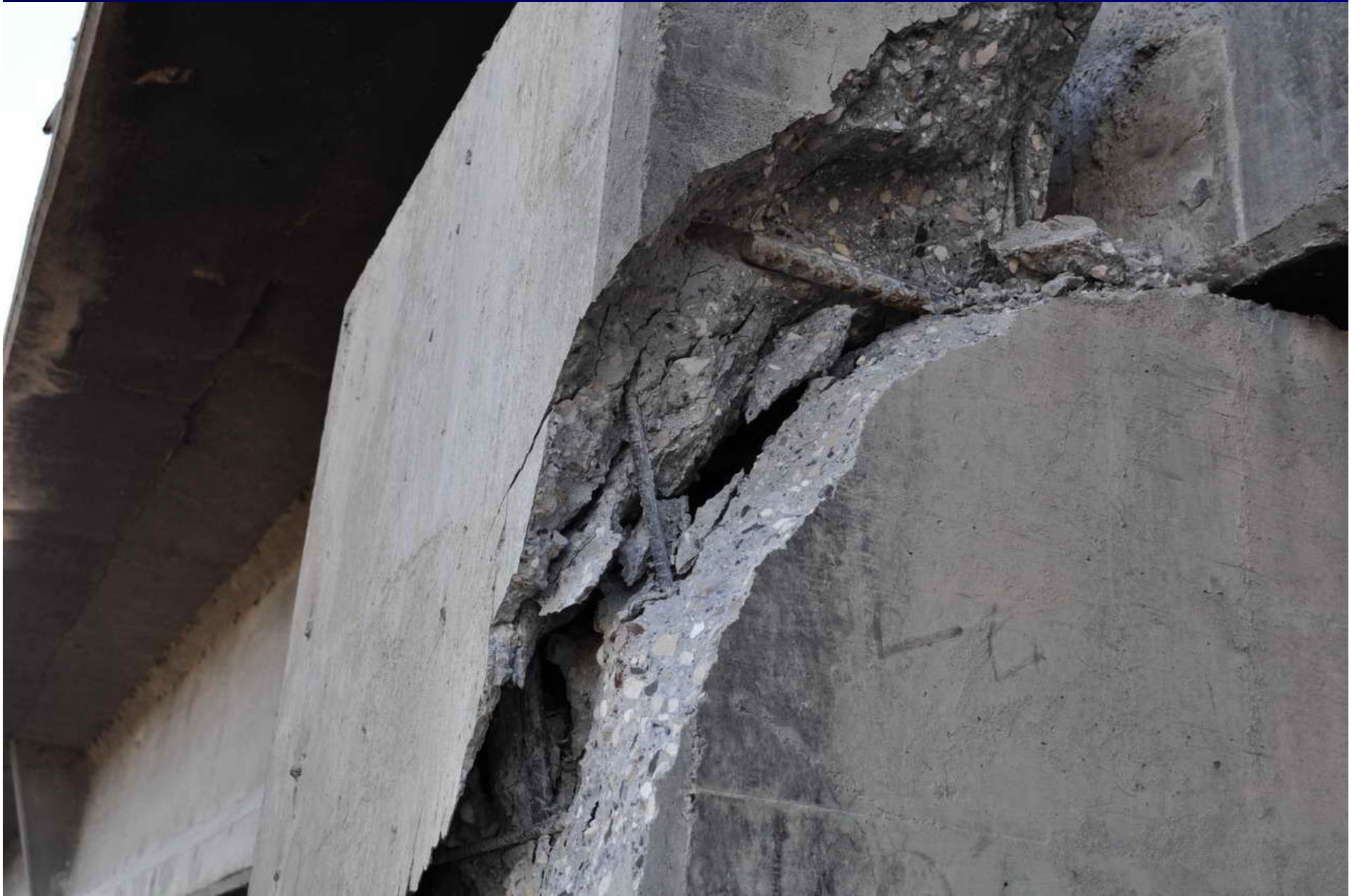


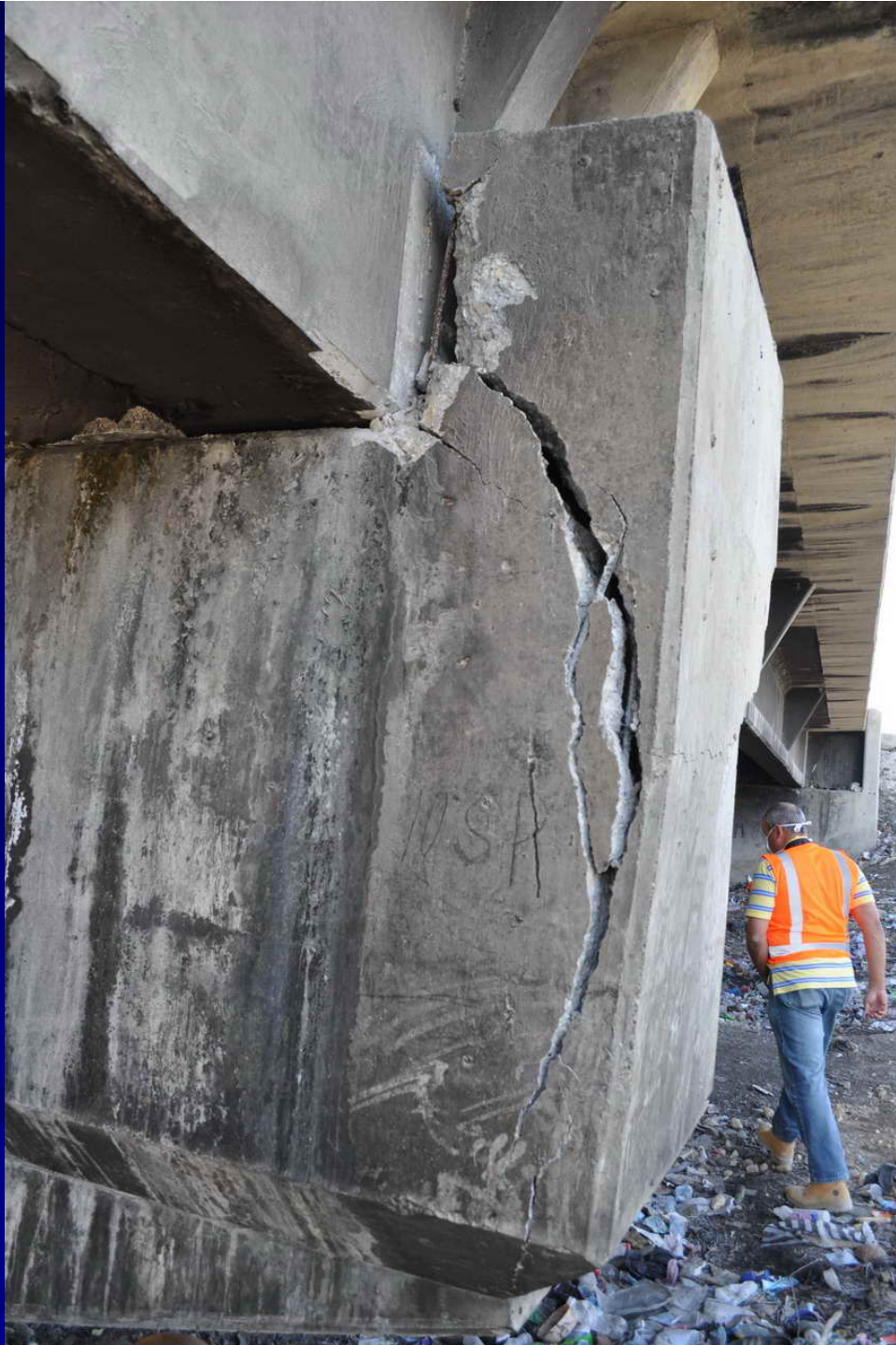


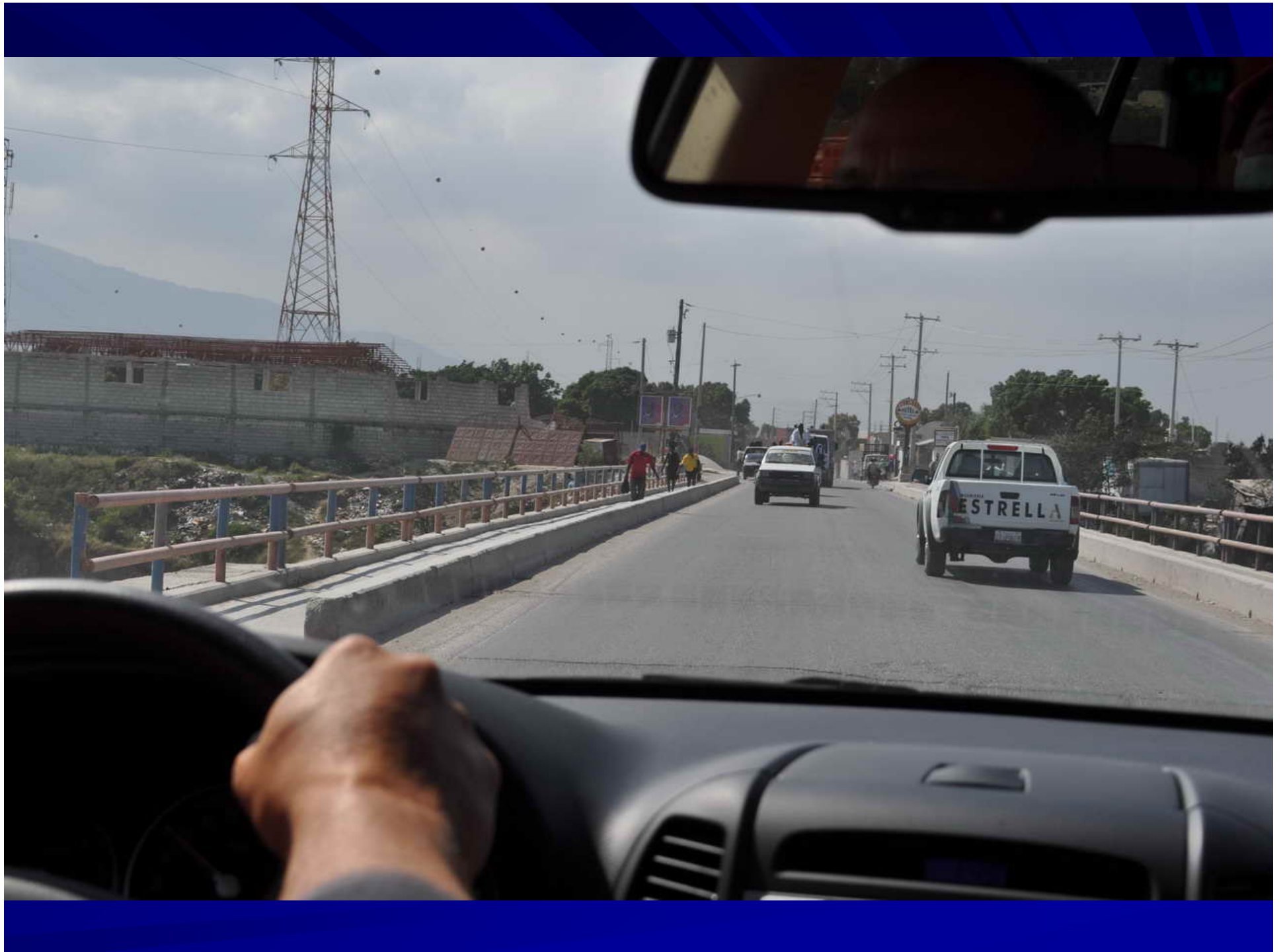








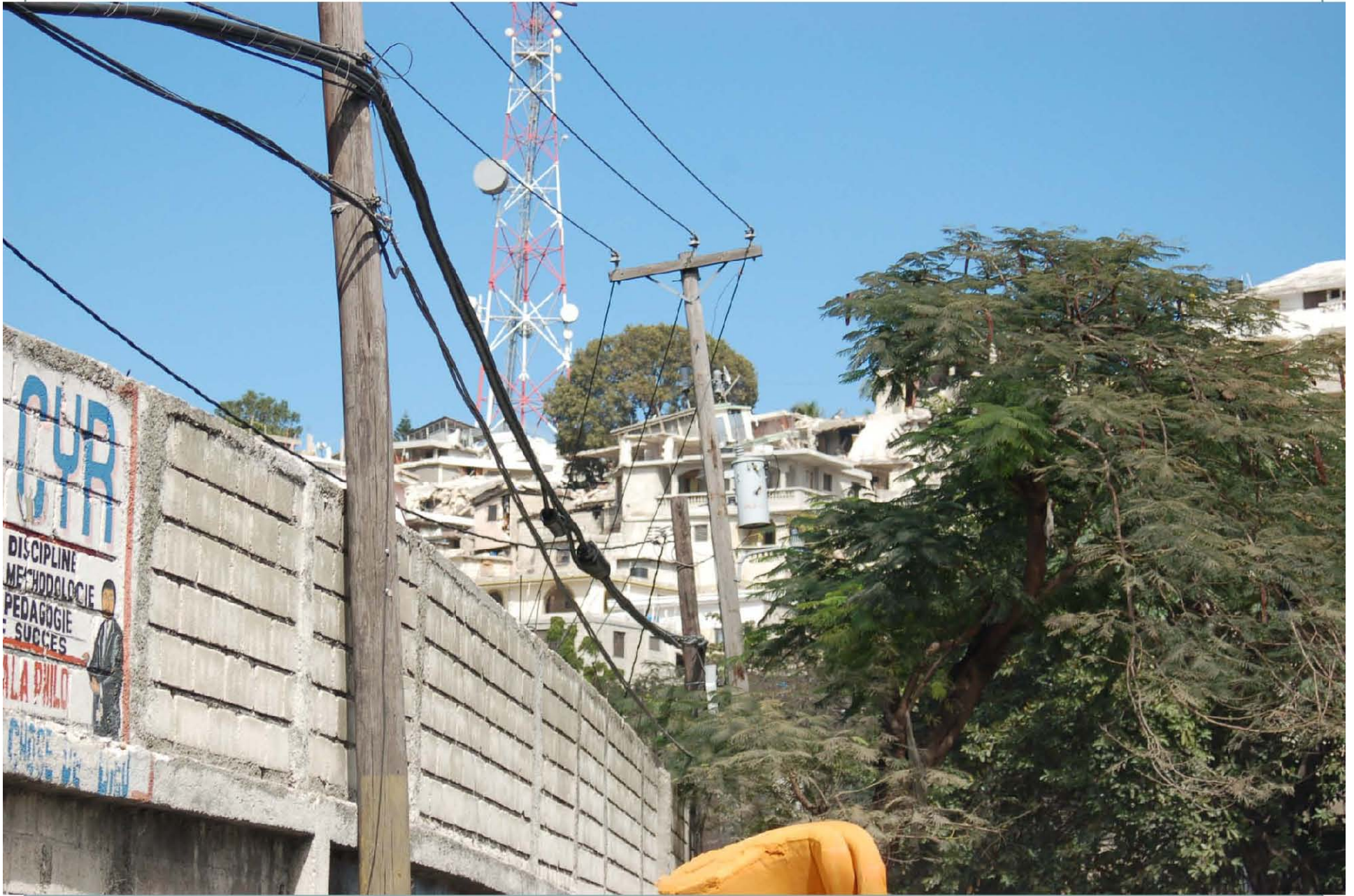




Electrical transmission and communication towers

- Very little damage unless other elements fell on top of them









Light structures

- Mainly canopies for gas station
- One collapsed due to anchorage failure







SE PA'M ! SE PA'M ! SE PA'M !

DIGICEL SE PA'M !

Boucicaut - Demi offensif de la Sélection Nationale

Digicel
De loin, le Meilleur Réseau.

www.digicel.com

The billboard features a central image of a soccer player in a blue and white jersey with 'Digicel' on the front, holding a red ball. Behind him is a large crowd of people in various colors. The background is a solid red color. Three speech bubbles with the text 'SE PA'M !' are positioned at the top. The Digicel logo and slogan are in the bottom right corner, and the website URL is in the bottom left.

ID
FDPlus











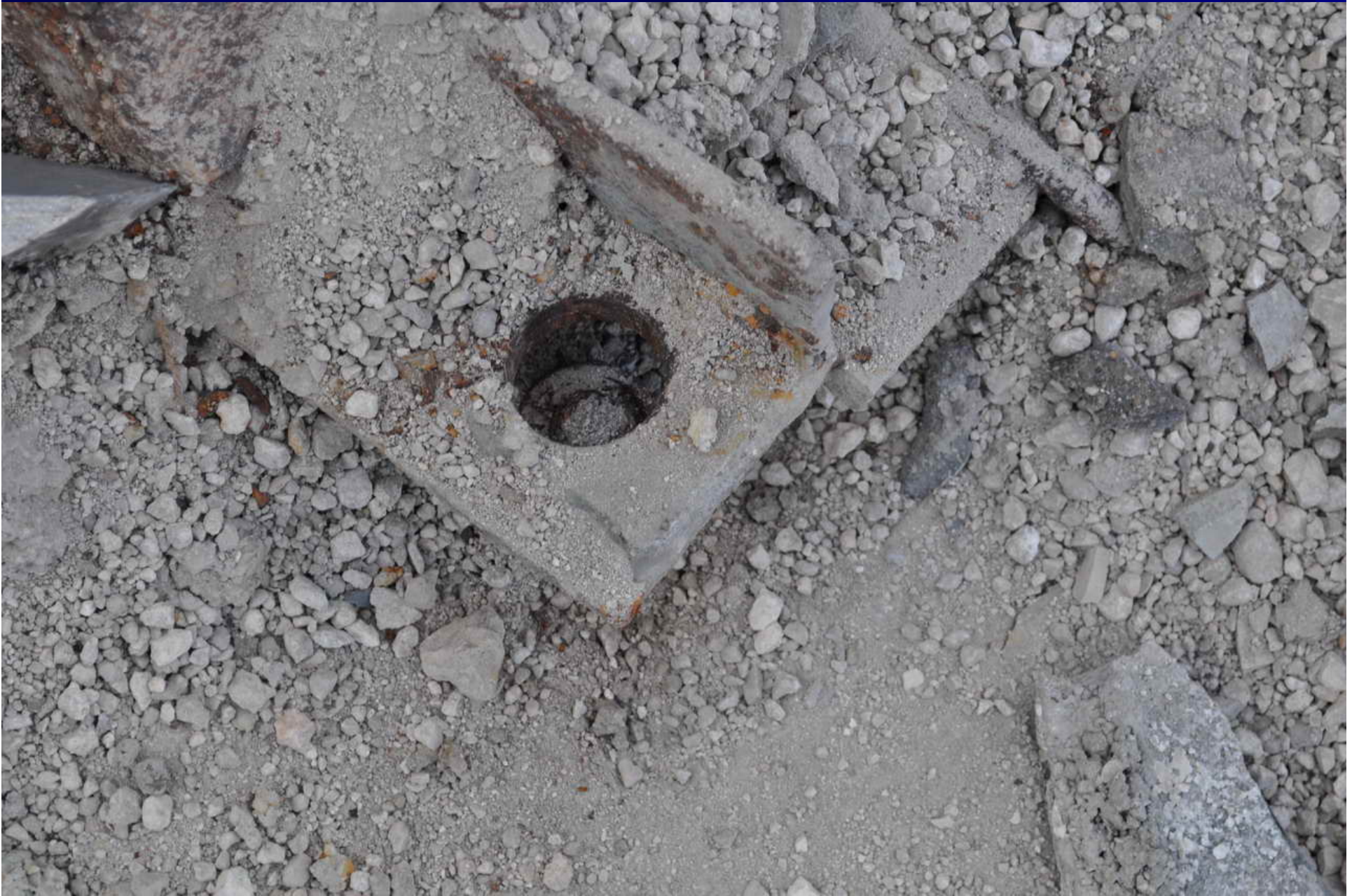




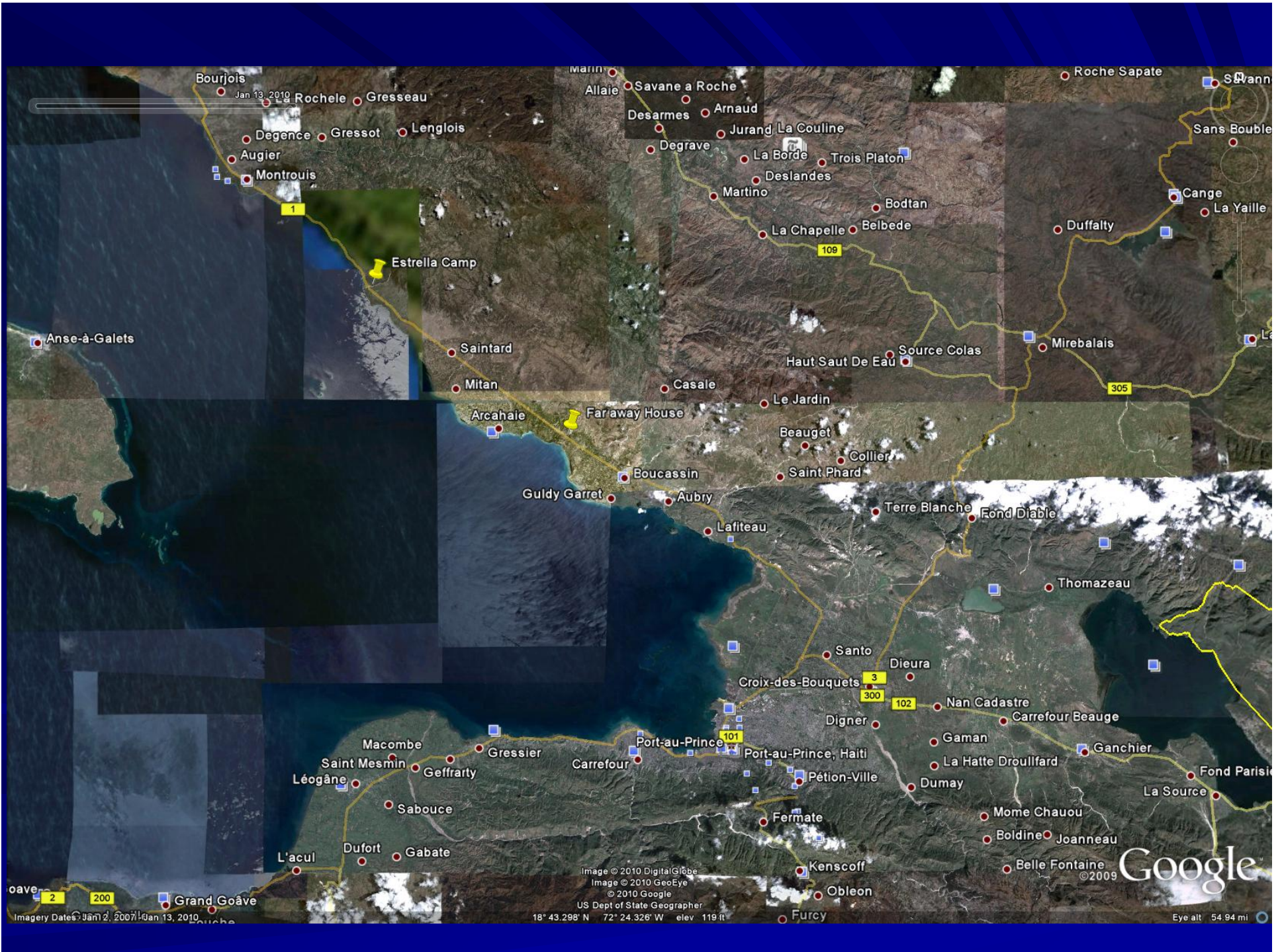








Away from Epicenter











Reconstruction







Conclusion

- The tall structures with long period suffered little damage, hinting to low values of spectral acceleration in the long period range
- It appear that there was an amplification of the accelerations due to soft soils in Port au Prince, some pocket of no damage
- Clear evidence of directivity west of the epicenter

Conclusion

- Maximum acceleration higher than 0.3 g estimated by USGS probably 0.4 to 0.5g
- Quality of construction and detailing very poor with very brittle structure. Very poor detail in the plastic hinge regions and in the joints
- Prevalent use of heavy unreinforced block walls
- Reconstruction with same detailing happening now

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